HELMINTHFAUNAS OF WILD CARNIVORES IN THE MONTSENY MASSIF; AN ATYPICAL ECOSYSTEM IN THE NORTHEAST OF THE IBERIAN PENINSULA

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HELMINTHFAUNAS OF WILD CARNIVORES IN THE MONTSENY MASSIF; AN ATYPICAL ECOSYSTEM IN THE NORTHEAST OF THE IBERIAN PENINSULA

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MONTSENY MASSIF
CATALONIA
HELMINTHS
CANOIDEA
FELOIDEA

ABSTRACT. – The atypical nature of the Montseny biotopes (NE of the Iberian Peninsula) seems to influence the parasitofaunas in the mammals of the Massif. The helminthological study of 348 hosts (102 Viverridae, 141 Mustelidae and 105 Canidae) provides faunistic and ecological data about their parasites. 34 parasite species have been detected (1 Digenetic Trematode, 8 Cestoda and 25 Nematoda). The effect of the host sex and seasonality on the helminthfaunas of *Genetta genetta* and *Martes foina* is discussed.

MASSIF DU MONTSENY
CATALOGNE
HELMINTHES
CANOIDEA
FELOIDEA

RÉSUMÉ. – Les biotopes du Massif du Montseny, au Nord-Est de la Péninsule Ibérique, montrent des caractéristiques écologiques particulières dues à sa situation de type insulaire. Ce phénomène se répercute sur les faunes des parasites des Mammifères du Massif. L'étude helminthologique de 348 hôtes (102 Viverridae, 141 Mustelidae et 105 Canidae) apporte des informations d'un point de vue faunistique et écologique. 34 espèces d'Helminthes ont été recensées (1 Trématode Digène, 8 Cestodes et 25 Nématodes). L'effet du sexe de l'hôte et de la saison sur l'helminthofaune de *Genetta genetta* et de *Martes foina* a été étudié.

INTRODUCTION

The helminthfaunas found in wild mammals in the Montseny Massif have been studied for seven years. Those found in the order Carnivora (Mustelidae, Felidae, Canidae, Viverridae) have been described elsewhere (Miquel *et al.*, 1992 and 1994a). Both reports also evaluated the effect of the Montseny Massif ecology on each parasitofauna. The continuing collection of faunistical and ecological data has furthered our understanding of both hosts and helminthfaunas. Previously, little has been published on the relationships between the sex of the host and the helminthfauna found on the one hand, and the season and the helminthfauna found on the other in the Carnivora of the Palaearctic region (Martínez *et al.*, 1978; Glickman and Schantz, 1981; Richards *et al.*, 1993). Our data are, we believe, of particular interest in this regard given the ecological features of the Montseny biotopes (Feliu *et al.*, 1992; Miquel *et al.*, 1992).

MATERIAL AND METHODS

The parasitological data were derived from the helminthological study of 348 hosts captured in the Montseny Massif, of which 102 were Viverridae [*Genetta genetta* (Linnaeus, 1758)], 141 were Mustelidae and 105 Canidae [*Vulpes vulpes* (Linnaeus, 1758)]. Among the Mustelidae, 13 specimens belonged to the species *Meles meles* (Linnaeus, 1758), 28 to *Mustela nivalis* Linnaeus, 1766, 11 to *Mustela vison* Schreber, 1777 and 89 to *Martes foina* (Erxleben, 1777). Since Miquel *et al.* (1994 a) no more Felidae were captured. Reference is, therefore, made to this report when discussing the helminths in Felidae hosts from the Montseny.

The hosts, killed by hunters or on the road, were preserved by freezing or using fixation liquids. The helminths were treated following the standard methods applied in Helminthology.

RESULTS

The following helminths were found :

TREMATODA
- Fam. Brachylaimidae Joyeux et Foley, 1930
  - *Brachylaima* sp.

CESTODA
- Fam. Anoplocephalidae Cholodkovsky, 1902
  - *Atriotaenia incisa* (Railliet, 1899)
- Fam. Taeniidae Ludwig, 1886
  - *Taenia pisiformis* (Bloch, 1780)
  - *Taenia crassiceps* (Zeder, 1800)
  - *Taenia martis* (Zeder, 1803)
  - *Taenia tenuicollis* Rudolphi, 1819
  - *Taenia parva* Baer, 1926
- Fam. Mesocestoididae Perrier, 1897
  - *Mesocestoides* sp.
- Fam. Dilepididae Railliet et Henry, 1909
  - *Joyeuxiella pasqualei* (Diamare, 1893)

NEMATODA
- Fam. Trichuridae (Ransom, 1911)
  - *Pearsonema plica* (Rudolphi, 1819)
  - *Eucoleus aerophilus* (Creplin, 1839)
  - *Aonchotheca putorii* (Rudolphi, 1819)
  - *Trichuris vulpis* Froelich, 1789
- Fam. Strongyloididae (Chitwood et McIntosh, 1934)
  - *Strongyloides mustelorum* Cameron et Parnell, 1933
  - *Strongyloides* sp.
- Fam. Ancylostomatidae (Looss, 1905)
  - *Ancylostoma* martinezi Miquel, Torres, Casanova et Feliu, 1994
  - *Uncinaria criniformis* (Goeze, 1782)
  - *Uncinaria stenocephala* (Railliet, 1884)
- Fam. Molineidae (Skrjabin et Schulz, 1937)
  - *Molineus patens* (Dujardin, 1845)
- Fam. Crenosomatidae Schulz, 1951
  - *Crenosoma vulpis* (Rudolphi, 1819)
  - *Crenosoma petrowi* Morozov, 1939
  - *Crenosoma melesi* Jancev et Genov, 1988
- Fam. Angiostrongylidae (Boehm et Gebauer, 1934)
  - *Angiostrongylus vasorum* (Baillet, 1866)
- Fam. Filaroididae Schulz, 1951
  - *Filaroides martis* (Werner, 1783)
- Fam. Skrjabingylidae Delamure et Kontrimavichus, 1976
  - *Skrjabingylus nasicola* (Leuckart, 1842)
- Fam. Ascaridiidae Baird, 1853
  - *Toxocara canis* (Werner, 1782)
  - *Toxocara cati* (Schrank, 1788)
  - *Toxocara genettae* Warren, 1972
  - *Toxascaris leonina* (von Linstow, 1902)
- Fam. Spirocercidae (Chitwood et Wehr, 1932)
  - *Cyathospirura seurati* Gibbs, 1956
  - *Mastophorus muris* (Gmelin, 1790)
- Fam. Filariidae (Weinland, 1858)
  - *Filaria martis* Gmelin, 1790
- Fam. Rictulariidae (Hall, 1915)
  - *Pterygodermatites affinis* (Jägerskiöld, 1904)
  - *Pterygodermatites leiperi* (Ortlepp, 1961)

34 helminth species were detected, of which 1 was a Trematode, 8 were Cestoda and 25 Nematoda. The helminth species are classified here according to published descriptions (Miquel *et al.*, 1994 b).

The helminthfaunas from the six host species are listed in tables IA, IB, and II. In tables IIIA and IIIB the helminthfaunas of *G. genetta* and *M. foina* are analysed by sex and the season in which they were captured.

Table I. – A, Prevalences and mean intensities in *Genetta genetta*. B, Prevalences and mean intensities in *Vulpes vulpes*.

A	*G. genetta* (n=102)	
	Prev.	Mean intens.
TREMATODA	0.9	
Brachylaima sp.	0.9	1.0
CESTODA	85.3	
T. parva	84.3	90.4
Mesocestoides sp.	0.9	6.0
J. pasqualei	5.8	7.0
NEMATODA	41.2	
A. martinezi	7.8	3.2
T. genettae	31.3	8.7
C. seurati	1.9	2.5
M. muris	1.9	2.2
P. leiperi	0.9	2.0
TOTAL PARASIT.	91.2	

B	*V. vulpes* (n=105)	
	Prev.	Mean intens.
TREMATODA	2.9	
Brachylaima sp.	2.9	5.3
CESTODA	17.3	
T. pisiformis	6.7	4.3
T. crassiceps	0.9	116.0
Mesocestoides sp.	7.7	70.6
J. pasqualei	1.9	1.0
NEMATODA	98.1	
P. plica	36.6	4.3
E. aerophilus	65.4	4.0
T. vulpis	14.4	1.8
Strongyloides sp.	0.9	3.0
U. stenocephala	74.0	11.7
M. patens	1.9	2.5
C. vulpis	20.4	14.3
A. vasorum	32.5	14.5
T. canis	28.8	3.9
T. cati	0.9	2.0
T. leonina	4.8	8.8
M. muris	3.9	5.0
P. affinis	4.8	8.4
TOTAL PARASIT.	98.4	

Table II. – Prevalences and mean intensities in the species of Mustelidae studied.

	M. meles (n=13)		*M. nivalis* (n=28)		*M. vison* (n=11)		*M. foina* (n=89)	
	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.
CESTODA	7.7		10.7		9.1		14.8	
A. incisa	7.7	6.0						
T. martis					9.1	9.0		
T. tenuicollis			10.7	2.0			14.8	4.4
NEMATODA	76.9		92.9		54.5		75.9	
P. plica	7.7	1.0					27.9	1.5
E. aerophilus							51.7	3.1
A. putorii	38.4	9.2	14.3	3.7			13.8	2.0
S. mustelorum			14.3	3.5				
Strongyloides sp.	23.1	8.0					11.4	24.5
U. criniformis	53.8	4.0						
M. patens	46.1	28.0	89.3	18.8	45.4	6.6	37.5	14.3
C. petrowi							19.5	2.9
C. melesi			10.7	4.0	9.1	16.0		
A. vasorum	7.7	4.0						
Filaroides martis			7.1	-			3.4	-
S. nasicola (n=8)			37.5	10.6				
T. cati							1.1	2.0
M. muris			10.7	1.7			3.4	2.0
F. martis (n=1)							100	13.0
TOTAL PARASIT.	84.6		92.8		54.5		80.5	

DISCUSSION

The paper reports further data on the helminthfaunas described elsewhere in the Montseny. In addition, among the helminthfauna of *G. genetta*, it reports the finding of one digenetic trematode (*Brachylaima* sp.), one cestode (*Mesocestoides* sp.) and four nematodes (*A. martinezi, T. genettae, C. seurati, P. leiperi*) new to this geographical zone. This increase might be related to the greater number of individuals studied. However, the helminthfauna from the Montseny genet is still poor as far as the number of species is concerned, as compared to the genets in neighbouring areas (Catalonia; Spain) (Miquel *et al.*, 1992 and 1994 b; Casanova, 1993). The high infestation percentage by *T. parva* (84.3 %) is also noticeable, which confirms the previous hypothesis (Miquel *et al.*, 1992). *A. martinezi* (7.8 %) and *T. genettae* (31.3 %) are two oioxenous species not previously found. This strict specificity is made evident in their prevalences, which are the highest after that of *T. parva*. The occurrence in the genet of other parasite species is poor, according to the data referring to the prevalence and worm burden (Table IA). The exception would be *J. pasqualei* whose presence seems to be constant (Miquel *et al.*, 1992).

In relation to *M. meles* helminthfauna (3 Nematoda species in Miquel *et al.*, 1992), the increase in the number of species has been marked. New species in this host, including 1 Cestoda and 3 Nematoda, were detected. Among the helminths there are oioxenous species (*A. incisa*) and eurixenous species (*A. putorii*, *Strongyloides* sp. and *A. vasorum*) which the badger acquires by cohabitation with other Canoidea (especially *V. vulpes* and *Mustela* spp.). In spite of this qualitative increase, the helminthfauna appear to be markedly impoverished, if we compare them with those of the badger in neighbouring areas (Motjé, 1995). Moreover, it appears to be configurated by those species more common in the Carnivore in the Iberian Peninsula, which in a way seems to indicate a loss of those species less habitual in its peninsular parasitofauna (Motjé, 1995). In Montseny, the ecological features might explain the higher prevalence values and parasitic intensities for *P. plica* and *A. vasorum*, which the badger shares with the red fox (Miquel *et al.*, 1992; Miquel, 1993; Motjé, 1995).

The prevalence of *M. nivalis* (92.8 %) is higher than that found in other surveys of this host in the Iberian Peninsula (Motjé, 1995). This value is explained by the high percentage of infestation by *M. patens* (89.3 %). In general, the faunistical data in this host are structurally similar to those previously recorded and fit in the Mustelidae helmin-

Table III. – A, Helminthfauna of *Genetta genetta* (prevalences and mean intensities) according to the sex and season of capture. B, Helminthfauna of *Martes foina* (prevalences and mean intensities) according to the sex and season of capture.

A	*Genetta genetta*											
	males (n=62)		females (n=38)		winter (n=24)		spring (n=45)		summer (n=23)		autumn (n=10)	
	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.
TREMATODA	1.6						2.2					
Brachylaima sp.	1.6	1.0					2.2	1.0				
CESTODA	82.5		92.1		87.5		80.0		95.6		80.0	
T. parva	80.9	106.3	89.4	76.3	87.5	72.7	77.7	115.3	95.6	77.4	80.0	63.5
Mesocestoides sp.			2.6	6.0			2.2	6.0				
J. pasqualei	4.7	13.0	2.6	2.0			4.4	1.0	8.7	2.0	20.0	19.0
NEMATODA	38.0		42.1		62.5		28.9		26.1		80.0	
A. martinezi	6.3	2.0	10.5	5.0	8.3	1.0	6.6	5.6	8.7	2.5	10.0	2.0
T. genettae	31.7	11.7	28.9	3.9	45.8	5.2	26.6	16.0	13.0	1.6	60.0	3.8
C. seurati	1.5	2.0	7.9	3.0	4.1	3.0	2.2	2.0				
M. muris	1.5	3.0	10.5	2.5	8.3	1.5			8.7	1.5	10.0	5.0
P. leiperi	1.5	2.0			4.1	2.0						
TOTAL PARASIT.	88.5		97.3		95.8		86.6		95.6		90.0	

B	*Martes foina*											
	males (n=58)		females (n=31)		winter (n=37)		spring (n=19)		summer (n=17)		autumn (n=16)	
	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.	Prev.	Mean intens.
CESTODA	10.3		23.3		27.8		10.5				6.2	
T. martis	10.3	2.7	23.3	6.3	27.8	3.3	10.5	12.5			6.2	2.0
NEMATODA	75.4		76.7		72.2		83.3		76.5		68.7	
P. plica	28.6	1.6	26.4	1.4	32.4	1.3	27.8	2.0	26.7	1.0	25.0	1.7
E. aerophilus	57.9	3.1	40.0	3.0	47.2	3.2	72.2	4.8	41.2	1.1	50.0	1.9
A. putorii	17.5	2.4	6.7	2.9	8.1	1.3	15.8	3.7	29.4	1.8	6.2	4.0
Strongyloides sp.	8.6	36.2	16.7	12.8	8.1	27.7	10.5	18.5	29.4	25.0		
M. patens	32.8	17.6	46.7	9.7	36.1	8.5	52.6	25.1	23.5	17.7	37.5	6.5
C. petrowi	24.6	2.9	10.0	3.0	11.1	1.5	55.6	4.0	11.8	2.0	6.2	1.0
Filaroides martis	3.5	-	3.3	-	2.7	-					6.2	-
T. cati			3.3	2.0	2.7	2.0						
M. muris	1.7	1.0	6.7	2.5	2.7	1.0			5.9	4.0	6.2	1.0
F. martis (n=1 male)	100	13.0			100	13.0						
TOTAL PARASIT.	80.7		80.0		77.8		94.1		76.5		75.0	

thfauna patterns (Miquel *et al.*, 1992). Only *T. tenuicollis, Filaria martis* and *S. nasicola* are new findings to the area. In view of the continuous presence of *M. muris* in the weasel of the Montseny, it is worth mentioning again what has been said (Casanova *et al.*, 1991; Miquel *et al.*, 1992) about the role of carnivores in the nematode life cycle in the Massif.

The similarity in the number of hosts belonging to the species *M. vison* studied previously (9 individuals) and those studied here (11 individuals) has meant that few differences in its helminthfauna were recorded (Miquel *et al.*, 1992). In contrast the great increase in the number of *M. foina* (7 individuals studied in 1992 parasited by *Filaroides martis* and *M. patens;* 89 in the current report), meant the detection of a new species of Cestoda and 8 Nematoda. In this carnivore, in contrast with most Mustelids, there are no important differences between the parasitofaunas from the Montseny and the rest of the Peninsula. It might be assumed, therefore, that future surveys will not find significant modifications in its helminthfauna. The reason for this may lie in several ecological features which, according to Miquel *et al.* (1994 c), determine the helminthfaunas of all peninsular Mustelidae. These are : a) the host chorology; b) its way of life; c) the population density and d) the phylogeny between Mustelidae genus (due to the coevolution parasite-host).

The faunistical and ecological results in relation to *V. vulpes* (table IB) show an evident similarity with those previously found (Miquel *et al.*, 1994 a). Only *Strongyloides* sp. was detected for the first time. It seems, therefore, that results regarding host can be catalogued as definitive (Miquel *et al.*, 1994 a and b) and that our level of knowledge of the red fox helminthfauna in the Montseny is definitive.

In spite of the imbalance between the number of males and females in *G. genetta*, and the fact that in some seasons the number of hosts studied has been low, Table IIIA includes some interesting data. Thus, no significant differences were detected between male and female helminthfaunas, either in their prevalences or in the intensities of parasitation.

If we group the genets captured between 1988 and 1991 by seasons, the results do not show significant differences in their prevalences (x^2 test). On the other hand, the helminths *T. parva*, *A. martinezi* and *T. genettae* occur with significantly higher mean intensities in spring. These differences could be due, in the case of *T. parva*, to the population dynamics of the intermediate host (the field mouse, *Apodemus sylvaticus*). For the two nematode species, spring would seem to be the ideal season for the development of its free life forms (larvae and eggs respectively).

Results in table IIIB are similar in part to those of *G. genetta*, with the absence of significant differences between male and female helminthfaunas in the stone marten. The seasonal study was carried out with stone martens captured from winter 1988-89 to spring 1993. Statistically significant differences were only detected in the case of the nematode *C. petrowi*, which shows a higher infestation percentage in spring. The phenomenon could be explained by an increase in Invertebrate ingestion of the Montseny hosts in spring (Ruíz-Olmo, unpublished data), which coincides with a decrease in fruit consumption. It should be noted that a pulmonate acts as an intermediate host of the helminth (Adisson and Fraser, 1994). The increase in the prevalences of *E. aerophilus* and *A. putorii* in spring, could be similarly explained. At the same time there is a clear parallelism in the infestation intensities. Other seasonal variations which were detected do not appear to be statistically significant; these include : the slight general infestation peak in spring, the higher prevalence of *M. patens* also in spring, of *T. martis* in winter, or of *Strongyloides* sp. in summer. In some of these results the reproductive cycle of *M. foina* in the Montseny plays an important role (gestation and birth between December and January) as this may mean females spend more time in their set in winter and spring. In this period the infestation by monoxenous helminths, with a direct cycle, would be more probable.

The results indicate the effect of the ecological factors of the Montseny on the helminthfaunas in carnivores. If we take into account the characteristics of the hosts helminthfaunas in insular ecosystems (Mas-Coma and Feliu, 1984) and we compare them with those found in the Montseny, the results show : a) there is a marked impoverishment in the number of parasite species from the Montseny compared with the number which infest the same hosts at a peninsular level; b) in general the percentages of infestation are slightly higher in the Montseny than in neighbouring peninsular areas; c) the worm burden is almost always higher in hosts from the Montseny; d) very occasionally parasites occur in hosts in wich they are not usually found. If we apply those four features to each of the helminthfauna studied, the results are diverse. As regards the three last characteristics, the structure of helminthfaunas differ depending on the host species. The only host whose helminthfauna does not fit in with the first characteristic is *M. foina*.

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