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Sex-ratio, reproduction and feeding habits of *Pomadasys incisus* (Haemulidae) in the Gulf of Tunis (Tunisia)

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The reproduction and feeding habits of the Bastard grunt, Pomadasys incisus *(Bowdich, 1825), in the Gulf of Tunis were investigated monthly from January to December 2003. An examination of the gonads of 463 specimens showed that the Bastard grunt is a gonochoric species and the sex-ratio wasn't significantly different from 1:1. The monthly variations of the gonadosomatic index and the percentage of the different gonadal development stages revealed that* P. incisus *spawning period occurred from August to October. This species uses its energetic reserves contained in the liver and the muscles to assure gonadal maturation. The size at first maturity (L_{50}) was estimated at 15.33 cm for both sexes pooled. The stomachs examined showed a high vacuity index throughout the year (56.8%) and presented a significant difference between seasons. The stomach contents analysis revealed that* P. incisus*' diet was especially constituted of crustacean species as well as benthic and planktonic organisms that belong to 19 taxa. The percentage frequency of occurrence (F) computed for* Crangon crangon, Hyperoche sp. *and* Geryon longipes *(the most abundant prey in the diet) showed significant differences among seasons (χ^2_{obs}= 31.228, 29.471 and 11.302 respectively, were superior to $\chi^2_{0.05}$).*

Key words: *Pomadasys incisus*, reproductive cycle, alimentary indices, central Mediterranean

INTRODUCTION

The diversity of the Haemulidae family allows their large distribution throughout the world and covers the Atlantic, Indian and Pacific oceans (BAUCHOT & HUREAU, 1990). The 126 species of this family are coastal and demersal fish; they are common from 20 to 50 m depth on hard bottoms, mainly coralian reefs (CHATEAU & WANTIEZ, 2005) and over sand (FISHER *et al*., 1987a). The Bastard grunt; *Pomadasys incisus* (Bowdich, 1825), caught by artisanal gears (trammel and gill nets, beach and purse seines, long lines and trawls), is present along the eastern central Atlantic coasts. It has been recorded in Portugal (RIBEIRO *et al*., 2001), Morocco (COL-

LIGNON, 1969), Mauritania (CAVERIVIÈRE *et al.*, 1986), Angola, around the Azores, Canary, and Cape Verde islands (PAJUELO *et al.*, 2003a, b). Around the above cited islands, the Bastard grunt is the most abundant of the discarded demersal species because of its low commercial value (PAJUELO, 1997). Several references have recorded this species in Mediterranean sea, along the southern Spanish and French coasts (LOZANO Y REY, 1952; MOREAU, 1891), in Greece (KASPIRIS, 1970) and recently in the Ligurian, Tyrrhenian and Egyptian seas (GAVAGNIN *et al.*, 1994; SERENA & SILVESTRI, 1996; EL MOR *et al.*, 2002). In Tunisia, a few references dealing with fishing activities had recorded the presence of the Bastard grunt in the Gulf of Tunis (AZOUZ, 1974) and in the Gulf of Gabès (FEHRI-BEDOUI, 1986), located in the North and the South respectively.

This species had also been mentioned in the Mediterranean sea as an indicator of changing marine conditions towards "tropicalisation" (FRANCOUR *et al.*, 1994; BRADAÏ *et al.*, 2004). In spite of observations concerning the important presence of the Bastard grunt on the Tunisian market since the 90' (CHAKROUN-MARZOUK & KTARI, 2006), there is no available fisheries information about this species in the Tunisian official statistics.

The ecobiology of this species in the Mediterranean area is limited to some aspects such as parasitism, reproduction and relative growth (EUZET & KTARI, 1970; CHAKROUN-MARZOUK & KTARI, 1995, 2006). This study presents an update of data on reproduction and the first data on the feeding habits of *P. incisus* from the Gulf of Tunis that covers a surface of 350 km² (Fig. 1).

MATERIALS AND METHODS

Collection of samples and fish treatment

Samples of Bastard grunt were taken from coastal fisheries operating in the Gulf of Tunis. The catches were carried out with trammel nets of 48 mm mesh (stretched). The nets were set in the sea by night and removed in the morning.

A total number of 474 specimens caught from Jan to Dec 2003, whose total length ranged from 11.9 to 24 cm, were examined. Some specimens, presenting infested gills, were excluded from this study.

The specimens (N = 463) were measured (Lt = total length) to the nearest mm and weighed

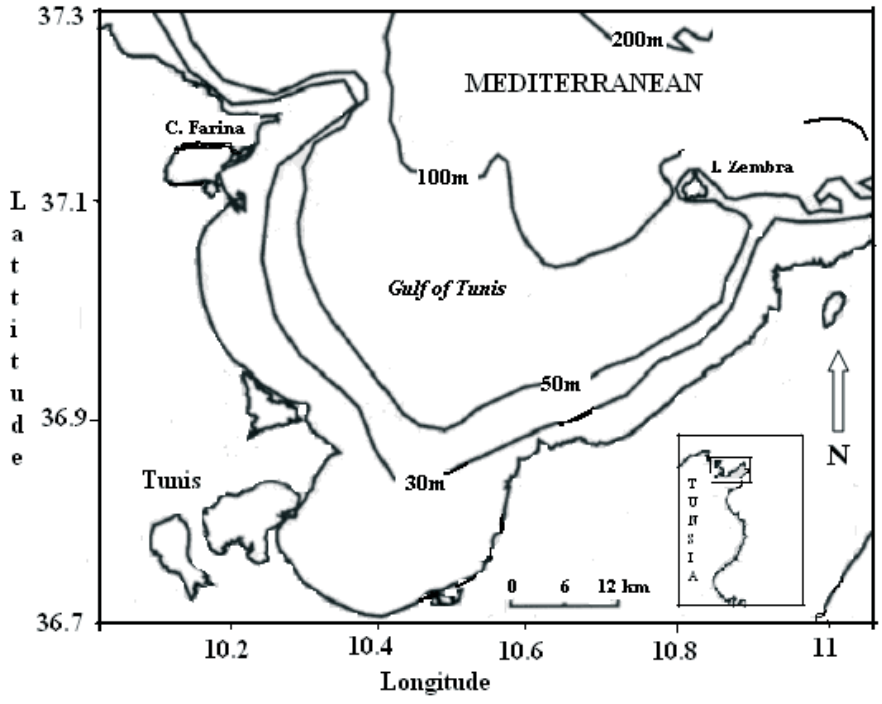

Fig. 1. Map showing the Gulf of Tunis

(Wt = total weight) to the nearest 0,01g. They were dissected and sex was assigned; gonads, liver and the alimentary tract were removed. Eviscerated fish, gonads, liver and stomach were weighed to the nearest 0,01g (Ws = mass weight, Wg = gonad weight, Wl = liver weight).

Sex-ratio, reproductive cycle and length at first maturity

$$SR = \frac{Number\ \ of\ \ males}{Total\ \ number} * 100$$

The sex-ratios, determined by month and by size classes, were statistically tested for significant deviations from the expected 1:1 ratio with a χ^2 test (DAGNÉLIE, 1975).

The reproductive cycle was observed monthly for males and females. The gonadal maturity was defined according to their macroscopic aspect and development (PAJUELO *et al*., 2003a). Five stages were distinguished*;* I: Immature, II: Resting, III: Maturation, IV: Mature and Spawning, V: Spent (Table 1). The spawning period was determined from the gonadosomatic index (GSI) according to ANDERSON & GUTREUTER (1983) and by computing the proportions of fish at each maturity stage.

The length at first sexual maturity (L_{50}) is considered as the length at which 50% of the specimens are mature. It was estimated by computing the proportions (P) of the reproductive fish during the reproduction period from stage III to stage V at each size class (interval: 1 cm). The proportions computed for males, females and both sexes were fitted to a logistic function (SAILA *et al*., 1988).

Hepatosomatic index and condition factor

During the reproductive cycle, physiological condition and fish stoutness were determined monthly from the hepatosomatic index (HSI) and the condition factor (CF) (LE CREN, 1951).

Stomach content analysis

The stomachs were removed from 365 specimens, out of which 91 were collected during winter (December-February), 122 during spring (March-May), 69 during summer (June-August) and 83 during autumn (September-November). The stomachs cut from the alimentary tracts were stored in 70% alcohol. Later, stomach contents were transferred to a Petri dish and the food items were sorted into large groups and, if possible, identified specifically based on TRÉGOUBOFF & ROSE (1957); FISHER *et al*. (1987b). When the digestion status was not so advanced, prey were counted. In the opposite case, the number of prey was deduced from the hard pieces.

Vacuity index (in %): VI, Percentage frequency of occurrence of a prey item i (in %): F and numerical percentage of a prey item i (in %): N were calculated according to PASQUAUD *et al.*, 2004 and expressed as:

$$VI = \frac{Nv}{Ne} * 100, \quad F = \frac{Ndi}{Nnv} * 100, \quad N = \frac{Nti}{Ni} * 100$$

where *Nv* = number of empty stomachs, *Ne* = total number of examined stomachs, *Ndi* = number of stomachs containing a prey I, *Nnv* = total number of non-empty stomachs, *Nti* = total number of individuals of a prey I, *Ni* = total number of ingested prey.

Table 1. Gonadal maturity stages of Pomadasys incisus

I- Immature	Ovaries and testes are very thin filaments. Distinguishing between sexes is not easy
II- Resting	Gonads become long, thin and translucent: Ovaries are yellowish; Testes are whitish
III- Maturation	Gonads increase in size especially in width and attain ¾ of the visceral cavity: Ovaries are yellow; Testes are white
IV-Mature and spawning	Gonads occupy the whole visceral cavity. Ovaries are bulky and yellow; Testes are white and have a milky aspect
V- Spent	Gonads decrease in volume and become flaccid; both ovaries and testes more or less empty and turn reddish

Table 2. Points given to items, eaten by Pomadasys incisus*, according to their digestibility and size proposed by UAUD et al. (2004) and BOUCHEREAU et al. (2006)*

Preys	Points	Preys	Points
Polychaeta	40	Shellfish	1
Decapoda (shrimps)	25	Amphipoda	10
Decapoda (crabs)	10	Euphausiacae	10
Echinodermata	25		

The point method (PASQUAUD *et al.,* 2004; BOUCHEREAU *et al.*, 2006) was applied in the present study. Each prey was allotted a number of points proportional to its estimated contribution to the stomach volume (Table 2).

This method is not influenced by the frequent occurrence of a small organism in small numbers, nor heavy bodies, and does not involve trying to count large numbers of small and broken organisms

$$P = \frac{Npi}{Ntp} * 100;$$

where *Npi* = total number of points of a prey item, *Ntp* = total number of points.

The Main Food Index (MFI) was assessed for each food item using the formula and interpretation of ZANDER (1982):

$$MFIi = [(\sqrt{Pi * (Ni + Fi)/2}) / [\sum_i (MFIi)]] * 100$$

According to the computed index values, prey are listed as follows:

MFI > 75: preferential prey, 50 < *MFI* < 75: principal prey, 25 < *MFI* < 50: secondary prey, *MFI* < 25: accessory prey.

A chi-square test (χ^2) was used to evaluate the significance of seasonal variations of the vacuity index (CI) and the occurrence frequency for a given prey (OF).

Considering that the validity of the test requires a value greater than 5, if a prey is absent, in the winter season in particular, this season was pooled with autumn and their frequencies added. In this case, statistical differences in OF values for a given prey were tested for the cold season, spring and summer. χ^2_{obs} was compared to χ^2_{theo} at $\alpha = 0.05$.

RESULTS

Sex-ratio

The Bastard grunt sexes were defined from macroscopic gonadal observations of 463 specimens, 205 (44%) were males and 258 (55.7%); males were ranged in size from 11.9 to 23.6 cm and females from 13.5 to 24 cm. The yearly ratio of males to females (1:1.25) wasn't significantly different from 50% (1:1) ratio ($\chi^2_{obs} = 6.06 < \chi^2_{theo\ (0.01,\ 1)} = 6.64$). The sex-ratio for males and females grouped into 7 size classes (interval: 2 cm) showed no significant differences from 1:1 ratio ($\chi^2_{obs} < \chi^2_{theo\ (0.01,\ 1)} = 6.64$ (Tables 3, 4).

Reproductive cycle, hepatosomatic index and condition factor

Macroscopically, the different stages of gonadal development were easily distinguished for both sexes. The GSI variations for males and females present a unimodal curve as the Bastard grunt spawn only one time per year (Figs. 2A, 2B). From June, the GSI values (GSI = 0.159 for males and 0.455 for females) increased for both sexes and reached its maximum in August (GSI = 4.81) for males and September for females (GSI = 7.88). This period corresponds to the maturation of the gonads. The decreases of the GSI values indicated that the spawning period started in August-September for males and September-October for females. From November-December to May, the important decreases of the GSI values for both sexes indicated their spent and resting periods. These results were confirmed by the similar trend of the maturity stages expressed in frequency throughout the year (Figs. 3A, B).

Table 3. Monthly variations of sex-ratio of Pomadasys incisus *in the Gulf of Tunis (ns: not significant)*

Month	Number of Males	Number of Females	Total number	Sex-ratio (SR)	χ^2_{obs}	Significance at 1%
Jan	27	32	59	45.76	0.42	ns
Feb	14	22	36	38.88	1.77	ns
March	29	29	58	50	0	ns
Apr	15	22	37	40.54	1.32	ns
May	16	16	32	50	0	ns
Jun	10	9	19	52.63	0.052	ns
Jul	15	33	48	31.25	6.075	ns
Aug	17	16	33	51.51	0.03	ns
Sept	14	12	26	53.84	0.15	ns
Oct	17	30	47	36.17	3.59	ns
Nov	15	21	36	41.66	1	ns
Dec	16	16	32	50	0	ns
	205	258	463	44.27	6.06	ns

Table 4. The sex-ratio of Pomadasys incisus *according to the size classes in the Gulf of Tunis (*: test χ^2 not applicable; ns: not significant)*

Size class (cm)	Number of males	Number of females	Total number	Sex-ratio (SR)	χ^2_{obs}	Significance at 1%
11.5-13.5	2	0	2	100	-	*
13.5-15.5	58	37	95	61,05	4,64	ns
15.5-17.5	100	115	215	46,51	1,04	ns
17.5-19.5	42	60	102	41,17	3,17	ns
19.5-21.5	10	17	27	37,03	1,81	ns
21.5-23.5	3	8	11	27,27	2,27	ns
23.5-25.5	2	9	11	18,18	4,45	ns

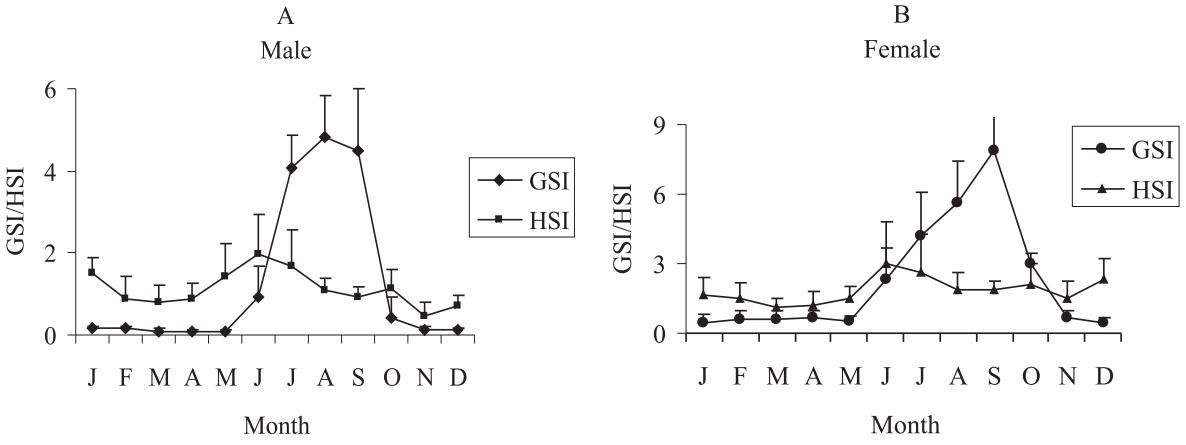

Fig. 2. Monthly variations of the gonadosomatic and the hepatosomatic indices for Pomadasys incisus *collected in the Gulf of Tunis*

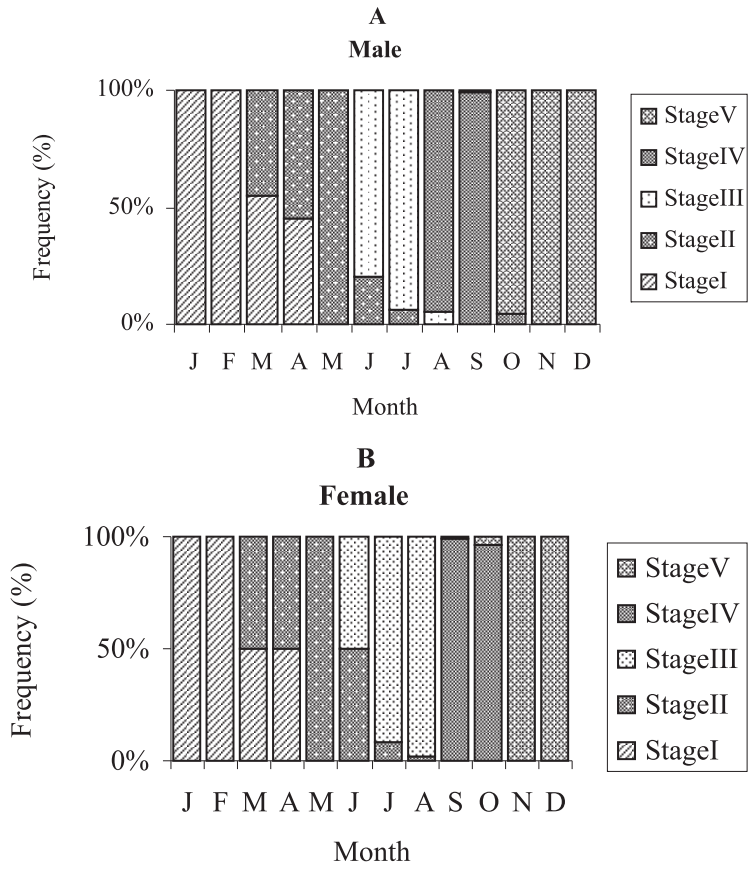

Fig. 3. Monthly variations of the gonadal maturity stages for Pomadasys incisus *collected in the Gulf of Tunis*

The HSI had an opposite trend to the GSI for both sexes (Figs. 2A, B). The length-weight relationship determined for 207 males ($Ws = 0.0188*Lt^{2.7907}$; $R^2 = 0.84$) and 250 females ($Ws = 0.0135*Lt^{2.9176}$; $R^2 = 0.83$) allowed the computation of their respective CF values. The CF values ranged between 1.677 and 2.21 for males, between 1.18 and 1.6 for females (Table 5) and show a sensitive variation during the reproduction period for both sexes.

Length at first sexual maturity

During the reproduction period 104 males and 127 females were considered to determine the length at first sexual maturity. Total lengths ranged between 13 and 21 cm for males and between 13.5 and 24 cm for females.

The estimated values, L_{50} = 15.06 cm for males and L_{50} = 15.63 cm for females, did not show a significant difference between sexes ($t_{obs} = 0.139 < t_{theo\ (0.05)} = 1.96$). For sexes pooled, L_{50} was estimated at 15.33 cm.

Table 5. Seasonal variations of the condition factor (CF) of male and female Pomadasys incisus

	Period	Resting J-F-M-A-M	Maturation J-J-A	Spawning S-O	Spent N-D
CF	M	1,773 ± 0,096	2,172 ± 0,065	2,04 ± 0,17	1,94 ± 0,292
	F	1,24 ± 0,061	1,496 ± 0,063	1,47 ± 0,116	1,413 ± 0,195

Feeding habits

The stomach content analysis was carried out on 265 *P. incisus* specimens whose sexes were pooled and whose total length ranged between 11.9 and 24 cm.

The analysis of the stomach contents showed that the vacuity index (VI) was affected by seasonal fluctuations. The VI was higher than 50% during spring and autumn, reaching 74.6% and 60.2% respectively, and decreased to 40.6% and 42% during winter and summer respectively. These percentages were significantly different within the year ($\chi^2_{obs} = 31.94 > \chi^2_{theo\ (0.05)} = 7.815$, df = 3).

The prey items identified in all stomach contents belonged to 19 different taxa (Tables. 6A, B). In summer the diet seemed to be diversified with 13 taxa being identified (Table 6A). The planktonic Amphipoda, represented only by *Hyeroche* sp., was the most abundant, more numerically (N = 94.54%) than in point (P = 87.76%) and its occurrence frequency reached (F = 67.5%). According to the Main Food Index, *Hyeroche sp.* constituted the preferential prey item (MFI = 76.88).

Table 6. Prey identified in Pomadasys incisus *stomach contents according to season (A: summer and autumn, B: winter and spring) during 2003. F: frequency of occurrence, N: Numerical percentage, P: Point percentage, MFI: Main Food Index*

A	SUMMER				AUTUMN			
Taxa	%F	%N	%P	MFI	%F	%N	%P	MFI
DECAPODA ADULTS AND JUVENILES : SHRIMPS								
Crangon crangon	30	1.63	3.8	7.07	33.33	2.82	6.31	10.32
Alpheus glaber	7.5	0.27	0.63	1.43	-	-	-	-
Melicertus kerathurus	-	-	-	-	-	-	-	-
Processa edulis	-	-	-	-	-	-	-	-
DECAPODA JUVENILES : LOBSTERS								
Scyllarus sp.	2.5	0.09	0.21	0.47	15.15	0.16	0.37	1.63
Homarus gammarus	2.5	0.09	0.21	0.47	-	-	-	-
Nephrops norvegicus	2.5	0.09	0.21	0.47	-	-	-	-
Palinurus elephas	-	-	-	-	6.06	0.49	1.11	1.84
DECAPODA ADULTS AND JUVENILES: CRABS								
Calappa granulata	5.18	0.18	0.16	0.60	-	-	-	-
Geryon longipes	22.5	0.72	0.67	2.55	9.09	0.49	0.44	1.41
Maja squinado	2.5	0.09	0.08	0.30	-	-	-	-
Liocarcinus arcuatus	2.5	0.09	0.08	0.30	-	-	-	-
Eriphia verrucosa	-	-	-	-	-	-	-	-
AMPHIPODA								
Hyperoche sp.	67.5	94.54	87.76	76.88	45.45	93.67	83.66	73.73
EUPHAUSIACEA								
Stylocherion sp.	-	-	-	-	-	-	-	-
POLYCHAETA								
Nereis sp.	20	1.36	5.06	6.70	27.27	2.16	7.72	10.30
BIVALVIA								
Unidentified	7.5	0.36	0.03	0.33	-	-	-	-
ECHINODERMATA								
Unidentified	-	-	-	-	-	-	-	-
Amphiura chiaje	12.5	0.45	1.05	2.38	3.03	0.16	0.37	0.74

Table 6. Cont'd

B	WINTER				SPRING			
Taxa	%F	%N	%P	MFI	%F	%N	%P	MFI
DECAPODA ADULTS AND JUVENILES: SHRIMPS								
Crangon crangon	44.44	42	42.39	43.52	29.9	8.52	17.39	17.94
Alpheus glaber	-	-	-	-	-	-	-	-
Melicertus kerathurus	5.55	4.34	4.38	4.73	-	-	-	-
Processa edulis	1.85	1.45	1.46	1.57	-	-	-	-
DECAPODA JUVENILES: LOBSTERS								
Scyllarus sp.	11.11	15.94	16.08	14.99	-	-	-	-
Homarus gammarus	-	-	-	-	-	-	-	-
Nephrops norvegicus	-	-	-	-	-	-	-	-
Palinurus elephas	27.77	33.33	33.62	32.58	3.22	0.77	1.58	1.76
DECAPODA ADULTS AND JUVENILES: CRABS								
Calappa granulata	-	-	-	-	-	-	-	-
Geryon longipes	-	-	-	-	12.90	4.65	3.79	5.73
Maja squinado	-	-	-	-	3.22	0.77	0.63	1.11
Liocarcinus arcuatus	1.85	1.44	0.58	0.99	-	-	-	-
Eriphia verrucosa	-	-	-	-	3.22	0.77	0.63	1.11
AMPHIPODA								
Hyperoche sp.	-	-	-	-	35.48	65.11	53.13	51.33
EUPHAUSIACEA								
Stylocherion sp.	-	-	-	-	6.45	15.50	12.65	11.70
POLYCHAETA								
Nereis sp.	-	-	-	-	12.9	3.1	10.12	8.93
BIVALVIA								
Non-identified	-	-	-	-	3.22	0.77	0.063	0.35
ECHINODERMATA								
Non-identified	1.85	1.44	1.46	1.57	-	-	-	-
Amphiura chiaje	-	-	-	-	-	-	-	-

The Bastard grunt diet was less diversified in the autumn period than in summer (Table 6A) where only 7 taxa were identified. *Hyperoche* sp. always showed the highest alimentary indices and became a principal prey.

During winter, 7 taxa were identified. According to their relative alimentary indices (Table 6B), *Crangon crangon* and *Palinurus elephas* were the most abundant prey in the Bastard grunt diet.

In spring, *Hyperoche sp*., having the highest alimentary indices, became the principal ingested prey item, MFI = 51.62 (Table 6B).

Significant differences among seasons were found for *Crangon crangon* ($\chi^2_{obs} = 31.228 > \chi^2_{theo\ (0.05)} = 7.815$, df = 3), *Hyperoche sp.* ($\chi^2_{obs} = 29.471 > \chi^2_{theo\ (0.05)} = 5.991$, df = 2) and *Geryon longipes* ($\chi^2_{obs} = 11.302 > \chi^2_{theo\ (0.05)} = 5.991$, df = 2).

DISCUSSION

Pomadasys incisus from the Gulf of Tunis is a gonochoric species and gonadal distinction between sexes is easily detemined macroscopically during the entire reproductive cycle.

The sex-ratio is balanced between males and females in all size classes. PAJUELO *et al*. (2003b) noted similar observations for this species in the Atlantic. On the other hand, our results do not accord with those observed in the same area where CHAKROUN & KTARI (2006) reported an unbalanced sex-ratio in favour of females. The authors had suggested that the natural mortality may be higher for males while the females may present a high vulnerability to the fishing gears. This unbalanced sex-ratio may be due to the cumulated specimen numbers of the Bastard grunt during three years, important monthly variations from year to year and the use of two probability levels to explain differences between males and females. As observed in the gulf of Tunis (CHAKROUN & KTARI, 2006), *Pomadasys incisus* has a well-defined reproductive period which extends over two seasons (summer and autumn). This finding contrasts with the observations recorded by PAJUELO *et al*. (2003b) in the Canaries archipelago where this species spawns throughout the year although mainly during two periods (summer and last autumn-winter).

In comparison with *P.kaakan* and *P.olivaceus* living in South African and Kuwaiti waters (JOUBERT, 1981; LEE *et al*., 1990; AL HUSSAINI *et al.*, 2001), *P. incisus* in the Gulf of Tunis seems to be impacted by less favourable environmental conditions that consequently reduces its spawning period. The temperature is considered to be the most important factor influencing the fish reproduction (WOOTTON, 1990). Indeed, the Bastard grunt spawning periods occur when the surface temperature rises to its highest yearly values - 24 °C in the Canaries archipelago (PAJUELO *et al*., 2003b) and 25.5 °C in the Gulf of Tunis, while in the same period an isotherm (17 °C) between 30 and 50 m forms (SAMMARI & BRAHIM, 2003).

The HSI values reach their maximum one month before spawning for both sexes and indicate that the reproduction involves the physiological activity of the liver. This organ stocks the energetic reserves during gonadal maturation and the spawning seasons. According to the CF monthly variations, the Bastard grunt also uses its muscle reserves for reproduction.

In the Gulf of Tunis, the lengths at first sexual maturity, L_{50} = 15.33 cm (present study) and 16.13 cm (CHAKROUN & KTARI, 2006) determined for *P. incisus,* for pooled sexes, are lower than those of the Atlantic species, L_{50} = 18.30 cm (PAJUELO *et al*., 2003b). It is also lower than those found for different species of the genus *Pomadasys* as *P. olivaceus* in South Africa (WALLACE & SCHLEYER, 1979; JOUBERT, 1981), *P. kaakan* in Kuwait waters (MATHEWS *et al*., 1989) and *P. prerotaei* in West Africa (DIOUF, 1996). It has also been reported by all these authors that in Atlantic waters, the sexual maturity is reached for these species at two years of age.

Pomadasys incisus vacuity index values which ranged between 40.66% and 74.60% over the year seems to be more affected by seasonal variations than reproduction as is usually observed in the feeding of demersal fish such as the Flounder (VIANET, 1985) and Gobies (PASQUAUD *et al.,* 2004). On the contrary, the fishing gears and fish behaviour may be the cause of the high VI values as is suggested for the Flounder (VERHEINJEN & DE GROOT, 1979). *P. incisus* specimens are caught mainly from coastal fisheries using static fishing gears. The nets are set in the sea by night when the fish are at their maximum activity, in particular moving for feeding. The individuals caught by night are extracted from the retrieved nets in the morning. Some of them had stayed several hours in the fishing gear. The capture may occur before prey ingestion or after digestion. Consequently, in the two cases, an important number of specimens may have an empty stomach at the harvest moment.

The prey groups and species found in *P. incisus* stomachs belong to different trophic levels. Prey organisms are characterised by a wide range of prey size and morphology. Throughout the year, the high proportion of crustacean prey found in the diet are close to those of other demersal species such as *Mullus barbatus* and *M. surmuletus* living in the same area (GHARBI & KTARI, 1979). In contrast with other species of Sparidae, the absence of fish prey in the *P. incisus* diet may suggest that this species didn't target potentially active prey. In fact, SANTOS *et al.* (2005), describing the

resident status and spatial occupation of fish assemblages in two artificial reefs deployed in Portuguese waters, recorded that *P. incisus* is among the species that find refuge in the reef and occupy the area inside the structure "inner sub-zone". In part, this behaviour may explain the high vacuity values over the year and their low catches by static fishing gears which are kept in the water at a minimum of 5 m from the bottom. The important presence of *Hyperoche* sp. in the *P. incisus* diet during summer suggests that the abundance of the plankton in the environment in that season may be linked to a local hydrodynamic movement. Probably, the presence of a gyratory movement created by a cyclonic underwater current in the centre of the Gulf of Tunis (BEN CHARRADA, 1997) contributes to concentrated plankton in this area. On the contrary, DALY YAHIA *et al.* (2001) reported that Amphipoda were poorly represented in the Gulf of Tunis; *Hyperoche sp.* may exist in lower water layers than those investigated.

During the winter season, the exclusive presence of benthic crustacean prey reveals that *P. incisus* avoids a low surface temperature, reduces its movement, remains near the bottom and behaves as a selective feeder. As had been suggested for *Oblada melanura* (PALLAORO, 1995), the relatively big eye size (32% of head length) may favour the catching of various preys as well as demersal and planktonic organisms present near the bottom and may also confirm the closed character of *P. incisus* to the sea bottom.

CONCLUSIONS

In conclusion, *Pomadasys incisus* in the Gulf of Tunis is a gonochoric species. Its spawning period occurs between August and October and sexual maturity is reached at a size inferior to that observed in the east Atlantic (PAJUELO *et al.,* 2003b). The diet composition, rich in crustacean groups and poor in fish, reveals that the Bastard grunt is a demersal species. Due to the observed cases of infested specimens, more data on parasitism may improve understanding of its life history and its involvement in certain parasitism cycles and consequently in the ecosystem of the Gulf of Tunis.

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Odnos spolova, reprodukcija i hranidbene navike morskog hroktača *Pomadasys incisus* (Haemulidae) u tuniskom zaljevu (Tunis)

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SAŽETAK

Istraživane su reprodukcija i prehrambene navike morskog hroktača, *Pomadasys incisus* (Bowdich, 1825), u tuniskom zaljevu od siječnja do prosinca 2003. Istraživanje gonada na 463 uzorka je pokazalo da je morski hroktač gonohorična vrsta i da odnos među spolovima nije značajno odstupao od razmjera 1:1. Mjesečna kolebanja gonadosomatskog indeksa i postotka različitih stadija razvoja gonada otkrivaju da se *P. incisus* mrijesti od kolovoza do listopada.

Ova vrsta koristi energetske pričuve iz jetre i mišića kako bi osigurala sazrijevanje gonada.

Izračunata dužina pri stadiju 50% zrelosti populacije (L_{50}) iznosila je 15.33 cm za oba spola ukupno. Analizirani sadržaj želuca je pokazao vrlo visoki indeks ispražnjavanja tijekom godine (56.8%) sa značajnom razlikom između sezona (godišnjih doba). Ustanovljeno je također da se prehrana *P. incisus* sastoji od rakova, bentičkih i planktonskih organizama iz 19 taksonomskih skupina. Postotak učestalosti pojavljivanja pronađen za *Crangon crangon*, *Hyperoche* sp. i *Geryon longipes* (najzastupljenije u prehrani) ukazuje na značajne razlike među sezonama (χ^2_{obs}= 31.228, 29.471 odnosno 11.302, a bile su veće od $\chi^2_{0.05}$).

Ključne riječi: *Pomadasys incisus*, reproduktivni ciklus, prehrambene navike, srednji Mediteran