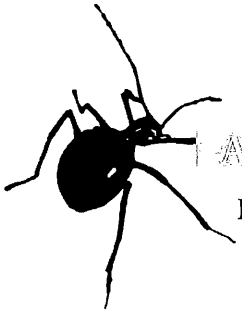

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ECTOPARASITES FROM THE NESTS OF THE HOUSE MARTIN *(DELICHON URBICA)* IN SLOVENIA: 2. SEX RATIO AND DEVELOPMENTAL CYCLES OF *OECIACUS HIRUNDINIS, CERATOPHYLLUS HIRUNDINIS* AND *STENEPTERYX HIRUNDINIS*

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Abstract - In an urban area of northern Slovenia, 145 nests of *Delichon urbica* were collected. We describe the sex ratio of ectoparasites living in the nests and the developmental cycles of *Oeciacus hirundinis, Ceratophyllus hirundinis* and *Stenepteryx hirundinis.*

KEY WORDS: *Delichon urbica*, ectoparasites, developmental cycles of *Oeciacus hirundinis, Ceratophyllus hirundinis* and *Stenepteryx hirundinis*.

Izvleček - ZUNANJI ZAJEDALCI V GNEZDIH MESTNE LASTOVKE (*DELICHON URBICA*) V SLOVENIJI: 2. RAZMERJE MED SPOLOMA IN RAZVOJNI KROGI VRST *OECIACUS HIRUNDINIS, CERATOPHYLLUS HIRUNDINIS* IN *STENEPTERYX HIRUNDINIS*

V urbanem okolju severne Slovenije smo zbrali 145 gnezd mestne lastovke (*Delichon urbica*). Pri zunanjih zajedalcih, ki smo jih našli v gnezdih, opisujemo razmerje med spoloma in razvojne kroge lastovičje stenice (*Oeciacus hirundinis*), lastovičje bolhe (*Ceratophyllus hirundinis*) in lastovičje muhe (*Stenepteryx hirundinis*).

KLJUČNE BESEDE: *Delichon urbica*, ektoparaziti, razvojni krogi vrst *Oeciacus hirundinis, Ceratophyllus hirundinis* in *Stenepteryx hirundinis*.

Introduction

In the first part of the article we discussed the faunistic survey of ectoparasites living in the nests of *Delichon urbica* (Linnaeus, 1758) and their indices of occurrence and indices of parasitism (TRILAR, 1998). Three species of ectoparasites were represented in the collected samples in reasonable amounts to discuss their developmental cycles. The present paper provides the sex ratio and developmental cycles of *Oeciacus hirundinis* (Jenyns, 1839), *Ceratophyllus hirundinis* (Curtis, 1826) and *Stenepteryx hirundinis* (Linnaeus, 1758).

Materials and Methods

Materials and methods are described in detail in the first part of this article (TRILAR, 1998).

Results

Table 1 gives the sex ratio for *Oeciacus hirundinis, Ceratophyllus hirundinis,* and *Stenepteryx hirundinis* in groups of samples in each sampling and in all samplings together. For *Oeciacus hirundinis* the ratio between males and females in all samplings together was 1:1 (n=3497). For the two other species there were more females than males, the ration being 1:1.4 (n=9877) for *Ceratophyllus hirundinis*, and 1:1.4 (n=56) for *Stenepteryx hirundinis*. For *Ceratophyllus rusticus* it was 1:1.2 (n=187).

To reconstruct the developmental cycles of *Oeciacus hirundinis, Ceratophyllus hirundinis* and *Stenepteryx hirundinis*, we used the data for occupied nests and for those occupied in the previous nesting season only. The data for March (15 nests), May (3 nests), June (20 nests), September (26 nests), and November (3 nests) are from one sampling, and for April (24 nests) the average of three samplings.

The adults of *Oeciacus hirundinis* were present in the nests of *Delichon urbica* during the whole year (Figure 1). In March, they were represented with an average number of 31.0 and in April with 12.3. The most frequent were in May with 105.7. By June the number of adults fell to 44.9 and by September to 38.9. In November they increased again to 54.3 per nest.

In March, the 4th larval stage was most frequent with an average number of 9.3 followed by the 5th stage with 9.1 and the 3rd with 3.6, while the 1st and 2nd stages were not present (Figure 1). By April the number of larvae fell and the most frequent was the 3rd stage with an average number of 4.8, followed by the 4th with 4.0 and the 5th with 0.5 larvae per nest; again the 1st and 2nd stages were not present. In May the number of larvae increased, the most frequent was stage 5 with 14.0, then stage 4 with 6.0 and stage 3 with 0.7. For the first time also appeared in samples stage 1 with an average number of 0.3. By June the number of larvae rapidly increased and the most frequent were the 1st and 2nd stages with an average number of 86.7 and 72.0, followed by the 3rd and 4th stages with 49.4 and 34.6, while the least frequent was stage 5 with 27.6. By September the number of larvae fell and the most frequent was the 2nd stage with an average num-

ber of 33.8, followed by the 3rd stage with 17.6, the 4th stage with 11.6, the 1st stage with 10.1 and the 5th stage with an average number of 7.9. The most frequent in November was stage 5 with 23.3, followed by stage 4 with 15.7 and stage 3 with 10.6, while the 1st and 2nd stages were not present.

Adults of *Ceratophyllus hirundinis* hatch from cocoons after the return of *Delichon urbica* to the nest (Figure 2). The adults were first observed during the sampling in May. Because of the nesting season of *Delichon urbica* with eggs in the nests, we collected three samples only, not a representative sample and therefore not taken into account. The average number of adults in June was 79.4 which in September increased to 100.0. In November, one month after *Delichon urbica* migrated, no adults were present.

In March, April and November no adults were observed during the samplings, but they hatched during the treatment of samples on the Berlese-Tullgren funnels. In March and April they copulated, but this was not observed in November. In March there were on average 150.6 adults, in April 124.3, and in November 164.7 *per* nest.

According to the abundance of flea species in the collected *Delichon urbica* nests (TRILAR, 1998), we assume that almost all flea larvae belong to *Ceratophyllus hirundinis*, and only a few of them to *Ceratophyllus rusticus* or *Ceratophyllus fringillae*.

The Siphonaptera larvae usually have three developmental stages (PEUS, 1968; ROSICKÝ, 1957; ASKEW, 1971). In March and April they were not present in the nests. In May the 1st developmental stage was the most frequent with an average number of 53.0, followed by the 2nd stage with 38.3, while the 3rd stage was not present (Figure 2). In June the number of larvae increased and the most frequent was stage 2 with an average number of 304.8, followed by stage 3 with 185.8, while the smallest was stage 1 with 155.7. By September the number of larvae fell and the most frequent was the 3rd stage with 174.1, followed by the 2nd stage with 124.2, and the 1st stage with 60.6. In November larvae were not present in the nests.

The puparions of *Stenepteryx hirundinis* were present in the nests at all seasons, but because of the used method were not represented in the samples properly. In March on average there were 0.13 adults, probably hatched during the treatment of samples on the Berlese-Tullgren funnels, as in April adults were not found. In May there were on average 1.0 adult *per* nest. In June the number increased to 2.45 and in September decreased to an average of 0.03. In November adults were not found (Figure 3).

Discussion

Data about the ecology of fleas of the genus *Ceratophyllus* in literature are scarce, found mainly in faunistic papers. Even worse is the data for *Oeciacus hirundinis* and *Stenepteryx hirundinis*.

The expected sex ratio in newborn adults is 1:1, but it could shift either way. Actually, the sex ratio is a reflection of regulation mechanisms in a population. In our nests there were more females then males for *Ceratophyllus hirundinis, Ceratophyllus rusticus* and *Stenepteryx hirundinis*, but the ratio was equal for *Oeciacus hirundinis*.

In Germany PEUS (1968) also found more females than males for *Ceratophyllus*

hirundinis and *Ceratophyllus rusticus*. In eleven samplings the ratio for *Ceratophyllus hirundinis* was between 1:1 and 1:1.6 and in nine samplings for *Ceratophyllus rusticus* 1:1 and 1:1.6 (calculated from PEUS, 1968). The only exception was the sampling in October in the Rügen area (Kap Arkona) where the *Ceratophyllus rusticus* sex ratio was 2:1 (calculated from PEUS 1968). In Greece on the Oiti Mts. it was 1:2 for *Ceratophyllus hirundinis* and on the Olympus Mts. 1:3.3 (calculated from PEUS, 1954).

The developmental cycles of ectoparasites are dependent on the *Delichon urbica* annual cycle. *Delichon urbica* returns from its migration to nests at the end of April. During the sampling in May there were eggs in the nests, in June juveniles of the first offspring and in September feathered juveniles of the second offspring. *Delichon urbica* leave the nests at the end of September.

Delichon urbica is in the nests five months during the nesting season, the remaining seven being on migration. Thus, for ectoparasites there are short period of opulence, followed by long periods of starvation or staying in an inactive stage.

In the developmental cycle of *Oeciacus hirundinis* there are three groups with different characteristics of development (Figure 1): adults, 1st and 2nd larval stages, and 3rd, 4th and 5th larval stages.

Adults were the most common stage during the winter, slightly decreasing from November up to March and April. They were most abundant in May, because after the return of *Delichon urbica* the overwintered larvae took the blood meal and quickly developed to the adult stage–a blood meal being the condition for the development to the next stage (USINGER, 1966). After this first spring blood meal, adults copulated and laid eggs. Till June the number of adults decreased, probably because of the death of overwintered adults and partly the dispersion and repopulation of new nests. During the summer months the number of adults was more or less constant. In autumn, after departure of *Delichon urbica*, the number of adults increased as some larvae finished metamorphosis.

The 1st and 2nd larval stage are not capable of surviving the winter, probably because they are too fragile and less chitinized. They first appeared in May when *Delichon urbica* began hatching eggs. In June both stages were the most abundant of all larvae. By September the 1st larval stage decreased, probably because adults stopped laying eggs, but the 2nd stage was still the most abundant. In November neither of both stages was present. Some of them probably died of cold and starvation, or developed to the 3rd stage that is capable of overwintering.

The larvae of the 3rd, 4th and 5th stages were present in the nests during all the winter, but their number slightly decreased from November till March and April. The 3rd and 4th stages decreased even more till May, as after the return of *Delichon urbica* to the nests they obtained a blood meal and continued to metamorphose. Thus, the 5th stage was the most abundant stage in May. All three stages rapidly increased till June because of the rapid development of the larvae of lower stages. Till September there was a slight decrease of all three stages. In autumn, after the departure of *Delichon urbica*, the development of larvae finished as the blood meal was not available anymore.

The adults of *Stenepteryx hirundinis* were present in the nests from May till

September (Figure 3), while the puparions were present during all seasons.

Ceratophyllus hirundinis overwintered as an adult in a cocoon. After *Delichon urbica* leave their nests, larvae bring to an end their development, spin a cocoon, and metamorphose to pupae. The pupal stage is short because they quickly metamorphose to adults. They wait in the cocoons to hatch in favorable conditions. The stimulus is spring warmth (BATES, 1962) or warmth of the host returning to the nest. DARSKAJA (1964) and CYPRICH et al. (1988) found the same scheme. DARSKAJA (1964) also classified *Ceratophyllus hirundinis* into the group of fleas in which adults are found outside the cocoons only during that part of the year when they reproduce. DARSKAJA (1964) and CYPRICH et al. (1988) also discovered that the occurrence of free adults is bound to the presence of a host in the nest.

The number of overwintered adults in cocoons is one third higher than those of the nesting season. The reason could be the adult spring dispersion and the repopulation of new nests. DARSKAJA (1964) suggested that *Ceratophyllus hirundinis* did not migrate, but the CYPRICH et al. (1988) results support the assumption of spring dispersion. In July PEUS (1968) found large numbers of dead fleas, as did JURÍK (1974) during the spring months when the juveniles of *Delichon urbica* were present in the nests. This fact could support the hypothesis that *Ceratophyllus hirundinis* does not migrate (CYPRICH et al., 1988). The method we used to separate the animals from the nests was unable to obtain dead fleas.

The flea larvae were present in the nests from May till September. JURÍK (1974) also reports the same period for the Czech Republic. CYPRICH et al. (1988) in south-west Slovakia found the larvae in the nests from April till December.

The occurrence of larvae and adults (Figure 2) suggests the existence of one generation of *Ceratophyllus hirundinis* within a year in Slovenia. Both JURÍK (1974) and DARSKAJA (1964) have the same thesis. CYPRICH et al. (1988) on the basis of bimodality of larvae and females with eggs suggests that there are two generations, but in the same study, on the basis of the occurrence of individual age categories, he also considers only one generation. *Ceratophyllus hirundinis* probably has one generation a year with a minor part of the population that might have two generations under favourable conditions (CYPRICH et al., 1988).

While these findings are extremely interesting, we are not in a position to say whether they are valid or not. We obviously need further studies with different methods to finally resolve this question.

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References

Askew, R.R., 1971: Parasitic insects. Heinemann Educational Books Limited, pp 316.

Bates, J.K., 1962: Field studies on the behaviour of bird fleas. I. Behaviour of the adults of tree species of bird fleas in the field. *Parasitology*, 52: 113-132.

Cyprich, D., M. Krumpál, D. Hornichová, 1988: Annual cycle of Ceratophyllus hirundinis (Curtis, 1826) (Siphonaptera, Insecta), in the nest of Delichon urbica Linnaeus, 1758 in south-west Slovakia. *Biológia*, 43(2): 141-152.

Darskaja, N. F., 1964: K sravnitel'noj ekologii ptitschich bloch roda Ceratophyllus Curt. 1832. *Ektoparazity*, 4: 31-180.

Jurík, M., 1974: Bionomics of fleas in birds' nests in the teritory of Czechoslovakia. *Acta Sci. Nat. Acad. Sci. Bohemoslov.*, 8: 1-54.

Peus, F., 1954: Zur Kenntnis der Flöhe Griechenlands Insecta, Siphonaptera. *Bonner Zoologische Beiträge,* 1: 111-147.

Peus, F., 1968: Zur Kenntnis der Flöhe Deutschlands II. Faunistik und Ökologie der Vogelflöhe Insecta, Siphonaptera. *Zool. Jb. Syst. Bd.*, 95: 571-633.

Peus, F., 1969: Flöhe aus Österreich. *Ber. nat.-med. Ver. Innsbruck*, 57: 153-158.

Rosický, B., 1957: Fauna ČSR, Svazek 10: Blechy Aphaniptera. Nakladatelství Československé Akademie Ved, Praha, pp. 1-446.

Trilar, T., 1998: Ectoparasites from the nests of the house martin (Delichon urbica) in Slovenia: 1. Faunistic survey. *Acta Entomologica Slovenica*, 6(2): 89-98.

Usinger, R.L., 1966: Monograph of Cimicidae Hemiptera - Heteroptera. The Thomas Say Foundation, Volume VII, pp 1-585.

		Hemiptera		Siphonaptera		Diptera	
		Oeciacus hirundinis		*Ceratophyllus hirundinis*		*Stenepteryx hirundinis*	
Locality	Date	♂♂ (%)	♀♀ (%)	♂♂ (%)	♀♀ (%)	♂♂ (%)	♀♀ (%)
Planina	26.3.1993	66.9	33.1	41.1	58.9	-	-
Savska loka	8.4.1993	47.6	52.4	40.5	59.5	-	-
Bled	9.4.1993	66.7	33.3	36.1	63.9	-	-
Bled	15.4.1992	22.5	77.5	45.8	54.2	-	-
Savska loka	23.5.1994	55.9	44.1	-	-	-	-
Savska loka	22.6.1993	40.4	59.6	45.8	54.2	42.0	58.0
Savska loka	6.9.1993	49.0	51.0	40.2	59.8	-	-
Bled	21.11.1992	60.7	39.3	47.4	52.6	-	-
Together		50.6	49.4	41.8	58.2	41.1	58.9

Table 1: Sex ratio of ectoparasites in the nests of *Delichon urbica*
- = insufficient data

Figure 1

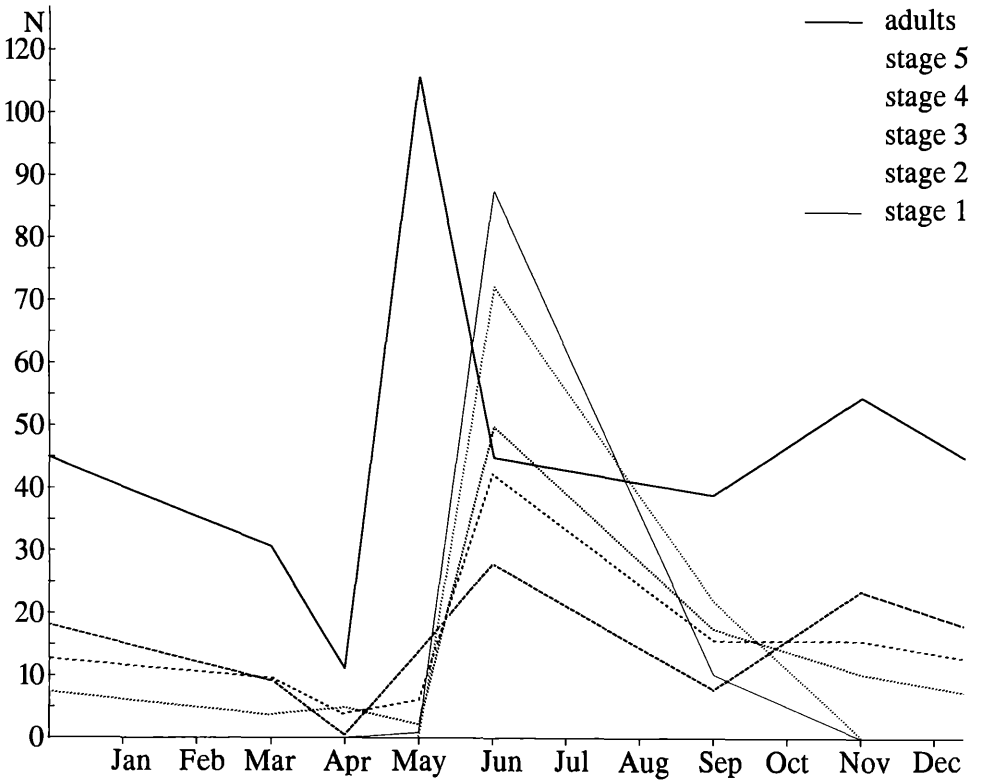

Fig. 1: Developmental cycle of *Oeciacus hirundinis*

Figure 2

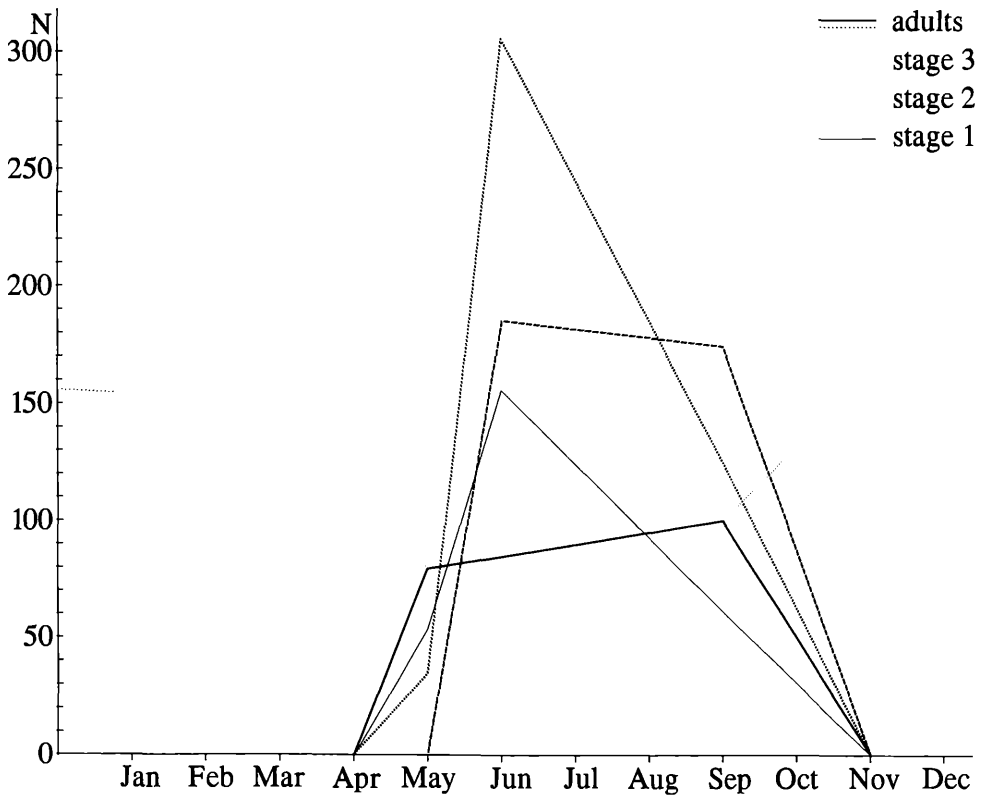

Fig. 2: Developmental cycle of *Ceratophyllus hirundinis*

Figure 3

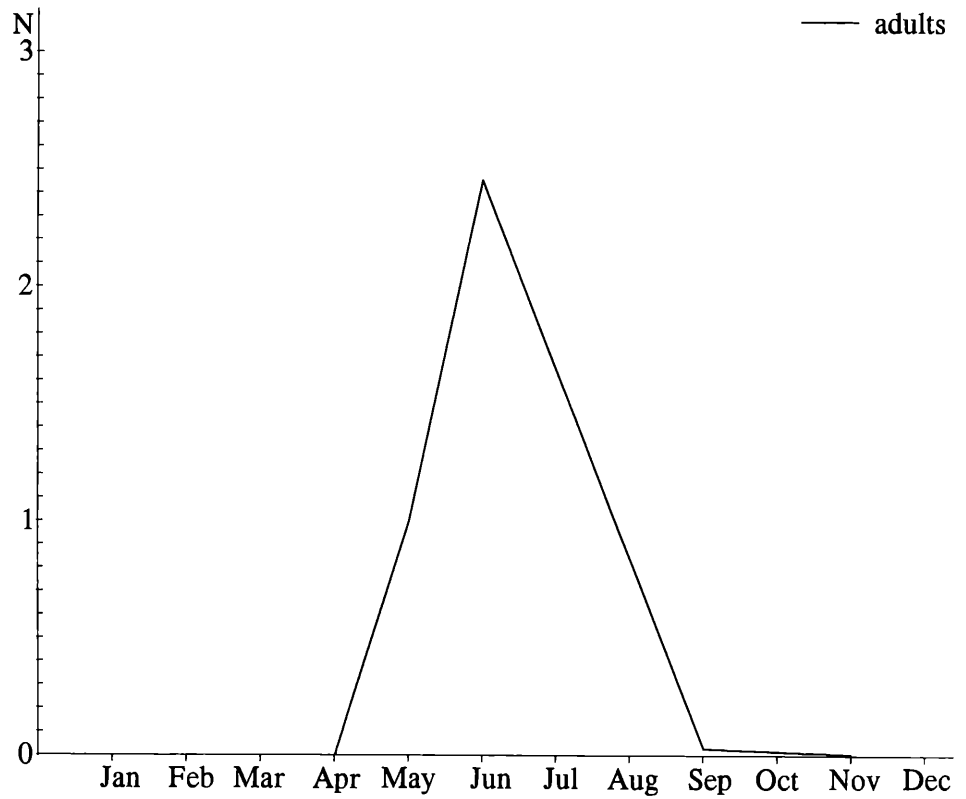

Fig. 3: Developmental cycle of *Stenepteryx hirundinis*