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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, $\chi 2$ 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 $TW=0.0363*TL^{2.858}$, Log TL = 0.802*Log CL+ 0.631 indicating a negative allometry growth. The parameters of Von Bertalanffy were: $L\infty$ =32.03 cm, K=0.18 yr-1and t0= -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 el 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 Bouidjra 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.

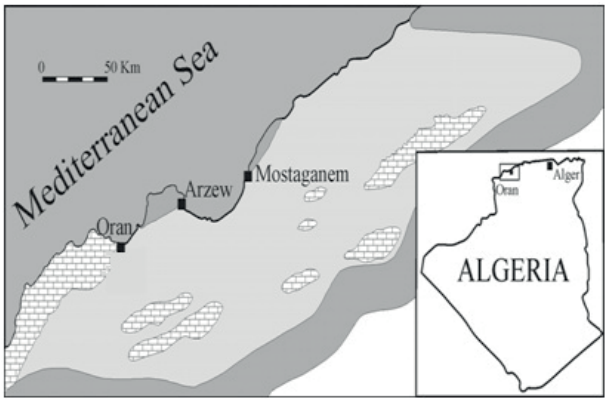

Figure 1. Sampling zone

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)].

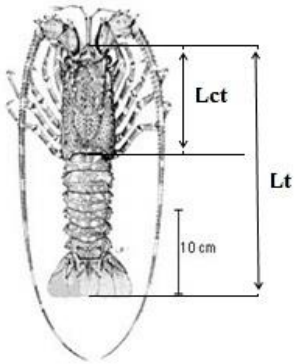

Figure 2. Measurements made on *P. mauritanicus* specimens

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: Log TL=b Log CL+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 $\chi 2$ test ($p<0.05$) didn't show any significant difference between the two sexes.

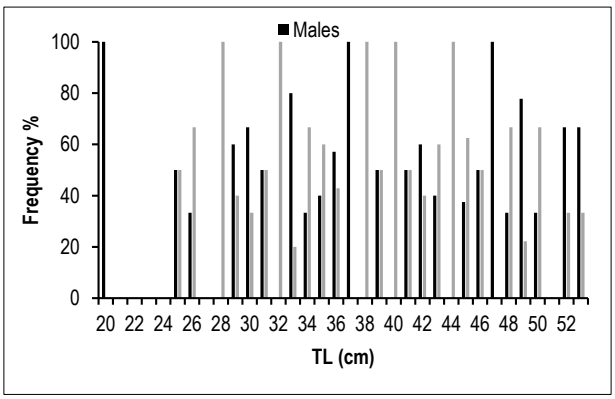

Figure 3. Length frequency distribution of males and females of *P. mauritanicus* specimens caught in Béni-Saf Bay

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

		TL (mm)		TW (g)		CL (mm)	
Sex	**n**	**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 (Agean Sea)

Sex	Allometric relation	Allometric equation	Determination coefficient (r2)	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	Log TL = 0.802*Log CL+ 0.631	0.908	0.78-0.82	A-
Male	TL/CL	Log TL = 0.750*Log CL+ 0.682	0.931	0.55-0.94	A-
Both	TL/CL	Log TL = 0.763*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_∞=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>t0.05=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	r2	Author
Mauritania	**M**	-	LogTW=2.720·LogTL-2.677	-	Boitard, 1981
	F	-	LogTW=2.750·LogTL-2.744		
Senegal	**M**	-	LogTW=2.35·LogCL+0.403	-	Caverivière et *al*., 1986
	F	-	LogTW=2.39·LogCL+0.394		
Ireland	**M**	-	LogTW=2.880·LogTL-6.760	-	Minchin, 1989
	F	-	LogTW=2.750·LogTL-6.120	-	
Mauritania	**C**	-	LogTL=0.338·LogCL+0.1620	0.8800	Diop, 1990
Algeria (Béni-Saf Bay)	**C**	121	LogTW =2.857·LogTL-1.439 LogTL=0.741·LogCL+0.6970	0.8530 0.8856	Present study
	M	60	LogTW =2.780·LogTL-1.289 LogTL=1.221·LogCL-0.7240	0.8690 0.9367	
	F	61	LogTW =2.908·LogTL-1.548 LogTL=0.755·LogCL+0.6860	0.8580 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
Palinurus elephas (France, Corsica)		**M**	417	166.025	0.15100	0.348	1.619	Marin, 1987
		F	278	135.916	0.18900	0.342	1.522	
Palinurus gilchristi South Africa (Aglhas Bank to Port Elizabeth)		**M**	-	111.00	0.09200	-	1.054	Groeneveld, 1997
		F	-	96.00	0.12900		1.075	
Palinurus gilchristi South Africa (Port Alfred)		**M**	-	96.00	0.05000		0.664	
		F	-	78.00	0.06500			
Palinurus mauritanicus	Mauritania	**F**	-	202.8	0.16900	0.227	1.842	Maigret, 1978
	Algeria (Béni-Saf Bay)	**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≈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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