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Full Length Research Paper

Copepod parasites of gills of 14 teleost fish species caught in the gulf of Annaba (Algeria)

Boualleg C.[1], Kaouachi N.[1], Seridi M.[1], Ternango S.[2] and Bensouilah M. A.[1]

[1]Laboratoire Ecobiologie des Milieux Marins et Littoraux, Faculté des Sciences. Université Badji Mokhtar Annaba. BP: 12 El- Hadjar. Annaba. 23000. Algérie.

[2]Laboratoire Parasites et Ecosystèmes Méditerranéens, Faculté des Sciences et Techniques, Université de Corse, BP 52, 20250 Corte, France.

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A parasitic copepods study of Algerian teleost fish, report 25 copepod species belonging to eight families harvested from the gills of 14 fish species. The analysis of species richness according to some ecological, biological and taxonomical variables (Diet, Displacement, Way of life, Family) of the whole of hosts are reported in this study, the differences between mean specific richness (MSR) of all variables is statically significant according to Kruskal-Walis test using sigma stat software. Parasitic specificity is discussed, infestation parameters were described.

Key words: Gulf of Annaba, copepods, species richness, parasitic indices, parasitic ecology, teleost fishes.

INTRODUCTION

Many ecologists now recognize that parasitism and diseases are important factors affecting the viability of natural populations and communities (Dobson, 1988; Scott, 1988; Combes, 1995). In the marine environment, it has been demonstrated that individual fish may suffer from parasitic attacks (Kabata, 1958, 1984; Faliex and Morand, 1994; Sasal et al., 1996; Athanassopoulou et al., 1999; Company et al., 1999; Ramdane, 2009). However, it still remains to be explained why some fish species have a higher parasite species richness than others, and how parasite communities build up on these hosts.

During these last years, interesting studies are carried to the determination of the richness of a community parasitic in many localities (Gregory, 1990; Gregory et al., 1991; Poulin, 1991a, b, 1995a, b; Guégan et al., 1992; Ranta, 1992; Holmes, 1996; Poulin and Rhode, 1997; Poulin, 1997; Benmansour and Benhassine, 1997; Caro et al., 1997; Hayward et al., 1998; Raibaut et al., 1998; Lo et al., 1998; Sures et al., 1999; Poulin and Morand, 1999; Sures and Streit, 2001; Ternango 2005a, b; Desdevise, 2006; Klimpela et al., 2006; Ramdane and Trille, 2007; Boxshall and Defaye 2008).

The aim of this work was to analyze species copepod parasitic richness according to some ecobiological and taxonomical variables, the study of copepod specificity, and evaluation of host epidemiological characters by calculating infestation parameters, because these knowledge, constitute a fundamental data for future marine aquaculture. These features will be compared with others studies.

MATERIALS AND METHODS

1260 specimen of 14 fish species were collected from the gulf of Annaba which is located in the east coast of Algeria; it is limited to the east from cape Rosa (8°15E and 36°58N) to the west by the cape Garde (57°16 E and 36°58 N)(Figure 1). The host species was identified using Fisher et al. (1987). Collected copepods were fixed and preserved in ethanol (70%). Before being dissected, they were cleared and stained in lactophenol. Copepods were studies using stereo and light microscopy. Parasites species identification was based on morphological features according to Yamaguti (1963), Kabata (1979) and Ho and Kim (2004).

Mean species richness (MSR) and parasitic copepod host ratio (P/H) were calculated as proposed in Raibaut et al. (1998); statistical test followed Dagnelie (1999) using sigma stat software. The ecological terms (prevalence, mean intensity and abundance) were used in accordance with Bush et al. (1997).

*Corresponding author. E-mail: boualleg.chahinez@yahoo.com.

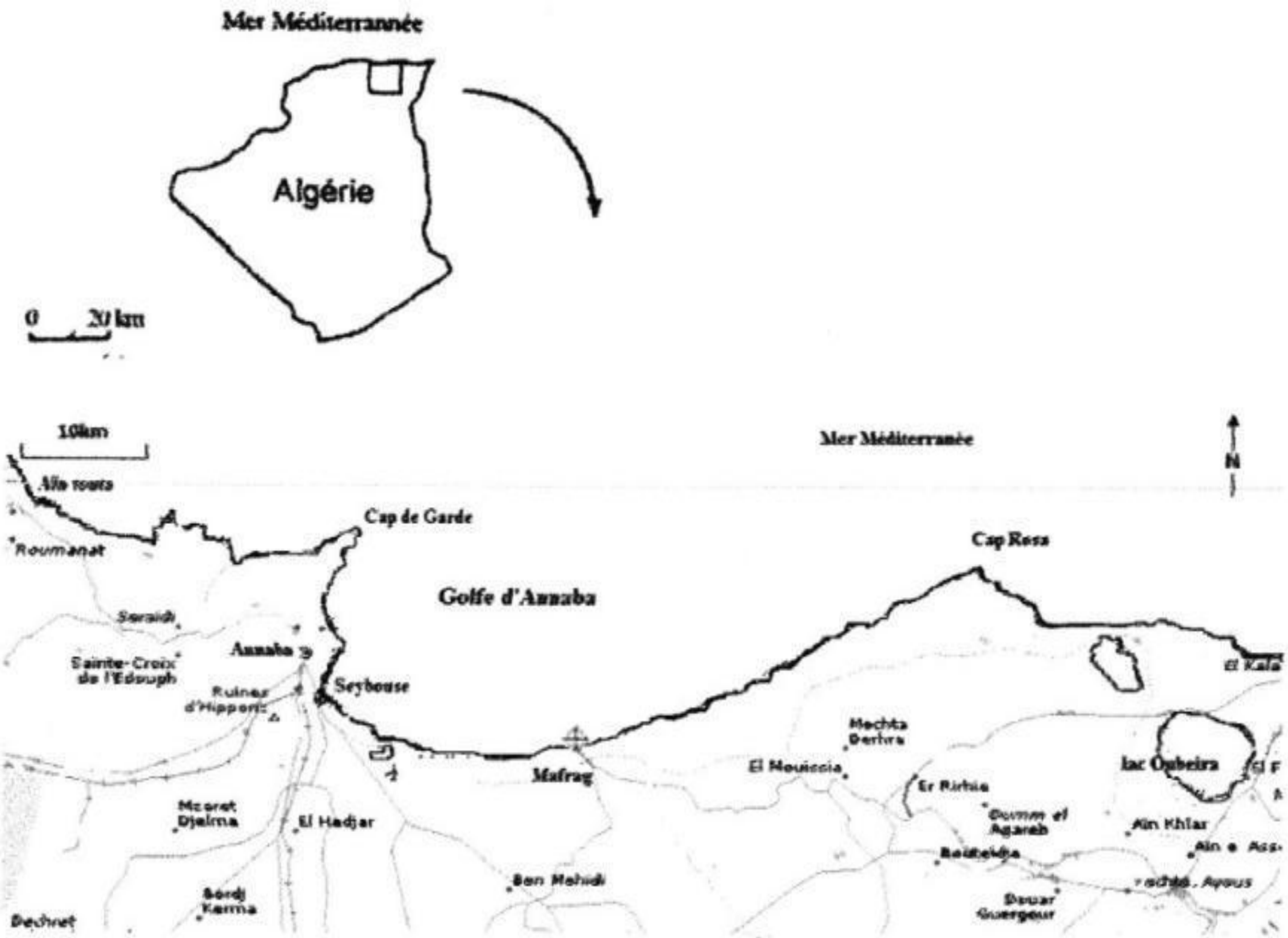

Figure 1. Location of the site of study.

RESULTS

Diversity per host fishes

Our data shows that the high diversity of copepod species is recorded in *Pagellus erythrinus* and *Lithognathus mormyrus* (5), flowed by *Diplodus annularis* (4), *Mugil cephalus* and *Merluccius merluccius* (3). However, *Liza saliens*, *Chelon labrosus*, *Syringa vulgaris*, *Sus scrofa* and *Mullus barbatus*, present a low species richness (1) in *Sardina pilchardus*, no parasites were found (Table 1).

Specific richness according to ecobiological variables

Diet

Table 2 shows, the values of MSR and P/H for omnivorous, carnivorous and planktivorous, we find that omnivorous are the more diversified species (MSR=2.87), the difference between MSR of these three categories are statically significant (Kruskal Walis test: H = 47.864, P = 0.001<0.05).

Displacements

Our study brings for the dominating importance of displacements criterion of fish species, Table 2 shows that migrating fish without environmental change are the most diversified (MSR=2.5) the difference between MSR values of the three characters is significant (Kruskal Walis test: H = 10.302, P = 0.006<0.05).

Way of life

The comparative analysis of parasite richness among nectonic, benthic and pelagic fish demonstrates that nectonic species have the highest parasite richness

Table 1. Fish species with their ecobiological and epidemiological characteristics, found to be infested by parasitic copepods.

Parasitic copepods	NPI	n	P (%)	I	A	Specificity
B. boops (*O,N,Mo*)						
Lernaeolophus sultanus	1	2	1.11	2	0.02	Stenoxenous
Naobranchia cygniformis	6	7	6.67	1.17	0.08	Oioxenous
Total	7	7	7.77	1	0.07	
S. vulgaris (C,B,Mc)						
Bomolochus solea	4	6	4.44	1.5	0.06	Oioxenous
M. merluccius (C ,B,Mo)						
Neobrachiella merluccii	4	13	4.44	3.25	0.14	Oioxenous
Neobrachiella insidosia	2	4	2.22	2	0.04	Oioxenous
Lernaocera branchialis	13	19	14.44	1.46	0.21	Oioxenous
Total	19	36	21.11	1.89	0.4	
S. scorfa (C, B,S)						
Prohatschekia mediterranea	13	68	14.44	5.23	0.76	Oioxenous
Sardina pilchardus (P,Pl,Mo)	0	0	0	0	0	-
No parasite found						
D. labrax (*C,B,Mc*)						
Caligus minimus	21	59	23.33	2.81	0.66	Oioxenous
Lernanthropus kroyeri	20	54	22.22	2.7	0.6	Oioxenous
Total	41	113	45.55	2.76	1.26	
L. aurata (O,N, Mc)						
Caligus mugilis	2	10	2.22	5	0.11	Stenoxenous
Lernanthropus mugilis	2	9	4.5	0.17	0.1	Oioxenous
Total	4	19	4.44	4.75	0.63	
L. saliens (O, N, Mc)						
Caligus pageti	14	22	15.56	1.57	0.24	Oioxenous
M. cephalus (O,N, Mc)						
Caligus mugilis	10	30	11.11	3	0.33	Stenoxenous
Ergasilus bora	4	13	4.44	3.25	0.14	Oioxenous
Ergasilus Lizae	15	133	16.67	8.87	1.48	Oioxenous
Total	29	176	32.22	6.06	1.96	
C. labrosus (O,N, Mc)						
Caligus mugilis	32	121	35.56	3.78	1.34	Stenoxenous
D. annularis (O,N, Mc)						
Clavellotis sargi	2	4	2.22	2	0.044	Oioxenous
Lernaolophus sultanus	2	2	2.22	1	0.022	Stenoxenous
Hatschekia pagellibogneravei	26	446	28.89	17.15	4.96	Stenoxenous
Alella macrotrachelus	4	7	4.44	1.75	0.078	Oioxenous
Total	34	459	37.78	13.5	5.1	
P. erythrinus (O, N, Mo)						
Caligus diaphanus	2	4	2.22	2	0.044	Oioxenous
Clavellotis pagri	2	6	2.22	3	0.067	Oioxenous
Clavellotis strumosa	1	1	1.11	1	0.011	Oioxenous
Lernaeolophus sp	1	4	1.11	4	0.044	Oioxenous
Neobrachiella exigua	24	91	26.67	3.79	1.01	Oioxenous
Total	30	106	33.33	3.53	1.18	

Table 1 Contd.

M. barbatus C,B, Mo)						
Hatschekia mulli	17	20	18.98	1.18	0.22	Oioxenous
L. mormyrus (C, B,Mc)						
Caligus ligusticus	15	10	16.67	0.67	0.11	Oioxenous
Clavellotis briani	4	14	4.44	3.5	0.16	Oioxenous
L. sultanus	1	2	1.11	2	0.022	Stenxenous
H. pagellibogneravei	5	5	5.56	1	0.056	Oioxenous
Sparidicola lithognathi	1	3	1.11	3	0.033	Oioxenous
Total	26	34	28.89	1.31	0.38	

NPI: Number of infested fishes; n: number of parasites; P (%): prevalence; I: mean intensity; A: Abundance; (the number of examined Fishes N PE = 90 for each species fishes). B: benthic; P: pelagic; N: nectonic; G: gregarious; So: solitary; Mi: migrant with change of environment; Mo: migrant without change of environment; Se: Sedentary.

(MSR= 2.57). We find the statistically significant differences between MSR of the three ways of life (Kruskal Walis test: H = 16.711, P =0.001<0.05) (Table 2).

Specific richness according totaxonomical variables

Family

The analysis of the parasitic richness per family indicate that sparids present the highest richness (MSR= 4), Kruskal Walis test shows the significant differences between families (H = 33.788, P = 0.001<0.05) (Table 2).

Parasitic specificity

The study of parasitic specificity revealed that 23 of this species are oioxenous, however, *Hatschekia pagellibogneravei*, *M. cephalus* and *Lernaeolophus sultanus* are stenoxeneous species because they are present in species of the same family (Table 1).

Epidemiological characteristics of fishes host

Table 2 shows that distribution of parasitological indices varies from one species to another, the important values of prevalence are observed in *Dicentrarchus labrax* (over 45%), followed by *D. annularis* (P=37.78%), *C. labrosus* (P=35.56%), *P. erythrinus* (P = 33.33%), *M. cephalus* (P=32.22%), *M. merluccius* (P=21.11%) and *M. barbatus* (P=18.98%), however all other copepods are less frequent and their prevalence is always lower than 17%. Furthermore, the maximum values of intensity and abundances are recorded in *D. annularis* (I= 13.5; A= 5).

The calculation of the parasitic indices of copepods species reveals that it is *H. pagellibognaravei* collected from *D. annularis* that presents the maximum values of parasitic burdens (I = 17.15, A = 4.96), next we finds *Elizae* in *M. cephalus* (I = 8.87, A =1.48) and *Neobrachiella exigua* (I = 3.79, A = 1.01) in *P. erythrinus*, however the values of intensity and abundance of all other copepods, are very few (not exceeding 5 and 0.7 respectively), The values of prevalence are maximal in *Caligus minimus* (P = 23.33%) and *Lernanthropus kroyeri* (P =22.22%) harvested from the gills of *D. labrax* (Table 2).

DISCUSSION

The study of parasitic diversity from 14 fish species shows an important variability between host species both in the same family and different families; *P. erythrinus* and *L. mormyrus* present the important number of parasitic species (5). On the coast of Algeria (Gulf of Bejaia), Ramdane and Trilles (2007); collected in *L. mormyrus* and *P. erythrinus*, three copepod species, Benmansour and Benhassine (1997) on the coast of Tunisia, shows in 44 fish species a highest parasitic diversify in: *P. erythrinus* (6) and *D. annularis* (5). In France, on the Bonifacio Strait Marine Reserve (Corse), Ternango et al. 2005b, reported that metazoan parasites in sparids fish, present an heterogeneity specific richness, although these fish 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).

Our data shows that omnivorous are the very diversified fishes, Kruskal Walis test reveals a statistically significant differences between MSR of omnivorous, carnivorous and planktivorous (H = 47.864, P = 0.001<0.05), Ternango (2004), Benmansour and Benhassine (1997), showed the important copepods diversity in *P. erythrinus* (omnivorous species). Klimpel et al. (2006) proved that the high parasite diversity of fishes corresponds to a highly diverse diet.

Table 2. Variation of mean species richness (MSR) and the parasitic copepod host ratio (P/H) in the relation different variables of fish hosts.

Specific richness	MSR	P/H	Mean MSR	Mean P/H
Ecobiological variables				
Diet				
Omnivorous (N=8)	2.87	2.37		
Carnivors (N= 5)	1.4	2.5	2.21	1.86
Planctonophages (N= 1)	0	0		
Kruscal walis test	H = 47.864.	P = 0.001<0.05	3df	
Displacement				
Migrant with changes of environnement (N=5)	2.2	2.2	2.21	1.86
Migrant without changes of environnement (N=8)	2.5	2.12		
Sedentary (N= 1)	1	1		
Kruscal walis test	H = 10.302	P = 0.006<0.05	2df	
Way of life				
Nectonic (N=7)	2.57	2.14		
Benthic (N=6)	2	2	2.21	1.86
Pelagic (N=1)	0	0		
Kruscal walis test	H = 16.711	P = 0.001<0.05	2df	
Taxonomical variables				
Family				
Sparidae (N= 4)	4	3.5		
Soleidae (N=1)	1	1		
Gadidae (N=1)	3	3		
Scorpeanidae (N=1)	1	1	2.21	1.86
Clupeidae (N=1)	0	0		
Moronidae(N=1)	2	2		
Mugilidae (N=4)	1.75	1.25		
Mullidae(N=1)	1	1		
Kruscal walis test	H=33.788	P = 0.001<0.05	7df	

N:number of fish hosts; MSR: mean species richness; P/H: parasitic copepod host ratio,df:degree of freedom.

Our investigation among way of life shows the important richness of nectonic fishes, flowed by benthic ones, the lowest species richness are found in pelagic fishes. Raibaut et al. (1989), Ternango (2004) and Ramdane and Trilles (2007) reported the same results. Klimpel et al. (2006) revealed the poor parasitic diversity in pelagic fish species compared by demersal species. However, our results are differ from those reported by Benmansour and Benhassine (1997) in the coast of Tunisia, which shows that the endemiotopes of copepods parasites would presumably be more benthic than pelagic.

The statistical analysis of our data, shows the significant differences between MSR of nectonic, benthic and pelagic fishes (KruskalWalis test: H = 16.711, P = 0.001<0.05). Our results concerning the important richness of migratory species without environmental change is confirmed by our statistical analyses which shows the significant differences between MSR of migrating fish with environmental change and those of either sedentary and migrating without environmental change, (Kruskal Walis test: H = 10.302, P = 0.006<0.05). Raibaut et al. (1998) confirmed our results and shows the significant differences between MSR of the three categories (Kruskal Walis test: H= 18.9, P<0.05).

Raibaut et al. (1975) proved that during migrations some copepod species could not tolerate the salinity variation and disappeared. For example, *E. lizae*, whose entirely free larval development takes place in brackish waters, infests Mullets while they remain in this brackish environment but does not survive when these same fishes return to the sea. Benmansour and Benhassine (1997) and Caro et al. (1997), indicated that migratory fishes with environment change are characterized by a high parasitic richness compared with sedentary.

Desdevises (2006), reported in some fish of sparids family and their monogenean gill ectoparasites of the genus *Lamellodiscus* that hosts undergoing migration may encounter more parasite species and therefore increase their richness. From a taxonomical point of view, the important mean richness specific is observed in sparids (4). The differences between MSR of families are statistically significant (Kruskal Walis test: H = 33.788, P = 0.001<0.05). Raibaut et al. (1998) supported our data because he showed the important values of MSR in sparids family (over 5).

Our data concerning the dominant of oixenous species was confirmed by Raibaut et al. (1998); these authors showed that the large majority (120) of oixenous species can be counted. Benmansour and Benhassine (1997) revealed that among the 38 copepod parasitic species collected, 30 were strict specialists. Moreover, we signal that *L. sultanus, H. pagellibogneravei* and *C. mugilis* are stenoxenous species because of its presences in species belonging to the same families.

The stenoxenous characters of *L. sultanus* is not supported by Raibaut et al. (1998), whose signaled the euryxenous character of this copepod because to its presence in several host species of different families. This difference between our 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) representing to a larger scale. Sasal (1997) proved that studies conducted at different scales may lead to opposite conclusion. However, 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 its presence in species belonging to the same families. Moreover, Euzet and Combes (1980), confirmed the stenoxenous character of *C. mugilis*, they showed that almost half of the parasitic copepods of the Migilids family present a stenoxenous specificity that remain within the family.

The parasitic indices among host species shows the high values only in six species (*D. labrax*, *D*. *annularis, C. labrosus, P. erythrinus*, *M. merluccius* and *M. barbatus*), the others parasitic species infest their host species so low. Our study is confirmed by Ramdane (2009), Benmansour (2001) and Ternango et al. (2005b), whose revealed that copepods species infested with low rates. The evolution of parasitic indices of copepod species, reveals the importance parasitic burdens of *H. pagellibognaravei* collected from *D. annularis* (I=17.15, A= 4.96). However, Ternango et al. (2005b), showed the importance of prevalence of this species collected from *D. annularis* (P= 36.4%) compared by other species copepods found. The important values of intensity and abundance in *D. annularis* (A=13.5, I=5.1) are probably explained by their biological and ecological characters (omnivorous, benthic and migratory fish). According to Ternango et al. (2005b), each fish species has a characteristic parasitofauna and particular levels of infestation.

Finally, it is very interesting to note that copepod species can cause serious fish diseases, although that which present a low parasitic indices. According to Athanassopoulou et al. (1999) and Company et al. (1999), parasites that have a low prevalence and abundance and minor pathological effects on their hosts in the wild can easily spread in populations confined to rearing systems, causing serious outbreaks of epizootic diseases.

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