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ATTEMPT TO DEFINE THE COMPLEXES OF BAT ECTOPARASITES IN THE BOREAL PALAEARCTIC REGION

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Attempt to Define the Complexes of Bat Ectoparasites in the Boreal Palaearctic Region. Orlova, M. V., Orlov, O. L. — The article presents the most complete data on the distribution of ectoparasites in the boreal Palaearctics (gamasid mites of the genera *Spinturnix*, *Macronyssus*, and *Steatonyssus*, bat flies of the family Nycteribiidae, fleas of the family Ischnopsyllidae) and its preferences for the hosts. On the basis of these data as well as the data for the resettlement of bats in Eurasia 30 species of boreal bat ectoparasites combined into three faunal complexes (Transpalaearctic, European-Ural and Siberian-Far East) and two groups (European-Ural species, penetrating to the east and Siberian-Far East, penetrating to the west). The boundary between the European-Ural and Siberian-Far East faunal complexes is situated presumably along the Irtysh River. The resulting zoning provides a new look at the parasitocenosis of ectoparasites in the taiga zone of the Palaearctics.

Key words: Chiroptera, Vespertilionidae, gamasid mites, Nycteribiidae, Ischnopsyllidae, ectoparasites, Palaearctic Region, boreal zone.

Попытка выделения комплексов эктопаразитов летучих мышей boreальной Палеарктики. Орлова М. В., Орлов О. Л. — В статье приведены полные данные по распространению эктопаразитов рукокрылых boreальной Палеарктики (гамазовых клещей родов *Spinturnix*, *Macronyssus* и *Steatonyssus*, кровососущих мух семейства Nycteribiidae, блох семейства Ischnopsyllidae) и их предпочтениям в отношении хозяев. На основании приведенных сведений, а также данных по расселению летучих мышей на территории Евразии, 30 видов эктопаразитов рукокрылых boreальной зоны объединены в три фаунистических комплекса (транспалеарктический, европейско-уральский и сибирско-дальневосточный) и две группы (европейско-уральские виды, проникающие на восток, и сибирско-дальневосточные, проникающие на запад). Граница между европейско-уральским и сибирско-дальневосточным фаунистическими комплексами предположительно проходит по р. Иртыш. Полученное районирование позволяет по-новому взглянуть на паразитоценозы эктопаразитов рукокрылых таёжной зоны Палеарктики.

Ключевые слова: Chiroptera, Vespertilionidae, гаммазовые клещи, Nycteribiidae, Ischnopsyllidae, эктопаразиты, Палеарктика, boreальная зона.

Introduction

North Palaearctic bat fauna is characterised by two mostly isolated complexes: the European-Ural and the Siberian-Far East. Previously, it was suggested that the division of chiropteran fauna in this territory is explained by the barrier role of the West Siberian Plain (Orlova, 2014).

The Russian plain provides a multiplicity of forms of microrelief as potential natural shelters. Residence in the Russian Plain sedentary population over the last two thousand years is responsible for the presence of additional shelters of anthropogenic representatives of resident bat species.

In this paper we define the complexes of the ectoparasites of bats in boreal Eurasia based on their distribution.

Description of study area

We mean the boreal zone as the complex formed by taiga zone, zone of mixed forests and northern wood-and-steppe subzone of the dominated forest plots (Horaček et al., 2000). In this complex we also include the high-altitude forest belt of mountain systems of Northern Eurasia.

Western Siberia is an extensive accumulative plain, swampy and devoid of karst landforms. Up until the mid-twentieth century, the human population was represented mainly by nomadic herders. Consequently, the potential anthropogenic shelters that are conducive to the distribution of bats were not enough. Thus, the West Siberian Plain prevents the spread of West Palearctic species to the east and East Palearctic species to the west (Orlova, 2014) and is “the chiropterological desert” — an area of a low density of bats. As the southern part of Western Siberia is hilly (Kazakh low hills), it forms a natural refuge for wintering bats, and this area does not prevent the distribution of bats. That is why the presence of two chiropteran complexes applies only to the boreal zone of Eurasia. The exact location of the border between the complexes has not yet been established, but the available data suggest that it is along the river Irtysh.

Material and methods

The basis of the study is from original and published data on the most common and well-studied groups of ectoparasites: gamasid mite genera *Spinturnix*, *Macronyssus* and *Steatonyssus*, blood-sucking flies of the family Nycteribiidae, fleas family Ischnopsyllidae, and the boreal Palearctic bat parasite species. The study does not include rare and poorly known species, the distribution and host range of which is difficult to see based on of the available data (gamasid mites of genus *Ornithonyssus*), as well as species whose status is not present in all areas (bugs species of genus *Cimex*). Random findings of specific ectoparasites from nemoral and sub-boreal species of bats (noctule bat *Nyctalus noctula* (Schreber, 1774), Leisler's bat *Nyctalus leisleri* (Kuhl, 1817), small pipistrelle *Pipistrellus pygmaeus* Leach, 1825, common pipistrelle *Pipistrellus pipistrellus* (Schreber, 1774), David's myotis *Myotis davidii* Peters, 1869, serotine bat *Eptesicus serotinus* (Schreber, 1774), etc.) on the boreal species were not considered.

Material collected in Eastern Europe (Northern Poland), Western Siberia (Novosibirsk region, Barsukovskaya cave; Altai, Reserve “Tigireksky”), Central Siberia (Krasnoyarsk Territory, the Sayano-Shushenskaya State Biosphere Reserve; Republic of Tuva, Uyukskaya basin) (fig. 1).

Ectoparasites were collected using a needle and tweezers and transferred into 70 % ethanol. Preparation and species identification of ectoparasites were carried out by the standard methods (Micherdzinsky, 1980; Radovsky, 1967; Stanyukovich, 1997).

Results and discussion

We applied to European-Ural boreal chiropteran fauna such species as Daubenton's bat *Myotis daubentonii* (Kuhl, 1817), Brandt's bat *Myotis brandtii* (Eversmann, 1845), Natterer's bat *Myotis nattereri* (Kuhl, 1817), whiskered bat *Myotis mystacinus* (Kuhl, 1817), brown long-eared bat *Plecotus auritus* (Linnaeus, 1758), Nathusius' pipistrelle *Pipistrellus nathusii* (Keyserling, Blasius, 1839) (Horaček et al., 2000; Il'in, Smirnov, 2000; Bolshakov et al., 2005). Siberian-Far Eastern fauna complex contains the eastern water bat *Myotis petax* Hollister, 1912, siberian bat *Myotis sibiricus* Kastschenko, 1905, amur bat *Myotis bombinus* Thomas, 1906, asian parti-coloured bat *Vespertilio sinensis* (Peters, 1880), Hilgendorf's tube-nosed bat *Murina hilgendorfi* Peters, 1880, ussuri tube-nosed bat *Murina ussuriensis* Ognev, 1913, *Plecotus ognevi* Kishida, 1927 (Tiunov, 1997; Matveev et al., 2005; Vasenkov, 2009; Bazhenov, 2013; Orlova et al., 2013; Ruedi et al., 2013). Solitary transpalearctic species that manage to cross the territory (or possibly “bypass” it from the south): pond bat *Myotis dasycneme* (Boie, 1825) (range extends from central Europe east to the Yenisey river) (Kuzyakin, 1950), parti-coloured bat *Vespertilio murinus* Linnaeus, 1758 (lives from the Atlantic to the Pacific coast) (Kuzyakin, 1950; Tiunov, 1997), northern bat *Eptesicus nilssonii* (Keyserling, Blasius, 1839) (areal is similar to the parti-coloured bat) (op. cit.).

Carried out in recent years, the study of ectoparasite fauna in the boreal zone of Central and Eastern Palearctic helped to clarify the distribution of many species of parasitic arthropods bats. To date, it has been found that most of them are confined to the European-Ural or Siberia and the Far East to the territory.

Total ectoparasite fauna of the boreal zone consists of 30 species, including 16 species of gamasid mites, 5 species of bat flies, and 9 species of fleas (table 1).

European-Ural boreal ectoparasite complex

This complex of ectoparasites lives in the taiga zone of Eurasia from the Atlantic coast to the Trans-Urals. Below is an annotated list of species of the complex.



Fig. 1. Map of collection localities of bat ectoparasites in the Palearctic Region. List of collection localities (1–7 — own data; 8–25 — literature data): 1 — Neighborhood of Kiel (Schleswig-Holstein, Germany); 2 — Neighborhood of Gdansk (Pomeranian, Poland); 3 — Old Ladoga gallery (Leningrad region, Russia); 4 — Reserve “Tigirekskiy” (Altai, Russia); 5 — Barsukovskaya cave (Novosibirsk Region, Russia); 6 — Sayano-Shushenskaya State Biosphere Reserve (Krasnoyarsk Territory, Russia); 7 — Uyukskaya basin (Republic of Tuva, Russia); 8 — Neighborhood of Oslo (Norway) (Brinck-Lindroth, Smit, 2007); 9 — Neighborhood of Helsinki (Finland) (Brinck-Lindroth, Smit, 2007); 10 — Neighborhood of Vyborg (Russia) (Brinck-Lindroth, Smit, 2007); 11–12 — Baltic States (Medvedev, Masing, 1987; Stanyukovich, 1990); 13 — Lower Silesia (South-Western Poland) (Haitlinger, 1979); 14 — Bialowieza Primeval Forest (Eastern Poland) (Haitlinger, Ruprecht, 1992); 15 — Kama-Vyatka interfluve (Russia) (Orlova et al., 2011); 16–18 — The Urals (Russia) (Orlova, 2011; Orlova, 2013); 19 — Neighborhood of village Korliki (Khanty-Mansi Autonomous Okrug, Russia) (Orlova et al., 2013); 20–21 — Eastern Kazakhstan (Hurka, 1969; Polkanov, Medvedev, 1997); 22–25 — Russian Far East (Medvedev, 1987; Medvedev et al., 1991).

Рис. 1. Карта мест сбора эктопаразитов рукокрылых Палеарктики. Цифрами обозначены (1–7 — собственные данные; 8–25 — литературные данные): 1 — окр. г. Киль (Шлезвиг-Гольштейн, Германия); 2 — окр. г. Гданьск (Поморское воеводство, Польша); 3 — штольни Старой Ладogi (Ленинградская обл., Россия); 4 — заповедник «Тигирекский» (Алтайский край, Россия); 5 — Барсуковская пещера (Новосибирская обл., Россия); 6 — Саяно-Шушенский государственный природный биосферный заповедник (Красноярский край, Россия); 7 — Уюкская котловина (республика Тува, Россия); 8 — окр. г. Осло (Норвегия) (Brinck-Lindroth, Smit, 2007); 9 — окр. г. Хельсинки (Финляндия) (Brinck-Lindroth, Smit, 2007); 10 — окр. г. Выборг (Россия) (Brinck-Lindroth, Smit, 2007); 11–12 — Прибалтика (Medvedev, Masing, 1987; Stanyukovich, 1990); 13 — Нижняя Силезия (Западная Польша) (Haitlinger, 1979); 14 — Беловежская Пуца (Восточная Польша) (Haitlinger, Ruprecht, 1992); 15 — междуречье Камы и Вятки (Orlova et al., 2011); 16–18 — Урал (Orlova, 2011; Orlova, 2013); 19 — окр. с. Корлики (Ханты-Мансийский автономный округ, Россия) (Orlova et al., 2013); 20–21 — Восточный Казахстан (Hurka, 1969; Polkanov, Medvedev, 1997); 22–25 — Дальний Восток (Medvedev, 1987; Medvedev et al., 1991).

Acarina Parasitiformes Macronyssidae

Macronyssus diversipilis (Vitzthum, 1920)

Described from Germany, and then found in Czechoslovakia, Hungary, the Baltic States, Udmurtia, in the Urals and Trans-Urals (Radovsky, 1967; Dusbábek, 1972; Haitlinger, 1979; Stanyukovich, 1990; Orlova, 2011; Orlova et al. 2011). Dusbábek pointed out that the main host of *M. diversipilis* is a Daubenton's bat (Dusbábek, 1964); the vast majority of our findings are also made on a given host. Areal of the parasite and host coincides almost completely.

Macronyssus kolenatii (Oudemans, 1902)

Previously found in Czechoslovakia, Hungary, Moldova, the Baltic States, Kazakhstan, Uzbekistan, Egypt (Radovsky, 1967; Dusbábek, 1972; Stanyukovich, 1990; Stanyukovich, 1997). Single finds were made in the Sverdlovsk and Chelyabinsk regions (Orlova, 2013). Areal of *M. kolenatii* probably covers an area of dissemination of the main hosts of this mite — species of the genus *Pipistrellus*.

Table 1. Distribution of bat ectoparasites in the boreal Palaearctic Region

Таблица 1. Распространение эктопаразитов рукокрылых в boreальной Палеарктике

Ectoparasite species	Western Europe	Scandinavia	Central Europe	Baltic and North-West of Russia	Vyatka-Kama region	The Urals and Trans-Urals	Western Siberia, Altai	West Sayan, Tuva	Far East	Notes	Total number of species	
European-Ural boreal ectoparasite complex												
<i>Macronyssus diversipilis</i>	+	+	+	+	+	+	-	-	-		8	
<i>Macronyssus kolenatii</i>	+	+	+	+	+	+	-	-	-			
<i>Ischnopsyllus variabilis</i>	+	+	+	+	+	+	-	-	-			
<i>Ischnopsyllus intermedius</i>	+	+	+	+	-	-	-	-	-			
<i>Ischnopsyllus simplex simplex</i>	+	+	+	+	-	-	-	-	-	European subcomplex		
<i>Ischnopsyllus simplex mysticus</i>	+	+	+	+	-	-	-	-	-			
<i>Ischnopsyllus octactenus</i>	+	+	+	+	-	-	-	-	-			
<i>Nycteribia kolenatii</i>	+	+	+	+	+	+	-	-	-			
Siberian-Far Eastern boreal ectoparasite complex												
<i>Spinturnix bregetovae</i>	-	-	-	-	-	-	?	+	+			
<i>Spinturnix maedai</i>	-	-	-	-	-	-	+	+	+			
<i>Macronyssus heteromorphus</i>	-	-	-	-	-	-	?	+	+			
<i>Macronyssus hosonoi</i>	-	-	-	-	-	-	+	+	+			
<i>Ischnopsyllus (H.) ussuriensis</i>	-	-	-	-	-	-	-	?	-	Species may be having only Far East distribution		
<i>Nycteribia quasiocellata</i>	-	-	-	-	-	-	+	+	+			
<i>Basilia rybini</i>	-	-	-	-	-	-	+	+	+			
<i>Basilia truncata</i>	-	-	-	-	-	-	+	+	+			
Transpalearctic boreal ectoparasite complex												
<i>Spinturnix myoti</i>	+	+	+	+	+	+	+	+	+		8	
<i>Spinturnix kolenatii</i>	+	+	+	+	+	+	+	+	+	Holarctic species		
<i>Spinturnix plecotinus</i>	+	+	+	+	+	+	+	+	+	Holarctic species		
<i>Macronyssus crosbyi</i>	+	+	+	+	+	+	+	+	+			
<i>Steatonyssus spinosus</i>	+	+	+	+	+	+	+	+	+			
<i>Ischnopsyllus (L.) obscurus</i>	+	+	+	+	+	+	+	+	+			
<i>Ischnopsyllus (H.) hexactenus</i>	+	+	+	+	+	+	+	+	+			
<i>Penicillidia monoceros</i>	+	+	+	+	+	+	+	+	+			
European-Ural species penetrating to the east												
<i>Macronyssus corethroproctus</i>	+	+	+	+	+	+	+	+	-			
<i>Macronyssus ellipticus</i>	+	?	+	+	?	+	+	?	-			
<i>Steatonyssus periblepharus</i>	+	+	+	+	+	+	-	-	-	Species is found in Central and Eastern Palearctic region, but not in the boreal zone		
Siberia-Far East species penetrating the west												
<i>Macronyssus charusnurensis</i>	-	-	-	-	-	+	+	+	+		3	
<i>Steatonyssus superans</i>	-	-	-	-	-	+	+	+	+			
<i>Myodopsylla trisellis</i>	-	-	-	+	+	+	+	+	+			

Insecta**Siphonaptera****Ischnopsyllidae*****Ischnopsyllus variabilis*** (Wagner, 1898)

Found in the forest area of Europe on migratory bats: species of the genus *Pipistrellus*, as well as noctule bat (Haitlinger, Ruprecht, 1992; Rupp et al., 2004). In Russia, findings were made in the Leningrad, Pskov, and Penza Regions (Medvedev, 1989), the Kirov Region and Udmurtia (Orlova et al., 2011), the Chelyabinsk Region (Orlova, 2013). Border distribution broadly coincides with the area of the main host — Nathusius' pipistrelle.

Ischnopsyllus intermedius Rothschild, 1898

Occurs in Northern, Western and Eastern Europe to the Baltics (Hopkins, Rothschild, 1956; Medvedev, Masing, 1987; Brinck-Lindroth, Smit, 2007; own data), hosts are pond bat, Daubenton's bat, Natterer's bat *Myotis nattereri* Kuhl, 1817, Nathusius' pipistrelle, northern bat.

Ischnopsyllus simplex simplex Rothschild, 1906

Dwells in the forest area of Europe (UK, Netherlands, Germany, Czech Republic, Scandinavia) on a large number of species of bats (whiskered bat *Myotis mystacinus* (Kuhl, 1817), Brandt's bat, pond bat, Natterer's bat, etc.) (Hopkins, Rothschild, 1956; Medvedev, Masing, 1987).

Ischnopsyllus simplex mysticus Jordan, 1942

Isolated finds are known from Scandinavia, the Baltic States and Austria with whiskered bat, Brandt's bat and Natterer's bat (Hopkins, Rothschild, 1956; Medvedev, Masing, 1987; Brinck-Lindroth, Smit, 2007).

Ischnopsyllus octactenus (Kolenati, 1856)

Most items dedicated to the temperate zone of Europe from the UK to Scandinavia and northern Poland (Hopkins, Rothschild, 1956; Brinck-Lindroth, Smit, 2007; own data). Single individuals are found in the Mediterranean region (Bulgaria, Greece, Italy, Spain, Morocco). Hosts in the boreal zone are species of the genus *Myotis* and *Pipistrellus*.

Insecta**Diptera****Nycteribiidae (the Bat flies)*****Nycteribia kolenatii*** Theodor and Moscona, 1954

The species is distributed throughout the forest zone from the Atlantic coast of Europe and the UK to Trans-Urals (Hurka, 1969; Nowosad, 1974; Rupp et al., 2004; Orlova et al., 2011; Orlova et al., 2013) within the boundaries of the areal of the main host — Daubenton's bat *M. daubentonii*.

Thus, all of these ectoparasites are mono- or oligoxenous parasites of European-Ural complex bats, their findings on the Siberian-Ural complex bat species are unknown. Available data highlight in the European-Ural complex European subcomplex uniting species, their findings are unknown to the east of the North-West region of Russia (*Ischnopsyllus intermedius*, *I. simplex simplex*, *I. s. mysticus*, *Ischnopsyllus octactenus*). The other species of the eastern boundary of habitat lies in the Urals (*Macronyssus kolenatii*, *Ischnopsyllus variabilis*) and Trans-Urals (*Macronyssus diversipilis*, *Nycteribia kolenatii*) (Orlova, 2013).

Siberian-Far Eastern boreal ectoparasite complex

Below is a list of ectoparasites, the findings of which are confined only to the Central and Eastern Palaearctic.

Acarina
Parasitiformes
Spinturnicidae

Spinturnix bregetovae Stanyukovich, 1995

Described in the Far East (Primorsky Krai, Suputinsky Reserve) with an unidentified species of bats; known finds from Tuva on the eastern water bat (own data). Likely range covers the Far East, Central, East, and possibly Western Siberia.

Spinturnix maedai Uchikawa and Wada, 1979

The species was described in Japan from the Hilgendorf's tube-nosed bat *Murina hilgendorfi*, then collected in the Far East and the Krasnoyarsk region with the Ussuri tube-nosed bat *Murina ussuriensis* (Stanyukovich, 1997), as well as in Novosibirsk Region and Altai with Hilgendorf's tube-nosed bat (own data).

Acarina
Parasitiformes
Macronyssidae

Macronyssus heteromorphus Dusbábek and Radovsky, 1972

The species was described in the Kuril Islands on the uncharacteristic host — the grey rat (*Rattus norvegicus* (Berkenhout, 1769)). Earlier findings were made on the eastern water bat, *Myotis sibiricus*, northern bat, Hilgendorf's tube-nosed bat *Murina hilgendorfi* in Krasnoyarsk Krai and the Far East (Stanyukovich, 1997), as well as on the territory of Tuva (own data).

Macronyssus hosonoi Uchikawa, 1979

It is widespread in the Central and Eastern Palearctic from Altai to Kamchatka and Japan (Uchikawa, 1979; Medvedev et al., 1991; Orlova, 2013; own data). Ussuri whiskered bat *Myotis gracilis* Ognev, 1927, Ikonnikov's bat *Myotis ikonnikovi* Ognev, 1912, eastern barbastelle *Barbastella darjelingensis* (Hodgson, 1855) (Uchikawa, 1979), Siberian bat, brown long-eared bat.

Insecta
Diptera
Nycteribiidae

Nycteribia quasiocellata (Theodor, 1966)

The species was described in Western Mongolia and then discovered in Eastern Kazakhstan (Zaisan Valley) (Hürka, 1969). Widely distributed in the Central and Eastern Palearctic, there are many findings in the Altai, Western Siberia, the Western Sayan, Tuva, Krasnoyarsk Krai, Far East (Medvedev et al., 1991; Polkanov, Medvedev, 1997; Orlova et al., 2013; Orlova et al., 2014; own data). Probably oligoxenous, prefer eastern water bat as a host, since the most findings were made in the boreal zone on it (Medvedev et al., 1991; Polkanov, Medvedev, 1997; Orlova et al., 2014).

Basilina rybini (Hürka, 1969)

The species was described from Eastern Kazakhstan. Widely distributed in the Central and Eastern Palearctic, there are many findings in Western Siberia, the Altai, the Western Sayan, Tuva, Krasnoyarsk Krai, Far East (Medvedev et al., 1991; Polkanov, Medvedev, 1997; Orlova et al., 2013; Orlova et al., 2014; own data). Apparently, as the previous species, oligoxenous of the *Myotis petax*, since most of the findings were made on this bat.

Basilina truncata Theodor, 1966

This species is widespread in the Central and Eastern Palearctic from the Altai (Eastern Kazakhstan) to the Far East (Medvedev et al., 1991; Polkanov, Medvedev, 1997), the findings

are scarce. Hosts are specified Siberian, Amur and eastern water bats, Hilgendorf's tubenosed bat.

***Ichnopsyllus (H.) ussuriensis* Medvedev, 1986**

Dwells in the Far East (Kamchatka, Kuril Islands, Primorsky Krai) (Medvedev, 1987; Medvedev et al., 1991), hosts are Siberian bat and Ikonnikov's bat.

It should be noted that, despite the considerable length, Siberia and the Far East complex is characterised by the uniformity of the ectoparasite fauna. The only exception — flea *I. ussuriensis* is found only in the Far East. Perhaps the species is more widespread, and the lack of finds in Western and Eastern Siberia is due to insufficient knowledge of the area.

Transpalaeartic boreal ectoparasite complex

Despite the natural barrier separating the faunal complexes, there is contact between them there (Orlova, 2014), one of which serves as evidence of transpalaeartic (sometimes holarctic) distribution of certain species of ectoparasites.

Acarina

Parasitiformes

Spinturnicidae

***Spinturnix myoti* (Kolenati, 1856)**

Distributed throughout the Palearctic from the UK to the Far East (Rudnick, 1960; Dusbábek, 1962; Stanyukovich, 1990, Medvedev et al., 1991; Stanyukovich, 1997; Rupp et al., 2004; Orlova et al., 2011; Orlova et al., 2014). The principal hosts of this type are considered ectoparasites bats genus *Myotis* (Rudnick, 1960; Dusbábek, 1962, 1972; Stanyukovich, 1997).

***Spinturnix kolenatii* Oudemans, 1910**

Holarctic species, finds are known from the United States, the United Kingdom, Central and Eastern Europe, the Urals, the Caucasus, Central Asia, the Far East (Rudnick, 1960; Dusbábek, 1962; Medvedev et al., 1991; Stanyukovich, 1997; Orlova, 2011). The principal hosts in the literature indicate northern bat and serotine bat (Stanyukovich, 1997).

***Spinturnix plecotinus* (Koch, 1839)**

Palaeartic species found in the UK, Western, Central and Eastern Europe, the Baltic states, Central Asia, Far East (Rudnick, 1960; Stanyukovich, 1990; Medvedev et al., 1991). In the boreal zone brown long-eared bat and *Plecotus ognevi* (Stanyukovich, 1990; Medvedev et al., 1991; Stanyukovich, 1997; Orlova, 2011) are of the main hosts.

Gamasid mites of the family Macronyssidae

***Macronyssus crosbyi* (Ewing and Stover, 1915)**

Holarctic form, findings are known from different parts of the United States and northern Mexico (Radovsky, 1967), the Baltic States and the Far East (Stanyukovich, 1990; Medvedev et al., 1991; own data). Pleoxenous, harboured by various species of bats of the family Vespertilionidae (Radovsky, 1967).

***Steatonyssus spinosus* Willmann, 1936**

Widely distributed throughout the Palearctic from the UK to the Far East and Japan. Pleoxenous, hosts are a large number of bat species belonging to the family Vespertilionidae and Rhinolophidae (Dusbábek, 1972; Haitlinger, 1978; Micherdzinski, 1980; Stanyukovich, 1990; Rupp et al., 2004), but often finds confined to the migratory species of bats (particolored bat, Asian particoloured bat (*Vespertilio superans* Thomas, 1899), different species of genus *Nyctalus*).

Insecta**Siphonaptera****Bat fleas family Ischnopsyllidae*****Ischnopsyllus (I.) obscurus* (Wagner, 1898)**

Trans-species. Dwells between 45° and 60° N (Hopkins, Rothschild, 1956; Medvedev, Masing, 1987; Medvedev, 1989; Brinck-Lindroth, Smit, 2007; Orlova, 2013). According to S. G. Medvedev (1989), the main host *I. obscurus* appears particolored bat — transpalaeartic species, that explain for the wide dissemination of this flea species. Some European data also indicate *V. murinus* as a main host *I. obscurus* (Rupp et al., 2004).

***Ischnopsyllus (H.) hexactenus* (Kolenati, 1856)**

Trans-species widely distributed in Europe (Haitlinger, Ruprecht, 1992; Rupp et al., 2004). In Russia, the findings known in the Urals, Siberia and the Far East (Medvedev et al., 1991). The main host *I. hexactenus* is the brown long-eared bat, but finds (both in Russia and abroad) are made on several species of bats, including the grey long-eared bat *Plecotus austriacus* Fischer, 1829, many species of genus *Myotis* (Brandt's bat, eastern water bat, Ikonnikov's bat) (Medvedev, Masing, 1987; Rupp et al., 2004; Orlova, 2011).

Insecta**Diptera****Nycteribiidae*****Penicillidia monoceros* Speiser, 1900**

Most of the findings are concentrated in the temperate zone of the Palaearctic from the Atlantic to the Pacific and Japan (Mogi, 1979; Medvedev et al., 1991; Orlova et al., 2014). Probably, the main host of *P. monoceros* is considered the pond bat, but its findings in other species, and at a considerable distance from the boundaries of the area of the main host (Far East) indicate that in areas where *M. dasycneme* is rare, *P. monoceros* acquires the ability to parasitize on other species of the genus *Myotis* (Orlova et al., 2014).

Transpalaeartic spread of ectoparasites — a consequence of two factors: the wide distribution of the species of host (fleas *Ischnopsyllus (I.) obscurus*, *Ischnopsyllus (H.) hexactenus*), oligo- and polyxenous feeding pattern (gamasid mites *Macronyssus crosbyi*, *Steatonyssus spinosus*), or both factors (gamasid mites *Spinturnix myoti*, *S. kolenatii*, *S. plecotinus*, bat fly *Penicillidia monoceros*).

Species dubiously occurring in the territory of the Palearctics

In a separate category, species with an unequal spread on both sides of the “chiropterological desert” are allocated.

Acarina**Parasitiformes****Macronyssidae*****Macronyssus charusnurensis* Dusbábek, 1966**

Areal of the species covers the taiga zone of Western and Eastern Siberia and the Far East, with known finds from the North Kazakhstan, Altai mountain forests, gallery forests of Tuva and Mongolia (Medvedev et al., 1991; Orlova et al., 2014; own data). It can be argued that *M. charusnurensis* is a specific ectoparasite of the eastern water bat (Orlova et al., 2014). Single findings (protonymphs) were made on the western slope of the Southern Urals and in the Perm region on the several species of the genus *Myotis* (Orlova, 2014).

***Macronyssus corethroproctus* (Oudemans, 1902)**

Found in Western and Central Europe, the Baltic states, in the Urals, Altai, and Western Siberia. The main host is specified for pond bat, with the area that matches the

area of distribution *M. corethroproctus* (Radovsky, 1967; Dusbábek, 1972; Haitlinger, 1979; Stanyukovich, 1990; Orlova, 2011; Orlova, Zappart, 2012, own data).

Macronyssus ellipticus (Kolenati, 1856)

Repeatedly detected in Czechoslovakia, Poland, the Baltic countries, the Leningrad region, the Urals and the Altai; known findings out of the boreal zone (Portugal, Bulgaria) (Radovsky, 1967; Dusbábek, 1972; Haitlinger, 1979; Stanyukovich, 1990; Orlova, 2011; own data). The eastern boundary of the distribution is not found. Polyxenous, parasitic on bat species hibernating in caves (Stanyukovich, 1990).

Steatonyssus periblepharus Kolenati, 1858

Previously found in Czechoslovakia, Poland, the Baltic countries and Germany. Known findings is the boreal zone (Bulgaria, Moldova, Armenia, Kyrgyzstan, Algeria, Egypt, Lebanon, Afghanistan, Mongolia and China) (Dusbábek, 1972; Haitlinger, 1978; Micherdzinski, 1980; Stanyukovich, 1990; Rupp et al., 2004). Polyxenous, parasitising on a many of hosts family Vespertilionidae, but the most preferred are the species of the genera *Myotis* and *Pipistrellus* (Haitlinger, 1978), and to a greater extent *S. periblepharus*, obviously focused on bats because all of the findings are made in the parasite within the range of species of this genus (Orlov, 2013).

Steatonyssus superans Zemskaia, 1951

The area covers the Urals, Western Siberia, the Far East, Japan (Medvedev et al., 1991; Orlova, 2014). Outside the boreal isolated finds made in Kazakhstan, Tajikistan and Korea. Prides itself on the parti-coloured bat, Asian parti-coloured bat and northern bat.

Insecta

Siphonaptera

Ischnopsyllidae

Myodopsylla trisellis Jordan, 1929

Species is found in most parts of Russia (from Leningrad Region to the Primorsky territory and Kamchatka). The north-western border runs through the territory of the Baltic States. The main hosts — species of the genus *Myotis* (Hopkins, Rothschild, 1956; Medvedev, Masing, 1987; Medvedev, 1989; Medvedev et al., 1991; Orlova, 2011).

Obviously, *Macronyssus charusnurensis*, *Steatonyssus superans* and *Myodopsylla trisellis* can be combined into a separate group with the Siberia-Far East species penetrating the west. Perhaps *Macronyssus charusnurensis* tends towards oligoxeny on several species *Myotis* and it gives them the opportunity to penetrate into the territory of the Urals through Kazakhstan, but its findings out of the main host are rare and mainly represented by immature individuals (Orlova, 2014). Numerous finds of *Steatonyssus superans* in the Urals indicate the active expansion of this species to the west. Transfer of *S. superans* through the “chiropterological desert”, apparently, is related to its preferred host — particoloured bat (Orlova, 2014). *M. trisellis* is absent in the Western Palearctic, which may indicate the penetration of the species from North America through Beringia (this assumption is confirmed by the fact that other species of the genus *Myodopsylla* are found only in North and South America) (Medvedev, 1989) and further spread from east to west through the territory of Northern Eurasia. Pervasion to the Urals and west is probably due to the pond bat. Further penetration of *M. trisellis* to the west might be obstructed by the European subcomplex ectoparasite species with which *M. trisellis* clearly occupies a similar ecological niche.

In turn, *Macronyssus corethroproctus*, *M. ellipticus* and *Steatonyssus periblepharus* can distinguish a group of European-Ural species of penetration to the east. *M. corethroproctus*

adjudged to Siberia with the main host — pond bat, but its status in the parasitic community is undergoing significant changes: from the species of “core” with high extensity and mean intensity indexes (Orlova et al., 2012) it turns into a species-satellite (Balashov, 2009), the findings of which are presented in single examples. The reasons for this phenomenon is not possible to establish, but we can assume that it cannot compete with the East Palaearctic species complex (in particular, single finds pond *Myotis* in Barsukovskaya cave indicate that these bats' ectoparasite community includes mainly two gamasid mites species of the genus *Macronyssus* that are unknown to science) (own data). In addition, to the east of the Ural Mountains, the pond bat does not form large colonies. Low host numbers also reduce the number of its specific ectoparasites. *M. ellipticus* and *S. periblepharus* may bypass the south “chiropterological desert” with species of bats that live in the steppes and semi-deserts. *S. periblepharus* further distribution in the subboreal belt of Eastern Palaearctic with different species of bats. The degree of penetration of *M. ellipticus* in Siberia is difficult to ascertain because of the absence of findings, which may be due to the scarcity of the species.

Overall, despite a roughly equal ratio of gamasid mites (16 species) and insects (14 species) of ectoparasites boreal bats, their distribution in the Palearctic vary. Almost two thirds of gamasid mites (10 species) are: trans-spread or come in groups of species spread across the two complexes. Insects' relationship is reversed: 10 of the 14 species are found only in one part of the Palearctic (fleas are often quite limited in the extent of the zone of distribution), and only 4 have transpalearctic or close to that distribution.

Thus, 30 species of ectoparasites boreal Palaearctic combined into three faunal complex and two independent groups. Complexes are characterised by different ratios of mites and insects. Thus, the European-Ural complex includes eight species, six of which are insects (five species of fleas and one bat fly). Four flea species are emerging in the European subcomplex of the complex. Siberian and Far Eastern complex is represented by eight species, half of which are gamasid mites, half — insects, one species of which has a narrow spread of the Far East. The Transpalearctic complex includes seven species, five of which are gamasid mites (including three species of the genus *Spinturnix*). Ectoparasites species group are unequally spread in the Palearctic and are also represented by mainly gamasid mites (five of six species).

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