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ECOLOGY

Contribution to the Ectoparasite Fauna of Rare and Poor Studied Bat Species of Southern Siberia

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Abstract—Forty-six chiropteran specimens from seven species have been captured on the territory of Southern Siberia. From them, 676 ectoparasites of 16 species (gamasid mites and insects) were collected. The bat fly *Basilia mongolensis mongolensis* Theodor, 1966 was found in Russia for the first time. The gamasid mites *Spinturnix maedai* Uchikawa et Wada, 1979 and *Macronyssus hosonoi* Uchikawa, 1979 have not previously been registered in Siberia. Several species have been recorded on new hosts. Three gamasid mite species of the genus *Macronyssus* are new to science. New data on the ecology of low-abundant and poorly studied bat species belonging to the Siberian–Far Eastern complex have been provided.

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INTRODUCTION

In recent years, several new species have been found in the chiropteran fauna of Russia, including Siberia and the Far East, using modern genetic methods (Benda and Tsytsulina, 2000; Matveev et al., 2005; Spitzenberger et al., 2006; Kruskop, 2012; Kruskop et al., 2012). Thus, it is urgent to study the ecology of these species, including the host-parasite relationship with arthropods, the data on which are extremely limited and must be revised with a review of the taxonomic status of the hosts.

MATERIALS AND METHODS

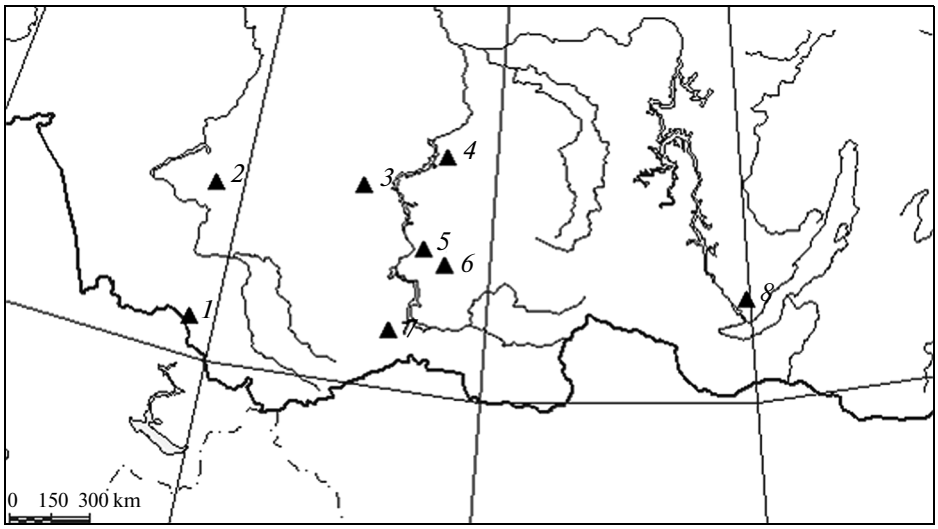
Bats were captured during winter in Northwestern Altai (Tigirekskiy State Nature Reserve), Maslyaninskii district of Novosibirsk region (villages of Verkhnie Iki and Legostaevo, Barsukovskaya Cave near the village of Pen'kovo), Krasnoyarsk region (Stolby State Nature Reserve). In summer, chiropterans were captured in Irkutsk province (Ol'khonskii district), Western Sayan (Sayano-Shushenskiy Nature Biosphere Reserve, near Shushenskoe village, Bol'shaya Rechka village), and Kuznetsk Alatau (Kiya River) (see figure).

The data on Novosibirsk oblast, Krasnoyarsk krai, and Irkutsk oblast were kindly provided by M.G. Mal'kova (Omsk Research Institute of Feral Herd Infections). In various years bats were caught and their ectoparasites were collected by I.V. Kuz'min, V.V. Yakimenko, A.D. Botvinkin, M.M. Shuteev, and A.V. Vakhrushev. The preparations are kept in the Museum of Medical Arachnoentomology, Laboratory of Arbovirus Infections, Department of Feral Herd Virus Infections.

A total of 46 bat specimens out of 7 species were examined: David's myotis *M. davidii* Peters, 1869 (4); the Siberian mouse-eared bat *M. sibiricus* Kastschenko, 1905 (5); fraternal myotis *M. frater* G. Allen, 1823 (2); Ikonnikov's bat *M. ikonnikovi* Ognev, 1912 (4); the eastern water bat *M. petax* Hollister, 1912 (15); the lesser mouse-eared bat *M. blythii* Tomes, 1857 (5); and the siberian tube-nosed bat *Murina hilgendorfi* Peters, 1880 (11). After the examination, the bats were returned to their wintering shelters or natural habitats.

Ectoparasites were collected with the use of a preparation needle and a pincer. They were fixed in a 70% ethanol solution. They were also mounted in a Fora–Berlese medium in a laboratory. Ectoparasites were identified under a light microscope (Nikon Eclipse 50i, Japan) in transmitted light and using the available taxonomic publications (Hurka, 1969; Uchikawa, 1979; Stanyukovich, 1997). The collected specimens are kept in the museum of the Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences.

The infestation rate was calculated as the mean number of ectoparasites per host specimen. The occurrence rate was expressed as the share (%) of bat specimens parasitized (Beklemishev, 1970). The indices were not calculated for materials from Novosibirsk



Collection sites in Southern Siberia. *1*—Tigirekskii State Nature Reserve, *2*—Maslyaninskii district of Novosibirsk province (villages of Verkhnie Iki and Legostaevo, Barsukovskaya Cave), *3*—Kiya River (Kuznetsk Alatau State Nature Reserve), *4*—Stolby State Nature Reserve, *5*—Shushenskoe village, *6*—Bol'shaya Rechka village, *7*—Sayano-Shushenskiy Nature Biosphere Reserve, *8*—Ol'khonskii district of Irkutsk province.

and Irkutsk provinces, as well as Krasnoyarsk region, because the exact number of host specimens on which mites and fleas were collected is unknown.

RESULTS AND DISCUSSION

For the species composition of ectoparasites and their host preferences, see the table. An annotated list of captured bats and ectoparasites collected on them is given below.

David's myotis M. davidii Peters, 1869. This species is common in the steppe and desert zones of Eastern Europe, the Lower Volga region, and the Caucasus, as well as in Lesser, Western, and Central Asia, Transbaikalia, North China, and Korea (Benda et al., 2012). We recorded it in the mountain steppe within the southern part of the Sayano-Shushenskiy Nature Biosphere Reserve. The only ectoparasite collected hosted by this species was the bat fly *Basilia mongolensis mongolensis* Theodor, 1966. It is the first time that this parasite was found on the territory of the Russian Federation.

Siberian mouse-eared bat M. sibiricus Kastschenko, 1905. It has been suggested that this species should be separated from *M. brandtii* Eversmann, 1845 based on the molecular and genetic data (Kruskop, 2012; Kruskop et al., 2012). It is distributed from Southern Siberia to Kamchatka, Sakhalin, Japan and Korea. It is the second most abundant species in the south of Middle Siberia (Zhigalin and Khritankov, 2013). Ectoparasites of five species (gamasid mites of two species and three species of insects) were collected on *M. sibiricus*. Two of them (the bat flea *Ischnopsyllus* (*H.*) *hexactena* Kolenati, 1856 and the bat fly *Penicillidia monoceros* Speiser, 1900) are transpalaearctic, whereas the other three (the gamasid mite *Macronyssus hosonoi* Uchikawa, 1979 and the bat flies *Basilia rybini* Hurka, 1969 and *Nycteribia quasiocellata* Theodor, 1966) are eastern palaearctic. Parasite specimens from *Myotis* bats in Maslyaninskii district of Novosibirsk province, which were registered by the collectors as *M. brandtii* and *M. mystacinus*, were also attributed to *M. sibiricus*, because it is the only *Myotis* species of this size group that has been known to inhabit the given territory.

Fraternal myotis M. frater G. Allen, 1823. This is a rare species that is distributed from southern Siberia, Manchuria, and Japan to Southeastern China; its habitat is highly fragmented (Tsytsulina and Strelkov, 2001). In southern Siberia, the species occurs sporadically in low- and middle-mountain taiga forests and hunts in the woods and at a low height above mountain reservoirs (Zhigalin and Khritankov, 2013). Four of five ectoparasite species collected on *M. frater* are insects. The only gamasid mite is *Spinturnix maedai* Uchikawa et Wada, 1979. It was found for the first time on *M. frater*.

Ikonnikov's bat M. ikonnikovi Ognev, 1912. This species is widely but sporadically distributed. Its habitat stretches from Altai and Eastern Kazakhstan to Mongolia, Manchuria, Korea, Japan, and Sakhalin (Kruskop, 2012). In the south of Middle Siberia, *M. ikonnikovi* has been registered in the taiga zone and gallery forests of the mountain and foothill areas in the Western Sayan (Zhigalin and Khritankov, 2013). Ectoparasites collected on *M. ikonnikovi* are few and do not include species-specific arthropods *S. myoti* and *P. monoceros* are common in *Myotis* bats, and *Nycteribia quasiocellata* infest many vesper bats.

Species composition of ectoparasites on rare and poorly studied bat species in Southern Siberia

Ectoparasite species	Host species							Previous findings, main hosts
	M. daviidii	*M. sibiricus*	*M. frater*	*M. ikonnikovi*	*M. petax*	*M. blythii*	*M. hilgendorfi sibirica*	
Class Arachnida, subclass Acarina, order Parasitiformes, fam. Spinturnicidae								
Spinturnix maedai Uchikawa et Wada, 1979**	–	–	1 ♂* 1 50	–	–	–	6 (2 ♂♂, 3 ♀♀) 1.5 55	Krasnoyarsk krai, Far East, Japan; oligoxene (*Murina* spp.) (Medvedev et al., 1991; Stanyukovich, 1997)
S. myoti Kolenati, 1856	–	–	–	1 ♂ 1 25	28 (12 ♂♂, 16 ♀♀) 4.7	19 (3 ♂♂, 16 ♀♀) 6.3	3 ♀♀ 1 27	Transpalaearctic species; oligoxene (*Myotis* spp.) (Rudnick, 1960; Stanyukovich, 1997)
Fam. Macronyssidae								
Macronyssus charusnurensis Dusbabek, 1962	–	7 (1 ♂, 6 ♀♀) 1.8 8.0	–	–	118 (1 ♂, 13 ♀♀, 100 N1) 13.1 60	2 N1 1 40	1 N1* 1 9	Central and Eastern palaearctic species; monoxene (*M. petax*) (Stanyukovich, 1997)
M. ellipticus Kolenati, 1856	–	–	–	–	–	2 N1 2 20	1 N1 1 9	Transpalaearctic species; nonmigratory bat species (Radovsky, 1967; Stanyukovich, 1997)
M. granulosus Kolenati, 1856	–	–	–	–	–	318 (6 ♂♂, 3 ♀♀, 309 N1) 63.6 100	1 N1 1 9	Semicosmopolite (Europe, Asia, Africa, Central America); polyxene (fam. Vespertilionidae and Rhinolophidae) (Radovsky, 1967; Stanyukovich, 1997)
M. hosonoi Uchikawa, 1979**	–	1 ♀ 1 20	–	–	–	–	–	Krasnoyarsk krai, Kamchatka, Japan; polyxene (fam. Vespertilionidae) (Uchikawa, 1979; Medvedev et al., 1991; Stanyukovich, 1997)
Macronyssus sp. 1***	–	–	–	–	5 ♀♀ 1.7 20	–	–	Novosibirsk prov.
M. sp. 2***	–	–	–	–	1 ♀ 1 7	–	5 ♀♀ 1.3 36	Novosibirsk prov., Northwestern Altai
M. sp. 3***	–	–	–	–	–	–	7 ♀♀ 1.8 36	Northwestern Altai
Steatonyssus spinosus Willmann, 1936	–	–	–	–	1 N1 1 7	–	–	Transpalaearctic species; polyxene (fam. Vespertilionidae and Rhinolophidae) (Till and Evans, 1964; Stanyukovich, 1997)

Table. (Contd.)

Ectoparasite species	Host species							Previous findings, main hosts
	M. davidii	*M. sibiricus*	*M. frater*	*M. ikonnikovi*	*M. petax*	*M. blythii*	*M. hilgendorfi sibirica*	
Class Insecta, order Siphonaptera, fam. Ischnopsyllidae								
Myodopsylla trisellis Jordan, 1929	–	–	–	–	9 (3 ♂♂, 6 ♀♀) 2	–	–	Palaearctic species, no findings in Western Europe; oligoxene (*Myotis* spp.) (Medvedev, 1996)
Ischnopsyllus (*H.*) *hexactena* (Kolenati, 1856)	–	2 ♂♂	1 ♂ 1 50	–	–	–	–	Transpalaearctic species; polyxene (fam. Vespertilionidae) (Medvedev, 1996)
Order Diptera, fam. Nycteribiidae								
Penicillidia monoceros Speiser, 1900	–	7 (1 ♂, 6 ♀♀) 2.3 60	1 ♀ 1 50	2 ♂♂ 2 25	5 (3 ♂♂, 2 ♀♀) 1.3 27	–	–	Transpalaearctic species; (temperate latitudes); oligoxene (*Myotis* spp.) (Theodor, 1967; Medvedev et al., 1991; *Opredelitel'* ..., 1999)
Basilia mongolensis Theodor, 1966 (!)	10 (3 ♂♂, 7 ♀♀)	–	–	–	–	–	–	Central Asia; probably monoxene (*M. davidii*) (Polkanov and Medvedev, 1997)
B. rybini Hurka, 1969	–	12 (6 ♂♂, 6 ♀♀) 2.4 100	10 (5 ♂♂, 5 ♀♀) 5 100	–	28 (10 ♂♂, 18 ♀♀) 2.6 73	–	1 ♀* 1 9	Central and Eastern palaearctic species; oligoxene (*Myotis* spp.) (Polkanov and Medvedev, 1997; *Opredelitel'* ..., 1999)
Nycteribia quasiocellata Theodor, 1966	–	6 (1 ♂, 5 ♀♀) 2 60	1 ♀ 1 50	4 ♂♂ 2 50	47 (21 ♂♂, 26 ♀♀) 4 80	–	–	Central and Eastern palaearctic species; oligoxene (*Myotis* spp.) (Polkanov and Medvedev, 1997; *Opredelitel'* ..., 1999)
In total	10	35	14	7	244	341	25	

In brackets—sex and age of collected specimens, below—infestation and occurrence indices. (!)—First finding in Russia.

* The first finding on this host species.

** The first finding in this region.

*** New species.

Eastern water bat M. petax Hollister, 1912. This species has been considered for a long time as a Siberian–Far Eastern subspecies of Daubenton's bat (*M. daubentonii* Kuhl, 1817) (Bogdanowicz, 1994). *M. petax* was separated into a separate species based on the molecular and genetic data (Matveev et al., 2005; Kruskop et al., 2012). *M. petax* is common in the forest and steppe zones of Siberia, Transbaikalia, China, Mongolia, Primorskii region, Sakhalin, Korea, and Japan (Kruskop, 2012). It has been registered in the forest and steppe zones of the Minusinsk Depression, Western Sayan, and Kuznetsk Alatau. In Southern Siberia, it is the most abundant species. The maternity colonies consist of up to 50–70 specimens; their natural shelters are natural and human made (buildings). *M. petax* forms mixed colonies with *M. sibiricus* (Zhigalin and Khritankov, 2013). It hosts the largest number of blood-sucking arthropods based on our materials (10). The collections from *Myotis* bats captured in Maslyaninskii and Ol'khonskii districts of Novosibirsk

and Irkutsk province and, respectively, identified previously as *M. daubentonii* were attributed by us to *M. petax*, because *M. daubentonii* does not inhabit the study area (Matveev et al., 2005; Orlova et al., 2013).

The fauna of ectoparasites harbored by *M. petax* includes both transpalaearctic and eastern palaearctic species. The high indices of host infestation and occurrence of the gamasid mite *Macronyssus charusnurensis* Dusbabek, 1962, which was collected mainly in winter, confirmed our previously obtained data (Orlova et al., 2012, 2014). In addition, the "winter" sex and age structure of populations corresponds to that in species of the genus *Macronyssus* in Europe and the Urals (the high values of the infestation and occurrence indices and the significant share of immature specimens point to the fact that a similar demographic structure is observed in *Macronyssus* species, regardless of the faunistic complex to which they belong (European–Ural or Siberian–Far Eastern little contacting with each other)). Two species of gamasid mites (one of them was previously collected on *M. hilgendorfi* on the territory of the Tigirekskiy State Natural Reserve) from Barsukovskaya Cave are new to science.

Lesser mouse-eared bat M. blythii Tomes, 1857. This species is listed in the Red Book of the Russian Federation. It is distributed from the Mediterranean region through the Caucasus and Western and Central Asia to Southern Kazakhstan, Altai, and Central and North China (Kruskop, 2012). Four species of gamasid mites (*S. myoti*, *M. granulosus* Kolenati, 1856, *M. charusnurensis*, and *M. ellipticus* Kolenati, 1856) were collected on *M. blythii*. They were all represented by the highest number of specimens (341). *M. granulosus* is characterized by the highest infestation index among all the studied species. Its sex and age structure dominated by protonymphs, as in the case of *M. charusnurensis*, confirms our previous data (Orlova et al., 2012).

Hilgendorf's tube-nosed bat Murina hilgendorfi Peters, 1880. This species is widely distributed but rare. It is found in the Altai and Sakhalin, Southern and Southeastern Siberia, Northern China, Amur province, Primorskii region, Japan, and Korea (Kruskop, 2012). In the south of Siberia, it has been recorded in the taiga areas of the West Sayan. This tube-nosed bat hunts in tree crowns above mountain rivers, sometimes near the ground. In analyzing data on the ectoparasites of *M. hilgendorfi*, it is necessary to revise the earlier findings, because they were incorrectly attributed by the researchers to *M. leucogaster* Milne-Edwards, 1872 (Uchikawa, 1979; Stanyukovich, 1997). Thus, *S. maedai*, *S. myoti*, *M. ellipticus*, and *M. granulosus* (op. cit.) were previously registered by us on *M. hilgendorfi*. The gamasid mite *M. charusnurensis* and the bat fly *B. rybini* were found on this host for the first time. Of particular interest are two species of gamasid mites from the genus *Macronyssus*. Their specimens were collected in Strashnaya Cave (Tigirekskiy State Nature Reserve) (one of them was later found in Barsukovskaya Cave). Their diagnosis does not correspond to any of those in the literature. Thus, they are, probably, new to science.

CONCLUSIONS

In general, the ectoparasitic fauna of the studied species is represented mainly by transpalaearctic and eastern palaearctic species. The bat flies *B. rybini* and *N. quasiocellata* do not show any host preferences with respect to the genus *Myotis* and are, probably, specific to this genus (a finding on *M. hilgendorfi* should be random), which contradicts our opinion that these ectoparasites are specific for *M. petax*.

The finding of three new ectoparasites, as well as one species that was not previously known in the fauna of Russia, proves that the ectoparasite fauna of chiropterans in Southern Siberia is poorly studied and requires further investigations.

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