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On the fauna of digenetic trematodes, parasites of small mammals, in the Natural Reserves of Py and Mantet (Oriental Pyrenees, France)

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Summary

A seven-year study in two adjacent Natural Reserves (Py and Mantet in the Oriental Pyrenees) provided data on the occurrence of digenetic trematodes parasitizing small mammals (Insectivora and Rodentia). Out of 5 insectivore and 9 rodent species examined, only *Neomys fodiens, Sorex araneus, Eliomys quercinus, Apodemus sylvaticus, Rattus rattus* and *Clethrionomys glareolus* were parasitized by digeneans belonging to 10 species (*Brachylaima* sp., *Brachylaima fulvus*, *Ectosiphonus* sp., *Macyella apodemi, Pseudocephalotrema pyrenaica, Skrjabinophyetus neomydis, Nephrotrema truncatum, Brachylecithum eliomydis, Collyricloides massanae* and *Mediogonimus jourdanei*. The detection of *Ectosiphonus* sp. (Brachylaimidae) found in water shrew in the Pyrenees represents the first record on this digenean throughout the Palearctic Region except of Japan. For the first time, *M. jourdanei* (Prosthogonimidae) was found not only in Arvicolinae rodents but also in Murinae (*A. sylvaticus*). Diagnosis of the genus *Mediogonimus* referred on specificity to voles has to be amended.

Key words: digenetic trematodes; Insectivora; Rodentia; Oriental Pyrenees; France

Introduction

Specific ecological characteristics of the Pyrenees broadly affect small mammal parasites. Several authors have discussed this phenomenon, above all an isolation of the Pyrenees that affects evolution of insectivores and rodents platyhelminth fauna (Jourdane, 1977; Feliu *et al.*, 1987; Gracenea *et al.*, 1987). As a part of the general study of biodiversity and population dynamics of small mammals in the Natural Reserves of Py and Mantet (Oriental Pyrenees), the helminthological analysis of several rodents and insectivores was conducted. Our long-term study (1997 – 2003) revealed valuable data on the faunistic and biology of several fluke species for the first time in Western Europe.

Material and Methods

The two small-mammal collection sites are located in the most easterly part of the Pyrenees, between the Canigó and Carença Massifs: Py Reserve (42°29'42''N, 2°21'08''E), ranging from 950 to 2,463m a.s.l.; and Mantet Reserve (42°28'42''N, 2°18'28''E), ranging from 1,450 to 2 700m a.s.l. The landscape shows traces of agriculture, pasture and forest management of the last few centuries. In these reserves, basal, montane, sub-alpine and alpine zones were found, with numerous ecosystems: leafy forests (beech, birch, fir, holm oak, oak, pine), grasses and prairies, torrents, landslides and rocky escarpments. Birch forests occupy the lower locations of the reserves; higher up, beech is found (*Fagus sylvatica*); and in the montane zone, fir (*Abies abies*) occurs. The sub-alpine stage is covered by pine (*Pinus uncinata*). The alpine stage is dominated by landslides and rocky escarpments. The flora and fauna of these sites have many endemisms.

The captures (one per year from 1997 to 2003) took place in autumn seasons (when small mammals have their population peaks). Rodents were caught to obtain a representtative sample for helminthological study. Insectivores (all protected by law except *Talpa europea*) were only studied when had been found dead in traps. A total of 440 hosts were studied, belonging to 14 species (number of individuals in parenthesis). Order Insectivora: *Crocidura russula* (Hermann, 1780) (8); *Neomys fodiens* (Pennant, 1771) (6); *Sorex araneus* Linnaeus, 1758 (31); *Sorex minutus* Linnaeus, 1766 (2) and *T. europea* Linnaeus, 1758 (4). Order Rodentia: *Eliomys quercinus* (Linnaeus, 1766) (21); *Glis glis* (Linnaeus, 1766) (10); *Apodemus* spp. [*A. sylvaticus* (Linnaeus, 1758) and *A. flavicollis* (Melchior, 1834)] (213); *Mus domesticus* (Linnaeus, 1758) (13); *Rattus rattus* (Linnaeus, 1758) (4); *Clethrionomys glareolus* (Schreber, 1780) (107); *Microtus agrestis* (Linnaeus, 1761) (10) and *Microtus arvalis* (Pallas, 1778) (11). Live digenean trematodes isolated were fixed in Bouin, stained in Borax Carmine and mounted in Canada balsam.

Results

Out of 14 mammal species, only 2 insectivores (*N. fodiens* and *S. araneus*) and 4 rodents (*E. quercinus, A. sylvaticus, R. rattus* and *C. glareolus*) served as hosts of digenean parasites during 7-year period (Tab. 1). In total, 10 flukes were recovered: *Brachylaima* spp.; *Brachylaima fulvus* Dujardin, 1843; *Ectosiphonus* sp. (Brachylaimidae); *Pseudocephalotrema pyrenaica* Combes and Jourdane, 1969; *Macyella apodemi* Jourdane and Triquell, 1973 (Lecithodendriidae); *Skrjabinophyetus neomydis* Dimitrova and Genov, 1967 (Nanophyetidae); *Nephrotrema truncatum* (Leuckart, 1842) (Troglotrematidae); *Mediogonimus jourdanei* Mas-Coma and Rocamora, 1978 (Prosthogonimidae); *Brachylecithum eliomydis* Jourdane and Mas-Coma, 1977 (Dicrocoeliidae); *Collyricloides massanae* Vaucher, 1969 (Collyriclidae). The presence of these species in different hosts and years is summarised in Tab. 1.

Out of digeneans of the genus *Brachylaima*, only insectivore parasite *B. fulvus* was identified at species level. Rodent brachylaimids were not distinguished because of a special morphological similarity of adults and non-revealed life cycles. Anyway, Mas-Coma & Montoliu (1986) and Gracenea & González-Moreno (2002) stated that a precise identification of the *Brachylaima* spp. requires a comparison of morphological characteristics of developmental stages of those flukes. The species identification of *Ectosiphonus* Sinitsin, 1931, was not possible because only one non-gravid individual was recovered.

For the first time, *M. jourdanei* was found in a host species belonging to the subfamily Murinae. Tab. 2 compares body parameters of adult worms with those collected previously from Arvicolinae reported by Gracenea *et al.* (1987).

Discussion

This study provides data on the faunistic and zoogeography of several digenetic species found in rodents and insectivores in the Pyrenean Mountains from 1997 to 2003.

The presence of *Brachylaima* spp. from myoxid and murid rodents was reported frequently in the Palaearctic Region (Baruš & Tenora, 1957; Erhardová, 1958; Dollfus *et al.*, 1961; Vaucher & Hunkeler, 1967; Jancev & Karapchanski, 1974; Prokopič & Genov, 1974, 1975; Behnke *et al.*, 1993, 1999; Gracenea & González-Moreno, 2002), as well as in Australia and New Zealand (Wheeler *et al.*, 1989; Cribb, 1990; Butcher & Grove, 2001). Despite of rare data on their prevalence and intensity of infection, low values have been reported in these hosts. For instance, *Brachylaima* spp. were found in *Apodemus* spp. with the prevalence from 0.4 to 15 % and mean intensity of 5 individuals (Jourdane & Triquell, 1973; Prokopič & Genov, 1974, 1975; Benhke *et al.*, 1999). Present data suggest that this digeneans are usually rare except for the garden dormouse *E. quercinus* (prevalence 57.5 %).

The brachylaimid from insectivores, *B. fulvus*, can be easily identified according to Zarnowski (1960) and Jourdane (1971). It was found in species of genera *Sorex* Linnaeus, 1758, *Crocidura* Wagler, 1832 and *Neomys* Kaup, 1829 throughout Europe. The prevalence values were usually high, in *Sorex* spp. up to 86 %, but data on intensity of infection usually lack (Zarnowski, 1960; Jancev & Karapchanski, 1974; Mas-Coma & Gallego, 1975; Meszaros *et al.*, 1981-82; Genov, 1984; Novikov, 1992; Shimalov, 2001; Casanova *et al.*, 2003). Overall scarce presence of *B. fulvus* in water shrews (*Neomys* spp.) could be explained by the terrestrial life cycle of this digenean (Pojmanska, 1961) and majority presence of aquatic invertebrates in its diet. In the present study, *B. fulvus* was the only parasite occurring yearly. This trematode was one of the most frequent species in *S. araneus* also in East European region (Shimalov, 2001).

The finding of another genus of Brachylaimidae, *Ectosiphonus* sp. in *N. fodiens* represents the new geographic and hosts record. *Ectosiphonus* was originally described as insectivore parasite of *Blarina* Gray, 1838 and *Sorex* in North America (Sinitsin, 1931; Wittrock & Hendrickson, 1979; Vaucher & Durette-Desset, 1978). The more recent finding of non-gravid specimens of this digenean genus by Asakawa *et al.* (1988) in *Sorex unguiculatus* Dobson, 1890 in Japan and the present results have broaden the distribution of *Ectopsinus* sp. to Palearctic Region. The surprising occurrence of *Ectopsinus* sp. in the Pyrenees can be put into context with the known phenomenon of endemic and relictual characteristics of helminth parasites of Iberian small mammals. For instance, Hugot & Feliu (1990) found a similar pattern of geographical distribution concerning Oxyurids parasites of Iberian Sciurids. Naturally, further studies of the biology and ecology of this rare brachylaimid are needed.

Three representatives of the families Lecithodendriidae and Nanophyetidae have been found, namely *M. apodemi*, *P. pyrenaica* and *S. neomydis*. The first species *M. apodemi* was detected in *A. sylvaticus* (3.4 %) in only 2 out of 7 years. Previously it was detected in low prevalences exclusively in Pyrenees - Jourdane & Triquell (1973) reported *M. apodemi* in *A. sylvaticus* (0.9 %) and Montoliu & Feliu (1986) in *E. quercinus* (0.7 %). Therefore, this digenetic species shows an endemic character of its occurrence in the Pyrenees. The remaining two parasites, *P. pyrenaica* and *S. neomydis*, were found very rarely in water shrew *N. fodiens*. However, quantitative data of these species should be treated with caution due to the few hosts analysed. Both digeneans were always found infecting *Neomys* (Euzet & Jourdane, 1970; Mas-Coma, 1977; Jourdane, 1977; Genov, 1984). The only prevalence data (1.02 %) was published by Genov (1984) from Bulgaria.

Nephrotrema truncatum (Troglotrematidae) is the relatively frequent insectivore digenean (Mas-Coma & Gallego, 1975; Mas-Coma, 1977; Jourdane, 1977; Genov, 1980; 1984; Meszaros *et al.*, 1981 – 1982). Genov (1984) reported its prevalence values (2.21 % in *Sorex* and 13.27 % in *Neomys*) which were lower comparing with the present data and might be affected by a limited number of hosts

Table 1. Occurrence of trematodes in small mammals in Pyrenees during 7-year period

Family	Brachylaimidae			Lecithodendriidae		Nanophyetidae	Troglotrematidae	Dicrocoeliidae	Collyriclidae	Prosthogonimidae
Helminth	*Brachylaima* sp.	*Brachylaima fulvus*	*Ectosiphonus* sp.	*Macyella apodemi*	*Pseudocephalotrema pyrenaica*	*Skrjabinophyetus neomydis*	*Nephrotrema truncatum*	*Brachylecithum eliomydis*	*Collyricloides massanae*	*Mediogonimus jourdanei*
Neomys fodiens			1 spec. in 1 host PD1/4		6 spec. in 1 host PD1/4	75 (50 – 100) 5.5 (3 – 8) PD2/4	75 (50 – 100 1.5 (1 – 2) PD2/4			
Sorex araneus		25.2 (9.1 – 50) 1.8 (1 – 2) PD4/4					45.2 (40 – 50) 3.1 (1 – 11) PD3/4			
Eliomys quercinus	57.5 (40 – 100) 3.9 (1 – 13) PD4/5							22.5 (20 – 25) 13 (5 – 16) PD2/5		
Apodemus sylvaticus	3.6 (2.3 – 5.9) 1.5 (1 – 3) PD4/7			3.4 (2.3 – 4.5) 2.5 (1 – 4) PD2/7					4.5 2 (1 – 3) PD1/7	4.5 (4.5) 5 (4 – 8) PD2/7
Rattus rattus	1 spec. in 1 host PD1/3									
Clethrionomys glareolus										9.3 (6.2 – 15.4) 21.2 (1 – 134) PD5/7

First line – mean prevalence (min-max. %); second line – mean intensity of infection (min-max. number); PD – number of years when the parasites was found / years when hosts were studied

Table 2. Metrical data of *Mediogonimus jourdanei* from *A. sylvaticus* and *C. glareolus* compared with those in *M. agrestis* reported by Gracenea *et al.* (1987)

	Apodemus sylvaticus (n = 9) mean (max-min) Present study	*Clethrionomys glareolus* (n = 30) mean (max-min) Present study	*Microtus agrestis* (n = 16) mean (max-min) Gracenea *et al.* (1987)
Body length	1 703 (2 163 – 1 349)	1 680 (1 936 – 1 390)	1 888 (2 461 – 1 515)
Body width	1 293 (1 442 – 999)	1 326 (1 586 – 1 246)	1 721 (1 988 – 1 420)
Oral sucker	120 (143 – 100) x 171 (194 – 128)	140 (177 – 120) x 152 (182 – 136)	196 (242 – 158) x 187 (210 – 137)
Ventral sucker	167 (197 – 136) x 168 (189 – 156)	170 (233 – 143) x 165 (223 – 148)	257 (316 – 210) x 244 (295 – 189)
Ratio OS/VS	0.72 (0.87 – 0.57)	0.80 (1.04 – 0.57)	0.55 (0.81 – 0.35)
Distance OS/VS	371 (463 – 268)	269 (361 – 175)	337 (452 – 168)
Pharynx	98 (113 – 77) x 99 (118 – 74)	105 (118 – 87) x 111 (121 – 81)	120 (148 – 89) x 106 (133 – 79)
Bursa cirri	266 (360 – 215) x 159 (288 – 103)	219 (269 – 143) x 212 (253 – 179)	280 (421 – 179) x 174 (221 – 126)
Right testis	337 (484 – 228) x 299 (556 – 227)	329 (391 – 266) x 282 (339 – 238)	401 (579 – 284) x 302 (421 – 210)
Left testis	342 (525 – 243) x 322 (463 – 218)	367 (412 – 320) x 296 (370 – 257)	348 (452 – 210) x 271 (368 – 210)
Ovary	228 (360 – 134) x 235 (319 – 144)	221 (324 – 212) x 225 (249 – 133)	333 (473 – 231) x 244 (389 – 179)
Right vitellaria	539 (639 – 391) x 155 (185 – 133)	568 (690 – 402) x 193 (261 – 128)	–
Left vitellaria	590 (783 – 474) x 160 (216 – 111)	549 (669 – 463) x 192 (235 – 131)	–
Eggs	30.0 (30.7 – 20.5) x 15.7 (17.9 – 15.4)	29.8 (32.3 – 26.3) x 12.9 (14.2 – 12.1)	31.2 (32.1 – 29.6) x 12.9 (14.8 – 12.3)

Data are in µm

analysed.

Two representatives of families Dicrocoeliidae (*B. eliomydis*) and Collyriclidae (*C. massanae*) were previously reported from *E. quercinus* (prevalence from 18.3 % to 31.33 %) and *Apodemus* (prevalence from 0.4 to 1.4 %) from various Pyrenean localities (Jourdane & Triquell, 1973; Jourdane & Mas-Coma, 1977; Feliu, 1980). The endemic Pyrenean character of both species is corroborated by similarity of present data.

Concerning present data on the occurrence of *M. jourdanei* (Prosthogonimidae), the most interesting fact undoubtedly is that this species parasitizes not only Arvicolinae but also Murinae rodents, namely *A. sylvaticus*. The original description of this species (Mas-Coma & Rocamora, 1978) and the subsequent amended diagnosis of the genus (Gracenea *et al.*, 1987) recorded the oligoxenous character of *Mediogonimus* spp. in voles of the subfamily Arvicolinae in the Holarctic Region. Congruently, our study has confirmed a rather frequent presence of *M. jourdanei* in vole *C. glareolus* in the Pyrenean Mountains, that is in concordance with another denounces (Mas-Coma & Rocamora, 1978; Gracenea *et al.*, 1987; Feliu *et al.*, 1997). Surprisingly, in two years *M. jourdanei* was found also in *A. sylvaticus*. However, its prevalence and mainly intensitiy of infection were lower. The morphological and metrical characters of adult helminths dissected from the new host *A. sylvaticus* didn't significantly differ from those from *C. glareolus* and *Microtus agrestis*. However, the majority of measured characters in this parasite of *A. sylvaticus* are smaller than in the typical hosts (Arvicolinae) (Tab. 2). This phenomenon of host-induced morphological differentces is well known in various helminths. For instance, differences in the digestive physiology of various hosts may affect ability of parasites to establish, grow and mature (Watson & Pike, 1993). Because of its abundance and a wide distribution, species of the genus *Apodemus* served as the target of numerous parasite surveys (Feliu *et al.*, 1987, 1997). However, the present findings of *M. jourdanei* in *A. sylvaticus* represent the new host record. Similarly to above discussed digeneans, the rare occurrence of *M. jourdanei*, restricted to the area of Pyrenees, confirms the endemism of this digenean species (Feliu *et al.*, 1997). In addition, the diagnosis of the genus *Mediogonimus* stated by Gracenea *et al.*, 1987 should be modified concerning to the zoogeographical aspects: digeneans of genus *Mediogonimus* are parasites of Muridae rodents (Arvicolinae, Murinae) from Holarctic Region.

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