

# Population dynamics of *Lernaea cyprinacea* (Crustacea: Copepoda) on four cyprinid species

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**ABSTRACT:** A total of 217 *Barbus graellsii*, 54 *Barbus haasi*, 417 *Cyprinus carpio* and 85 *Leuciscus cephalus* captured at 9 sampling stations in the central basin of the Llobregat River (NE Spain) were studied for *Lernaea cyprinacea* parasitism. Prevalence (*B. graellsii* 39.2, *B. haasi* 31.5, *C. carpio* 8.4, *L. cephalus* 48.2), intensity of infection (*B. graellsii* range 1 to 39, mean 4.6; *B. haasi* range 1 to 7, mean 2.6; *C. carpio* range 1 to 16, mean 3.1; *L. cephalus* range 1 to 8, mean 2.4), and abundance (*B. graellsii* 1.80; *B. haasi* 0.83; *C. carpio* 0.26; *L. cephalus* 1.15) varied with the fish species studied. Correlations between abundance and host size were positive and significant for *B. graellsii* and *L. cephalus*. Correlation was positive but non-significant for *B. haasi*. Correlation between intensity and fish size was positive but not significant for *B. graellsii*, *C. carpio*, and *L. cephalus*. This is the first record of *L. cyprinacea* infecting *B. graellsii* and *B. haasi*.

**KEY WORDS:** *Lernaea cyprinacea* · Infection levels · *Barbus graellsii* · *Barbus haasi* · *Cyprinus carpio* · *Leuciscus cephalus*

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## INTRODUCTION

*Lernaea cyprinacea* L. is a cosmopolitan copepod parasite of freshwater and marine fishes. In Europe, its main hosts are cyprinid fishes (Kabata 1979). In Spain, previous records of the genus *Lernaea* on cyprinids are provided by Simón Vicente et al. (1973), Álvarez Pelitero et al. (1979), Carbonell et al. (1992), Sterling et al. (1995), and Pérez-Bote (2000). Host size is an important determinant of the structure of ectoparasite assemblages (Gregory & Woolhouse 1993, Hayward et al. 1998). In fish populations, parasite abundance (Lo et al. 1998) and intensity of infection (Poulin 2000) of meta-zoan parasites increase with the age or size of the host. Older fish have had longer to accumulate parasites than have younger ones. Being larger, they provide more internal and external space for parasite establishment, and they have higher infection rates because they offer a larger contact area for parasite attachment (des Clers 1991). The relationship between the size of cyprinid fishes and *L. cyprinacea* infections has been studied by Amin et al. (1973), Dorovskikh (1993) and Pérez-Bote (2000).

Consequently, the aims of this study were to determine the prevalence, intensity, and abundance of *L. cyprinacea*, to analyze the relationships between infection levels and host size, and to compare the infection levels between host species among 4 cyprinid species of the central basin of the Llobregat River (NE Spain).

## MATERIALS AND METHODS

A total of 217 *Barbus graellsii* Steindachner (length 7 to 34.6 cm, mean 21.2 cm, standard deviation 5.1), 54 *Barbus haasi* Mertens (length 7.5 to 25.5 cm, mean 15.0 cm, standard deviation 3.7), 417 *Cyprinus carpio* L. (length 5.2 to 46.0 cm, mean 20.7 cm, standard deviation 5.4), and 85 *Leuciscus cephalus* L. (length 8.5 to 26.6 cm, mean 16.0 cm, standard deviation 3.9) were captured by electro-fishing, over a period of 16 mo, at 9 sampling stations in the central basin of the Llobregat River (NE Spain). Fish were transported immediately to the laboratory in plastic bags. Each fish was measured (total length in cm) before observation. The external surface of the fish was examined micro-

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scopically for *Lernaea cyprinacea*. Copepods were fixed in 70% ethanol and transferred to Berlese's solution. Parasites were mounted and identified following Kabata (1979). Prevalence, intensity and abundance of infection were recorded (Bush et al. 1997). The parasites were ascribed to 1 of the 5 sites: fins, gills, nasal cavities, oral cavity, or skin. The percentage of parasites on each of the sites was calculated. Correlations computed across average values for different size classes are excluded to ensure that variation among individual fish was retained (Pacala & Dobson 1988).

Spearman's rank correlation coefficients between fish length and number of parasites per individual host were calculated. Differences in infection levels between species were tested for significance using Mann-Whitney *U*-tests. Statistical testing was performed using SPSS, version 12.0.

## RESULTS

*Lernaea cyprinacea* was the only crustacean found on cyprinids captured in the central basin of the Llobregat River (NE Spain). Severe lesions including haemorrhages and occasional ulcers and fibrous nodules were evident in parasitized fish. The infection parameters obtained are given in Table 1. The number of parasitized fish, number of parasites collected, prevalence and percentage of *L. cyprinacea* at each location on the 4 cyprinid species are given in Table 2. The correlation coefficients and the significance between abundance and intensity of infection are given in Table 3. This is the first record of *L. cyprinacea* on *Barbus graellsii* and *B. haasi*.

The highest parasite burdens and mean intensity were found on fish of more than 16.0 cm on all 4 host

Table 1. Parasitism indices of *Lernaea cyprinacea* on 4 cyprinid species

Species	No. of examined fish	No. of parasitized fish	Prevalence	No. of parasites collected	Intensity of parasitism		Abundance
					Range	Mean	
<i>Barbus graellsii</i>	217	85	39.2	390	1–39	4.6	1.80
<i>Barbus haasi</i>	54	17	31.5	45	1–7	2.6	0.83
<i>Cyprinus carpio</i>	417	35	8.4	110	1–16	3.1	0.26
<i>Leuciscus cephalus</i>	85	41	48.2	98	1–8	2.4	1.15
TOTAL	773	178	23.0	643	1–39	3.6	0.83

Table 2. Location of *Lernaea cyprinacea* on 4 cyprinid species; a = no. parasitized fish, b = prevalence, c = no. parasites collected, d = % parasites collected

Site	<i>Barbus graellsii</i>				<i>Barbus haasi</i>				<i>Cyprinus carpio</i>				<i>Leuciscus cephalus</i>			
	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
Fins	59	27.2	195	50.0	11	20.4	28	62.2	28	6.7	77	70.0	32	37.6	65	62.3
Gills	28	12.9	77	19.7	8	14.8	9	20.0	6	1.4	10	9.1	9	10.6	11	11.2
Nasal cavities	7	3.2	10	2.6	0	0.0	0	0.0	0	0.0	0	0.0	1	1.2	1	1.0
Oral cavity	17	7.8	56	14.4	1	1.9	1	2.2	0	0.0	0	0.0	1	1.2	1	1.0
Skin	28	12.9	52	13.3	5	9.3	7	15.6	15	3.6	23	20.9	15	17.6	20	20.4
TOTAL			390	100.0			45	100.0			110	100.0			98	100.0

Table 3. Correlation coefficients and significance between the number of *Lernaea cyprinacea*/location and length on 4 cyprinid species. \**p* < 0.001; \*\**p* < 0.05; *r* = Spearman's rank correlation coefficient

Site	<i>Barbus graellsii</i>		<i>Barbus haasi</i>		<i>Cyprinus carpio</i>		<i>Leuciscus cephalus</i>	
	Abundance <i>r</i>	Intensity <i>r</i>	Abundance <i>r</i>	Intensity <i>r</i>	Abundance <i>r</i>	Intensity <i>r</i>	Abundance <i>r</i>	Intensity <i>r</i>
Fins	0.254*	0.275**	0.143	–0.097	–0.022	0.130	0.325*	0.215
Gills	0.385**	0.356	0.163	0.247	0.005	0.778	0.198	0.000
Nasal cavities	0.154**	0.668	–	–	–	–	–	–
Oral cavity	0.293*	0.451	–	–	–	–	–	–
Skin	0.201*	0.224	0.124	–0.296	–0.049	0.259	0.277**	0.410
TOTAL	0.378*	0.340*	0.220	–0.027	–0.061	0.182	0.450*	0.183

species. Thirty-nine *Lernaea cyprinacea* were found on a *Barbus graellsii* measuring 26.7 cm. Sixteen *L. cyprinacea* were found on a *Cyprinus carpio* 20.0 cm in length. The lowest prevalence of *L. cyprinacea* was found on *C. carpio*, but on this host species the range and mean intensity were higher than the range and mean intensity found on *Barbus haasi* and *Leuciscus cephalus* (Table 1).

The highest prevalences were found on fins, gills and skin. *Lernaea cyprinacea* was not found in the nasal cavities of *Barbus haasi* or *Cyprinus carpio* whilst it was found in the nasal cavities of 1 *Leuciscus cephalus*. The copepod was not found in the oral cavity of *C. carpio*, but it was found in the oral cavities of only 1 *B. haasi* and another *L. cephalus*. Higher percentages of *L. cyprinacea* were found on fins than on gills and skin. On *B. graellsii*, *L. cyprinacea* was found in nasal and oral cavities only on those fish which showed a higher total parasite load (Table 2).

Statistically significant differences ( $p < 0.001$ ) occurred between the parasite abundance of *Cyprinus carpio* and the parasite abundances of the other 3 cyprinid species. There were no statistically significant differences between parasite abundance in *Barbus graellsii* and *B. haasi* or between parasite abundance in the 2 barbell species and *Leuciscus cephalus*. There were no statistically significant differences in intensity in the 4 cyprinid species studied.

As regards parasite locations, there was a statistically significant difference ( $p < 0.001$ ) between *Lernaea cyprinacea* abundance on fins and gills of *Cyprinus carpio* and on fins and gills of the other cyprinid species. There were statistically significant differences ( $p < 0.01$ ) between parasite abundance on the skin of *C. carpio* and the skin of *Barbus graellsii* and *Leuciscus cephalus*. When intensity was compared, the differences were seen to be statistically significant ( $p < 0.05$ ) between parasitism levels of *B. haasi* and *C. carpio* in gills. Parasitism levels of nasal and oral cavities were not compared because parasites were not found at these sites on the 4 fishes studied.

The correlation between fish length and parasite abundance was positive and significant on *Barbus graellsii* and *Leuciscus cephalus*, with the exception of the gills of *L. cephalus*. On *B. haasi*, the correlation was positive but not significant, and on *Cyprinus carpio* the correlation was negative (with the exception of the gills). The correlation between fish size and intensity of infection was positive but not significant on *B. graellsii*, *C. carpio*, and *L. cephalus*. This correlation was significant on the fins of *B. graellsii* (Table 3).

Statistically significant differences were found between parasite abundance on *Cyprinus carpio* and parasite abundance of the other 3 studied cyprinids; however, the differences were not statistically signifi-

cant when the intensity of the 4 fish species was compared (Table 3), even though parasite range was greater in *Barbus graellsii* and *C. carpio* than in *B. haasi* and *Leuciscus cephalus*.

## DISCUSSION

The general preference of *Leuciscus cyprinacea* for cyprinid fishes is evident in records of no fewer than 46 species of Cyprinidae (Kabata 1979). These records did not include *Barbus graellsii* or *B. haasi*, 2 barbell species endemic to Spain.

Álvarez Pellitero et al. (1979) found *Lernaea* sp. on 5 cyprinid species in the Esla River (NW Spain) with lower prevalences than those found on the 4 fish species in the present study, although only 2 species, *Cyprinus carpio* and *Leuciscus cephalus*, were common to both studies. Sterling et al. (1995) found *Lernaea cyprinacea* on *Chondrostoma toxostoma miegii* Steindachner, another cyprinid species; the prevalence was similar to that determined for *Barbus graellsii* and *B. haasi* in this study, but higher than the prevalence we ascertained for *C. carpio* and lower than that for *L. cephalus*. Pérez-Bote (2000) found, in a study of 3 cyprinid species of the Guadiana River (SW Spain), a higher prevalence in *Barbus sclateri* Günther than the prevalence found on *B. graellsii* and *B. haasi*, and a lower prevalence in *Leuciscus alburnoides* Steindachner than that found on *L. cephalus*. However, this author classes the fish by size making it difficult to compare the data with the results of the current study.

It is difficult to account for the differences in infection levels between the 4 fish hosts. *Barbus graellsii* had a higher range of parasitism than the other 3 fish species studied, and the range of parasitism of *Cyprinus carpio* was higher than the ranges of *B. haasi* and *Leuciscus cephalus*, whose parasitism ranges were similar. These facts could not be explained only by fish behaviour because the 4 hosts are benthic species. Therefore, more studies will need to be conducted on the epidemiology of infection by *L. cyprinacea* on these host species.

A number of studies have investigated the differences in parasitism levels of *Lernaea cyprinacea* on host species (Amin et al. 1973, Saraiva & Valente 1988, Sterling et al. 1995, Dorovskikh 1996, Pérez-Bote 2000). In the present study, the preferred site was the fins, where the highest percentage and prevalence were observed for all 4 host species. The cyprinid species studied seem to be mainly located in the fins. In agreement with Medeiros & Maltchik (1999), one hypothesis proposed to explain this site preference was that *L. cyprinacea* shows a preference for locations which offer greater protection against currents.

The relationship between fish size and parasite abundance and intensity may vary from statistically non-significant to highly significant (Marcogliese 1991, Lo et al. 1998, Poulin 2000). The present study verifies the above hypothesis, with the proviso that its validity depends on the fish species and the attachment site of *Lernaea cyprinacea*. Thus, the correlation between fish length and parasite abundance was positive and significant on *Barbus graellsii* and *Leuciscus cephalus* both for the fish as a whole and at the sites where *L. cyprinacea* was found on these fish species. On *B. haasi*, the correlation was positive but not significant, and on *Cyprinus carpio* the correlation was negative. This did not occur on gills where the correlation was positive but not significant although, in this fish species, only 6 *L. cyprinacea* were collected from the gills.

In contrast, the correlation between fish size and intensity was positive but not significant on *Barbus graellsii*, *Cyprinus carpio* and *Leuciscus cephalus*, in agreement with Pérez-Bote (2000). On *B. graellsii*, this correlation was, however, positive and significant for the fins. On *B. haasi*, the cited correlation was negative, in accordance with Amin et al. (1973) and Álvarez Pellitero et al. (1979), who found that smaller or younger fish tended to be more heavily infected than larger ones.

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