

Parasite populations of the European eel (*Anguilla anguilla* L.) in the Rivers Ulla and Tea (Galicia, northwest Spain)

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Abstract

A two-year study was performed of the parasite fauna of the European eel in two rivers, the Ulla and the Tea, in the region of Galicia in northwest Spain, with monthly sampling. A total of 523 eels were captured, and a total of 20 parasite species identified: 7 protozoa (*Trypanosoma granulosum*, *Eimeria anguillae*, *Myxidium giardi*, *Myxobolus portucalensis*, *Hofferellus gilsoni*, *Ichthyophthirius multifiliis* and *Trichodina jadranica*), 12 helminths (*Pseudodactylogyrus anguillae*, *Pseudodactylogyrus bini*, *Nicola gallica*, *Diplostomum* sp., *Bothriocephalus claviceps*, *Paraquimperia tenerrima*, *Spinitectus inermis*, *Cucullanus heterochrous*, *Pseudocapillaria tomentosa*, *Anisakis simplex* L₃ larvae, *Anguillicola crassus*, and *Acanthocephalus clavula*) and a copepod (*Ergasilus gibbus*). This is the first report for *M. portucalensis*, *T. jadranica*, and *P. tomentosa* from Spain, and for *N. gallica* from the Iberian Peninsula. Statistically significant differences in prevalence were observed between the two rivers only in the cases of *T. granulosum*, *T. jadranica*, *Diplostomum* sp. and *C. heterochrous*. The presence of some species was positively correlated with host body length. Some species pairs showed positive or negative mutual correlations of presence, but only for the pair *T. granulosum*–*Pseudodactylogyrus* spp. were there statistically significant correlations in both rivers.

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1. Introduction

The European eel (*Anguilla anguilla* L.) is a fish of growing commercial value. In recent years there has been rapid development in various European countries

of commercial on-growing culture of eels, generally in freshwater. This reflects declining natural populations and increasing demand.

The environmental conditions seen in fish farms (overcrowding, poor hygiene, temperature variations, etc.) greatly favour disease transmission. This means that parasites present in the fish farm's natural environment may have a very significant impact on the captive fish populations. There is thus clearly a need

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to have a good knowledge of parasites affecting natural fish populations in fish-farming areas: in the present case, parasites infecting eel populations in Galicia (northwest Spain).

There have been numerous previous studies of the parasite fauna of the European eel in freshwater environments (Carvalho-Varela et al., 1984; Conneely and McCarthy, 1986; Orecchia et al., 1987; Køie, 1988a,b; Orecka-Grabda and Wierzbicka, 1994; Kennedy, 1997; Schabuss et al., 1997; Kennedy et al., 1998; Borgsteede et al., 1999; Sures et al., 1999; Kennedy and Hartvigsen, 2000; Di Cave et al., 2001; Maillo et al., 2001; Sures and Streit, 2001). In Spain, two studies of eel parasite faunas in marine environments have been published recently (Outeiral et al., 2001, 2002), but little is known about eel parasite faunas in freshwater environments in the Iberian Peninsula.

In the present study we describe the parasite fauna of the European eel in rivers of the region of Galicia in northwest Spain. We investigated possible influences on parasite faunas and infection intensities of host habitat type and host length, and also considered possible interactions between different parasite species.

2. Materials and methods

Sampling was carried out over a two-year period in two of Galicia's major river basins, those of the River Ulla and the River Miño. Eels were sampled at two permanent ichthyological stations run by the Xunta de Galicia, at Ximonde (River Ulla) and A Freixa (River Tea, a tributary of the Miño). These stations have fish-trapping systems for routine monitoring of fish populations, and we took advantage of this system to obtain monthly eel samples over the period January 1999–December 2000 for the River Ulla (total 323 eels) and the period May 1999–April 2000 for the River Tea (total 200 eels). In both rivers there were months in which sampling was not possible because heavy rains caused overflow of the fish-trapping systems.

In the laboratory, the eels were maintained alive in freshwater tanks with aeration and recirculating flow, for up to 4 days before examination. Eels were killed by immersion in a concentrated solution (1 ml/l) of the anaesthetic 2-phenoxyethanol. After weighing

and measurement, the outer body surface, body cavity and viscera were examined under a stereomicroscope. For examination of the gills, the eight branchial arches were separated (4 right, 4 left), and each arch divided into three regions (dorsal, medial and ventral) (Buchmann, 1989; Dzika, 1999), which were placed in separate recipients containing physiological saline for examination under a stereomicroscope. Individual filaments were also examined by light microscopy (4×). The stomach was divided into 3 regions (oesophageal region, caecum, intestinal union region), and the intestine into 4 portions of equal length (Outeiral et al., 2002), which were later examined separately under a stereomicroscope. For detection of protozoan parasites, we also examined smears of blood, of cutaneous, branchial and intestinal mucus, and of the viscera.

All helminths detected were washed in freshwater, fixed in Berland's fluid and stored in 70° alcohol. Specimens of all species were examined by light and scanning electron microscopy, following standard parasitology laboratory procedures.

For all parasite species detected in both rivers, we calculated infection prevalence ($P\%$) as defined by Bush et al. (1997). In the case of helminths and the copepod *Ergasilus gibbus*, we additionally calculated mean intensity of infection (I_m) and mean abundance (A_{bm}), also as defined by Bush et al. (1997).

In the case of protozoan parasites, we only determined presence/absence, and made no attempt to estimate intensity or abundance. In the case of monogeneans of the genus *Pseudodactylogyrus* in the gills, the very large numbers of individuals detected prevented us from identifying all individuals to species level, so that in the data analyses we consider these parasites as *Pseudodactylogyrus* sp.

Prevalences in the two rivers were compared by chi-square tests. Possible relationships between host weight/length and presence of the different parasite species were investigated by Spearman rank correlation tests. All statistical analyses were performed with the aid of ExcelXP and SPSS 9.0.

3. Results and discussion

Prevalence, intensities and mean abundance are shown in Table 1.

Table 1

List of the parasites detected, showing a) anatomical location in the host, b) prevalence ($P\%$), mean intensity ($Im \pm$ standard deviation, range in brackets) and mean abundance ($Abm \pm$ standard deviation), for the River Ulla and the River Tea

Parasites	Localization in hosts	Ulla River			Tea River		
		<i>P</i> (%)	Im ± S.D. (range)	Abm ± S.D.	<i>P</i> (%)	Im ± S.D. (range)	Abm ± S.D.
Protozoans							
<i>Trypanosoma granulosum</i> *	Blood	73.99			89		
<i>Eimeria anguillae</i>	Intestine	3.72			2.5		
<i>Myxidium giardi</i>	Skin, branchiae, nasal fossae, stomach, intestine, kidney, gall bladder, liver	95.05			95		
<i>Myxobolus portucalensis</i>	Skin, branchiae, nasal fossae, eyes, stomach, intestine, spleen, kidney, gall bladder, liver	26.63			34.5		
<i>Hofferellus gilsoni</i>	Kidney	—			0.5		
<i>Ichthyophthirius multifiliis</i>	Skin, branchiae	23.53			30.5		
<i>Trichodina jadranica</i> *	Skin, branchiae	9.91			1.5		
Monogenea							
<i>Pseudodactylogyrus</i> spp.	Branchiae	56.04	40.58 ± 84.95 (1–644)	22.74 ± 66.64	61.5	30.24 ± 76.74 (1–602)	18.6 ± 61.87
Digenea							
<i>Diplostomum</i> sp.*	Crystalline	18.27	1.63 ± 1 (1–6)	0.3 ± 0.76	2.5	3.20 ± 2.95 (1–8)	0.08 ± 0.65
<i>Nicola gallica</i>	Intestine	—	—	—	14	3.93 ± 6.39 (1–31)	0.55 ± 2.72
Cestoda							
<i>Bothriocephalus claviceps</i>	Intestine	0.62	5 ± 2.83 (3–7)	0.03 ± 0.42	1	1 ± 0	0.01 ± 0.10
Nematoda							
<i>Paraquimperia tenerrima</i>	Intestine	35.91	2.67 ± 4.35 (1–43)	0.96 ± 2.90	35.5	2.41 ± 1.70 (1–10)	0.86 ± 1.53
<i>Cucullanus heterochrous</i> *	Intestine	9.29	3.30 ± 4.47 (1–23)	0.31 ± 1.65	17	4.32 ± 6.64 (1–30)	0.74 ± 3.16
<i>Anisakis simplex</i>	Visceral cavity	0.31	85 ± 0	0.26 ± 4.73	—	—	—
<i>Anguillicola crassus</i>	Swimbladder	—	—	—	55.5	5.50 ± 5.82 (1–35)	3.05 ± 5.12
<i>Spinitectus inermis</i>	Stomach (gastric caecum)	18.89	7.30 ± 10.51 (1–56)	1.38 ± 5.36	12	3.79 ± 4.87 (1–25)	0.46 ± 2.07
<i>Pseudocapillaria tomentosa</i>	Intestine	4.02	1.46 ± 0.88 (1–4)	0.06 ± 0.33	4.5	1.89 ± 1.45 (1–5)	0.09 ± 0.49
Acantocephala							
<i>Acanthocephalus clavula</i>	Intestine	3.72	2.5 ± 1.51 (1–5)	0.09 ± 0.55	2	1.5 ± 0.58 (1–2)	0.03 ± 0.22
Copepoda							
<i>Ergasilus gibbus</i>	Branchiae	1.55	7.4 ± 7.67 (1–19)	0.11 ± 1.25	3.5	1.29 ± 0.49 (1–2)	0.05 ± 0.25

* Statistically significant difference in prevalence between the two rivers ($p < 0.01$).

At least one parasite was detected in 521 (99.6%) of the 523 eels analysed: all eels from the Tea, and 99.4% of eels from the Ulla. The number of parasite species per host individual ranged from 1 to 10, although most host individuals had 3 (20.5% of

hosts), 4 (24.9%) or 5 (21.8%) parasite species; only 17 individuals contained only 1 parasite species, and only 1 individual contained 10 parasite species.

The 20 parasite species comprised 7 protozoans, 12 helminths and 1 copepod crustacean (Table 1). Three

parasite species were present only in eels from the River Tea, namely *Hofferellus gilsoni* (Debaiseux, 1925) Lom, Molnár and Dyková, 1986 (in 1 eel), *Nicolla gallica* (Dollfus, 1941) Dollfus, 1959 (in 28 eels, 14%) and *Anguillicola crassus* Kuwara, Niimi and Itagaki, 1974 (in 11 eels, 55.5%). *Anisakis simplex* Rudolphi, 1809 (L₃ larvae) was present only in a single eel from the River Ulla.

Of the 16 species present in eels from both rivers, 4 showed significant differences in prevalence between the rivers: *Trypanosoma granulosum* Laveran and Mesnil, 1902 and *Cucullanus heterochrous* Rudolphi, 1802, both with significantly higher prevalence in the Tea, and *Trichodina jadranica* Haider, 1974 and *Diplostomum* sp., both with significantly higher prevalence in the Ulla ($p < 0.01$ in all cases) (Table 1). Fig. 1 compares the presence/absence of these four species in both rivers.

Weight of the eel individuals ranged from 4 to 2585 g, and length from 145 to 1060 mm. Body length is closely related to age in eels (Tesch, 1977),

and we therefore used this variable rather than weight in our data analyses. Body length showed a significant positive correlation with the presence of *Pseudodactylogyrus* spp. and *C. heterochrous* in both rivers ($p < 0.001$), with the presence of *Bothriocephalus claviceps* (Goeze, 1782) Rudolphi, 1809, *Acanthocephalus clavula* (Dujardin, 1845) Grabda-Kazsubska and Chubb, 1968, and *E. gibbus* von Nordmann, 1832 in the River Ulla only ($p < 0.05$), and with the presence of *Ichthyophthirius multifiliis* Fouquet, 1876 and *Pseudocapillaria tomentosa* (Dujardin, 1843) Freitas, 1959 in the River Tea only ($p < 0.05$). Body length showed a significant negative correlation with the presence of *T. granulosum* and *Myxobolus portucalensis* Saraiva and Molnár, 1990 ($p < 0.01$) in both rivers, with the presence of *Eimeria anguillae* Léger and Hollande, 1922 ($p < 0.05$) and *Spinitectus inermis* Zeder, 1800 ($p < 0.01$) in the River Ulla, and with the presence of *N. gallica* ($p < 0.01$) and *A. crassus* ($p < 0.05$) in the River Tea.

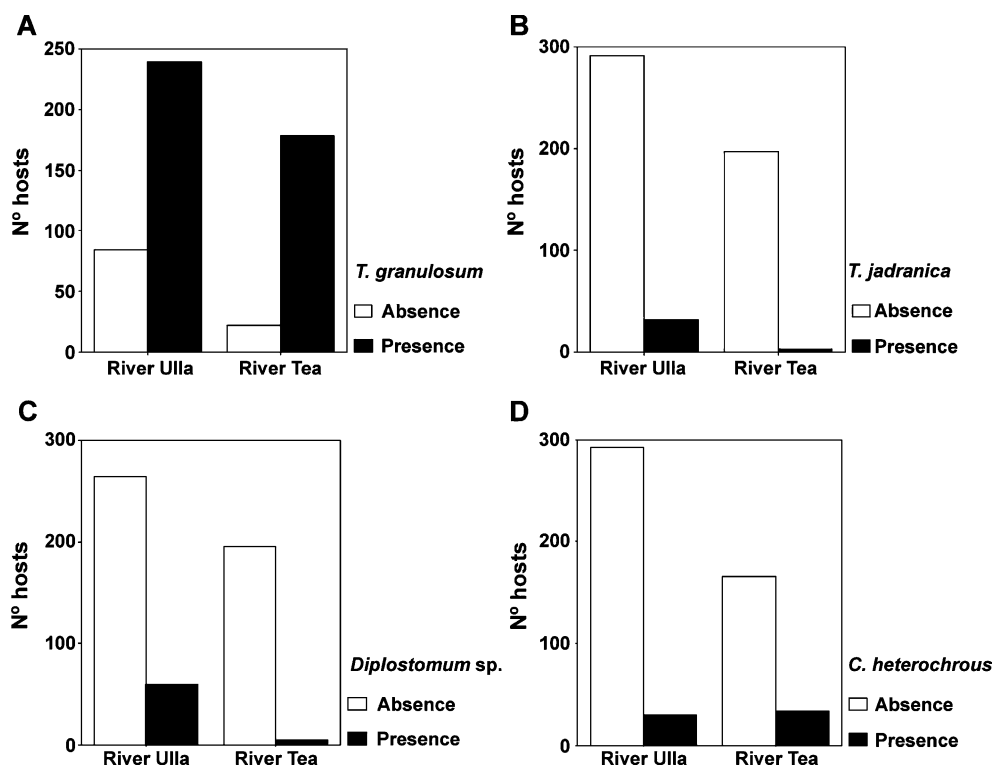


Fig. 1. Graphic representation of the presence in each river of those species showing significant differences in prevalence ($p < 0.01$) between the two rivers. A) *Trypanosoma granulosum*. B) *Trichodina jadranica*. C) *Diplostomum* sp. D) *Cucullanus heterochrous*.

showed significantly correlated presence in both rivers.

T. granulorum, a blood parasite specific for the genus *Anguilla* (Koie, 1988a), was detected with high prevalence in both rivers (Table 1), in line

Parasites	Rivers											
<i>T. granulorum</i>	Ulla	T. g.										
	Tea											
<i>E. anguillae</i>	Ulla	E. a.										
	Tea											
<i>M. giardi</i>	Ulla	M. g.										
	Tea											
<i>M. portucalensis</i>	Ulla	0.18**									M. p.	
	Tea											
<i>I. multifiliis</i>	Ulla	0.15**							I. m.			
	Tea											
<i>T. jadratica</i>	Ulla				0.11*	0.16**					T. j.	
	Tea	0.24**										
<i>Pseudodactylogyrus</i> spp.	Ulla	0.14**									P.s.	
	Tea	0.18*	-0.20**									
<i>Diplostomum</i> sp.	Ulla	0.24**							0.25**	0.13*	D.i.	
	Tea											
<i>N. gallica</i>	Ulla											
	Tea				0.14*	-0.14*	0.19*					
<i>B. claviceps</i>	Ulla											
	Tea		-0.21**									
<i>P. tenerrima</i>	Ulla											
	Tea									P. te.		
<i>C. heterochrous</i>	Ulla						0.11*	-0.13*				
	Tea					0.16*				C. h.		
<i>A. crassus</i>	Ulla											
	Tea							0.14*				
<i>S. inermis</i>	Ulla			0.17**							S. i.	
	Tea											
<i>P. tomentosa</i>	Ulla				0.11*						0.14*	
	Tea										0.16*	
<i>A. clavula</i>	Ulla	-0.14**										
	Tea	0.21**										
<i>E. gibbus</i>	Ulla											
	Tea											

*Statistically significant correlation ($p < 0.05$), **Statistically significant correlation ($p < 0.01$). Columns only show species with statistically significant correlations. Shadowed lines are indicative of absence of that species in that river. Abbreviations: T. g.=*T. granulosum*; E. a.=*E. anguillae*; M. g.=*M. giardi*; M. p.=*M. portucalensis*; I. m.=*I. multifiliis*; T. j.=*T. jadranica*; P.s.=*Pseudodactylogyrus* spp.; D.i.=*Diplostomum* sp.; P. te.=*P. tenerrima*; C. h.=*C. heterochrous*; S. i.=*S. inermis*.

with previous studies in freshwater (Saraiva and Eiras, 1996; Zintl et al., 1997). In marine environments, in contrast, this species has been detected with only very low prevalence (Outeiral et al., 2002), which may reflect its requirement for a freshwater intermediate host (leeches). Like Baker (1963) we have found that despite its high prevalence, this species has only minor effects on host health; Baker suggests that this indicates a well-balanced host–parasite relationship.

E. anguillae, another parasite specific for *Anguilla* spp., was detected in the mucosa of the anterior portions (1 and 2) of the intestine, with very low prevalence in both rivers, in line with previous studies in freshwater (Orecchia et al., 1987; Molnár and Székely, 1995), but in contrast with results obtained in the marine environment (Outeiral et al., 2002) (Table 1).

3.2. Myxosporidians

Myxidium giardi Cépedè, 1882 was present in almost all eels, and indeed was the parasite with highest prevalence in both rivers. This is a characteristic parasite of the genus *Anguilla*. Plasmodia were both histozoic (in gills, skin, stomach, intestine and kidney) and coelozoic (in bile duct), in all cases visible under the stereomicroscope as white points of varying size. Plasmodia were most frequently observed in the branchial lamellae, and we did not observe any particular area of preferential implantation: plasmodia were present in both distal and proximal positions on the branchial filaments, as reported previously by Orecchia et al. (1987). We also found spores propagated via the bloodstream, in the liver, spleen and nasal fossae, but plasmodia were not observed in these organs.

Like other authors (Ghittino et al., 1974; Komourdjian et al., 1977; Copland, 1981; Saraiva, 1994), we have observed morphometric differences between spores of different origins, but the form and size of the spores, the location of the polar capsules, and the striation of the valves was in all cases in line with existing descriptions of *M. giardi*.

In one of the eels from the River Ulla, we found *M. giardi* as a hyperparasite within *Pseudodactylogyrus bini* (Kikuchi, 1929) Gussev, 1965 (Aguilar et al., 2004).

M. portucalensis is a parasite specific to *A. anguilla*. This is the first report of this species for Spain. We found it in both rivers with moderate prevalence (Table 1). Like Wierzbicka and Orecka-Grabda (1996), we found spores in diverse organs: gills, skin, nasal fossae, eyes, stomach, intestine, liver, spleen, kidney and bile duct. It was located with highest prevalence in the intestine, followed by the gills and the nasal fossae. It was present with only low prevalence in the kidney, by contrast with Wierzbicka and Orecka-Grabda (1996) who found it with highest prevalence in this organ (particularly its terminal portion). In the original description of this species (Saraiva and Molnár, 1990), it was reported only from subcutaneous tissue, with a mean prevalence of 53.5%, much higher than in the present study. However, our findings agree with those of these authors as regards the negative correlation between the presence of *M. portucalensis* and host size.

H. gilsoni was detected only in the urinary bladder of a single eel from the River Tea. In a smear from this bladder, we observed only spores, not trophozoites. Although this parasite is specific to *A. anguilla*, its presence in the present study can probably be considered accidental. This is the first report of this species from Spain, though it has been reported from Portugal by Saraiva and Molnár (1990).

3.3. Ciliates

I. multifiliis was present on the gills and skin of eels from both rivers, with moderate prevalence. It has been described from numerous freshwater fishes, including the European eel in Denmark (Køie, 1988a) and Portugal (Saraiva, 1994).

T. jadranica was detected in eels from both rivers, preferentially in the gills. In the River Ulla it was also found on the skin. Prevalences were moderate in both rivers (Table 1), in line with data from other authors for *Trichodina* sp. (Køie, 1988a; Sures et al., 1999) and *T. anguilli* (Carvalho-Varela et al., 1984), which is probably the same species, since *T. jadranica* is the only species that has been described from *A. anguilla* (Saraiva, 1994). Other authors (Saraiva and Eiras, 1996 for *T. jadranica*, and Orecchia et al., 1987 for *T. anguilli*) have reported high prevalence. We found that prevalence was significantly higher in the Ulla. This is the first report of this species for Spain.

3.4. Monogeneans

In branchial tissues we detected a total of 11,064 individuals of the genus *Pseudodactylogyrus*, of which we took a subsample for species-level identification. The species identified were *Pseudodactylogyrus anguillae* (Yin and Sproston, 1948) Gussev, 1965 and *P. bini*. For data analysis, these species were grouped together as *Pseudodactylogyrus* spp. On numerous occasions these two species have been reported from the gills of *A. anguilla*, ever since they were introduced to Europe with their natural host, *A. japonica*. Saraiva (1994) reported the presence of both species in a river in northern Portugal, very close to our study area, with the two species together showing a slightly lower prevalence than in the present study, and considerably lower infection intensity (see Table 1).

3.5. Digeneans

Metacercariae of *Diplostomum* sp. were detected in the crystalline lens of eels from both rivers, though with significantly higher prevalence in eels from the Ulla. Infection intensity was greater in eels from the Tea, but was in both rivers moderate. The eel is an intermediate host in the biological cycle of *Diplostomum* spp., so that we only found larval stages, which could not be identified to species level.

N. gallica is a generalist parasite, which was observed in the intestine of eels from the Tea. Most were found in the distal portion of the intestine. This species has been reported previously for *A. anguilla* in freshwater by Køie (1988a) and Kennedy et al. (1998), though with lower prevalence than in the present study (Table 1). This is the first report of this species from the Iberian Peninsula.

3.6. Cestodes

B. claviceps is an intestinal parasite specific for the genus *Anguilla*. It was found in eels from both rivers, but with very low prevalence and infection intensities. There have been numerous reports of this species in *A. anguilla* from freshwater environments in various countries (see Borgsteede et al., 1999). Previous studies in the Iberian Peninsula (Saraiva and Eiras, 1996; Maillo et al., 2001) have detected this species with

higher prevalence and infection intensity than in the present study (Table 1).

3.7. Nematodes

Paraquimperia tenerrima (Linstow, 1878) Baylis, 1934 is a specific parasite of *A. anguilla*, adults and L₄ larvae of which were observed throughout the intestine. In all infected individuals, this parasite was most abundant in the distal third of the intestine. Prevalence was much higher than that observed by Saraiva and Eiras (1996). Infection intensity was higher in eels from the Ulla than in eels from the Tea (Table 1).

C. heterochrous is a generalist intestinal parasite. We found adult individuals throughout the intestine (most frequently the medial portion) of eels from both rivers. This species was first reported from *A. anguilla* in a marine environment by Outeiral et al. (2002), with a very low prevalence (only one infected individual) but with very high infection intensity in this individual (Table 1). In the present study we found statistically significant differences in prevalence between the two rivers (Table 1), though infection intensities were very similar, in line with previous findings (Outeiral et al., 2002).

A. simplex L₃ larvae were detected encysted in the visceral cavity of a single eel from the Ulla, with rather high intensity (85 individuals). This eel was a large specimen (62 cm): large eels typically feed on insect larvae, crustaceans and small fishes, and it seems likely that infection probably occurred as a result of ingestion of a small marine fish. In general, *A. simplex* is an infrequent parasite in freshwater fish, as expected given that both its intermediate and definitive hosts are marine. However, it should be borne in mind that the European eel is migratory, entering freshwater habitats from the sea as juveniles. It is thus likely that the *A. simplex* larvae present in this individual were acquired in the marine environment. Only L₃ larvae were found, suggesting that the eel can be considered a transport host for this parasite. As far as we know, there has been only one previous report of this parasite in *A. anguilla*, in eels from rivers in Portugal, in the visceral cavity as in the present study; again, only L₃ larvae were detected. *A. simplex* L₃ larvae have also been found in the visceral cavity of other freshwater fishes. Thus Bychowskii (1964)

cites the presence of larvae encysted in the body cavity of the sturgeon, salmon and catfish in the River Amur; Wootton and Smith (1975) detected these larvae in *Salmo trutta* and *Oncorhynchus mykiss* in Ireland, England and Belgium; Moravec et al. (1985) detected L₃ larvae in mesentery of a migratory fish (*Tribolodon hakonensis*) in Japan. In principal, there does not seem to be any reason why this species should not infect freshwater fish, as long as the fish host comes into contact with intermediate hosts or transport hosts (small fish) of marine origin. Evidently, though, freshwater fish can be expected to feed on marine species only infrequently, which would explain why *A. simplex* is uncommon in freshwater species.

A. crassus is specific to the genus *Anguilla*. We only detected it in eels from the Tea. We do not know whether its presence in the Tea and absence from the Ulla reflects some sort of ecological difference between the two rivers. In future work we plan to analyse copepod populations in the two rivers, since copepods are the intermediate hosts in the *A. crassus* cycle, and the absence of suitable copepods would limit the spread of this parasite. As regards the anatomical distribution of this parasite, our results are in full agreement with those of Moravec and Taraschewski (1988): L₃ larvae in the wall of the swim-bladder, L₄ larvae and adults in the lumen, and L₂ larvae in the bloodstream. In the Iberian Peninsula this species has only been reported in one previous study (Maillo et al., 2001), with a prevalence similar to that of the present study, but much lower intensity (Table 1).

S. inermis is again specific for *A. anguilla*, and one of the two species of *Spinitectus* reported from freshwater fish in Europe. We found adult and larval forms of this species in the stomach, the typical location. Morphometric characteristics and sexual dimorphism (females markedly larger than males) were also as described by Moravec (1979). This species has been reported previously from eels captured in the River Sousa in northern Portugal (Saraiva et al., 2002), with prevalence and intensity similar to those obtained in the present study. In a previous study of two estuaries in Galicia, Outeiral et al. (2002) reported the presence of *S. inermis* in a single host, with very low intensity. This was probably attributable to accidental presence in the marine environment, since *S. inermis* is basi-

cally a freshwater species, whose intermediate host is a freshwater insect larva.

P. tomentosa (Dujardin, 1843) Freitas, 1959 is a generalist species that can use diverse freshwater fishes as definitive host, though the majority are cyprinids (Moravec, 1987). The individuals of this species detected in the present study showed morphology and preferential location (posterior intestine) in line with the description of Moravec (1987). Prevalence and intensity were very similar in the two rivers, and similar to the values reported by Saraiva (1994) in a study of the parasite fauna of the European eel in a river in northern Portugal. This is the first report of this species from *A. anguilla* in Spain.

3.8. *Acanthocephalans*

A. clavula is another generalist species, infecting numerous species of freshwater fish. It is characterized by the fact that it remains in the host intestine throughout the infection period, even when conditions are unfavourable (Kennedy and Lord, 1982). In the present study, this species was present in both rivers. Males and females were detected in similar numbers, and parasites showed a basically uniform distribution along the length of the intestine, without preference for any particular region, in contrast to Orecchia et al. (1987) who reported preferential localization in the posterior region. In both rivers prevalence and intensity were very low.

3.9. *Crustaceans*

E. gibbus is a copepod specific to *A. anguilla*, found infecting eels in both rivers, in the branchial arches. Its prevalence and intensity were very low in eels from the Tea, and rather higher in eels from the Ulla. Under natural conditions, copepods are infrequently present in sufficient numbers to cause significant damage to the host. According to Kabata (1981), copepod ectoparasites of fishes tend to be relatively inoffensive, except at very high infection intensities.

4. Conclusions

The parasite fauna of the eel in our study area comprises a total of 20 species. This total is similar to

that reported in previous studies of the eel in freshwater environments (Køie, 1988a; Saraiva, 1994). Most (12) are freshwater species, and some (7) are specific to the genus *Anguilla*, or even to the species *A. anguilla* (5). Prevalences were highest for the species specific to this host, and for the freshwater species. Parasite faunas differed little between the two rivers, perhaps because they are two very similar environments.

Although several parasite species showed significantly correlated presence in one of the capture sites, only one pair of taxa (*T. granulorum* and *Pseudodactylogyrus* spp.) showed significantly correlated presence in both.

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