

## TICKS ON BIRDS IN SWITZERLAND

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IXODIDAE, ARGASIDAE,  
BIRDS, SWITZERLAND

**SUMMARY :** Birds, hosts of several tick species, play an important role in the dissemination of ticks and tick-borne infectious agents. Examination of bird tick collections gathered during research studies of several years in Switzerland lead to an inventory of eleven tick species. The telotropic species *Ixodes ricinus*, feeding on birds only at larval and nymphal stages, is the most common. In Switzerland, *I. ricinus* is the vector of Lyme borreliosis (*Borrelia burgdorferi* sensu lato), the tick-borne encephalitis (TBE virus) and cattle babesiosis (*Babesia divergens*). Passerine birds, and especially robins (*Erithacus rubecula*) and blackbirds (*Turdus merula*), are the main hosts of immature *I. ricinus*. Nymphs of *Haemaphysalis punctata* were rarely collected from birds in Switzerland. Five other hard and one soft bird-specific tick species were sampled: *I. lavigatus*, a strictly host-specific species, from sand martins (*Riparia riparia*) and their nests; *I. arboricola* from birds nesting or roosting in tree cavities; *I. frontalis*, *I. festai* and *I. caledonicus* collected in low numbers; *Argas reflexus* chiefly from domestic pigeons (*Columba livia domestica*) and their nests. *Hyalomma marginatum marginatum* and *Rhipicephalus simus* were imported by migratory birds. Nymphs of *I. hexagonus* were found on a magpie (*Pica pica*).

IXODIDAE, ARGASIDAE,  
OISEAUX, SUISSE

**RÉSUMÉ :** Les Oiseaux, hôtes de plusieurs espèces de tiques, jouent un rôle important dans la dissémination de ces arthropodes et de leurs agents pathogènes. L'examen des collections de tiques réunies au cours de plusieurs années de recherches en Suisse a permis d'en inventorier 11 espèces. *Ixodes ricinus*, une tique télotrope et triphasique, ne se nourrissant sur les oiseaux qu'à l'état de larves et de nymphes, est de loin l'espèce la plus commune. En Suisse, *I. ricinus* est le vecteur de la maladie de Lyme (*Borrelia burgdorferi* sensu lato), de l'encéphalite à tiques (TBE virus) et de la babésiose bovine (*Babesia divergens*). Les passereaux, et plus particulièrement le rouge-gorge (*Erithacus rubecula*) et le merle (*Turdus merula*), sont les hôtes principaux pour les immatures d'*I. ricinus*. Les nymphes de *Haemaphysalis punctata* se rencontrent rarement sur les oiseaux

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en Suisse. Cinq autres espèces d'Ixodides et un Argaside, toutes spécifiques aux oiseaux, sont répertoriées : *I. lividus*, une tique strictement monotope, sur l'hirondelle de rivage (*Riparia riparia*) et dans ses nids; *I. arboricola* sur des oiseaux nidifiant ou se réfugiant dans les cavités des arbres; *I. frontalis*, *I. festai* et *I. caledonicus* qui sont récoltées en petit nombre; *Argas reflexus* principalement sur le pigeon domestique (*Columba livia domestica*) et dans ses nids. *Hyalomma marginatum marginatum* et *Rhipicephalus simus* ont été importés par des oiseaux migrateurs. Des nymphes d'*I. hexagonus* ont été trouvées sur une pie (*Pica pica*).

## INTRODUCTION

Birds as hosts of several tick species and reservoirs of some tick-borne pathogens play an important role in the circulation of these arthropods and their pathogens in nature. Our knowledge on ticks in Switzerland was consistently increased since 1965 when the first synthesis study on Swiss tick fauna was published (AESCHLIMANN *et al.*, 1965), but a comprehensive work concerning bird ticks was never published. Most of the detailed studies were conducted for the ticks of domestic animals, small mammals and wild carnivores (AESCHLIMANN *et al.*, 1968, 1970; IMMLER *et al.*, 1970; AESCHLIMANN, 1972; GRAF *et al.*, 1979; (AESCHLIMANN *et al.*, 1986b; TOUTOUNGI *et al.*, 1991). With regard to host specific bird ticks we are limited to several publications on two host specific ticks, *viz Ixodes lividus* and *Argas reflexus*, and their hosts (STADLER, 1924; BÜTTIKER, 1959, 1969; BÜTTIKER & AESCHLIMANN, 1975), listings of parasites collected from birds or their nests (HESS, 1923, 1924; WEGELIN, 1932, 1934; Fritz, 1944), articles citing new records for Switzerland (AESCHLIMANN & BÜTTIKER, 1975; MOREL & AESCHLIMANN, 1983; COTTY *et al.*, 1986) and two studies on the tick population of birds in a woodland, which dealt mainly with the immature stages of *I. ricinus* (AESCHLIMANN *et al.*, 1974; HUMAIR *et al.*, 1993). However, during the last decades a considerable number of tick specimens were collected from birds, mainly in the course of research studies on ticks and tick-borne diseases or resulting from parasitological fieldwork. All these specimens, most of them consisting in unpublished material,

were identified in the Institute of Zoology of Neuchâtel.

In the present paper, we give a full list of all tick species collected from birds in Switzerland and a list of their hosts. Their presence in Switzerland as well as their biology and their vector role of human and animal pathogens are briefly discussed.

## MATERIAL AND METHODS

The material consists of 6136 ticks collected from birds and bird nests. The majority of the material comes from the "Swiss ticks collection" got together by AESCHLIMANN and deposited in the Natural History Museum of Lausanne, and the "Bird ticks" collection realised by BÜTTIKER and entrusted to the Institute of Zoology of Neuchâtel. The first collection mainly consists of the material collected during research studies on ticks and tick-borne diseases in Switzerland while the second pertains to the material collected from wounded and dead birds, sand martin colonies, birds captured throughout the country but principally at some Alpine migration passages (Col de Bretolet [VS]\*<sup>4</sup>, Iragna [TI], Cazis [GR]), and specimens collected by taxidermists. Ticks collected during diploma studies at the Institute of Neuchâtel provided additional material. Swiss records published in previous articles on bird ticks and their hosts are also included in the present publication (HESS, 1923; 1924; STADLER, 1924; WEGELIN, 1932; 1934; Fritz, 1944).

Most of the ticks have been collected from birds without mentioning the number of birds investigated.

4. Abbreviations of the names of the Swiss cantons:

BE: Bern, BL: Basel-Land, BS: Basel-Stadt, GR: Graubünden, TI: Ticino, VD: Vaud, VS: Valais

However, detailed information is available from two studies carried out at Statswaald/Ins [BE], a humid woodland of the Swiss midlands at an altitude of 433 m. In this woodland the tick population of birds was studied in a systematic way in a first survey from April through November 1973 and from February through June 1974 (AESCHLIMANN *et al.*, 1974) and in a second survey from May through October 1988 (HUMAIR *et al.*, 1993). In both studies bird trapping occurred twice monthly on two to four successive days using Japanese mist nets.

## RESULTS

The examination leads us to a listing of ten species belonging to Ixodidae (hard ticks) and of one species

to Argasidae (soft ticks): *Ixodes (Ixodes) ricinus* Linneaus 1758, *I. (I.) festai* Rondelli 1926, *I. (Pholeoixodes) arboricola* Schulze & Schlottke 1929, *I. (Ph.) hexagonus* Leach 1815, *I. (Ph.) lividus* Koch 1844, *I. (Scaphixodes) caledonicus* Nuttall 1910, *I. (Trichotoixodes) frontalis* Panzer 1798, *Haemaphysalis (Aboimisalis) punctata* Canestrini & Fanzago 1878, *Hyalomma (Hyalomma) marginatum marginatum* Koch 1844, *Rhipicephalus (Rhipicephalus) simus* Koch, 1844 and *Argas (Argas) reflexus* Fabricius 1794 the unique soft tick on birds in this country.

*IXODES (IXODES) RICINUS*: It is the most common tick species collected from 51 different bird species and in 47 localities (TABLE 1 & FIG. 1). Almost all collected specimens were immature (3009: 1692 larvae and 1317 nymphs; only 5 adults: 3 females and 2

Bird species found infested	No of inf. birds	No of ticks found				Mean no of ticks per infested bird
		Larvae	Nymphs	Females	Males	
<i>Milvus milvus</i>	1	0	4	0	0	4.00
<i>Accipiter nisus</i> *	?	?	?	?	?	?
<i>Buteo buteo</i>	1	0	3	0	0	3.00
<i>Aquila chrysaetos</i>	1	0	0	1	0	1.00
<i>Falco tinnunculus</i>	1	1	26	0	0	27.00
<i>Gallus domesticus</i>	1	0	0	0	1	1.00
<i>Phasianus colchicus</i>	2	0	1	0	1	1.00
<i>Asio otus</i>	2	0	2	0	0	1.00
<i>Delichon urbica</i>	1	0	0	1	0	1.00
<i>Anthus trivialis</i>	22	42	17	0	0	2.68
<i>Motacilla flava</i>	2	1	1	0	0	1.00
<i>Troglodytes troglodytes</i>	8	46	18	0	0	8.00
<i>Prunella modularis</i>	3	0	16	0	0	5.33
<i>Erithacus rubecula</i>	171	759	243	0	0	5.86
<i>Luscinia megarhynchos</i>	4	4	4	0	0	2.00
<i>Luscinia svecica</i>	1	2	0	0	0	2.00
<i>Phoenicurus phoenicurus</i> **	15	12	11	0	0	1.53
<i>Turdus iliacus</i>	2	0	2	0	0	1.00
<i>Turdus merula</i>	88	478	614	0	0	12.41
<i>Turdus philomelos</i>	33	81	106	0	0	5.67
<i>Turdus pilaris</i>	6	3	17	0	0	3.33
<i>Turdus torquatus</i>	1	0	3	0	0	3.00
<i>Turdus viscivorus</i>	1	0	3	0	0	3.00
<i>Acrocephalus scirpaceus</i>	1	0	1	0	0	1.00
<i>Hippolais icterina</i>	1	0	1	0	0	1.00
<i>Phylloscopus collybita</i>	1	1	0	0	0	1.00
<i>Phylloscopus trochilus</i>	9	2	7	0	0	1.00
<i>Sylvia atricapilla</i>	26	27	15	0	0	1.62
<i>Sylvia borin</i>	4	0	6	0	0	1.50
<i>Sylvia communis</i>	2	0	3	0	0	1.50
<i>Ficedula hypoleuca</i>	3	5	1	0	0	2.00

<i>Muscicapa striata</i>	3	0	5	0	0	1.67
<i>Parus ater</i>	2	8	0	0	0	4.00
<i>Parus caeruleus</i>	4	8	1	0	0	2.25
<i>Parus major</i>	35	97	44	0	0	4.03
<i>Parus montanus</i>	4	0	5	0	0	1.25
<i>Parus palustris</i>	4	5	3	0	0	2.00
<i>Sitta europaea</i>	5	2	7	0	0	1.80
<i>Certhia brachydactyla</i>	1	1	0	0	0	1.00
<i>Corvus corone</i>	2	0	2	0	0	1.00
<i>Garrulus glandarius</i>	18	43	52	0	0	5.28
<i>Pica pica</i>	2	0	1	1	0	1.00
<i>Sturnus vulgaris</i>	5	2	7	0	0	1.80
<i>Passer domesticus</i>	1	0	1	0	0	1.00
<i>Passer montanus</i>	3	2	2	0	0	1.33
<i>Fringilla coelebs</i>	42	55	45	0	0	2.38
<i>Fringilla montifringilla</i>	3	1	3	0	0	1.33
<i>Carduelis spinus</i>	3	1	3	0	0	1.33
<i>Coccothraustes coccothraustes</i>	1	0	1	0	0	1.00
<i>Pyrrhula pyrrhula</i>	6	3	9	0	0	2.00
<i>Serinus serinus</i>	1	0	1	0	0	1.00
Total	559	1692	1317	3	2	

TABLE 1.— Bird hosts of *I. (I.) ricinus* in Switzerland (51 bird species from 47 localities).

\* Wegelin (1934) mentioned the presence of immatures of *I. ricinus* on goshawk (*Accipiter gentilis*).

\*\* Wegelin (1933) mentioned the presence of several larvae of *I. ricinus* around the eyes of another redstart (*Phoenicurus phoenicurus*) as well.

males). Robin (*Erithacus rubecula*) and blackbird (*Turdus merula*) were the main hosts. Forty six per cent of the infested birds were belonging to these two species, which harboured 73% of the collected total larvae and 65% of the collected total nymphs. Song thrush (*Turdus philomelos*), great tit (*Parus major*) and chaffinch (*Fringilla coelebs*) were frequently infested. Nymphs were also collected from the nests of great tits (*Parus major*) and of a pied flycatcher (*Ficedula hypoleuca*).

In the two studies conducted at Staatswald, all ticks except one (a larva of *I. frontalis*) collected from birds were identified as immatures of *I. ricinus* (AESCHLIMANN *et al.*, 1974; HUMAIR *et al.*, 1993). Hundred ninety six out of 430 birds (46%) captured from April to November 1973 and from February to June 1974 and 95 out of 178 birds (53%) captured from May to October 1988 were parasitized by *I. ricinus*. In total 768 nymphs and 1114 larvae were collected during the first survey and 162 nymphs and 300 larvae during the second one (TABLES 2 & 3). Among commonly captured bird species robin (*Erithacus rubecula*) and blackbird (*Turdus merula*) were the most frequently infested. The prevalence of infestation was high also for some less common species as jay (*Garrulus glandarius*), wren (*Troglodytes troglodytes*) and song thrush (*Turdus philomelos*).

The seasonal variation on the percentage of infested birds and in the mean number of nymphs and larvae per bird during 1973, 1974 and 1988 are shown in Fig. 5. The prevalence (percentage of infested birds) as well as the intensity (mean number of ticks per bird) of infestation seems to follow a bimodal pattern with a first peak in late spring and a second one in late summer.

*IXODES (IXODES) FESTAI* : *I. festai* was collected from 3 bird species and in 3 localities (TABLE 4 & FIG. 2). Seven out of 8 infested birds were captured in two localities, Col de Bretolet [VS] and Iragna [TI], which are considered as migration bird passages across the Alps, during the period 1989-1991. Blackbird (*Turdus merula*) was the most frequently infested bird species (TABLE 4). Six of the infested birds, 5 blackbirds and a dunnock (*Prunella modularis*), were captured in April-May, while the remaining two, a blackbird and a chaffinch (*Fringilla coelebs*), in October.

*IXODES (PHOLEOIXODES) ARBORICOLA* : All stages of *I. arboricola* were collected from 9 bird species and

Bird species found infested	No of birds examined	Birds infested (%)		Mean no of ticks per bird		
		No	%	Larvae	Nymphs	Larv. + Nymp.
<i>Troglodytes troglodytes</i>	6	5	83	4.17	2.83	7.00
<i>Erythacus rubecula</i>	111	82	74	4.87	1.52	6.39
<i>Turdus merula</i>	43	41	95	8.88	9.49	18.37
<i>Turdus philomelos</i>	4	2	50	9.25	16.25	25.50
<i>Turdus pilaris</i>	6	2	33	0.00	1.17	1.17
<i>Sylvia atricapilla</i>	30	9	30	0.43	0.27	0.70
<i>Sylvia borin</i>	2	1	50	0.00	0.50	0.50
<i>Muscicapa striata</i>	7	3	43	0.00	0.71	0.71
<i>Parus ater</i>	3	1	33	0.67	0.00	0.67
<i>Parus caeruleus</i>	16	3	19	0.38	0.06	0.44
<i>Parus major</i>	42	16	38	1.33	0.74	2.07
<i>Parus montanus</i>	12	4	33	0.00	0.42	0.42
<i>Parus palustris</i>	4	2	50	0.50	0.25	0.75
<i>Sitta europaea</i>	5	2	40	0.00	0.40	0.40
<i>Certhia brachydactyla</i>	6	1	17	0.17	0.00	0.17
<i>Garrulus glandarius</i>	2	2	100	6.50	11.00	17.50
<i>Sturnus vulgaris</i>	8	4	50	0.25	0.75	1.00
<i>Passer montanus</i>	6	3	50	0.33	0.33	0.66
<i>Fringilla coelebs</i>	34	12	35	0.91	0.50	1.41
<i>Carduelis spinus</i>	83	1	1	0.01	0.01	0.02
Total	430	196	46			

TABLE 2. Prevalence and intensity of infestation of different bird species in the Staatswald, Ins, during the periods April-November 1973 and February-June 1974.

Bird species found infested	No of birds examined	No of birds infested (%)		Mean no of ticks per bird		
		No	%	Larvae	Nymphs	Larv. + Nymp.
<i>Alcedo atthis</i> *	1	0	0	0.00	0.00	0.00
<i>Dendrocopos major</i> *	2	0	0	0.00	0.00	0.00
<i>Troglodytes troglodytes</i>	2	2	100	0.60	0.50	6.50
<i>Erythacus rubecula</i>	42	35	83	3.64	0.79	4.43
<i>Turdus merula</i>	17	14	82	2.29	5.12	7.41
<i>Turdus philomelos</i>	6	5	83	4.00	2.50	6.50
<i>Phylloscopus trochilus</i>	2	0	0	0.00	0.00	0.00
<i>Regulus ignicapilla</i>	1	0	0	0.00	0.00	0.00
<i>Regulus regulus</i>	4	0	0	0.00	0.00	0.00
<i>Sylvia atricapilla</i>	33	13	39	0.39	0.12	0.51
<i>Sylvia borin</i>	7	1	14	0.00	0.14	0.14
<i>Ficedula hypoleuca</i>	1	0	0	0.00	0.00	0.00
<i>Parus ater</i>	5	1	20	1.20	0.00	1.20
<i>Parus caeruleus</i>	8	1	13	0.25	0.00	0.25
<i>Parus major</i>	24	14	58	0.02	0.33	1.96
<i>Parus montanus</i>	3	0	0	0.00	0.00	0.00
<i>Parus palustris</i>	7	2	29	0.43	0.29	0.72
<i>Sitta europaea</i>	9	3	33	0.22	0.56	0.78
<i>Garrulus glandarius</i>	1	1	100	1.00	1.00	2.00
<i>Fringilla coelebs</i>	3	3	100	2.00	1.67	3.67
Total	178	95	53			

TABLE 3. Prevalence and intensity of infestation of different bird species in the Staatswald, Ins, during the period May-October 1988  
(\* non-passenger birds).

Bird species found infested	No of inf. birds	No of ticks found				Main no of ticks per infested bird
		Larvae	Nymphs	Females	Males	
<i>Prunella modularis</i>	1	0	2	0	0	2.00
<i>Turdus merula</i>	6	0	5	4	0	1.50
<i>Fringilla coelebs</i>	1	0	0	1	0	1.00
Total	8	0	7	5	0	

TABLE 4. — Bird hosts of *I. (I.) festai* in Switzerland (3 bird species from 3 localities).

Bird species found infested	No of inf. birds	No of ticks found				Main no of ticks per infested bird
		Larvae	Nymphs	Females	Males	
<i>Accipiter gentilis</i>	1	7	0	0	0	7.00
<i>Falco tinnunculus</i>	1	0	0	7	0	7.00
<i>Columba palumbus</i>	1	11	0	0	0	11.00
<i>Athene noctua</i>	6	0	3	3	0	1.00
<i>Phoenicurus phoenicurus</i> *	1	0	0	1	0	1.00
<i>Turdus merula</i>	1	0	1	0	0	1.00
<i>Parus major</i>	4	0	8	38	0	11.50
<i>Sitta europea</i>	1	0	1	0	0	1.00
<i>Sturnus vulgaris</i>	2	2	3	2	0	3.50
Total	18	20	16	51	0	

TABLE 5. — Bird hosts of *I. (Ph.) arboricola* in Switzerland (9 bird species from 17 localities).

\* Wegelin (1934) mentioned the presence of *I. arboricola* (without indicating the stage) around the eye of another redstart (*Phoenicurus phoenicurus*) as well.

Bird species found infested	No of inf. birds	No of ticks found				Main no of ticks per infested bird
		Larvae	Nymphs	Females	Males	
<i>Erythacus rubecula</i>	7	2	6	0	0	1.14
<i>Turdus merula</i>	1	2	0	0	0	2.00
<i>Turdus philomelos</i>	1	0	2	0	0	2.00
<i>Acrocephalus arundinaceus</i> *	?	?	?	?	?	?
<i>Parus major</i>	1	1	0	0	0	1.00
<i>Emberiza schoeniclus</i> **	1	0	0	1	0	1.00
Total	11	5	8	1	0	

TABLE 6. — Bird hosts of *I. (Tr.) frontalis* in Switzerland (6 bird species from 7 localities).

\* Wegelin (1932) cited the great reed warbler (*Acrocephalus arundinaceus*) as a host of *I. frontalis*.

\*\* Wegelin (1934) mentioned the presence of *I. frontalis* on another reed bunting (*Emberiza schoeniclus*) as well.

Bird species found infested	No of inf. birds	No of ticks found				Main no of ticks per infested bird
		Larvae	Nymphs	Females	Males	
<i>Motacilla alba</i>	2	0	2	0	0	1.00
<i>Luscinia svecica</i>	1	0	12	0	0	12.00
<i>Phoenicurus phoenicurus</i>	2	0	2	0	0	1.00
<i>Saxicola rubetra</i>	1	1	13	0	0	14.00
<i>Turdus viscivorus</i>	1	0	1	0	0	1.00
<i>Acrocephalus palustris</i>	1	0	1	0	0	1.00
<i>Acrocephalus scirpaceus</i>	1	0	0	1	3	4.00
Total	9	1	31	1	3	

TABLE 7. — Bird hosts of *H. (H.) m. marginatum* in Switzerland (7 bird species from 4 localities).

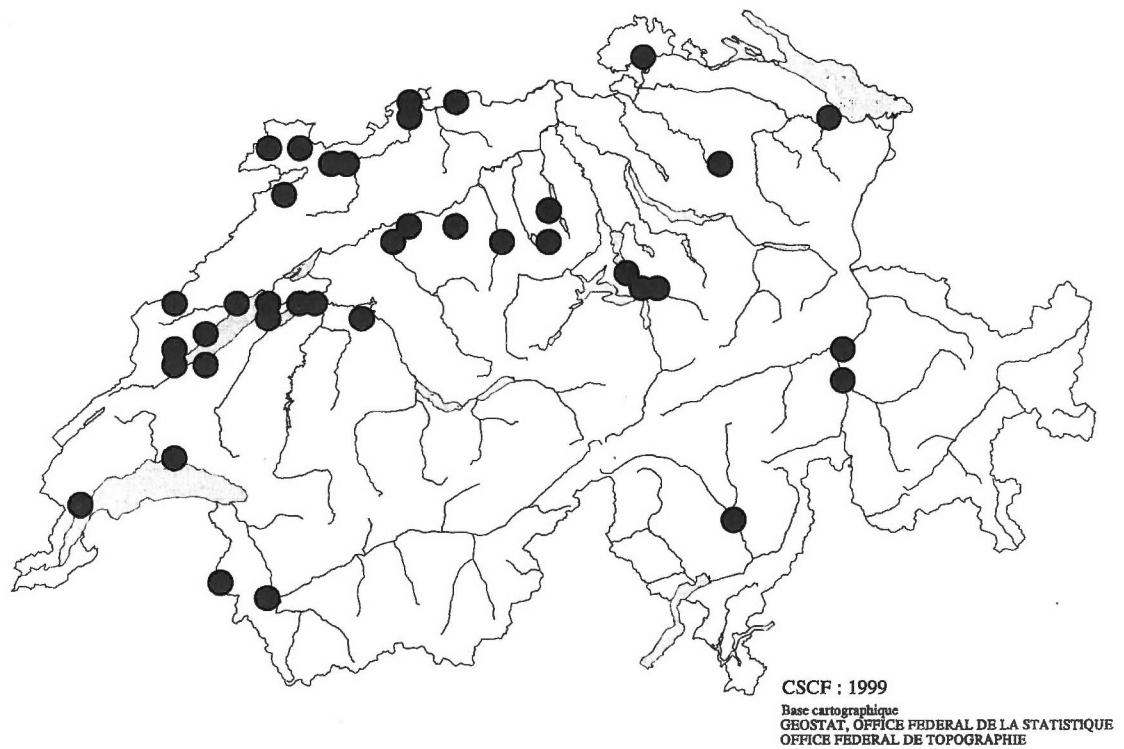


FIG. 1. — Distribution of *I. (I.) ricinus* collected from birds and bird nests in Switzerland.

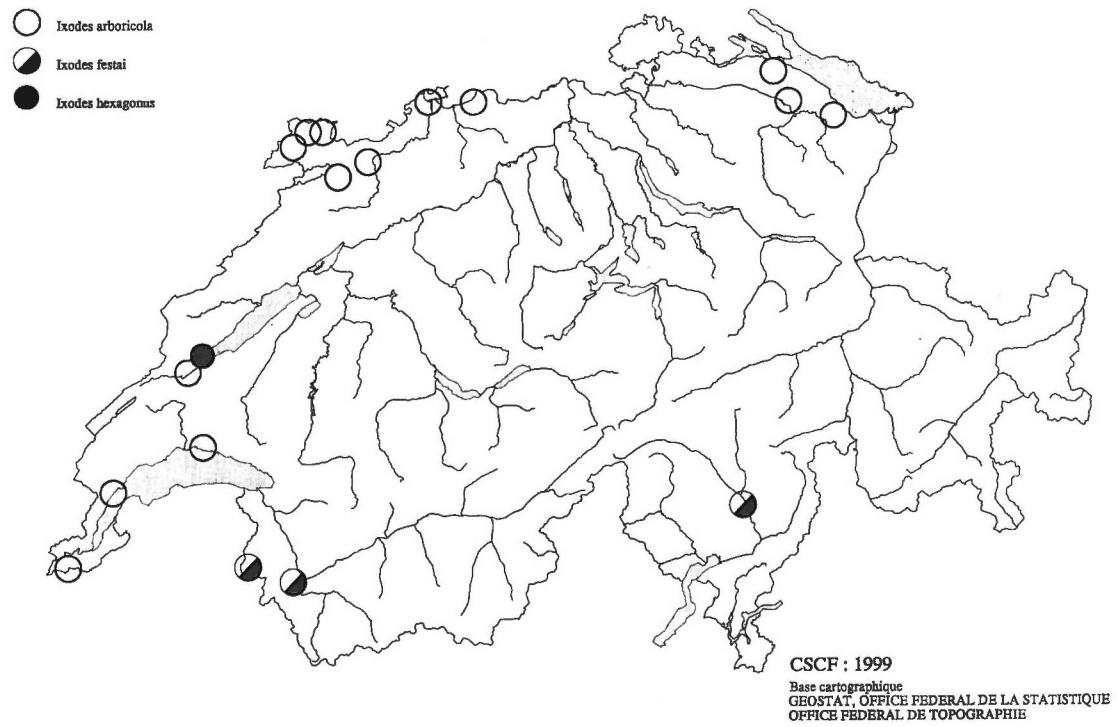


FIG. 2. — Distribution of *I. (I.) festai*, *I. (Ph.) arboricola* and *I. (Ph.) hexagonus* collected from birds and bird nests in Switzerland.

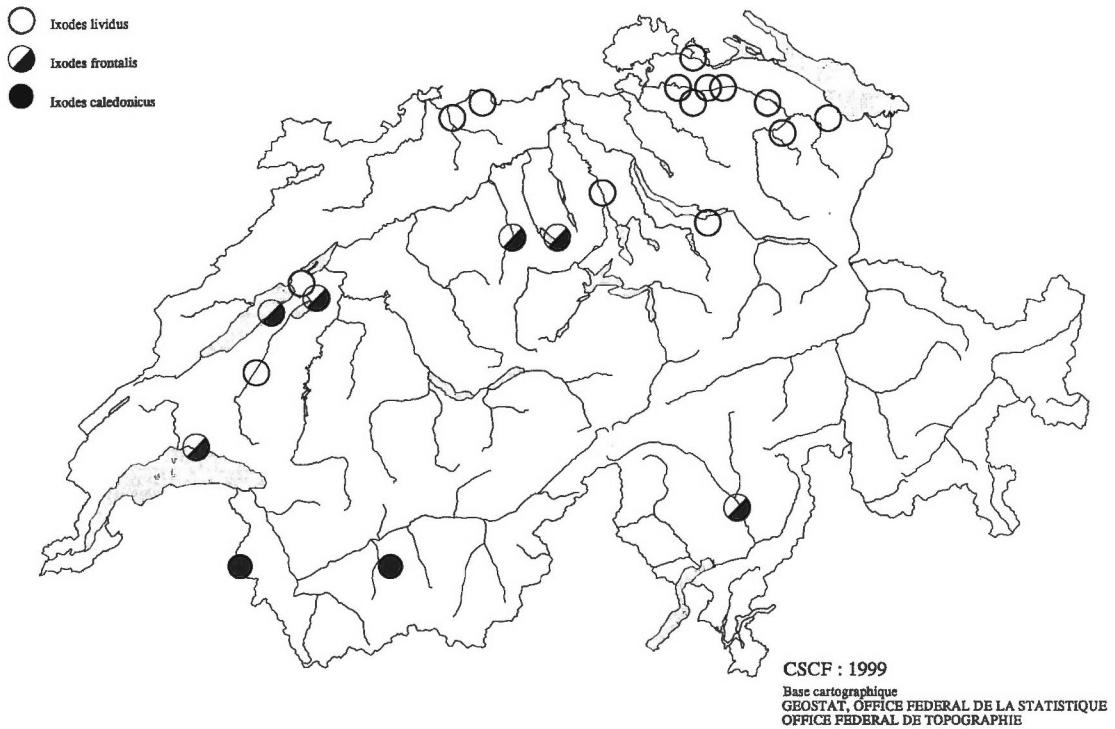


FIG. 3.— Distribution of *I. (Ph.) lividus*, *I. (Sc.) caledonicus* and *I. (Tr.) frontalis* collected from birds and bird nests in Switzerland.

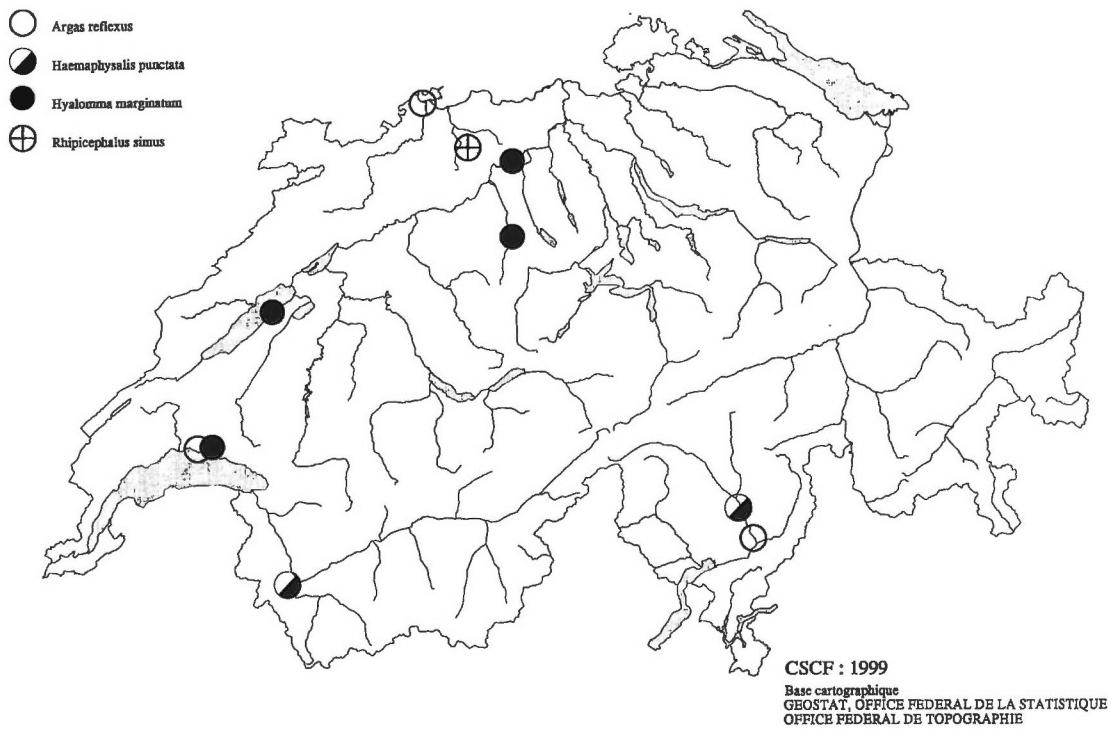


FIG. 4.— Distribution of *H. (A.) punctata*, *H. (H.) m. marginatum*, *R. (R.) simus* and *A. (A.) reflexus* collected from birds and bird nests in Switzerland.

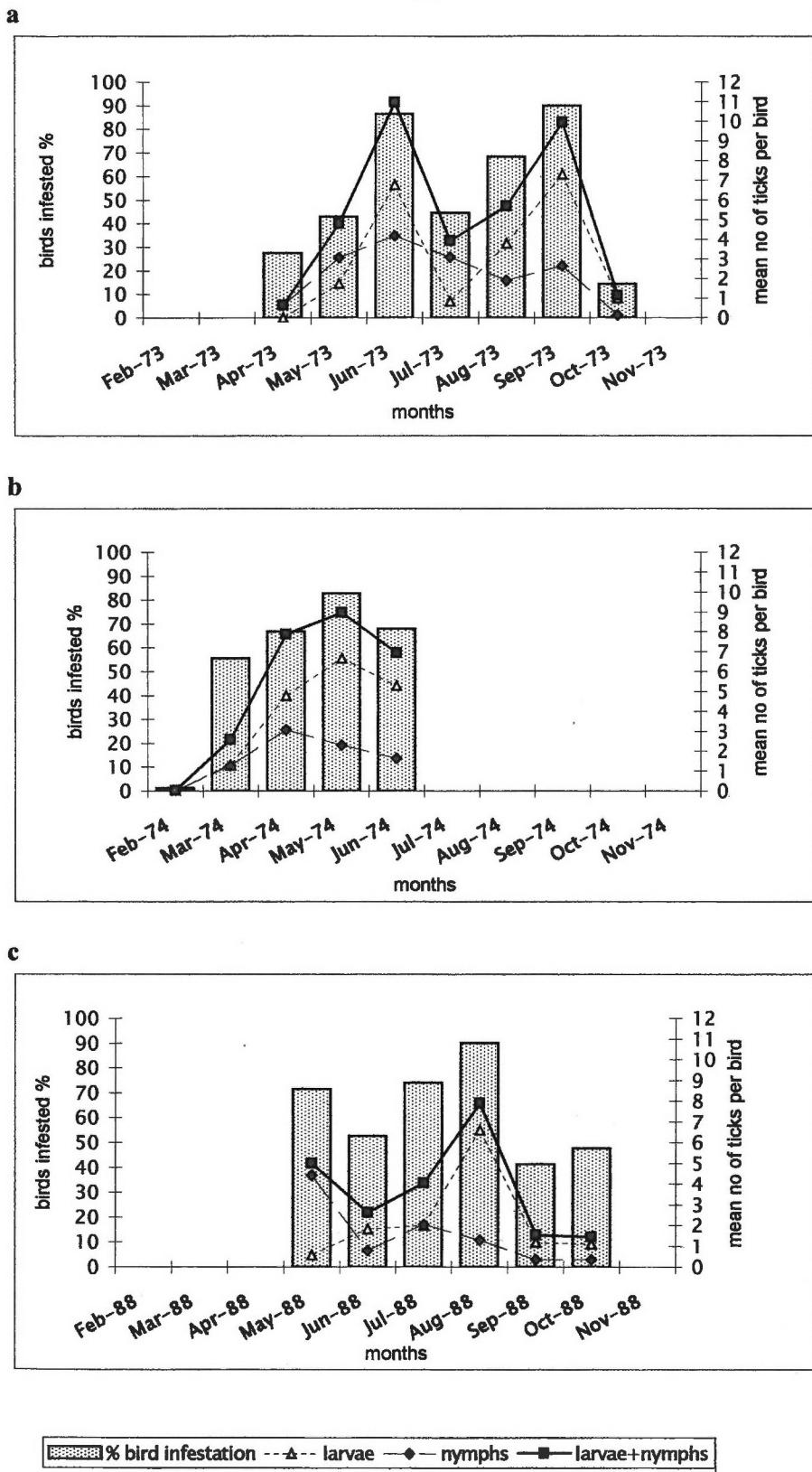


FIG. 5.—Prevalence and intensity of infestation of birds by month in the Staatswald, Ins, during the periods April-November 1973 (a), February-June 1974 (b) and May-October 1988 (c).

in 17 different localities (TABLE 5 & FIG. 2). Little owl (*Athene noctua*) and great tit (*Parus major*) were their preferential hosts. Immatures of *I. arboricola* were also collected from the nests of a great tit (*Parus major*) and of a starling (*Sturnus vulgaris*).

*IXODES (PHOLEOIXODES) HEXAGONUS* : Two nymphs of *I. hexagonus* were recorded from a magpie (*Pica pica*) at Grandson [VD] in 1961 (FIG. 2).

*IXODES (PHOLEOIXODES) LIVIDUS* : Almost all specimens of *I. lividus* were collected during the investigations of nests of sand martin colonies in various parts of Switzerland from 1965 to 1968 (BÜTTIKER, 1969). Sand martin (*Riparia riparia*) was the only host found. In total 748 larvae, 10 nymphs, 26 females and 12 males have been collected from sand martins and more than 2000 larvae, 58 nymphs, 26 females and 15 males from the their nests in 15 localities (FIG. 3). Few of the adults and the nymphs were found in the nests even during the autumn or winter period when sand martins had left their nests.

*IXODES (SCAPHIXODES) CALEDONICUS* : This species were found only twice in Switzerland. Five females and a nymph were collected from an alpine accentor (*Prunella collaris*) at La Maya, Saint-Martin [VS] in August 1974 (MOREL & AESCHLIMANN, 1983) while a female was collected from a wallcreeper (*Trichodroma muraria*) at Col de Bretolet [VS] in October 1990 (FIG. 3). Both localities are situated in the Alps at altitudes close to 2000 m.

*IXODES (TRICHOTOIXODES) FRONTALIS* : Few specimens were collected from 6 bird species and in 6 localities (TABLE 6 & FIG. 3). Robin was the most common host. Six of them, as well as a song thrush, were found infested at Iragna [TI] during spring 1990.

*HAEMAPHYSALIS (ABOIMISALIS) PUNCTATA* : Nymphs of *H. punctata* were collected in two cases from birds in Switzerland, i.e. from a blackbird (*Turdus merula*) at Vernayaz [VS] in April 1982 (COTTY *et al.*, 1986) and from a tree pipit (*Anthus trivialis*) at Iragna [TI] in April 1990 (FIG. 4).

*HYALOMMA (HYALOMMA) MARGINATUM MARGINATUM* : *H. m. marginatum* was collected from 7

migrating bird species in 4 localities (TABLE 7 & FIG. 4). All specimens were collected during spring and early summer. In one case, three males and a female were found on a reed warbler (*Acrocephalus scirpaceus*) (AESCHLIMANN & BÜTTIKER, 1975). The other records consisted of immatures.

*RHIPICEPHALUS (RHIPICEPHALUS) SIMUS* : The single specimen of *R. simus* was collected from a wounded house martin (*Delichon urbica*) found at Diegten [BL] in July 1969 (AESCHLIMANN & BÜTTIKER, 1975) (FIG. 4).

*ARGAS (ARGAS) REFLEXUS* : *A. reflexus* (7 larvae, 262 nymphs, 196 females, 180 males) have been collected from several domestic pigeons (*Columba livia domestica*) and their nests at Basel [BS] and Lausanne [VD]. Moreover, three female ticks were found in a nest of crag martins (*Ptyonoprogne rupestris*) at Castionne [TI] (BÜTTIKER, 1959) (FIG. 4).

## DISCUSSION

### Biology

*I. festai*, *I. arboricola*, *I. lividus*, *I. caledonicus*, *I. frontalis* and *A. reflexus* are bird specific ticks at all their developmental stages. *I. lividus* is even species specific, associated with the sand martin (*Riparia riparia*), while *A. reflexus* is specific to a limited host group, the domestic pigeon (*Columba livia domestica*) being its principal host.

*I. lividus* is widely distributed across the Palaearctic region. Its distribution coincides with that of the sand martin (*Riparia riparia*). House martin (*Delichon urbica*) and swallow (*Hirundo rustica*) are occasional hosts, while also other bird species which have been using sand martin nests were found accidentally infested with various stages of this tick species (STOLBOV, 1966; UCHIKAWA & SATO, 1969; ULMANEN *et al.*, 1977; GILLOT, 1984; HILLYARD, 1996). In Switzerland, all the sand martin colonies investigated were infested with *I. lividus* (BÜTTIKER, 1969), as it was also the case in Germany and in Finland (WALTER *et al.*, 1979a; ULMANEN *et al.*, 1977). During the nesting period, all stages are found on the sand martins or in their nest burrows. Although larvae are assumed to be the ove-

rwintering stage of *I. lavigatus* in the nest burrows until the sand martins return in late spring (BABOS, 1964), the hibernation of imagos and nymphs was observed in addition to Switzerland also in other European countries (ZOLOTOV & BUKER, 1976; ULMANEN *et al.*, 1977; GILOT, 1984).

Northern and central Europe forms the normal distribution area of *I. arboricola* (ARTHUR, 1963; SIXL, 1971). However, this species was also collected from migrating, wintering and resident birds at the Mediterranean coast of Egypt (CLIFFORD & HOOGSTRAAL, 1965; HOOGSTRAAL *et al.*, 1967), a fact that suggests the possibility of its transport and its establishment outside of Europe. *I. arboricola* is parasitic on birds nesting or roosting in tree hollows or caves, wall holes or nesting boxes. Heavy infestations of great tits (*Parus major*) were also observed in Germany (WALTER *et al.*, 1979a; HUDDE & WALTER, 1988). The presence of *I. arboricola* on a woodpigeon (*Columba palumbus*), a goshawk (*Accipiter gentilis*) and a kestrel (*Falco tinnunculus*) is noteworthy, as these bird species constitute new hosts for this tick species.

*I. frontalis* is widely distributed in Europe, from Transcaucasia to Great Britain. In Switzerland, it seems to be very rare comparing to regions with milder climates as in western and central France or north-eastern Spain where it is the most abundant ixodid on passerine birds (GILOT & BEAUCOURNU, 1973; GILOT, 1984; ESTRADA-PEÑA *et al.*, 1992; OSÁCAR-JIMÉNEZ *et al.*, 1998; DOBY, in press).

*I. festai*, a little-known species, was often confused with *I. ventalloi* (GILOT & PEREZ, 1978). Previously, this species was considered as imported due to the rarity of records (CORDAS *et al.*, 1993). However, the recent collections of this species from birds during both spring and autumn migrations argue in favour of its presence in Switzerland. A similar case is probably that of *I. caledonicus* found only twice in Switzerland. Nevertheless, its distribution extends according to FILIPPOVA (1977) from Great Britain to Tajikistan, and Switzerland being situated within this area. Consequently, it is considered that also this species has to be included in the Swiss tick fauna, regardless of the scarce records.

*I. ricinus* and *H. punctata* are considered as telotrophic species, i.e. the immature stages infest all kind of

available animals while the adults feed on large mammals. On the other hand, *H. m. marginatum* is a ditropic two-host tick, i.e. larvae and nymphs feed mainly on birds or small mammals, while adults parasitize large mammals. The presence of *I. hexagonus*, a species closely associated with nesting wild carnivores and hedgehogs (ARTHUR, 1953; GILOT & AUBERT, 1985; TOUTOUNGI *et al.*, 1991), on a magpie (*Pica pica*) could be considered as accidental.

Many bird species, particularly passerines, are important hosts of immature stages of *I. ricinus*. Larval and nymphal *I. ricinus* have been recorded from 27 bird species, 26 of which were passerines, in Norway (MEHL, 1983); from 49 bird species, 40 of which were passerines, in British Isles (MARTYN, 1988); from 56 bird species, 48 of which were passerines, in Sweden (JAENSON *et al.*, 1994); from 13 species, all passerines, in Czech Republic (HUBÁLEK *et al.*, 1996) and from 51 bird species, 43 of which were passerines, in Switzerland. In particular, the Turdidae (*Turdus* spp., *Erithacus rubecula*) were more frequently infested with *I. ricinus* than other avian species (AESCHLIMANN *et al.*, 1974; HUMAIR *et al.*, 1993; HUBÁLEK *et al.*, 1996). COLQUHOUN & MORLEY (1943) showed a vertical zonation of bird species in a woodland and found that blackbirds, robins and wrens are more active near the ground than other bird species, such as tits, nuthatches or goldcrests. Considering the vertical distribution of *I. ricinus* (GIGON & MOUTTET, 1984), it is comprehensible that the former bird species are more often and more heavily infested than the latter ones. The seasonal variations on the prevalence and the intensity of infestation with *I. ricinus* observed at Staatswald correspond to the bimodal annual activity of its free living immature stages studied previously in the same area (MERMOD *et al.*, 1973; 1974). Golden eagle (*Aquila chrysaetos*), tree sparrow (*Passer montanus*) and serin (*Serinus serinus*) are new host records for this tick species. They have never been cited before as hosts in any publication.

In Spain, passeriform birds are the main hosts for immatures of *H. punctata* (ESTRADA-PEÑA *et al.*, 1992). In Switzerland, this species is restricted to the cantons of Ticino and Valais in the southern part of the country and occurs often in small numbers only (AESCHLIMANN *et al.*, 1986b; COTTY *et al.*, 1986), hence the scarce captures of its immatures on birds.

Migrating birds play a significant role in carrying and dispersing ticks and the infectious agents that they harbour. *H. m. marginatum* and *H. punctata* were the most common tick species found on birds migrating from Europe and Asia to Africa during the southward autumn migration, while numerous *I. ricinus* and *I. frontalis* were also collected from these birds (HOOGSTRAAL *et al.*, 1963; 1964; KAISER *et al.*, 1974). On the contrary, birds captured in Finland, Sweden and North Germany during the northward spring migration were parasitized almost exclusively by *I. ricinus* (BRINK *et al.*, 1965; NUORTEVA & HOOGSTRAAL, 1973; SAIKKU *et al.*, 1971; SAIKKU, 1974; WALTER *et al.*, 1979b; MEHL *et al.*, 1984; OLSÉN *et al.*, 1995). As to *H. m. marginatum*, it was rarely collected from these northward migrating birds. This is also the case for Switzerland where this Mediterranean *Haemaphysalis* species was collected only from migrating bird species in spring and early summer during the northward migration. The four adults of *H. m. marginatum*, collected from a reed warbler (*Acrocephalus scirpaceus*) as well the single female of *R. simus*, a three-host tick of the Ethiopian faunal region, collected from a house martin (*Delichon urbica*) have probably arrived at the nymphal stage in Switzerland during the northward bird migration and then moulted to adults in the nest before infesting these birds. However, birds are listed only among the exceptional hosts of immatures stages of *R. simus* whose adults feed chiefly on carnivores, pigs, buffalo and other large or medium size game animals, while larvae and nymphs feed on burrowing rodents (HOOGSTRAAL, 1956).

Finally, the soft tick species *A. reflexus* was collected from three localities only in Switzerland. However, its distribution area is much wider and corresponds to that of the domestic pigeon (*Columba livia domestica*), its principal host of all feeding stages. It is noteworthy that the use of insecticides for the control of parasites in pigeon lofts has drastically diminished the incidents of tick infestations in the past. According to the information obtained from pigeon breeders in 1992 their lofts were apparently tick-free.

#### ***Pathogenic role***

Some of the collected ticks transmit pathogens to man or animals. First, *I. ricinus* is the proven or

suspected vector of several infectious agents also in Switzerland (AESCHLIMANN & PAPADOPoulos, 1998). Among these agents two are of high importance for the human health: *Borrelia burgdorferi* sensu lato, the etiological agent of Lyme borreliosis, and the European variant of tick-borne encephalitis (TBE) virus, responsible for the spring-summer encephalitis cases in Central Europe. The vector role of *I. ricinus* in the transmission of *Borrelia burgdorferi* sensu lato in Switzerland is well known (BARBOUR *et al.*, 1983; AESCHLIMANN *et al.*, 1986a). The prevalence of spirochete infection in free-living nymphs and adults ranges from 5% to 50%, while in larvae from 0% to 5%, depending on the enzootic sites (AESCHLIMANN *et al.*, 1986a; MISEREZ *et al.*, 1990; PÉTER, 1990; ZHIOUA *et al.*, 1994). The infection rate of nymphs and larvae collected on birds averaged 21.7% and 16.3% respectively (HUMAIR *et al.*, 1993). Some heavily infested passerine species, such as robins and blackbirds, could play the role of reservoir and disseminator of this infectious agent. The implications of blackbirds as reservoirs of two genospecies of *Borrelia* spirochetes, *B. valaisiana* and *B. garinii*, have been recently proved (HUMAIR *et al.*, 1998).

Although some other tick species infesting birds, e.g. *I. frontalis* and *H. punctata*, have been found infected with *B. burgdorferi* sensu lato (MARQUEZ & CONSTAN, 1990; DOBY *et al.* 1995; ESTRADA-PEÑA *et al.*, 1995; TÄLLEKLINT, 1996), the vector role of these species has not yet been proved. It is noteworthy that in Spain immatures of *I. frontalis* removed from passerine birds were highly infected with *B. burgdorferi*, but only in zones where *I. ricinus* was also present (ESTRADA-PEÑA *et al.*, 1995). That probably means that in absence of the main vector, *I. frontalis* cannot assure alone the bird cycle of the spirochete. Among the tick species collected from birds in Switzerland, only *I. hexagonus* was showed to be an efficient potential vector of *B. burgdorferi* (GERN *et al.*, 1991; TOUOUNGI & GERN, 1993). However, as *I. hexagonus* infests only accidentally avian hosts, it is assumed that it cannot maintain a transmission cycle of this borreliosis in birds.

TBE virus was isolated from *I. ricinus* in four regions of Switzerland, the infection rates varying from 0.18 to 0.84% according to the region (MATILE *et al.*, 1981). In Britain, Ireland and Scotland, *I.*

*ricinus* is the vector of Louping ill virus responsible for sheep encephalomyelitis (GORDON *et al.*, 1962). In Switzerland, *I. ricinus* is also the vector of *Rickettsia helvetica*, a distinct species of the spotted fever group of Rickettsiae (BURGDORFER *et al.*, 1979; BEATI *et al.*, 1993). *R. helvetica* was present in 1.8 to 11.7% of *I. ricinus* collected from vegetation in various parts of the country (BURGDORFER *et al.*, 1979).

*I. ricinus* is a proven vector of *B. divergens*, a cattle babesia (JOYNER *et al.*, 1963) and of *B. microti*, a rodent babesia (WALTER & LIEBISH, 1980). In Switzerland, cattle babesiosis cases have been mainly observed in young animals during the seasonal activity of *I. ricinus* (GERN *et al.*, 1982). Human clinical babesiosis cases due to *B. divergens* have been reported from different European countries, and cases due to *B. microti* from USA (TELFORD *et al.*, 1993). Finally, *I. ricinus* was found infected with the infectious larval form of *Dipetalonema rugosicauda*, a roe deer filaria, and a trypanosome closely related to *Trypanosoma theileri* (AESCHLIMANN *et al.*, 1979).

Among the other tick species found on the birds in Switzerland, *H. m. marginatum* is considered as the chief vector of Crimean-Congo hemorrhagic fever (CCHF) virus in steppes of eastern Europe, in the Balkan countries and in Transcaucasia (HOOGSTRAAL, 1979). *I. lividus* was found naturally infected with a strain of Russian spring-summer encephalitis in western Siberia (FEDOROV & TYUSNYAKOVA, 1958). *Rickettsia conori*, the pathogen of the Mediterranean spotted-fever was isolated from *R. simus* ticks fed on Ethiopian cattle (PHILIP *et al.*, 1966). *A. reflexus* transmits to birds *Borrelia anserina*, the agent of fowl spirochetosis, and *Aegyptianella pullorum*, the agent of fowl piroplasmosis (ARTHUR, 1963).

Given their migrations, birds play an important role in distributing ticks and infectious agents (HOOGSTRAAL, 1972). Furthermore, species of the Mediterranean or African tick fauna, such as *H. m. marginatum* or *R. simus*, can be temporarily established in unsuitable biotopes and introduce tick-borne pathogens among the susceptible animals.

Besides transmitting pathogens, some tick species also trouble their hosts in various ways, such as by causing lesions, anaemia, toxicoses, immunosuppression or allergies. High numbers of *A. reflexus* are likely to cause the death of pigeons by exsanguination

(HOOGSTRAAL, 1956). In Germany, losses of sand martin broods, due to heavy infestations of *I. lividus*, were recorded by HESSE (1985). *I. frontalis* was considered responsible for tick-paralysis or other severe pathological disorder leading to the death of birds under special conditions (CHASTEL *et al.*, 1981; 1991).

The prevalence of ticks collected from birds is enough to suspect they play a significant role in the transmission of pathogens. Furthermore, the migrating hosts may disperse the vectors in short time and at long distance. In that, the avian hosts of ticks differ considerably from the mammalian hosts. This difference could be at the basis of new hypotheses for further field or experimental studies on the ticks of birds in relation to the tick-borne diseases.

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