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Research Article

Seasonal variation of ectoparasites infestation levels in the comber, *Serranus cabrilla* (Serranidae) from Northern and Eastern Tunisian coasts (South Mediterranean)

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Abstract: The aim of this study is to investigate ectoparasites communities of *S. cabrilla* in Northern and Eastern Tunisian waters (Bay of Bizerte and Gulf of Hammamet), and to compare infestation parameters depending on seasons and localities variations.
Four different metazoan ectoparasite species were identified: two copepods (*Lernaeolophus sultanus* and *Anchistrotos laqueus*), one isopod (*Gnathia* sp.), and one annelid hirudinean species (*Pontobdella muricata*). In the present study, the comber is reported for the first time as a suitable host for the latter parasite. *P. muricata*, *Gnathia* sp., and *A. laqueus* were prevalent mainly during summer. *Gnathia* sp. is the most prevalent parasite species reaching 86.7% in the Gulf of Hammamet during summer season.
Fish from the Gulf of Hammamet showed higher infection levels of almost all the ectoparasites. The variation in infestation parameters of parasites is influenced by biotic and abiotic drivers of the hosts habitat as well as seasonal changes.

Keywords: *Serranus cabrilla*; Ectoparasites; infestation parameters; Seasonality; New records.

1. Introduction

Serranids are an important component of the coastal marine ecosystems due to their position in the food web and their predation on a wide variety of benthic invertebrates and fish (Heemstra and Randall 1993; Tuset et al., 1996). Despite their commercial and environmental importance and abundance, few biological and ecological studies have focused on the genus *Serranus* (Tuya et al., 2006). In the Mediterranean, four species of the genus are reported, namely *S. atricauda* Günther, 1874, *S. cabrilla* (Linnaeus, 1758), *S. hepatus* (Linnaeus, 1758) and *S. scriba* (Linnaeus, 1758) (Froese and Pauly, 2023). The comber, *S. cabrilla* (Linnaeus, 1758) is widely spread, with a geographical distribution extending to the Mediterranean, the Black Sea, the Red Sea, the Aegean Sea and the Atlantic Ocean (Bauchot, 1987; Ilhan et al., 2010). The fish species is a reef associated, and lives on the shelf and upper slope, outside of caves, on rocks, *Posidonia oceanica* meadows, sandy and muddy bottoms (Bussotti and Guidetti, 2009; Giakoumi and Kokkoris, 2013 Guidetti and Cattaneo-Vietti, 2002; Tortonese, 1986).

Several parasite surveys have been conducted in the Mediterranean on *S. cabrilla*, revealing infections with Metazoan parasites (Alas et al., 2009; Bartoli and Bray, 1990; Bartoli et al., 2005; Bouderbala et al., 2019; Essafi et al., 1984; Euzet and Oliver, 1965; Figus et al., 2005; Moravec et al., 2006; Petter and Radujkovic, 1989). In addition to pathogenic effects of parasites on their hosts (Sindermann, 1987), ectoparasites may affect reef fish populations size by influencing hosts behavior (Adlard and Lester 1994, Finley, 2003) and making them more vulnerable to predation (Hudson and Dobson 1995). The aim of this study is to investigate ectoparasites communities of *S. cabrilla* in Northern and Eastern Tunisian waters, and to compare the seasonal distribution of the infestation parameters between the two localities.

2. Materials and Methods

From March 2017 until February 2018, 242 fresh specimens of *S. cabrilla* were collected, on a seasonal basis, from local fishers from two localities in Tunisian coasts: the Bay of Bizerte and the Gulf of Hammamet (Figure1, Table 1).

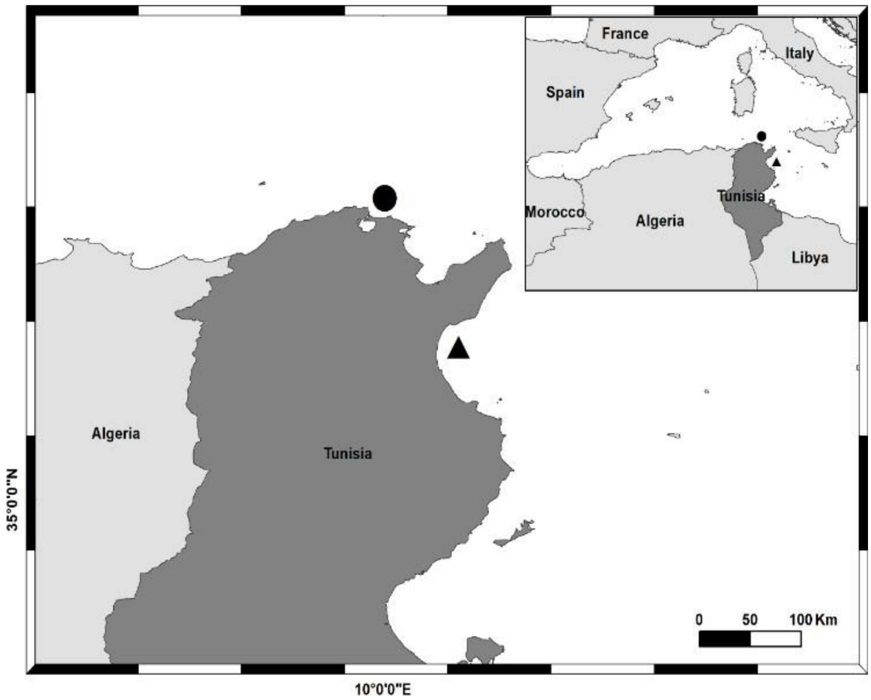

Figure 1. Map showing the sampling localities: Bay of Bizerte (black circle) and Gulf of Hammamet (black triangle)

The collected fish were transported to the laboratory, measured, and weighed. The host species were analyzed for ectoparasites. The skin, mouth and gill chambers were thoroughly observed. Gills were removed and placed in Petri dishes containing seawater. Each gill arch was separately observed under a stereomicroscope. All parasites were collected and preserved in 70% ethanol. The date and the locality of sampling, length, weight of host fish and the microhabitat of the ectoparasite were noted. Subsequently, specimens were processed according to taxonomic group for examination by stereo and light microscopy. Parasites were morphologically identified following taxonomic guides and original descriptions in the literature. In this study, prevalence

(P%) and mean intensity of infection (MI) were determined according to Bush et al. (1997). Comparisons of prevalence and mean intensity of parasite infestation between seasons and localities were assessed, using a Chi-square test for prevalence, and: Kruskall - Wallis test (Four samples) and Wilcoxon Mann-Whitney test (two samples) for mean intensities. All statistical tests were performed at the significance level of 5%. The relative abundance (R) of a given parasite is the percentage it represents among all the collected parasites.

Table 1. Total number and mean body size of *S. cabrilla* collected from Tunisian waters (Bay of Bizerte and Gulf of Hammamet)

Bay of Bizerte	Gulf of Hammamet	Total number	Body length (cm)	Body weight (g)
121	121	242	16.95 ± 1.32	53.47 ± 12.4

3. Results

Among the 242 specimens examined, 160 fish (69 from the Bay of Bizerte and 91 from the Gulf of Hammamet) were infected with at least one ectoparasite species with overall prevalence reaching 66.1%. Four ectoparasitic species were identified (Figure 2): one leech annelid *Pontobdella muricata* (Linnaeus, 1758), the isopod *Gnathia* sp. Leach, 1814 and two copepods: *Lernaeolophus sultanus* (Milne Edwards, 1840) and *Anchistrotos laqueus* Leigh-Sharpe, 1935. In the present study, we record for the first time the occurrence of copepods, *L. sultanus* and *A. laqueus* on *S. cabrilla* in Tunisian waters.

3.1. Infestation parameters of ectoparasites in S. cabrilla

Overall and seasonal prevalence, mean intensity and site of infection of ectoparasites of the comber are presented in Table 2.

The prevalence and mean intensity of infestation of ectoparasites in the comber were significantly higher in the Gulf of Hammamet (P=75.2% and MI=11.5) compared to those from the Bay of Bizerte (P=57% and MI=2.3). *Pontobdella muricata* was detected on several comber from both sampling localities, with a higher prevalence in the Bay of Bizerte (P=31.4%) showing a maximum in autumn (P=43.3%).

Prevalence and mean intensity of infection with *P. muricata* were variable during the year, but no significant differences were detected between seasons or sampling areas.

Among the crustacean ectoparasites, the isopod larvae *Gnathia* sp. presented a significantly higher infestation parameters (*P*>0.05) in the Gulf of Hammamet (P=62%, MI=11.9) than in the Bay of Bizerte, with a single fish potentially hosting more than 100 specimens of *Gnathia* sp. The prevalence of gnathiids in comber was highest in the Gulf of Hammamet during the summer (P=86.7%), a value significantly different from those of other seasons (*P*>0.05) in the same locality. Between both study areas and during summer, a significant variability in prevalence and mean intensity was found (*P*>0.05).

The copepod *A. laqueus* was also recorded in both sampling areas with a maximum prevalence (P=15.7%) and low intensity of infection (MI=1.4) in the Gulf of Hammamet. The infestation parameters were variable, but no significant differences were detected between seasons and localities. A single female of the copepod *L. sultanus* was found in the buccal cavity of a fish from the Gulf of Hammamet waters during the winter causing a large lesion in the attachment site.

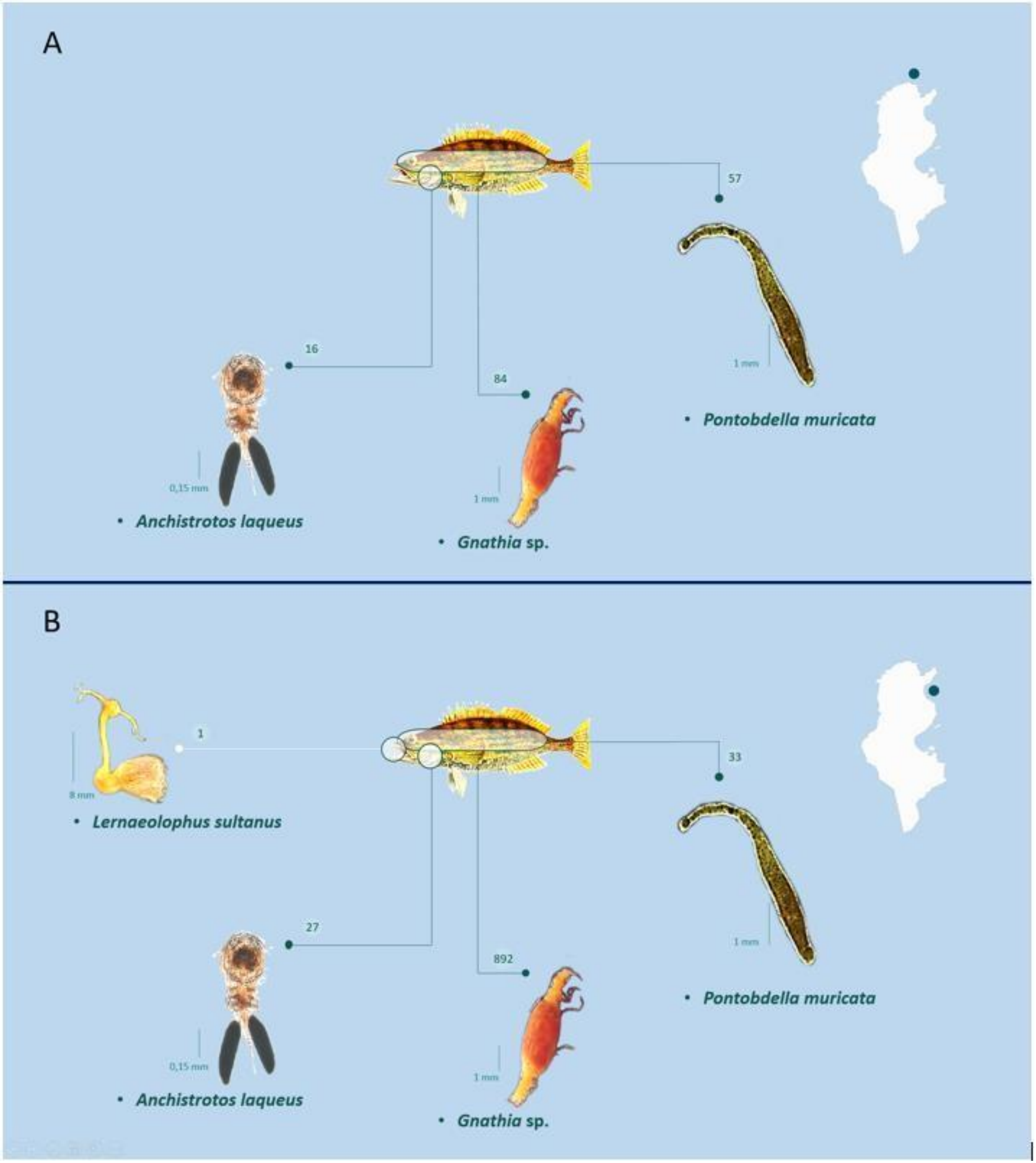

Figure 2. Parasite communities and site of infestation on *Serranus cabrilla* from Tunisian coasts (A: Bay of Bizerte; B: Gulf of Hammamet)

Table 2. Prevalence P(%) and mean intensity (MI ± SD) of ectoparasites in *Serranus cabrilla* from locations in Tunisia (Bay of Bizerte and Gulf of Hammamet)

		Bay of Bizerte					Gulf of Hammamet					Overall Tunisia **(IF/EF)**
Parasite species		Spring	Summer	Autumn	Winter	Overall **(IF/EF)**	Spring	Summer	Autumn	Winter	Overall **(IF/EF)**	
Hirudinea												
Pontobdella muricata	**P(%)**	23.3	40.0	43.3	19.4	31.4 (38/121)	13.3	33.3	23.3	25.8	24.0 (29/121)	27.7 (67/242)
	MI ± SD	1 ± 0	2.2 ± 2.3	1.4 ± 0.7	1 ± 0	1.5 ± 1.4	1 ± 0	1.2 ± 0.4	1.1 ± 0.7	1.1 ± 0.4	1.1 ± 0.4	1.3 ± 1.1
Isopoda												
Gnathia sp.	**P(%)**	30	36.7 A	33.3	32.3	31.1 (40/121)	56.7 b	86.7 a A'	56.7 b	48.4 bc	62* (75/121)	47.5 (115/242)
	MI ± SD	2.3 ± 2.3 A	2.5 ± 1.8 B	1.9 ± 1.1 C	1.6 ± 0.7	2.1 ± 1.6	35.6 ± 30.3 a A'	7.2 ± 7.3 b B'	3.9 ± 2.6 bc C'	2.3 ± 1.2 c	11.9 ± 19.7*	8.5 ± 16.6
Copepoda												
Anchistrotos laqueus	**P(%)**	16.7	20	6.7	3.2	11.6 (14/121)	13.3	26.7	13.3	9.7	15.7 (19/121)	13.6 (33/242)
	MI ± SD	1.2 ± 0.5	1.2 ± 0.4	1 ± 0	1 ± 0	1.1 ± 0.4	2.3 ± 1.9	1.4 ± 0.5	1 ± 0	1 ± 0	1.4 ± 1.0	1.3 ± 0.8
Lernaeolophus sultanus	**P(%)**	0.0	0.0	0.0	0.0	0.0 (0/121)	0.0	0.0	0.0	3.2	0.88 (1/121)	0.4 (1/242)
	MI ± SD	-	-	-	-	0.0	-	-	-	1.0 ± 0	1.0 ± 0	1.0 ± 0
TOTAL ECTOPARASITES	**P(%)**					57.0 (69/121)					75.2* (91/121)	66.1 (160/242)
	MI ± SD					2.3 ± 1.8					11.5 ± 18.2*	6.9 ± 14.4

(IF: infested fish; EF: examined fish; *Level of significance with *P*<0.05 between localities ; similar letters indicate no significant differences at *P*>0.05 between seasons)

3.2. Ectoparasite community structure

Ectoparasite species richness in both localities varied between 3 and 4 (Figure 2). The highest values of diversity were shown in the Gulf of Hammamet with a maximum in the winter season.

The isopod *Gnathia* sp. was the most frequently recorded parasite in both sampling sites with relative abundance (R) being 53.5% and 93.6% in the Bay of Bizerte and the Gulf of Hammamet respectively, followed by *P. muricata* (R=36.3% and 3.5 % in Bay of Bizerte and Gulf of Hammamet respectively). *A. laqueus* was recorded in the Bay of Bizerte with R=10.2% and in the Gulf of Hammamet with relative abundance as low as 2.8%, and the copepod *L. sultanus* was only recorded from the Gulf of Hammamet with low relative abundance (0.1%) (Figure 3).

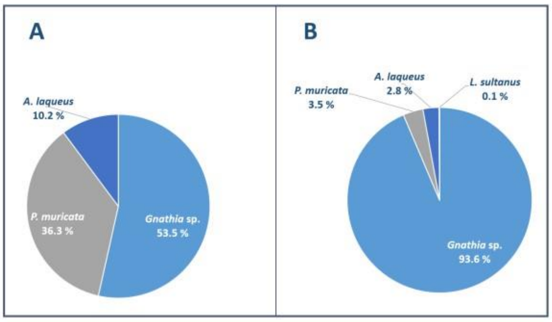

Figure 3. Percentage of ectoparasites in *Serranus cabrilla* according to the locality (A: Bay of Bizerte; B: Gulf of Hammamet)

4. Discussion

The hirudinean *Trachelobdella* sp. Diesing, 1850 has been previously reported in Tunisia from the Gulf of Tunis on the comber *S. cabrilla* by Bouderbala et al. (2019) with very low parameters of infestation (P=4.34%, MI=1.66).

On a previous study, the parasitic hirudinean *Pontobdella* sp. has been reported on *S. atricauda* Günther, 1874 by Cuyás et al. (2004) in the Central East Atlantic in the Canary Islands. *Pontobdella muricata* occured in the Mediterranean on some elasmobranchs (Başusta et al., 2016; Ben Ahmed et al., 2015; Bottari et al., 2017; Bulguroğlu et al., 2015; Çınar et al., 2014; Ergüven and Candan, 1992; Sağlam et al., 2003; Yanar et al., 2019; Youssef et al., 2024). It has also been recorded from the Black Sea and from the Atlantic Ocean (Çınar et al., 2014).

Based on results of the current study, *P. muricata* is more prevalent in the Bay of Bizerte during the autumn. This is probably due to the rocky topography of the Bay of Bizerte (Jaafar et al., 2004), which favors egg cocoon attachment on hard substrates until hatching (Kearn, 2004). Furthermore, this difference may be attributed to their life cycle, which alternates between a free-living juvenile stage and a parasitic adult stage. According to Kearn (2004), mating occurs in spring, suggesting that the summer-autumn period may correspond to the adult phase of the parasite. The leech *P. muricata* has been shown causing damages like hemorrhages and swelling on the attachment sites (Sağlam et al. 2003). In the present study, the comber is reported for the first time as a suitable host for this parasite.

Praniza larvae of the isopod *Gnathia* sp. have been recorded in previous studies on the comber with prevalence and mean intensity values lower than those observed in this study. It has been reported on the same host from the Tunisian coasts in the Bay of Bizerte with (P=18.84% and MI=2.23) by Bouderbala et al. (2019) and from the Turkish coasts (Both Marmara Sea and the Aegean Sea) (P=14.7% and MI=2.6) by Alas et al. (2009). Gnathiids are recognized for their role as temporary fish ectoparasites during their larval stages and as vectors for fish blood parasites (Smit and Davies, 2004). These larvae may lead to fish mortality through a dual parasitic effect: mechanical damage to the gills, skin and buccal cavity, combined with the potential for hematophagy (Marino et al., 2004). Small fish are also vulnerable to respiratory failure due to gill damage and anemia due to hematophagy, as well as loss of homeostatic control due to the severe gill and skin damage; the above might be lethal (Marino et al., 2004). In addition, the higher prevalence and intensity of gnathiid larvae in both localities during spring/ summer/ autumn seasons are in accordance with previous findings of increased abundance of these ectoparasites on marine teleosts (Tanaka, 2003). Indeed, the majority of gnathiid larvae are breeding in summer and releasing their young in autumn. Therefore, warmer conditions are optimal for the development of these parasites (Hadfield et al., 2009).

In the present study *A. laqueus* was identified in both locations with no significant differences in parameters of infestation observed between localities and seasons. This copepod has previously been reported on *S. scriba* from Bay of Bizerte (Bouderbala et al., 2019) with prevalence and mean intensity of infection values (P=1.33% and MI=0.013, respectively) lower than the current values (P=13.6% and MI=1.3, respectively) which is may be related to host preference and sampling period.

A single specimen of the copepod *L. sultanus* was detected in the mouth cavity of *S. cabrilla* from Gulf of Hammamet producing a large perforation caused by the penetration in the attachment site. This parasite has been reported previously on *S. scriba* and *S. cabrilla* from the Mediterranean Sea (Raibaut et al., 1998). In Tunisian waters *L. sultanus* was also found on *Pagellus erythrinus* (L, 1758) in the Gulf of Tunis (Raibaut and Ktari, 1971) and on *Trachinus draco* (L, 1758) in the Bay of Bizerte (Azizi and Bahri, 2016).

In the present study, we found four ectoparasite species in *S. cabrilla* from the Gulf of Hammamet whereas three of them are being reported from specimens caught in the Bay of Bizerte. Which is in agreement with those of Rohde and Heap (1998) that show a significant increase of species and community richness of metazoan ectoparasites of marine fishes with decreasing latitude. Furthermore, the Siculo-Tunisian Strait constitutes a transition zone between the Eastern and Western Mediterranean Basins (Béranger et al., 2004), which could affect the species richness as parasite survival depends on optimal abiotic factors (T, ph, salinity, photoperiodism, nature of marine substrate for the spawn…) of the habitat they are living in. Indeed, on both sides of this barrier, water masses are characterized by different hydrological and physicochemical characteristics (Béranger et al., 2004).

The results of this study show that infestation parameters of ectoparasites had often higher values in the spring-summer period with significant differences for *Gnathia* sp. Such seasonal trend is a proof that hosts are more vulnerable in this period. In temperate climatic regions, the seasonal variation in temperature is an important factor influencing infestation with ectoparasites in wild fish populations (Rakauskas and Blazeevicius, 2009). Moreover, the peak of infestation is coinciding with the breeding activity of the hosts which occurs during the spring and the summer seasons (Whitehead et al., 1986). Indeed, several authors have reported an association between reproduction and the prevalence and abundance of parasites and have attributed this fact to the physiological stress of the host during this period, as a higher investment in reproduction may decrease the energy dedicated to the immune system and thereby facilitate parasite infections (Luo et al., 2010; Sinderman et al., 1987).

Numerous factors influence the aggregation of parasites (Quinnell et al., 1995). However, host resistance and behavior are considered as important determinant of variable parasite burdens (Tanguay and Scott, 1992), and host susceptibility has been proposed to explain the higher infection levels in host (Alston and Lewis, 1994). Moreover, parasite distribution may be influenced more by non-environmentally based changes in host susceptibility.

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