African Journal of Microbiology Research Vol. 4(9), pp. 801-807, 4 May, 2010
Available online http://www.academicjournals.org/ajmr
ISSN 1996-0808 ©2010 Academic Journals

Full Length Research Paper

The Copepod parasite of the gills of four teleost fishes caught from the gulf of Annaba (Algeria)

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Accepted 15 April, 2010

The examination of the gills of 960 fishes belonging to four species: *Diplodus annularis*, *Pagellus erythrinus*, *Lithognatus mormyrus* and *Mullus barbatus* collected from the Gulf of Annaba, enabled us to identify 13 species of parasitic copepods*: Caligus ligusticus*, *Caligus diaphanus*, *Clavellotis sp*, *Clavellotis sargi*, *Clavellotis pagri*, *Clavellotis strumosa*, *Lernaeolophus sultanus*, *Hatschekia pagellibogneravei*, *Hatschekia* sp, *Hatschekia mulli*, *Sparidicola lithognathi*, *Neobrachiella exigua* and *Alella macrotrachelus*. The distribution of copepods identified, varies from one host species to another and one season to another. *P. erythrinus* and *L. mormyrus* present the important number of copepods species. However, the winter presents the highest parasitic diversity (13). Furthermore, the majority of oixenous species are counted. The rates of most values are recorded in summer (33%) and spring (25%). It is also, *D. annularis* which shelters more of the 2/3 population of copepods collected. The copepod *H. pagellibogneravei* is the most abundant. The evaluation of parasitic indices shows that, it is during the summer and spring that the maximum values are recorded.

Key words: Copepod gills, Gulf of Annaba, teleost fish, season.

INTRODUCTION

The copepods occupy a privileged place in the world of parasitism because of their extraordinary adaptive capacity. More than 2,000 species of copepods are parasites. Their presence from sponges to vertebrates (Cressey, 1983), can cause pathogenic effects resulting to important economic incidences (Kabata, 1958; 1984; Faliex and Morand 1994; Sasal et al., 1996; Athanassopoulou et al.,1999 ; Company et al., 1999 and Ramdane, 2009).

Close to the Algerian coasts, the studies on the ecto-parasites copepods are very few: (Brian, 1931a, b, 1932, 1935; Argilas, 1931; Rose, 1952; Nunes-Ruivo, 1954; Hamza et al., 2007; Ramdane, 2007; Ramdane, 2009). The aim of this work is to analyze species of copepod parasitic richness, study copepod specificity and evaluate host epidemiological characters by calculating infestation parameters, because this knowledge constitute a fundamental data for future marine aquaculture. These features will be compared with other studies.

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MATERIALS AND METHODS

960 specimen of four fish species; *Diplodus annularis*, *Lithognatus mormyrus*, *Pagellus erythrinus* and *Mullus barbatus* were collected from the Gulf of Annaba which is located in the littoral East of Algeria. It is limited to the East by Cape Rosa (8°15E and 36°58N) and to the West by Cape Garde (57°16E and 36°58 N) (Figure 1). The host species was identified using Fischer et al. (1987). Collected copepods were fixed and preserved in ethanol (70 %). Before being dissected, they were cleared and stained in lactic acid and the size was measured using an ocular micrometer. Copepods were studied using stereo and light microscopy.

The anatomical terminology used, conforms mostly to that of Kabata (1979). The terms- prevalence, mean intensity and abundance were used as defined by (Margolis et al., 1982; Bush et al., 1997). The independence test (χ^2) is used for statistical comparisons using sigma stat soft ware.

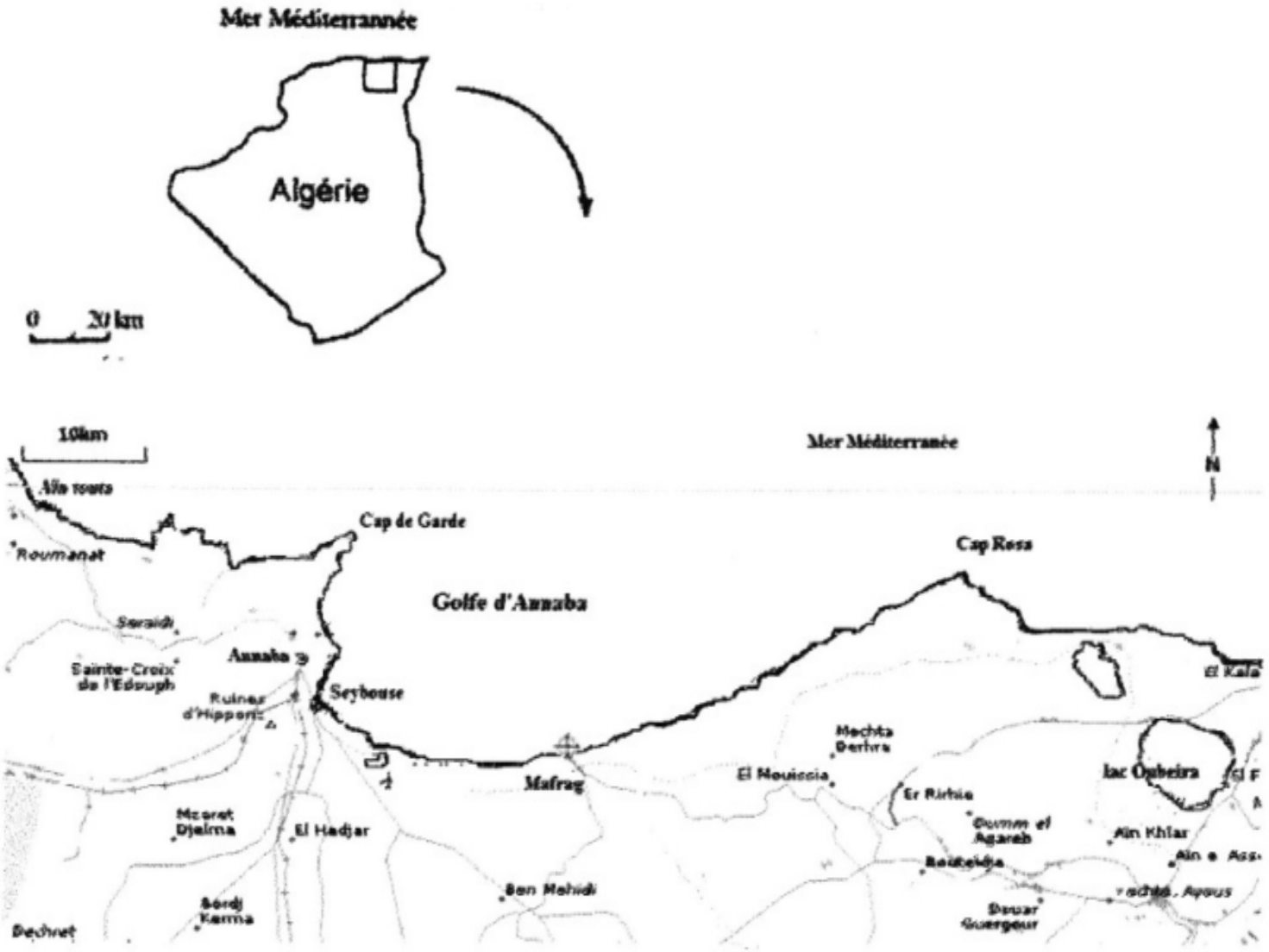

Figure 1. Location of the study

RESULTS

Parasite spectrum

The examination of gills of the whole fish species, enabled us to collect 1,077 parasite copepods belonging to 13 species, of which nine are hosted by *P. erythrinus* and *L. mormyrus and* the four others are found in *D. annularis* and *M. barbatus* (Table 1).

Diversity per fish's host

The data shows, that the highest diversity of copepod species is recorded in *P. erythrinus* and *L. mormyrus* (5), followed by *D. annularis* (4) and *M. barbatus*, presented a low species richness (1) (Table 1).

Seasonal evolution of parasitic species diversity

If taking into consideration all combined parasites from these four hosts, the values of species richness are slightly different and are higher in autumn (13), followed by winter and spring (12), then falls to the summer (11) (Table 1).

Parasitic specificity

The study of parasitic specificity revealed that 11 of the species are *O. Oixenous*. However, *Hatschekia pagellibognaravei*, and *L. sultanus* are *S. Stenoxeneous* species, because they are present in species belonging to the same family (Sparidae) (Table 1).

Table 1. Seasonal distribution of Copepods species.

	Autumn	Winter	Spring	Summer	Total	Specificity
			P. erythrinus			
Caligus diaphanus	7	1	5	1	14	O
Clavellotis pagri	4	2	3	3	12	O
Clavellotis strumosa	2	0	1	0	3	O
Lernaeolophus sultanus	1	2	2	2	7	S
Neobrachiella exigua	18	39	40	51	146	O
Global rates of species hosts			17%			
Diversity /species hosts	5	4	5	4	5	
			M. barbatus			
Hatschekia sp	7	2	0	0	9	O
Hatschekia mulli	32	33	11	9	85	O
Global rates of species hosts			9%			
Diversity /species hosts	2	2	1	1	2	
			D. annularis			
Clavellotis sargi	3	2	2	2	9	O
Lernaolophus sultanus	1	2	1	0	4	S
Hatschekia pagellibogneravei	127	132	188	258	705	S
Alella macrotrachelus	5	3	6	1	15	O
Global rates of species hosts			68%			
Diversity /species hosts	4	4	4	3	4	
			L. mormyrus			
Caligus ligusticus	3	5	4	6	18	O
Clavellotis sp	6	10	5	9	30	O
Lernaeolophus sultanus	1	0	0	2	3	S
Hatschekia pagellibogneravei	1	3	3	2	9	S
Sparidicola lithognathi	1	2	1	2	6	O
Global rates of species hosts			6%			
Global rates of season	20%	22%	25%	33%		
Diversity /species hosts	5	4	4	5	5	
Diversity /season	13	12	12	11	13	

P.e: *Pagellus erythrinus;* L.m: *Lithognathus mormyrus;* M.b: *Mullus barbatus;* D.a: *Diplodus annularis;* O: *Oixenous,* S: *Stenoxenous*

Enumeration of copepod species

The enumeration of copepods collected shows that, *D. annularis* shelters more of the 2/3 population of the collected copepods. However, they are present all year round, but the most abundant is observed in the summer (33%) and spring (25 %) (Table 1).

Epidemiological characteristics of fishes host

The calculation of parasitic indices of copepod species reveals that, it is *H. pagellibognaravei*, which was collected from *D. annularis* presented the maximum values of parasitic indices (P = 60%, I = 4.89, A = 2.94). The next one finds *Neobrachiella exigua* in *P. erythrinus* (P = 32.92%, I = 1.87, A = 0.61). In addition, one finds *Hatschekia mulli* in *M. barbatus* (P = 20.83%, I = 1.7, A = 0.35). However, all other copepods are less frequent and their prevalence is always lower than 10%. (Table 2).

The seasonal distribution of parasitic indices varies from one species to another. In *D. annularis* and *P. erythrinus,* the prevalent values, are highest in the spring (85 and 51%), but the intensity and abundance reach their maximum peak in summer (I = 6.07, A = 4.35 (in *D. annularis*)); (I = 2.21, A = 1.06 (in *P.erythrinus*)). In *M. barbatus,* the values of the three parasitic indices show a peak in autumn (P = 31.66%, I = 2.05, A = 0.65); in *L. mormyrus*, the prevalence shows two maximum: one in summer (28.3%) and the other in winter (21.6%), but, the

Table 2. Distribution of parasitic indices of copepods species in the four host fishes.

	NPI	n	P (%)	I	A
			P. erythrinus		
Neobrachiella exigua	79	148	32.92	1.87	0.62
Caligus diaphanus	11	14	4.58	1.27	0.06
Clavellotis strumosa	2	3	0.83	1.5	0.01
Clavellotis pagri	8	12	3.33	1.5	0.05
Lernaeolophus sultanus	5	7	2.08	1.4	0.02
			M. barbatus		
Hatschekia sp	5	9	2.08	1.80	0.037
Hatschekia mulli	50	85	20.83	1.7	0. 35
			D. annularis		
Clavellotis sargi	7	9	2.92	1.29	0.037
Lernaolophus sultanus	4	4	1.67	1	0.02
Hatschekia pagellibogneravei	144	705	60	4.89	2.94
Alella macrotrachelus	9	15	3.75	1.67	0.06
			L. mormyrus		
Caligus ligusticus	9	18	3.75	2	0.075
Clavellotis sp	22	30	9.16	0.75	0.11
Lernaeolophus sultanus	4	4	1.67	1.5	0.02
Hatschekia pagellibogneravei	6	8	2.5	1.33	0.033
Sparidicola lithognathi	5	6	2.08	1.2	0.025

Table 3. Seasonal distribution of parasitic indices for each species fish.

	Autumn	Winter	Spring	Summer
		P. erythrinus		
NE	60	60	60	60
NI	17	28	31	29
n	32	44	51	57
I	1.88	1.57	1.65	2.21
A	0.53	0.73	0.85	1.06
P (%)	28.33	46.66	51.66	48.33
χ^2	2.60	0.23	0.40	0.13
		M. barbatus		
NE	60	60	60	60
NI	19	19	9	8
n	39	35	11	9
I	2.05	1.84	1.22	1.13
A	0.65	0.58	0.18	0.15
P (%)	31.66	31.66	15	13.33
χ^2	6.70	3.45	3.85	4.76
		D. annularis		
NE	60	60	60	60
NI	38	32	51	43
n	136	139	197	261

Table 3. Continued.

I	3.58	4.34	3.86	6.07
A	2.26	2.32	3.28	4.35
P (%)	63.33	53.33	85	71.66
χ^2	0.20	3.15	1.67	0
		L. mormyrus		
NE	60	60	60	60
NI	7	13	9	17
n	12	20	13	21
I	1.71	1.54	1.44	1.24
A	0.20	0.33	0.21	0.35
P (%)	11.66	21.66	15	28.33
χ^2	1.56	0.35	1.58	0.13

NPI: Number of infested fishes; n: number of parasites; P (%): prevalence; I: intensity; A: Abundance; (the number of examined Fishes NPE = 240 for each species fishes); (χ^2 obs = 34.035 greater than $\chi^2_{1-0,05} = \chi^2_{0,95}$ = 16.919 with ddl = 9).

intensity is highest in autumn (1.71) and abundant in summer (0.35) (Table 3).

Statistic analyses

The χ^2 test of independence to determine the association between the prevalent seasonal values of selected hosts from the four seasons, shows the presence of strong alterations within the investigated seasons ($\chi^2_{obs} = 34.035$ as higher at $\chi^2_{1-0.05} = \chi^2_{0.95} = 16.919$ with 9 degrees of freedom (P = 0.05)) (Table 3).

DISCUSSION

The observation of morpho-anatomical characters of copepod species, enabled the identification of 13 species, of which 11 (*Caligus ligusticus, Caligus diaphanus, Clavellotis sargi, Clavellotis pagri, Clavellotis strumosa, Lernaeolophus sultanus, H. pagellibogneravei, Sparidicola lithognathi, N. exigua, Alella macrotrachelus and H. mulli)* are reported on the fishes of the Tunisian coasts (Benmansour, 2001).

In the Algerian coasts, *C. sargi, C. pagri, C. strumosa, L. sultanus, H. pagellibogneravei, A. macrotrachelus and H. mulli* are found in the gulf of Béjaia (Ramdane and Trille, 2007). The data shows that, the structure of parasite populations in this study varies from one host species to another. It is *L. mormyrus* and *D. annularis* which are characterized by the most important parasite species richness that houses five species of parasites each. However, it is *M. barbatus* which shelters the fewest parasite species (only one). On the Algerian coast (Gulf of Bejaia), Ramdane and Trilles (2007), collected from *L. mormyrus* and *P.erythrinus*, three copepod species. Benmansour and Benhassine (1997) on the coast of Tunisia, shows the highest parasitic diversity in *P. erythrinus* (6) and *D.annularis* (5) in 44 fish species. In France, on the Bonifacio Strait Marine Reserve (Corse), Ternango et al. (2005), reported that, metazoan parasites in sparids fish, presented an heterogeneity of specific richness. Although, these fishes belong to the same family, the same authors revealed that parasitic copepod richness was low. Only three species were found in *D. annularis*, *D. vulgaris* and *P. erythrinus*. Raibaut et al. (1998) reported that, the highest copepod richness species were encountered in *P. erythrinus* (14). According to Ternango et al. (2005), each fish species has a characteristic parasitofauna and particular levels of infestation.

The data concerning the dominance of oixenous species was confirmed by Raibaut et al. (1998). These authors showed that, the large majority (120) of oixenous species can be counted. Benhassine and Benmansour (1997) revealed that, among the 38 species of parasitic copepod collected, 30 were of strict specialists. More-over, we signal that *L. sultanus* and *H. pagellibogneravei* are stenoxenous species, because of their presence in species belonging to the same families. Furthermore, the stenoxenous character of *L. sultanus* is not supported by Raibaut et al. (1998), who signaled the euryxenous character of this copepod, because of it's presence in several host species of different families. This difference between these results and those of Raibaut et al. (1998) is probably explained by the small taxonomical and geographical scale of our study, because those of Raibaut et al. (1998) is represented to a larger scale. Sasal (1997) proved that, studies conducted at different scales may lead to opposite conclusion. How-ever, the stenoxenous character of *H. pagellibogneravei* is also observed by Benmansour and Benhassine (1997), Raibaut et al. (1998) and Ramdane and Trilles (2007), because of it's presence in species belonging to the

same families.

The presence of *C. pagri* is reported in *Sarpa salpa* and *P. erythrinus* both in Tunisian and Algerian coasts (Benmansour, 2001; Ramdane and Trilles, 2007). The presence of *C. strumosa* is reported in Bejaia, only in *P. erythrinus* (Ramdane and Trilles, 2007), but in Tunisia, these species are found according to Benmansour (2001) both in *P. erythrinus* and *L. Mormyru.* These same authors also noted a narrow specificity in *N. exigua* and *S. lithognathi* for *P. erythrinus* and *L. mormyrus*, respectively (Benmansour, 2001). Hassine et al. (1978), reported that *D. sargus* constitutes the preferential host of *A. macrotrachelus*. According to Kabata and Tareen (1997), the original hosts of *S. lithognathi* are undoubtedly species of the *Lithognathus* genus. The species *H. mulli* is only found in Mullidae (Valle, 1880; Papoutsoglou, 1976; Essafi et al., 1984; Benmansour, 2001; Ramadane and Trilles, 2007). The enumeration of identified copepods shows important rates of parasites during the summer and in *D. annularis*. The evaluation of parasitic indices of copepod species, reveals the important parasitic indices of *H. pagellibognaravei* collected from *D. annularis* (P = 60%, I = 4.89, A = 2.94). However, Ternango et al. (2005), showed the important values of prevalence of this species collected from *D. annularis* (P = 36.4%).

The maximum values of parasitic indices in summer and spring period are supported by those of Benmansour (2001), who reported the important values of parasitic indices of the majority of copepods species, found on the gills of 44 teleost fish species, belonging to 20 families on the Tunisian coasts. In the Gulf of Béjaïa, the highest prevalences of parasites on *Boops Boops* and *M. barbatus*, are observed in spring and summer (Ramdane, 2009). According to Marcogliese (2003), several parasites present stages of free life (eggs, larvae or both), where they are exposed to the external environment (ectoparasites). Like every other organization, their distribution and abundance could be affected by the environmental conditions, as it is the case for the host organisms, (for example, the temperature, the depth and water quality, etc). According to Benmansour (2001), the temperature is one of the essential factors of seasonal fluctuations of fish parasites populations. Mahdi and Belghyti (2006), report in their monthly survey on the two monogeneans (*Gotocotyla acanthura and Pyragraphorus hollisae*) of *Trachinotus ovatus* in the coast of Mehdia, to have high prevalence in winter (75.9 and 55.3%, respectively) and lower in summer (48.6 and 11.5%, respectively). The analysis of monthly variation of intensity and parasitic abundance shows that, they evolve in the same direction and varies enormously according to time. The peaks were recorded in August and the minimum was observed in April.

Conclusion

The present study shows the heterogeneity of parasitic diversity, of which *P. erythrinus and L. mormyrus* presents the highest parasitic diversity. However, the autumn presents the maximum value of parasitic species. The study of parasitic specificity shows that, the majority of oixenous copepods are counted. Moreover, only two species (*L. sultanus* and *H. pagellibognaravei)* are stenoxenous. The evaluation of parasitic indices reveals that, *H. pagellibognaravei* collected at *D. annularis*, presented the maximum values. Furthermore, it is in summer and spring that the important parasitic indices were shown. The statistic analysis shows the influence of the season on the prevalence.

ACKNOWLEDGEMENT

We would like to thank Pr. Bernard Marchand (University of Corse) for their moral and material help, for the examination of this paper and for the confirmation of the identified species.

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