Krištofík et al 1996

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

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

Ján KRIŠTOFÍK, Peter MAŠÁN, Zbyšek ŠUSTEK

Institute of Zoology, Slovak Academy of Sciences, Dúbravská cesta 9, SK-84206 Bratislava, Slovakia; tel.:++42-7-3783244, fax ++42-7-374494, e-mail: uzaekris@savba.savba.sk

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 Species	Locality CH	M	JCH	MH	P	S	Total
ANCISTRONIDAE *Meromenopon meropis*			3/2	-/1	5/10	4/7 2L	34
PHILOPTERIDAE *Meropoecus meropis*	7/6	24/16 5L	68/66 10L	43/36 5L	32/32 3L	25/27 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

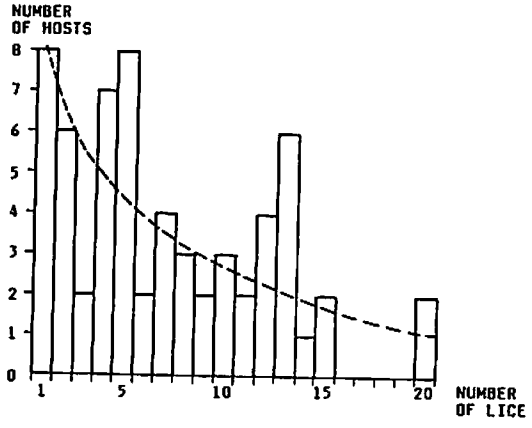

Fig. 1. Abundance distribution of feather lice on adult bee-eaters (dashed – logarithmic regression curve, $y = 8.03 - 2.33 \ln x$, $\chi^2 = 11.06$, $P < 0.01$).

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

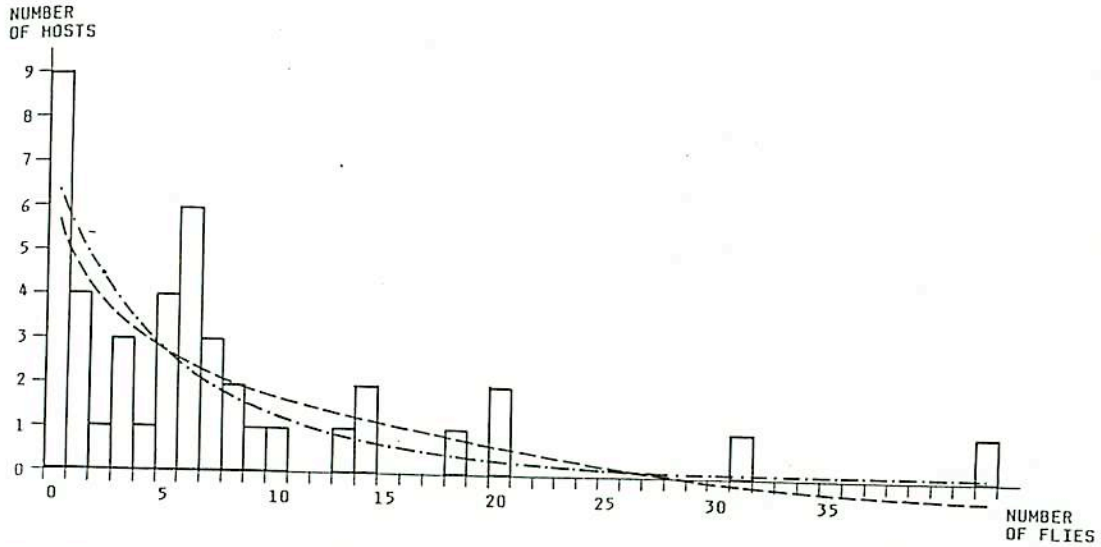

Fig. 2. Abundance distribution of *Carnus hemapterus* on bee-eater chicks (dashed – logarithmic regression curve, $y = 5.65 - 1.65 \ln x$, $\chi^2 = 18.20$, $P < 0.01$; dotted and dashed – negative binominal distribution, $x = 6.04$, $s^2 = 44.99$, $\chi^2 = 49.89$, $P < 0.01$).

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 Species	Year 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

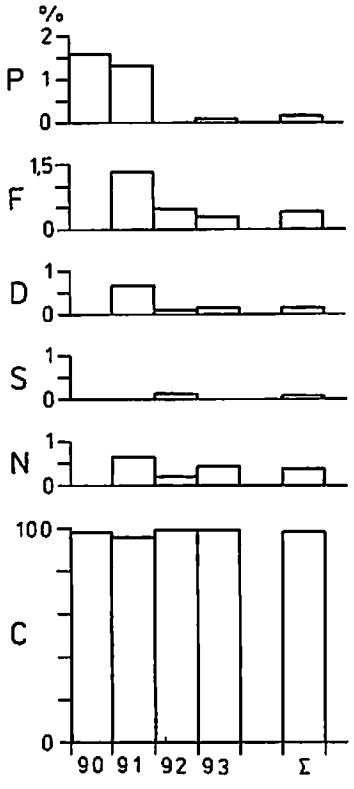

Fig. 7. Representation of different trophic groups of beetles in bee-eater nests in 1990–1993 (P – phytophagous, F – fungivorous, D – detritivorous, S – saprophagous, N – necrophagous, C – carnivorous).

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 Species	Year 1989	1990	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 Species	Year 1989	1990	1991	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.

References

ASH, J. S., 1960: A study of the Mallophaga of birds with particular reference to their ecology.- Ent. mon. Mag. **89:** 93-110.

BALÁT, F., 1956: Přehled všenek (Mallophaga) zjištěných na ptácích a ssavcích Slovenska I.- Sbor. Kraj. Múz. Trnava **2:** 56-77.

BEIER, H., 1963: Ordnung Pseudoscorpionidae.- Akademie Verlag, Berlin, 313 pp.

BORISOVA, V. I., 1977: Itogy izucheniya ekologii gnezdovo-norovykh parasitov ptits TASSR.- Parasitologiya **6:** 141-146.

BORISOVA, V. I., 1978: K strukture gnezdovo-norovykh cenozov lastochek.- Parasitologiya **12:** 377-382.

BRELIH, S., TOVORNIK, D., 1961: Prispevek k poznanju tekutov (Mallophaga) Jugoslavie I.- Biol. Vest. **9:** 93-107.

BRELIH, S., TOVORNIK, D., 1964: Prispevek k poznanju tekutov (Mallophaga) Jugoslavie IV.- Biol. Vest. **12:** 12-127.

BÜTTIKER, W., AESCHLIMANN, A., 1974: Die Ektoparasiten der schweizerischen Vögel.- Ornitol. Beob. **71:** 297-302.

CAPELLE, K. J., WITWORTH, T. L., 1973: The distribution and avian hosts of *Carnus hempterus* (Diptera: Milichiidae) in North America.- J. med. Ent. **10:** 525-526.

CLARK, F., FARRELL, J., HILL, L. A., 1994: A study of a population of the House Martin (*Delichon urbica* (L.)) feather louse *Brüelia gracilis* NITZSCH (Mallophaga: Ischnocera) in Lincolnshire, UK.- Entomologist **113:** 198-206.

DARSKAYA, H. F., 1964: K sravniteľnoĭ ekologii ptichikh blokh roda *Ceratophyllus* CURT. 1832, p. 31-180.- In: BEKLEMISHEVA, V. N., IOFF, I. G., (eds), Ektoparazity. Fauna, biologiya i prakticheskoe znachenie 4, Moskva, 298 pp.

GAJDOŠ, P., KRIŠTOFÍK, J., ŠUSTEK, Z., 1991: Spiders (Araneae) in the bird nests in Slovakia.- Biológia, Bratislava, **46:** 887-905.

GLASHCHINSKAYA-BABENKO, L. V., 1956: *Ixodes lividus* KOCH kak predstavitel' norovykh kleshcheĭiksodid, p. 21-104.- In: BEKLEMISHEVA, V. N., IOFF, I. G., (eds), Ektoparazity. Fauna, biologiya i prakticheskoe znachenie 3, Moskva, 179 pp.

HICKS, E., 1959: Check-list and bibliography on the occurrence of insects in bird nests.- Ames. Iowa, 681 pp.

HICKS, E., 1962: Check-list and bibliography on the occurrence of insects in bird nests. Suppl. I.- Iowa ST. J. Sci. **36:** 233-348.

HICKS, E., 1971: Check-list and bibliography on the occurrence of insects in bird nests. Suppl. II.- Iowa ST. J. Sci. **46:** 123-338.

HUDEC, K., (ED.) 1983: Fauna ČSSR. Ptáci 3/1.- Akademia Praha, 704 pp.

JURÍK, M., 1974: Bionomics of fleas in birds nests in the territory of Czechoslovakia.- Acta sci. natur. Acad. Sci. bohemoslov. Brno 8 (10): 1-54.

KACZMAREK, S., 1988: Pasozyty zewnętrzne z gniazd jaskólki *Riparia riparia* (L.).- Wiad. Parazyt. **34:** 347-351.

KIRKPATRICK, C. E., COLVIN, B. A., 1989: Ectoparasitic fly *Carnus hemapterus* (Diptera: Carnidae) in a nestling population of Common Barn-Owls (Strigiformes: Tytonidae).- J. med. Ent. **26:** 109-112.

KRIŠTOFÍK, J., ŠUSTEK, Z., GAJDOŠ, P., 1994: Arthropods in nests of the Sand Martin (*Riparia riparia* LINNAEUS, 1758) in South Slovakia.- Biologia, Bratislava, **49:** 683-690.

LEE, P. L. M., CLAYTON D. H., 1995: Population biology of swift (*Apus apus*) ectoparasites in relation to host reproductive success.- Ecol. Ent. **20:** 43-50.

MARSHALOVA, N. A., 1980: Gamazovye kleshchi gnezd beregovoĭ lastochki v Karelii.- Krovososushchie chlenistonogie evropeĭskogo severa, Petrozavodsk p. 152-159.

MARSHALL, A. G.,1981: The ecology of ectoparasitic insects.- Academic press, London-New York-Toronto-Sydney-San Francisco, 459 pp.

MARTIN, D., 1991: Zur Autökologie der Spinnen (Arachnida: Aranea). I. Charakteristik der Habitusaustattung und Präferenzverhalten epigäischer Spinnenarten.- Arachnol. Mitt. **1:** 5-56.

MARTIN-MATEO, M. P., MANILLA, G., 1993: Nuovi reperti di mallofagi degli uccelli con 23 specie nuove per la fauna d' Italia. - Parasitologia **35:** 21-29.

MAŠÁN, P., KRIŠTOFÍK, J., 1993: Mites and ticks (Acarina: Mesostigmata et Ixodida) from the nests of *Riparia riparia* L. in South Slovakia.- Biológia, Bratislava, **48:** 155-162.

MILLER, F., 1971: Řád Pavouci - Araneida, p. 51-306.- In: DANIEL, M., ČERNÝ, V., (eds), Klíč zvířeny ČSSR IV, Academia, Praha, 603 pp.

NORDBERG, S., 1936: Biologisch-ökologische Untersuchungen über die Vogelnidicolen.- Acta Zool. Fenn. **21:** 1-168.

NOSEK, J., SIXL, W., 1972: Central-European Ticks (Ixodoidea).- Mitt. Abs. Zool. Landesmus. Joannum Jg.1 H2: 61-92.

ORSZÁGH, I., KRUMPÁL, M., CYPRICH, D., 1990: Contribution to the knowledge of the Martin Bug - *Oeciacus hirundinis* (Heteroptera, Cimicidae) in Czechoslovakia.- Zbor. Slov. nár. Múz., Prír. Vedy **36:** 36-60.

PESENKO, J. A., 1978: Kontseptsiya vidovogo raznoobraziya i indexy ego izmeryayushchie.- Zh. obshch. Biol. **30:** 380-393.

RÉKÁSI, J., 1993: Bird lice (Mallophaga) parasiting the bird of Hungary.- Aquila **100:** 71-93.

ROUBAL, J., 1930: Katalog Coleopter Slovenska a Podkarpatska. Vol. I.- Bratislava, 527 pp.

ROUBAL, J., 1936: Katalog Coleopter Slovenska a Podkarpatska. Vol. II.- Bratislava, 434 pp.

ROUBAL, J., 1939: Katalog Coleopter Slovenska a východních Karpat. Vol. III.- Bratislava, 363 pp.

ROTHSCHILD, M., CLAY, T. 1952: Fleas, Flukes and Cuckoos. A study of bird parasites.- Collins, London, 623 pp.