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A Study of Parasitic Copepod Infesting Two Freshwater Fish Populations (*Cyprinus carpio* and *Abramis brama)* from Beni-Haroun Dam (Mila) North-East of Algeria

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Authors' contributions

This work was carried out in collaboration among all authors. The results of the article are part of author HB doctoral thesis. Author HB wrote her article from introduction to conclusion. Author MT participated in practical work in the laboratory and realization of the map and the statistical analysis. Author CB director of thesis, she participated in the revision of this article. All authors read and approved the final manuscript.

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ABSTRACT

Copepods are one of the main fish ectoparasites, commonly known among the parasitism world, due either to their special adaptive capacity or to induce stress in aquatic organisms, as well as the parasitism result is overall a physiological rate affecting the survival of host. This study was, therefore, aimed to investigate the ectoparasite copepods, infesting 277 fishes including 135 of *Cyprinus carpio* (Linnaeus, 1758) and 142 of *Abramis brama* (Linnaeus,1758), collected from Beni-Haroun dam (Mila, northeast Algeria). The fishes were subjected to some morphometric measurements and gill dissections and the harvested parasites were afterwards stored and identified. The parasitic indices were determined to examine the effect of size, sex, season and

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microhabitat on the parasitic infestation by using χ^2 test. The gill examination of individuals of the two host fishes led to harvest 135 copepods, including 127 individuals from *Cyprinus carpio* belonging to five species (*Ergasilus sieboldi, Ergasilus briani, Neoergasilus japonicus*, *Neoergasilus longispinosis* and *Lernaea cyprinacae)* and 8 individuals from *Abramis brama* belonging to the two species: *Ergasilus sieboldi* and *Ergasilus briani*, and hence *Cyprinus carpio* is the most infested species than *Abramis brama.* This study also revealed that the parasitic index values were high in *C. carpio* (P=53.00%; A=3.7; I=6.93) compared to *A. brama* (P=12,0.5%, A=0.12, I=1.00) during autumn, since no effect on infestation was noticed during winter. The statistical analysis has revealed the effect of season on parasitic copepod infestation in the two fish species (χ^2_{Obs} =30,959 > $\chi^2_{0.05}$ = 7,815, ddl =3), Since there was no effect due to the microhabitat and sex.

Keywords: Beni-Haroun dam; Cyprinus carpio; Abramis brama; parasitic parameters; copepods.

1. INTRODUCTION

The freshwater fishes are of concern, indeed, a one-third of known species would have disappeared or would be strongly threatened. These living beings found in the aquatic environment are subjected to various anthropogenic attack or natural attack, which mainly includes the parasitism exhibiting a very ubiquitous lifestyle where the individual species radically different and could live together in close relationship [1,2]. So far as known, the parasitism provides the benefit of only one species and makes an essential relationship with living organisms generally involves pathogen action, however, a good parasite does not kill its host [3, Bernard, 2014). Hence, they play a crucial role in the ecosystem processes as different as the regulation of free animals, the structuring of ecosystems or the acquisition of new forms of life. Fish ectoparasites are considered one of the most primary parasites represented by copepods often attached to fish gill arches and occupy an important place in parasitism due to their efficient adaptive capacity. Further, some copepod species can thus weaken the fish host and can negatively affect its body weight gain, reproduction and growth [4,5], while other species appeared even as very pathogenic and induced a massive mortality in infested fish populations [6,7,8,9].

Until now, very limited ecological and taxonomic studies investigating the parasites of freshwater fishes were performed in Algeria, among which those performed by Meddor (2009) on the original descriptions of the parasite entities discovered at the first time on freshwater ichthyofauna. Also, other authors have investigated the parasites of freshwater fish, in particular Cyprinidae family in some freshwater sites of northern Algeria including Bounamouca river [10], various water bodies of El-Kala National Parck (Aoun-Kaid and Chaib, 1994), Isser river (Boukhalfa, 2008), Oubeira lake [11, Mouaissia et al., 2107), various continental hydrosystems of the Aures regions and the northern Sahara [12], Foum El-khonga dam and Aineldalia region of Souk Ahras city (Brahmia, 2017) and Beni-Haroun dam [13,14]. Therefore, this work was devoted to study the parasites of freshwater fishes, and to provide an inventory of copepod parasites infesting two fish populations of Cyprinidae family (*Cyprinus carpio* and *Abramis brama*) from Beni-Haroun dam (Mila city, north–east of Algeria), and hence, the study focuses on the evaluation of epidemiological indices of parasites identified as a function of some biotic parameters, like sex, size, season and microhabitat.

2. MATERIALS AND METHODS

The study was conducted on freshwater fish of Beni-Haroun dam (Northeast Algeria), having an important hydraulic strategy with 120 m high and storage capacity of 960 million cubic meters reserve of water, noting also that the dam has started receiving water from August 2003. The dam is located in Mila province with convergence to Rhumel and Endja rivers of northwestern Graram region (northeast, Algeria). Mila province is 40 km away from Constantine province and feeds several provinces of northeast Algeria (viz., Jijel, Batna, Ouem elbaouaghi, khenchla and Constantine) by drinking water. Beni-Haroun water dam (Fig. 1) is intended to provide drinking water to more than one-quarter millions of citizens and few hectares and farms [15,16].

2.1 Sampling, Identification and Fish Dissections

In this study, the used fishes were randomly collected using gillnet (old fishing method also called as “catch fish”) and divided into 135

individuals of *C. carpio* and 142 individuals of *A. brama* (Meddour et al. 2011). The captured fishes were transferred to the Laboratory of Aquatic and Terrestrial Ecosystems of Souk-Ahras University of Algeria, and then the species identification was performed according to the nomenclature and criteria provided by Fischer et al. [17]. Thereafter, the identified fishes were weighed before being dissected, fish sex was determined, the gill arches were gently detached by two scissors (dorsal and ventral parts) and stored in pillboxes containing 70% ethanol.

2.2 Collection and Identification of Parasites

The collected copepod parasites were immediacy stored in pillboxes containing 5% formaldehyde, and labelled by the fish name, sampling date and sample number. The identification of the parasite species was focused on the parasite morpho-anatomical features according to a previously reported method [18].

2.3 Data Treatment Procedure

We have used the parasitic indices (Prevalence, Intensity and Abundance) proposed by Margolis et al., [19] and Bush et al., [20] in order to describe the levels of parasite loads.

2.4 Statistical Analysis

The independence between parasitic indices and various studied factors including seasons, sexes, size classes and microhabitat were statistically analysed by χ^2 test, using Statistica Software, for Microsoft Windows (version 8.0) where $p<0.05$ was considered significant.

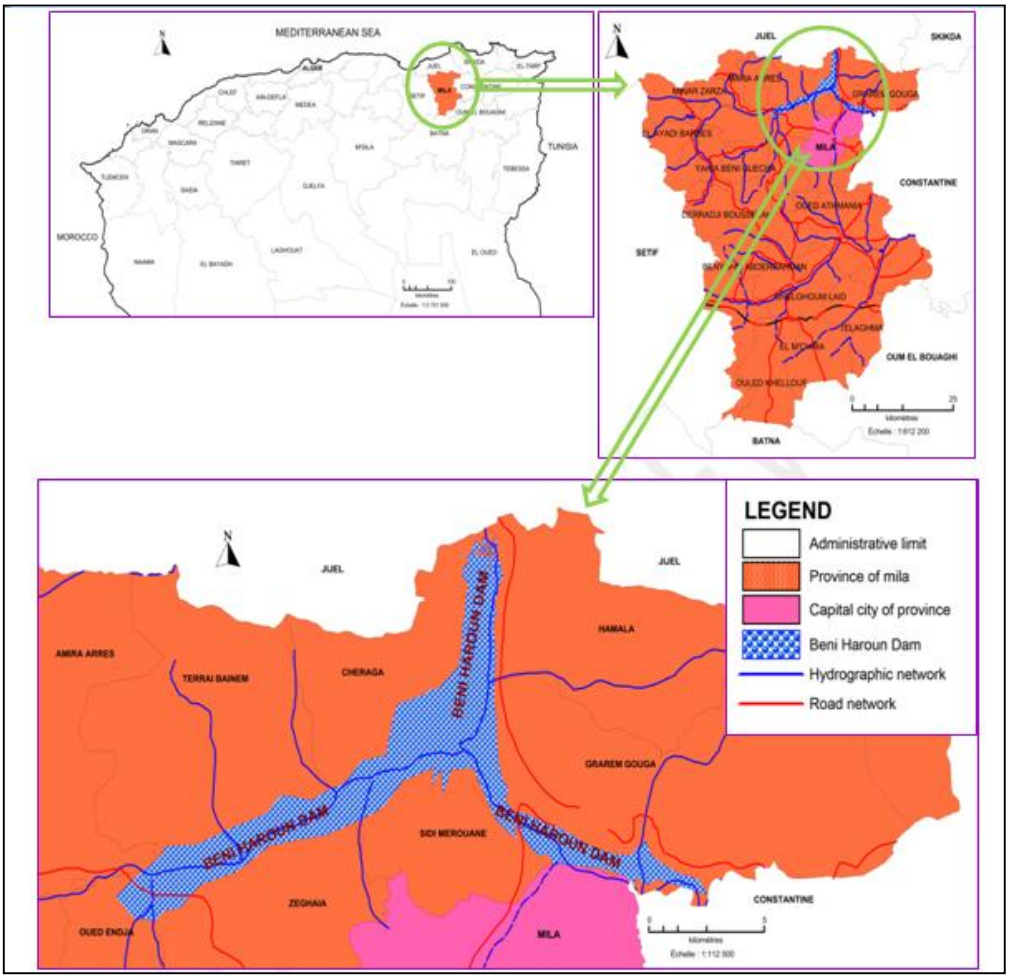

Fig. 1. Map showing the sampling site of Dam Beni-Harroun (Berrouk, 2019)

3. RESULTS

Among the 135 gill fishes of *Cyprinus carpio*, five species of copepod parasites (*Ergasilus sieboldi, Ergasilus briani*, *Neoergasilus japonicas, Neoergasilus longispinosis* and *Lernaea cyprinacae)* were collected, while only two species (*Ergasilus sieboldi* and *Ergasilus briani*) were collected from 142 fishes of *Abramis brama*.

3.1 Epidemiological Indices

3.1.1 Variations of parasitism is the function on the number of collected copepods in *Cyprinus carpio* and *Abramis brama*

The parasitic indices of the collected copepods in *C. carpio* showed highest prevalence values in *E. briani* (P=7.40%) and *L. cyprinacea* (P=5.92), since the highest values of intensity and mean abundance were noticed in *E. sieboldi* (I=6.66; A=0.26), where the collected copepods were recorded (P=3.52, I=1.00, A=0.03). The *A. brama* revealed the highest values of parasitic indices (Fig. 2).

3.1.2 Variation of parasitism is the function of seasons

The highest parasitic indices of five parasitic copepod species collected in *C. carpio* were observed during autumn (P=53.33%; A=3.7?; I=6.93), and the lowest values were noticed in winter (P=5.4?, A=0.05, I=1.??). Whilst, *A. brama* revealed high values of prevalence and abundance (P=12.5?%; A=0.12) in autumn along with the same intensity value during spring and summer, but no parasitic infestation was observed during winter (Fig. 3).

The prevalence values showed the season effect on the parasitic infestation in the two host species of *C. carpio* and *A. brama* (χ^2 obs =30,959 > $\chi^2_{0.05}$ =7,815; ddl=3)

3.1.3 Variation of parasitism is the function of host fish sex

The parasitic indices of *C. carpio* showed the highest values of prevalence in males (P=26.02%), since the abundance and intensity were respectively high in females of the same host species (A=1.06; I=5.07). However, the species *A. brama* revealed high prevalence and abundance values in females (P=9,09; A=0,09), but the intensity was found to be the same in both sexes of the same host species (I=1.??) (Fig. 4). Both fish sexes appeared to have no effect on the parasitic copepod infestation in the two host species (χ^2 obs = 2.451< 0.05=$\chi^2_{0.05}$ 3.841;ddl=1).

3.1.4 Variation of parasitism is the function of fish host size

The parasitic indices of copepods identified from different size classes of *C. carpio* showed that specimens of sizes higher than 40 cm exhibit the highest prevalence levels (P=100%). Regarding the abundance and intensity, the highest values

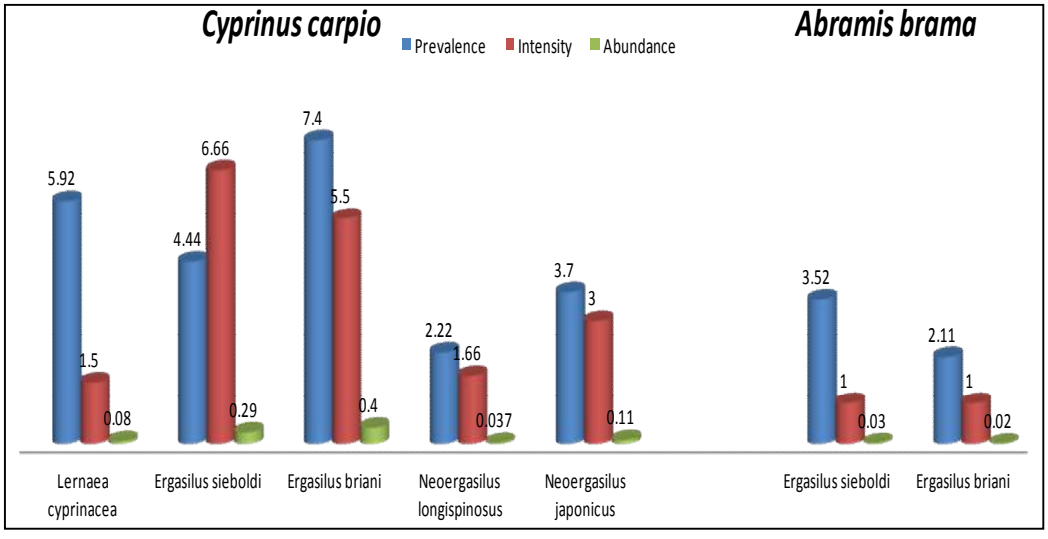

Fig. 2. Distribution of prevalence (P%), Intensity (I) and Abundance (A) of the collected copepods in two host species of *Cyprinus carpio* and *Abramis brama*

were noticed in the specimens of size class of 35-40 cm, where A=2.?? and I= 9.37. On top of that, the parasitic indices of copepods identified in various classes of *A. brama* showed that the specimens of the small size of 15-20 cm exhibit the highest values of prevalence (P=33.33%), while the abundance and intensity were found to be equal or nearly the same (Fig. 5).

3.1.5 Variation of parasitism is the function of micro-habitat

The distribution of the parasitic indices of copepods collected from the two gill arches of *C. carpio* showed a slight increase in the prevalence (P=12.59%) in the left gill, but the abundance and intensity were slightly increased in the right gill (A=0.48; I=4.44). Likewise, a slight increase was noticed in the prevalence and abundance in the right gill arches (P=3.52; A=0.03), since the intensity was found as the same in both gill arches (I=1.??) (Fig. 6).

However, the prevalence did not differ in the two gill arches (left and right gills) of both the studied species (χ^2 obs = 0.44< $\chi^2_{0.05}$ =3.841,ddl=1), which statistically explained that the microhabitat had no effect on the parasitic copepod infestations.

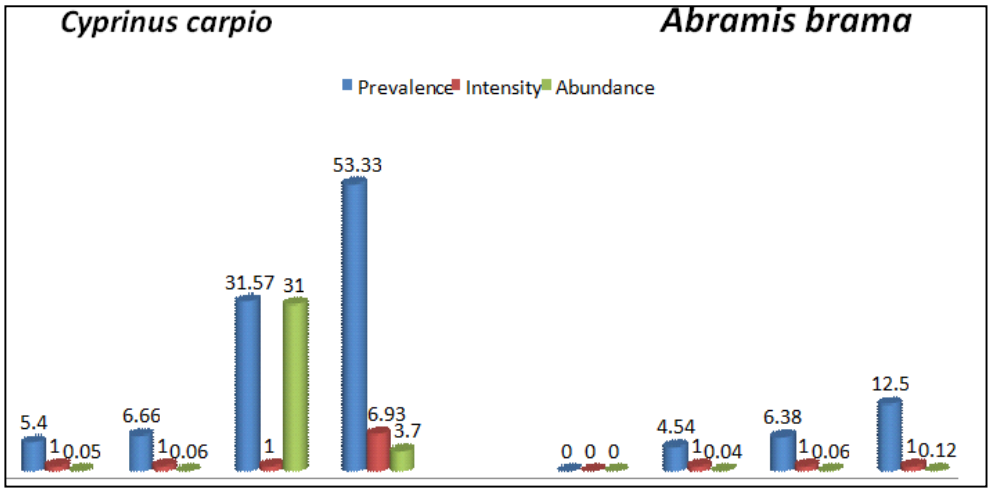

Fig. 3. Seasonal variation of prevalence (P%), Intensity (I) and abundance (A) in two host species of *Cyprinus carpio* and *Abramis brama*

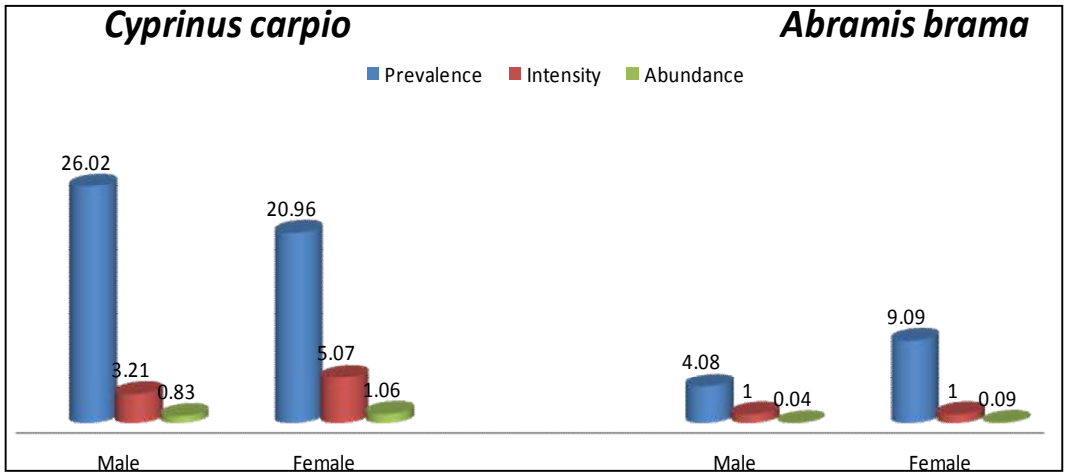

Fig. 4. Distribution of prevalence (P%), Intensity (I) and Abundance (A) of parasitic copepods is the function of sex in two host species of *Cyprinus carpio* and *Abramis brama*

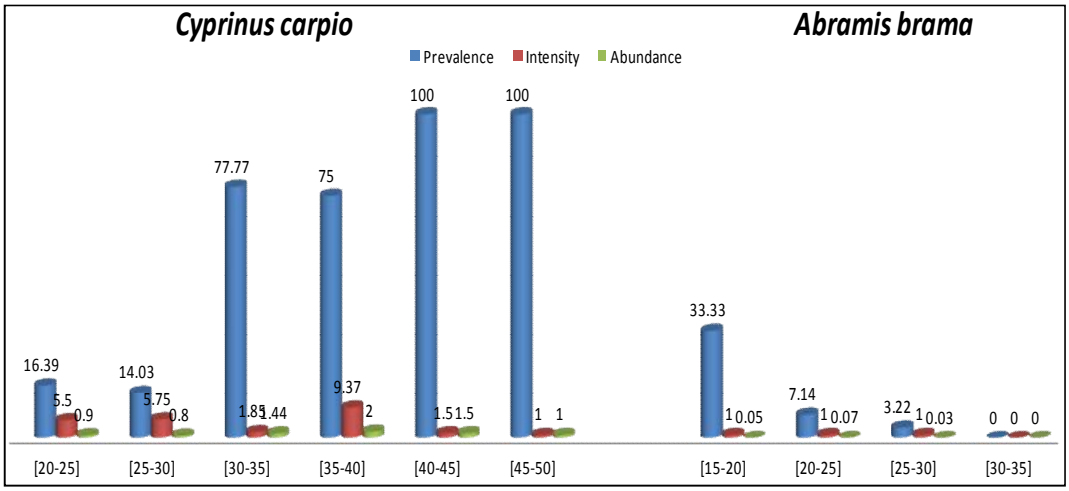

Fig. 5. Distribution of prevalence (P%), Intensity (I) and Abundance (A) of the collected copepods is the function the size classes in two host species of *Cyprinus carpio* and *Abramis brama*

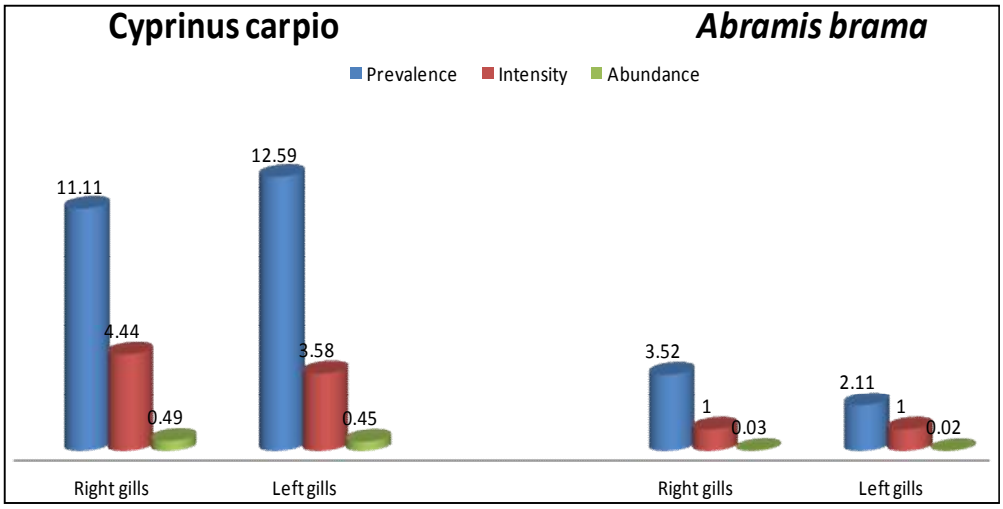

Fig. 6. Distribution of prevalence (P%), Intensity (I) and Abundance (A) in two gills of the two host species of *Cyprinus carpio* and *Abramis brama*

4. DISCUSSION

The findings of the present study revealed a very weak parasitic infestation in Beni-Haroun dam, where the examination of 135 individuals of *Cyprinus carpio* and 142 individuals of *Abramis brama* promoted us to collect 127 individual parasites in carp and 8 individual parasites in bream, thus suggesting that *C. carpio* sheltered parasites 15 times more than *A. brama* species. The study also showed the existence of inequality in parasitism against both host species. In this regard, other study conducted on Obeira Lake had proved that *Luciobarbus callensus* can shelter a number of parasites 11 times more than *C. carpio* (Brahmia, 1995), and according to Combes [21], this variation could be resulted from genetic factors, the age of host and even the presence of other parasites. The morphometric features of the inventoried parasites of the gill arches of the two species lead to identify five species, among which three parasite species (*Neoergasilus japonicus, Neoergasilus longispinosis* and *Lernaea cyprinacea*) were found in *C. carpio,* since the two other ones (*E. briani* and *E. sieboldin)* are common in the two host species. Furthermore, the parasitic indices of the collected copepods

were variably distributed in the two host species, and the highest prevalence values in *C. carpio* were noticed by *E. briani* and *Lcyprinacea*. In addition to that, the highest parasitic loads were evidenced by *E. sieboldin*, but the index in *A. brama* species was presented by *E. sieboldin*, exhibiting the highest prevalence and parasitic loads. Thus, parasite infestations in various aquatic organisms have been well-documented in many works including those performed in lake Balatonen (Bulgary) showing *E. sieboldi* as a parasite species on the gill of *C. carpio, A. brama* and *Carassus carassus* [22], the parasite species *L. cyprinacea* and *Ergasilus* sp. were found in *Luciobarbus callensus* and *C. carpio in* Bounamoussa river and Oubeira lake [10], and also Chaibi [11] reported that the parasite *Ergasilus* sp. was found in *L. callensus* in Timgad dam (Batna city, North-eastern Algeria) and *Lernaea cyprinacea* in Ghardia (South Algeria) river. Further, Reza et al. [23] had reported the presence of *L. cyprinacea* as a parasite species on the gills of *C. carpio* in Iran region, and Boucenna [12] found the parasite *L. cyprinacea* in the gill of *C. carpio* and *L. callensus* in Foum Elkounga and Ain Eldalia dams, and the parasites *Neoergasilus japonicus* and *Neoergasilus longispinosis* in the gills of *L. callensus ,C. carpio* and *C. carassus,* as well as no parasitic infestation was noticed in *A. brama* in the same zones and periods of study. Mokliayer (1981) and Jalali [24] had identified *L. cyprinacea* as the most harmful species in Cyprinidae family. Moreover, Piasecki et al. [9] confirmed that *E. sieboldi* has no specificity on the host and thus, it can infest the majority of freshwater fishes and cause a major parasitic disease for the worldwide aquaculture. In contrast, Euzet and Combe [25] have criticized this study by the reason of using only one host, although the parasite using many hosts are known as generalist parasite, and according to Kitahara and Fuji [26], the concepts "generalist and specialist" are relatives. Noteworthy, the evaluation of the parasitic indices revealed that the five collected copepod species from the two host species show variation as a function of seasons, i.e the infestation rate and parasitic loads are highly increased in the species *C. carpio A. brama* during autumn along with no parasitic infestation during winter. This variation is likely due to the increased temperature even during the autumn period, after its elevation during summer. Boualleg et al. [27] reported that the isopod *Gnathia* sp. markedly infests its hosts during autumn and summer, and Aliniaeema et al. (2015) reported that the prevalence and intensity of copepods infesting *C. carpio, C. Auratus* and six other host fishes are highly increased during autumn and summer in three sites of El-basrah (Iraq). Additionally, Boucenna [12] had shown that the monthly collected crustacean from gills of *C. carpio* and *L. callensus* from Foum-Elkhonga dam revealed the highest infestation levels during autumn and then during summer, meanwhile the highest parasitic loads were observed during winter in males of *L. callensus.* A study conducted in Finland on Ergasilidae copepods did not reveal a regular seasonal phenomenon, indicating subsequently that *N. japonicus* could breed or recruit on the fish hosts not only due to a higher temperature but also to a lower temperature in autumn and winter [28]. Benmansour [29] reported the crucial role of seasons in the development and the abundance of copepod parasites, as well as the temperature, was found to be one of the main factors acting in the seasonal fluctuations of parasite populations, and here Koskivaara et al. [30] proved that water temperature change is generally considered as one of the highly important factors determining the presence and abundance of parasites. Regarding the variation of parasitism as a function of sex, the parasitic indices were highly increased in females of *C. carpio* and *A. brama,* but no significant difference in the prevalence of the collected copepods was observed between fish sexes, thus indicating that both sexes are equally infested. Some authors have reported the effect of sex on parasitic infestation, and among them, Koyun et al. [31] showed no sex effect on parasitic infestation of *Paraergasilus longidigitus* in *A. alburnus* species in Enne Dam (Turkey). Ramadane [32] indicated from eastern Algeria that just *Argulus sp* appeared a preference on female hosts. Allalgua et al., [33] had found no effect of sex of *C. carpio* infested by monogen parasites from Foum- ElKhanga dam, and Boucenna [12] have reported that females of *C. carpio* are highly affected than males, however, males of *L. Callensus* are the most infested and no significant difference in the prevalence and intensities of the collected copepods was noticed between fish sexes. Conversely, Abdelhusein [34] found that the prevalence of *Ergasilus* sp. is affected by sexes of *C. carpio* and *O. niloticus*, and similarly, Anvarifar et al. [35] found significant differences in copepod *Tracheliastes polycolpus* infestation between both sexes of *Capoeta gracilis.* Therefore, the parasitic copepods infesting fish hosts do not choose between fish sexes. On the other hand, the distribution of parasitic indices of gill

ectoparasites as a function of host fish sizes had shown that in *C. carpio*, the fishes of high size ranging from 45 to 50 are highly infested, and this is in line with the work conducted in the same study zone by Berrouk et al. [14]. Further, Morand et al. [36] found a positive relation between host sizes of 36 marine fish species and the ectoparasite infestation in the case when data are phylogenetically controlled. Moreover, the work of Brahmia (2017) conducted on Oubeira Lake had indicated that the monogen *Dactylogyrus anchoratus* infests the big sized carps as compared to those of small size, and the copepod, *Argulus foliaceus* infests the specimens of big sized carps, while the work of Tolba et *al,* [13] conducted on Beni-Haroun dam revealed that the nematodes never infest the small individuals of *Luciobarbus callensus* and the cestodes infest the individuals whose sizes are ranging between 30 and 35. What's more, Winermiller et Rose [37] had reported that big sized hosts are overall, those surviving longer and so they become susceptible to be exposed during long period to infestation by new parasite species. Accordingly, Zelmer and Arai [38] found that the older poles and the big size hosts have a tendency to host a large number of parasite species and greater parasitic infra-communities, and Sasal et al. [39] suggested that the big sized hosts are susceptible to offer a large number of niches to parasites and likely have been exposed during long period. Furthermore, Zapata et al. [40] had mentioned that the biggest fishes could have more different parasite species compared to those of small size. As previously reported [41,42,43,44], the big sized fishes have great gill surface to host many parasites. But, Ramadane (2010) indicated that the identified ectoparasites of the teleost fishes in eastern Algeria infest the specimens of different size classes. Furthermore, the distribution of the parasitic indices of the collected copepods in gills of *C. carpio* revealed that the left gills were found to be highly infested as compared to right gills, and inversely in *A. brama*, showing that the right gills are the most infested. In parallel, the work of Boualleg [45] conducted on three species of the genus *Pagellus* in eastern coast of Algeria had revealed that left gills are the most infested than the right ones. Meanwhile Boucenna et al. [46] had shown from Foum El-Khonga dam that the infestation affects equally the aches of the two gills (right and left gills) in *C. carpio*n, and this author in 2017 found in the same study zone that the infestation level in *L. callensus* by copepod parasites were found to be almost equal in both gills, and from Ain Eldalia dam (North-eastern Algeria), the author had found the highest level of parasitic infestation and loads in the right gills of *C. carpio*.

5. CONCLUSION

The examination of 277 fishes belonging to two species (*C. carpio* and *A. brama)* in Beni-Haroun dam (Mila, Algeria) promoted us to collect 135 parasites, including 127 copepods in *C. carpio* attached to five species, namely *E .sieboldi, E. briani, N. japonicus N. longispinosis* and *L. cyprinacae,* and eight copepods in *A. brama* attached to two species: *E. sieboldi* and *E. briani.*

Conclusively, the present study highlighted the following points:

- The two studied host species were not equal against parasitism.
- *Cyprinus carpio* was the most infested species by copepod parasites.
- The copepod parasites infested the two host species during autumn period.
- The parasitic infestation was low or absent during winter period.
- The specimens of the big and medium sizes were the most infested in the two host species.
- The sex and microhabitat revealed no effect on the parasitic infestation in the two host species.

Consequently, it seemed worthwhile to develop the following points:

- Extend such a study on other fresh water surfaces, like dam, lakes and even rivers in the Algerian territory.
- Display such a study to other teleost fishes of several other families to search for their parasitic copepods.
- Remove the sampling effort that can show the importance in estimating the specific parasitic richness.
- Study the pathogenic effect of the identified copepod parasites and to evaluate its effect on the growth and development of host fishes.
- Evaluation of the impact of certain parameters (temperature, salinity, pH and pollution) on parasite diversity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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