



**ECTOPARASITES FROM THE NESTS OF THE HOUSE MARTIN  
(*DELICHON URBICA*) IN SLOVENIA: 1. FAUNISTIC SURVEY**

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**Abstract** - In an urban area of northern Slovenia, 145 nests of *Delichon urbica* were collected. In these nests 4132 males and 5745 females of *Ceratophyllus hirundinis*, 59 males and 128 females of *Ceratophyllus rusticus*, 4 males of *Ceratophyllus fringillae* and 22430 Siphonaptera larvae, 1770 males, 1727 females and 7760 larvae of *Oeciacus hirundinis*, and 23 males and 33 females of *Stenopteryx hirundinis* were found. *Ceratophyllus fringillae* and *Stenopteryx hirundinis* are new species in Slovenia, *Ceratophyllus rusticus* is found for the third time, and *Ceratophyllus hirundinis* for the fifth.

**Izveček** - ZUNANJI ZAJEDALCI V GNEZDIH MESTNE LASTOVKE (*DELICHON URBICA*) V SLOVENIJI: 1. FAVNISTIČNI PREGLED

V urbanem okolju severne Slovenije smo zbrali 145 gnezd mestne lastovke (*Delichon urbica*). V teh gnezdih smo našli 4132 samcev in 5745 samic lastovičje bolhe (*Ceratophyllus hirundinis*), 59 samcev in 128 samic bolhe vrste *Ceratophyllus rusticus*, 4 samce vrabčje bolhe (*Ceratophyllus fringillae*) in 22430 boljnjih ličink, 1770 samcev, 1727 samic in 7760 ličink lastovičje stenice (*Oeciacus hirundinis*) ter 23 samcev in 33 samic lastovičje muhe (*Stenopteryx hirundinis*). Vrabčja bolha (*Ceratophyllus fringillae*) in lastovičja muha (*Stenopteryx hirundinis*) sta novi vrsti za Slovenijo, bolha vrste *Ceratophyllus rusticus* je najdena tretjič in lastovičja bolha (*Ceratophyllus hirundinis*) petič.

## Introduction

The basic taxonomic studies of the ectoparasites of birds and mammals in Slovenia were done by Savo Brelih (BRELIH & PETROV, 1978; BRELIH, 1986). His study collections consist of Mallophaga, Anoplura, and Siphonaptera.

In Europe there are thirteen ecological groups of fleas (ROSICKÝ, 1957): the group of fleas of *Sciurus vulgaris* and dormice (mainly *Myoxus glis*); flea group of small ground mammals; fleas of *Oryctolagus cuniculi*; fleas of large ground rodents (*Cricetus*, *Spermophilus*); fleas of large Carnivora; fleas of humans, cats, dogs, and domestic pigs; fleas of Chiroptera; fleas of *Erinaceus europaeus*; fleas of birds which nest on the ground or on water surfaces; fleas of swallows; fleas of *Riparia riparia*; the flea group of *Columba livia* and the ecological group of fleas of small singing birds which nest in tree canopies, holes, nest boxes, and bushes.

In Slovenia only 3 ecological groups are quite well known: those of *Sciurus vulgaris* and dormice, of small ground mammals, and of *Erinaceus europaeus*; all others are incompletely known.

For *Delichon urbica* (Linnaeus, 1758), whether from animals or nests, different authors cite following species of fleas: *Ceratophyllus hirundinis* (Curtis, 1826) (WAGNER, 1929, 1939; JACOBSON, 1940; VOLYANSKY, 1966; ROSICKÝ, 1950, 1957; ROTHSCHILD, 1952; PEUS, 1954, 1968, 1969, DUNNET & ALIA, 1955; SKURATOWITCZ, 1960, 1964; SZABO, 1965, 1969; SUCIU, 1975; BEAUCOURNU & HELLAL, 1977; TRAUB et al., 1983; CYPRICH et al., 1988; KACZMAREK, 1993), *Ceratophyllus rusticus* Wagner, 1903 (WAGNER, 1929, 1939; JACOBSON, 1940; ROSICKÝ, 1950, 1957; ROTHSCHILD, 1952; PEUS, 1954, 1968; DUNNET & ALIA, 1955; SKURATOWITCZ, 1964; TRAUB et al., 1983; CYPRICH et al., 1988), *Ceratophyllus delichoni* Nordberg, 1935 (TRAUB et al., 1983), *Ceratophyllus orites* Jordan, 1937 (TRAUB et al., 1983), *Ceratophyllus farreni* Rothschild, 1905 (PEUS, 1954, 1968; DUNNET & ALIA, 1955; ROSICKÝ, 1957; SKURATOWITCZ, 1964; TRAUB et al., 1983), *Ceratophyllus styx* Rothschild, 1900 (TRAUB et al., 1983), *Ceratophyllus fringillae* (Walker, 1856) (ROSICKÝ, 1957; PEUS, 1968; TRAUB et al., 1983; CYPRICH et al., 1988), *Ceratophyllus gallinae* (Schrank, 1803) (DUNNET & ALIA, 1955; ROSICKÝ, 1957; PEUS, 1968; TRAUB et al., 1983; KACZMAREK, 1993), *Ceratophyllus tribulis* Jordan, 1926 (TRAUB et al., 1983), *Ceratophyllus sciurorum sciurorum* (Schrank, 1803) (PEUS, 1968, 1972), *Callopsylla waterstoni* (Jordan, 1925) (DUNNET & ALIA, 1955; TRAUB et al., 1983), *Dasypsylla gallinulae* (Dale, 1878) (DUNNET & ALIA, 1955), *Frontopsylla laeta* (Jordan & Rothschild, 1920) (DUNNET & ALIA, 1955), *Amalaraeus penicilliger kratochvili* Rosický, 1955 (TRAUB et al., 1983), *Myoxopsylla laverani laverani* (Rothschild, 1911) (TRAUB et al., 1983), *Ischnopsyllus octactenus* (Kolenati, 1856) (SKURATOWITCZ, 1964) and *Nycteridopsylla eusarca* Dampf, 1905 (SKURATOWITCZ, 1964). In Slovenia only *Ceratophyllus hirundinis* and *Ceratophyllus delichoni* are cited for *Delichon urbica* (WAGNER, 1939).

The present paper provides new data on ectoparasites living in the nests of *Delichon urbica* and their ecological indices.

## Materials and Methods

Nests of *Delichon urbica* were collected in two localities in Kranj (Planina and Savska Loka) and at Bled (Figure 1). In the Bled area (altitude 510 m, UTM VM33) nests of *Delichon urbica* were situated under the jutting roof of the Hotel Park ground floor. The nests in Kranj in the Planina area (altitude 390 m, UTM VM52) were located above the 13<sup>th</sup> floor of an apartment house and in the Savska Loka area (altitude 360 m, UTM VM42) under the concrete roof on the 5<sup>th</sup> floor of the factory Iskra Števeci. The contents of the nests were transported from the field in airtight plastic bags to prevent the escape of any arthropods. They were placed over Berlese-Tullgren funnels (SOUTHWOOD, 1978) for 5 days for the collection of the arthropods.

The preparation methods for ectoparasites were used according to Brelih (cf. TRILAR, 1991) and were identified by comparison with specimens from the Ectoparasite Study Collections in the Slovenian Museum of Natural History.

The material is kept at the Slovenian Museum of Natural History in Ljubljana.

The following ecological indices were calculated:

Constancy is the percentage of samples in which a species was found compared to all the samples. The following constancy categorisation was applied (BALOGH, 1958): above 75.1 %, euconstant species; 50.1 to 75.0 %, constant species; between 25.1 and 50.0 %, accessory species; and below 25.0 %, accidental species.

Index of Occurrence (IO) (IOFF, 1949) is the average number of adults of ectoparasitic species in all inspected samples, whether on animals or in the nests.

Index of Parasitism (IP) (IOFF, 1949) is the average number of adults of ectoparasitic species in infested samples only, whether on animals or in nests. By this index we simply avoid old or inactive nests which are represented in the index of occurrence.

## Results

In the Bled area we collected 18 nests of *Delichon urbica*, 24 in the Planina area and 103 nests in the Savska Loka area. Thirteen arthropod groups were present (Table 1). From the ectoparasitic groups, Siphonaptera and Hemiptera appeared euconstantly and Hippoboscidae (Diptera) accidentally. From the nonparasitic groups, Acarina and Lepidoptera (fam.: Tineidae) appeared constantly; Coleoptera accessorily; while Aranea, Pseudoscorpiones, Protura, Collembola, Psocoptera, Homoptera, Hymenoptera and Diptera appeared accidentally (Table 1).

Table 2 gives the data for groups of samples in each sampling and for all samplings together. Altogether, in 145 *Delichon urbica* nests (Table 2) we found 4132 males and 5745 females of the flea *Ceratophyllus hirundinis*, 59 males and 128 females of the flea *Ceratophyllus rusticus*, 4 males of the flea *Ceratophyllus fringillae*, 7760 larvae, 1770 males and 1727 females of the bug *Oeciacus hirundinis* (Jenyns, 1839), and 23 males and 33 females of the fly *Stenopteryx hirundinis* (Linnaeus, 1758). There were also 22430 flea larvae probably from all three present species belonging to all three developmental stages.

Table 3 provides the IO and IP for groups of samples in each sampling and for all samplings together for *Stenopteryx hirundinis*, *Oeciacus hirundinis*, *Ceratophyllus hirundinis*, *Ceratophyllus rusticus*, *Ceratophyllus fringillae*, and for all flea species together. The IO for all flea species in the nests of *Delichon urbica* was between 2.0 and 146.5 for a group of samples collected by single sampling, and 69.4 for all samplings (Table 3). The same figures for *Oeciacus hirundinis* were 6.4 to 78.0 and 77.7 (Table 3). For *Stenopteryx hirundinis* the results were 0.02 to 1.5, and 0.4 (Table 3).

The IP for all flea species was between 2.7 and 195.3 for group of samples collected by a single sampling, and 92.4 for all samplings (Table 3). For *Oeciacus hirundinis* they were 9.1 to 104.0, and 84.6 (Table 3). The same numbers for *Stenopteryx hirundinis* were 1.0 to 3.8, and 3.3 (Table 3).

## Discussion

The arthropod fauna in *Delichon urbica* nests is quite varied, but we cannot compare it with other European regions, because the literature does not contain data for all arthropod fauna in the nests, but only the ectoparasites. Thus, from the nonparasitic species we would only mention the mass appearance of the moth *Tinea lapella* (Tineidae, Lepidoptera), found in Slovenia for the first time (CARNELUTTI, personal communication), and *Chelifer cancroides* (Pseudoscorpiones), which is a predatory species which could also prey on the ectoparasites. From the ectoparasitic species, this is the first finding of *Ceratophyllus fringillae* and *Stenopteryx hirundinis* in Slovenia, the third for *Ceratophyllus rusticus* (WAGNER, 1939; TRILAR, 1997b) and *Oeciacus hirundinis* (TRILAR, 1997a, 1997b) and the fifth for *Ceratophyllus hirundinis* (WAGNER, 1939; TRILAR, 1997a).

The greatest number of ectoparasites in one nest was collected in June 22., 1993 in Savska Loka area: 1723 larvae and 156 adults of *Oeciacus hirundinis*, 535 flea larvae and 51 adults of *Ceratophyllus hirundinis*, giving a total of 1930 bloodsucking ectoparasites. This enormous number in the nests has, however, no effect on the *Delichon urbica* brood size. At the time of nest inspections we also ringed juveniles of *Delichon urbica*. Juveniles were present in altogether 15 inspected nests. In 14 nests there were 4 juveniles and only in one nest there were 3, but it is possible that the fourth had already left the nest. All other inspected nests were nonactive or the juveniles had already left them. There were no unhatched eggs or dead offspring.

Samples from the *Delichon urbica* nests showed three species of fleas, *Ceratophyllus hirundinis*, *Ceratophyllus rusticus*, and *Ceratophyllus fringillae*. *Delichon urbica* is the major host for *Ceratophyllus hirundinis* and *Ceratophyllus rusticus*, which ecologically belong to the group of swallow fleas (ROSICKÝ, 1950, 1957; JURÍK, 1975, 1976, 1978). *Delichon urbica* is an occasional host for *Ceratophyllus fringillae* (TRAUB et al., 1983), ecologically belonging to the flea group of small singing birds, which nest in tree canopies, holes, nest boxes, and bushes (ROSICKÝ, 1950, 1957; JURÍK, 1975, 1976, 1978).

This siphonapterofauna is quite poor in comparison with other parts of Europe,

where 17 species of fleas are reported, whether from animals or nests: *Ceratophyllus hirundinis*, *Ceratophyllus rusticus*, *Ceratophyllus delichoni*, *Ceratophyllus orites*, *Ceratophyllus farreni*, *Ceratophyllus styx*, *Ceratophyllus fringillae*, *Ceratophyllus gallinae*, *Ceratophyllus tribulis*, *Ceratophyllus sciurorum sciurorum*, *Callopsylla waterstoni*, *Dasypsyllus gallinulae*, *Frontopsylla laeta*, *Amalaraeus penicilliger kratochvili*, *Myoxopsylla laverani laverani*, *Ischnopsyllus octactenus* and *Nycteridopsylla eusarca*.

*Delichon urbica* is the major host for *Ceratophyllus hirundinis*, *Ceratophyllus rusticus*, *Ceratophyllus delichoni*, *Ceratophyllus farreni*, *Ceratophyllus orites* and *Callopsylla waterstoni* (TRAUB et al., 1983), which ecologically belong to the group of swallow fleas (ROSICKÝ, 1950, 1957; JURÍK, 1975, 1976, 1978). Here also belong three central Asian species *Callopsylla oreinus* Jordan, 1937, *Ceratophyllus caliotetes* (Jordan, 1937) and *Ceratophyllus maculatus* Wagner, 1927, for which *Delichon urbica* is also the major host (TRAUB et al., 1983). Beside *Ceratophyllus hirundinis* and *Ceratophyllus rusticus* we could expect in Slovenia only *Ceratophyllus farreni*, because its known range of distribution is near to Slovenia (TRAUB et al., 1983). *Delichon urbica* is an occasional or accidental host for the other 11 flea species, therefore their absence in our siphonapterofauna from its nests is not surprising.

Our three registered flea species, *Ceratophyllus hirundinis*, *Ceratophyllus rusticus* and *Ceratophyllus fringillae*, in the first research of ectoparasitic fauna from the nests of *Delichon urbica* is not a bad result, because the samples were collected in relatively isolated nesting places (high up at the apartment house, in the middle of the factory and above the big parking lot of the hotel). Isolation of nesting places prevents contact with other hosts, with the exception of *Passer domesticus*, who most probably brings also *Ceratophyllus fringillae*, which ecologically belongs to the flea group of small singing birds, which nest in tree canopies, holes, nest boxes, and bushes (ROSICKÝ, 1950, 1957; JURÍK, 1975, 1976, 1978). New samplings at different localities will probably show a higher diversity of siphonapterofauna. Special attention should be paid to natural rock walls (i.e. nesting places near Krn Lake, in Bavščica Valley and Zadnja Trenta Valley) and less isolated nesting places (i.e. on farmhouses in Žabnica near Kranj, where *Delichon urbica* nests under the jutting roof of a cowshed and other buildings). If we find no flea species from the ecology group of swallows with different microecological requirements (natural rock walls), we will probably find that species for which is *Delichon urbica* an occasional or accidental host.

For a complete survey of the ectoparasite fauna we should mention also *Oeciacus hirundinis* and *Stenepteryx hirundinis*. *Delichon urbica* is the major host for both species and by the analogy with fleas they ecologically belong to the group of swallow ectoparasites.

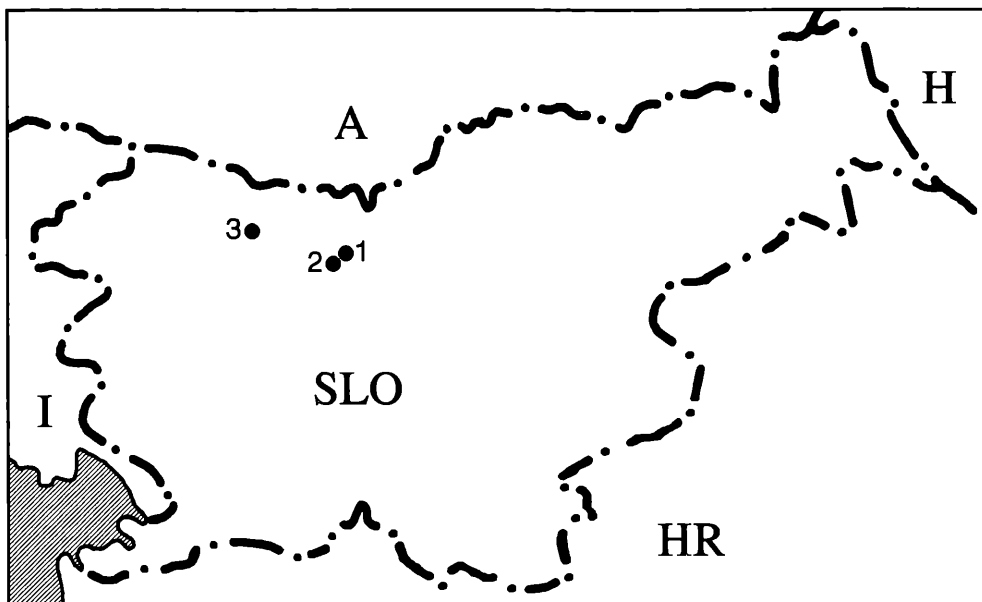
In comparison with other European regions, the lowest values of IO and IP (Table 3) for fleas in *Delichon urbica* nests are higher, while the highest ones are lower than those quoted in the literature. The smallest cited IO is 12.8 for Greece (calculated from PEUS, 1954), and the highest 204.9 for Germany (calculated from PEUS, 1968). JURÍK (1978) reports 50.5 for the Czech Republic. The smallest cited index of parasitism is 3.0, and the highest 588.2 for north-east Scotland (calculated from DUNNET &

ALIA, 1955). In Germany lies IP between 77.0 and 234.7 (calculated from PEUS, 1968, 1970, 1972). IP reported for Greece is 12.8 (calculated from PEUS, 1954), for the Czech Republic 55.0 (JURÍK, 1978), for Slovakia 82.8 (CYPRICH et al., 1988) and for Ukraine 128.0 (VOLYANSKY, 1966).

In comparison with other European regions, the lowest values of IO and IP (Table 3) for *Oeciacus hirundinis* in *Delichon urbica* nests are lower, while the highest ones are higher than those quoted in the literature. KACZMAREK (1991) reports for the Poland IO between 6.9 and 62.9, and IP between 13.8 and 123.0 (IP is calculated from KACZMAREK, 1991).

For *Stenopteryx hirundinis* the literature does not contain sufficient data to calculate the IO and IP.

There is a negative correlation,  $r = -0.15$ , between the numbers of *Ceratophyllus hirundinis* and *Oeciacus hirundinis* in *Delichon urbica* nests, but this is not statistically significant:  $r = 0.15 < r_{0.05} = 0.205$ ,  $t = 1.48 < t_{0.05} = 1.99$ . Therefore, the results do not support the assumption for competition of these two species.



**Fig. 1:** Map of collecting sites  
 1 - SLO: Kranj, PLANINA  
 2 - SLO: KRANJ, Savska loka  
 3 - SLO: BLED

**Table 1:** Fauna in the nests of *Delichon urbica*

S	Amount (Sum)	
C(%)	Constancy	
No.	Locality	Date
1	- SLO: Kranj, PLANINA	26. 3. 1993
2	- SLO: KRANJ, Savska loka	8. 4. 1993
3	- SLO: BLED	9. 4. 1993
4	- SLO: BLED	15. 4. 1994
5	- SLO: KRANJ, Savska loka	23. 5. 1993
6	- SLO: KRANJ, Savska loka	22. 6. 1993
7	- SLO: DRAGA	6. 9. 1993
8	- SLO: BLED	21. 11. 1992

Locality	1	2	3	4	5	6	7	8	$\Sigma$	C(%)
No. of samples	24	31	4	10	4	33	35	4	145	
Siphonaptera	23	24	3	9	4	27	29	3	122	84.1
Hippoboscidae	2	3	0	2	2	13	5	0	27	18.6
Heteroptera	23	27	3	8	4	30	35	4	134	92.4
Aranea	1	4	0	1	0	2	1	0	9	6.2
Pseudoscorpiones	23	0	0	1	0	0	0	0	24	16.6
Acarina	12	15	3	5	1	19	21	3	79	54.5
Protura	0	0	0	1	0	0	0	0	1	0.7
Collembola	0	6	0	3	0	0	0	0	9	6.2
Psocoptera	0	0	1	0	0	0	1	2	4	2.8
Homoptera	0	0	0	0	0	1	0	0	1	0.7
Coleoptera	6	16	0	4	0	22	13	2	63	43.4
Hymenoptera	0	0	0	0	0	1	0	0	1	0.7
Lepidoptera	10	29	3	9	2	23	16	3	95	65.5
Diptera	0	5	0	1	1	16	3	0	26	17.9

**Table 2:** Active stages of ectoparasites in the nests of *Delichon urbica*

No - number of the nests

M - male

F - female

L - Larvae

Locality	Date	No	Heteroptera			Siphonaptera						Diptera		
			Oeciacus			All spp.	Ceratothylus		Ceratothylus		Ceratothylus		Stenopteryx	
			hirundinis	hirundinis	hirundinis		hirundinis	rusticus	fringillae	fringillae	hirundinis	hirundinis		
L	M	F	L	M	F	M	F	M	F	M	F			
Planina	26.3.1993	24	406	401	198	0	933	1338	1	0	0	0	1	1
Savska loka	8.4.1993	31	160	171	188	3	887	1305	5	4	1	0	0	0
Bled	9.4.1993	4	94	10	5	0	156	276	1	7	0	0	0	0
Bled	15.4.1992	10	24	9	31	0	231	273	22	54	3	0	0	0
Savska loka	23.5.1994	4	52	181	143	286	2	6	0	0	0	0	1	2
Savska loka	22.6.1993	33	5303	373	551	12933	733	866	0	0	0	0	21	29
Savska loka	6.9.1993	35	1572	526	547	9208	956	1421	0	1	0	0	0	1
Bled	21.11.1992	4	149	99	64	0	234	260	30	62	0	0	0	0
Together		145	7760	1770	1727	22430	4132	5745	59	128	4	0	23	33

**Table 3:** Index of Occurrence and Index of Parasitism for ectoparasites in the *Delichon urbica* nests

IO - Index of Occurrence

IP - Index of Parasitism

Locality		Planina	Savska loka	Bled	Bled	Savska loka	Savska loka	Savska loka	Bled	Ali
		26.3.'93	8.4.'93	9.4.'93	15.4.'92	23.5.'93	22.6.'93	6.9.'93	21.11.'94	samplings
<i>Ceratothylus hirundinis</i>	IO	94.6	70.7	108.0	50.4	2.0	48.5	67.9	123.5	68.1
	IP	103.2	104.4	144.0	100.8	2.7	63.9	84.9	164.7	91.5
<i>Ceratothylus rusticus</i>	IO	0.04	0.3	2.0	7.6	-	-	0.03	23.0	1.3
	IP	1.0	2.3	4.0	12.7	-	-	1.0	30.7	14.4
<i>Ceratothylus fringillae</i>	IO	-	0.03	-	0.3	-	-	-	-	0.03
	IP	-	1.0	-	1.0	-	-	-	-	1.0
Siphonaptera together	IO	94.7	71.0	110.0	58.0	2.0	48.5	67.9	146.5	69.4
	IP	103.3	104.9	146.7	96.7	2.7	63.9	84.9	195.3	92.4
<i>Oeciacus hirundinis</i>	IO	41.9	16.7	27.3	6.4	93.8	178.4	75.6	78.0	77.7
	IP	43.7	19.2	36.3	9.1	93.8	196.3	75.6	104.0	84.6
<i>Stenopteryx hirundinis</i>	IO	0.04	-	-	-	0.8	1.5	0.02	-	0.4
	IP	2.0	-	-	-	1.5	3.8	1.0	-	3.3



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