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Some parasitic copepods of selected Teleost and Chondrichthyan fishes from the Tunisian gulfs

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The examination of 415 specimen belonging to twelve species of Teleostean fish and 339 specimen belonging to seven species of Chondrichthyan fish collected from the Tunisian coasts, it enabled us to identify 10 species of parasitic copepods: *Lernaeopoda galei*, *Lernaeocera lusci, Neobrachiella merluccii, Hatschekia mulli, Caligus elongatus, Caligus pageti, Neobrachiella mugilis, Clavellotis fallax, Clavelissa pagri* and *Clavelissa scombri*. The distribution of copepods identified, varies from one host species to another. *Merluccius merluccius* and *Liza saliens* present the important number of copepods species. The copepod *Hatschekia mulli* is the most abundant. The presence of *Lernaeopoda galei* on *Scyliorhinus canicula, Mustelus mustelus* and *Mustelus punctalatus* was reported for the first time in the southern banks of the Mediterranean.

Key words: Copepods, Teleost fish, Chondrichthyan fish, Tunisian coasts, parasitic indices.

INTRODUCTION

Copepods are common parasites of marine fishes and have been reported from a great range of depths (Boxshall, 1998). This group of ectoparasites exhibits an astounding variety of lifestyles, host associations and morphology, to the extent that their crustacean affinities may be obscured (Huys et al., 2007). More than 2000 species of copepods parasitize marine and freshwater fishes and most are ectoparasitic: they are found all over the external body surface of the host as well as in more sheltered microhabitats that are permanently directly connected to the external environment, including the external nares, the eyes, the oral and branchial cavities, the gills and the cloaca (Rosim et al., 2013). Many copepod parasites negatively affect the appearance and reduced production of species of economically important fish, both from the wild and fish farms, thus making them difficult to market (Aladatohun et al., 2013). It is important to mention that in addition to their impact on host demographics populations, parasites also influence the ecosystem processes that are diverse as competition, migration and speciation of the hosts (Kaouachi et al., 2010).

Copepods parasites have been studied extensively in the world and in Tunisian coast, where they have become pests of Teleost fish species of commercial importance (Kabata, 1958; 1984; Faliex and Morand, 1994; Sasal et

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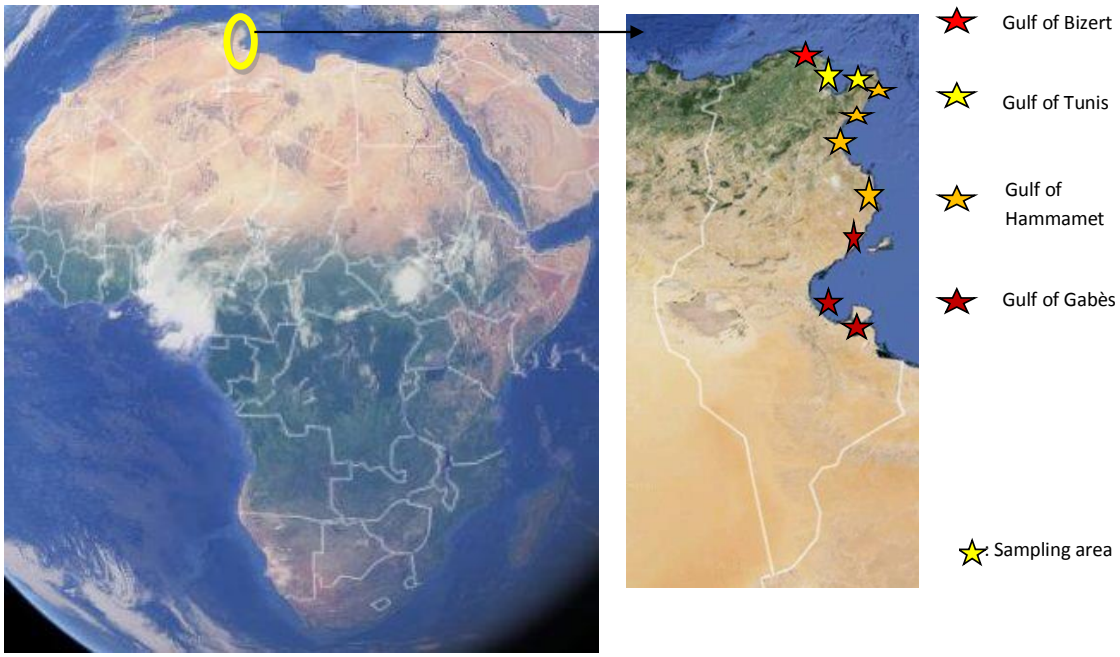

Figure 1. Location of the study.

al., 1996).

However, little is known of the diversity of parasitic copepods of Chondrichthyan fishes. The aim of this work is to analyze species of copepods parasitic richness, study copepods specificity and evaluate host epidiomogical characters by calculating infestation parameters. These features will be compared with other studies.

MATERIALS AND METHODS

A total of 415 specimens belonging to twelve species of Teleostean fish and 339 specimens belonging to seven species of Chondrichthyan fish were collected from 4 different Tunisian gulfs: Bizerte, Tunis, Hammamet and Gabès (Figure 1). The host species was identified using the method of Fischer et al. (1987) and Froese and Pauly (2014). Collected copepods were immediately removed from the hosts and preserved in 70% ethanol. Subsequently, specimens were cleared in lactic acid for 2 h prior to examination using stereo and light microscopy. Specimens were dissected on glass-slides and mounted as temporary preparations in lactophenol under a dissecting microscope. Measurements were made using an ocular micrometer. The drawings were made with the aid of a drawing tube. The data, the sampling area, the name and the size of host fish and the position of the parasite were noted.

Parasites species identification was based on morphological features according to Yamaguti (1963), Kabata (1979) and Ho and Kim (2004). The terms prevalence, mean intensity and abundance were used as defined by Margolis et al. (1982) and Bush et al. (1997) (Figure 1).

RESULTS

The examination of different host species allowed us to harvest 10 species of copepods. Among them are, 8 species which were present on Teleost fish (*Lernaeocera lusci, Neobrachiella Merluccii, Caligus pageti, Neobrachiella mugilis, Hatschekia mulli, Clavelissa scombri, Clavelloti spagri* and *Clavellotis fallax)* (Figures 3, 4, 5, 6, 7, 9, 10 and 11). On the other hand, only 2 species of copepods were collected on chondrichthyan fish (*Caligus elongatus* and *Lernaeopoda galei*) (Figures 2 and 8).

The hosts, the number of examined fish, the number of the infected fish, the parasitic indices (Prevalence (P), Intensity (I) and Abundance (A)) of each species of copepod were calculated, the specificity and the site of fixation are registered in Table 1.

Parasite spectrum

The examination of the whole fish species enabled us to collect 10 species of parasite copepods of which eight are hosted by Teleost fishes and two others are found in Chondrichthyan fishes (Table 1) (Figures 2 to 11).

Parasitic specificity

The study of parasitic specificity revealed that 3 of the species are O. Oixenous. However, 5 are *S. stenoxenous*. *C. elongatus* and *L. galei* are *E. Euryxenous* (Table 1).

Epidemiological characteristics of copepods species:

Our results (Table 1) show that, the distribution of

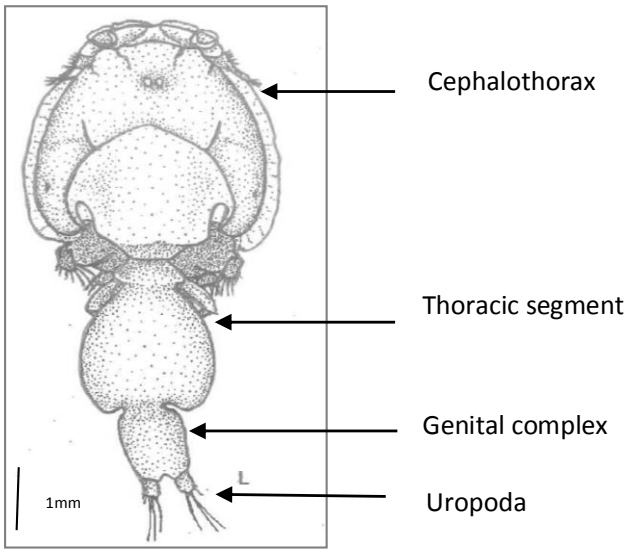

Figure 2. *Caligus elongatus* (Von Nordman, 1832) According to Kabata, 1979.

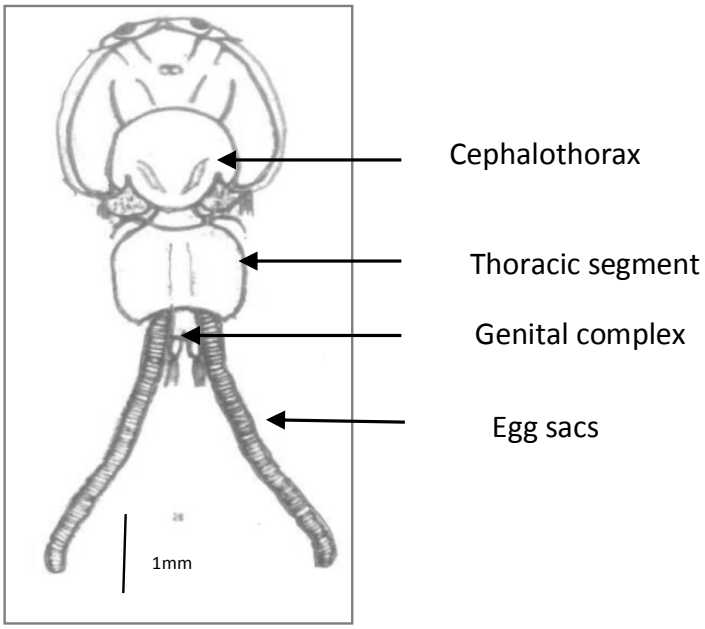

Figure 3. *Caligus pageti* (Russel, 1925) According to Ben Hassine 1971.

parasitological indices varies from one species to another. The important values of prevalence are observed in *M. barbatus* (P=29.3%), followed by *S. auratus* (P=13.33%), *Liza saliens* (P=10.8%) and *M. merluccius* (P=10%). However, all other copepods are less frequent and their prevalence is always lower than 10%. Furthermore, the maximum values of intensity is recorded in *S. scombrus* (I=1.5). *M. barbatus* shows the highest abundance (A= 0.29) (Figure 12 and Table 1).

L. galei was the only copepod collected on 3 different hosts (*S. canicula, M. mustelus* and *M. punctalatus*). We found the lowest prevalence in *M. punctalatus* (P= 3.04%) and the highest in *S. canicula* (P= 8.33 %). *L. galei* is more abundant in *S. canicula* (0.08) (Figure 13).

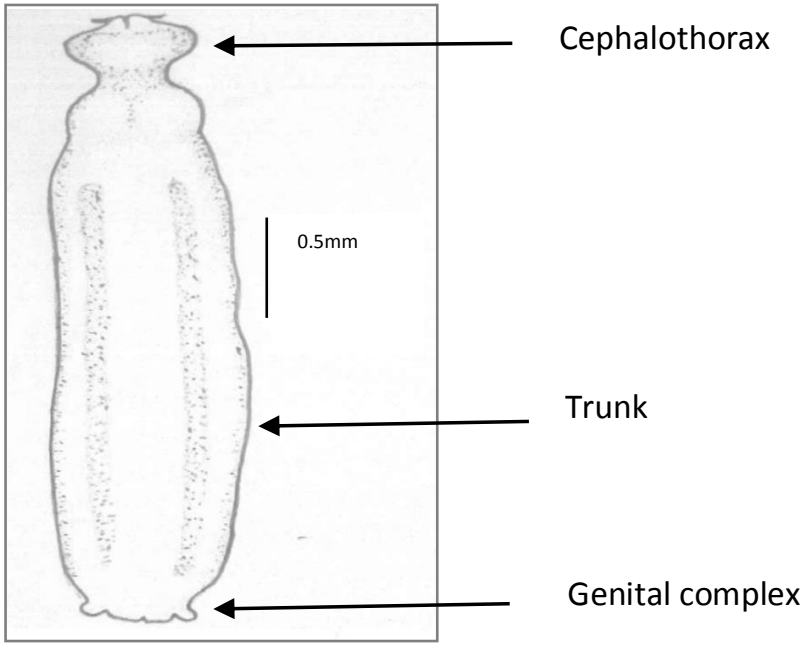

Figure 4. *Hatschekia mulli* (Van Benden, 1851) According to Kabata, 1979.

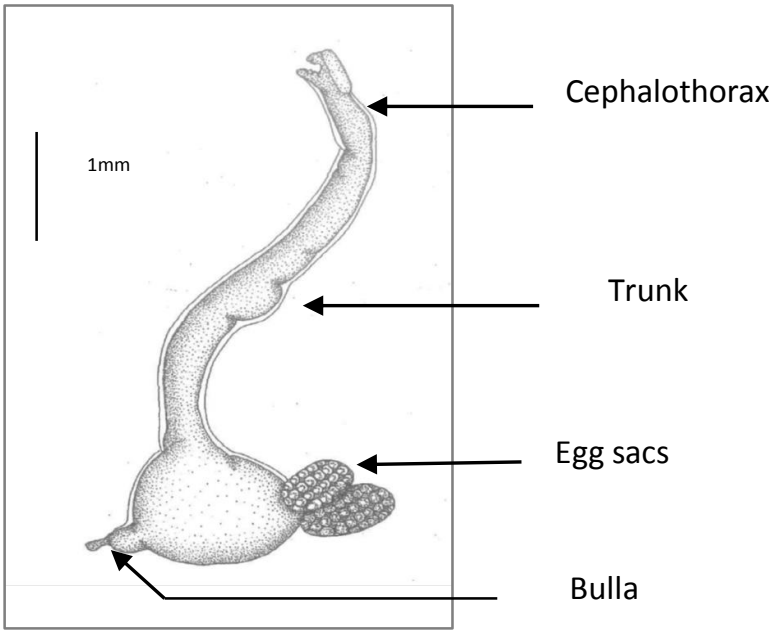

Figure 5. *Clavellisa scombri* (Kruz, 1877) According to Benmansour, 2001.

Analysis of richness of parasites per family

The analysis of the parasitic richness indicate that the family of Lernaeopodidae present the highest richness (MSR= 6) and the lowest one is recorded on Hatschekiidae (MSR=1) (Figure 14).

DISCUSSION

The observation of morpho-anatomical characters of copepod species, enabled the identification of 10 species (*C. elongatus, Caligus pageti, Clavelissa scombri, Clavellotis fallax, Clavellotis pagri, Hatschekia mulli,*

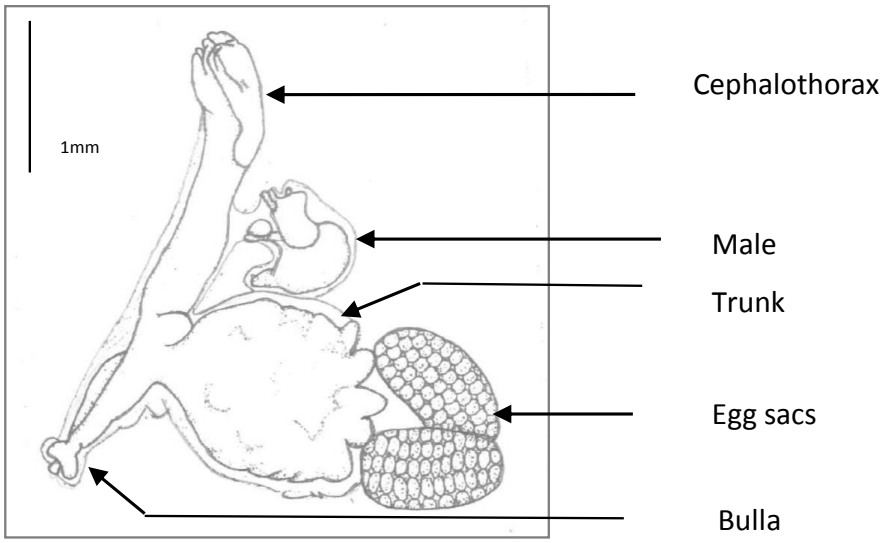

Figure 6. *Clavellotis fallax* (Female) (Heller, 1865) According to Benmansour, 2001.

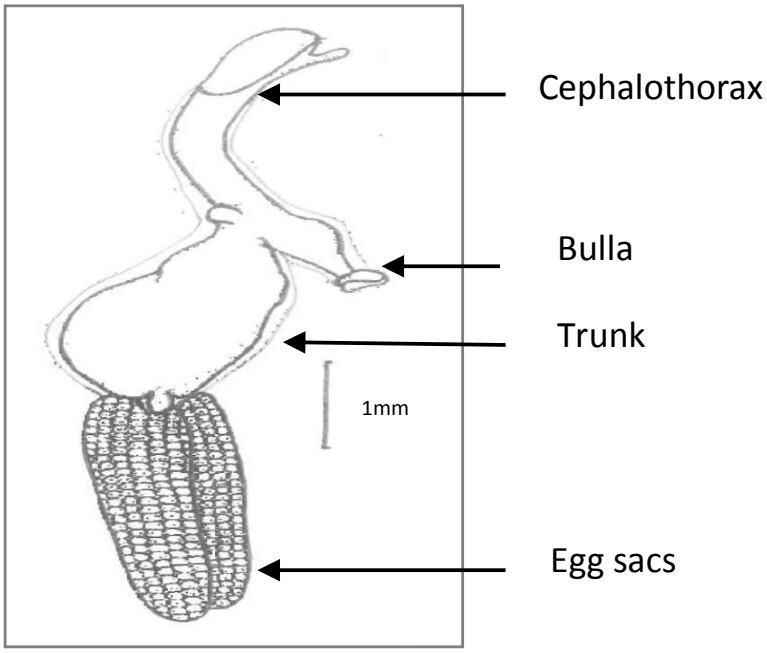

Figure 7. *Clavellotis pagri* (Kroyer, 1863) According to Benmansour, 2001.

Neobrachiella mugilis, Neobrachiella merlucii, Lernaeocera lusci and *L. galei*). In the Algerian coasts, *Clavellotis pagri* and *Hatschekia mulli* were also found in the gulf of Béjaia (Ramdane and Trilles, 2007) and the gulf of Annaba (Boualleg et al., 2010). The prevalence of *Clavellotis pagri* in our sampling is higher (P=9.67%) than the prevalence recorded in the Algerian coasts by Boualleg et al., (2010) (P=3.33%). Furthermore, the prevalence of *Hatschekia mulli* in tunisan coasts was more important (P=29.03%) than in Algerian waters (P=20.83%) (Boualleg et al., 2010).

Merluccius merluccius and *Liza saliens* present the highest number of parasitic species (2). In Tunisia, the highest parasitic diversity was mentioned by Benmansour and Ben Hassine (1997) in *Pagellus erythrinus* (6) and *Diplodus annularis* (5). On the coast of Algeria, *Pagellus erythrinus* and *Lithognathus mormyrus* present the important number of parasitic species (5) (Boualleg et al.,

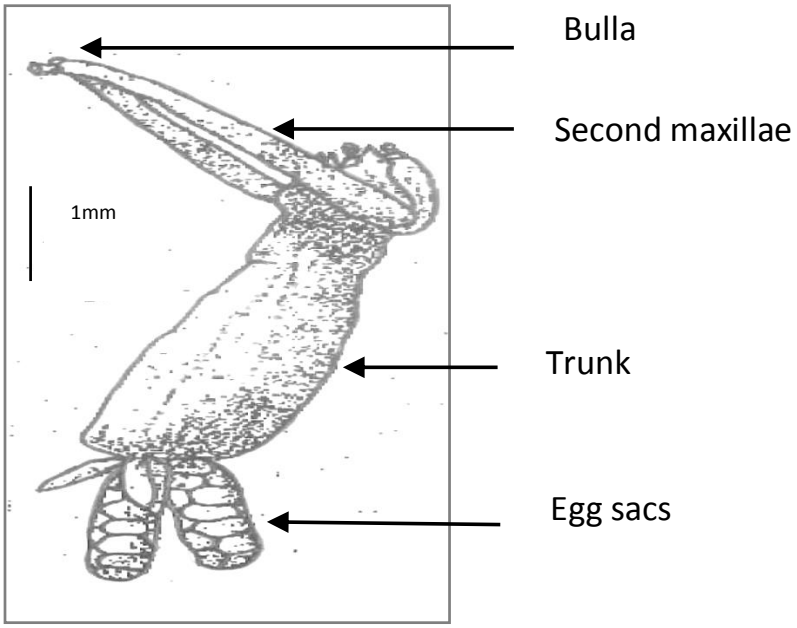

Figure 8. *Lernaeopoda galei* (Kabata, 1979) According to Radujkovic and Raibaut, 1987.

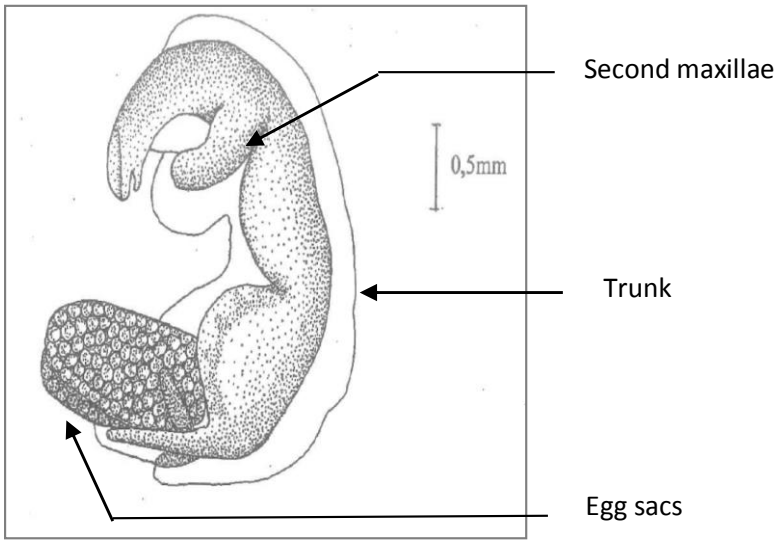

Figure 9. *Neobrachiella merluccii* (Bassett-Smith, 1896) According to Benmansour, 2001.

2010).

However, we found only two species of copepods on Chondrichthyan fish. The study of Essafi (1984) on Chondrichtyan fishes in Tunisian waters allowed in the collection of 22 different species of copepods. Nevertheless, we report for the first time the occurrence of *Lernaeopoda galei* on *Scyliorhinus canicula, Mustelus mustelus* and *Mustelus punctalatus* on the southern banks of the Mediterranean. This can be explained by the scarcity of studies on parasitic copepods of Chondrichthyan fish in this part of the Mediterranean. *L. galei* parasite in several Chondrichthyan fish species was never harvested on *M. punctalatus*. This is the first mention of this copepod on this host fish.

Also we assign *Caligus elongatus* as parasite of *Raja clavata* in Tunisia. *C. elongatus* parasitize several species

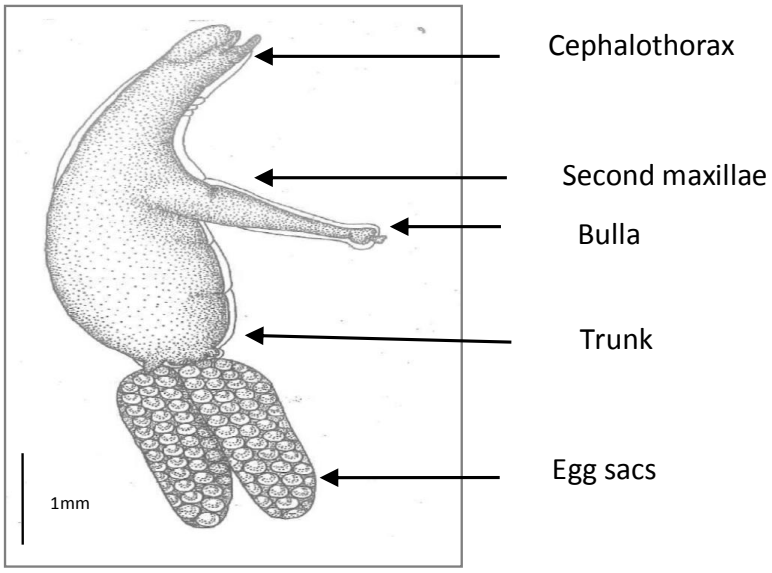

Figure 10. *Neobrachiella mugilis* (Kabata et al., 1971) According to Benmansour, 2001.

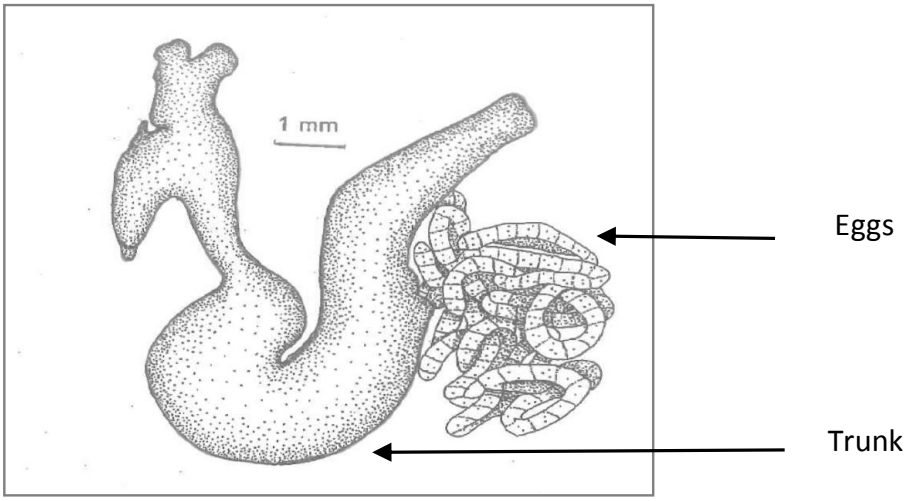

Figure 11. *Lernaeocera lusci* (Bassett-Smith, 1896) According to Benmansour, 2001.

of Chondrichthyan fish among them, 5 species of Rajidae (*Raja batis, Raja clavata, Raja laevis, Raja maevus* and *Raja radiata*) (Boxshall, 2001). In Tunisia, it was harvested for the first time on *Symphodus tinca* by Benmansour and Ben Hassine (1997).

The phenomenon of host specificity is the extent to which a parasite is restricted in the range of hosts it utilizes. Levels of host specificity can range through a continuum from high, with the parasite species occurring on only a single host species, to low, with the parasite species occurring on a wide range of phylogenetically unrelated host species (Boxshall, 1998).

The data concerning the dominance of stenoxenous species was different from the results recorded by Raibaut et al. (1998) and Benmansour and Ben Hassine (1997). Those authors showed that the large majority of copepod species are oioxenous. This difference between our results and those of the other authors is probably explained by the small taxonomical and geographical scale of our study. Sasal (1997) proved that studies conducted at different scales may lead to opposite conclusion.

Conclusion

Finally, it is very interesting to note that copepod species

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

Host	NEF	NIF	Copepods	P(%)	I	A	Location on the host	Specificity
Teleost fishes								
Boops boops	39	0	**********	****	****	****	*****	*****
Caranx rhonchus	40	0	**********	****	****	****	*****	*****
Spicara maena	42	0	**********	****	****	****	*****	*****
Merluccius merluccius	30	3	*Lernaeocera lusci*	10	1	0.10	Gills	O
		2	*Neobrachiella Merluccii*	6.66	1	0.06	Gills	O
Liza saliens	37	2	*Caligus pageti*	5.4	1	0.05	Fins	S
		4	*Neobrachiella mugilis*	10.8	1	0.10	Fins	S
Mullus barbatus	30	9	*Hatschekia mulli*	29.03	1	0.29	Gills	S
Mullus surmuletus	31	0	**********	****	****	****	*****	*****
Scomber scombrus	45	4	*Clavelissa scombri*	6.66	1.5	0.08	Gills	O
Sarpa salpa	31	3	*Clavellotis pagri*	9.67	1	0.09	Gills	S
Scorpaena porcus	30	0	**********	****	****	****	*****	*****
Scorpaena scrofa	30	0	**********	****	****	****	*****	*****
Sparus auratus	30	4	*Clavellotis fallax*	13.33	1	0.13	Gills	S
Chondrichthyan fishes								
Dasyatis centroura	38	0	**********	****	****	****	*****	*****
Pteromylaeus bovinus	48	0	**********	****	****	****	*****	*****
Raja clavata	52	3	*Caligus elongatus*	5.76	1	0.05	Gills	E
Rhinobatos cemiculus	32	0	**********	****	****	****	*****	*****
Scyliorhinus canicula	60	5	*Lernaeopoda galei*	8.33	1	0.08	Cloaca	E
Mustelus mustelus	60	3	*Lernaeopoda galei*	5	1	0.05	Cloaca	E
Mustelus punctalatus	49	1	*Lernaeopoda galei*	2.04	1	0.02	Cloaca	E

(NEF: Number of examined fishes; NIF: Number of infested fishes; P (%): Prevalence; I: mean intensity; A: Abundance; O: Oixenous; S: Stenoxenous, E: Euryxenous; *: absence of parasites).

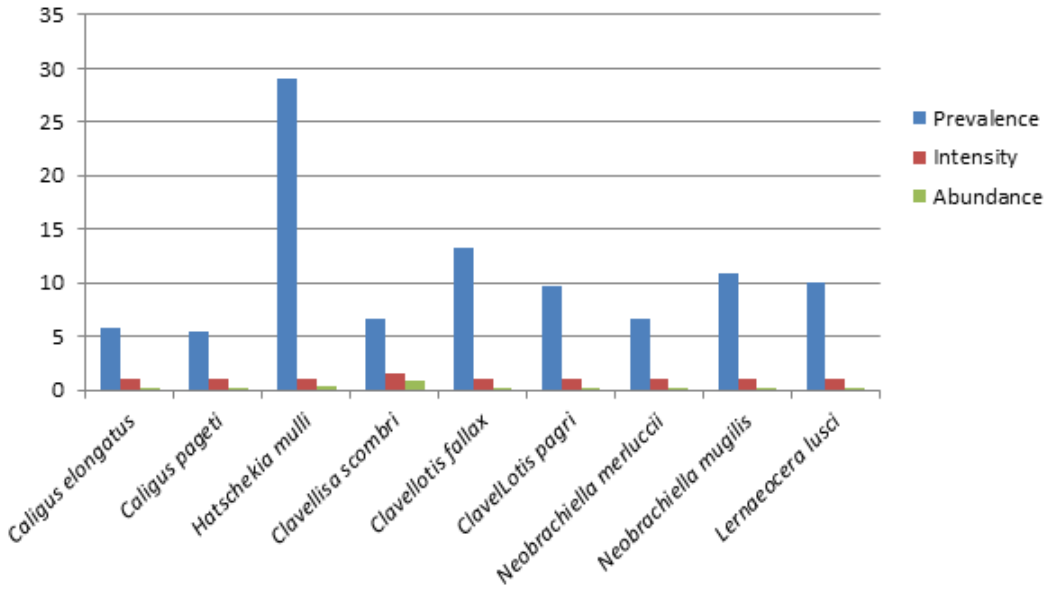

Figure 12. Epidemiological parameters of Copepods collected.

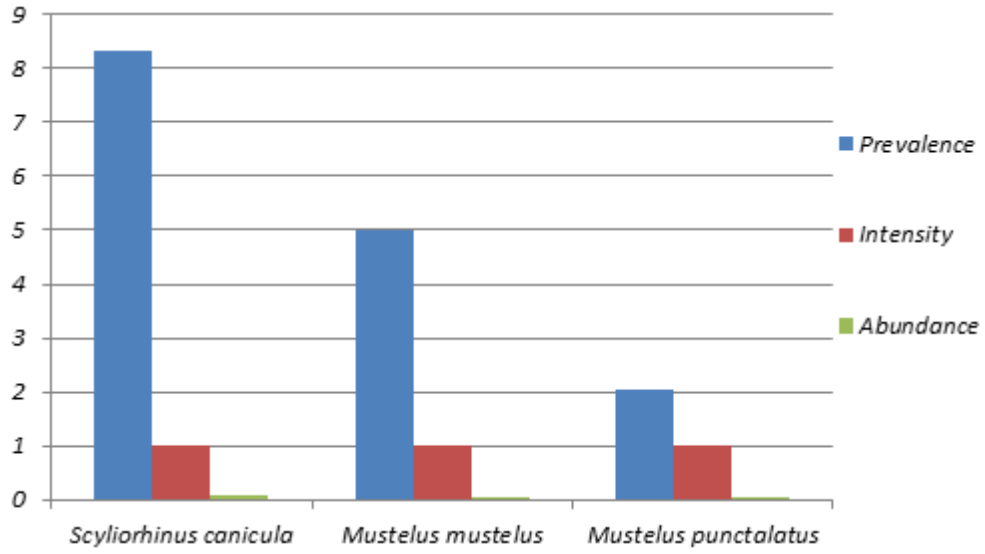

Figure 13. Epidemiological parameters of *Lernaeopoda galei*.

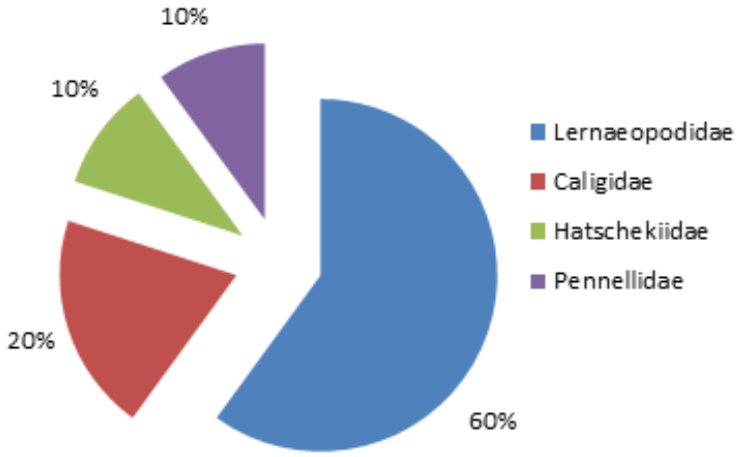

Figure 14. Richness of parasites per family.

can cause serious fish diseases, even though they present low parasitic indices. According to Company et al. (1999) and Athanassopoulou et al. (2001) parasites that have a low prevalence and abundance and minor pathological effects on their hosts in the wild can easily spreads in populations, confined to rearing systems and causing serious outbreaks of epizootic diseases.

Therefore, further investigations are still needed to deepen our knowledge of these ectoparasites of Teleost and Chondrichthyan fish.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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