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

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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.

INTRODUCTION

Knowledge of the fecundity of a species is an important factor in fish stock management. The fecundity-size relationship has been used principally as a rapid means of predicting the fecundity of fish stocks when the length distribution is known (Dulcic *et al.*, 1998). Variations seen from year to year, and over decades, reflect the amelioration or deterioration of the habitat in relation to the individual fish (Nikolskii, 1969).

Pagellus acarne is a widespread species in Africa, Europe, the Mediterranean and Black Sea and very frequent on the western Algerian coast (Fig. 1). It is often caught at depths ranging from 350 to 500 m (Fischer *et al.*, 1987), by trawl or trammel net, fishing techniques very used in this region (Lalamy, 1979; Kadari, 1984).

Studies on *P. acarne* focused on its reproductive biology, growth, age, population dynamics (Arculeo *et al.*, 2000; Domingez, 2000; Pajuelo & Lorenzo, 2000; Neves Santos *et al.*, 1995; Coelho *et al.*, 2005; El Oumari *et al.*, 2011) but few data are available on its fecundity; Alboran sea, Atlantic (Velasco *et al.*, 2011), Atlantic (Mauritanian and Moroccan coasts) (Le Trong-Phan & Kompowsky, 1972; Lamrini, 1986). Also no data are available for that species in Algerian waters. This paper presents the first results on the total potential annual fecundity (Considered as the total number of developing oocytes potentially capable of being released in the current spawning season) of seabream from Oran bay in relation to total length, total weight and gonad weight.

MATERIALS AND METHODS

Samples of *P. acarne*, $n=892$; 272 males (29.92%); 347 females (38.17%); 208 indetermined (22.88%) and 65 hermaphrodites (7.15%) were caught by trawlers between April 2007 and July 2008 and only 22 mature females (stages III and IV) were taken for fecundity estimation. The sex of individuals was determined macroscopically after opening the abdominal cavity and stages of maturity were classified as follows (Holden & Raitt, 1974): I, immature; II, resting; III, ripe; IV, ripe and running; V, spent. Total length (L_t) was measured to the nearest mm, total weight (W_t) to the nearest g and gonad weight (W_g) to the nearest 0.01 g.

For fecundity estimates, the volumetric method was employed, ovaries were labeled and dropped in Gilson's fluid, a preservative and dissociative solution (100 ml 60% alcohol, 800 ml water, 15 ml 80% nitric acid, 18 ml glacial acetic acid, 20 g mercuric chloride) (Stéquert & Ramcharrun, 1995). The ovaries were shaken periodically to help loosen the ovarian tissue and ensure rapid penetration of the preservative. After 48 hours in preservative, the eggs can be completely liberated from the tissues by vigorous shaking (Holden & Raitt, 1974). Eggs were cleaned and put in a measuring cylinder and made up to a known volume with water.

Subsamples were then taken by shaking the container until all the eggs are evenly distributed through the water; a subsample of known volume was picked-up with a Stempel pipette (Holden & Raitt, 1974), and the number of eggs in

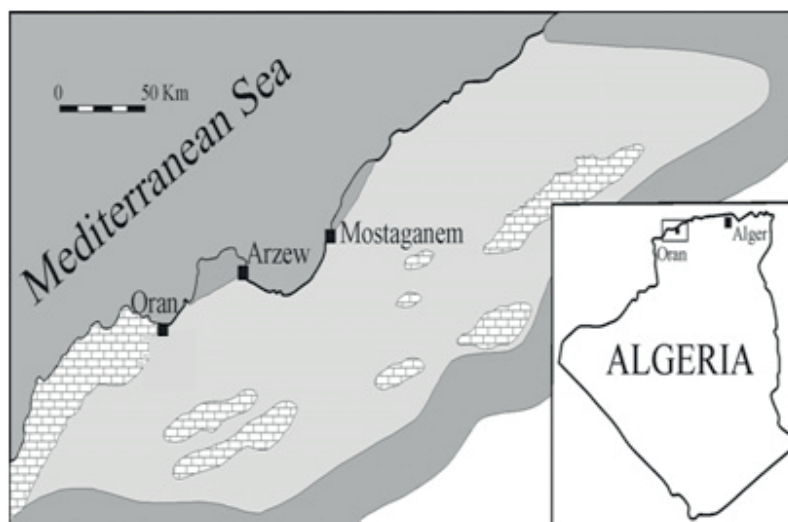


Figure 1: Sampling zone

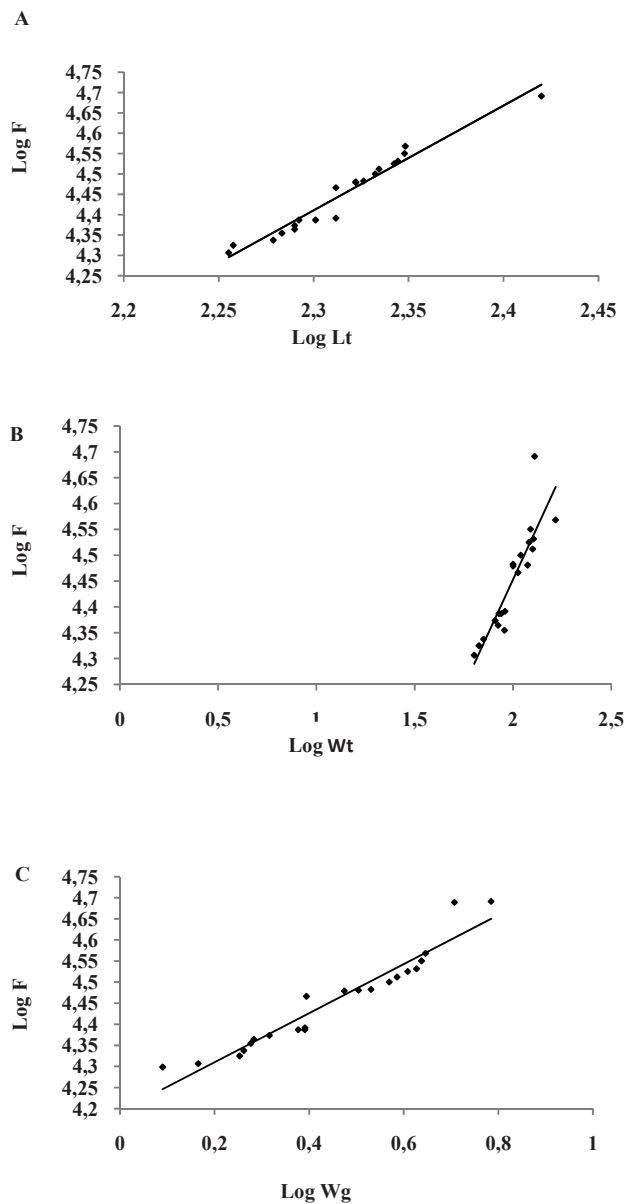


Figure2:
Relationship of total fecundity (F) to: A, total length (Lt); B, total weight (Wt); and C, gonad weight (Wg) of *P.acarne* females fished in Oran Bay.

the subsample was counted with a Dollphus box under a binocular microscope (Gx16). Only oocytes with diameter between 300 and 800 μ m were considered as mature.

22 females were taken for fecundity (F) estimation. The degree of association between F with total length (L_t), total weight (W_t) and gonad weight (W_g) was assessed by the coefficient of determination (r^2); statistical significance level was estimated with a one-way analysis of the variance (ANOVA) using STATISTICA 6.0[®] software.

We used the multiplicative regression model ($y = ax^b$) modified with the logarithmic function then measures were log-transformed in order to eliminate any effect of 'scale', to keep relations linear and their variances comparable. The equation can be expressed as:

$$\text{Log } F = b \text{ Log } X + \text{Log } a, \text{ where } X \text{ is } L_t, W_t \text{ or } W_g$$

a is the intercept of the regression and **b** is the regression coefficient.

Table 1:
Relation between absolute fecundity (F), total length (Lt), total weight (Wt) and gonad weight (Wg) of *Pagellus acarne* fished in Oran bay (Algeria).

Relationship	Equation	r ²
F vs Lt	Log F = 2.575 Log Lt - 1.514 F=0.0306 Lt ^{2.575}	0.955*
F vs Wt	Log F = 0.742 Log Wt + 2.959 F = 909.91 Wt ^{0.742}	0.905*
F vs Wg	Log F = 0.582 Log Wt + 4.193 F = 0.622 Wt ^{0.582}	0.925*

*: significant relationship (ANOVA: P < 0.01).

RESULTS AND DISCUSSION

The 22 individuals sampled ranged from 169 to 263 mm Lt (206.62±19.93); from 63.5 to 234.2 g Wt (109.98±37.57) and from 1.23 to 6.09 g Wg (3.06±1.2). Potential fecundity (F) ranged from 19875 to 49125 (29448.86 ± 8198.12) this important value of SD can be explained by the biometric variation of the specimens. Added to this, the volumetric method is subject to considerable bias because it is very difficult to get all the eggs evenly distributed throughout the measuring cylinder (Holden & Raitt, 1974).

Table 1 and Fig. 2 show the relationships between total potential fecundity and total length, total weight, gonad weight obtained from the application of the multiplicative regression model.

Knowledge of fecundity is regarded as an important contributor in understanding stock dynamics and obtaining basic biological information for use in stock assessments. Estimated fecundity for *P. acarne* of Oran bay was compared to other results found in the literature (Table.2).

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REFERENCES

Arculeo, M., Brusle-Sicard, S., Potoschi, A & Riggio, S. (2000). Investigations on gonadal maturation in *Pagellus acarne* (Pisces, Sparidae) in the Strait of Messina (Sicily).Ital.J. Zool,67: 4, 333-337.

Bensahla Talet, L., Dalouche, F., Boutiba, Z & Bensahla Talet, A. (2010). Détermination de la période de ponte du pageot blanc *Pagellus acarne* (RISSO, 1826) pêché dans la baie d’Oran. BEL 2nd Colloquium LRSE-INOC, 2010.28-30 Nov.2010 Oran.216-222 :551.

Burt, A., Kramer, D.L., Nakatsura, K & Spry, C .(1988). The tempo of reproduction in *Hyphessobrycon pulchripinis* (Characidae), with a discussion of “multiple spawning” in fishes. Environ. Biol. Fish., 22: 15-27.

Coelho, R., Bentes, L., Correia, C., Goncalves, J.M.S., Lino, P.G., Monteiro, P., Ribeiro, J & Erzini, K. (2005). Age, growth and reproduction of the axillary seabream, *Pagellus acarne* (Risso, 1827), from the south coast of Portugal. Thalassas 21, 79–84.

Dominguez, J.B. (2000). Biología pesquera del besugo *Pagellus acarne* (Risso, 1826) del mar de Alborán. Ph.D. thesis, Univ. Malaga.

Dulic, J., Skakelja, N., Kraljevic, M & Cetinic, P.(1998). On the fecundity of the Black Sea bream, *Spondyliosoma cantharus* (L.), from the Adriatic Sea (Croatian coast). Sci. Mar., 62 (3): 289-294.

El oumari, N., Melhaoui, M., & Idrissi, M.H., 2011. Étude

Table 2:
Relation between absolute fecundity (F), total length (Lt), total weight (Wt) and gonad weight (Wg) of *Pagellus acarne* fished in Oran bay (Algeria).

Locality	F	n	Lt cm	Author
Atlantic ocean	85000 to 536000	22	-	Le Trong-Phan&Kompowsky (1972)
	10 ⁵ to 10 ⁶	20	-	Lamrini (1986)
	290070 ± 196.617	15	20.9 to 28.2	Velasco et al(2011)
Mediterranean sea -Alboran, Spain	173509±183.076	14	20.8 to 29.4	Velasco et al(2011)
-Oran bay (Algeria)	19875 to 49125 29448.86± 8198.12	22	16.3 to 26.3	Presentstudy

- de la croissance de *Pagellus acarne* : le cas de la côte Méditerranéenne marocaine. J. Sci. Hal. Aquat., 4:110-119.
- Fischer, W., Bauchot, M.-L., Schneider, M. (1987). fiches FAO d'identification des espèces pour les besoins de la pêche (révision 1). Méditerranée et Mer Noire, zone de pêche 37. volume 2. Vertébrés, CEE, FAO, ed. FAO, Rome, 761-1530p.
- Holden, M.J & Raitt, D.F.S. (1974). Manual of fisheries science. Part 2. Methods of resource investigations and their application. FAO., Rome (Italy). 214 pp.
- Kadari, G. (1984). Les techniques de pêche utilisées en Algérie. Ed Enap et Publisud, ISBN : 2-86600-018-8/36A83. Alger.134p.
- Lalami, Y. (1979). Etude Biologique et halieutique du Rouget de vase (*Mullus barbatus* L.) des côtes Algériennes. Thèse Doctorat. Université des Sciences et Techniques du Languedoc.510 p.
- Lamrini, A. (1986). Sexualité de *Pagellus acarne* (Risso, 1826) (Teleostéen, Sparidae) de la côte Atlantique méridionale du Maroc (21°-26° N). Cybium,10 :3-14 p.
- Le Trong-Phan & Kompowsky, A. (1972). The bronze bream *Pagellus acarne* from North West African region. Acta. Ichtyol.Piscat. Vol II,1.16 p.
- Munro, A.D., Scott, A.P. & Lam, T.J.(1990). Reproductive Seasonality in Teleosts: Environmental Influences. CRC Press Inc., Boca Raton, Florida.109-124.
- Neves Santos, M., Costa Monteiro, C & Erzini, K.1995. Aspects of the biology and gillnet selectivity of the axillary seabream (*Pagellus acarne*, Risso) and common Pandora (*Pagellus erythrinus*, Linnaeus) from the Algarve (south Portugal). Fish.Res.1995, vol. 23, n°23-4, pp. 223-236.
- Nikolskii, G.V. (1969). Fish Population Dynamics. Oliver and Boyd, Edinburgh, 323p.
- Pajuelo, J.G & Lorenzo, J.M.2000. Reproduction, age, mortality and growth of axillary seabream, *Pagellus acarne* (Sparidae), from the Canarian archipelago. J. Appl. Ichthyol. 16:41-47.
- Stéquert, B & Ramcharrun, B. (1995). La fécondité du listao (*Katsuwonus pelamis*) de l'ouest de l'océan Indien. Aquat. Living. Resour. 8 (1995) 79-89.
- Velasco, E.M., Jiménez-Tenorio, N., Del Arbol, J., Bruzón, M.A., Baro, J & Sobrino, I. (2011). Age, growth and reproduction of the axillary seabream, *Pagellus acarne*, in the Atlantic and Mediterranean waters off southern Spain. J. Mar. Biol. Assoc. U.K, 2011, 91(6), 1243–1253.

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Contribution to the Characterization of Peri-urban Natural Areas of Sidi Bel Abbès Town (Northwestern Algeria)

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Abstract

Peri-urban areas are very important in the geographical structure of the city, a boundary for urban sprawl, diversifying the territory and its landscape, creating continuity. These areas constituted a problem to geographers and statisticians who wished to assign them contours. The delimitation of peri-urban areas is indeed difficult and must combine geographic, urban, economic and human parameters that might render account of a movement that affects almost all areas. Our approach is a contribution to the use of simple and rapid decisions as a tool for the characterization of natural space in the suburban town of Sidi Bel Abbès. It is based on a diagnosis of the current situation in this municipality. The study allowed us to identify 106 natural areas in a suburban area of over 3969.36 hectares. Despite their spatial importance, these areas remain largely forgotten; It is therefore necessary to know their functions, developments and potential in order to keep the suburban biodiversity.

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Keywords: Suburban natural space; Sidi Bel Abbes; valorization; Biodiversity.

1-Introduction

Although cities are by definition the field of human, nature has also its place. The human being causes permanent changes in its environment to satisfy their basic needs, and has therefore an impact on the natural environment artificialized [6]. Natural spaces can help people to feel as responsible citizens in their city and its environment, since they are very important to the geographical structure forming a boundary for urban sprawl, diversifying the territory and its landscape, creating continuity [7]. These areas often welcome, generally involuntarily, populations who have difficulty finding venues for their activities in the rest of the urban area. Peri-urban natural areas become a necessity and a priority in view of advantages they bring to our cities [2].

Our present study has as an objective the diagnosis of peri-urban natural areas in the town of Sidi Bel Abbes, to deduce subsequently the crucial role it plays in the ecological balance of our city, knowing that the said town occupies the central part of a vast plain, recognized as the most fertile agricultural areas of the province.

2. Study area

The plain of Sidi Bel Abbes (Figure 1) is situated between Jebel Tessala in the north and the mountains of Daya in the south. It is isolated from the marine influence by the imposing barrier of Tessala-Beni Chougrane. It has a continental Mediterranean climate, with low rainfall and strong temperature variations, summer storms are the dominant features [1].

2.1 climate

The plain of Sidi Bel Abbes, is at a 470m of altitude. It is almost closed north east at the junction Tessala-Beni Chougrane. The plain of Sidi Bel Abbes therefore has a semi-arid continental Mediterranean climate, characterized by drought, high temperature differential and summer storms, are the dominant features. The climatic characteristics of Sidi Bel Abbes town were established from the meteorological station of Sidi Bel Abbes [3].

2.1.1 Pluviometry

The pluviometric data for the period 1988-2005 showed that precipitation remain in their average at 400mm. The dominant seasonal pluviometric type is the HP AE. The average volume of annual rainfall is around 1.6 billion cubic meters, often badly distributed in space and time with very significant agronomic impacts [4].

2.1.2 Températures

Temperatures are characterized by a significant increase in the summer, and a flagrant decrease in winter, especially during the night. The coldest months are usually January and February, during which the average annual temperatures vary between 0.4 and 14.2 °C. The warmest month is August, where the average annual temperature

varies between a minimum of $26,6^{\circ}\text{C}$ and a maximum of $34,8^{\circ}\text{C}$. Winter is characterized by a decrease in temperature between November and April, frosts are to be feared in this period too. The following table shows the average temperatures of the town of Sidi Bel Abbès for a period of 17 years [4].

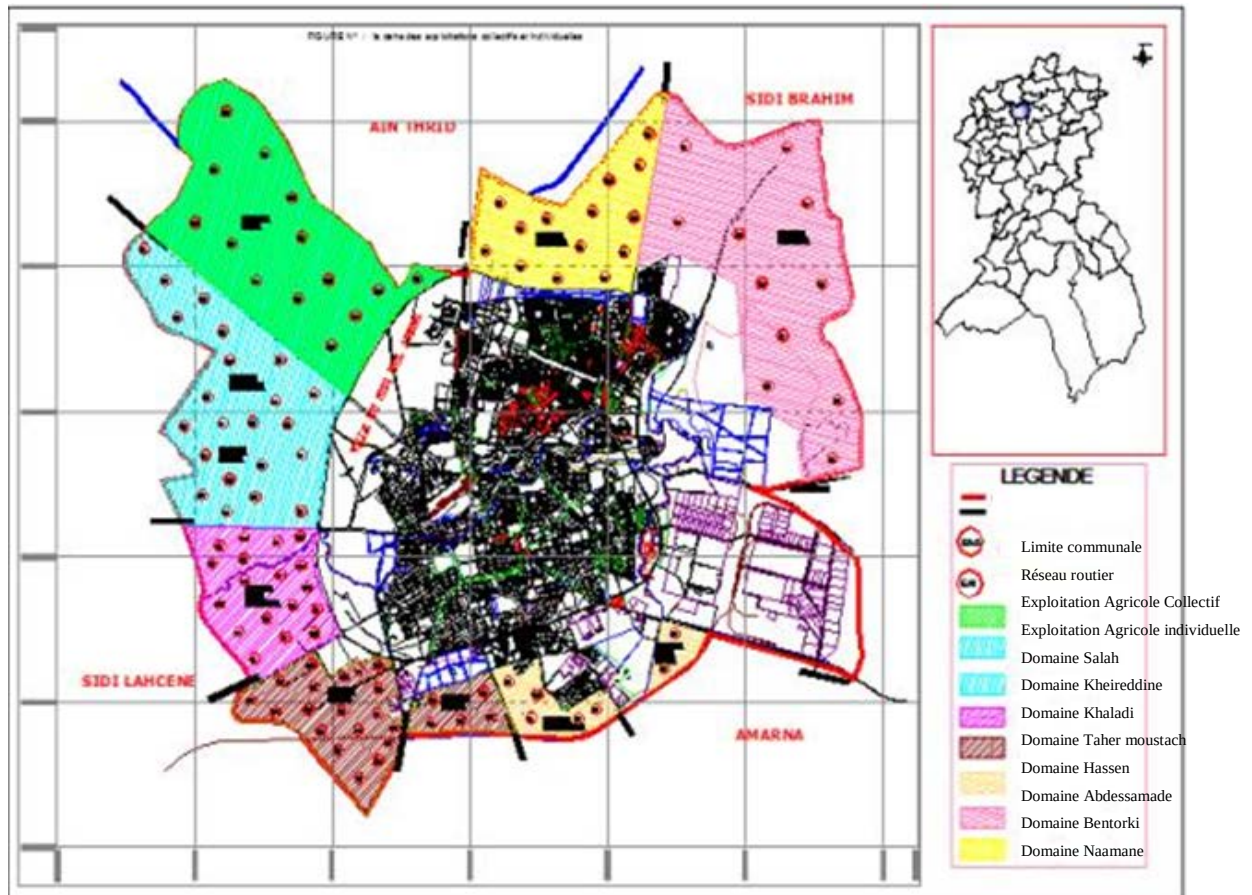


Figure 1: Geographical position of the study area (Sidi Bel Abbès-Algeria). Source [3].

2.2 Environmental characteristics

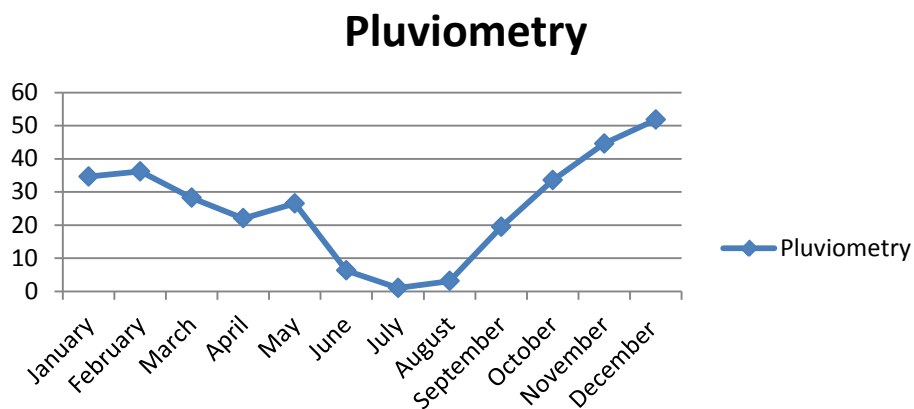


Figure 2: Average monthly rainfall in 17 years in Sidi Bel Abbès town (1988 to 2005) [4]

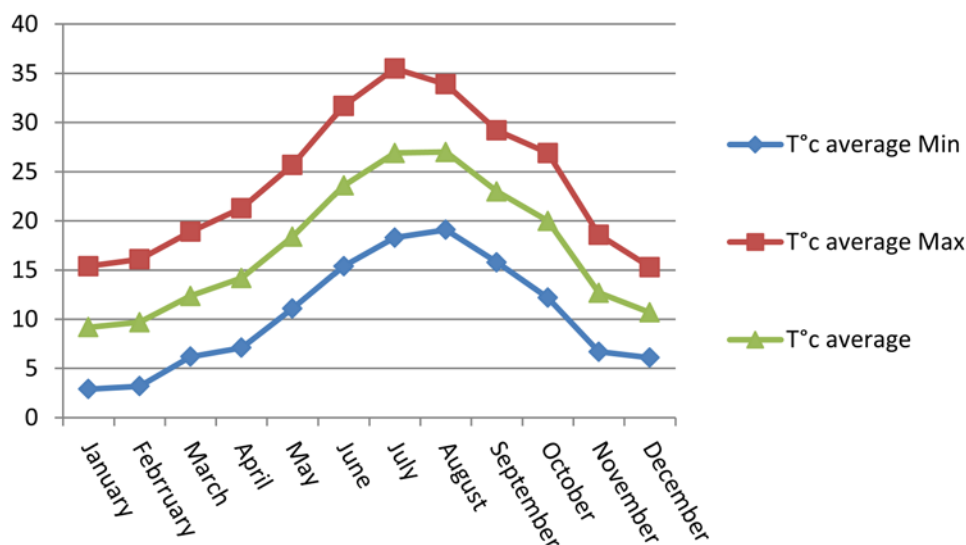


Figure3: Average monthly temperature for the period (1988-2005). Source [4]

2.3 Soil

Regarding soils in semi-arid regions. These are made of materials from the alteration of sandstone or limestone torn from surrounding landforms. These soils are thin and contain low organic matter content, (Aubert, 1960). The rocks are calcareous and make difficult the differentiation of soils [4].

2.3.1 Main soil types

- Alluvial soils in the valleys of the wadi Mekerra. On average, deep soils occupy about 30% of the plain of Sidi BelAbbes.
- Limestone crust soils in the high steppe plains (90%of the area), also in the alluvial plains of Sidi Bel Abbes. Limestone crust is more or less hardened and variable depth, depending on the local terrain.
- Limestone crust soils in the high steppe plains (90% of the area), also in the alluvial plains of Sidi Bel Abbes. The limestone soils whose importance varies from one area to another, 40% in the plains of Sidi Bel Abbes, 70% in the high plains and mountains of Telagh and Beni Chougrane, and 90 to 100% in the Mountains of Tessala [1].

2.3.2 Land use in the town of Sidi Bel Abbes

Urban sprawl changed the image of the city. We now accept that the expansion of cities cannot be stopped, and the solution is to control the expansion of cities, so that they will be synonymous of economic growth and satisfactory environment. In this context, the creation and conservation of peri-urban natural is necessary [5].

Indeed, the town of Sidi Bel Abbès had a population in the order of 88632 inhabitants in 1966 to attain 204181 in 2008. The forecast for 2015 estimates the population at 305,000 inhabitants. The city of Sidi Bel Abbès is a confirmed regional pole with a strategic position in the region, dense communication network with great economic, commercial and industrial potentialities to exploit [5].

The analysis of the general distribution of land, revealed that the vegetation cover occupied only 3% (221 ha) of the total area, against 36% reserved for built-up land, and more than half of the total area of the municipality, 4243 ha was represented by bare land [5].

Table 1: Soil classification according to their agro-soil potentials [1].

Class	Surface (ha)	Classification criteria	Pedological suitability	Localization
<u>Class1</u> High potentiality	3.563	- Alluvial soil high organic matter content. -Rooting depth greater than 80cm. - Low Slope of 0-3% -Location of ground water at shallow depth.	-Intensive arboriculture.	- South-West of SBA. - North-East and South of Sidi Lahcène.
<u>Class2</u> Good potentiality	6.945	-brown Soil with the presence of limestone elements. -Rooting depth between 60 and 80cm. -Slope of 3 to 5%.	-shallow rooted culture -tracing root System: apricot, plum, Pêche, grapes	-West and South-East of SBA municipality. -North of Amarnas municipality. Periphery of Sidi Brahim. -South of Tilmouni municipality.
<u>Class3</u> Average potentiality	19.730	Ground with light limestone crust. Rooting depth less than 30cm. Brackish water presence.	-Cereals, forages on a low slope -rustic viticulture on a medium slope -Oleiculture.	-West of Sidi Lahcène -¾ of Sidi Brahim and Zérouala municipalities. -South of Amarnas -West de Tilmouni.
<u>Class4</u> Low potentiality	6.760	- calcimorphic soils on soft rocks or shallow Rendzines. -Slope more than 8%. - High porosity.	-Reforestation -Rustic apiculture	North of Tilmouni Sidi Lahcène municipalities Northeast and Southwest of Zérouala.



Figure4: Map showing soil classification in the town of Sidi Bel Abbès. Source [8]

4. Material and Methods

The methodological approach was done following this steps:

First step: we considered important to begin our study with data collection concerning the town of Sidi Bel Abbès, by contacting state agencies responsible of management and planning of land use.

Second step: a survey on land was necessary on one side to get closer to land realities, and to confirm or refute the data collected, and on the other hand, to adapt the same data, to the objective of our study, which is characterization, and conservation of the natural suburban areas of the town of Sidi BelAbbès.

Third step: cartographic representations of our results.

4.1 Data Collection

For the purposes of this study, we investigated, with the various departments concerned, which are:

1. The Cadastre,
2. Urbat,
3. The environment directorate,

4. The agricultural services directorate of the wilaya of SBA (DSA)
5. The delegation of agricultural services at Municipality of SBA.

5. Results and discussion

After the achievement of several investigations in the field and on the basis of information collected from municipal delegates of agricultural services of the wilaya of Sidi Bel Abbas we realized that our study was represented by 08 main areas including a number of suburban areas.

Table 2: Representation of the different agricultural domains [8].

Domain	Localization	Soil nature	Activity
Salah	North and North-West	Alluvial soil	Market gardening
Hassen	South and South-West	brown calcareous+ alluvial soil	
Khalladi	West	brown calcareous	
Taher Moustache	West et south-west		
Kheireddine	west		
Abd Es Samad	East		
Ibn eTorki	North and North-East		
Naama	North		Cereals et Forage
			Cereals and Market gardening

The surface of areas studied varied from 1ha to 167ha, which will allow us to classify them;

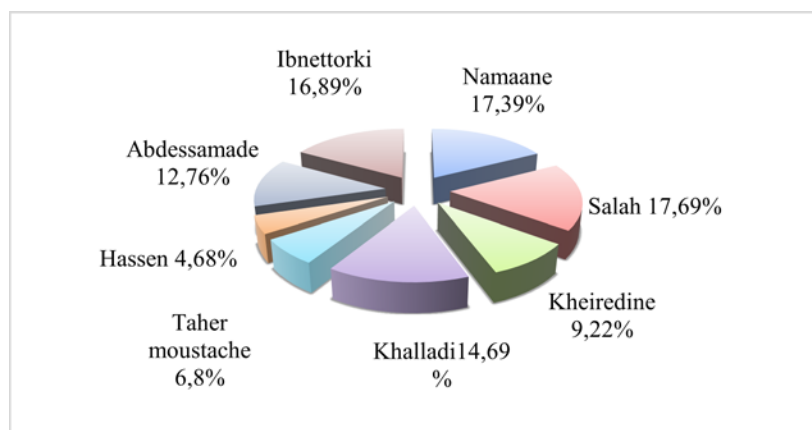


Figure5: Classification of domains according to the area occupied [9].

Peri urban spaces of Sidi Bel Abbas town are agricultural and are mainly represented by collective farms and individual ones. They are usually employed in most, by cereal crops, market gardening and fruit growing.

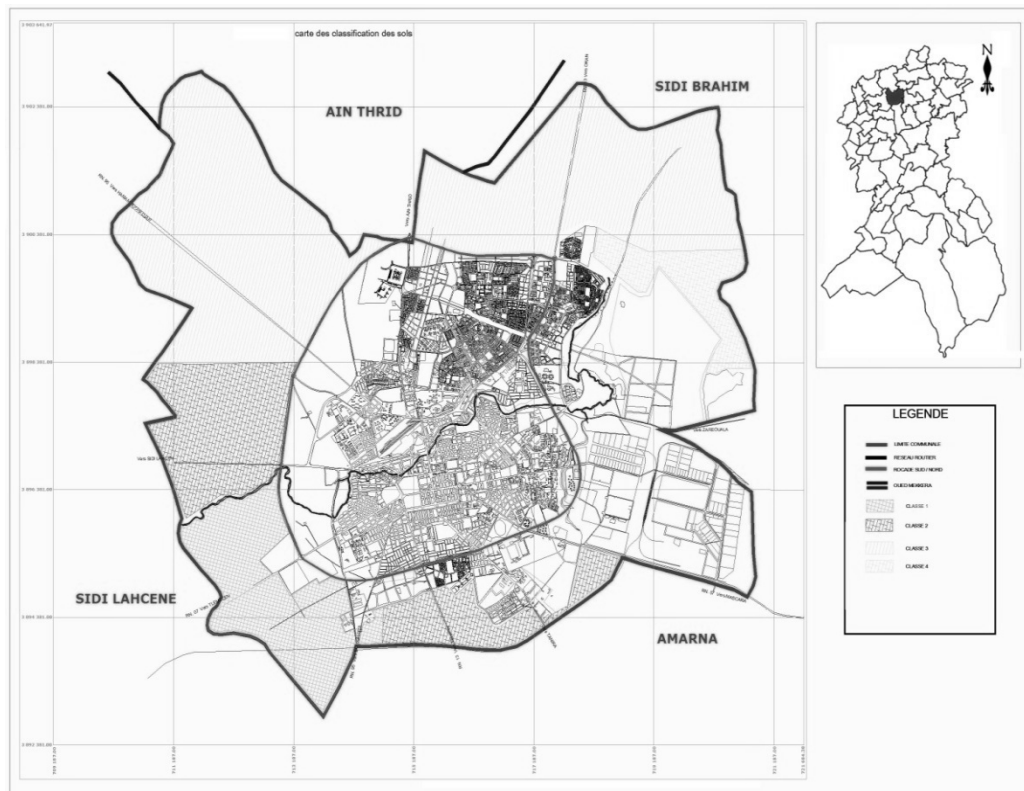


Figure 6: Map of collective and individual farms [5].

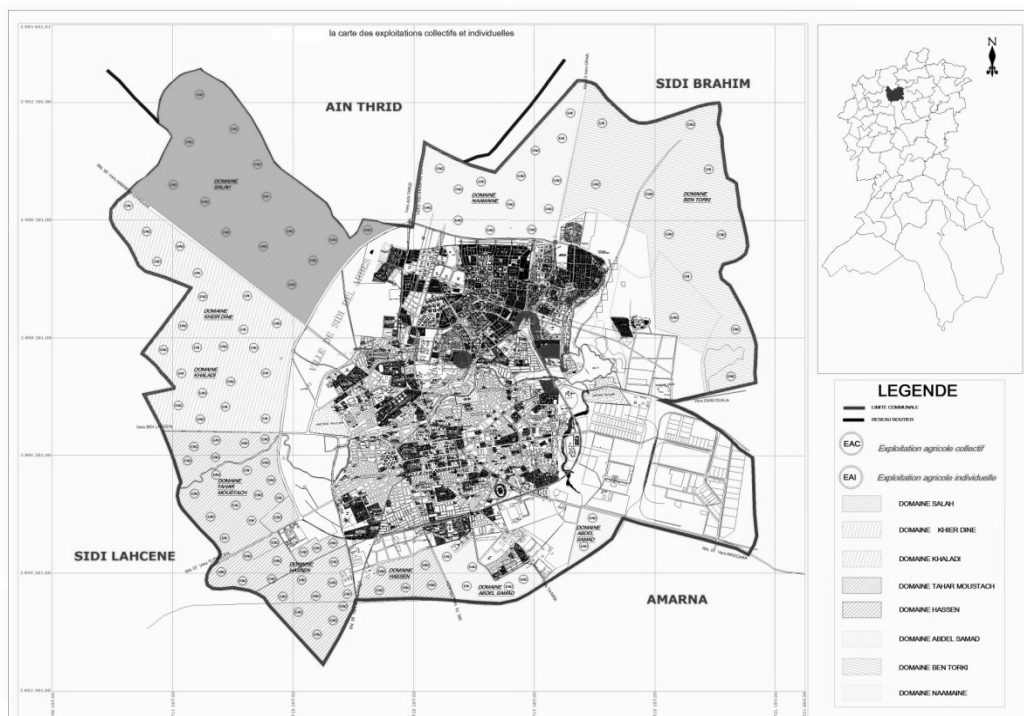


Figure 7. Map of cultures carried out by exploitation [5]

These agricultural areas represent a considerable challenge for the community in general, and the city in particular. They welcome important economic activities and play a role in the social balance of the city. Also represents places of oxygenation for urban residents in contact with the nature and rural areas.

However, the aggression of these urban agricultural areas, in the case of the city of Sidi Bel Abbes, caused by the constant urbanization accelerated their destruction, generating the following consequences:

- The weakening of ecosystem functioning.
- The irreversible loss of values of large agricultural lands.
- The destruction of natural habitats, hence a threat to plant and animal species living in these habitats.
- The increase in land prices.
- The increase in global warming due to the removal of natural agricultural areas, which store carbon.

5.1 Identification of the peri urban-biodiversity

We have deduced that the vegetal biodiversity is represented by an exclusively agricultural species, mainly formed by the cereal crop, then market gardens and fruit trees.

Agricultural biodiversity includes all components of biological diversity, which are important for trophic chain. The variety of animals, plants and microorganisms, are necessary to maintain the essential functions of the agricultural ecosystem [10].

In addition, to this agricultural biodiversity, a parallel spontaneous plant biodiversity cohabits. After several trips to the field during all seasons of the year 2008, a herbarium was performed at each PNA (Peri urban Natural Area). Identification of species collected, was done in the laboratory of plant taxonomy, in the environmental sciences department at the Faculty of Life Sciences and Nature, University of Sidi Bel Abbes-Djillali Liabes. The results are described in the following table:

Table 3: Identification of the different species collected [5].

n°	Scientific name
01	<i>Anchusa azurea</i> Mill
02	<i>Avena sterilis</i> L.
03	<i>Cardaria draba</i> L.
04	<i>Centaurea diluta</i> Ait
05	<i>Chenopodium vulvaria</i> L.
06	<i>Chrysanthemum coronarium</i> L.
07	<i>Convolvulus arvensis</i> L.
08	<i>Hordeum murimum</i> L.
09	<i>Lolium multiflorum</i> L.
10	<i>Malva sylvestris</i> L.

11	<i>Papaver hybridum L.</i>
12	<i>Papaver rhoeas L.</i>
13	<i>Rumex bucephalophorus L.</i>
14	<i>Silène fuscata Link</i>
15	<i>Sinapis alba L.</i>
16	<i>Triticum aestivum L.</i>
17	<i>Triticum durum L.</i>
18	<i>Daucus gummifer Lamk</i>
19	<i>Solanum tuberosum L.</i>
20	<i>Lycopersicon esculentum Mill.</i>
21	<i>Mentha sp.</i>
22	<i>Eucalyptus globulus labill</i>
23	<i>Pinus halepensis L.</i>
24	<i>Amygdalus communis</i>
25	<i>Olea europea L.</i>
26	<i>Ficus carica L.</i>
27	<i>Pirus longipes</i>
28	<i>Persica communis</i>
29	<i>Prunus domestica</i>
30	<i>Malus communis</i>

After species identification, we found the presence of two groups of species divided on two subgroups, as shown in the above schemes:

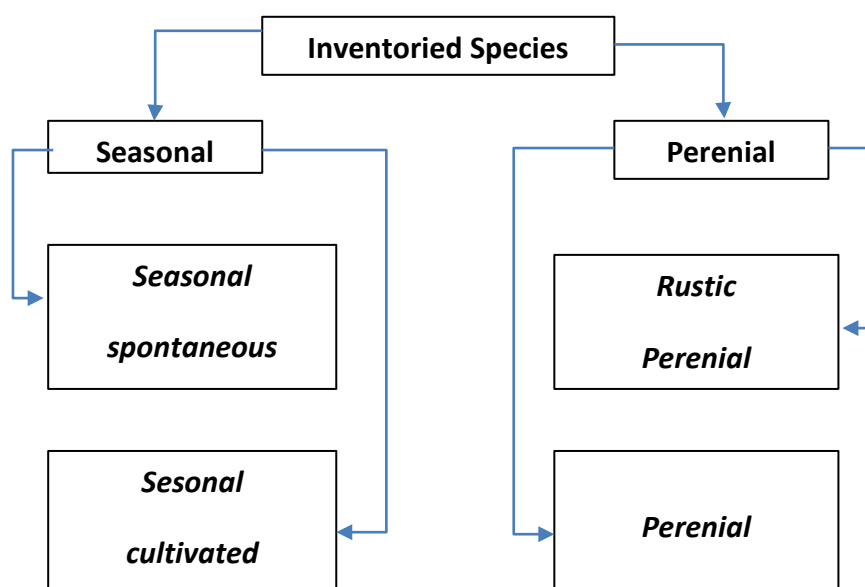


Figure 8: Types of species inventoried according to their lifespan.

Note: cultivated seasonal plant species are vegetable crops, while spontaneous seasonal weeds are usually cereal crops. For perennial species, they are represented by fruit trees such as apple, pear and rustic perennials, which are usually species such as olive tree, the Alep pine and Eucalyptus.

6. Conclusion

Our study on peri urban natural areas revealed a lot of information about their characteristics. These first strategic areas, which are part of the city of Sidi Bel Abbes are unfortunately neglected by the authorities in spite of their environmental, social and economic importance.

Nonetheless, these undeveloped areas are not simply gaps to the proximity of the urban tissue but constitute useful territories, hosting many important economical and social human activities, marking the meeting of the city and the countryside, landscape, recreation, agriculture and production. Knowledge and recognition by all of peri urban natural areas are an unavoidable action for their valorization [11]. These natural areas are real tools for the reconquest of urban and suburban landscapes. They are at the heart of the major challenges of future sustainable urban development. Even more, sustainability and identity of cities are largely related. Peri-urban natural areas must be protected by adapted legislation. Citizens must be engaged in the valuation process of vital areas, but also becoming full participants of the projects. Thus, peri urban natural areas may become fundamental elements at the service of a sustainable city.

6.1 Recommendations

The action towards suburban natural areas must have two main objectives: Protect and Enhance.

Protect

Under considerable pressure, peri-urban natural areas often know rapid regression (urbanization, transport infrastructure...), and even more significant degradation (artificial) that are usually irreversible. It is therefore essential to preserve natural areas and highlight that PNA should be spread over the entire urban area, to be easily accessible by citizens.

Develop

These spaces deserve to express their great potential. Peri-urban natural areas are the places of mixed uses and functions. This diversity contributes to the richness of the territories, which host both rural functions (agriculture) and urban functions (recreation), and cultural functions (landscape, historical heritage).

The mixed nature of spaces does not mean that "anything is possible"; these spaces should not be considered as gaps in the urban tissue, but as integral elements of cities, designed to accommodate the functions that enhance the natural character of the place.

The issue of agriculture is an important theme of management of peri-urban areas. It is desirable to maintain a

dynamic agriculture nearby cities, protecting them from the effects of urban pressure. Agriculture must become one of the multifunctional spaces facets. In this sense, it must take into account the other functions of this space, such as public reception and biodiversity. Since the natural areas of the suburban town of Sidi Bel Abbès, are agricultural areas, preferably with an economic role, and it would be desirable that they remain profitable for the population as a means of contact with the natural environment, away from any stress or pollution.

Knowing that the city of Sidi Bel Abbès, is always exposed to dusty winds in summer coming from the south and southwest, it would be necessary to establish a green belt for protection fitting the existing outlines of the urban tissue, with an average width of 20 meters depending on the availability and configuration of space.

The planting must staggered, with a very high density of the order of 5,000 plants per hectare, to provide a biological curtain. To this end it is appropriate to choose shrub and tree species, allowing the use of this belt by citizens as a place of relaxation and leisure.

The recommended plant species can be summarized as follows:

- Evergreen Tree Species: Pine, Cypress, Casuarina, ash, willow, poplar, hackberry, carob tree, plum trees
- Deciduous tree Species: Sophora, Melia, plane tree, Judas tree, maple.
- Shrub species: Privet, Pittosporum, Charcoal, Laurier, Palm and Tuya.

References

- [1] PDAU : Plan Directeur d'Aménagement et d'Urbanisme de la Wilaya de Sidi Bel Abbès pour les Années 1995_1997, 2005, 2007 et 2008.
- [2] BENABDELI K., BENMANSOUR S., 1998. Protection de l'environnement : quelques bases fondamentales appliquées et réglementaires. Présentation d'une expérience réussie. Sidi Bel Abbès ; Algérie., éd. à compte d'auteurs, Sidi Bel Abbès, 1998. 243 p
- [3] DPAT, 2006. Direction de la planification et d'aménagement du territoire, 2006 : Annuaire Statistique de la Wilaya de Sidi Bel Abbès.
- [4] ONM : Office National de météorologie de la wilaya de Sidi Bel Abbès.
- [5] ANAT, 2008. Agence nationale d'aménagement du territoire de la wilaya de sidi bel Abbès 2008, plan d'aménagement de la wilaya de sidi bel Abbès
- [6] ANONYME, 2006. Les espaces verts urbains et périurbains. Paris.
- [7] ARSEN G., 2003. La relation homme-nature: L'émergence de l'éthique de l'environnement. Roumanie
- [8] DIRECTION DE L'ENVIRONNEMENT de la Wilaya de Sidi Bel Abbès, 2008. Rapport relatif à l'état de l'environnement de la Wilaya de Sidi Bel Abbès.

[9] ONS : Office national de statistique de la wilaya de Sidi Bel Abbès

[10] MICHELOT J-L, 2004, la place des espaces naturels périurbains pour une ville durable. Rapport de Fedenature à la commission Européenne DG Environnement. Bruxelles Commission Européenne. 39p.

[11] HUPPE S., 2007. Les espaces naturels périurbains. Gestion des milieux naturels et biodiversité. Ministère de l'Ecologie, du développement et de l'aménagement durable. Paris : MEDAD-DNP, 2007.- 89 p



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Spatial Distribution of Norway Lobster *Nephrops norvegicus* (Linnaeus, 1758) Caught in Bouzedjar Bay and Associated Benthic Fauna

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Abstract

Surveys were conducted in the field, near the port of Bouzedjar with fishermen, to acquire a knowledge of the spatial and depth distribution of the Norway lobster *Nephrops norvegicus* (Linnaeus, 1758). To complete our investigations, we referred to the informations obtained during the Spanish trawling and acoustic survey which was carried out on the Algerian coast in 2004 aboard the Spanish research vessel R / V Vizconde de Eza. Analysis of the results reveals that the rich funds in norway lobster were located in the central area of the continental shelf between the immersions 250 and 400 m. It is thus observed very clearly that fish caught on these funds are mostly represented by Gadidae family; the most common species is the Greater forkbeard *Phycis blennoides* (Brünnich, 1768) (12.30%) followed by *L. budegassa* (10.86%) and *P. bograveo* (6.27%). Elasmobranchs were very few except the small dogfish, *Scyliorhinus canicula* (L., 1758) (6.15%) which is quite common.

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Two Crustaceans mainly represented invertebrates that appear in this survey, in association: *Palinurus elephas* (23.16%) and *Parapaneus longirostris* (12.18%). Finally, there was a proportion of discarded fish that was very significant and consisted of small specimens that didn't reach the commercial length mainly represented by dogfish *Scyliorhinus canicula* (L., 1758).

Keywords: Spatial distribution; depth; fisheries; Norway lobster; Associated fauna; Bouzedjar Bay; Algeria; Western Mediterranean

1. Introduction

Aïn Témouchent province is situated between latitudes 35° 20' N and 35° 40' N and from longitude 2° 00' West to 2° 30' East, occupies over 5000 km². It extends over a length of 80 km from Cape Falcon in the east to Ras Honaine (cap Noé) (Figure 1). It's marine biomass was evaluated at 60 000 tones (ISTPM, 1982). Two main ports are noted hosting more than 452 trawlers divided between Beni Saf (256) and Bouzedjar (185) fisheries.

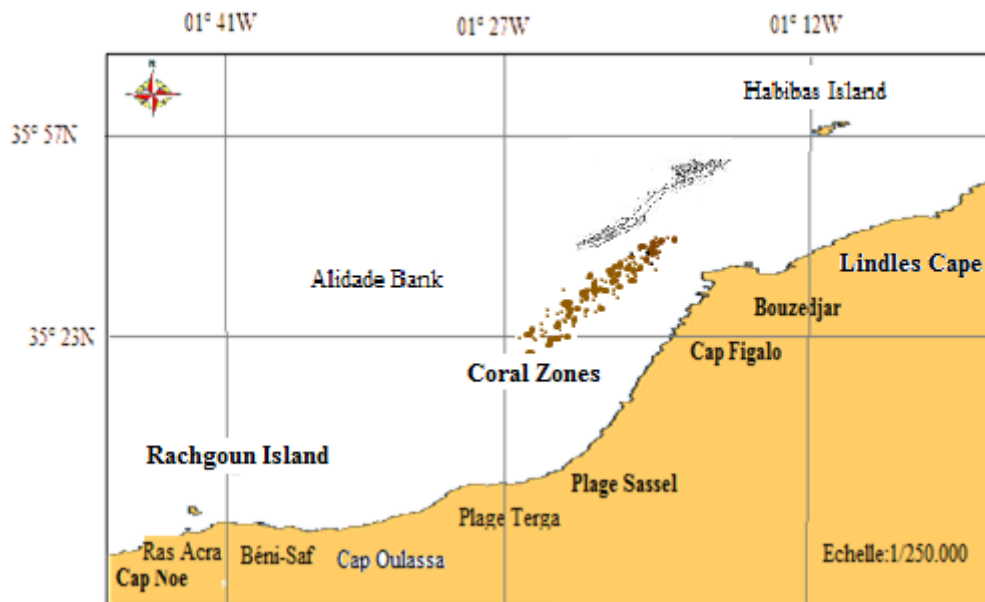


Figure 1: Localization of the study area.

The observations of the research vessel "Thalassa", during its campaign in 1982 in the Algerian continental shelf state that Ghazaouet fishing zone in Bouzedjar, has one of the largest continental shelf in our coasts [1,2].

Among the crustaceans caught in Bouzedjar Bay the Norway lobster *Nephrops norvegicus* (Linnaeus, 1758) frequenting depths comprised between 267-863 m. The highest densities were observed between 280-400 meters near coral areas (figure 1) ([3,4,5]).

Market demand for Norway lobster has increased significantly this recent years, with an average selling price around 35 € / Kg. Aware of the high economic value represented by this decapod species professionals in this

sector have accentuated their fishing efforts with a current production near 27.530 tons per year [6].



Figure 2: General aspect of *N. norvegicus* (Linneaus, 1758).

2. Material and methods

A total of 21 fishing trips (Fig. 3), as well as investigations were carried out on with fishermen from Bouzedjar port, to acquire knowledge of the spatial distribution and bathymetry of the species.



Figure 3a: On board of a trawler (Syphax) on the arrival of the trawl.

For each sea trip, the boats moved towards well-known fishing areas and sometimes to other non-prospected ones. The information obtained was used as a basis to establish a map showing fishing areas for Norway lobster of Bouzedjar Bay. To complete our investigations, we referred to the information obtained during the Spanish trawling and acoustic survey which was carried out on Algerian coast in 2004 aboard the Spanish research vessel “**R/V Vizconde de Eza**”.

Additional information on the distribution of the species is the study of associated fauna, allows us to complete our knowledge of the ecology of the lobster and also to inventory, the specific composition of the different associated species.

The associated fauna is very diverse. First, we have considered only the species that live in the same habitat. Secondly, to highlight the most characteristic species, we defined criterion: relative abundance, corresponding to the percentage of individuals of a fish species considered to the total number of individuals captured, except for individuals of the targeted species.

$$A_R = (n/N) \times 100.$$

n: number of individuals of each species associated.

N: total number of individuals of all species.

We highlight that we took into consideration only those species that present a relative frequency greater than 0.05%. Also for every fishing trip, we note the common name of the species as well as the weight of the total catch. Thereafter, we established taxonomy of each species caught during the landing of sea products.

3. Results

It appears from our investigation that the fishing zones of *N. norvegicus* in the bay Bouzedjar extend from the Borj Bouabed Cape to Lindles Cape (Figure 1). Also we can add that areas of distributions and high biomass (Figure 3b) of this decapod are at aggregated near coral zones, bathymetric limits are presented in Table 1.

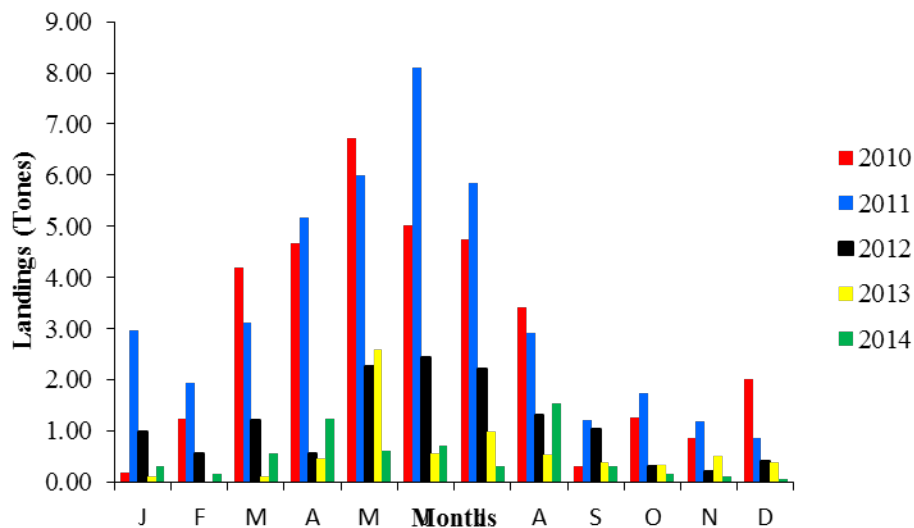


Figure 3b: Monthly landings of Norway lobster *N. norvegicus* caught in Bouzedjar Bay (Algeria)

Table 1: Data on fishing area frequented by *N. norvegicus* obtained during the study.

Fishing area	Latitude	Longitude	Minimal depth (m)	Maximal depth (m)
A1	35° 41' 000'' N	01° 21' 600'' W	336	357
A2	35° 41' 565'' N	01° 21' 770'' W	362	383
A3	35° 41' 000'' N	01° 22' 560'' W	430	455
A4	35° 47' 107'' N	01° 15' 967'' W	330	463

During the landing, we have listed different families: Gadidae, Elasmobranchs, invertebrates (crustaceans and cephalopods) (Figure 4) which has the same depth distribution. We have subsequently plotted the percentage of fish and crustaceans species (Figure 5) associated to our species.



Figure 4: Associated fauna to Norway lobster caught in Bouzedjar Bay.

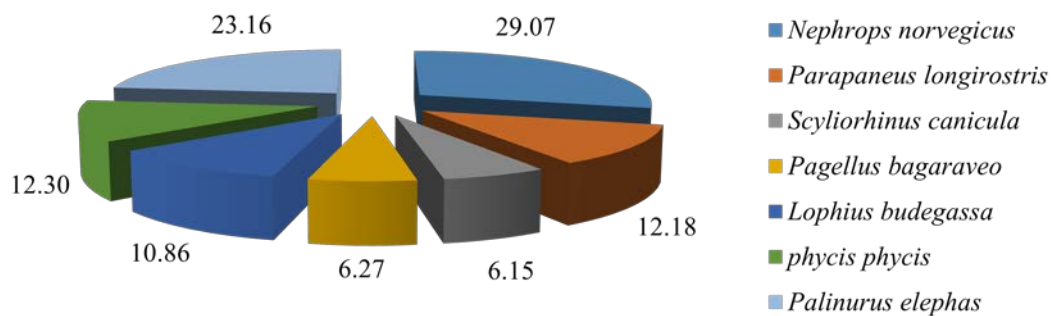


Figure 5: Frequency of associated fauna with Norway lobster *N. norvegicus* (Linnaeus, 1758).

4. Discussion and conclusions

Nephrops norvegicus (L. 1758) (Decapoda: Nephropidae) is a species with a wide geographical distribution from the Atlantic coast of north-west to the east of the Mediterranean [7]. The Norway lobster fishing on the Algerian west coast was only initiated in recent years. According to [8], the fishing grounds of this species remained undeveloped until the end of the last century because of their distance from ports and fishing activity

strongly influenced by hazardous weather conditions, and lack of appropriate equipment (insufficient cables length, old board equipment, unskilled crew, delapidation of the fishing fleet, ...).

Trawling in the study area was focused on the white shrimp *Parapenaeus longirostris* (Lucas, 1846). The fishing zones that were identified show that vessels operate from Habibas islands to banc d'alidade a coral bottom area where norway lobster is abundant. Our results show a clear development of the fishing for *Nephrops norvegicus* (Linnaeus, 1758) performed at depths varying from 180 to 550 m.

Reference [8] affirmed that, the fishing grounds of this crustacean in Algeria, are distributed at depths of around 400 m, while in other regions of the Mediterranean, fishing depths for norway lobster oscillate between 200 and 750 m [9,10,11,12,13].

The analysis of our results shows that the richest areas in norway lobster are mainly located in the central region of the continental shelf, between 250 and 400 meters. We can also affirm that fish caught on these funds are mostly represented by Gadidae family; the most common species is *Phycis blennoides* (Brünnich, 1768) (12.30%) followed by *Lophius budegassa* (10.86%) and *Pagellus bogarveo* (6.27%). Elasmobranchs are very few except the small dogfish, *Scyliorhinus canicula* (L., 1758), which is rather frequent (6.15%)

Invertebrates are widely represented by two species: the spiny lobster *Palinurus elephas* (Fabricius, 1787) (23.16%) and the white shrimp, *Parapenaeus longirostris* (Lucas, 1846) (12.18%). Finally, there is discarded fish that was very significant and consisted of small dogfish *Scyliorhinus canicula* (L., 1758) that didn't reach a commercial length. The analogy of this associated fauna of the continental shelf of Bouzedjar Bay with that of the Adriatic in the Mediterranean, and the great mudflat in European Atlantic is remarkable and have been already reported by [14].

References

- [1] I.S.T.P.M., 1982. Evaluation des ressources halieutiques de la marge continentale algérienne. Stocks pélagiques-Stocks démersaux exploitables au chalut. Rapport Institut Supérieur Techniques et Pêches Maritimes (Nantes-France), 101p, annexes.
- [2] Leclaire, L., 1972. La sédimentation holocène sur le versant méridional du bassin algéro-baléares (Précontinent algérien). *Mém. Mus. Nat. Hist. Nat. Ed. Paris. Fr.*, XXIV (Fas. Unique) : 391 p.
- [3] CGPM., 1982. Rapports de la quatrième session du Comité de l'aménagement des ressources 1982 (Rome, 17-18 juin 1982) et de la Consultation technique sur la régulation de l'effort dans les pêcheries au chalut en Méditerranée (Rome, 14-16 juin 1982).
- [4] Massuti E, Guijarro B, Pomar B, Fliti K, Reghis M, Zaghdoudi Bouaicha M, & Ait Ferroukh B., 2003. Informe de la campaña Argelia 0204 para la evolución de recursos demersales en las costas de Argelia, IEO, MPRH, SGPM, 123p

- [5] Massuti, E., Ordines, F., Guijarro, B., Pomar, B., Fliti, K., Refes, W., ZAGHDOUDI Bouaicha, M., Reghis, M., & Ait Ferroukh B., 2004. Informe de la campaña Argelia 0204 para la evolución de recursos demersales en las costas de Argelia, *IEO, MPRH, SGPM*, 123p.
- [6] DPRH., 2013. Directorete of fisheries and fisheries Ressources.
- [7] Zariquiey Alvarez, R., 1968. Crustáceos decápodos ibéricos. *Investigación Pesquera*, 32 : 1-510.
- [8] Mouffok, S., Kherraz, A., Bouras, D., & Boutiba, Z., 2008b. The fishery for, and local distribution of, *Aristeus antennatus* (Risso, 1816) (Crustacea: Dendrobranchiata) off western Algeria. *African Journal of Aquatic Science*. ISSN 1022-0119, Vol 33 (2) (Aout 2008).118-122p
- [9] Farmer A.S.D., 1975. Synopsis of biological data on the Norway lobster *Nephrops norvegicus* (Linnaeus, 1758). *F.A.O. Fisheries Synopsis*, 112: i-iv, 1-97.
- [10] Morizur, Y., 1981. Evolution du taux de présence de spermatophore chez les femelles de *Nephrops norvegicus* (L.) (Decapoda, Reptantia) et développement ovarien. *J. Exp. Mar. Biol. Ecol.* 52, 15–24.
- [11] Abello, P. & F. Sarda., 1982. The fecundity of the Norway lobster (*Nephrops norvegicus*) of the Catalan and Portuguese coasts. *Crustaceana.*, 43:13-20.
- [12] Dintheer Christian (1982). Distribution des grands pélagiques autour de la Corse - campagne de prospections aériennes 1980. *Science et Pêche*, 322, 1-14. Open Access version : <http://archimer.ifremer.fr/doc/00000/6673/>
- [13] Orsi Relini, L., & Relini G., 1985. Notes on the distribution, reproductive biology and fecundity of *Nephrops norvegicus* in the Ligurian Sea. *FAO Fish. Rep.*, 336: 107-111.
- [14] Fontaine, B., & Warluzel, N., 1969. Biologie de la langoustine du golfe de Gascogne *Nephrops norvegicus* (L.). *Revue Trav. Inst. (scient, tech.) Pêch. marit.* 33, 223-246.

RESEARCH ARTICLE

ARAŞTIRMA MAKALESİ

Some population characteristics of the pink spiny lobster *Palinurus mauritanicus* (Gruvel, 1911) caught in the Béni-Saf Bay (Western Algeria)

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Abstract: This study is aimed to pinpoint the morphometrics, state of exploitation dynamic in order to assess the *P. mauritanicus* (Gruvel, 1911) stock. Specimens were caught by trawlers operating in Béni-Saf Bay. In total 121 individuals were collected: 60 males (49.58%) and 61 (50.41%) females, χ^2 test ($p < 0.05$) didn't show any significant difference between the two sexes. FISAT II software was used to estimate growth parameters, recruitment, mortality and exploitation rates. Total length-total weight, total length, carapace length equations parameters for the entire population were respectively $TW = 0.0363 \cdot TL^{2.858}$, $\log TL = 0.802 \cdot \log CL + 0.631$ indicating a negative allometry growth. The parameters of Von Bertalanffy were: $L_{\infty} = 32.03$ cm, $K = 0.18$ yr⁻¹ and $t_0 = -0.16$ year⁻¹. Total mortality was estimated $Z = 0.760$ yr⁻¹, natural maturity $M = 0.458$ yr⁻¹, fishing mortality $F = 0.302$ yr⁻¹ and exploitation ratio $E = 0.397$ reflecting a situation near the full exploitation of the resource.

Keywords: *Palinurus mauritanicus*; fishery; mortality; exploitation; Béni-Saf Bay

INTRODUCTION

The fishery products (fish, crustaceans, shellfish) landed daily at our fisheries continue to decline day by day. The effort and resources deployed at sea to meet the growing needs of a population strongly piscivorous are the major cause of the rarity of some species followed by anthropic actions that destroy aquatic environment (tourism, pollution, over fishing, excessive trawling). The approach of our work seeks to enhance and preserve the pink spiny lobster *Palinurus mauritanicus* and attempt to assess the current status of the population.

P. mauritanicus is a high economic value species occurring in the Eastern Atlantic from western Ireland (53° N; Mercer, 1973) to southern Senegal (14° N; Vincent-Cuaz, 1958) and in all the Western Mediterranean from Gibraltar to Sicily, west of 16° E, not in the Adriatic (Holthuis, 1991). It is frequent in the western Atlantic Ocean from Ireland to Senegal, in western Mediterranean we found it in Libya, Sicily, Sardinia, Corsica and Gibraltar but stay very abundant in Mauritania and Rio de Oro waters, at depths ranging between 150 to 300 meters. Generally fished by trawlers at depth ranging from 180 to 600 m but the baited cylindrical traps stay the most selective and appropriate tool for this crustacean. In the western Mediterranean mostly between 400 and 500 m on rocky and coral substrates, as well as on mud.

In Béni-Saf Bay *P. mauritanicus* is found around Rachgoun Island (Pers. obs) that have suitable rocky substrates. It

commands high prices supporting the local economy. In the past the pink spiny lobster was caught using baited traps, but now this gear has practically disappeared to be replaced almost exclusively by non-selective gears trammel nets (Goñi et al., 2003a) and trawl. With the replacement of traps, fishing effort on has increased contributing a lot in the decline of the exploitable stock.

Many works exist on the European spiny lobster *Palinurus elephas* but scarce data are available for *P. mauritanicus* (Maigret, 1978; Campillo and Amadei, 1978; Boitard, 1981; Caverivière et al., 1986; Minchin, 1989; Diop, 1990; Goñi and Latrouite, 2005) and especially concerning the Algerian waters except the works of Bensahla Talet et al., 2011 and Bachir Boudjra et al., 2014 focusing on ecology and some aspects of reproduction of this decapod.

The weight-length relationship (WLR) is a necessary parameter in fishery assessment. In sampling programs, it is usually easier to measure length only (e.g., because of the bobbing motion of the boat), or weight cannot be measured simply (e.g., underwater visual censuses). The WLR of a particular species allows the inter-conversion of these parameters (Morey et al., 2003). Also, morphometric comparisons can be made between species and populations (Gonçalves et al., 1997). Added to this, the WLR allows specimens condition to be estimated in relation to different

environmental conditions. The relationship between Total length, carapace length and total body weight are described for the first time in this paper concerning *P. mauritanicus* living in Béni-Saf Bay. The relationship between total length (TL), carapace length (CL) can be a useful tool given that the minimum landing size is expressed as TL an easier and faster measure to take (Latrouite and Noel, 1997; Secci et al., 2000; Tidu et al., 2004) allowing us to convert the two measures easily.

MATERIAL AND METHODS

Samples of *P. mauritanicus* were collected monthly (Fig. 1) between June and December 2001 caught by trawlers (mesh size 40 mm) operating in Béni-Saf Bay at depths ranging between 15 to 300 m.

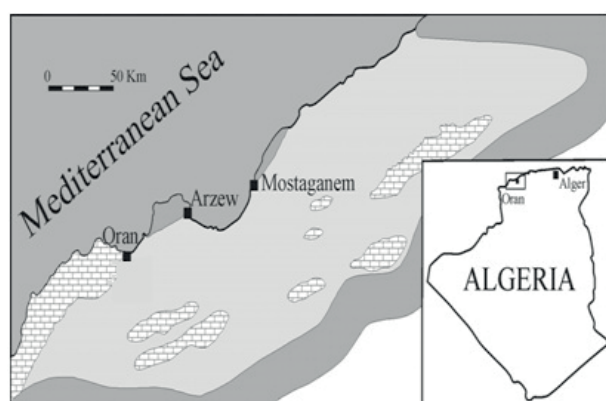


Figure 1. Sampling zone

Biological informations (sex, individual length and weight) (Fig. 2) were recorded during landings [with respect of a Minimum landing size set up by Algerian legislation fixed at 10 cm of CL (JORADP,2004)].

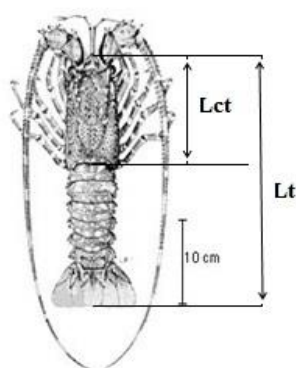


Figure 2. Measurements made on *P. mauritanicus* specimens

After the macroscopically sex determination, deviation from 1:1 null hypothesis was statistically tested by χ^2 test. Total (TL) and carapace length (CL) were measured to the nearest mm and total weight (TW) to the nearest g. Mean length comparison was performed with t-test (Zar,1999). The Length weight

relationship is expressed as; $TW = aTL^b$ (Ricker, 1973) where TW is total body weight (g), TL is total length (cm). Also relationship between TL and CL was established with the following equation: $\text{Log TL} = b \text{ Log CL} + \text{Log a}$ (b the slope and a the intercept for the two equations) In order to confirm if values of b obtained in regressions were significantly different from isometric value ($b=3$ or $b=1$), the null hypotheses of isometric growth were tested by the t-test (Zar,1999).

Parameters of the Von Bertalanffy growth equation were estimated using ELEFAN I method (FISAT II: Gayanilo et al., 1989) grouping the population in length classes of 1 cm (Carapace Length, CL). Growth performance index was calculated using Munro and Pauly,1983 equation: $\Phi = 2 \text{ Log } L_{\infty} + \text{Log K}$. The total mortality (Z) was estimated using Jones van Zalinge (1981) plot. Pauly's (1983) equation was used to determine natural mortality; $\ln(M) = -0.0152 - 0.279 \ln(L_{\infty}) + 0.6543 \ln(K) + 0.463 \ln(T)$ [T: annual mean temperature of Béni-Saf bay 17.5°C] (Zemenzer,2011). Fishing mortality (F) was deducted from the equation: $Z = M + F$, so $F = Z - M$ and exploitation rate from $E = F/Z$ (Gulland, 1971).

RESULTS

In total 121 individuals were collected (table 1) 60 (49.58%) were males (TL:20-53.3 cm) and 61 (50.41%) were females (TL:25-53.2 cm) (figure 3), ranging in weight between 275 and 4000 g for males and between 330 and 3100 g for females. Males (40.68 ± 80.77) and females (40.32 ± 68.12) mean length were not significantly different (t-test, $p < 0.05$) (figure 3). Also χ^2 test ($p < 0.05$) didn't show any significant difference between the two sexes.

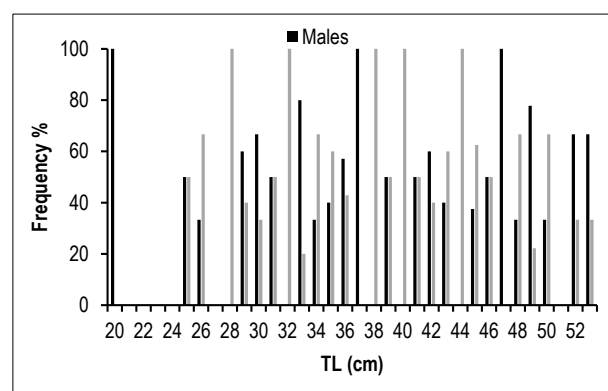


Figure 3. Length frequency distribution of males and females of *P. mauritanicus* specimens caught in Béni-Saf Bay

Table 1. Maximum and minimum values of the total length, carapace length and total weight for all population of *P. mauritanicus* specimens off Béni-Saf Bay

Sex	n	TL (mm)		TW (g)		CL (mm)	
		min	max	min	max	min	max
Female	61	250	532	300	3100	9.7	30
Male	60	200	533	275	4000	9.7	24
Both	121	200	533	275	4000	9.7	30

Length–weight and length–length regression parameters estimated for males, females and all individuals are presented

in Table 2. The length–weight relationships were well correlated ($0.853 < r^2 < 0.869$) found statistically significant and the null hypothesis ($H_0: b=3$ was rejected), a negative allometric growth was observed for the three different groups (t-test, $P < 0.05$, $t_{obs} > t_{th} = 1.65$, $n > 120$).

Length–length relationships were better correlated ($0.931 < r^2 < 0.905$) than the previous relationship and found statistically significant and the null hypothesis $H_0: b=1$ was rejected, a negative allometric growth was observed for the three different groups (t-test, $P < 0.05$, $t_{obs} > t_{th} = 1.65$, $n > 120$).

Table 2. Range and mean of total length (cm) and weight (g) values of Spotted flounder from Izmir bay (Aegean Sea)

Sex	Allometric relation	Allometric equation	Determination coefficient (r^2)	95% CI of b	Relationship t-test
Female	TW/TL	$TW = 0.0283 \cdot TL^{2.909}$	0.858	2.80-2.92	A-
Male	TW/TL	$TW = 0.0513 \cdot TL^{2.781}$	0.869	2.72-2.84	A-
Both	TW/TL	$TW = 0.0363 \cdot TL^{2.858}$	0.853	2.76-2.92	A-
Female	TL/CL	$\text{Log TL} = 0.802 \cdot \text{Log CL} + 0.631$	0.908	0.78-0.82	A-
Male	TL/CL	$\text{Log TL} = 0.750 \cdot \text{Log CL} + 0.682$	0.931	0.55-0.94	A-
Both	TL/CL	$\text{Log TL} = 0.763 \cdot \text{Log CL} + 0.673$	0.905	0.74-0.78	A-

Growth parameters of the von Bertalanffy equation for *P. mauritanicus* (Table 3) were estimated as $CL_{\infty} = 32.03$ cm, $K = 0.18$ year⁻¹, $t_0 = -0.16$ year. Growth performance index Φ was

found to be equal to 2.266. The results of Total (Z), natural (M), fishing (F) mortalities, exploitation rate (E) were estimated for all the individuals as 0.760, 0.458, 0.397 respectively.

Table 3. Von Bertalanffy growth parameters, growth index, total, natural, fishing mortalities and exploitation rate (E) for all individuals of *P. mauritanicus* fished in Béni-Saf Bay

	n	CL_{∞} (mm)	K (yr ⁻¹)	t_0 (yr)	Φ	Z	M	F	E
All samples	121	320.3	0.18	-0.16	2.266	0.760	0.458	0.302	0.397

DISCUSSION

It appears that *P. mauritanicus* from Béni-Saf Bay had a negative allometric growth ($b < 3$, $t > t_{0.05} = 1.65$) showing that increase in length is faster than increase in weight an observation already made by others authors in other localities (Boitard, 1981; Caverivière et al., 1986; Minchin, 1989; Diop,

1990). Comparing our results of the equation total length versus carapace length in other regions (Table 4) led us to conclude that females records negative growth rate of TL in relation to CL, conversely for males the b parameter is greater than 1 and this can be explained by the fact that females have larger abdomen than males given that it constitutes the zone of egg attachment.

Table 4. Length–weight; length–length relationship for the spiny lobster *P. mauritanicus* given by different authors

Locality	sex	n	equation	r^2	Author
Mauritania	M	-	$\text{Log TW} = 2.720 \cdot \text{Log TL} - 2.677$	-	Boitard, 1981
	F	-	$\text{Log TW} = 2.750 \cdot \text{Log TL} - 2.744$		
Senegal	M	-	$\text{Log TW} = 2.35 \cdot \text{Log CL} + 0.403$	-	Caverivière et al., 1986
	F	-	$\text{Log TW} = 2.39 \cdot \text{Log CL} - 0.394$		
Ireland	M	-	$\text{Log TW} = 2.880 \cdot \text{Log TL} - 6.760$	-	Minchin, 1989
	F	-	$\text{Log TW} = 2.750 \cdot \text{Log TL} - 6.120$		
Mauritania	C	-	$\text{Log TL} = 0.338 \cdot \text{Log CL} + 0.1620$	0.8800	Diop, 1990
	C	121	$\text{Log TW} = 2.857 \cdot \text{Log TL} - 1.439$ $\text{Log TL} = 0.741 \cdot \text{Log CL} + 0.6970$	0.8530 0.8856	
Algeria (Béni-Saf Bay)	M	60	$\text{Log TW} = 2.780 \cdot \text{Log TL} - 1.289$	0.8690	Present study
			$\text{Log TL} = 1.221 \cdot \text{Log CL} - 0.7240$	0.9367	
	F	61	$\text{Log TW} = 2.908 \cdot \text{Log TL} - 1.548$	0.8580	
			$\text{Log TL} = 0.755 \cdot \text{Log CL} + 0.6860$	0.9048	

M: males, F: females, C: combined, n: number, r^2 : coefficient of regression

For the growth parameters of the spiny lobster from Béni-Saf Bay the values are the highest ones compared to that referenced data (Table 5) for this Palinuridae. In fact, asymptotic length found during our study was equal to 320.3 mm with Lmax recorded during sampling equal to 300 mm CL (Female, 07/2001) while this parameter varied in other localities for the same species between 78 to 202.8 mm CL.

The estimated values of growth factor $K=0.18$ show that *P.mauritanicus* is a fast-growing crustacean, observation already noted by Marin, 1987 near Corsica (France) and Maigret, 1978 working on the same species off Mauritanian coasts. Also the growth performance index Φ was the higher one evaluated at 2.266 for this study and was noted between 0.664 and 1.842 in other areas (Table 5).

Table 5. Von Bertalanffy growth parameters for the genus *Palinurus* from different areas

Species/Locality	Sex	n	CL _∞ (mm)	K (yr ⁻¹)	t ₀ (yr)	Φ	Author
<i>Palinurus elephas</i> (France, Corsica)	M	417	166.025	0.15100	0.348	1.619	Marin, 1987
	F	278	135.916	0.18900	0.342	1.522	
<i>Palinurus gilchristi</i> South Africa (Agulhas Bank to Port Elizabeth)	M	-	111.00	0.09200		1.054	Groeneveld, 1997
	F	-	96.00	0.12900	-	1.075	
<i>Palinurus gilchristi</i> South Africa (Port Alfred)	M	-	96.00	0.05000		0.664	
	F	-	78.00	0.06500			
<i>Palinurus mauritanicus</i> Mauritania Algeria (Béni-Saf Bay)	F	-	202.8	0.16900	0.227	1.842	Maigret, 1978
	C	121	320.3	0.1800	-0.16	2.226	Present study

M: males, F: females, C: combined, n: number

Growth parameters can vary between stocks and even between areas as stated by (Sparre et al., 1989; Andrade and Campos, 2002; Hoşsucu and Cakır., 2003). It can be attributed to the combination of one or more of the following factors: a) differences in the number of specimen examined, b) area/season effect and c) differences in the observed length ranges of the specimen caught. Dulcic and Kraljevic (1996) stated that temperature, food (quantity, quality and size), sex and stage of maturity are responsible for the differences.

As we said previously, the rarity of data on *P. mauritanicus* fisheries didn't allow us to compare our results with other works but we can note that natural mortality found during our study is the same for the different localities with other species for the same genera given that they live in same habitat around islands that have suitable rocky substrates. Marin, 1985 states that predation is the major cause of natural mortality during moulting and early stages of *P.elephas* a congeneric species of *P.mauritanicus* living in the same habitat, *Epinephelus marginatus*, *Octopus vulgaris* are the major predators and pelagic fishes also predate on fragile puerulii.

Despite the value ($E \approx 0.4$) of the exploitation ratio calculated that expresses a situation near the full exploitation of the resource in Béni-Saf Bay, the rarity of *P.mauritanicus* specimens among fish and sea products landed daily these last years is obviously seen. More than fifty lobster species exist all

around the world more or less exploited. Some of them occupies large geographical zones ensuring a balanced production of thousand tons per year, the case of Caribbean, Australian, New Zealand and South African waters, other lobsters including *P. mauritanicus* engender few tons per year given that it occupies limited territory around small islands and rocky substrates. If we consider that trawlers are capable of destroying 33 square kilometers of habitat on the continental shelf in just 15 days (Fossa, 2002), urgent measures must be taken to preserve this resource from imminent extinction:

- establishment of a total authorized catch value per year
- initiate quotas system inside each fishing area
- control fishing effort and gears (mesh size)
- respect of the closed season
- creation of MPA (Marine Protected Areas)
- update of the Minimum landing size set at 10 cm CL (JORADP, 2004) and increase it at least at 15 cm CL
- Forbid and sanction the capture of berried females

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REFERENCES

- Andrade, H.A. & Campos, R.O. (2002). Allometry coefficient variations of the length-weight relationship of skipjack tuna (*Katsuwonus pelamis*) caught in the southwest South Atlantic. *Fisheries Research*, 55: 307-312. doi: 10.1016/S0165-7836(01)00305-8
- Bachir Boudjra, B.A, Ghellai, M, Bachir Boudjra, M.A, Bensahla Talet, L. & Kerfouf, A. (2014). The spiny lobster, *Palinurus mauritanicus* (Gruvel, 1911) from Algerian west coasts: a species to protect. *International Journal of Sciences: Basic and Applied Research* (IJSBAR), 103-109.

- Bensahla Talet, L., Bensahla Talet A, Benfdal, Y., Bachir Boudjra, B.A. & Boutiba, Z., (2011). Connaissance, conservation et valorisation d'un Crustacé (Palinuridae), la langouste rose *Palinurus mauritanicus* (Gruvel, 1911) des côtes Ouest-Algériennes (in French). 2^{ème} séminaire Maghrébin sur la gestion des ressources naturelles et le développement durable (GRN2D) "mieux optimiser pour mieux gérer". Sidi Bel-Abbes 17 et 18 Mai, 2011.
- Boitard, J.F. (1981). La dynamique des stocks de langouste rose *Palinurus mauritanicus* sur les côtes mauritaniennes (in French). Mémoire de fin d'étude ISTPM, (Institut Spécialisé de Technologie des Pêches Maritimes) la Trinité sur mer, 1-133.
- Campillo, A. & Amadei, J. (1989). Données Biologiques sur La Langouste de Corse *Palinurus elephas* Fabricius (in French). Revue des travaux de l'I.S.T.P.M. (Institut Spécialisé de Technologie des Pêches Maritimes), 42(4): 347-373.
- Caverivière, A., Thiam, M., Thiam, D. & Lopez Abela, I. (1986). Rapport de synthèse des campagnes conjointes hispano-sénégalaise de chalutage sur les stocks profonds du Sénégal (1982-1984) (in French). Archives Scientifiques du Centre de Recherches Océanographiques, 3(4): 55p.
- Diop, M. (1990). Relations biométriques de quelques espèces de Crustacés pêchées en Mauritanie (in French). Bulletin du Centre National des Recherches Océanographiques et de Pêche. 27.60p.
- Dulcic, J. & Kraljevic, M. (1996). Weight-length relationships for 40 fish species in the eastern Adriatic (Croatian waters). *Fisheries Research*, 28:243-251. doi: [10.1016/0165-7836\(96\)00513-9](https://doi.org/10.1016/0165-7836(96)00513-9)
- Fossa, J.H. (2002). Coral reefs in the North Atlantic. Marine World. ICES. <http://www.ices.dk/marineworld/deepseacoral.asp>
- Gayanilo, F.C. Jr., Soriano, M. & Pauly, D. (1989). A draft guide to the Complete ELEFAN. ICLARM Software 2. 70p.
- Gonçalves, J.M.S., Bentes, L., Lino, P.G., Ribeiro Canário, A.V.M. & Erzini, K. (1997). Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. *Fisheries Research*, 30:253-256. doi: [10.1016/S0165-7836\(96\)00569-3](https://doi.org/10.1016/S0165-7836(96)00569-3)
- Gofii, R. & Latrouite D. (2005). Review of the biology, ecology and fisheries of *Palinurus* species of European waters: *Palinurus elephas* (Fabricius, 1787) and *Palinurus mauritanicus* (Gruvel, 1911). *Cahiers de Biologie Marine*, 46, 127-142.
- Groenvelde, J.C. (1997). Growth of spiny lobster *Palinurus gilchristi* (Decapoda: Palinuridae) off South Africa. *South African Journal of Marine Science*, 18, 19-29. doi: [10.2989/025776197784160983](https://doi.org/10.2989/025776197784160983)
- Gulland, J.A. (1971). The Fish Resources of the Ocean. Fishing News. (Books) Ltd, West Byfleet.
- Holthuis, L.B. (1991). Marine Lobsters of the World. FAO Species Catalogue, Vol. 13. FAO Fisheries Synopsis, 125. FAO, Rome.
- Hoşsucu, B. & Cakir, D.T. (2003). Some Parameters about Population Biology of the Common Pandora (*Pagellus erythrinus* L., 1758) (Sparidae) in the Edremit Bay (Turkey). *Ege Journal of Fisheries and Aquatic Sciences*, 20: 329-336.
- J.O.R.A.D.P. (2004). Journal Officiel de la République Algérienne Démocratique et Populaire N° 18. 3 Safar 1425 du 24 mars 2004 fixant les tailles minimales marchandes des espèces Biologiques (in French).5p.
- Jones, R. & Van Zalinge, N.P. (1981). Estimations of mortality rate and population size for shrimp in Kuwait waters. *Kuwait Bulletin of Marine Sciences*, 2: 273-288.
- Kadari, G. (1984). Les techniques de pêche utilisées en Algérie (in French). Edition Enap et Publisud., 134p.
- Latrouite, D. & Noel, P. (1997). Pêche de la langouste rouge *Palinurus elephas* en France. Elements pour fixer une taille marchande (in French). International Council for exploration of the Sea. ICES CM 1997/BB:13 Theme Session on Biology and Behaviour (I). 12p.
- Maigret, J. (1978). Contribution à l'étude des langoustes de la côte occidentale d'Afrique. *Palinurus regius* et *Palinurus mauritanicus* (in French). Thèse de Doctorat d'État. Sciences Naturelles. Université d'Aix-Marseille, 264 p.
- Marin, J. (1985). La langouste rouge: Biologie et exploitation (in French). La pêche maritime. Février 1985:105-113.
- Marin, J. (1987). Exploitation, biologie et dynamique du stock de la langouste rouge de Corse *Palinurus elephas*, Fabricius (in French). Thèse de Doctorat de l'université d'Aix Marseille II. 348 p.
- Minchin, D. (1989). The most northerly population of the deep water crawfish *Palinurus mauritanicus* Gruvel. *Irish Naturalists' Journal*. 23 (4), 142-145.
- Morey, G., Moranta, J., Massuti, E., Grau, A., Linde, M., Riera, F. & Morales-Nin, B. (2003). Weight-length relationships of littoral to lower slope fishes from the Western Mediterranean. *Fisheries Research*, 62: 89-96. doi: [10.1016/S0165-7836\(02\)00250-3](https://doi.org/10.1016/S0165-7836(02)00250-3)
- Munro, J.L. & Pauly, D. (1983). A simple method for comparing the growth of fishes and invertebrates. *ICLARM Fishbyte*. 1(1):5-6.
- Pauly, D. (1983). Some simple methods for the assessment of tropical fish stocks. *FAO Fisheries Technical Paper*. (234): 52 p.
- Secci, E., Cuccu, D., Follesa, M.C. & Cau, A. (2000). Fishery and tagging of *Palinurus elephas* in Sardinian seas. In: vonVaupel Klein, J.C., Schran, F.R. (Eds.), The Biodiversity Crisis and Crustacea. *Crustacean Issues* (pp. 665-672), vol. 12.
- Sparre, P., Ursin, E. & Venema, S.C. (1989). Introduction to tropical fish stock assessment. Part I. Manual. *FAO Fisheries Technical Paper* No. 306.
- Tidu, C., Sarda, R., Pinna, M., Canna, A., Meloni, M.F., Lecca, E. & Savarino, R. (2004). Morphometric relationships of the European spiny lobster *Palinurus elephas* from northwestern Sardinia. *Fisheries Research*, 69:371-379. doi: [10.1016/j.fishres.2004.06.003](https://doi.org/10.1016/j.fishres.2004.06.003)
- Vincent-cuaz, L. (1958). La langouste rose de Mauritanie *Palinurus mauritanicus* Gruvel (in French). Revue des Travaux de l'Institut des Pêches Maritimes., 22 (3) 1958.
- Zar, J.H. (1999). Biostatistical Analysis, fourth ed. Prentice Hall Inc., p. 663.
- Zemenzer, S. (2011). Application du modèle ROMS dans la méditerranée occidentale (in French). Circulation de LIW dans le bassin Algérien. Master Université de la Méditerranée. Aix-Marseille II. 22p.

Original Article

Population dynamic parameters of the red mullet *Mullus barbatus* (Mullidae) in the Arzew Gulf, Algeria

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Abstract: Population dynamic parameters of red mullet, *Mullus barbatus* (n=592) caught by trawlers operating in Arzew Gulf (Algeria) in the western Mediterranean were studied. Samples were collected between February 2003 and January 2004. Females ranged from 10.9-23.2 cm in total length and 12-149.2 g in weight whereas males length was comprised between 12.6 and 19.7 cm and weight between 21.3 and 99.9 g. The relationship between length and weight was $W=0.00167L^{2.842}$ ($r^2=0.850$). Growth parameters of the von Bertalanffy equation were: $L_{\infty}=208.9$ cm, $K=0.66$ year⁻¹, and $t_0=-0.143$ year for males, while for females: $L_{\infty}=250.9$ cm, $K=0.6$ year⁻¹, and $t_0=-0.015$ year. Estimates of total (Z), natural (M) and fishing (F) mortalities were: 1.58, 0.8 and 0.79, respectively and the estimated exploitation ratio 0.5 indicating that the resource is being exploited at its limit in this area. The virtual population analysis of *M. barbatus* by VIT software showed that the number of recruits per year was estimated at 4447304.6 individuals, balanced total biomass was estimated at 168 486 tons, the gains are represented by recruitment 51.71 tons (30.69%) and growth 116.76 tons (69.31%), losses are represented by natural mortality 98.48 tons (58.45%) and fishing mortality 70 tons (41.55%). The current yield per recruit was estimated to $Y/R=15.74$ g and maximum sustainable yield can be reached by increasing the current fishing effort to stabilize it at $MSY=17.91$ g.

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Introduction

Red mullet, *Mullus barbatus* is a demersal fish living on muddy, sandy or gravel bottoms of the continental shelf between 10 to 500 m of depth. It is usually caught by trawlers (Bauchot and Hureau, 1986) and represents one of the economically most important species for trawl fishery at Oranian coasts. Several works have already been made on its biological features in the Mediterranean basin (Ardizzone, 1998; Jukic-Peladic, 1998; Marano et al., 1998; Morey et al. 2003; Gharbi et al., 2004; Ozbilgin et al., 2004; Layachi, 2007; Joksimović et al., 2008; Maximov et al., 2008; Mehanna, 2009; Giacalone et al., 2010; Sieli et al., 2011; Aydın and Karadurmuş, 2013; Cherif, 2014; Çiçek, 2015).

Arzew Gulf is located between Stidia and Mostaganem towns in the Algerian shoreline of

Mediterranean with the geographical coordinates of 35°49'59"N and 00°10'00"W. It constitutes one of the biggest petroleum harbors and many industrial complexes are situated in this area making it an industrial and commercial hub for Algerian economy. Arzew fishery is the second one in the area after Oran town fishery and supplies the surrounding towns in sea products.

The aim of this work was to describe some population dynamical parameters of *M. barbatus* in the Arzew Gulf to ensure the renewal of the resource given that it is under over fishing pressure during these last decades (Bensahla Talet and Boutiba, 2000) similar to benthic species of this Gulf. Also, this study will contribute enriching the available data on growth and fisheries of this species in the Western Mediterranean.

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Materials and Methods

A total of 594 specimens of *M. barbatus* were caught by a commercial bottom trawlers, operating in the Gulf of Arzew (Fig. 1) at depths of 150-300 m between February 2003 and January 2004. The total length (L) was measured with an ichthyometer to the nearest 1 mm; total weight (W) was measured with a precision balance to the nearest 0.1 g, and sex of individuals was determined after opening their abdominal cavity.

The length-weight relationship (LWR) is generally expressed by the following equation: $W = \alpha * L^b$ (Ricker, 1973), where W is the total weight (g) and L = total length (cm). The parameters α and b were estimated by the method of least squares obtained by logarithmic transformation to correct the nonlinearity of the original curve and the heterogeneity of variances:

$$\text{Log } W = b * \text{Log } L + \text{Log } \alpha$$

The null hypothesis for the isometric growth ($H_0: b=3$) was analyzed by t-test, using the following statistical formula: $t_s = (b-3)/S_b$, where S_b is the standard deviation of the parameter b , for $\alpha=0.05$ (Morey et al., 2003). The parameters of the equation of von Bertalanffy growth were estimated using the ELEFAN method (FISAT II Gayanilo et al., 2005): $L_t = L_\infty [1 - e^{-k(t-t_0)}]$, where L_t is total length in cm at a given age L_∞ is asymptotic length, k is growth curve parameter, and t_0 is hypothetical age for a length equal to zero.

The Jones and Van Zalinge plot (Jones and Van Zalinge, 1981) was used to estimate total mortality using FISAT II (Gayanillo et al., 2005), the natural mortality was calculated using Pauly's empirical equation (Pauly, 1980) as following:

$$\ln(M) = -0.0152 - 0.279 \ln(L_\infty) + 0.6543 \ln(K) + 0.463 \ln(T)$$

Where T is the mean annual habitat temperature (in °C) considered here at 17.5°C, and F the fishing mortality was deducted from the subtraction of M from Z ($Z=M+F$). The selection length which corresponds to the probability of capture of each individual by the fishing gear was determined by plotting the cumulated catch curve (Pauly, 1984). The exploitation ratio E was estimated from Gulland

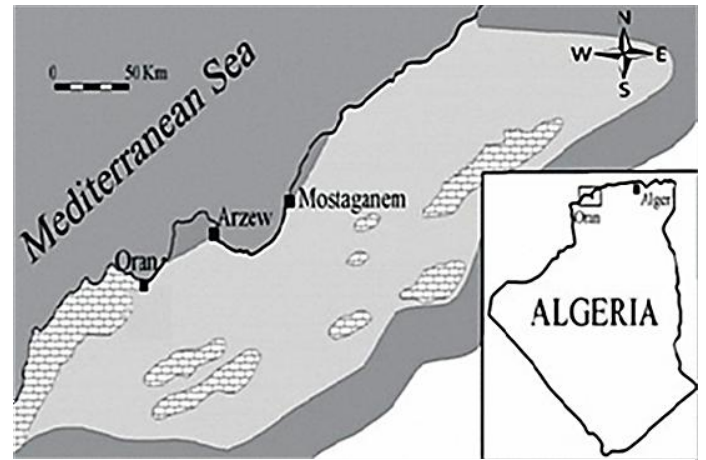


Figure 1. Sampling area (Arzew Gulf).

formula (Gulland, 1971): $E = F/Z$. ($E < 0.5$ underexploited stock, and $E > 0.5$ overexploited stock). VIT Software (Leonart and Salat, 1997) was developed initially for assessing Mediterranean fisheries dealing with pseudo-cohorts when information about annual catch at length or age is limited to a short period of individual or few consecutive years (Ratz et al., 2010). The program has as entry data: growth parameters of von Bertalanffy (L , k , t_0), LWR, natural mortality (M), fishing mortality (F), and length at first maturity. Also it only requires knowledge of annual catches for a given exploited species (70 tons in the case of this study) instead of a long historical series of ten years (Bouaziz et al., 2010).

Results

From 594 collected specimens of *M. barbatus*, 258 were males (43.58%), 318 were females (53.37%) and 18 were unsexed (3.04%). The sex ratio was in favor of females 1:0.81 (Fig. 2) but the χ^2 test did not reveal any significant difference ($\chi^2 = 2.93 > \chi^2_{1,0.05} = 3.84$). The total length of males ranged 12.6-19.7 cm and their weight 21.3-99.9 g. The total length of females ranged 10.9-23.2 cm and their weight 12-149.2 g. The length frequency distribution of the entire population of *M. barbatus* is presented in Figure 3.

The LWRs are shown in Table 1 and Figure 4a, b, c. Males exhibits a positive allometric growth pattern, while females had a negative allometric

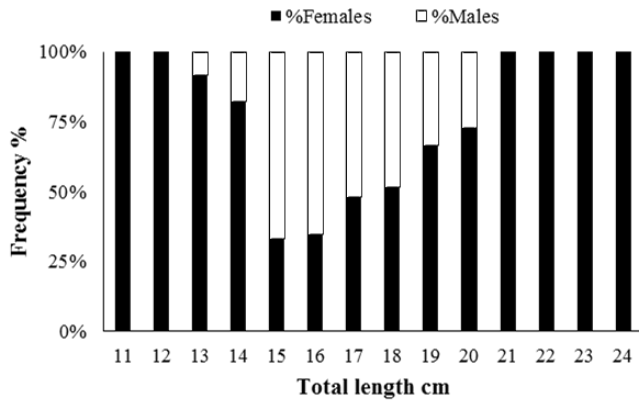


Figure 2. Sex ratio distribution in relation to length of *Mullus barbatus* caught in Arzew Gulf.

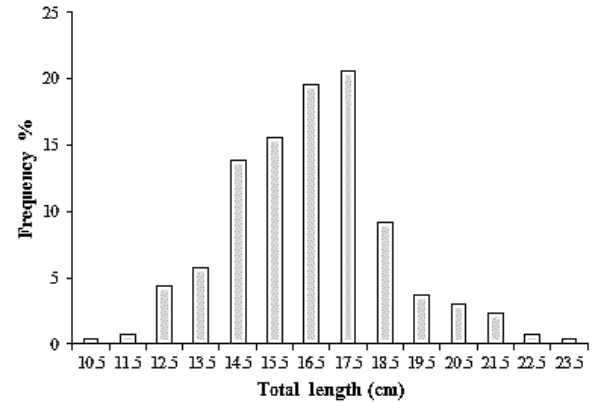


Figure 3. Length frequency distribution of *Mullus barbatus* caught in Arzew Gulf.

Table 1. Parameters of the length-weight relationship of *Mullus barbatus* caught in Arzew Gulf.

	n	α	b	se of b	r ²
Combined	594	0.0172	2.83*	0.015	0.83
Males	258	0.0079	3.11*	0.041	0.84
Females	318	0.0176	2.82*	0.057	0.86

n: number, se of *b*: standard error of *b*, *: significant test-t (t-test, $P < 0.05$).

Table 2. Parameters of the von Bertalanffy growth equation, the rates of total (Z), natural (M) and fishing (F) mortalities and exploitation ratio (E) of *Mullus barbatus* caught in Arzew Gulf.

	L _∞ (mm)	K (Yr ⁻¹)	t ₀ (Yr)	Z	M	F	E
Combined	250.9	0.49	-0.185	1.580	0.794	0.786	0.490
Males	208.9	0.66	-0.143	1.560	1.010	0.550	0.350
Females	250.9	0.60	-0.150	1.700	0.906	0.794	0.467

Table 3. Virtual population analysis parameters of *Mullus barbatus* caught in Arzew Gulf obtained by VIT 1.3 software.

Class (cm)	Catch in Weight (g)	Catch in number	Z	F	VPA parameters	Result
10.5	62226.66	4447304.6	0.808	0.008	Total Biomass Balance, D	168.486 t
11.5	163381.13	3971900.97	0.817	0.017		
12.5	1354669.35	3513191.49	0.917	0.117	Spawning Stock Biomass (SSB)	79.48 t
13.5	2201490.45	3027695.76	0.965	0.165	Stock Mean Age	1.537 year
14.5	6495585.79	2554243.99	1.246	0.446		
15.5	8796137.83	2008513.55	1.392	0.592		
16.5	13215384.38	1493064.51	1.752	0.952	Stock mean length	13.872 cm
17.5	16378226.85	984290.21	2.265	1.465		
18.5	8495328.58	534870.29	1.814	1.014	Virgin stock mean age	1.674 year
19.5	4015651.3	304651.16	1.4	0.6		
20.5	3785692.09	182491.4	1.526	0.726	Virgin stock mean length	15 cm
21.5	3353111.66	92335.88	1.813	1.013		
22.5	1083359.34	32727.46	1.401	0.601	Biomass/Rercuit	27.681 g
23.5	599754.59	10696.75	1.586	0.786	SSB/Recruit	17.87 g
Total	70000000	23157978.02	-			

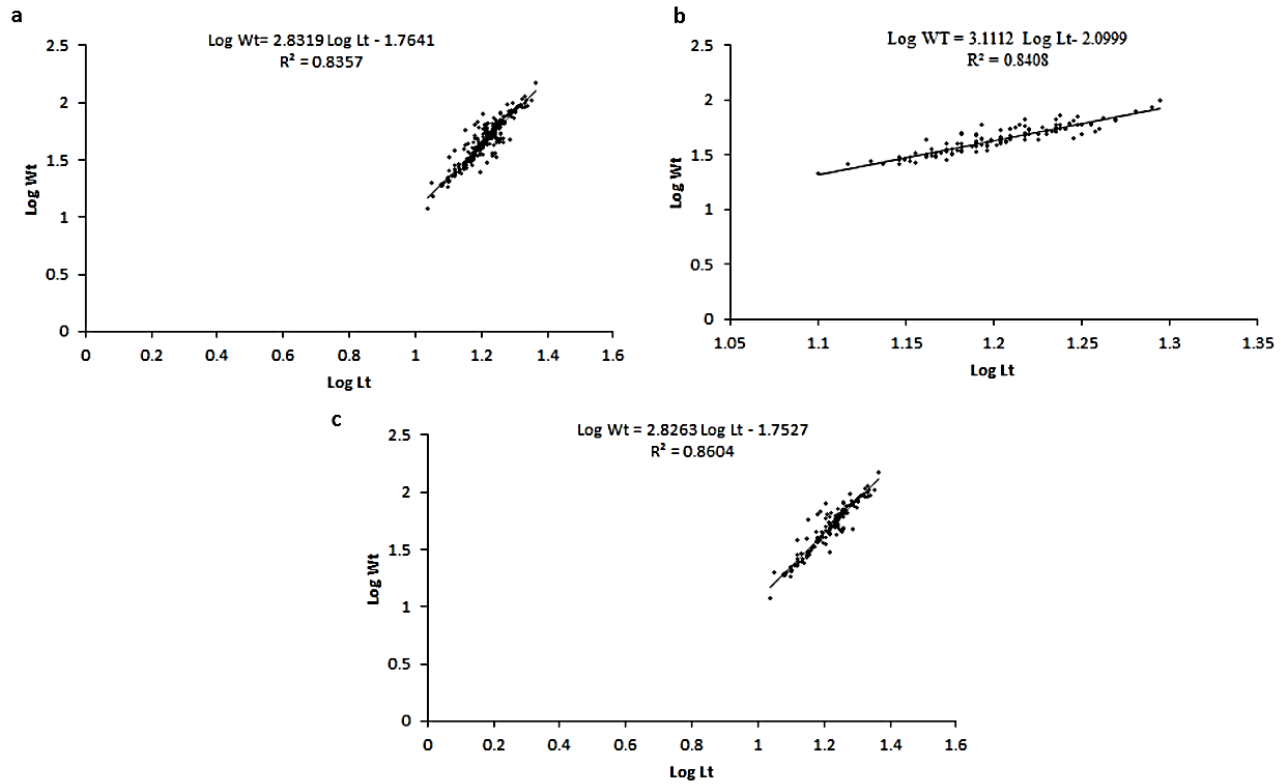


Figure 4. Parameters of the length-weight relationship of *Mullus barbatus* caught in Arzew Gulf. (a) all individuals, (b) males, and (c) females.

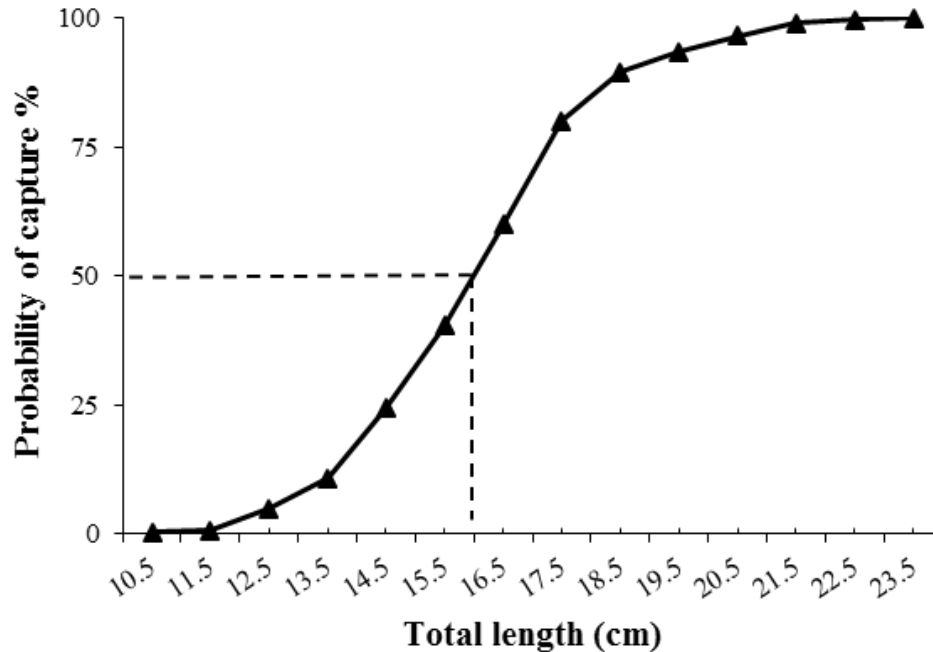


Figure 5. Gear selection ogive for *Mullus barbatus* caught by trawl in Arzew Gulf (codend mesh size of 4 cm).

growth pattern (t-test, $P < 0.05$). The selection length at which 50% of individual can be captured by the fishing gear was determined graphically (Fig. 5) and was evaluated at 16.08 cm of L_t . The von Bertalanffy

growth parameters, mortalities (Fig. 6a, b) and exploitation ratio are shown in Table 2. The exploitation ratio ($E = 0.49$) reflects a fishing situation near the equilibrium concerning the

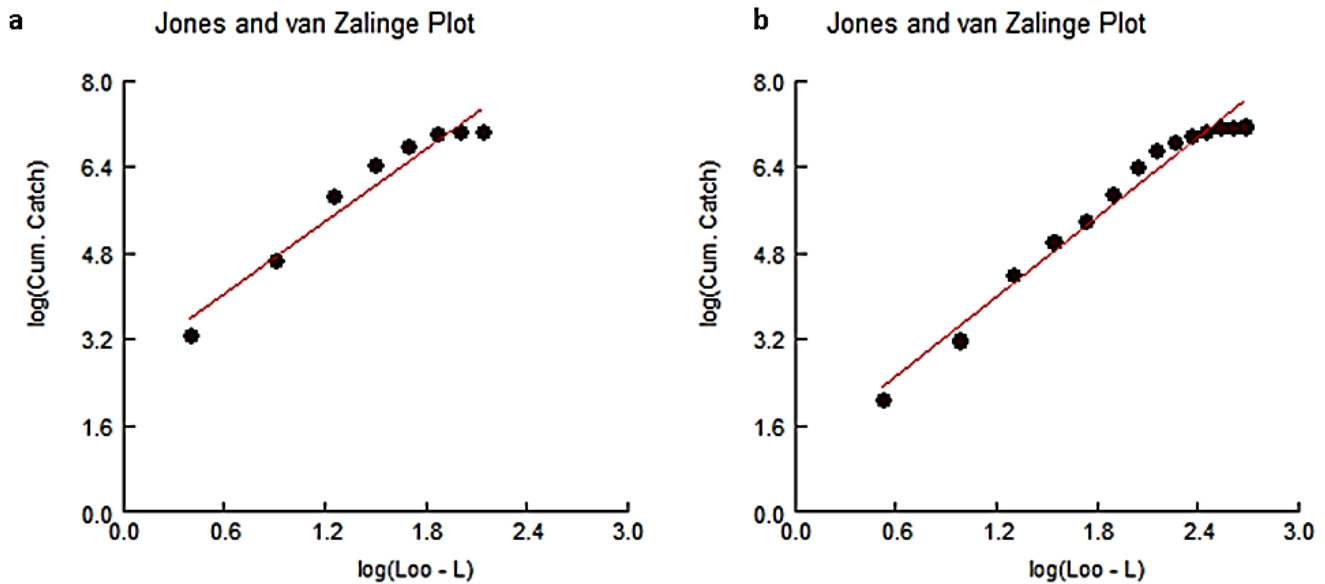


Figure 6. Total mortality of *Mullus barbatus* fished in Arzew Gulf. (a) males and (b) females.

Table 4. Length-weight relationship parameters for *Mullus barbatus* in the previous studies.

Locality	sex	n	α	b	se of b	r^2	Author
Turkey (Black Sea)	C	1435	0.00880	3.03	-	-	Aydın and Karadurmuş, 2013
Turkey (Iskenderun Bay, Mediterranean)	C	212	0.0072	3.1618	-	0.95	Çiçek, 2015
Romania (Black Sea)	C	680	0.00842	3.12	-	0.99	Maximov et al., 2008
Montenegro (Adriatic Sea)	C	-	0.00773	3.09	-	-	Joksimović et al., 2008
	M	-	0.00729	3.11	-	-	
	F	-	0.00767	3.10	-	-	
Italy (Castellammare Gulf)	C	18932	0.00820	3.09	0.00	0.98	Giacalone et al., 2010
	M	9596	0.00660	3.17	0.01	0.94	
	F	4730	0.00630	3.19	0.01	0.98	
Egypt (Mediterranean)	-	-	0.00770	3.10	-	-	Mehenna, 2009
Morocco (Mediterranean)	C		0,000009	3,03	-	0.98	Layachi et al., 2007
Algeria (Arzew Gulf)	C	594	0.01720	2.83	0.150	0.83	Present study
	M	258	0.00790	3.11*	0.041	0.84	
	F	318	0.01760	2.82*	0.057	0.86	

n: number, M: males, F: females, C: combined sexes, se of b : standard error of b , and r^2 : coefficient of regression.

exploitation of this Mullidae.

The virtual population analysis of *M. barbatus* by VIT software showed that the mean number of *M. barbatus* specimen in Arzew Gulf is $23.15 \cdot 10^6$ while the number of recruits per year was estimated at 4447304.6 represented by size class 10.5 cm (Table 3). Individuals between 16.5 and 19.5 are the most affected by the fishing gear deployed (bottom trawl). The average age of the current stock is 1.53

years and the average size 13.87 cm.

The total balanced biomass is equal to 168.48 tons with gains mainly represented by growth 116.76 tons (69.31%) and recruitment 51.71 tons (30.69%) and losses are represented by natural mortality 98.48 tons (58.45%) and fishing mortality 70 tons (41.55%). The current yield per recruit was estimated to $Y/R=15.74$ g (for $F=0.79$) and maximum sustainable yield can be reached by increasing the current fishing

Table 5. Growth parameters of *Mullus barbatus* given by different authors.

Locality	Sex	n	L_{∞} (mm)	K (Yr ⁻¹)	t_0 (Yr)	Author
Tunisia (Gabes Gulf)	C	-	267.3	0.51	-0.010	Gharbi et al., 2004
Montenegro (Adriatic Sea)	C	671	301.2	0.11	-3.182	Joksimović et al., 2008
	M	-	178.1	0.28	-3.013	
	F	-	274.7	0.14	-2.688	
Romania (Black Sea)	C	680	163.2	0.37	-1.390	Maximov et al., 2008
Turkey (Izmir Bay)	C	110891	242.6	0.56	-0.305	Ozbilgin et al., 2004
Turkey (Iskenderun Bay)	C	212	219.8	0.19	-1.168	Çiçek, 2015
Italy (Castellammare Gulf)	F	595	221.2	0.38	-0.940	Sieli et al., 2011
Egypt (Mediterranean)	C	-	271.0	0.66	-	Mehenna, 2009
Morocco (Mediterranean)	C	-	270.0	0.43	-0.090	Layachi et al., 2007
Algeria (Arzew Gulf)	C	594	250.9	0.49	-0.158	Present study
	M	258	208.9	0.66	-0.143	
	F	318	250.9	0.60	-0.150	

n: number, M: males, F: females, and C: combined sexes.

Table 6. Total (Z), natural (M), fishing (F) mortalities and exploitation ratio (E) of *Mullus barbatus* in different areas.

Locality	Sex	n	Z	M	F	E	Author
Montenegro (Adriatic Sea)	C	671	0.749	0.342	0.407	0.54	Joksimović et al., 2009
Italy (Adriatic Sea)	-	-	3.51	0.91	2.60	0.74	Ardizzone, 1998
	-	-	1.2-1.9	0.43-0.77	0.77-1.13	0.59-0.64	Marano et al., 1998
Croatia (Adriatic Sea)	-	-	1.48	0.58	0.90	0.6	Vrgoč, 2000
Turkey (Izmir Bay)	C	110891	3.85	1.07	-	0.71-0.72	Ozbilgin, 2004
Turkey (Iskenderun Bay)	C	212	1.39	0.45	0.93	0.67	Çiçek, 2015
Algeria (Arzew Gulf)	C	594	2.86	0.82	2.03	0.71	Present study
	M	258	-	-	-		
	F	318	-	-	-		

effort to stabilize it at $MSY=17.91$ g ($F=1.73$).

Discussion

The growth pattern of *M. barbatus* in the Arzew Gulf seems to be different between the two sexes. In fact, males of this species grow faster than females as reported by Joksimović et al. (2008) from the Adriatic. Based on the results, females' asymptotic length is important than that of males due to the fact that males do not attain larger sizes in their natural habitat given that the males ($F=1.23$) are under a more fishing pressure than females ($F=0.79$). Furthermore, the females had a negative allometric growth pattern compared to the males ($b>3$) which confirms that males gain weight faster than length and this was in agreement with the results of Papaconstantinou et al. (1981) for this species in

Termaikos Gulf. Growth differences between sexes can be explained by the fact that females undergo significant physiological changes compared to males during their sexual cycle. The positive allometric growth pattern have been reported for this species in some other areas of Mediterranean (Table 4) which is not the case of females caught in Arzew Gulf probably due to weight loss after the spawning period.

The growth parameters of the von Bertalanffy equation differ greatly from one region to another (Table 5) probably due to the biotic and abiotic differences of their habitat. In fact, Magnan (1988), Walker (1997) and Svanbäck (2004) noticed that inter-population variation in LWR parameters are correlated with differences in the availability of resources or by geographical differences in

ecological conditions such as water temperature, salinity, and food supply. The maximum value of the growth constant (k) in the Arzew Gulf reflects fast growth of this species in agreement with findings of Mehenna (2009). This shows the fertility of Algerian waters probably due to entrance of the enriched water with plankton from the Atlantic and coastal upwelling (Taupier-Letage and Millot, 1988). Mortier (1992), Taupier-Letage and Millot (1988), and Salas et al. (2001) found that the Algerian current has a higher nutrient content than the other parts of the Mediterranean being supplied directly from the entering Atlantic current. Furthermore, Bosc et al. (2004) noted that nutrients concentrations are higher in the western Mediterranean basin than the eastern basin allowing the development of phytoplankton and zooplankton. The values of exploitation ratio differ from one region to another (Table 6) depending on the environmental factors affecting the natural mortality and the fishing effort deployed.

Conclusion

Based on the results, the stock of *M. barbatus* in Arzew Gulf is exploited at its maximum limit. In order to maintain a sustainable exploitation of this resource, it would be wise to increase reasonably the fishing effort for a better yield per recruit ensuring the renewal of this resource in Arzew Gulf. Algerian legislation had already set a minimum landing size (15 cm of total length) to preserve the resource but to our knowledge, it is insufficient.

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References

Ardizzone G.D. (1998). Un tentativo di valutazione delle condizioni di *Merluccius merluccius* e *Mullus barbatus* nei mari italiani. *Biologia Marina Mediterranea*, 5(2): 151-168.

- Aydın M., Karadurmuş U. (2013). An investigation on age, growth and biological characteristics of red mullet (*Mullus barbatus ponticus*, Essipov, 1927) in the Eastern Black Sea. *Iranian Journal of Fisheries Sciences*, 12(2): 277-288.
- Bauchot M.L., Hureau J.C., (1986). Sparidae. In: P.J.P. Whitehead, M.L. Bauchot, J.C. Hureau, J. Nielsen, E. Tortonese (Eds.). *Fishes of the North-eastern Atlantic and the Mediterranean*, Volume II, UNESCO, Paris. pp: 883-907.
- Bensahla Talet A., Boutiba Z. (2000). La pêche à Oran de 1995 à 1999. Actes des 4èmes journées tunisiennes des sciences de la mer: 17-19 novembre 2000, Mehdiia (Tunisie). 5 p. (In French)
- Bosc E., Bricaud A., Antoine D. (2004). Seasonal and inter annual variability in algal biomass and primary production in the Mediterranean Sea, as derived from 4 years of Sea Wifs observations, *Global Biogeochemical Cycles*, (GB1005)18.
- Bouaziz A., Kerzabi F., Brahmi B. (2014). Impact of the natural mortality (m) variability on the evaluation of the exploitable stock of sardine, *Sardina pilchardus* (Actinopterygii: Clupeiformes: Clupeidae) of the central region of the Algerian coast. *Acta Ichthyologica et Piscatoria*, 44(2): 87-97.
- Çiçek E. (2015). Age, growth and mortality parameters of *Mullus barbatus* Linnaeus, 1758 (Perciformes: Mullidae) in Iskenderun Bay, northeastern Mediterranean. *Iranian Journal of Ichthyology*, 2(4): 262-269.
- Gayanilo F.C.JR., Sparre P., Pauly D. (2005). FISAT II, FAO-ICLARM Stock Assessment Tool II. Revised version. User's Guide. FAO Computerized Information Series (Fisheries). 168 p.
- Gharbi H., Ben Meriem S., Bedoui R., El Abed A. (2004). Les pêcheries tunisiennes du rouget de vase (*Mullus barbatus* Linnaeus, 1758): évaluation des stocks et aménagement des pêcheries. *Marine Life*, 14(1-2): 49-57. (In French)
- Giacalone V.M., Anna G.D., Badalamenti F., Pipitone C. (2010). Weight-length relationships and condition factor trends for thirty-eight fish species in trawled and untrawled areas off the coast of northern Sicily (central Mediterranean Sea). *Journal of Applied Ichthyology*, 26(6): 954-957.
- Gulland J.A. (1971). The fish resources of the ocean. Fishing News (Books) Ltd, West Byfleet. 255 p.
- Joksimović A., Regner S., Gačić Z. (2009). Mortality of

- red mullet (*Mullus barbatus* Linnaeus, 1758) on the Montenegrin shelf (South Adriatic) Archives of Biological Science Belgrade, 61(3): 493-499.
- Joksimović A., Regner S., Kasalica O., Đurović M., Pešić A., Milica Mandić M. (2008). Growth of the red mullet, *Mullus barbatus* (Linnaeus, 1758) on the Montenegrin Shelf (South Adriatic). Electronic Journal of Ichthyology, 1: 1-7.
- Jones R., Van Zalinge N.P. (1981). Estimates of mortality rate and population. Size of shrimp in Kuwait waters. Kuwait Bulletin of Marine Sciences, 2: 273-288.
- J.O.R.D.P. (2004). Journal Officiel de la république algérienne démocratique et populaire N° 18. Décret exécutif n° 04-86 du 26 Moharram 1425 correspondant au 18 mars 2004 fixant les tailles minimales marchandes des ressources biologiques. (In French)
- Jukic-Peladic S., Vrgoc N. (1998). Problems and dilemmas in applying different techniques in fish population dynamics studies. CIHEAM - Options Méditerranéennes, 345-355.
- Layachi M., Melhaoui M., Srouf A., Ramdani M. (2007). Contribution à l'étude de la reproduction et de la croissance du Rouget barbet de vase (*Mullus barbatus* L., 1758) de la zone littorale méditerranéenne de Nador (Maroc). Bulletin de l'Institut Scientifique, Rabat, section Sciences de la Vie, 29: 43-51. (In French)
- Leonart J., Salat J. (1997). Vit 4 Win (1999-2011). Version 1.3-1999-2011. Software for fisheries analysis (User's guide). Institut de Ciències del mar (CSIC). FAO, Barcelona, Spain.
- Magnan P. (1988). Interactions between brook charr, *Salvelinus fontinalis*, and non-salmonid species: ecological shift, morphological shift, and their impact on zooplankton communities. Canadian Journal of Fisheries and Aquatic Science, 38: 240-244.
- Marano G., Ungaro N., Marzano M.C., Marsan R. (1998c). Le risorser demersali dell'Adriatico pugliese: Analisi di una serie storica ('85-'95) relativa ai dati di cattura e demografia degli stock. Biologia Marina Mediterranea, 5 (2): 52-67.
- Maximov V., Nicolaev, Radu S.G., Staicu I. (2008). Estimation of growing parameters for the main demersal fish species in the Romanian marine area. Cercetări Marine (Researches Marines), 37: 289-304.
- Mehanna S. (2009). Growth, mortality and spawning stock biomass of red mullet *Mullus barbatus* in the Egyptian Mediterranean Waters. Biophysical and Socio-economic Frame Conditions for the Sustainable Management of Natural Resources. Tropentag, October 6-8, 2009, Hamburg.
- Morey G., Moranta, J., Massuti E., Grau A., Linde M., Riera F., Morales-Nin B. (2003). Weight-length relationships of littoral to lower slope fishes from the Western Mediterranean. Fisheries Research, 62: 89-96.
- Mortier M., (1992). Instabilités du courant algérien. Thèse de Doctorat, Université d'Aix- Marseille II. 288 p. (In French)
- Ozbilgin H., Tosunoglu Z., Bilecenoglu M., Tokac A. (2004). Population parameters of *Mullus barbatus* in Izmir Bay (Aegean Sea), using length frequency analysis. Journal of Applied Ichthyology, 20: 231-233.
- Papaconstantinou C., Tsimenides N., Daulas C. (1981). Age, growth and reproduction of red mullet (*Mullus barbatus* L. 1758) in the Gulfs of Saronikos and Thermaikos. Thalassographica, 4: 39-66.
- Pauly D. (1980). On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. Journal du Conseil/Conseil Permanent International pour l'Exploration de la Mer, 39(3):175-192.
- Pauly D. (1984). Recent developments in the methodology available for the assessment of exploited fish stocks of reservoirs. In: J.M. Kapetzky, T. Petr (Eds.) Status of African reservoir fisheries. Committee for Island Fisheries of Africa, Technical Paper 10. pp: 321-326.
- Rätz H-J., Cheilari A., Leonart J. (2010). On the performance of fish stock parameters derived from VIT pseudo-cohort analysis. Scientia Marina, 74(1): 155-162.
- Ricker W.E. (1973). Linear regressions in fishery research. Journal of Fisheries Research, 30: 409-434.
- Salas J., Garcia-Ladona E., Font J. (2001). Statistical analysis of the surface circulation in the Algerian Current using Lagrangian buoys. Journal of Marine Systems, 29: 69-85.
- Sieli G., Badalucco C., Di Stefano G., Rizzol P., Anna G. D., Fiorentino F. (2011). Biology of red mullet, *Mullus barbatus* (L. 1758), in the Gulf of Castellammare (NW Sicily, Mediterranean Sea) subject to a trawling ban. Journal of Applied Ichthyology, 27: 1218-1225.
- Svanbäck R. (2004). Ecology and evolution of adaptive

morphological variation in fish populations. PhD Thesis, Umea University, Sweden.

Taupier-Letagee I., Millot C. (1988). Surface circulation in the Algerian basin during 1984. *Oceanologica Acta*, 9: 79-86.

Vrgoč N. (2000). Struktura i dinamika pridnenih zajednica riba Jadranskog mora. Disertacija. Sveučilište u Zagrebu. 198 p. (In Czech)

Waker J.A. (1997). Ecological morphology of lacustrine threespine stickleback *Gasterosteus aculeatus* L. (Gasterosteidae) body shape. *Biological Journal of the Linnean Society*, 61: 3-50.

چکیده فارسی

پارامترهای پویایی‌شناسی جمعیت کفال قرمز، *Mullus barbatus* (Mullidae) در خلیج آرزو، الجزایر

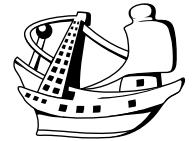
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چکیده:

در این تحقیق پارامترهای پویایی‌شناسی جمعیت کفال قرمز، *Mullus barbatus* (به تعداد ۵۹۲) صید شده به وسیله ترال در خلیج آرزو (الجزایر) در غرب مدیترانه مطالعه شد. نمونه‌برداری‌ها بین فوریه ۲۰۰۳ و ژانویه ۲۰۰۴ انجام شد. طول کل و وزن ماده‌ها به ترتیب ۲۳/۲-۱۰/۹ سانتیمتر و ۱۲-۱۴۹/۲ گرم بودند، در حالی که طول کل و وزن نرها به ترتیب ۱۹/۷-۱۲/۶ سانتیمتر و ۲۱/۳-۹۹/۹ گرم بود. رابطه طول-وزن نمونه‌ها $W=0.0167L^{2.842}$ ($r^2=0.85$) بدست آمد. پارامترهای رشد معادله وان‌برتلانفی عبارت بودند از: $L_{\infty}=20.8/9$ cm، $K=0.66$ year⁻¹ و سال $t_0=0.143$ برای نرها و $L_{\infty}=25.0/9$ و $K=0.6$ year⁻¹ و سال $t_0=0.15$ برای ماده‌ها. مرگ و میر کل (Z)، طبیعی (M) و صیادی (F) به ترتیب ۱/۵۸، ۰/۸ و ۰/۷۹ تخمین زده شدند و نسبت بهره‌برداری نیز ۰/۵ تخمین زده شد که بیانگر بهره‌برداری این منبع در حد نهایی در این منطقه می‌باشد. تحلیل مجازی جمعیت گونه *M. barbatus* توسط نرم‌افزار VIT نشان داد که تعداد بازسازی‌ها به میزان ۴۴۴۷۳۰۴/۶ قطعه در سال می‌باشد، زی‌توده کل بالانس شده ۱۶۸۴۸۶ تن تخمین زده شد، افزایش زی‌توده به واسطه بازسازی به میزان ۵۱/۷۱ تن (۳۰/۶۹ درصد) و به واسطه رشد به میزان ۱۱۶/۷۶ تن (۶۹/۳۱ درصد) را نشان داد، تلفات به واسطه مرگ و میر طبیعی به میزان ۹۸/۴۸ تن (۵۸/۴۵ درصد) و به واسطه مرگ و میر صیادی به میزان ۷۰ تن (۴۱/۵۵ درصد) را نشان داد. بازده جاری به بازسازی به صورت $Y/R=15.74$ g تخمین زده شد و حداکثر محصول پایدار که می‌تواند به وسیله افزایش تلاش صیادی بدست آید باید در حد $MSY=17.91$ g ثابت شود.

کلمات کلیدی: بهره‌برداری، صیادی، مرگ و میر، رابطه طول-وزن، وان‌برتلانفی.



Biometric characteristics and reproduction in the lesser-spotted dogfish *Scyliorhinus canicula* (Elasmobranchii: Scyliorhinidae) from the west coast of Algeria

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Abstract: A morphological study of *Scyliorhinus canicula* in Algerian coastal waters was undertaken using biometric measurements. Size variation of males and females was determined and the state of sexual development was assessed for functional significance. The total monthly sampling over one year comprised 209 males and 251 females. All specimens were collected from commercial landings of the Oran fishery. Total length of fish varied between 28.5 and 50 cm for females and 28.5 to 55 cm for males. Females showed no distinct morphological features of maturity but some changes in ovary and oviduct structure were observed. Mature males were easily recognizable by morphological changes in the urogenital tract. Adult testes are in an elongated mass form. The right testis is typically more developed and heavier than the left. Sexual maturity is reached after 5 years for both males and females when they are around 38 cm in total length and 290 g in weight. The maximum total length recorded was 55 cm, rather less than the maximum length of 80 cm reported for Atlantic populations. *Scyliorhinus canicula* is oviparous and eggs are produced throughout the year with peak periods occurring in different regions. Females with *in utero* egg-cases were observed throughout the year confirming a protracted breeding season but with peak egg-laying in June.

Resumé : *Caractéristiques biométriques et reproduction de la petite roussette Scyliorhinus canicula (Elasmobranchii : Scyliorhinidae) de la côte occidentale algérienne.* Une étude des caractéristiques morphologiques et de la reproduction a été menée sur la petite roussette *Scyliorhinus canicula* sur la base de mesures biométriques. La distribution des fréquences de taille des mâles et des femelles a été déterminée et l'état du développement sexuel a été évalué pour une interprétation fonctionnelle. L'échantillonnage mensuel dans le port de pêche d'Oran durant une année, comprend 209 mâles et 251 femelles. Les tailles varient entre 28,5 et 50 cm pour les femelles et 28,5 à 55 cm pour les mâles. Les femelles ne présentent pas de caractéristiques morphologiques distinctes indicatives de la maturité, mais certains changements de la structure de l'ovaire et de l'oviducte ont été observés. Les mâles matures sont reconnaissables par des changements morphologiques dans le tractus urogénital. Les testicules des adultes sont sous forme de masse allongée. Le testicule droit est plus développé et plus lourd. La maturité sexuelle est atteinte après 5 ans pour les deux sexes avec une taille de 38 cm et un poids de 290 g. Les femelles avec des œufs *in utero* sont observées le long de l'année confirmant une saison de reproduction prolongée, avec un pic de ponte en juin.

Keywords: *Scyliorhinus canicula* • Sexual maturity • Reproduction • Weight-testes mass relationship

Introduction

The lesser-spotted dogfish, *Scyliorhinus canicula* (Linnaeus, 1758) (Fischer et al. 1987) is widespread throughout the Mediterranean Sea and is common in the Northeast and Eastern Central Atlantic, from Norway to Senegal. It is one of the most abundant elasmobranchs around the Mediterranean coast of Algeria (Jardas, 1979; Lyle 1983; Baino et al. 2001; Capapé et al., 2008a, 2008b & 2014; Kousteni et al., 2010; Taleb Bendiab et al., 2012). Scientific surveys throughout most of its range suggest that populations are stable or even increasing in some coastal areas such as the UK (Rogers & Ellis, 2000). Reproduction is oviparous and the species appears to be relatively productive biologically (Mellenger, 1983), and so stocks may be able to withstand high levels of exploitation. The species is classified as of "Least Concern" IUCN (2009) because overall population trends appear to be stable in the Atlantic and in some parts of the Mediterranean Sea. There is no evidence to indicate that the regional population has declined significantly in the western part of the Algerian coast (Taleb Bendiab et al., 2012). However, since the species is being commercially more exploited most in Algerian waters. Catches and population trends now need to be monitored to assist the global vision for fisheries management in the Algerian coastal waters by better regulation of the fisheries to ensure their sustainability.

The lesser-spotted dogfish is common throughout the year in the Port of Oran fish market. Its frequency of occurrence fluctuates between 3-10% of the total fish in Algerian trawl catches (Zelmat, 2009; Bekada, 2014). Following information from local fishermen, the abundance of this fish in trawls from the Bay of Oran is highest between December to August. The fish are most frequently caught between 40 and 200 m depth (Massuti & Moranta, 2003; Bertrand et al., 2000). Baino et al. (2001) and Capapé et al. (2008a & 2014) reported juveniles made up the main proportion of the population (78%) as sampled in Italy and Tunisia. During the last decade, increased fishing pressure along the Algerian coasts is very likely to disturb the population dynamics of this species but no evidence about population trends is yet available and useful data are absent. Apparent discrepancies in available catch size estimates for this species were considered attributable to a shift in target species and changes in the operational range of the fishery (Abella et al., 2005; Taleb Bendiab et al., 2012; Bekada, 2014; Capapé et al., 2014).

The objective of this study is to provide data on the growth and sexual maturity of the lesser-spotted dogfish by qualitative analysis of male and female sex organs size of this species in the western part of the Algerian Mediterranean coastal fishery between Beni-Saf and Oran Bay. These data are considered important for the fishery management of this species in Algeria.

Material and Methods

The Algerian coast extends over 1280 km, and comprises two regions, eastern and western fishing areas. The western region extends over 500 km, from the Moroccan border to the western part of Algiers (including the Gulf of Oran). Trawlers mainly operating in Oran Bay target depths up to 400 m and the fishing activities are mainly concentrated between Beni Saf and the Gulf of Oran. The fish are mainly landed in the Port of Oran (Zelmat, 2009; Bekada, 2014).

For this study, lesser-spotted dogfish specimens were collected from the fish market at the port of Oran on a monthly basis between January and December 2014. A total of 460 individuals, 209 males and 251 females, were dissected and the organs were examined and analyzed. Specimens of each sex were studied separately. The proportions of males and females were calculated for each monthly sample. The total length and weights were recorded for both males and females and for the former the internal clasper length was measured. A qualitative assessment of female maturity was based on the condition of the gonad/duct system and the width of the nidamental (egg-case secreting) gland. Categories of sexual maturity were determined in females from the morphology of the ovary and the reproductive tract following Henderson & Casey (2001), Capapé et al. (2008a, 2008b & 2014) and Kousteni et al. (2010). Clasper length (CL) was measured from the anterior rim of the pelvic girdle to the clasper tip following Collenot (1966) and Capapé et al. (2014). The testes were extracted and weighted. For both males and females, three stages were considered:

- Stage 1. Juvenile phase with short and flexible claspers, testes and genital ducts discreetly developed (males) undeveloped ovaries, threadlike oviducts and inconspicuous oviducal glands (females)
- Stage 2. Sub-adult phase with developed claspers bordered by pelvic fins, testes increasing in mass, no spermatocytes externally visible, genital duct slightly convoluted anteriorly (males), ovary showing translucent follicles, well differentiated genital duct, oviducal glands visible and slightly round (female)
- Stage 3. Adult phase with claspers elongated, calcified, and rigid, slightly longer than pelvic fins that still surrounded them, testes well-developed with spermatocytes externally visible (male); genital duct twisted, a single functional ovary containing batches of yolky oocytes and fully developed genital ducts, oviducal glands conspicuously rounded with mass considerably increased, usually with one egg case in one or both oviducts at egg laying (female), following Henderson & Casey (2001), Kousteni et al. (2010) and Capapé et al. (2014). Size at sexual maturity was determined in females from the observations of ovaries and of the morphology of the reproductive tract

The linear and exponential regressions were expressed in decimal logarithmic coordinates. Correlations were assessed by least squares regression. In the relationship between mass and total length; and among clasper length and total length, comparisons of curves were carried out by using ANCOVA. ANOVA and ANCOVA were performed by using logistic model MINITAB 16.

Results

Growth and sex ratio

The parameter measurements (total length, clasper length, total weight and testes mass), are presented in Figures 1-5. The highest abundances of this dogfish in the Oran fish market was mainly observed during the period of February-March for females (Fig. 1) with the largest sizes in March and the highest abundance for males in April (Fig. 2). The male sizes ranged between 28.5 and 55 cm and female sizes between 28 and 49 cm (Fig. 3).

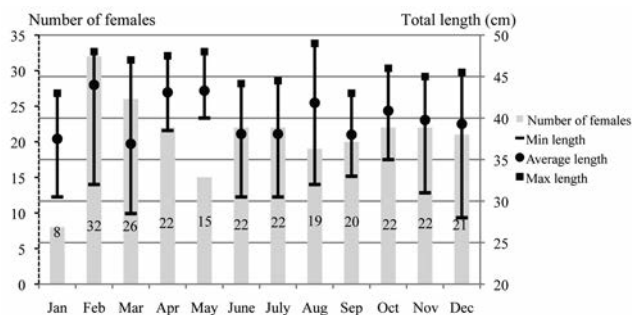


Figure 1. *Scyliorhinus canicula*. Total number, average, minimum and maximum for the total length of females (N = 251).

The demographic structure of the lesser-spotted dogfish specimens characterized the population as consisting mainly of medium-sized individuals (38-48 cm TL (Fig. 3) and weight 189-365 g). Sub-adult males (37.5-40 cm TL) had the elongated and rigid claspers. The smallest sexually mature male observed was 37.5 mm TL and weighed 189 g. The observed juveniles ranged between 27.5 and 37.5 cm TL and weighed between 99 and 170 g; 45 juveniles were observed, and all males above 42.5 cm TL were adults. The largest male was 55 cm TL and weighed 454 g. The adult males were observed throughout the year, except during November.

Except in April and September, females formed the greatest proportion of the sample population during the year (Fig. 4). Fluctuations in the proportion of females during autumn and winter could be related to the early

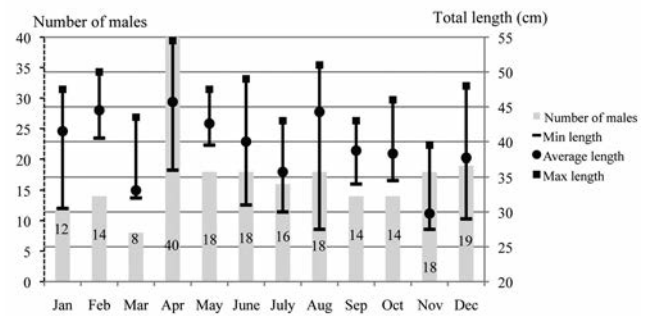


Figure 2. *Scyliorhinus canicula*. Total number, average, minimum and maximum for the total length of males (N = 209).

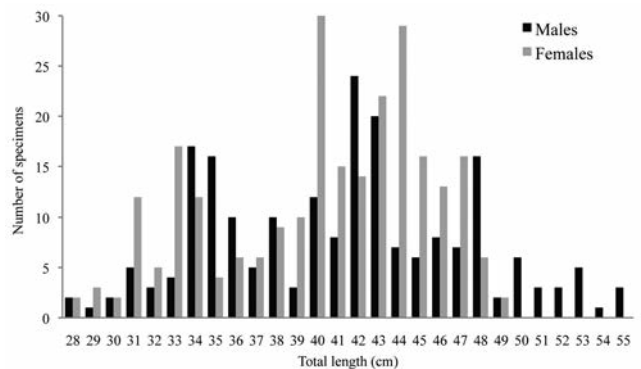


Figure 3. *Scyliorhinus canicula*. Total length distribution in the Oran bay during the study period.

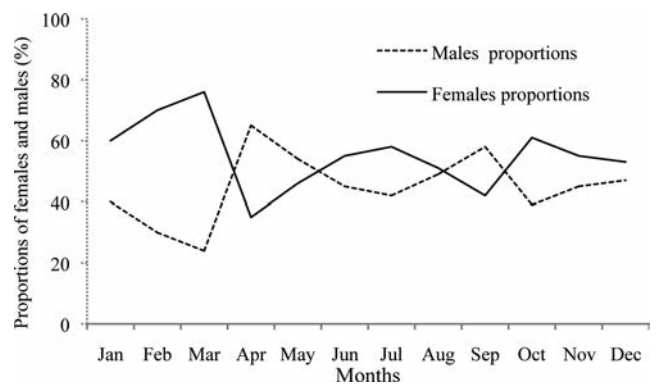


Figure 4. *Scyliorhinus canicula*. Monthly changes in proportions of females and males during the period January 2014-December 2014.

maturation period of the ovaries. March and April seem to correspond to a sexual rest or post-spawning period (Taleb Bendiab et al., 2012). Specimens from 37 to 43 cm of total length are mostly females. Large individuals are represented only by males with a total length of 45-50 cm.

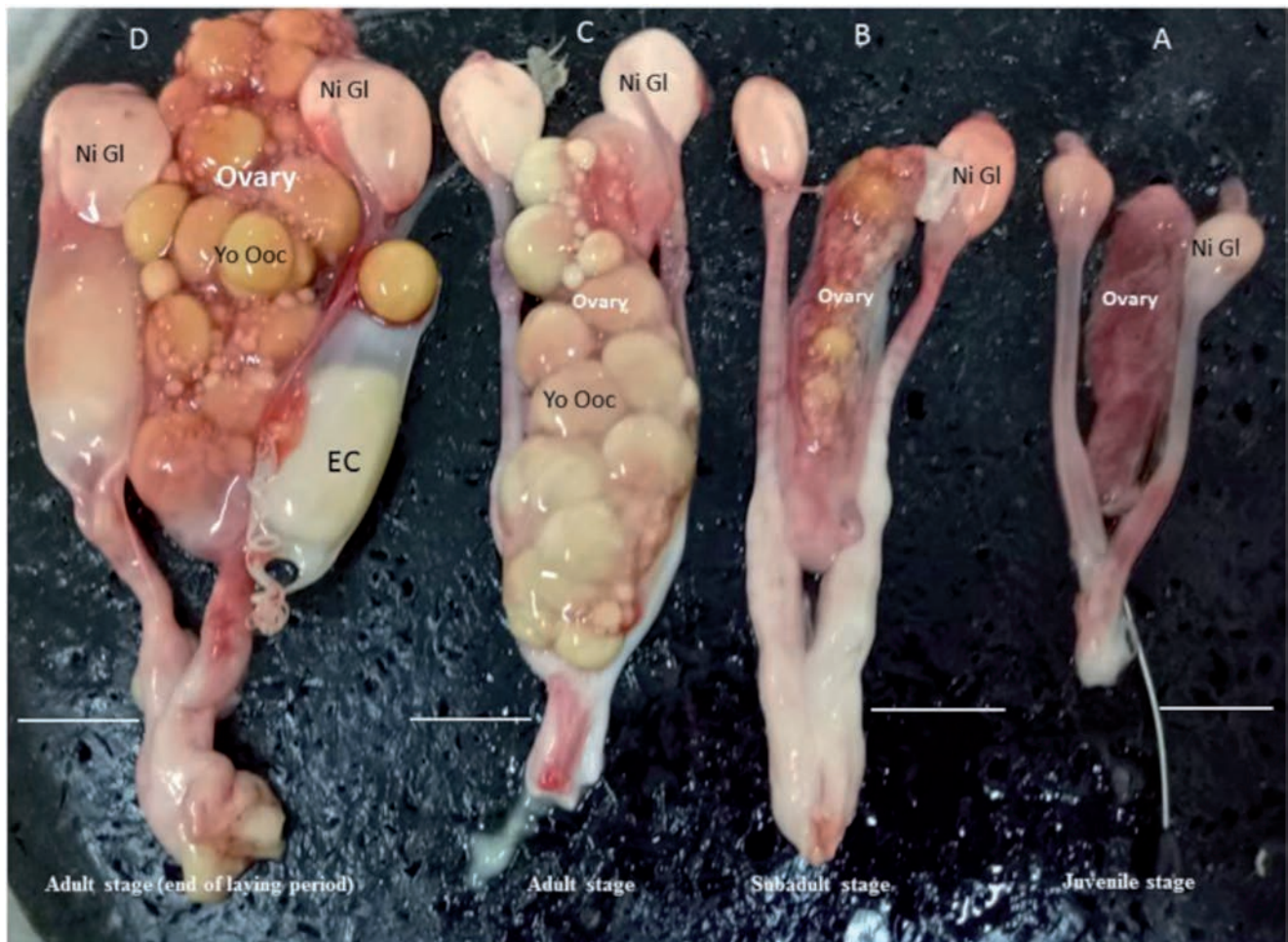


Figure 5. *Scyliorhinus canicula*. Females showing the ovary stages with yolky oocytes (Yo Ooc), the nidamental gland (Ni Gl) and egg capsule (EC) inside the genital tract. Scale bar = 2 cm.

The relationship between total length and total weight is very similar between females and males (Figs 6 & 7). The exponential regression for females is: $TW = 0.0005 TL^{3.5482}$ ($R^2 = 0.9655$, $p < 0.001$) (Fig. 6) and for males is $TW = 0.002 TL^{3.1096}$ ($R^2 = 0.9526$, $p < 0.001$) (Fig 7).

Sexual development

The relationship between the total length and the claspers indicate the sexual phases of male. The juvenile males ranged from 27.5 to 37.5 cm total length and weighed from 99 to 170 g. Sub-adults ranged between 38 and 45 cm and weighed between 145 and 345 g. This phase is represented throughout the year, with a peak in April and December. All specimens above 46 cm in total length are adult showing the elongated and calcified claspers. The relationship between total length and clasper length is a linear equation (Fig. 8). The coupling elements become rigid claspers and increased in size but they do not exceed the length of the pelvic fins that limited them. The smallest sexually mature

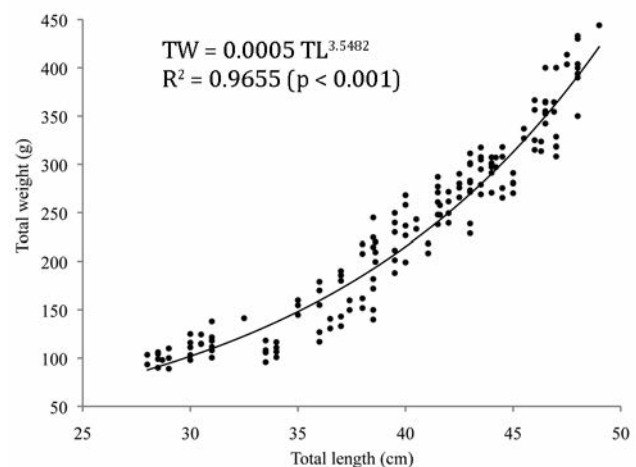


Figure 6. *Scyliorhinus canicula*. Relationship between total weight (g) and total length (cm) in females.

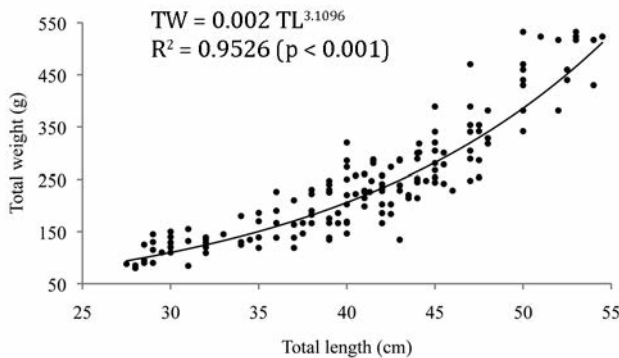


Figure 7. *Scyliorhinus canicula*. Relationship between total weight (g) and total length (cm) in males.

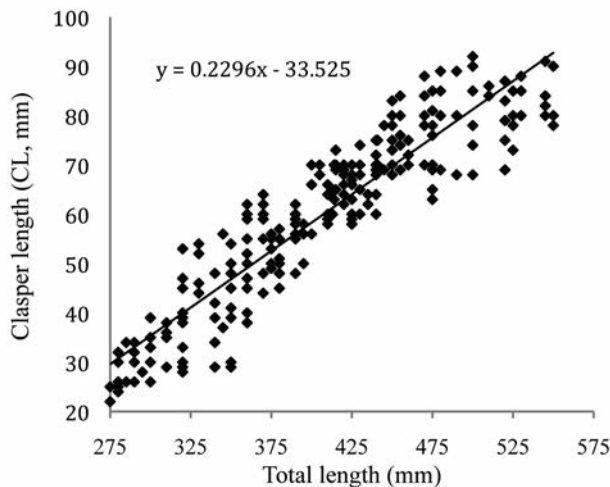


Figure 8. *Scyliorhinus canicula*. Relationship between total length (mm) and clasper length (mm).

male observed was 39 cm and weighed 295 g. The juvenile phase includes individuals with poorly developed and very flexible claspers. In the sub-adult phase, the growth claspers rate increases gradually and are rigid in the adult phase. The relationship between total length and testis weight is plotted in figure 9 and significant linear regression is noted.

The development of sexual maturity in females (Fig. 5) and in males (Figs 8-10) was considered separately. There is no external morphological character indicating the attainment of sexual maturity in females. Internally the changes in reproductive structures during the three stages of development in the female are however striking (Fig. 5). Females in the juvenile phase show no vitellogenesis activity and ovary has the appearance of a small and

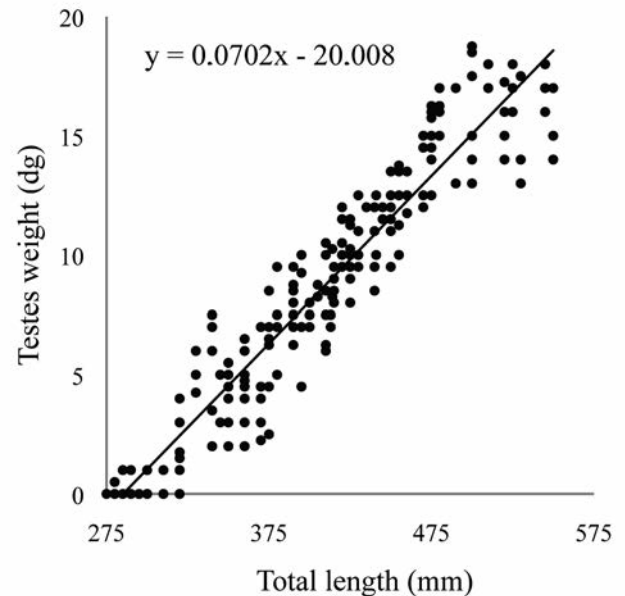


Figure 9. *Scyliorhinus canicula*. Relationship between total length (mm) and testes mass (dg).

inconsistent grey mass. The genital tract is threadlike and membranous. Ovary walls are thin with oocytes extremely small; nidamental glands undeveloped (Fig. 5A). After the juvenile stage, the ovary expands and takes a warty form in the sub-adult phase as oocytes multiply towards the periphery of the gland (Fig. 5C). They grow slowly, being translucent and greenish at first and gradually turn yellow. The oocytes (Fig. 5B) are in the low vitellogenesis growth phase. The genital tract continues to grow; the tubes and oviducts thicken and bulge. The nidamental glands separate from other organs and eventually become rounded laterally. During the adult phase, vitellogenesis activity is intense and ongoing. This results in a rapid growth phase and vitellogenesis culminates in the formation of mature oocytes in preparation for fertilization. The reproductive tract of adult females then acquires its final form (Fig. 5C-D). The walls of the various constituents are thick and muscular. The nidamental glands are noticeable and large and egg capsules are formed.

Adult testes are elongated mass form, richly vascularized in the elliptical section (Fig. 10 A-D). Changes shown in this figure show the marked size increase in both testes from 3-4 cm in length at the earliest stage to around 12 cm by the late stage. Both testes are poorly vascularization during the juvenile stage (Fig. 10D) but by the sub-adult stage (Fig. 10C) both vascularization and tissue growth have increased considerably. The mature testes are firmer, reddened and very well supplied with blood (Fig. 10A) and the sperm ducts are fully formed by

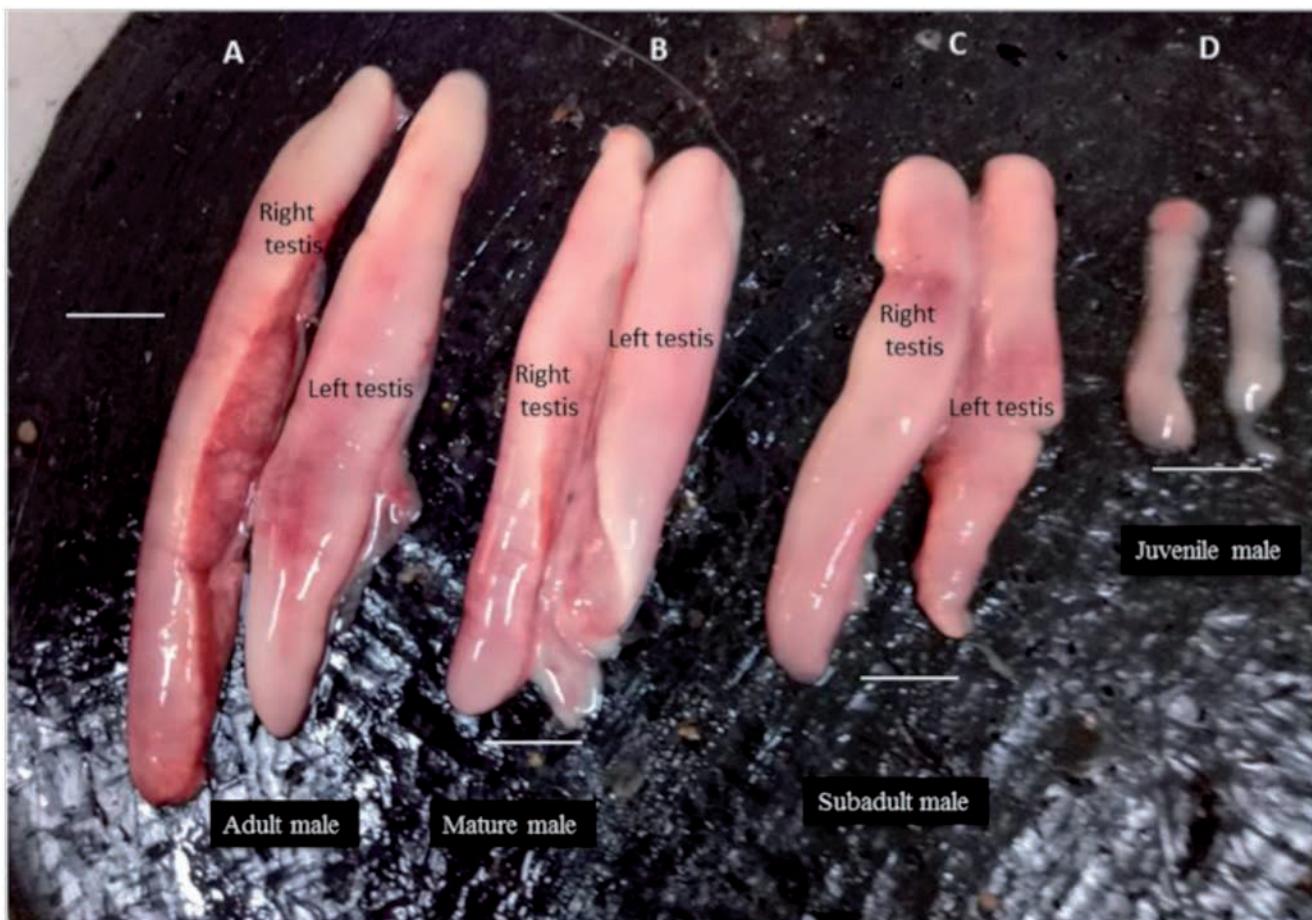


Figure 10. *Scyliorhinus canicula*. Stages of the testis maturation. Scale bar = 2 cm.

this stage (not shown). The right testis was the most developed in all specimens (Fig. 10A-C).

Discussion and Conclusion

The small-spotted dogfish was studied in the Mediterranean Sea by examining weight-length relationships, sexual dimorphism, and depth distribution pattern in some areas in Algeria. Similar studies on the development characteristics of this species have been carried out in other regions of the Mediterranean Sea (Taleb Bendiab, 2012), Tunisia (Capapé et al., 2014) and in North Aegean Sea (Kousteni et al., 2010). The present study has focused on basic information regarding the reproductive biology of the species population in the bay of Oran area. The morphometric data indicate that this fish reaches sexually maturity earlier and begins to reproduce at a smaller length in the Mediterranean Sea in comparison with East the Atlantic Ocean. Similarly differences in size in favor of males were also reported for different areas of the Mediterranean Sea by Rodriguez-Cabello et al. (2007), Capapé et al. (1991,

2008a, 2008b & 2014), and Taleb Bendiab (2012). These authors suggested the size difference between females and males could be related to the reproduction period with large females moving to specific reproduction habitats where they are less accessible to fishing gear (Rodriguez-Cabello et al., 1998).

Studies conducted by several authors in different areas of the Mediterranean and Atlantic, confirm that the length of first sexual maturity is similar for males and females. However, important differences in the size at maturity between the Atlantic and Mediterranean populations are reported, with small-spotted dogfish maturing between 520 and 600 mm at Roscoff and between 370 and 475 mm at Banyuls (Kousteni et al., 2010). Size ranges of male and female fish were also reported by Kousteni et al. (2010) were 37.1-48.8 and 36.4-46.7 cm for males and females respectively so compared with the Oran data (28.5-55 and 28-49 cm) this indicates that the Oran fishery may be better developed and that fishing intensity may be less as larger fish were recorded for the latter. Furthermore, in this study the fish matured between 380 and 450 mm and weighed

between 145 and 345 g (males and females) and this growth phase is represented throughout the year, with a peak in April and December. Our data indicates that sexual maturity of male fish was reached at about 38 cm and this compares favorably with that reported in the literature (Henderson & Casey, 2001; Kousteni et al., 2010; Capapé et al., 2014). The sexual development in the Oran specimens was assigned to stages that broadly corresponded to those described previously recognized (Sumpter & Dodd, 1979) and where the presence of mature oocytes and development of egg capsules in the genital tract are the main criteria of sexual maturity (Fig. 5D). Parameters that distinguish mature from immature specimens of *Scyliorhinus canicula* are the weight and width of the nidamental gland in females and testes form and the clasper outer length in males. Male sexual maturity is manifested by morphological changes in the urogenital tract as reported by different authors (Capapé et al., 2008a, 2008b & 2014; Kousteni et al., 2010; Taleb Bendiab, 2012). Capapé et al. (2014) indicated 40 cm TL for the smallest sexually mature male and this size is probably related to the sample size and periods in different regions of the Mediterranean Sea. Catch data for the lesser-spotted dogfish population in coastal waters of western Algeria showed that fish with an average size ranging from 35 to 45 cm were the most targeted and these corresponded to sub-adults and adults based on sexual maturity of the reproductive organs). However, large quantities of immature individuals (28.5-37 cm) are also caught contributing to overfishing of the species in the studied area. This study of growth and sexual maturity of *S. canicula*, indicates that inshore fishing is applying considerable pressure to the brood stock but as yet there is little evidence that the current stock is being depleted unsustainably. It is well known that increased fishing reduces mean size and loss of older fish and the Oran stock seems better placed than that of the north Aegean Sea (see Kousteni et al., 2010). Where target fisheries are changing, longer term data are needed to establish catch stability trends and consideration to climate change forcing effects on food availability also needs to be given (Perry et al., 2010). In the short-term however, it should be noted that depletion of targeted ground fisheries, for example in the Georges Bank area (North America) and elsewhere (Rogers & Ellis, 2000), and prescient new target fisheries can lead to increased dogfish catches (Fogarty & Murawski, 1998). Globally however estimated cartilaginous fish stocks are generally in decline although by-catch losses are unrecorded and the main the fishery is unmanaged (Stevens et al., 2000). For the Oran lesser spotted dog fish stock, increased fishing effort by the trawler fleet can only add pressure on the sustainability this fishery resource. Although IUCN and other studies indicate the lesser

spotted dogfish stock is not over-exploited this is expected to change in the future as fishing intensity increases. It is therefore prudent to use fisheries management instruments to reduce fishing effort in the inshore zone are continue careful monitoring of the stocks. Fishing effort can be reduced by transferring the commercial Oran fishery to offshore zones, beyond 3 nautical miles and so help off-set any future collapse of the fishery stock in the western Algerian Mediterranean coastal zone.

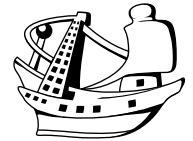
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References

- Abella A.J. & Serena F. 2005.** Comparison of elasmobranch catches from research trawl surveys and commercial landings at Port of Viareggio, Italy, in the last decade. *Journal of Northwest Atlantic Fisheries Science*, **35**: 345-356.
- Baino R., Serena F., Ragonese S., Rey J. & Rinelli P. 2001.** Catch composition and abundance of elasmobranchs based on the MEDITS program. *Rapport Commission Internationale Mer Méditerranée*, **36**: 234.
- Bekada D.E. 2014.** La pêche et ses statistiques: Cas des ports de Beni-Saf, Bouzedjar, Oran, Arzew et Mostaganem. Thèse de Magister. Université Oran 01, 60 pp.
- Bertrand J., De Sola G., Papakostantinou C., Relini G. & Souplet A. 2000.** Contribution on the distribution of elasmobranchs in the Mediterranean (from the MEDIT Surveys). *Biologia Marina Mediterranea*, **7**: 385-399.
- Capapé C., Tomasini J.A. & Bouchereau J.L. 1991.** Observations sur la biologie de reproduction de la petite roussette, *Scyliorhinus canicula* (Linnaeus, 1758) (Pisces, Scyliorhinidae du golfe du Lion, France méridionale). *Ichthyophysiological Acta*, **13**: 87-109.
- Capapé C., Reynaud C., Vergne Y. & Quignard J.P. 2008a.** Biological observations on the small-spotted catshark *Scyliorhinus canicula* (Chondrichthyes: Scyliorhinidae) off the Languedocian coast (southern France, northern Mediterranean). *Pan-American Journal of Aquatic Sciences*, **3**: 282-289.
- Capapé C., Vergner Y., Reynaud C., Guéllorget O. & Quignard J.P. 2008b.** Maturity, fecundity and occurrence of the smallspotted catshark *Scyliorhinus canicula* (Chondrichthyes: Scyliorhinidae) off the Languedoc coast (Southern France, northwestern Mediterranean). *Vie et Milieu*, **58**: 47-55.
- Capapé C., Mnasri Sioudi N., El Kamel-Moutalibi O., Boumaïza M., Ben Amor M.M. & Reynaud C. 2014.** Production, maturity, reproductive cycle and fecundity of

- small-spotted catshark, *Scyliorhinus canicula* (Chondrichthyes: Scyliorhinidae) from the Northern coast of Tunisia (Central Mediterranean). *Journal of Ichthyology*, **54**: 111-126.
- Collenot G. 1966.** Etude biométrique de la croissance relative des ptérygopodes chez la roussette *Scyliorhinus canicula* L. *Cahiers de Biologie Marine*, **7**: 319-330.
- Fischer W., Bauchot M.-L. & Schneider, M. 1987.** *Fiches FAO d'identification des espèces pour les besoins de la pêche (révision 1). Méditerranée et Mer Noire, zone de pêche 37. Vol. 2 Vertébrés.* Organisation des Nations Unies pour l'Alimentation et l'Agriculture: Rome. pp. 761-1530
- Fogarty M.J. & Murawski S.A. 1998.** Large-scale disturbance of the structure of marine systems: fishery impacts on Georges Bank. *Ecological applications*, **8**: 6-22.
- Halit F. & Taşkavak E. 2006.** Sexual dimorphism in the head, mouth, and body morphology of the smallspotted catshark, *Scyliorhinus canicula* (Linnaeus, 1758) (Chondrichthyes: Scyliorhinidae) from Turkey. *Acta Adriatica*, **47**: 37-47.
- Henderson A.C. & Casey A. 2001.** Reproduction and growth in the lesser-spotted dogfish *Scyliorhinus canicula* (Elasmobranchii: Scyliorhinidae), from the west coast of Ireland. *Cahiers de Biologie Marine*, **42**: 397-405.
- IUCN 2009.** IUCN Red list of threatened species (ver. 2009.2). Available at: www.iucnredlist.org.
- Jardas I. 1979.** Morphological, biological and ecological characteristics of the lesser-spotted dogfish, *Scyliorhinus canicula* (L., 1758). *Population in the Adriatic Sea Reports*, **4**: 104.
- Kousteni V., Kontopoulou M. & Megalofonou P. 2010.** Sexual maturity and fecundity of *Scyliorhinus canicula* (Linnaeus, 1758) in the Aegean Sea. *Marine Biology Research*, **6**: 390-398.
- Lyle J.M. 1983.** Food and feeding habits of the lesser-spotted dogfish, *Scyliorhinus canicula* (L.), in Isle of Man waters. *Journal of Fish Biology*, **23**: 725-737.
- Massuti E. & Moranta J. 2003.** Demersal assemblages and depth distribution of elasmobranchs from the continental shelf and slope off the Balearic Islands (western Mediterranean). *ICES Journal of Marine Science*, **60**: 753-766.
- Mellinger J. 1983.** Egg case diversity among dogfish, *Scyliorhinus canicula* (L.): a study of egg laying rate and nidamental gland secretory activity. *Journal of Fish Biology*, **22**: 83-90.
- Perry R.I., Cury P., Brander K., Jennings S., Moellmann C. & Planquet B. 2010.** Sensitivity of marine ecosystems to climate and fishing: concepts, issues and management responses. *Journal of Marine Science*, **79**: 427-435.
- Rodriguez-Cabello C., Velasco F. & Olaso I. 1998.** Reproductive biology of lesser-spotted dogfish *Scyliorhinus canicula* (L., 1758) in the Cantabrian Sea. *Scientia Marina*, **62**: 187-191.
- Rodriguez-Cabello C., Sanchez F., Fernandez A. & Olaso I. 2007.** Distribution patterns and sexual segregations of *Scyliorhinus canicula* (L.) in the Cantabrian Sea. *Journal of Fish Biology*, **70**: 1568-1586.
- Rogers S.I. & Ellis J.R. 2000.** Changes in the demersal fish assemblages of British coastal waters during the 20th century. *ICES Journal of Marine Science*, **57**: 866-881.
- Stevens J.D., Bonfil R., Dulvy N.K. & Walker P.A. 2000.** The effects of fishing on sharks rays and chimaeras (chondrichthyans) and the implications for marine ecosystems. *ICES Journal of Marine Science*, **57**: 476-494.
- Sumpter J.P. & Dodd J.M. 1979.** The annual reproductive cycle of the female lesser spotted dogfish, *Scyliorhinus canicula* L. and its endocrine control. *Journal of Fish Biology*, **15**: 687-695.
- Taleb Bendiab A.A., Mouffok S. & Boutiba Z. 2012.** Reproductive biology and growth of Lesser-spotted dogfish *Scyliorhinus canicula* (Linnaeus, 1758) in western Algerian coasts (Chondrichthyes, Scyliorhinidae). *Biodiversity Journal*, **3**: 41-48.
- Zelmat K. 2009.** Contribution à l'étude d'un chondrichthyen : la petite roussette (*Scyliorhinus canicula* L. 1758) pêchée dans la baie d'Oran : Biométrie et biologie de la reproduction. Thèse de magister, University of Oran, 96 pp.



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

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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.

Introduction

The quantity of fish caught annually in Oran Bay makes that this port provides almost cities in western Algeria in fish and seafood. To preserve this natural wealth, we found it useful to focus on the axillary sea bream *Pagellus acarne* (Risso, 1827) one of the main sparidae species caught by trawl in the Algerian waters and representing an important part of fish landed in Oran fishery (Bensahla Talet & Boutiba., 2000). The axillary seabream is a species of commercial importance representing 24.28% of total demersal fish landed annually. From an ecological point of view, *Pagellus acarne* is one of the most important species in typifying the demersal fish community of coastal shelf (Colloca et al., 2003; Busalacchi et al., 2010). Fished at depth ranging between 100 and 350 m (pers. obs.) it has been captured by gill, trammel nets and longline but the trawl stay the most appropriate gear for this species in Oran Bay.

Several studies have been carried out on this species in the Mediterranean Sea focusing on its biology and population dynamics (Le Trong-Phan & Kompowsky, 1972; Andaloro, 1982; Santos et al., 1995; Lamrini, 1996 & 1998; Arculeo et al., 2000; Dominguez, 2000; Pajuelo & Lorenzo, 2000; Coelho et al., 2005; Recasens et al., 2007; Velasco et al., 2011). However, biological studies of this species in Algerian coasts are very scarce (Bensahla Talet et al., 2010 & 2013; Boufersaoui & Harchouche., 2015). Therefore, the present study aims to estimate reproduction parameters of this species for the first time, to help comparative studies in the W. Mediterranean, allow renewal of the resources and management implications.

Material and Methods

Specimens of *P. acarne* (n = 892) were caught by trawlers operating in Oran Bay located on the North West of Algerian coasts (Western Mediterranean Sea) situated between “Pointe de l’Aiguille” and “Cap Falcon” (35.95°N-0.65°E) (Fig. 1) at depths ranging between 100 and 350 m between April 2008 and June 2009.

At the laboratory and for each individual, were recorded the total length (TL), measured to nearest millimeter with an ichthyometer (± 1 mm), the total weight (TW), and gonad weight (GW) using a digital precision balance (± 0.01 g).

Sex-ratio

The sex-ratio was calculated monthly during the study period in relation to individual sizes (1 cm class interval) and seasons with the following formula:

$$SR = \frac{nF}{nM + nF} \times 100 \quad (1)$$

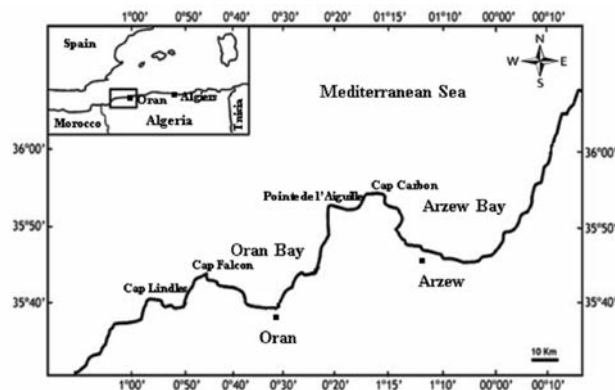


Figure 1. Map of the study area (Oran Bay).

where nF is the number of females and nM the number of males.

In order to detect statistically significant deviations from the expected 1:1 ratio, the chi-square (χ^2 , $P < 0.05$) test was used (Sokal & Rohlf, 1987).

Spawning period

For the description of the sexual cycle of *P. acarne*, several approaches were used:

- The maturation scale was established following Holden & Raitt (1975) macroscopic scale, while microscopic description was based on (Aboussouan & Lahaye, 1979) with slight modification to fit *P. acarne* gonad development. Both being based on the macroscopic aspect, relative dimensions and microscopic characteristics of the gonads (I: immature, II: resting, III: ripe, IV: ripe and running, V: spent).
- Between 10 and 30 specimens of *P. acarne* were selected each month for histological examination of sexual organs that was dropped in Bouin's fixative solution for 48 h, dehydration was done with increasing concentrations of acetone/toluene then fragments were embedded in paraffin wax. Gonads were sectioned with microtome to 5-6 μ m sections and stained with hematoxylin-eosin.
- Monthly evolution of the gonado-somatic (GSI) and hepato-somatic (HSI) indices as follows:

$$GSI = \frac{GW}{TW} \times 100 \quad (2)$$

where GSI is gonado-somatic index, GW is gonad weight and TW is total weight.

$$HSI = \frac{LW}{TW} \times 100 \quad (3)$$

where HSI is hepato-somatic index, LW is liver weight and TW is total weight.

The nucleoplasmic ratio is considered to be closely related to the mitotic cellular cycle and to the functional phase of cells. It is also a good indicator of dynamic changes in cells. The nucleoplasmic ratio (NPR) is expressed

mathematically as:

$$NPR = \frac{Nd}{Cd - Nd} \quad (4)$$

where Nd is the nucleus diameter and Cd is the total cell diameter

Fulton's condition factor (k) was calculated using the equations given by Htun-Han (1978) as:

$$k = \frac{W}{L^3} \times 100 \quad (5)$$

where W is the body weight in g, L is the total length (TL) in cm. According to Froese (2006), the factor 100 is used to bring k a value close to unity

Size at first sexual maturity

Size at first sexual maturity (L_m) was defined as the size class at which 50% of individuals are mature. Specimens were grouped into 1cm size classes and the proportion of mature and immature individuals was recorded. The total length at which 50% of the specimens were mature was estimated by a logistic non-linear least-squares regression (King, 1995):

$$P = 1/[1 + e^{-a(L-L_m)}] \quad (6)$$

where P is the percentage of mature individuals, a is the slope of the curve or rate of increase in maturity, L_m is length at 50% maturity and L is the 1 cm length class.

Results

In total, 892 specimens of *P. acarne* were collected, 272 males (30.49%), 347 females (38.90%), 65 hermaphrodites (7.29%) and 208 unsexed (23.31%). The length frequency distribution of the entire population is shown in figure 2, male length range was 13.0 to 23.0 cm, female length range was 13.0 to 26.3 cm while hermaphrodite length range was 17.5 to 25.7 cm.

The overall ratio of males to females was 1:1.27 and χ^2 analysis showed this to be significant ($\chi^2 = 9.08$,

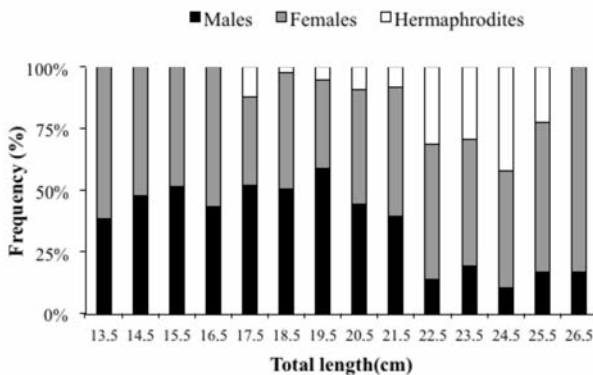


Figure 2. *Pagellus acarne*. Length frequency distribution of males and females caught in Oran Bay.

$\chi^2_{1,0.05} = 3.84$). Sex-ratios of males and females by size intervals departed significantly from 1:1 ratio from 22 cm of total length were females predominate beyond this length, while for smallest length classes the χ^2 test didn't reveal any statistical difference.

Maturity stages

Females with ripe gonads (Stage III) were observed (Fig. 3) in two periods of the year, the first one between April and June and the second in autumn, ripe and running gonads (stage IV) were also met in the same interval and are dominant in May of each cycle, spent fish (stage V) were recorded in late spring with high values in June while the remaining period of the year gonads in stage II were dominant marking the sexual rest period of this sparidae.

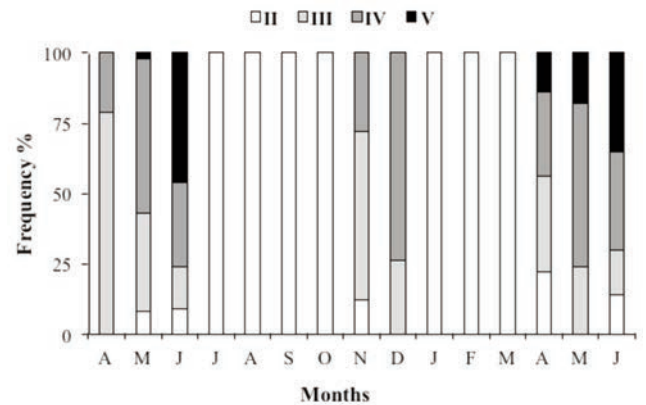


Figure 3. *Pagellus acarne*. Maturity stages of females from Oran Bay. (II: resting, III: maturing, IV: ripe and running, V: spent).

Microscopic analysis

Microscopic analysis of *Pagellus acarne* gonads allowed us to describe the following stages.

Ovaries

- Immature period: oogonia constituting the reserve batch are small round cells not exceeding 40 μ m with a clear nucleus (Fig. 4A), some of them have already began their first cellular division.
- Resting period: During this stage (Fig. 4B-D) the oocytes are spherical (about 60 μ m) cells arranged as ovarian lamellae with a homogenous and transparent cytoplasm having numerous nucleoli mixed to a large nucleus containing dense chromatin (NPR, nucleoplasmic ratio at its maximum 0.6).
- Maturing period: during previtellogenesis, ovogonia undergo progressive increase in size reaching (Fig. 4E-F) of

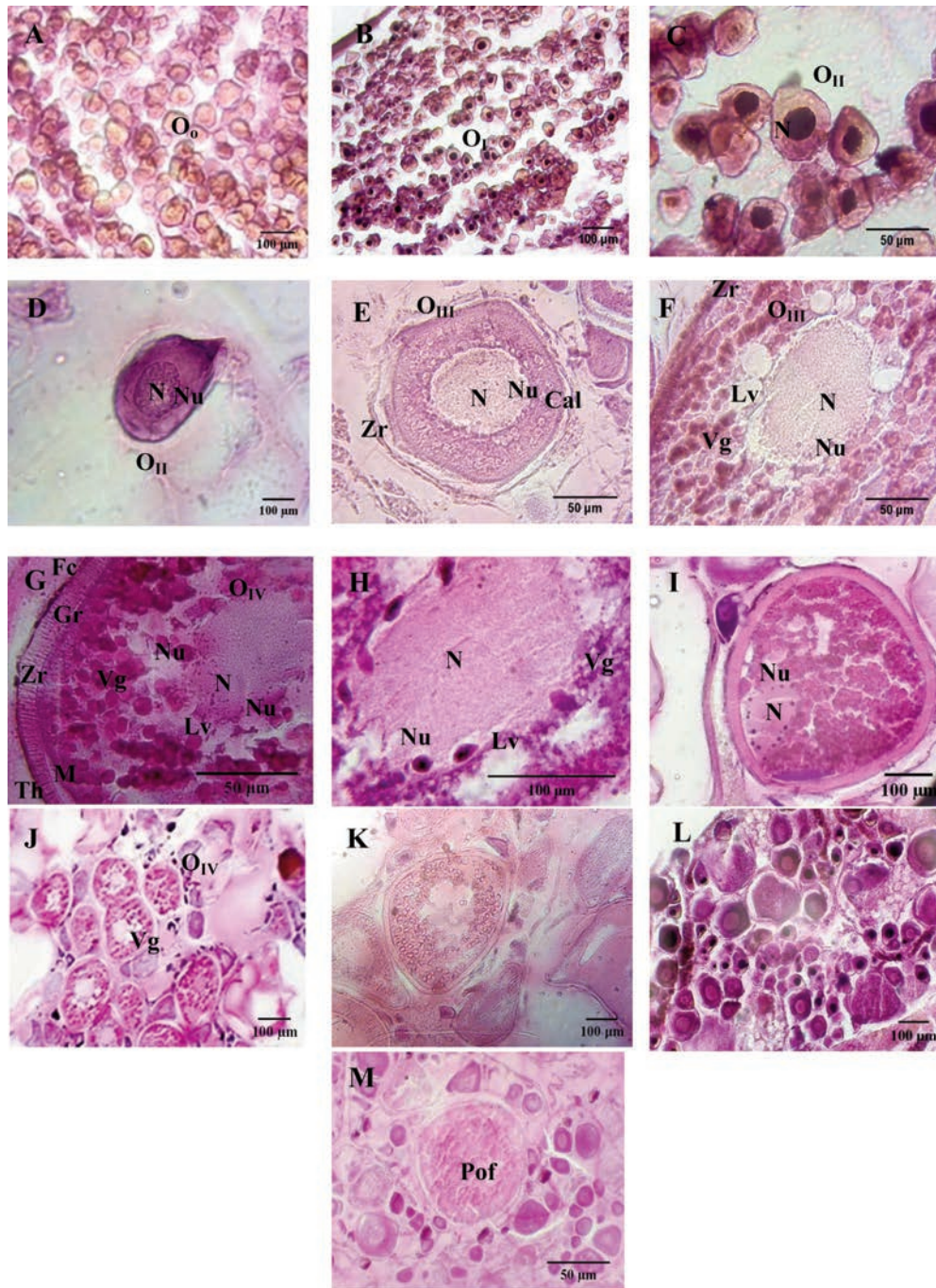


Figure 4. *Pagellus acarne*. Ovarian histological slides of females gonads (A-M) stained by haematoxylin-eosin. Resting ovary with: **A.** Initial peri nucleolar oocytes (O_I) x100. **B.** Advanced peri nucleolar oocytes (O_{II}) with large nucleus and homogenous cytoplasm x400. **C.** Advanced peri nucleolar stage with a homogenous cytoplasm and several nucleoli peripherally arranged x400. **D.** Maturing ovary containing previtellogenic (O_{III}) presenting large nucleus surrounded by several lipoprotein vesicles x100. **E.** Vitellogenic oocytes with large translucent vitelline vesicles and thin zona radiata (O_{III}) x400. **F.** Early maturing large O_{III} with important nucleus, nucleoli, thick zona radiata and apparition of granulosa x400. **G.** Nucleus surrounded by nucleoli x1000. **H.** Hydrated large oocytes (mature) O_{IV} ready to be released with numerous important lipid vesicles fused with the nucleus x40. **I.** Hydrated large oocytes (mature) x100. **J.** Hydrated large oocytes (mature) O_{IV} ready to be released with numerous important lipid vesicles fused with the nucleus x40. **K.** PHydrated large oocytes (mature)x100. **L.** Beginning of atrisea x100. **M.** Post-ovulatory follicle x400.

Cal: Cortical alveoli; **Fc:** Follicular cells; **Gr:**granulosa ; **Gv:** Germinal vesicle; **Lv:** Lipid vesicle; **M:** oocyte membrane; **N:** nucleus; **Nu:** Nucleoli; **O:**oocyte; **O:**oogonia; **Pof:** Post-ovulatory follicle; **Th:** theca; **Vg:** Viteline µglobules; **Zr:** Zona radiata.

up to 217.6 μm with an average NPR equal to 0.41. The period is mainly characterized by a clearer central nucleus containing some supernumerary nucleoli distributed at the periphery; the appearance of thousands of cortical alveoli that marks the beginning of the endogenous lipidic vitellogenesis; granulosa and zona radiata becomes visible.

- Vitellogenesis period (pre-spawning): this phase is characterized by a rapid increase in the size of the oocytes (422 μm), resulting from a massive entry of the proteinic yolk, also the vitelline vesicles are rounded and colored in red marking the exogenous vitellogenesis. (Fig. 4G & H). Lipid inclusions (colorless) move massively near the nucleus and fuse with it (Fig. 4H). The central cytoplasmic zone is filled and repels the cytoplasm at the periphery. The NPR decreases to attain 0.36. At this stage, the oocyte membrane is enveloped by a protective thick membrane zona radiata, measuring 7.26 μm , the whole is enveloped by one layer of ovarian cells forming the granulosa, and the fibrous theca (Fig. 4G).

- Ripening and spawning period: The nucleus moves to the animal pole to initiate the first meiotic division (Fig. 4I). The ovary is full of mature oocytes characterized by fusion of the yolk vesicles into a single hyaline vacuole, hence the name of hyaline mature oocytes (Fig. 4J & K), their diameter is at most 500 μm .

- Post spawning: Some un-emitted mature oocytes enter atresia; the cytoplasm becomes disorganized, the nucleus enters into pycnosis and the yolk disintegrates into a compact cluster. Remains in the ovary only the oogonia reserve that will be activated during the next spawning season (Fig. 4L & M). At the end of the laying period, the fish enters the resting phase. The ovary gets back to its initial appearance, recognized by the presence of the ovigerous lamellae (Fig. 4B). The presence of the atretic oocytes marks the end of the spawning season.

Testes

Parallel to the study of oogenesis, we followed spermatogenesis. The testes were mature at the same time as the ovaries. The testicles are formed of a multitude of oval ampoules separated by a connective tissue (Fig. 5). Seminiferous tubules are composed of isogenic cysts at different stages of maturation (Fig. 5B & C). At maturity, spermatids are transformed to spermatozooids that are dumped in the central lumen then in the deferent ducts.

Hermaphrodite gonads

Pagellus acarne exhibits a protandric hermaphroditism already described (Alekseev, 1967; Andaloro, 1982; Lamrini, 1986; Pajuelo & Lorenzo, 1994 & 2000; Arculeo, 2000; Erzini et al., 2001; Coelho et al., 2005) and during our sampling period 65 individuals were hermaphrodites presenting the two sexes in the same gonad, the ovotestis. The histological analysis of ovotestis allowed us to examine germinal tissues for males and females

which co-exist. The female part is not yet functional and is represented in each case by oogonous cells and few ovocytes I (O_I) arranged in ovigerous lamellae. The male part is active and is made of seminiferous tubes containing isogenic cysts at different stages of spermatogenesis (Fig. 6)

Sexual cycle and spawning period

The gonado-somatic index (GSI) was used to determine the reproductive period, which was calculated from samples taken monthly. For females, the maximum GSI value was 3.36 in May and 3.29 in December while for males the highest values were 3.57 and 1.90 in the same period. The rest of the year and for the both sexes, the GSI values decreased considerably in summer and February-March period confirming the sexual rest period (Fig. 7) which is in accordance with our macroscopic observation on maturity stages of *P. acarne*.

The monthly changes in hepato-somatic index (HSI) for both sexes followed the same pattern of gonado-somatic index reaching the maximal values in mid spring and autumn respectively 1.99 and 0.79% for males and 1.64 and 1.77% for females. However, the HSI values recorded during these two periods of the year highlight the important metabolic role of the liver in the reproductive cycle of the species. The variations in the condition factor (k) were not very palpable. In fact, k values varied between 0.110 and 0.134 for males and between 0.110 and 0.143 for females all over the sampling period showing that *P. acarne* doesn't undergo important physio-morphological changes during the sexual cycle

Size at first sexual maturity

Proportions of mature specimens analysis (Fig. 8) for each sex showed statistical differences (t-test, $t = 15.35 > t_{0.05,614} = 1.65$), in fact 50% of females were mature before males at 12.75 cm of total length and males were mature at 15.99 cm of total length in Oran Bay.

Discussion

The predominance of males in smaller length classes and females in larger classes is probably due to protandric hermaphroditism already described for this species (Le Trong-Phan & Kompowsky, 1972; Andaloro, 1982; Pajuelo & Lorenzo, 2000; Coelho et al., 2005; Velasco et al., 2011; Bensahla Talet et al., 2010 & 2013; Boufersaoui & Harchouche, 2015), specimens being first males and becoming progressively females.

Evolution of sex ratio in relation to length classes allow us to affirm that sexual inversion for this sparidae occurs at 22 cm of total length which is in accordance to observation

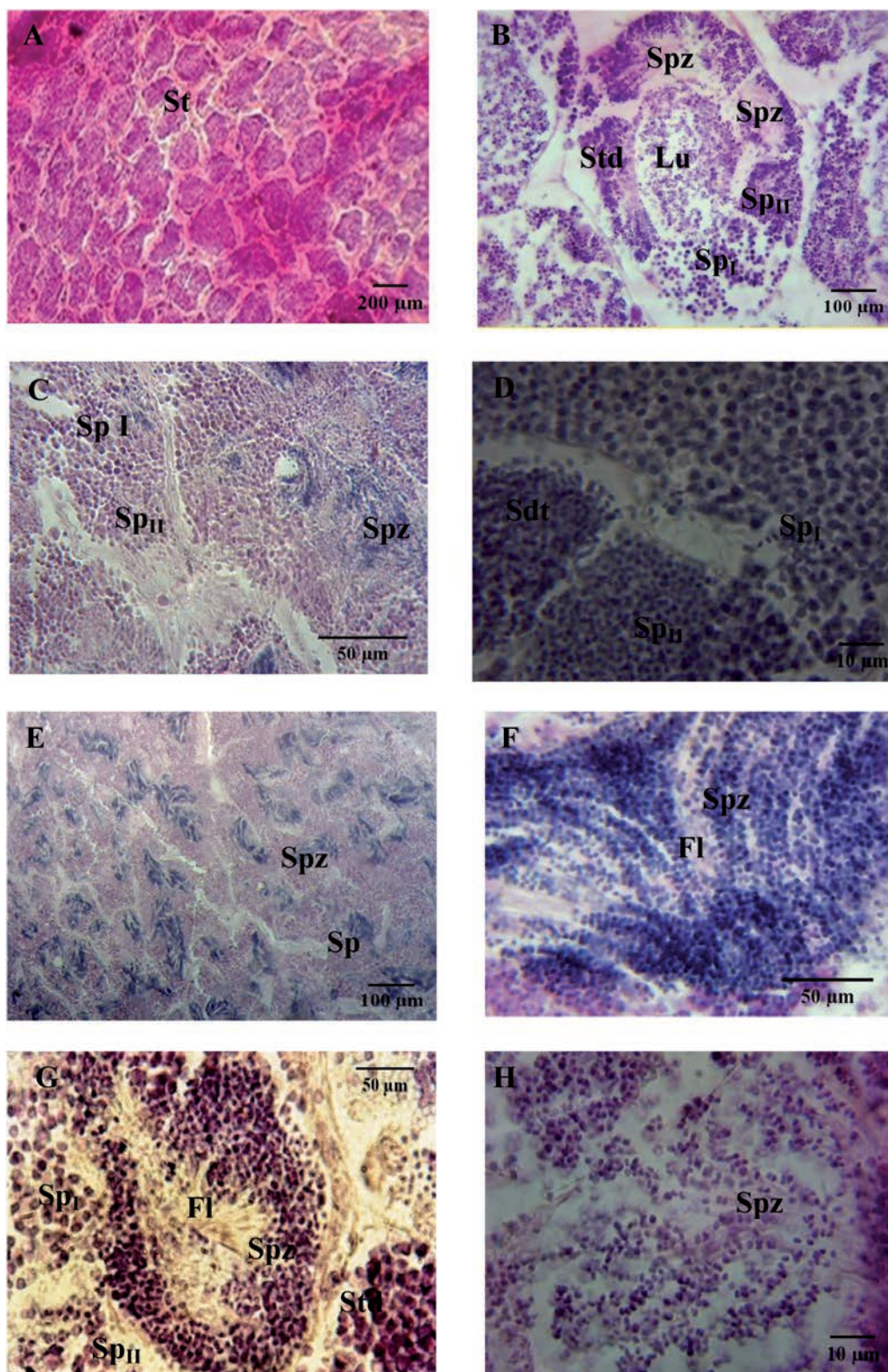


Figure 5. *Pagellus acarne*. Spermatogenesis stages. **A.** Overview of seminiferous tubules x40. **B.** Isogenic cyst at different stages of maturation x100. **C.** x400. **D.** x1000. **E.** x100. **F.** x400: spermiation at the beginning. **G.** x400. **H.** x1000: mature testicle showing seminiferous tubules with lumen full of spermatozoa with their flagella x400.

Fl: flagella; **Lu:** central lumen; **Sp I:** spermatocyte I; **Sp II:** spermatocyte II; **Spz:** spermatozoa; **Std:** spermatids; **St:** seminiferous tubule.

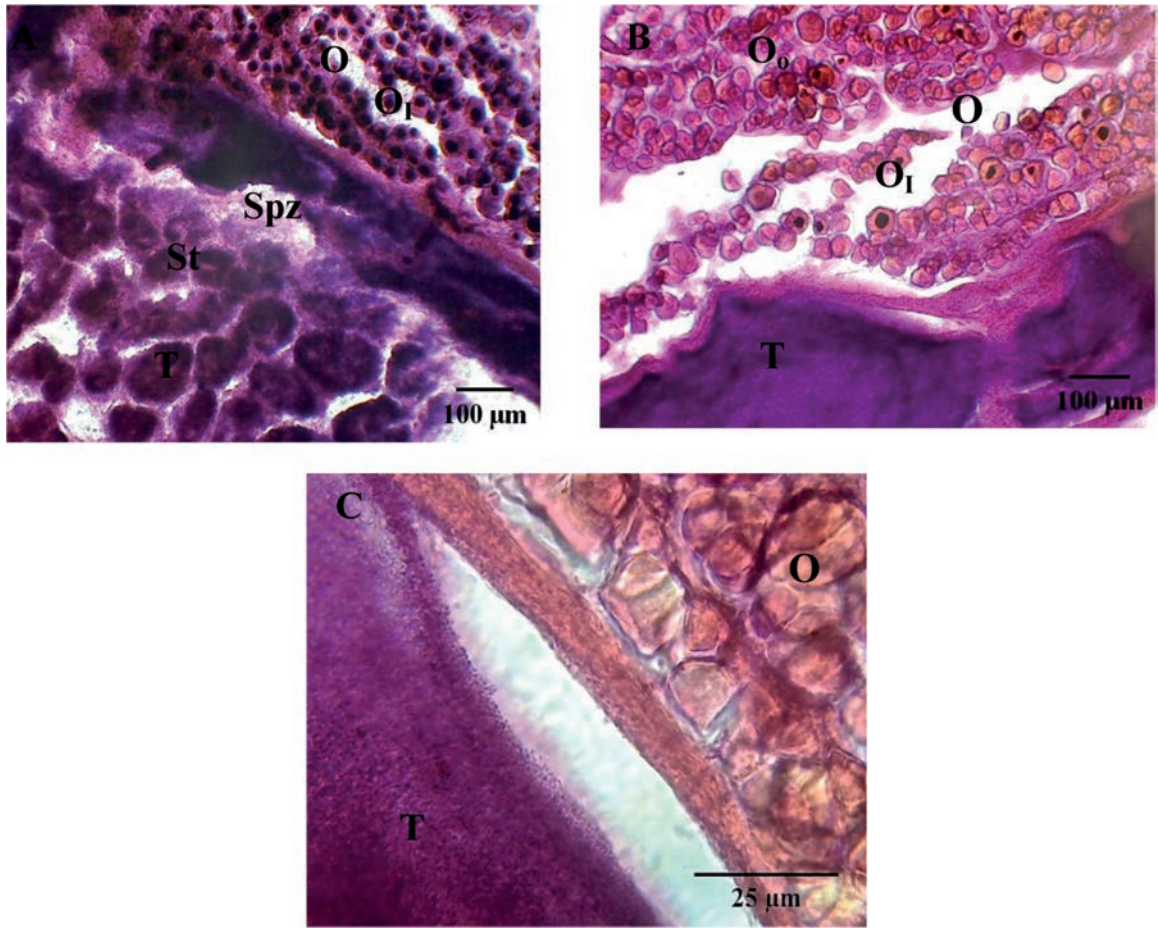
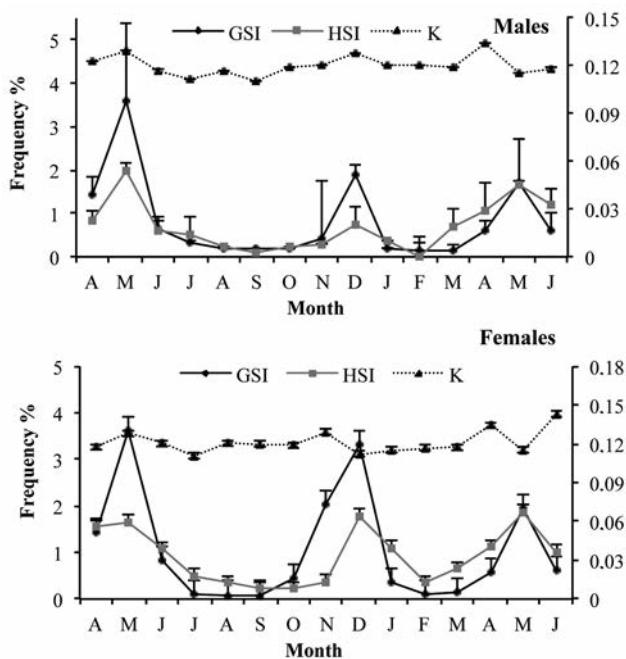


Figure 6. *Pagellus acarne*. Section in hermaphrodite gonad. **A.** and **B.** x100. **C.** Mature male gonad with immature female part x1000. **O:** Ovary; **O_I:** ovocyte I; **Oo:** Oogonia; **Spz:** Spermatozoa; **St:** Seminiferous tubule; **T:** Testis.



already made by other authors working on the same species: 20.5-20.9 cm (Dominguez, 2000), 20-24 cm (Coelho et al., 2005), 21.5-23.5 cm (Velasco et al., 2011).

Conducted studies on the reproduction period of *P. acarne* showed that this species had one long spawning season that extends from May to October in south Spain (Dominguez, 2000; Velasco et al., 2011) and Portugal (Neves Santos et al., 1995; Coelho et al., 2005) with an important peak in summer. In western Algerian coasts the monthly evolution of the different indexes showed that this sparidae had two spawning periods the first one between April to June with a peak in May and an autumnal period, between November and January with a peak in December a finding already described in Algiers Bay (Boufersaoui & Harchouche, 2015) for the same species, also in Sarpa

Figure 7. *Pagellus acarne*. Monthly changes in the gonadosomatic, hepatosomatic indexes and condition factor (GSI, HIS and k) of males and females caught in Oran Bay.

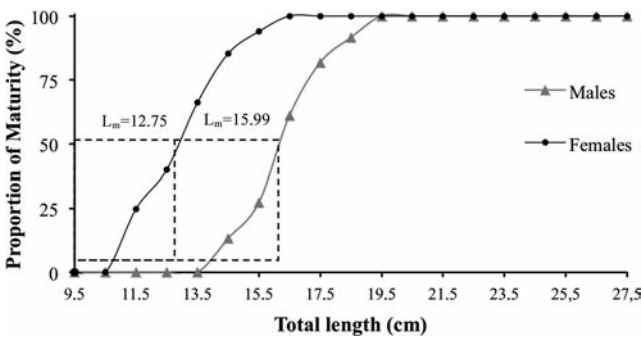


Figure 8. *Pagellus acarne*. Sexual maturity ogives for males and females caught in Oran Bay.

genus (Corbera et al, 1996; Mendez, 2001; Criscoli et al, 2006).

Unlike, spawning period of the axillary seabream in the eastern Atlantic begins in autumn and ends in spring, from November to March with a maximum in winter (Le Trong-Phan & Kompowsky, 1972; Lamrini, 1986; Pajuelo & Lorenzo, 2000). While this process occurs in August in the Italian waters (Arculeo et al., 2000) and in autumn along the Egyptian coasts (Faltas, 1995). It appears that, *P. acarne* has a tendency to spawn in winter and mid spring in low latitudes and late during the rest of the year in high latitudes.

In the other hand, some authors (Wootton, 1979; Pajuelo & Lorenzo, 2000; Mouine et al, 2007) link these regional differences in time and duration of the spawning act with biotic and abiotic factors such as hydro dynamism, temperatures, salinity and food availability in the different regions of the Mediterranean basin. In fact, the reproduction period is correspondingly much longer when environmental conditions are favorable (Gonçalves & Erzini, 2000), the

upwellings and related zooplankton abundance can also affect many species reproduction (Parrish et al., 1981).

For the length of first sexual maturity (table 1), Dominguez (2000), Pajuelo & Lorenzo (2000), Velasco et al. (2011) reported it between 19 and 21.7 cm in Spanish waters. In Italian coasts Andaloro (1982) recorded it at 16.5 cm while in Portuguese waters Coelho et al., (2005) found it equal to 17.6 cm for females and 18.1 cm for males. In the eastern Atlantic, the size at the first sexual maturity was comprised between 19 and 20.9 cm of TL (Le-Trong Phan & Kompowski, 1972; Lamrini, 1986). In the Egyptian waters, the first sexual maturity is reached for most of the population at sizes between 14 and 19 cm of TL (Faltas, 1995). In Algerian waters, Boufersaoui & Harchouche (2015) found females to be mature at 16.45 cm while males were mature at 16.80 cm while in Oran Bay first sexual maturity was reached at 12.75 cm for females and 15.99 cm for males precociously compared to females in other regions of the Mediterranean Sea.

The richness of Algerian waters is probably due to Algerian current which is considered to be the most energetic in the Mediterranean basin (Taupier-Letage & Millot, 1988; Mortier, 1992; Salas et al., 2001). In fact, the entrance of Atlantic waters via the strait of Gibraltar generates important upwelling's enhancing the development of plankton first link of the aquatic food web. Differences in sizes at first sexual maturity can be attributed to the geographic location of the studied areas and consequently to the different environmental conditions, such as temperature, salinity and food (Gonçalves & Erzini, 2000; Moutopoulos & Stergiou, 2002; Bottari et al., 2014).

The MLS (Minimum Landing Size) set for *P. acarne* at 15 cm of TL according to Algerian legislation (Executive

Table 1. Length at first sexual maturity of *Pagellus acarne* given by different authors. **M:** Males, **F:** females, **L_m:** length at first sexual maturity (cm).

Region		L _m	Author
Portugal	Atlantic	M 18.10	Coelho et al., 2005
		F 17.60	
		20.95	Neves Santos et al., 1995
Morocco		19.00	Le-Trong Phan & Kompowski, 1972
		20.90	Lamrini, 1986
Spain	Canary Island	M 15.80	Pajuelo & Lorenzo, 2000
		F 19.40	
	Atlantic	21.70	Velasco et al., 2011
	Alboran Sea	20.10	
Algeria	Oran Bay	19.00	Dominguez, 2000
		M 15.99	Present study
		F 12.75	
Italy	Tyrrhenian Sea	16.50	Andaloro, 1982
Egypt	Alexandria	14.00-19.00	Faltas, 1995

decree n° 2004-86 of 18 March 2004), seems to be insufficient given that it is higher than the length at first sexual maturity found during our study (12.75 cm for females and 15.99 cm for males), it would be recommended to increase this length and set it at 18 cm assuring the renewal of the resource.

Conclusions

The sparidae family constitutes an important portion of daily landed demersal fish in Algerian fisheries and *P. acarne* is of commercial importance to local and national fisheries. According to Algerian legislation, the trawl fisheries closure from the 1st May to the 1st August (Executive decree n° 3-481a of 24 April 2004) aiming to protect renewal of the national resources is to our viewpoint insufficient to insure this objective. We can suggest the increase of the Minimum landing size and the establishment of two closure fishing periods per year to allow renewal of the resources by protecting juvenile and adult spawners from excessive fishing.

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References

- Aboussouan A. & Lahaye J. 1979.** Les potentialités des populations ichtyologiques fécondité et ichtyo plancton. *Cybum*, **6**: 29-46.
- Andaloro F. 1982.** Résumé des paramètres biologiques sur *Pagellus acarne* de la mer Tyrrhénienne méridionale et de la mer Ionienne septentrionale. *FAO Fisheries Repport*, **266**: 89-92.
- Arculeo M., Bruslé-Sicard S., Potoschi A. & Riggio S. 2000.** Investigations on gonadal maturation in *Pagellus acarne* (Pisces, Sparidae) in the Strait of Messina (Sicily). *Italian Journal of Zoology*, **67**: 333-337.
- Bensahla Talet L., Dalouche F., Boutiba Z. & Bensahla Talet A. 2010.** Détermination de la période de ponte du pageot blanc *Pagellus acarne* (RISSE, 1827) pêché dans la baie d'Oran. *Deuxième colloque international de biodiversité et écosystèmes littoraux bel02.28-30 nov.2010 Oran*. 216-222. (In French)
- Bensahla Talet L., Mouffok S., Bensahla Talet A. & Boutiba Z. 2013.** On the fecundity of the seabream *Pagellus acarne* (RISSE, 1827) of the Western Mediterranean Sea, Algerian Coasts. An international Journal of Marine science. *Thalassas*, **29**: 9-13.
- Bensahla Talet A. & Boutiba Z. 2000.** La pêche à Oran de 1995 à 1999. *Actes des 4^{èmes} journées tunisiennes des sciences de la mer : 17-19 novembre 2000, Mehdi (Tunisie)*. 5 pp.
- Bottari T., Micale V., Liguori M., Rinelli P., Busalacchi B., Bonfiglio R. & Ragonese S. 2014.** The reproductive biology of *Boops boops* (Linneus, 1758) (Teleostei: Sparidae) in the southern Tyrrhenian Sea (Central Mediterranean). *Cahiers de Biologie Marine*, **55**: 281-292.
- Boufersaoui S. & Harchouche K. 2015.** Dynamique de la reproduction et fécondité de *Pagellus acarne* (Sparidae) de la région Centre du littoral algérien. *Cybum*, **39**: 59-69.
- Busalacchi B., Rinelli P., De Domenico F., Profeta A., Perdichizzi F. & Bottari T. 2010.** Analysis of demersal fish assemblages off the Southern Tyrrhenian Sea (central Mediterranean). *Hydrobiologia*, **654**: 111-124.
- Coelho R., Bentos L., Correia C., Goncalves J.M.S., Monteiro P., Ribeiro J., Lino P.J. & Erzini K. 2005.** Age, growth and reproduction of the axillary seabream, *Pagellus acarne* (Risso, 1827) from the south cost of Portugal. An international Journal of Marine science. *Thalassas*, **21**: 79-84.
- Colloca F., Cardinale M., Belluscio A. & Ardizzone G. 2003.** Pattern of distribution and diversity of demersal assemblages in the central Mediterranean Sea. *Estuarine, Coastal and Shelf Science*, **56**: 469-480.
- Corbera J., Sabates A. & Garcia-Rubies A. 1996.** *Peces de Mar de la Péninsula iberica*. Ed. Planeta: Barcelona. 312 pp.
- Criscoli A., Colloca F., Carpentieri P., Beluscio A. & Ardizzone G. 2006.** Observations on the reproductive cycle, age and growth of the salema, *Sarpa salpa* (Osteichthyes: Sparidae) along the western central coasts of Italy. *Scientia Marina*; **70**: 131-138.
- Dominguez J.B. 2000.** Biología pesquera del besugo *Pagellus acarne* (Risso, 1826) del mar de Alboran. Microfichas. *Instituto Espanol de Oceanografia*. **14**: 1-228.
- Faltas S.N. 1995.** Fecundity of sea breams, *Pagellus* spp. from Egyptian Mediterranean, off Alexandria. *Bulletin of the National Institute of Oceanography and Fisheries*, **21**: 461-468.
- Froese R. 2006.** Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, **22**: 241-253.
- Gonçalves J.M.S. & Erzini K.I. 2000.** The reproductive biology of *Spondyliosoma cantharus* (L.) from the SW coast of Portugal. *Scientia Marina*, **64**: 403-411.
- Holden M.J. & Raitt D.F.S. 1975.** *Manual of Fisheries Science Part 2. Methods of resource investigation and their application*. FAO: Rome. 214 pp.
- Htun-Han M. 1978.** The reproductive biology of the dab *Limanda limanda* (L.) in the North Sea: seasonal changes in the ovary. *Journal of Fish Biology*, **13**: 351-359.
- King M. 1995.** *Fisheries biology, assessment and management*. Fishing News Books, Blackwell Science: Oxford, UK. 341 pp.
- Lamrini A. 1986.** Sexualité de *Pagellus acarne* (Risso, 1826) (Téléostéen, Sparidae) de la côte Atlantique méridionale du Maroc (21°-26°N). *Cybum*, **10**: 3-14.
- Le-Trong Phan & Kompowsky A. 1972.** The bronze bream *Pagellus acarne* from North West African region. *Acta Ichthyologica y Piscatoria*, **2**: 3-18.

- Mendez-Villamil M., Pajuelo L.G., Lorenzo J.M., Coca J. & Ramos A. 2001.** Age and growth of the salema, *Sarpa salpa* (Osteichthyes, sparidae) of the Canary Islands (East-Central Atlantic). *Archives of Fisheries and Marine Researches*, **49**: 139-148.
- Mortier L. 1992.** Instabilités du courant Algérien. Thèse de Doctorat, Université d'Aix- Marseille II, 288 pp.
- Mouine N., Francour P., Ktari M.H. & Chakroune-Marzouk N. 2007.** The reproductive biology of *Diplodus sargus sargus* in the Gulf of Tunis (central Mediterranean). *Scientia Marina*, **71**: 461-469.
- Moutopoulos D.K. & Stergiou K.I. 2002.** Length–weight and length–length relationships of fish species from the Aegean Sea (Greece). *Journal of Applied Ichthyology*, **18**: 200-203.
- Pajuelo J.G. & Lorenzo J.M. 2000.** Reproduction, age, mortality and growth of axillary seabream, *Pagellus acarne* (Sparidae), from the Canarian archipelago. *Journal of Applied Ichthyology*, **16**: 41-47.
- Parrish R.H., Nelson C.N. & Baikun A. 1981.** Transport mechanisms and reproductive success of fishes in the California Current. *Biological Oceanography*, **1**: 175-203.
- Recasens L., Sabates A., Demestre M., Martin P. & Sanchez P. 2007.** Relationship between temperature and fisheries: the case of *Pagellus acarne* in the NW Mediterranean. *Rapport du Comité International de la Mer Méditerranée*, **38**: 580-581.
- Salas J., Garcia-Ladona E. & Font J. 2001.** Statistical analysis of the surface circulation in the Algerian current using Lagrangian buoys. *Journal of Marine Systems*, **29**: 69-85.
- Santos M.N., Monteiro C.C. & Erzini K. 1995.** Aspects of the biology and gillnet selectivity of the axillary seabream (*Pagellus acarne*, Risso) and common Pandora (*Pagellus erythrinus*, Linnaeus) from the Algarve (south Portugal). *Fisheries Research*, **23**: 223-236.
- Sokal R.R. & Rohlf F.J. 1987.** *Introduction to biostatistics*. 2nd ed. Freeman & Company: New York. 365 pp.
- Taupier-Letage I. & Millot C. 1988.** Surface circulation in the Algerian basin during 1984, *Oceanologia Acta*, **9**: 119-131.
- Velasco E.M., Jiménez-Tenorio N., Del Arbol J., Bruzón M.A., Baro J. & Sobrino I. 2011.** Age, growth and reproduction of the axillary seabream, *Pagellus acarne*, in the Atlantic and Mediterranean waters off southern Spain. *Journal of the Marine Biological Association of the United Kingdom*, **91**: 1243-1253.
- Wootton R.J. 1979.** Energy cost of egg production and environmental determinants of fecundity in teleost fishes. In: *Fish phenology, anabolic adaptativeness in teleosts* (P.J. Miller ed). *Symposium of the Zoological Society of London*, **44**: 133-159.



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

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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,

Gonçalves, Lino, Monteiro, & Erzini, 2010) the western Mediterranean (Valdes et al, 2004); Tyrrhenian sea (Busalacchi, Bottari, Giordano, Profeta, & Rinelli, 2014). In Tunisia, studies were conducted from Gulf of Gabès (Ghorbel & Ktari, 1982) also in the Gulf of Tunis (Fassatoui & Romdhane, 2010; Zarrad, Cherif, Gharbi, Jarboui, & Missaoui, 2010), and the Bay of Monastir (Ben s mida & Hadhri, 2014), El Habouz, Bhar, Rafik & Yousra. (2009) studied the reproduction of *P.erythrinus* in Morocco in Agadir's Bay.

To date there is no information published on the biology of this Sparid in Oran Bay, nevertheless a number of studies were conducted, we mention (Dieuzeide, Novella, & Roland, 1955); Cherabi, (1987) in the Bay of Algiers and Rouidi., (2011) in the Bay of Jijel.

In Oran Bay, the common pandora is of commercial importance and has been captured by trawl and artisanal fleet. The landings of this species reached 67.3 t in 2014, which corresponds to 23.9% of total production of demersal fishes in Oran's fishery according to D.P.R.H., (2014). The economic

value of this species in the Algerian waters and lack of sufficient research on this subject for Oran Bay make necessary a better understanding of its reproductive cycle. The present paper consists of an original study of some reproductive characteristics of the Algerian sea common pandora including size at first maturity, sex-ratio for males and females, variation of Hepato somatic index HIS, condition factor K and the reproduction period during one year.

Material and Methods

In total 320 samples of *P. erythrinus* were collected, 86 males, 202 females and 32 unsexed, were caught by trawlers fishing in Oran Bay - 35°41'27" N - 0°38'30" W (Figure 1), between February 2014 and January 2015. They were brought to the laboratory and for each specimen measurements included total length (TL) to the nearest millimeter, total weight (TW) and gonad's weight to the nearest 0.01g. Fish lengths were classified in 1 cm group intervals Figure 2. Sex was recorded after opening the abdominal cavity and maturity stages were

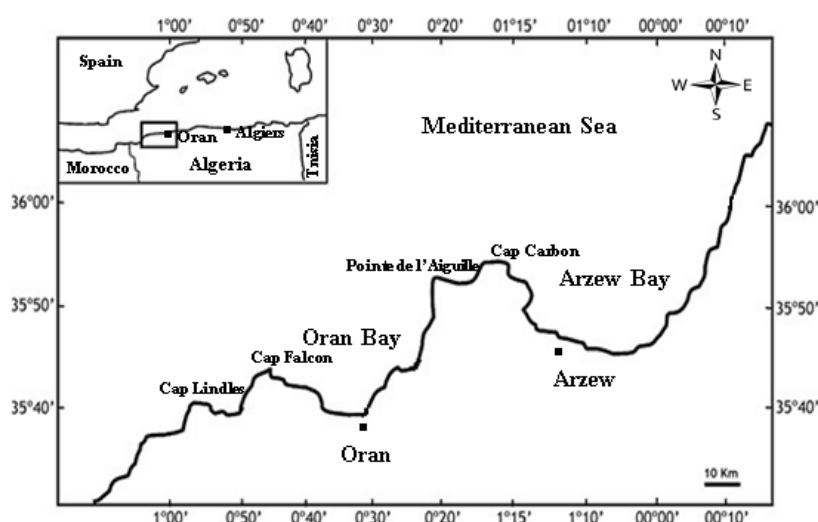


Figure 1. Location of the sampling area.

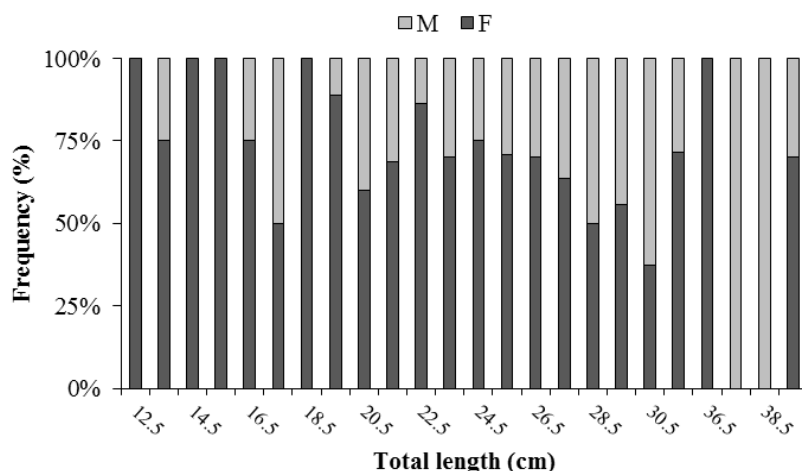


Figure 2. Length frequency distribution males and females of *P.erythrinus* caught in Oran Bay. M:males, F:feamles

determined macroscopically based on morphology and color of gonads according to (Holden & Raitt, 1975) as follows: stage I, immature; stage II immature or in resting phase; stage III, pre-spawning; stage IV, spawning; stage V, post-spawning.

Sex ratio of males and females was monthly calculated according to the following formula:

$$\text{Sex ratio F} = (F/(F+M)) \times 100$$

$$\text{Sex ratio M} = (M/(F+M)) \times 100$$

F: number of females,
M: number of males.

The sex ratio was analyzed by 1cm length class. Deviation from 1:1 null hypothesis was statistically tested by χ^2 test. In order to understand the sexual cycle and determine the spawning period the gonad somatic index (GSI) was calculated monthly for females and males:

$$\text{GSI} = \text{GW}/\text{TW} \times 100 \text{ (Htun-Han, 1978).}$$

During reproduction fish undergoes physiological changes due to the mobilization of its energetic reserves. Thus, the monthly variation of hepato somatic index (HSI) and the monthly variation of the condition factor (K) were calculated for females and males:

$$\text{HSI} = \text{LW}/\text{EVW}$$

$$\text{K} = \text{TW}/\text{TL}^3 \times 1000 \text{ (Ricker, 1975).}$$

GW: gonad weight
LW: liver weight
EVW: eviscerated weight
TW: total weight
TL: total length

Size at first maturity (L_{50}) was estimated for females from the percentages of mature individuals (stage III, IV, V) and the proportion of mature individuals in each size class (1 cm intervals) was calculated. A logistic function relating the proportions

of mature individuals to total length of the fish (Ghorbel et al, 2002) was used. This function makes possible to monitor the degree of sexual maturity by size and to accurately estimate the ($L_{50\%}$), ($L_{25\%}$) and ($L_{75\%}$) lengths often used in the majority of stock assessment models. This function of sigmoid shape is expressed as follows:

$$P = 1 / 1 + e^{-(b + aTL)} \text{ (Ghorbel, 2002)}$$

P: proportion of mature individuals;
a and b: constants.
TL: total length in cm.

Results

Total length of males and females ranged from 120 to 380 mm. Of 320 specimens, 86 (29.86%) were males and 202 (70.14%) were females, 32 were unsexed.

Sex Ratio

The overall ratio of males to females was 1:2.34 and χ^2 analysis showed a significant difference from expected ratio 1:1 ($\chi^2 = 46.72 > \chi^2_{1,0.05} = 3.84$) Table 1. Sex ratio by size class showed a dominance of females in sizes ranging between 12.5cm and 28.5cm while statistic test didn't reveal any significance for size class 16.5cm where males and females were equal and in size class 30.5cm where males outnumbered females.

Gonado Somatic Index GSI, Hepatosomatic Index HSI, and Condition Factor K

The evolution of mean GSI of males and females shows similar patterns. The monthly values of GSI ranged between 0.13 and 3.80 in females and from 0.11 and 2.38 in males. From May to July the mean values reached the highest values, a second peak was observed on October. Those values are low from November to April. Figure 3.

Table 1. Monthly variations of sex ratio for *P.erythrinus* in the west Algerian coast

Months	M	F	SR%	χ^2
F	8	16	66.67	2.67
M	8	22	73.33	6.53*
A	8	23	74.19	7.26*
M	11	22	66.67	3.67
J	7	17	70.83	4.17*
J	6	21	77.78	8.33*
S	9	19	67.86	3.57
O	9	19	67.86	3.57
N	16	9	36.00	1.96
D	2	17	89.47	11.84*
J	2	17	89.47	11.84*

*statistically significant ($P < 0.05$). SR: sex ratio

The analysis of the mean gonado somatic index indicates that the spawning period extends from May to July and that there is a secondary spawning period on October. The sexual resting period takes place between November and April.

In females, the curve of the HSI showed the same trend as the GSI. Maximal values were observed between May and July; a second peak was observed on October. These values decrease between November and April.

The condition factor K curve shows difference between males and females. Higher values of this factor were observed from May to November and lower values from February to April in females. In contrast, male's condition factor shows fewer

variations than females with two peaks on March and May.

Size at First Maturity

During our study period from February 2014 to January 2015 size at first maturity was reached at 12.5cm for females as shown in Figure 4

Discussion

This study is the first to provide detailed information on the biology of *Pagellus erythrinus* in Oran Bay. Common pandora is a hermaphrodite protogynous sparidae (Girardin & Quignard, 1985;

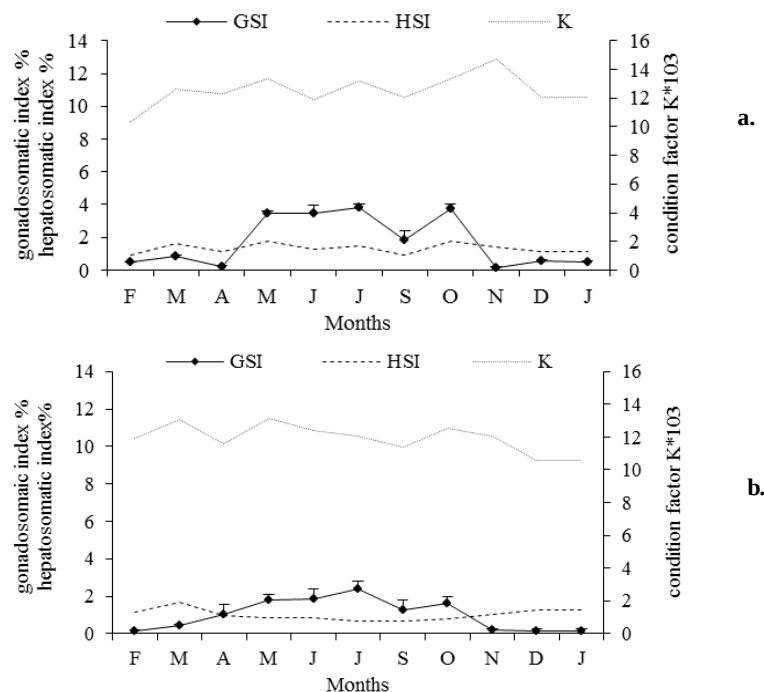


Figure 3. Monthly changes in the gonadosomatic index, hepatosomatic index and condition factor of *P. erythrinus*. (mean± SD): a. Females; b. Males GSI: gonadosomatic index, HSI: hepato somatic index, K: condition factor.

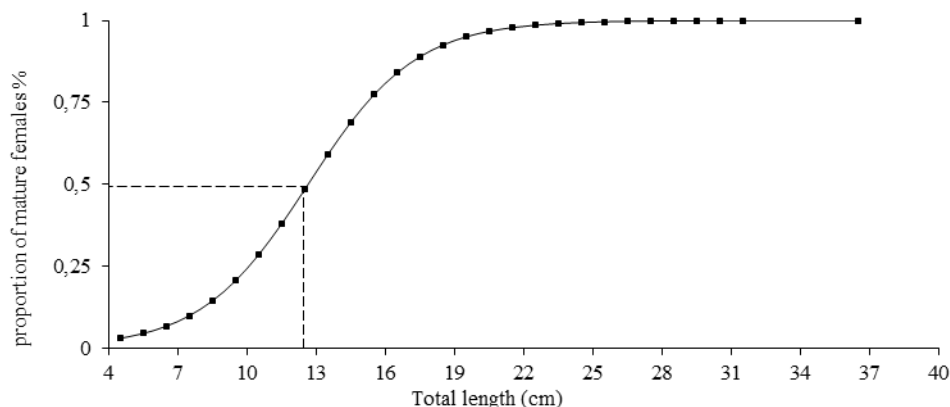


Figure 4. Length at first maturity L_{50} for females of *P. erythrinus*

Papaconstantinou, Mytilineou, & Panos, 1988; Livadas, 1989; Pajuelo & Lorenzo 1998), without sexual dimorphism and presents a sex ratio with a significant difference between females and males.

The sex ratio was unbalanced in favor of females, which is in accordance with the results reported for Mediterranean and Atlantic populations (Vassilopoulou & Papaconstantinou, 1986; Ghorbel, 1996., Pajuelo & Lorenzo 1998., Busalacchi et al, 2014). The predominance of females can be explained by protogynous hermaphroditism and an abundance of young individuals among the stock (Metin., 2011). The presence of small sized males (primary males) and large females in our samples suggests that sex change does not occur in each individual (Busalacchi et al, 2014).

The common pandora of the western Algerian coast shows a spawning period extending from May to July with a second peak on October. In different areas of Mediterranean Sea as Bay of Monastir (Ben Smida., 2014), Gulf of Tunis (Zarrad et al, 2010), Gulf of Gabès (Ghorbel., 1996), Southern Portugal (Coelho et al, 2010) and Canary Islands (Pajuelo & Lorenzo., 1998), the common pandora have the same behavior and generally spawns in spring/summer, a second spawning period in autumn has also been reported by some authors (Dieuzeide et al. 1955; Ghorbel & Ktari 1982; Vassilopoulou & Papaconstantinou 1990).

For females, the curve of HSI followed the same pattern as the GSI. Out of the reproduction period the values are low, increase during the gonadal maturation and decrease again in spawning period. This could be explained by the fact that this fish probably stores its energetic reserves in liver during the gonadal maturation period. Such reserves might be used for the energetic requirements of the spawning.

In contrast, males have high HSI values out of the reproduction which decreased and keep constant during the period of reproduction, this is presumably due to the lower energetic investment in sperm production in some species (Al Mamry, McCarthy, Richardson, & Ben Meriem., 2009), which is a common characteristic already observed for the same species from the Bay of Monastir (Ben Smida & Hadhri., 2014).

Length at first maturity (L_{50}) estimated in western Algerian coast for *Pagellus erythrinus* is lowest than those observed in Tunisia 15.32cm (Ben smida & Hadhri., 2014); Tyrrhénian sea 15.7cm (Busalacchi et al, 2014); Portugal 17.29cm (Coelho et al, 2010); and higher than those found by (Metin et al, 2011) in the central Aegean Sea 11.30cm.

The minimum landing size MLS regulation set at 150 mm TL adopted within the European Union Common Fisheries Policy (EU Regulation 1967/2006) and the Algerian Ministry of Fisheries and Fish Resources (M.P.R.H., 2004) for the common pandora is to our opinion insufficient to ensure stock renewal

and should be increased, a suggestion already proposed concerning a congener species *Pagellus acarne* (Bensahla Talet, Gheram, Dalouche, Bensahla Talet, Boutiba., forthcoming, 2017).

Conclusion

At the light of this first data about the reproductive cycle of *P.erythrinus* in the Bay of Oran we conclude that there is a significant difference between males and females with a predominance of females. The spawning period extends from May to July with a second peak on October. Length at first maturity L_{50} for females is reached at 12.5cm.

References

- Abella, A., Colloca, F., Sartor, P., & Mannini, A. (2010). General fisheries commission for the Mediterranean (GFCM). SAC SCSSA. WG on Stock Assessment of Demersal Species. Stock Assessment Forms.
- Al Mamry, J. M., McCarthy, I. D., Richardson, C. A., & Ben Meriem, S. (2009). Biology of the kingsoldier bream (*Argyrops spinifer*, Forsskal 1775; Sparidae), from the Arabian Sea, Oman *Journal of Applied Ichthyology*. 25(5), 559-564, <https://dx.doi.org/10.1111/j.1439-0426.2009.01260.x>
- Bensahla Talet, L., Gherram, M., Dalouche, F., Bensahla Talet, A., & Boutiba Z. (2017). Reproductive biology of *Pagellus acarne* (Risso, 1927) (Teleostei, Sparidae) of western Algerian waters (W. Mediterranean). *CAHIERS DE BIOLOGIE MARINE* 58-4 accepted in press.
- Ben smida, M.A., & Hadhri, N. (2014). Reproductive Cycle and size at first sexual maturity of common pandora *Pagellus erythrinus* (sparidae) from the Bay of Monastir (Tunisia, central Mediterranean). *Annales, Series Historia Naturalis*. 24. (1), 31-40. UDK 597.556.33:591.16 (262.26).
- Bonnet, M. (1969). Les sparidés des côtes nord-ouest africaines. *Revue des Travaux de l'Institut des Pêches maritimes*, 33(1), 97-116.
- Busalacchi, B., Bottari, T., Giordano, D., Profeta, A., & Rinelli, P. (2014). Distribution and biological features of the common pandora, *Pagellus erythrinus* (Linnaeus, 1758), in the southern Tyrrhenian Sea (Central Mediterranean). *Helgoland Marine Research*, 68(4), 491-501. <http://dx.doi.org/10.1007/s10152-014-0404-5>
- Cherabi, O. (1987). *Contribution a l'étude de la biologie du pageot commun Pagellus erythrinus et a l'écologie de la famille des Sparidés de la baie d'Alger*. Thèse de magister, USTHB université . Alger, Algérie.(in french)
- Coelho, R., Bentes, L., Correia, C., Gonçalves, J., Lino, P. G., Monteiro, P., & Erzini, K. (2010). Life history of the common pandora, *Pagellus erythrinus* (Linnaeus, 1758)(Actinopterygii: Sparidae) from southern Portugal. *Brazilian Journal of Oceanography*, 58(3), 233-245. <https://dx.doi.org/10.1590/s1679-87592010000300006>
- Dieuzeide, R., Novella, M. & Roland, J. (1955). Catalogue des poissons des côtes algériennes. III. Bulletin des Travaux. Station d'Aquaculture et de Pêche de

- Castiglione. Alger., n. spec., 6, 384 (in french)
- El Habouz.H., Bhar.L., Rafik.J et Yousra.M., (2009). Biologie des principales espèces ciblées par les chalutiers côtiers dans la zone Atlantique Centre Marocain, travaux techniques et scientifiques 2TS, Edition février 2015. (www.inrh.ma). 57p
- European Commission. (2006). Council Regulation (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 1626/94. *Official Journal L* 409, 30/12/2006, pp. 9–86.
- Fassatoui, C., & Romdhane, M.S. (2010). Variabilité génétique entre les classes d'âge chez le pageot commun (*Pagellus erythrinus*, Sparidae) des côtes nord tunisiennes. *Bulletin de l'Institut National des Sciences et Technologies de la Mer*, Salammbô, 37, 1–12. (in french)
- Fiorentino, F., Knittweis, L., Gancitano, V., Mifsud, R., Gravino, F. & Gristina, M. (2012). General fisheries commission for the Mediterranean (GFCM). Scientific Advisory Committee (SAC). *Report of the 14th of the Working Group on Stock Assessment of Demersal Species*, Chania (Crete), Greece.
- Fischer, W., Bauchot, M.-L. & Schneider, M. (1987). Fiches FAO d'identification des espèces pour les besoins de la pêche (Révision 1). Méditerranée et mer Noire. Zone de pêche 37. Vol II. Vertébrés. *FAO et Commission des Communautés Européennes*, Rome, 2, (761–1530)
- Fredj, G., & Maurin, C. (1987). Les poissons dans la banque de données MEDIFAUNE: Application à l'étude des caractéristiques de la faune ichthyologique méditerranéenne. *Cybiurn*, 11(3), 217–299.
- Froese, R., & Pauly, D. (2014). *Pagellus erythrinus*. FishBase Editors World Wide Web electronic publication. <http://www.fishbase.fr>.
- Ghorbel, M. & Ktari, M.H. (1982). Etude préliminaire de la reproduction de *Pagellus erythrinus* des eaux tunisiennes. *Bulletin de L'Institut National Scientifique et Technique D'Océanographie et de Pêche de Salammbô*. 9. 23–38. (in french)
- Ghorbel, M. (1996). *Le Pageot commun Pagellus erythrinus (poisson, sparidae): ecobiologie et état d'exploitation dans le golfe de Gabes* PhD thesis, Faculté des Sciences de Sfax, Tunisie.
- Ghorbel, A. O., Bradai, M. N., & Bouain, A. (2002). Période de reproduction et maturité sexuelle de *Symphodus (Crenilabrus) tinca* (Labridae), des côtes de Sfax (Tunisie). *Cybiurn*, 26(2), 89–92.
- Girardin, M., & Quignard, J. P. (1985). Croissance de *Pagellus erythrinus* (Pisces: Teleostéen, Sparidae) dans le Golfe du Lion. *Cybiurn*, 9(4), 359–374.
- Gurbet, R., Akyol, O. & Yalcin, E. (2012). Catch per unit effort and mortality rates of two sparid species, *Pagellus acarne* and *Pagellus erythrinus* from bottom trawl fishery in Izmir Bay, Aegean Sea. *Journal of Animal and Veterinary Advances* 1. 681–686. <http://dx.doi.org/10.3923/javaa.2012.681.686>
- Holden, M.J., & Raitt, D.F.S., (1975). Manual of Fisheries Science Part 2 - Methods of Resource Investigation and their application. Rome, Italy. FAO corporate document repository. Food and agriculture organization of the united nations, 115–211
- Hoşsucu, B. & Çakir, D.T. (2003). Some parameters about population biology of the common Pandora (*Pagellus erythrinus* L., 1758) (Sparidae) in Edremit Bay (Turkey). *Ege University Journal of Fisheries and Aquatic Sciences*. 20, 329–336 <http://dx.doi.org/10.12714/egejfas.2003.20.3.500015>
- 7078.g
- Htun-Han, M. (1978). The reproductive biology of the dab *Limanda limanda* (L.) in the North Sea : Gonosomatic index, hepatosomatic index and condition factor. *Journal of Fish Biology*, 13 :369–378. <http://dx.doi.org/10.1111/j.1095-8649.1978.tb03445.x>
- Jarboui, O., Ghorbel, M. & Bouain, A. (1998). Stock of common pandora (*Pagellus erythrinus*) in the Gabes Gulf (Tunisia): fishing situation and management possibilities. *Cahiers Options Méditerranéennes (CIHEAM)*, 35. 251–260.
- J.O.R.A.D.P. (2004). fixant les tailles minimales marchandes des espèces Biologiques. (rapport No 18). Alger, Algérie. *Journal Officiel de la République Algérienne Démocratique et Populaire* 5pp. (in french)
- Linné, C. von. (1758). Caroli Linnaei...Systema naturae per regna tria naturae :secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. <http://dx.doi.org/10.5962/bhl.title.542>
- Livadas, R. J. (1989). A study of the biology and population dynamics of pandora (*Pagellus erythrinus* L., 1758), family Sparidae, in the Seas of Cyprus. *FAO. Fish. Rep*, 412, 58–76.
- Mehanna, S. (2011). General fisheries commission for the Mediterranean (GFCM). Scientific Advisory Committee (SAC). *Report of the 13th of the SCSA Working Group on Stock Assessment of Demersal Species*. Istanbul, Turkey, 2010, pp 38–39
- Metin, G., İlkyaz, A.T., Soykan, O. & Kinacigil, H.T. (2011). Biological characteristics of the common pandora, *Pagellus erythrinus* (Linnaeus, 1758), in the central Aegean Sea. *Turkish Journal of Zoology*, 35(3) 307–31. <http://dx.doi.org.3906/zoo-0904-4>.
- Mytilinéou, C. (1989). Données biologiques sur le pageot, *Pagellus erythrinus*, des côtes orientales de la Grèce centrale. *FAO Fisheries Report*, 412 pp.
- Orsi Relini, L. & Romeo, G. (1985). Vertical distribution, age, growth and mortality of *Pagellus erythrinus* on trawled areas of Ligurian Sea. *Rapport Commission Internationale de la Mer Méditerranée.*, 29 (8), 103–106.
- Pajuelo, J.G., Lorenzo, J.M., Méndez-Villamil Nespereira. & Mata, M. (1996). Determinación del estado de explotación de la breca *Pagellus erythrinus* (Linnaeus, 1758) en aguas de Gran Canaria a través del análisis de cohortes en longitud. *Boletín del Instituto Español de Oceanografía* 12(2), 115–130.
- Pajuelo, J. G. & Lorenzo, J.M. (1998). Population biology of the common pandora *Pagellus erythrinus* (Pisces: Sparidae) off the Canary Islands. *Fisheries Research.*, v.36, n.2-3, 75–86, [http://dx.doi.org/10.1016/S0165-7836\(98\)00110-6](http://dx.doi.org/10.1016/S0165-7836(98)00110-6)
- Papaconstantinou, C., Mytilineou, C. & Panos, T. (1988). aspects of the life history and fishery of red pandora, *Pagellus erythrinus* (sparidae) off western greece. *Cybiurn*. 12 (4), 267–28
- Ricker, W. E. (1975). The Fisheries Research Board of Canada — Seventy-Five Years of Achievements. *Journal of the Fisheries Research Board of Canada*,

- 32(8), 1465–1490. <http://dx.doi.org/10.1139/f75-17>
- Rouidi, S. (2011). *Contribution à l'étude du pageot rose (Pagellus erythrinus, Linnaeus, 1758) dans la région de Jijel : les associations ichtyologiques, la biologie et l'exploitation*. Magister en sciences biologiques, Océanographie Biologique et Environnement Marin. Université des Sciences et Technologies Houari BOUMEDIENE. Alger, Algérie 147 p. (in french)
- Santos, M.N., Monteiro, C.C. & Erzini, K. (1995). Aspects of the biology and gillnet selectivity of the axillary seabream (*Pagellus acarne*, Risso) and common pandora (*Pagellus erythrinus*, Linnaeus) from the Algarve (South Portugal). *Fisheries Research*. 23, 223–236. [http://dx.doi.org/10.1016/0165-7836\(94\)00354-Y](http://dx.doi.org/10.1016/0165-7836(94)00354-Y)
- Somarakis, S. & Machias, A. (2002). Age, growth and bathymetric distribution of red pandora (*Pagellus erythrinus*) on the Cretan shelf (eastern Mediterranean). *Journal of Marine Biological Association of the United Kingdom*. 82: 149–160. <http://dx.doi.org/10.1017/S002531540200526X>
- Spedicato, M. T., Greco, S., Sophronidis, K., Lembo, G., Giordano, D., & Argyri, A. (2002). Geographical distribution, abundance and some population characteristics of the species of the genus *Pagellus* (Osteichthyes: Perciformes) in different areas of the Mediterranean. *Scientia Marina*, 66(S2), 65–82. <http://dx.doi.org/10.3989/scimar.2002.66s265>
- Tomiyama, T. (1974). Fisheries in Japan: Sea Bream, Vol. 3. The Japan Marine Products Photo Materials Association, Tokyo.
- Valdés, P., García-Alcázar, A., Abdel, I., Arizcun, M., Suárez, C. & Abellán, E. (2004). Seasonal changes on gonadosomatic index and maturation stages in common pandora *Pagellus erythrinus* (L.). *Aquaculture International*, 12, 333–343. <http://dx.doi.org/10.1023/B:AQUI.0000042136.91952.9e>
- Vassilopoulou, V., Mytilineou C, Papaconstantinou C (1986) Preliminary biological data on the red pandora (*Pagellus erythrinus* L., 1758) in the Greek seas. *FAO. Fish.Rep* 361:107–112
- Vassilopoulou, & Papaconstantinou, C. (1990). Growth by weight, condition factor and reproductive cycle of red pandora *Pagellus erythrinus* in the Saronicos Gulf. In: *Proceedings of 3rd Hellenic symposium on Oceanography and Fisheries*, Athens, vol 3, pp 584–591.
- Whitehead, P.J. P., Bauchot, M.-L., Hureau, J.-C., Nielsen J., & Tortonese, E. (1986). Fishes of the North-eastern Atlantic and the Mediterranean. *Journal of the Marine Biological Association of the United Kingdom*, 68(01), 1013–1473. <http://dx.doi.org/10.1017/s0025315400050360>
- Zarrad, R., Cherif M., Gharbi H., Jarboui, O. & Missaoui, H. (2010). Reproductive cycle and sex reversal of *Pagellus erythrinus* (Linnaeus, 1758) in the gulf of Tunis (central Mediterranean). *Bulletin de l'Institut National des Sciences et Technologies de la Mer Salammbô*, 37, 13–20. (in french)

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

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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

waters, some works have already been done on *B. boops* (Chali-Chabane, 1988 in Djabali et al., 1993); *T. mediterraneus*; *T. trachurus* (Korichi, 1988 in Djabali et al., 1993) but to our knowledge no such study was done for *P. acarne*, *M. barbatus*, *M. surmuletus* and *Trachurus picturatus* about WLRs (Weight–Length Relationships) so our aim is to remedy this deficiency and providing the missing data. Length-weight regressions have been used frequently to estimate weight from length because direct weight measurements can be time-consuming in the field (Sinovcic et al., 2004). In sampling programs, it is usually easier to measure length because of bobbing motion of the fishing boat, than weight. Also, weight cannot be measured easily in underwater visual censuses (Morey et al., 2003). These data are essential to estimate growth rates, length and age structures (Kolher et al., 1995) and also to other components like conversion of growth in length to growth in weight (Pauly, 1993). Also, this relationship provides useful tool for fish species dynamics and allows morphological comparison between fish populations in a given geographic region in relation to different environmental scenarios (Gonçalves et al., 1997; Ritcher et al., 2000).

2. Material and Methods

A total of 4.070 fish specimens were collected for the three fish families: Sparidae, Mullidae and Carangidae. Samples of *P. acarne*, *B.boops*, *M. barbatus*, *M. surmuletus*, *T. trachurus*, *T. mediteraneus* and *T. picturatus* were obtained from fish landings in Oran Bay (Fig.1) between April 2008 and August 2011, mainly caught using midwater and bottom trawl at depths ranging from 130 to 350 m.

The most abundant species in the present study was *T. mediteraneus* (1.795), followed by *P. acarne* with (844) individuals, *T. trachurus* (769), *M. barbatus* (369), *B. boops* (111), *T. picturatus* (94) and *M. surmuletus*, (88).

Specimens were measured to the nearest 1 mm (total length, L_t) and weighed to the nearest 0.1 g (weight, W_t). The relationship between weight and length of a fish is usually expressed by the equation $W=aL^b$ (Ricker, 1973) where W is the body weight (g), L is the total length (cm), “ a ” is the intercept and “ b ” is the slope (allometry coefficient) (Beverton and Holt, 1996). The parameters “ a ” and “ b ” of the weight-length relationships were estimated by the least-square method from logarithmically transformed data to correct for non-linearity and heterogeneous variances: $\text{Log } W_t = b \text{ Log } L_t + \text{Log } a$.

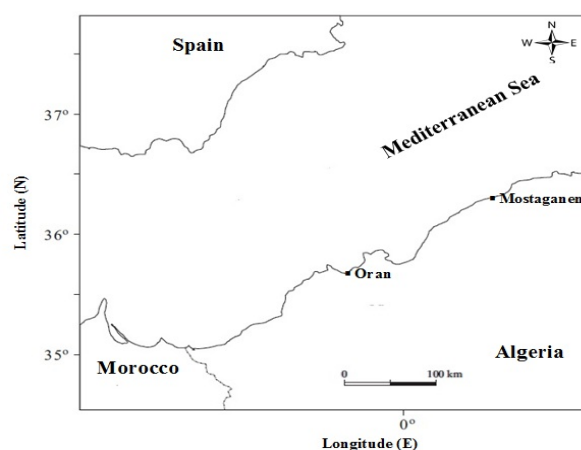


Fig. 1. Map of Study Area showing location of Oran Bay.

The association degree between weight-length variables was calculated by the determination coefficient (r^2) and analyzed with ANOVA. Values of the exponent “ b ” provide information on fish growth. If $b=3$, so increase in weight is isometric. When the value of “ b ” is other than 3, so weight increase is allometric, (positive allometric if $b>3$, or negative allometric if $b<3$). The null hypothesis of the isometric growth ($H_0: b=3$) was tested by t-test, using the statistic formula: $t_s = (b-3)/S_b$, where S_b is the standard error of the slope, for $\alpha=0.05$ (Morey et al., 2003). All calculations were done using Microsoft EXCEL 2007® and STATISTICA 6.0® software. It is important to highlight that

our data are not representative of a particular time or period of the year and for comparison purposes are considered only as mean annual. Froese (2000) has suggested that plotting of log a versus b (Fig. 3) for all known weight-length relationships of a species results in a linear relationship, and that this relationship can be used to identify outliers. In this paper, we have applied this method to all species.

3. Results

Table 1. Estimated parameters of the weight-length relationship ($W = aL^b$) for seven fishes from Oran Bay (Algeria). (W in g, L in cm).

Species	n	L_t (min-max)	W_t (min-max)	a	$b \pm s.e (b)$	r^2	Growth
<i>Pagellus acarne</i>	844	11.9-26.3	27.0-234.0	0.00890	$3.100^* \pm 0.020$	0.959	+ allometric
<i>Boops boops</i>	111	14.4-24.0	25.9-123.1	0.00504	$3.192^* \pm 0.029$	0.94	+ allometric
<i>Mullus barbatus</i>	369	10.9-23.2	20.4-149.2	0.01670	$2.842^* \pm 0.028$	0.854	- allometric
<i>Mullus surmuletus</i>	88	12.0-22.5	20.7-109.7	0.01070	2.970 ± 0.043	0.978	0 isometric
<i>Trachurus picturatus</i>	94	13.8-20.3	18.7-60.70	0.00458	$3.161^* \pm 0.015$	0.962	+ allometric
<i>Trachurus mediterraneus</i>	1795	13.2-35.0	16.9-344.4	0.00589	$3.094^* \pm 0.030$	0.948	+ allometric
<i>Trachurus trachurus</i>	769	14.2-23.5	20.7-97.70	0.00310	$3.296^* \pm 0.027$	0.932	+ allometric

n: sample size, a: intercept, b: slope, s.e (b): standard error of b, r^2 :coefficient of determination, *:significant t-test ($P < 0.05$).

4. Discussion

The comparison of b values for the species appearing both in this study and those obtained by other authors in the Mediterranean Sea had suggested inter-regional differences. “b” values for *P. acarne* ranged from 2.84 to 3.26, for *B. boops* from 2.87 to 3.19, for *M. barbatus* from 2.83 to 3.28, for *M. surmuletus* from 2.97 to 3.25, *T. picturatus* from 3.04 to 3.16, *T. mediterraneus* from 2.82 to 3.30 and *T. trachurus* from 3.27 to 3.29.

W-L relationships parameters can vary between stocks and even between areas as stated by (Sparre *et al.*, 1989; 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

Table 1 shows the results of W-L relationship for the fish species studied. The sample varied between 88 to 1795 specimens and b values varied between 2.842 and 3.296. All relationships were highly significant (ANOVA, $P < 0.001$) and r^2 values ranged from 0.854 to 0.978 indicating a positive correlation between total weight (W_t) and total length (L)

the number of specimen examined, b) area/season effect and c) differences in the observed length ranges of the specimen caught. Dulcic and Kraljevic (1998) stated that temperature, food quantity, quality and size), sex and stage of maturity are responsible for the differences in parameters of WL relationship. In addition, Froese (2006) stated that small specimens have a different WLR relationship than larger specimens.

Concerning the type of growth, isometric growth was found in *M. surmuletus*, negative allometry for *M. barbatus*, and positive allometry in Sparidae: *P. acarne*, *B. boops* and carrangidae: *T. picturatus*, *T. mediterraneus*, *T. trachurus* (Fig. 2). All relationships were significant (t-test, $P < 0.05$) except for *M. surmuletus*.

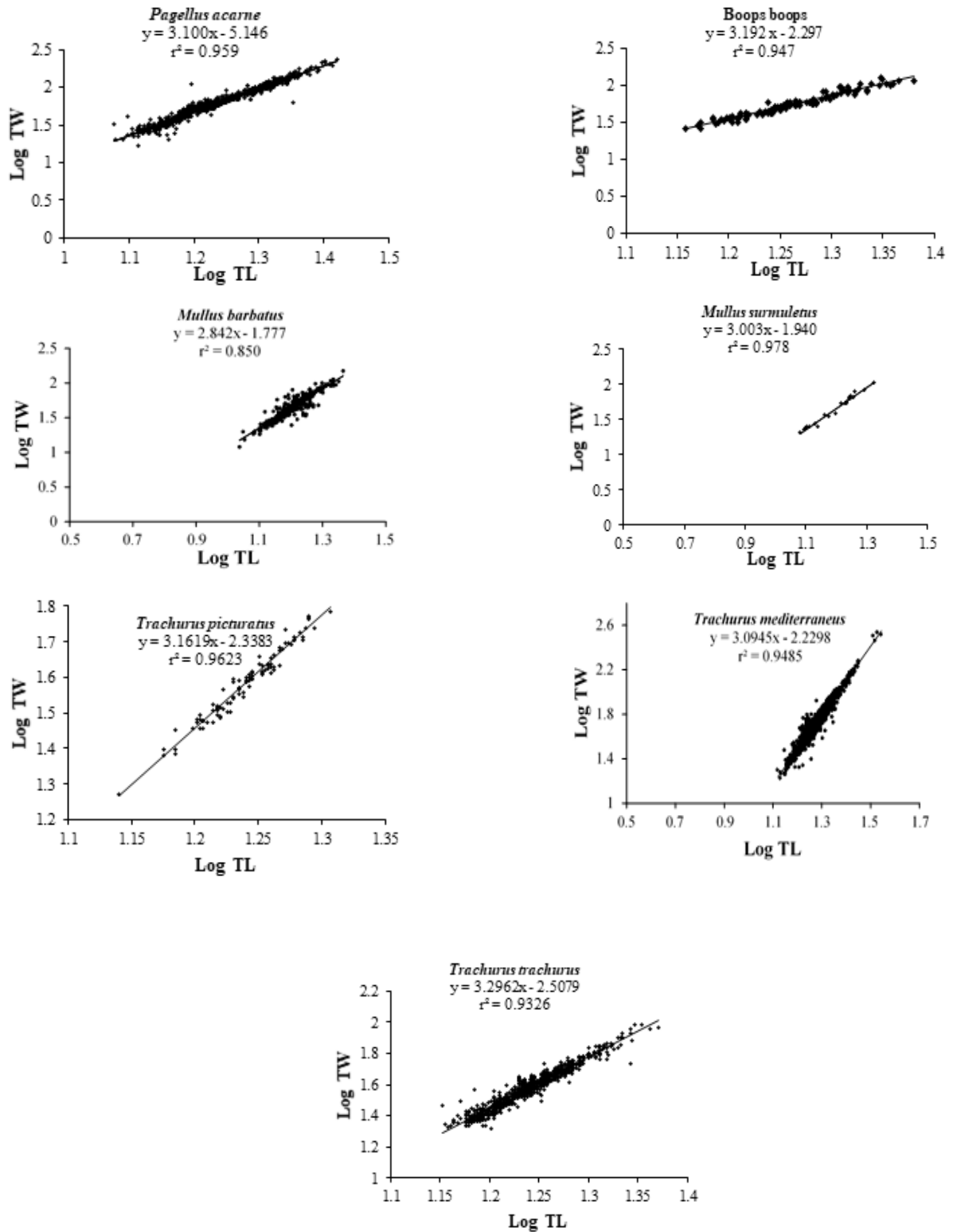


Fig. 2. Weight-length relationships for seven fish species from the W. Mediterranean Sea (Oran Bay-Algeria).

Table 2. Estimated parameters for the Weight-Length relationship ($W = aL^b$) for *P. acarne*, *B. boops*, *M. barbatus*, *M. surmuletus*, *T. picturatus*, *T. mediterraneus* and *T. trachurus* given by several authors. (W in g, L in cm).

	Author	Locality	n	Lt	Wt	a	b ± se(b)	r ²	All
<i>P. acarne</i>	Present study	Oran Bay, Algeria	844	11.9-26.3	27-234	0.0089	3.10±0.020	0.95	+
	Ceyhan <i>et al.</i> , 2009	Turkey	46	12.1-16.5	-	0.0094	3.26±0.11	0.95	+
	Sangun <i>et al.</i> , 2007	Turkey	83	11.0-17.0	16.49-57.43	0.0186	2.84±0.146	0.91	-
	Moutopoulos and Stergiou, 2002	Kyclades Greece	96	-	15.3-62.6	0.0150	2.93	0.97	0
<i>B. boops</i>	Present study	Oran Bay, Algeria	111	14.4-24	25.9-123.1	0.0050	3.19±0.029	0.94	+
	Korichi, 1988 in Djabali <i>et al.</i> , 1993	Bousmail Bay, Algeria	-	-	-	0.0097	3	-	0
	Petrakis and Stergiou, 1995	Evvoikos Greece	256	9.6 -24.3	-	0.0148	3.09	0.94	0
	Ceyhan <i>et al.</i> , 2009	Aegean Sea, Greece	32	16.5 – 27.0	-	0.0085	3.09±0.137	0.94	0
	Sangun <i>et al.</i> , 2007	NE Mediterranean	172	11.20–21.1	10.66-110.76	0.0072	3.08±0.096	0.93	0
	Abdallah, 2002	Egypt	284	3.7 - 14.6	-	0.007	3.13	0.97	+
	Cherif <i>et al.</i> , 2008	Gulf of Tunis,Tunisia	243	12-26	-	0.007	3.06±0.027	0.98	0
<i>M. barbatus</i>	Present study	Oran Bay, Algeria	369	109-232	20.4-149.2	0.022	2.84±0.028	0.85	-
	Gökçe <i>et al.</i> , 2007	Turkey	111	8-19.6	6-90	0.0091	3.10 ± 0.10	0.97	+
	Sangun <i>et al.</i> , 2007	Turkey	451	8.2-22.0	4.96-106.40	0.0032	3.06±0.051	0.94	0
	Moutopoulos and Stergiou, 2002	Kyclades	15	19.1-29	-	0.0177	2.83	0.75	-
	Vassilopoulou and Papaconstantinou, 1992a	Aegean Sea	438	7.5-17.5	-	0.0073	3.28	0.97	+
	Vassilopoulou and Papaconstantinou, 1992a	Aegean Sea	472	7.5-17.5	-	0.0105	3.15	0.98	+
	Papaconstantinou <i>et al.</i> , 1994	Aegean Sea	2206	5-24	-	0.0000157	2.99	0.93	0
	Cherif <i>et al.</i> , 2008	Gulf of Tunis,Tunisia	1763	6.3-25	-	0.005	3.23	0.99	+
	Gökçe <i>et al.</i> , 2007	Aegean Sea	111	8-19.6	6–90	0.0091	3.1	0.97	+
	Abdallah, 2002	Egypt	512	3.6 - 15.7	-	0.012	3	0.92	0
<i>M. surmuletus</i>	Present study	Oran Bay, Algeria	220	120-210	20.7-108.2	0.0000113	3.00±0.014	0.97	0
	Ceyhan <i>et al.</i> , 2009	Turkey	120	13.1-25.1	-	0.0069	3.21±0.044	0.97	+
	Gökçe <i>et al.</i> , 2007	Turkey	38	7.3-18.6	6–82	0.0131	2.97 ± 0.13	0.98	-
	Moutopoulos and Stergiou., 2002	Kyclades	257	13.8- 32	-	0.014	2.95	0.94	0
	Moutopoulos and Stergiou, 1998	Kyclades	42	14-32	-	0.0176	2.9	0.92	0
	Vassilopoulou and Papaconstantinou, 1992b	Aegean Sea	451	10-20	-	0.00909	3.25	0.97	+
	Abdallah, 2002	Egypt	122	5.4 - 20.8	-	0.0110	3.03	0.73	0
	Present study	Oran Bay, Algeria	94	14.2-23.5	20.7-97.7	0.0045	3.16±0.015	0.96	+
<i>T. picturatus</i>	Merella <i>et al.</i> , 1997	Balearic Islands, Spain	180	4-23.9	-	0.0089	2.86	0.99	-
	Present study	Oran Bay, Algeria	1795	13.2-35	16.9-344.4	0.0058	3.09	0.94	0
<i>T. mediterraneus</i>	Korichi, 1988 in Djabali <i>et al.</i> , 1993	Bousmail Bay, Algeria	-	-	-	0.01420 F	3	-	0
			-	-	-	0.01270 M	3	-	0
	Cherif <i>et al.</i> , 2008	Gulf of Tunis,Tunisia	462	8.8-30	-	0.007	3.01	0.99	0
	Moutopoulos and Stergiou., 2002	Kyclades	191	17.3-34.1	-	0.0144	2.82	0.92	-
	Pešić <i>et al.</i> , 2012	Montenegro	730	8.9-31.3	-	0.0073 M 0.0088 F	3.02 2.95	- -	0 -
	Ozdemir and Duyar, 2013	Turkey	526	9.4-15.1	4.6-25.2	0.0032	3.30	0.89	+
	Present study	Oran Bay, Algeria	769	13.8-20.3	18.7-60.7	0.0031	3.29	0.93	+
<i>T. trachurus</i>	Korichi, 1988 in Djabali <i>et al.</i> , 1993	Bousmail Bay, Algeria	-	-	-	0.001270 M	3	-	0
			-	-	-	0.001500 F	3	-	0
	Cherif <i>et al.</i> , 2008	Gulf of Tunis,Tunisia	229	9-32	-	0.007	2.98	0.99	0
	Moutopoulos and Stergiou, 2002	Kyclades	12	15.8-28	-	0.00339	3.27	0.96	+

n: sample size, a: intercept, b:slope, s.e (b): standard error of b, r²:coefficient of determination, All: allometry (0: isometric, -: negative allometric,+: positive allometric).

Froese (2000) has suggested that a plot of **log a** versus **b** (Fig.3) for all known weight-length relationships of a species results in a linear relationship, and this relationship can be used to identify outliers. In this paper, we have applied this method to all species. This led to

the detection of outliers, where the respective point deviated more than two standard deviations from the regression line. One outlier was detected for *B.boops* and one for *M. barbatus* off the seven studied species.

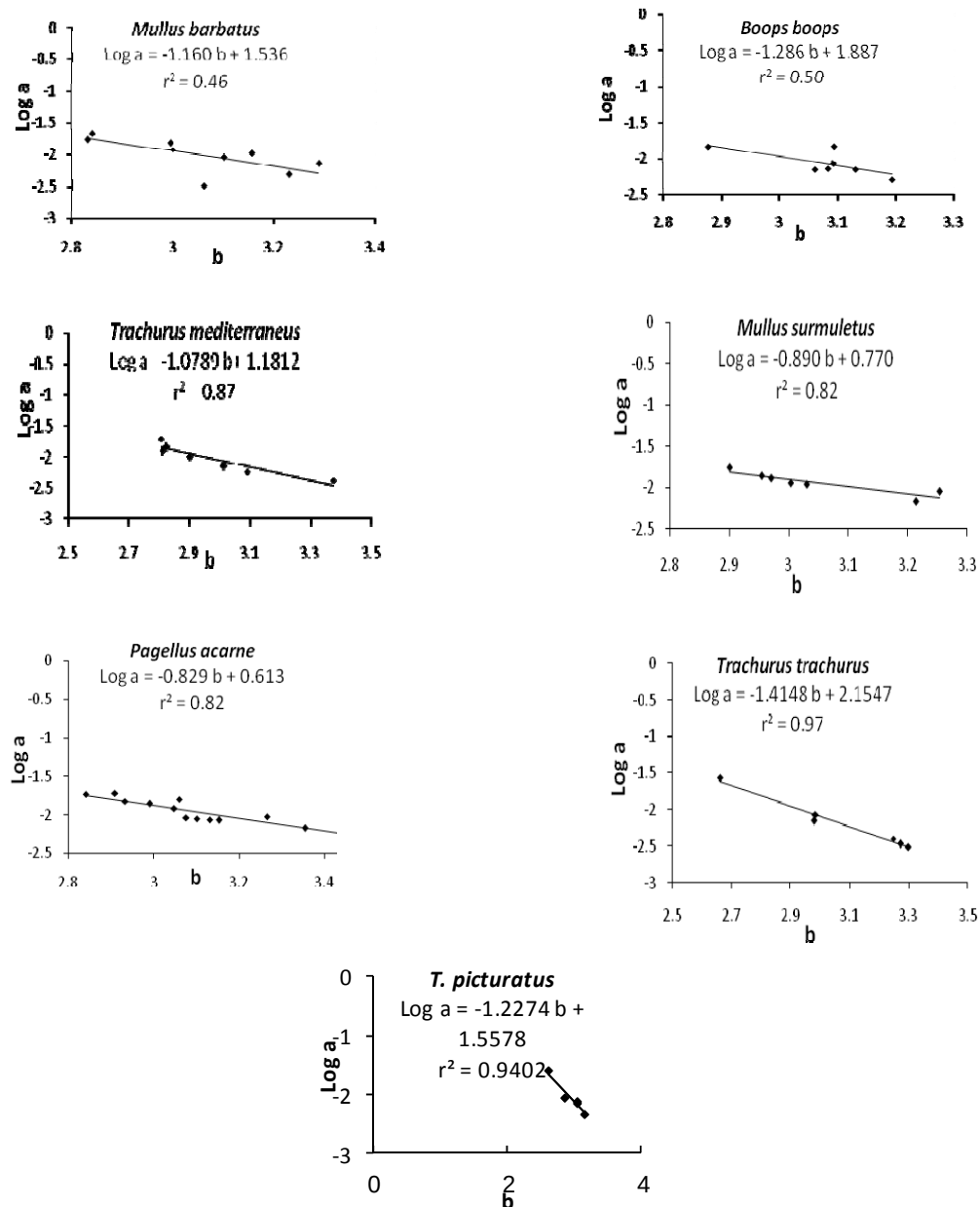


Fig. 3. Plots of $\log a$ versus b for available weight-length relationships of seven fish species in the Mediterranean waters.

However, these results are important by the fact that they contribute to enrich the available data on species living in the Mediterranean and constitute the first reference on W-L relationships for four species from Algerian waters (*Pagellus acarne*; *Mullus barbatus*; *Mullus surmuletus*; *Trachurus picturatus*).

5. Conclusion

For Algerian waters, scarce data exist on the relation between weight and length for species cited previously we can cite works of Korichi 1988 (*T. mediterraneus* and *T. trachurus*) and Chali-Chabane, 1988 (*B. boops*). Concerning Oran Bay data are presented for the first time in this paper helping comparative studies in this field to explain differences in growth trend (WL) found between different fish populations. Further studies will target a large number of species occupying the area to understand the inter-population and shape variations using the outliers method.

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References

- Abdallah, M.** (2002). Length-Weight Relationship of Fishes Caught by Trawl off Alexandria, Egypt. *Naga, the ICLARM Quarterly*, **25**(1) January-March: 19-20.
- Andrade, H.A.** and **Campos, R.O.** (2002). Allometry coefficient variations of the length-weight relationship of skipjack tuna (*Katsuwonus pelamis*) caught in the southwest South Atlantic. *Fisheries Research*, **55**, 307-312.
- Bensahla Talet, A.** and **Boutiba, Z.** (2000) *La pêche à Oran de 1995 à 1999. Actes des 4^{èmes} journées tunisiennes des sciences de la mer: 17-19 novembre 2000, Mehdi (Tunisie)*. 18-23 p.
- Beverton, R.J.H.** and **Holt, S.J.** (1996) *On the Dynamics of Exploited Fish Populations*. Chapman and Hall. London, 533 p.
- Ceyhan, T., Akyol, O.** and **Erdem, M.** (2009) Length-Weight Relationships of Fishes from Gökova Bay, Turkey (Aegean Sea). *Turkish Journal of Zoology*. **33**: 69-72.
- Chali-Chabane, F.** (1988). *Contribution à l'étude biologique et dynamique de bogues, Boops boops (Linné, 1758) de la baie de Bou-Ismaïl. Thèse de Magister. Ministère aux Universités, Institut des Sciences de la Mer et de l'aménagement du Littoral, Alegria*. 111 p.
- Cherif, M., Zarrad, R., Gharbi, H., Missaoui, H.** and **Jarboui, O.** (2008) Length-weight relationships for 11 fish species from the Gulf of Tunis (SW Mediterranean Sea, Tunisia). *Pan-American Journal of Aquatic Sciences*, **3** (1): 1-5.
- Djabali, F., Mehailia, A. Koudil, M.** and **Brahmi, B.** (1993). Empirical equations for the estimation of natural mortality in Mediterranean teleosts. *Naga ICLARM Quarterly*. **16**(1):35-37.
- Dulcic, J.** and **Kraljevic, M.** (1996) Weight-length relationships for 40 fish species in the eastern Adriatic (Croatian waters). *Fisheries Research*, **28**: 243-251.
- Froese, R.** (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of applied ichthyology*, **22**(4): 241-253.
- Froese, R.** (2000). Evaluating length-weight relationships. In: *FishBase 2000: Concepts, Design and Data Sources*. R. Froese and D. Pauly (Eds). ICLARM, Los Baños, Laguna, Philippines, p. 133.
- Gökçe, G., Aydin, I.** and **Metin, C.** (2007) Length-weight relationships of 7 fish species from the North Aegean Sea, Turkey. *International Journal of Nature and Engineering. Sciences*, **1**: 51-52 (2007).
- Gonçalves, J.M.S., Bentes, L., Lino, P.G., Ribeiro Canário, A.V.M.** and **Erzini, K.** (1997) Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. *Fisheries Research*, **30**:253-256.
- Kolher, N., Casey, J.** and **Turner, P.** (1995) Length-weight relationships for 13 species of sharks from the western North Atlantic. *Fisheries Bulletin*, **93**: 412-418.
- Korichi, H.S.** (1988) *Contribution à l'étude biologique des deux espèces de saurels: Trachurus trachurus (Linné, 1758) et Trachurus mediterraneus (Steindachner, 1868) et de la dynamique de Trachurus trachurus (Linné, 1758) en baie de Bou-Ismaïl (Alger)*. Thèse de Magister. ISMAL. Alger. 203 p.
- Merella, P., Quetglas, A., Alemany, F.** and **Carbonell, A.** (1997) *Length-Weight relationship for fishes and cephalopods from the Balearic Islands (Western Mediterranean)*. NAGA. The ICLARM Quarterly. July-December 1997.3 p.
- Morey, G., Moranta, J., Massuti, E., Grau A., Linde, M., Riera, F.** and **Morales-Nin, B.** (2003) Weight-length relationships of littoral to lower slope fishes from Western Mediterranean. *Fisheries Research*. **62**: 89-96.
- Moutopoulos, D.K.** and **Stergiou, K.I.** (1998) Length-weight

and length relationships for seven fish species of the Aegean Sea. *Proceedings of the 20th meeting of the Hellenic Society of Biological Sciences*, **20**: 207-208.

Moutopoulos, D.K. and Stergiou, K.I. (2002). Length-weight and length-length relationships of fish species from the Aegean Sea (Greece). *Journal of Applied Ichthyology*, **18** (2002), 200–203.

Ozdemir, S. and Duyar, H.A. (2013). Length-Weight Relationships for Ten Fish Species Collected by Trawl Surveys from Black Sea Coast, Turkey. *International Journal of Chemical, Environmental & Biological Sciences (IJCEBS)*, 1(2): 405-407.

Papaconstantinou, C., Politou, C.Y., Caragitsou, E., Stergiou, K.I., Mytilineou, CH., Vassilopoulou, V., Fourtouni, A., Karkani, M., Kavadas, S., Petrakis, G., Siapatis, A., Chatzinikolaou, P. and Giagnisi, M. (1994). *Investigations on the abundance and distribution of demersal stocks of primary importance in the Thermaikos Gulf and the Thracian Sea (Greece)*. National Centre for Marine Research, Athens, Greece, Technical Report, North Aegean Series 4/ 1994, 356 p.

Pauly, D. (1993). Fishbyte Section. Editorial. *Naga. ICLARM Quart.* **16**: 26.

Pešić, A., Joksimović, A., Đurović, D., Mandić, M., Marković, O. and Ikica, Z. (2012). Biological Characteristic of Mediterranean Horse Mackerel (*Trachurus Mediterraneus*, Steindachner, 1868) from the Montenegrin Shelf (Southern Adriatic). *Water Resource Management*, **2**(3): 29-33.

Petrakis, G. and Stergiou, K.I. (1995). Weight-length relationships for 33 fish species in Greekwaters. *Fisheries Research*, **21**:465–469.

Sangun, L., Akamca, E. and Akar, M. (2007). Weight-Length Relationships for 39 Fish Species from the North-Eastern Mediterranean Coast of Turkey. Turkish. *Journal of Fisheries and Aquatic Sciences*, **7**: 37-40.

Sinovic, G., Franicevic, M., Zorica, B. and Ciles-Kec, V. (2004). Length-weight and length-length relationships for 10 pelagic fish species from the Adriatic Sea (Crotia). *Journal of Applied Ichthyology*, **20**: 156-158.

Ricker, W.E. (1973). *Linear regressions in fishery research*. *Journal of Fisheries Research. Board Can.* **30**: 409-434.

Ritcher, H., Luckstadt, C., Focken, U. and Becker, K. (2000). An improved procedure to assess fish condition on the basis of length-weight relationships. *Archive of Fishery and Marine Research*, **48**: 255-264.

Sparre, P., Ursin, E. and Venema, S.C. (1989) *Introduction to tropical fish stock assessment. Part I. Manual*. FAO Fisheries Technical Paper No. 306.

Vassilopoulou, V. and Papaconstantinou, C. (1992a) *Aspects of the biology of red mullet (Mullus barbatus) in the Aegean Sea*. FAO Fisheries Report 477:115-126.

Vassilopoulou, V. and Papaconstantinou, C. (1992b). *Preliminary biological data on the striped red mullet (Mullus surmuletus) in the Aegean Sea*. FAO Fisheries Report 477:85-96.

علاقات الوزن - الطول لسبعة أنواع من الأسماك (عظميات: سباريڊاي، وموليڊاي، وكرانجيداي) في غرب البحر الأبيض المتوسط - خليج وهران، الجزائر

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المستخلص. لا توجد معلومات حاليا عن علاقات الطول بالوزن لعائلة سباريڊاي: المرجان الأبيض (Risso, 1827) (*Pagellus acarne*)، والبوق (Linnaeus, 1758) (*Boops boops*)، وموليڊاي: روجي الرمل (Linnaeus, 1758) (*Mullus barbatus*)، روجي الحجر (Mullus) (*Trachurus mediterraneus*)، وكرانجيداي: الخورير الأزرق (Linnaeus, 1758) (*surmuletus*)، والصوري (Bowdich, 1825) (*Trachurus picturatus*)، والخوري (Linnaeus 1758) (*Trachurus trachurus*) المستخرجة من خليج وهران في الأبيض المتوسط الغربي. ويعرض هذا البحث للمرة الأولى بخصوص هذه المنطقة من البحر الأبيض المتوسط للمساهمة والمساعدة في دراسات مقارنة النمو. تم جمع العينات من مصائد الأسماك في خليج وهران في الجزائر. قيم الميل ب في العلاقة طول الوزن $W = aL^b$ ، تراوحت بين ٢,٨٤١ و ٣,٢٩٦. أما معاملات الارتباط r^2 فتراوحت قيمتها ما بين ٠,٨٥ و ٠,٩٧. تمت مقارنة المعاملات "أ" و "ب" مع مواقع الصيد الأخرى لأنواع الأسماك نفسها باستعمال المعادلة البيانية [Froese plot $\log a = f(b)$].

الكلمات الدالة: علاقة الطول بالوزن *Trachurus picturatus*; *Trachurus mediterraneus*; *Trachurus trachurus*; *Mullus surmuletus*; *Mullus barbatus*; *Boops boops*; *Pagellus acarne*; خليج وهران، الجزائر.

Fecundity of the blotched picarel, *Spicara maena* (Linnaeus, 1758) from Oran Bay (Western Mediterranean Sea)

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Abstract

The fecundity of the blotched picarel *Spicara maena* from the western Mediterranean (Oran Bay) was assessed by the volumetric method. Total length (TL) of studied females varied between 91 and 140 mm (mean $\pm$ SD: 111.9 ± 10.6 mm). Estimates of total potential annual fecundity varied from 16,750 to 28,125 oocytes per individual (mean $\pm$ SD: $21,404.7 \pm 2,698.8$). Relationships between total potential fecundity (F) and TL, total weight, gonad weight were established using the multiplicative regression model and a high significant correlation was found in all the cases.

Keywords: Blotched picarel; *Spicara maena*; Sparidae; fecundity; Oran Bay.

1 | INTRODUCTION

The fecundity of a fish is defined as the number of eggs that are likely to be laid during a spawning season (Bagenal and Braum 1978). The reproductive potential is an important biological parameter that plays a significant role in evaluating the commercial potentials of fish stocks (Gómez-Márquez 2003). Also, fecundity is an important aspect of the reproductive biology of species which must be understood to manage the species concerned including exploration of aquaculture potentials. The fecundity-size relationship has been used principally as a rapid means of predicting the fecundity of fish stocks when the length distribution is known (Dulčić *et al.* 1998).

The fecundity and its relation to body size make it possible to estimate the potential of egg output (Chondar

1977) and the potential number of offspring in a season and reproductive capacity of fish stocks (Qasim and Qayyum 1963). Variations in number of oocytes emitted seen from year to year, and over decades, reflect the amelioration or deterioration of the habitat in relation to the individual fish (Nikolskii 1969).

Spicara maena (Linnaeus, 1758) is a commercial species inhabiting in the Mediterranean, Black Sea, and along the European and African coast of Atlantic, from Morocco to Portugal and Canary Islands (Fischer *et al.* 1987) and very frequent on the western Algerian coast (Figure 1). This species commonly inhabits over posidonia beds and sandy or muddy bottoms, and distributes up to 100 m depth (Soykan *et al.* 2010). *S. maena* feeds primarily on zooplankton (Froese and Pauly 2017). It is often caught at depths ranging from 100 to 150 m (personal observation),

by trawl or trammel net, most commonly used fishing techniques (Kadari 1984).

Published works on *S. maena* focused on several aspects including growth, feeding habits or molecular differentiation (Dulčić *et al.* 2000; Çiçek *et al.* 2007; Ismen *et al.* 2007; Karakulak *et al.* 2007; Altinagac *et al.* 2009; Imsiridou *et al.* 2011; Minos *et al.* 2013; Cengiz *et al.* 2014; Karachle and Stergiou 2014; Saygili *et al.* 2016a, 2016b) but investigations on reproductive biology of this species are very limited and reported only from the Turkish waters (Çiçek *et al.* 2007; Soykan *et al.* 2010) and Adriatic Sea (Matic-Skoko *et al.* 2004).

However, in Algerian waters works are limited to the study of feeding habits of *S. maena* (Harchouche *et al.* 2009). Therefore, the present study aims to estimate the fecundity of this species for the first time in relation to total length, total weight and gonad weight to help comparative studies in the Mediterranean.

2 | METHODOLOGY

Specimens of *S. maena* ($N = 2,638$) were caught by trawlers operating in Oran Bay located on the North West of Algerian coasts (West Mediterranean Sea) situated between “Pointe de l’Aiguille” and “Cap Falcon” ($35.95^{\circ}\text{N} - 0.65^{\circ}\text{E}$) (Figure 1) at depths ranging between 100 and 150 m between April 2002 and June 2003 and only 64 mature females (stages III and IV) were taken for fecundity estimation.

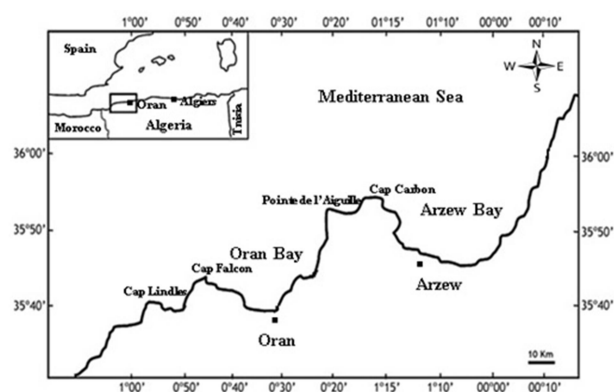


FIGURE 1 Map of the study area (Oran Bay)

The sex of individuals was determined macroscopically after opening the abdominal cavity and stages of maturity were classified according to colour, shape, vascularization and the volume occupied in the abdominal cavity as follows (Harchouche 2006, adapted): I, immature; II, resting; III, ripe; IV, ripe and running; V, spent (Table 1). Fork length (TL) was measured with an ichthyometer to the nearest mm, total weight (Wt) to the nearest g and gonad weight (Wg) to the nearest 0.01 g using a precision balance.

For fecundity estimates, the volumetric method was employed, ovaries were labelled and dropped in Gilson’s fluid, a preservative and dissociative solution (100 ml 60% alcohol, 800 ml water, 15 ml 80% nitric acid, 18 ml glacial acetic acid, 20 g mercuric chloride) (Stéquert and Ramcharrun 1995). The ovaries were shaken periodically to help loosen the ovarian tissue and ensure rapid penetration of the preservative. After 48 hours in preservative, the eggs can be completely liberated from the tissues by vigorous shaking (Holden and Raitt 1974). Eggs were cleaned and put in a measuring cylinder and made up to a known volume with water.

TABLE 1 Macroscopic description of *Spicara maena* gonads

Stage	Description
I: Immature	Transparent or pale pink small filamentous gonads, (invisible oocytes).
II: Resting	Pale pink to light orange firm ovaries; some oocytes can be visible through ovarian membrane.
III: Ripe	Usually orange clear then dark more developed and less firm gonad; the visible oocytes confer a grainy aspect of the ovary.
IV: Ripe and running	Voluminous very vascularised ovary occupying the entire abdominal cavity with a very thin ovarian membrane; the hyaline eggs are visible and are emitted with a simple pressure exerted on the abdomen.
V: Spent	The ovary is flaccid, vascularized; the colour is red-pink with the typical general appearance of an empty bag.

Subsamples were then taken by shaking the container until all the eggs are evenly distributed through the water; a subsample of known volume was picked-up with a Stempel pipette (Holden and Raitt 1974), and the number of eggs in the subsample was counted with a Dollphus box under a binocular microscope ($G \times 16$). Only oocytes with diameter between 200 and $760\ \mu\text{m}$ were considered as mature (Harchouche 2006) corresponding to eggs in stage III (ripe: vascularized light orange ovary occupying almost the abdominal cavity with visible oocytes conferring a granular aspect to the gonad) and stage IV (ripe and running: voluminous vascularized orange ovary occupying all the abdominal cavity containing hyaline eggs that can be easily expelled by simple pressure on the abdomen).

Given the very soft and fragile characteristics of gonadal tissue, only 64 females from 2,638 specimens were taken for fecundity estimation during April–June of the sampling period corresponding to the reproduction period of the species (Harchouche 2006, Soykan *et al.* 2010). The degree of association between fecundity with total length (TL), total weight (TW) and gonad weight (GW) was as-

sessed by the coefficient of determination (R^2); statistical significance level was estimated by a *t*-test using Excel 2016© software.

We used the multiplicative regression model ($y = ax^b$) modified with the logarithmic function then measures were log-transformed in order to eliminate any effect of 'scale', to keep relations linear and their variances comparable (Froese 2006). The equation can be expressed as:

$$\text{Log } F = b \text{ Log } X + \text{Log } a,$$

where *F* is the fecundity, *X* is TL, TW or GW; *a* is the intercept of the regression and *b* is the regression coefficient.

3 | RESULTS AND DISCUSSION

Of 2,638 specimens of *S. maena* collected, 120 were male and 2,610 were female and sex ratio was 1:20.98 (male to female) was in favour of female during all months of the sampling period. Given the gonads fragility, only 64 gonads were considered for the fecundity estimation ranging from 16.9 to 26.3 cm TL (mean $\pm$ SD: 206.6 $\pm$ 19.9 cm) weighing 63.5 to 234.2 g (mean $\pm$ SD: 110.0 $\pm$ 37.6 g) with gonadal weight of 1.2 to 6.1 g (mean $\pm$ SD: 3.1 $\pm$ 1.2 g). Potential fecundity (*F*) ranged from 19,875 to 49,125 (mean $\pm$ SD: 29,448.9 $\pm$ 8,198.1), the value of SD can be explained by the biometric variation of the specimens. Added to this, the volumetric method is subject to considerable bias because it is very difficult to get all the eggs evenly distributed throughout the measuring cylinder (Holden and Raitt 1974).

Table 2 and Figure 2 show the relationships between total potential fecundity and TL, TW and GW obtained from the application of the multiplicative regression model. The significance test (*t*-test) calculated for the regression coefficient of the relationship between fecundity and TL, TW and GW of *S. maena* was higher than tabulated *t*-value ($t = 3.46$, $df = 62$) confirming high correlation.

Knowledge of fecundity is regarded as an important contributor in understanding stock dynamics and obtaining basic biological information for use in stock assessments. Estimated fecundity for *S. maena* of Oran Bay was compared to other results found in the literature (Table 3).

Only a few articles are available in the literature concerning the biology of *S. maena* and more precisely dealing with reproduction and fecundity to allow us to compare our results.

However, in the current study, the mean number of oocytes in ovaries was 29,448 $\pm$ 8,198, with a range from 19,875 to 49,125 oocytes number and 16.9 to 26.3 cm of TL. The statistical analysis revealed that the relationships between fecundity and TL, TW and GW were found signif-

icant (all $P < 0.001$) and that the fecundity increases linearly with the increase ($0.92 < R^2 < 0.98$) of TL, TW and GW (Table 1) of specimens. The total weight related to absolute fecundity appeared to be the more appropriate parameter to estimate fecundity for *S. maena*.

Table 2 Relation between absolute fecundity (*F*), total length (TL), total weight (TW) and gonad weight (GW) of *Spicara maena* collected from the Oran Bay (Algeria)

Relationship	Equation	R^2	<i>t</i> -test
F vs TL	$\text{Log } F = 1.3197 \text{ Log TL} + 2.945$	0.979	53.39*
F vs TW	$\text{Log } F = 0.4216 \text{ Log TW} + 3.794$	0.986	64.80*
F vs GW	$\text{Log } F = 0.4670 \text{ Log GW} + 4.228$	0.903	24.06*

*, significant relationship ($t = 3.46$, $df = 62$; $P < 0.001$)

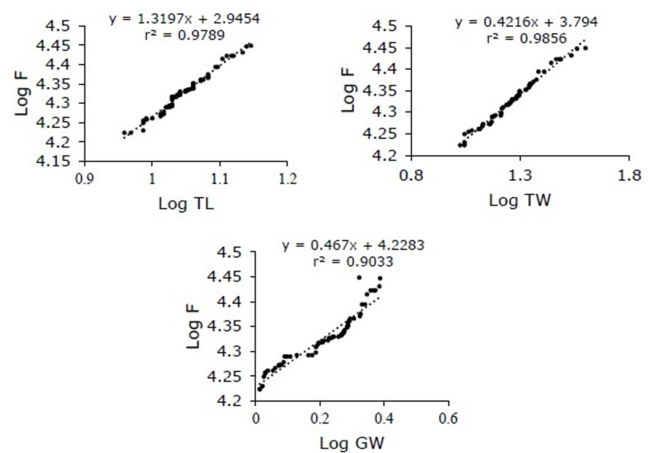


FIGURE 2 Relationship of total fecundity (*F*) to total length (TL; above left), total weight (TW; above right) and gonad weight (GW; below) of *S. maena* female

TABLE 3 Fecundity of *Spicara maena* given by different authors

Locality	Fecundity (range; mean $\pm$ SD)	N	Length (cm)	Source
Eastern Adriatic Sea	42,140 – 80,509 (64,730 $\pm$ 9,634)	74	13.5–20	Matik-Skoko <i>et al.</i> 2004
Algiers Bay, Algeria	9,000 – 92,000 (30,960 $\pm$ 5,420)	42	11.5–18.5	Harchouche 2006
Oran Bay, Algeria	19,875 – 49,125 (29,448 $\pm$ 8,198)	64	16.9–26.3	Present study

Despite the difference in length range during sampling, our results were found similar to Harchouche (2006) who estimated fecundity of *S. maena* between 9,000 and 92,000 for a total length ranged from 11.5 to 18.5 cm. Matik-Skoko *et al.* (2004) estimated the fecundity between 42,140 and 80,509 with a mean fecundity equal to 64,730 eggs.

The variation of fecundity is very common in fish (Doha

and Hye 1970; Kraus *et al.* 2000) and the number of eggs produced by an individual female is dependent on various factors like size and age (Lagler *et al.* 1967, Burt *et al.* 1988, Munro *et al.* 1990; Alam *et al.* 2012). In addition, some authors attribute these differences to food availability and /or quality in *S. maena* (Matik-Skoko *et al.* 2004). Several studies on genus *Gadus* revealed that temperature can affect the fecundity positively (e.g. Kjesbu *et al.* 1998, Kraus *et al.* 2000). Dulčić *et al.* (1998) compared fecundity in Sparidae family and concluded that fecundity oscillates considerably depend on the species and geographical location.

In conclusion, there is lack of data on reproductive biology of *S. maena* a commercially important species for the Mediterranean and Algerian fisheries. Further studies on the histological approach, first maturity, growth and exploitation status will be treated in order to determine details of the reproductive biology of the blotched picarel.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

- Alam MM, Galib SM, Islam MM, Flowra FA and Hussain MA (2012) Morphometric study of the wild population of pool barb, *Puntius sophore* (Hamilton, 1822) in the River Padma, Rajshahi, Bangladesh. *Trends in Fisheries Research* 1(2): 10–13.
- Altinagac U, Kara A, Ozekinci U, Ayaz A and Ismen A (2009) Selectivity of fishhooks used in blotched picarel (*Spicara maena*) in artisanal fishery in Dardanelles. *Journal of Animal and Veterinary Advances* 8(8): 1646–1652.
- Bagenal TB and Braum E (1978) Eggs and Early Life History. IBP Hand Book No. 3, 3rd edition. Blackwell Scientific Publication, Oxford, 106 pp.
- Burt A, Kramer DL, Nakatsura K and Spry C (1988) The tempo of reproduction in *Hyphessobrycon pulchripinis* (Characidae), with a discussion of “multiple spawning” in fishes. *Environmental Biology of Fishes* 22: 15–27.
- Cengiz Ö, Özekinci U, Öztekin A, Aslan A (2014) Gelibolu yarımadası’ndaki izmarit baliği’nin (*Spicara maena* Linnaeus, 1758) büyüme ve üreme özelliklerinin belirlenmesi. *Doğu Anadolu Bölgesi 5. Su Ürünleri Sempozyumu*. 30 Mayıs 2014. Elazığ, Turkey (in Turkish).
- Chondar SL (1977) Fecundity and its role in racial studies of *Gudusia chapra* (Pisces: Clupeidae). *The Proceedings of the Indian Academy of Sciences* 86: 245–254.
- Çiçek E, Avsar D, Ozyurt CE, Yelda H and Ozutok M (2007) Population characteristics and growth of *Spicara maena* inhabiting in Babadillimanı Bight (Northeastern Mediterranean-Turkey). *International Journal of Natural and Engineering Sciences* 1: 15–18.
- Doha, S and Hye MA (1970) Fecundity of Padma river hilsa (*H. ilisha*). *Pakistan Journal of Science* 22: 176–184.
- Dulčić J, Kraljević M, Grbec B and Cetinić P (2000) Age, growth and mortality of blotched picarel *Spicara maena* L. (Pisces: Centranchidae) in the eastern central Adriatic. *Fisheries Research* 48(1): 69–78.
- Dulčić J, Skakelja, N, Kraljevic, M and Cetinic P (1998) On the fecundity of the Black Sea bream, *Spondyliosoma cantharus* (L.), from the Adriatic Sea (Croatian coast). *Scientia Marina* 62(3): 289–294.
- Fischer W, Bauchot ML and Schneider M (1987) fiches FAO d’identification des espèces pour les besoins de la pêche (révision 1). Méditerranée et Mer Noire, zone de pêche 37. Vol. 2. Vertébrés, CEE, FAO, ed. FAO, Rome, pp. 761-1530 (in French).
- Froese R (2006) Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology* 22: 241–253.
- Froese R and Pauly D (editors) (2017) FishBase. World Wide Web electronic publication. www.fishbase.org, version (10/2017).
- Gómez-Márquez JL, Peña-Mendoza B, Salgado-Ugarte IH and Guzmán-Arroyo M (2003) Reproductive aspects of *Oreochromis niloticus* (Perciformes: Cichlidae) at Coatetelco lake, Morelos, Mexico. *Revista de Biología Tropical* 51(1): 221–228.
- Harchouche K (2006) Contribution à la systématique du genre *Spicara*; écologie, biologie et exploitation de *Spicara maena* (Poisson, Téléostéen) des côtes algériennes. Thèse de doctorat en océanographie. U.S.T.H.B., Alger: 210 pp. (in French).
- Harchouche K, Maurin C and Zerouali-Khodja F (2009) Régime alimentaire de *Spicara maena* (centranchidae), des eaux algériennes. *Bulletin de la Société Zoologique de France* 134(1-2): 125–143 (in French).
- Holden MJ and DFS Raitt (Eds) (1974) Manual of fishery science, part 2, methods of resource investigations and their application. FAO Fisheries and Aquaculture Technical Paper. 214 pp.
- Imsiridou A, Minos G, Gakopoulou A, Katsares V, Karidas T and Katselis G (2011) Discrimination of two picarel species *Spicara flexuosa* and *Spicara maena* (Pisces: Cen-

- tracanthidae) based on mitochondrial DNA sequences. *Journal of Fish Biology* 78(1): 373–377.
- İsmen A, Ozen O, Altınagac U, Ozekinci U and Ayaz A (2007) Weight–length relationships of 63 fish species in Saros Bay, Turkey. *Journal of Applied Ichthyology* 23: 707–708.
- Kadari G (1984) Les techniques de pêche utilisées en Algérie. Ed Enap et Publisud [Fishing techniques used in Algeria], Alger. 134 pp. (in French).
- Karachle PK and Stergiou KI (2014) Diet and feeding habits of *Spicara maena* and *S. smarís* (Pisces, Osteichthyes, Centranchidae) in the North Aegean Sea. *Acta Adriatica*, 55(1), 75–84.
- Karakulak FS, Bilgin B, Zengin M and Erk H (2007) Blotched picarel, *Spicara maena* L. 1758, in the trammel and gill net catches in the Aegean Sea (Turkey). *Rapports de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée* 38: 511.
- Kjesbu OS, Witthames PR, Solemdal P and Greer Walker M (1998) Temporal variations in the fecundity of Arcto-Norwegian cod (*Gadus morhua*) in response to natural changes in food and temperature. *Journal of Sea Research* 40: 303–321.
- Kraus G, Müller A, Trella K and Köuster FW (2000) Fecundity of Baltic cod: temporal and spatial variation. *Journal of Fish Biology* 56(6): 1327–1341.
- Lagler KF, Bardach, JFZ and Miller RR (1967) *Ichthyology*, John Wiley and Sons, Inc, New York, London, Sydney. pp. 59–301.
- Matic-Skoko S, Kraljevic M and Dulčić J (2004) Fecundity of blotched picarel, *Spicara maena* L. (Teleostei: Centranchidae), in the eastern central Adriatic Sea. *Acta Adriatica* 45(2): 155–162.
- Minos G, Imsiridou A and Katselis G (2013) Use of morphological differences for the identification of two picarel species *Spicara flexuosa* and *Spicara maena* (Pisces: Centranchidae). *Mediterranean Marine Science* 14(3): 26–31.
- Munro AD, Scott AP and Lam TJ (1990) Reproductive seasonality in teleosts: environmental influences. CRC Press Inc., Boca Raton, Florida. pp. 109–124.
- Nikolskii GV (1969) Fish population dynamics. Oliver and Boyd, Edinburgh. 323 pp.
- Qasim SZ and Qayyum A (1963) Fecundities of some freshwater fish. *Proceedings of the National Institute of Sciences of India* 29: 373–382.
- Saygili B, İşmen A and İhsanoğlu MA (2016a) Age and growth of blotched picarel (*Spicara maena* Linnaeus, 1758) in the Sea of Marmara and Northern Aegean Sea. *Ege Journal of Fisheries and Aquatic Sciences* 33(2): 413–449.
- Saygili B, İşmen A and İhsanoğlu MA (2016b) Differences in the otolith shape between the Marmara and Northern Aegean Sea stocks of blotched picarel (*Spicara maena* Linnaeus, 1758). *Journal of Black Sea/Mediterranean Environment* 22(2): 137–148.
- Soykan O, İlkyaz AT, Metin G and Kinacigil HT (2010) Growth and reproduction of blotched picarel (*Spicara maena* Linnaeus, 1758) in the central Aegean Sea, Turkey. *Turkish Journal of Zoology* 34(4): 453–459.
- Stéquert B and Ramcharrun B (1995). The fecundity of skip-jack tuna (*Katsuwonus pelamis*) from the Western Indian Ocean. *Aquatic Living Resources* 8(1): 79–89.

CONTRIBUTION OF THE AUTHORS

FD & LBT fish specimen collection, fecundity estimation and data analysis; LBT manuscript preparation; LBT & ABT research supervision; SMEAAA provided laboratory facilities



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RESEARCH ARTICLE

A preliminary inventory of biodiversity and benthic habitats of “Plane” Island (Paloma) in Oran Bay, north western Algeria (western Mediterranean)

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Abstract

This study aimed to create an inventory of the prominent species in “Plane” Island on the Algerian coast of the Mediterranean Sea for the conservation interest and to classify rocky benthic habitats. The study was carried out at eight stations by 27 dives between the surface and 34 m depth from 2014 to 2015. In total, 201 taxa were listed, of which 30% consists of macroalgae, 1% phanerogams, 52% macroinvertebrates and 17% fish. The biotope was characterized by the presence of 6 biocenosis of hard rock (19 associations and 9 facies). The bioconcretions were represented by red and yellow gorgonians and other sessile macrofauna that embellishes the coralligenous habitat. The macrobenthos were marked by the presence of several species. Exotic and sometimes invasive species were also present, such as *Caulerpa racemosa* var. *cylindracea*, *Codium fragile*, *Asparagopsis armata*, *Asparagopsis taxiformis* and *Oculina patagonica*. “Plane” Island represents a space with multiple stakes and uses, which requires a thorough study, valorization and a rational and durable exploitation in order to preserve its major assets. The study will provide support for the management of coastal ecosystems, such as those in “Plane” Island, aiming to create a marine protected area and the strengthening of fisheries regulations, as a veritable hot spot of biodiversity along the Algerian coasts.

Keywords: Biodiversity, biocenosis, fauna, flora, coastline, Plane Island, Oran, Algeria, western Mediterranean

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Introduction

“Paloma” or “Plane” Island, a component of the insular environment of the Oran's coastline, has a great potential in terms of specific biodiversity and underwater habitats, favorable to the development of a diversified marine population. Due to the proximity to the Strait of Gibraltar, it benefits from

continuous supply of currents rich in nutrients and oceanic plankton (Millot 1999; Hussein 2015). A significant circulation of horizontal and vertical currents sweeps the region, called "Oran current" between Almeria and Algeria (Millot and Taupier-Letage 2005). The topography of the area is characterized by the presence of Alidade seamounts (30 miles long) that generated the insular formations of the region and a very narrow continental margin with a tight continental shelf from where an important "upwelling" enriches the area (Hussein and Bouras 2014). The potentialities offered are under-exploited due to the lack of harmony and integration of the management of this coastal zone (Hussein 2015). The absence of scientific work on the environment and marine organisms of "Plane" Island gives to the study its originality with important results that can provide support for the management of coastal ecosystems and could help designing a new marine protected area (MPA).

This initial biodiversity data obtained can inform us about populations quality through the species richness "S" of the macrobenthos, which is represented either in number of species or in biomass value, all referred to a surface unit which is a criterion to characterize a population or a habitat, according to its rarity (e.g. rosworms reefs), its structural interest (e.g. coralligenous) or because it serves as a feeding or recruitment zone for other species (e.g. seagrass meadows). Populations characterization is an essential tool for understanding and monitoring the coastal and marine environment under the influence of the various human activities that discharge liquid and solid waste into the sea (Bellan-Santini 1969, 1994; Boudouresque 1970, Eleftheriou *et al.* 1984; Bensahla Talet *et al.* 2015). Detailed inventories of species and habitats are necessary in order to identify future losses that might result from anthropogenic impacts. Such biodiversity databases are available for the NW Mediterranean where biodiversity is monitored over decades. It is important to set an initial inventory of the local biodiversity and follow its evolution through time to evaluate potential biodiversity losses induced mainly by global climate change that highly impact local biodiversity in the Mediterranean (Cramer *et al.* 2018).

An inventorial scientific study on "Paloma" or "Plane" Island, part of the island complex of western Algeria, offers an opportunity to relaunch a global conservation dynamic of the relevant marine sites of Algeria and could, with the promulgation of decrees on the classification of insular sites as Rachgoun Island and Habibas Islands (already classified as MPAs), constitute a pole of nature conservation in the southwestern sector of the western Mediterranean. Therefore, the present work aims to constitute a preliminary database resulting from investigations carried out *in situ* on the characterization of the biodiversity and the benthic habitats of the island, with the objective to provide an initial diagnosis and necessary arguments to start a classification process of the island's as a MPA in the Wilaya (District) of Oran.

Material and Methods

Study area

“Plane” Island or “Paloma” is located approximately 7 km off Bousfer beach in “Les Andalouses” Bay, at 35°46.281'N and 0°54.115'W, between Cape Falcon and Cape Lindless (Figure 1). This island is located in the South-West of the Algerian basin, which is part of the island complex of Western Algeria.

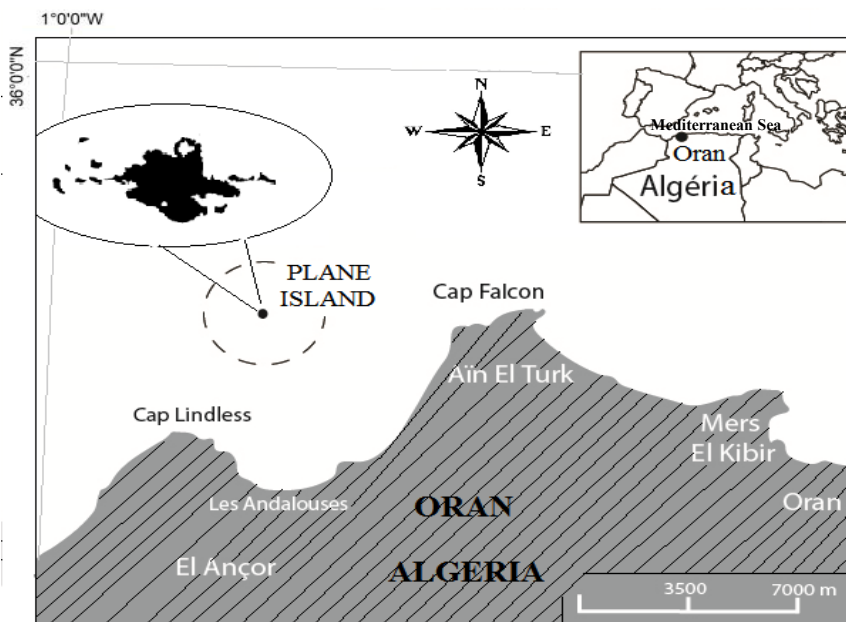


Figure 1. Study area in Oran, Algeria, Mediterranean Sea

Methodology

The *in situ* study was carried out between 2014 and 2015 on eight random band transects corresponding to eight stations (Figure 2) by 27 dives in total (Snorkeling for shallow waters; scuba dives for the infralittoral zone): 16 dives (2 replicates for visual identification and counting of species) and 11 additional dives for benthic typology realized from the surface to a maximum of 34 m depth, depending on stations (Table 1).

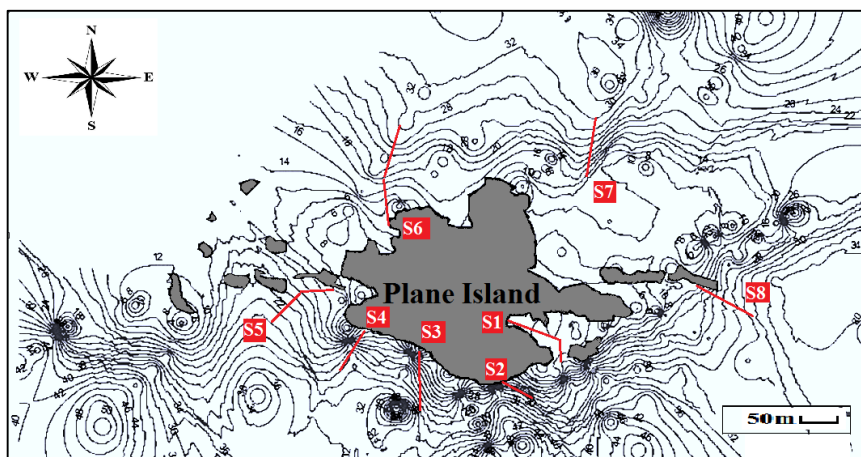


Figure 2. Eight transects investigated around Plane Island

A tentative inventory based on *in situ* observations was used to cross-monitor the sector on a vertical profile from the deepest point to the surface, so the dominant and remarkable species of different habitats were visually identified. A description of the topography and the submarine landscape (Table 1) was also noted (Bajjouk *et al.* 2010; Besnard and Salles 2010) to determine substrate typology. Then, a transect (the length of which varied according to the underwater topography of each station (Table 1) was monitored by visual census (UVC) according to the method applied in the Mediterranean Sea (Harmelin-Vivien and Harmelin 1975; Harmelin-Vivien *et al.* 1985). For each station (S1 to S8) two divers performed the study, the first diver counted the mobile species and the second one the fixed species. As stated previously, 11 supplementary dives were realized to describe the ecological aspects and benthic habitats. The selected parameters for the flora and fauna were as follows: absent: 0, present: + and strong presence: ++ (Lenfant *et al.* 2011). The biodiversity aspects and benthic habitats were supported by underwater images (videos and photographs) of band transects according to the REBENT MED protocols (Kantin *et al.* 2006).

The identification and classification of species was made through FAO species identification sheets (Fischer *et al.* 1987), as well as other scientific documents (Boudouresque 2005, Pergent *et al.* 2007). For the characterization of communities, Pérès and Picard (1964) and UNEP-MAP (1998) protocols were used. For species and habitats of conservation interest, we used Annexes II and III of the Protocol on Specially Protected Areas and Biological Diversity in the Mediterranean of Barcelona Convention (1976) and Bern Convention (1979).

Results and Discussion

Benthic biodiversity of the mediolittoral zone

The bionomic study of the macrobenthos in the upper medio littoral levels revealed a richness of 55 species: of which 36 species were distributed as:

-7 Chlorophyceae (green algae) *Ulva rigida*, *Ulva lactuca*, *Catheomorpha aerea*, *Caulerpa racemosa*, *Enteromorpha compressa*, *Flabellia petiolata*, *Valonia macrophysa*,

-17 Rhodophyceae (red algaeae) *Amphiroa rigida*, *Bonnemaisonnia asparagoides*, *Ceramium ciliatum*, *Ceramium codii*, *Chylocladia verticillata*, *Corallina elongata*, *Corallina officinalis*, *Hypnea musciformis*, *Jania rubens*, *Laurencia* sp., *Laurencia papillosa*, *Lithophyllum incrustans*, *Lithothamnion valens*, *Nemalion helmintoides*, *Peyssonnelia* spp., *Pterocladia capillacea*, *Sphaerococcus cornopifolius*,

-12 Phaeophyceae (brown algae) *Arthrocladia villosa*, *Cladostephus spongiosus*, *Cystoseira amentacea*, *Dictyopteris polypodioides*, *Dictyota dichotoma*, *Dilophus faciola*, *Halopteris filicina*, *Leathesia difformis*, *Padina pavonica*, *Ralfsia verrucosa*, *Sargassum vulgar*, *Taonia atomaria*.

Fauna was represented by 19 species:

-4 cnidarians *Actinia equina*, *Anemonia viridis*, *Astroides calycularis*, *Parazoanthus axinellae*,

-1 echinoderm *Paracentrotus lividus*,

-10 mollusks *Aplysia punctata*, *Cerithium rupestre*, *Dendropoma petraeum*, *Mitra corniculata*, *Patella furigenea*, *Patella rustica*, *Patella ceriola*, *Osilinus articulatus*, *Osilinus turbinatus*, *Stramonita haemostom*,

-4 crustaceans: *Dardanus arrosor*, *Eriphia verrucosa*, *Euraphia depressa*, *Pachygrapsus marmoratus*.

It appears from the study of the medio-littoral level that the photophilous algae is well developed and diversified with coexistence of a large population of the highly endangered patellid limpet *Patella ferruginea* (Rivera–Ingraham *et al.* 2011) which has been maintained around the island.

The results obtained showed the different distributions of the floristic taxa, by a dominance of the Rhodophyceae (47%), Pheophyceae (33%) and Chlorophyceae with only 20% (Figure 3). The fauna seemed much influenced by the topographical aspect, the echinoderms were the least represented, but the distribution of certain species of this phylum like the common sea urchin *Paracentrotus lividus* was wider than the other macroinvertebrates, the beadlet anemone *Actinia equina* and the green anemone *Anemonia viridis*. The medio-littoral zone was mainly dominated by gastropods. The total of 55 species, belonging to 7 phyla, reflected a good taxonomic diversity in the area. This richness seems closely related to the hydrodynamism of the island and sediments nature. Contributions of organic matter and nutrients determining the

establishment of the biocenosis was already reported by Vaissiere and Fredj (1963).

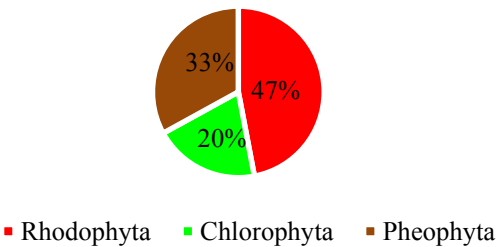


Figure 3. Proportion of floristic taxa encountered in the medio-littoral zone of “Paloma” Island

Distribution of some dominant species in the upper mediolittoral level is presented in Figure 4, where the distribution of six macroalgae and two macroinvertebrates were mapped. The analysis of the distribution map shows the existence of *Cystosiera* sp. mainly in the areas exposed to the north/north-west currents, whereas the nitrophilic species, presented by *Ulva*, was mainly present in the south/south-east part of “Plane” Island. *Jania rubens* has a high recovery rates for a long period of the year (Hussein 2015) and it appears that the mode of exposure of the terrestrial part of the island strongly influences the distribution of these species.

Benthic biodiversity of the infralittoral zone

The stations were dominated by hard substrates, mainly in the form of steep cliffs, screes and drop-offs (Table 1), favoring the installation of rich biodiversity, as is generally the case in the Northwestern Mediterranean (Bonhomme *et al.* 2009; UNEP-MAP RAC/SPA 2010). Overall, more than 195 species were recorded between 0 and 30 m depth in the Island, 60 floristic taxa and 135 faunal taxa (Tables 2 and 3), composed of 30 % macroalgae, 52 % of macroinvertebrates, 17 % of fish and 1% phanerogams (Figure 5).

Table 1. Habitat characteristics of sampling stations in “Plane” Island

Stations	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8
Habitat	Rocky							
Depth: Min-Max (m)	0-17	0-29	1-30	0-27	0-26	0-31	7-24	0-34
Topographic profile	Gentle slope	Steep slope	Steep slope	Steep slope	Gentle slope	Irregular slope	Irregular slope	Steep slope
Transect length (m)	80	40	50	40	60	80	60	50

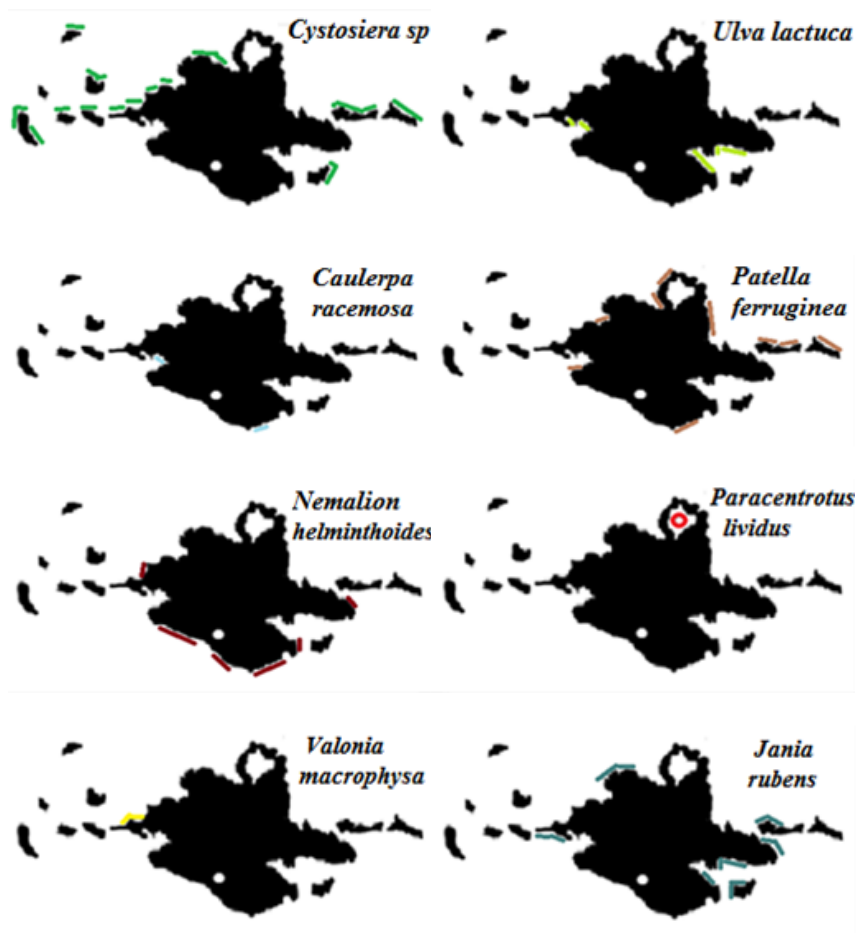


Figure 4. Distribution of the benthic flora and fauna of the medio littoral zone of “Plane” Island

The presence of three groups of algae have been recorded: Chlorophyceae (19 species), Rhodophyceae (25 species), Pheophyceae (with 15 species), the nominative listing of species is presented in Table 2.

Table 2. Benthic flora taxa found in 8 stations of “Plane” Island
S: Number of species. Species presence are marked as: absent: 0, present: + and strong presence: ++, *: endangered species, **: alien species

Stations	S1	S2	S3	S4	S5	S6	S7	S8
Flora								
Macroalgae								
A -Chlorophyceae								
<i>Acetabulria acetabulum</i> (Linnaeus) P.C. Silva 1952	+	0	0	0	+	+	0	0
<i>Anadyomene stellata</i> (Wulfen) C. Agardh, 1823	+	+	0	0	++	+	0	0
<i>Bryopsis muscosa</i> (J.V.Lamouroux., 1809)	+	++	+	+	+	++	+	++
<i>Chaetomorpha aerea</i> (Dillwyn) Kützing., 1849	+++	0	0	0	++	++	0	0
<i>Caulerpa racemosa</i> ** (Forsskål J.Agardh 1873)	0	0	+	0	++	0	0	0
<i>Cladophora</i> spp. (Kützing, 1843)	+	0	0	0	0	0	0	0
<i>Cladophora rupestris</i> (Linnaeus) Kützing 1843	++	+	0	+	++	+++	+	+
<i>Codium bursa</i> (Olivi) C.Agardh, 1817	+++	++	++	++	++	++	+	++
<i>Codium fragile</i> ** (Suringar Hariot, 1889)	+	+	0	+	+	0	+	0
<i>Codium effusum</i> (Rafinesque) Delle Chiaje, 1829	0	+	0	0	++	+	0	+
<i>Codium vermilara</i> (Olivii) Delle Chiaje 1829	0	+	++	0	+	++	+	+
<i>Dasycladus vermicularis</i> (Scopoli) Krasser 1898	0	0	+	0	0	0	0	0
<i>Enteromorpha compressa</i> (Linnaeus) Nees,1820	++	0	0	0	+	+	0	0
<i>Flabellia petiolata</i> (Turra) Nizamuddin 1987	+	++	+	0	+	++	+	+
<i>Halimeda tuna</i> (J.Ellis & Solander) J.V.Lamouroux 1816	+	++	+++	++	+++	++	+++	+++
<i>Palmophyllum crassum</i> (Naccari) Rabenhorst 1868	0	+	+	0	++	+	0	0
<i>Ulva rigida</i> (C. Agardh,1823)	0	0	0	0	+	+	0	0
<i>Ulva lactuca</i> (Linnaeus,1753)	+++	+	0	0	+++	+	0	0
<i>Valonia macrophysa</i> (Kützing, 1843)	0	0	0	0	++	++	0	0
S = 19	12	11	8	5	17	15	7	7
B - Pheophyceae								
<i>Arthrocladia villosa</i> (Hudson) Duby, 1830	+	+	0	0	++	+	0	+
<i>Cladostephus spongiosus</i> (Hudson) C. Agardh,1817	+	0	0	+	0	0	0	0
<i>Colpomenia sinuosa</i> (Mertens ex Roth) Derbès & Solier, 1851	++	+	+	++	++	+	+	+
<i>Cystoseira amentacea</i> * (C.Agardh) Bory de Saint-Vincent, 1832	0	0	0	0	++	+++	0	0
<i>Cystoseira compressa</i> (Esper) Gerloff & Nizamuddin 1975	+	0	0	0	+	++	+	+
<i>Dictyopteris polypodioides</i> (A.P.De Candolle) J.V.Lamouroux 1809	+	+	+	+	+	+	0	0

Table 2. Continued

<i>Dictyota dichotoma</i> (Hudson) J.V. Lamouroux 1809	+++	+	++	++	+++	+++	++	++
<i>Dilophus fasciola</i> (Roth) M.A.Howe, 1914	+	0	0	0	+	+	+	0
<i>Halopteris filicina</i> (Grateloup) Kützinger, 1843	++	0	0	0	+	++	+	+
<i>Leathesia difformis</i> (Areschoug, 1847)	+	+	+	0	++	+	++	+
<i>Padina pavonica</i> (Linnaeus) Thivy, 1960	++	+	++	+	+++	+++	+++	++
<i>Ralfsia verrucosa</i> (Areschoug) Areschoug 1845	++	++	+	++	+	++	+	0
<i>Sargassum acinarium</i> (Linnaeus) Setchell, 1933	0	+	0	0	0	+	0	0
<i>Taonia atomaria</i> (Woodward) J.Agardh, 1848	0	0	+	+	0	+	++	0
<i>Bugula neritina</i> (Linnaeus, 1758)	+	++	0	+	++	0	++	+
S = 15	12	9	7	8	12	13	10	8
C - Rhodophyceae								
<i>Amphiroa rigida</i> (J.V.Lamouroux, 1816)	++	+	+	++	+++	++	+++	++
<i>Asparagopsis armata</i> (Harvey 1855)**	+++	++	++	++	++	++	+	++
<i>Asparagopsis taxiformis</i> ** (Delile) Trevisan de Saint-Léon, 1845	+	+	+	+	0	0	+	+
<i>Bonnemaisonia asparagoides</i> (Woodward) C.Agardh, 1822	+++	+	+	0	+	+++	++	++
<i>Ceramium ciliatum</i> (J.Ellis) Ducluzeau, 1806	+	+	0	0	+	++	0	++
<i>Chylocladia verticillata</i> (Lightfoot) Bliding 1928	++	+	+	+	++	0	+	0
<i>Corallina elongata</i> (J.Ellis & Solander 1786)	++	0	+	0	+	+	0	0
<i>Corallina officinalis</i> (Linnaeus, 1758)	+	+	+	0	++	0	0	+
<i>Halymenia</i> sp.	0	+	0	+	++	+	0	+
<i>Hypnea musciformis</i> (Wulfen) J.V.Lamouroux, 1813	++	++	+	0	++	0	0	++
<i>Jania corniculata</i> (Linnaeus) J.V.Lamouroux, 1816	++	0	0	0	++	++	+	++
<i>Jania rubens</i> (Linnaeus) J.V.Lamouroux, 1816	+++	+	+	++	+++	+	++	+
<i>Laurencia</i> sp.	+	0	++	0	+	++	+	+
<i>Laurencia papillosa</i> (C.Agardh) Greville, 1830	+	0	0	+	+	+	0	0
<i>Lithophyllum incrustans</i> Philippi, 1837	++	+++	+	++	+++	+	+++	+++
<i>Lithothamnion valens</i> Foslie, 1909	+	+	++	+	0	+	+	0
<i>Mesophyllum alternans</i> (Foslie) Cabioch & M.L. Mendoza, 1998	++	+	0	+++	+	++	++	+
<i>Nemalion elminthoides</i> (Velley) Batters, 1902	++	+++	++	+++	++	+	0	+
<i>Peyssonnelia</i> spp.	+++	+	+++	+	++	++	++	+
<i>Peyssonnelia rosa-marina</i> Boudouresque & Denizot, 1973	+	+++	++	++	+	+++	+++	+++

Table 2. Continued

<i>Peyssonnelia squamaria</i> (S.G.Gmelin) Decaisne ex J.Agardh, 1842	+++	+	+	++	++	++	+++	++
<i>Plocamium cartilagineum</i> (Linnaeus) P.S.Dixon, 1967	0	++	+	+	++	+++	++	0
<i>Pterocladia capillacea</i> (S.G.Gmelin) Bornet, 1876	+	+	++	0	+	+	++	++
<i>Schottera nicaeensis</i> (J.V.Lamouroux ex Duby) Guiry & Hollenberg, 1975	0	0	+	+	0	+	0	0
<i>Sphaerococcus coronopifolius</i> Stackhouse, 1797	+	++	+	0	++	+	++	+
S = 25	22	20	20	16	22	21	17	19

The inventory of the macroinvertebrates of the infralittoral level of the studied stations showed the different distributions of the taxa by a dominance of the sponges and mollusks presented by 23 species in each taxon. Crustaceans were the least represented by 8 species (Table 3).

The rocky characteristics of the “Plane” Island showed that the macrofauna was represented by 1 phylum of vertebrates counting 33 Fish (5 orders and 14 family) and 99 invertebrate species belonging to 8 phyla (23 sponges, 23 mollusks, 22 cnidarians, 12 echinoderms, 8 crustaceans, 5 polychaetas, 4 tunicates and 2 bryozoans). However, underwater visual census method used during our survey seem to underestimate the actual marine biodiversity in Plane Island. In fact, small size species require a high taxonomic expertise and the numbers could potentially rise if visual census used during our study was coupled to laboratory taxonomic and molecular identification protocols.

Table 3. An inventory of faunal taxa in the infralittoral of 8 stations of “Plane” Island.
S: Number of species. Species presence are marked as: absent: 0, present: + and strong presence: ++, *: endangered species

Stations	S1	S2	S3	S4	S5	S6	S7	S8
Macroinvertebrates								
A - Porifera								
<i>Agelas oroides</i> (Schmidt,1864)	+	+	0	0	0	0	+	0
<i>Anchinoe fictitius</i> (Bowerbank,1866)	++	+	+	0	+	+	0	+
<i>Aplysilla sulfurea</i> (Schulze,1878)	++	++	+	0	0	+	0	+
<i>Aplysina</i> sp.	0	+	+	0	0	0	+	0
<i>Axinella cannabina</i> (Esper,1794)	0	+	+	0	0	0	0	0
<i>Axinella polypoides</i> * (Schmidt,1862)	+	0	0	+	0	0	+	+
<i>Axinella verrucosa</i> (Esper,1794)	0	0	+	+	0	+	0	+
<i>Cacospongia mollior</i> (Schmidt,1862)	+	+	+	+	++	+	+	+
<i>Chondrilla nucula</i> (Schmidt,1862)	+	++	+	+	+	+	++	+
<i>Chondrosia reniformis</i> (Nardo,1847)	++	++	+	+	++	+	++	++
<i>Clathrina coriacea</i> (Montragu,1814)	+	+	+	0	+	+	0	+
<i>Crambe crambe</i> (Schmidt,1862)	+++	++	++	+	+++	++	++	+++
<i>Dysidea avara</i> (Schmidt,1862)	+	+	0	0	+	0	0	+
<i>Dysidea fragilis</i> (Montagu,1814)	+	0	0	0	+	0	+	0
<i>Hamigera hamigera</i> (Schmidt,1862)	+	0	0	0	+	+	+	+

Table 3. Continued

<i>Hippospongia communis</i> (Lamarck, 1814)	0	+	0	+	+	0	+	+
<i>Ircinia fasciculata</i> (Pallas, 1766)	+	+	+	0	++	+	+	0
<i>Ircinia oros</i> (Schmidt, 1864)	+	0	++	+	+	+	++	+
<i>Phorbas paupertas</i> (sensu Boury-Esnault, 1971)	+	++	0	+	+	+	+	++
<i>Phorbas tenacior</i> (Topsent, 1925)	+	0	0	0	+	+	0	+
<i>Sarcotragus spinosula</i> (Schmidt, 1862)	+	+	0	0	0	+	+	+
<i>Spirastrella cunctatrix</i> (Schmidt, 1868)	+	0	0	+	0	0	0	+
<i>Spongia officinalis</i> * (Linnaeus, 1759)	++	++	++	+	++	++	+++	+++
S = 23	19	16	13	11	15	15	15	18
B - Cnidaria								
<i>Alcyonium acaule</i> (Marion, 1878)	+	++	+	+	+	+	+	+
<i>Actinia equina</i> (Linnaeus, 1758)	+++	++	+	+	+++	++	0	+
<i>Aglaophenia tubiformis</i> (Marktanner Turneretscher, 1890)	+	+	0	+	+	0	+	0
<i>Aiptasia mutabilis</i> (Gravenhorst, 1831)	++	+	0	0	+	0	+	0
<i>Anemonia viridis</i> (Forsskål, 1775)	+++	++	+++	++	+++	++	+++	++
<i>Astroides calycularis</i> * (Pallas, 1766)	+++	++	++	++	+++	++	++	+++
<i>Bunodeopsis strumosa</i> (Andrès, 1881)	+	++	0	0	+	0	0	0
<i>Calliactis parasitica</i> (Couch, 1842)	+++	++	++	++	+++	++	+++	++
<i>Caryophyllia inornata</i> (Duncan, 1878)	++	++	+++	++	+	+	+	++
<i>Cladocora caespitosa</i> (Linnaeus, 1767)	+	+	0	0	+	+	+	+
<i>Cotylorhiza tuberculata</i> (Macri, 1778)	0	0	+	0	0	0	0	+
<i>Condylactis aurantiaca</i> (Delle Chiaje, 1825)	++	+	+	0	+	0	+	+
<i>Eunicella singularis</i> (Esper, 1791)	++	++	+++	++	++	+++	++	++
<i>Eunicella cavolini</i> (Koch, 1887)	++	++	++	++	+	++	+++	++
<i>Leptogorgia sarmentosa</i> (Esper, 1789)	+++	++	+++	++	++	+++	++	++
<i>Leptopsammia pruvoti</i> (Lacaze Duthiers, 1897)	++	+	+++	+	+++	+	+	++
<i>Paramuricea clavata</i> (Risso, 1826)	++	++	+++	++	+	+	+	+++
<i>Parazoanthus axinellae</i> (Schmidt, 1862)	+	+	+	++	++	++	0	+
<i>Pelagia noctiluca</i> (Forskål, 1775)	++	++	++	++	++	++	++	++
<i>Pourtalesmilia anthophyllites</i> (Ellis & Solander, 1786)	+	++	++	0	0	0	0	++
<i>Pteroeides griseum</i> (Linnaeus, 1767)	+	+	0	0	+	0	0	+
<i>Bolinopsis vitrea</i> (L. Agassiz, 1860)	+	+	+	+	+	+	+	+
S = 22	21	21	16	14	19	14	15	18
C - Polychaeta								
<i>Hermodice carunculata</i> (Pallas, 1766)	++	+	+	0	++	0	+	0
<i>Sabella spallanzanii</i> (Gmelin, 1791)	+	0	0	0	+	+	0	+
<i>Veretillum cynomorium</i> (Pallas, 1766)	0	0	0	0	0	0	+	0
<i>Prostheceraeus</i> sp.	+	0	0	0	+	0	0	0
<i>Protula tubularia</i> (Montagu, 1803)	+++	+	++	++	+++	+	+	++
S = 5	4	2	2	1	4	2	3	2
D - Crustacea								
<i>Dardanus calidus</i> (Risso, 1827)	+++	++	++	+	++	+	++	++
<i>Dromia personata</i> (Linnaeus, 1758)	++	+	++	+	+	+	+	++
<i>Eriphia verrucosa</i> (Forskål, 1775)	+	0	0	0	+	0	0	0
<i>Euraphia depressa</i> (Poli, 1791)	++	+	0	0	++	0	0	+
<i>Maja squinado</i> * (Herbst, 1788)	+	0	0	0	0	+	+	+
<i>Scyllarides latus</i> (Latreille, 1803)	0	+	+	0	0	0	+	+
<i>Pachygrapsus marmoratus</i> (Fabricius, 1787)	++	+	0	0	++	+	0	0

Table 3. Continued

<i>Palinurus elephas</i> * (Fabricius,1787)	0	+	0	0	0	0	+	+
S = 8	6	6	3	2	5	4	5	6
E - Mollusca								
<i>Aplysia punctata</i> (Cuvier,1803)	++	+	0	+	+	+	0	+
<i>Arca noae</i> (Linnaeus,1758)	+	0	0	0	+	+	+	0
<i>Cancellaria cancellata</i> (Linnaeus,1767)	+	+	+	0	+	+	+	+
<i>Cerithium vulgatum</i> (Bruguière,1792)	++	++	+	+	++	++	++	+
<i>Chlamys</i> sp.	+	0	0	0	0	0	0	+
<i>Charonia lampas</i> (Linnaeus,1758)	+++	++	++	+	++	++	+++	++
<i>Cratena peregrina</i> (Gmelin,1791)	+	+	+	0	+	0	+	0
<i>Dendropoma petraeum</i> (Monterosato, 1984)	+	+	0	0	+	+	0	0
<i>Erosaria spurca</i> (Linnaeus,1758)	+	0	0	0	+	+	+	0
<i>Tarantinaea lignaria</i> (Linnaeus,1758)	+	+	+	+	+	+	+	+
<i>Hypselodoris</i> sp.	0	0	+	0	0	0	0	0
<i>Lima lima</i> (Linnaeus,1758)	+	++	0	0	0	+	0	+
<i>Lithophaga lithophaga</i> (Linnaeus,1758)	+	+	+	+	0	0	+	+
<i>Mitra</i> sp.	0	+	+	+	0	0	+	0
<i>Octopus vulgaris</i> (Cuvier,1797)	++	0	+	0	++	0	0	0
<i>Osilinus articulatus</i> (Lamarck,1822)	+	+	0	0	+	0	+	+
<i>Phorcus turbinatus</i> (Born,1778)	+	+	+	0	+	++	0	0
<i>Ostrea edulis</i> (Linnaeus,1758)	+	+	+	+	+	0	+	0
<i>Pinna nobilis</i> * (Linnaeus,1758)	++	+	++	+	++	+	+	++
<i>Pinna rudis</i> * (Linnaeus,1758)	+	+	0	0	+	+	++	0
<i>Semicassis granulata</i> (Born,1778)	++	++	+	+	++	+	++	++
<i>Sepia officinalis</i> (Linnaeus,1758)	+	+	+	+	+	+	+	+
<i>Stramonita haemostoma</i> (Linnaeus,1767)	++	+	0	0	0	+	+	+
S = 23	21	18	14	10	17	15	16	13
F - Bryozoa								
<i>Cellepora pumicosa</i> (Pallas, 1766)	+	+	0	+	+	0	+	+
<i>Myriapora truncata</i> (Pallas, 1766)	++	+	+	++	+	+	++	++
S = 2	2	2	1	2	2	1	2	2
G-Echinodermata								
<i>Arbacia lixula</i> (Linnaeus,1758)	+	++	+	0	0	0	+	+
<i>Astrospartus mediterraneus</i> (Risso, 1826)	+++	++	+	0	+	0	++	0
<i>Centrostephanus longispinus</i> * (Philippi,1845)	+++	++	+	++	++	+	++	+
<i>Echinaster sepositus</i> (Retzius,1783)	++	+	0	0	+	+	++	+
<i>Hacelia attenuata</i> (Gray, 1840)	+	+	+	++	+	++	+	++
<i>Holothuria tubulosa</i> (Gmelin,1791)	++	++	0	0	++	++	0	0
<i>Holothuria forskali</i> (Delle Chiaje,1823)	+++	+++	++	++	+++	++	++	++
<i>Ophioderma longicauda</i> (Bruzellius,1805)	++	++	0	0	++	+	0	++
<i>Ophiura ophiura</i> (Linnaeus,1758)	+++	++	+	0	++	++	+	+
<i>Ophidiaster ophidianus</i> * (Lamarck,1816)	+++	++	+++	++	+++	++	++	++
<i>Paracentrotus lividus</i> * (Lamarck,1816)	+++	+++	++	++	+++	+++	+++	+++
<i>Sphaerechinus granularis</i> (Lamarck,1816)	++	++	+	++	++	+++	+	++
S = 12	12	12	9	6	11	10	10	10
H - Tunicata								
<i>Aplidium nordmanni</i> (Milne-Edwards, 1841)	0	+	+	0	0	0	+	0
<i>Aplidium</i> sp.	0	+	0	+	+	0	+	+

Table 3. Continued

<i>Botryllus</i> spp.	+	+	+	+	+	+	+	+
<i>Halocynthia papillosa</i> (Linnaeus, 1767)	+	+	0	0	+	0	0	+
S = 4	2	4	2	2	3	1	3	3
Fish								
Class: Osteichthyes								
Ord: Anguilliformes								
Fam: Muraenidae								
<i>Muraena helena</i> (Linnaeus, 1758)	++	+	+	0	+	0	+	++
Fam: Congridae								
<i>Conger conger</i> (Linnaeus, 1758)	+	+	0	0	+	+	0	0
Ord: Scorpaeniformes								
Fam: Scorpaenidae								
<i>Scorpaena porcus</i> (Linnaeus, 1758)	+++	++	+	+	+	++	++	++
<i>Scorpaena scrofa</i> (Linnaeus, 1758)	++	+	0	0	+	++	+	+
Ord: Perciformes								
Fam: Serranidae								
<i>Anthias anthias</i> (Linnaeus, 1758)	++	++	+	0	+	+	+	+
<i>Epinephelus costae</i> * (Steindachner, 1878)	0	0	+	+	0	+	+	+
<i>Epinephelus marginatus</i> * (Lowe, 1834)	+	+	+	+	+	++	+	++
<i>Serranus scriba</i> (Linnaeus, 1758)	++	+	++	++	++	++	+	++
<i>Serranus cabrilla</i> (Linnaeus, 1758)	++	++	++	+	+	++	+	++
Fam: Apogonidae								
<i>Apogon imberbis</i> (Linnaeus, 1758)	++	+	++	+	++	++	+	++
Fam: Sparidae								
<i>Boops boops</i> (Linnaeus, 1758)	0	+	+	+	+	+	++	++
<i>Dentex dentex</i> (Linnaeus, 1758)	0	+	+	0	0	0	+	+
<i>Diplodus annularis</i> (Linnaeus, 1758)	+	+	+	+	+	+	+	+
<i>Diplodus cervinus cervinus</i> (Lowe, 1838)	+	+	0	0	0	+	+	+
<i>Diplodus puntazzo</i> (Walbaum, 1792)	0	+	0	+	+	+	0	0
<i>Diplodus sargus sargus</i> (Linnaeus, 1758)	+	+	++	+	+	++	+	+
<i>Diplodus vulgaris</i> (Geoffroy Saint-Hilaire, 1817)	++	+	++	++	+	+	+	+
<i>Oblada melanura</i> (Linnaeus, 1758)	+	++	+	+	+	+	+	++
<i>Sarpa salpa</i> (Linnaeus, 1758)	+	++	+	0	+	+	+	+
Fam: Mugilidae								
<i>Liza aurata</i> (Risso, 1810)	+	+	0	0	0	+	0	0
Fam: Mullidae								
<i>Mullus surmuletus</i> (Linnaeus, 1758)	+	++	++	+	+	+	0	+
Fam: Pomacentridae								
<i>Chromis chromis</i> (Linnaeus, 1758)	++	++	++	++	++	++	+	++
Fam: Labridae								
<i>Coris julis</i> (Linnaeus, 1758)	++	+	+	0	++	+	+	+
<i>Symphodus cinereus</i> (Bonnaterre, 1788)	+	0	+	0	+	0	+	+
<i>Symphodus doderleini</i> (Jordan, 1890)	+	+	0	0	0	+	+	0
<i>Symphodus roissali</i> (Risso, 1810)	+	+	+	+	+	+	0	0
<i>Thalassoma pavo</i> (Linnaeus, 1758)	++	++	+	+	++	++	++	++
Fam: Blenniidae								
<i>Parablennius zvonimiri</i> (Kolombatovic, 1892)	+	0	0	+	+	0	+	0
Fam: Tripterygiidae								
<i>Tripterygion minor</i> (Kolombatovic, 1892)	+	+	0	+	+	+	0	+
<i>Tripterygion tripteronotum</i> (Risso, 1810)	+	0	+	0	+	0	+	+
<i>Tripterygion delaisi</i> (Cadenat & Blache, 1970)	+	+	+	0	0	+	+	+

Table 3. Continued

Ord: Pleuronectiformes								
Fam: Soleidae								
<i>Solea solea</i> (Linnaeus,1758)	0	0	0	0	+	0	0	0
Ord: Gadiformes								
Fam: Gadidae								
<i>Phycis phycis</i> (Linnaeus,1766)	+	++	0	+	+	0	+	+
S = 33	28	28	23	19	27	26	26	26

The benthic fish fauna of the infralittoral zone of “Plane” Island counted 33 species, rich and diversified but threatened by human activity (pollution, fishing and illegal spearfishing). The development of actions to promote biodiversity conservation, including the establishment of a monitoring system and strict legislation towards endangered species of ecological/economic interest is essential as is the case of the dusky grouper *Epinephelus marginatus* classified as a vulnerable species giving the alarming situation of its population (decline of mature individuals) (IUCN: Pollard *et al.* 2018).

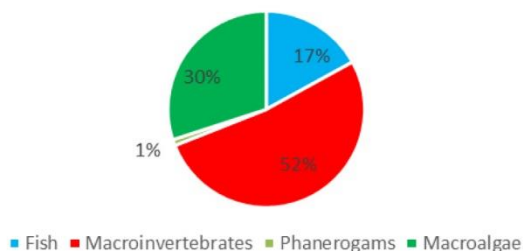


Figure 5. Percentage of phyla recorded in the infralittoral zone of “Plane” Island

We compared our floristic inventory with two islands in the western Algerian waters where 113 algal species have been recorded (MATE 2004) in the Habibas Islands (total island surface of 0.4 km²), where 64 species of Rhodophytes, 25 Chlorophyte and 24 Pheophyte species were reported. However, around Rachgoun Island (total island surface of 0.16 km²) a total of 80 taxa of macroflora species have been recorded (PNUE/PAM-CAR/ASP 2016) in the depths between 0 and 43 m. The most diversified group is Rhodophytes with 38 species followed by Pheophytes with 25 and Chlorophytes with 17 species. These results show that more focused taxonomic studies could possible reveal a higher biodiversity at “Plane” Island which covers a small area of only 0.04 km², but our preliminary study could identify 59 macroalgae species and one important species of phanerogam presented by *Posidonia oceanica*.

The results obtained at the infralittoral zone of different stations show a very clear qualitative difference between the sites subjected to the anthropogenic actions (infrastructures, overexploitations, pollution and tourism) and those

relatively distant from these actions. Given its ease of access, the stations 1, 2, 3, 4 are more exposed to anthropogenic perturbations than stations 5, 6, 7 and 8. In the southern part of the island there is a small jetty used by fishermen all year long and this also receives thousands of tourists, pleasure boats and other motorized watercrafts in summer period generating physical and chemical aggressions to that fragile ecosystem and affecting biodiversity. The most represented species around the island were the sea urchin *Paracentrotus lividus*, the beadlet anemone *Actina equina*, the green anemone *Anemonia viridis*, the sponge *Spongia officinalis* and the Mediterranean chromis *Chromis chromis*.

As stated by Fredj and Maurin (1987), the fish species encountered have an Atlanto-Mediterranean origin (Table 1), as is the case of the majority of the Mediterranean fish fauna. They have an affinity to temperate and warm waters. The listed species had a thermal preference having as origin southern Ibero-Moroccan and Saharian regions of the Mediterranean province such as *Epinephelus marginatus*, *Epinephelus costae* while endemics are represented by *Diplodus sargus sargus*.

The richness seems strongly influenced by the abiotic factors of each station, such as hydrodynamism, mode of exposure, and anthropogenic activity, Figure 6 shows an important richness in ichthyofauna, rhodophytes, sponges and cnidarians in the eight stations studied. This reflects the importance of the geographical location and the substrate nature. Generally, transects were characterized by very small shallow bottoms and many areas of scree, as a result of erosion and disruption of the rock wall resulting in a very rugged and highly complex underwater bottom.

All these elements are a major component of the island's underwater seabed, and constitute important fixation surfaces (hard substrates) for benthic organisms and allow the establishment of various biocenoses: coralligenous (red coral), ichthyological and carcinological settlements. The rocky facies is juxtaposed on the soft sedimentary facies, where it constitutes true rocky enclaves. The extensions of the cliffs and scree are appropriate substrates which are colonized in large part by macrophyte algae, hence proliferation of a strong plant dominance, such as photophilic algae at low depths. In fact, all these conditions give Paloma or "Plane" Island the characteristics of a nursing ground.

From 15 to 30 m deep the bottoms are mainly in the form of scree. Deep bedrock outcrops (25 to 34m), characterized by low illumination and many anfractuosités, resulted in sciaphilous flora and exuberant sessile fauna that make up the coralligenous ecosystem. The singular sea fan *Eunicella singularis* was one of the most remarkable species of "Plane" island bottoms marked by the presence of large fish such as *Muraena helena*, *Physis physis*, *Conger conger*, *Epinephelus costae* and *Epinephelus marginatus*.

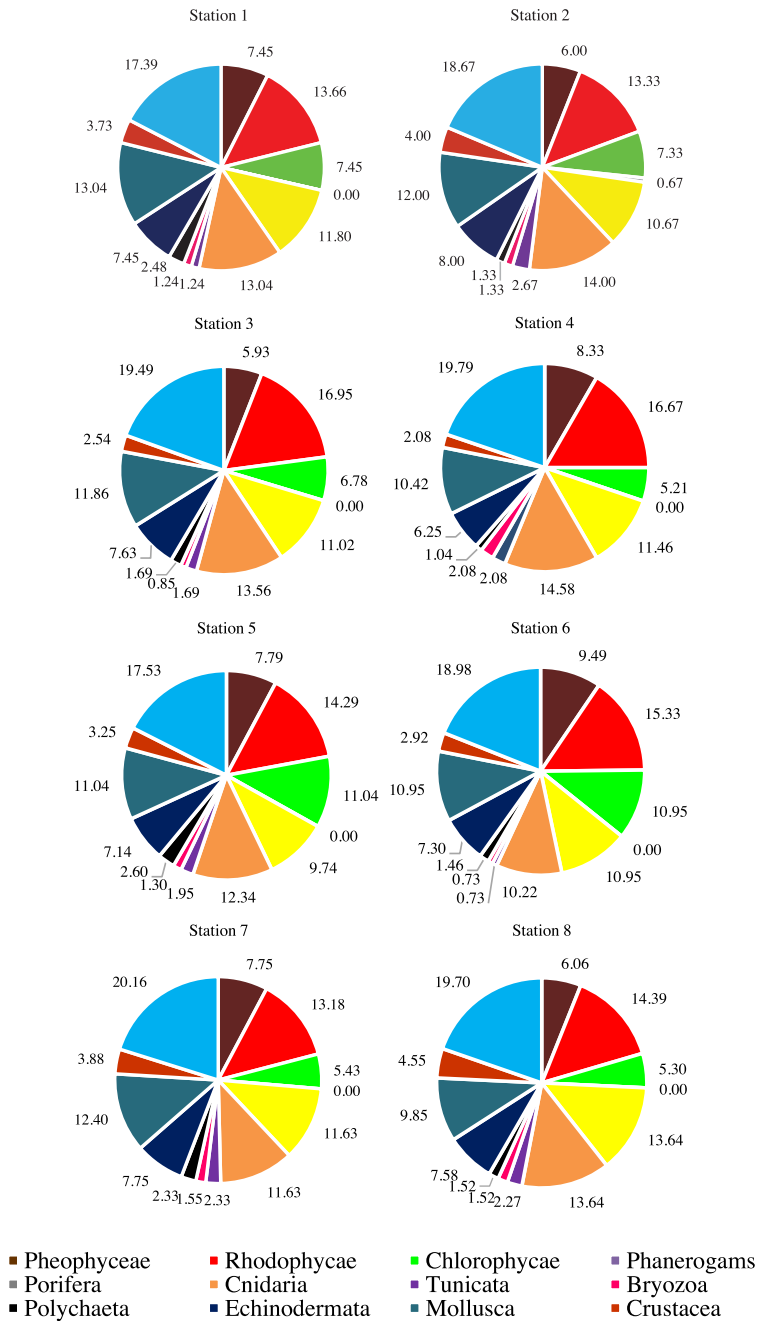


Figure 6. Specific richness (%) in the eight stations studied

Given the lack of financial means and diving personnel (only two scientific divers), our first inventory was limited to eight stations and 34m depth. Further investigations, however, will explore biodiversity beyond this limit where habitats are less exposed to the solar rays and are subject to much colder water than surface, thus an extraordinary fauna are sheltered and the famous "coralligenous reef walls" are formed.

The island contains also several underwater caves, with dark and semi-dark characteristics. Four of them were explored, having several openings, which are between 16 and 37m seen as a hot spot of biodiversity in littoral zone for a wide range of organisms which do not depend directly on the luminous energy in their life cycle like macro invertebrates that have a fixed way of life. Thus, the shape of the cave, its size, depth contribute a lot to this specific richness. The most abundant communities are the bryozoans *Myriapora truncata*, the cnidarians *Astroides calycularis*, *Leptopsammia pruvoti*, *Parazoanthus axinellae*, *Pourtalosmilia anthophylites*, some dominant sponges: *Agelas oroides*, *Clathrina clathrus*, *Chondrosia reniformis*. The presence of bristleworm *Protula tubularia* and ascidians *Halocynthia papillosa* should be noted. At the opening of the caves there is also a strong presence of *Apogon imberbis*, which feed on small particles displaced by marine currents. Some caves have faults and crevices in their walls where we met large specimens of *Muraena helena*, *Conger conger* and the forkbeared *Phycis phycis*.

Of the 201 species inventoried, some are protected by Algerian legislation to preserve the national biological heritage and international conventions (Barcelona and Bern Conventions) in their different annexes and also appear in the Red List of the IUCN. Status of protected species encountered in "Plane" Island are resumed in Table 4.

Unlike the fish species strongly impacted by the various fishing practices, the macrobenthic species are very diversified, marked by the presence of species with special status or subject to protective measures indicated by international conventions such as Barcelona Convention (1976) and Bern Convention (concerning marine species in 1996) such as Macrophytes (*Posidonia oceanica*, *Cystoseira* sp, *Sargassum trichocarpum*, *Lithophyllum byssoides*), Mollusks (*Patella ferruginea*, *Pinna nobilis*, *Pinna rudis*, *Charonia lampas*, *Lithophaga lithophaga*, *Dendropoma lebeche*, *Luria lurida*), Crustaceans (*Scyllarides latus*, *Scyllarus arctus* *Palinurus elephas* *Homarus gammarus*, *Maja squinado*), Echinoderms (*Centrostephanus longispinus*, *Ophidiaster ophidianus*, *Paracentrotus lividus*), Cnidarians (*Astroides calycularis*, *Savalia savaglia*) and Sponges (*Axinella polypoides*, *Spongia officinalis*). The immediate protection of biodiversity of this area is needed to ensure the heritage value for the Oranian shoreline and for Algerian waters.

Table 4. Protection status of species encountered in “Plane Island”: Algerian Protection status, Barcelona and/or Bern Convention, Red List Category of the IUCN.

	Algerian Protection status*	Barcelona convention	Bern convention	IUCN Red List Category**
Flora				
<i>Cystoseira amentacea</i>	Critically Endangered	Annex II	Annex I	-
<i>Posidonia oceanica</i>	Endangered	Annex II	Annex I	LC
Fauna				
Mollusca				
<i>Patella ferruginea</i>	Threatened	Annex II	Annex II	-
<i>Lithophaga lithophaga</i>	Threatened	Annex II	Annex II	-
<i>Pinna nobilis</i>	Critically Endangered	Annex II		-
<i>Pinna rudis</i>	Threatened	Annex II	Annex II	-
Crustacea				
<i>Palinurus elephas</i>	Threatened	Annex III	Annex III	VU
<i>Scyllarides latus</i>	Threatened	Annex III	Annex III	DD
<i>Maja squinado</i>	Near threatened	Annex III	Annex III	-
Echinodermata				
<i>Centrostephanus longispinus</i>	Critically Endangered	Annex II	Annex II	-
<i>Ophidiaster ophidianus</i>	Near threatened	Annex II	Annex II	-
<i>Paracentrotus lividus</i>	Near threatened	Annex III	Annex III	-
Cnidria				
<i>Astroides calycularis</i>	Near threatened	Annex II	Annex II	-
Porifera				
<i>Axinella polypoides</i>	Near threatened	Annex II	Annex II	-
<i>Spongia officinalis</i>	Near threatened	Annex III	Annex III	-
Fish				
<i>Epinephelus marginatus</i>	Threatened	Annex III	Annex III	VU
<i>Epinephelus costae</i>	Threatened	Annex III	Annex III	DD

*J.O.R.A.D.P, 2006 (Presidential Decree n° 2006-405).

** LC: Least Concern; VU: Vulnerable; DD: Data Deficient

Biocenosis of the “Plane” Island

This list is based on the classification of benthic marine habitat types for the Mediterranean region elaborated by Experts on Marine Habitat Types in the Mediterranean Region (Hyères, France, 18-20 November 1998) and reviewed subsequently by experts in the 4th Meeting of National Focal Points for ASP (UNEP (OCA)/MED WG 1999).

Hard bottoms and rocks

Biocenosis of upper mediolittoral rock

Association with *Nemalion helminthoides* and *Rissoella verruculosa*

Biocenosis of the lower mediolittoral rock

Association with *Lithophyllum byssoides*

Association with *Gelidium* spp.

Association with *Ulva* spp.

Biocenosis of mediolittoral caves

Association with *Phymatolithon lenormandii* and *Hildenbrandia rubra*

Biocenosis of infralittoral algae

Association of Photophilic Algae in beaten Mode

Overgrazing Association of Encrusting Seaweeds and Urchins

Association of Hemiphotophilic Algae

Association of Photophilous Algae in beaten mode:

Overgrazing facies with encrusting seaweed and sea urchins

Association with *Cystoseira amentacea* (var *amentacea*, var *stricta*, var *spicata*)

Association with *Corallina elongata*

Association with *Sargassum vulgare*

Association with *Dictyopteris polypodioides*

Association in *Calpomenia sinuosa*

Association with *Ulva* sp.

Association with *Padina pavonica* and Dictyotales

Association with *Posidonia oceanica*

Association of Sciaphile Algae in beaten Mode:

Facies with large hydrates

Facies with *Astroides calycularis*

Sciaphile Algae Association in sheltered Mode

Association with *Peyssonnelia rubra* and *Peyssonnelia* spp.

Coralligenous biocenosis

Facies with gorgonians

Facies with *Eunicella cavolini*

Facies with *Eunicella singularis*

Facies with *Parazoanthus axinellae*

Facies and association of Coralligenous biocenosis (in enclave)

Biocenosis of semi-dark caves

Facies with *Parazoanthus axinellae*

Facies with *Astroides calycularis*

Conclusion

The examination of “Plane” Island's benthic biodiversity shows an undeniable specific richness of these seabed showing a high diversity with 55 species distributed between the supra and mid-littoral stage and 195 species to the infralittoral stage. The total number of taxa inventoried after the elimination of the species present in both parts is around 201 benthic species.

The island is characterized by the presence of six biocenosis of hard rock with 19 associations and 9 facies. The bioconcretions, the colored facies of red gorgonians (*Paramuricea clavata*), yellow gorgonians (*Eunicella cavolini*) and sessile macrofauna mark the coralligenous habitat. The presence of large and

small pelagics (sardine, bogue, Atlantic horse mackerel, tuna, swordfish...) adds interest to the area as evidenced by the large numbers of purse seiners, common dolphins (*Delphinus delphis* Linnaeus, 1758) and grey petrels *Procellaria cinerea* (Gmelin, 1789) around the island.

In addition to the ichthyofauna of the hard and soft substrates, the landings in the region reveal an important fishing potential, especially in demersal species. A population of common dolphins regularly visits the area between "Plane" and the Habibas Islands, as well as two species of turtles: leatherback (*Dermochelys coriacea* Linnaeus, 1758) and loggerhead sea turtles (*Caretta caretta* Linnaeus, 1758), that are also reported around the island (Lanteri, 1982; Laurent, 1988, 1990, Boutiba, 1992, Hussein 2015).

However, like the Oranian coast, "Plane" Island is not immune to aggressions of exotic and invasive species, such as *Caulerpa racemosa* var. *cylindracea*, *Codium brittle*, *Asparagopsis armata* and *Asparagopsis taxiformis*, bryozoan *Amathia verticillata*, scleractinaria *Oculina patagonica*.

From a biogeographic point of view, "Plane" island is located in the transition zone between Alboran Sea and the western Mediterranean basin, rich in plankton necessary for the functioning of the benthic domain. The inventory of "Plane" Island should be used to help administrative management and decisions on protection, responding to international programs and obligations.

All of these preliminary elements aiming to evaluate biodiversity in "Plane" Island are at the same time a foundation and a real advocacy to initiate a process of classification and preservation of the terrestrial and marine heritage components of this insular ecosystem. To date, the Algerian legislation (Official Journal of the Algerian Republic 14 December 2003) has protected marine resources by prohibition of fishing activity within the 6 miles zone and around insular areas but to our point of view illegal spearfishing and ghost fishing stay as the most destructive factors resulting in biodiversity loss. Strict political decisions were taken since 2003 for the Oranian shoreline, then the protection of Habibas Island was achieved as an MPA. Recently on 1 October 2018, a second project of MPA was suggested concerning "Plane" Island.

This study aimed to inventory the prominent species in "Plane" Island, determine the presence of species of conservation interest and categorize rocky benthic habitats in order to help decision-makers and managers with the conservation plans of the island. Further studies are necessary for the taxonomic identification of small, cryptic and less flagrant species and should include depths beyond 34 m and the various caves present in the island. Investigations must include the monitoring of some pertinent species with emphasis on populations density, dynamics, and ecology. This first inventory of biodiversity

in “Plane” Island will surely help national and international MPA’s managers to fill the gaps for the threatened and vulnerable species of the Mediterranean Sea.

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References

Bajjouk, T., Derrien, S., Gentil, F., Hily, C., Grall, J. (2010) Typologie d’habitats marins benthiques: analyse de l’existant et propositions pour la cartographie. Habitats côtiers de la région Bretagne - Note de synthèse n° 2, Habitats du circalittoral. Projets REBENT-Bretagne et Natura 2000-Bretagne. RST/IFREMER/DYNECO/AG/11-03/TB.

Barcelona Convention (1976). Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. Annex II Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean. United Nations Environment Programme. Barcelona, 16 February 1976. Available at: <http://web.unep.org/unepmap/1-barcelona-convention-and-amendments> (accessed 7 Mar 2019).

Bellan-Santini, D. (1969) Contribution a l’étude des peuplements infralittoraux sur substrat rocheux. Thèse Université Aix-Marseille.

Bellan-Santini, D., Lacaze, J.C., Poizat, C. (1994) Les biocénoses marines et littorales de Méditerranée, synthèse, menaces et perspectives. Muséum National d’Histoire Naturelle.

Bensahla Talet, L., Mezedjri, L., Bensahla Talet, A., Anas, M., Ahmed, K. (2015) Physico-chemical quality and metallic pollution levels in wastewater discharges from Mostaganem (Algerian West Coasts). *International Journal of Sciences: Applied and Basic Research (IJSBAR)* 15(2): 116-125.

Bern Convention (1979) Convention on the conservation of European wildlife and natural habitats. Appendix II Strictly protected fauna species. Council of Europe. Bern, 19 September 1979. Available at: <https://www.coe.int/en/web/conventions/full-list/-/conventions/treaty/104> (accessed 7 Mar 2019).

Besnard, A., Salles, J.M. (2010) Suivi scientifique d’espèces animales. Aspects méthodologiques essentiels pour l’élaboration de protocoles de suivis. Note méthodologique à l’usage des gestionnaires de sites Natura 2000. Rapport DREAL PACA, pôle Natura 2000.

Bonhomme, P., Bricout, R., Astruch, P., Le Direach, L., Bonhomme, D., Boudouresque, C. F. (2009) Suivi de l'effort de pêche professionnelle dans les eaux du Parc national de Port-Cros. Année 2008. Contract PNPC and GIS Posidonie, GIS Posidonie publ, Marseilles, pp. 1-56.

Boudouresque, C.F. (1970) Recherches de bionomie analytique, structurale et expérimentale sur les peuplements benthiques sciaphiles de Méditerranée occidentale (fraction algale), Université d'Aix-Marseille II.

Boudouresque, C.F. (2005) Excursion au Cap-Croisette (Marseille): le milieu marin. Ed. GIS Posidonie publ, Marseilles, Fr, pp. 1-48.

Boutiba, Z. (1992) Les Mammifères marins d'Algérie. Statut, Répartition, Biologie et Ecologie. Doctoral dissertation, Thèse Doctorat d'Etat, Université d'Oran, Algérie.

Cramer, W., Guiot, J., Fader, M., Garrabou, J., Gattuso, J. P., Iglesias, A., Lange, M.A., Lionello, P., Llasat, M.C., Paz, S., Peñuelas, J., Snoussi, M., Toreti, A., Xoplaki, E. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. *Nature Climate Change* 8(11): 972-980.

Eleftheriou, A, NA Holme (1984) Macrofauna Techniques. In: Methods for the Study of Marine Benthos, 2nd edition. (eds., Holme, N.A., McIntyre, A.D.) Blackwell Scientific Publications, London, Oxford, XII, pp. 140-216.

Fischer, W., Bauchot, M.-L. et M. Schneider (rédacteurs) (1987) Fiches FAO d'identification des espèces pour les besoins de la pêche. (Révision 1). Méditerranée et mer Noire. Zone de pêche 37. Volume I. Végétaux et Invertébrés. Publication préparée par la FAO, résultat d'un accord entre la FAO et la Commission des Communautés Européennes (Projet GCP/INT/422/EEC) financée conjointement par ces deux organisations. Rome, FAO, 1.

Fredj, G., Maurin, C. (1987) Les poissons dans la banque de données MEDIFAUNE application à l'étude des caractéristiques de la faune ichtyologique méditerranéenne. *Cybium* 11(3): 217-341.

Harmelin-Vivien ML., Harmelin J.G. (1975). Présentation d'une méthode d'évaluation «in situ» de la faune ichtyologique. *Trav Sci Parc nation Port-Cros* 1: 47-52.

Harmelin-Vivien, M., Harmelin J.G., Chauvet, C., Duval, C., Galzin, R., Lejeune, P., Barnabe, G., Blanc, F., Chevalier, R., Duclerc, J., Lasserre, G. (1985) Evaluation visuelle des peuplements et populations de poissons: problèmes et méthodes. *Rev Ecol (Terre Vie)*, Fr 40: 467-539.

Hussein, K.B. (2015) Suivi et Evaluation de la structure écologique et biodiversitaire infralittorale de la zone côtière Oranaise. *Thèse de Doctorat*: Faculté des Sciences de la Nature et de la Vie Département. Biologie. Université Oran 1: 277.

Hussein, K.B., Bouras, D. (2014) First observations of the macrozoobenthos biodiversity of Oran coastal area, Algeria. *Journal of Biodiversity and Environmental Sciences (JBES)* 5(1): 625-637.

J.O.R.A.D.P. (2006) Journal Officiel de la Republique Algerienne Démocratique et Populaire. Décret présidentiel n° 2006-405 du 22 Chaoual 1427 correspondant au 14 novembre 2006 portant ratification du protocole relatif aux aires spécialement protégées et à la diversité biologique en Méditerranée, signé à Barcelone le 10 juin 1995. JORA N°74.

Kantin, R., Andral, B., Debard, S., Denis, J., Derolez, V., Emery, E., Ganzin, N., Hervé, G., Laugier, T., Le Borgne, M., L'Hostis, D., Oheix, J., Orsoni, V., Raoult, S., Sartoretto, S., Tomasino, C. (2006) Le référentiel benthique méditerranéen (REBENT MED). Avant projet sommaire. Doc. IFREMER. R.INT.DOP/LER-PAC/06-08-Décembre 2006.

Lanteri A. (1982) Note sur un important rassemblement de *Caretta caretta* au large de la cote oranaise. *Bull soc Herp Fr* 23: 63-65.

Laurent, L. (1988) Observations pelagiques de la Caouanne *Caretta caretta* en , Mediterranee occidentale. *Bull Soc Herp Fr* 45(1): 9-16.

Laurent, L. (1990) les tortues marines en algerie et au maroc (Mediterranee). *Bull Soc Harp Fr* 55: 1-23.

Lenfant, P., Hussein, C., Verdoit-Jarraya, M., Pastor, J., Ibrahim, A., Saragoni, G., Pelletier, D., Mahévas, S. (2011) Assessing the impact of artisanal and recreational fishing and protection on a white seabream (*Diplodus sargus sargus*) population in the north-western Mediterranean Sea using a simulation model. Part 1: Parameterization and simulations. *Fisheries Research* 108: 163-173.

MATE. (2004) Ministère de l'Aménagement du Territoire et de l'Environnement - Format annoté pour les rapports de presentation des aires proposées pour inscription sur la liste des ASPIM - Réserve naturelle marine des îles Habibas (Oran).

Millot, C. (1999) Circulation in the western Mediterranean Sea. *Journal of Marine Systems* 20(1-4): 423-442.

Millot, C., Taupier-Letage, I. (2005) Circulation in the Mediterranean Sea. In: The Mediterranean Sea, Handbook of Environmental Chemistry, Vol. 5, Part K, (ed., Saliot, A.), Springer-Verlag, Berlin, pp. 29-66.

Pérès, JM., Picard, J. (1964) Nouveau manuel de bionomie benthique de la Mer Méditerranée. *Recueil Travaux Station Marine Endoume* 31(47): 137pp.

Pergent, G., Bellan-Santini, D., Bellan, G., Bitar, G., Harmelin, J.G. (2007) Manuel d'interprétation des types d'habitats marins pour la sélection des sites à inclure dans les inventaires nationaux de sites naturels d'intérêt pour la Conservation, Ed. CAR/ASP publ. Tunis, Tunisie.

PNUE/PAM-CAR/ASP (2016) Algérie: Île de Rachgoun. Cartographie des habitats marins clés de Méditerranée et initiation de réseaux de surveillance. (eds., Par Ramos Esplá A., Benbdi M., Sghaier Y.R., Forcada Almarcha A., Valle Pérez C., Ouerghi A.) CAR/ASP - Projet MedKeyHabitats, Tunis.

Pollard, D.A., Afonso, P., Bertoncini, A.A., Fennessy, S., Francour, P., Barreiros, J. (2018) *Epinephelus marginatus*. The IUCN Red List of Threatened Species 2018: e.T7859A100467602 (accessed 20 Nov 2018).

Rivera-Ingraham, G. A., Espinosa, F., García-Gómez, J. C. (2011) Conservation status and updated census of *Patella ferruginea* (Gastropoda, Patellidae) in Ceuta: distribution patterns and new evidence of the effects of environmental parameters on population structure. *Animal Biodiversity and Conservation* 34(1): 83-99.

UNEP (OCA)/MED WG (1999) Rapport de la quatrième réunion des Points Focaux Nationaux pour les ASP, Tunis 12-14 Avril 1999. 159/5.

UNEP-MAP RAC/SPA (2010) The Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities. (eds., Bazairi, H., Ben Haj, S., Boero, F., Cebrian, D., De Juan, S., Limam, A., Lleonart, J., Torchia, G., Rais, C.) RAC/SPA, Tunis.

UNEP-MAP (1998) Rapport de la réunion d'experts sur le type d'habitats marins dans la région méditerranée. United Nations Environment Program, Mediterranean Action Plan, UNEP (OCA)/ MED WG.149/5.

Vaissiere, R, Fredj, G. (1963) Contribution à l'étude de la faune benthique du plateau continental de l'Algérie. *Bull Inst Océanogr Monaco* 60(1272).

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

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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.

Oran shoreline faced this situation of invasion from East and North Algeria, also accentuated by Almeria-Oran current which sweeps the Algerian coast accelerating the invasion process coming from Spain (South European shore) where it was reported in several cities, including Almeria (Andalusia) 30 m of isobath¹⁵, and the anthropogenic factor stay the most incriminated^{36,39}.

This study clearly indicated the invasion of the Oranian coast by *Caulerpa cylindracea*, since 2012. The 124 km long coast was a subject of spatio-temporal prospection and bathymetric follow-up of coastal ecosystem, already weakened by anthropization and littoralization. The objective was to provide a map of the chronological invasion and spatial distribution of the species and to describe its bathymetric distribution and its interaction with the local ecosystems including the associated flora and fauna.

Materials and Methods

Few protocols are designed specifically for signaling exotic species and invasive alien species to help facilitate early understanding of the relative risk of invasion of marine coastal ecosystems by different species¹⁶. This in turn helps to identify potential invasion patterns and target management efforts to reduce additional risks. These data can also be used to facilitate identification of the area's most likely to be invaded in the future.

The present study depicted the recent situation of *Caulerpa cylindracea* on the Oranian coastline, North-West coastal fringe of Algeria, using scuba diving as a means of study at the depth ranging between 25 and 30 m, based on the field data obtained, focusing on the morphological, bathymetric, recovery status and associated fauna and flora¹⁷.

Study area

The Oranian coastline is located on the southern shore of the Mediterranean basin about 432 km from the capital Algiers. The coastal line extends over 124 km and represents 1/10 of the national coastline. Along this zone, more than 10 stations were identified and explored (Fig.1) by way of autonomous diving at 30 m depth (photic zone) during different periods (winter and summer). Each station was transected from the shore to the large^{18,19}.

The stations were selected to represent all types of habitats, depths, substrates, and wave exposure conditions, from the surface to the deepest area reached in each transect. In the second stage (during

the ascent), each benthic community was carefully examined for characterization of the fauna and associated flora.

Study methodology

The survey was based on the observations made by recreational divers already aware of the situation and their personal statements. Surveillance and sensitization campaigns among sea users, fishing vessels, yachtsmen and divers helped to detect the presence of the exotic species, following the supply of information cards distributed previously to facilitate its recognition.

Once the stations were chosen, the methods used varied according to the nature of the habitat of each station and also on the available financial and logistical resources. The monitoring was carried out at each exit by two divers (Fig. 2), which followed a linear transect perpendicular to the littoral and carried out in summer and in winter to detect the presence of the species in relation to the two seasons²⁰. Only individuals or colonies with at least 50% of the area within the strip transect were considered and counted to avoid distorting the sample²¹.

During this process, care was taken to control propagation of the species in other areas by the use of non-destructive methods. The organization of such protocol of early warning system ensured rapid transmission of information so that an assessment and

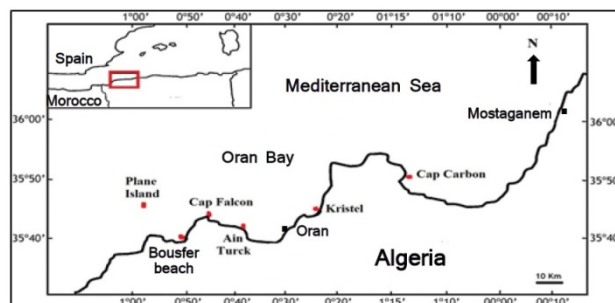


Fig. 1 — Presentation of the Oranian littoral and the stations invaded by *C. cylindracea*.



Fig. 2 — Prospection and diving surveys on random transect to study *C. cylindracea* in Oran coastline.

corrective action can be proposed (cf. Marine Alien Invasive Species Strategy for the MedPAN Network, 2012). The identification sheets were used for marine exotic species in the Mediterranean¹⁷ and the international standardization procedure for the mapping evaluation of *Caulerpa taxifolia*^{22,23}

Results and Discussion

Although the transport of algae on floating woods has been considered for some distant colonies, most of them have an anthropogenic origin^{24,38}. In Oran, this was the first work concerning the introduction and invasion of marine algae on a regional scale. The presence of the Caulerpe was reported in the Eastern region of Oran^{25,26} at "Port aux Poules" harbor and at Cap Carbon between 2 and 7 m depth.

It was found that the seaweed frequented the Oranian coast since 2011-2012 (*pers.obs*), precisely, at Cap Carbon in Arzew zone^{9,26}. The eastern littoral welcomed the first fronds of *C. racemosa* var. *cylindracea*, which installed first as spots of disseminated individuals in the biocenosis of photophilic algae of the upper infra-littoral. Several *C. racemosa* individuals were detected at Cap Carbon in 2012, at 0.3 m depth in a small bedrock cuvette (Fig. 3). This first signaling allowed for follow up of its distribution, knowing that the species was absent or never encountered in the rest of the Oranian littoral.

Species identification

Caulerpa cylindracea is a green marine chlorobionte (green alga) recognized by its creeping axes (stolons) with rhizoids and upright fronds with ramules in the form of vesicles, sized between 1 and 11 cm and characterized by a sexual and vegetative

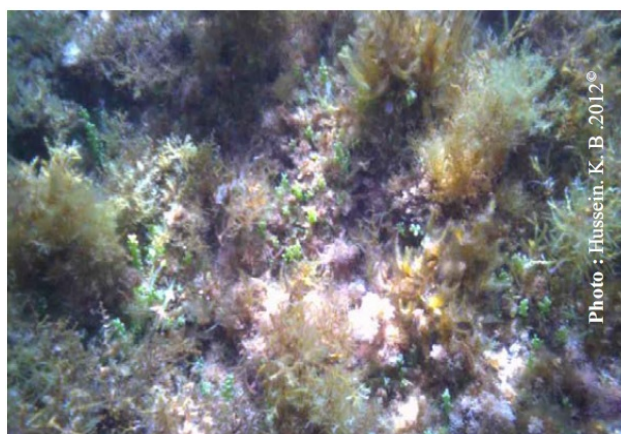


Fig. 3 — First signaling of *C. cylindracea* in Cap Carbon at 30 cm depth, Gulf of Arzew, Eastern Oranian coasts, 2012.

reproduction. Observations on the distribution of *C. cylindracea* in Oran since 2012 showed that the specimens present the same appearance with irregular and entangled branched stolons attached to the substrate by colourless rhizoids (Fig. 4).

Spatio-temporal evolution of invasion by *C. cylindracea*

Caulerpa cylindracea invasion occurred from east to west along the Oranian coastline, chronologically since 2011-2012, the species spread to the extreme west in only four years (Fig. 5).

The affected stations with their GPS position are represented in Table 1.

The sense of invasion was the same as the one which affected the Algerian coast. After the first signaling in Algeria in 2006 at Algiers harbor, this species was present in the west coasts after only five years, which highlighted the speed of its distribution and the need to control this invasion Reaping in view the detected consequences on the communities and coastal ecosystems of the Algerian coastline. Its presence on the western Algerian coasts was monitored to better assess the extent of its proliferation, given that the invasive variety of *Caulerpa racemosa* spread in Algeria in a very short time²⁵.

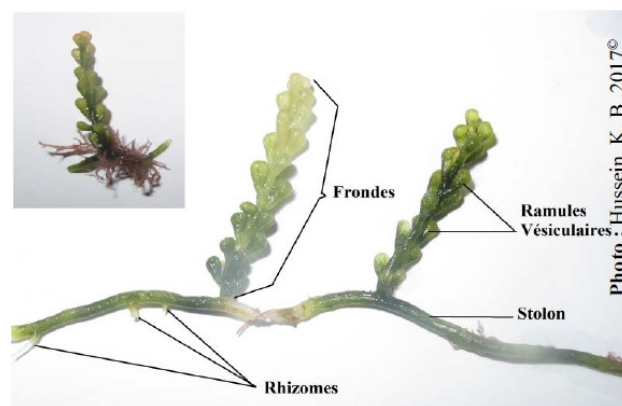


Fig. 4 — Specimen of *Caulerpa cylindracea* present in Oran Bay.



Fig. 5 — Geographical, chronological invasion and habitat characterization of *C. cylindracea* in the Oranian coastline.

Table 1 — Geographical coordinates for invasions by *C. cylindracea* in the Oranian coastline.

Location	Latitude	Longitude	bottom	Depth	Year*
Cap Carbon	N 35° 54' 11.6706"	0° 20' 23.4414"	Rocky, seagrass	0.3-8m	2012
Kristel	N 35° 50' 29.2992"	0° 29' 3.6132"	Sandy/Galets	1.5m	2013
Ain Türck	N 35° 44' 13.4802"	0° 43' 43.338"	Sandy/Galets	3m	2014
Cap Falcon	N 35° 46' 16.4742"	0° 47' 33.6876"	Rocky	5m	2014
Bousfer beach	N 35° 43' 33.8484"	0° 50' 55.9386"	Rocky/Sandy	1m	2015
Plane Island	N 35° 46' 16.0278"	0° 54' 10.3206"	Rocky	0.2-37m	2016

*Year of the First Observation

All *in situ* surveys and *in visio* monitoring showed that the invasion spots were mainly represented by low density communities with modest tangle rates and the presence of small tufts, indicating a recent invasion, and hence the felt need to take early and urgent measures to control its geographical distribution and to limit its impact on the marine environment.

Bathymetry

Found at depths ranging from few centimeters to 37 m, the invasive species also occupies various substrates (hard, sandy, muddy) between the rhizomes of marine phanerogams and also between the lower mid-littoral algae and the upper infra-littoral algae associated to *Posidonia aceanica* herbarium and on dead matter.

Scientific survey dives indicated that invasion by *C. cylindracea* in the Oranian coastline took place from the bottom to the surface. In fact, in all the study sites, sea grapes were always observed first at a depth of more than 2 m, and later at the surface, spread in small crevasses between the mid-littoral and the upper infra-littoral. Algerian waters were invaded around Algiers in 2006, Mostaganem littoral in 2008 and then Oranian coastline in 2011-2012; the introduction vector remains unknown at present. This rapidity could be explained by its reproduction mode, in synergy with anthropogenic activities. Figure 6 shows an update of its distribution in the Mediterranean basin as well as new indications of the species in the west Algerian water duly integrated.

Situation of *C. cylindracea* in Oran

Cap Carbon Station

In 2010, the species was reported in the Gulf of Arzew^{13,14} and in 2012 it was observed at Cap Carbon⁹ as isolated fronds in an area of 2 m² of a rocky micropiscine (Fig. 7) between tufts of *Cystosiera* sp, *Coralina elongata* and *Ulva* at a depth of 0.2 m. The species was encountered in 2013 between 1 and 3 m depth with *Posidonia oceanica* herbarium⁹.

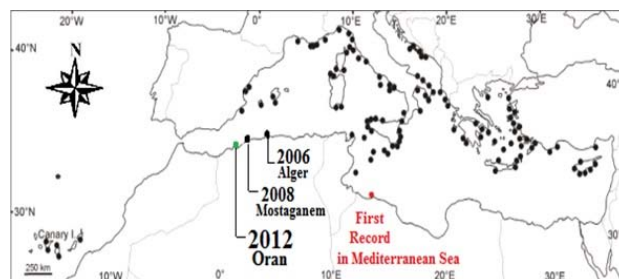


Fig. 6 — Updated map of *C. cylindracea* distribution in the Mediterranean and North Atlantic (Canary Islands). Red dot: First signaling in Libya⁸ modified; green dot: First signaling in the Oranian coastline, 2017.

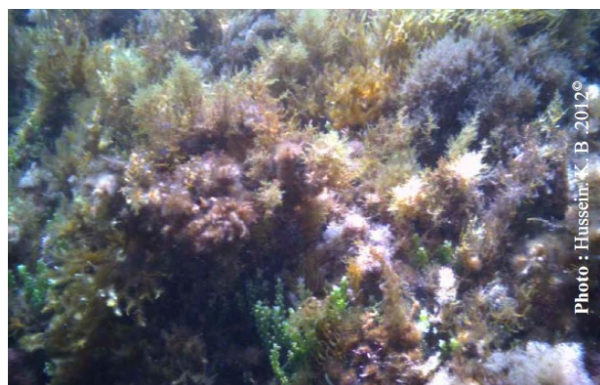


Fig. 7 — *C. cylindracea* at Cap Carbon in 2012 east of the Oranian littoral.

Cap Falcon Station

Cap Falcon was the most infected site with 90% of recovery to a depth of 5 m. In some rocks, the spots were characterized by ramulas with bulky vesicles (Fig. 8), indicating an old invasion with large fronds. This could be attributed to the maritime traffic at this station, favored by the presence of a local boat house.

“Plane” island (Paloma) Station

C. cylindracea invaded the island in 2014, where a spot of 30 fronds was found at 37 m, in June 2016, during the beginning of the summer season. It surfaced and settled in a micro-cuvette with a covering rate of 70% at a depth of 0.3 m on a surface of 1 m² characterized by fronds of 5 cm (Fig. 9).



Fig. 8 — *C. cylindracea* at Cap Falcon in 2014 in the center of the Oranian littoral.



Fig. 9 — Spot of *C. cylindracea* at “Plane” Island in 2016 West of the Oranian littoral.

During the winter season, around mid-December, a marked decrease in the occupied area was observed due to the reduction in foliar production of the species marking the dormancy state of its life cycle. This was the best time to treat the phenomenon of the biological invasion of *C. cylindracea* on the Oranian coast by manual eradication of the spots to stop its spread and to maintain the equilibrium of infected spaces^{17,40,41,42}. Several individuals were recorded recently in 2017 on the wall of a steep rocky cliff underwater near the landing stage of the island at 8 m of isobath.

Flora and associated fauna

So far algae sharing the same biotope as *C. cylindracea* is concerned, there was dominance of rhodophytes (*Lithophyllum* sp, *Peyssonnelia* spp and *Mesophyllum* sp), sciaphil algae chlorophytes (*Codium bursa*, *Flavellia petiolata*, and *Halimeda tuna*), and phaeophytes, (*Cystoseira* sp).

In the enclaves (<1 m deep), photophilic algal biocenosis competed in space with *C. cylindracea*, In the case of Ulves, *Enteromorpha*, *Carolina elongata* and *Dichtyota dictyotoma* were abundant. Other non-

indigenous algae that colonized the Mediterranean also competed in space, as in the case of *Asparagopsis armata* and *A. taxiformis*; the indigenous species are represented by microalgae which recover the rocky walls. It also frequented the upper limits of the *Posidonia oceanica* herbarium as found in Cap Carbon.

For associated fauna, the dominant species were: Sessile filtering organisms, such as Greek bathing sponge *Spongia officinalis* sponges, *Chondrosia reniformis*, *Crambe crambe*, sessile and vagile micro invertebrates. These used *C. cylindracea* spots as shelter which attract considerable ichthyofauna³⁵; fronds can be disseminated and settled on any surface, with species such as the anemones *Anemonia viridis*, sea tomato *Actina equina* and polychaete *spirograph* sp. Also encountered were the populations of echinoderms common urchin *Paracentrotus lividus*, sea star *Hacelia attenuata*, and sea cucumber *Holothuria* sp and fish juvenile: bogue *Boops boops*, golden mullet *Liza aurata*, *Gobidea*, Mediterranean rainbow wrasse *Coris julis*, *Trypterygion delesai* and comber *Serranus* sp, which continually frequented the stollons.

Intreaction of *C. cylindracea* with native benthic communities

The colonization of the substrate by *C. cylindracea* seemed to affect the evolution of the benthic communities in terms of diversity, abundance, and seasonal dynamics^{8,27,28,35}, probably due to the presence of *C. cylindracea* that modifies the physico-chemical parameters in the sediments²⁹.

This seaweed is eaten by several herbivorous fish, mainly sparidae: the bogue *Boops boops*, the axillary seabream *Pagellus acarne*³⁰, the saupe (*Sarpa salpa*) and *Spondyllosoma cantharus*³⁷. It is also consumed by the common sea urchin (*Paracentrotus lividus*) and the granular sea urchin (*Sphaerichinus granularis*), as well as molluscs (*Aplysia* sp, *Ascobulla fragilis*, *Bittium latreilli*, *Elysia tomentosa*, *Lobiger serradifalci* and *Oxynoe olivacea*).

The invasion effects of *C. cylindracea* on the functioning of ecosystems may depend on the feeding choice of herbivores between native and non-native algae. Competition of *C. cylindracea* with macroalgae on space may increase habitat disturbance. In a study in southern Sicily³¹ investigating the feeding preferences of *Paracentrotus lividus* exposed to native macroalgae and non-native species, it was found that over a period of 48 h, *P. lividus*

preferentially consumed *C. cylindracea* and *D. membranacea* (mixture of non-indigenous macroalgae), when the mixture of native macroalgae had barely been consumed.

In addition, our observation suggested that potential control and bioremediation by *P. lividus* on propagation might be possible when the invasive species coexisted with other indigenous macroalgae. The presence of toxins in this variety and their potential effects on herbivorous fauna and on the movement of organic matter through trophoblastic chains remained to be established, including the last consumer who is man.

Conclusion

The work presented allowed preparation of an initial inventory of the invasion by *C. cylindracea* at the level of the coastal zone of Oran. It is particularly an invasive species given that only five years from the first signaling in Algeria were sufficient for this species to invade the Oranian coast, to colonize and disturb the ecosystem, resulting in a reduction of the indigenous phytobenthos^{32, 33, 34}.

In recent years, the Oranian coastline is experienced a galloping trend of anthropogenic activities on the maritime façade with the presence of one of the most important ports of Algeria, which remain exposed to an intense fishing activity and maritime traffic.

The detailed map and recent data from the original *in situ* surveys supplemented by underwater photographs confirmed high propagation speed of *C. cylindracea* in the Oranian littoral, which allowed signaling of the invasion in several stations. Indeed, the seaweed frequented the eastern coasts of Oran beginning in 2011-2012, precisely, the zone of Arzew - Cap Carbon^{26,9}, that welcomed the first fronds of *Caulerpa cylindracea*. Then it extended its geographical repartition area to the center in 2013 precisely in Kristel. In 2014, it reached Ain Türk and Cap Falcon and in 2015 it settled in the western coast of Oran at Bousfer beach, and finally in 2016, it was found in the "Plane" island (Paloma).

The investigations carried out on the Oranian coast have so far been partial; the observations reported in this study provided the dimension of the tasks still to be accomplished. It would be desirable to extend similar research to other stations on the Oranian seaboard on the one hand and on the other hand to rocky and littoral bottoms, to better control and evaluate its dangerous spread in this important and vulnerable zone.

The study also provided interesting reflection on the state of *C. cylindracea* to take measures to signal other invasive species and to propose management of invaded habitats. The scientist will have the heavy task of finding the method(s) to control this invasion, for example, the use of biological control or manual eradication techniques. It is certain that the marine ecosystem has been affected in recent decades by the impact of a growing population and what it generates as exhaustion of natural resources, most often by using non-controlled pressures. Climate change and industrialization are also amplifying the degradation of these ecosystems. Faced with this problem, it appears that the only way to hope preserving ecosystems is to establish follow-ups at different levels of the affected coastline.

References

- 1 Hamel, G. Quelques algues rares ou nouvelles pour la flore méditerranéenne. *Bull. Mus. Nat. Sci. Nat. Paris* 32, (1926) 420.
- 2 Ould-Ahmed, N & Meinesz, A. First record of the invasive alga *Caulerpa racemosa* (Caulerpales, Chlorophyta) on the coast of Algeria. *Cryptogamie. Algologie* 28.3 (2007): 303-305.
- 3 IUCN. IUCN technical guidelines on the management of ex situ populations for conservation. IUCN, Gland, Switzerland (2002).
- 4 Nizamuddin, M. The Green Marine Algae of Libya. Édit. Elga Publisher, Berne, (1991) 227 p.
- 5 Argyrou, M., Demetropoulos, A & Hadjichristophorou, M. Expansion of the macroalga *Caulerpa racemosa* and changes in softbottom macrofaunal assemblages in Moni Bay, Cyprus. *Oceanologica Acta* 22.5 (1999): 517-528.
- 6 Piazza, L & Cinelli, F. Développement et dynamique saisonnière d'un peuplement méditerranéen de l'algue tropicale *Caulerpa racemosa* (Forsskl) J. Agardh. *Cryptogamie Algologie* 20.4 (1999): 295-300.
- 7 Verlaque, M., Boudouresque, C & Meinesz, A. The *Caulerpa racemosa* complex (Caulerpales, Ulvophyceae) in the Mediterranean sea. *Botanica marina* 43.1 (2000): 49-68.
- 8 Klein, J & Verlaque M. The *Caulerpa racemosa* invasion: a critical review. *Marine Pollution Bulletin* 56.2 (2008): 205-225.
- 9 Hussein, K.B. Suivi et évaluation de la structure écologique et biodiversitaire infralittorale de la zone côtière oranaise. These de Doctorat. Université d'Oran1-Algerie (2015).
- 10 Alomar, C., Deudero, S., Andaloro, F., Castriota, L., Consoli, P., Falautano, M & Sinopoli, M. *Caulerpa cylindracea* Sonder invasion modifies trophic niche in infralittoral rocky benthic community. *Marine Environmental Research* . 120 (2016): 86-92.
- 11 Seridi, H. Etude de la flore Algale de l'Algérie. Etude phytosociologique des peuplements algaux photophiles de l'infralittoral superficiel de substrat dur. Diss. 2007.
- 12 Lamouti, S., Rebzani, C & Bacharin, E.I. Répartition de deux espèces introduites à caractère invasif dans la région centre

- de la côte algéroise: *Caulerpa racemosa* et *Oculina patagonica*. *Actes de la Conférence Méditerranéenne Côtière et Maritime*. 2011.
- 13 Bachir Boudjra, B., Belbachir, N., Benkada, M.Y., Maarouf, A & Riadi, H. Sur la présence de l'algue marine *Caulerpa racemosa* (Forsskal) J. Agardh (Caulerpales, Chlorophyta) devant la côte Mostaganemoise (Ouest Algérie). *Acta Botanica Malacitana*, vol. 35, (2010-a) 1-7.
 - 14 Bachir Boudjra, B., Taleb, M.Z., Benkada, M.Y., Maarouf, A., Youcef, M & Riadi, H. First record of the invasive alga *Caulerpa racemosa* (Caulerpales, Chlorophyta) in the Gulf of Arzew (western Algeria). *Aquatic Invasions* 5.1 (2010-b): S97-S101.
 - 15 Altamirano, M., Andreakis, N., Souza-Egipsy, V., Zanolla, M & De la Rosa, J. First record of *Caulerpa cylindracea* (Caulerpaceae, Chlorophyta) in Andalusia (Southern Spain). *Anales del Jardín Botánico de Madrid*. Vol. 71. No. 2. 2014.
 - 16 AEE. Technical report No 16/2012. The impacts of invasive alien species in Europe. *Publications Office of the European Union*, (2012). ISBN 978-92-9213-345-0. 114 pp.
 - 17 Otero, M., Cebrian, E., Francour, P., Galil, B & Savini, D. Surveillance des espèces envahissantes marines dans les aires marines protégées (AMP) méditerranéennes : guide pratique et stratégique à l'attention des gestionnaires. *UICN*. (2013) 136 pages.
 - 18 PNUE-PAM-CAR/ASP. Impact des changements climatiques sur la biodiversité en Mer Méditerranée. Tunis, CAR/ASP. pp.: (2008) 1-62.
 - 19 UNEP/MAP-RAC/SPA. Guide for Risk Analysis assessing the Impacts of the Introduction of Non-indigenous Species. Ed. RAC/SPA, Tunis. (2008) 30 pp
 - 20 Occhipinti-Ambrogi, A., Marchini, G., Cantone, A., Castelli, C., Chimenz, M., Cormaci, C., Frogli, G., Furnari, G., Gambi M.C., Giaccone, G. Giangrande, A., Gravili, C., Mastrototaro, F., Mazziotti, C., Orsi-Relini, L & Piraino, S. Alien species along the Italian coasts: an overview. *Biological Invasions* 13.1 (2011): 215-237.
 - 21 Nugues, M.M, Roberts, C.M. Coral mortality and interaction with algae in relation to sedimentation. *Coral reefs* 22.4 (2003): 507-516.
 - 22 Meinesz, A., Cottalorda, J.M., Chiaverini, D., Garcia, D., Thibaut, T & de Vaugelas J., Suivi de l'expansion de l'algue tropicale *Caulerpa taxifolia* en Méditerranée : situation en France au 31 décembre 2000. LEML (UNSA) publ., Fr. : (2001) 1-74.
 - 23 De Vaugelas, J., Meinesz, A., Antolic, B., Ballesteros, E., Belsher, T., Cassar, N & Grau, A.M. Standardization proposal for the mapping of *Caulerpa taxifolia* expansion in the Mediterranean Sea. *Oceanologica acta* 22.1 (1999): 85-94.
 - 24 Verlaque, M., & Fritayre, P. Modifications des communautés algales méditerranéennes en présence de l'algue envahissante *Caulerpa taxifolia* (Vahl) C. Agardh. *Oceanologica Acta* 17.6 (1994): 659-672.
 - 25 Bentaallah, M.E & Kherfouf, A. Prolifération de *Caulerpa racemosa* in coastal ecosystems of Algeria: current situation and knowledge. *Physio-Géo* 7 (2013): 157-164.
 - 26 Chahrouf, F. Étude de la vitalité des herbiers à *Posidonia oceanica* (L.). Delile de la cote occidentale algérienne. Thèse doctorat, université Oran1, Ahmed Ben Bella. (2013) Algérie.
 - 27 Klein, J & Verlaque, M. The *Caulerpa racemosa* invasion: a critical review. *Marine Pollution Bulletin* 56.2 (2008): 205-225.
 - 28 Vázquez-Luis, M, Sanchez-Jerez, P & Bayle-Sempere, J.T. Comparison between amphipod assemblages associated with *Caulerpa racemosa* var. *cylindracea* and those of other Mediterranean habitats on soft substrate. *Estuarine, Coastal and Shelf Science* 84.2 (2009): 161-170.
 - 29 Piazza, L., Meinesz, A., Verlaque, M., Akc, A., Antolic', B., Argyrou, B., Balata, M., Ballesteros D., Calvo, E., Cinelli, S., Cirik, F., Cossu, S., D'Archino, A., Djellouli, F., Javel, A.S., Lanfranco, F., Mifsud, E., Pala, C., Panayotidis, D., Peirano, P., Pergent, A., Petrocelli, G., Ruitton, A., Z uljevic, S Ceccherelli, A., . Invasion of *Caulerpa racemosa* var. *cylindracea* (Caulerpales, Chlorophyta) in the Mediterranean Sea: an assessment of the spread. *Cryptogamie-Algologie* 26.2 (2005): 189-202.
 - 30 Bensahla Talet, L. Biologie et dynamique de la population du pageot argenté *Pagellus acarne* (Risso, 1827) pêché dans la baie d'Oran. These de Doctorat. Université d'Oran1-Algerie. (2014)
 - 31 Musco, L, Andaloro, F, Mikac, B, Mirto, S, Vega Fernandez, T & Badalamenti F. Concern about the spread of the invader seaweed *Caulerpa taxifolia* var. *distichophylla* (Chlorophyta: Caulerpales) towards the West Mediterranean. (2014).
 - 32 Piazza, L & Ceccherelli, G. Persistence of biological invasion effects: recovery of macroalgal assemblages after removal of *Caulerpa racemosa* var. *cylindracea*. *Estuarine, Coastal and Shelf Science* 68.3 (2006): 455-461.
 - 33 Klein, J. Impact of *Caulerpa racemosa* var. *cylindracea* (Caulerpales, Chlorophyta) on macrophyte assemblages of the north-western Mediterranean Sea. *PhD thesis Marseille: University of Aix-Marseille II* (2007).
 - 34 Klein, J & Verlaque, M. *Caulerpa racemosa* effect on macrophyte assemblages of dead *Posidonia* beds. In: United Nations Environment Programme (Ed.), *Proceedings of the 3rd Mediterranean Symposium on Marine Vegetation*, Marseille, France, 27–29 March 2007. Regional Activity Centre for Specially Protected Areas, Tunis, Tunisia, pp. (2007) 78–2.
 - 35 Baldacconi, R & Corriero, G. Effects of the spread of the alga *Caulerpa racemosa* var. *cylindracea* on the sponge assemblage from coralligenous concretions of the Apulian coast (Ionian Sea, Italy). *Marine Ecology* 30.3 (2009): 337-345.
 - 36 Cantasano, N., Pellicone, G., & Di Martino, V. The spread of *Caulerpa cylindracea* in Calabria (Italy) and the effects of shipping activities. *Ocean & Coastal Management* 144 (2017): 51-58.
 - 37 Box, A., Deudero, S., Sureda, A., Blanco, A., Alòs, J., Terrados, J & Riera, F. Diet and physiological responses of *Spondyllosoma cantharus* (Linnaeus, 1758) to the *Caulerpa racemosa* var. *cylindracea* invasion. *Journal of Experimental Marine Biology and Ecology* 380.1 (2009): 11-19.
 - 38 Gennaro, P., & Piazza, L. The indirect role of nutrients in enhancing the invasion of *Caulerpa racemosa* var. *cylindracea*. *Biological invasions* 16.8 (2014): 1709-1717.
 - 39 Ceccherelli, G., & Piazza, L. Exploring the success of manual eradication of *Caulerpa racemosa* var. *cylindracea* (Caulerpales, Chlorophyta): the effect of habitat. *Cryptogamie. Algologie* 26.3 (2005): 319-328.

- 40 Ruitton, S., Verlaque, M., Aubin, G & Boudouresque, C. F. Grazing on *Caulerpa racemosa* var. *cyllindracea* (Caulerpales, Chlorophyta) in the Mediterranean Sea by herbivorous fishes and sea urchins. *Vie et Milieu* 56.1 (2006): 33-42.
- 41 Zuljevic, A., Nikoloic, V., Onofri, V., Srsen, P., Tefan, A. A., Kruzic, P & Petric, M. Eradication of invasive alga *Caulerpa racemosa* var. *cyllindracea* in national park Mljet (Croatia). *CIESM Congress Proceedings. No. 38. CIESM*, Monaco, (2007).
- 42 Walker, D. I & Kendrick, G. A. Threats to macroalgal diversity: marine habitat destruction and fragmentation, pollution and introduced species. *Botanica marina* 41. 1-6 (1998): 105-112.



Age, Growth and Mortality of the Common Carp (*Cyprinus carpio*) Population in Merdja Sidi Abed Dam, Algeria.

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ABSTRACT

We tried to estimate age, growth parameters, condition factor, length-weight relationship and mortality rates (Z , M , and F) of the common carp in Merdja Sidi Abed dam. *Cyprinus carpio* specimens were captured by long line between April and June 2013 in Merdja Sidi Abed. 220 individuals were collected and weights ranged between 265.5 and 620.3 g while the total length ranged between 26.3 and 35.6 cm. Length-converted catch curve was used to estimate total annual instantaneous mortality rates (Z), natural mortality was calculated using Pauly formula [$\ln(M) = -0.0152 - 0.279 \ln(L_\infty) + 0.6543 \ln(K) + 0.463 \ln(T)$]. Recruitment patterns were determined from the routine implemented in FISAT II. For all individuals ($n = 220$) of the common carp, the relationship between total length and body weight was: $W = 0.0384 L^{2.70}$ ($r^2 = 0.906$) for females and $W = 0.0467 L^{2.653}$ ($r^2 = 0.976$) for males a minor allometry was found for this species, mean condition factor K was estimated at 1.41. The maximum value of recruitment was recorded in March-April period with 19.56 and 15.20% respectively. The Battacharya method was used to estimate age of individuals that was comprised between 1 and years 3. The equation of Von Bertalanffy growth was: $L = 36.75 [1 - e^{-0.46(t + 0.33)}]$ for all the population. Total mortality (Z), natural mortality (M) and fishing mortality (F) were as follows: $Z = 1.08$, $M = 0.82$, $F = 0.26 \text{ yr}^{-1}$ while exploitation ratio (E) was evaluated at 0.24 indicating an under exploitation of this local resource.

Keywords: Common carp, *Cyprinus carpio*, Sidi Abed dam, age, growth, fisheries.

1. Introduction

The common carp (*Cyprinus carpio* L. 1758) belongs to a family Cyprinidae of order Cypriniformes is a freshwater species inhabiting warm, deep, slow-flowing and still waters such as lowland rivers and large, well vegetated lakes (Kottelat and Freyhof 2007). Hardy and tolerant of a wide variety of conditions but generally favor large water bodies with slow flowing or standing water and soft bottom sediments. Thrive in large turbid rivers (Scott and Crossman 1998). Most active at dusk and dawn. Both adults and juveniles feed on a variety of benthic organisms and plant material. Common carps (*Cyprinus carpio*) are frequently cultured and are of great commercial value as a

food fish both over their native and introduced range (Aguirre and Poss, 2000).

It is known to be a non-native fresh water species in Algeria, its first introduction dates from 1860 (Dieuzeide and Roland, 1951). It has been chosen as an ideal candidate for repopulating Algerian wetlands given its easy adaptation to a large variety of aquatic environments (dams, lakes, reservoirs).

Scarce data exist on the common carp from the south side of the mediterranean basin and especially from Algeria except works of Hadjlaoui *et al.*, 2016 on Tunisian carp, Tandjir and Djebar 2008 focusing on general traits of carpiculture in Algeria, Kara 2012 focusing on fresh water fish biodiversity and Mimeche *et al.*,

2015 describing the growth of this species for Eastern Algeria, the aim of our study is to give primary results on age, growth and exploitation of this cyprinid in order to adopt the appropriate management for its conservation.

2. Material and Methods

Common carp *Cyprinus carpio* (Linnaeus 1758) specimens were captured by long line between April and June 2013 in Merdja Sidi abed dam (figure 1) in Wilaya (district) of Ghelizane (36°00'12"N, 1°00'37"E). Total length (L) was measured with an ichthyometer to the

nearest 0.1 cm and total weight (W) weighed with 1 g precision digital scale. Length-weight relationship was calculated as follows:

$$W=aL^b \text{ (Ricker, 1973).}$$

where " W " is the body weight (g) and " L " is the total body length (cm), " b " is the regression coefficient and " a " is the regression constant. A Student's t-test (Zar, 1999) was used to test the difference of the parameter " b " from the theoretical value of 3.

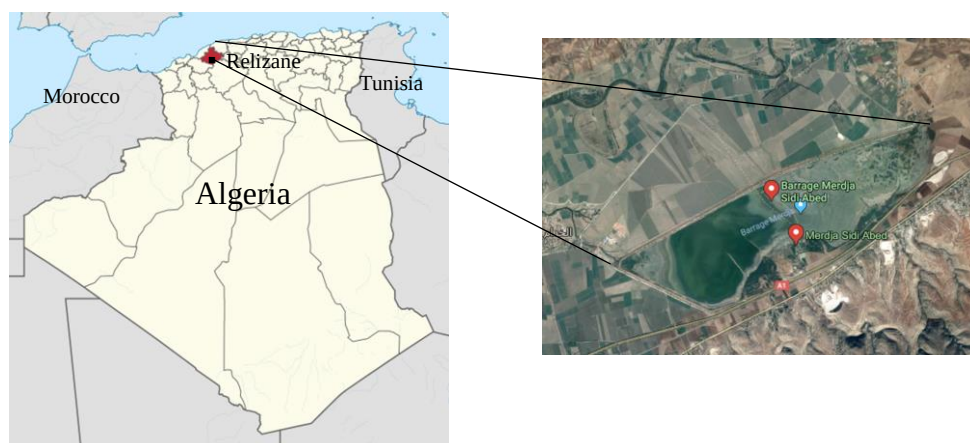


Figure 1. Study area (googlemap 2018, modified).

Fulton's condition factor calculated as follows:

$$C=(W*100)/L^3 \text{ (Fulton, 1904).}$$

where " W " is the body weight (g) and " L " is the total body length (cm).

The Von Bertalanffy growth function was used to describe the growth of this Cyprinidae. The Battacharya method was employed to determine age of individuals. Bhattacharya's method, distinguishing parameters with normal distribution from a combined distribution pattern (Sparre and Venema 1992) was used for splitting composite distributions for fish length distributions into separate normal distributions, applicable to cohorts. Length-

converted catch curve was used to estimate total annual instantaneous mortality rates (Z), natural mortality was calculated using Pauly formula [$\ln(M) = -0.0152 - 0.279 \ln(L_{\infty}) + 0.6543 \ln(K) + 0.463 \ln(T)$] K : growth coefficient; T : annual mean water temperature (°C); Recruitment patterns were determined from the routine implemented in FISAT II; and fishing mortality deducted from the Equation:

$$F=Z-M. \text{ (Pauly, 1984).}$$

3. Results

The length frequency distribution of 220 fish is shown in Table 1. The total length of individuals ranged from 17 to 47.8 cm, while the weight ranged from 72 to 1275.2 g.

Table 1. Maximum and minimum values of the total length and total weight for males, females and undetermined of *C. carpio* off Merdja Sidi Abed, Algeria.

	Total length (cm)		Total weight (g)	
	Minimum	Maximum	Minimum	Maximum
Males	17	46.2	72	1180
Females	18.2	47.8	89.9	1275.2
undetermined	13.8	40.9	41	170.9

The length–weight relationships (Table 2) were calculated as $W = 0.0252L^{2.8014}$ ($r^2 = 0.9928$) for females, $W = 0.0178L^{2.9015}$ ($r^2 = 0.9905$) for males and $W = 0.0197L^{2.8704}$ ($r^2 = 0.9936$) for all specimens showing negative allometric growth. The parameter “b” of length–weight relationships was significantly different from 3

($t = 3.58 > t_{0.05, 220} = 1.65$) while condition factor was calculated as 1.62 for males and as 1.76 for females.

Bhattacharya's analysis of length frequencies (Figure 2) of *Cyprinus carpio* specimens allowed us to distinguish 2 cohorts for the both sexes summarized in (Table 3.)

Table 2. Parameters of the length–weight relationship for males, females and all *C. carpio* off merdja Sidi Abed and isometry tested by Student t-test* ($t > t_{0.05, n > 200} = 1.96$).

	a	b	s.d (b)	n	r ²	t-test
Males	0.0178	2.90	0.023	74	0.99	4.69*
Females	0.0252	2.80	0.023	98	0.99	8.58*
All fish	0.0198	2.87	0.025	220	0.99	3.58*

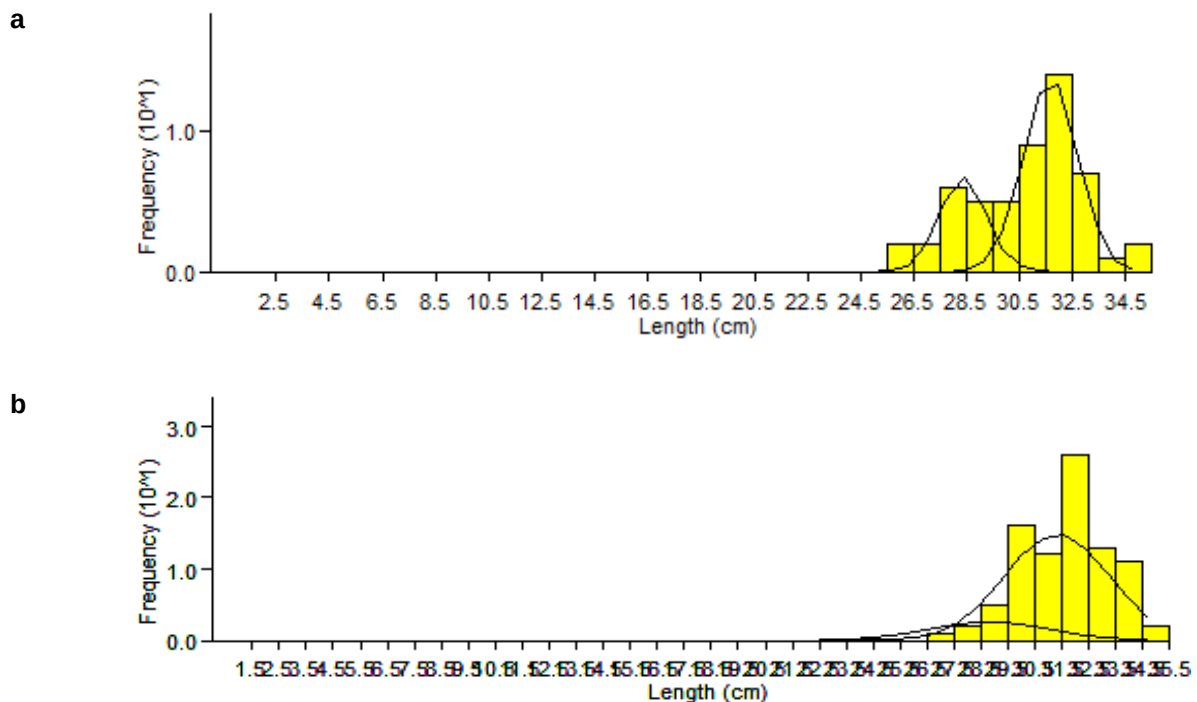


Figure 2. Total length-frequency distribution for *C. carpio* caught in Merdjet sidi abed dam: **a)** males, **b)** females separated into two length groups (cohorts) by Bhattacharya's method.

Table 3. Length-age key for the common carp, of *C. carpio* caught in Merdja sidi Abed dam calculated by Bhattacharya's method.

Age group	Males	Females
1	28.6±0.88 cm	28.83±2.21 cm
2	31.66±1.02 cm	31.30±1.93 cm

Table 4. Parameters of the von Bertalanffy growth equation for males, females and all *C. carpio* off merdjet Sidi Abed.

	<i>n</i>	<i>L_∞</i> (mm)	<i>k</i> (year ⁻¹)	<i>t₀</i> (year)	<i>Z</i>	<i>M</i>	<i>F</i>	<i>E</i>
Males	74	36.75	0.35	-0.44	0.85	0.67	0.18	0.21
Females	98	36.75	0.46	-0.33	0.89	0.81	0.08	0.09
All fish	220	36.75	0.46	-0.33	1.08	0.82	0.26	0.24

Von Bertalanffy's growth curve parameters for males, females and all fish were calculated and are shown in Table 4. Total mortality rate (*Z*) for all samples was 1.08 year⁻¹. The annual mean water temperature at the study locality was 17°C. Thus, natural mortality rate (*M*) was estimated as 0.82 year⁻¹. Fishing mortality rate (*F*) was found to be 0.26 year⁻¹. The exploitation rate (*E*) was calculated as 0.24 year⁻¹.

4. Discussion

The exponent *b* of the length-weight relationships in each sex (*b* = 2.9 for females, *b* = 2.8 for males) showed that weight increased with length in negative allometry which agrees with the majority of works done on this cyprinid and *b* factor varied between 2.66 and 2.93 (table 4) while positive allometry was found for this species in Almus Dam Lake (Karataş *et al.*, 2007) and Hatay province (Özcan, 2008).

In fact, as fish grows, changes in weight are relatively greater than changes in length. The *b* values in fish differ according to species, sex, age, seasons and feeding (Ricker 1975; Bagenal and Tesch, 1978). In addition, changes in fish shape, physiological conditions, different amounts of food available, life span or growth increments can all affect the *b* growth exponent (Frost 1945; Treer *et al.*, 1998, 1999; Koç *et al.*, 2007). Changes in fish shape, physiological changes, hydrological environmental conditions, different food availability during life span, growth increment can all affect growth exponent *b* (Sinovčić, 2000).

The Bhattacharya's method determined only two cohorts while in other studies age varied between 5 and 14 determined from scale or otoliths readings. this analysis method needs a sufficient number of individuals in every age group. however, only 220 individuals were available for our study and age should be determined by otolithometry or scalimetry.

L_∞ and *K* values in relevant literature are shown in table 5. In our estimations, the asymptotic length of *C. carpio* was *L_∞*=36.75 and *K* value was 0.46 for all individuals, indicating a relatively fast growing speed in Merdjet Sidi Abed as found in some studies in India in Thirumoorthy Reservoir (*K*=0.958, Palaniswamy *et al.*, 2011) and Iran in Mangla reservoir (*K*=0.6, Mirza *et al.*, 2012) which is not the case for other studies where *K* factor was comprised between 0.0754 and 0.28 year⁻¹. Our findings in *CF* are lower than those estimated in the literature (Table 3).

In Merdjet sidi abed *C. carpio* grows relatively fast during the first years of life with a *K* constant higher than other regions (Table 5) as noticed by Palaniswamy *et al.*, 2011 in India while in other studies this parameter reflects a slow growth of the species.

The length-converted catch curve gave a rate of total mortality (*Z*=1.08) which is in accordance to results shown in table 5, natural mortality (*M*) was evaluated at 0.82 with Pauly empiric formula with a mean annual habitat of 17°C which is similar to works done on the same species (Mirza *et al.*, 2012) in Pakistan and greater than other studies.

Table 4. Length - weight relationships for *C. carpio* in several studies, based on $W=aL^b$ (weight in g, length in cm)

	Locality	Sex	n	a	b	s.e (b)	r ²	Author
Iran	Caspian sea	M	130	0.00004	2.84	-	0.97	Fatemi <i>et al.</i> , 2009
		F	198	0.00004	2.82		0.98	
		C	2090	0.03140	2.84	0.017	0.93	Moradinasab <i>et al.</i> , 2012
		F	151	0.00700	3.21	-	-	
		C	604	0.02500	2.90	-	0.92	Sedaghat <i>et al.</i> , 2013
Turkey	Gölhisar Lake	F	350	0.02580	2.86	-	-	Alp and Balik. 2000
		M	324	0.02430	2.88	-	-	
	Karamik Lake	C	108	0.02450	2.92	0.031	0.99	Balik <i>et al.</i> , 2006
	Liman Lake	C	288	0.02830	2.87	-	0.96	Demirkalp 2007a
		M	121	0.02890	2.86	-	-	
		F	141	0.02820	2.87	-	-	
	Çernek Lake	C	364	0.05470	2.66	-	0.95	Demirkalp 2007b
	Almus Dam Lake	C	308	0.00490	3.31	-	0.94	Karataş <i>et al.</i> , 2007
	Hatay province	C	95	0.02100	3.11	0.176	0.98	Özcan 2008
	Lake Işıklı	C	158	0.03500	2.84	-	-	Yağcı <i>et al.</i> , 2008
	Damsa Dam Lake	C	160	0.02190	2.90	0.900	0.96	Mert and Bulut. 2014
	Mogan Lake	M	180	0.00004	2.87	-	0.94	Saylar and Benzer.
		F	168	0.000080	2.70	-	0.94	
South Africa	Lake Gariep	C	566	0.000053	2.829	-	0.97	Winker <i>et al.</i> , 2011
Romania	Brăila Island	C	367	0.027100	2.84	-	0.97	Gheorghe <i>et al.</i> , 2011
Tunisia	Sidi Saâd dam	C	2285	0.08600	2.93	-	0.97	Hajlaoui <i>et al.</i> , 2016
Algeria	Ain zada reservoir	C	114	0.09100	2.43	0.050	0.95	Mimeche <i>et al.</i> , 2013
	K'sob reservoir	C	150	0.04400	2.66	0.060	0.92	Mimeche <i>et al.</i> , 2015
	Merdja Sidi Abed	C	220	0.01970	2.87	0.026	0.99	Present study
		M	74	0.01780	2.90	0.023	0.99	
		F	98	0.02520	2.80	0.023	0.99	

A low fishing mortality (*F*) factor was found $F=0.26$ as mentioned by other authors (Table 5) (Balik *et al.*, 2006; Karataş *et al.*, 2007; Winker *et al.*, 2011; Mirza *et al.*, 2012; Tesfaye and Wolff. 2015) may be due to the absence of commercial fishing in Merdjjet sidi abed.

A suggested by Gulland (1971) the exploitation ratio quite equal to 0.50 reflect an equilibrated situation of the exploited stock which is the case of Almus Dam Lake *C. carpio*

population (Karataş *et al.*, 2007). In other studies, this ratio exceeded 0.5 reflecting signs of over exploitation (Alp and Balik. 2000; Balik *et al.*, 2006; Palaniswamy *et al.*, 2011; Njiru *et al.*, 2008; Fatemi *et al.*, 2009) while our findings ($E=0.24$) are similar to those done in Lake Gariep (Winker *et al.*, 2011), Koka Lake (Tesfaye and Wolff. 2015), Mangla reservoir (Mirza *et al.*, 2012) exhibiting an under exploitation of the resource probably due the presence one fishing gear (long lines).

Table 5. Parameters of the von Bertalanffy growth equation, Total (Z), natural (M) and fishing (F) mortality rate and the exploitation ratio (E) for males, females and all *C. carpio* in several studies

Locality		n	L_{∞}	K	t_0	Age	k	Z	M	F	E	Author
Turkey	Golhisar Lake	693	72.76	0.1723	-0.44	6	1.84	1.36	0.35	1.01	0.74	Alp and Balik. 2000
	Karamık Lake	108	130	0.0754	-0.24	10	2.02	0.40	0.16	0.24	0.6	Balik <i>et al.</i> , 2006
	Almus Dam Lake	308	46.39	0.153	-1.92	7	1.33	0.64	0.32	0.32	0.5	Karataş <i>et al.</i> , 2007
	Lake Işikli	152	108.4	0.101	-0.22	14	1.92	-	-	-	-	Yağcı <i>et al.</i> , 2008
	Damsa Dam Lake	160	88.45	0.168	0.583	8	1.58	-	-	-	-	Mert and Bulut. 2014
	Mogan Lake	180	49.06	0.25	-1.44	6	1.99	-	-	-	-	Saylar and Benzer. 2014
		168	49.60	0.24	-1.74	6	1.99	-	-	-	-	
South Africa	Lake Gariep	566	62.58	0.16	0.39	7	-	0.82	0.6	0.12	0.14	Winker <i>et al.</i> , 2011
India	Thirumoorthy Reservoir	1370	58.6	0.958	-0.95	12	-	2.12	0.70	1.41	0.66	Palaniswamy <i>et al.</i> , 2011
Kenya	Naivasha lake	-	60.8	0.14		-	-			0.81	0.65	Njiru <i>et al.</i> , 2008
Ethiopia	Koka Lake	6139	74.1	0.28	-0.46	-	-	0.83	0.55	0.28	0.33	Tesfaye and Wolff. 2015
Iran	S.Caspian Sea	328	72.0	0.18		10	-	0.71	0.29	0.42	0.59	Fatemi <i>et al.</i> , 2009
Croatia	Vransko Lake	70	8197	0.122	-0.81	11	1.62	-	-	-	-	Treer <i>et al.</i> , 2003
Pakistan		1018										
	Mangla reservoir	2	80.33	0.60	-0.39	-	-	1.22	0.89	0.33	0.27	Mirza <i>et al.</i> , 2012
Romania	Brăila Island	367	84.7	0.161	-0.81	-	-	-	-	-	-	Gheorghe <i>et al.</i> , 2011
New Zealand	Whangamarino River	566	67.5	0.21	0.15	12	-	-	-	-	-	Tempero <i>et al.</i> , 2006
Algeria	Merdjet Sidi Abed Dam	220	36.75	0.46	-0.33	2	1.4	1.08	0.82	0.26	0.24	Present study

In Merdjat sidi abed *C. carpio* population seems to be under exploited and the actual fishing effort estimated should be increased in response to a growing ichthyophagous population. Also, other appropriate fishing techniques or gears should be employed to capture this *Cyprinidae* without endangering the actual population or harm this stable ecosystem.

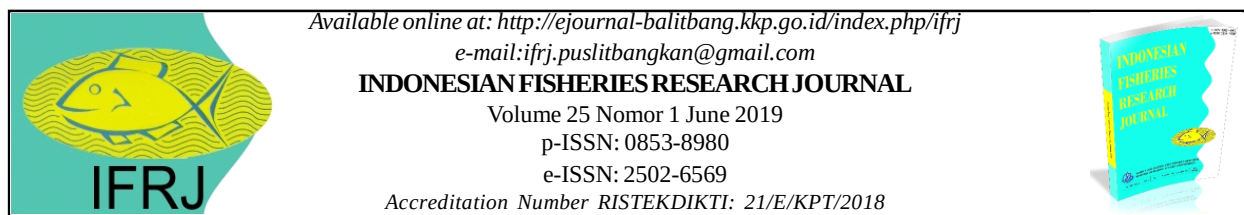
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References

- Aguirre, W., Poss, S.G. 2000. *Cyprinus carpio* Linnaeus, 1758. Non-Indigenous Species in the Gulf of Mexico Ecosystem - Gulf States Marine Fisheries Commission (GSMFC). Accessed October 20, 2016 in <http://www.dpi.nsw.gov.au/fisheries/pests-diseases/freshwater-pests/species/carp/general-information>.
- Alp, A., Balik, S. 2000. Growth conditions and stock analysis of the carp (*Cyprinus carpio*, Linnaeus 1758) population in Gölhisar Lake. *Turk J Zool*, 24(3), 291-304.
- Bagenal, T.B., Tesch, F.W. 1978. Age and Growth. In: Methods for Assessment of Fish production in Freshwater. (Ed. T.B. Bagenal) 3rd ed. IBP Handbook, Blackwell, Oxford, pp. 93-130.
- Balik, İ., Çubuk, H., Özkök, R., Uysal, R. 2006. Some characteristics and size of carp (*Cyprinus carpio* L., 1758) population in the Lake Karamık (Afyonkarahisar/Turkey). *Turk J Fish Aquat Sc*, 6: 117-122 (2006)
- Demirkalp, F.Y. 2007a. Growth characteristics of carp (*Cyprinus carpio* L., 1758) in Liman Lake (Samsun, Turkey). *Hacettepe J Biol Chem*, 35(1), 1-8.
- Demirkalp, F.Y. 2007b. Some of the growth characteristics of Carp (*Cyprinus carpio* L., 1758) in Çernek Lake (Samsun, Turkey). *Twenty-second Annual Report, Part III. Fisheries Board of Scotland, Edinburgh*, pp. 141-241.
- Gheorghe, D.C., Răzlog, G.P., Cristea, V., Enache, I. 2011. The growth characteristics of common carp (*Cyprinus carpio*) in the northern part of the Small Island of Brăila Natural Park. *AACL Bioflux*, 4(2), 154-158.
- Hajlaoui, W., Mili, S., Troudi, D., Missaoui, H. 2016. étude de la biologie de reproduction chez la carpe commune *Cyprinus carpio* communis pêchée dans la retenue du barrage de sidi saad (centre de la tunisie). *Bull Soc zool Fr*, 141(1), 25-39.
- Kara, H.M. 2012. Freshwater fish diversity in Algeria with emphasis on alien species. *Eur J Wildl Res* (2012) 58:243-253. <https://doi.org/10.1007/s10344-011-0570-6>
- Karataş, M., Çiçek, E., Baştusta, A., Baştusta, N. 2007. Age, Growth and Mortality of Common Carp (*Cyprinus carpio*, Linnaeus, 1758) Population in Almus Dam Lake (Tokat- Turkey). *J App Biol Sci*. 1(3): 81-85, 2007
- Koç, H.T., Erdoğan, Z., Tinkci, M., Treer, T. 2007. Age, growth and reproductive characteristics of chub, *Leuciscus cephalus* (L., 1758) in the İkizcetepeler dam lake (Balıkesir), Turkey. *J App Ichthyol*, 23(1), 19-24. <https://doi.org/10.1111/j.1439-0426.2006.00787.x>
- Kottelat, M., Freyhof, J. 2007. Handbook of European freshwater fishes. Publications Kottelat, Cornol and Freyhof, Berlin. 646 pp. In [<http://www.fishbase.se/summary/Cyprinus-carpio.html>].
- Mert, R., Bulut, S. 2014. Some biological properties of carp (*Cyprinus carpio* L., 1758) introduced into Damsa Dam Lake, Cappadocia Region, Turkey. *Pak J Zool*, 46(2), 337-346.
- Mimeche, F., Biche, M., Ruiz-Navarro, A., Oliva-Paterna, F.J. 2013. The population structure, age and growth of *Luciobarbus callensis* (Cyprinidae) in a man-made lake in the Maghreb (NE Algeria). *Limnetica*, 32(2), 391-404.
- Mimeche, F., Belhamra, M., Mimeche, H. 2015. growth parameters of *Cyprinus carpio* linnaeus, 1758 (Cyprinidae) in the k'sob reservoir in m'sila (Algeria). *Courrier du Savoir*. N°19, Mars 2015, pp.59-64.
- Mirza, Z.S., Nadeem, M.S., Beg, M.A., Qayyum, M. 2012. population status and biological characteristics of common carp, *Cyprinus carpio*, in mangla reservoir (Pakistan). *JAPS, J Ani Plant Sci*, 22(4), 933-938.
- Moradinasab, G.H., Raeisi, H., Paighambari S.Y., Ghorbani, R., Bibak, Z. 2012.

- Length-weight relationships, relative condition factor and relative weight of three fish species from beach seine fishing grounds in Iranian coastal waters of Caspian Sea. *Scientific Research and Essays*. Vol. 7(18), 1809-1812. <https://doi.org/10.5897/SRE12.255>
- Njiru, M., Ojuok, J.E., Ngugi, C., Morara, G., Mugo, J. 2008. Does seasonal closure have effect on fishery?: the case of common carp, *Cyprinus carpio* L in Lake Naivasha, Kenya. In *Proceedings of Taal 2007: The 12th World Lake Conference* (Vol. 137, p. 140).
- Özcan, G. 2008. Length-weight relationships for seven freshwater fishes caught in Kemer reservoir, Turkey. *J App Ichthyol*, 24(3), 337-338. <https://doi.org/10.3153/jfscm.2008005>
- Palaniswamy, R., Manoharan, S., Geethalakshmi, V. 2011. Assessment of population parameters of Indian major carps and common carp in a culture based reservoir. *Indian J Fish*, 58(2) : 41-44, 2011
- Ricker, W.E. 1973. Linear regressions in fishery research. *J Fish Res Board Can*. 30: 409-434.
- Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. *Bull Fish Res Bd Can*, 191,1-382.
- Saylar, Ö., Benzer, S. 2014. Age and growth characteristics of carp (*Cyprinus carpio* L., 1758) in Mogan Lake, Ankara, Turkey. *Pak J Zool*, 46(5), 1447-1453.
- Scott, W., Crossman, E.J. 1998. Freshwater fishes of Canada. Oakville (Ontario, Canada): Galt House Publications. xx+966 p [in <http://www.fishbase.se/summary/Cyprinus-carpio.html>].
- Sedaghat, S., Hoseini S.A., Larijani, M., Shamekhi Ranjbar, K. 2013. Age and Growth of Common Carp (*Cyprinus carpio*, Linnaeus, 1758) in Southern Caspian Sea, Iran. *World J Fish Mar Sci* 5(1): 71-73, 2013. <https://doi.org/10.5829/idosi.wjfm.2013.05.01.64124>
- Sinovčić, G. 2000. Anchovy, *Engraulis encrasicolus* (Linnaeus, 1758) biology, population dynamics and fisheries case study. *Acta Adriat*, 1(41), 3-53.
- Sparre, P., Venema, S. 1992. Introduction to tropical fish stock assessment. Part 1 - Manual. FAO Fish Tech Pap. 306/1 Rev. 1. FAO Rome.
- Tandjir, L., Djebbar, A.B. 2008. Carpiculture au barrage guenitra (Skikda, Algerie). *Sci Tech C – N°29 juin* (2009), pp.30-34.
- Tempero, G.W., Ling N., Hicks, B.J., Osborne, M.W. 2006. Age composition, growth, and reproduction of koi carp (*Cyprinus carpio*) in the lower Waikato region, New Zealand. *New Zeal J Mar Fresh*, 40(4), 571-583.
- Tesfaye, G., Wolff, M. 2015. Stock assessment of fishery target species in Lake Koka, Ethiopia. *Rev biol trop*, 63(3), 755-770.
- Treer, T., Habeković, D., Safner, R., Aničić, I., Kolak, A. 1998. growth of pike (*Eso lucius* L.) in croatian reservoir kruscica. *Ribarstvo*, 56(3), 85-90.
- Treer, T., Habeković, D., Safner, R., Kolak, A., Aničić, I. 1999. Length-mass relationship in chub (*Leuciscus cephalus*) from five Croatian rivers. *Agr Cons Sci*, 64(2), 137-142.
- Treer, T., Varga B., Safner, R., Aničić, I., Piria, M., Odak, T. 2003. Growth of the common carp (*Cyprinus carpio*) introduced into the Mediterranean Vransko Lake. *J App Ich*, 19(6), 383-386. <https://doi.org/10.1111/j.1439-0426.2003.00475.x>
- Winker, H. 2011. Life history and population dynamics of invasive common carp, *Cyprinus carpio*, within a large turbid African impoundment. *Mar Fresh Res*, 2011, 62, 1270-1280
- Yağcı, M.A., Alp, A., Yeğen, V., Uysal, R., Yağcı, A., Ceylan, M. 2008. Işıklı Gölü'ndeki (Çivril-Denizli) sazan populasyonu (*Cyprinus carpio* L., 1758)'nun büyüme özellikleri. *Ege Üniversitesi Su Ürünleri Dergisi/Ege Univ J Fish Aquat Sci*, 25, 337-341.
- Zar, J.H. 1999. Biostatistical Analysis, 4th ed. Prentice-Hall, New Jersey. Turkey. *Hacettepe J Biol Chem*, 35, 57-65.
- Dieuzeide, R., Rolland, J. 1951. Le laboratoire d'hydrobiologie et de pisciculture d'eau douce du Mazafran. *Bull Stat Aquic Pêche Castiglione* 3:190-207.
- Fatemi, S.M., Kaymaram, F., Jamili, S., Taghavi Motlagh, S.A., Ghasemi, S. 2009. Estimation of growth parameters and mortality rate of common carp (*Cyprinus carpio*), Linnaeus 1758) population in the southern Caspian Sea. *Iran J Fish Sci*. 8(2) 127-140
- Frost, W.E. 1945. The age and growth of eels (*Anguilla anguilla*) from the Windermere catchment area. *J Ani Ecol*, 106-124.



NEW RECORD OF GIANT DEVIL RAY (CHONDRICHTHYES: MYLIOBATIDAE) FROM ORAN BAY (WESTERN MEDITERRANEAN SEA)

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ABSTRACT

The present paper reports a new record of Giant devil ray *Mobula mobular* (Bonnaterre, 1788) from western Algerian waters that is encountered for the first time in that coast since its first description in 1901 and last observation in late 80's. This elasmobranch is categorized as endangered on the IUCN Red List (Endangered A2d ver 3.1) and is likely to be the rarest of the nine species of *Mobula* genus. Occasionally it is captured in Mediterranean Sea by purse seines, bottom and pelagic trawls, pelagic nets, bottom longlines, drifters and harpoons. The specimen stranded in "la Madrague Beach" in Western Algerian coasts. Its disc length was measuring 108.96 cm and disc width was 226.02 cm. This Myliobatidae is rarely seen with daily landed fish at Oran fishery. Up to date no explicit reason can be given for the strand of *M. mobular* but ghost fishing and important maritime traffic stay the most plausible cause of this incident.

Keywords: Myliobatidae; Morphometric measurements; Western Mediterranean; Oran Bay; Algeria

INTRODUCTION

Mobula mobular is a semi-pelagic or pelagic over the continental shelf; gregarious; met often near the surface, swimming in vertical undulations from its broad pectoral fins, occasionally jumping out of the water, but also floating motionless; can also rest on the bottom (Fischer *et al.*, 1987). Satellite tag data for three *M. mobular* individuals in the Messina Strait, central Mediterranean Sea, have shown that they spent >80% of their time within the upper 50 m of the water column and dived to 700 m depth (Canese *et al.*, 2011). *Mobula mobular* is aplacental viviparous (one or two embryos). Feeds on small planktonic fish and crustaceans filtered through its gill plates (Abudaya *et al.*, 2017).

Also, this species is categorized as endangered on the IUCN Red List (Endangered A2d ver 3.1) and is likely to be the rarest of the nine species of *Mobula* genus (Notarbartolo di Sciara *et al.*, 2015). Occasionally it is captured in Mediterranean Sea by purse seines, bottom and pelagic trawls, pelagic nets, bottom longlines, drifters and harpoons (FAO, 2009).

Algeria, Greece, Italy, Spain, Tunisia, Turkey and Ukraine are together responsible for slightly more than 80 % of total landings in the Mediterranean and the

Black Sea. Between the year 2000 and 2013: 115 400 t were landed in Algerian fisheries occupying the third place after Italy 249 500t and Turkey 459 400 t (FAO, 2016). The ranking of capture fisheries production in 2014 and 2016 total catches continued to be dominated by Turkey: 321 800 t (26 % of total landings), followed by Italy: 185 300 t (16%), Algeria: 96 300 t (8%) and Greece: 65 700 t (5%) (FAO, 2018).

In the western Mediterranean, landings by weight are dominated by Algeria (37 %), Spain (29 %) and Italy (19 %), which account for 85 percent of all landings in the sub region, followed by Morocco (10 %) and France (5 %). approximately 30 % of total revenue in the region. Turkey, Egypt, Spain, Tunisia, Greece and Algeria, in addition to Italy, remain the countries producing the highest revenue from fisheries in the GFCM (General Fisheries Commission for the Mediterranean) area of application (FAO, 2018).

Incidental catches of vulnerable species as *M. mobular* taken as by-catch in many fisheries can be highly correlated to a recent report of the FAO concerning the state of Mediterranean and Black Sea Fisheries (FAO, 2016) stating that in those areas, a discard value corresponding to 20-35 % of total catch has been calculated (Sartor *et al.*, 2003; EU, 2011; Piroddi *et al.*, 2014 in FAO, 2016). The trawling discard

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rate for the French Mediterranean was estimated between 27 and 40 % (Ifremer, 2010; Bultel *et al.*, 2015 in FAO, 2016). In Morocco, trawler fisheries (mainly catching cephalopods and/or shrimp) are associated with higher rates of discards: between 12 and 46 % (Kelleher, 2005; Belhabib *et al.*, 2013 in FAO, 2016). In Algeria, high values of discards of up to 50 %, mainly related to the shrimp fishery, have also been recorded (Bouaicha, 2011; Belhabib *et al.*, 2013 in FAO, 2016) and for pelagic trawl landing values accounted for around 20% in 2010 (MPRH, 2011). In the Turkish and Bulgaria Black Sea, discard rates for pelagic trawls are estimated to be around 5.1 % of total catch (Kelleher, 2005; Keskin *et al.*, 2015 in FAO, 2016).

Despite the increasing catches worldwide, dramatic declines in mobulid catches have been documented in some areas, suggesting serial depletions through over-fishing. Mobulids are caught as by-catch in purse-seine and trawl fisheries as well as netting programs (e.g. Philippines: Alava *et al.*, 2002 in Couturier *et al.*, 2012). As a result, harmonized methodologies for data collection on discards (FAO, 2018d in FAO, 2018) and incidental catches of vulnerable species (FAO, 2018e in FAO, 2018) were produced to support the implementation of the bycatch monitoring program, which was first launched in seven countries (Algeria, Lebanon, Montenegro, Morocco, Tunisia, Turkey and Ukraine) and included training of onboard observers and, as appropriate, the development of awareness material (FAO, 2018).

Although early historical accounts painted devil and manta rays as 'diabolical creatures' and 'ferocious brutes', accusing them of stealing boats and deliberately killing divers (Gill, 1908; Saenz-Arroyo *et al.*, 2006), it is now known that these rays are harmless to humans and feed mainly on zooplankton. Fisheries for mobulids are considered to be unsustainable because of large, directed catches coupled with the low fecundity and conservative life history of this group. Estimates of the world global catch of mobulids have increased from 900 t in 2000 to >3300 t in 2007 (FAO, 2009; Lack & Sant, 2009 in Couturier *et al.*, 2012).

Although mobulids have been recorded for over 400 years, critical knowledge gaps still compromise the ability to assess the status of these species. There has been a marked increase in the number of published studies on mobulids since 1990, particularly for the genus *Manta*, although the genus *Mobula* remains poorly understood (Couturier *et al.*, 2012). Literature

reports works on this Myliobatidae in Mediterranean: Notarbartolo-di-Sciara, 1987; Bustamante *et al.*, 2016 on systematics; Bradai & Capapé, 2001; Celona, 2004; Correia *et al.*, 2008; Scacco *et al.*, 2009; Bello *et al.*, 2012; Holcer *et al.*, 2012; Yaglioglu *et al.*, 2013; Fortuna *et al.*, 2014; Ba'usta & Özbek, 2017; Abudaya *et al.*, 2017 on occurrence and fisheries, Canese *et al.*, 2011; Couturier *et al.*, 2012; 2013; Notarbartolo di Sciara *et al.*, 2015; Duffy & Tindale, 2018; Sakalli, 2017 on ecobiology and behaviour of *M. mobular*. For Algerian waters works are limited to old descriptions of Pellegrin, 1901; Dieuzeide *et al.*, 1953 also McEachran & Capape, 1984; Fisher *et al.*, 1987 and works of Hemida *et al.*, 2002 on *Mobula mobular* and Hemida *et al.*, 2016 on *Mobula japanica* in central Algerian waters so our observation is reporting the presence of this Myliobatidae in that part of the Mediterranean not observed for more than 30 years.

MATERIALS AND METHODS

On 5th September 2017 a specimen of *M. mobular* (Bonnaterre, 1788) stranded at "la Madrague" beach 35°46'2.54"N, 0°48'48.96"E (Figure. 1) in the western Algerian coast (Oran Bay). FAO identification sheet (Bauchot, 1987) was used to identify *M. mobular*. All measurements were made in situ to the nearest millimeter (Table 1). Unfortunately, the specimen was in advanced state of deterioration and the tail was missing, some measures were not taken as well as color of the back, so total length was measured from cephalic fins to the end of the tail spine and all measurements made on *M. mobular* specimen were reported as percentages of total length.

RESULT AND DISCUSSION

Result

M. mobular is a mobulid rarely encountered in its natural environment (Oran Bay) as in local fisheries, it is generally taken as a bycatch in trawl fisheries and the only specimen took as object of our study is suspected to be a victim of ghost fishing, a devastating practice quite common in the area (*pers.obs*). Stranded *M. mobular* (Figure 2) was characterized by a diamond-shaped disc, nearly twice as wide as long, its anterior edges almost rectilinear, its lateral angles very acute and its posterior edges clearly concave. Head wide, its front part distinct from the disc. Tail containing a long spine with prickles. Anterior part of the pectoral fins forming two long cephalic fins. Eyes and spiracles in lateral position; mouth on the ventral side of the head, devoid of fleshy taste buds; over the entire length of the jaws (Fischer *et al.*, 1987) (Figure 2).



Figure 1. Stranding zone of *Mobula mobular* ("La Madrague" Beach).
Source: Google earth 2019®



Figure 2. The specimen *Mobula mobular* stranded at "la Madrague" Beach (05/09/2017).

Measurements were made on biometric characteristics of *M. mobular* stranded on "la Madrague beach", and description are resumed in table 1. It appears that measurements reported as percentage of total length (TL) were as follows: Disc Length (82.56%), Disc width (171.27%), Tail spine length (136.42%), Eye diameter (4.73%), Mouth width

(5.24%), Clasper (10.71%), Pre-oral length (7.56%), Pre-orbital length (19.28%), Pectoral fin (convex length) (132.14%), Pectoral fin (concave length) (78.44%), Cephalic fin length (16.51%), Cephalic fin width (5.36%), Distance between cephalic fins (16.50%), Cranial width (21.86%), Preoral length (8.42%).

Table 1. Morphometric measurements of *Mobula mobular* specimen

Morphometrical characteristic	Measurement (mm)	%TL
Total length*	131.97*	100.00
Disc Length	108.96	82.56
Disc width	226.02	171.27
Tail spine length	180.03	136.42
Eye diameter	6.24	4.73
Mouth width	6.92	5.24
Clasper	14.14	10.71
Pre-oral length	9.98	7.56
Pre-orbital length	25.45	19.28
Pectoral fin (convex length)	174.38	132.14
Pectoral fin (concave length)	103.52	78.44
Cephalic fin length	21.79	16.51
Cephalic fin width	7.07	5.36
Distance between cephalic fins	21.78	16.50
Cranial width	28.85	21.86
Preoral length	11.11	8.42

*Total length measured from the cephalic fins to the end of the tail spine

Discussion

The length of Algerian coastline is about 1622 km (PAP RAC/PAM, 2015-Ministry of the Environment) and as stated previously, *M. mobular* haven't been encountered in Western Algerian coast (Oran Bay) for more than 30 years since Pellegrin, 1901; Dieuzeide *et al.*, 1953 also McEachran & Capape, 1984; and Fisher *et al.*, 1987 descriptions. There were only observations and works of Hemida *et al.*, 2002 in

Central and Eastern Algerian waters but no information exists on its occurrence in the Western Algerian waters. Population trends and behavior of this mobulid are difficult to obtain given that the majority of studies available in the literature were mainly based on visual observations (Holcer *et al.*, 2012; Fortuna *et al.*, 2014) of population of that giant aquatic animals or limited to only 1 or two specimens as is the case of our study (table 2).

Table 2. Main studies exhibiting the number of *Mobula mobular* specimens observed and/or caught and/or described and their respective length given by several authors.

Reference	Observed	Caught	Described	Length (m)	Area
Capapé <i>et al.</i> , 1990	-	-	1	2.2	France, Aigues-Morte Gulf
Duffy & Tindale, 2018	-	-	5	1.8-2.8	Northern New Zealand
Fortuna <i>et al.</i> , 2014	3255	-	3	≈3	Otranto strait
Celona, 2004	50	45	5	-	Messina Strait
Canese <i>et al.</i> , 2011	-	-	3	2.5-3	Italy
Holcer <i>et al.</i> , 2012 (3 years)	-	-	20	1.3-3	
Scacco <i>et al.</i> , 2009	-	-	1	3	
Storai <i>et al.</i> , 2011 (1990-2009)	15	-	3-12	1.8-3.5	Tyrrhenian Sea
Jardas, 1996	-	-	1	-	South Adriatic
Marano <i>et al.</i> , 1988	-	-	2	-	
Dulčić & Lipej, 2002	-	-	2	3.5-5	Cres Island, North Adriatic
Yaglioglu <i>et al.</i> , 2013	-	-	1	1.40	Mediterranean
Başusta and Özbek, 2017	-	30	2	2.70-2.72	Turkey
Bradai & Capapé., 2001	-	-	2	2.09 and 2.9	Gulf of Gabes
Capapé & Zerouali, 1976	-	-	1	3	Tunisia
Hemida <i>et al.</i> , 2002 (1999-2001)	-	14 East 7 Center 0 West	21	1.30-3.34	Central and Eastern Algerian coasts
Present study	-	-	1	2.26	Western Algerian coasts

According to UNEP/CMS, 2014, Notarbartolo di Sciara *et al.*, 2015, Arnoud, 2018, giant devil ray (*Mobula mobular*) is the largest species of the genus *Mobula* and has a very low reproductive capacity. Its geographic range is limited to the Mediterranean Sea and possibly adjoining North Atlantic waters. This species is taken as bycatch in many different fisheries (most notably in pelagic driftnets) in several locations within its range. There are no overall regional population estimates for this species. A report of the first stranding of this mobulid species in Oran Bay can help us to trace a precise trajectory of this migratory species beginning in Alboran Sea and fill gaps concerning its population ecobiology.

Generally, it occurs in low densities (with group sizes of one to four individuals) throughout its range, although a recent episode in which these rays were mass captured off Gaza indicates that the species may occasionally occur in large aggregations. This species occurs both in neritic (Notarbartolo di Sciara & Serena 1988, Bradai & Capapé 2001, Scacco *et al.*, 2009, Holcer *et al.*, 2012 in Notarbartolo di Sciara *et al.*, 2015) and offshore (Canese *et al.*, 2011 in Notarbartolo di Sciara *et al.*, 2015) waters ranging in depth from a few tens of meters to several thousand meters.

The main threat to the Mediterranean giant devil ray is fishing, although the species is rarely targeted and is usually caught accidentally. Unfortunately, this elasmobranch is sometimes targeted as was the case in Gaza strip on 26th February 2013 where nearly 500 individuals were captured by purse seine vessels before being consumed or devoid of their precious fins (Couturier *et al.*, 2013). In reality, according to the NGO IFAW (International Fund for Animal Welfare) (Elsayed, 2016), gills are also used in traditional Chinese medicine to treat ailments such as asthma, rashes, chicken pox or even cancer. Where approximately, a single ray can give up to 3.5 kilograms of dried gills, which can be sold up to 502 € per kilo in China. Water pollution mainly hydrocarbons, solid wastes as plastic can contribute a lot to harm these creatures may be swallowing hundreds of plastic particles a day. Debris has been recognized as a global environmental problem including within deep habitats and recent studies showed that microplastic pollution can impact filter-feeding marine megafauna, namely mobulid rays, filter-feeding sharks, and baleen whales (Anastasopoulou *et al.*, 2013; Germanov *et al.*, 2018)

Related to conservation strategy Lawson *et al.*, (2017) resumed the international, national, and territorial protections currently in place for devil and

manta rays. The most important of them are:

- International protections that restricts fishing and/or trade of multiple species of the genus (*Mobula* spp.).
- CMS Appendix I & II (2014) conservation of migratory species of wild animals,
- European Union (2015) The fishing opportunities for certain fish stocks and groups of fish stocks,
- IATTC (2015) Resolution on the conservation of mobulid rays,
- CITES (2016) Inclusion of the genus *Mobula* spp. in appendix II of the Convention on International Trade in Endangered Species

M. mobular is also listed in:

- Annex II to the Barcelona Convention SPA/BD Protocol, Barcelona Convention SPA/Bio Protocol Annex II (1976). (Algeria, Ratification: 16.02.81/ AC Acceptance of Amendments: 09.06-04)
- Bern Convention Appendix II (1979)

Furthermore, Basusta & Özbek, 2017 reported that the parties to the Barcelona Convention agreed that this species cannot be retained on board, trans-shipped, landed, transferred, stored, sold, displayed or offered for sale, and must be released unharmed and alive, to the extent possible, pursuant to Recommendation GFCM/36/2012/3 (FAO, 2012) *M. mobular* is also protected by National and territorial initiatives (Ba^austa & Özbek, 2017; Lawson *et al.*, 2017):

- EU (72/2016/EU),
- Australia (2015),
- Maldives (2014),
- Brazil (2013),
- Croatian (Law of the Wild Taxa 2006),
- Maltese (Sch. VI),
- Israeli (since 2005),
- Greek (PD 67/1981),
- Turkish (Environmental Law No. 2 872) legislation,
- Guam, USA Territory (2011),
- Raja Ampat, Indonesia Regency (2012),

Added to this since 90's European legislation authorized driftnet no longer to 2.5 km to limit capture of marine mammals, turtles and migratory species. Many attempts were tried to banish completely the use of driftnets [amending Regulations (EC) No 894/97, (EC) No 812/2004 and (EC) No 2187/2005 as concerns drift nets in Council Regulation (EC) No 809/2007 and (Davies & Laura, 2015). To our vision, it seems insufficient to protect such epipelagic marine organisms that are encountered from tens to hundreds of meters. According to local fisherman (seiner owner) witnesses, it is very rare to meet or capture *M. mobular* in Oran Bay, since 2015 this elasmobranch

was met only two times in different places, 1st at "Pointe de l'aiguille" and the 2nd at Cape Falcon where they were swimming slowly very close to the surface confirming that the species frequents the western Algerian coasts and probably a small population exists.

CONCLUSION

Water pollution (mainly hydrocarbons, solid waste as plastic) and important maritime traffic can contribute a lot to harm these inoffensive animals that haven't been observed for more than 30 years in that part of the Mediterranean, but up to date no explicit reason can be given for the real strand of *Mobula mobular* in "la Madrague" beach but ghost fishing and important maritime traffic (commercial, tourism) stay the most plausible cause of this incident. Research on *M. mobular* is very scarce and more studies should focus on its occurrence by visual observation and/or GPS tagging, ecobiology, distribution, reproduction and nursery areas should be identified and fishing should strictly been prohibited along Algerian coasts and in the Mediterranean Sea.

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REFERENCES

- Abudaya, M., Ulman, A., Salah, J., Fernando, D., Wor, C., & Notarbartolo di Sciara, G. (2017). Speak of the devil ray (*Mobula mobular*) fishery in Gaza. *Rev. Fish. Biol. Fisheries*, 1-11. doi: <http://dx.doi.org/10.1007/s11160-017-9491-0>.
- Alava, M. N. R., Dolumbalo, E. R. Z., Yaptinchay, A. A., & Trono, R. B. (2002). Fishery and trade of whale sharks and manta rays in the Bohol Sea, Philippines. In *Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop*, Sabah, Malaysia, July 1997 (Fowler, S. L., Reed, T. M. & Dipper, F. A., eds), pp. 132–148. Occasional Paper of the IUCN Species Survival Commission No. 25.
- Anastasopoulou, A., Mytilineou, C., Smith, C. J., & Papadopoulou, K. N. (2013). Plastic debris ingested by deep-water fish of the Ionian Sea (Eastern Mediterranean). *Deep. Sea. Res. Part 1 Oceanogr. Res. Pap.*, 74, 11-13.
- Arnoud, C. (2018). *Le diable de mer de Méditerranée*. Breuillet. France. *Especies-menacees.fr. Le portail sur les especes menacees et les animaux en voie de disparition*. Retrieved 26/08/2018 (Published 26.07.2018 at 16h06 / Modified 30.07.2018 at 11h15/). Available at <https://www.especies-menacees.fr/diable-de-mer-mediterranee/>. [In French].
- Barcelona Convention. (1976). Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. Annex II Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean. United Nations Environment Programme. Barcelona, 16 February 1976.
- Bağusta, N., & Özbek, E. Ö. (2017). New record of giant devil ray, *Mobula mobular* (Bonnaterre, 1788) from the Gulf of Antalya (Eastern Mediterranean Sea). *J. Black Sea/Mediterranean. Environ*, 23(2), 162-169.
- Bauchot, M.-L. (1987). Raies et autres batoides. In W. Fischer, M. L. Bauchot & M. Schneider (Eds.) *Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et Mer Noire. Zone de pêche 37* (pp. 761- 1530). Italy, Rome. FAO. [In French]
- Belhabib, D., Harper, S., Zeller, D., & Pauly, D. (2013). Reconstruction of marine fisheries catches for Morocco (north, central and south), 1950–2010. Fisheries Centre Working Paper 2015–48. University of British Columbia, Vancouver, Canada. 18 pp.
- Bello, G., Lipej, L., & Dulèiæ, J. (2012). Comments on a finding of *Mobula mobular* (Mobulidae) in the Adriatic Sea. *Cybium*, 36(4), 575-577.
- Bern Convention. (1979). Convention on the conservation of European wildlife and natural habitats. Appendix II Strictly protected fauna species. Council of Europe. Bern, 19 September 1979.
- Bouaicha, M. (2011). Étude de suivi des rejets de la pêche crevette dans la baie de Bou-Ismaïl. Centre national d'étude de la pêche et de l'aquaculture, Bou-Ismaïl. 37 pp.
- Bradai, M.N., Capapé, C. (2001). Capture du diable de mer *Mobula mobular* dans le Golfe de Gabes (Tunisie Meridionale Méditerranée Centrale) (Capture of the giant devil ray *Mobula mobular* in

- the Gulf of Gabes (southern Tunisia, central Mediterranean). *Cybium*, 25, 389–391.
- Bultel, E., Le Manach, F., Ulman, A., & Zeller, D. (2015). Catch reconstruction for the French Mediterranean Sea, 1950–2010. Fisheries Centre Working Paper 2015–38, University of British Columbia, Vancouver, Canada. 20 pp.
- Bustamante, C., Barriá, C., Vargas-Caro, C., Ovenden, J. R. & Bennett, M. B. (2016). The phylogenetic position of the giant devil ray *Mobula mobular* (Bonnaterre, 1788) (Myliobatiformes, Myliobatidae) inferred from the mitochondrial genome. *Mitochondrial DNA Part. A*, 27(5), 3540–3541. Doi: [10.3109/19401736.2015.1074208](https://doi.org/10.3109/19401736.2015.1074208).
- Canese, S., Cardinali, A., Romeo, T., Giusti, M., Salvati, E., Angiolillo, M., & Greco, S. (2011). Diving behavior of the giant devil ray in the Mediterranean Sea. *Endanger. Species. Res*, 14(2), 171–176. Doi: [10.3354/esr00349](https://doi.org/10.3354/esr00349)
- Capapé C., & J. Zaouali. (1976). Note sur la présence de la mante de mer *Mobula mobular* (Bonnaterre, 1788) (Sélaciens, Rajiformes) dans les eaux tunisiennes. *Doriana*, 5(223): 1– 8. [In French]
- Capapé, C., Bouchereau, J.L., & J.A. Tomasini. (1990). Présence du diable de mer, *Mobula mobular* (Bonnaterre, 1788) (Pisces, Rajiformes, Mobulidae) dans le golfe d'Aigues-Mortes. Anatomie de la ceinture pelvienne et des ptérygopodes. *Mésogée*, 50: 9–14. [In French]
- Celona, A. (2004). Catture ed avvistamenti di mòbula, *Mobula mobular* (Bonnaterre, 1788) nelle acque dello Stretto di Messina. *Ann. Ser. Hist. Nat.* 14, 11–18. [In Italian].
- CITES. (2016). Consideration of proposals for amendment of appendix I and II. CoP17 Prop. 44. Inclusion of the genus *Mobula* spp. in appendix II. Available at <https://cites.org/sites/default/files/eng/cop/17/prop/060216/E-CoP17-Prop-44.pdf>.
- CMS. (2015). Notification to the parties No. 2015/007. Amendment to appendices I and II of the convention on the conservation of migratory species of wild animals (CMS). Available at http://www.cms.int/sites/default/files/document/Appendices_COP11_E.pdf.
- Correia, J. P., Graça, J. T., & Hirofumi, M. (2008). Long term transportation, by road and air, of Devil ray (*Mobula mobular*), Meagre (*Argyrosomus regius*), and Ocean Sunfish (*Mola mola*). *Zoo Biol.* Published in affiliation with the American Zoo and Aquarium Association, 27(3), 234–250. Doi: [10.1002/zoo.20178](https://doi.org/10.1002/zoo.20178).
- Council Regulation (EC) No 809/2007 of 28 June 2007 amending Regulations (EC) No 894/97, (EC) No 812/2004 and (EC) No 2187/2005 as concerns drift nets. OJ L 182, 12.7.2007, p. 1–2 (BG, ES, CS, DA, DE, ET, EL, EN, FR, IT, LV, LT, HU, MT, NL, PL, PT, RO, SK, SL, FI, SV) Special edition in Croatian: Chapter 04 Volume 004 P. 184 – 185. Retrieved 08/02/2019. Available at: <http://data.europa.eu/eli/reg/2007/809/oj>
- Council Regulation (EU). 2015. The fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union vessels, in certain non-Union waters, amending Regulation (EU) No 43/2014 and repealing Regulation (EU) No 779/2014. Available at <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R0104&from=EN>.
- Couturier, L. I. E., Marshall, A. D., Jaïne, F. R. A., Kashiwagi, T., Pierce, S. J., Townsend, K. A., Weeks, S. J., Bennett M. B., & Richardson, A. J. (2012). Biology, ecology and conservation of the Mobulidae. *Journal of fish biology*, 80(5), 1075–1119.
- Couturier, L. I. E., Bennett, M. B., & Richardson, A. J. (2013). Mystery of giant rays off the Gaza strip solved. *Oryx*, 47(4), 480. Doi: [10.1017/S0030605313000793](https://doi.org/10.1017/S0030605313000793).
- Davies, A., & Zandersone, L. (2015). Initial Appraisal of a European Commission Impact Assessment. Prohibition on driftnet fisheries. EPRS. European Parliamentary Research Service.1–7.
- Dieuzeide R., Novella, M., & Roland J. (1953). Catalogue des Poissons des côtes algériennes. *Bull. Trav. Stn. Aquic. Pêche Castiglione*. 4, 1–135. [In French]
- Duffy, C. A., & Tindale, S. C. (2018). First observation of the courtship behaviour of the giant devil ray *Mobula mobular* (Myliobatiformes: Mobulidae). *N. Z. J. Zool.*, 1–8. Doi: [10.1080/03014223.2017.1410850](https://doi.org/10.1080/03014223.2017.1410850).
- Dulèiæ, J., & Lipej, L. (2002). Rare and little-known fishes in the Eastern Adriatic during last two decades (1980–2001). *Period. Biol.*, 104(2), 185–194.

- Elsayed A.M. (2016). Pour le transfert des raies mobulas dans l'annexe II de la CITES pour une meilleure protection. Document IFAW. Retrieved 12/02/2019. Available at <https://www.ifaw.org/france/actualites/pour-le-transfert-des-raies-mobulas-dans-lannexe-ii-de-la-cites-pour-une-meilleure-protec>.
- EU. (2011). Impact assessment of discard reducing policies. EU Discard Annex. Studies in the field of the Common Fisheries Policy and Maritime Affairs. Impact Assessment Studies related to the CFP. European Commission. Project: ZF0926_S10, Brussels, Belgium.
- FAO. (2009). Sharks and Rays of the Mediterranean and Black Sea. FAO Species Identification Cards. Rome, FAO. 2009. 113 p
- FAO. (2012). FAO General Fisheries Commission for the Mediterranean: Report of the thirty-sixth session. Marrakech, Morocco, 14–19 May 2012. GFCM Report No. 36. Food and Agricultural Organization of the United Nations (FAO), Rome.
- FAO. (2016). The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean. Rome, Italy. 152 pp.
- FAO. (2018). The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean. Rome. 172 pp.
- Fischer, W., Schneider, M., & Bauchot, M. L. (1987). Fiches FAO d'identification des espèces pour les besoins de la pêche: Méditerranée et Mer Noire, Zone de pêche 37. (v. 2: Vertébrés), [In French].
- Fortuna, C. M., Kell, L., Holcer, D., Canese, S., Filidei Jr, E., Mackelworth, P., & Donovan, G. (2014). Summer distribution and abundance of the giant devil ray (*Mobula mobular*) in the Adriatic Sea: Baseline data for an iterative management framework. *Sci. Mar.*, 78(2), 227-237. Doi: [10.3989/scimar.03920.30D](https://doi.org/10.3989/scimar.03920.30D).
- Germanov, E. S., Marshall, A. D., Bejder, L., Fossi, M. C., & Loneragan, N. R. (2018). Microplastics: No small problem for filter-feeding megafauna. *Trends. Ecol. Evol*, 33(4), 227-232.
- Hemida, F., Mehezem, S., & Capapé, C. (2002). Captures of the giant devil ray, *Mobula mobular* Bonnaterre, 1788 (Chondrichthyes: Mobulidae) off the Algerian coast (southern Mediterranean). *Acta. Adriat*, 43(2), 69-76.
- Hemida, F., Kassas, A., & Capape, C. (2016). Mediterranean occurrence of *Mobula japonica* (Chondrichthyes: Mobulidae) with first record from the Algerian coast. *Rapp. Comm. int. Mer Médit.*, 326. (2016, September). http://ciesm.org/online/archives/abstracts/pdf/41/CIESM_Congress_2016_Kiel_article_0326.pdf.
- Holcer, D., Lazar, B., Mackelworth, P., & Fortuna, C. M. (2012). Rare or just unknown? The occurrence of the giant devil ray (*Mobula mobular*) in the Adriatic Sea. *J. Appl. Ichthyol.*, 29(1), 139-144. Doi: [10.1111/jai.12034](https://doi.org/10.1111/jai.12034)
- IATTC. (2015). Resolution on the conservation of mobulid rays caught in association with fisheries in the IATTC convention area. Available at <https://www.iattc.org/PDFFiles2/Resolutions/C-15-04-Conservation-of-Mobulid-Rays.pdf>.
- Ifremer. (2010). Panorama des rejets dans les pêcheries françaises. Edited by Guérine, L., Rochet, M.J., Peronnet. 49 pp. [In French].
- Jardas, I. (1996). Adriatic Ichthyofauna. Zagreb: Školska knjiga. 552 p. [In Croatian].
- Kelleher, K. (2005). Discards in the world's marine fisheries. An update. FAO. Rome. No. 470, 131 pp.
- Keskin, Ç., Ulman, A., Raykov, V., Daskalov, G. M., Zyllich, K., Pauly, D., & Zeller, D. (2015). Reconstruction of fisheries catches for Bulgaria: 1950–2010. Fisheries Centre Working Paper 2015–20. University of British Columbia, Vancouver, Canada, 18 pp.
- Lack, M., & Sant, G. (2009). Trends in Global Shark Catch and Recent Developments in Management. Cambridge: TRAFFIC International, 33.
- Lawson, J.M., Fordham, S.V., O'Malley, M.P., Davidson, L.N.K., Walls, R.H.L., Heupel, M.R., Stevens, G., Fernando, D., Budziak, A., Simpfendorfer, C.A., Ender, I., Francis, M.P., Notarbartolo di Sciara, G., Dulvy, N.K. (2017). Sympathy for the devil: a conservation strategy for devil and manta rays. *PeerJ* 5:e3027.
- Marano, G., Rositani, L., Ungaro N., & De Zio, V. (1988). Catches by surface longlines in the southern Adriatic Sea (Italian coasts), triennium 1984-86. *FAO Fish. Rep.*, 394: 112-120.

- McEachran, J.D., & Capapé, C. (1984). *Mobulidae, Dasyatidae*, In: Whitehead, P.J.P., Bauchot, M.-L., Hureau, J. C., Nielsen, J., & Tortonese, E. (eds.): *Fishes of the North-Eastern Atlantic and the Mediterranean*. Vol. 1. Unesco, Paris: 197–202, 210–211.
- MPRH. 2011. Canevas des statistiques locales mensuelles. Ministère des pêches et des ressources halieutiques, 34 pp. [In French]
- Notarbartolo di Sciara, G. (1987). A revisionary study of the genus *Mobula* Rafinesque, 1810 (Chondrichthyes: Mobulidae) with the description of a new species. *Zool. J. Linnean Soc*, 91(1), 1–91. Doi: [10.1111/j.1096-3642.1987.tb01723.x](https://doi.org/10.1111/j.1096-3642.1987.tb01723.x).
- Notarbartolo di Sciara, G., & Serena, F. (1988). Term embryo of *Mobula* (Bonnaterre, 1788) from the Northern Tyrrhenian Sea (Chondrichthyes, Mobulidae). *Atti Soc. ital. Sci. Nat. Museo Civ. Stor. Nat. Milano*, 129(4), 396–400.
- Notarbartolo di Sciara, G., Serena, F., & Mancusi, C. (2015). *Mobula mobular*. *The IUCN Red List of Threatened Species 2015* Retrieved on 23 August, 2018 available at <http://dx.doi.org/10.2305/IUCN.UK.2015-1.RLTS.T39418A48942228.en>
- PAP RAC/PAM. (2015). Ministry of the Environment. National Strategy for Integrated Coastal Zone Management in Algeria. (Support PAM-Med Partnership, UNESCO). 94 p.
- Pellegrin, J. (1901). Sur une Raie cornue gigantesque pêchée à Oran. *Bull. Mus. Natl. Hist. Nat. Paris*, 7, 327–328, [In French].
- Piroddi, C., Gristina M., Zyllich, K., Ulman, A., Zeller, D., & Pauly, D. 2014. Reconstruction of Italy's marine fisheries catches (1950–2010). *Fisheries Research*, Volume 172, pp. 137–147.
- Sakalli, A. (2017). Relationship between Climate Change Driven Sea Surface Temperature, Chl-a Density and Distribution of Giant Devil Ray (*Mobula Mobular* Bonnaterre, 1788) In Eastern Mediterranean: A First Schooling By-Catch Record off Turkish Coasts. *Aquac. Stud.*, 17(1), 005–016. Doi: <http://10.17693/yunusae.v17i26557.280070>.
- Sartor, P., Sbrana, M., Reale, B., & Belcari, P. (2003). Impact of the deep sea trawl fishery on demersal communities of the northern Tyrrhenian Sea (Western Mediterranean). *J. Northwest Atl. Fish. Sci.*, 31, 275–284.
- Scacco, U., Consalvo, I., & Mostarda, E. (2009). First documented catch of the giant devil ray *Mobula mobular* (Chondrichthyes: Mobulidae) in the Adriatic Sea. *Mar. Biodivers. Rec.*, 2. E93. Doi: [10.1017/S1755267209001110](https://doi.org/10.1017/S1755267209001110)
- Storai, T., Zinzula, L., Repetto, S., Zuffa, M., Morgan, A., & Mandelman, J. (2011). Bycatch of large elasmobranchs in the traditional tuna traps (tonnare) of Sardinia from 1990 to 2009. *Fisheries Research*, 109(1), 74–79.
- UNEP/CMS. (2014). Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS) 2014: PROPOSAL FOR THE INCLUSION OF ALL SPECIES OF MOBULA RAYS (GENUS *Mobula*) In CMS APPENDIX I AND II. (Submitted by Fiji), Retrieved 26/08/2018. Available at [https://www.cms.int/sites/default/files/document/Doc 7 2 10 Prop I 10 %26 II 11 Mobula spp FJI.pdf](https://www.cms.int/sites/default/files/document/Doc%207%20Prop%20I%20%26%20II%20Mobula%20spp%20FJI.pdf).
- Yaglioglu, D., Turan, C., & Gurlek, M. (2013). On the occurrence of the giant devil ray *Mobula mobular* (Bonnaterre, 1788) from the Mediterranean coast of Turkey-a bycatch documentation. *J. Appl. Ichthyol*, 29(4), 935–936.



First Report of the Invasive Marine Flora of Oran Coast, Northwestern Algeria (Western Mediterranean)

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Abstract. The Mediterranean flora and fauna are changing. The warming of marine waters leads to changes and modifications in the distribution of species within the Mediterranean. Due to disturbance, more and more species of the tropical Atlantic migrate to the north and some enter the Mediterranean through Gibraltar strait. The objective is to provide a first black list of invasive flora in the marine environment at the regional and national levels by in situ observations made by diving focusing on the presence of the different Exotic Flora of Oran coastline (EFO) these last twenty years. We report a total of 6 species (Macrophyta with 3 Chlorophyceae and 3 Rhodophyceae). Some species are appearing on the Westside of Oran coastline, via the Strait of Gibraltar (for species coming from the Atlantic) and others mark their origin on the East side of the coast, via the Suez Canal (for species coming from the Red Sea) like sea grapes *Caulerpa racemosa* var *cylindracea*. This black list of non-native flora, which has invaded Oran coasts in recent years, must be completed by work on the 14 coastal wilayas (district) in order to draw up a national blacklist and this for contributing to a national and Mediterranean strategy for monitoring and managing non-native species that threaten the marine coastal environment, resources and users.

Key words: Flora, Exotic, Non-native, Alien species, Oran, Western Mediterranean.

INTRODUCTION

In Algeria, the study of biological invasions remains fragmentary, generally characterized by reports of a species in a given region. This study is aiming to provide a black list of non-native flora which in recent years has invaded the Oran coast pushing scientists and sea users to be involved in the elaboration of a blacklist of invasive species.

Some non-native species may under certain conditions become invasive. Indeed, they find all the conditions to develop in their new environment without any limiting factor opposing to their proliferation. Managers are often disarmed face of these complex phenomena that are difficult to stop (Verlaque et al., 2003).

The objective is to provide a black list of invasive species in the marine environment at the regional and national levels, relying on photo-identification for identification and vulgarization of species to sea users and also monitoring and management of this threat in Oran coastline.

Non-native species (species of fauna or flora found outside their known range) are species for which the Mediterranean Sea is not part of their original range. About 925 non-native species have been counted so far in the Mediterranean represented by 13 phyla. Mollusks are the most important phylum (216 species), followed by fish (127 species), plants (124 species) and crustaceans (106 species) (Streftaris and Zenetos, 2006; Unep-Map RAC/SPA, 2017; Worms editorial board, 2017).

The Oranian coastline is located along the southern shore of the Mediterranean basin (Fig.1); also called Alboran Sea is located in North-West of Algeria at 432 km from the capital Algiers. It is made up of 70% of rocky coasts and 30% of sandy coasts; the West sector is characterized by rocky character beaches: Ain Türk, Cape Falcon, la Madrague, les Andalouses, Madagh in the form of steep cliffs sometimes delimited by caps with an island complex (Plane and Habibas Islands) that are clearly visible in this region. In the East, the Macta (Arzew Gulf) is limited to the West by Cape Carbon (35° 45'NW 20' W) and to the East by the Cape Ivi (36° 37'N -0 13'W) where we can find a long arched sandy beach that ends with the large terminal (harbor) of Bethioua for liquefied natural gas. From this last point the rocky character spreads to the North until the islets of Arzew and extends to the West to Cape Carbon (Hussein, 2015). The continental shelf is very small with a steep slope that is interrupted by numerous rocky bottoms deep and not well suited for trawling activity (Hussein, 2015).

According to Hydrothermal structures of Western Mediterranean waters and especially Oran coast it appears clear that the cooling of the Atlantic waters at the level of Gibraltar can be incriminated to the brewing of water masses due to the tightening of the Spanish and Algerian coasts and to the bathymetry which ascends in the Strait. The entry of the Atlantic water flow through the Strait results in the formation of cold water reefs along the Spanish coasts that mix with the Atlantic waters (Millot et al., 2017). This phenomenon is particularly visible in figure

2a (MSG images acquired over the Mediterranean between June and September 2005), the cold waters flowing from the coast of Spain, coming from the Atlantic are deviated to the south-east by the Cape of Gata in the south of Spain to form a beautiful reversed mushroom structure from their encounter with the Moroccan coasts (Taupier-letage, 2008).

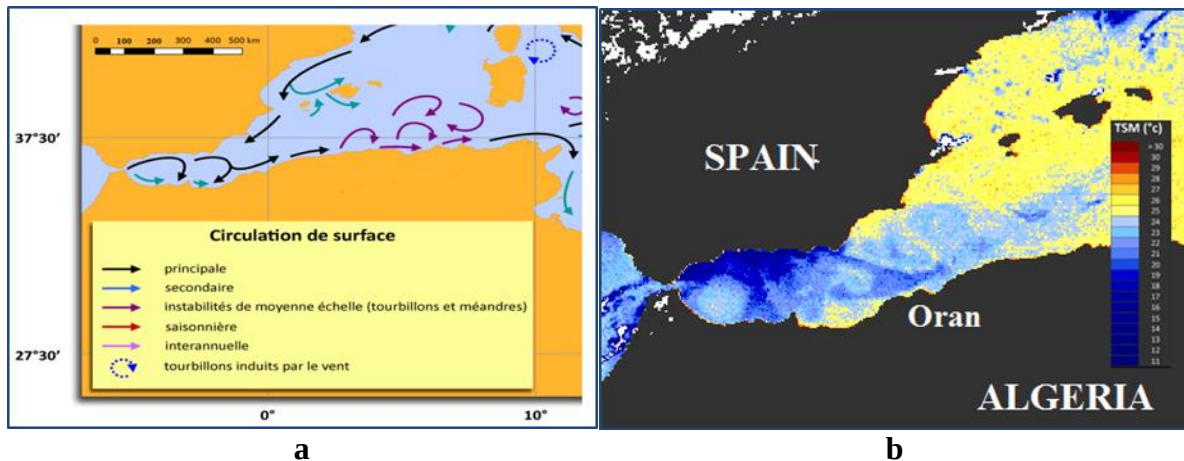


Fig. 2. Circulation of surface waters and thermodynamics of the Oran coast, North West Algeria, Western Mediterranean (Millot et al., 2017) (adapted).

At the level of Oran, the current of Oran front reflects waters to the west form a second anticyclonic vortex, the eastern Alboran gyre (Hussein, 2015; Hussein and Bouras, 2014) (Fig 2b). In general, these water masses circulations facilitate the biological invasions on Western Algerian waters. These geo-hydro-bathymetric factors in the region considerably accelerate the distribution of non-native species of Atlantic origin in Oran coastline (Hussein and Bensahla Talet, 2019a; Hussein and Bensahla Talet, 2019b).

METHODOLOGY

Oran coastline length is about 124 km which represents 1/10 of Algerian coast. Ten (10) stations were chosen for their ease of access and their environmental characteristics were explored in scuba diving (Fig.1), the work was based on photo-identification (Fig.3) for the invasive species encountered (non-destructive method), between the surface (biological zero) and 30 m of isobaths (photic zone). Since 2004, monitoring was performed and the species identification was done in situ and sometimes from the analysis of video sequences taken during the dives. In total, the study required more than fifty exploratory dives some of which were deep (35m: Plane island, Ain Türk, Cap Carbon) and others were made by snorkeling. The investigation was supported by underwater images (videos and photographs of non-native species) by the transect method according to the protocols of photo-identification Rebut Med, as well as the abiotic parameters (Kantin et al., 2006). The method followed consists in describing the type of substrate and the underwater landscape at the same time, as well as the date and time, usual name of the diving site, location, visibility, water temperature, depth, substrate type and any type of information that may be relevant to the observations (Harmelin-Vivien et al., 1985).

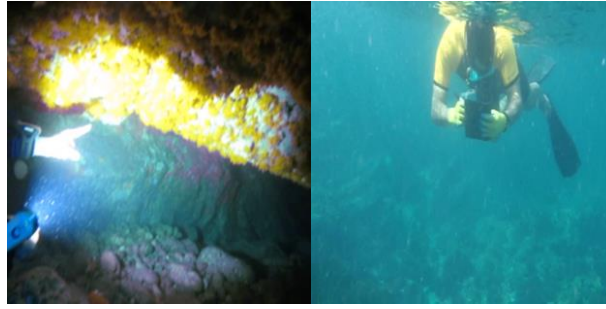


Fig.3. Observation (photography and underwater video) in situ.

The identification and classification of species were done according to FAO species identification sheets, as well as other scientific documents in the field (Boudouresque, 2005; Pergent et al., 2007; Barcelona Convention, 1976). Digital photographs were also taken to facilitate species identification. For species of conservation interest, Annex II and III of the Barcelona Protocol on Specially Protected Areas and Biological Diversity of the Barcelona Convention have been used (Barcelona Convention, 1976). The observations noted in situ and also from underwater photographs analyzed could constitute a basic data to establish a first blacklist of non-native species reported in Oran coast.

RESULTS AND DISCUSSION

Synthesis of in situ surveys and the observations realized allowed us to draw up a list of the different invasive species (EFO) present in Oran coastline. We have inventoried 4 flora species, inventory realized on non-trawable hard and soft substrates at a depth between 0 and 30m. Adding 2 species reported from the bibliography on Oran coast we obtain a blacklist of 6 Macrophytes species cryptogenic or installed (Table 1).

Non-native flora of the Oran coast

The invasive flora frequented Oran coast for a long time that fauna, the totality of the observed floristic species belong to the macroalgae, among which 3 species of Chlorophyceae (*Codium fragile*, *Ulva lactuca* and *Caulerpa racemosa* var *cylindracea*) and 3 species of Rhodophyceae (*Asparagopsis armata*, *Asparagopsis taxiformis* and *Chondria coerulescens*). All the species encountered are old and their reporting exceeds 20 years of survival. They have adapted perfectly with their new environment, integrating with the different native benthic communities. Their geobathymetric distribution spreads all along the Oran coast, only the caulerpe or sea grape, seems recently introduced (Hussein and Bensahla Talet, 2019a; Hussein and Bensahla Talet, 2019b) and its introduction appears to come from the East coast of Algeria. This presence remains modest for the moment in the form of one or two turfs of 50cm maximum in very limited places. This real and direct threat to the marine coastal ecosystem will, in the very near future, harm this environment already weakened by anthropic actions, which requires priority follow-up with urgent measures to completely eradicate this alga on our coastlines.

Non-native flora species description

Codium fragile (Suringar) (Hariot , 1889). Dead man's fingers or Oyster thief is considered highly invasive. This species native to the Pacific (Japan) was introduced in the Mediterranean in 1940. It frequented the coast of Oran and Algerian between 1985 and 1987 (Verlaque, 1994). This photophilic species is found in the upper infralittoral zone from the surface up to 13 m deep, it is found all along the Oran coast on hard substrate (Hussein, 2015). The species was photographed in 2016 at "Plane Island" (Fig.4) at 35° 46.281'N and 0° 54.11'W.

Caulerpa racemosa var cylindracea (Forsskål J.Agardh, 1873). Caulerpa racemosa var cylindracea is a lessepsian species that by a "step by step" spread in different ports would have

migrated from Australia to the Red Sea and then the Mediterranean in 1990 via the Suez Canal. Called also sea grapes frequented the Algerian coast from the East then the center (Ould-Ahmed and Meinesz, 2007), and then invaded Oran coast where it was first reported in 2012 at Cape Carbon at 0.2m (East coast of Oran) (Hussein and Bensahla Talet, 2019a; Hussein and Bensahla Talet, 2019b). Figure 4 was photographed in 2014 at Cape Falcon at 35° 46 '16.47 N and 0° 47' 33.68 W (West coast of Oran).

Asparagopsis armata (Harvey 1855). The harpoon alga is native to New Zealand and Australia; shortly before the discovery of gametophytes in 1925 (Sauvageau, 1925a; Sauvageau, 1925b). Almost simultaneously, the latter appeared in Algeria in 1923 (Sauvageau, 1925b), then in the Eastern Pyrenees, in Banyuls, in 1926 (Hamel, 1926). This species inhabits the infralittoral stage on hard substrate and often very epiphyteal. Generally, it has been found in the majority of the studied stations to a maximum depth of 27 m in Oran coastline, it was photographed in the same place with *Asparagopsis taxiformis* at “pain sucre” (la madrague) in 2015 at 35° 37 '952 N and 0° 104' 243 " W (Hussein, 2015) (Fig. 5).

Asparagopsis taxiformis (Delile) (Trevisan de Saint-Léon, 1845). According to Verlaque (1994) (Oceanology Center of Marseille-DIMAR), the species is present in Habibas Islands and is an introduced form coming from Australia and not the Atlantean-Mediterranean form. But it appears to be well integrated in the subtidal coral community up to the upper coralligenous level and is a major feature of the landscape (Dixon, 1964; Grimes, 2000). It also coexists in some places with *Asparagopsis armata*, but this one is more abundant (Hussein, 2015) (Fig.6).



Fig.4. *Codium fragile* (2016).

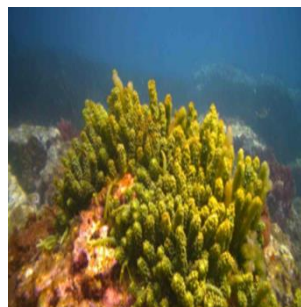


Fig.5. *Caulerpa racemosa* var. *cylindracea* (2014).

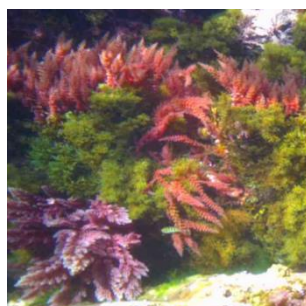


Fig.6. *Asparagopsis armata* (lower left) and *Asparagopsis taxiformis* (upper and lower right) (2015).

Black list of invasive species of Oran coast (EFO)

Six exotic species, listed in the black list of invasive, cryptogenic species of flora have established themselves on the Oran coast (Table 1).

Table 1. Black list of Alien marine species introduced in Oran coastline based on *in situ* data and bibliography of signalization with geographic coordinates, origin, locality, year and author of first sighting.

Species	YFRA	Coordinates	Org	Locality	Authors	Success
Chondria coerulescens (J. Agardh) Falkenberg	Since 1893	NIA	At.E	Oran costline	Debray, 1893	Est
Asparagopsis taxiformis (Delile) Trevisan de Saint-Léon, 1845	Since 1939	35.748383°; -0.613843°*	At-IP	NIA	Verlaque, 1994 (	Inv
Asparagopsis armata (Harvey 1855)	Since 1923	35.748383°; -0.613843°*	SW. P	NIA	Sauvageau, 1925 a	Est
Codium fragile (Suringar) Hariot, 1889	Between 1985 et 1987	35.748383°; -0.613843°*	NW. P	Oran Bay	Verlaque, 1994 (	Est
Caulerpa racemosa (Forsskål) Agardh 1873	Between 2010-2013	35.920824°; -0.340679°*	IP	Cap Carbon	Hussein, 2015	Inv
Ulva lactuca (Linnaeus 1758)	Since 1834	36.7773393°; 3.114887°*	IP	Algeria	Steinheil 1834 Montagne, 1846 As U. fasciata	Cas

(Abbreviations: YFRA: Year of first record in Algeria, Org:origine; IP: Indo Pacific; P: Pacific; I: Indian Ocean; RS: Red Sea; At: Atlantic; Tr: Tropical; Circ: Circumtropical; Est: Established; Ques: Questionable; Cas: Casual; Inv: Invasive; E: East; W: West; N: North; S: South; NIA: Non identified Area; * : First signaling).

They have been reported along the coast of Oran during the last twenty years, this is due to several natural and anthropogenic factors, as well as the geographical location and underwater topography of the region, favoring a great hydrodynamism, facilitating the propagation and the installation of several non-native species.

Origins and pathways of EFO of Oran

In figure 7 each invasive plant is represented with its probable region of origin. In fact, compiled a list of the likely vectors of introduction of flora and fauna from which we have been inspired (Zibrowius, 1991):

- Maritime traffic and "offshore" activities, either on the hulls of ships, on towed structures (fouling or fouling), or in water for ancient times, on sand and rocks used as ballast;
- The Suez Canal;
- Importation for breeding or cultivation purposes;
- Accidental transport during previous imports;
- The rejection of living organisms imported for other purposes (consumption, bait, packaging, scientific research, aquariums). These anthropogenic vectors are responsible and contribute to the biological pollution and the imbalance of the ecosystems as well as the depletion of their renewable resources.

The lessepsian species recorded at Oran coasts seems to be less represented than those from Atlantic origin (Herculean species), the origin of the exotic species on the black list of the region differs according to the probable origin of the species. EFO seems strongly influenced by Gibraltar strait active hydro dynamism. In fact, we can note four Atlantic alien species coming from the Atlantic Ocean using straight currents as main access way against only two lessepsian species coming from the Red Sea via Suez Canal (Fig.7).



Fig.7. Pathway and origin of the invasive species of Oran.

CONCLUSION

Six EFO or invasive plants species have been recorded during the last 15 years. The reports have been based on bibliographic research, diving exploration and in situ research of non-indigenous species between 0 and 30m depth, along the 124 km of the Oran coast. 3 Chlorophyceae and 3 Rhodophyceae were reported with 4 Atlantic alien species and 2 lessepsian species (red Sea). This EFO black list of non-native flora species, which have invaded Oran coasts in recent years, must be completed by work on the 14 coastal wilayas (province) in order to draw up a national blacklist or EFO (Exotic Flora and Fauna of Oran) black list, and this for contributing to a national and Mediterranean strategy for monitoring and managing non-native species that threaten the marine coastal environment, resources and users.

REFERENCES

Barcelona Convention ,1976. Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. Annex II Protocol concerning Specially Protected

- Areas and Biological Diversity in the Mediterranean. United Nations Environment Programme. Barcelona, 16 February 1976. Available at: <http://web.unep.org/unepmap/1-barcelonaconvention-and-amendments> (accessed 7 Mar 2019).
- Boudouresque C.F., 2005. Ed. *Gis posidonie* publ., marseilles, fr. 1-48.
- Debray F., 1893. Bulletin Scientifique de la France et de la Belgique. 25, 1-19.
- Dixon P. S., 1964. *Asparagopsis* in europe. Nature 201: 902. & irvine I. M., 1977: seaweeds of the British isles, 1. Rhodophyta. Part j introduction, nemaliales, gigartinales. - London.
- Grimes S., 2000. Eléments de la réserve marine des îles Habibas marche Mate/Isma/001/97, 27.
- Hamel G., 1926. Bulletin du Muséum National de Sciences Naturelles, Paris. 32 (6), 420.
- Harmelin-Vivien M., Harmelin J.G., Chauvet C., Duval C., Galzin R., Lejeune P., Barnabe G., Blanc F., Chevalier R., Duclerc J., Lasserre G., 1985. Rev. Ecol. (Terre Vie), fr. 40, 467-539.
- Hussein K.B, Bouras D., 2014. Journal of Biodiversity and Environmental Sciences (JBES). 5, (1), 625-637.
- Hussein K.B., 2015. Thèse de doctorat. Université Oran1 ahmed BENBELLA. 252.
- Hussein K.B Bensahla Talet L., 2019a. Journal of the Black Sea/Mediterranean Environment. 25(1), 49-72.
- Hussein, K.B, Bensahla Talet L., 2019b. Indian Journal of Geo Marine Sciences. 48(3), 335-342.
- Kantin R., Andral B., Debard S., Denis J., Derolez V., Emery E., Ganzin N., Herve G., Laugier T., Le Borgne M., L'hostis D., Oheix J., Orsoni V., Raoult S., Sartoretto S., Tomasino C., 2006. Le référentiel benthique méditerranéen (rebtmed) ; R.Int.Dop/LER-PAC/06-08 ; ifremer LER/Pac et LER/LR ; 124 (+ 123 pages d'annexes) ; Décembre 2006.
- Millot C., Benzohra M., Taupier-Letage I., 1997. Deep Sea Research Part I: Oceanographic Research Papers, 44, 1467-1495.
- Montagne J.F.C., 1846. Acotyledoneae Juss: Ordo I. Phyceae Fries.
- Ould-Ahmed N., Meinesz A., 2007. Algologie. 28(3), 303-305.
- Pergent G., Bellan-santini D., Bellan G., Bitar G., Harmelin J.G., 2007. Manuel d'interprétation des types d'habitats marins pour la sélection des sites à inclure dans les inventaires nationaux de sites naturels d'intérêt pour la conservation, Ed. Car/Asp Publ.Tunis, Tunisie, 199 p.
- Refes W., 2012. MATE/ ONEDD. 127.
- Sauvageau C., 1925 a. Comptes Rendus Académie Sciences., Paris, 180.
- Sauvageau C., 1925b. Bulletin de la Station Biologique d'Arcachon, 22, 43 pp.
- Steinheil A., 1834. Annuaire des Sciences Naturelles de France. 2 (1), 282-283.
- Streftaris N., Zenetos A., 2006. Mediterranean Marine Science. 7 (1), 87-118.
- Taupier-letage I., 2008. In 'remote sensing of the European seas', v. Barale and m. Gade eds., 2008, 153 – 164. Springer verlag.
- Unep-Map RAC/SPA, 2005. Protocol concerning specially protected areas and biological diversity in the Mediterranean. United Nations Environmental Programme, Mediterranean action plan, 26 pp.
- Unep-Map Rac/Spa., 2017. Marine Mediterranean invasive aliens species (mamias). <http://www.mamias.org>
- Verlaque M., 1994. Oceanologica acta. Paris. 17(1), 1-23.
- Verlaque M., Durand C., Huisman J.M., Boudouresque C.F., Le Parco Y., 2003. European Journal of Phycology. 38, 325-339.
- Worms editorial board, 2017. World register of marine species. Available from <http://www.marinespecies.org> at vliz.
- Zibrowius H., 1991. Mésogée. 51,83-107.

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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)

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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

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). This species is common in shallow coastal waters off the north-eastern Atlantic, from Iceland to the Islands of Cape Verde. It is also found in the Mediterranean, the sea of Marmara and more rarely in the Black Sea (Polonsky, 1969; Arneri, 1983), in the Eastern Channel and the North Sea. *T. trachurus* is a migratory species; it lives and hunts in shoals. Usually, it migrates towards the coasts in summer and returns to offshore waters in winter; it can be found close to the bottom where it can live between 50 and 400 m depth with a capacity to adapt to brackish water (Santic et al., 2003). In the Mediterranean Basin *T. trachurus* is very common (Fezzani et al., 2006), 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).

The study of the reproductive activity through the analysis of certain parameters such as variation of some biological indexes can help us better characterize the reproduction cycle by indicating the spawning period and the strategy of these fish. Several works have dealt with *T. trachurus* (Polonsky, 1969;

1996, 1997; Viette et al., 1997; Fezzani et al., 2002; Abaunza et al., 2003; Šantić et al., 2008; Tahari, 2011; Aydin & Karadurmuş, 2012; Carbonara et al., 2012; Wahbi et al., 2015; Aydin & Erdoğan, 2018; Gherram et al., 2018; Azzouz et al., 2019; Ferreri et al., 2019). The present paper focuses on the reproductive biology of *T. trachurus* of Béni-Saf Bay, with an emphasis on the reproduction period and the size at first sexual maturity to complete gaps in the life cycle of this carangid species and to better manage this resource in this Mediterranean area.

MATERIAL AND METHODS

A total of 355 specimens of *Trachurus trachurus* were collected from Béni-Saf fishery, fished by trawlers operating between 30-130 m depth, from November 2015 to October 2016 (Fig. 1). For each individual, total length (TL) was measured to the nearest millimetre, total weight (TW) and gonads weighed to the nearest 0.01 g. Fish lengths were classified in 1 cm group intervals (Fig. 2), and sex was determined macroscopically based on the morphology and the colour of the gonads (Mahdi et al., 2018).



Fig. 1: Map showing the exact location where the estimated 500-cm TL female shortfin mako shark was observed on 28 June 2018.

Sl. 1: Zemljevid obravnavanega območja z označeno lokaliteto, kjer so avtorji 28. junija 2018 opazovali na 500 cm dolžine ocenjeno samico atlantskega maka.

Sedletskaya, 1971; Macer, 1974; Arneri, 1983; Ar-ruda, 1984; Kerstan, 1985; Korichi, 1988; Eaton, 1989; Hecht, 1990; Ben Salem & Ktari, 1994; Abaunza et al., 1995; Kerstan, 1995; Karlou-Riga & Economidis,

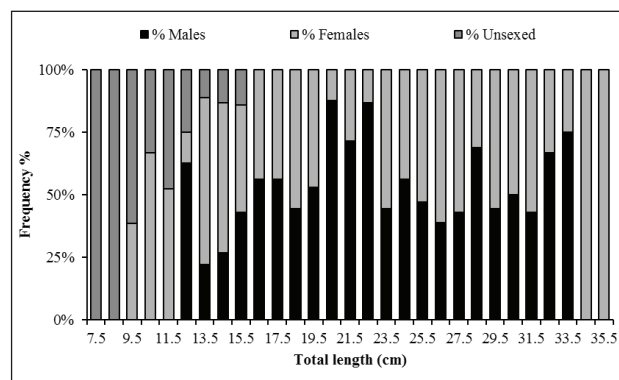


Fig. 2: *Trachurus trachurus* length frequency distribution of males and females caught in Béni-Saf Bay.

Sl. 2: Porazdelitev dolžine pri samcih in samicah navadnih šnjurov, ujetih v zalivu Béni-Saf.

Sex ratio

Sex ratio is defined as being the proportion of the male or female individuals compared to the total number of individuals. It also gives an idea regarding the balance of the sexes within the population. The sex ratio generally relates the rate of femininity or masculinity of the population:

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

F = number of females,

M = number of males.

Gonado-somatic index (GSI)

In order to understand the sexual cycle and determine the spawning period the gonado-somatic index (GSI) was calculated monthly for both females and males, according to the equation below. The description of the reproductive cycle of this species and the determination of the spawning period were figured by tracking the monthly variations of this index.

$$\text{GSI} = \text{GW} / \text{TW} \times 100 \text{ (Ferreri et al., 2019)}$$

GW: gonads weight in g,
TW: total weight in g.

Coefficient of condition

The coefficient of condition K is defined by the relationship between the weight and the size of fish according to the equation:

$$K = \frac{\text{TW}}{\text{TL}^3} \times 1000 \text{ (Crim et al., 1990; Ferreri et al., 2019)}$$

TW: total weight,
TL: total length.

Size at first sexual maturity

The size at first sexual maturity (Lm 50 %), which corresponds to the length at which 50 % of the individuals are mature, was calculated for our specimens. When considered ripe, the gonads occupy, or almost so, the totality of the visceral cavity. For males, the testes are milky white; for the females, the ovaries are bulky and pink, with oocytes visible through the ovary walls. For each size class (1 cm) previously defined, we counted mature individuals on one hand and immature individuals on the other. Consequently, we determined the relative proportions of each group in relation to the total size of each size class. We determined the values corresponding to the sizes at first maturity from an equation (1) whose curve is sigmoid:

$$P = \frac{1}{1 + e^{-(b + a \cdot \text{TL})}} \quad (1) \text{ (Wahbi et al., 2015) } (1)$$

P: proportion of mature individuals,
TL: total length in cm,

The constants a and b are determined by the method of least squares transforming the equation (1) into linear type:

$$\text{Ln} \left(\frac{p}{1-p} \right) = b + a \cdot \text{L} \quad (2)$$

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. 2). Male length range was 12 to 33.5 cm; female length range was 8.8 to 35.4 cm. Male weight varied from 14.36 to 292.83 g and female weight varied from 5.28 to 312.78 g.

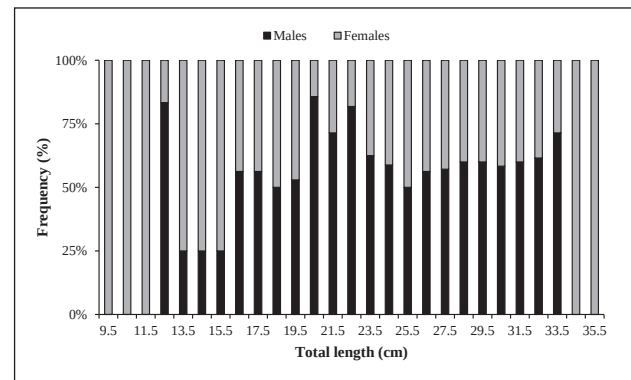


Fig. 3: Sex ratio of *Trachurus trachurus* by length size.

Sl. 3: Delež spolov pri primerkih navadnega šnjura glede na telesno dolžino.

Of the 355 individuals sampled sex ratio was in favour of males 1:0.95 and the χ^2 test did not reveal any significant difference ($p < 0.05$). In addition, the variations of sex ratio according to the size (Fig. 3), revealed by khi2 test significant differences in favour of females for length classes between 9.5 to 11 cm of TL ($\chi^2 = 11 > \chi^2_{1,0.05} = 3.84$); beyond 16.5 cm of total length, males have the advantage but without significance (khi2). Beyond 34.5 cm of TL females are dominant.

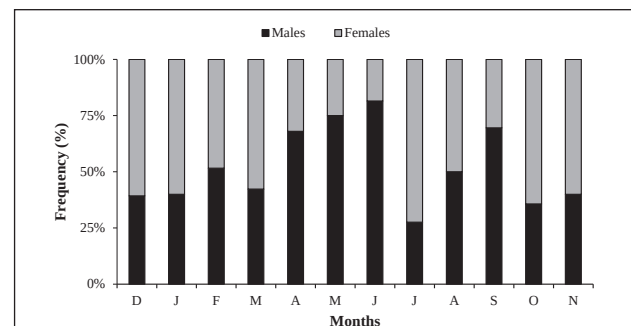


Fig. 4: Monthly evolution of sex ratio of *Trachurus trachurus*.

Sl. 4: Delež spolov pri primerkih navadnega šnjura po mesecih.

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, December, June and September, with numerical equality in August and February.

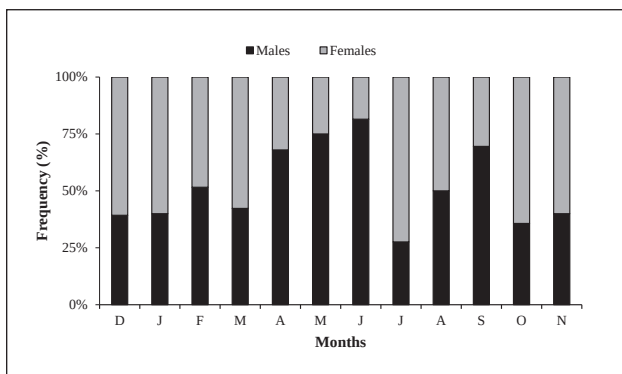


Fig. 4: Monthly evolution of sex ratio of *Trachurus trachurus*.
Sl. 4: Delež spolov pri primerkih navadnega šnjura po mesecih.

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.

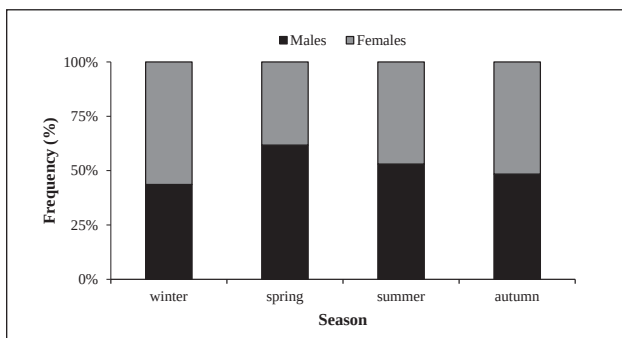


Fig. 5: Evolution of sex ratio of *Trachurus trachurus* by seasons.
Sl. 5: Delež spolov pri primerkih navadnega šnjura po sezonah.

Gonado-somatic index (GSI) ¶

The monthly changes of the gonado-somatic index (GSI) allowed the determination of the spawning period during an annual cycle (Fig. 6); the monthly values of

this index varied between 0.47 and 5.69 for females and between 0.37 and 4.98 for males. From February, this index increases for both sexes to attain a maximum in June, after which values begin to gradually decrease until they reach their lowest value in October for males and females.

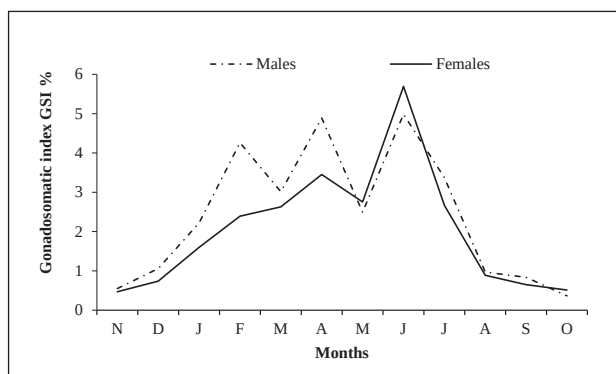


Fig. 6: Monthly evolution of gonado-somatic index for males and females of *Trachurus trachurus*.

Sl. 6: Gonadosomatčni indeks pri samicah navadnega šnjura po mesecih.

Gonado-somatic index related to size classes

To investigate the role of small specimens and their contribution to the renewal of the resource we linked GSI to the total length of individuals (Fig. 7) and it was established that GSI increased simultaneously with length.

For males, we recorded a maximum GSI at 5.94, corresponding to a size 26.5 cm TL, and a minimum of GSI with 12.5 cm TL. For females, the GSI maximum value was recorded at 4.89 corresponding to a size of 22.5 cm TL, while the GSI minimum was recorded for a size of 13.5 cm TL.

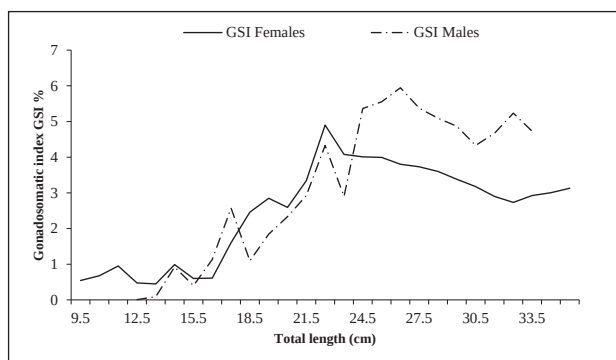


Fig. 7: Evolution of gonado-somatic index related to total length of males and females of *Trachurus trachurus*.

Sl. 7: Gonadosomatčni indeks pri navadnem šnjuru glede na celotno dolžino samcev in samic.

Condition factor K

Evolution of the condition factor coefficient K seems to be closely related to the gonado-somatic ratio GSI, but the two indices tended to be inversely proportional. In fact, during the spawning period, the condition factor of the specimens is recorded at its lowest values (7.05) and in rest period the same factor records its highest values (8.54). The maturation of the sexual products and their emissions requires relatively high energy expenditure, and as a consequence the fish weight during spawning period is reduced (Figs. 8 and 9), corresponding to a reduction in condition factor of ~14 and 20 % for males and females, respectively.

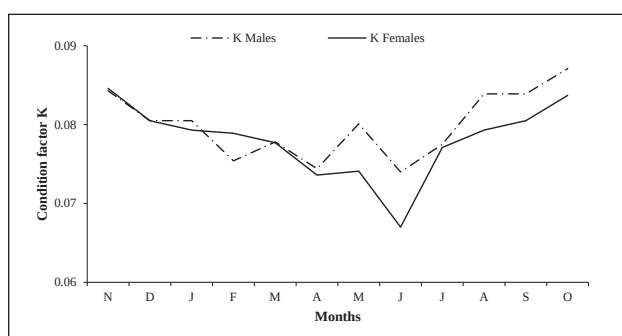


Fig. 8: Annual evolution of condition factor K of *Trachurus trachurus* males and females.

Sl. 8: Letna dinamika kondicijskega faktorja K pri samcih in samicah navadnega šnjura.

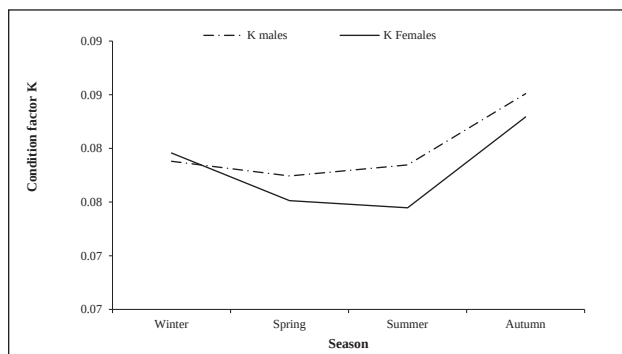


Fig. 9: Seasonal evolution of condition factor K of *Trachurus trachurus* males and females.

Sl. 9: Sezonska dinamika kondicijskega faktorja K pri samcih in samicah pri primerkih navadnega šnjura.

Size at first sexual maturity

The proportion of mature individuals in each size class (Fig. 10) showed that first maturity was attained at 14.9 cm TL where 50 % of the females were mature,

whereas 50% of males attained this proportion at 15.6 cm TL.

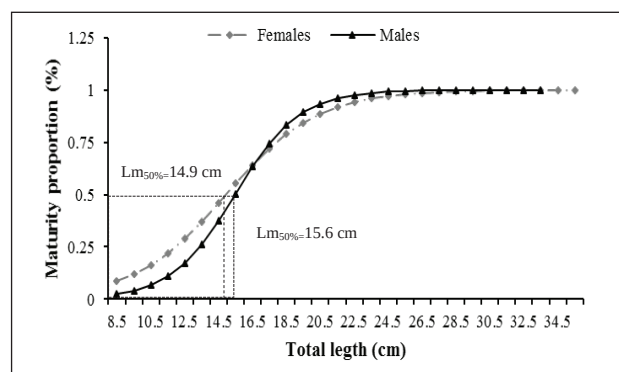


Fig. 10: Length at sexual maturity of males and females of *Trachurus trachurus*.

Sl. 10: Dolžina, pri kateri samci in samice navadnega šnjura dosežejo spolno zrelost.

DISCUSSION

The sex ratio is slightly in favour of the males. The evolution of this index does not have phenological 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 are predominantly males or females. According to Carbonara et al. (2012) and Wahbi et al. (2015) fluctuations of the sex ratio are due to ethologic phenomena (stray species, demographic segregations) responsible for the overdispersion and segregated distribution of the sexes. The difficulty in interpreting the fluctuations of this ratio is due to several factors, such as the behaviour of the species, the spawning period and mortality, sampling procedure, aggregation of the of the same sex individuals, etc. The change in weight of the ovaries and the testes during the cycle of maturation shows that the gonads develop at stage II, increased at stage III then regress at stage IV. The weight of the testes is higher than that of the ovaries during this last phase; this could indicate intense expulsion of the sexual products of females.

The monthly evolution of GSI follows a similar pattern for the two sexes, the spawning starting at the beginning of February to continue until July. The period of reproduction (Tab. 1) extends from February to July with a peak in June, while in central Algerian waters (Bousmail Bay), the reproduction is during summer and at its maximum in July-August. In certain areas (Spain, Portugal, France and Morocco) *T. trachurus* has an early spawning period beginning in spring with a maximum around March and all

Tab. 1: The spawning period and length at first maturity obtained for *Trachurus trachurus* by various authors.**Tab. 1: Obdobje drstivne in dolžina, ko šnjur *Trachurus trachurus* doseže spolno zrelost po različnih avtorjih.**

Authors	Area	Lm50% (cm)	Spawning period
Polonsky, 1969	North Sea and English Channel	20 - 24 *	-
Sedletskaia, 1971	North Africa	16 - 23	-
Macer, 1974	North Sea and English Channel	20 - 24	March to August
Arneri, 1983	Adriatic	15 - 18	-
Arruda, 1984	Portuguese coast	Western coast	November to May
		Matosinhos Bay	April to December
		Southern coast	Whole year
Kerstan, 1985	North -East Atlantic (British water)	24.2 - 24.6	-
Korichi, 1988	Algiers Bay (Bou-Ismaïl bay)	14.2 *	-
Eaton, 1989	West of the British Isles		March to July
Hecht, 1990	South-East coast of South Africa	32 - 33	June to November
Abaunza et al., 1995	North-west of Spain Galician and Cantabrian shelf	20.9 M 21.9 F	February to May
Kerstan, 1995	Southwest coast of Ireland	19.8 M 25 F	-
	Northern biscary	19.4 M 24.6 F	-
	South of biscary	19 M 25.3 F	-
Karlou-Riga & Economidis, 1996	Aegean Sea	22	-
Karlou-Riga & Economidis, 1997	Saronikos Gulf (Greece)	-	December to April
Viette et al., 1997	Italy Gulf of Trieste	15.6 M 16 F	May to August
Abaunza et al., 2003	Northwest Atlantic	16 - 25	February to August
Šantić et al., 2008	Eastern Adriatic Sea	-	December to May
Tahari, 2011	Oran Bay (Algeria)	-	October to March
Aydin & Karadurmuş, 2012	Ordu Black Sea (Turkey)	-	May to August
Carbonara et al., 2012	Central-Western Mediterranean Sea	GSA 10 17.8 M 18.9 F	
		GSA 18 17.8 M 18.9 F	
		GSA 19 17.8 M 18.9 F	
Aydin & Erdoğan, 2018	Northern Aegean Sea between (Turkey)	13 F	April to August
Gherram et al., 2018	Oran Bay (Algeria)	18.42 M 18.28 F	January to May
Azzouz et al., 2019	Gulf of Skikda (Algeria)	14 M 13.65 F	December-April
Ferreri et al., 2019	Central Mediterranean Sea: Strait of Sicily: Tyrrhenian Sea	16.1 17.6	-
Present study	Béni-Saf Bay	15.6 cm M 14.9 F	February to July

the authors attribute this to the temperature of the medium. An increase in the temperatures beyond 11 °C conditions the development of the eggs (Villamor *et al.*, 1997; Wahbi *et al.*, 2015). Our study shows that *Trachurus trachurus* females reached their sexual maturity at 14.9 cm, earlier than males, which attain this maturity at 15.6 cm TL.

To indicate the importance of our results regarding size at first sexual maturity (Lm 50%), the comparative study sets out with different research groups (Tab. 1). Firstly, it is clear that our (Lm 50%) value was much higher than those reported by Aydin & Erdoğan (2018, Northern Aegean Sea near Turkey) and Azzouz *et al.* (2019, Gulf of Skikda, Algeria). On the other hand, the obtained (Lm 50%) value comported fairly well with Viette *et al.* (1997, Italy, Gulf of Trieste), Arneri (1983, Algeria; 1983, Adriatic), and Korichi (1988, Algiers

Bay). We found no significant differences compared with research groups of Arruda (1984, Portuguese coast), Abaunza *et al.* (2003, Northwest Atlantic) and Ferreri *et al.* (2019, central Mediterranean Sea), etc. (see Tab. 1).

T. trachurus from Béni-Saf Bay reaches sexual maturity at an earlier size, and this suggests that the fish has changed its sexuality strategy to ensure its sustainability. The species changes the size of its first sexual maturity and reproduces very early.

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OBDOBJE DRSTENJA, SPOLNA ZRELOST IN SPOLNI DELEŽ ŠNJUROV *TRACHURUS TRACHURUS* IZ ZALIVA BÉNI-SAF BAY (ZAHODNA OBALA ALŽIRIJE, JUGOZAHODNO SREDOZEMSKO MORJE)

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POVZETEK

Avtorji so raziskovali razmnoževalne posebnosti pri navadnem šnjuru, *Trachurus trachurus* (Linnaeus, 1758), iz zaliva Béni-Saf. V obdobju med novembrom 2015 in oktobrom 2017 so analizirali skupno 355 primerkov, od katerih je bilo 47,04 % samcev, 44,79 % samic in 8,17 % nedoločenih primerkov. Šnjuri so merili med 7,2 in 35,4 cm v dolžino in tehtali od 5,28 do 312,7 g. Spolno zreli samci so merili v dolžino 15,6 cm, spolno zrele samice pa so dosegle 14,9 cm v dolžino. Spremembe v gonadosomatskem indeksu (GSI) so pokazale, da se gonade pri obeh spolih pričnejo razvijati konec februarja, spolno dozoriijo pa v maju in juniju, kar opredeljuje obdobje drstenja pri vrsti. Primerki *T. trachurus* iz zaliva Béni-Saf porabljajo prehranske rezerve, pridobljene spomladi, za razvoj spolnih produktov za zgodnje poletni drst.

Ključne besede: navadni šnjur, *Trachurus trachurus*, razmnoževanje, Béni-Saf Bay, Alžirija

REFERENCES

- Abaunza, P., L. Gordo, C. Karlou-Riga, A. Murta, A.T.G.W. Eltink, M.G. Santamaría & J. Molloy (2003):** Growth and reproduction of horse mackerel, *Trachurus trachurus* (Carangidae) Reviews in Fish Biology and Fisheries, 13(1), 27-61, <https://doi.org/10.1023/A:1026334532390>.
- Abaunza, P., A.C. Farina & P. Carrera (1995):** Geographic variations in sexual maturity of the horse mackerel, *Trachurus trachurus*, in the Galician and Cantabrian shelf (Spain). Scientia Marina, 59(3-4), 211-222.
- Arneri, E. (1983):** Nota preliminare sulla biologia della specie del genere *Trachurus* (*T. mediterraneus*, *T. trachurus*, *T. picturatus*) in Adriatico. Nova Thalassia, 6, 459-464.
- Arruda, L. M. (1984):** Sexual maturation and growth of *Trachurus trachurus* (L.) along the Portuguese coast. Investigacion Pesquera, 48(3), 419-430.
- Athanassios, T. & S. Konstantinos (2015):** Age at maturity of Mediterranean marine fishes. Mediterranean Marine Science, 16(1), 5-20, <https://doi.org/10.12681/mms.659>.
- Aydin, M. & U. Karadurmuş (2012):** Age, growth, length-weight relationship and reproduction of the Atlantic horse mackerel (*Trachurus Trachurus* Linnaeus, 1758) in Ordu (Black Sea). Ordu Üniversitesi Bilim ve Teknoloji Dergisi, 2(2), 68-77, <https://dergipark.org.tr/en/pub/ordubtd/issue/11064/132159>.
- Aydın, G.U. & Z. Erdoğan (2018):** Edremit Körfezi (Kuzey Ege Denizi, Türkiye)'nden avlanan *Trachurus trachurus* (L., 1758)'un bazı üreme özellikleri. Balıkesir Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 20(2), 164-176, <https://doi.org/10.25092/baunfbed.412525>.
- Azzouz, S., L. Mezedjri & A. Tahar (2019):** Reproductive cycle of the pelagic fish Saurel *Trachurus trachurus* (Linnaeus, 1758) (Perciformes Carangidae) Caught in the Gulf of Skikda (Algerian East Coast). Biodiversity Journal, 10(1), 13-20, <https://doi.org/10.31396/Biodiv.Jour.2019.10.1.13.20>.
- Ben Salem, M. & M. Ktari (1994):** Sexualité et reproduction des espèces du genre *Trachurus* Rafinesque, 1810 des côtes tunisiennes (Poissons Téléostéens Carangidae). Bulletin Institut National Scientifique & Technologie de la mer Salammbô, 21, 88-103.
- Carbonara, P., L. Casciaro, I. Bitetto & M.T. Spedicato (2012):** Reproductive cycle and length at first maturity of *Trachurus trachurus* in the central-western Mediterranean Sea. Biol. Mar. Mediterr., 19(1), 204-205.
- Crim, L. W., B.D. Glebe, C.B. Schreck & P.B. Moyle (1990):** Methods for fish biology. CB Schreck & PB Moyle (eds.), pp. 529-553.
- Eaton, D.R. (1989):** Spawning-stock biomass of scad (*Trachurus trachurus* L.) to the west of the British Isles, as indicated by egg surveys. ICES Journal of Marine Science, 45(3), 231-247, <https://doi.org/10.1093/icesjms/45.3.231>.
- Ferreri, R., R.S. McBride, M.Barra, A. Gargano, S. Mangano, M. Pulizzi & G. Basilone (2019):** Variation in size at maturity by horse mackerel (*Trachurus trachurus*) within the central Mediterranean Sea: Implications for investigating drivers of local productivity and applications for resource assessments. Fisheries Research, 211, 291-299, <https://doi.org/10.1016/j.fishres.2018.11.026>.
- Fezzani Serbaji, S., A. Gaamour, L. Ben Abdallah & A. El Abed (2002):** Période de reproduction et taille de première maturité sexuelle chez les Chinchards (*Trachurus trachurus* et *Trachurus mediterraneus*) de la région Nord de la Tunisie. Bulletin Institut National des Sciences et Technologies de la Mer, Salammbô, pp. 9-12.
- Gherram, M., A. Bensahla Talet, F. Dalouche & S.M.E.A. Abi Ayad (2018):** Study of reproductive aspects of *Trachurus trachurus* (L. 1758) from western coast des of Algeria. Indian Journal of Geo-Marine Sciences, 47(12), 2469-2476.
- Hecht, T. (1990):** On the life history of Cape horse mackerel *Trachurus trachurus* capensis off the south-east coast of South Africa. South African Journal of Marine Science, 9(1), 317-326, <https://doi.org/10.2989/025776190784378907>.
- Karlou-Riga, C. (1996):** Ovarian atretic rates and sexual maturity of European horse mackerel, *Trachurus trachurus* (L.), in the Saronikos Gulf (Greece). Fisheries Bulletin, 94, 66-76.
- Karlou Riga, C. & P.S. Economidis (1997):** Spawning frequency and batch fecundity of horse mackerel, *Trachurus trachurus* (L.), in the Saronikos Gulf (Greece). Journal of Applied Ichthyology, 13(3), 97-104, <https://doi.org/10.1111/j.1439-0426.1997.tb00108.x>.
- Kerstan M. (1985):** Age, growth, maturity, and mortality estimates of horse mackerel (*Trachurus trachurus*) from the waters west of Great-Britain and Ireland in 1984. Archiv fur Fischereiwissenschaft, 36(1-2), 115-154.
- Kerstan, M. (1995):** Ages and growth rates of Agulhas Bank horse mackerel *Trachurus trachurus* capensis-comparison of otolith ageing and length frequency analyses. South African Journal of Marine Science, 15(1), 137-156, <https://doi.org/10.2989/025776195784156368>.
- Korichi, H.S. (1988):** Contribution à l'étude biologique de deux espèces de saurel : *Trachurus trachurus* (L. 1758) et *Trachurus mediterraneus* (Steinsachner 1868) et de la dynamique de *Trachurus trachurus* en baie de Bou-Ismaïl (Algérie). Thèse de magister en halieutique, ISMAL. 260 pp.
- Mahdi, H., L. Bensahla Talet & Z. Boutiba (2018):** Reproductive biology of the common pandora *Pagellus erythrinus* (Linnaeus, 1758) of Oran Bay (Algerian west coasts). Turkish Journal of Fisheries and Aquatic Sciences, 18(1), 1-7, https://doi.org/10.4194/1303-2712-v18_1_01.

Macer, C.T. (1974): The reproductive biology of the horse mackerel *Trachurus trachurus* (L.) in the North Sea and English Channel. *Journal of Fish Biology*, 6(4), 415-438, <https://doi.org/10.1111/j.1095-8649.1974.tb04558.x>.

Parsons, D.M., M.A. Morrison M.J. & Slater (2010): Responses to marine reserves: decreased dispersion of the sparid *Pagrus auratus* (snapper). *Biological Conservation*, 143(9), 2039-2048, <https://doi.org/10.1016/j.biocon.2010.05.009>.

Polonsky, A.S. (1969): Growth, age and maturation of the horse mackerel (*Trachurus trachurus* Linné) in the north-east Atlantic. *Trudy Atlant NIRO*, 23, 49-60.

Šantić, M., Jardas I. & A. Pallaoro (2003): Feeding habits of Mediterranean horse mackerel, *Trachurus mediterraneus* (Carangidae), in the Central Adriatic Sea. *Cybium*, 27(4), 247-253.

Šantić, M., Pallaoro A. & Jardas I. (2008): Seasonal variation of gonado-somatic index and length-weight relationship in the horse mackerel, *Trachurus trachurus* (Osteichthyes: Carangidae) from the eastern Adriatic Sea. *Cahiers de biologie marine*, 49(4): 303-310.

Sedletskaya, V.A. (1971): The dynamic of spawning in *Trachurus trachurus* L. by shores of North-West Africa. *Trudy Atlant NIRO*, 41, 122-130.

Tahari, F.Z. (2011): Contribution a l'étude de la biologie de la reproduction d'un petit pélagique le saurel *Trachurus trachurus*: Spermatogenèse, Condition, RGS, RHS. Thèse de Magister. Université d'Oran, 69 pp.

Viette, M., P.G. Giulianini & E.A. Ferrero (1997): Reproductive biology of scad, *Trachurus mediterraneus* (Teleostei, Carangidae), from the Gulf of Trieste. *ICES Journal of Marine Science*, 54(2), 267-272, <https://doi.org/10.1006/jmsc.1996.0185>.

Villamor, B. & P. Abaunza, P. Lucio & C. Porteiro (1997): Distribution and age structure of mackerel (*Scomber scombrus*, L.) and horse mackerel (*Trachurus trachurus*, L.) in the northern coast of Spain, 1989-1994. *Scientia Marina*, 61(3), 345-366.

Wahbi, F., F. Le Loc'h, Am. Berreho, A. Benazzouz, Ab. Ben Mhmed & A. Errhif (2015): Composition et variations spatio-temporelles du régime alimentaire de *Trachurus trachurus* (Carangidae) de la côte atlantique marocaine. *Cybium*, 39(2), 131-142.

NEW RECORD OF THE ATLANTIC POMFRET *Brama brama* (Bonnaterre, 1788) (SCOMBRIFORMES: BRAMIDAE) FOR GHAZAOUET BAY, WESTERN MEDITERRANEAN SEA

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ABSTRACT

The present paper reports the first record of the Atlantic pomfret *Brama brama* for western Algerian waters in the Western Mediterranean Sea. It is a high migratory species, rarely met in Algerian fisheries. One specimen of *B. brama* was caught by a seiner operating in Ghazaouet Bay on September 6th 2018, measuring 672.5 mm of standard length (SL), and weighting 4,740 grams (g), constituting the new maximum length recorded for the species in the Mediterranean Sea. Accordingly, we describe biometrical and meristic characteristics, literature, databases and fish collections review of this bramid, firstly record for the Algerian waters.

Keywords: Algeria, bramid, morphometrics, new occurrence.

RESUMO

O presente artigo consiste no primeiro registro da espécie palombeta *Brama brama* para a águas do mar Mediterrâneo ocidental na Argélia. É uma espécie altamente migratória, mas raramente encontrada nas peixarias da Argélia. Um espécime de *B. brama* foi capturado por um pescador que operava na Baía de Ghazaouet em setembro 2018, o exemplar obtido mediu 672,5 mm de comprimento padrão e pesou 4.740 g, constituindo no novo comprimento máximo registrado para a espécie no mar Mediterrâneo. Desta forma, apresentamos as características biométricas e merísticas, revisão de literatura, bancos de dados e revisão de coleções do primeiro registro dessa espécie de bramídico em águas argelinas. Palavras-chave: Argélia, bramídeo, morfometria, nova ocorrência.

Brama brama (Bonnaterre, 1788) is a pelagic neritic and oceandromous species occurring at depths ranging from 0 to 1,000 meters (m), usual between 0 and 200 m, occasionally coming close to the shore (Smith, 1986). It lives in temperatures ranging from 12°C to 24°C, being a seasonal migrant species, occurring in small schools performing movements apparently related to the water temperature (Mead & Haedrich, 1965; Kells & Carpenter, 2011). This species usually feeds on small fishes, cephalopods, amphipods, and euphausiids (Haedrich, 1986).

This species possesses a widespread distribution, occurring along the Atlantic, Indian and South Pacific oceans, from 65°N to 70°S, and from 180°W to 180°E (McMillan *et al.* 2011). In Western Atlantic it is distributed from Nova Scotia, Canada and Bermuda (Robins & Ray, 1986) to Belize and the Antilles (Claro, 1994). It can also be found in Brazil and in Argentine (Menni *et al.* 1984), and lives from zero to 400 m depth in northern continent from Cape Cod (39°58'N, 70°46'W) to the Grand Banks of Newfoundland, Canada and south to northern South America (Scott & Scott, 1988; Moore *et al.*

2003). In the Eastern Atlantic, *B. brama* occurs from central Norway to Algoa Bay, in South Africa. For West African coasts, it ranges from Morocco (30°N) to South Africa (35°S) (Haedrich, 2016 in Carpenter & De Angelis, 2016). This species ranges from Walvis Bay, in Namibia, to the extreme south around the Cape of Good Hope to Algoa Bay, in South Africa, in depths from 50 to 1,000 m, rarely occurring near land (Heemstra & Heemstra, 2004). It could also be found in Pacific Ocean: in Australia (May & Maxwell, 1986) and New Zealand (Paulin *et al.*, 1989).

The Atlantic pomfret is a cosmopolitan and highly migratory oceanic and epipelagic species. It is generally found on the continental slope (at depths down to 1000m) (Bianchi *et al.* 1993). In the Northeast Atlantic and western Mediterranean, *B. brama* is targeted as a seasonally important fisheries resource in semi-pelagic longline fisheries in Galicia (northwestern Spain), in Portugal and off northwest Africa (Lobo & Erzini, 2001). In Spain *Brama brama* has a great economic importance, being generally

marketed fresh (Pérez-Alonso *et al.* 2004). It also has been used as a replacement for higher-cost species in the production of smoked fish products (Pérez-Alonso *et al.* 2003). In a majority of fisheries this bramid is taken as bycatch, which is the case of south coast of Portugal, where *B. brama* is the second most abundant commercial species in the hake (*Merluccius merluccius* Linnaeus, 1758) fishery (Erzini *et al.*, 2001). It is also taken as bycatch in legal and illegal tuna driftnet fisheries (Bănarău *et al.*, 2010).

Heemstra & Heemstra (2004) and Quigley (2008) argued that *B. brama* is a pelagic offshore species constituting an important prey item to large marine predators as tunas, mackerels and marlins. Despite its commercial importance, relatively little is known about the species' population dynamics. Although the species was first recorded for Irish waters in 1843, it was still regarded as scarce up until the late 1950s, but between 1960s and 1970s large numbers were recorded. Nevertheless, the species would appear to have made a comeback between 2003 and 2007, with increasingly significant quantities landed by commercial long-liners off the west coast. Significant numbers have been found stranded on North Sea coasts, possibly due to disorientation caused by decreasing water temperatures (<13°C) (Quigley, 2008). The vast majority (>80%) of Ray's Bream recorded in Irish waters have been taken by commercial trawlers, and specimens were taken near the surface with feather/mackerel/jigs during the hours of darkness (Quigley, 2008). In Eastern Atlantic (Galicia, NW Spain) Rodriguez, 1980 noticed the same phenomenon between 1969 and 1975 that *B. brama* became scarce and fleet was obliged to move to the North-West coasts of Africa. To evaluate population trends a first attempt was leaded by IUCN experts (Quignard *et al.*, 2011) and concluded that the species is data deficient then a second report in 2015 concluded that the species is classified as LC (Least Concern) with a decline in mature individuals (Colette *et al.*, 2015).

Brama brama is not directly targeted by fishing gears but can be a by-catch of semi-industrial fishing, purse seines, trawls, gillnets, bottom longlines, drifting longlines, it is also a Least Concern (LC) species on the IUCN Red List (ver 3.1) (Iwamoto *et al.* 2015). Many documents dealing with this species are available in the literature, such as: age and growth (Lobo & Erzini, 2001; Paul *et al.* 2004; Hermas *et al.* 2019); occurrence and fisheries (Mead & Haedrich, 1965; Boyd, 1970; Williams, 1977; Quigley, 2008; Quigley & Flannery, 2008; Quero *et al.* 2009; Garibaldi, 2015; Anastasopoulou *et al.* 2016; Bolshakova & Evseenko, 2016; Masski & Ait Hammou, 2016; Mafwila, 2017; Akyol *et al.* 2019); bioecology and behavior (Rodriguez, 1980; Dulčić, 1999; Richards, 2003; Hanel & John, 2014; Quinzán *et al.* 2016); pollution (Neves *et al.*, 2015; Štrbac *et al.*, 2015; Dione *et al.*, 2018); parasites (Llarena-Reino *et al.*, 2015); and food process (Pérez-Alonso *et al.*, 2003; Pérez-Alonso *et al.*, 2004); but up to date there are no works reporting this species for Algerian waters.

On 6th September 2018 a single specimen of *B. brama* (Figure 1) was caught by a seiner in Ghazaouet Bay (35°06'18.4"N 1°51'26.7"W) (Figure 2), in the western Algerian coast. Thirteen morphometric characteristics were made adapted from Akyol *et al.* (2019) (Table 1). The measures were carried out using a digital caliper to the nearest 0.01mm.

FAO identification sheets (Gomes, 1990; Haedrich, 2016) was used to identify the specimen as *Brama brama* (Figure 1), and morphometric characteristics are summarized in Table 1. The species is characterized by having: a moderate body height and somewhat compressed; head very compressed with very convex back profile; very rounded interorbital space; large oblique mouth; wide and scaly maxillary extending at least up to the middle of the eye; lower edge of the mandibles in close contact on the ventral median line behind the symphysis, the isthmus not being visible between

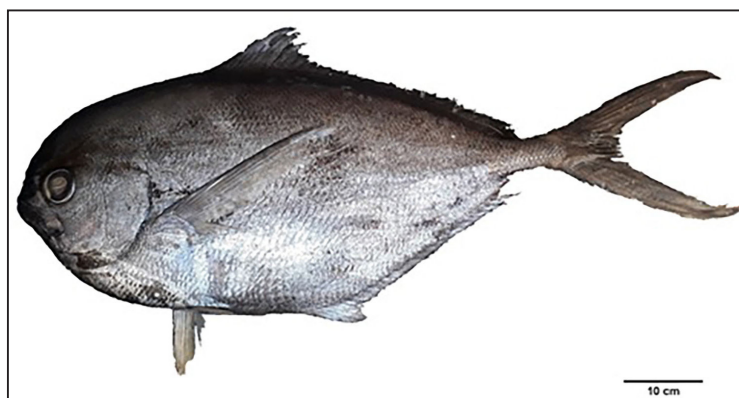


Figure 1. Specimen of *Brama brama* (672.5 mm SL) collected in Ghazaouet Bay, Algeria. Photographed by L. Bensahla-Talet.

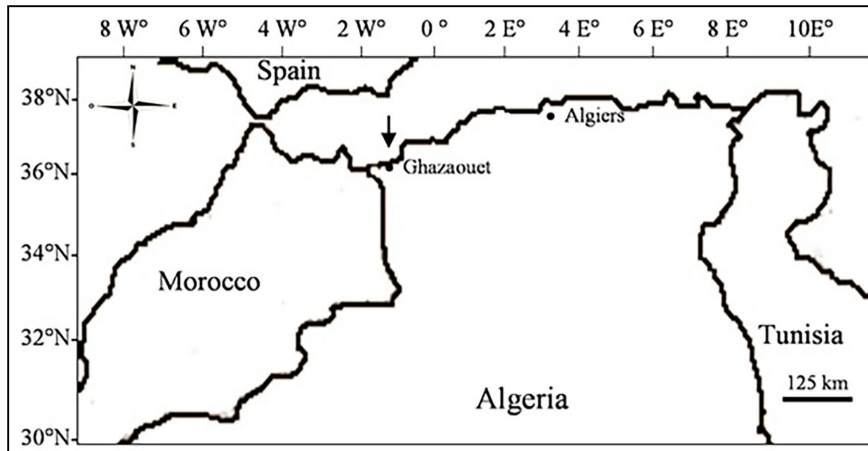


Figure 2. Localization of sampling zone (Ghazaouet Bay), western Algerian coast, Mediterranean Sea. The arrow indicates the location where the specimen was collected.

Table 1. Morphometric measurements in mm of the specimen of *Brama brama*.

Morphometrical characteristic		Measurement (mm)	% of SL
TL	Total length	850.53	126.46
FL	Fork length	720.47	107.12
SL	Standard length	672.57	100.00
POD1	Pre ocular distance	33.54	4.99
ED	Eye diameter	38.27	5.69
POD2	Post ocular distance	90.02	13.38
H	Head length	165.42	24.60
Dfl	Dorsal fin length	370.64	55.11
Afl	Anal fin length	296.18	44.04
Vfl	Ventral fin length	62.80	9.34
Pfl	Pectoral fin length	237.47	35.31
Hmin	Minimum body height	42.00	6.24
Hmax	Maximum body height	297.16	44.18
Meristic characters			
Dorsal fin rays		36	
Anal fin rays		28	
Pectoral fin rays		20	
Ventral fin rays		8	
Scales rows		46	
Scales of lateral line		83	

them; pectoral fins extending beyond the lobe of the anal; pelvic fin inserted under the base of the pectorals or slightly further back and surmounted by a large axillary scale; lateral line barely visible in adults; smooth scales, with unequal edges, covering the head, the body and extending on the odd fins; and a coloration characterized by a silvery black, odd fins slightly lighter (Gomes, 1990; Haedrich, 2016).

Brama brama can easily be misidentified with a similar species occurring in the same area named the lesser bream, *Brama dussumieri* Cuvier, 1831, which presents 19 to 21 pectoral-fin rays (usually 22), 35 to 38 dorsal-fin rays, 29 to 32 anal-fin rays, 15 to 18 gill rakers on first arch, 70 to 80 lateral-line scales with a maximum length not exceeding 37 cm of total length; while *B. brama* presents 19 to 21 pectoral-fin

rays (usually 20), 33 to 35 dorsal-fin rays, 26 to 28 anal-fin rays, 13 to 15 gill rakers on first arch, 57 to 65 lateral-line scales (Haedrich, 2016) with a maximum length of 101 cm of total length (Claro, 1994) and a maximum weight of 6 kg (Muus & Dahlström, 1978).

Brama brama is rare in the Mediterranean Sea (Bauchot, 1987; Quignard *et al.* 2011). It was reported for: the Eastern Mediterranean by Bilecenoglu *et al.* (2002), Golani *et al.* (2005), Akyol & Ulaş (2019); the Central Mediterranean by Dulčić *et al.* (1999, 2003), Corsini-Foka (2009), Mytilineou *et al.* (2013), Garibaldi *et al.* (2015), Anastasopoulou *et al.* (2016), Elbaraasi *et al.* (2019); and the Western Mediterranean by Quero *et al.* (2008), Ranz (2017) where it seems to be concentrated in Balearic Sea (GBIF, 2020; OBIS, 2020). However, there are no records for North African waters nor for Algerian waters.

According to Mead (1972), *B. brama* has specific temperature requirements. Quinzán *et al.* (2016) unveiled the influence of the environment on the migration pattern of the Atlantic pomfret (*Brama brama*), and observed that during years with cooler surface waters the Atlantic pomfret is only available in restricted areas and yields are low while large migrations are observed in scenarios of high SSTs in the migratory area (above 14.7°C). Migrations, however, are constrained during years when temperatures are below this threshold. Migration is often driven by biological needs such as reproduction and food but is also often constrained by climate variability.

Occhipinti-Ambrogi & Galil (2010) argued that climate changes facilitate overcoming historic geographic barriers. Although, recent increases, over the last thirty years, in the sea surface temperature (SST) of the Canary Islands area, with records over 24°C, can be observed, influencing the distribution of the species (Santos *et al.* 2012) due to global warming (Walther *et al.*, 2002; Parmesan, 2006; González-Lorenzo *et al.*, 2013). Moullec *et al.* (2016) have noticed the same phenomenon in the Mediterranean basin and deducted that temperature has a major direct effect on the physiology, growth, reproduction, recruitment and behavior of poikilothermic organisms such as fishes. The warming of the Mediterranean Sea affects the fitness of marine biota as already shown by records of changes in abundance, survival and fertility, phenology and species migration (Marbà *et al.* 2015).

This first record of *B. brama* in western Algerian waters can be explained by the fact that Algerian waters are located at the entrance of Gibraltar strait,

being the second point after the first one in Morocco (Masski & Hammou, 2016), since the whole trajectory of this high migratory bramid movement is highly influenced by elevated water temperatures in this period of the year (Mead, 1972). Consistent studies should be leaded to retrace real migratory pathway of this species and explain why its unusual presence is scattered throughout the Mediterranean basin, and at the same time concentrated around the Balearic Islands. It is also concluded whether this presence in the Mediterranean was not influenced only by temperature fluctuations, but also by other environmental factors namely nutritional or physiological needs such as the search for new spawning grounds for the species.

The largest specimen of *B. brama* ever reported was in Cuba (Claro, 1994) with 1,010 mm TL and with 6000g, while the largest specimen in the Mediterranean was recorded in Greek waters of the southern Aegean Sea, with 700 mm TL and 4,500 g (Corsini-Foka, 2009). In the Eastern Ionian Sea, Mytilineou *et al.* (2013) reported the largest specimen, measuring 643 mm TL and with 3,638 g; and in the Eastern Adriatic Sea Dulčić *et al.* (2003) reported a specimen measuring 4,062 mm TL and weighting 6,442 g. Recently, a specimen with 710 mm TL and 5,696 g was caught in Turkish waters (Akyol & Ulaş, 2019). Our specimen collected in Ghazaouet Bay has 850.5 mm TL and 4,740 g, constituting the new maximum record for the species in the Mediterranean Sea.

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REFERENCES

- AKYOL, O. & ULAŞ, A. 2019. Occurrence of the Atlantic pomfret, *Brama brama* (Bonnaterre 1788) (Perciformes: Bramidae) in the Aegean Sea (Siğacik Bay, Turkey). *Aquat. Res.* 2 (1): 32-35.
- ANASTASOPOULOU, A., BIANCOLINO, F., CHATZISPYROU, A., HEMIDA, F., GUIJARRO, B., KOUSTENI, V., MYTILINEOU, C.H. & PRATO, E. 2016. New Fisheries-related data from the Mediterranean Sea (November, 2016). *Medit. Mar. Sci.* 17(3), 822-827. doi:10.12681/mms.1909
- BĂNARU, D., DEKEYSER, I., IMBERT, G. & LAUBIER L. 2010. Non-target and released alive

- by-catch distributions observed during French driftnet fishery in the Northwestern Mediterranean Sea (2000-2003 database). *J. Oceanogr. Res. Data* 3: 33-45.
- BAUCHOT, M. L. 1987. Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Commission des Communautés Européennes and FAO, Rome.
- BIANCHI, G., CARPENTER, K. E., ROUX, J. P., MOLLOY, F. J., BOYER, D. & BOYER, H. J. 1993. FAO species identification field guide for fishery purposes. The living marine resources of Namibia. FAO, Rome.
- BILECENOGLU, M., TASKAVAK, E., MATER, S., & KAYA, M. 2002. Checklist of the marine fishes of Turkey. *Zootaxa*, 113(1), 1-194.
- BOLSHAKOVA, Y. Y. & EVSEENKO, S. A. 2016. On species composition of ichthyoplankton of the Mid-Atlantic Ridge (South Atlantic). *J. Ichthyol*, 56(4), 522-533. doi: 10.1134/S0032945216040020
- BONNATERRE, P. J. 1788. Tableau encyclopédique et méthodique des trois règnes de la nature. *Ichthyologie*. - pp. i-lvj [= 1-66], 1-215. Paris. (Pancoucke).
- BOYD, R. J. 1970. A Ray's Bream, *Brama brama* (Bonnaterre), Found Stranded in Belfast Lough. *Ir. Nat.' J.*, 313-314.
- CARPENTER, K. E. & DE ANGELIS, N. (EDS.) 2016. The living marine resources of the Eastern Central Atlantic. Volume 4. Bony fishes part 2 (Perciformes to Tetraodontiformes) and Sea turtles. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. [Orders and families by individual authors.]. i-xiii + 2343-3124.
- CLARO, R. 1994. Características generales de la ictiofauna. p. 55-70. In R. Claro (ed.) Ecología de los peces marinos de Cuba. Instituto de Oceanología Academia de Ciencias de Cuba and Centro de Investigaciones de Quintana Roo.
- CORSINI-FOKA, M. 2009. Uncommon fishes from Rhodes and nearby marine region (SE Aegean Sea, Greece). *J. Biol. Res-Thessaloniki*, 12, 125-133.
- DIONE, C. T., DIAGNE, I., NDIAYE, M., DIEBAKATE, C., NDIAYE, B. & DIOP, A. 2018. Contamination Métallique D'une Espèce De Poisson (*Brama Brama*) De La Côte Dakaroise. *Eur. Sci. J.* 14(12). doi: 10.19044/esj.2018.v14n12p374
- DULČIĆ, J. 1999. First record of larval *Brama brama* (Pisces: Bramidae) and *Corphaena hippurus* (Pisces: Coryphaenidae) in the Adriatic Sea. *J. Plankton. Res.*, 21(6).
- DULČIĆ, J., PALLAORO, A., ONOFRI, V., LUČIĆ, D., JARDAS, I. 2003. New additional records of Imperial blackfish, *Schedophilus ovalis* (Cuvier, 1833), White trevally, *Pseudocaranx dentex* (Bloch & Schneider, 1801), and Atlantic pomfret, *Brama brama* (Bonnaterre, 1788), in the eastern Adriatic. *Ann. Ser. Hist. Nat.*, volume 13, issue 2, str. 149-154.
- ELBARAASI, H., ELABAR, B., ELAABIDI S., BASHIR A., ELSILINI O., SHAKMAN, E. & AZZURRO, E. 2019. Updated checklist of bony fishes along the Libyan coast (southern Mediterranean Sea). *Mediterr. Mar. Sci.* 20 (1): 90-105.
- ERZINI, K., GONÇALVES, J.M.S, BENTES, L., LINO, P.G. & RIBEIRO, J. 2001. The hake deepwater semi-pelagic ("pedra-bola") longline fishery in the Algarve (southern Portugal). *Fish. Res.* 51: 325-334.
- FRICKE, R., BILECENOĞLU, M. & SARI, H. M. 2007. Annotated checklist of fish and lamprey species (Gnathostomata and Petromyzontomorphi) of Turkey, including a Red List of threatened and declining species. *Stuttg. Beitr. Naturkd., A (Biologie)*. 706: 1-169.
- GARIBALDI, F. 2015. By-catch in the mesopelagic swordfish longline fishery in the Ligurian Sea (Western Mediterranean). *Collect. Vol. Sci. Pap. ICCAT*, 71(3), 1495-1498.
- GONZÁLEZ-LORENZO, G., GONZÁLEZ JIMÉNEZ, J. F., BRITO, A. & GONZÁLEZ, J. A. 2013. The family Bramidae (Perciformes) from the Canary Islands (northeastern Atlantic Ocean), with three new records. *Cybium*. 37(4): 295-303.
- GBIF. 2019. *Brama brama* (Bonnaterre, 1788) GBIF Backbone Taxonomy. Checklist dataset <https://doi.org/10.15468/39omei> accessed via GBIF.org on 2020-03-21.
- GOLANI, D. 2005. Checklist of the Mediterranean fishes of Israel. *Zootaxa* 947: 1-90.
- GOMES, J., 1990. Bramidae. p. 758-764. In J.C. Quéro, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNCT, Lisbon; SEI, Paris; and UNESCO, Paris. Vol. 2.

- HAEDRICH, R. L. 1986. Bramidae. p. 847-853. In WHITEHEAD, P.J.P. BAUCHOT M. L., HUREAU, J.C., NIELSEN, J. & TORTONESE, E. (eds.) *Fishes of the north-eastern Atlantic and the Mediterranean*. UNESCO, Paris. Vol. 2.
- HANEL, R. & JOHN, H. C. 2014. A revised checklist of Cape Verde Islands sea fishes. *J. App. Ichthyol*, 31(1), 135-169. doi: 10.1111/jai.12621
- HEEMSTRA, P. C. & HEEMSTRA, E. 2004. Coastal fishes of southern Africa. NISC (PTY) LTD.
- HERMAS, D., EL GOUMRI, Y., ELBAHI, A., HAFIDI, N & KAYAA, A. 2019. Age and growth of ray's bream: *Brama brama* (bonnaterre, 1788) From the south Atlantic coast of morocco. *International Journal of Agriculture, Environment and Bioresarch* 4, (03):234-241. doi: 10.35410/IJAEB.2019.234241
- IWAMOTO, T., SINGH-RENTON, S., ROBERTSON, R., MARECHAL, J., AIKEN, K. A., DOOLEY, J., COLLETTE, B. B., OXENFORD, H., PINA AMARGOS, F. & KISHORE, R. 2015. *Brama brama*. The IUCN Red List of Threatened Species 2015: e.T195091A19929350. <http://dx.doi.org/10.2305/IUCN.UK.20154.RLTS.T195091A19929350.en>. Downloaded on 12 September 2018.
- KELLS, V. A. & CARPENTER, K. 2011. A field guide to coastal fishes: from Maine to Texas. JHU Press.
- LLARENA-REINO, M., ABOLLO, E., REGUEIRA, M., RODRÍGUEZ, H. & PASCUAL, S. 2015. Horizon scanning for management of emerging parasitic infections in fishery products. *Food Control*, 49, 49-58.
- LOBO, C. & ERZINI, K. 2001. Age and growth of Ray's bream (*Brama brama*) from the south of Portugal. *Fish. Res.*, 51(2-3), 343-347.
- MAFWILA, S. K. 2017. The community structure of demersal fish species from bottom-trawls off Namibia and the West coast of South Africa. *Int. J. Life Sci*, 5(2), 180-188.
- MARBÀ, N., JORDÀ, G., AGUSTÍ, S., GIRARD, C. & DUARTE, C. M. 2015. Footprints of climate change on Mediterranean Sea biota. *Front. Mar. Sci.*, 2, 56.
- MASSKI, H. & AIT HAMMOU, A. 2016. Naming Moroccan fish: when diversity faces standardisation imperatives. *J. App. Ichthyol*, 32(5), 873-882. doi: 10.1111/jai.13098
- MASUDA, H., AMAOKA, K., ARAGA, C., UYENO, T. & YOSHINO, T. 1984. The fishes of the Japanese Archipelago. Vol. 1. Tokai University Press, Tokyo, Japan. 437 p.
- MAY, J. L. & MAXWELL, J. G. H. 1986. Trawl fish from temperate waters of Australia. CSIRO Division of Fisheries Research, Tasmania. 492 p.
- MCMILLAN, P. J., FRANCIS, M. P., JAMES, G. D., PAUL, L. J., MARRIOTT P. J, MACKAY E., WOOD B. A., GRIGGS, L. H., SUI, H. & WEI, F. 2011. New Zealand fishes. Volume 1: A field guide to common species caught by bottom and midwater fishing. New Zealand Aquatic Environment and Biodiversity Report No. 68. 329 p.
- MEAD, G. W. & HAEDRICH, R. L., 1965. The distribution of the oceanic fish *Brama brama*. *Bull. Nhis. Comp. Zool.*, 134(2): 29-68, June, 1965.
- MEAD, G. W. 1972. Bramidae. The Carlsberg Foundation's oceanographical expedition round the World 1928-30 and previous Dana-expeditions. Dana-Report, 1-166.
- MENNI, R. C., RINGUELET R. A. & ARAMBURU, R. H. 1984. Peces marinos de la Argentina y Uruguay. Editorial Hemisferio Sur S.A. Buenos, Aires, Argentina. 359 p.
- MYTILINEOU, C., ANASTASOPOULOU, A., CHRISTIDES, G., BEKAS, P., SMITH, C. J., PAPADOPOULOU, K.N., LEFKADITOU, E. & KAVADAS, S. 2013. New records of rare deep-water fish species in the Eastern Ionian Sea (Mediterranean Sea). *J. Nat. Hist*, 47(25-28), 1645-1662.
- MOORE, J. A., HARTEL, K. E., CRADDOCK, J. E. & GALBRAITH, J. K. 2003. An annotated list of deepwater fishes from off the New England region, with new area records. *Northeast. Nat*, 10 (2): 159-248.
- MOULLEC, F., BEN RAIS LASRAM, F., COLL, M., GUILHAUMON, F., HALOUANI, G. & HATTAB, T. 2016. Climate change impacts on marine resources: From individual to ecosystem responses *In The Mediterranean Region under Climate Change: A Scientific Update* IRD Éditions/ AllEnvi (2016) Marseille. 2(1.3): 229-248.
- MUUS, B. & DAHLSTRÖM, P. 1978. Meeresfische der Ostsee, der Nordsee, des Atlantiks. BLV Verlagsgesellschaft, München. 244 p.
- MUUS, B. J. & NIELSEN, J. G. 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene,

Denmark. 340 p.

NEIRA, F. J., MISKIEWICZ, A. G. & TRNSKI, T. 1998. Larvae of temperate Australian fishes: laboratory guide for larval fish identification. University of Western Australia Press. 474 p.

NEVES, D., SOBRAL, P., FERREIRA, J. L. & PEREIRA, T. 2015. Ingestion of microplastics by commercial fish off the Portuguese coast. *Mar. Poll. Bull.*, 101(1), 119-126. doi:10.1016/j.marpolbul.2015.11.008

OBIS. 2020. Distribution records of *Brama brama* (Bonnaterre, 1788). Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. accessed via www.iobis.org on 2020-03-21.

OCCHIPINTI-AMBROGI, A. & GALIL, B. 2010. Marine alien species as an aspect of global change. *Adv. Oceanogr. Limnol.*, 1(1), 199-218.

PARMESAN, C. 2006. Ecological and evolutionary responses to recent climate change, *Annu. Rev. Ecol. Evol. Syst.* 37 (2006), pp. 637-669.

PAUL, L. J., FRANCIS, M. & MAOLAGÁIN C. O. 2004. Growth rate, age at maturity, longevity, and natural mortality rate of Ray's bream (*Brama sp.*). Final Research Report for Ministry of Fisheries Research Project TUN2003/01 Objective 2. National Institute of Water and Atmospheric Research Limited (NIWA). 29 September 2004.

PAULIN, C., STEWART, A., ROBERTS, C. & MCMILLAN, P. 1989. New Zealand fish. A complete guide. National Museum of New Zealand Miscellaneous Series No. 19. 279 p.

PAVLOV, Y. P. 1991. Information on morphometrics and ecology of pomfrets of the genus *Brama* inhabiting the southeastern Pacific Ocean. *J. Ichthyol.* 31(2):120-123.

PÉREZ-ALONSO, F., ARIAS, C. & AUBOURG, S. P. 2003. Lipid deterioration during chilled storage of Atlantic pomfret (*Brama brama*). *Eur. J. Lip. Sci. Tech.*, 105(11), 661-667.

PÉREZ-ALONSO, F., AUBOURG, S. P., RODRÍGUEZ, Ó. & BARROS-VELÁZQUEZ, J. 2004. Shelf life extension of Atlantic pomfret (*Brama brama*) fillets by packaging under a vacuum-skin system. *Eur. Food. Res. Tech.*, 218(4), 313-317. September 2004. doi: 10.1007/s00217-003-0831-z

QUERO, J. C., SPITZ, J., VAYNE, J. J., AUBY, I., CASAMAJOR, D., LEAUTE, J. P., MARIE,

F., MONHUREL, L. & QUINQUIS, J. 2009. Observations ichtyologiques effectuées en 2008. In *Ann. Soc. Sci. Nat. Charente-Maritime*, 2009,9(9) : 932-940

QUIGLEY, D. T. 2008. Pomfrets (Bramidae) in Irish and Northern European Waters. In *Sherkin Comment. Environmental Quarterly of Sherkin Island Marine Station*. Issue No. 45, 8:1-31.

QUIGLEY, D. T. G. & FLANNERY, K. 2008. Notes on some uncommon and unusual fishes recorded between 1988 and 2007. *Ir. Nat. J.*, 29, 60-65.

QUIGNARD, J. P., BARICHE, M., OZTURK, B., BIZSEL, C., KARA, M. H. & YOKES, B. 2011. *Brama brama*. The IUCN Red List of Threatened Species 2011: e.T195091A8941573.

QUINZÁN, M., CASTRO, J., MARÍN, M., COSTAS, G., MONSERRAT, S., AMORES, A., MASSUTI E. & HIDALGO, M. 2016. Unveiling the influence of the environment on the migration pattern of the Atlantic pomfret (*Brama brama*) in North-eastern Atlantic waters. *Fish. Oceanogr.* 25(6), 610-623. doi:10.1111/fog.12176.

RANZ, J. 2017. Banco de Datos de la Biodiversidad de la Comunitat Valenciana. Biodiversity data bank of Generalitat Valenciana. Occurrence dataset <https://doi.org/10.15468/b4yqdy> accessed via GBIF.org on 2020-03-21.

RICHARDS, W. J. 2003. Preliminary guide to the identification of the early life history stages of bramid fishes of the western central north Atlantic. NOAA. Tech. Mem. NMFS-SEFSC-500 (May 2003)

RIEDE, K. 2004. Global register of migratory species - from global to regional scales. Final Report of the R&D-Projekt 808 05 081. Federal Agency for Nature Conservation, Bonn, Germany. 329 p.

ROBINS, C. R. & RAY G. C., 1986. A field guide to Atlantic coast fishes of North America. Houghton Mifflin Company, Boston, U.S.A. 354 p.

RODRIGUEZ, V. A. 1980. On the biology and fishery of rays bream (*Brama brama*). *Inv. Pesq.*, 44(2), 241-252.

SANTOS, F., DECASTRO, M., GÓMEZ-GESTEIRA, M. & ÁLVAREZ, I. 2012. Differences in coastal and oceanic SST warming rates along the Canary upwelling ecosystem from 1982 to 2010. *Cont. Shelf. Res.*, 47, 1-6.

SCOTT, W. B. & SCOTT M. G. 1988. Atlantic fishes of Canada. *Can. J. Fish. Aquat. Sci.* 219. 731 pp.

- SMITH, M. M. 1986. Bramidae. p. 633-636. In SMITH M. M. & HEEMSTRA P. C. (eds.) Smiths' sea fishes. Springer-Verlag, Berlin.
- ŠTRBAC, S., KAŠANIN-GRUBIN, M., JOVANČIĆEVIĆ, B. & SIMONOVIĆ, P. 2015. Bioaccumulation of heavy metals and microelements in silver bream (*Brama brama* L.), northern pike (*Esox lucius* L.), sterlet (*Acipenser ruthenus* L.), and common carp (*Cyprinus carpio* L.) from Tisza River, Serbia. *J. Toxicol. Env. Heal. A.*, 78(11), 663-665. 10.1080/15287394.2015.1023406.
- WALTHER, G. R., POST, E., CONVEY, P., MENZEL, A., PARMESAN, C., BEEBEE, T.J.C., FROMENTIN, J.M., HOEGH-GULDBERG, O. & BAIRLEIN, F. 2002. Ecological responses to recent climate change, *Nature* 416 (2002), pp. 389–395.
- WILLIAMS, R. B. 1977. A note on Ray's bream in Norfolk. *Trans. Norfolk Norwich Nat. Soc.* Vol 24 Part 2 (April 1977):1-89.

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

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Short Article

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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 yayılış 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.

As stated by Deudero et al. 2005, Azzurro et al. 2011, Katsanevakis et al. 2011 *P. gibbesi* population invaded the coasts in a short time, and specimens were found everywhere. The high dispersal capacity of *P. gibbesi* suggests that this species could be a potential competitor for the native marbled crab *Pachygrapsus marmoratus*. Nevertheless, Sciberras and Schembri, 2008 observed that in the shallow rocky intertidal zone, *P. gibbesi* overlap with the native grapsid, *Pachygrapsus marmoratus* where they have been considered potential competitors for space and to a lesser degree with the native xanthid, *Eriphia verrucosa*. Müller (2001) found that the two species compete also for food since they have been observed to occur in close proximity.

MATERIALS and METHODS

Our extensive knowledge and monitoring of invasive species in Oran shoreline past years allowed us to easily notice the new presence of this species in July 2017. The method used for the reporting of non-native species consisted of visual patrols, carried out by snorkeling with waterproof camera in the rocky areas and bottom of Oran shoreline (Mazzoldi and De Girolamo, 1998). Visual surveys were realized in free diving between 0 and 3 m and ecological parameters studied were: abundance, habitat (herbarium, sand, rocks, and crevasses), behavior (Indifferent, slow leakage, fast leakage).

RESULTS and DISCUSSION

During our investigation of benthic species richness of Oran coast, we met by chance one specimen of nimble spray crab *P. gibbesi* for the first time in July 2017, at la Madrague beach $35^{\circ}46'02.2''\text{N}$ $0^{\circ}49'06.6''\text{W}$ (Sugar Loaf) (Figure 1). Since then, the species has been observed in 2018 and 2019 (Figure 2), in the same place between 1 and 3m of isobaths.



Figure 1. Location of the signaling zone, la Madrague (Sugar Loaf), Western Mediterranean.

P. gibbesi is a very flat crab. Its shell is slightly longer than wide, and its length measures up to 39 mm in males, 34 mm in females, and between 26 and 30 mm in ovigerous females. It has three front teeth and four-pointed anterolateral teeth. Each ambulatory leg is provided of a row of strong thorns on the anterior margin of the merus. Male pliers are uneven and stronger than those of females or juveniles. The general color is brownish-reddish (Williams, 1965; Noël, 2015).

The species is difficult to photograph in scuba diving because it is very fearful and takes refuge very quickly under stones and in crevices (Noël 2015). It hides with agility in cracks or various cavities. It particularly appreciates the rocks lined with calcareous red algae in a beaten environment. It occurs mainly in the intertidal zone and the first three or four meters deep. Large individuals are met more deeply than young ones (Deudero et al., 2005). It has been reported down to -30 m (Verrill, 1908; Fransen, 1991; Galil, 2006; Otero et al., 2013).

The zone is characterized by rocks, resulting from local development works (aquaculture farm) which offer an ideal habitat for the installation of *P. gibbesi*. As stated previously specimen of this grapsid crab moves very fast and made the task difficult for us to determine the sexes of individuals and population was estimated by the visual census (Mazzoldi and De Girolamo, 1998). For 150 m shorelines we counted 10 individuals in 2017, 30 individuals in 2018, the last estimation was performed in 2019 as a mean of 8 individuals per 10 m so 120 individuals to date. It is to highlight that nimble spray crab is difficult to photograph under scuba diving because it is a very fearful crab and takes refuge very quickly under the cracks and crevices. It was photographed after several attempts in 2019 (Figure 2).



Figure 2. *Percnon gibbesi* photographed in 28th, September 2019 in la Madrague, Oran.
Photograph by Dr. Lotfi Bensahla-Talet

Grapsid crab is considered as Herculean species (reached the Mediterranean by the Strait of Gibraltar). It can be consumed by several fish: common dentex, bar, sea bream, porgies; to this list of predators we can add cephalopods such as octopus and large crustaceans. Perhaps the *Percnon* resist the waves better than the *Pachygrapsus*, being stronger to hold on a rocky substrate (flatter, taller, longer legs). Vegetarian, the species does not seem to have a significant effect on the coastal ecosystems it frequents and to date has no known ecological or economic negative impact.

CONCLUSION

The location of the *P. gibbesi* is very limited in Oran coast, so we can conclude that its distribution is currently discontinuous and localized. More in-depth and methodical studies will give us a broader view of population dynamics and a meaningful response to all relationships with other native species or any changes that this recently introduced alien species could bring to the marine ecosystem.

Acknowledgments: This paper is dedicated to the memory of Professor Ahmed BENSAHLA-TALET (December, 1st 1946 – July, 31th 2020) (Algeria).

REFERENCES

- Azzurro, E., Milazzo, M., Maynou, F., Abelló, P., & Temraz, T. (2011). First record of *Percnon gibbesi* (H. Milne Edwards, 1853) (Crustacea: Decapoda: Percnidae) from Egyptian waters. *Aquatic Invasions*, 5(1), 123-125.
- Bada, N., & Derbal, F. (2018). Premières données écologiques sur le crabe plat exotique et invasif, *Percnon gibbesi* (Milne Edwards, 1853) du golfe d'Annaba, Algérie. *Approche écosystémique en mer méditerranée : avancées et perspectives*, 24-26 Avril 2018. INAT, Tunis.
- Deudero, S., Frau, A., Cerda, M., & Hampel, H. (2005). Distribution and densities of the decapod crab *Percnon gibbesi*, an invasive Grapsidae, in western Mediterranean waters. *Marine Ecology Progress series* (Halstenbek), 285, 151-158.
- Noël, P., & Prouzet A. (2017). in : DORIS, 17/12/2017 : *Percnon gibbesi* (H. Milne Edwards, 1853), <https://doris.ffessm.fr/ref/specie/2848>. Données d'Observations pour la Reconnaissance et l'Identification de la faune et la flore Subaquatiques. Last assessed 26/09/2019.
- Fransen, C. H. J. M. (1991). Preliminary report on Crustacea collected in the eastern part of the North Atlantic during the Cancap and Mauritania expeditions of the former Rijksmuseum van Natuurlike Historie, Leiden. *Nationaal Natuurhistorisch Museum*, Leiden, October 1991, 1-200.
- Galil, B., (2006). *Percnon gibbesi* (H. Milne Edwards, 1853). in DAISIE (Delivering Alien Invasive Species Inventories for Europe), Last Modified: November 6th, 2006: http://www.europe-alien.org/pdf/Percnon_gibbesi.pdf Consulté le 8 Décembre 2019.
- Garcia, L., & Reviriego, B., (2000). Presència del cranc subtropical *Percnon gibbesi* (H. Milne-Edwards, 1853) (Crustacea, Decapoda, Grapsidae) a les Illes Balears. Primera cita a la Mediterrània occidental. *Bolleti de la Societat d'Història Natural de les Balears*, 43, 81-90.
- Katsanevakis, S., Poursanidis, D., Yokes, M.B, Mañic, V., Beqiraj, S., et al. (2011). Twelve years after the first report of the crab *Percnon gibbesi* (H. Milne Edwards, 1853) in the Mediterranean: current distribution and invasion rates. *Journal of Biological Research - Thessaloniki*, 16, 224-236.
- Lamouti, S. (2010). Contribution au développement de cartes biocénétiques dans la région centre de la côte algérienne par la combinaison de méthodes de télédétection et d'observation in situ. Mémoire de magister, USTH, 78 pp.
- Manning, R.B., & Holthuis, L.B. (1981). West Africa Brachyuran Crabs (Crustacea: Decapoda). *Smithsonian Contributions to Zoology*, 306, 1-379.
- Mazzoldi, C., & De Girolamo, M. (1998). Littoral fish community of the Island Lampedusa (Italy): A visual census approach, *Italian Journal of Zoology*, 65(1), 275-280, DOI: 10.1080/11250009809386832
- Menail, A. A., Rachedi, M., & Derbal, F. (2019). New locality records and morphological characterization of the invasive crab population *Percnon gibbesi* (Decapoda: Grapsidae) in the extreme west of the gulf of annaba (algeria). *Vie et milieu-life and environment*, 69(2-3), 169-175.
- Mori, M., & Vacchi, M. (2002). On a new occurrence of the alien flat crab *Percnon gibbesi* (H. Milne-Edwards), in the southern Sicily (Central Mediterranean Sea). *Annali del Museo Civico di Storia Naturale 'Giacomo Doria'*, 94, 295-301.
- Müller, C. (2001). Erstnachweis der Flachkrabbe *Percnon gibbesi* (Crustacea: Decapoda: Grapsidae) für die Balearischen Inseln. *Senckenbergiana Maritima*, 31, 83-89.
- Noël, P. (2015). Le crabe plat des oursins *Percnon gibbesi* (Milne-Edwards H., 1853). in Muséum national d'Histoire naturelle [Ed.], 20juillet2015. Inventaire national du Patrimoine naturel, 10pp., site web <http://inpn.mnhn.fr>
- Otero, M., Cebrian, E., Francour, P., Galil, B., & Savini, D. (2013). Surveillance des espèces envahissantes marines dans les aires marines protégées (AMP) méditerranéennes: guide pratique et stratégique à l'attention des gestionnaires. *UICN*, 1-136.
- Relini, M., Orsi, L., Puccio, V., & Azzurro, E. (2000). The exotic crab *Percnon gibbesi* (H. Milne Edwards, 1853) (Decapoda, Grapsidae) in the Central Mediterranean. *Scientia Marina*, 64, 337-340.
- Sciberras, M., & Schembri, P.J. (2008). Biology and interspecific interactions of the alien crab *Percnon gibbesi* in the Maltese Islands. *Marine Biology Research*, 4(5), 321-332.
- Verrill, A.E. (1908). Geographical distribution; origin of the Bermudian decapod fauna. *American Naturalist (The)*, 289-296.
- Williams, A.B. (1965). Marine Decapod Crustaceans of the Carolinas. *Fishery Bulletin, US Fish and Wildlife Service*, 65(1):xi+298pp.

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

Fatiha DALOUCHE, Lotfi BENSAHLA-TALET, Sidi Mohamed El Amine ABI AYAD & Ahmed BENSAHLA-TALET
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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

INTRODUCTION

The bogue is a widespread species in the eastern Atlantic, found from Norway to Angola, including the Canary, Cape Verde, and Sao Tome-Principe Islands. It is common between the Bay of Biscay and Gibraltar, and in the Mediterranean and Black Seas (Bauchot & Hureau, 1986). This sparid can be found in the shelf or coastal pelagic zone on various bottoms (sand, mud, rocks and seaweeds). Gregarious and ascending to the surface mainly at night, the species is omnivorous, feeding mainly on crustaceans, as well as planktonophagous (Frimodt, 1995).

In Algeria, the Sparidae family is of high commercial importance, with the bogue representing ~ 20 % of all demersal fish landed and 45 % of all sparid catches (D.P.R.H, 2016). *B. boops* is a demersal and semi-pelagic species typifying the daily landed fish in Oran Bay. It moves in aggregations, ascending to the surface mainly at night (Campillo, 1992); in Oran Bay it is fished at depths ranging between 100 and 250 m (*pers. obs.*) and captured by line gear, with bottom trawls and purse seines.

There is some published data on the biology of this species, focusing mainly on the weight-length relationship (Gonçalves *et al.*, 1997; Moutopoulos & Stergiou *et al.*, 2002; Özeydin & Taskavak, 2006; Kara & Bayhan, 2008; Karachle & Stergiou, 2008; Crec'hriou *et al.*, 2013; Özvarol, 2014; Crec'hriou *et al.*, 2015), fishing gear selectivity (Ayaz *et al.*, 2009; Cengiz *et al.*, 2013; Kumova *et al.*, 2015; Eryaşar, 2017; Ilkyaz *et al.*, 2017), feeding habits (Sánchez-Velasco & Norbis, 1997; El-Maremie & El-Mor, 2015), and biology and population dynamics (Anato & Ktari, 1983; Alegria Hernandez, 1989; Gordo, 1996; Allam, 2003; Khemiri *et al.*, 2005; Manaşirli *et al.*, 2006; Monteiro *et al.*, 2006; El-Okda, 2008; Kara & Bayhan, 2008).

Several biological studies on its reproductive cycle have also been conducted (Frau, 1966; Gordo

1995, 1996; Cano Fortuna & Lizaso, 1996; El-Agamy *et al.*, 2004; Monteiro *et al.*, 2006; Kasalica *et al.*, 2011; Bottari *et al.*, 2014; Layachi *et al.*, 2015; Taylan & Bayhan, 2015; Mobilia *et al.*, 2016; Dobrosravić *et al.*, 2017), but in relation to Algerian waters, the works are limited to Derbal & Kara, 2008 on feeding habits; Boubaïou, 2014 (morphometrics); Benina, 2015; Kherraz *et al.*, 2016 (population dynamics), Ider *et al.*, 2017 (otolithometry), and only works of Chali-Chabane (1988) in Algiers Bay, and Bensahla-Talet *et al.* (1990) and Kherraz (2011) in Oran Bay dealt with the reproductive cycle of this species. Therefore, the present study aims to estimate more precisely the reproduction parameters of this species to help comparative studies in the Mediterranean and propose measures to allow a renewal of the resources and improved management.

MATERIAL AND METHODS

Specimens of *B. boops* (n=7153; 3317 in 2016, and 3836 in 2017) were caught by trawlers operating in Oran Bay, located in northwestern Algerian coast (western Mediterranean Sea), between Pointe de l'Aiguille and Cape Falcon (35.95 °N-0.65 °E) (Fig. 1) at depths ranging between 100 and 250 m between January 2016 and December 2017. Samples were randomly collected from daily landed fish at the Oran fishery.

At the laboratory, total length (TL), measured to the nearest millimeter with an ichthyometer (± 1 mm), total weight (TW), and gonad weight (GW), using a digital precision balance (± 0.01 g), were recorded for each individual.

Sex ratio

The sex ratio was calculated monthly throughout the study period according to individual sizes (1 cm class interval) and seasons using the formula below, while sexually indeterminate and immature individuals were not taken into account:

$$SR = \frac{nF}{nM + nF} \times 100$$

where:

nF = number of females,

nM = number of males.

To detect statistically significant deviations from the expected 1:1 ratio, the chi-square (χ^2 , $P < 0.05$) test was used (Sokal & Rohlf, 1987).

Spawning period

For the description of the sexual cycle of *B. boops* several approaches were used:

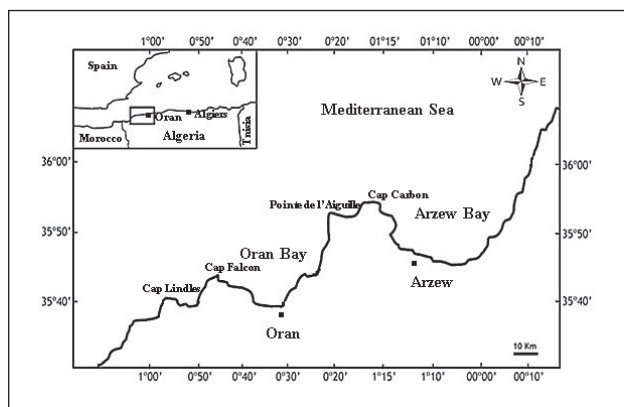


Fig. 1: Map of the study area (Oran Bay).

Sl. 1: Zemljevid obravnavanega območja (Oranski zaliv).

Tab. 1: Sexual maturity scale (macro- and microscopic) of the Sparidae modified and used in this study to classify *B. boops* gonads, with a focus on female gonads (Bensahla-Talet *et al.*, 2017).

Tab. 1: Spolna zrelost (makro- in mikroskopska) predstavnikov iz družine Sparidae, prirejena za potrebe te študije za opredelitev gonad vrste *B. boops*, s posebnim poudarkom na samičjih gonadah (Bensahla-Talet *et al.*, 2017).

	Level name	Macroscopic	Microscopic
I	Immature	Very small and translucent ovaries. Very small testes; no signs of development.	Oocytes are small arranged on ovigerous lamellae. The nucleus is relatively clear.
II	Resting	Ovaries in recovering condition; Testes in recovering condition.	Oocytes are small spherical (about 60 µm), no vitellus is found in their cytoplasm. The nucleus is relatively dense and large with a NPR at its maximum attaining 0.6.
III	Vitellogenesis (Maturing)	Larger ovaries and eggs visible. Larger testes, not running.	Vitellogenesis initiate characterized by massive entry of small vitelline and lipidic vesicles. Zona radiata begin to thicken and appearance of granulosa formed of single cell layer.
IV	Ripening and Spawning	Large transparent eggs that are released under moderate pressure. Sperm released by a light press on the abdomen.	Oocytes attained their maximal size (~500 µm). The nucleus migrates to the animal pole. The follicle includes a thick zona radiata. The cytoplasm is overload with vitellus and lipid vesicles conferring to the egg a hyaline aspect.
V	Post spawning	Ovaries shrunken with few residual eggs, much slime and often redish. Testes small, slack testes and often redish; resting condition.	Many atretic follicles are encountered corresponding to oocytes that have not attained their maturation or mature ones that were not emitted and which will degenerate. The cytoplasm is disorganized and cells undergo pycnosis.

1 - The maturation scale was established following the Holden & Raitt (1974) macroscopic scale, while microscopic description was based on the Aboussouan & Lahaye (1979) scale with a slight modification to fit *B. boops* gonad development (Tab. 1). Both are based on the macroscopic aspect, relative dimensions and microscopic characteristics of the gonads (I: immature, II: resting, III: ripe, IV: ripe and running, V: spent).

2 - Between 10 and 30 specimens of *B. boops* were selected each month for histological examination of the sexual organs, which were placed in Bouin's fixative solution for 48 h, dehydration was carried out by increasing concentrations of acetone/toluene, then fragments were embedded in paraffin wax. Gonads were sectioned with a microtome into 5-6 µm sections and stained with hematoxylin-eosin.

3 - Monthly evolution of the gonado-somatic (GSI) index was calculated as follows:

$$GSI = \frac{GW}{TW} \times 100$$

where:

GSI = gonado-somatic index,

GW = gonad weight (g),

TW = total weight (g).

The nucleoplasmic ratio is considered to be closely related to the mitotic cellular cycle and to the functional phase of cells. It is also a good indicator of dynamic changes in cells (Bensahla-Talet *et al.*,

2017). The nucleoplasmic ratio (NPR) is expressed mathematically as:

$$NPR = \frac{Nd}{Cd - Nd}$$

where:

Nd = nucleus diameter,

Cd = total cell diameter.

Size at first sexual maturity

Size at first sexual maturity (L_m) was defined as the size class at which 50 % of the individuals are mature. Specimens were grouped into 1 cm size classes, and the proportion of mature and immature individuals was recorded. The total length at which 50 % of the specimens were mature was estimated by a logistic non-linear least-squares regression (King, 1995):

$$P = 1 / [1 + e^{-a(L - L_m)}]$$

where:

P = percentage of mature individuals,

a = slope of the curve or rate of increase in maturity,

L_m = length at 50 % maturity,

L = 1 cm length class.

RESULTS

In total, 3317 specimens of *B. boops* were collected in 2016, 1319 of which were males (39.76 %)

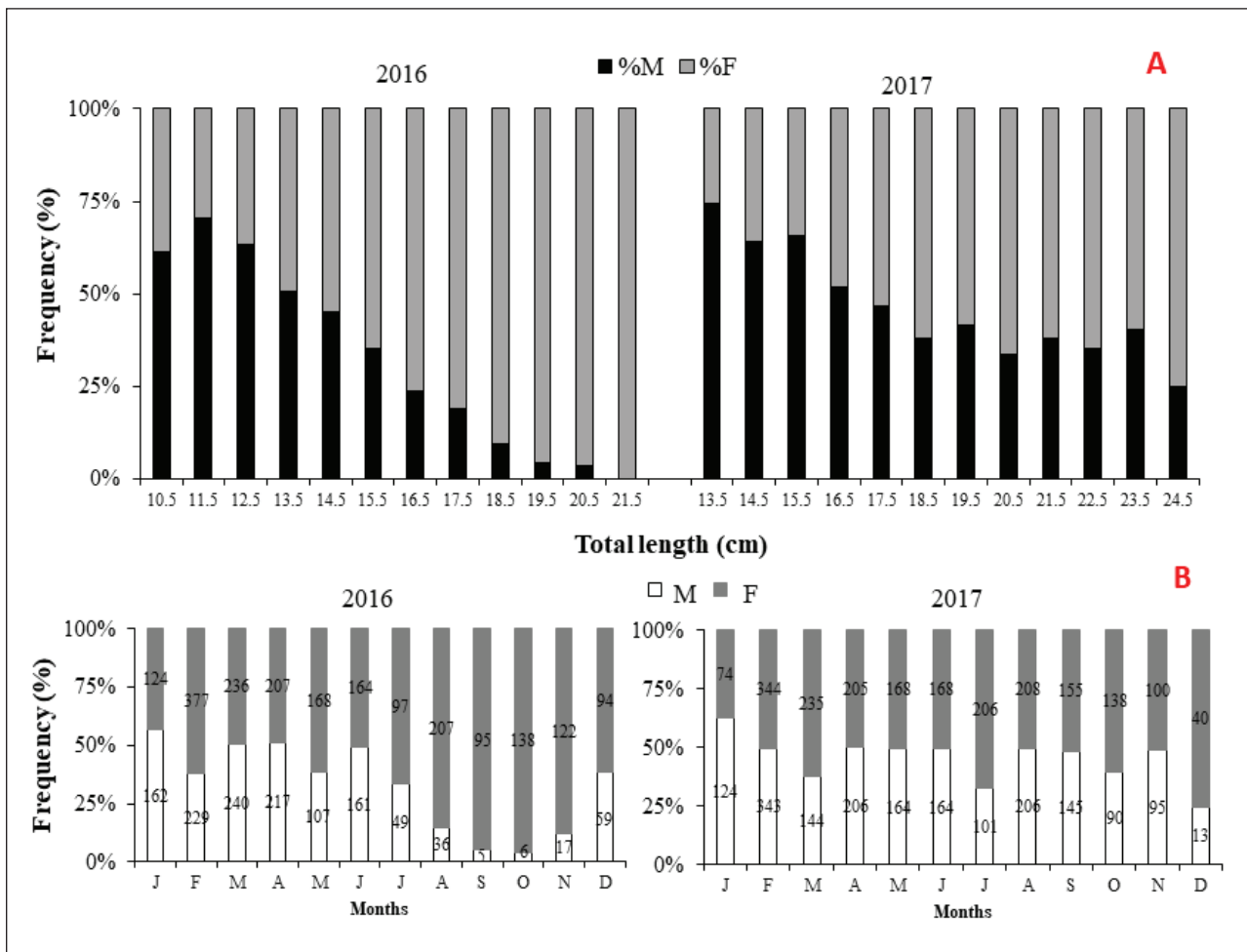


Fig. 2: A. Length frequency distribution of males and females of *B. boops* caught in Oran Bay. B. Monthly length frequency distribution of males and females of *B. boops* caught in Oran Bay.

Sl. 2: A. Frekvenčna porazdelitev velikosti samcev in samic bukke (*B. boops*), ujetje v Oranskem zalivu. B. Frekvenčna porazdelitev velikosti samcev in samic bukke (*B. boops*) po različnih mesecih, ujetih v Oranskem zalivu.

and 1998 were females (60.23 %), while in 2017, 3836 specimens were collected, 1798 males (46.87 %) and 2038 females (53.12 %). The length frequency distribution of the entire population is shown in Fig. 2a, b; the male length range was between 10 and 22.9 cm, the female between 12 and 24.9 cm.

The overall female-male ratio was in favor of females (F:M 1:1.51 in 2016 and F:M 1:1.13 in 2017) and was significantly different from the 1:1 ratio ($\chi^2=138.99$ and $\chi^2 = 15.02$ respectively $> \chi^2_{t, 1, 0.05} = 3.84$). Sex ratios between males and females by size class were also significantly different from the 1:1 ratio ($\chi^2_{\text{observed}} > \chi^2_{t, 1, 0.05} = 3.84$) for most size classes, the difference was significant beyond the 14 cm length class in 2016, while in 2017, this difference was distinguished beyond the 17 cm of total length, where females predominated. Males predominated in smaller size classes and females in larger ones (Fig. 2).

Maturity stages

Females with ripe gonads (stage III) and those with ripe and running gonads (stage IV) were observed (Fig. 3) in early winter and were dominant in the March-July period, thus highlighting the spawning period of *B. boops* in Oran Bay. Spent fish (stage V) were recorded from June to November with a maximum in August, while the remaining period of the year gonads in stage II were dominant, marking the sexual rest period of this Sparidae species.

Nucleoplasmic ratio (NPR)

The variation of the nucleoplasmic ratio according to maturity stages is presented in Fig. 3b, reflecting the changes that affect the oocytes. It appears that high values of this ratio are encountered in early oogenesis

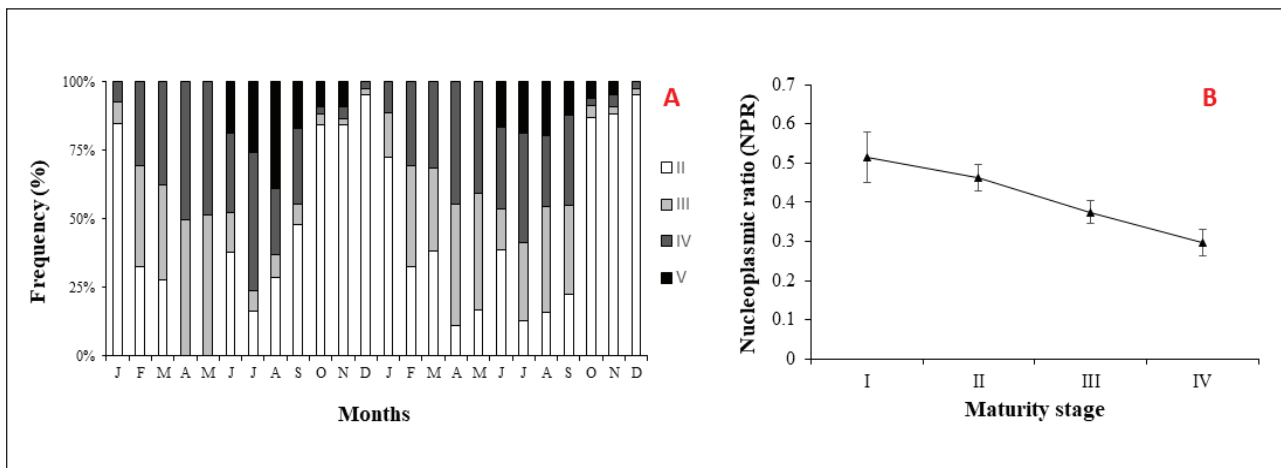


Fig. 3: A. Maturity stages of *B. boops* females caught in Oran Bay (II: resting, III: maturing, IV: ripe and running, V: spent). B. Variation of the nucleoplasmic ratio (NPR) in relation to maturity stages of *B. boops* females.

Sl. 3: A. Zrelostni stadiji samic bukev (*B. boops*) ujetih v Oranskem zalivu (II: počivajoči stadiji, III: dozorevajoči, IV: zreli, V: dokončani). B. Variacije v nukleoplazmičnem deležu (NPR) v odnosu na zrelostne stadije samic bukev (*B. boops*).

stages, attaining 0.51, and as the oocyte develops, this ratio tends to decrease, attaining its lowest value of 0.29 in stage IV, when the oocytes are ready to be emitted.

Microscopic analysis

As with the majority of teleost fish and especially sparids, the microscopic analysis of the gonads allowed us to describe the following stages in *B. boops*:

Ovaries

Immature period

The oogonia representing the reserve batch are small round cells with a clear nucleus (Fig. 4a), varying in size between 36 and 169 μm , and the NPR is at its maximum value of 0.51.

Resting period

At this stage (Fig. 4b) the oocytes are spherical (169–260 μm), some of them have already began their first cellular division and the cells are arranged as ovarian lamellae with a homogenous and transparent cytoplasm, having numerous nucleoli mixed to a large nucleus containing dense chromatin, the NPR is at 0.46.

Maturing period

Previtellogenesis

Oogonia undergo progressive increase in size reaching 205–390 μm (Fig. 4c, d) with an average NPR of 0.37. The maturation period is mainly characterized by:

A- A clear central nucleus containing some supernumerary nucleoli distributed at the periphery.

B- Thousands of cortical alveoli appearing to mark the beginning of the endogenous lipidic vitellogenesis.

C- The granulosa and zona radiata becoming visible.

The vitellogenesis period (pre-spawning)

A rapid increase in the size of the oocytes is observed at this stage (416 μm), resulting from an intense entry of the protein yolk, also the vitelline globules are rounded and colored red with a mean diameter of 9.5 μm marking the exogenous vitellogenesis (Fig. 4e, f).

Lipid (colorless) inclusions move massively around the nucleus (Fig. 4g, h) forming a central vacuole. The central cytoplasmic zone is filled and repels the cytoplasm at the periphery. The NPR decreases to 0.38.

The oocyte membrane is enveloped by a protective thick membrane, zona radiata, measuring 10.16 μm . The whole is enveloped by the granulosa, formed by one layer of ovarian cells, and the fibrous theca (Fig. 4i).

Ripening and spawning period

The nucleus moves to the animal pole to initiate the first meiotic division (Fig. 4j). Egg release is imminent, cytoplasmic structures merge and give the mature egg a translucent appearance, hence the name hyaline oocyte (Fig. 4k, l); their diameter is max 500 μm (390–542 μm) with an average NPR of 0.29.

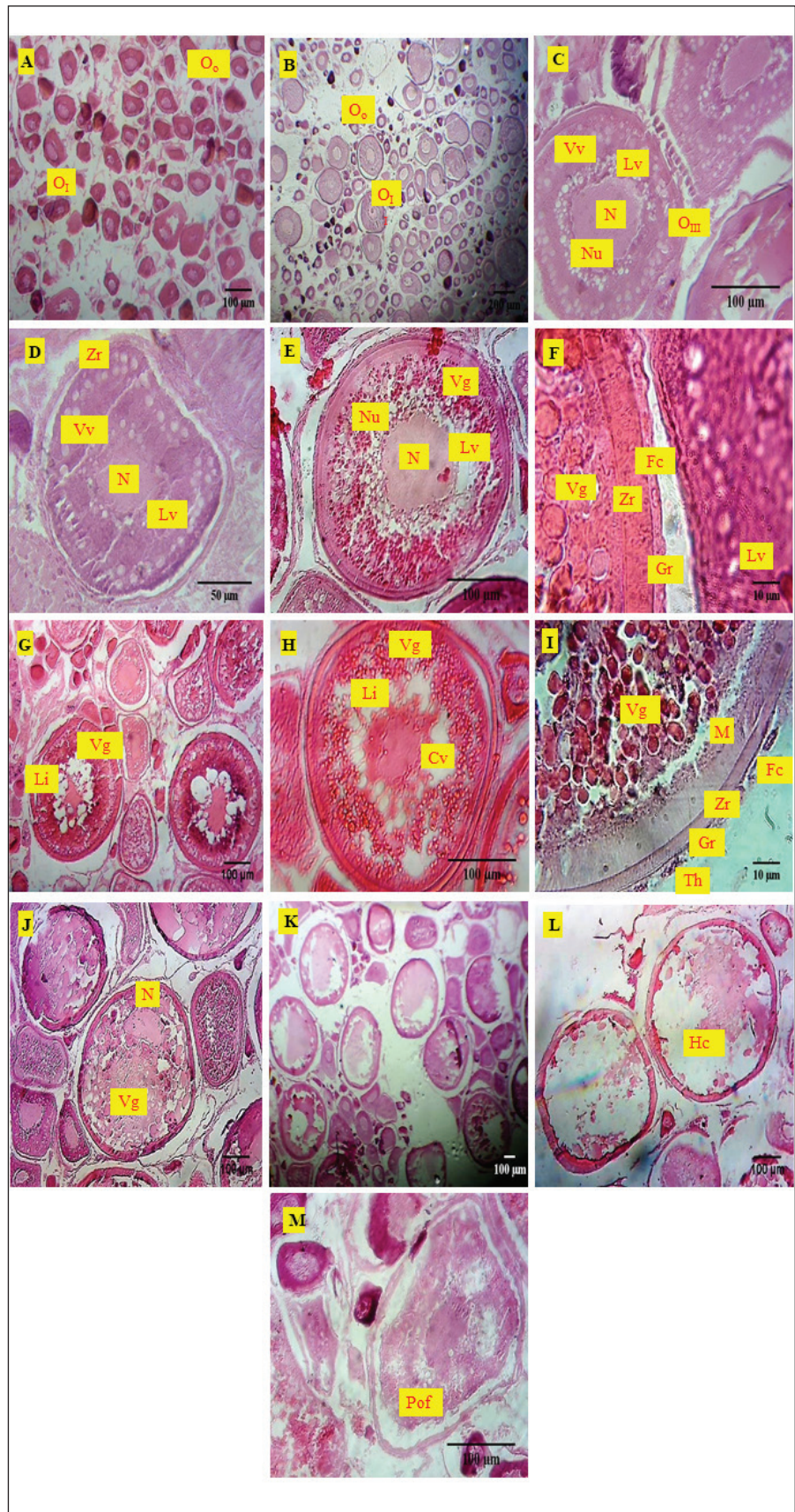


Fig. 4: Ovarian histological slides of *B. boops* female gonads (a-m) stained by hematoxylin-eosin: (a) general view of an immature ovary $\times 100$; (b) resting ovary with advanced peri nuclear oocytes (OII), a large nucleus and homogeneous cytoplasm $\times 40$; (c) previtellogenic oögonia (OIII) presenting a large nucleus surrounded by several lipoprotein vesicles $\times 250$; (d) previtellogenic oögonia (OIII) $\times 400$; (e) early maturing large oocytes with large translucent vitelline vesicles and a thin zona radiata (OIV) $\times 250$; (f) OIV with a thick zona radiata and apparition of granulosa $\times 1000$; (g) hydrated large oocytes (mature) OIV with numerous vitelline globules and important lipid inclusions forming a central vacuole $\times 100$; (h) hydrated large oocytes (mature) $\times 250$; (i) mature oocyte with a thick zona radiata, granulosa and fibrous theca $\times 1000$; (j) hyaline oocyte with nucleus in the animal pole $\times 100$; (k) general view of ovary in spawning phase $\times 40$; (l) hyaline oocyte ready to be released $\times 100$; (m) post-ovulatory follicle $\times 250$. Fc: follicular cells; Gr: granulosa; Hc: hyaline cytoplasm; Li: lipid inclusion; Lv: lipid vesicle; M: oocyte membrane; N: nucleus; Nur: nucleoli; O: oocyte; Oo: oögonia; Vg: vitelline globules; Zr: zona radiata of chorion; Pof: post-ovulatory follicle; Th: theca; Vv: vitelline vesicle; Zr: zona radiata.

Sl. 4: Histološki rezi ovarija samice bučke (*B. boops*) (a-m), obarvani z hematoxilinom-eozinom: (a) pogled na nezrel ovarij $\times 100$; (b) počivajoči ovarij z razvitimi perinuklearnimi oocitami (OII), veliko jedro in homogeno citoplazmo $\times 40$; (c) previtelogenska oögonia (OIII) $\times 400$; (d) zgodnje dozorevajoče velike oocite z velikimi prozornimi vitelinskimi vezikli in tanko "zona radiata" (OIV) $\times 250$; (e) OIV s številnimi vitelinskimi globuli in pomembni lipidni vključki, ki tvorijo centralno vakuolo "zona radiata" in pojavom "granulosa" $\times 1000$; (f) hidrirane velike oocite (zrele) OIV s številnimi vitelinskimi globuli in pomembni lipidni vključki, ki tvorijo centralno vakuolo $\times 100$; (g) hidrirane velike oocite (zrele) $\times 250$; (h) hidrirane velike oocite (zrele) OIV s številnimi vitelinskimi globuli in pomembni lipidni vključki, ki tvorijo centralno vakuolo $\times 100$; (i) hialna oocita tik pred sprostitvijo $\times 100$; (j) post-ovulatorni folikel $\times 250$. Fc: folikularne celice; Gr: granulosa; Hc: hialna citoplazma; Li: lipidni vključki; Lv: lipidni vezikel; M: membrane oocite; N: jedro; Nur: nukleoli; O: oocita; Oo: oögonija; Vg: vitelinski globuli; Zr: zona radiata pri horionu; Pof: post-ovulatorni folikel; Th: teka; Vv: vitelinski vezikel; Zr: zona radiata.

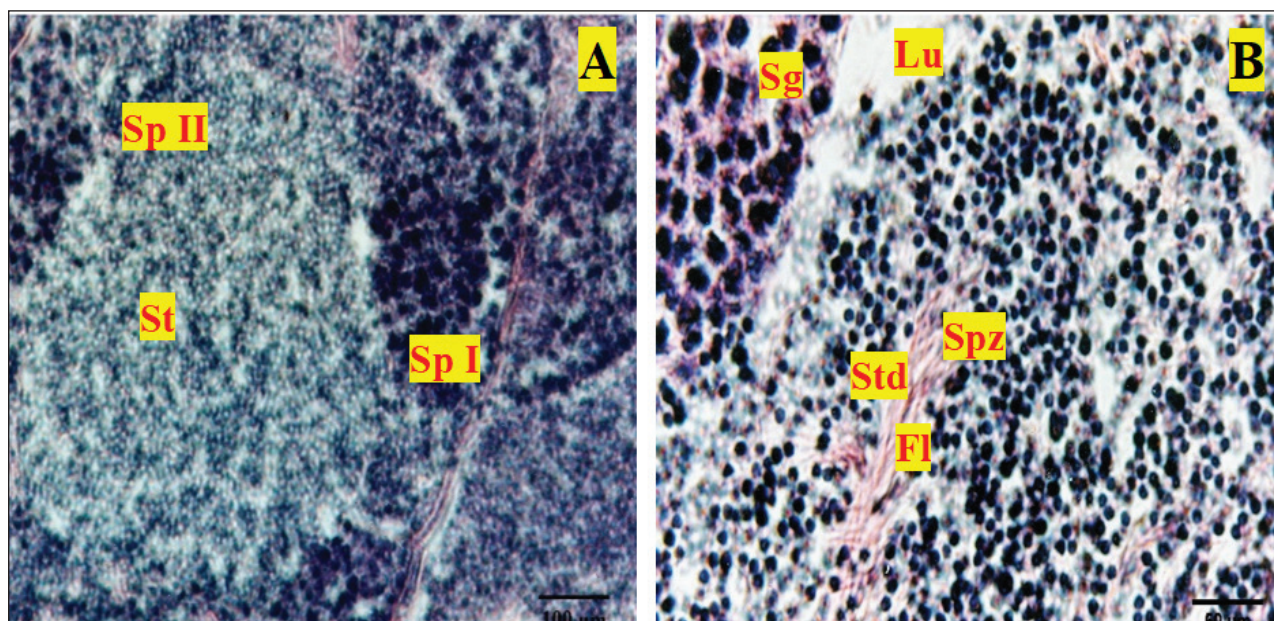


Fig. 5: Spermatogenetic stages; (a) seminiferous tubule with isogenic cysts at different stages of maturation $\times 100$; (b): mature testicle showing seminiferous tubules with lumen full of spermatozoa with their flagella $\times 1000$. Fl: flagella; Lu: central lumen; Sp I: spermatocyte I; Sp II: spermatocyte II; Spz: spermatozoa; Std: spermatids; St: seminiferous tubule.

Sl. 5: Stadiji spermatogeneze; (a) seminiferni tubuli z izogenimi cistami pri različnih zrelostnih stadijih $\times 100$; (b): zreli testikli z vidnimi seminifernimi tubuli z lumnom, napolnjeni s semenčicami z bički $\times 1000$. Fl: bički; Lu: centralni lumen; Sp I: spermatocita I; Sp II: spermatocita II; Spz: spermatozoi; Std: spermatide; St: seminiferni tubul.

Post spawning

In the ovary, a fraction of unemitted mature oocytes enter atresia marking the end of the spawning season; the nucleus enters pycnosis and the yolk disintegrates into a compact cluster; the cytoplasm becomes disorganized; remaining in the ovary is only the reserve oogonia that will be used during the next spawning season (Fig. 4m). At the end of the spawning period, the fish enters the resting phase and the ovary reverts to its initial appearance, which can be recognized by the presence of ovigerous lamellae (Fig. 4a, b).

Testes

With regard to the spermatogenesis in male gonads, the testes studied were mature at the same time as the ovaries. The testicles are formed of a multitude of oval ampoules separated by a connective tissue (Fig. 5). Seminiferous tubules are composed of isogenic cysts at different stages of maturation (Fig. 5a, b). At maturity, spermatids are transformed to spermatozooids, which move into the central lumen and from there into deferent ducts to be released via the genital opening.

Hermaphrodite gonads

B. boops exhibits a protogynous hermaphroditism already described (D'Ancona, 1949; Reinboth, 1962; Frau, 1966; Girardin, 1981; Gordo, 1992; Massaro, 2012). During our sampling period, 90 individuals were hermaphrodites presenting the two sexes in the same gonad, the ovotestis. The histological analysis of ovotestis (Fig. 6) allowed us to examine germinal tissues for males and females, which co-exist (Fig. 6a, b, c). The female part is functional and represented by ovogonous cells and some oocytes I (O_1) arranged in ovigerous lamellae. The male part is not yet active and is made up of spermatogonia arranged in isogenic cysts at the beginning of spermatogenesis.

Sexual cycle and spawning period

To determine the reproductive period of *B. boops*, the gonado-somatic index (GSI) was used, which was calculated from samples taken monthly. The GSI value began to rise from January and remained high until May, with a peak in April (3.75 in 2016, and 3.66 in 2017). The GSI then decreased from June and remained low until November, confirming the sexual rest period (Fig. 7), which is in accordance with our macroscopic observation on maturity stages of *B. boops*.

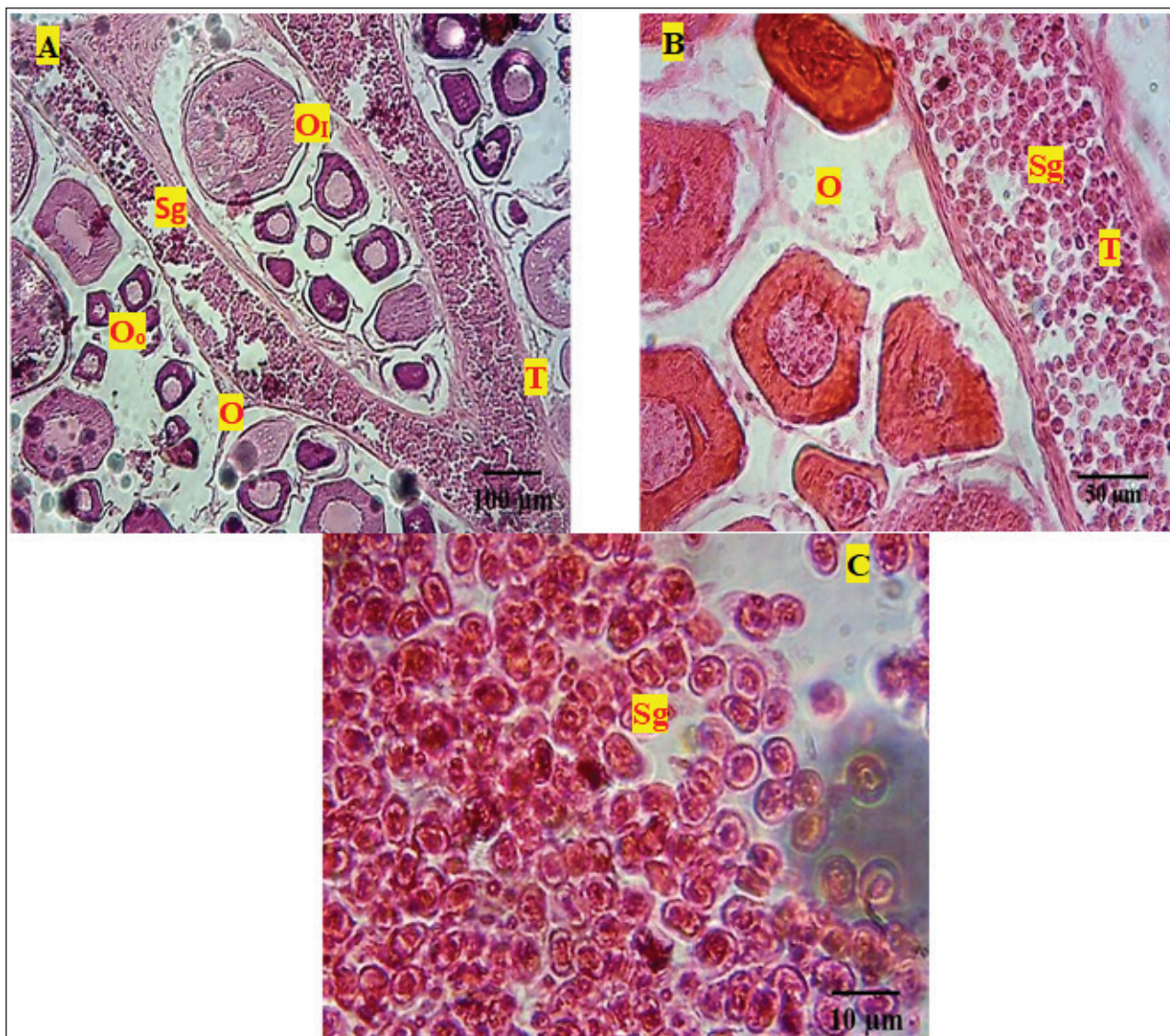


Fig. 6: Section of hermaphrodite gonad of *B. boops*; (a) section of ovotestis $\times 100$; (b) section of hermaphrodite gonad showing a functioning female part and early development of a male part $\times 250$; (c) spermatogonia $\times 1000$. O: ovary; Ol: oocyte I; Oo: oogonia; Sg: spermatogonia; T: testis.

Sl. 6: Sekcija hermafroditske gonade pri bukvi (*B. boops*); (a) sekција ovotestisa $\times 100$; (b) sekcija hermafroditske gonade, ki kaže funkcionalni del samice in zgodnji razvoj moškega dela $\times 250$; (c) spermatogonija $\times 1000$. O: ovarij; Ol: oocita I; Oo: oogonija; Sg: spermatogonija; T: testis.

Size at first sexual maturity

An analysis of shares of mature specimens (Fig. 8) showed that in Oran Bay, 50 % of *B. boops* females were mature at 14 cm of total length.

DISCUSSION

In Oran Bay, the overall female-male ratio was found in favor of females, an observation already made by Lamrini, 1998; Monteiro *et al.*, 2006; Kher-

raz, 2011; Kasalika *et al.*, 2012; and Dobroslavić *et al.*, 2017, while Bottari *et al.*, 2014 found this ratio equally distributed in the southern Tyrrhenian Sea.

The predominance of males in smaller length classes and females in larger classes is probably due to protogynic hermaphroditism already described for this species by D'Ancona, 1949; Reinboth, 1962; Frau, 1966; Gordo, 1995; Cano Fortuna & Sánchez Lizaso, 1996; Lamrini, 1998; Bottari *et al.*, 2014. Specimens are first female and became progressively male, which is characterized by the development of

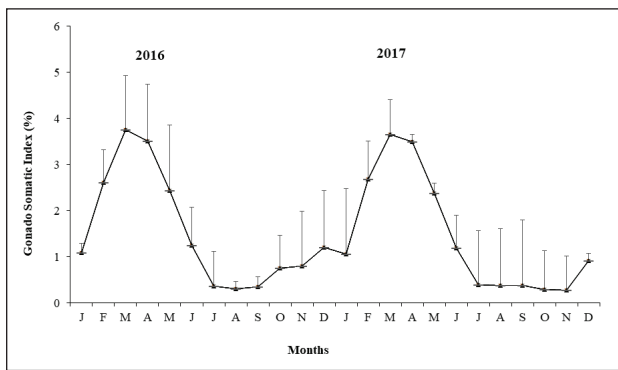


Fig. 7: Monthly changes in the gonado-somatic index of *B. boops* females caught in Oran Bay.

Sl. 7: Mesečne spremembe v gonadosomatičnem indeksu pri samicah bukve (*B. boops*), ujete v Oranskem zalivu.

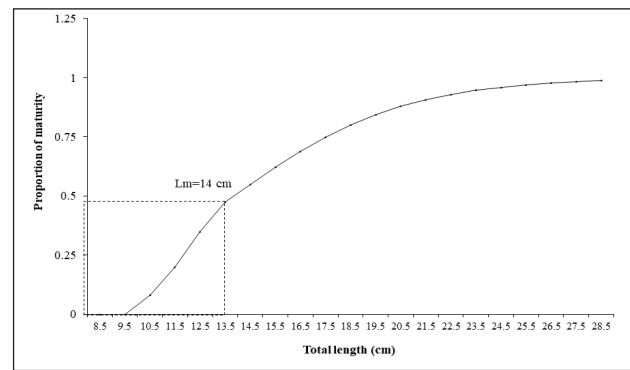


Fig. 8: Sexual maturity for females of *B. boops* caught in Oran Bay.

Sl. 8: Spolna zrelost pri samicah bukve (*B. boops*), ujete v Oranskem zalivu.

female organs or maturation of their products before the appearance of the corresponding male product.

Evolution of the sex ratio in relation to length classes led us to establish that sexual inversion for this sparid occurs between 13 and 17 cm of total length, which is in accordance with observations made by other authors who studied the same species (Lamrini, 1998) (16 cm).

Investigation of the reproduction period of *B. boops* following a longitudinal evolution showed that (Tab. 2), generally, this species has one long spawning season that extends from January to July. Our findings in western Algerian coasts showed that the spawning period of this Sparidae species extends from January to July, peaking in spring period, which was already reported for this same bay by Bensahla-Talet *et al.* (1990), and Kherraz (2011), and for the Gulf of Annaba by Derbal & Kara (2008).

In central Algerian waters, this period seems to be shortened to 3 or 4 months, as reported for Algiers Bay (Chali-Chabane, 1988) and Bousmail Bay (Dieuzeide *et al.*, 1955; Benina, 2015). The same finding was previously observed in the Gulf of Lion (Girardin, 1981), the Thyrrenian Sea (Bottari *et al.*, 2014), in the Gulf of Tunis (Anato & Ktari, 1983), in Egyptian waters (Hassan, 1990), and in the Lebanese coasts (Mouneimne, 1978). The differences in the spawning period duration could be due to the inflow of Atlantic water through the Strait of Gibraltar, namely, regional differences in the time and duration of the spawning act of species in the Mediterranean basin can be related to biotic and abiotic factors, such as climate, hydro dynamism, temperatures, salinity, and food availability (Wootton, 1979; Pajuelo and Lorenzo, 2000; Mouine *et al.*, 2007; Tsikliras *et al.*, 2010). Gonçalves & Erzini, 2000, stated that the reproduction period is correspondingly much longer when environmental conditions are favorable. The

upwellings and related zooplankton abundance can also affect many species reproduction (Parrish *et al.*, 1981).

With regard to the length at first sexual maturity (Tab. 2) in Algerian waters, Derbal *et al.* (2007) found females to be mature at 13.5 cm; in Algiers Bay this length was reported at 13.5 cm (Chali-Chabane, 1988) and 14.6 cm (Benina, 2015), in Oran Bay between 12 and 14 cm, like in some other studies in the Mediterranean. Gordo (1995) and Monteiro *et al.*, (2006) reported that length to be between 13 and 15.22 cm in Portuguese waters, while in Spanish waters Cano Fortuna & Sanchez Lizaso (1996) found it equal to 10.2 cm. In Italian coasts, Bottari *et al.* (2014) recorded it at 13.8 cm. In the Adriatic (Kasalica *et al.*, 2011) this size was reported to be 11.5 cm TL. In Tunisian waters, the first sexual maturity was reached, by most of the population, at sizes between 14 and 18 cm. In Egyptian and Lebanese waters, this maturity was attained at 13 cm.

Most studies found this length to be comprised between 12 and 14 cm in the Mediterranean, except Bounhiol & Pron (1916) and Kherraz (2011), while in Atlantic waters the bogue seems to reach maturity later, at 17 cm (Lamrini, 1998; Monteiro *et al.*, 2006; Massaro, 2012), probably due to environmental conditions, which differ from one habitat to another.

Environmental factors, such as temperature, salinity and food (Gonçalves & Erzini, 2000; Moutopoulos & Stergiou, 2002; Karakulak *et al.*, 2006; Bottari *et al.*, 2014) are at the origin of the difference in size at first sexual maturity and in the spawning period between individuals of the same species from different geographic locations.

Mortier (1992), Taupier-Letage & Millot (1998), Salas *et al.* (2001) consider the Algerian current as the most energetic in the Mediterranean basin, conferring to Algerian waters their relative richness.

Tab. 2: Spawning season of *B. boops* in different areas.**Tab. 2: Obdobje drstenja pri bukvi (*B. boops*) v različnih predelih.**

Region		J	F	M	A	M	J	J	A	S	O	N	D	Lm50%	Author
Portugal	Algarve													13-15	Gordo, 1995
	Peniche														
	Algarve													15.22	Monteiro <i>et al.</i> , 2006
Morocco	Gibraltar strait													15.40	Lamrini, 1998
	Beni Ensar Port													13.30	Layachi <i>et al.</i> , 2015
Spain	Port of Castellon													-	Zuniga, 1967
	Western Mediterranean													10.20	Cano Fortuna & Sanchez Lizaso, 1996
	Canary island													17.90	Massaro, 2012
France	Gulf of lion													10-20	Girardin, 1981
Algeria	Algerian coasts													17.20	Bounhiol & Pron, 1916
	Annaba Bay													13.50	Derbal <i>et al.</i> , 2007
	Algiers Bay													13.50	Chali-chabane, 1988
	Bousmail Bay													14.60	Benina, 2015
														-	Dieuzeide <i>et al.</i> , 1955
	Oran Bay													17.10	Kherraz, 2011
														11.70	Bensahla-Talet <i>et al.</i> , 1990
														13.30	Aoudjit, 2001
														14.00	Present study
Italy	Gulf of Naples													-	Lo Bianco, 1909
	Tyrrhenian Sea													-	Bini, 1968
														13.80	Bottari <i>et al.</i> , 2014
Tunisia	Gulf of Tunis													14-18	Anato & Ktari, 1983
Croatia	Adriatic Sea													-	Dobroslavić <i>et al.</i> , 2017
Montenegro														11.50	Kasalica <i>et al.</i> , 2011
Greece	Central Mediterranean													-	Vidalis, 1950
Egypt	Alexandria Bay													-	Hassan, 1990
														13.00	El Agamy <i>et al.</i> , 2004
Lebanon	Libanian coasts													13.00	Mouneimne, 1978

Important upwellings, which enhance the development of plankton, the first link of the aquatic food web, are generated by the entrance of Atlantic waters via the Strait of Gibraltar.

The MLS (Minimum Landing Size) set for *B. boops* at 15 cm of TL according to Algerian legislation (Executive Decree no. 2004-86 of 26 Muharram 1425, corresponding to 18 March 2004) (J.O.R.A.D.P, 2004), seems to be inadequate, given that it is too close to the length at first sexual maturity, as has been established during our study (14 cm). It would

be recommendable to increase this length and set it at 18 cm, thus giving the opportunity to young females to contribute to and ensure the renewal of the resource.

CONCLUSIONS

The results obtained in the present study shed light on the reproductive biology of *B. boops* in the western Algerian coast. The bogue is of commercial importance to local and national fisheries. The

ban on trawl fishery from 1 May to the 1 August as per Algerian legislation (Executive Decree no. 03-481a of 4 Rabi' al-Awwal 1425, corresponding to 24 April 2004), aiming to protect the renewal of the resources, is from our viewpoint insufficient to insure the set objective. We suggest an increase of the minimum landing size and the establishment of two closed fishing seasons per year to allow the renewal of multiple spawning species in Oran Bay and protect juvenile and adult spawners from overfishing.

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RAZVOJ GONAD PRI BUKVI, *BOOPS BOOPS* (LINNAEUS, 1758), IZ ORANSKEGA ZALIVA (TELEOSTEI, SPARIDAE)

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POVZETEK

Avtorji poročajo o reproduktivnem ciklu primerkov bukve *Boops boops*, ujetih v Oranskem zalivu. Vzorce so z obravnavanega območja enkrat mesečno dostavili ribiči od januarja 2016 do decembra 2017. Spolni delež je bil v korist samic. Frekvenčna porazdelitev dolžine je pokazala, da so samice prevladovala pri dolžinah, večjih od 14 cm celotne dolžine, kar verjetno odraža začetek spolne inverzije, sicer že opisane pri tej vrsti špara. Obdobje drstenja, ki je bilo določeno na podlagi gonadosomatičnega indeksa, je bilo od februarja do poznega junija z vrhom v marcu in aprilu. Izsledki avtorjev prispevajo k boljšemu poznavanju razmnoževalnega cikla te vrste in bodo pomagali k pripravi ukrepov za primernejše upravljanje s staležem najbolj pogoste vrste špara, ki ga dnevno ribiči ulovijo v mnogih Sredozemskih državah in Alžiriji.

Ključne besede: *Boops boops*, razmnoževalni cikel, sezone drstenja, velikost pri zrelosti, Oran, Alžirija

REFERENCES

- Aboussouan, A. & J. Lahaye (1979):** Les potentialités ichtyologiques. Fécondité et ichtyoplancton. *Cybiurn*, 3^{ème} série (6), 29-46. (In French).
- Alegria Hernandez, V. (1989):** Study on the age and growth of bogue *Boops boops* (L.) from the central Adriatic Sea. *Cybiurn*, 13(3), 281-288.
- Allam, S.M. (2003):** Growth, mortality and yield per recruit of Bogue, *Boops boops* (L.), from the Egyptian Mediterranean waters off Alexandria. *Mediterr. Mar. Sci.* 4(1), 87-96. doi:10.12681/mms.244.
- Anato, C.B & M.M. Ktari (1983):** Reproduction de *Boops boops* (Linne 1758) et de *Sarpa salpa* (Linnaeus, 1758), poissons téléostéens, sparidés du golfe de Tunis. *Bull. Inst. Natl. Sci. Tech. Océanogr. Pêche. Salammbô. Salammbô*, 10, 49-53. (In French).
- Aoudjit, N. (2001):** Etude de certains facteurs biologiques et de la contamination de la Bogue (*Boops boops*) par les métaux lourds provenant de la baie d'Oran. (Magister dissertation), University of Oran1 Ahmed BEN-BELLA. Oran, Algérie. (In French).
- Ayaz, A.S., Ö. Kale, U. Cengiz, U. Altinagac, A. Ozekinci, A. Oztekin & A. Altin (2009):** Gillnet selectivity for Bogue (*Boops boops*) caught by drive-in fishing method from Northern Aegean Sea, Turkey. *J. Anim. Vet. Adv.*, 8(12), 2537-2541.
- Bauchot, M.L & J.C. Hureau (1986):** Sparidae. p. 883-907. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) *Fishes of the northeastern Atlantic and the Mediterranean*. Volume 2. UNESCO, Paris.
- Benina, R., S. Mouffok & Z. Boutiba (2014):** Estimation of the exploitable biomass and the reference biological point, F0.1, of bogue *Boops boops* L., in the Bay of Bou-Ismaïl, centre Algerian. *Journal. Biodiv. Envir. Sci.*, 5(2), 420-427.
- Benina, R. (2015):** Biologie et Exploitation de la Bogue *Boops boops* (Linné, 1758) dans la baie de Bou-Ismaïl (Doctoral dissertation), University of Oran1 Ahmed BEN-BELLA, Oran, Algérie. (In French).
- Bensahla-Talet, A., D. Belaouda & L. Matoub (1990):** Période de ponte et taille à la première maturité sexuelle de *Boops boops* (Linné, 1758) des Cotes Oranaïses (Algérie). *Rapp. Comm. Int. Mer. Médit.* 32, I (In French).
- Bensahla-Talet, L., M. Gherram, F. Dalouche, A. Bensahla-Talet & Z. Boutiba (2017):** Reproductive biology of *Pagellus acarne* (Risso, 1827) (Teleostei: Sparidae) off western Algerian waters (Western Mediterranean). *Cah. Biol. Mar.* 58:443-452. doi:10.21411/CBM.A.D5BB353B.
- Bianco, S.L. (1909):** Notizie biologiche riguardanti specialmente il periodo di maturità sessuale degli animali del golfo di Napoli. *Mittheilungeu a. d. Zoolog. Station Neapel*. Vol XIX, 513-576. (In Italian).
- Bini, P. (1968):** Atlante dei pesci delle coste Italiani. Edit Mondo Sommerso, Vol IV, Roma. 63 pp. (in Italian).
- Bottari, T., V. Micale, M. Liguori, P. Rinelli, B. Busalacchi, R. Bonfiglio & S. Ragonese (2014):** The reproductive biology of *Boops boops* (Linnaeus, 1758) (Teleostei: Sparidae) in the southern Tyrrhenian Sea (Central Mediterranean). *Cah. Biol. Mar.*, 55, 281-292.
- Boubaïou, A. (2014):** La biométrie comparée de la bogue *Boops boops* (Linnaeus, 1758) dans le littoral Algérien. Magister dissertation, University of Skikda-20 Août 1955. 146pp. Skikda, Algeria. (In French).
- Bounhiol, J.P & L. Pron (1916):** La précocité sexuelle et les conditions thermiques de la maturation génitale et de la ponte chez quelques sparidés communs d'Algérie: *P. erythrinus*, *P. acarne*, *P. centrodonatus*, *P. vulgaris*, *Box vulgaris*, *O. melanura*, *O. macrophthalmus*. *C. R. Seances. Soc. Biol. Fil.* LXXIX, p. 140. (In French).

- Campillo, A. (1992):** Les pêcheries françaises de Méditerranée. Synthèse des connaissances. Contrat CEE/IFREMER n° 92/1211 625/TF. <http://archimer.ifremer.fr/doc/00393/50467/>. (In French).
- Cano Fortuna, M.R. & J.L. Sanchez Lizaso (1996):** Biología reproductiva de la boga *Boops boops* (L., 1758) (Pisces, Sparidae), en el Sureste de la Península Ibérica. Tomo Extraordinario. 125 Aniversario de la RSEHN. (In Spanish).
- Cengiz, Ö., A. Ayaz, A. Öztekin & C. Kumova (2013):** Gelibolu Yarımadası'nda (Kuzey Ege Denizi, Türkiye) Kupes balığı (*Boops boops* Linnaeus, 1758) avcılığında kullanılan multifilament galsama ağı seçiciliğinin boyçevre ilişkisi ile belirlenmesi. Menba Su Ürünleri Fakültesi Dergisi, 1, 28-32. (In Turkish).
- Chali-Chabane, F. (1988):** Contribution à l'étude biologique et dynamique de la bogue, *Boops boops* (Linné, 1758) de la baie de Bou-Ismaïl Magister dissertaion, Institut des Sciences de la Mer et de l'aménagement du Littoral, Alger, Algérie. (In French).
- Crec'hriou, R., V. Zintzen, I. Moore & C.D. Roberts (2015):** Length–weight relationships of 33 fish species from New Zealand. J. Appl. Ichthyol., 31(3), 558-561. doi:10.1111/jai.12709.
- D.P.R.H. (2016):** Annual statistics report of the Directorate of fisheries and fisheries Resources. Document Direction de la Pêche et des Ressources Halieutiques. Oran, Algérie. (In French).
- D'Ancona, U. (1949):** Ermafroditismo ed intersessualita nei Teleostei. Experientia. 5(10), 381-389. (In Italian)
- Derbal, F., M.H. Kara & S. Madache (2007):** Cycle sexuel et fécondité de la bogue *Boops boops* des cotes de l'Est algérien. Workshop international sur la gestion des ressources halieutiques « GRH-2007 ». ISMAL- Alger, 29, 30 Oct 2007. Dély Ibrahim, Alger, Algérie. (In French).
- Derbal, F. & M.H. Kara (2008):** Composition du régime alimentaire du bogue *Boops boops* (Sparidae) dans le golfe d'Annaba (Algérie). Cybium, 32(4), 325-333.
- Dieuzeide, R., M. Novella & J. Roland (1955):** Catalogue des poissons des côtes algériennes. Bull. Trav. Stn. Aquic. Pêche. Castiglione, III(6), 384 pp. (In French).
- Dobrosłavić, T., R. Mozara, B. Glamuzina & V. Bartulović (2017):** Reproductive patterns of bogue, *Boops boops* (Sparidae), in the southeastern Adriatic Sea. Acta Adriatica, 58(1), 117-125.
- El-Agamy, A., M.I. Zaki, G.S. Awad & R.K. Negm (2004):** Reproductive Biology of *Boops boops* (Family Sparidae) in the Mediterranean environment. Egypt. J. Aquat. Res., 30(B), 241-254.
- El-Maremie, H. & M. El-Mor (2015):** Feeding Habits of the Bogue, *Boops boops* (Linnaeus, 1758) (Teleostei: Sparidae) in Benghazi Coast, Eastern Libya. J. Life. Sci., 9, 189-196. doi:10.17265/1934-7391/2015.05.001.
- El-Okda, N. (2008):** Age and growth of *Boops boops* (L.) from Egyptian Mediterranean waters off Alexandria. Egypt. J. Aquat. Res., 12(1), 13-23. doi:10.21608/ejabf.2008.1968.
- Eryaşar, A.R. (2017):** Selectivity of commercial and alternative codends for Bogue (*Boops boops*) and Common sole (*Solea solea*) in Northeastern Mediterranean. Ege. JFAS., 34(1), 57-62. doi:10.12714/egejfas.34.1.08.
- Frau, A.L. (1966):** Sulla presenza di ovociti nell'area testicolare delle gonadi ermafrodite della boga [*Boops boops* (L.)]. Ital. J. Zool., 33(2), 343-349. (In Italian).
- Frimodt, C. (1995):** Multilingual illustrated guide to the world's commercial warm water fish. Fishing News Books, Osney Mead, Oxford, England. 215 pp.
- Girardin, M. (1981):** *Pagellus erythrinus* et *Boops boops* du golfe du Lion. Ecobiologie, prises commerciales et modèles de gestion. (Doctoral dissertation). 3^{ème} cycle, USTL. Montpellier, France. (In French).
- Gonçalves, J.M.S., L. Bentes, P.G. Lino, J. Ribeiro, A.V. Canario & K. Erzini (1997):** Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. Fish. Res., 30(3), 253-256. doi:10.1016/S0165-7836(96)00569-3.
- Gordo, L.S. (1992):** Contribuicao para o conhecimento da biologia e do estado de exploracao do stock de boga (*Boops boops* Linneo. 1758) da costa portuguesa. Faculdade de Ciencias, Tese de Doutoramento, Lisboa, Portugal. 361 pp. (In Portuguese).
- Gordo, L.S. (1995):** On the sexual maturity of bogue (*Boops boops*) (Teleostei, Sparidae) from Portuguese Coast. Sci. Mar., 59(3-4), 279-286.
- Gordo, L.S. (1996):** On the age and growth of bogue, *Boops boops* (L.), from the Portuguese coast. Fish. Manag. Ecol., 3(2), 157-164.
- Hassan, M.W.A. (1990):** Comparative biological studies between two species of family Sparidae, *Boops boops* and *Boops salpa* in Egyptian Mediterranean waters. M.Sc. Thesis, Faculty of Science, Alexandria University, Alexandria, Egypt, 198 pp.
- Holden, M.J. & D.F.S. Raitt (eds.) (1974):** Manual of fisheries science. Part 2: Methods of resource investigation and their application. FAO Fish Tech Rep., 115(Rev. 1), Rome, Italy.
- Ider, D., Z. Ramdane, K. Mahé, J.L. Duffour, M. Bacha & R. Amara (2017):** Use of otolith-shape analysis for stock discrimination of *Boops boops* along the Algerian coast (southwestern Mediterranean Sea). Afr. J. Mar. Sci., 39(3), 251-258. doi:10.2989/1814232X.2017.1363817.
- İlkyaz, A.T., T. Şensurat, H. Dereli & C. Aydin (2017):** Codends Selectivity for Bogue (*Boops boops* L., 1758) in the Eastern Mediterranean Demersal Trawl Fishery. Turk. J. Fish. Aquat. Sc., 17(4), 673-680. doi:10.4194/1303-2712-v17_4_03.
- J.O.R.A.D.P. (2004):** Journal Officiel de la République Algérienne Démocratique et Populaire N° 18. 3 Safar 1425 du 24 mars 2004 fixant les tailles minimales marchandes des espèces Biologiques. Algiers, Algérie. (In French).
- Kara, A. & B. Bayhan (2008):** Length-weight and length-length relationships of the bogue *Boops boops* (Linnaeus, 1758) in Izmir Bay (Aegean Sea of Turkey). Belg. J. Zool., 138(2), 154-157.
- Karachle, P. & K.I. Stergiou (2008):** The effect of season and sex on trophic levels of marine fishes. J. Fish Biol., 72(6), 1463-1487. doi:10.1111/j.1095-8649.2008.01809.x.

- Karakulak, F.S., H. Erk & B. Bilgi (2006):** Length–weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. *J. Appl. Ichthyol.*, 22(4), 274–278. doi:10.1111/j.1439-0426.2006.00736.x.
- Kasalica, O., S. Regner & M. Đurović (2011):** Some aspects of the biology of the bogue, *Boops boops* (Linnaeus, 1758) in Montenegrin waters (South Adriatic Sea). *Stud. Mar.*, 25(1), 59–72.
- Khemiri, S., A. Gaamour, L. Zylberberg, F. Meunier & M.S. Romdahane (2005):** Age and growth of bogue, *Boops boops*, in Tunisian waters. *Acta Adriatica*, 46(2), 159–175.
- Kherraz, A. (2011):** Aspect biologique et évaluation de la pêche de la Bogue *Boops boops* (Linné, 1758) de la frange côtière oranaise: Biologie-Croissance-Exploitation. (Magister dissertation) University of Oran1 Ahmed BENBELLA. Oran, Algeria. (In French).
- Kherraz, A., A. Kherraz & Z. Boutiba (2016):** Inter-relationship age and growth of *Boops boops* (Linnaeus, 1758) in Western Mediterranean coasts of Algeria. *Adv. Environ Biol.*, 10(4), 140–146.
- King, M. (1995):** FISHSIM: a generalized fishery simulation model. *Naga, the ICLARM Quarterly*, 18(4), 34–37.
- Kumova, C.A., U. Altınağaç, A. Öztekin, A. Ayaz & A. Aslan (2015):** Effect of Hanging Ratio on Selectivity of Gillnets for Bogue (*Boops boops*, L.). *J. Aquacult. Eng. Fish. Res.*, 15, 561–567. doi:10.3153/JAEFR15007.
- Lamrini, A. (1998):** Sexualité de la bogue (*Boops boops*, Linnaeus, 1758) au sud du détroit de Gibraltar. *Actes. Inst. Agron. Vet. (Maroc.)*, 18(1), 5–14. (In French).
- Layachi, M., M.H. Idrissi, M. Ramdani, F. Sahnouni & R. Flower (2015):** Growth and reproduction of the Bogue *Boops boops* L. 1758 in the Mediterranean coastal area between Nador and Saïdia (Morocco). *Bull. Inst. Sci. (Rabat)*, (37), 53–59.
- Manaşirli, M., D. Avşar, H. Yeldan, E. Çiçek & C.E. Özyurt (2006):** Estimation of growth, mortality and the exploitation rate of the bogue (*Boops boops* Linnaeus, 1758) population from the Babadillmani (Mersin). *Bight. Ege. JFAS.*, 23(3).
- Massaro, A. (2012):** Reproductive Biology of *Boops boops* (Linnaeus, 1758) off gran Canaria (Canary Islands) ider: a preliminary study. Thesis, Acreditación de la Etapa Investigadora. Universidad de Las Palmas de Gran Canaria. Las Palmas de Gran Canaria, Spain, 37 pp. (In Spanish).
- Mobilia, V., S. Ragonese, T. Bottari & P. Rinelli (2016):** On the Fecundity of the Bogue, *Boops boops* (Linnaeus, 1758), from the Northern Sicilian Coast (Central Mediterranean). *Poult. Fish. Wild. Sci.*, 4, 1. doi:10.4172/2375-446X.1000148.
- Monteiro, P., L. Bentes, R. Coelho, C. Correia, J.M.S. Gonçalves, P.G. Lino, J. Ribeiro & K. Erzini (2006):** Age and growth, mortality, reproduction and relative yield per recruit of the bogue, *Boops boops* Linné, 1758 (Sparidae), from the Algarve (south of Portugal) longline Fishery. *J. Appl. Ichthyol.*, 22, 345–352.
- Mortier, L. (1992):** Les instabilités du courant algérien (Doctoral dissertation, Aix-Marseille 2). Marseille, France. (In French).
- Mouine, N., P. Francour, M.H. Ktari & N. Chakroun-Marzouk (2007):** The reproductive biology of *Diplodus sargus sargus* in the Gulf of Tunis (central Mediterranean). *Sci. Mar.*, 71(3), 461–469. doi:10.1017/S0025315411000798.
- Mouneimne, N. (1978):** Poissons des côtes du Liban (Méditerranée Orientale). Biologie et pêche. Thèse Doctorat Etat (Univ. Paris VI), Paris, France, 490 pp. (In French).
- Moutopoulos, D.K & K.I. Stergiou (2002):** Length–weight and length–length relationships of fish species from the Aegean Sea (Greece). *J. Appl. Ichthyol.*, 18(3), 200–203. doi:10.1046/j.1439-0426.2002.00281.x.
- Özaydin, O & E. Taskavak (2006):** Length-weight relationships for 47 fish species from Izmir Bay (eastern Aegean Sea, Turkey). *Acta Adriatica*, 47(2), 211–216.
- Özvarol, Y. (2014):** Length-weight relationships of 14 fish species from the Gulf of Antalya (Northeastern Mediterranean Sea, Turkey). *Turk. J. Zool.* 2014, 38(3), 342–346. doi:10.4194/1303-2712-v17_5_14.
- Pajuelo, B.J & J.M. Lorenzo (2000):** Reproduction, age, growth and mortality of axillary seabream, *Pagellus acarne* (Sparidae), from the Canarian archipelago. *J. Appl. Ichthyol.*, 16(2), 41–47.
- Parrish, R.H., C.S. Nelson & A. Bakun (1981):** Transport mechanisms and reproductive success of fishes in the California Current. *Biol. Oceanogr.*, 1(2), 175–203.
- Reinboth, R. (1962):** Morphologische und funktionelle zweigeschlechtigkeit bei marinen teleostiern (Serranidae, Sparidae, Centracanthidae, Labridae). *Zool. Jahrb., Abt. allg. Zool. Physiol. Tiere.*, 69, 405–480. (In German).
- Salas, J., E. Garcia-Ladona & J. Font (2001):** Statistical analysis of the surface circulation in the Algerian Current using Lagrangian buoys. *J. Marine Syst.*, 29(1–4), 69–85.
- Sánchez-Velasco, I & W. Norbis (1997):** Comparative diets and feeding habits of *Boops boops* and *Diplodus sargus* larvae, two sparid fishes co-occurring in the north-western Mediterranean. *Bull. Mar. Sci.*, 61(3), 821–835.
- Sokal, R.R & F.J. Rohlf (1987):** Introducción a la Bioestadística. Vol. 5, Reverté. (In Spanish).
- Taupier-Letage, I., C. Millot, S. Dech, R. Meisner, J.L. Fuda, I. Puillat & C. Albérola (1998):** Suivi Des Structures Dynamiques De Mésoéchelle Dans Le Bassin Algérien Pendant L'opération Elisa (1997–1998) Par L'Imagerie Satellitaire Thermique NOAA/AVHRR: Les Obstacles Potentiels à une Reconnaissance Automatique. Séminaire-Atelier PNOC Séries à long terme, (Séminaire-Atelier PNOC Séries à long terme). (In French).
- Taylan, B. & B. Bayhan. (2015):** On the fecundity of the bogue *Boops boops* (Linnaeus, 1758) in the Turkish Aegean Sea. *J. Coast. Life. Med.*, 3(8), 589–591. doi:10.12980/JCLM.3.2015J5-39.
- Tsikliras, A.C., E. Antonopoulou & K.I. Stergiou (2010):** Spawning period of Mediterranean marine fishes. *Rev. Fish. Biol. Fisher.*, 20(4), 499–538. doi:10.1007/s11160-010-9158-6.
- Vidalis, F. (1950):** Study on the biology of *Boops boops* in Greek water. *Praktika Hellen Hydrobiol. Inst.*, 4, 51–71.
- Zuniga, L.R. (1967):** Estudio del crecimiento de *Boops boops* del levante español. *Invest Pesqu.*, 31, 333–481. (In Spanish).

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

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*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).

Limited bibliography is available for *T. araneus* focusing mainly on envenomation (BEDINI *et al.*, 2003; ERYILMAZ *et al.*, 2006; SMITH and WHEELER, 2006; PORTILLO STREMPER, 2009; ALPARSLAN *et al.*, 2010, YILDIZ and KARAKULAK, 2018) or heavy metal contents (CABRERA *et al.*, 1994; LÓPEZ *et al.*, 2000 and BRAMBILLA *et al.*, 2013). Up to date, no studies were conducted on this trachinid in Algerian waters. The aim of this paper is to present the maximum total length of the spotted weever *T. araneus* documented up to now in the Mediterranean.

MATERIAL AND METHODS

On the 29th of October 2018, one specimen of *T. araneus* (Fig. 1) measuring 47.3 cm in total length (TL) was captured by trammel net in Oran Bay (Kristel fishery) (35°49'36.0"N 0°32'30.7"W), on sandy bottom at a depth of 100 m (Fig. 2). *T. araneus* specimen was measured to the nearest millimeter and weighted to the nearest g then photographed. For otoliths (Fig. 3) measurements an electronic caliper (Digiroch) was used, unfortunately otoliths were too thick to be read directly under binocular microscope to determine the age of *T. araneus* specimen.

The specimen was identified using FAO species identification sheets (BAUCHOT and HUREAU, 1986; DJABALI *et al.*, 1993) on the basis of the following morphological characters: the body elongated and compressed; very small eyes located

near the dorsal profile of the head; very oblique large mouth, with maxillary extending slightly beyond the posterior edge of the eye; villiform teeth; presence of 2 strong venomous spines on the operculum, 2 spines on the anterodorsal edge of the orbit and 6 dorsal spines in the first dorsal fin, the second dorsal fin contains 29 soft rays and the anal fin counts 27; the back and flanks yellowish gray, with 9 dorsal brownish to blackish spots and, beneath the lateral line, an alignment of large, more or less rounded or quadrangular spots; black dorsal fin; caudal fin lined with black and with some dark spots.

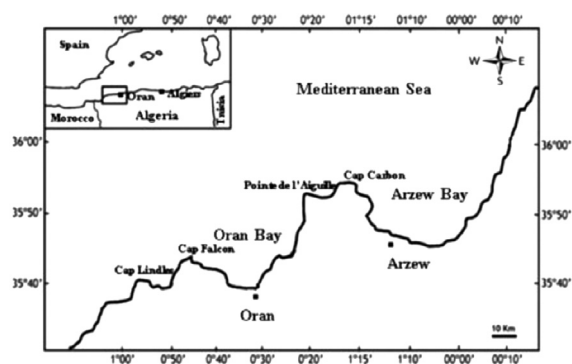


Fig. 2. Sampling location of spotted weever (*Trachinus araneus*) specimen



Fig. 1. *Trachinus araneus* (♀ 47.3 cm TL) caught in Oran Bay, (Photo: Lotfi BENSATLA TALET)



Fig. 3. Otoliths of *T. araneus* caught in Oran Bay

RESULTS AND DISCUSSION

Measurements and percentage of each body part and otolith measurements are reported in relation to total length and are given in Table 1.

Table 1. *Morphometric measurements as percentage of total length (%TL) of Trachinus araneus caught in Oran Bay, Western Mediterranean Sea*

Morphometric characteristic	Measurement (cm)	Proportion (%)
Total length (TL)	47.283	100.00
Fork length (FL)	45.837	96.94
Standard length (SL)	41.21	87.16
Pectoral fin length (LP)	6.992	14.79
Ventral fin length (LV)	3.585	7.580
Pre-ventral fin distance (PVD)	5.623	11.89
Cephalic length (LC)	7.258	15.35
Post-orbital distance (PO1)	5.859	12.39
Eye diameter (O)	0.705	1.490
Post-orbital distance (POD2)	3.084	6.520
Pre-pectoral distance (PPD)	9.861	20.86
Maxillary length (LM)	2.722	5.760
Anal fin length (LA)	27.08	57.27
Pre-anal fin distance (PAD)	11.38	24.07
Minimum body height (TPC)	2.650	5.600
Maximum body height (T)	9.080	19.20
Total weight (TW, g)	0.968	-
Otoliths measurements	Right	Left
Total length	1.470	1.488
Wide	0.727	0.743
Total weight (g)	0.338	0.345

Comparing our findings to those of MOUTOPOULOS and STERGIOU (2002), fork length represented 95.13% from total length and standard length represented 87.33% of total length of *T. araneus* from Greek waters which is close to our results with fork length representing 96.94% from total length and standard length representing 86.16% of total length. In an unpublished observation for the same species in Philippines, REYES in FROESE and PAULY, 2018 proportions of different body parts reported to total length were the same as our findings except two parameters,

Pre-ventral distance represented 15.3% while we found 11.89%, and Head length represented 23.4% while we found only 15.35% for *T. araneus* caught in Oran Bay.

For Atlantic waters, maximum length recorded for *T. araneus* was 45 cm (SL) (ROUX, 1990 in QUÉRO *et al.*, 1990), the same length (standard length) was assumed by CARPENTER *et al.*, 2015. Central Mediterranean basin recorded a specimen in Greece (Table 2) measuring 39 cm TL and weighting 490.75 g while in Turkey one specimen was caught measuring 31 cm and weighting 230g in 2006 (KARAKULAK *et al.*, 2006). The maximum length ever recorded for Turkish and Mediterranean waters (40.8 cm TL and weighting 758 g) was reported by OZTEKIN *et al.*, 2016.

Table 2. *Maximum length records of Trachinus araneus given by several authors*

Location	TL (cm)	TW(g)	References
Aegean Sea (Greece)	39.0	490.75**	MOUTOPOULOS and STERGIOU, 2002
Aegean Sea (Turkey)	31.0	230.00	KARAKULAK <i>et al.</i> , 2006
Gallipoli peninsula, Turkey	40.8	758.00	OZTEKIN <i>et al.</i> , 2016
North Eastern Atlantic	40*	-	HUREAU <i>et al.</i> , 1979
Eastern tropical Atlantic	45*	-	ROUX, 1990 in Quéro <i>et al.</i> , 1990
Oran Bay	47.3	968.00	Present study

*Standard length (SL)**calculated from LWR (Length weight relationship)

CONCLUSIONS

The maximum size found for the spotted weever *T. araneus* (47.3 cm, 968 g) caught in Oran Bay can be considered as a new maximum length for this species in Algerian and Mediterranean waters.

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The author is very grateful to fishermen of Kristel Fishery and especially to Mr. Mokhtar. This paper is dedicated to the memory of Professor Ahmed BENSABLAH-TALET, my beloved father and mentor, who was an Algerian marine biologist. He worked more than 49 years and was dedicated to science. He was also Dean of Faculty of Natural sciences and life at University Oran 1 Ahmed BENBELLA (2012-2020). He passed away on 31st July 2020 (December, 1st 1946 – July, 31st 2020)

REFERENCES

- AKYOL, O., H. ŞEN & H. T. KINACIGIL. 2007. Reproductive biology of *Eledone moschata* (Cephalopoda: Octopodidae) in the Aegean Sea (Izmir Bay, Turkey). J. Mar. Biol. Assoc. UK, 87(4), 967-970.
- ALPARSLAN, M., H. BARIS ÖZALP & S. DOĞU. 2010. "Poisonous Marine Organisms In Turkey And First Medical Aids." (2010): 616-623.
- BAUCHOT, M.-L. & J.-C. HUREAU. 1986. Sparidae. p. 883-907. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. volume 2. UNESCO, Paris, pp. 517-1007.
- BEDINI, R., M.G. CANALI & A. BEDINI. 2003. True and false threatening visual cues in some Mediterranean fish. J. Mar. Biol. Assoc. UK, 83(2), 265-270.
- BORGES, L. 2001. A new maximum length for the snipefish *Macroramphosus scolopax*. Cybium, 25(2): 191-192.
- BRAMBILLA, G., M.C. ABETE., G. BINATO., E. CHIARAVALLE., M. COSSU, E. DELLATTE & A. UBALDI. 2013. Mercury occurrence in Italian seafood from the Mediterranean Sea and possible intake scenarios of the Italian coastal population. Regul. Toxicol. Pharmacol., 65(2), 269-277.
- CABRERA, C, M.L. LORENZO, C. GALLEGU, M.C. LOPEZ & E. LILLO. 1994. Cadmium contamination levels in seafood determined by electrothermal atomic absorption spectrometry after microwave dissolution. J. Agri. Food. Chem., 42(1), 126-128.
- CARPENTER, K.E., W.F. SMITH-VANIZ., G. DE BRUYNE & L. de MORAIS. 2015. *Trachinus araneus*. The IUCN Red List of Threatened Species. 2015:e.T198718A42691939. <http://dx.doi.org/10.2305/IUCN.UK.20154.RLTS.T198718A42691939.en>
- CUVIER, G & A. VALENCIENNES. 1829. Suite du Livre troisième. Des percoides à dorsale unique à sept rayons branchiaux et à dents en velours ou en cardes. Tome troisième. i-xxviii, [1-2], 1-500, pls. 41-71. Eds.F.G. Levrault Paris (Avril 1829).
- ERYILMAZ, M., M. DURUSU., M. Ö MENTEŞ., T. YİĞİT., N. ZEYBEK & K. ÖNER. 2006. Envenomation caused by weever fish. Turk. J. Emer. Med, 6(3), 142-145.
- FROESE, R & C. BINOHLAN. 2000. Empirical relationships to estimate asymptotic length, length at first maturity, and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. J. Fish. Biol, 56(4): 758-773.
- FROESE, R & D. PAULY. 2018. FishBase. World Wide Web electronic publication. www.fishbase.org, version (10/2017) (accessed date: 01 November. 2018).
- HUREAU, J.-C. & T. MONOD (Editors), 1979. Checklist of the fishes of the north-eastern Atlantic and of the Mediterranean (CLOFNAM I and II). United Nations Educational Scientific and Cultural Organization (UNESCO), Paris, France. Vols 1-2. 683 p.
- LEGENDRE, M & J.J. ALBARET. 1991. Maximum observed length as an indicator of growth rate in tropical fishes. Aquacult., 94: 327-341.
- LÓPEZ, F. F., C. CABRERA., M. LORENZO & M.C. LÓPEZ. 2000. Aluminum content in foods and beverages consumed in the Spanish diet. J. Food. Sci, 65(2), 206-210.
- MOUTOPOULOS, D.K & K.I. STERGIOU. 2002. Length-weight and length-length relationships of fish species of the Aegean Sea (Greece). J. Appl. Ichthyol. 18(3):200-203.
- PORTILLO STREMPER, A., E. CEBALLOS HERRERA

- & J. PORTILLO STREMPER. 2009. Poisonous fish stings on the coast of Malaga, Spain: summertime incidence= Incidencia de picaduras de peces venenosos en la costa de Málaga, España, durante la época estival. Emergencias, (1).
- QUÉRO, J.-C., J.-C. HUREAU, C. KARRER, A. POST & L. SALDANHA (Editors), 1990. Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT (Lisbon), EIU (Paris) and UNESCO (Paris), pp. xxxii+1492.
- ROUX, C. 1990. Trachinidae. p. 893-895. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (Editors). Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris. Vol. 2., pp. xxxii+1492.
- SMITH, W. L & W.C. WHEELER .2006. Venom evolution widespread in fishes: a phylogenetic road map for the bioprospecting of piscine venoms. J. Hered, 97(3), 206-217.
- YILDIZ, T. & F.S. KARAKULAK. 2018. Türkiye'nin Zehirli Balıklarından Trakonya Balığının Toksik Etkileri. Aquat. Sci. Eng, 33(1), 20-24.

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Nova maksimalna dužina pauka crnca, *Trachinus araneus* Cuvier, 1829 (Perciformes: Trachinidae) iz zapadnog Mediterana, zaljev Oran

Lotfi BENSAHLA-TALET i Ahmed BENSAHLA-TALET

SAŽETAK

Dana 29. listopada 2018. g. ulovljen je jedan primjerak pauka crnca, *Trachinus araneus* Cuvier, čija je totalna dužina iznosila 47,3 cm, a masa 968 grama. Primjerak je ulovljen na dubini od 100 m u zaljevu Oran (zapadna alžirska obala).

Ovo je dosada najveća zabilježena dužina za ovu vrstu u mediteranskom bazenu.

Ključne riječi: pauk crnac, *Trachinus araneus* Cuvier, maksimalna veličina, zaljev Oran, Sredozemno more

A review on maximum length of the greater weever *Trachinus draco* Linnaeus 1758 (Perciformes: Trachinidae) with a new maximum length from Oran Bay (Western Algeria)

Lotfi BENSABLA-TALET^{1,2} , Hichem ADDA NEGGAZ² 

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ABSTRACT

On the 15th April 2017, one female specimen of the greater weever, *Trachinus draco* measuring 44.69 cm in total length and weighting 885 g was captured by trammel net in Oran Bay (Cape Rousseau) at 120 m depth. Up to date, this length is a new record of maximum length reached for this trachinidae for Algerian waters and the second maximum length recorded in Mediterranean basin according to Fischer *et al.*, 1987 observation noted at 45 cm.

Keywords: The greater weever, *Trachinus draco*, Maximum size, Oran Bay, Mediterranean Sea

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Introduction

The greater weever is a trachinidae found in Eastern Atlantic; Norway to Morocco, Madeira and Canary Islands, including the Mediterranean and the Black Sea (Fischer *et al.*, 1987; FishBase: Froese and Pauly, 2020). *Trachinus draco* Linnaeus 1758 inhabits sandy, muddy or gravelly bottoms, from a few meters to about 150 m. Rest on the bottom, often buried with eyes and tip of first dorsal fin exposed (Frimodt, 1995). The first dorsal fin rays, as well as the spine on the pre-operculum contains venomous spines protecting the species from predators. During night, the greater weever leaves the burrow to feed on small invertebrates and fishes (Carpenter *et al.*, 2015). At night, it also swims around freely, even pelagically (Muus and Nielsen 1999). *T. draco* is oviparous, eggs and larval stages are pelagic (Tortonese, 1986). There are dark markings along the scales; the anterior dorsal fin is black and contains venomous spines. Its length is very common between 10 and 30 cm with a maximum of 45 cm in the Mediterranean and common between 15 to 20 cm with a maximum of 36 cm in the Black Sea (Fischer *et al.*, 1987).

Available bibliography for *T. draco* is diversified dealing with reproduction (Bagge, 2004; Ak and Genç, 2013), Parasites (Azizi *et al.*, 2016; Kayış and Er, 2016), lipid content (Loukas *et al.*, 2010), feeding habits (Santic *et al.*, 2016), population structure and dynamics (Quigley, 1994; Portillo Stempel *et al.*, 2008; Buz and Basusta, 2015; Carpenter *et al.*, 2015; Custovic *et al.*, 2014) but most of them focused on envenomation and toxin properties (Muir evans 1907; Skeie, 1962; Chahl and Kirk, 1975; Perriere and Michel, 1986; Halstead and Vinci, 1987; Chhatwal and Dreyer, 1992; Bouree and Lançon, 2002; Church and Hodgson, 2002; Acciaro *et al.*, 2003; Verdiglione *et al.*, 2003; Berger and Caumes, 2004; Russell and Emery, 2006; Lopacinski *et al.*, 2009; Benlier *et al.*, 2010; Portillo Stempel and Ceballos, 2012) and mainly on weight length relationship (Dorel 1986; Coull *et al.*, 1989; Gonçalves *et al.*, 1997; Merella *et al.*, 1997; Moutopoulos and Stergiou, 2002; Mendes *et al.*, 2004; Mendes *et al.*, 2006; Ozaydin *et al.*, 2007; Karakulak *et al.*, 2006; Ikyaz *et al.*, 2008; Mata *et al.*, 2008; Ak *et al.*, 2009; Giacalone *et al.*, 2010; Benmessaoud *et al.*, 2015; Öztekin *et al.*, 2016; Özdemir *et al.*, 2017; Hamed *et al.*, 2016).

In fisheries science maximum length and maximum age are important theoretical parameters found as entry data in majority of the models used in stock assessments (Allen, 1971; Pauly, 1980; Welcomme, 1999; Froese and Binohlan, 2000).

In this context, updating the maximum size of a species harvested for commercial or recreational purposes is gaining more importance (Borges, 2001; Dulčić and Soldo, 2005; Akyol and Şen, 2008). The maximum observed length is a useful tool for a rapid evaluation of growth rates in the absence of basic data (Legendre and Albaret, 1991, Froese and Binohlan, 2000). To date, for Algerian waters no such studies were leaded on this trachinidae.

Material and Methods

On the 15th April 2017, one female specimen of the greater weever, *Trachinus draco* measuring 44.69 cm in total length and weighting 885 g was captured by captured by trammel net operating in Oran Bay (Cape Rousseau: 35°48'45.0"N 0°36'46.8"W) on sandy/rocky bottom at 120 m depth (Fig. 1).

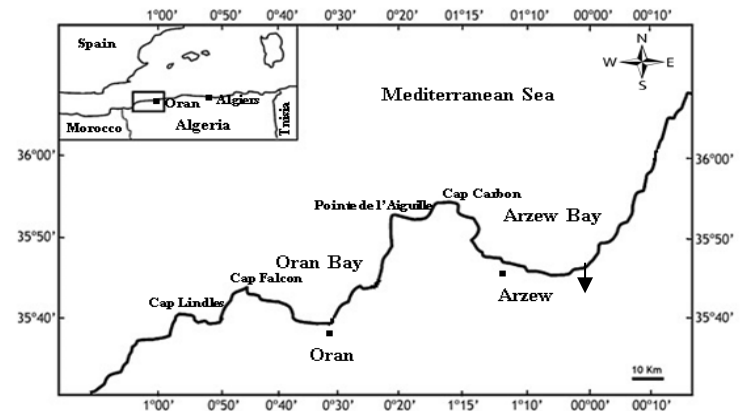
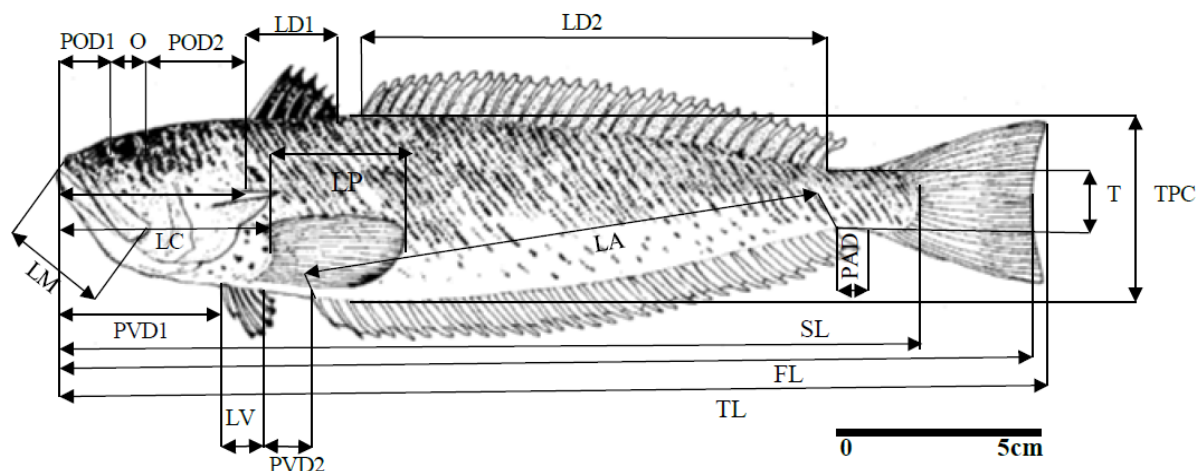


Figure 1. Sampling location of greater weever (*Trachinus draco*) specimen.

The specimen was measured with an electronic caliper to 0.1 mm precision and weighted to the nearest 0.1 g then photographed. Eighteen morphometric characteristics were measured (Figure 2): Total length (TL), Fork length (FL), Standard length (SL), Pectoral fin length (LP), Ventral fin length (LV), 1st dorsal fin length (LD1), 2nd dorsal fin length (LD2), Cephalic length (LC), Maxillary length (LM), Post-orbital distance (POD1), Eye diameter (O), Post-orbital distance (POD2), Pre-ventral fin distance (PVD1), Post-ventral fin distance (PVD2), Anal fin length (LA), Post-anal fin distance (PAD), Caudal peduncle minimal depth (T), Maximum body height (TPC), Total weight (TW). Description, measurements and percentage of each body part are reported to total length are given in (Table 1).



Total length (TL), Fork length (FL), Standard length (SL), Pectoral fin length (LP), Ventral fin length (LV), Cephalic length (LC), Maxillary length (LM), Pre-orbital distance (POD1), 1st Dorsal fin length (LD1), 2nd Dorsal fin length (LD2), Eye diameter (O), Post-orbital distance (POD2), Anal fin length (LA), Caudal peduncle minimal depth (T), Maximum body height (TPC), Pre-ventral fin distance (PVD1), Post-anal fin distance (PAD), Post ventral fin distance (PVD2).

Figure 2. Morphometric measurements of the greater weever *Trachinus draco* adapted from Fischer *et al.* (1987).

Results and Discussion

On the 15th April 2017, one female specimen of the greater weever, *Trachinus draco* measuring 44.69 cm in total length and weighting 885 g was captured by trawler operating in Oran Bay at 120 m depth. Species identification sheets (Fischer *et al.*, 1987; Djabali *et al.*, 1993) were used to identify the specimen of *T. draco* (Fig.3) where the body appear elongated and compressed. Small eyes located near the dorsal profile of the head; width of the interorbital space roughly equal to half the diameter of the eye; large oblique mouth, the maxillary extending beyond the posterior edge of the eye when the mouth is closed with villiform teeth.

According to Fischer *et al.*, (1987) *T. draco* has a strong venomous spine on the operculum, 2 spines on the anterodorsal edge of the orbit and another above the upper lip, in front of the eye. Two dorsal fins, the first short counting 5 to 7 spines, the second, long counting 29 to 32 soft rays; anal with 2 spines and 29 to 32 soft rays. Generally, the greater weever is greenish brown back with dark spots on the head, yellowish-white flanks according to the oblique rows of scales, of brown, blue, yellow lines; second dorsal fin yellowish, anal mauve.



Figure 3. *Trachinus draco* (44.69 cm TL ♀) caught in Oran Bay, (Photographed by: ADDA NEGGAZ Hichem).

Measurements, meristic characteristics, weight and percentage of each body part of the greater weever caught in Oran Bay reported to total length are given in (Table 1).

Table 1. Morphometric measurements as percentage of total length (% TL) of *Trachinus draco* caught in Oran Bay (W. Mediterranean Sea).

Morphometric characteristics	Measurement (cm)	Proportion (%)
Total length (TL)	44.69	100.00
Fork length (FL)	43.44	97.20
Standard length (SL)	39.30	87.94
Pectoral fin length (LP)	5.76	12.90
Ventral fin length (LV)	3.28	7.360
1 st dorsal fin length (LD1)	2.74	6.140
2 nd dorsal fin length (LD2)	19.76	44.22
Cephalic length (LC)	7.67	17.16
Maxillary length (LM)	1.41	3.160
Post-orbital distance (POD1)	2.96	6.620
Eye diameter (O)	0.77	1.720
Post-orbital distance (POD2)	5.68	12.72
Pre-ventral fin distance (PVD1)	6.15	13.78
Post-ventral fin distance (PVD2)	2.70	6.060
Anal fin length (LA)	25.70	57.51
Post-anal fin distance (PAD)	2.66	5.950
Maximum body height (TPC)	2.57	5.750
Caudal peduncle minimal depth (T)	8.40	18.80
Total weight (TW)	0.88	-
Meristic characteristics		
Operculum spines	2*	
Short eye spines	2	
1 st dorsal fin spines	7 (2*+5)	
2 nd dorsal fin	32	
Pelvic fin	6	
Pectoral fins	15	
Anal fin	31	
Caudal fin	16	

*: venomous

According to Portillo Stempel *et al.*, 2008 *T. draco* showed a seasonal migratory behavior, with a preference for shallower waters, up to 75 m depth during autumn and for deeper waters up to 160 m depth, during spring in the northern Alboran Sea (SW Mediterranean) which is the case of our specimen captured in April 2017.

The maximum length ever recorded of *T. draco* belongs to IGFA 2001 in the Atlantic Ocean (Canary island, 56cm) and by Otel (2007) in Danube Delta (53cm) followed by Fischer *et al.*, 1987 (45cm) in the Mediterranean, all successive records are shown in Table 2.

Greater Weever is caught as bycatch in the majority of fisheries and landings are declared from the following FAO regions: Northeast Atlantic, Mediterranean and Black Sea. The overall trend in landings is one of dramatic fluctuations with a general increase in landings over time (Carpenter *et al.*, 2015). As stated previously little is known on its ecobiology, population trends and most of studies focused on its toxins.

In the Mediterranean Sea, the maximum length of *T. draco* were reported as 45 cm TL (n=1124); 36 cm from Black Sea (Fischer *et al.*, 1987); If we consider to maximum length recorded during our study so this length represents the maximum length for both Algerian and Western Mediterranean Sea. The aim of this paper is to present a compilation of maximum length for *T. draco* with a new record for the greater weever caught in Western Mediterranean Sea (Oran Bay).

Wootton 1990; 1999 in Helfman *et al.* (2009) stated that factors such as temperature, food availability, nutrient availability, light regime, oxygen, salinity, pollutants, current speed, predator density, intraspecific social interactions, and genetics often working in combination, creating large variations in size of fishes of the same and different ages, also populations exposed to high fishing mortality/pressure will respond by reproducing at smaller average sizes and ages. Generally, in the Mediterranean and Black Sea where fishing activity is intensive, the maximum length was relatively low (Table 2) 32 cm in Tunisian waters, 38cm in French waters, 32.9 in Greek waters, 23 cm in Egyptian waters cm TL.

Contrarily, in oceanic and northern seawaters individuals doesn't face the same fishing pressure, maximum length appears more important with a maximal length recorded in Canary Islands reaching 56 cm (IGFA, 2001). In this context, frequenting the eastern part of oranian shoreline an area undergoing a less fishing pressure than the western area (Oran Bay) (*Pers.obs*) we can explain that our specimen may have reached this maximum length observed. Also, we can add the fact that there is no predator known for *T. draco* at the top of the trophic chain.

Table 2. Maximum length records of *Trachinus draco* given by several authors.

Location		Depth (m)	TL (cm)	TW (g)	References
Turkey	Aegean Sea	<30	35.2	235.82*	Karakulak <i>et al.</i> , (2006)
	Saros Bay	28-370	37.0	427.00	Ismen <i>et al.</i> , (2007)
	Izmir Bay	-	34.1	288.99*	Ozaydin <i>et al.</i> , (2007)
	N. Eastern Mediterranean	5-100	20.0	53.18	Sangun <i>et al.</i> , (2007)
	Aegean Sea	30-70	36.6	365.42*	Ilkyaz <i>et al.</i> , (2008)
	Aegean Sea	-	36.6	401.43	Kınacıgil <i>et al.</i> , (2008)
	Eastern Black Sea	60	35.0	549.20	Ak <i>et al.</i> , (2009)
	İskenderun Bay	18-19m	20.6	55.84	Gökçe <i>et al.</i> , (2010)
	Eastern Black Sea	60	25.8	131.76	Ak and Genç, (2013)
	Iskenderun Bay	-	28.7 M 32.0 F	145.21 237.48	Buz and Basusta, (2015)
	Aegean Sea	0-400	36.4	294.00	Öztekin <i>et al.</i> , (2016)
Romania	Black Sea	-	40	-	Bănărescu, (1964)
	Agigea Eforie Nord Area	9.3-12.5	16.5	18-27	Roșca <i>et al.</i> , (2010)
	Danube Delta	-	53.0	-	Otel, (2007)
Tunisia	Gulf of Tunis	-	32.0	236.30	Hamed and Chakroun-Marzouk, (2016)
France	Gulf of Gascogne	-	38.5	317.97*	Dorel, (1986)
	Catalan coast	1-80	38.5	375.00	Crec'hriou <i>et al.</i> , (2012)
Greece	Cyclades, Aegean Sea	4-90	32.5		Erzini <i>et al.</i> , (1999)
	Greece, Aegean Sea	-	32.0	219.03*	Moutopoulos and Stergiou, (2002)
	Greece, Thermaikos Gulf	-	30.5	189.37*	Karachle and Stergiou, (2008)
	Greece North Aegean Sea	15-800	28.8	149.40	Torres <i>et al.</i> , (2012)
	Korinthiakos Gulf	50-300	32.9	206.13*	Moutopoulos <i>et al.</i> , (2013)
Spain		40-80	24.2	83.90*	Merella <i>et al.</i> , (1997)
	Balearic Islands	0.5-1713	26.5	125.00	Morey <i>et al.</i> , (2003)
		-	34.0	259.64*	Garmon, (2005)
	Eastern Atlantic	<20	29.5	167.94*	Mata <i>et al.</i> , (2008)
	Alboan Sea	50-164	39.0	-	Portillo Stempel <i>et al.</i> , (2008)
Portugal	Eastern Atlantic Ocean	13-55	34.0	502.06*	Gonçalves <i>et al.</i> , (1997)
	Algarve coast	-	39.6	554.10	Santos <i>et al.</i> , (2002)
	Eastern Atlantic	30-350	39.0	460.00	Mendes <i>et al.</i> , (2004)
Egypt	Alexandria Bay	30-200	23.0	200.52*	Abdallah <i>et al.</i> , (2002)
Croatia	Eastern Adriatic	-	26.8	330.00	Dulčić and Kraljević, (1996)
Italy	Sicily	10-200	29.5	169.26*	Giacalone <i>et al.</i> , (2010)
Ireland	Schull Bay	-	42.0	510.00	Went, (1973)
	Keem Bay (Co Mayo)	-	35.4	311.00	Quigley <i>et al.</i> , (1990)
	Ballycotton Bay (Co Mayo)	-	38.7	-	Quigley <i>et al.</i> , (1994)
-	North East Atlantic		35.0	344.00	Coull <i>et al.</i> , (1989)
	North Sea/North-East Atlantic	-	36.5	352.78*	Wilhelms, (2013)
	Western Atlantic, Canary island	-	56.0	1740.00	IGFA, (2001)
	Northern/Central Adriatic	-	32.8	-	Custovic <i>et al.</i> , (2014)
Denmark	Kattegat	9.9-27.1	32.5 M 37.6 F	221.40 350.20	Bagge, (2004)
-	Mediterranean Sea	-	45.0	-	Fischer <i>et al.</i> , (1987)
	Black Sea	-	36.0	-	
Algeria	Oran Bay	120	44.69	885.00	Present study

*Weight calculated from LWR (length weight relationship).

Conclusion

As conclusion, more efforts and means must be deployed to explore Oran Bay biodiversity deeply, target large specimens and try to study fish population's dynamics and their interaction with different biotopes present in the area (sandy, muddy, rocky, gravelly).

Compliance with Ethical Standard

Conflict of interests: The authors declare that for this article they have no actual, potential or perceived conflict of interests.

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References

- Abdallah, M. (2002).** Weight-length relationships of fishes caught by trawl off Alexandria, Egypt. *Naga ICLARM Q.*, 25(1), 19-20.
- Acciaro, A.L., Caserta, G., Gagliano, M., Busa, R., Landi, A. (2003).** La Rigidità Articolare Nella Mano Nelle Lesioni Da *Trachinus draco*. *Rivista di Chirurgia della Mano*, 40 (3) 2003.
- Ak, O., Kutlu, S., Aydın, İ. (2009).** Length-weight relationship for 16 fish species from the Eastern Black Sea, Türkiye. *Turkish Journal of Fisheries and Aquatic Sciences*, 9(1), 125-126.
- Ak, O., Genç, Y. (2013).** Growth and reproduction of the greater weever (*Trachinus draco* L., 1758) along the eastern coast of the Black Sea. *Journal of Black Sea/Mediterranean Environment*, 19(1), 95-110.
- Akyol, O., Şen, H. (2008).** A new maximum size for *Eledone moschata* (Cephalopoda: Octopodidae). *Marine Biodiversity Records*, 1, e71.
<https://doi.org/10.1017/S1755267207007531>
- Allen, K. R. (1971).** Relation between production and biomass. *Journal of the Fisheries Research Board of Canada*, 28, 1573-1581.
<https://doi.org/10.1139/f71-236>
- Azizi, R., Rangel, L.F., Castro, R., Santos, M.J., Bahri, S. (2016).** Morphology, seasonality and phylogeny of *Zschokkella trachini* n. sp. (Myxozoa, Myxosporea) infecting the gallbladder of greater weever *Trachinus draco* (L.) from Tunisian waters. *Parasitology Research*, 115(11), 4129-4138.
<https://doi.org/10.1007/s00436-016-5187-y>
- Bagge, O. (2004).** The biology of the greater weever (*Trachinus draco*) in the commercial fishery of the Kattegat. *ICES Journal of Marine Science*, 61(6), 933-943.
<https://doi.org/10.1016/j.icesjms.2004.07.020>
- Bănărescu, P. (1964).** Fauna Republicii Socialiste Romania. Pisces-Osteichthyes. Editura Academiei R.S.R., Bucureşti XIII, 1: 958 p.
- Benlier, E., Alicioglu, B., Kir, K., Sarikaya, A. (2010).** Using liposuction for late complication of *Trachinus draco* envenomation. *Aesthetic Plastic Surgery*, 34(2), 179.
<https://doi.org/10.1007/s00266-009-9406-0>
- Berger, L., Caumes, E. (2004, April).** Accidents cutanés provoqués par la faune et la flore sous-marines. In *Annales de Dermatologie et de Vénéréologie*, 131(4), 397-404
[https://doi.org/10.1016/S0151-9638\(04\)93626-5](https://doi.org/10.1016/S0151-9638(04)93626-5)
- Borges, L. (2001).** A new maximum length for the snipefish *Macrohamphosus scolopax*. *Cybium*, 25, 191-192.
- Bourée, P., Lançon, A. (2002).** Les animaux aquatiques dangereux. *Revue Francaise des Laboratoires*, 2002(342), 61-64.
[https://doi.org/10.1016/S0338-9898\(02\)80063-4](https://doi.org/10.1016/S0338-9898(02)80063-4)
- Buz, K., Başusta, N. (2015).** Age and growth of the greater weever, *Trachinus draco* (Linnaeus, 1758) inhabiting Iskenderun Bay, North-Eastern Mediterranean Sea. *Cahiers de Biologie Marine*, 56, 289-295.

- Carpenter, K.E., Smith-Vaniz, W.F., de Bruyne, G., de Morais, L. (2015). *Trachinus draco*. The IUCN Red List of Threatened Species, 2015, e.T198719A42691954. <https://doi.org/10.2305/IUCN.UK.2015-4.RLTS.T198719A42691954.en>
- Chahl, L.A., Kirk, E.J. (1975). Toxins which produce pain. *Pain*, 1(1), 3-49. [https://doi.org/10.1016/0304-3959\(75\)90003-2](https://doi.org/10.1016/0304-3959(75)90003-2)
- Chhatwal, I., Dreyer, F. (1992). Biological properties of a crude venom extract from the greater weever fish *Trachinus draco*. *Toxicon*, 30(1), 77-85. [https://doi.org/10.1016/0041-0101\(92\)90503-W](https://doi.org/10.1016/0041-0101(92)90503-W)
- Church, J.E., Hodgson, W.C. (2002). The pharmacological activity of fish venoms. *Toxicon*, 40(8), 1083-1093. [https://doi.org/10.1016/S0041-0101\(02\)00126-5](https://doi.org/10.1016/S0041-0101(02)00126-5)
- Coull, K.A., Jermyn, A.S., Newton, A.W., Henderson, G.I., Hall, W.B. (1989). Length/weight relationships for 88 species of fish encountered in the North Atlantic. *Scottish Fisheries Research Reports*, 43, 1-80.
- Crec'hriou, R., Neveu, R., Lenfant, P. (2013). Length-weight relationship of main commercial fishes from the French Catalan coast. *Journal of Applied Ichthyology*, 29, 1191-1192. <https://doi.org/10.1111/jai.12320>
- Čustović, S., Vrgoč, N., Isajlović, I., Šifner, S.K., Krželj, M., Ferri, J. (2014). Growth dynamic of the greater weever (*Trachinus draco* Linnaeus 1758) in the Northern and Central Adriatic. 49. hrvatski i 9. međunarodni simpozij agronoma, 16. do 21. veljače 2014, Dubrovnik, Hrvatska. *Zbornik Radova*, 448-452.
- Djabali, F., Brahmi, B., Mammasse, M. (1993). Poissons des côtes algériennes. *Pelagos*, N. spec., 1-215.
- Dorel, D. (1986). Poissons de l'Atlantique Nord-Est: Relations Taille-Poids. DRV-86-001/RH/NANTES. *Ifremer Report. DRV*. <https://archimer.ifremer.fr/doc/00000/1289/> (accessed: 15/05/2020).
- Dulčić, J., Kraljević, M. (1996). Weight-length relationships for 40 fish species in the eastern Adriatic (Croatian waters). *Fisheries Research*, 28(3), 243-251. [https://doi.org/10.1016/0165-7836\(96\)00513-9](https://doi.org/10.1016/0165-7836(96)00513-9)
- Dulčić, J., Soldo, A. (2005). A new maximum length for the grey triggerfish, *Balistes capriscus* Gmelin, 1789 (Pisces: Balistidae) from the Adriatic Sea. *Institute of Oceanography and Fisheries-Split Croatia*, 88, 1-7.
- Erzini, K., Stergiou, K.I., Bentes, L., Economides, P.S., Gonçalves, J.M.S., Lino, P.G., Moutopoulos, D.K., Petrakis G., Ribeiro, J., Voulgaridou, P. (1999). Comparative fixed gear selectivity studies in Portugal and Greece. *Final Report to the European Union* (EU No 96/065). University of Algarve and Aristotle University of Thessaloniki.
- Evans, H.M. (1907). Observations on the poisoned spines of the weever fish (*Trachinus draco*). *British Medical Journal*, 1(2402), 73. <https://doi.org/10.1136/bmj.1.2402.73>
- Fischer, W., Schneider, M., Bauchot, M.L. (1987). Fiches FAO d'identification des espèces pour les besoins de la pêche: Méditerranée et mer noire zone de pêche 37: vol. 2 vertébrés: ((FAO species identification sheets for fishery purposes. Mediterranean and Black Sea (Fishing Area 37). vol. 2 vertebrates.)).
- Frimodt, C. (1995). Multilingual illustrated guide to the world's commercial coldwater fish. Fishing News Books, Osney Mead, Oxford, England. 215 p.
- Froese, R., Binohlan, C. (2000). Empirical relationships to estimate asymptotic length, length at first maturity, and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. *Journal of Fish Biology*, 56(4), 758-773. <https://doi.org/10.1111/j.1095-8649.2000.tb00870.x>
- Froese, R., Pauly, D. (2020). FishBase. World Wide Web electronic publication. www.fishbase.org, version (10/2017) (accessed: 27 May 2020).
- Garmón, A.C. (2005). Biología, dinámica poblacional y tasas de mortalidad y explotación pesquera de *Trachinus*

draco en las Islas Baleares (Mediterráneo Occidental) (Master dissertation).

Giocalone, V.M., Anna, G.D., Badalamenti, F., Pipitone, C. (2010). Weight-length relationships and condition factor trends for thirty-eight fish species in trawled and untrawled areas off the coast of Northern Sicily (Central Mediterranean Sea). *Journal of Applied Ichthyology*, 26, 954-957.
<https://doi.org/10.1111/j.1439-0426.2010.01491.x>

Gonçalves, J.M.S., Bentes, L., Lino, P.G., Ribeiro, J., Canário, A.V.M., Erzini, K. (1997). Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and South-West coast of Portugal. *Fisheries Research*, 30(3), 253-256.
[https://doi.org/10.1016/S0165-7836\(96\)00569-3](https://doi.org/10.1016/S0165-7836(96)00569-3)

Gökçe, G., Çekiç, M., Filiz, H. (2010). Length-weight relationships of marine fishes off Yumurtalık coast (Iskenderun Bay), Turkey. *Turkish Journal of Zoology*, 34, 101-104.

Halstead, B.W., Vinci, J.M. (1987). Venomous fish stings (Ichthyocanthotoxicoeses). *Clinics in Dermatology*, 5(3), 29-35.
[https://doi.org/10.1016/S0738-081X\(87\)80005-6](https://doi.org/10.1016/S0738-081X(87)80005-6)

Hamed, O., Chakroun-Marzouk, N. (2016). First investigation on the reproductive traits of *Trachinus radiatus* Cuvier, 1829. *Rapports de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée*, 41, 457.

Helfman, G.S., Collatte, B.B., Facey, D.E., Bowen, B.W. (2009). The diversity of fishes: biology, evolution, and ecology, 2nd edn, Wiley-Blackwell, UK, 720 pp.

IGFA 2001. Database of IGFA angling records until 2001. IGFA, Fort Lauderdale, USA.

Ilkyaz, A.T., Metin, G., Soykan, O., Kinacigil, H.T. (2008). Weight-Length relationships of 62 fish species from the Central Aegean Sea, Turkey. *Journal of Applied Ichthyology*, 24, 699-702.
<https://doi.org/10.1111/j.1439-0426.2008.01167.x>

Ismen, A., Ozen, O., Altinagac, U., Ozekinc, U., Ayaz, A. (2007). Weight–Length relationships of 63 fish species in Saros Bay, Turkey. *Journal of Applied Ichthyology*, 23, 707-708.

<https://doi.org/10.1111/j.1439-0426.2007.00872.x>

Karachle, P.K., Stergiou, K.I. (2008). Length–Length and weight-length relationships of several fish species from the North Aegean Sea (Greece). *Journal of Biological Research-Thessaloniki*, 10, 149-157.

Karakulak, F.S., Erk, H., Bilgin, B. (2006). Length–weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. *Journal of Applied Ichthyology*, 22(4), 274-278.
<https://doi.org/10.1111/j.1439-0426.2006.00736.x>

Kayış, Ş., Akif, E.R. (2016). First record of *Nerocila bivittata* (Cymothidae, Isopoda) on Greater Weever (*Trachinus draco*) in the Worldwide. *Aquaculture Studies*, 16(4), 335-339.
<https://doi.org/10.17693/yunusae.v16i26717.281033>

Kinacigil, H.T., İlkyaz, A.T., Metin, G., Ulaş, A., Soykan, O., Akyol, O., Gurbet, R. (2008). Determining the first reproduction length, age and growth parameters of Aegean Sea demersal fish for the regulation of fisheries management. TÜBİTAK-ÇAYDAG, 327p. (in Turkish).

Legendre, M., Albaret, J.J. (1991). Maximum observed length as an indicator of growth rate in tropical fishes. *Aquaculture*, 94, 327-341.
[https://doi.org/10.1016/0044-8486\(91\)90177-9](https://doi.org/10.1016/0044-8486(91)90177-9)

Linnaeus, C. (1758). Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata. Impensis Direct. Laurentii Salvii, Holmiae. 824 p.
<https://doi.org/10.5962/bhl.title.542>

Łopaciński, B., Bak, M., Fiszer, M., Czerniak, P., Krakowiak, A. (2009). Poisoning with weever fish venom: a case report. *Przegląd Lekarski*, 66(8), 464-465.

Loukas, V., Dimizas, C., Sinanoglou, V.J., Miniadis-Meimaroglou, S. (2010). EPA, DHA, cholesterol and phospholipid content in *Pagrus pagrus* (cultured and wild),

Trachinus draco and *Trigla lyra* from Mediterranean Sea. *Chemistry and Physics of Lipids*, 163(3), 292-299.

<https://doi.org/10.1016/j.chemphyslip.2010.01.004>

Mata, A.J., Morales, J., Marquez, L. (2008). Weight–Length relationships for 26 demersal fish species of the Spanish South-Atlantic coastal waters. *Journal of Applied Ichthyology*, 24, 330-333.

<https://doi.org/10.1111/j.1439-0426.2008.01058.x>

Mendes, B., Fonseca, P., Campos, A. (2004). Weight–Length relationships for 46 fish species of the Portuguese west coast. *Journal of Applied Ichthyology*, 20(5), 355-361.

<https://doi.org/10.1111/j.1439-0426.2004.00559.x>

Mendes, B., Fonseca, P., Campos, A. (2006). Relationships between opercula girth, maximum girth and total length of fish species caught in gillnet and trammel net selectivity surveys off the Portuguese coast. *Journal of Applied Ichthyology*, 22(3), 209-213.

<https://doi.org/10.1111/j.1439-0426.2006.00734.x>

Merella, P., Quetglas, A., Alemany, F., Carbonell, A. (1997). Weight-length relationships of fishes and cephalopods from the Balearic Islands (western Mediterranean). *Naga ICLARM Quarterly*, 20(3-4), 66-68.

Morey, G., Moranta, J., Massuti E., Grau A., Linde M., Riera F., Morales-Nin B. (2003). Weight-Length relationships of littoral to lower slope fishes from the Western Mediterranean. *Fisheries Research*, 62, 89-96.

[https://doi.org/10.1016/S0165-7836\(02\)00250-3](https://doi.org/10.1016/S0165-7836(02)00250-3)

Moutopoulos, D.K., Stergiou, K.I. (2002). Length-Weight and length-length relationships of fish species from the Aegean Sea (Greece). *Journal of Applied Ichthyology*, 18(3), 200-203.

<https://doi.org/10.1046/j.1439-0426.2002.00281.x>

Moutopoulos, D.K., Ramfos, A., Mouka, A., Katselis, G. (2013). Length-Weight relations of 34 fish species caught by small-scale fishery in Korinthiakos Gulf (Central Greece). *Acta Ichthyologica et Piscatoria*. 43(1), 57-64.

<https://doi.org/10.3750/AIP2013.43.1.08>

Muus, B.J., Nielsen, J.G. (1999). Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. ISBN: 87-90787-00-5

Otel, V. (2007). The Atlas of the fish species of the Danube Delta Biosphere Reserve. Edit. Centrul de Informare Tehnologica Delta Dunarii: Tulcea, Romania.

Ozaydin, O., Uckun, D., Akalin, S., Leblebici, S., Tosunoglu, Z. (2007). Length-Weight relationships of fishes captured from Izmir Bay, Central Aegean Sea. *Journal of Applied Ichthyology*, 23, 695-696.

<https://doi.org/10.1111/j.1439-0426.2007.00853.x>

Öztekin, A., Özekinci, U., Daban, I.B. (2016). Length-Weight relationships of 26 fish species caught by longline from the Gallipoli peninsula, Turkey (northern Aegean Sea). *Cahiers de Biologie Marine*, 57, 335-342.

Özdemir, S., Özsandıkçı, U., Büyükdeveci, F., Erdem, Y., Özdemir, Z.B. (2017). Some Biological Characteristics and Length-Weight Relationship of Dangerous Venomous Fishes from Black Sea Coasts. ISEEP-2017 VIII. *International Symposium on Ecology and Environmental Problems*. Çanakkele, Turkey: 402.

Pauly, D. (1980). On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. *Journal du Conseil International pour l'Exploration de la Mer*, 39, 175-192.

<https://doi.org/10.1093/icesjms/39.2.175>

Perrière, C., Michel, C. (1986). Les glandes operculaires de la petite vive, *Trachinus vipera* C.V. (Téléostéens, Trachinoidea, Trachinidae). *Cahiers de Biologie Marine*, 27, 469-490.

Portillo Strempe, A., Baro Domínguez, J., Mancera, Romero, J.M., Herrera Ceballos, E., Ceballos, R. (2008). Distribución espacial de *Trachinus draco* (Linnaeus, 1758), (Pesciforme, Trachinidae) en el norte del Mar de Alborán (España). *Zoologica Baetica*, 19, 3-14.

Portillo Strempe, A., Herrera Ceballos, E. (2014). Histology of the venom gland of *Trachinus draco* (*A. ctinopterygii*, *T. rachinidae*). *Acta Zoologica*, 95(2), 125-132.

<https://doi.org/10.1111/azo.12004>

- Quigley, D.T.G., Flannery, K. (1994).** Fish Notes. *The Irish Naturalists' Journal*, 24(10), 408-412.
- Quigley, D.T.G., Flannery, K., O'Shea, J. (1990).** The Greater Weever *Trachinus draco* (L.) in Irish waters: First Record from Co. Mayo and a Review of Irish Records. *The Irish Naturalists' Journal*, 23(5/6), 208-210.
- Rimel, B., Mourad, C., Koched, W. (2015).** Length-Weight relationships of 15 ground fish species caught in Tunisian deep water (SW Mediterranean Sea). *International Journal of Recent Scientific Research*, 6(9), 6386-6388.
- Roșca, I., Arteni, O.M., Ion, I. (2010).** Recent data on some benthic fish populations of the Black Sea coast (Agigea Eforie Nord Area). *Analele Științifice ale Universității, Al. I. Cuza" Iași, s. Biologie animală*, Tom LVI, 2010.
- Russell, F.E., Emery, J.A. (1960).** Venom of the Weevers *Trachinus draco* and *Trachinus vipera*. *Annals of the New York Academy of Sciences*, 90(3), 805-819.
<https://doi.org/10.1111/j.1749-6632.1960.tb26424.x>
- Sangun, L., Akamca, E., Akar, M. (2007).** Weight-Length relationships for 39 fish species from the North-Eastern Mediterranean coast of Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, 7(1), 37-40.
- Šantić, M., Pallaoro, A., Rađa, B., Jardas, I. (2016).** Diet composition of greater weever, *Trachinus draco* (Linnaeus, 1758) captured in the eastern-central Adriatic Sea in relation to fish size, season and sampling area. *Journal of Applied Ichthyology*, 32(4), 675-681.
<https://doi.org/10.1111/jai.13081>
- Santos, M.N., Gaspar, M.B., Vasconcelos, P., Monteiro, C.C. (2002).** Weight-Length relationships for 50 selected fish species of the Algarve coast (southern Portugal). *Fisheries Research*, 59, 289-295.
[https://doi.org/10.1016/S0165-7836\(01\)00401-5](https://doi.org/10.1016/S0165-7836(01)00401-5)
- Torres, M.A., Ramos F., Sobrino I. (2012).** Weight- Length relationships of 76 fish species from the Gulf of Cadiz (SW Spain). *Fisheries Research*, 127, 171-175.
<https://doi.org/10.1016/j.fishres.2012.02.001>
- Tortonese, E. (1986).** Trachinidae. p. 951-954. In J.C. Hureau and Th. Monod (eds.) Checklist of the fishes of the North-Eastern Atlantic and of the Mediterranean (CLOFNAM). UNESCO, Paris. Vol. 2. ISBN: 92-3-001100-2
- Verdiglione, R., Mammola, C.L., Gargano, M., Montesi, F. (2003).** Ultrastructure of Venom Glands in *Trachinus draco* (Osteichthyes, Trachinidae). *Italian Journal of Anatomy and Embryology (Archivio Italiano di Anatomia ed Embriologia)*, 108(3), 182.
- Welcomme, R.L. (1999).** A review of a model for qualitative evaluation of exploitation levels in multi-species fisheries. *Fisheries Management and Ecology*, 6, 1-19.
<https://doi.org/10.1046/j.1365-2400.1999.00137.x>
- Went, A.E.J. (1973).** Some interesting fishes taken from Irish Waters in 1972. *The Irish Naturalist' Journal*, 17(11), 375-378.
- Wilhelms, I. (2013).** Atlas of length-weight relationship of 93 fish and crustacée species from the North Sea and the North-East Atlantic (N°. 12). Johann Heinrich von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries. ISBN: 978-94-009-0829-1
https://doi.org/10.1007/978-94-009-0829-1_1
- Wootton, R.J. (1990).** Ecology of teleost fishes. Fish and Fisheries Series 1. Chapman & Hall, London, 404. ISBN: 978-94-009-0829-1
- Wootton, R. J. (1999).** Ecology of teleost fishes, 2nd edn. Fish and Fisheries Series No. 24. New York: Springer-Verlag. ISBN: 978-94-010-6859-8

A Review on the Occurrence of the Blunthead Puffer, *Sphoeroides pachygaster* (Müller & Troschel, 1848) in the Mediterranean with a New Occurrence from Oran Bay (Western Algeria)

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ABSTRACT

The blunthead puffer, *Sphoeroides pachygaster* was first recorded in Algerian waters in 2009 from Annaba Gulf (Western Mediterranean) caught by a trawler at 150 m depth. Since then the records show there been no further observations in Algerian waters. In this paper, we report a new record of *S. pachygaster* from western Algerian coasts, eleven years after it was first recorded in Eastern Algeria. Two specimens were caught, the first by an angler in Bousfer beach on 25th January, 2020, measuring 360.6 mm TL and weighting 2250g and the second by trammel net in "Les Andalouses" bay measuring 409.5 mm TL and weighting 2420g. Accordingly, we describe biometrical and meristic characteristics, literature, databases and fish collections reviews of this Tetraodontidae, a species new to the Western Algerian fish fauna.

Keywords: Puffer, Blunthead, Tetraodontidae, Oran Bay, Algeria, Western Mediterranean

INTRODUCTION

Non-native fauna or flora are organisms found outside their known area of distribution in which the Mediterranean Sea is not part of their original distribution area (UNEP-MAP-RAC/SPA.2011). Marine environment is continuously assaulted by anthropic activities pressures namely habitat destruction, resources over-exploitation and climate change (Crain et al., 2008; Halpern et al., 2015). Occhipinti-Ambrogi & Galil (2010), stated that climate change on its own facilitates overcoming historic geographic barriers.

Blunthead *Sphoeroides pachygaster* is a marine benthopelagic species living in a depth between 50 and 480 m (Matsuura and Tyler, 1997) but usually lives between 50 and 250 m (Ragonese et al., 1992). Found in all oceans of central and temperate latitudes (Shipp, 1974 in

Carpenter et al., 2016) it is also the most wide-ranging species in the genus *Sphoeroides* (Shipp, 2002). This family shares with its near relatives, the diodontidae, the ability to inflate, probably for protection from predation (Martin and Drewry, 1978). It inhabits sandy, muddy and rocky bottoms (Schneider, 1990) and young specimens are pelagic (Robins and Ray, 1986). *S. pachygaster* feeds mainly on squid (Smith and Heemstra, 1986), cuttlefish, octopus, but also feeds on small bony fish (Psomadakis et al., 2008). Juveniles of *S. pachygaster* are known to be pelagic whereas adults prefer benthic habitats such as sandy, muddy, and rocky bottoms (Robins and Ray 1986; Tortonese, 1986). In general, Tetraodontidae are capable of inflating their abdomens with water when frightened or disturbed and are capable of producing and accumulating toxins such as tetrodotoxin and saxitoxin in the skin, gonads, and liver. The de-

gree of toxicity varies by species, and also according to geographic area and season (Allen and Erdmann, 2012). Noguchi and Arakawa (2008) consider blunthead puffer as weakly toxic while in the Mediterranean, it is considered non-toxic (Ragonese and Morara 2012). Little is known about reproduction and other life history aspects of this species.

Sphoeroides pachygaster is not directly targeted by fishing gears but can be a by-catch of semi-industrial fishing, purse seines, trawls, gillnets, bottom longlines, drifting longlines. Shao et al., (2014) stated that it is a least concern species on the IUCN Red List (ver 3.1) and that although it may be subject to high discard mortality when taken as bycatch in some fisheries, there do not appear to be any major threats and there are no recorded population declines.

A review of available literature showed that a reduced number of articles dealt with this Tetraodontidae: Ishizaki et al., (2006); Vella et al., (2017) on molecular identification, Carlucci et al., (2019) on isolation of glycoconjugates, Nagashima et al., (2018) on toxicity, Ragonese and Morara (2012); Peatman et al., (2017) on by-catch; Cammilleri et al., (2019) on parasites. The remaining available documentation focused on occurrence all around the world: Wirtz et al., (2017) in Ascension Island (South Atlantic Ocean); Sampaio et al., (2001) in Brazilian waters; Gilhen et al., (1985) in Canadian waters; Hanel and John, (2014) in Cape Verde islands; Quero et al., (1991; 1998); Bearez et al., (2017) in Atlantic French waters; Wheeler and Van Oijen, (1985); Quigley and Flannery, (1992; 2004) in Irish waters; Shinohara et al., (2009, 2011, 2014) in Japanese waters; Duffy and Ahung, (2015) in New Zealand waters; Okan and Aydın, (2017) in Turkish waters; Edwards and Glass, (1987) in Saint Helena Island (South Atlantic Ocean).

In the Mediterranean basin, the first occurrence of this Tetraodontidae was observed for the first time in 1979 (Oliver, 1981) near the Balearic Islands, since then the blunthead puffer has spread through the western Mediterranean as a new environment; in the western basin it was recorded first in the early '90s in Tunisian waters Bradai et al., (1993) then in Algerian waters Hemida et al., (2009). in central Mediterranean, it was recorded first in Italian waters Tursi (1992); then in Croatian waters Dulcic (2002); Slovenian waters Lipej et al., (2013) and Libyan waters Shakman et al., (2017). The occurrence of *S. pachygaster* in eastern Mediterranean was noticed lately, first in Turkish waters Erilmaz et al., (2003); then in Greek waters Peristeraki et al., (2006); in Syrian waters Rahman et al., (2014); Egyptian Farrag et al., (2016) bottom trawl; and Lebanese waters Crocetta and Bariche in Gerovasileiou et al., (2017). Except observation of Hemida et al., (2009), in eastern Algeria (Annaba) up to date, no works or new occurrences were reported on this Tetraodontidae for Algerian water this last decade.

Here, we report the first confirmed record of the blunthead, *Sphoeroides pachygaster* from the Oran shoreline and the second for Algerian waters. This record is also an additional data for the entire Mediterranean basin to help with monitoring and managing invasive species newly established.

MATERIALS AND METHODS

On January 25th, 2020 a blunthead puffer (Fig.1) was caught by an angler in Bousfer Beach (35°43'33.1"N 0°50'56.5"W) at 300 m from the shoreline at a depth of 10 m using squid as bait. The second specimen was caught on May 5th, 2020 in "les Andalouses" Bay (35°45'36.1"N 0°53'58.7"W) by trammel net at 120 m depth but the specimen was in a deteriorated (dried out) condition. The two fishermen reported the specimens and donated them to our team composed of researchers from university Oran1 Ahmed BENBELLA and marine ecology association members (BARBAROUS). Morphometric and meristic characteristics were taken.



Figure 1. Caught specimen of *Sphoeroides pachygaster* reported in this study (36.06 cm TL) caught in Oran Bay, Algeria (Photographed by L. Bensahla-Talet).

Measures were carried out using a caliper to the nearest 0.01 mm. Three meristic characters and thirteen morphometric characteristics (Fig.2) were measured: total length TL; standard length SL; preocular POD1; eye diameter ED; post ocular POD2 distance; post ocular POD3 distance; dorsal fin length DFL; pectoral fin length PFL; Inter orbital distance (IOD); Body thickness (BT); maximum body height Hmax; minimum body height Hmin; Caudal width (CFW).

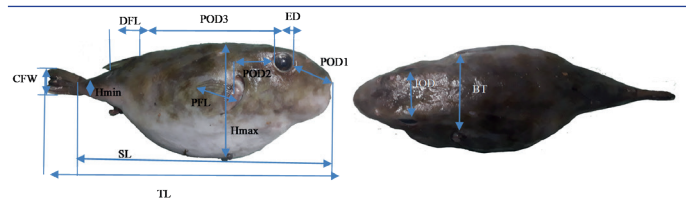


Figure 2. Morphometric measurements of the blunthead puffer *Sphoeroides pachygaster* caught in Bousfer Beach.

RESULTS AND DISCUSSION

Specimen morphological characteristics were in accordance with those described by Shipp (1974) for blunthead *Sphoeroides pachygaster*, the body was entirely smooth; pigmentation mostly uniform, except for a few dark spots on the flanks. Also, this species differs from other species of *Sphoeroides* genus by hav-

ing no spinules or spines on the body. Morphometric measurements are presented in Table 1.

Table 1. Morphometric (in cm) and meristic characters of analyzed specimen of blunt head *Sphoeroides pachygaster* from the western Algerian coasts (Oran Bay).

Measurements	Length (mm)	% of TL	Length (mm)	% of TL
Total length (TL)	384.00	100.00	409.50	100.00
Standard length (SL)	342.40	89.17	356.40	87.0
Preorbital distance (POD1)	55.78	14.53	54.92	13.4
Eye diameter (ED)	23.60	6.15	24.40	0.60
Post orbital distance (POD2)	43.42	11.31	39.41	0.96
Post orbital distance (POD3)	178.28	46.43	187.84	45.87
Inter orbital distance (IOD)	66.40	17.29	55.65	13.59
Body thickness (BT)	115.34	30.04	104.06	25.41
Pectoral fin length (PFL)	51.29	13.36	62.70	15.31
Dorsal fin length (DFL)	36.98	9.63	24.04	5.87
Hmax	126.03	32.82	113.6	27.74
Hmin	15.94	4.15	17.56	4.29
Caudal fin width (CW)	57.26	14.91	55.21	13.48
Meristic characters				
Dorsal fin rays			8	
Anal fin rays			8	
Pectoral fin rays			14	

Streftaris and Zenetos (2006) included *Sphoeroides pachygaster* in the list of the 100 "Worst Invasives" in the Mediterranean coming from the Atlantic Ocean; characterized by a fast spread (Ragonese et al., 1997; Psomadakis et al., 2008; Lipej et al., 2013). In the Mediterranean basin, the first occurrence of this Tetraodontidae was observed for the first time in 1979 (Oliver, 1981) near the Balearic Islands, since then the blunthead puffer has spread through the western Mediterranean as a new environment; in the western basin it was recorded first in the early '90s in Tunisian waters Bradai et al., (1993) then Cherif et al., (2010); Enajjar et al., (2015) then in Algerian waters Hemida et al., (2009).

The majority of records concerning this invasive species (Figure 3) were made in central Mediterranean, first in Italian waters Tursi (1992); Arculeo and Riggio (1994); Ragonese et al., (1997); Bedini (1998); Ligas et al., (2007); Psomadakis et al., (2008); Giordano et al., (2012); Carbonara et al., (2017) then in Croatian waters Dulcic (2002); Slovenian waters Lipej et al., (2013) and Libyan waters

Shakman et al., (2017) but established population seems to be concentrated between Italian waters and Malta (Ragonese et al., 1997; Sciberras and Schembri 2007; Ragonese and Morara 2012; Evans et al., 2015).

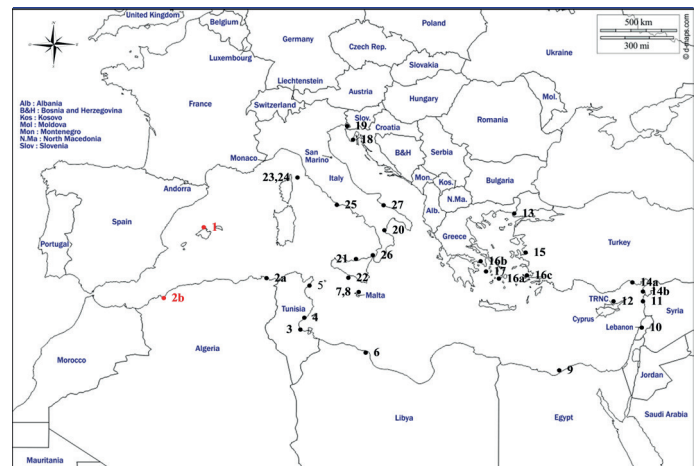


Figure 3. Map showing countries in the Mediterranean Sea where Blunthead *Sphoeroides pachygaster* has been recorded (1-first record in the Mediterranean, 2b-new record in Oran Bay in red). (d-maps.com©2020 adapted). 1) Oliver,1981, 2a) Hemida et al.,2009, 2b) Present study, 3) Bradai et al., 1993, 4) Cherif et al., 2010, 5) Enajjar et al., 2015, 6) Shakman et al., 2017, 7) Sciberras and Schembri, 2007, 8) Evans et al., 2015, 9) Farrag et al 2016, 10) Crocetta et al 2017, 11) Rahman et al., 2014, 12) Ioannou et al 2009 in Katsanevakis et al., 2009, 13) Erilmaz et al., 2003, 14a) Erguden et al in Elefteriou et al., 2011, 14b) Erguden et al in Elefteriou et al., 2011, 15) Akyol and Aydin 2017, 16a) Peristeraki et al 2006, 16b) Peristeraki et al 2006, 16c) Peristeraki et al 2006, 17) Dailanis et al., 2016, 18) Dulcic,2002, 19) Lipej et al.,2013, 20) Tursi,1992, 21) Arculeo and Riggio,1994, 22) Ragonese et al., 1997, 23) Bedini, 1998, 24) Ligas et al 2007, 25) Psomadakis et al., 2008, 26) Giordano et al 2012, 27) Carbonara et al., 2017.

The occurrence of *S. pachygaster* in eastern Mediterranean was noticed lately, first in Turkish waters Erilmaz et al., (2003); Erguden et al in Elefteriou et al., (2011); Akyol and Aydin (2017), then in Syrian waters Rahman et al., (2014); Greek waters Peristeraki et al., (2006); Dailanis et al., (2016); Egyptian Farrag et al., (2016); and Lebanese waters Crocetta and Bariche in Gerovasileiou et al., (2017). Except observation of Hemida et al., (2009), up to date, no works or new occurrence were reported on this Tetraodontidae for Algerian waters.

In a recent study, Kleitou et al., (2020) noticed that a large number of pufferfish species (Diodontidae and Tetraodontidae) have invaded or expanded their ranges in the Mediterranean Sea. Golani et al., (2002) supported the hypothesis that the blunthead puffer entered the Mediterranean from the Atlantic Ocean via Gibraltar Strait given

that most of the records were recorded from the western and central Mediterranean regions. Coll et al., (2010) characterized the semi-enclosed Mediterranean Sea as a basin "under siege" at the forefront of ecosystem alterations, facing human pressures. The spread of non-indigenous species these last year's causes an increasing impact over time, resulting in changes in trophic flows, interactions between native and non-indigenous species and biodiversity loss and/or changes (Galil, 2007; Corrales, 2019).

Global warming was already mentioned in several regions of the world (Walther et al., 2002; Parmesan, 2006; González-Lorenzo et al., 2013). Santos et al., (2012) observed a change in species distribution around the Canary Islands related to an increase in sea surface temperature (SST) this thirty years with records of temperatures over 24 °C. in the Mediterranean basin. Moullec et al., (2016) concluded the same phenomenon and deducted that temperature has a major direct effect on the physiology, growth, reproduction, recruitment and behavior of poikilothermic organisms such as fish. It is clear that the warming of the Mediterranean Sea nowadays affects the fitness of marine biota as already shown by records of changes in abundance, survival, fertility, phenology and the most important species migration (Quero et al., 1998, Dulčić 2002, Marbà et al., 2015). Data available from online biogeographic information databases contain between 2,435 (GBIF,2020) and (OBIS,2020) 2900 georeferenced records with a majority around the Australian continent and Eastern Atlantic which let us suppose that migration of this invasive species initiated from the West African coastline to reach the Mediterranean basin.

CONCLUSION

We concluded that citizens have contributed and still contribute to the detection of non-indigenous species in Algerian waters via social media as it is the case of our study which is an efficient tool already tried in other regions of the Mediterranean (Giovos et al., 2019; Kleitou et al., 2019; Kousteni et al., 2019). We believe that eco-citizen concept coupled with NGO efforts can surely contribute to enrich future databases of alien marine species and cover all Algerian coastline to detect, manage and monitor this biological invasion harmful to aquatic biodiversity.

Conflict of interests: There are no conflicts of interest to declare.

Ethics committee approval: Ethics committee approval is not required.

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Disclosure: -

REFERENCES

Akyol, O. & Aydın, I. (2017). Occurrence of blunthead After *Sphoeroides pachygaster* (Müller and Troschel, 1848) Tetraodontidae in north eastern Aegean Sea, Izmir Bay, Turkey. *Journal of Applied Ichthyology*, 33, 524-526 pp. [CrossRef]

Allen, G. R. & Erdmann, M. V. (2012). *Reef fishes of the east indies*. Tropical Reef Research, Perth, Australia.

Arculeo, M., Riggio, S., & D'anna, G. (1994). First record of *Sphoeroides pachygaster* (Tetraodontidae) in the south Tyrrhenian (N/W Sicily). *Cybiurn* (Paris), 18(2), 209-210.

Bazairi, H., Sghaier, Yr, Benamer, I., Langer, H., Pergent, G., Bouras, E., Verlaque, M., & Zenetos, A. (2013). Alien marine species of Libya: first inventory and new records in El-Kouf national park (Cyrenaica) and the neighbouring areas. *Mediterranean Journal of Marine Science*, 14(2): 224-237. [CrossRef]

Bearez, P., Pruvost, P., Feunteun, E., Iglesias, S., Francour, P., Causse, R., & Bailly, N. (2017). Checklist of the marine fishes from metropolitan France. *Cybiurn*, 4, 351-371.

Bedini, R. (1998). First record of *Sphoeroides pachygaster* (Tetraodontidae) from the northern Tyrrhenian Sea. *Cybiurn* (Paris), 22(1), 94-96.

Bradai, M. N., Ghorbel, M., Bouain, A. (1993). Premières observations dans le golfe de Gabès (Tunisie) de *Sphoeroides cutaneus* (Tetraodontidae). *Cybiurn*, 17(1), 86.

Cammilleri, G., Graci, S., Buscemi, M. D., Collura, R., Costa, A., Dico, G. M. L., & Cumbo, V. (2019). New report of Anikasis larvae from Blunthead Puffer, *Sphoeroides pachygaster* caught off Strait of Sicily. *Biodiversity Journal*, 10(4): 475-478. [CrossRef]

Carbonara, P., Kolitari, J., Đurović, M., Gaudio, P., Ikica, Z., Kroqi, G., & Spedicato, M. T. (2017). The presence of Tetraodontidae species in the Central Mediterranean: an update from the southern Adriatic Sea. *Acta Adriatica: International Journal of Marine Sciences*, 58(2), 325-336. [CrossRef]

Carlucci, R., Mentino, D., Semeraro, D., Ricci, P., Sion, L., & Scillitani, G. (2019). Comparative histochemical analysis of intestinal glycoconjugates in the blunthead pufferfish *Sphoeroides pachygaster* and grey triggerfish *Balistes caprisus* (Teleostei: Tetraodontiformes). *Journal of Fish Biology*, 94(1), 122-131. [CrossRef]

Cherif, M., Amor, M. M. B, Bdioui, M., Salem, S. B., & Missaou, H. (2010). Additional records of the Blunthead Puffer, *Sphoeroides pachygaster* (Osteichthyes: Tetraodontidae) off the Tunisian coast (central Mediterranean). *Annales, Series Historia Naturalis*, 20(1): 33-36.

Crain, C. M., Kroeker, K., & Halpern, B. S. (2008). Interactive and cumulative effects of multiple human stressors in marine systems. *Ecology Letters*, 11(12), 1304-1315. [CrossRef]

Dailianis, T., Akyol, O., Babali, N., Bariche, M., Crocetta, F., Gerovasileiou, V., & Julian, D. (2016). New mediterranean biodiversity records (July 2016). *Mediterranean Marine Science*, 17(2), 608-626. [CrossRef]

Duffy, C. A., & Ahyong, S. T. (2015). Annotated checklist of the marine flora and fauna of the Kermadec Islands Marine Reserve and northern Kermadec Ridge, New Zealand. *Bulletin of the Auckland Museum*, 20, 19-124.

Dulčić, J. (2002). Northernmost occurrence of *Sphoeroides pachygaster* (Tetraodontidae) in the Adriatic Sea. *Bulletin of Marine Science*, 70(1): 133-139.

Edwards, A. J., & Glass, C. W. (1987). The fishes of Saint Helena Island, South Atlantic Ocean: I. The shore fishes. *Journal of Natural History*, 21(3), 617-686. [CrossRef]

Enajjar, S., Hamida, N. B. H., Saadaoui, A., & Bradai, M. N. (2015). New data on puffer fish species (Osteichthyes: Tetraodontidae) occurring in Tunisian waters (central Mediterranean Sea). *Marine Life*, 18, 33-41.

Erguden, D., Eleftheriou, A., Anagnostopoulou-Visilia, E., Anastasopoulou, E., Ates, A. S., Bachari, N. E. I., Cavas, L., & Derici, O. B. (2011). New mediterranean biodiversity records (December 2011). *Mediterranean Marine Science*, 12(2), 491-508. [CrossRef]

Eryilmaz, L., Özüluğ, M., & Meriç, N. (2003). The Smooth Pufferfish, *Sphoeroides pachygaster* (Müller & Troschel, 1848) (Teleostei: Tetraodontidae), new to the Northern Aegean Sea. *Zoology in the Middle East*, 28(1), 125-126. [CrossRef]

- Evans, J., Barbara, J., & Schembri, P. J. (2015). Updated review of marine alien species and other 'newcomers' recorded from the Maltese Islands (Central Mediterranean). *Mediterranean Marine Science*, 16(1), 225-244. [CrossRef]
- Farrag, M., El-Haweet, A. A., & Moustafa, M. A. (2016). Occurrence of puffer fishes (Tetraodontidae) in the eastern Mediterranean, Egyptian coast-filling in the gap. *Biol Invasions Record*, 5(1). [CrossRef]
- Figueiredo, J. L., Santos, A. P. D., Yamaguti, N., Bernardes, R. Á., & Wongschowski, C. L. D. B. R. (2002). Peixes da Zona Econômica Exclusiva da Região Sudeste-Sul do Brasil: levantamento com rede de meia água. São-Paulo: Editora da Universidade de São Paulo; Imprensa Oficial do Estado, 242 p.
- GBIF. (2020) Secretariat. *Sphoeroides pachygaster* (Müller & Troschel, 1848) in GBIF Backbone Taxonomy. Checklist dataset <https://doi.org/10.15468/39omei> accessed via GBIF.org on 2020-04-23.
- Gerovasileiou, V., Akel, E. K., Akyol, O. K. A. N., Alongi, G., Azevedo, F., Babali, N., & Chintiroglou, C. C. (2017). New Mediterranean Biodiversity Records (July, 2017). *Mediterranean Marine Science*, 18(2), 355-384. [CrossRef]
- Gilhen, J., Gruchy, C. G., & McAllister, D. E. (1985). The blunthead puffer, *Sphoeroides pachygaster* (Muller and Troschel, 1848) (Pisces: Tetraodontidae) new to Nova Scotia and Canada.
- Giordano, D., Profeta, A., Pirrera, L., Soraci, F., Perdichizzi, F., Greco, S., & Rinelli, P. (2012). On the occurrence of the blunthead puffer, *Sphoeroides pachygaster* (Osteichthyes: Tetraodontidae), in the Strait of Messina (Central Mediterranean). *Journal of Marine Biology*, 2012. [CrossRef]
- González-Lorenzo, G., González Jiménez, J. F., Brito, A. & González, J. A. (2013). The family Bramidae (Perciformes) from the Canary Islands (northeastern Atlantic Ocean), with three new records. *Cybium*, 37(4): 295-303.
- Halpern, B. S., Frazier, M., Potapenko, J., Casey, K. S., Koenig, K., Longo, C., & Walbridge, S. (2015). Spatial and temporal changes in cumulative human impacts on the world's ocean. *Nature Communications*, 6(1), 1-7. [CrossRef]
- Hanel, R., & John, H. C. (2014). A revised checklist of Cape Verde Islands sea fishes. *Journal of Applied Ichthyology, J Appl Ichthyol*, 1–35. [CrossRef]
- Hemida, F., Ben Amor, M. M., & Capapé, C. (2009). First confirmed record of the blunthead puffer, *Sphoeroides pachygaster* (Osteichthyes: Tetraodontidae) off the Algerian coast (south-western Mediterranean). *Pan-American Journal of Aquatic Sciences*, 4(2), 188-192.
- Ioannou et al., 2009 in Katsanevakis, S., Tsiamis, K., Ioannou, G., Michailidis, N., & Zenetos, A. (2009). Inventory of alien marine species of Cyprus (2009). *Mediterranean Marine Science*, 10(2), 109-134. [CrossRef]
- Ishizaki, S., Yokoyama, Y., Oshiro, N., Teruya, N., Nagashima, Y., Shiomi, K., & Watabe, S. (2006). Molecular identification of pufferfish species using PCR amplification and restriction analysis of a segment of the 16S rRNA gene. *Comparative Biochemistry and Physiology Part D: Genomics and Proteomics*, 1(1), 139-144. [CrossRef]
- Katsanevakis, S., Tsiamis, K., Ioannou, G., Michailidis, N., & Zenetos, A. (2009). Inventory of alien marine species of Cyprus. *Mediterranean Marine Science*, 10(2), 109-134. [CrossRef]
- Kleitou, P., Giovos, I., Antoniou, C., Ioannou, G., & Bernardi, G. (2020). The third record of black-spotted porcupinefish *Diodon hystrix* Linnaeus, 1758 in the Mediterranean Sea. *Journal of Applied Ichthyology*, 36(2), 227-230. [CrossRef]
- Ligas, A., Sartor, P., Sbrana, M., Sirna, R., & De Ranieri, S. (2007). New findings of *Fistularia commersonii* Rüppell, 1835 and *Sphoeroides pachygaster* (Müller & Troschel, 1848) in the northern Tyrrhenian Sea. *Atti della Società Toscana di Scienze Naturali Memorie, Serie B*, 114, 131-133.
- Lipej, L., Mavric, B., & Paliska, D. (2013). New Northernmost Record of The Blunthead Pufferfish, *Sphoeroides Pachygaster* (Osteichthyes: Tetraodontidae) In The Mediterranean Sea/Nuova Segnalazione A Nord Del Pesce Palla Liscio, *Sphoeroides pachygaster* (Osteichthyes: Tetraodontidae), Nel Mare Mediterraneo. In *Annales: Series Historia Naturalis* (Vol. 23, No. 2, p. 103). Scientific and Research Center of the Republic of Slovenia.
- Marbà, N., Jordà, G., Agustí, S., Girard, C. & Duarte, C. M. (2015). Footprints of climate change on Mediterranean Sea biota. *Front Mar Sci*, 2, 56. [CrossRef]
- Martin, F. D., & Drewry, G. E. (1978). Development of Fishes of the Mid-Atlantic Bight. Volume VI. Stromateidae through Ogcocephalidae. US Department of the Interior, Fish and Wildlife Service, Biological Services Program. FWS/OBS-78/12.
- Matsuura, K. & Tyler, J. C., (1997). Tetraodontiform fishes, mostly from deep waters, of New Caledonia. p.173-208. In Séret B. (ed.) Paris 1997. Résultats des Campagnes MUSORSTOM, vol. 17. no.9. Mem. Mus. Natl. Hist. Nat. MNHN (Mémoires du Muséum National d'Histoire Naturelle. Zoologie), 174, 215 p 174.
- Moullec, F., Ben Rais Lasram, F., Coll, M., Guilhaumon, F., Halouani, G. & Hattab, T. (2016). Climate change impacts on marine resources: From individual to ecosystem responses in The Mediterranean Region under Climate Change: A Scientific Update IRD Éditions/AllEnvi (2016) *Marseille*, 2(1.3): 229-248. [CrossRef]
- Müller, J. P., & Troschel, F. H. (1848). *Pachygaster*, *Tetrodon* (Cheilichthys) in Schomburgk, R. H. 1848. The history of Barbados; comprising a geographical description of the island and an account of its geology and natural productions. London. i-xx + 1-722, 7 pls. [Fishes are on pp. 664-678. Reprinted as Schomburgk, R. H., 1848. Ann. Mag. Nat. Hist., ser. 2, v. 2 (no. 7):11-20.]
- Nagashima, Y., Ohta, A., Yin, X., Ishizaki, S., Matsumoto, T., & Ishibashi, T. (2018). Difference in uptake of tetrodotoxin and saxitoxins into liver tissue slices among pufferfish, boxfish and porcupinefish. *Marine Drugs*, 16(1), 17. [CrossRef]
- Noguchi, T., & Arakawa, O. (2008). Tetrodotoxin–distribution and accumulation in aquatic organisms, and cases of human intoxication. *Marine Drugs*, 6(2), 220-242. [CrossRef]
- OBIS. (2020). Distribution records of *Sphoeroides pachygaster* (Müller & Troschel, 1848). Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO. accessed via www.iobis.org on 2020-04-23.
- Ochchipinti-Ambrogi, A. & Galil, B. (2010). Marine alien species as an aspect of global change. *Adv. Oceanogr. Limnol*, 1(1), 199-218. [CrossRef]
- Parnesan, C. (2006). Ecological and evolutionary responses to recent climate change. *Annu Rev Ecol Evol Syst*, 37(2006), pp. 637–669. [CrossRef]
- Peatman, T., Allain, V., Caillot, S., Williams, P., & Smith, N. (2017). Summary of purse seine fishery bycatch at a regional scale, 2003–2016. In 13th Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission, WCPFC-SC13, Rarotonga, Cook Islands (pp. 9-17).
- Peristeraki, P., Lazarakis, G., Skarvelis, C., Georgiadis, M., & Tserpes, G. (2006). Additional records on the occurrence of alien fish species in the eastern Mediterranean Sea. *Mediterranean Marine Science*, 7(2), 61-66. [CrossRef]
- Psomadakis, P., Ceddia, P., & Vacchi, M. (2008). Additional record of *Sphoeroides pachygaster* (Pisces: Tetraodontidae) in the Tyrrhenian Sea and notes on the distribution of the species in the Mediterranean. *Marine Biodiversity Records*, 1, E18. [CrossRef]
- Quero, J. C., Du Buit, M. H., Fonteneau, J., Kergoat, B., & Vayne, J. J. (1991). Premières observations dans les ports français de *Sphoeroides pachygaster* (pisces, tetraodontiformes, tetraodontidae), capturés au nord de leur aire de répartition connue. In *Annales de la Société des Sciences Naturelles de la Charente-Maritime* (Vol. 7, No. 9, pp. 1059-1063). Société des Sciences Naturelles de la Charente-Maritime. [CrossRef]

- Quero, J. C., Du Buit, M. H., & Vayne, J. J. (1998). Les observations de poissons tropicaux et le réchauffement des eaux dans l'Atlantique européen. *Oceanologica acta*, 21(2), 345-351. [\[CrossRef\]](#)
- Quigley, D. T. G., & Flannery, K. (1992). Further specimens of blunt head puffer fish *Sphoeroides pachygaster* Muller & Troschel 1848 (*S. cutaneus* Gunther 1870) from Irish waters. *The Irish Naturalists' Journal*, 24(4), 155-157.
- Quigley, D. T. G., & Flannery, K. (2004). Blunt Head Puffer Fish *Sphoeroides pachygaster* Muller & Troschel, 1848. *The Irish Naturalists' Journal*, 27(10), 408-409.
- Ragonese, S., Rivas G. & Jereb, P. (1992). Spreading of puffer *Sphoeroides cutaneus* Günther, 1870 (Pisces, Tetraodontidae) in the Sicilian Channel. Is it an exploding population?. *Rapp Comm Int Mer Méditerr*, 33, 308.
- Ragonese, S., Jereb, P., & Morara, U. (1997). Morphometric relationships of *Sphoeroides pachygaster* (Pisces-Tetraodontidae) of the strait of sicily (Mediterranean Sea). *Cahiers de Biologie marine*, 38(4), 283-290.
- Ragonese, S and Morara U. 2012. Evidence of short-term discard mortality of trawled *Sphoeroides pachygaster* (Osteichthyes, Tetraodontidae) off the southern coast of Sicily (Central Mediterranean Sea). *Pan-American Journal of Aquatic Sciences*, 7(2):73-76
- Rahman, W. A., Galiya, M., & Ali, A. K. (2014). First record of the blunthead puffer *Sphoeroides pachygaster* (Osteichthyes: Tetraodontidae) in Syrian marine waters (eastern Mediterranean). *Marine Biodiversity Records*, 7. [\[CrossRef\]](#)
- Robins, C. R. & G. C. Ray, (1986). A field guide to Atlantic coast fishes of North America. Houghton Mifflin Company, Boston, U.S.A. 354 p.
- Sampaio, C. L. S., Lopes, P. R. D., & Olavo, G. (2001). Registros de *Lagocephalus lagocephalus* (linnaeus, 1758) e *Sphoeroides pachygaster* (Müller & Troschel, 1848) (actinopterygii: tetraodontidae) para o litoral da bahia, nordeste do Brasil. *Interciencia*, 26(4), 157-160.
- Santos, F., Decastro, M., Gómez-Gesteira, M. & Álvarez, I. (2012). Differences in coastal and oceanic SST warming rates along the Canary upwelling ecosystem from 1982 to 2010. *Cont Shelf Res*, 47, 1-6. [\[CrossRef\]](#)
- Schneider, W., (1990). FAO species identification sheets for fishery purposes. Field guide to the commercial marine resources of the Gulf of Guinea. Prepared and published with the support of the FAO Regional Office for Africa. Rome: FAO. 268 p.
- Sciberras, M., & Schembri, P. J. (2007). A critical review of records of alien marine species from the Maltese Islands and surrounding waters (Central Mediterranean). *Mediterranean Marine Science*, 8(1), 41-66. [\[CrossRef\]](#)
- Shakman, E. A., Abdalha, A. B., Thala, F., Al-Faturi, A., & Bariche, M. (2017). First records of seven marine organisms of different origins from Libya (Mediterranean Sea). *BioInvasions Records*, 6(4), 377-382. [\[CrossRef\]](#)
- Shao, K., Liu, M., Jing, L., Matsuura, K., Hardy, G. & Leis, J. L. (2014). *Sphoeroides pachygaster*. The IUCN Red List of Threatened Species 2014: e.T190193A1943625. [\[CrossRef\]](#)
- Shinohara, G., Narimatsu, Y., Hattori, T., Ito, M., Takata, Y., & Matsuura, K. (2009). Annotated checklist of deep-sea fishes from the Pacific coast off Tohoku District, Japan. *National Museum of Nature and Science Monographs*, 39, 683-735.
- Shinohara, G., Shirai, S. M., Nazarkin, M. V., & Yabe, M. (2011). Preliminary list of the deep-sea fishes of the Sea of Japan. *Bulletin of the National Museum of Nature and Science, Series A (Zoology)*, 37, 35-62.
- Shinohara, G., Nakae, M., Ueda, Y., Kojima, S., & Matsuura, K. (2014). Annotated checklist of deep-sea fishes of the Sea of Japan. *National Museum of Nature and Science Monographs*, 44, 225-291.
- Shipp, R. L. (1974). The pufferfishes (Tetraodontidae) of the Atlantic Ocean. Publications of the Gulf Coast Research Laboratory Museum, 41: 162 p in Carpenter, K. E. & De Angelis, N., eds. 2016. The living marine resources of the East ern Central Atlantic. Volume 4: Bony fishes part 2 (Perciformes to Tetradontiformes) and Sea turtles. FAO Species Identification Guide for Fishery Purposes, Rome, FAO. pp. 2343-3124.
- Shipp, R. (2002). Tetraodontidae. In: Carpenter, K. (ed.), The Living Marine Resources of the western central Atlantic, pp. 1988-2006. FAO, Rome.
- Smith, M. M. & Heemstra, P. C. (1986). *Smith's Sea Fishes*. Springer-verlag Berlin Heidelberg New York London Paris Tokyo. 1047p.
- Streftaris, N., & Zenetos, A. (2006). Alien marine species in the Mediterranean-the 100 'Worst Invasives' and their impact. *Mediterranean Marine Science*, 7(1), 87-118. [\[CrossRef\]](#)
- Tortonese, E. (1986). Tetraodontidae. p. 1341-1345. In: P.J.P. Whitehead, J.C. Hureau, J. Nielsen, E. Tortonese (Eds.), *Fishes of the northeastern Atlantic and the Mediterranean, 1984-1986*, Unesco 1, Paris. [\[CrossRef\]](#)
- Tursi A., D'Onglia G. & Matarrese A. 1992. First finding of *Sphoeroides pachygaster* (Muller and Troschel, 1848) (Tetraodontidae) in the Ionian Sea (middle eastern Mediterranean). *Cybium*, 16(2): 171-172.
- UNEP-MAP-RAC/SPA.2011. Non-native species in the Mediterranean: What, when, how and why? Ed: RAC/SPA, Tunis. 28 pp.
- Vella, A., Vella, N., Karakulak, F. S., & Oray, I. (2017). DNA barcoding of Tetraodontidae species from the Mediterranean Sea: Filling knowledge gaps for improved taxonomic accuracy. *Genetics of Aquatic Organisms*, 1(2), 61-69. [\[CrossRef\]](#)
- Walther, G. R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T. J. C., Fromentin, J. M., Hoegh-Guldberg, O. & Bairlein, F. 2002. Ecological responses to recent climate change. *Nature*, 416 (2002), 389-395. [\[CrossRef\]](#)
- Wirtz, P., Bingeman, J., Bingeman, J., Fricke, R., Hook, T. J., & Young, J. (2017). The fishes of Ascension Island, central Atlantic Ocean—new records and an annotated checklist. *Journal of the Marine Biological Association of the United Kingdom*, 97(4), 783-798. [\[CrossRef\]](#)

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ON THE MAXIMUM LENGTH
FOR *SARDINELLA AURITA* (OSTEICHTHYES: CLUPEIDAE)
FROM THE MEDITERRANEAN SEA

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Two specimens of round sardinella, *Sardinella aurita* Valenciennes, 1847, with a total length of 39.1 and 36.6 cm and a weight of 359.01 and 293.48 g, respectively, were caught by a purse seine net in Bouzedjar Bay, Algeria, on 8 August, 2019. These sizes of both specimens are the maximum recorded for this species in the Mediterranean Sea.

Keywords: round sardinella, *Sardinella aurita*, maximum size, measurements, Bouzedjar Bay, Algeria, Mediterranean Sea

Sardinella aurita Valenciennes, 1847 is a coastal, pelagic species preferring clear saline water with a maximum temperature below +24 °C (Bianchi et al., 1999). The species is distributed from in-shore and near surface to the shelf edge and down to 350 m in the Eastern Atlantic along African coast from Gibraltar to South Africa; in the Mediterranean Sea, but is rare in the Black Sea; and in Western Atlantic (Cape Cod to Argentina) including Bahamas, Antilles, Gulf of Mexico, and the Caribbean coast (Whitehead, 1985). It mainly feeds on zooplankton, especially copepods. Juveniles feed on phytoplankton (Bianchi et al., 1999). Gregarious; forms schools that migrate seasonally related to water temperature and richness in plankton. Growth is rapid, and young individuals can reach about 11 cm during their first year of life (Dahel et al., 2016). It breeds perhaps all year round; the breeding pattern is extremely complex, with two principal spawning periods in some areas linked to upwelling regimes off West Africa (Whitehead, 1985), while in Algerian waters one single period was noted June to October (Bouaziz, 2007). In the Black Sea, there is no spawning (Whitehead, 1984). Maturity occurs during the second year; batch fecundity is estimated at 9,397–176,712 eggs in Eastern Atlantic (Baali et al., 2021) and 11,680–40,348 eggs in central Algerian waters (Bouaziz, 2007). Maximum age of *S. aurita* is estimated in the range from 4.5 years in Congolese waters (Gheno, 1975) to 8 years on Brazilian coast (Richardson et al., 1960). It can be caught with purse and beach seines, lamparos, bottom gillnets, and bottom and pelagic trawls.

Herrings, sardines, and anchovies make up a major part of the total fish species landed in the Mediterranean Sea (44.3 %) and Black Sea (73.2 %) fisheries (FAO, 2020). For Algerian waters, *S. pilchardus* accounts for 59 %, and *S. aurita* accounts for 22 % of the total Algerian catch (DPRH, 2019). We have to mention that the third species, *Sardinella maderensis*, occurs in the fishing area and can easily be confused with two other sardines. Tous et al. (2015) noticed that landing statistics are not comprehensive due to inconsistent reporting of landings, and *S. aurita* catches are often mixed with *S. maderensis* ones.

MATERIAL AND METHODS

On 8 August, 2019, two large Clupeidae specimens were caught by a seiner at 100-m depth in Bouzedjar Bay ($35^{\circ}34'24.0''\text{N}$, $1^{\circ}09'58.9''\text{W}$) on the western Algerian coast. FAO identification sheets (Whitehead, 1985) were used to identify the specimens as *Sardinella aurita* (Fig. 1). Counts and proportional measurements were carried out using a caliper to the nearest 0.01 mm. Twelve morphometric characteristics were measured (Table 1).



Fig. 1. General view of two *Sardinella aurita* specimens, total length of 39.10 cm and 36.57 cm, caught in Bouzedjar Bay (the Mediterranean Sea)

Рис. 1. Общий вид двух особей *Sardinella aurita*, общая длина 39,10 см и 36,57 см, пойманных в заливе Бузеджар (Средиземное море)

RESULTS AND DISCUSSION

Data on morphometric measurements of the specimens studied are shown in Table 1.

The maximal length ever recorded for *S. aurita* was 41 cm for fish caught on the Mauritanian shelf of the Eastern Atlantic (Thuoc & Szypula, 1973) (Table 2). For the Mediterranean basin, it was stated as follows: this Clupeidae could attain 33 cm, with a common length between 15 and 25 cm (Fischer et al., 1987). The largest known *S. aurita* specimen in the Mediterranean Sea, measuring 36 cm, was caught in Greek waters (Moutopoulos et al., 2013). We found two *S. aurita* specimens in purse seine catches from Algerian waters, making this observation a new record for both Algerian and Mediterranean waters and the second one after reported from Eastern Atlantic.

Maximal length of *S. aurita* varied 19.7 to 27.0 cm in the Western Atlantic, 30 to 41 cm in the Eastern Atlantic, and 25.5 to 39.1 cm in the Mediterranean basin. The differences in the maximum length observed can be attributed to environmental conditions and fishing pressure. Helfman et al. (2009) stated that individuals from populations exposed to high fisheries mortality/pressure will respond by reproducing at reduced average sizes and ages. Our specimens demonstrated that this species can grow beyond maximum length data available in literature despite the fact that the specimens were caught in such an important fishing activity area as Bouzedjar Bay (Bensahla-Talet et al., 2019).

Environmental factors, such as temperature, food availability, nutrient availability, light regime, oxygen, salinity, pollutants, current speed, predator density, intraspecific social interactions, and genetics, are also known to affect growth rates and maximum size (Helfman et al., 2009), but in our case

two specimens sampled are insufficient to link these environmental factors to the largest length observed. Nevertheless, it is to be added that producing large specimens is due to the richness of Algerian waters generated by Algerian current which is considered to be the most energetic in the Mediterranean basin (Salas et al., 2001). The entrance of Atlantic waters through the Strait of Gibraltar generates important upwellings, enhancing the development of plankton first link of the aquatic food web (Bensahla-Talet et al., 2017), and primary production reveals a west–east decreasing trend (Bosc et al., 2004 ; Siokou-Frangou et al., 2010).

Table 1. Morphometric measurements of *Sardinella aurita* caught in Bouzedjar Bay (the Mediterranean Sea)

Таблица 1. Морфометрические измерения *Sardinella aurita*, выловленной в заливе Бузеджар (Средиземное море)

Morphometric characteristic, cm	Specimen 1	% of TL	Specimen 2	% of TL
Total length (TL)	39.10	100.00	36.57	100.00
Fork length	34.51	88.27	31.88	87.18
Standard length	33.68	86.13	31.13	85.12
Pre-orbital length	1.67	4.26	1.62	4.43
Eye diameter	1.53	3.92	1.42	3.88
Post-orbital length	3.99	10.20	3.45	9.43
Head length	7.16	18.31	6.45	17.64
Dorsal fin length	4.92	12.58	4.24	11.59
Anal fin length	3.77	9.65	3.66	10.01
Pectoral fin length	5.09	13.02	4.78	13.07
Minimum body height	2.27	5.81	2.20	6.01
Maximum body height	6.81	17.42	6.72	18.38
Total weight, g	359.01	–	293.48	–

Table 2. Maximum length of *Sardinella aurita* in the Western and Eastern Atlantic and Mediterranean Sea given by several authors

Таблица 2. Максимальная длина *Sardinella aurita* в Западной и Восточной Атлантике и в Средиземном море по данным нескольких авторов

Location			TL, cm	References
Western Atlantic	USA	Gulf of Mexico	19.7	Johnson & Johnson, 1986
	Venezuela	Northeastern	26.6	Barrios et al., 2010
		–	27	Fréon & Mendoza, 2003
Eastern Atlantic	Morocco	Dakhla	35.5	Amenzoui & Baali, 2018
	Mauritania	Rio de Oro – Cap Verde	41	Thuoc & Szypula, 1973
	Senegal	Port Kafoutine – St Louis	37	Baldé, 2019
	Côte d'Ivoire	Côte d'Ivoire shelf	30	Marchal, 1993
Mediterranean Sea	Mediterranean	–	33	Fischer et al., 1987
	Egypt	Alexandria	26	Akel, 2009
	Turkey	Izmir Bay	28.5	Bayhan & Kara, 2012
	Greece	Corinthians Gulf	36	Moutopoulos et al., 2013
	Algeria	Bou Ismaïl Bay	31	Bouaziz, 2007
		Eastern Algeria	25.5	Dahel et al., 2016
		Bouzedjar Bay	39.1	Present study

Maximum length, weight, and age are the key indicators used in fisheries science. These data are applied in most models for stock assessment. Therefore, updating maximum length of an exploited species is important, and our results could constitute a starting point for further studies on factors that affect growth and/or longevity of other species.

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REFERENCES

1. Akel E. K. Fisheries of experimental purse seine net using light and population dynamics of *Sardinella aurita* (family Clupeidae) east of Alexandria, Egypt. *Egyptian Journal of Aquatic Biology and Fisheries*, 2009, vol. 13, iss. 1, pp. 55–77. <https://doi.org/10.21608/ejabf.2009.2023>
2. Amenzoui K., Baali A. Biological parameters of *Sardinella aurita* (Valenciennes 1847) exploited in the Dakhla zone (South Atlantic Morocco). *International Journal of Scientific and Engineering Research*, 2018, vol. 9, iss. 8, pp. 85–90.
3. Baali A., Belhsen O. K., Ouazzani K. C., Amenzoui K., Yahyaoui A. Age, growth and ovarian histology of *Sardinella aurita* (Valenciennes, 1847) in the south of Atlantic Moroccan coast. *Turkish Journal of Fisheries and Aquatic Sciences*, 2021, vol. 21, iss. 4, pp. 191–204. http://doi.org/10.4194/1303-2712-v21_4_04
4. Baldé B. S. *Dynamique des petits poissons pélagiques (Sardinella aurita et Ethmalosa fimbriata) au Sénégal dans un contexte de changement climatique : Diagnostic et synthèse bioécologiques*. Thèse de Doctorat / Université Cheikh Anta Diop. Dakar, Sénégal, 2019, 174 p.
5. Barrios A., Guzmán R., Mendoza J., Gómez G., Vizcaino G. Growth parameters and total mortality of the sardine *Sardinella aurita* (Valenciennes, 1810) in Northeastern Venezuela in the period 1990–2008. *Zootecnia Tropical*, 2010, vol. 28, iss. 4, pp. 457–466.
6. Bayhan B., Kara A. Length-length and length-weight relationships of the round sardinella *Sardinella aurita* Valenciensis, 1847 (Osteichthyes, Clupeidae) from the Aegean Sea. In: *3rd International Symposium on Sustainable Development*, 31 May – 01 June, 2012. Sarajevo : International Burch University, 2012, pp. 110–112.
7. Bensahla-Talet L., Allami M. N., Benaissa N. Statistiques de débarquement des principales ressources halieutiques du port de Bouzedjar (W. Ain temouchent). In: *9^{èmes} Journées Nationales des Sciences de la Nature et de la Vie 'JNSNV 2019' 06 et 07 Novembre 2019*, Mostaganem, Algérie : Recueil des Résumés. [Mostaganem, Algérie, 2019], pp. 4.
8. Bensahla-Talet L., Gherram M., Dalouche F., Bensahla-Talet A., Boutiba Z. Reproductive biology of *Pagellus acarne* (Risso, 1927) (Teleostei: Sparidae) off western Algerian waters (Western Mediterranean). *Cahiers de Biologie Marine*, 2017, vol. 58, iss. 4, pp. 443–452. <https://doi.org/10.21411/CBM.A.D5BB353B>
9. Bianchi G., Carpenter K. E., Roux J.-P., Molloy F. J., Boyer D., Boyer H. J. *The Living Marine Resources of Namibia*. Rome : FAO, 1999, 265 p. (FAO species identification field guide for fishery purposes).
10. Bosc E., Bricaud A., Antoine D. Seasonal and interannual variability in algal biomass and primary production in the Mediterranean Sea, as derived from 4 years of SeaWiFS observations. *Global Biogeochemical Cycles*, 2004, vol. 18, iss. 1, art. no. GB1005 (17 p.). <https://doi.org/10.1029/2003GB002034>
11. Bouaziz A. *La sardinelle (Sardinella aurita Valenciennes, 1847) des côtes algériennes distribution, biologie et estimation des biomasses*. Thèse de Doctorat d'Etat / Université des Sciences et de la Technologie, Houari Boumedienne-USTHB. [Bab Ezzouar, Algérie], 2007, 158 p.
12. Dahel A., Tahri M., Bensouilah M., Amara R., Djebbar B. Growth, age and reproduction of *Sardinella aurita* (Valenciennes, 1847) and *Sardina pilchardus* (Walbaum, 1792) in the Algerian eastern coasts. *Aquaculture, Aquarium, Conservation and Legislation*, 2016, vol. 9, iss. 5, pp. 1172–1181.

13. DPRH. *Annual Statistics Report of the Directorate of Fisheries and Fisheries Resources*. Document Direction de la Pêche et des Ressources Halieutiques. Oran, Algérie, 2019. (in French.)
14. FAO. *The State of World Fisheries and Aquaculture 2020. Sustainability in action*. Rome : FAO, 2020, 224 p.
15. Fischer W., Bauchot M. L., Schneider M. (Eds). Fiches FAO d'identification pour les besoins de la pêche (rev. 1). *Méditerranée et mer Noire. Zone de pêche 37*. Rome : FAO, 1987, vol. 2, pp. 761–1530.
16. Fréon P, Mendoza J. *The Sardine (Sardinella aurita), Its Environment and Exploitation in Eastern Venezuela: A Synthesis* / Institut De Recherche Pour Le Développement Collection : Colloques et séminaires. Paris : IRD Éditions, 2003, pp. 25–165.
17. Ghéno Y. Détermination de l'âge et croissance de *Sardinella aurita* val. de la région de Pointe-Noire. *Cahiers ORSTOM. Série Océanographie*, 1975, vol. 13, no. 3, pp. 251–262.
18. Helfman G. S., Collatte B. B., Facey D. E., Bowen B. W. *The Diversity of Fishes: Biology, Evolution, and Ecology*. 2nd ed. Chichester, UK ; Hoboken, NJ : Blackwell, 2009, 720 p.
19. Johnson A. G., Vaught R. N. Species profile of Spanish sardine (*Sardinella aurita*). In: *NOAA Technical Memorandum, NMFS-SEFIC(187)* / US Department of Commerce. Silver Spring : NOAA, National Marine Fisheries Service, 1986, 82 p.
20. Marchal E. Biologie et Écologie des Poissons Pélagiques Côtiers du Littoral Ivoirien. In: *Environnement et ressources aquatiques de Côte-d'Ivoire*. T. I. Le milieu marin / Le Lœuff P., Marchal É., Amon Kothias J.-B. (Eds). Paris : ORSTOM, 1993, pp. 237–270.
21. Moutopoulos D. K., Ramfos A., Mouka A., Katselis G. Length-weight relations of 34 fish species caught by small-scale fishery in Korinthiakos Gulf (Central Greece). *Acta Ichthyologica et Piscatoria*, 2013, vol. 43, no. 1, pp. 57–64. <https://doi.org/10.3750/AIP2013.43.1.08>
22. Richardson I. D., Vazzoler G., De Faria A., De Moraes M. N. Report on sardine investigations in Brazil. In: *Proceedings of the World Scientific Meeting on the Biology of Sardines and Related Species*, Rome, Italy, 14–21 September, 1959 / H. Rosa, Jr., G. Murphy (Eds). Rome : FAO, 1960, vol. 3, Experience Paper (13), pp. 1051–1079.
23. Salas J., Garcia-Ladona E., Font J. Statistical analysis of the surface circulation in the Algerian Current using Lagrangian buoys. *Journal of Marine Systems*, 2001, vol. 29, iss. 1–4, pp. 69–85. [http://dx.doi.org/10.1016/S0924-7963\(01\)00010-0](http://dx.doi.org/10.1016/S0924-7963(01)00010-0)
24. Siokou-Frangou I., Christaki U., Mazzocchi M. G., Montresor M., Ribera d'Alcalá M., Vaqué D., Zingone A. Plankton in the open Mediterranean Sea: A review. *Biogeosciences*, 2010, vol. 7, iss. 5, pp. 1543–1586. <https://doi.org/10.5194/bg-7-1543-2010>
25. Thuoc P., Szypula J. Biological characteristics of gilt sardine, *Sardinella aurita* Cuv. et Val. 1847, from northwest African coast. *Acta Ichthyologica et Piscatoria*, 1973, vol. 3, iss. 1, pp. 19–37. <https://doi.org/10.3750/AIP1973.03.1.03>
26. Tous P., Sidibé, A., Mbye E., de Morais L., Camara K., Munroe T., Adeofe T. A., Camara Y. H., Djiman R., Sagna A., Sylla M. *Sardinella maderensis*. In: *The IUCN Red List of Threatened Species* : [database] : site. 2015, e.T198582A15543624. <http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T198582A15543624.en>
27. Whitehead P. J. P. Clupeidae (incl. Dussumieridae) In: *Fishes of the North-eastern Atlantic and the Mediterranean* / P. J. P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, E. Tortonese (Eds). Paris : UNESCO, 1984, vol. 1, pp. 268–281.
28. Whitehead P. J. P. *FAO Species Catalogue*. Vol. 7. *Clupeoid Fishes of the World (Suborder Clupeoidei). An annotated and illustrated catalogue of the herrings, sardines, pilchards, sprats, anchovies and wolf herrings*. Part 1. *Chirocentridae, Clupeidae and Pristigasteridae*. Rome : FAO, 1985. 303 p. (Fisheries Synopsis, no. 125, vol. 7, pt. 1).

**О МАКСИМАЛЬНОЙ ДЛИНЕ
SARDINELLA AURITA (OSTEICHTHYES: CLUPEIDAE)
ИЗ СРЕДИЗЕМНОГО МОРЯ**

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Два экземпляра круглой сардины *Sardinella aurita* Valenciennes, 1847, общей длиной 39,1 и 36,6 см и весом 359,01 и 293,48 г соответственно, были пойманы кошельковой неводной сетью в заливе Бузеджар (Алжир) 08 августа 2019 г. Данные размеры обоих экземпляров являются максимальными для этого вида в Средиземном море.

Ключевые слова: круглая сардина, *Sardinella aurita*, максимальный размер, измерения, залив Бузеджар, Алжир, Средиземное море

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

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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),

marine traffic (Mato *et al.*, 2001; Moore, 2008) and recreational coastal activities (Gregory, 1996; Bravo *et al.*, 2009) are also important sources of coastal and marine litter.

The versatility of plastic materials has resulted in a substantial increase in their use. The global production of plastics has increased from 5 million tons/year (1950s) to nearly 300 million tons/year in 2013 (Andrady & Neal, 2009; Lechner *et al.*, 2014). Geyer *et al.* (2017) estimated that, until 2015, 8300 million metric tons (Mt) of virgin plastics have been produced and 6300 Mt of plastic waste have been generated, 9% of which had been recycled, 12% was incinerated, and 79% was accumulated in landfills or natural environments. In 2016, the global average production was 335 million tons, from them between 33% and 50% was designed to be non-reusable (Crawford & Quinn, 2017; Alimba & Faggio, 2019). These plastic materials can be found into a vast range of products that bring numerous societal benefits, especially in healthcare, agriculture, transport, construction and packaging (Plastics Europe, 2016). About 50% of these materials is in the form of such products as plastic bags, drinking bottles, cutlery, straws, ear sticks etc., which are discarded after a single use (Nerland *et al.*, 2014). In 2002, 58% of the debris collected in the International Coastal Cleanup was attributed to shoreline and recreational activities (Allsopp *et al.*, 2006). Work in the Northern area of the South China Sea also found that most floating and beached plastic debris originated from coastal recreational activities and land-based sources (Lee *et al.*, 2013).

Macroplastics typically refer to items larger than 20 mm (Arthur *et al.*, 2009). Depending on the size, plastic litter is classified generally as nanoplastic (<1 µm), microplastic (1 µm - 5 mm), and macroplastic (>5 mm) (SAPEA, 2019), while other studies describe debris > 5 cm as macroplastics (Van Emmerik *et al.*, 2018). Due to the high visibility of plastic material and its contamination in the environment, the macroplastics may be perceived as one of the most disturbing forms of plastic pollution, as well as micro and nanoplastics (Thompson & Napper, 2019).

Most studies on marine plastic debris have focused on its occurrence in coastal waters and open ocean areas. Researching macro-debris on beaches uses different approaches (Hidalgo-Ruz & Thiel, 2015), and relevant studies typically range from a local (Lee *et al.*, 2013) to a regional scale (Bravo *et al.*, 2009) covering a broad temporal range. Research by Barnes *et al.* (2010) found that macroplastics have spread to uninhabited areas, such as Antarctica, where they found a plastic cup and two fishing buoys in the Dumont d'Urville and Davis seas, as well as two pieces of plastic packaging and a fishing buoy in the Amundsen Sea.

Pollution produced by macroplastics has become a problem of global concern, so due to the importance that the government program gives to touristic development, the control of this problem becomes essential to manage and

conserve these spaces. If tourism is one of the sectors that suffer from this pollution, it is, on the other hand, one of the main incriminated factors.

To increase awareness of this pollution and obtain new scientific information at a national level, the paper presents a characterization of the pollution by macroplastics on the beaches of western Algeria. The aim of the present study was to determine the composition and spatial distribution of plastics on the beach; there were investigated regional distribution, composition, and abundance of plastic items in order to improve marine governance, awareness and ecosystem health.

2. MATERIAL AND METHODS

The current study was performed on the shores of Aïn El Turk Bay, which is located about fifteen kilometers west of the wilaya of Oran (Fig. 1). It is a highly coveted area by summer visitors who come to enjoy its extraordinary natural landscapes. The Bay of Aïn El Turk opens to a length of about 8 km, between Cap Falcon in the north-west and the tip of Saint Roch in the south-east. The contact between sea and land is ensured by a discontinuous line of shallow sandy beaches covering a rocky substratum, at the foot of a modest slope, which does not rise above 15 m. These slopes form the edge of a large sand-limestone shell-shaped frame, to some extent encrusted, covering a plateau that extends south to the schist formations on the northern slope of Murdjadjo Mountain. The submarine topography slopes quite steadily down to the isobath of -50 m. The continental shelf then plunges into the abyss, which carves out an important underwater valley (Ghodbani, 2009; Ghodbani & Semmoud, 2010).

The data analyzed in this study were collected on ten (10) beaches of Aïn El Turk Bay in the western region of the Algerian coastline (Fig.1). To identify the characteristic distributions of litter accumulated on the selected beaches, the identification, the description and the counting were carried out *in situ*, manually, following European methodology (Cheshire *et al.*, 2009; Hanke *et al.*, 2013) for the assessment of marine litter. All ten beaches were sampled on a single occasion, between March and April 2019. For each beach, a fixed section was delimited, covering the whole area between the water line to the beach backshore over a length of 100 m. Sampling was always performed at low tide, recording all macro-litter items (>5 cm). This procedure was repeated until the sea line was reached, and the entire sampling area was covered.

3. RESULTS AND DISCUSSION

In this study, ten (10) beaches were selected according to substratum similarity and exposition to the same marine currents: a total of 14537 items were collected and the number of recorded items varied between 245 in Claire Fontaine to a maximum of 3472 in La Madrague beaches (Fig. 3). It seems that beach litter mainly originates from

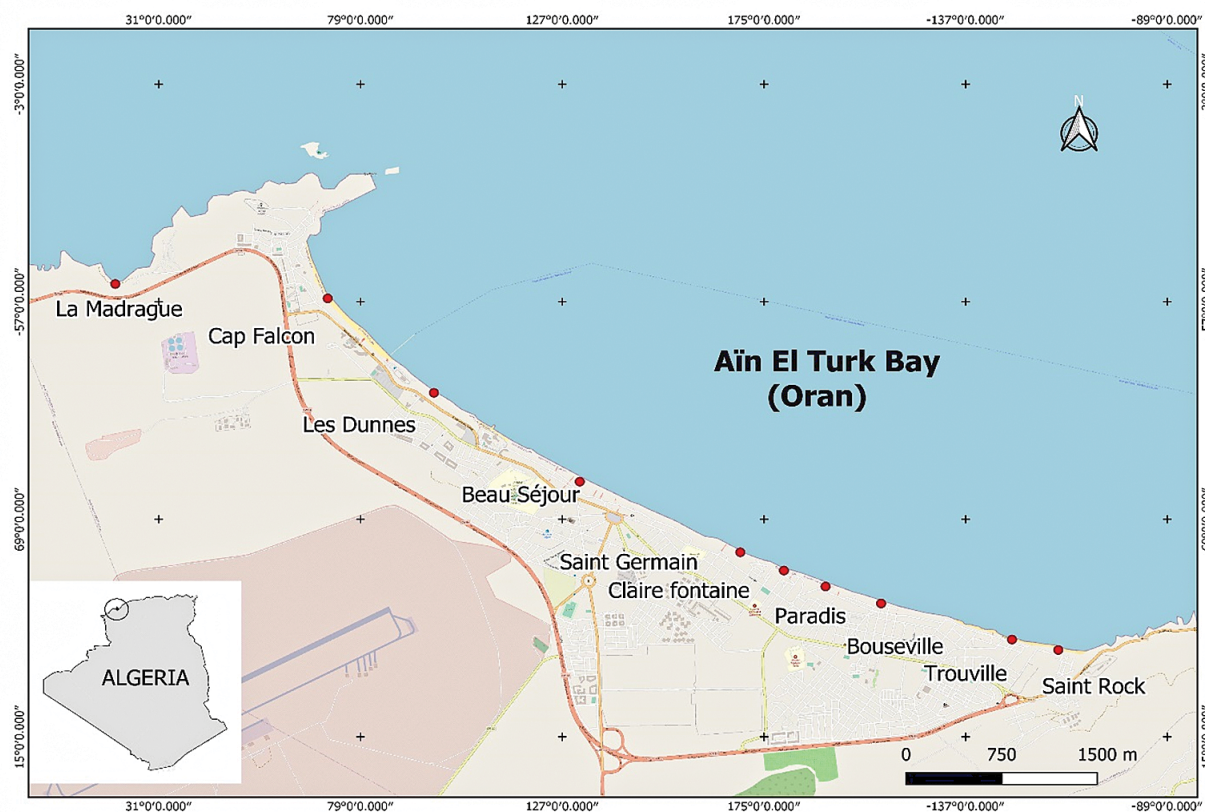


Fig. 1. Location of study sites.



Fig. 2. Litter pollution.

anthropic sources, tourism and river inflow. The results are presented in a global way by comparing all the sampled sites with each other, regarding the concentrations of macro-litter as number, then according to the categories of plastics found.

Four beaches presented very low densities (≤ 0.05 items/ m^2): Trouville, Bousseville, Paradis and Claire Fontaine. The beaches presenting highest density of litter (> 1 item/ m^2) were Saint Roch, Saint Germain, Beau Séjour, Les Dunes, Cap Falcon and La Madrague.

Plastic is the dominant component found on the beaches (Table 1). In the studied area, it was observed that plastics represent 93% of all beached litter items found, this being confirmed by a project carried out by the European Regional Development Fund in 2016-2018 and published in January 2021. Within these plastics, the most prevalent litter type found was food wrappers, followed by plastic bags. Three types of polymers have been identified as those commonly used in the plastic items: polyethylene (PE), polypropylene (PP) and polyethylene terephthalate (PET).

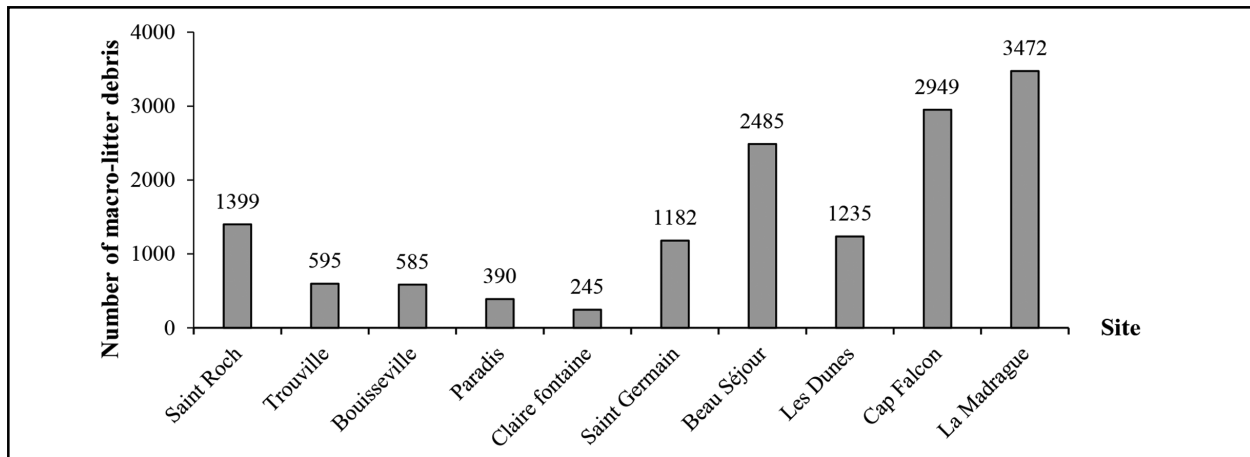


Fig. 3. Concentration of macro debris in number per beach.

Table 1. Most common macro-litter collected from the beaches.

Items	Count	Frequency (%)	Plastic type usually used in the items
Plastic beverage bottles	880	6.08	Polyethylene terephthalate (PET)
Food wrappers	8893	61.48	Polyethylene (PE), Polypropylene (PP)
Plastic bags	3809	26.33	Polyethylene (PE)
Other	884	6.11	-

Litter densities are related to the closeness of urban centers, and the beach characteristics, such as the slope, vegetation and the type of shore (Table 2). On the studied beaches, the abundance of plastic litter was found positively correlated with the type of shore. Some sedimentary types are considered being more prone to marine litter than others, as observed on Cape Falcon and La Madrague beaches, which have a rocky nature in their composition.

Three beaches presented the highest densities (> 1 item/ m^2): La Madrague, Cap Falcon and Saint Germain (Fig. 4).

The first two sites are rocky in nature, which has allowed the installation of many illegal constructions that discharge debris in the form of domestic waste. The surfaces of the beach of Beau Séjour and that of the Dunes are very close, however, the Dunes beach is far from being as polluted as it is Beau Séjour beach; the reason is the urbanization of Beau Séjour which is more important than that of the Dunes. The beaches presenting low densities (< 0.5 items/ m^2) are: Trouville, Bouisseville, Paradis and Claire Fontaine.

Table 2. Variation of plastics beach densities depending on the type of shore.

Site	Plastics (%)	Size (cm)	Type of shore
Saint Roch	60	> 5	sandy
Trouville	60	> 5	sandy
Bouisseville	53	> 5	sandy
Paradis	55	> 5	sandy
Claire Fontaine	41	> 5	sandy
Saint Germain	56	> 5	sandy, boulders
Beau Séjour	57	> 5	sandy
Les Dunes	57	> 15	sandy, boulders
Cape Falcon	64	> 10	boulders, cliffs
La Madrague	63	> 10	pebbles, boulders, cliffs

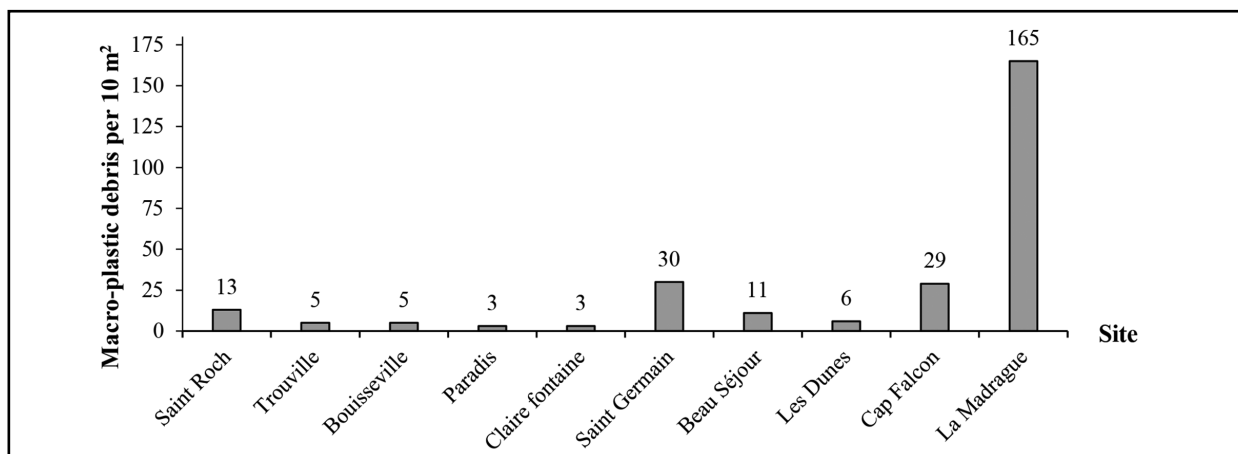


Fig. 4. Concentration of macro-litter in number per 10 m² of beach.

For a better representativeness, the results were brought back to the same scale of comparison and presented in Figure 4, which highlights the concentrations of macro-litter per 10 m² of surface. The concentrations vary from 3 items in Paradis and Claire Fontaine to 165 at La Madrague. The plastic waste collected on La Madrague beach showed a significantly higher average over an area equivalent to the remaining beaches. Saint Germain and Cap Falcon beaches follow with, respectively, 30 and 29 macro debris per 10 m². Saint Roch and Beau Séjour showed similar concentrations with, respectively, 12 and 11 macro debris on the same surface. The significant

pollution recorded at La Madrague can be attributed to the presence on the site of an open landfill where the inhabitants of the area dump their domestic waste.

At the various sites, among all the debris collected (macro debris), it should be noted that plastic debris made up nearly 90% of the total number, the other types of macro debris consisted mainly of rubber, glass and metal. The general composition of macro-litter showed the preponderance of food packaging, which was always the most represented category (61%) (Fig. 5).

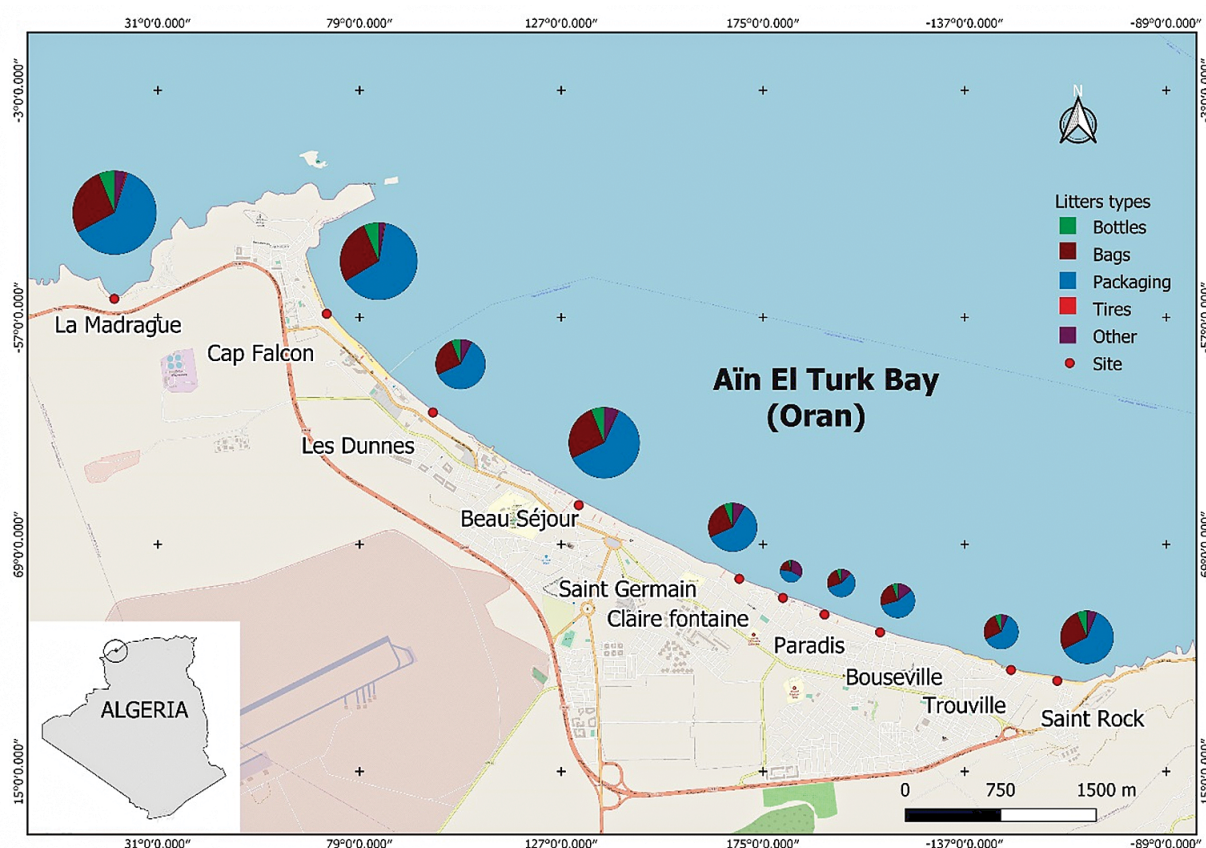


Fig. 5. Types of litters collected.

This food packaging litter comes from the waste rejected mainly by the inhabitants of the area, where plastic bags and bottles reached 33%. Considering the other categories, such as containers, care products, baits, lollipop sticks and straws, they reached the proportion of 6%. What was noted during this study is that these beaches are exposed to litter coming from land rather than from maritime activities, and this is due to the rapid urbanization that this area is experiencing, which causes a great damage.

4. CONCLUSIONS

According to the Bouroumi 2014 Report, Aïn el Turk is a city that is already 90% urbanized. Uncontrolled and unsuitable urbanization of the Oran corniche has negatively transformed the formerly popular, natural space. In Algeria, even though coastal areas are regulated by coastal law (02-02) of February 5th, 2002, urban planning and regional planning law (90-29) of December 1st, 1990 and state law (91-454) of November 23rd, 1991, unfortunately, they did not prevent from suffering a lot of damage. The concentration of population in coastal areas is one of the direct consequences of the establishment of industrial zones in this sector, and the direct cause of the pollution by macroplastics.

During the investigations, intra-site spatial variations were observed, and a tendency for litter accumulation in the upper levels of the beach was noted, in accordance with the results of other studies carried out notably in Australia (Plastics

Europe, 2015), and in the Gulf of Oman (Cleareboudt, 2004). This would therefore imply pollution mainly of land origin, caused by beach users whose activities are concentrated in the upper parts of the beaches. There were also noticed a heterogeneous distribution along the coastal beaches with a high concentration at La Madrague; these differences are due to tourist activities and to the density of the population.

The west shore of the coast has a proven dominance in the concentration of plastic debris compared to the east coast, and this is due to the high density of its population and to the path of marine currents caused by winds, without forgetting the shape of the bay of Aïn El Turk, which influences the dispersion of plastic debris. The current caused by the westerly wind is blocked by l'Aiguille off Oran Cape, which turns it into an easterly current and the water carries a considerable quantity of debris towards the beaches of Aïn El Turk.

This study constitutes a preliminary work that can serve as a premise for a more in-depth study concerning a larger number of beaches in Algeria. However, this study has the merit of demonstrating the urgency of the situation regarding the pollution of western beaches. This pollution could, in the short term, destroy biodiversity, but also affect the tourist activity of the region, with tourists who could turn away from those beaches in favor of other destinations. Therefore, awareness-raising campaigns should be carried out, to reach the citizens.

REFERENCES

- ALIMBA, C., FAGGIO, C. (2019). Microplastics in the marine environment: current trends in environmental pollution and mechanisms of toxicological profile. *Environ. Toxicol. Pharmacol.* **68**: 61-74, <https://doi.org/10.1016/j.etap.2019.03.001>
- ALLSOPP, M., WALTERS A., SANTILLO D., JOHNSTON P. (2006). Plastic Debris in the World's Oceans. *Greenpeace International*, Amsterdam, Netherlands, 43 p.
- ANDRADY, A.L., NEAL, M.A. (2009). Applications and societal benefits of plastics. *Phil. Trans. R. Soc. B: Biol. Sci.*, **364**: 1977-1984.
- ARTHUR, C., BAKER, J., BAMFORD, H., (EDS). (2009). Proceedings of the *International Research Workshop on the Occurrence, Effects and Fate of Microplastic Marine Debris*, Tacoma, WA, USA, September 9-11, 2008; NOAA Technical Memorandum NOS-OR&R-30
- BARNES, D.K.A., WALTERS, A., GONCALVES, L. (2010). Macroplastics at sea around Antarctica. *Mar. Environ. Res.*, **70**: 250-252.
- BOUROUMI, M.T. (2014). Le littoral Algérien entre dégradation et protection du patrimoine, cas de la commune côtière d'Aïn El Türk. *Colloque Francophone International Cultures, Territoires Et Développement Durable*, 23p.
- BRAVO, M., DE-LOS-ÁNGELES GALLARDO, M., LUNA-JORQUERA, G., NÚÑEZ, P., VÁSQUEZ, N., THIEL, M. (2009). Anthropogenic debris on beaches in the SE Pacific (Chile): Results from a national survey supported by volunteers. *Mar. Pollut. Bull.*, **58**: 1718-1726.
- CHESHIRE, A.C., ADLER, E., BARBIÈRE, J., COHEN, Y., EVANS, S., JARAYABHAND, S., JEFTIC, L., JUNG, R.T., KINSEY, S., KUSUI, E.T., LAVINE, I., MANYARA, P., OOSTERBAAN, L., PEREIRA, M.A., SHEAVLY, S., TKALIN, A., VARADARAJAN, S., WENNEKER, B., WESTPHALEN, G. (2009). *UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter*. UNEP Regional Seas Reports and Studies, No. 186; IOC Technical Series No. 83: xii + 120 p.
- CLEAREBOUDT, M. (2004). Shore litter along sandy beaches of the Gulf of Oman. *Mar. Pollut. Bull.*, **49** (9-10): 770-777.
- CRAWFORD, C.B., QUINN, B. (2017). Chap. 3. Plastic production, waste and legislation. In: Christopher Blair Crawford, Brian Quinn (Eds). *Microplastic Pollutants*. Elsevier: 39-56, ISBN 9780128094068. <https://doi.org/10.1016/B978-0-12-809406-8.00003-7>.
- EUROPEAN REGIONAL DEVELOPMENT FUND (2021). BLASTIC – Plastic waste pathways into the Baltic Sea Distribution – Shoreline – <https://www.blastic.eu/knowledge-bank/knowledge-bank-distribution/shoreline/shorelinemacroplastic/>

- GESAMP (2019). Guidelines for the monitoring and assessment of plastic litter and microplastics in the ocean. In: Kershaw, P.J., Turra, A., Galgani, F. (Eds.), (IMO/ FAO/UNESCO-IOC/UNIDO/ WMO/IAEA/UN/UNEP/UNDP/ISA Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). *Rep. Stud. GESAMP*, **99**, 130 p.
- GEYER, R., JAMBECK, J., LAVENDER, K. (2017). Production, use, and fate of all plastics ever made. *Science Advance*, **3** (7), e1700782/DC1. <https://doi.org/10.1126/sciadv.1700782>.
- GHODBANI, T. (2009). Environnement et littoralisation de l'Ouest algérien, Thèse de doctorat en géographie, Université d'Oran Es Sénia, Université de Paris 8 Seine-St-Denis, 306 p.
- GHODBANI, T., SEMMOUD B. (2010). « Urbanisation côtière en Algérie, processus et impacts sur l'environnement : le cas de la baie d'Ain el Turk », *Etudes Caribéennes*, URL : <<https://etudescaribeennes.revues.org/4431>>, n°15.
- GREGORY, M.R. (1996). Plastic 'scrubbers' in hand cleansers: a further (and minor) source for marine pollution identified. *Mar. Pollut. Bull.*, **32**: 867-871.
- HANKE, G., GALGANI, F., WERNER, S., OOSTERBAAN, L., NILSSON, P., FLEET, D., KINSEY, S., THOMPSON, R., PALATINUS, A., VAN FRANEKER, J., VLACHOGIANNI, T., SCOULLOS, M., VEIGA, J., MATIDDI, M., ALCARO, L., MAES, T., KORPINEN, S., BUDZIAK, A., LESLIE, H., GAGO, J., LIEBEZEIT G. (2013). Guidance on Monitoring of Marine Litter in European Seas. *Joint Research Centre Report*, EUR 26113. Luxembourg: Publications Office of the European Union, 2013. JRC83985, 128 p. <https://doi.org/10.2788/99475>
- HIDALGO-RUZ, V., THIEL, M. (2015). The contribution of citizen scientists to the monitoring of marine litter. In: Bergmann M., Gutow L., Klages M. (Eds.) *Marine Anthropogenic Litter*, Springer, Berlin: 429-447. https://doi.org/10.1007/978-3-319-16510-3_16
- KURTELA, A., ANTOLOVIĆ, N. (2019). The problem of plastic waste and microplastics in the seas and oceans: impact on marine organisms. *Croatian Journal of Fisheries*, **77**: 51-56. DOI: 10.2478/cjf-2019-0005
- LECHNER, A., KECKEIS, H., LUMESBERGER-LOISL, F., ZENS, B., KRUSCH, R., TRITTHART, M., GLAS, M., SCHLUDERMANN, E. (2014). The Danube so colourful: a potpourri of plastic litter outnumbers fish larvae in Europe's second largest river. *Environ. Pollut.* **188** (100): 177-181.
- LEE J., HONG S., SONG Y.K., HONG S.H., JANG Y.C., JANG M., HEO, N.W., HAN, G.M., LEE, M.J., KANG, D., SHIM, W.J. (2013) Relationships among the abundances of plastic debris in different size classes on beaches in South Korea. *Mar. Pollut. Bull.*, **77** (1-2): 349-354. doi: 10.1016/j.marpolbul.2013.08.013. Epub 2013 Sep 17.
- MATO, Y., ISOBE, T., TAKADA, H., KANEHIRO, H., OHTAKE, C., KAMINUMA, T. (2001). Plastic resin pellets as a transport medium for toxic chemicals in the marine environment. *Environ. Sci. Technol.* **35**: 318-324.
- MOORE, C.J. (2008). Synthetic polymers in the marine environment: a rapidly increasing, long-term threat. *Environ. Res.*, **108**: 131-139.
- NERLAND, I.L., HALSBAND, C., ALLAN, I., THOMAS, K.V. (2014). Microplastics in marine environments: Occurrence, distribution and effects. NIVA-Norwegian Institute for Water Research, Oslo, Report No. 6754-2014, 71p.
- PLASTICS EUROPE (2015). Plastics – The Facts 2015, An analysis of European plastics production, demand and waste data, 30 p.
- PLASTICS EUROPE (2016). Plastics – The Facts 2016, An analysis of European plastics production, demand and waste data, 38 p.
- SAPEA, SCIENCE ADVICE FOR POLICY BY EUROPEAN ACADEMIES (2019). *A Scientific Perspective on Microplastics in Nature and Society*. Berlin: SAPEA. <https://doi.org/10.26356/microplastics>
- THOMPSON, R.C., NAPPER, I.E. (2019) Microplastics in the Environment. p. 60-81. In: R M Harrison, R E Hester (Eds.) *Plastics and the Environment, Environmental Sciences and Technology*, **47**, The Royal Society of Chemistry, 191p.
- TSCHERNI, V., LARSSON, P.O. (2003). Ghost fishing by lost cod gill nets in the Baltic Sea. *Fish. Res.*, **64**: 151-162.
- UNEP/PAM/MEDPOL (2009). Results of the assessment of the status of marine litter in the Mediterranean. Meeting of MED POL Focal Points No. **334**, 91 p.
- UNEP/WHO/IAEA (1988): Guidelines for monitoring the quality of coastal recreational and shellfish areas. Reference Methods for Marine Pollution Studies, No **1**, Rev 1. United Nations Environments Programme, Athens.
- VAN EMMERIK, T., KIEU-LE, T.-C., LOOZEN, M., VAN OEVEREN, K., STRADY, E., BUI, X.-T., EGGER, M., GASPERI, J., LEBRETON, L., NGUYEN, P.-D., SCHWARZ, A., SLAT, B., TASSIN, B. (2018). A Methodology to Characterize Riverine Macroplastic Emission into the Ocean. *Front. Mar. Sci.* **5**, Art. 372: 3404, doi:10.3389/fmars.2018.00372.
- WWF (2018). Living planet report - 2018: aiming higher. Grooten, M., Almond, R.E.A. (Eds.) WWF, Gland, Switzerland, 75 p. <https://www.worldwildlife.org/pages/living-planet-report-2018>
- WWF. (2019). No plastic in nature: assessing plastic ingestion from nature to people. An analysis for WWF by Dalberg-Switzerland and The University of Newcastle, Australia, 9 p. https://awsassets.panda.org/downloads/plastic_ingestion_press_singles.pdf

