Observation on distribution, biology, growth, diet and feeding strategy of blackmouth catshark *Galeus melastomus* (Rafinesque, 1810) (Chondrichthyes Scyliorhinidae) in Western Algerian coast

Samira Ait Darna, Ahlem Amina Taleb Bendiab, Salim Mouffok[*], Alae-Eddine Belmahi & Mohammed Bouderbala

Laboratoire Réseau de Surveillance Environnementale, Département de Biologie, Faculté des Sciences de la Nature et de la Vie, Université d'Oran 1, BP 1524 El Menaouar, Algeria
[*]Corresponding author, email: halieutsalim@yahoo.fr

ABSTRACT
The blackmouth catshark *Galeus melastomus* (Rafinesque, 1810) (Chondrichthyes Scyliorhinidae) is an accidentally caught species and it acts as a sentinel, by reflecting the state of the region's fish stocks. Its vulnerability to the impact of fishing, along with the low fertility and late reproduction, do not ensure a good renewal. Data, collected during 13 months from November 2015 to November 2016, were analysed to enrich our knowledge on the population, reproductive biology, growth, and feeding strategy of the blackmouth catshark from the Western coast of Algeria. A total of 551 specimens, 360 males and 191 females, were caught. Their size ranged from 25 cm to 56 cm for both sexes. The length of the first sexual maturity was stunted at 54 cm in females. The asymptotic length was deduced from the von Bertalanffy growth equation to be higher for males than females (females: $L\infty$ = 51.79 cm; males $L\infty$ = 52.14 cm) and the study of the height-weight relationship revealed allometric growth. 551 stomachs were examined and the vacuity index was found to be 63.75%. The preys identified belonged primarily to three major groups: Crustaceans, Osteichthyes, and Cephalopods. Our results show that the feeding strategy of *G. melastomus* is to be considered generalist and differs from one month to another.

INTRODUCTION

The Blackmouth catshark, *Galeus melastomus* (Rafinesque, 1810) (Chondrichthyes Scyliorhinidae) is a small Elasmobranch distributed in the eastern Atlantic Ocean, from Norway to Senegal, and in the whole Mediterranean Sea (Compagno, 1984). Although its bathymetrical distribution is quite wide and ranges from 55 to 1,750 m of depth (Stefanescu et al., 1992; Relini et al., 1999), *G. melastomus* prefers muddy bottoms from 200 to 500 m in depth (Fisher et al., 1987; Compagno, 1984). In the western basin, it lives between 400 and 1,400 m in depth (Moranta et al., 1998). *Galeus melastomus* has a strong distribution, due to its morphological characteristics and quick adaptation to the environment, and is very abundant and frequent in the west coast of Algeria (Hemida, 2005). In the Mediterranean Sea the distribution, behaviour and biology of *G. melastomus* have been studied, mainly in the central area including Tunisia (Capapé & Zaouali, 1976, 1977), Italy (Relini Orsi &

Wurtz, 1975, 1977; Tursi et al., 1993; Sartor & Ranieri 1995; Scacco et al., 2002), and the western basin (Macpherson, 1980; Carrasón et al., 1992; Bozzano et al., 2001). These small sharks are considered a sentinel species and excellent indicators to reflect the state of the fish stocks of the ecosystem of which they are part, but the vulnerability to the impact of fishing, low fertility and late reproduction do not ensure a good renewal of the species (Camhi et al., 1998). The purpose of this document was to study the biological characteristics of *G. melastomus*, including the state of fecundity and maturity as well as the sex ratio and feeding habits, which are important parameters for the study of the dynamics of the reproduction of the populations of Elasmobranchs to evaluate the level of exploitation of the Algerian west coast.

MATERIAL AND METHODS

Study area

The hydrodynamic environment of the northern African coast is mainly conditioned by the strong influence of water interchange through the Strait of Gibraltar, a shallow and narrow channel 320 m deep and 14 km wide that connects the Mediterranean to the Atlantic Ocean. This strait allows low-density Atlantic waters to intrude into the Mediterranean as surface waters, while denser Mediterranean waters (high salinity waters resulting from low freshwater supply and high evaporation) travel at mid-depths into the Atlantic Ocean. The inflow of Atlantic water spreads along the Al-

gerian coast, resulting in a general, anti-clockwise flow that forms the Almeria-Bouzedjar front, an anti-cyclonic gyre that joins the Iberian Peninsula to Algeria, and which also has small cyclonic gyres linked to it (Millot, 1999). The Atlantic waters flow into the Algerian sub-basin as the "Algerian current", a relatively narrow and deep current, 30–50 km wide and 200–400 m deep at the coast, which becomes thinner (in depth) and wider (in horizontal extension) in an easterly direction (Benzohra & Millot, 1995). The instability of this current leads to the development of a series of coastal eddies, associated with a non-wind-induced upwelling. The Mediterranean deep waters also flow along the Algerian continental slope with a general anticlockwise circulation, and it is hypothesized that they induce intense currents in the whole deep layer and near the bottom (Millot et al., 1997) (Fig. 1).

Study of reproduction

A series of biological samples were conducted on specimens of *G. melastomus* caught by the commercial trawlers in the sampling area of Oran and Arzew (Fig. 1) during the period from November 2015 to November 2016. Specimens were measured and weighted; sex and maturity were reported for the females that represent the object of our study. Three different stages of maturity have been defined, according to Mellinger (1989), Rodriguez-Cabello et al. (2007) and Capapé et al. (2008) (Table 1).

In reference to the work of Cabello-Rodriguez (2008) and Capapé et al. (2008), to specify the spawning period, we used the oviduco-somatic index (*OSI*) which is the seasonal evolution of the weight of the capsules (*CW*) compared to the total weight of the individual (*TW*) expressed as a percentage, defined by the relation:

$OSI = (CW/TW)*100$

To follow the evolution of egg-laying, the hepato-somatic index (*HSI*) was calculated using the following equation:

$HSI = (LW/TW)*100$

where *LW* is the liver's weight and *TW* the total weight of the specimens. Variations in *OSI* and *HSI* related to sexual maturity stages were examined in
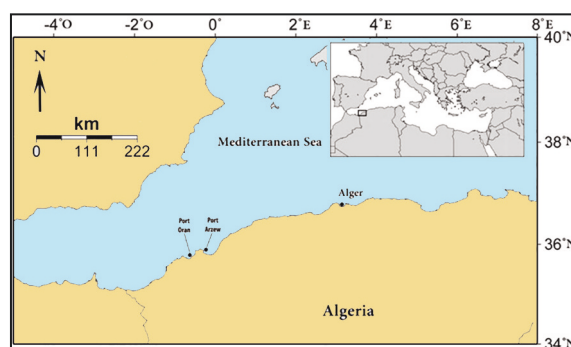

Figure 1. Location of the study area
(Western Algerian coast).

females, in order to know the morphological variations, the degree of overweight or fineness resulting from the genital development and the state of repletion of the target species.

Condition factor (*Kn*) (Le Cren, 1951) was studied in females in order to show differences related to time, according to the formula:

$Kn = W/Wth$ with $Wth = aLb$

where *W* is the total weight, *Wth* is the theoretical weight, *a* and *b* are the coefficients of the relative growth between weight and length and *L* is the total length.

The size of first sexual maturity was described by Fontana et al. (1969) as the size for which 50% of individuals are mature. This size is determined from the abscissa corresponding to the ordinate 50% (*L50*) of the logistic curve linking the percentage of mature females at size classes (Nelder 1961; Cardenas et al., 1997) corresponding to the expression:

$pi = exp (a+b * Li)/ 1+ exp (a+b * Li)$

where *pi* is the proportion of the mature females, *a* and *b* are the coefficients of the equation and *Li* is the total length.

The sex-ratio analysis was performed by studying the global sex-ratio, sex-ratio by length classes and sex-ratio by seasons using the STATISTICA Software logistic model (StatSoft Inc, 2001) and calculating the χ^2 heterogeneity test with one degree of freedom, p <0.05.

Growth study

The objective of this part of the study was to define several biological characteristics, such as the structure of the population size, and the growth and the age of *G. melastomus* in the study area.

There are several mathematical models to express the growth in Elasmobranchs. A detailed review was made by Beverton & Holt (1957), Ursin (1967), Gulland (1983), Sparre & Venema (1996), and Pauly & Moreau (1997). The most popular model is Von Bertalanffy growth equation:

$Lt = L\infty [1-]$

where *Lt* is the expected size at age *t* and *L∞* is the average maximum size.

In this study, the numerical method ELEFAN (Electronic Length Frequency Analysis; Pauly & Moreau, 1997) and the LFDA software (Kirkwood et al., 2001), for mathematical modeling, were used. Analyses were made for males and females, separately.

Study of diet and feeding strategy

This study, carried out during 13 months of sampling, allowed us to know the diet of *G. melastomus* in natural habitat, in addition to its feeding behavior and its trophic migrations, which could explain the influence that could exist on its reproduction (Stergiou & Kapouzi, 2002). This study also allowed to determine the different species that are a part of the same assemblage as the target species as well as the inter and intra specific relationships that can exist between them, for a better understanding of the structures and dynamics of marine stands (Silva, 1999).

Stomach sampling and analysis

551 stomachs were examined, of which 205 were full and 346 empty, the extracted stomachs were isolated, weighed and then placed in pill containers containing a 10% formalin solution, to (i) preserve stomachs samples while hardening the wall tissue of the stomachs and the prey's tissues to facilitate observation; and (ii) interrupt the activity of the gastric digestion performed by the stomach acids still present in the stomachs after landing (Olaso et al., 2005; Cabello-Rodriguez, 2008; Taleb Bendiab, 2014). Generally speaking, the analysis of stomach content is based on two analyses, a qualitative one which makes it possible to draw up a list as complete as possible of the preys ingested, and a quantitative one to stress the relative importance of the different preys found in the overall composition of the food and to highlight the possible variations of the diet (Quinius, 1978). The vacuity index (*Cv*) was calculated according to the formula proposed by Hureau (1970):

$Cv = Nev/N*100$

expressing the percentage of empty stomachs (*Nev*) relative to the total number of stomachs studied (N).

Three indices of prey classification were calculated to provide a representative interpretation of the diet of *G. melastomus*:

(1) index of relative importance (*IRI*) (Pinkas & al., 1971), *IRI* = *F*+ (*Cn*+*Cp*), where *F* = frequency of occurrence of the food item, *Cn* = percentage number of a prey species and *Cp* = percentage by weight of a prey species. According to the value of the *IRI*, preys are classified as follows: Main prey (200 <*IRI* <20,000); Secondary prey (20 <*IRI* <200); Accidental prey (*IRI* <20).

(2) Food index (*IA*) of Lauzanne (1975), *IA* = F*Cp/100, where *F* = frequency of occurrence of the food item; *Cp* = percentage by weight of the food item: based on its values it is possible to distinguish: Secondary prey (*IA*≤10); Not negligible prey (10< *IA* ≤25); Essential prey (25 < *IA* ≤50) and Dominant prey (*IA* >50).

(3) The food coefficient (*Q*) (Hureau, 1970), *Q* = *Cn*Cp,* where *Cn* = percentage number of a prey species and *Cp* = percentage by weight of a prey species, According to the value of the *Q*, preys are classified as follows: Preferential (*Q*> 200); Accessory (*Q* <20).

RESULTS

Reproductive aspects and maturity stage

In order to specify the spawning period and to follow its evolution, we used three biological indexes, the oviduco-somatic index (*OSI*) specific to Elasmobranchs, the hepato-somatic index (*HSI*) and the condition index (Kn). These indices allowed us to evaluate the morphological changes of the specimens and to determine the breeding season by studying the evolution stages of ovarian maturity.

The monthly results of the macroscopic observations of the gonads and the maturity stage of *G. melastomus* females are shown in figure 2. Following the calculation of the monthly averages of the *OSI* and *HSI* from 191 females, we drew up a graph illustrated in figure 3. The peaks observed correspond to the annual spawning period of the population. The highest values of *OSI* were found in December, March, April and May, while the lowest values in February, June, August, September and October. The highest values of the *HSI* occurred in December, April and May, the lowest in January, February, March, June and July (Fig. 3). The evolution of the condition factor (*Kn*) as a function of months on *G. melastomus* females over a period of 13 months is illustrated in figure 4. The values of *Kn* above 1 reveal a breeding period all along the annual cycle with the lowest values confirming a maturation period in December, March, and May.

Size at first maturity L50

The size at first maturity (L50) was estimated as 54 cm. We found substantially the same values in the Mediterranean, with differences in other regions of the world. All data are combined in Table 4.

Sex-ratio analysis

After sexing 551 specimens, we obtained a total femininity rate of 35.09% for a total masculinity rate of 64.90% (Table 2). According to the χ^2 significance test, we notice that males outnumber females. The length/abundance curve is shown in figure 5, and figure 6 shows the variation in percentage of males and females per month. The percentage of males is always dominant during all months.

Growth Parameters results

Table 4 includes the growth parameters $L\infty$ (asymptotic length), *K* (coefficient of growth), t0 the theoretical age at which the size is zero, and ϕ (growth index) calculated in this study. These values, once estimated for *G. melastomus* specimens, were then replaced in the equation of Von Bertalanffy; the parameters obtained from the equation did not differ significantly between the two sexes. We obtained a value of the asymptotic length L∞, the growth coefficient *K* and the growth index ϕ, slightly different in favour of males (Table 5). The results of the height-weight relationship show a significantly lower allometry in both sexes, i.e., the weight does not grow faster than the cube of the length.

The adjusted values of *a* and *b* (*W* = *a Lb*) were used as input data in the stock assessment models. The biometric relations observed by analysis of relative growth are shown in Table 6. These results are close to the results obtained by other authors in different study areas (Table 7).
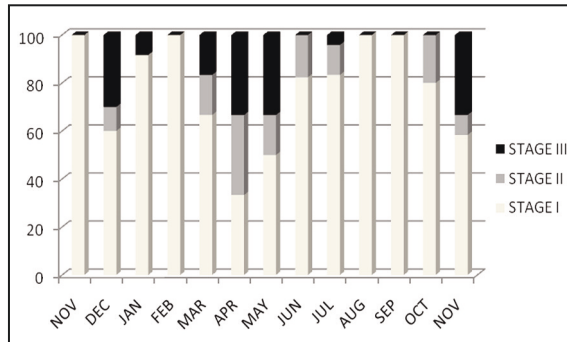
Figure 2. Percentages of different stages of sexual maturity in *Galeus melastomus* females per month.

Stage	Microscopic aspect (color and eggs' texture)
Immature (1)	No eggs and no Capsules
Beginning of maturation (2)	Ovaries small, light brown, egg-capsules rigid
Advanced maturation (3)	Ovaries enlarged, dark brown, egg-capsules rigid

Table 1. Different stages of maturity of *Galeus melastomus* females.

Sex	Total	Percentage
Females	191	34.66%
Males	360	*65.34%
Total	551	100

Table 2. Percentage of sexes in *Galeus melastomus* (*p<0.05).

Author	Areas	Males (cm)	Females (cm)
Tursi et al. (1993)	Ionian Sea (Mediterranean)	45	49
Moreno (1995)	Iberian waters, north-eastern Atlantic and Mediterranean	40	40
Costa et al. (2005)	Portuguese South coast	49	56-59
Rinelli et al. (2005)	Tyrrhenian Sea Mediterranean	44.30	48.80
Rey et al. (2005)	Alboran Sea Central Mediterranean	44	48.3
Capapé et al. (2008)	Languedocian coasts	51-55	52-61
Moore et al. (2012)	The Rockall Trough, north-east Atlantic	55.6	59.7
Christoforos et al. (2015)	Gulf of Euboea, Corinth, north western Aegea	44.7	49
Present study	Algeria (West)		54

Table 3. Comparison of size at first maturity by sex of *Galeus melastomus* for various geographical area.

Sex	Females			Males			
Parameters	K	L∞	t₀ φ	K	L∞	t₀	φ
Results	0.42	51.79	-0.51 3.051	0.42	52.14	-0.93	3.057

Table 4. Growth parameters for *Galeus melastomus* females and males.

Sex	Von Bertalanffy Equation
Females	$L_t = 51.79\,[1 - e^{-0.42(t+0.51)}]$
Males	$L_t = 52.14\,[1 - e^{-0.42(t+0.93)}]$

Table 5. Von Bertalanffy Equation.

Sex	$Wth = a\,L^b$
Females	$Wth = 0.0085\,L^{2.809}$
Males	$Wth = 0.0035\,L^{2.909}$

Table 6. Biometric relation in *Galeus melastomus*.

Feeding intensity

After 13 months of sampling, from November 2015 to November 2016, with 346 empty stomachs and 205 full stomachs operated, we also determined ingested preys. For this period, the average *Cv* was 63.75%. Figure 7 represents the maximum values of the vacancy coefficient that were noted in August and October, summer and autumn, while the lowest values were recorded in May and December for males and females, respectively. This trophic activity could be related to the period of maturation and spawning. This nutritional need would provide sufficient energy for the development of the genitalia.

Diet composition (qualitative analysis)

The diet of *G. melastomus* in the waters of the western Algerian coasts was rather varied and mainly based on the undigested hard parts or whole

Sex	length (Cm)	a	b	r²	Areas	Authors
M	9.5-60	0.0025	3.02		portuguese coast Mediterranean	Mendes et al. (2004)
F	11.1-66.1	0.0017	3.15			
M	13.5-50	0.078	3.019	0.989	Tyrrhenian Sea Mediterranean	Rinelli et al. (2005)
F	14-50	0.084	2.960	0.981		
M		0.002	3.052		Aegean Sea Sigacik gulf Mediterranean	Özütemiz et al. (2007)
F	9-19	0.004	2.857			
M	34-64	0.038	2.93		Rockall Trough Atlantic	Moore et al. (2012)
F	32-69	0.0024	3.06			
M	25-55	0.0035	2.909	0.934	Western algerian coasts	Present study
F	29-56	0.0085	2.809	0.938		

Table 7. Relation length weight of *Galeus melastomus* according to different authors.

phylum	class	subclass	superorder	order	family	genus	species
Crustacea	Malacostraca	Eumalacostraca	Eucarida	Decapoda	Pasiphaeidae	*Pasiphaea*	*sivado*
Arthropoda	Malacostraca	Eumalacostraca	Eucarida	Decapoda	Pasiphaeidae	*Pasiphaea*	*multidentata*
Arthropoda	Malacostraca	Eumalacostraca	Eucarida	Decapoda	Nephropidae	*Nephrops*	*norvegicus*
Arthropoda	Malacostraca	Eumalacostraca	Eucarida	Decapoda	Penaeidae	*Parapenaeus*	*longirostris*
Arthropoda	Malacostraca	Eumalacostraca	Eucarida	Decapoda	Sergestidae	*Sergestes*	*arcticus*
Arthropoda	Malacostraca	Eumalacostraca	Eucarida	Decapoda	Goneplacidae	*Goneplax*	*rhomboides*
Arthropoda	Malacostraca	Eumalacostraca	Eucarida	Decapoda	Goneplacidae	*Goneplax*	*nipponensis*
Mollusca	Cephalopoda	Coleoidea	Octopodiformes	Octopoda	Octopodidae	*Octopus*	*vulgaris*
Mollusca	Cephalopoda	Coleoidea	Decapodiformes	Myopsida	Loliginidae	*Loligo*	*vulgaris*
Chordata	Actinopterygii			Gadiformes	Gadidae	*Miscromesistius*	*poutassou*
Chordata	Actinopterygii			Perciformes	Carangidae	*Trachurus*	*trachurus*
Annelida	Polychaeta	Ind	Ind	Ind	Ind	Ind	Ind

Table 8. Diversity of prey ingested by *Galeus melastomus*.

Nature of prey	Total of prey	Cn	Cp	Q	LA	IRI
Crustaceans	491	112.0314	76.2238	717225.75	813.372	7358.5717
Cephalopoda	105	39.4743	39.9373	1225.3711	7.276	100.3025
Osteichthyes	89	19.4406	61.6301	1020.4408	9.272	106.0372
Undetermined	34	14.76	7.623	159.2625	0.274	26.5326

Table 9. Ranking of prey ingested by *Galeus melastomus* according to Hureau's methods (1970), Lauzanne (1975), and Pinkas et al. (1971).

organisms of three categories of preys: Crustaceans, Osteichthyes and Cephalopoda, of which 719 preys were counted (see Table 8). The determination of the different preys ingested by *G. melastomus* allowed us to calculate the different values of the dietary indices. Crustaceans are significantly present in both sexes with a value of 52.83%, then come the Cephalopoda with 24.25% and Osteichthyes with a value of 19.26% (Fig. 8).

Quantitative composition of the diet of Galeus melastomus

The calculated values of the different indices, Q, IRI, IA, show that Crustaceans are essential or preferential preys for males and females (Tables 9 and 10). Osteichthyes as well as Cephalopoda represent secondary preys, not insignificant. From the study of the different food indices we classified the different ingested preys as shown in Table 10.

DISCUSSION

From a sample collected during 13 months represented by a total workforce of 551 *G.melastomus* individuals sexed, the results show that the number of males was higher than the number of females, as already reported in the Mediterranean Sea, in the Alboran Sea, in the South Tyrrhenian Sea, in Gulf of Euboea and Corinth and North-Western Aegean off the Greek coasts and in Aegean Sea (Sığacık Gulf) (Rey et al., 2005; Rinelli et al., 2005; Özütemiz et al., 2007; Christoforos et al., 2015). We noted a fluctuation in the rate of masculinity with a significant dominance during autumn and winter, which could correspond to the maturation periods. We also observed a clear statistically significant decrease in the rate of masculinity tending to reach a numerical equality with females at the beginning of summer, i.e., in July, August and September, which could correspond to sexual rest or post-spawning periods. Regarding the correlation between sex and body size, one can observe that size classes between 25 and 55 cm of total length are almost significantly dominated by males, with only the two size classes 31 and 56 cm being dominated by females. This difference in size was also reported by other authors in the Mediterranean Sea, including in the south coast of Portugal (Costa et al., 2005), in the southern

Tyrrhenian Sea (Rinelli et al., 2005), in the Alboran Sea (Rey et al., 2005) and in the Gulf of Euboea, Corinth, and North-Western Aegean (Christoforos et al., 2015), all pointing out the size difference between females and males, which could be explained by the fact that large females are likely to be less accessible to fishing gear as they move to specific reproduction areas (Rodriguez- Cabello et al., 1998). From the three indexes studied (OSI, HSI and Kn) we have determined the spawning period of the species. Moreover, from a macroscopic approach, we studied the sexual cycle of the species The breeding that appears to be annual with maximum phases of maturation occurs in December, April and May during the laying period, with interruptions occurring in February, August, September and October, which is the period of sexual rest or repletion of the target species. Many other authors (Capapé ,1977; Rey et al., 2005; Rinelli et al., 2005; Capapé et al., 2008) maintained that the reproduction would be annual, while we found periods of strong maturation of ovaries that differ from one fishery to another, probably influenced by variations in the environmental conditions and by fluctuations in bodies of water (Harris, 1952; D'Onghia et al., 1995).

To accurately determine breeding and spawning periods of species, either demersal or benthic, several indices are used. Referring to a work from ISRA-IRD (1979), it is recommended to use at least two indices when studying the reproduction of a target species. We note that the trend of the values of *OSI* and *HSI* is opposite to that of the condition factor (*Kn*). As for the latter studies, its values above 1 reflect an overweight, and therefore reveal a repro-

Method used	Ranking	Nature of prey
Hureau (1970)	preferential prey Q > 200	Crustaceans, Cephalopoda
	secondary prey 20 < Q < 200	
	accessory prey Q < 20	
Louzanne(1975)	IA > 50 dominant prey	Crustaceans
	25 < IA ≤ 50 essential prey	
	10 < IA ≤ 25 not negligible prey	
	IA ≤ 10 secondary prey	Cephalopoda, Osteichthyes
Pinkas (1971)	200 < IRI < 20000 preferential prey	Crustaceans
	20 < IRI <200 accessory prey	Cephalopodes, Osteichthyes

Table 10. Classification of prey ingested by *Galeus melastomus* according to Hureau's methods (1970), Lauzanne (1975), and Pinkas et al. (1971).
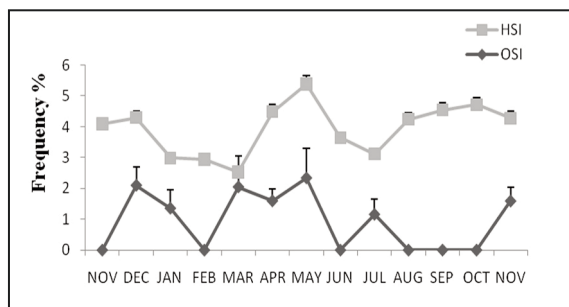
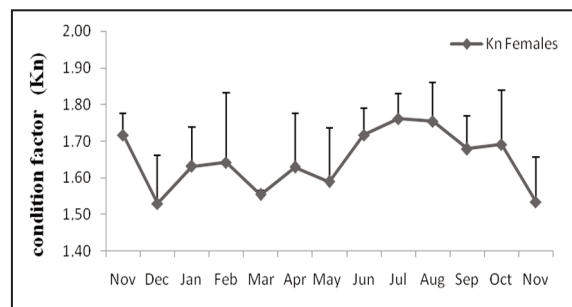Figure 3. Monthly trend of OSI and HSI with standard errors in *Galeus melastomus* females.

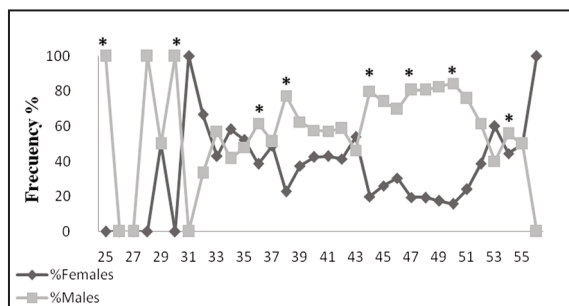Figure 4. Condition factor (Kn) with standard error according to the season in *Galeus melastomus*.

Figure 5. Abundance curve. Results of χ^2 test show a predominance of males over the females by length of specimens(* $p<0.05$).
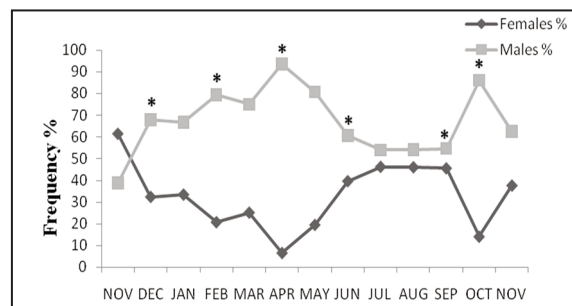

Figure 6. Distribution of males and females of *Galeus melastomus* by season. χ^2 test results show a prevalence of males over the females per sampling month.
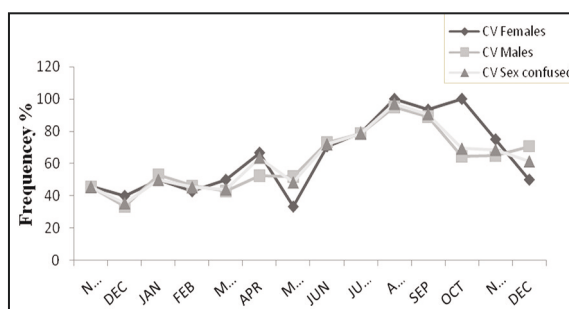

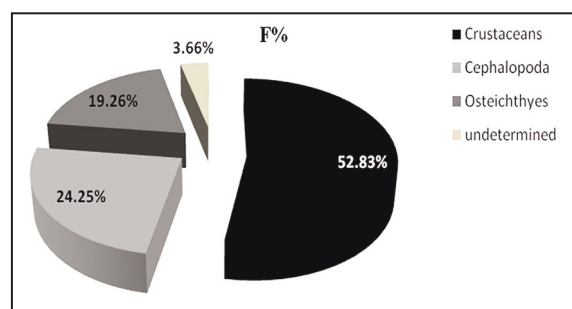Figure 7. Variation of CV% according to sex in *Galeus melastomus*

Figure 8. Variation of frequencies of prey ingested by *Galeus melastomus* (F%=Frequency of occurrence).

ductive period all along sampling and confirm a period of strong maturation in the intervals of December, March, April and May where the *Kn* values are relatively low. We estimated the size of first maturity (*L50*) at 54 cm, which is greater than that reported for the Mediterranean fisheries, as can be seen in Table 3. Tursi et al. (1993) also found that sexual maturity in *G. melastomus* would be reached

around the third or fourth year of life and Capapé (1977) in Capapé & Brahim (1984) stated that maximum total length and size at first maturity are random in some species of selachians and, notably, that there could be very important variations within the Scyliorhinidae family. Notably, results obtained in our study confirm and support the results of the various authors mentioned above and the different

breeding parameters of *G. melastomus* differ from one region to another, under the influence of different environmental and geographical features (Leloup et al., 1951; Relini & Orsi-Relini, 1987; Demestre & Martín, 1993; Guijarro et al., 2007), such as the passage of Atlantic currents (rich in organic matter) entering the Mediterranean through the Gibraltar Strait, and the existence of many canyons providing enrichment of deep Algerian waters (Cartes et al., 2002).

The conclusions drawn from this work is that *G. melastomus* has a broad food spectrum, reflecting the richness of the environment in which it lives and the diversity of the assemblages of which it is a part of. This small shark feeds mainly on Crustaceans that represent its preference, whatever the age or sex, and on cephalopods and teleosts (mostly Gadidae) which represent secondary preys, in line with the conclusions of other authors regarding the importance of these three categories of preys in the diet of *G. melastomus* (Olaso et al., 2005; Neves et al., 2007; Fanelli et al., 2009; Anastasopoulou et al., 2013). The blackmouth catshark moves from the juvenile state to the adult state by changing its environment and the older it gets the more it moves to the coastal environments where the waters get less deep. This species has also been described as an active benthic eater using a wide range of active senses to find the preys (Olaso et al., 2005; Kimber et al., 2009). As previously reported (Olaso et al., 2005; Neves et al., 2007), *G. melastomus* food composition shows a certain heterogeneity of ingested preys - confirming that the species is both a generalist and an opportunistic - which means that the population occupies a large niche, where the individuals have much narrower niches. Taking into account the lack of reference works on this item, this study contributed to widen the knowledge of *G. melastomus* habits on the western Algerian coasts. Nevertheless, further studies are certainly still needed to deepen our knowledge on this very important and fascinating species.

ACKNOWLEDGEMENTS

REFERENCES

Anastasopoulou Ch., Mytilineou E., Lefkaditou J., Dokos C.J. Smith., Siapatis A., Bekas P. & Papadopoulou K.N., 2013. Diet and feeding strategy of blackmouth catshark *Galeus melastomus*, The Fisheries Society of the British Isles, Journal of Fish Biology, 83: 1637–1655

Benzohra M. & Millot C., 1995. Characteristics and circulation of the surface and intermediate water masses off Algeria. Deep Sea Research., 42: 1803–1830.

Beverton R.J.H. & Holt S.J., 1957. On the dynamics of exploited fish populations. Fishery investigation, series II., 19: 1–533.

Bozzano A., Murgia R., Vallerga S., Hirano J. & Archer S., 2001. The photoreceptor system in the retinae of two dogfishes, *Scyliorhinus canicula* and *Galeus melastomus*: possible relationship with depth distribution and predatory lifestyle. Journal of Fish Biology, 59: 1258–1278.

Cabello-Rodriguezc., 2008. Biologia y ecologia de la pintarroja *Scyliorhinus canicula* (Linneaus, 1758) en el mar Cantabrico.Thèse de Doctorat, Université de Cantabrique. Espagne.

Camhi M., Flower S.L., Musick J.A ., Brautigam A. & Fordham S.V., 1998. Sharks and their relatives ecology an conservation IUCN/SSC. Shark specialist Group IUCN Gland. Switzerland and Cambridge, UK .IV +39 pp.

Capapé C., 1977. Contribution à la biologie des Scyliorhinidae des côtes tunisiennes. I *Scyliorhinus canicula* (Linné, 1758): répartition géographique et bathymétrique, sexualité, reproduction, fécondité. Bulletin de l'Office National des Pêches de Tunisie, 1: 83–101.

Capapé C. & Zaouali J., 1977. Contribution à la biologie des Scyliorhinidae des côtes tunisiennes. VI *Galeus melastomus* Rafinesque, 1810. Répartition géographique et bathymétrique, sexualité, reproduction, fécondité. Cahiers de Biologie Marine, 18: 449–463.

Capapé C. & Brahim R.B., 1984. Nouvelles données sur la morfologie de *Galeus melastomus* Rafinesque, 1810 (Pisces, Scyliorhinidae). Oebalia (N. S.), 10: 1–16.

Capapé C., Guélorget O., Vergne Y. & Reynaud C., 2008. Reproductive biology of the blackmouth catshark, *Galeus melastomus* (Chondrichthyes: Scyliorhinidae) off the Languedocian coast

(Southern France, Northern Mediterranean). Journal of the Marine Biological Association of the United Kingdom, 88: 415–421.

Capapé C., Vergner Y., Reynaud C., Guéllorget O. & Quignard J.P., 2008. Maturity, fecundity and occurrence of the small spotted cats hark *Scyliorhinus canicula* (Chondrichthyes: Scyliorhinidae) off the Languedoc coast (Southern France, northwestern Mediterranean). Vie et Milieu, 58: 47–55.

Cardenas E., Avila de Melo A., Iglesias S. & Saborido F., 1997. Selectivity of 130 mm mesh size in deep sea bottom trawl fishery in NAFO regulatory area. NAFO Scientific Council Studies, 30: 21–25.

Cartes J.E., Abelló P., Lloris D., Carbonell A., Torres P., Maynou F. & Gil De Sola L., 2002. Feeding guilds of western Mediterranean demersal fish and crustaceans: an analysis based on a spring survey. Scientia Marina, 66 (Suppl.2): 209–220.

Carrasón M., Stefanescu C. & Cartes J., 1992. Diets and bathymetric distributions of two bathyal sharks of the Catalan Sea (western Mediterranean). Marine Ecology Progress Series, 82: 21–30.

Christoforos P.M., Greta Carmona A.A., Vasiliki K., Dimitrios D. & Persefoni M., 2015. Population structure and aspects of the reproductive biology of the blackmouth catshark, *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes: Scyliorhinidae) caught accidentally off the Greek coasts. Journal of the Marine Biological Association of the United Kingdom, 98: 909–925. DOI: 10. 1017/S0025315416001764

Compagno L.J.V., 1984. Sharks of the World: An Annotated and Illustrated Catalogue of Shark Species Known to Date. Food and Agricultural Organization, 312 pp.

Costa M.E., Erzini K. & Borges T.C., 2005. Reproductive biology of the blackmouth catshark, *Galeus melastomus*, off the south coast of Portugal. Journal of the Marine Biological Association of the United Kingdom, 85: 1173–1183.

Demestre M. & Martin P., 1993. Optimum exploitation of a demersal resource in the western Mediterranean: the fishery of deep-water shrimp *Aristeus antennatus* (Risso,1816). Scientia Marina, 57: 175–182.

D'Onghia G., Matarrese A., Tursi A. & Sion L., 1995. Observations on the depth distribution pattern of the smallspotted catshark in the North Aegean Sea. Journal of Fish Biology, 47: 421–426.

Fanelli E., Rey J., Torres P. & Gil De Sola L., 2009. Feeding habits of blackmouth catshark *Galeus melastomus* (Rafinesque, 1810) and velvet belly lantern shark *Etmopterus spinax* (Linnaeus, 1758) in the western Mediterranean. Journal of Applied Ichthyology, 25: 83–93. DOI: 10.1111/j.1439-0426.2008.01112.x

Fischer W., Bauchot M.L. & Schneider M., 1987. Fiches FAO d'Identification des Espèces pour les Besoins de la Pêche. Méditerranée et Mer Noire. Zone de Pêche 37. 2. Rome: FAO. Vertébrés: 61–1530.

Fontana A. & Le Guen J.C., 1969. Etude de la maturité sexuelle et de la fécondité de *Pseudotolithus elongatus.* Cahiers O.R.S.T.O.M. Série océanographie, 7: 9–19.

Gulland J.A., 1983. Fish stock assessment. A manual of basic methods. Ed. John Wiley and Sons, Chichester, UK, FAO/Wilies Series on Food and Agriculture, 1: 223 pp.

Guijarro B., Massutí E., Moranta J. & Díaz P., 2007. Population dynamics of the red- shrimp *Aristeus antennatus* in the Balearic Islands (western Mediterranean): short spatio-temporal differences and influence of environmental factors. Journal of Marine Systems, 71: 385–402.

Harris J.E., 1952. A note on the breeding season, sex ratio and embryonic development of the dog fish *Scyliorhinus canicula* (L.). Journal of Marine Biological Association of the United Kingdom, 31: 269–274.

Hemida F., 2005. Les sélaciens de la côte algérienne: biosystématique des requins et des raies, écologie, reproduction et exploitation de quelques population caprutées. Thèse de Doctorat, USTHB.

Hureau J., 1970. Biologie comparée de quelques poissons antarctiques (Nototheniidae). Bulletin de l'Institut océanographique de Monaco, 68 (1391): 1–244

ISRA-IRD (ex ORSTOM).,1979. La reproduction des espèces exploitées dans le golfe de Guinée. Rapport du groupe de travail ISRA-ORSTOM (Dakar, 7–12 novembre 1977). Document. Scientifique Provenant du Centre de

Recherche Océanographique. Dakar-Thiaroye, 68: 213 pp.

Kimber J.A., Sims D.W., Dellamy B.H. & Gill A.B., 2009. Male-female interactions affet foraging behaviour within groupe of small. Spotted Catsharks, *Scyliorhinus canicula*. Animal Behaviour, 77: 1435–1440.

Kirkwood G.P., Aukland R. & Zara J.S., 2001. Length Frequency Distribution Analysis (LFDA), Version 5.0. MRAG Ltd., London, UK.

Lauzanne L., 1975. Régime alimentaire d'*Hydrocyon forskalii* (Pisces Characidae) dans le lac Tchad et ses tributaires. Cahiers O.R.S.T.O.M. Série hydrobiologie, 9: 105–121.

Leloup J. & Olivereau M., 1951. Données biométrique comparatives sur la roussette (*Scyllium canicula* L.) de la Manche et de la Méditerranée. Vie et Milieu, 2: 182–209.

Le Cren E.D., 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology, 20: 201–219.

Moranta J.C., Stefanescu E., Massuti E., Moralesnin B. & D. Lloris, 1998. Fish community structure an depth related trends on the continental slope of the Balearic Islands (Algerian basin, western Mediterranean). Marine Ecology Progress Series, 171: 247–259.

Macpherson E., 1980. Régime alimentaire de *Galeus melastomus* Rafinesque, 1810, *Etmopterus spinax* L., (1758) et S*cymnorhinus licha* (Bonaterre, 1788) en Méditerranée occidentale. Vie et Milieu, 30: 139–148.

Mellinger J., 1989. Reproduction et developpement des *Chondrichtyens*. Oceanis, 15: 283–308.

Moore D.M., Neat F.C . & Mccarthy I.D., 2012. Population biology and ageing of the deep water sharks *Galeus melastomus*, *Centroselachus crepidater* and *Apristurus aphyodes* from the Rockall Trough, north-east Atlantic. Journal of the Marine Biological Association of the United Kingdom, page 1 of 10. Marine Biological Association of the United Kingdom, 93: 1941–1950. DOI: 10.1017/S0025315413000374

Mendes B., Fonseca P. & Campos A., 2004. Weight–length relationships for 46 fish species off the Portuguese west coast. Journal of Applied Ichthyology, 20: 355–361.

Millot C., 1999. Circulation in the western Mediterranean Sea. Journal of Marine Systems, 20: 423–442.

Millot C., Benzhora M. & Taupier-Letage I.,1997. Circulation off Algeria inferred from the MEDIPROD-5 current meters. Deep Sea Research, 44: 1467–1495.

Moreno J.A., 1995. Guia de los tiburones de aguas ibéricas, Atlantico nororiental y Mediterràneo, 1st edition. Madrid: Ediciones Piramide, S.A.

Nelder J.A., 1961. The fitting of a generalization of the logistic curve. Biometrics, 89–110.

Neves A., Figueredo I., Moura T., Assis C. & Gordo L.S., 2007. Diet and feeding strategy of *Galeus melastomus* in the continental slope off southern Portugal. Vie et Milieu, 57: 165–169.

Olaso L., Velasco F., Sánchez F., Serrano A., Rodríguez-Cabello C. & Cendrero O., 2005. Trophic Relations of Lesser-Spotted Catshark (*Scyliorhinus canicula*) and Blackmouth Catshark (*Galeus melastomus*) in the Cantabrian Sea. Journal of Northwest Atlantic Fishery Science, 35: 481–494. DOI:10.2960/J.v35.m494

Özütemiz S., Murat Kaya & Okan Özaydın, 2007. Growth and Feeding Characteristics of Two Sharks Species [*Galeus melastomus* (Rafinesque, 1810) and *Squalus blainvillei* (Risso, 1826)] from Sığacık Bay (Aegean Sea). Journal of Fisheries & Aquatic Sciences, 26: 211–217.

Pauly D. & Moreau J., 1997. Méthodes pour l'évaluation des ressources halieutiques. Cépaduès-Editions, Toulouse, 288 pp.

Pinkas L., Oliphant M.S. & Iverson I.L.K., 1971. Food habits of Albacore, Bluefin tuna and Bonito in California waters. Fish Bulletin, 152: 1–105

Quinius L., 1978. Les poisons demerseaux du baie de Douranez. Alimentation et ecologie. These de doctorat 3eme cycle, Université de Bretagne-Occidentale, 222 pp.

Rey J.L., De Sola G. & Massutí E., 2005. Distribution and Biology of the Blackmouth Catshark *Galeus melastomus* in the Alboran Sea (Southwestern Mediterranean). Journal of Northwest Atlantic Fishery Science, 35: 215–223. DOI:10.2960/J.v35.m484

Rinelli P., Bottari T., Florio G., Romeo T., Giordano D. & Greco S., 2005. Observations on distribution and biology of *Galeus melastomus* (Chondrichthyes, Scylliorhinidae) in the southern Tyrrhenian Sea (central Mediterranean). Cybium, 29: 41–46.

Relini G. & Orsi Relini L., 1987. The decline of red shrimps stocks in the Gulf of Genova. Investigación Pesquera, 51: 245–260.

Relini Orsi L. & Wurtz M., 1977. Patterns and overlap in the feeding of two selachians of bahyal fishing grounds in the Ligurian Sea. Rapports et procés-verbaux des réunions Commission internationale pour l'exploration scientifique de la Mer Méditerranée, 24: 89–93.

Rodríguez-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.

Rodríguez-Cabello C., Sanchez F., Fernandez A. & Olaso I., 2007. Distribution patterns and sexual segregations of *Scyliorhinus canicula* in the Cantabrian Sea. Journal of Fish Biology, 70: 1568–1586.

Silva A., 1999. Feeding habits of john dory, *Zeus faber*, off the Portuguese continental coast. Journal of the Marine Biological Association of the United Kingdom, 79: 333–340.

Stergiou & Karpouzi V.S., 2002. Feeding of Mèditerranean fish. Reviews in Fish Biology and Fisheries, 11: 27–254.

Stefanescu C., Lloris D. & Rucubado J., 1992. Deepliving demersal fishing fishes in the Catalan Sea (Western Mediterranean) below a depth of 1000 m. Journal of Natural History, 26: 197–213.

Sartor P. & S De Ranieri., 1995. *Hetrotruthis dispar* (Rupell, 1844) (Cephalopoda, Sepiolidae) nella dieta di due selaci batiali nel Mar Tirreno Settentrionale. Biologia Marina Mediterranea, 2: 517–518.

Scacco U., La Mesa G., Dalu M. & Vacchi M., 2002. Changes of swimming ability with length in a small benthic elasmobranch, *Galeus melastomus* a work hypothesis. In: Vacchi M., La Mesa G., Serena F. & Séret B. (Eds.), Proceedings of the 4th European Elasmobranch Association Meeting, Livorno (Italy), 2000, pp. 127–134. ICRAM, ARPAT & SFI, 2002.

Sparre P. & Venema S.C., 1996. Introduction à l'évaluation des stocks des poissons tropicaux. Première partie: Manuel FAO. Document Technique sur les Pêches, 306, Danida, Rome, 401 pp.

Statsoft Inc., 2001. STATISTICA (data analysis-softwaresystem) version 6 WWW.statsoft.com.

Taleb Bendiab A.A., 2014. Contribution à l'étude de la reproduction, la croissance, la pêcherie et le régime alimentaire d'un sélacien, la petite roussette *Scyliorhinus canicula* (Linnaeus, 1758) de la façade maritime oranaise. Thèse de Doctorat, Université Es Sénia, Oran, Algérie.

Tursi A., D'Onghia G., Matarrese A. & Piscitelli G., 1993. Observations on population biology of the blackmouth catshark *Galeus melastomus* (Chondrichthyes, Scyliorhinidae) in the Ionian Sea. Cybium, 17: 187–196.

Ursin E., 1967. A mathematical model of some aspects of fish growth, respiration and mortality. Journal of Fisheries Research Board of Canada, 24: 2355–2453.

Von Bertalanffy L., 1938. A quantitative theory of organic growth (inquiries on growth laws II). Human Biology, 10: 181–213.