TICKS (ACARINA: IXODIDAE) OF WILD BIRDS IN THE EBRO MIDDLE BASIN (NORTH-EAST SPAIN)

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BIRDS
IXODES FRONTALIS
IXODES RICINUS

SUMMARY: Living birds (n = 1776) were trapped and their ticks removed in Ebro Middle Basin (N.E. Spain) between January 1990 and July 1991. Positive hosts were *T. troglodytes, Prunella modularis, Erithacus rubecula, Phoenicurus ochruros, Turdus merula, T. philomelos, Sylvia atricapilla, Phylloscopus collybita, Parus major, Certhia brachydactyla, P. pyrrhocorax, Fringilla coelebs, Emberiza citrinella, E. cirlus, E. cia* and *E. schoeniclus.* Ticks collected (N = 255) for this study belong to the species *Ixodes ricinus* and *Haemaphysalis punctata* (immatures only), *Ixodes frontalis* (all stages) and *Hyalomma marginatum* (nymphs). The estimated prevalence for some bird species (*Sylvia atricapilla, Phylloscopus collybita, Parus major* and *Pyrrhocorax pyrrhocorax*) is very low, but others like *Erithacus rubecula, Turdus merula* and *Turdus philomelos* it reaches values of about 20 % or even higher.

Most of the cases of parasitism by ticks are due to *Ixodes frontalis.* This tick can attach a wide range of hosts, although *Erithacus rubecula* and *Turdus philomelos* are the commonest. With regard to *Ixodes ricinus, Turdus merula* seems to be the most important carrier, whereas *Emberiza cirlus* may be the main host for *Haemaphysalis punctata.*

OISEAUX
IXODES FRONTALIS
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RÉSUMÉ : Dans le Bassin moyen de l'Ebre (N.E. de l'Espagne), entre janvier 1990 et juillet 1991, 1776 oiseaux ont été capturés vivants et leurs tiques prélevées. Les hôtes positifs furent *T. troglodytes, Prunella modularis, Erithacus rubecula, Phoenicurus ochruros, Turdus merula, T. philomelos, Sylvia atricapilla, Phylloscopus collybita, Parus major, Certhia brachydactyla, P. pyrrhocorax, Fringilla coelebs, Emberiza citrinella, E. cirlus, E. cia* et *E. schoeniclus.* Les 255 tiques récoltées au cours de cette étude appartiennent aux espèces *Ixodes ricinus* et *Haemaphysalis punctata* (immatures seulement), *Ixodes frontalis* (tous les stades) et *Hyalomma marginatum* (nymphes). L'estimation de la prévalence pour quelques espèces d'oiseaux (*Sylvia astricapilla, Phylloscopus collybita, Parus major* et *Pyrrhocorax pyrrhocorax*) est très basse, mais pour d'autres comme *Erithacus rubecula, Turdus merula, Turdus merula* et *Turdus philomelos* elle atteint des valeurs d'environ 20 % ou même plus élevées. La plupart des cas de parasitisme par les tiques sont dus à *Ixodes frontalis.* Cette tique peut s'attacher à un large éventail d'hôtes, bien que *Erithacus rubecula* et *Turdus philomelos* soient les plus communs. En ce qui concerne *Ixodes ricinus, Turdus merula* semble être le porteur le plus important, tandis qu'*Emberiza cirlus* pourrait être l'hôte principal d'*Haemaphysalis punctata.*

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Introduction

Wild birds have been often regarded as long-distance carriers of ticks and possible spreaders of several pathogens transmitted by these arthropods (Hoogstraal, 1977; Filipe, 1980). Furthermore, many bird species play a significant role as intermediate hosts for some ticks that are of importance in medical or veterinary epidemiology. Thus, birds are one of the most common host groups for *Ixodes ricinus* immatures (Humair *et al.*, 1993). This is of epidemiological significance because the possibilities of maintaining endemic cycles of *I. ricinus* transmitted diseases or spreading them into new areas potentially suitable for ticks. On the other hand, *Borrelia burgdorferi* has been detected in *Ixodes frontalis*, a strict bird-feeding tick. Although some authors have pointed out the lack of epidemiological importance of some birds as reservoirs of the spirochaete, birds must be considered as introductory agents of ticks into spirochaete-infected areas.

In this paper, we present the data from an intensive survey of trapped birds and the ticks they carried. Figures for species collected in several biotopes, and tick prevalence on the different hosts species are also analyzed.

Materials and methods

Living birds (n = 1776) were trapped with mist-nets and mesh-traps between January 1990 and July 1991 in the Ebro Middle Basin (Fig. 1). Species, sex, and age were determined following several authors (Bruun & Singer, 1971; Svensonn, 1992). Birds were ringed while the body was carefully examined for ticks. Feathers were blown to expose the skin surface, and ticks were removed with fine forceps and stored in glass vials (one per bird) containing alcohol. Immature ticks were mounted in Hoyer's medium and identified.

Sampling points were classified into five biotopes according to geographical, geological, climatic and ecological factors. These are: 1) Fluvial groves, located on alluvial soil, with dense growth of *Populus* forest in areas dominated by stepped Mediterranean climate. *Zea mais*, fruit trees, and other crops that grow on irrigated land are widespread. Spontaneous vegetation includes *Typha* sp. and *Phragmites* sp. in shallow waters, associations of *Tamaricetum gallicae* and *Salicetum neotrichae* on lands that are periodically under water, and *Fraxinus oxycarpa* woods. 2) Xeromediterranean areas, with semiarid Mediterranean climate, occupying the main part of Ebro mid-valley. These can be divided into three climatic subdivisions *Juniperus thurifera* stratum, between 350 and 400 meters above sea level (m.a.s.l.), with stepped Mediterranean climate and the *Rhamneto-Cocciferetum thuriferetosum* association as terminal climatic community. *Pinus halepensis* and *Quercus coccifera* stratum, located at 350–700 m.a.s.l. in a semiarid Mediterranean climate and distinguished by the sub-associations *Rhamneto-Cocciferetum cocciferetosum*, *R.-C. pistacietosum* and *R.-C. caricetosum humilis.* The third stratum is that of *Quercus ilex rotundifolia*, above 700 m.a.s.l., where the oromediterranean climate and *Quercus rotundifolia* association are dominant. Dry-land crops are common in this biotope, but man's influence is not important. 3) Endorreic lagoons, typical of the Ebro depression. Vegetation is composed by hyperhaline communities belonging to the class Salicornieta and large reed beds and areas covered by rushes. 4) Mountain valleys, in Pirineos mountains (Spanish-French border) and Sistema Ibérico (The western most portion of the study area), at above 1000 m.a.s.l., with woods of *Fraxinus excelsoir*, *Corilus avellana*, *Sorbus* sp., *Quercus petrae*.

The χ^2 test was used to compare the prevalence of birds parasitized by ticks in each biotope. The estimated prevalence in the bird population was calculated by means of the standard mean error, according to the size of the sample; this test was done only when abundant hosts were available.

Results

Table 1 shows the number and species of birds checked, including the data concerning the presence of ticks. Positive hosts were *T. troglodytes*, *Prunella modularis*, *Erithacus rubecula*, *Phoenicurus ochruros*, *Turdus merula*, *T. philomelos*, *Sylvia atricapilla*, *Phylloscopus collybita*, *Parus major*, *Certhia brachydac-*

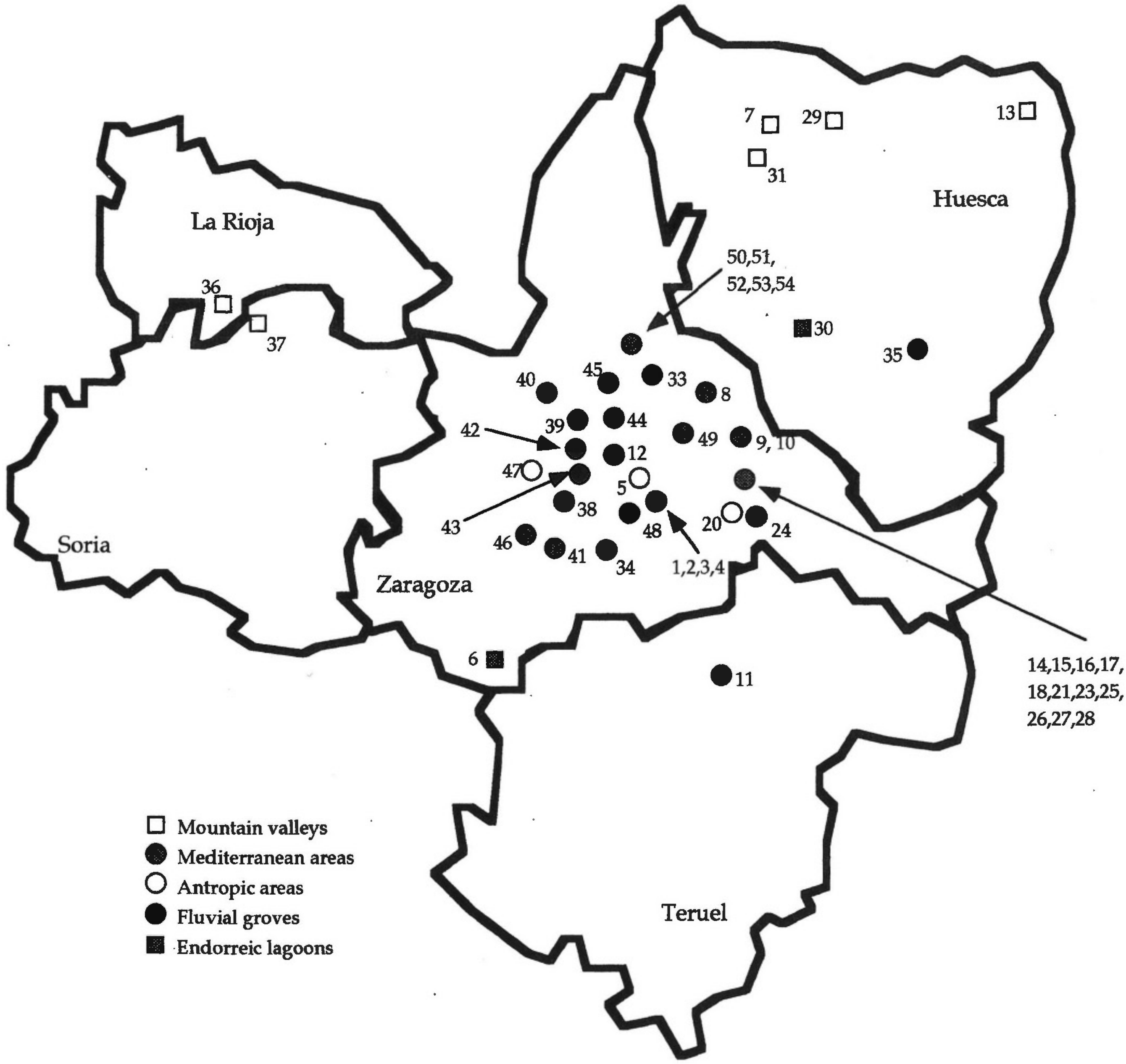

FIG. 1: Sampling locations.

tyla, *P. pyrrhocorax*, *Fringilla coelebs*, *Emberiza citrinella*, *E. cirlus*, *E. cia* and *E. schoeniclus*. Ticks collected (Table 2) belong to the species *Ixodes ricinus* and *Haemaphysalis punctata* (only immatures) and *Ixodes frontalis* (all stages). Nymphs of both *Hyalomma marginatum* and *Argas persicus* were rarely collected (see Table 2) and were ignored in subsequent studies.

The estimated prevalence for each bird species is shown in Fig. 2. For some species this parameter is very low (*Sylvia atricapilla*, *Phylloscopus collybita*, *Parus major*, and *Pyrrhocorax pyrrhocorax*) but for others such as *Erithacus rubecula*, *Turdus merula* and *Turdus philomelos*, are important tick carriers. For *Emberiza citrinella*, *E. cirlus* and *E. cia*, the sample sizes are too small to accurately estimate this prevalence.

Species	number	no. parasitized	% parasitized
Falco tinnunculus	2		
Gallinula chloropus	1		
Philomachos pugnax	1		
Actitis hypoleucos	3		
Columba palumbus	1		
Apus melba	45		
Strix aluco	1		
Alcedo atthis	17		
Merops apiaster	1		
Picus viridis	2		
Jynx torquilla	4		
Calandrella cinerea	4		
Galerida cristata	1		
Galerida theklae	6		
Lullula arborea	1		
Riparia riparia	14		
Delichon urbica	23		
Anthus pratensis	2		
Anthus spinoletta	3		
Motacilla cinerea	1		
Motacilla alba	6		
Troglodytes troglodytes	14	3	21.42
Prunella modularis	27	3	11.11
Erithacus rubecula	168	31	18.45
Luscinia megarhynchos	33		
Cyanosylva svecica	2		
Phoenicurus ochuros	12	1	8.33
Phoenicurus phoenicurus	7		
Saxicola torquata	4		
Oenanthe oenanthe	4		
Oenanthe hispanica	1		
Turdus merula	38	7	18.42
Turdus philomelos	8	5	62.50
Turdus viscivorus	8		
Cettia cetti	73		
Cisticola juncidis	2		
Locustella naevia	1		
Acrocephalus scirpaceus	69		
Hippolais poliglotta	9		
Sylvia undata	2		
Sylvia cantillans	4		
Sylvia melanocephala	5		
Sylvia hortensis	1		
Sylvia communis	33		
Sylvia borin	108		
Sylvia atricapilla	126	1	0.78
Phylloscopus bonelli	4		
Phylloscopus collybita	101	2	1.98
Regulus regulus	9		
Regulus igniczapillus	23		
Muscicapa striata	10		
Ficedula hypoleuca	76		
Aegithalos caudatus	29		
Parus ater	10		
Parus caeruleus	35		
Parus major	84	4	4.76
Certhia brachydactyla	8	1	12.50
Remiz pendulinus	16		
Lanius excubitor	2		
Garrulus glandarius	1		
Pica pica	1		
Pyrrhocorax pyrrhocorax	112	1	0.89
Corvus corone	5		
Corvus corax	1		
Passer domesticus	29		
Passer montanus	1		
Fringilla coelebs	66		
Serinus serinus	69		
Carduelis chloris	18		
Carduelis carduelis	22		
Carduelis spinus	12		
Carduelis cannabina	17		
Loxia curvirostra	29		
Pyrrhula pyrrhula	5		
Emberiza citrinella	1	1	100.00
Emberiza cirlus	3	1	33.33
Emberiza cia	4	1	25.00
Emberiza schoeniclus	25	1	4.00

TABLE 1: Number of birds checked and rates of tick presence.

Most of the cases of parasitism by ticks on birds are accounted for by *Ixodes frontalis* (Fig. 3). In the chart, we also included the figures for prevalence of the different tick species on the birds captured. For example, between 55.39% and 88.14% (95% C.I.) of the *Erithacus rubecula* are expected to be parasitized by *Ixodes frontalis*; this figure ranges between 42.13% and 99.64% (95% C.I.) for *Turdus merula*.

Species	Larvae	Nymphs	Females
Ixodes frontalis	149	19	7
Ixodes ricinus	17	8	
Haemaphysalis punctata	42	10	
Hyalomma marginatum	1		
Argas persicus	2		

TABLE 2: Number, species and stages of ticks collected.

Regarding the host preferences for the different tick species (Fig. 4), *Ixodes frontalis* has been collected from a wide range of birds, although *Erithacus rubecula* (carrying 31.64% to 46.08% (95% C.I.) of the specimens) and *Turdus philomelos* (11.56% to 22.72% (95% C.I.)) are the most common. *Ixodes ricinus* (Fig. 5) has a lower abundance in our captures, and its spectrum of hosts is consequently narrower. However, *Turdus merula* seems to be the most important host for *I. ricinus*, with 50.61% to 87.93% (95% C.I.) of the ticks of this species captured.

Immatures of *Haemaphysalis punctata* have been collected in high number on individual birds. These massive infestations may have influenced our results for tick preferences: our results indicate *Emberiza cirlus* as the preferred host, with 32.23% to 60.53% (95% C.I.) of the ticks on this host.

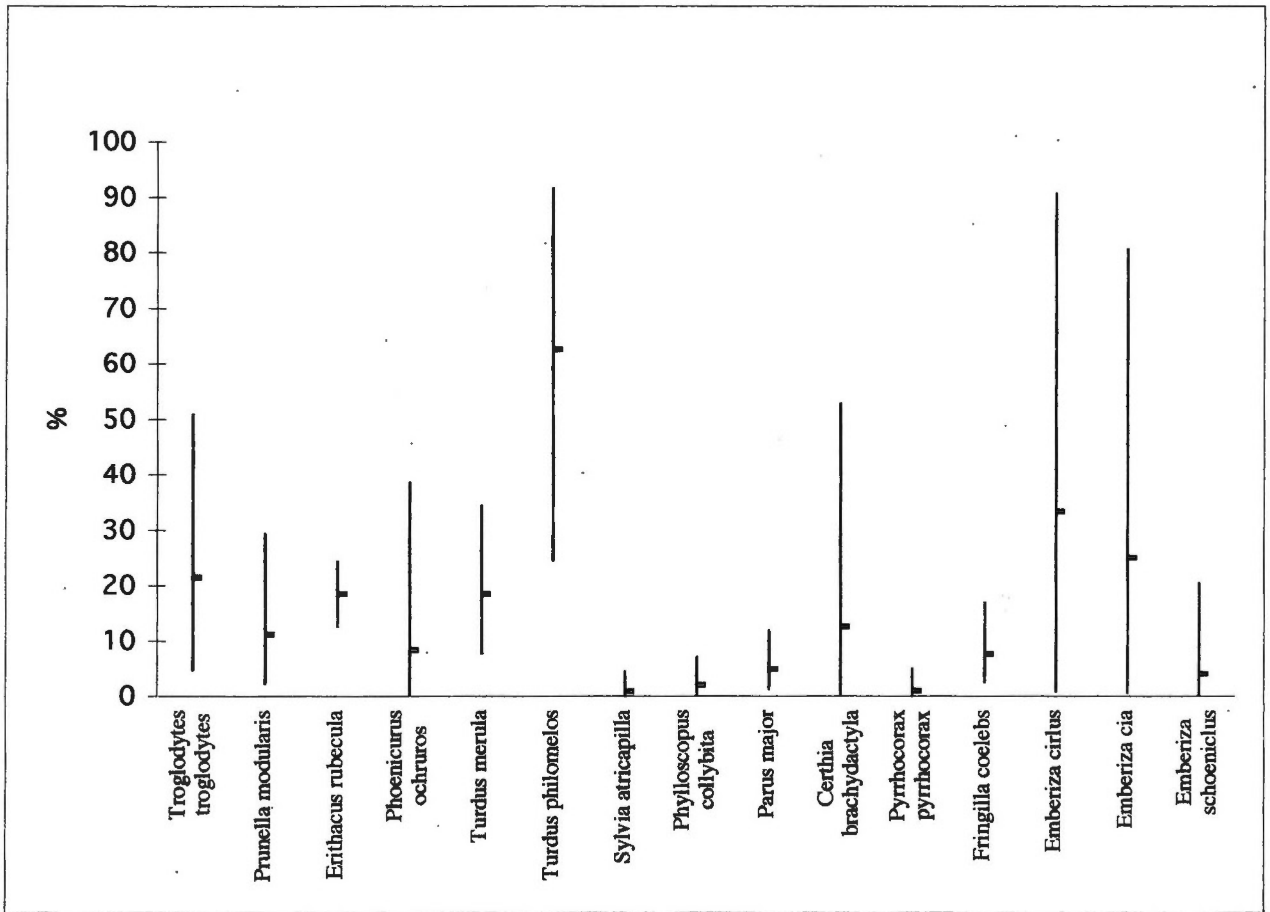

FIG. 2: Estimated prevalence for each bird species (95 % C.I.).

Comparison	χ^2	p value
Overall	186.174	<0.001
Fluv. groves End. lagoon	0.029	>0.1
Fluv. groves Mount. valley	156.836	<0.001
Fluv. groves Xerom. area	3.668	>0.05
End. lagoon Mount. valley	20.748	<0.001
End. lagoon Xerom. area	0.522	>0.1
Mount. valley Xerom. area	67.645	<0.001

TABLE 3: Comparisons of prevalences in different biotopes (χ^2 with Bonferroni method and Yates correction).

Birds collected in mountain valleys display a significantly higher prevalence of infestation than those caught in other biotopes, as is shown in Fig. 7 and Table 3. According to our data, between 18.03% and 32.66% (95% C.I.) of the birds captured in mountain valleys are parasitized by ticks, whereas the percentages are lower in fluvial groves (0.80% to 2.31%, 95% C.I.), endorreic lagoons (0.03% to 6.30%, 95% C.I.) and xeromediterranean areas (1.5% to 4.651%, 95% C.I.).

DISCUSSION

In this paper, we have summarized the results of a study on the ticks collected on birds in a wide area of the Northeast of Spain. The importance of birds as carriers of ticks have been pointed out previously (HOOGSTRAAL, 1977), these being migratory hosts that can introduce "exotic" species into new habitats suitable for tick survival and development.

I. frontalis was the most common tick species collected on birds. This was an expected result, because it is a strict bird-feeding species (HOOGSTRAAL & AESCHLIMANN, 1985). However, the epidemiological inter-

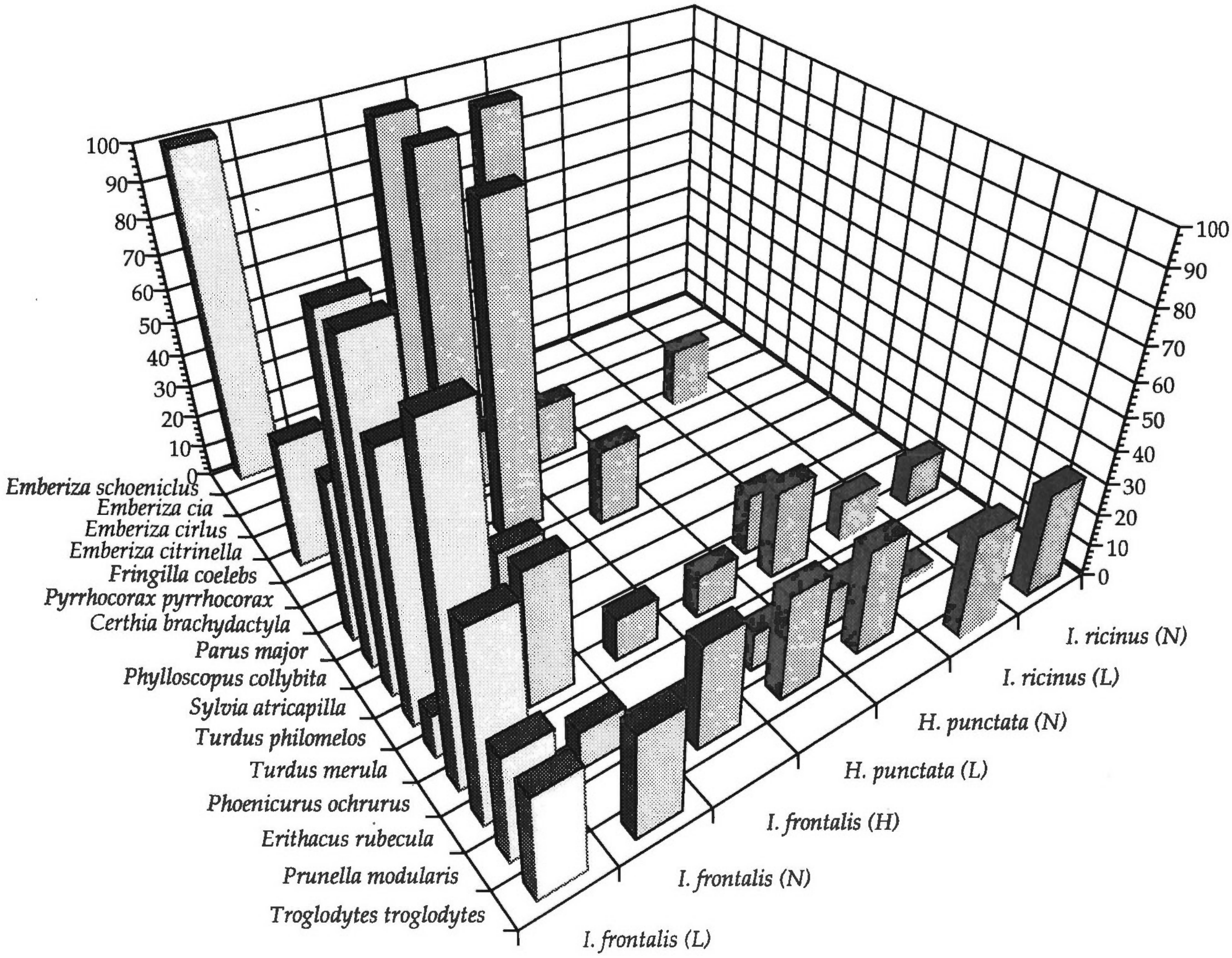

FIG. 3: Proportions of each bird species parasitized by each tick species.

est of this result must not to be disregarded, due to the finding of specimens infected with *B. burgdorferi* (ESTRADA-PEÑA *et al.*, 1992; PIESMAN & GRAY, 1994). Although the vectorial capacity of this tick species for the Lyme disease spirochaete remains to be demonstrated in the laboratory, it is possible to presume a closed cycle maintained in birds by *I. frontalis.*

The importance of birds as amplifying reservoirs for *B. burgdorferi* in *I. ricinus* is controversial. Some authors (MATUSCHKA & SPIELMAN, 1992) have pointed out the inability of *I. ricinus* to be infected while feeding on *Turdus* infected hosts. However, other reports (HUMAIR *et al.*, 1993) suggest this possibility. The latter authors studied the infestation of passerine birds by immature stages of *I. ricinus* in a Swiss woodland (the Staatswald, in the Canton of Berne) during May–October 1988. Thirteen bird species were found to be parasitized by larvae and nymphs of *I. ricinus*, with blackbirds (*Turdus merula*), song thrushes (*T. philomelos*) and robins (*Erithacus rubecula*) being most heavily infested. Infested ticks were removed from 5 species of bird—*T. merula*, *T. philomelos* and *E. rubecula* again being most heavily parasitized. The infection rate of larvae and nymphs removed from birds averaged 16.3 and 21.7%, respectively. It is suggested that some Turdidae may act as amplifying hosts for *Borrelia burgdorferi. I. ricinus* is a common species on blackbirds (*Turdus* spp.) in many portions of Europe (see, for example, DURIO *et al.*, 1982; MANILLA, 1987; WALTER *et al.*, 1986) and the role played by birds in the epidemiological cycles of the Lyme disease has to be considered. Similar

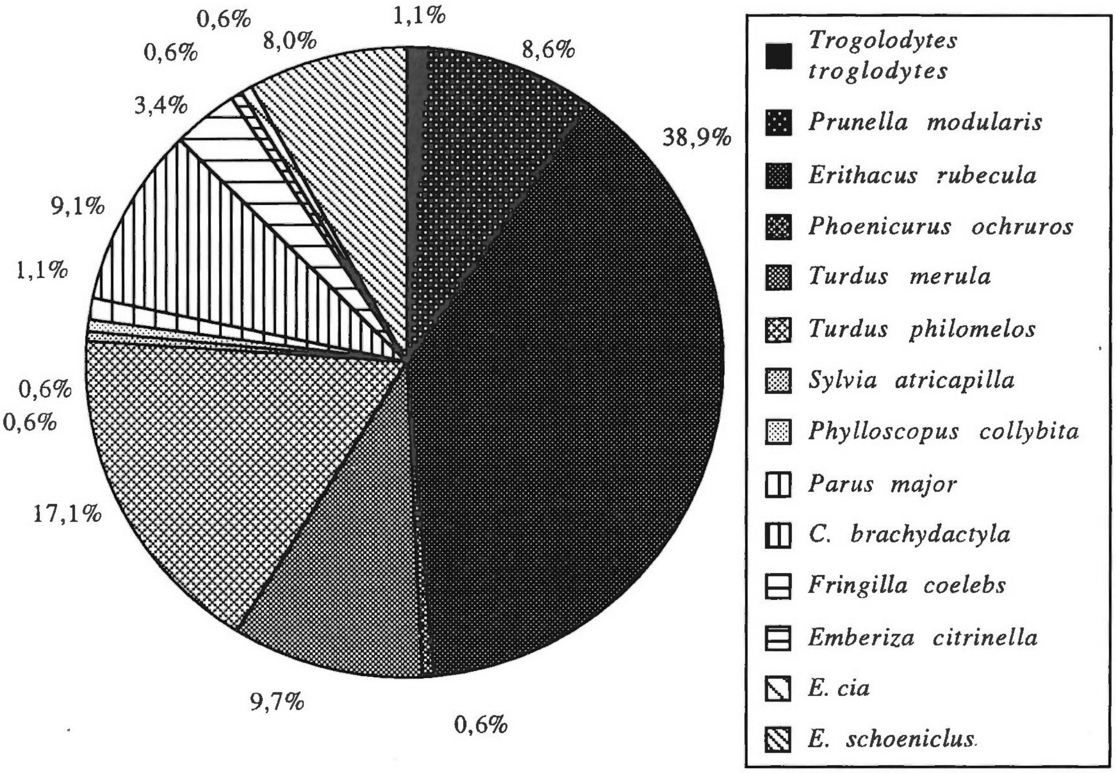

FIG. 4: Percentage of *I. frontalis* specimens collected on each bird species.

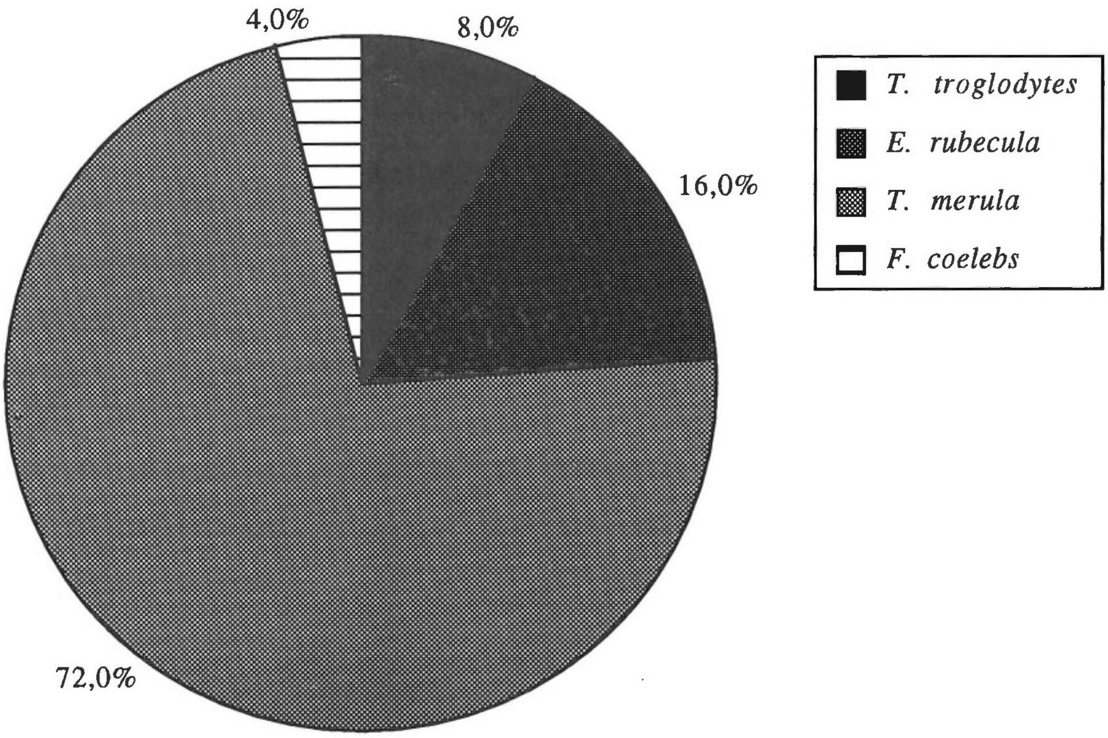

FIG. 5: Percentage of *I. ricinus* specimens collected on each bird species.

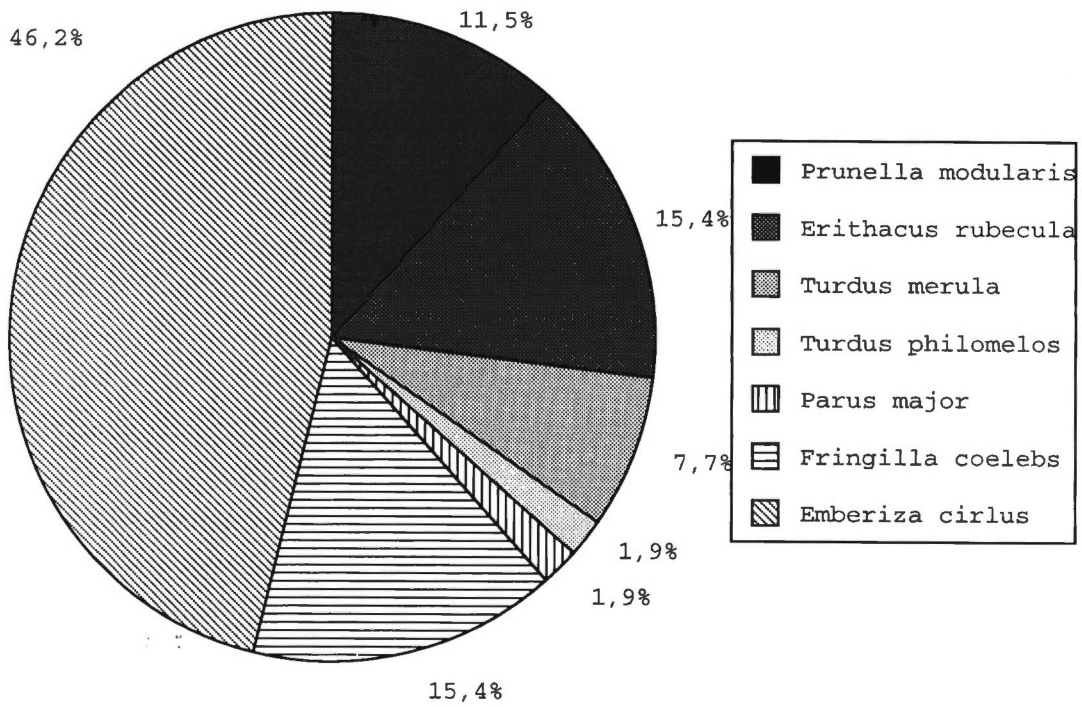

FIG. 6: Percentage of *H. punctata* specimens collected on each bird species.

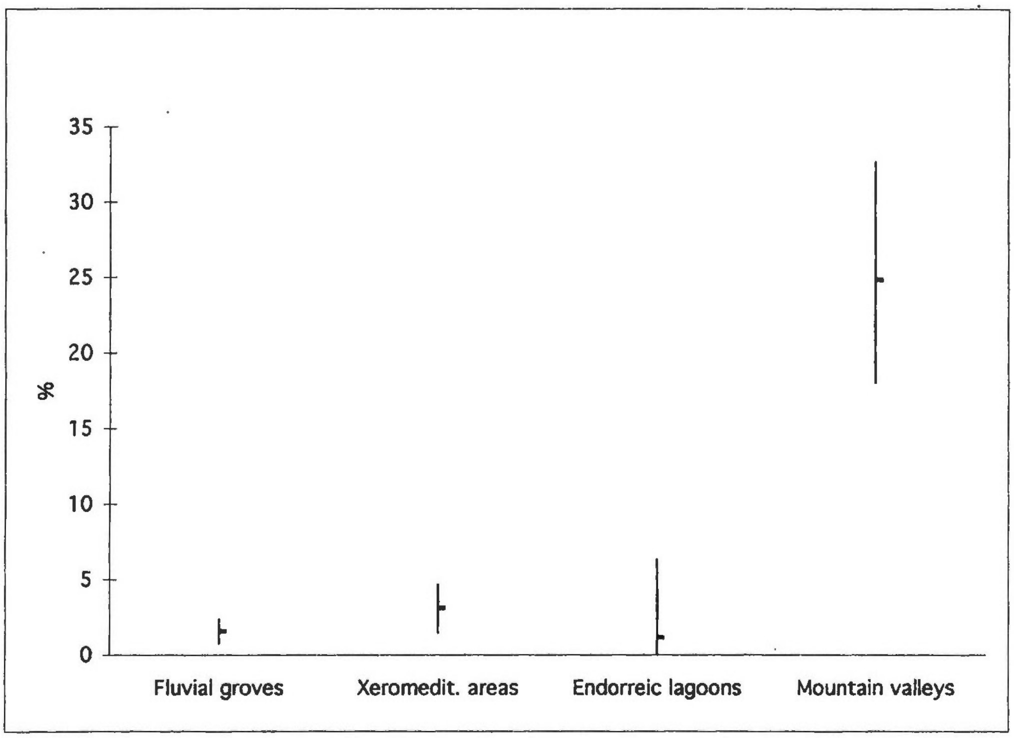

FIG. 7: Estimated prevalence for each biotope (95 % C.I.).

epidemiological cycles have been observed between *Turdus* spp. and some other *Ixodes* species, even in Japan (MIYAMOTO *et al.*, 1993) and the United States (BATTALY & FISH, 1993) concerning the infection with *B. burgdorferi*.

Our data about the phenology of ticks according to different biotopes agrees well with the known habitat preferences of the species involved. Thus, the mountain habitats tend to preserve high relative humidity levels in the soil, allowing a higher tick survival; on the other hand, the high summer temperatures observed in the middle of the river basin (ESTRADA-PEÑA *et al.*, 1992) are far above the tolerable limits for most of the ticks involved in this study.

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