Biologia, Bratislava, **51**/5: 557—570, 1996

# Ectoparasites of bee-eater (*Merops apiaster*) and arthropods in its nests

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KRIŠTOFÍK, J., MAŠÁN, P., ŠUSTEK, Z., Ectoparasites of bee-eater (*Merops apiaster*) and arthropods in its nests.– Biologia, Bratislava, **51**: 557—570, 1996; ISSN 0006-3088.

We studied the abundance of ectoparasites of young and adult bee-eaters and the arthropod fauna in their nests. The feather lice *Meropoecus meropis* and *Meromenopon meropis* were found on both adult and young bee-eaters while chicks were additionally parasitized by the fly *Carnus hemapterus*. The distribution of these parasites was characterized by a descending logarithmic curve. The nest fauna consisted mostly of parasitic mites and predaceous beetles. Mites were represented by a large number of *Androlaelaps casalis*, a facultative ectoparasite of birds. On the contrary, the blood-sucking mites *Dermanyssus hirundinis*, *D. gallinae* and *Ornithonyssus sylviarum* were little numerous and the occurrence of other mites was only occasional. Beetles were represented by a large number of the nidicolous staphylinide *Haploglossa nidicola* which was accompanied by a low number of the nidicolous histeride *Gnathoncus buyssoni*. Occurrence of *H. nidicola* and *A. casalis* was moderately positively correlated. Large numbers of *Dermestes* spp. larvae occurred in the nests, too. Other beetle species occurred occasionally in the nest holes. Ticks and fleas occurred sporadically and were probably introduced by adult birds. They did not develop there. On the contrary, some flies, whose larvae had suitable conditions, developed in some nests. Spiders, pseudoscorpions and bugs were recorded only in a small number of species and individuals.

Key words: *Merops apiaster*, bee-eater, feather lice, flies, ticks, spiders, mesostigmatic mites, pseudoscorpions, bugs, beetles, fleas, nests.

## Introduction

The investigation of the ectoparasites of bee-eater (*Merops apiaster* LINNAEUS, 1758) has mostly been focused on feather lice. In Slovakia, BALÁT (1965) found three feather lice species, viz. *Brueelia apiastri* (DENNY, 1842), *Meromenopon meropis* CLAY et MEINERTZHAGEN, 1941 and *Meropoecus meropis* (DENNY, 1842) parasitizing exclusively on bee-eater. These species were found on bee-eaters also in Hungary (RÉKÁSI, 1993), in the former Yugoslavia (BRELIH, TOVORNIK, 1961, 1964), in Italy (MARTIN-MATEO, MANILA, 1993) and in other countries. However, HUDEC et al. (1983) recorded also other parasites of bee-eater – the mite *Androlaelaps casalis*, the flies *Ornithomyia avicularia* (LINNAEUS, 1758), *Pseudolynchia canarensis* (MAQUART, 1840) and the fleas *Ceratophyllus gallinae* and *C. garei*. Other arthropods living in the nests of bee-eater were studied only sporadically (HICKS, 1959).

The aim of the present paper is to assess abundance of ectoparasites on both adult and juvenile bee-eaters and the composition of the

Table 1. Abundance of feather lice on adults and of the fly *C. hemapterus* on chicks of bee-eater in 1995.

| FAMILY<br>Species | CH | M | JCH | Locality<br>MH | P | S | Total |
|---|---|---|---|---|---|---|---|
| ANCISTRONIDAE | | | | | | | |
| *Meromenopon meropis* | | | 3/2 | –/1 | 5/10 | 4/7<br>2L | 34 |
| PHILOPTERIDAE | | | | | | | |
| *Meropoecus meropis* | 7/6 | 24/16<br>5L | 68/66<br>10L | 43/36<br>5L | 32/32<br>3L | 25/27<br>4L | 409 |
| CARNIDAE | | | | | | | |
| *Carnus hemapterus* | | 62/116 | 15/32 | | 2/1 | 12/46 | 286 |

Explanations: CH – Chotín, M – Mudroňovo, JCH – Jurský Chlm, MH – Malá nad Hronom, P – Pavlová, S – Sikenička; L – larvae, males/females.

arthropod fauna in their nests as well as their eventual influence on the chick development.

### Material and methods

The bee-eaters dig 75–150 cm deep horizontal burrows with a non-lined nest cavity at their ends. In this cavity, chitinous remainders of insects and excrements of nestlings are accumulated (Hudec et al., 1983). After fledging of the chicks, we took this material and extracted it in the Tulgren's funnels. In 1989–1993 we collected material from 174 nest cavities of bee-eater in 10 localities in southern Slovakia (Jarovce 47°14′ N, 17°06′ E – 21 nests; Chotín 48°11′ N, 18°14′ E – 9 nests; Mudroňovo 48°10′ N, 18°20′ E – 26 nests, Gbelce 48°09′ N, 18°31′ E – 14 nests; Jurský Chlm 48°12′ N, 18°33′ E – 8 nests; Štúrovo 48°12′ N, 18°43′ E – 3 nests; Kamenica nad Hronom 48°10′ N, 18°43′ E – 6 nests; Malá nad Hronom 48°09′ N, 18°40′ E – 15 nests; Pavlová 48°06′ N, 18°40′ E – 14 nests; Sikenička 48°04′ N, 18°40′ E – 15 nests) and in 3 localities in eastern Slovakia (Beša 49°28′ N, 28°56′ E – 18 nests; Somotor 49°35′ N, 21°48′ E – 22 nests; Kolibabovce 49°15′ N, 22°15′ E – 3 nests).

During the breeding period of 1995 (May-July) we collected ectoparasites from 62 adult bee-eaters (Chotín – 1 ind., Mudroňovo – 5 ind., Jurský Chlm – 19 ind., Malá nad Hronom – 14 ind., Pavlová – 8 ind., Sikenička – 15 ind.) and from 46 chicks (Mudroňovo – 21 ind., Jurský Chlm– 12 ind., Pavlová – 4 ind., Sikenička 9 ind.).

Truncated lognormal distribution was calculated according to Pesenko (1978), negative binominal distribution and logarithmic regression were used to characterize abundance distribution of some arthropod species.

## Ectoparasites of bee-eaters

*Feather lice*

From 62 adult bee-eaters we obtained 443 feather lice belonging to 2 species (Tab. 1). 409 individuals (92.3%) belonged to *Meropoecus meropis* and

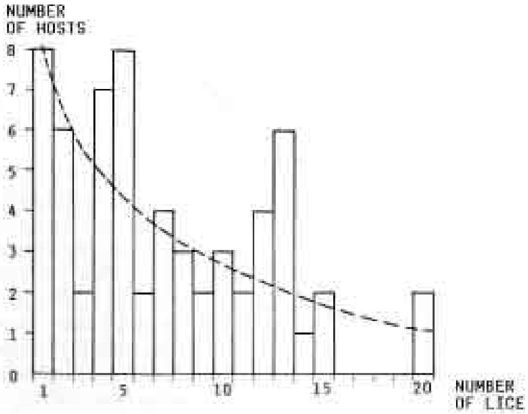


Fig. 1. Abundance distribution of feather lice on adult bee-eaters (dashed – logarithmic regression curve, $y = 8.03 - 2.33 \ln x$, $\chi^2 = 11.06$, $P < 0.01$).

were found on 56 bee-eaters (7.3 ind. per bird). *Meromenopon meropis* was represented only by 34 individuals (7.7%) and was found on 14 birds (1.8 ind. per bird). Both species occurred together on 8 birds. All examined adult bee-eaters were parasitized by feather lice. The highest number of feather-lice found on one bird was 20, while the lowest number was 1. The mutual proportion of males, females and larvae was 0.6:1:0.1 in *Meromenopon meropis* and 1:0.9:0.1 in *Meropoecus meropis*, respectively. The distribution pattern of feather lice abundance in the adult bee-eater can be characterized by a descending logarithmic curve (Fig. 1), according which the number of feather lice is low (0.8 ind.) in the majority of examined birds. A higher abundance (more than 10) was recorded only in a small number of birds. On contrary, the feather lice were found only on 2 young bee-eaters (4.4%), (1 male and 1 female of

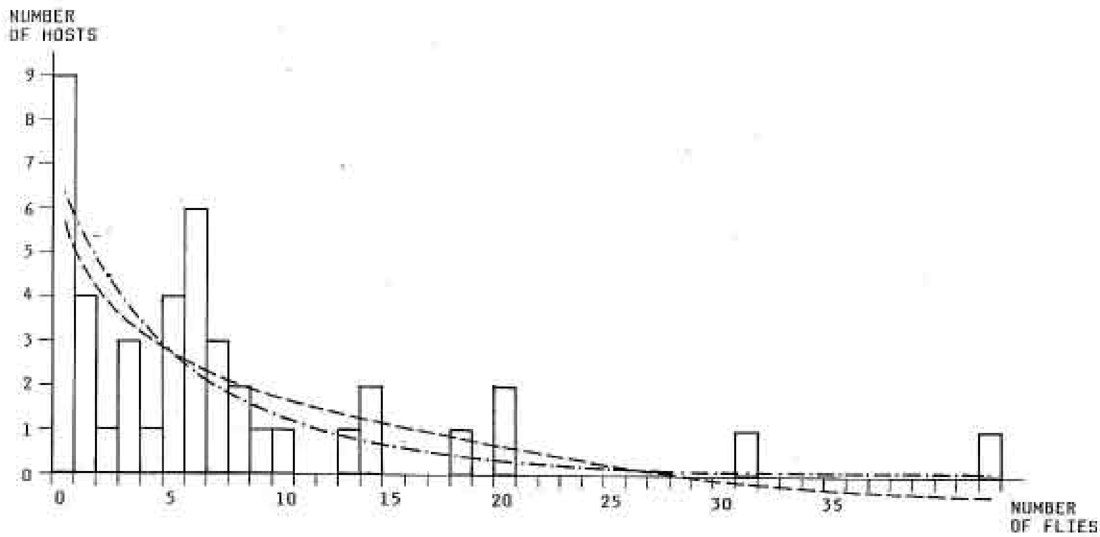


Fig. 2. Abundance distribution of *Carnus hemapterus* on bee-eater chicks (dashed – logarithmic regression curve, $y = 5.65 - 1.65 \ln x$, $\chi^2 = 18.20$, $P < 0.01$; dotted and dashed – negative binominal distribution, $\bar{x} = 6.04$, $s^2 = 44.99$, $\chi^2 = 49.89$, $P < 0.01$).

*Meropoecus meropis* and 1 female of *Meromenopon meropis*). In our material, we have not found *Brueelia apiasteri*, which was recorded from Slovakia by BALÁT (1956).

Numbers of feather lice varied considerably in individual species of birds. The highest number of feather lice per bird (10,000 ind. on a dead *Larus canus* LINNAEUS, 1758) was recorded by ASH (1960). In England, according to ROTSCHILD and CLAY (1952), the number of feather lice on passerines usually does not exceed 10, more than 20 indiv./bird occur sporadically. In Canada, WOODMAN and DICKE (1954) found on average 3.3 feather lice per bird in 391 sparrows (the highest number was 68). According to data given in MARSHALL (1981), the average and maximal number of feather lice per bird was 5.5 and 181, respectively. CLARK et al. (1994) found that abundance of *Brueelia gracilis* (BURMEISTER, 1838) in *Delichon urbica* (LINNAEUS, 1758) is negatively binominally distributed. He has not found a significant difference between feather-lice number on adult males, females and young birds. The abundance of *B. gracilis* on house martins culminated in June, i. e. during the nestling phase. The population biology of ectoparasites of *Apus apus* (LINNAEUS, 1758) was studied by LEE and CLAYTON (1995), who found that 94% of adult birds were parasitized by *Dennys hirundinis* (LINNAEUS, 1761). Its abundance was negatively binominally distributed. The distribution patterns of parasites found by them are very similar to those found by us in bee-eater.

*Flies*

Among 46 examined young bee-eaters, we found 286 individuals of the blood-sucking fly *Carnus hemapterus* NITZSCH, 1818 (Tab. 1) on 37 birds (80.4%). Other parasitic flies, like louse flies or species of the genus *Protocalliphora* were not found. The average and maximal number of *C. hemapterus* per nestling was 7.7 and 42, respectively. The proportion of males and females was 0.47:1. Abundance of *C. hemapterus* was very low in the majority of nests (less than 5) and only in a small number of nests it was higher than 20. The frequency distribution of *C. hemapterus* follows a negative binominal distribution or a descending logarithmic regression curve (Fig. 2). *C. hemapterus* occurred in the nestlings up to the age of 24 days. In Europe, the occurrence of this species was recorded in Falconiformes, Strigiformes and Passeriformes (NORDBERG, 1936; HICKS, 1959, 1962, 1971; BÜTTIGER, AESCHLIMANN, 1974; WALTER, HUDDE, 1987). In North America, *C. hemapterus* was found in chicks of 15 bird species (CAPPELLE, WITWORTH, 1973; KIRKPATRICK, COLVIN, 1989). WALTER and HUDDE (1987) found *C. hemapterus* already on one-day old starling nestlings. The maximal number of these flies was found on 6 to 7 days old nestlings. Adult *C. hemapterus* contained blood in

Table 2. Abundance of spiders in bee-eater nests in 1989–1993.

| FAMILY<br>Species | Year<br>1989 | 1990 | 1991 | 1992 | 1993 | Total |
|---|---|---|---|---|---|---|
| THERIDIIDAE | | | | | | |
| *Anelosimus* sp. | | | | | 1 | 1 |
| MIMETIDAE | | | | | | |
| *Evo tuberculata* (De Geer, 1778) | | | | 1 | | 1 |
| LINYPHIIDAE | | | | | | |
| *Leptphyphantes leprosus* (Ohlert, 1865) | | | | 1 | | 1 |
| *Ostearius melanopygius* (O. P. Cambrige, 1865) | | | | | 1 | 1 |
| *Syedra gracilis* (Menge, 1869) | 1 | 1 | 1 | | | 3 |
| *Thyreosthenius parasiticus* (Westring, 1851) | | | 1 | | | 1 |
| LYCOSIDAE | | | | | | |
| *Pardosa* sp. | | | | | 1 | 1 |
| DICTYNIDAE | | | | | | |
| *Dictyna* sp. | | | | 1 | | 1 |
| *Lathys humilis* (Blackwall, 1855) | 1 | | 1 | | | 2 |
| AMAUROBIIDAE | | | | | | |
| *Amaurobius fenestralis* (Stroem, 1830) | | | | | 1 | 1 |
| LIOCRANIDAE | | | | | | |
| *Phrurolithus festivus* (L. C. Koch, 1835) | | | | | 1 | 1 |
| CLUBIONIDAE | | | | | | |
| *Clubiona* sp. | 1 | | 1 | | | 2 |
| GNAPHOSIDAE | | | | | | |
| *Trachyzelotes pedestris* (C. L. Koch, 1837) | | | | | 1 | 1 |
| *Drassodes* sp. | | | | 1 | | 1 |
| THOMISIDAE | | | | | | |
| *Ozaptila praticola* (C. L. Koch, 1837) | | 1 | 1 | | 1 | 3 |
| *Xysticus* sp. | | 1 | 1 | | | 2 |
| Total | 3 | 3 | 6 | 4 | 7 | 23 |

their abdomen. Kirkpatrick and Colvin (1989) found that parasitization of young owls by *C. hemapterus* culminated in 2–3 weeks-old nestlings. Analysis of the blood remainders in the digestive tract of males and females of *C. hemapterus* confirmed that the blood came from the owl nestlings.

*Ticks*

One larva of *Ixodes ricinus* was found on an adult bee-eater in the locality Jurský Chlm on 26 May, 1995. More details about ticks in the bee-eater nests are given below.

## Structure of the nest fauna

*Spiders*

In 23 bee-eater nests, we found 16 species of spiders belonging to 10 families (Tab. 2). The actual number of species might be even higher, but six juvenile individuals could be identified only to the generic level. According to Martin (1991), *Lathys humilis*, *Thyreosthenius parasiticus* and *Ozaptila praticola* are scotophilous and prefer dark places. *Leptphyphantes leprosus* and *Amaurobius fenestralis* are hemiscotophilous (Miller, 1971). Burrows represent a natural habitat for the species mentioned above, but it is probable that they have not a specific relation to bee-eater nests, in spite of the fact that *T. parasiticus* was found also in the sand martin nests (Gajdoš et al., 1991; Krištofík et al., 1994). The ecological requirements of other spider species indicate that they occur in the bee-eater nests occasionally or search for a hiding place there.

*Pseudoscorpions*

Two pseudoscorpions, 1 female of *Laprochernes nodosus* (Schrank, 1761) (Jarovce, 16 August, 1993) and 1 male of *Chernes hahni* L. Koch, 1873 (Chotín, 22 August, 1991) were found in the studied nests. *L. nodosus* occurs frequently in soil, hotbeds, compost, etc. Females live on the bodies of different insects (Beier, 1963). *C. hahni* prefers open landscape and occurs less in forests and under bark of the broadleaved trees (Beier, 1963). Based on the fact that premature stages of both

Table 3. Abundance, dominance and infestation indices of mesostigmatic mites in bee-eater nests and the number of positive nests in 1989–1993.

| Species | $\sum$(n) (ind.) | D (%) | $\sum$PN (n) | P (%) | MEAN (ind.) | EG |
|---|---|---|---|---|---|---|
| *Macrocheles merdarius* (Berlese, 1889) | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SP |
| + *Macrocheles matrius* (Hull, 1925) | 269 | 0.20 | 15 | 8.15 | 1.46 | NP |
| *Macrocheles glaber* (Müller, 1860) | 2 | $15 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SP |
| *Macrocheles muscaedomesticae* (Scopoli, 1772) | 50 | 0.04 | 6 | 3.26 | 0.27 | SP |
| *Pseudoparasitus myrmophilus* (Michael, 1891) | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SPM |
| *Hypoaspis vacua* (Michael, 1891) | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SPM |
| + *Hypoaspis miles* (Berlese, 1892) | 1,441 | 1.08 | 46 | 25.00 | 7.83 | SPM |
| + *Hypoaspis aculeifer* (Canestrini, 1883) | 2 | $15 \times 10^{-4}$ | 2 | 1.09 | 0.01 | NP |
| + *Hypoaspis lubrica* Voigts et Oudemans, 1904 | 435 | 0.33 | 38 | 20.65 | 2.36 | NP |
| *Hypoaspis praesternalis* Willmann, 1949 | 5 | $37 \times 10^{-4}$ | 3 | 1.63 | 0.03 | SP |
| *Hypoaspis astronomica* (C. L. Koch, 1839) | 2 | $15 \times 10^{-4}$ | 2 | 1.09 | 0.01 | SPM |
| + *Androlaelaps casalis* (Berlese, 1887) | 129,961 | 97.71 | 167 | 90.76 | 706.31 | FPB |
| *Androlaelaps fahrenholzi* (Berlese, 1911) | 4 | $30 \times 10^{-4}$ | 3 | 1.63 | 0.02 | FPM |
| *Laelaps agilis* C. L. Koch, 1836 | 2 | $15 \times 10^{-4}$ | 2 | 1.09 | 0.01 | OPM |
| *Laelaps hilaris* C. L. Koch, 1836 | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | OPM |
| + *Eulaelaps stabularis* (C. L. Koch, 1840) | 58 | 0.04 | 11 | 5.98 | 0.32 | FPM |
| + *Haemogamasus nidi* Michael, 1892 | 53 | 0.04 | 5 | 2.72 | 0.29 | FPM |
| + *Hirstionyssus latiscutatus* (Meillon et Lavoipierre, 1944) | 26 | 0.02 | 4 | 2.17 | 0.14 | OPM |
| + *Dermanyssus hirundinis* (Hermann, 1804) | 356 | 0.27 | 75 | 40.76 | 1.93 | OPB |
| + *Dermanyssus gallinae* (De Geer, 1778) | 85 | 0.06 | 3 | 1.63 | 0.46 | OPB |
| + *Ornithonyssus sylviarum* (Canestrini et Fanzago, 1877) | 69 | 0.05 | 30 | 16.30 | 0.38 | OPB |
| *Ameroseius plumosus* Oudemans, 1902 | 4 | $30 \times 10^{-4}$ | 1 | 0.54 | 0.02 | SP |
| + *Blattisocius keegani* Fox, 1947 | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SP |
| + *Paragarmania dentritica* (Berlese, 1918) | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SP |
| *Amblyseius zwoelferi* (Dosse, 1957) | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SP |
| *Proctolaelaps ventrianalis* Karg, 1971 | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SP |
| + *Proctolaelaps scolyti* Evans, 1958 | 9 | 0.01 | 6 | 3.26 | 0.05 | SP |
| *Proctolaelaps pygmaeus* (Müller, 1860) | 11 | 0.01 | 5 | 2.72 | 0.06 | NP |
| *Digamasellus punctum* Berlese, 1904 | 3 | $22 \times 10^{-4}$ | 1 | 0.54 | 0.02 | SP |
| *Dendrolaelaps* sp. | 72 | 0.05 | 2 | 1.09 | 0.39 | SP |
| + *Punctodendrolaelaps fallax* (Leitner, 1949) | 7 | 0.01 | 2 | 1.09 | 0.04 | SP |
| *Cornodendrolaelaps presepum* (Berlese, 1918) | 18 | 0.01 | 11 | 5.98 | 0.10 | SP |
| *Parasitus coleoptratorum* (Linnaeus, 1758) | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SP |
| *Vulgarogamasus remberti* (Oudemans, 1912) | 5 | $37 \times 10^{-4}$ | 3 | 1.63 | 0.03 | SP |
| *Gamasodes spiniger* (Trägardh, 1910) | 2 | $15 \times 10^{-4}$ | 2 | 1.09 | 0.01 | SP |
| *Nenteria oudemansi* Hirschmann et Zirngiebl-Nicol, 1969 | 1 | $7 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SS |
| *Trichouropoda patavina* (G. Canestrini, 1885) | 21 | 0.02 | 7 | 3.80 | 0.11 | SS |
| + *Trichouropoda longiovalis* Hirschmann et Zirngiebl-Nicol, 1961 | 5 | $37 \times 10^{-4}$ | 1 | 0.54 | 0.06 | SS |
| + *Uroseius infirmus* (Berlese, 1887) | 2 | $15 \times 10^{-4}$ | 1 | 0.54 | 0.01 | SS |
| *Uroseius* sp. | 27 | 0.02 | 11 | 5.98 | 0.15 | SS |
| Total, ø | 133,016 | 100.00 | 176 | 95.65 | 722.95 | |

Explanations: D – dominance, PN – positive nests, P – presence, MEAN – individuals per host (infestation intensity), ind. – individuals, EG – ecological group: OPB – obligatory parasite of birds, FPB – facultative parasite of birds, OPM – obligatory parasite of mammals, FPM – facultative parasite of mammals, NP – nidicolous predator, SP – soil predator, SPM – soil predator (myrmecophilous), SS – soil saprophag; + – species found in the burrow nests of *Riparia riparia* in southwestern Slovakia (Mašán, Krištofík, 1993).

species did not occur in the examined nests, we consider both species to have no specific relation to the bee-eater nests.

*Mesostigmatic mites*

From 176 nests (95.7% of nests) of bee-eater, we obtained 133,016 mesostigmatic mites belonging to 40 species (Tab. 3). On average, 765 mites

Table 4. Abundance and infestation indices of *Androlaelaps casalis* in bee-eater nests in individual localities in 1989–1993.

| Locality | Number of nests | | | | Infestation extensity (%) | | | | Infestation intensity (ind.) | | | | D (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989–1991 | 1992 | 1993 | 1989–1993 | 1989–1991 | 1992 | 1993 | 1989–1993 | 1989–1991 | 1992 | 1993 | 1989–1993 | 1989–1993 |
| Jarovce | – | 14 | 7 | 21 | – | 92.9 | 100.0 | 95.2 | – | 434.6 | 1,829.4 | 901.3 | 99.8 |
| Chotín | 7 | 2 | – | 9 | 42.9 | – | – | 44.4 | 0.7 | – | – | 20.8 | 75.1 |
| Mudroňovo | 6 | 9 | 11 | 26 | 83.3 | 100.0 | 100.0 | 96.2 | 20.2 | 783.9 | 1,410.2 | 872.6 | 98.9 |
| Gbelce | 12 | 2 | – | 14 | 50.0 | – | – | 57.1 | 2.6 | – | – | 2.4 | 20.1 |
| Jurský Chlm | – | – | 8 | 8 | – | – | 100.0 | 100.0 | – | – | 235.6 | 235.6 | 92.1 |
| Štúrovo | 3 | – | – | 3 | 33.3 | – | – | 33.3 | 0.3 | – | – | 0.3 | 1.1 |
| Malá nad Hronom | – | 13 | 12 | 25 | – | 100.0 | 100.0 | 100.0 | – | 638.4 | 719.7 | 677.4 | 92.2 |
| Kamenica nad Hronom | – | 6 | – | 6 | – | 66.7 | – | 66.7 | – | 5.5 | – | 5.5 | 94.3 |
| Pavlová | – | 8 | 6 | 14 | – | 100.0 | 100.0 | 100.0 | – | 438.6 | 2,033.5 | 1,122.1 | 98.6 |
| Sikenička | – | 6 | 9 | 15 | – | 100.0 | 100.0 | 100.0 | – | 409.0 | 2,894.6 | 1,900.3 | 99.0 |
| Beša | – | – | 18 | 18 | – | – | 100.0 | 100.0 | – | – | 297.0 | 297.0 | 98.0 |
| Somotor | – | – | 22 | 22 | – | – | 100.0 | 100.0 | – | – | 896.2 | 896.2 | 98.8 |
| Kolibabovce | – | – | 3 | 3 | – | – | 100.0 | 100.0 | – | – | 10.3 | 10.3 | 96.9 |

were in one nest. 97.7% of individuals belonged to *Androlaelaps casalis* and 1.1% to *Hypoaspis miles*. Further 38 species represented only 1.2% of individuals. *A. casalis* occurred in 167 nests (90.8%), *D. hirundinis* in 75 nests (40.8%) and *H. miles* in 46 nests (25.0%), *H. lubrica* in 38 nests (20.7%) and *O. sylviarum* in 30 nests (16.3%). Other species occurred in less than 10 % of nests. The average number of individuals in one nest was 732.9 ± 90.0 (mean ± SE) ($n = 174$) in *A. casalis*, 8.3 ± 3.3 in *H. miles*, 2.1 ± 0.5 in *D. hirundinis*, 2.5 ± 0.7 in *H. lubrica* and 1.6 ± 0.8 in *M. martius*. In other species, average number of individuals did not exceed 0.1. *A. casalis* (13), *D. hirundinis* (11), *H. miles* (9), *H. lubrica* (9), *O. sylviarum* (9) and *M. matrius* (7) occurred in more than half of the localities.

Almost in all localities, infestation of the nests by *A. casalis* was considerably higher in 1992 than in 1991 (2–7 times, only in one case 1.1 times) (Tab. 4). In 1993, the highest numbers of *A. casalis* observed in one nest were 7,103; 5,655 and 5,052 individuals, respectively. *A. casalis* was absent in 8 nests (4.4%) and in 45 (24.5%) nests its abundance exceeded 1,000 individuals.

Differences in infestation of the nests by *A. casalis* can have different reasons, for instance they can be due to seasonal climatic changes between years, by population fluctuations of *A. casalis* and by age of nest colony. *A. casalis* is known to be a facultative ectoparasite of birds. Under certain conditions, it becomes predaceous or schizophagous. We suppose that its high abundance in the bee-eater nests was caused by suitable ecological conditions and by a wide food supply in bee-eater nests. The mite community consisted also of 26 (65%) species of free-living soil predators (Tab. 3). However, their dominance was very low. The myrmecophilous *H. miles* represented 1.1% of all individuals and the remaining 25 species only 0.2%. Except *H. miles*, we found also three other myrmecophilous predators (*Pseudoparasitus myrmophilus*, *Hypoaspis vacua* and *H. astronomica*) in the nests. All these species were introduced into bee-eater nests by ants which used the remainders of insects as a rich food resource. Nidicolous predators were represented in the nest by 717 (0.5%) individuals belonging to 4 (10%) species.

Further, the specific obligatory ectoparasites of rodents of the genus *Apodemus* (*Laelaps agilis* and *Histrionyssus latiscutatus*), *Microtus* and *Clethrionomys* (*Laelaps hilaris* ) and the nonspecific facultative parasites of mammals (*Androlaelaps fahrenholzi*, *Eulaelaps stabularis* and *Haemogamasus nidi*) were found. In general, their representation in the bee-eater nests was very low, but it was still 8 times higher than in the similar nests of sand martin (MAŠÁN, KRIŠTOFÍK, 1993). Their occurrence indicates that, after fledging, the nest burrows are very highly visited or inhabited by small mammals.

The average number of *A. casalis* in the bee-eater nests was about 100 times higher (706 ind. per nest) than in the sand martin nests (7.5 ind. per nest) (MAŠÁN, KRIŠTOFÍK, 1993). Also its dominance and presence were higher in the bee-eater nests (97.7% compared to 64.1% and 90.8% compared to 55.4%, respectively). This cor-

Table 5. Abundance of ticks in bee-eater nests in 1992–1993.

| Species | Year 1992 | 1993 | Total |
|---|---|---|---|
| Ixodes ricinus LINNAEUS, 1758 | 4N | 2FF | 2FF 4N |
| Ixodes lividus KOCH, 1844 | 4N 202L | 11N 124L | 15N 326L |

Explanations: FF – females, N – nymphs, L – larvae.

responds with the data from Russia (BORISOVA, 1977, 1978; MARSHALOVA, 1980), where the average number of mites in sand martin nests fluctuated between 42 and 143. This difference was probably due to a considerably larger accumulation of food rests and excrements in the bee-eater nests. As to the species number, we recorded by 11 species more in the bee-eater nests than in the sand martin nests. 17 species were recorded in nests of both bird species. The representation of the blood-sucking mites *O. hirundinis* (1.9 ind. per nest), *D. gallinae* (0.5 ind per nest) and *O. sylviarum* (0.4 ind per nest) in bee-eater nests was as low as in the sand martin nests. The abundance of *M. matrius* and *H. miles* was 100 and 150 times higher, respectively, in the bee-eater nests than in sand martin nests. On the contrary, the specific facultative parasite *Eulaelaps novus* VITZHUM, 1925 of sand martin was not recorded in the bee-eater nests.

*Ticks*

We found 15 nymphs and 326 larvae of *Ixodes lividus* in 7 (3.8%) bee-eater nests and 2 females and 4 nymphs of *I. ricinus* in 4 (2.2%) nests (Tab. 5). *I. lividus* is a specific parasite of the sand martin, whose small colonies in the localities Pavlová, Beša and Somotor were located in the same walls as the bee-eater nests. In spring, larvae and nymphs of *I. lividus* wait usually at the entry of burrows for the arriving sand martins (MAŠÁN, KRIŠTOFÍK, 1992). In that time, the bee-eaters use to sit at the entry of the last-year nests like sand martins do. We suppose that, in this way, the ticks might penetrate occasionally bee-eater nests, too. Another cause of their presence in bee-eater nests might be active migration. The question whether ticks reproduce in bee-eater nests will be an object of further investigation. According to our present knowledge, bee-eaters are occasional hosts of ticks (GLASHCHINSKAYA-BABENKO 1956). In those localities, where sand martins had not nested prior to our investigation, we did not record any individual of *I. lividus* in the bee-eater nests. According to NOSEK and SIXL (1972), larvae and nymphs of *I. ricinus* were recorded on 64 species of Passeriformes, 5 species of Galliformes, 4 species of Piciformes, 3 species of Charadriiformes and Falconiformes, 2 species of Anseriformes, 1 species of Strigiformes and Coraciformes. So it is obvious that *I. ricinus* come into bee-eater nests occasionally, being introduced by adult birds.

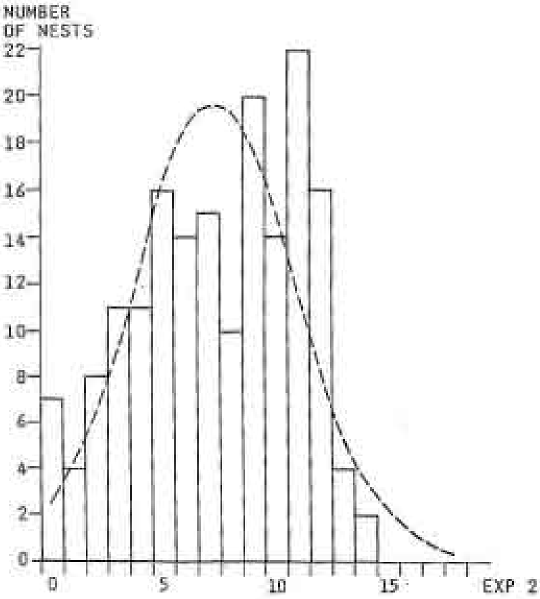


Fig. 3. Abundance distribution of *Androlaelaps casalis* in bee-eater nests (dashed – truncated lognormal curve, $x = 8.32$, $s = 3.56$, $\chi^2 = 36.22$, $P < 0.01$).

*Bugs*

Two bug species were found in the bee-eater nests – *Oeciacus hirundinis* (LAMARCK, 1816) and *Holocranum saturejae* (KOLENATI, 1845). *O. hirundinis* was found in 6 (3.3%) nests: 3 females and 1 larva of 3rd instar (Štúrovo, 27 September, 1989), 5 males, 6 females, 3 larvae of 2nd instar, 4 larvae of 3rd instar and 2 larvae of 4th instar (Jarovce, 27 August, 1992), 1 male, 1 female, 2 larvae of 3rd- 4th instar and 1 larva of 5th instar (Pavlová, 28 September, 1992). According to ORSZÁGH et al. (1990) the main host of this species

Table 6. Abundance and trophic relations of beetles found in the nest of bee-eater in 1990–1993.

| FAMILY<br>Species | T | 1990 | 1991 | 1992 | 1993 | Total |
|---|---|---|---|---|---|---|
| STAPHYLINIDAE | | | | | | |
| *Philonthus cephalotes* (GRAVENHORST, 1802) | C | 1 | | | 2 | 3 |
| *Philonthus varipennis* W. SCRIBA, 1864 | C | | | | 2 | 2 |
| *Philonthus spermophili* GANGELBAUER, 1897 | C | 1 | | 1 | 1 | 3 |
| *Heterothops dissimilis* (GRAVENHORST, 1802) | C | | | | 1 | 1 |
| *Atheta* sp. | C | | 1 | 1 | 3 | 5 |
| *Haploglossa nidicola* FAIRMAIR, 1852 | C | 47 | 123 | 967 | 1,627 | 2,764 |
| *Haploglossa puncticollis* (KIRBY, 1832) | C | 1 | | | 4 | 5 |
| HISTERIDAE | | | | | | |
| *Gnathoncus buyssoni* AUZAT, 1917 | C | 7 | 22 | 58 | 78 | 165 |
| *Gnathoncus rotundatus* (KUGELANN, 1827) | C | | | 1 | | 1 |
| CATOPIDAE | | | | | | |
| *Sciodrepoides watsoni* (SPENCE, 1815) | N | | | | 3 | 3 |
| TROGIDAE | | | | | | |
| *Trox hispidus* (PONTOPPIDAN, 1763) | N | | 1 | | 5 | 6 |
| SCARABAEIDAE | | | | | | |
| *Oxyomus sylvestris* (SCOPOLI, 1763) | S | | | 1 | | 1 |
| DERMESTIDAE | | | | | | |
| *Anthrenus pimpinelae* FABRICIUS, 1775 | N | | | 2 | | 2 |
| ANOBIIDAE | | | | | | |
| *Stegobium paniceum* LINNAEUS, 1758 | D | | 1 | | | 1 |
| CRYPTOPHAGIDAE | | | | | | |
| *Cryptophagus dentatus* (HERBST, 1793) | F | | | 2 | 2 | 4 |
| *Cryptophagus pseudodentatus* BRUCE, 1936 | F | | 1 | | | 1 |
| RHIZOPHAGIDAE | | | | | | |
| *Monotoma bicolor* A. et G. B. VILLA, 1835 | F | | | | 1 | 1 |
| COCCINELIDAE | | | | | | |
| *Coccidula scutelata* (HERBST, 1783) | C | | | | 1 | 1 |
| LATHRIDIIDAE | | | | | | |
| *Lathridius minutus* (LINNAEUS, 1767) | F | | | 3 | 2 | 5 |
| *Cortinicara gibbosa* (HERBST, 1763) | F | | 1 | | | 1 |
| ANTHICIDAE | | | | | | |
| *Formicomus pedestris* (ROSSI, 1790) | D | | | 1 | 1 | 2 |
| TENEBRIONIDAE | | | | | | |
| *Opatrum sabulosum* (LINNAEUS, 1761) | D | | | | 1 | 1 |
| HALTICIDAE | | | | | | |
| *Phyllotreta undulata* KUTSCHERA, 1860 | P | | 1 | | | 1 |
| CURCULIONIDAE | | | | | | |
| *Sitona hispidulus* (FABRICIUS, 1776) | P | | | | 1 | 1 |
| *Ceutorhynchus atomus* BOHEMAN, 1845 | P | 1 | 1 | | | 2 |
| Number of species | | 6 | 9 | 10 | 17 | 25 |
| Number of individuals | | 58 | 152 | 1,037 | 1,735 | 2,982 |

Explanations: T – trophic relations, C – carnivorous, N – necrophagous, S – saprophagous, P – phytophagous.

is the house martin, but it was found in nests of 17 other bird species and in one case also in a nest of bee-eater. This bug was found, in a small number, also in sand martin nests (HICKS, 1959, 1962, 1971; BORISOVA, 1978; KACZMAREK, 1988; KRIŠTOFÍK et al., 1994, etc.). Because of its low abundance it is unlikely that *O. hirundinis*, as a blood sucking parasite, could substancially influence development of bee-eater chicks.

*H. saturajea* was found in 2 (1.1%) nests (1 female in Somotor, 5 August, 1993, 1 larva of 3rd stage in Mudroňovo, 30 August, 1992). It is a phytophagous hygrophilous species bound to reedmace in summer, but in autumn it abandon this habitat. It is distributed in southeastern Europe and in a part of the mediterranean area. It occurs also in southern Slovakia (WAGNER, 1966). Its occurrence in the bee-eater nests is fully occasional.

Table 7. Representation of *Haploglossa nidicola* in nests of bee-eater in 1990–1993.

| | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|
| Presence [%] | 33.0 | 41.7 | 41.7 | 61.6 |
| Number of individuals/nest | 3.9 | 10.3 | 16.1 | 18.7 |
| Number of individuals/positive nest | 11.8 | 24.6 | 38.7 | 30.7 |
| Minimal number/nest | 1 | 4 | 1 | 1 |
| Maximal number/nest | 21 | 56 | 228 | 167 |

Table 8. Representation of *Gnathoncus buyssoni* in nests of bee-eater in 1990–1993.

| | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|
| Presence [%] | 25.0 | 33.3 | 30.0 | 40.7 |
| Number of individuals/nest | 0.6 | 1.8 | 1.0 | 0.9 |
| Number of individuals/nest | 2.3 | 5.5 | 3.2 | 1.5 |
| Minimal number/nest | 1 | 1 | 1 | 1 |
| Maximal number/nest | 3 | 9 | 11 | 8 |

*Beetles*

Beetles were represented by 2,982 adults belonging to 25 species of 15 families and by 1,505 larvae belonging to 4 genera.

Staphylinidae were the richest in number of species and individuals (7 species, 2,783 individuals), followed by the Dermestidae larvae (*Dermestes* spp., 1,391 larvae), adults of Histeridae (2 species, 166 individuals) and Elateridae larvae (*Agriotes* sp., 78 larvae). Adult beetles were represented almost exlusively by two species – *Haploglossa nidicola* (92.4%) and *Gnathoncus buyssoni* (5.6%), occurring in the nests constantly during all four years. The remaining 23 species represented only 2.0% of all individuals.

*H. nidicola* is a typical nidicolous staphylinide known to occur often in large numbers in the sand martin nests (HICKS, 1959) accompanied by a limited number of other beetle species, which occasionally penetrate these nests. The similar location and internal environment of the nests of both bird species might be the reason why *H. nidicola* also occurs in the nests of bee-eaters. The probability of its occurrence in the bee-eater nests increases also due to the common occurrence of its nests and nest colonies of sand martin in some localities (Chotín, Jurský Chlm). *H. nidicola* was present in 33–62% of bee-eater nests/year (Tab. 7). The average number of its individuals per positive nest and in all examined nests was 11.8–38.7 and 3.9–18.7, respectively. The highest number of individuals in a nest was 228 (Tab. 7). The abundance distribution of *H. nidicola* may be described by the truncated lognormal distribution (Fig. 4).

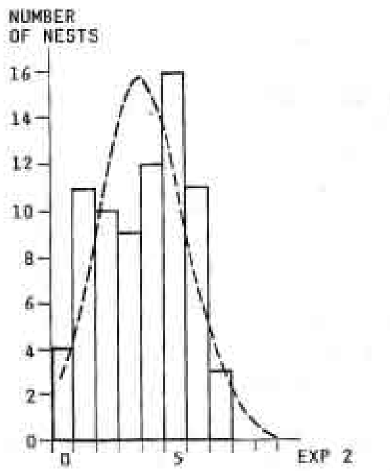


Fig. 4. Abundance distribution of *Haploglossa nidicola* in bee-eater nests (dashed – truncated lognormal curve, $x = 4.59$, $s = 1.92$, $\chi^2 = 10.08$, $P < 0.01$)

*G. buyssoni* is a typical nidicolous species occurring in nests of many bird species, mainly Passeriformes. However, it occurs rather exceptionally in the nests of sand martins (ŠUSTEK, JURÍK, 1980; KRIŠTOFÍK et al., 1994) but it was present in 25–40.7% of the examined bee-eater nests (Tab. 8). In individual years, the average number of *G. buyssoni* in all nests moved in the narrow limits of 0.6–1.8 and 1.5–5.5 in the positive nests, respectively. The abundance distribution of *G. buyssoni* can be described by a logarithmic re-

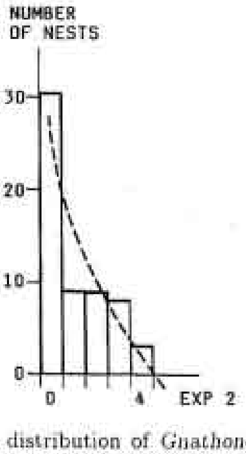


Fig. 5. Abundance distribution of *Gnathoncus buyssoni* in bee-eater nests (dashed – logarithmic regression curve, $y = 27.06 - 15.73 \ln x$, $\chi^2 = 6.13$, $P < 0.01$).

gression line (Fig. 5). The highest density was 11 ind./nest (Tab. 8).

Occurrence and number of *H. nidicola* and *G. buyssoni* was slightly positively correlated ($r = 0.154$). They occurred in common in 49.0% of nests, *H. nidicola* occurred separately in 39.8% of nests, while *G. buyssoni* in 11.2% of nests.

Other nidicolous species rarely found in the studied nests were *Haploglossa puncticollis* and *Gnathoncus rotundatus*. Both occur in small numbers in nests of many other bird species (HICKS, 1959).

The staphylinides *Philonthus varipennis* and *P. spermophili* are typical inhabitants of burrows of terrestrial mammals. They may penetrate the nests of bee-eater from mammal burrows and can find there suitable conditions similar to those in their primary ecological niche.

The species *Trox hispidus*, *Oxyomus sylvestris*, *Anthrenus pimpinelae*, *Stegobium paniceum*, *Cryptophagus dentatus*, *C. pseudodentatus*, *Lathridius minutus*, *Cortinicara gibbosa* are not primarily nidicolous, but they frequently occur in small numbers in nests of various bird species (HICKS, 1959). The mouldy nest material and rests of nestlings' food and feathers offer them a rich food basis. The other beetle species (Tab. 6) have no relation to the nests of bee-eater and occurred accidentally.

The majority of beetle larvae were *Dermestes* spp. They are not primarily nidicolous, but in the bee-eater nests they find an extremely rich food offer consisting of large quantities of dry rests of dead insect bodies accumulated in nest cavities. Their distribution in the nests can be described

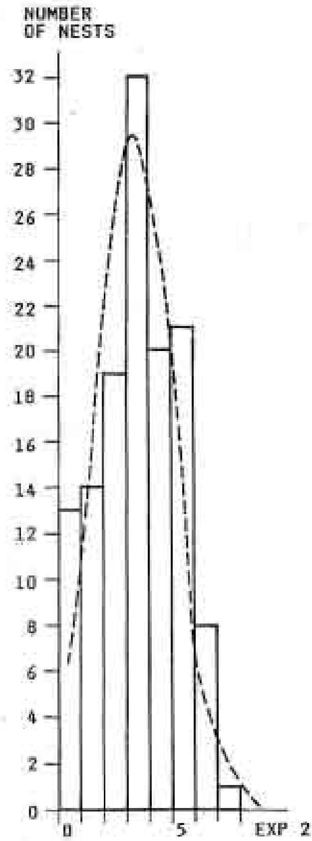


Fig. 6. Abundance distribution of *Dermestes* spp. larvaein bee-eater nests (dashed – truncated lognormal curve, $x = 4.03$, $s = 1.73$, $\chi^2 = 12.16$, $P < 0.01$).

by truncated lognormal distribution (Fig. 6). The larvae of *Agriotes* sp. live in the soil of open areas. They are predominantly phytophagous and penetrate the nests accidentally.

The representation of beetle larvae shows that in late spring and early summer the beetle fauna in bee-eater nests probably will be characterized by a higher number of adult *Dermestes* spp. than in late summer.

As to the trophic relations of the beetles found in the examined nests (Fig. 7), 98–99% of adults were carnivorous. The necrophagous, saprophagous, detritivorous, fungivorous and phytophagous species were also present, but their number was negligible and did not exceed 1.5% of all individuals. On the contrary, the most common beetle larvae (*Dermestes* spp.) were necrophagous. Only a negligible part of larvae was carnivorous (*Gnathoncus* sp.) or phytophagous (*Agriotes* sp.).

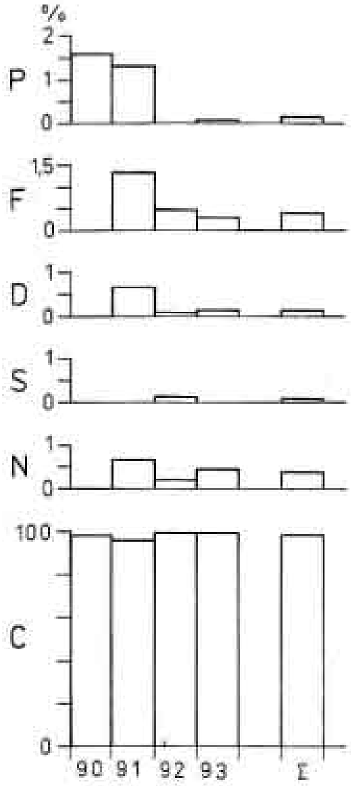


Fig. 7. Representation of different trophic groups of beetles in bee-eater nests in 1990–1993 (P – phytophagous, F – fungivorous, D – detritivorous, S – saprophagous, N – necrophagous, C – carnivorous).

*Flies*
In 26 (14.1%) nests, we found 50 flies belonging to 14 species (Tab. 9). According to the food preference of their larvae, we can classify them into five trophic groups: coprophags, necrophags, saprophags, mycetophags and microphags. However, the borders between these groups are not sharp. These species were found in nests of other bird species, too (HICKS, 1959, 1962, 1971). The bee-eater nests offer to their larvae rich food source and suitable life conditions.

*Fleas*
From 16 (8.7%) bee-eater nests, we obtained 166 fleas belonging to 7 species (Tab. 10). *Ctenophalmus s. solutus*, *C. a. assimilis* and *Nosopsyllus fascialis* are ectoparasites of small mammals. They were apparently introduced into the bee-eater nests by their original hosts which visited the nest burrows after fledging of the chicks. *Ceratophyllus hirundinis*, *C. gallinae*, *C. garei* and *C. tribulis* are ectoparasites of birds. The walls, where the bee-eaters nested, were occupied, besides the sand martins mentioned above, also by a large number of tree and house sparrows which nested in the unfinished nest burrows. The above mentioned flea species were recorded just in sparrow nests (DARSKAYA, 1964; JURÍK, 1974). These flea species can penetrate the bee-eater nests by active migration. However, their low numbers indicate that they do not find suitable conditions for reproduction in the bee-eater nests (altogether 54 individuals). That is why we consider them only as occasional ectoparasites of bee-eaters.

## Conclusions

1. Feather lice were found first of all on adult bee-eaters. On the contrary, the fly *C. hemapterus* parasitized on young bee-eaters.
2. Spiders, pseudoscorpions, bugs and flies were poorly represented in the bee-eater nests.
3. Pseudoscorpions and fleas did not reproduce in bee-eater nests. Pseudoscorpions got into the nests occasionally. Ticks and fleas penetrated into the nests occasionally and were introduced by their original hosts or by active migration from the nests of sparrows or sand martins which frequently nested together with bee-eaters in the same walls.
4. *A. casalis* predominated in the nests and found suitable life conditions there. On the contrary, the blood sucking mites *D. hirundinis*, *D. gallinae* and *O. sylviarum* occurred in small numbers. Bee-eater nests probably do not offer suitable conditions for their reproduction. Other mite species occurred only occasionally. Only nidicolous predators found food resources in bee-eater nests.
5. The beetle fauna in the nests consisted mainly of two characteristic nidicolous predators – *H. nidicola* and *G. buyssoni*. Presence of *H. nidicola* is caused by a very similar character of both bee-eater and sand martin nests, where *H. nidicola* occurs primarily, and by the common occurrence of both bird species in some localities.

In comparison with the beetle fauna in sand martin nests, the beetle fauna in bee-eater nests was much richer and more similar to the beetle fauna in nests of many other bird species. Contact of bee-eater nests with burrows of small mammals was evidenced by the presence of two staphylinids (*P. variipes* and *P. spermophili*). The large amount of dry rests of insect bodies deposited in the nests resulted in high abundance of *Dermestes* spp. larvae.

Table 9. Abundance of flies in bee-eater nests in 1989–1993.

| FAMILY<br>Species | 1989 | 1990 | Year<br>1991 | 1992 | 1993 | Total |
|---|---|---|---|---|---|---|
| SCATOPSIDAE | | | | | | |
| *Coboldia fuscipes* (MEIGEN, 1830) | | | | 1 | | 1 |
| PHORIDAE | | | | | | |
| *Anevrina curvinervis* (BECKER, 1901) | | 1 | 9 | | | 10 |
| DROSOPHILIDAE | | | | | | |
| *Drosophila* (s. str.) *funebris* (FABRICIUS, 1787) | 1 | | 3 | 5 | 2 | 11 |
| *Drosophila* (s. str.) *phalerata* MEIGEN, 1830 | | | 3 | | | 3 |
| MILICHIIDAE | | | | | | |
| *Madiza glabra* FALLÉN, 1820 | | | | 1 | 1 | 2 |
| PIOPHILIDAE | | | | | | |
| *Parapiophila vulgaris* (FALLÉN, 1820) | | | 4 | | 2 | 6 |
| FANNIIDAE | | | | | | |
| *Fannia canicularis* (LINNAEUS, 1761) | 2 | | | | 4 | 6 |
| *Fannia mutica* (ZETTERSTEDT, 1845) | | | | | 1 | 1 |
| *Fannia scalaris* (FABRICIUS, 1794) | | | | | 1 | 1 |
| MUSCIDAE | | | | | | |
| *Muscina prolapsa* (HARRIS, 1780) | | | | | 1 | 1 |
| *Hydrotaea occulta* (MEIGEN, 1826) | | | | 1 | 1 | 2 |
| *Musca domestica* LINNAEUS, 1758 | | 1 | | 2 | | 3 |
| *Stomoxys calcitrans* (LINNAEUS, 1758) | | | | | 2 | 2 |
| CALLIPHORIDAE | | | | | | |
| *Calliphora vomitoria* (LINNAEUS, 1758) | | | | | 1 | 1 |
| Total | 3 | 2 | 19 | 9 | 16 | 50 |

Table 10. Abundance of fleas in bee-eater nests in 1989–1993.

| FAMILY<br>Species | 1989 | 1990 | 1991 | Year<br>1992 | 1993 | Total |
|---|---|---|---|---|---|---|
| CTENOPHTALMIDAE | | | | | | |
| *Ctenophtalmus solutus solutus* JORDAN et ROTHSCHILD, 1920 | | | 1/- | 3/5 | 3/- | 12 |
| *Ctenophtalmus assimilis assimilis* (TASCHENBERG, 1880) | | | 1/1 | 7/14 | -/2 | 25 |
| CERATOPHYLLIDAE | | | | | | |
| *Nosopsyllus fasciatus* (BOSC, 1801) | | | -/3 | 4/9 | 5/53 | 74 |
| *Ceratophyllus hirundinis* (CURTIS, 1826) | | | | 16/29 | 1/- | 46 |
| *Ceratophyllus gallinae* DAMPF, 1907 | -/1 | -/1 | | -/2 | | 4 |
| *Ceratophyllus garei* ROTHSCHILD, 1902 | | 1/- | | | | 1 |
| *Ceratophyllus tribulis* JORDAN, 1826 | | | | | -/4 | 4 |
| Total | 1 | 2 | 6 | 89 | 68 | 166 |

Explanations: males/females.


## Acknowledgements

The research was supported by the grant 95/5305/360 "Ecology and strategy of reproduction of penduline tit and bee-eater". The authors thank to Dr. A. DAROLOVÁ for her help in collection of ectoparasites and of nests and to Dr. H. HOI, Dr. M. HOI and Dr. L. VIKTOR for their assistance at catching birds and collecting ectoparasites. Dr. Š. DANKO, Dr. S. PAČANOVSKI nad V. HOŠEK contributed considerably to searching for and collecting the nests. The authors are also obliged to Dr. P. GAJDOŠ for identification of spiders, to Dr. M. KRUMPÁL for identification of pseudoscorpions, to Dr. I. ORSZÁGH for identification of bugs and to Dr. D. CYPRICH and Dr. A. DUDICH for revision of some species of fleas.

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Received May 22, 1996
Accepted June 19, 1996