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Ectoparasites of Bats in Mongolia (Ischnopsyllidae, Nycteribiidae, Cimicidae and Spinturnicidae)

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Ectoparasites of bats in Mongolia (Ischnopsyllidae, Nycteribiidae, Cimicidae and Spinturnicidae)¹

I. Scheffler, D. Dolch, J. Ariunbold, N. Batsaikhan, A. Abraham & K. Thiele

Abstract

For large parts of the world, the knowledge of bat ectoparasites is still scanty. Regarding Mongolia, only few studies exist to date. This paper analyses results from extensive captures between 2005 -2008, carried out in different sites of Mongolia. Discussed ectoparasites include bat fleas, (Ischnopsyllidae), bat flies (Nycteribiidae), and bat bugs (Cimicidae) and spinturnicid mites (Spinturnicidae). A number of species found in this study were new records for Mongolia, and for many species additional sites were reported. For some bat species, the spectrum and frequency of larger ectoparasites could be determined for the first time.

Keywords: ectoparasites, chiroptera, Mongolia, taxonomy, distribution, Ischnopsyllidae, Nycteribiidae, Cimicidae, Spinturnicidae.

1. Introduction

Bats are the only mammals to develop active flight, and a number of adaptations necessary to achieve this end also affect the range of potential ectoparasites. Typical bat behaviour includes roosting hanging upside down, little or no contact with any substrate while hunting, and frequently changing roost locations. All of these behaviours restrict possibilities of colonisation by insects, ticks, or mites. Most bat ectoparasites are highly host specific, and almost all Eurasian species are wingless. Only few strategies exist to ensure survival under such extreme circumstances. The so called permanent ectoparasites spend their entire life cycle on the host's body (i.e. Spinturnicidae on the wings, Macronyssidae in the fur). These species have to cope with their host's high body temperature during all stages of development. Some temporary species (Nycteribiidae, Ischnopsyllidae) can only do that during the adult life stage. Other species utilize a different strategy, where they remain at roost sites and await their host's return (i.e. Cimicidae, adult Argasidae). Such parasites often possess the ability to starve, and they can survive a prolonged absence of their host. Finally, those species which live temporarily separate from their host need the ability to climb, in order to feed on their host's blood. Studying bat ectoparasites is difficult, and despite carefully examining many specimens, results are often meagre. The known distribution and ecology of many species is yet scanty. A number of studies exist on the ectoparasite fauna of Mongolia, partly as a result of Mongolian-German excursions (THEODOR 1966, SMITH 1967, 1980; MINAR & HÜRKA 1980, KIEFER et. al. 1984, KERZHNER 1989). Given the large size of the study area and the low number of studies to date, it seemed worthwhile to perform an up-to-date analysis of bat ectoparasites. DOLCH et al. (2007) introduced a first list of new findings from 2005. This paper significantly adds to these data.

2. Methods

Part of the parasite collection stems from bat captures during an excursion in 2005, where other parameters such as morphometrics, diet, and genetic analyses took priority. DOLCH et al. (2007) published these results in detail. Captures from other locations, collected by J. Ariunbold, B. Nyambayar and G. Sukhchuluun in 2006 and 2007, substantially complement the 2005 data set. Further data originate from an excursion by the Landesfachausschuss (LFA) Säugetierkunde Brandenburg (the Regional Committee of Mammalogy Brandenburg) in 2008, where para-

¹ Ergebnisse der Mongolisch-Deutschen Biologischen Expeditionen seit 1962, Nr. 304.

Table 1: List of bat capture sites and dates

ID	Site	Geo.-Ref.	Date	Collectors	Host species
01	Sum Hoh Burd	046°09'41,6"N 105°45'02,8"E	17.08.2005	LFA-05	<i>M. "mystacinus" F2</i>
02	Zulganai oasis	043°35'02,5"N 100°04'05,7"E	24.08.2005	LFA-05	<i>M. "mystacinus" F2</i>
03	Orog Nuur Quelle Harztai	044°49'09,9"N 100°48'29,9"E	26.08.2005	LFA-05	<i>E. gobiensis</i>
04	Böön Tsagaan Nuur	045°37'19,2"N 099°14'58,2"E	29.08.2005	LFA-05	<i>M. "mystacinus" F1</i>
05	Bayanhongor, Tuy bridge	046°10'42,3"N 100°43'44,8"E	01.09.2005	LFA-05	<i>M. "mystacinus" F1</i>
06	Orkhon river, near Hujirt	047°01'37,2"N 102°39'51,3"E	03.09.2005 04.09.2005	LFA-05	<i>M. petax</i> <i>P. ognevi</i>
07	Dornod, Dashbalbar, Baga dalai Nuur	047°98'17,8"N 114°40'38,0"E	28.07.2006	A	<i>M. petax</i>
08	Arkhangai, Ondor- Ulaan, Chuluut gol	048°06'91,4"N 100°17'61,6"E	19.08.2006	A	<i>M. "mystacinus"</i>
09	Uvs, Zavhan, Airag Nuur	048°52'90,6"N 093°18'80,9"E	18.09.2006	A	<i>M. "mystacinus"</i>
10	Tuv, Erdenesant	047°16'22,1"N 104°30'69,2"E	24.07. - 27.07.2007	A	<i>V. sinensis</i> <i>M. "mystacinus"</i> <i>V. murinus</i> <i>E. gobiensis</i> <i>P. ognevi</i>
11	Gobi-Altai, Biger, Boornii els	045°43'76,6"N 097°19'91,2"E	09.08.2007	A	<i>M. "mystacinus"</i>
12	Dungovi, Adaatsag, Sum Hoh Burd	046°09'62,6"N 105°45'58,7"E	19.08.2007	A	<i>M. "mystacinus"</i>
13	Onon gol	048°50'24,7"N 111°38'32,8"E	30.05.2008 01.06.2008	LFA-08	<i>P. ognevi</i> <i>M. petax</i>
14	Baldsh gol	049°03'41,7"N 111°32'01,4"E	31.05.2008	LFA-08	<i>P. ognevi</i> <i>M. "nattereri"</i> <i>M. ikonnikovii</i> <i>M. petax</i>
15	Chuch Nuur	049°31'44,5"N 114°39'06,7"E	03.06.2008	LFA-08	<i>V. murinus</i> <i>M. "mystacinus" F2</i>
16	Choibalsan	048°04'54,5"N 114°37'24,6"E	04.06.2008	LFA-08	<i>M. "mystacinus" F2</i>
17	Sumber sum	047°38'04,3"N 118°38'55,8"E	06.06.2008	LFA-08	<i>M. petax</i>
18	Southern Tsagaanuur	047°14'37,0"N 118°33'10,8"E	09.06.2008	LFA-08	<i>P. ognevi</i> <i>M. "mystacinus" F2</i>
19	Öndörkhan	047°14'44,9"N 110°34'30,0"E	12.06.2008	LFA-08	<i>V. murinus</i>
20	Homoltiin Nuur, Herlen gol	046°59'56,0"N 108°50'12,5"E	13.06.2008	LFA-08	<i>M. "mystacinus" F2</i>
21	Barun Churen gol	048°14'10,5"N 108°20'36,0"E	16.06.2008	LFA-08	<i>P.ognevi</i>
22	Khushingiyn Ovoo uul	047°53'06,1"N 108°04'01,4"E	17.06.2008	LFA-08	<i>E. nilssonii</i>

A = collected by J. Ariunbold; LFA = material from the German-Mongolian excursions

sites were collected between 30 May and 17 June. Table 1 lists all capture sites. Since ectoparasite analysis was not the primary goal of these excursions, not all their findings were suitable for parasite density analysis. Bats were mostly caught in nets especially developed for this purpose, measuring between 3.2 m – 4 m in height, and between 40 m and 100 m in length. Nets were placed in either bat hunting grounds or bat flight paths, and mostly in separate parts, rather than in one continuous wall formed by the net. In addition, animals were caught at their roost, using nets or static hand-nets, and sometimes collected directly. Caught animals were inspected visually. Parasites were ousted by blowing onto the coat or spreading the bat's wing.

They were carefully collected using tweezers or fine brushes, and preserved in 70 % ethanol. Whenever possible, bats were kept separately to avoid transfer of parasites between species. Ectoparasites intended for microscopy analysis were bleached in 10 % KOH, neutralised with a vinegar water solution, and dehydrated with ethanol baths of increasing concentration, before treatment with xylene and embedding in Canadabalsam.

The nomenclature of bat species analysed in this paper largely follows that of DOLCH et al. (2007). We collected ectoparasites from the following bat species:

- Eptesicus gobiensis* BOBRINSKOJ, 1926
- Eptesicus nilssonii* KEYSERLING & BLASIUS, 1839
- Myotis petax* HOLLISTER, 1912
- Myotis ikonnikovi* OGNEV, 1912
- Myotis* "mystacinus"
- Myotis* "nattereri"
- Plecotus ognevi* KISHIDA, 1927
- Vespertilio murinus* LINNAEUS, 1758
- Vespertilio sinensis* PETERS, 1880.



Fig. 1: Net-wall for catching bats in the forest steppe zone (photo: D. STEINHAUSER).



Fig. 2: Installation of nets on the Herlen gol in 2008, N. Batsaikhan (left) and D. Dolch (right); (photo: B. GÄRTNER).



Fig. 3: *Myotis* „nattereri“ from Baldsh gol. The specimen carried 2 *Ischnopsyllus hexactenus*, 5 *Basilia spec.* (new), 4 *Penicillidia monoceros* and several *Spinturnix myoti*; (photo: D. STEINHAUSER).

M. petax represents the Eastern Daubenton's Bat, which was separated from *M. daubentonii* KUHL, 1817. *M. ikonnikovi* and *M. "mystacinus"* belong to the polytypic species complex of *Myotis mystacinus* KUHL (1817), but are not identical with that species. According to DOLCH et al. (2007), *M. "mystacinus"* separates into two genetically and morphologically distinct varieties (*M. n. sp. F1* and *M. n. sp. F2*), which also inhabit different regions and habitats. However, since the separation into these two varieties was only partly applied to the examined host animals (Table 1), all parasites found were consistently ascribed to *M. "mystacinus"* in this analysis.

The species listed in quotes as *Myotis "nattereri"* is not identical with the European species of the same name, *Myotis nattereri* (KUHL 1817).

3. Results and Discussion

Identified bat flea species (*Ischnopsyllidae*) and their distribution

Ischnopsyllus comans JORDAN & ROTHSCCHILD, 1921

1♂ ex 29 *Myotis "mystacinus"* 9.VI.2008, ID 18



Fig. 5: *Ischnopsyllus comans*, batflea, male (photo: I. SCHEFFLER).

Ischnopsyllus hexactenus (KOLENATI, 1856)

1♂, 3♀ ex 25 *Plecotus ognevi*, 31.V.2008, ID 14 / 1♀ ex 3 ♀ *Myotis petax*, 6.VI.2008, ID 17 / 1♀ ex 1♀ *Plecotus ognevi*, 9.VI.2008, ID 18 / 1♂, 2♀ ex 2 *Eptesicus nilssonii*, 17.VI.2008, ID 22 / 1♂ ex 1♀ *Plecotus ognevi*, 16.VI.2008, ID 21 / 2♀ ex 1♀ *Myotis "nattereri"*, 31.V.2008, ID 14 / 1♀ ex 1♀ *Myotis ikonnikovi*, 31.V.2008, ID 14 / 1♀ ex *Myotis "mystacinus"*, 19.VIII.2006, ID 08

Ischnopsyllus needhami HSÜ, 1935

6♂, 3♀ ex *Vespertilio sinensis* 24.VII.2007, ID 10

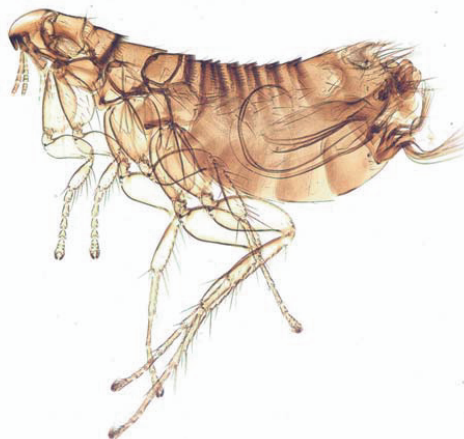


Fig. 6: *Ischnopsyllus needhami*, batflea, male (photo: I. SCHEFFLER)

Ischnopsyllus obscurus (WAGNER, 1898)

7♂, 25♀ ex 167♀ *Vespertilio murinus* 3.VI.2008, ID 15 / 1♀ ex *Vespertilio murinus* 12.VI.2008, ID 19 / 1♂ ex 2 *Eptesicus nilssonii* 17.VI.2008, ID 22 / 1♂, 3♀ ex *Vespertilio murinus*, 24.-27.VII.2007 ID 10 / 1♀ ex *Vespertilio murinus*, 26.VIII.2005, ID 03

Ischnopsyllus petropolitanus WAGNER, 1898

1♂ ex *Myotis "mystacinus"*, 9.VIII. 2007, ID 11

Mydopsylla trisellis JORDAN, 1929

1♀ ex 3♀ *Myotis petax*, 6.VI.2008, ID 17 / 1♀ ex *Myotis petax*, 6.VI.2008, ID 14 / 2♀ ex 29 *Myotis "mystacinus"*, 9.VI.2008, ID 18 / 1♂ ex 10 *Myotis petax*, 1.VI.2008, ID 13 / 1♀ ex *Plecotus ognevi*, 3.-4. IX. 2005, ID 06 / 1♂, 1♀ ex *Myotis petax*, 3.-4. IX. 2005, ID 06

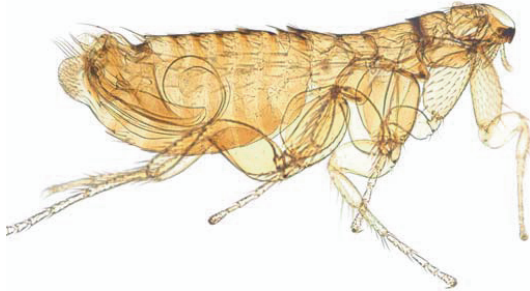


Fig. 7: *Mydopsylla trisellis*, batflea, male (photo: I. SCHEFFLER).

A first comprehensive account of the Mongolian flea fauna stems from results of German-Mongolian biological excursions, and also considered references in SMITH (1967). Among the 90 flea species known at the time, only three were bat parasites: *Ischnopsyllus hexactenus* on *Eptesicus nilssonii*; *Ischnopsyllus needhami* on *Vespertilio superans* and *Mydopsylla trisellis* on *Myotis mystacinus* spp. By 1975 (SMITH 1980), the number of known Mongolian flea species increased to 122, but no additional bat parasites were established. KIEFER et al. (1984) published 157 flea species and sub-species in his checklist for Mongolia. For the first time, a fourth bat flea species was reported (*Ischnopsyllus obscurus*), but only a single record exists. The distribution charts and tables of KIEFER et al. (1984) are based on ten findings for all four known Mongolian species of Ischnopsyllidae. Reported results herein markedly increase the knowledge of bat parasite fauna.

We report six new sites from Mongolia for *Ischnopsyllus hexactenus* (Fig. 4). The host range determined during this excursion included the previously known host species *Eptesicus nilssonii*, as well as *Plecotus ognevi*, *Myotis petax*, *M. "mystacinus"*, *M. "nattereri"* and *M. ikonnikovi*. Our findings suggest *Plecotus ognevi* as the preferred host of this flea species. The distribution of *I. hexactenus* ranges from Western Europe to Russia's Far East (HŪRKA, 1963). HOPKINS & ROTHSCCHILD (1956) assumed a discrete species, *I. kolenatii* WAGNER (1930), to replace *I. hexactenus* in Siberia and other eastern parts of Russia. IOFF & SKALON (1954) list this morphological variety as a sub-species (*I. hexactenus kolenatii*). Morphologically, males caught in this study matched the traits attributed to *I. kolenatii*. However, the differences to *I. hexactenus* are miniscule (Fig. 336 in IOFF & SKALON 1954), and the separation into species or sub-species was revised (HŪRKA 1963, PEUS 1978). DNA-analysis could possibly revive this discussion, given availability of sufficient material. *Ischnopsyllus hexactenus* seems to prefer *Plecotus*-species throughout its entire range (HOPKINS & ROTHSCCHILD 1956, HŪRKA 1963, WALTER & KOCK 1994). According to these authors, *Barbastella barbastellus* and *Myotis myotis* are side hosts of this flea species in Central Europe.

Ischnopsyllus petropolitanus belongs to the species with six dorsal ctenidia, and was segregated from *I. hexactenus* as a separate species (SMITH & WRIGHT 1965). Anatomical differences include the shape of the "crochet", an appendage of the male genital apparatus, and the shape of the VIII. sternites (Fig. 963 in SKALON 1989). Contrary to *I. kolenatii*, the status of *I. petropolitanus* as independent species was recognized (PEUS 1976). The distribution of this flea species is too vaguely known. According to SKALON (1989), it exists in the region around Leningrad and in Kazakhstan. *Eptesicus* species and "other bats" are listed as its hosts. To our knowledge, the occurrence of *I. petropolitanus* described herein is a first record for Mongolia. The species was caught on *Myotis "mystacinus"*.

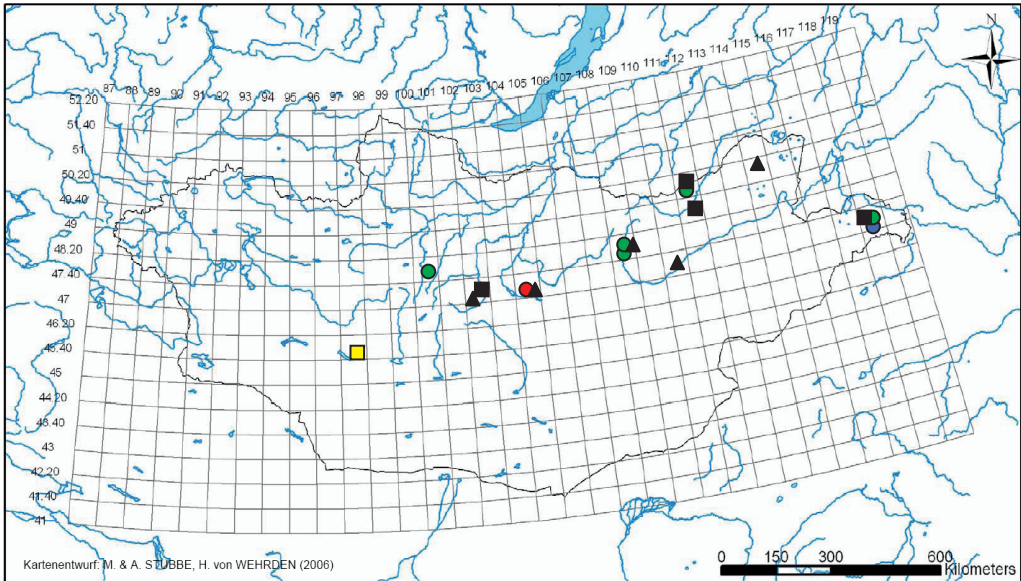


Fig.4: Distribution of bat fleas: Circle: blue = *I. comans*, green = *I. hexactenus*, red = *I. needhami*; Square: yellow = *I. petropolitanus*, black = *Mydopsylla trisellis*; Triangle = *I. obscurus*.

Ischnopsyllus obscurus is a robust flea species with a macroscopically visible dark sclerotized part of the posterior abdomen. It has eight well developed dorsal ctenidia. The almost triangular “moving finger“ and the long finger-shaped process on the dorsal margin of the body of the clasper are conspicuous, species specific characteristics in males. In relation to its length (length/ width < 2), the anal stylet in females is considerably wider than it is in all other related bat flea species.

Collecting 38 specimens of *I. obscurus* in four different localities (Fig. 4) confirms this species' status as a natural part of Mongolian fauna. Further findings verify its range throughout large parts of Europe and Asia (HOPKINS & ROTHSCCHILD 1956, SKALON 1989). To date, this species is rarely documented in Germany, and its first sighting here occurred in 1984 (WALTER & KOCK 1994). *I. obscurus* largely depends on its main host, *Vespertilio murinus*. HÜRKA (1963) mentions sporadic findings of *I. obscurus* on *Myotis daubentonii* (Norway), *Eptesicus serotinus* (Romania) and *E. nilssoni* (Russia).

The results clearly confirm *Vespertilio murinus* as main host of *I. obscurus* in its eastern range. As per the literature to date, this flea species was only caught sporadically, and in low numbers (see HÜRKA 1963). In this light, our collection of 32 fleas from 167 bats (*Vespertilio murinus*) at location 15 (Chuch Nuur) is exceptional. The roost was located behind wall cladding. According to the Mongolian camp administrator, bats regularly utilized this roost for many years, which was confirmed by substantial fecal deposits in its bottom part. These conditions apparently provide a favourable environment for the developmental stages of this flea species. However, these findings do not suggest a higher abundance of *I. obscurus* in its eastern range compared to its western range. Our own recent captures from the region of Brandenburg, Germany, confirm the occurrence of locally strong populations (SCHEFFLER 2009).

Ischnopsyllus needhami is a flea species currently recorded only from Asia. The few largely scattered records come from Mongolia (SMITH 1966, KIEFER 1984: four sites), China and adjacent parts of Russia, extending to the Far East (HOPKINS & ROTHSCCHILD 1956, IOFF & SKALON 1954). The only known host species from the literature to date is *Vespertilio superans*

(= *V. sinensis*). Males of *I. needhami* are characterized by especially long, bent bristles on sternite VIII, which reliably preclude confusion with other species.

Records of *Ichnopsyllus comans* exist from China on *Vesperugo planeyi* and *Leuconoe taiwanensis*, from Korea on *Myotis spec.*, and from Russia's Far East on *Vespertilio savii* (HOPKINS & ROTHSCCHILD 1956). These data stem from only nine individuals caught between 1926 and 1952. To our knowledge, *I. comans* has not been recorded in Mongolia before. *Myotis "mystacinus"* was not formerly known as a host species of this flea. Males of *I. comans* possess conspicuous bristles on the mesonotum, and are readily identified.

Mydopsylla triselis differs from most other bat fleas by lacking true ctenidia on its abdominal tergites. It has thickened bristles ("false ctenids") on some tergites instead. This species is the only representative of its genus in Eurasia. According to SKALON (1989), it ranges from northwestern Russia to Siberia and China. JAUNBAJERE et al. (2008) list recent captures of this species from Latvia, found on *Myotis dasycneme*, *M. brandti* and *M. mystacinus*. To date, *Mydopsylla triselis* was reported from three sites in Mongolia, with *Myotis mystacinus* as the host (SMITH 1966, KIEFER 1984). This host specificity is confirmed by our study. Furthermore, independent discoveries of this species on *Plecotus ognevi* and *Myotis petax* confirm the occurrence of additional host species in Mongolia.

Identified bat fly species (Nycteribiidae) and their distribution

Basilia mongolensis mongolensis THEODOR, 1966

2 ♂ ex *Myotis "mystacinus"*, 18.IX.2007, ID 09 / 1 ♂, 1 ♀ ex *Myotis "mystacinus"*, 24.VIII.2005, ID 02 / 2 ♀ ex *Myotis "mystacinus"*, 29.VIII.2005, ID 04 / 1 ♂, 1 ♀ ex *Myotis "mystacinus"*, 1. IX. 2005, ID 05

Basilia sp. (suspected new species)

3 ♂, 2 ♀ ex 1♀ *Myotis "nattereri"*, 31.V.2008, ID 14



Basilia truncata THEODOR, 1966

4 ♂, 10 ♀ ex 33 *Myotis "mystacinus"*, 13.VI.2008; ID 20 / 1 ♂ ex 10 *Myotis petax*, 1.VI.2008, ID 13 / 9 ♂, 18 ♀ ex 29 *Myotis "mystacinus"*, 9.VI.2008, ID 18 / 3 ♂, 2 ♀ ex 18 *Myotis "mystacinus"*, 3.VI.2008, ID 15 / 1 ♂, 3 ♀ ex *Myotis "mystacinus"*, 24.VII.2007, ID 10 / 2 ♂, 3 ♀ ex *Myotis "mystacinus"*, 17.VIII.2005, ID 01

Fig. 9: *Basilia truncata*, bat fly, male (photo: I. SCHEFFLER).

Nycteribia quasiocellata THEODOR, 1966

1♀ ex *Myotis petax*, 31.V.2008, ID 14 / 3♂, 1♀ ex 10 *Myotis petax*, 1.VI.2008, ID 13 / 4♂, 9♀ ex *Myotis petax*, 3.-4. IX. 2005, ID 06



Fig. 10: *Nycteribia quasiocellata*, bat fly, female (photo: I. SCHEFFLER)

Penicillidia monoceros SPEISER, 1900

3♂, 1♀ ex 1♀ *Myotis "nattereri"*, 31.V.2008, ID 14 / 1♂, 2♀ ex 10 *Myotis petax*, 1.VI.2008, + 30.V.08, ID 13 / 4♂, 3♀ ex *Myotis petax*, 3.-4. IX. 2005, ID 06.

Information on nycteribiid species from Mongolia is scarce. THEODOR (1966) compiled results of the Mongolian-German biological expeditions regarding this taxon, and described three previously unknown species: *Nycteribia quasiocellata* (ex *Myotis daubentonii*), *Basilia mongolensis* and *B. truncata* (both found on *M. mystacinus*). The author noted the absence of westpalaearctic nycteribiids, despite presence of their host species.

We documented eight specimens of *Basilia mongolensis mongolensis* from four sites. Exclusive host was *Myotis "mystacinus"*. Apart from the original description of the species by THEODOR, MINAR & HÜRKA (1980) provide additional information on this species. They also introduced the sub-species nomenclature, a step they justified with the discovery of another sub-species from the Balkan Peninsula (*Basilia mongolensis nudior* HÜRKA, 1972). These authors confirmed *Myotis mystacinus* as the main host, while mentioning *Eptesicus gobiensis* as accidental host. Among other traits, the females of this species differ from *Basilia truncata* in their prolonged anal processes.

With 66 specimens, *Basilia truncata* was the most common bat fly species collected during the excursions. However, these findings only represent the eastern part of Mongolia (Fig. 8). As for *Basilia mongolensis mongolensis*, the main host was *Myotis "mystacinus"*. There was no evidence of both bat fly species co-occurring at the same site, which suggests a geographical separation of these species. Perhaps this is why it is not mentioned in MINAR's & HÜRKA's (1980) account of their Mongolian findings.

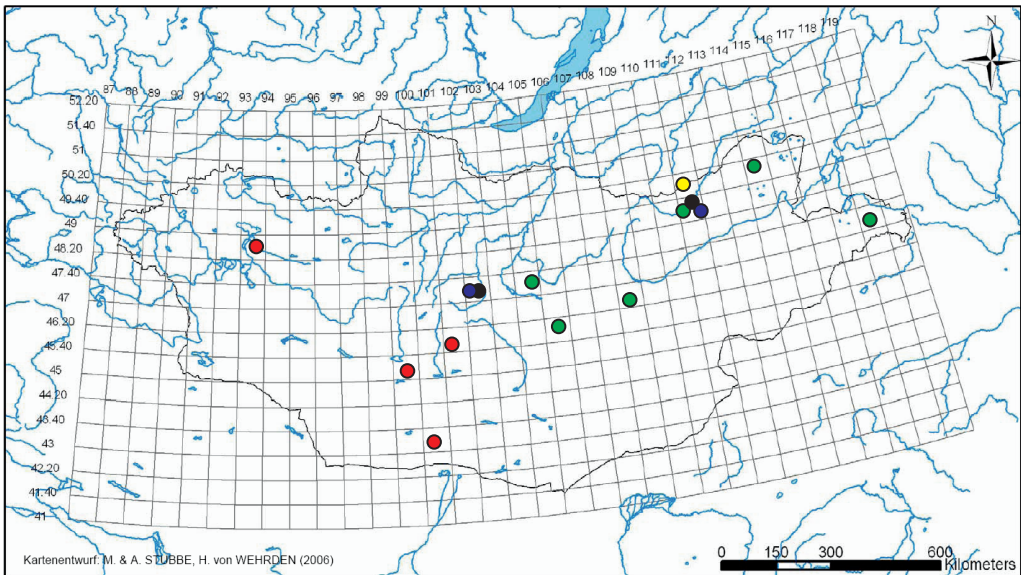


Fig. 8: Distribution of Nycteribiidae: red = *B. mongolensis*, yellow = *B. spec* (new), green = *B. truncata*, black = *N. quasiocellata*, blue = *P. monoceros*.

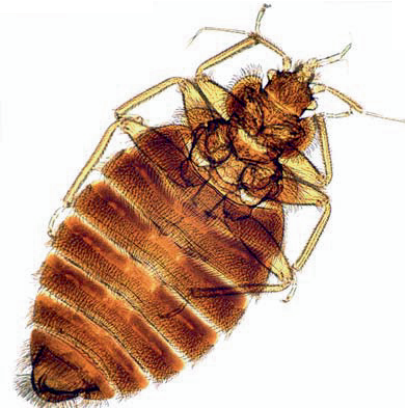
We documented 18 specimen of *Nycteribia quasiocellata* in three locations. Its exclusive host was the Eastern Daubenton's Bat, *Myotis petax*. Analysing excursion data from Halle, Germany, MINAR & HÜRKA (1980) found *N. quasiocellata* on *M. daubentoni volgensis* (= *Myotis petax*, in keeping with current nomenclature) and declared *Eptesicus nilssoni gobiensis* as accidental host. Further records of this bat fly are mentioned from East Kazakhstan and Manchuria in

China. The anal processes of females are similar to those of *Basilia truncata*, yet *N. quasiocellata* lacks eyes and its abdominal segment bristles differ clearly.

We previously encountered *Penicillidia monoceros* in 2005 (DOLCH et al. 2007), a species that also occurs in Central Europe. Additional, more recent findings are reported here. In Europe, Daubenton's bat (*M. daubentonii*) is the main host of *P. Monoceros*. Eastern Daubenton's Bat (*Myotis petax*) and Daubenton's bat (*M. daubentonii*) were long viewed as the same species, until MATVEEV et al. (2005) classified them as separate. In Central Europe, the small bat fly *Nycteribia kolenatii* is more commonly found on Daubenton's Bat than is the larger bat fly species *P. monoceros*. Our findings suggest a similar situation for Eastern Daubenton's Bat, although *Nycteribia quasiocellata* substitutes *Nycteribia kolenatii* as the small bat fly species here. In this study, *Myotis "nattereri"* was also recorded as a side host.

Importantly, we observed a presumably fifth nycteribiid-species from Mongolia, which resembles some morphological criteria of *Basilia nana* (THEODOR 1954, 1966; THEODOR & ROTHSCILD 1967, SHAKELBERG 1989). However, *B. nana* has a mostly west palearctic range, and its typical host in Central Europe is *Myotis bechsteinii*. Moreover, there are morphological differences (such as the structure of the female genital plates), that indicate the existence of an independent species.

Identified bat bugs (Cimicidae)



Cimex pipistrelli JENYNS, 1839

2 ♂, 2 ♀ ex 29 *Myotis "mystacinus"*, 9.VI.2008, ID 18 / 1 ♂ ex 10 *Myotis petax*, 1.VI.2008, ID 13

Fig. 11: *Cimex pipistrelli*, batbug male (photo: I. SCHEFFLER).

True bug species identification utilized the key by USINGER (1966), which includes cimicids known worldwide. The author confines the range of *Cimex pipistrelli* to England and Ireland, and suspects misnomers for records of that species in other countries, with the exception of one specimen from Tajikistan, which apparently showed typical characteristics of *C. pipistrelli*. Due to the geographical separation, the presence of *C. pipistrelli* in our samples was doubtful and warranted a comprehensive analysis of various traits. We calculated the following ratios (mean values in mm): most posterior femur, length/ width = 2.99 (S = 0.28); head width/ length of 3rd antenna segment = 1.42 (S = 0.07); length of bristles on side of pronotum = 0.153 (S = 0.017); head width = 0.892 (S = 18.84); antenna length = 1.841 (S = 0.071); ratio of antenna segments 4:13:14:10; pronotum width = 1.408 (S = 0.045); ratio pronotum width/ length = 2.48 (S = 0.05); ratio side bristles of pronotum/ width of first antenna segment = 6.44: 5; ratio of elytra width/ length = 17.1: 11; length of elytra bristles > than distance between bristles (72.29/ 50.62). These and additional traits (shape of spermalege, length of tergite bristles in relation to their distance of each other; the small hook on the most posterior coxa) did not markedly differ from Usinger's description of *C. pipistrelli*. Thus, this species identification seemed appropriate.

KERZHNER (1989) reported on Mongolian Cimicidae, describing captures of *C. pipistrelli* (ex *Myotis daubentonii*, *M. mystacinus* and *Eptesicus gobiensis*), and listing the bed bug *Cimex lectularius* and a swallow bug (*Oeciacus montandoni*) as other representatives of true bugs in

Mongolia. KERZHNER's data (1989) originate from only seven adult specimen of *Cimex pipistrelli*. These low numbers, which were not exceeded by our study, owe to the fact that true bugs only temporarily frequent their host for feeding, and otherwise live in cracks and crevices of the roost. KERZHNER (1989) argues that bat bugs (*pipistrelli* group) all belong to the same species, and that there are intermediate traits between the Central European species *Cimex dissimilis* and the Asian species *Cimex pipistrelli*. We cannot conclude that from our study, and continue to view both species as independent until verified otherwise.

Identified Spinturnicid Mites (Spinturnicidae)

Spinturnix andegavinus DEUNFF, 1977

3 ♀ ex *Myotis petax*, 3 - 4.IX.2005, ID 06

Spinturnix myoti (KOLENATI, 1856)

2♂, 1♀ ex *Myotis petax*, 31.V.2008, ID 14 /

1♂, 3♀ ex *M. petax*, 1.VI.2008, ID 13 /

1♂ ex *M. "nattereri"*, 31.V.2008, ID 14 /

2♂ ex *Myotis petax*, 3 - 4.IX.2005, ID 06 /

1♀ ex *E. gobiensis*, 27. VII.2007, ID 10



Fig. 12: *Spinturnix myoti*, Spinturnicidae, male, phase contrast microscopy (photo: I. SCHEFFLER).

Spinturnix mystacinus (KOLENATI, 1857)

1♂ ex *Myotis "mystacinus"*, 9.VI.2008, ID 18 / 2♂ ex *Myotis "mystacinus"*, 4.VI.2008, ID 16 / 4♂, 2♀ ex *Myotis "mystacinus"*, 13.VI.2008, ID 20 / 2♂, 3♀ ex *Myotis "mystacinus"*, 17.VIII.2005, ID 01 / 3♀ ex *Myotis "mystacinus"*, 3.VI.2008, ID 15 / 1♂ ex *Myotis ikonnikovii*, 31.5.2008, ID 14

Spinturnix plecotinus (KOCH, 1839)

1♂, 4♀ ex *Plecotus ognevi*, 16.VI.2008, ID 21 / 2♂, 2♀ ex *P. ognevi*, 4.IX.2005, ID 06 / 2♂, 1♀ ex *P. ognevi*, 31.V.2008, ID 14 / 1♂, 3♀ ex *P. ognevi*, 30.V.2008; ID 13 / 2♀ ex *P. ognevi*, 20.VII.2007, ID 10

Spinturnix kolenatii OUDEMANS, 1910

2♂, 2♀ ex *Eptesicus gobiensis*, 26.VIII.2005, ID 03 / 1♀ ex *E. nilssonii*, 17.VI.2008, ID 22 / 3♂ ex *E. gobiensis*, 27. VII.2007, ID 10 / 2♂ ex *Vespertilio murinus*, 24.-27.VII.2007 ID 10

We could not find any literature on the distribution of spinturnicid mites in Mongolia. Hence, the data reported herein may be a first record for the region. Identification of spinturnicids considered the works of RUDNICK (1960), DEUNFF (1977), UCHIKAWA et al. (1994), DEUNFF et al. (1997), and STANYUKOVICH (1997). Apart from dorsal and ventral bristles, the ventral shield is an important trait for distinguishing species. Spinturnicids occur in variable numbers on bats, and are usually tallied by sampling. The host specificity is still unclear. Following published distribution records (i.e. STANYUKOVICH 1997), some spinturnicid species utilize a broad host range, whereas others seem to be monoxenic. Spinturnicids do not leave their host and generally cannot survive for more than a few hours without it. Direct body contact is necessary to transfer between hosts. Spinturnicid mite taxonomy is still unclear, with revised and new descriptions of species published during recent decades (i.e. DEUNFF et al. 1997).

Our findings represent samples verified by specimen mounts. With the exception of *Spinturnix andegavinus*, all parasite species were abundant on their main hosts. Thus, the distribution of spinturnicids is congruent with that of their host species, and can be gathered from bat distribution charts (see DOLCH et al. 2007).

Spinturnix andegavinus is deemed a parasite specific to Daubenton's Bat, *Myotis daubentonii*. The species was first described in 1977. Its separation from *S. myoti* is difficult, and not always clears in large collections. One distinction in males is the number of bristles below the ventral shield (4-6 in *M. myotis*, >10 in *M. daubentonii*). In females, the distances between coxae I-II and III-IV is important, supposedly broad and distinct in *M. myotis*, and small in *M. daubentonii*, with coxae converging in a v-shape (after DEUNFF 1977). The species' occurrence in Germany and the Czech Republic seems well founded (DIETZ & WALTER 1995, LUČAN 2006), whereas records from other European regions do not list it (STANYUKOVICH 1997, BAKER & CRAVEN 2003, JAUNBAUERE et al. 2007). Here, *Spinturnix myoti* is still regarded as the parasite of Daubenton's Bat. Apparently not all authors accept the separation of *S. andegavinus* and *S. myoti* as distinct species. In our study, most specimens found on Eastern Daubenton's Bat *Myotis petax* were unmistakably *Spinturnix myoti*, and only three individuals showed traits hinting at *Spinturnix andegavinus*.

Spinturnix myoti was found on *Myotis petax*, *Eptesicus gobiensis* and *M. "nattereri"*. This species has a broad host range, as evidenced by the literature. Its main host in Europe is *Myotis myotis*. *Spinturnix myoti* also occurs in the Asian part of Russia, ranging to the Far East, and in Kazakhstan, Turkmenistan, Uzbekistan, Tajikistan and Kirgizia (STANYUKOVICH 1997). Thus, our recent findings from Mongolia are within reason.

The ventral shield in ***Spinturnix mystacinus*** males easily distinguishes this species from others. In Central Europe, *Spinturnix mystacinus* is specific parasite to *Myotis mystacinus*. There are sporadic records from Russia and adjacent countries (Kazakhstan and Uzbekistan), which mention *M. dasycneme*, *M. brandti*, *Eptesicus serotinus*, *Plecotus auritus*, and *Vespertillio murinus* as side hosts, apart from *Myotis mystacinus* (STANYUKOVICH 1997). We found *S. mystacinus* on both *M. ikonnikovii* and *M. mystacinus*, which are classified as separate species from *Myotis "mystacinus"*, emphasizing the close relatedness of these species.

Spinturnix kolenatii was not mentioned in DEUNFF's compilation of European species (1977), but part of RUDNICK's account (1960) pertains to Europe. *Eptesicus serotinus* is deemed host species in Germany and the Netherlands. There were records of *S. kolenatii* from Russia and its south-eastern neighbouring countries (Kazakhstan, Turkmenistan, Uzbekistan, Kirgizia) from 12 bat species. Main host was *Myotis blythi* (STANYUKOVICH 1997). Our findings suggest *Eptesicus*-species as possible main hosts for *S. kolenatii*, and *Vespertilio murinus* is a known side host of this species.

With ***Spinturnix plecotinus***, we first thought to be able to describe a new species. Traits typical for the "Plecotinus" group were prominent: scanty bristles dorsally and on the abdomen, the existence of a lancet shaped bristle on the front tarsi, and ribbed coxae. However, the ventral shields in males differed markedly from those shown in DEUNFF (1977) or STANYUKOVICH (1997). However, comparison with a 2009 series of *Plecotus auritus* from Germany yielded similar structures, and thus it is very likely the same species.

In Central Europe, *Spinturnix plecotinus* occurs on both long-eared bat species, *Plecotus auritus* and *P. austriacus*. The eastern range of those species does not extend beyond the poorly defined border between Ukraine and Turkey (DIETZ et al. 2007). STANYUKOVICH (1997) did not consider the separation of both host species, yet the distribution of *S. plecotinus* on *Plecotus*-species was documented from Russia, Uzbekistan, and Tajikistan. Furthermore, other bat species are mentioned as side hosts (*Nyctalus noctula*, *Rhinolophus*-Arten, *Eptesicus nilssonii*, *Myotis daubentonii*, *M. nattereri*, *M. mystacinus*, *M. brandti*).

Table 2: Ectoparasite species composition of Mongolian bats (+ = species determined qualitatively)

bat species \ ectoparasite species	<i>Eptesicus gobiensis</i>	<i>Eptesicus nilssonii</i>	<i>Myotis ikonnikovi</i>	<i>Myotis "mystacinus"</i>	<i>Myotis „nattereri“</i>	<i>Myotis petax</i>	<i>Plecotus ognevi</i>	<i>Vespertilio sinensis</i>	<i>Vespertilio murinus</i>
Ischnopsyllidae									
<i>Ischnopsyllus comans</i>				1					
<i>Ischnopsyllus hexactenus</i>		3	1	1	2	1	6		
<i>Ischnopsyllus needhami</i>								9	
<i>Ischnopsyllus obscurus</i>		1							38
<i>Ischnopsyllus petropolitanus</i>				1					
<i>Mydopsylla trisellis</i>				2		5	1		
Nycteribiidae									
<i>Basilia spec. (new)</i>					5				
<i>Basilia mongolensis</i>				7					
<i>Basilia truncata</i>				55		1			
<i>Nycteribia quasiocellata</i>						18			
<i>Penicillidia monoceros</i>					4	10			
Cimicidae									
<i>Cimex pipistrelli</i>				4		1			
Spinturnicidae									
<i>Spinturnix andegavinus</i>						+			
<i>Spinturnix kolenatii</i>	+	+							
<i>Spinturnix myoti</i>					+	+			
<i>Spinturnix mystacinus</i>			+	+					
<i>Spinturnix plecotinus</i>							+		

Ectoparasite species composition of Mongolian bats

Table 2 lists all bat parasite species caught in this study in relation to their host species. The diversity of parasites among bat species presumably reflects different ecological requirements, and is similar to the situation in Central Europe. Most bats exhibit just one or two ectoparasite insect species, and only *Myotis "mystacinus"*, *M. "nattereri"* and *M. petax* showed a more diverse assembly of ectoparasites.

During the summer months, bats use maternity roosts and temporary quarters. These must provide a suitable environment for insect larval development, since this life stage of bat parasites does not occur on the body of their host. Roosts harboring a large number of bats are optimal for high ectoparasite diversity and abundance. Bat flies attach their nearly mature eggs inside the roost, and thrive on its regular use by bats. As expected, we caught bat flea species occurring in summer. How many bat flea species typically present in winter (genus *Nycteridopsylla*) exist in Mongolia, if at all, is subject to further study. The noticeable accumulation of different parasite species on the Mongolian *Myotis "mystacinus"* contrasts with our findings from Germany on *M. mystacinus*, where hardly any ectoparasites were present. This difference supports the hypothesis of dealing with two separate bat species. For some bats, dominant ectoparasite species can be deduced from quantitative results (Table 2). For spinturnicids, the survey was more qualitative.

These mites' distribution is mostly species or genus specific.

From the literature, common criteria for estimating ectoparasites are those of intensity (I = number of parasites per individual host), prevalence (P = number infested hosts animals/ number examined host individuals), and abundance (total number of parasites/ number of examined host animals). Intensity values for *Myotis "nattereri"* and *M. ikonnikovi* can be directly gathered from Table 2, as only one animal was caught and examined for each species. Therefore, these results hold low significance. We examined 167 individuals of *Vespertilio murinus*. Only one ectoparasite species, *Ischnopsyllus obscurus*, was present, with an abundance of 0.19 parasites per host animal. A range of parasite species was found on *Myotis petax* (two flea species, three bat fly species, and one bat bug species). The largest analysed group among this bat species was only ten individuals. However, in this group alone, five ectoparasite species were caught simultaneously at the same site. *Nycteribia quasiocellata* was the most numerous, with an abundance value of 0.4. *Myotis "mystacinus"* showed a similar diversity of ectoparasite fauna, and *Basilia truncata* was most abundant (0.66) here. These data stem from 62 host animals collected at sites from 2008. Our results did not permit density calculations for other parasite species. Even a diligent analysis of data collected during a specific time at one location generally yields only limited results in regards to parasite densities. For example, the intensity of infestation largely depends on the host animal's condition. Thus, we do not expect each Mongolian *Myotis "nattereri"* to carry a parasite load similar to that of the individual randomly caught in our study.

Prevalence and abundance values are highly species specific. Extreme examples from northern Germany are the Water Bat (almost always with numerous ectoparasites), and Bechstein's Bat, which rarely yields any parasites. Due to the low numbers of animals caught, and owing to scanty data, an objective estimate of parasite load is difficult for most bat species. Many parasite species climax during specific months, so that study time frames can influence results considerably. Additionally, acyclic fluctuations of ectoparasite frequency occur between years and locations, and the same bat species may carry different parasites in different regions, or differ in frequencies of present parasite species. This warrants further study. Our qualitative results are representative for the bat and ectoparasite species discussed herein. Table 2 shows that each bat species harbours its own array of ectoparasites. Assessing the ectoparasite fauna of additional Mongolian bat species and the examination of other ectoparasite taxa are interesting approaches for further research.

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