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GAMASID MITES (MESOSTIGMATA: GAMASINA) PARASITIZING BATS (CHIROPTERA: RHINOLOPHIDAE, VESPERTILIONIDAE, MOLOSSIDAE) OF PALAEARCTIC BOREAL ZONE (RUSSIA AND ADJACENT COUNTRIES)

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Bat gamasid mites is a highly specialized ectoparasite group which is of great interest due to strong isolation and other unique features of their hosts (the ability to fly, long distance migration, long-term hibernation).

The book summarizes the results of almost 60 years of research and is the most complete summary of data on bat gamasid mites taxonomy, biology, ecology. It contains the first detailed description of bat wintering experience in several regions of the boreal Palaearctic.

The book is addressed to zoologists, ecologists, experts in environmental protection and biodiversity conservation, students and teachers of biology, veterinary science and medicine.

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CONTENTS

PREFACE

Despite of increasing number of publications devoted to bats biology investigations in Russia and adjacent countries at present time, still no monographic summary on bat ectoparasites of this vast territory has been produced. This book uncovers some aspects of taxonomy and biology of the most numerous group of Arthropod, parasitizing bats of boreal Palaearctic (taiga zone of Old World) – gamasid mites of Spinturnicidae and Macronyssidae families. Ectoparasite species assemblage is determined for the investigated territory as well as the peculiarities of their life cycle, the features of mites biology are described, the hosts of which are the bats, belonging to different ecological groups. Particularly, the detailed data on survival aspects during the long host hibernation periods were received. The results of the experience on Palaearctic taiga zone ranking and separation of bat ectoparasites faunistic complexes are described for the first time. Also the keys for the determination of the Old World boreal and subboreal mite species, belonging to families Spinturnicidae and Macronyssidae are presented in book.

The base of our book is formed by the investigations on ectoparasite fauna of bats of the ex-USSR and Russia that were made by M.K. Stanyukovich in 80s and 90s of the last century with additional data on fauna and ecology on bats and their ectoparasites received by M.V. Orlova and O.L. Orlov from different parts of Russia (Leningrad region, the Urals, Western and Eastern Siberia, the Kurile islands) and foreign Europe (Poland, Germany) from 1996 till present time.

The pictures of mites are made by E.V. Koroleva, M.K. Stanyukovich, L.V. Linnik, M.V. Orlova. Many thanks also to J. Burazerović (University of Belgrade) for the linguistic revision of the manuscript.

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INTRODUCTION

Ectoparasite fauna of Chiroptera is of particular practical interest due a high ecological isolation of its hosts – bats and also because of active usage of buildings and constructions by these animals that may be a factor contributory of dangerous infections transmission for man.

Bats of Palaearctic boreal zone belongs to family Vespertilionidae (Mammals…, 1963) and are the hosts of few parasite mites and ticks taxons (Ixodidae, Argasidae, Gamasina, Trombiculidae, Myobiidae, Chirodicidae, Sarcoptidae, Demodicidae, Psorergatidae) (Balashov, 2009; Medical teriology, 1989), among its the haematophagous are the ixod, argasid ticks and many species of gamasid mites (Balashov, 2009). Besides, the bats harbored parasitic insects from three orders (Diptera, Siphonaptera and Hemiptera).

The poor study of bat ectoparasites of the Palaearctic region (especially its eastern part) was mostly related with poor studying of hosts on this territory. However the active investigations on the biology and ecology of bats expanded on the boundary of XX-XXIth centuries in the Urals, Western Siberia and adjacent territories (Starikov et al., 1990; Ilyin, Kurmaeva, 1996; Ilyin, 1999; Bolshakov, Orlov, 2000; Orlov, 2000; Smagin et al., 2000; Snit'ko, 2004; Bolshakov et al., 2005; Orlov et al., 2005; Pervushina, 2006; Bernikov, 2009) allowed to begin the examinations of its parasite fauna. The important biological feature of bats is their prolonged (up to half a year) hibernation during a winter. The ecology of ectoparasites throw its hosts wintering is extremely poor studied to present time, as long as environmental regulations in the Europe and North America countries forbids the inspections of bat colonies during the hibernation. Meanwhile without the knowledge about winter ecology of ectoparasites it is impossible to form the holistic conception about its life cycles and reproductive strategies.

Ectoparasite fauna reports the important aspect of host's ecology and its studies could clear up many aspects of vital activity of bats – the animals group the biology of which is still studied not enough in Russia. Furthermore, the investigations of bat's ectoparasite fauna allowed make the conclusions about the bat distribution and migrations throw the territory of Northern Eurasia.

CHAPTER 1. MATERIALS, METHODS AND INVESTIGATED TERRITORY

1.1. The volume and character of collected materials

This book is the result of almost 60 years of research. The objects of our investigations are bat ectoparasites. In total, about 3,000 individuals belonging to 40 bat species andthree families (Rhinolophidae, Vespertilionidae, Molossidae) were captured and examined alive:

Rhinolophidae:

1. Greater horseshoe bat *Rhinolophus ferrumequinum* (Schreber, 1774).
2. Mehely's horseshoe bat *Rhinolophus mehelyi* Matschie, 1901.
3. Lesser horseshoe bat *Rhinolophus hipposideros* (Bechstein, 1800).
4. Mediterranean horseshoe bat *Rhinolophus euryale* Blasius, 1853.

Vespertilionidae:

5. Mouse-eared bat *Myotis myotis* (Borkhausen, 1797).
6. Lesser mouse-eared bat *Myotis blythii* (Tomes, 1857).
7. Pond bat *Myotis dasycneme* (Boie, 1825).
8. Daubenton's bat *Myotis daubentonii* (Kuhl, 1817).
9. Natterer's bat *Myotis nattereri* (Kuhl, 1817).
10. Eastern water bat *Myotis petax* (Hollister, 1912).
11. Eastern long-fingered bat *Myotis macrodactylus* (Temminck, 1840).
12. Long-tailed bat *Myotis frater* (G. Allen, 1823).
13. Brandt's bat *Myotis brandtii* (Eversmann, 1845).
14. Siberian bat *Myotis sibiricus* (Kastschenko, 1905).
15. Ikonnikov's bat *Myotis ikonnikovi* Ognev, 1912.
16. David's bat *Myotis davidi* Peters, 1869.
17. Whiskered bat *Myotis mystacinus* (Kuhl, 1817).
18. Geoffroy's bat *Myotis emarginatus* (E. Geoffroy, 1806).
19. Common noctule *Nyctalus noctula* (Schreber, 1774).

20. Leisler's bat *Nyctalus leisleri* (Kuhl, 1817).

21. Nathusius' pipistrelle *Pipistrellus nathusii* (Keyserling, Blasius, 1839).

22. Common pipistrelle *Pipistrellus pipistrellus* Schreber, 1774.

23. Soprano pipistrelle *Pipistrellus pygmaeus* Leach, 1825.

24. Kuhl's pipistrelle *Pipistrellus kuhlii* (Kuhl, 1817).

25. Savi's pipistrelle *Hypsugo savii* (Bonaparte, 1837).

26. Brown long-eared bat *Plecotus auritus* (Linnaeus, 1758).

27. Grey long-eared bat *Plecotus austriacus* (Fischer, 1829).

28. Ognev's long-eared bat *Plecotus ognevi* Kishida, 1927.

29. Strelkov's long-eared bat *Plecotus strelkovi* Spitzenberger, 2006.

30. Western Barbastelle *Barbastella barbastellus* Schreber, 1774.

31. Eastern Barbastelle *Barbastella darjelingensis* (Hodgson, 1855).

32. Common serotine *Eptesicus serotinus* Schreber, 1774.

33. Northern bat *Eptesicus nilssonii* (Keyserling, Blasius, 1839).

34. Particoloured bat *Vespertilio murinus* (Linnaeus, 1758).

35. Asian parti-colored bat *Vespertilio superans* Thomas, 1899.

36. Hilgendorf's tube-nosed bat *Murina hilgendorfi sibirica* Peters, 1880.

37. Ussuri Tube-nosed Bat *Murina ussuriensis* Ognev, 1913.

38. Schreibers' bat *Miniopterus schreibersi* (Kuhl, 1817).

39. Desert long-eared bat *Otonycteris leucophaea* Severtzov, 1873

Molossidae:

40. European free-tailed bat *Tadarida teniotis* Rafinesque, 1814.

In general, the material includes more than 25,000 ectoparasite individuals. The Collection of the Zoological Institute, RAS, has been used here (Stanyukovich, 1990; Medvedev et al., 1991; Stanyukovich, 1991; Stanykovich, 1995; Stanykovich, 1996; Stanykovich, 1997).

The collections of ectoparasites from the Biological Station of the Ural Federal University (2004), from Udmurtia and KMAA were kindly provided by Eugenia M. Pervushina, PhD, (Institute of Plant and Animal Ecology, UB RAS), V.I. Kapitonov (Udmurt State University) and K.A. Bernikov, PhD (Surgut State University) respectively. Information about some collections from Novosibirsk, Krasnoyarsk and Irkutsk regions has kindly been shared by Doctor of Sciences M.G. Mal'kova (Omsk Scientific Research Institute of Feral Herd Infections), captures of bats and collections of ectoparasites from them were made in different years by I.V. Kuzmin, V.V. Yakimenko, A.D. Botvinkin, M.M. Shuteev and A.V. Vakhrushev. Materials from Baikal territory were collected by D.V. Kazakov (Irkutsk State University), from Kunashir island by A.V. Zhigalin and D.I. Zhigalina. Ectoparasite collections from other sites were made by Oleg Orlov and Maria Orlova.

Capture of bats for further ectoparasite collecting were made in locations of bat colonies (winter and summer roosts in speleodistricts and nursery districts). The places of bat captures are presented in Table 1.

Table 1

The places of captures and the number of investigated bat individuals

Sampling site	Coordinates	Time of the capture
Germany (collector F. Kruger)		
Schleswig-Holstein, outskirts of Kiel	54° 19’ N 10° 08’ E	Summer
Polland (collectors A. Zappart, M.V. Orlova, O.L. Orlov)		
Warmian-Masurian Voivodeship, Kadyny	54° 18’ N 19° 29’ E	July 2012
Warmian-Masurian Voivodeship, Tolkmicko	54° 19’ N 19° 39’ E	July 2012
Pomeranian Voivodeship, Nozhinko	54° 18’ N 17° 27’ E	July 2012
Pomeranian Voivodeship, Gorki	53° 44’ N 18° 57’ E	July 2012
Podlaskie Voivodeship, Ogrodniki	54° 08’ N 23° 28’ E	July 2012
Mylof	53° 46’ N 17° 43’ E	July 2012
Pomeranian Voivodeship, Lyubnya	53° 56’ N, 17° 48’ E	May-August 2009, June 2011
Pomeranian Voivodeship, Lorynec	54° 02’ N 17° 54’ E	June 2011
Pomeranian Voivodeship, Plesno	53° 52’ N 17° 33’ E	June 2011
Russia, Leningrad region		
Staraya Ladoga (galleries)	60° 00’ N, 32° 17’ E	November 2012
Udmurt Republic (collector V.I. Kapitonov)		
Kambarskiy district, Kambarka outskirts	56° 16’ N, 54° 12’ E	June-July 1992, May 1993
Malopurginskiy district, Srednee Kechevo village	56° 52’ N, 53° 21’ E	June 1993
Votkinskiy district, Children’s Camp “Serebryaniy ruchey”	57° 01’ N, 54° 32’ E	May 1998
Perm region		
Cherdinskiy district, Divya cave	60° 48’ N, 56° 44’ E	August 2009

Sampling site	Coordinates	Time of the capture
Kishertskiy district, Perm State University’s biological station «Predural’e»	57° 21’ N, 57° 05’ E	July 2011, July 2012
Sverdlovsk region (collectors O.L. Orlov, M.V. Orlova, E.M. Pervushina, A.P. Golovanova)		
Severoural’sk urban district, Bol’shaya Konovalovskaya cave	60° 08’ N, 59° 56’ E	December 2010, March and December 2011
Severoural’sk urban district, cave complex “Chertovo Gorodische”	60° 24’ N, 60° 40’ E	August 2010
Novouralsk town outskirts	57° 13’ N, 60° 05’ E	July 2010
Sysertskiy district, Biostation of UrFU	56° 36’ N, 61° 06’ E	May, July, August 2004, June 2010
Nizhne-Serginskiy district, caves of the Nature Park “Olen’i Ruch’i”: Bol’shaya Arakaevskaya, Malaya Arakaevskaya, Druzhba, the cave of the rock Karstov most, the cave of Bol’shoy Proval	56° 31’ N, 59° 15’ E	January, March, July 2010, February, July 2011
Krasnoufimsk district, Sarana settlement	56° 28’ N, 57° 44’ E	October 1993
Ekaterinburg city and outskirts (Novo-Sverdlovskaya CHP, Flyus)	56° 50’ N, 60° 35’ E	August of 2009 and 2010
Kamenskiy district, Smolinskaya cave	56° 28’ N, 61° 37’ E	March 2001, June 2010, October 2010 – April 2011
Outskirts of Revda town	56° 47’ N 60° 05’ E	July 2013
Chelyabinsk region (collectors O.L. Orlov, M.V. Orlova, V.A. Mishchenko)		
Katav-Ivanovskiy district, cave complex Serpievskiy, outskirts of Ignat’evskaya cave: cave Alenushka, valley of Sim river	54° 54’ N, 57° 47’ E	July 2011
Kyshtym urban district, outskirts of the settlement Slyudorudnik	55° 40’ N, 60° 21’ E	October 2010
Kyshtym urban district, outskirts of Kyshtym town (Children’s camp «Zvezdochka»)	55° 37’ N, 60° 39’ E	July 2010
Karabashskiy urban district, the bank of Argazinskiy storage pond, recreation department «Berezka»	55° 24’ N, 60° 20’ E	July 2011
Republic of Bashkortostan (collector O.L. Orlov)		
Burzyanskiy district, “Shul’gan-Tash” Natural Reserve, Kapova cave	53° 03’ N, 57° 04’ E	October 2011
Khanty-Mansi Autonomous Area – Ugra (KMAA) (collector K.A. Bernikov)		

Sampling site	Coordinates	Time of the capture
Kondinskiy district: outskirts of the settlement Kuminskoe, settlement Mortka	59° 20’ N, 66° 01’ E	May 2007, August 2008
Kondinskiy district: settlement Kondinskoe, settlement Yagodnyi	59° 39’ N, 67° 25’ E	September 2006
Sovetskiy district, game reserve «Verkhne-Kondinskyi»	61° 10’ N, 63° 21’ E	August 2007, July 2008
Nizhnevartovskiy district, settlement Korliki outskirts	61° 32’ N, 82° 25’ E	July 2007
Nefteyugansiy district, outskirts of Salym settlement	60 ° 03’ N, 71° 27’ E	July 2006
Khanty-Mansi district, outskirts of Tsingaly settlement	60 ° 11’ N, 69° 41’ E	July 2008
Altai region		
State Natural Reserve “Tigirekskiy”	51° 16’ N, 83° 02’ E	December 2012
Omsk region (collectors I.V. Kuzmin, V.V. Yakimenko, A.D. Botvinkin, M.M. Shuteev, A.V. Vakhrushev)		
Bolsherechinskiy district, outskirts of the lake Laginkul’	55° 51’ N, 74° 09’ E	July 1990
Village Lesnaya	55° 52’ N, 72° 12’ E	August 1979
Siberian Research Institute of Agriculture	55° 02’ N, 73° 19’ E	July 1992
Novosibirsk region		
Outskirts of Pen’kovo settlement, Barsukovskaya cave	54° 22’ N, 83° 58’ E	November 2013, January and March 2014
Outskirts of Legostaevo settlement	54° 39’ N, 83° 49’ E	October 1990
Mountain Pikhtoviy Greben’	54° 43’ N, 84° 20’ E	October 1990
Village Verkhnie Iki	54° 36’ N, 84° 08’ E	June 1987
Tomsk region		
Village Kolarovo (biological station)	56° 20’ N 84° 56’ E	July 2014
Krasnoyarsk region (collectors A.V. Zhigalin, A.M. Khritankov)		
Shushenskoe settlement	53° 20’ N 91° 56’ E	September 2012
Sayano-Shushenskiy State Natural Biosohere Reserve, river Khannyg	52° 02’ N 92° 08’ E	July 2012
Sayano-Shushenskiy State Natural Biosohere Reserve, river Bazaga	52° 08’ N 92° 21’ E	July 2012
River Oya, settlement Bol’shaya rechka	53° 02’ N 92° 25’ E	June 2012
Nature Park «Ergaki», river Talovka	52° 21’ N 93° 10’ E	June 2012
Kemerovo region		
Kuznetskiy Alatau (river Kiya)	54° 56’ N 88° 21 E	August 2013
Republic of Tuva (collectors A.V. Zhigalin, A.M. Khritankov)		

Sampling site	Coordinates	Time of the capture
Sush river	52° 03’ N 94° 03 E	August 2013
Uyuk river	51° 56 N 94° 18 E	August 2013
Tere-Hol’ lake	50° 03 N 95° 05 E	July 2007
Irkutsk region		
Sarma settlement (Ol’khonskiy district)	53° 06 N 106° 50 E	August 1989
Tayshetka river (Tayshetskiy district)	55° 59’ N 97° 14 E	August 2014
Republic of Buryatia (collector D.V. Kazakov)		
Rechka Vydrinaya settlement	51° 29’ N 104° 51 E	July 2014
Baikal’ Natural Reserve, river Pereemnaya	51° 34’ N 105° 18 E	July 2014
Sakhalin region (collectors A.V. Zhigalin, D.I. Zhigalina)		
Kunashir island, river Sernovodka	43° 95 N, 145° 50 E	July – August 2014
Kunashir island, Pervushin’s bay (cave)	44° 03’ N 145° 04’ E	July – August 2014
Tajikistan		
Lake Iskanderkul’	39° 05’ N 68° 22’ E	May 2013
Guzlon mountains	40° 04’ N 70° 35’ E	May 2013

1.2. General characteristics of investigation methods

During the summer period captures of bats were made with the help of ornithological or mist nets and Borisenko mobile trap (Borisenko, 1999). During the winter months bats were took away from shelter walls (caves, galleries et al.) or took out from chinks with the help of dressing forceps (Stanyukovich, 1993). Each individual was set apart in a separate sack to exclude the possibility of ectoparasite exchange after the capture. **After the investigation all animals were returned to their wintering places or released since most bat species are included in the Red Data Book of the Russian Federation.**

Body mass, sex and the length of fore arms were determined for the captured animals. Their body condition was determined with BCI (Body Condition Index), which represents a ratio of the observed body weight W (g) to the expectant weight W_0: $BCI = W/W_0$, $W_0 = bR^3$, where R (cm) is the length of the forearm, *b* a coefficient (Vasen’kov, Potapov, 2007). Since at the beginning of wintering most morphological features distinguishing young and adult bats become leveled, it is impossible to identify young animals visually, that is why the age influence on infestation of bats has not been studied through hibernation.

Ectoparasites were collected with a microscopic needle and pincers and fixed in 70% ethanol. Later, mites and ticks were put in Faure-Berlese medium (Bregetova, 1956; Whitaker, 1988).

Microscopic slides of ectoparasites are deposited in the Zoological Institute RAS (Saint-Petersburg), the Zoological Museum of National Research State University of Tomsk, and the Museum of Medical Arachnoentomology, a component of the Laboratory of Arbovirus Infections of the Department of Feral Herd Infections of Omsk Research Institute of Feral Herd Infection.

The identification of ectoparasites and their photographs were made under a light microscop (Nikon Eclipse 50i with digital camera) with the use of keys and publications (Rudnick, 1960; Micherdzinsky, 1980; Radovsky, 1967; Stanyukovich, 1997, et al.).

Range typology is presented according to K.B. Gorodkov (1984).

Species only known from the literature (*Macronyssus leislerianus* Fain, Walter & Heddergott, 2003 and so on) are not discussed in the book.

Standard parasitological indices are used for the mathematical processing of data:

a) Prevalence (P) – the share of infected host individuals (%);

b) Mean intensity (MI) – mean number of parasites on one infected host.

For the characterization of ectoparasite fauna components we have used the classification after Esch et al. (1990) (Balashov, 2009), in which core-species, satellite-species and accidental species are determined. The core is formed by species of ectoparasites that are systematically found and therefore fairly numerous. Satellite-species are also systematically found but not numerous. Accidental species are not specific to one host, that is why they are represented in few findings. The boundary between core and satellite species is drawn on MI equalling 10% (Kennedy, Bakke, 1989), however in most cases the number of core-species is much higher than this border, while the number of satellite species is substantially lower. This classification traces to «Core-satellite» theory of I. Hanski (1982), according to which all species in the community could be subdivided into basic (core), numerous and widely spread, and satellite-species (satellite) with the opposite characteristics.

Statistical analysis of the data

Size parameters of S. myoti (Chapter 2.2)

For the analysis, the length and width of dorsal and sternogenital shields were determined for individuals previously considered within the *S. myoti* species collected from four bat species (*Myotis blytii, M. dasycneme*, *M. daubentonii*, *M. petax*). Altogether 189 individuals of mites (120 females and 69 males) were included in the analysis. The data analysis has been conducted by the method of main component with the help of statistical environment R (statistical medium R) (R 3.1.2, packet "ade4") (Chessel, Dufour, Thioulouse, 2004; Shitikov, Rozenberg, 2014).

Investigation of number dynamics in the period of hibernation (Chapter 3.3)

Gamasid mite *Macronyssus corethroproctus* Oudemans, 1902 (a specific ectoparasite of the pond bat) has been chosen for the investigation of population dynamics during hibernation. This species is not sufficiently studied but is very numerous, which has allowed us to receive maximally correct data. Population dynamics of ectoparasites during pond bat hibernation (the years of 2010-2011) has been studied according to Reisen et al. (1976). Gamasid mites were collected from 8-10 hosts of hibernacula from the moment of winter colony forming (October) with the intervals of 2-4 weeks till the moment of its disband (May). In total, 84 individuals of *Myotis dasycneme* have been investigated. 4392 samples of *M. corethroproctus* were collected for the analysis. The prevalence (P) was defined as the chance of infestation (C), i.e. the numerical ratio of host individuals infested (I) and not infested (NI) with the ectoparasite (C = I/NI). The mean intensity (MI) was defined as the median (Me) as well as the geometric mean (GM) of parasite abundance with its 95% confidence interval (CI), ind. per host, calculated only for infested bats. The data were analyzed in Statistica software (StatSoft, 2001), using the methods of multimodel inference (Burnham, Anderson, 2002), robust regression analysis (Atkinson, Riani, 2000), and nonlinear assessment (the Levenberg–Marquardt algorithm). When linear regression was calculated, the constant +1 was initially added to the number of collected mites (because six bats were free from mites), and a decimal logarithm was taken for stabilizing the variance. The models were ranked according to their “weight” (*w*) calculated on the basis of the consistent Akaike information criterion (CAIC); the relative importance of predictors (*w*+) was estimated from the sum of the weights of models containing each particular predictor (Burnham, Anderson, 2002).

Investigation into population dynamics of the species of Siberian-Far East complex during wintering was focused on the gamasid mite *Macronyssus charusnurensis* Dusbábek, 1962 – a specific ectoparasite of the eastern water bat *Myotis petax.* The first day of hibernation was October 10th, and the last day was May 12. Bats were collected in Barsukovskaya cave (Novosibirsk region, Maslyaninskyi district) during host hibernation in 3 visits (November 8, 2013, January 3, 2014 and March 26, 2014) (the temperature during wintering was +4°C). A total of 34 individuals of the Eastern water bat were examined. From those bats, 578 gamasid mites of the genus *Macronyssus* were collected, 540 of which belong to the species *Macronyssus charusnurensis.*

Sample characteristics are presented as the mean ± standard error of the mean (M ± m). Data were processed using univariate (one-way) and two-factor (two-way) analysis of variance (ANOVA) (Chambers, Hastie, 1992). The appropriate form of normal sampling distributions was assessed using the Shapiro-Wilk test criterion. The homogeneity of variances was confirmed using the criterion of Leuven. We accounted for two important assumptions in the analysis of variance. For pairwise comparisons between samples, posterior criteria were used (Tukey’s test). To stabilize the dispersion among the previously collected mites, a constant was added because some specimens were free from mites, and a base-10 logarithm was used.

CHAPTER 2. FAUNA OF GAMASID MITES – BAT ECTOPARASITES

2.1. A brief history of the investigation of bat gamasid mites

The mite (*Pediculus vespertilionis*) parasitizing bats was first described by C. Linnaeus in the middle of the XVIIIth century (Linnaeus, 1758). The proceedings of C. von Heyden (1826), C.L. Koch (1836, 1838), F.A. Kolenati (1856) were devoted to the investigation of this group of ectoparasites. The most considerable papers on the systematic of bat ectoparasites were written by A. Berlese (1882-1892), A.C. Oudemans (1902-1904), S. Hirst (1927), H. Vitzthum (1929, 1942), F.A. Fonseca (1948) and other authors. The first investigations of bat ectoparasites' biology during their hosts' hibernation appeared in the 1930s of the XXth century (Markova, 1938). These investigations were continued by American scientists (Beck, 1966; Reisen et al., 1976). The facts of the decrease in ectoparasite numbers during hibernation, the essential shift in sexual structure (towards females) of mites of the genus *Macronyssus*, the presence of the most part of the indicated ectoparasites on hosts' females – *Myotis velifer* (Allen, 1890) were first described in the article of W. Reisen with coauthors (1976).

In the second half of the XXth century conclusive monographs focused on the systematic were published. They are the revision of the family Spinturnicidae by A. Rudnick (1960), the review of Western Palaearctic spinturnicids by J. Deunff (1977), brief systematic reviews of some macronyssids and dermannysids of Britain and a detailed description of the genus *Steatonyssus* by W.M. Till and G.O. Evans (1964, 1966). A considerable contribution to the development of the taxonomy and morphology of mites belonging to the Macronyssidae and Laelapidae families parasitizing bats was made by F. Radovsky (1967, 2010). He also studied the evolution aspects of biology of gamasides associated with chiropterans (Radovsky, 1994). The subfamily Ornithonyssinae is described in detail in the monograph of W. Micherdzinsky (1980) where the data on morphology, taxonomy and biological features of mites of the genus *Steatonyssus* and *Ornithonyssus* parasitizing bats are presented.

From the beginning of the 1960s of the XXth century a lot of works devoted the fauna of gamasid mites with the description of bat ectoparasites from different territories of Palaearctic were published. The territories mentioned include Northern Europe (Mrciak, Nyholm, 1967), Central and Eastern Europe (Beacournu, 1961; Beron, 1973; Dusbábek, 1962, 1964, 1966, 1967, 1968, 1972; Haitlinger, 1978a, 1978b; Haitlinger, Ruprecht, 1985; 1992, 1997; Haitlinger, Łupicki, 2008;

Schmidt, 1987; Imaz et al., 1999), China (Teng, 1980; Gu, Wang, 1985), Korea (Kim, Byung, 1991; Kim, Hai, Byung, 1992), Japan (Uchikawa, Kumada, 1977; Uchikawa, 1979; Uchikawa, Wada, 1979). The description of new species of the genus *Spinturnix* similar to each other makes it necessary to revise and describe in detail the phylogeny of *S. myoti* species group (Deunff, 1977; Haitlinger, 1978; Peribanez-Lopez et al., 1989; Deunff et al., 2004; Pocora et al., 2013; Orlova et al., 2015).

The epidemiologic significance of gamasid mites – bat ectoparasites was communicated in detail in "Medical theriology" (edited by V.V. Kucheruk, 1989).

Gradually European scientists return to the examination of biology peculiarities and life cycles of gamasides parasitizing bats (see the details in Chapter 4).

The development of molecular methods of biological investigations allowed to study different aspects of coevolution relationships of chiropterans and their ectoparasites more profoundly. The results of molecular-genetic investigations of spinturnicids' phylogenetic structure on the territory of Central and South Europe are highlighted in the works of N. Brujndonx with coauthors (2009), Baulechner with coauthors (2013).

The investigations of the fauna of bat ectoparasites on the ex-USSR territory were carried out periodically. N.G. Bregetova (1956) pointed out 4 species of gamasid mites parasitizing bats, however, only one of the names mentioned is valid today (Stanyukovich, 1993). A lot of regional faunistic researches on different territories of the former USSR appeared later. The territories include the Crimea (Vshivkov, 1963), Azerbaijan (Gadzhiev, Dubovchenko, 1966, 1967, 1976), Moldavia (Pinchuk, 1970, 1971a, b), Armenia (Arutyunyan, Ogadjanyan, 1974a, b), Kazakhstan (Tagil'tsev, 1971, Senotrusova, Tagil'tsev, 1968; Senotrusova, 1987), Kyrgyzstan (Rybin, 1983), Tadjikistan (Stanyukovich, Malinovskiy, 1992).

In the 1990s of the XXth century the research was carried out on the territory of Russia in the Leningrad region and Far East (Stanyukovich, 1990; Stanyukovich, 1995; Medvedev et al., 1991).

Table 2

Gamasid mites – bat ectoparasites distribution in the Boreal Palaearctic region

	Mite species	Baltic Region	Belarus’	Ukrain	Crimea	Moldova	Leningrad district	Russian North (Arkhangelsk and Vologda district)	Central Russia (Moscow district, Voronezh district)	Volga (Penza district, Nighniy Novgorod district, Saratov district, Samara district)	Volga-Caspian region (Volgograd district, Astrakhan’ district)	Vyatka-Kama interfluve (Kirov district, Udmurtia republic)	Caucasus (Stavropol’ region, North Osetia republic)	South Caucasus (Georgia, Armenia, Azerbeijan)	Urals	Kazakhstan	Central Asia (Uzbekistan, Tajikistan, Kirgizstan, Turkmenistan)	Altai	Western Siberia	Southern Siberia	Baikalian Siberia	Russian Far East	Kuril Island
1	*Eyndhovenia euryalis euryalis*													○									
2	*E. e. oudemansi*				○									○		○							
3	*Paraperiglischrus rhinolophinus*				○	○								○			○						
4	*Spinturnix acuminatus*	○	○	○	○			○	○	○	○			○		○	○			○		○	
4a	(*S. andegavinus*)	+		○		○			+														
5	*S. barbastelli*	○				○								○			○						
6	*S. bakeri*													○									
7	*S. bregetovae*																			+		○	
8	*S. helvetiae*		○		○																		
9	*S. emarginatus*																○						
10	*S. kolenatii*	*	○		○	○	○			○	○		○	○	*	○	*	+	+	*		○	
11	*S. maedai*																	+	+	*		○	
12	*S. myoti*	*	○	○	○		*	○	○	○	○	+	○	○	*	○	*	+	+	*	+	○	*

Continuation of the Table 2

	Mite species	Baltic Region	Belarus’	Ukrain	Crimea	Moldova	Leningrad district	Russian North (Arkhangelsk and Vologda district)	Central Russia (Moscow district, Voronezh district)	Volga (Penza district, Nighniy Novgorod district, Saratov district, Samara district)	Volga-Caspian region (Volgograd district, Astrakhan’ district)	Vyatka-Kama interfluve (Kirov district, Udmurtia republic)	Caucasus (Stavropol’ region, North Osetia republic)	South Caucasus (Georgia, Armenia, Azerbeijan)	Urals	Kazakhstan	Central Asia (Uzbekistan, Tajikistan, Kirgizstan, Turkmenistan)	Altai	Western Siberia	Southern Siberia	Baikalian Siberia	Russian Far East	Kuril Island
13	*S. mystacinus*		○			○	○			○		+	○		+	○	○			○			
14	*S. plecotinus*	○				○	○			○			○	○	*		*	+		○	+		
15	*S. nobleti*																					○	
16	*S. psi*			○										○								○	
17	*S. uchikawai*																					?	+
18	*Macronyssus barbastellinus*					○											○						
19	*M. charusnurensis*														+	○		+	+	*	+	○	+
20	*M. corethroproctus*	*				○	*			○		+	○		+	○		+	+				
21	*M. crosbyi*						○								+			+		○			
22	*M. cyclaspis*	○				○											○						
23	*M. diversipilis*	*			○		○					+			+								
24	*M. ellipticus*	○			○		*						○		+			+				○	
25	*M. flavus*	*	○	○	○	*	○	○		○	○	+	○	○		○	○						
26	*M. granulosus*			○	○	○							○	○		○	○	+		○		○	+
27	*M. heteromorphus*																	+	+	○		○	○

Continuation of the Table 2

	Mite species	Baltic Region	Belarus'	Ukrain	Crimea	Moldova	Leningrad district	Russian North (Arkhangelsk and Vologda district)	Central Russia (Moscow district, Voronezh district)	Volga (Penza district, Nighniy Novgorod district, Saratov district, Samara district)	Volga-Caspian region (Volgograd district, Astrakhan' district)	Vyatka-Kama interfluve (Kirov district, Udmurtia republic)	Caucasus (Stavropol' region, North Osetia republic)	South Caucasus (Georgia, Armenia, Azerbeijan)	Urals	Kazakhstan	Central Asia (Uzbekistan, Tajiki-stan, Kirgizstan, Turkmenistan)	Altai	Western Siberia	Southern Siberia	Baikalian Siberia	Russian Far East	Kuril Island
28	*M. hosonoi*																	+		+	+	○	+
29	*M. kolenatii*	*			○	○		○	○	○	○		○		+	○	○						
30	*M. rhinolophi*												○	○			○						
31	*M. sibiricus*																		+				
32	*M. stanyukovichi*																	+	+				
33	*M. tigirecus*																		+				
34	*Steatonyssus aglaiae*				○																		
35	*St. cavus*																○						
36	*St. desertorus*																○						
37	*St. mongolicus*																○						
38	*St. occidentalis evansi*		○											○		○	○						
39	*St. noctulus*	○	○	○	○			○		○				○		○	○						
40	*St. periblepharus*	*	○	○	○			○	○	○	○		○	○	+	○	○				○		

End of the Table 2

	Mite species	Baltic Region	Belarus’	Ukrain	Crimea	Moldova	Leningrad district	Russian North (Arkhangelsk and Vologda district)	Central Russia (Moscow district, Voronezh district)	Volga (Penza district, Nighniy Novgorod district, Saratov district, Samara district)	Volga-Caspian region (Volgograd district, Astrakhan’ district)	Vyatka-Kama interfluve (Kirov district, Udmurtia republic)	Caucasus (Stavropol’ region, North Osetia republic)	South Caucasus (Georgia, Armenia, Azerbeijan)	Urals	Kazakhstan	Central Asia (Uzbekistan, Tajikistan, Kirgizstan, Turkmenistan)	Altai	Western Siberia	Southern Siberia	Baikalian Siberia	Russian Far East	Kuril Island
41	*St. spinosus*	○									○				+				+			○	
42	*St. superans*														+	○	○		+			○	
43	*Ornihonyssus flexus*				○										+		○						
44	*O. hoogstraali*																○						
45	*O. pipistrelli*	*								○			○		+			○			+	?	
46	*O. olesovi*						+								+			+					
47	*O. guzlonicus*																+						
48	*Ichoronyssus scutatus*			○	○								○	○			○					○	

Notes:
+ - own data;
* - own (current) and literature data;
○ - literature data.

The first generalized publication on fauna of gamasid mites – ectoparasitic bats of Russia and adjacent territories was published (Stanyukovich, 1997).

Complex investigations of bat parasitic gamasides in the Urals, Siberia and adjacent territories were expanded in the second decade of the XXI century (Orlova, 2011; Orlova, Orlov, 2011; Orlova et al., 2011; Orlova et al., 2012; Orlova, 2013a; Orlova, 2013b; Orlova et al., 2013; Orlova, 2014; Orlova et al., 2014a; Orlova et al., 2014b; Orlova, Orlov, 2015; Orlova et al., 2015) (tabl. 2).

2.2. Species list

Taxonomy
Class Arachnida
Subclass Acarina
Order Parasitiformes
Cohort Gamasina

Gamasid mites – bat ectoparasites are represented by three families: Spelaeorhinchidae, Spinturnicidae and Macronyssidae (also mites of two genera of fam. Laelapidae parasitize megachiropterans in Australia and New Zealand), last two of them inhabit temperate zone (Stanyukovich, 1993).

Spinturnicid mites are widely distributed around the world, family Spinturnicidae includes 13 genera with 96 species (Dusbábek, 1962, 1972; Baker, Delfinado, 1964; Radovsky, 1967; Uchikawa et al., 1994). This family is specific for bats. Only three spinturnicid mite genera (*Spinturnix*, *Eyndhovenia*, *Paraperiglischrus*) were described for Russia and adjacent countries (Stanyukovich, 1997).

Family Macronyssidae includes reptiles, bird and mammals ectoparasites (total 27 genera and more than 150 species), and are known as vectors of murine typhus, rickettsial pox, equine encephalitis, and coxsackievirus disease, which they may transmit to humans (Saunders, 1975). However the most of macronyssid mites are specific bat ectoparasites. Bats of Russia and ex-USSR republics harbor mites belonging to two subfamilies: Macronyssinae (two genera and 17 species) and Ornithonyssinae (two genera and 14 species) (Stanyukovich, 1997).

Familia of gamasid mites on bats

Large sclerotized mites (body length 400-1700 µm). Coxa immovable, smooth and radial. Tritosternum without branches, may be strongly reduced. Palpal trochanter without ridge-like process ……………………………………………Spinturnicidae Oudemans, 1901

Mite size medium or small. Coxae free movable. Tritosternum with branches. Palpal trochanter with ridge-like process …......……....………………….. Macronyssidae Oudemans, 1936

Family Spinturnicidae (Oudemans, 1902)

Large, highly sclerotized mites with yellow-brown rhomboid or ovoid bodies (fig. 1). Spinturnicids are exclusively parasitic on bats and inhabit the wing and tail membranes (Rudnick, 1960). These mites have strong legs with immovable coxae and are dorsal-ventrally flattened to facilitate adherence to smooth hairless patagia. In addition, they adhere to and move over wing and tail membranes equally well, whether their dorsal or ventral side is against the host. They locomote poorly when not on patagia and die within few hours of removal from the host.

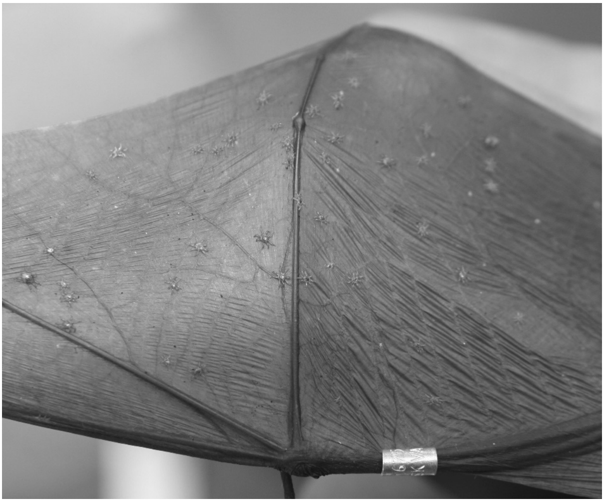


Fig. 1. *Spinturnix uchikawai* on the bat wing membrane (Kunashiri island, summer 2014). Photo by A.V. Zhigalin

Genera of Spinturnicidae

Females

1. Peritremes short (length only 2-3 times larger stigma diametr). Dorsal shield divided into two lightly sclerotized parts (only several parts of dorsal shields strongly sclerotized) .... *Paraperiglischrus* Rudnick, 1960

   Peritremes long (length more 5 times larger stigma diametr). Dorsal shield undivided ………..................................………. 2

2. Peritremes curved. Between coxae II and III bending from dorsal to ventral surface. Tritosternum small or lacking ……………………………..………… *Spinturnix* von Heyden, 1826

   Peritremes completely dorsal. Tritosternum is large ……….......................................… *Eyndhovenia* Rudnick, 1960

Males

1. Peritremes short (length only 2-3 times larger than stigma diametr). On two dorsal shields there are few strongly sclerotized parts ………..…………………..………… *Paraperiglischrus* Rudnick

   Peritremes long (length more 5 times larger stigma diametr). Sole dorsal shield well sclerotized ....… 2

2. Peritremes completely dorsal. Seta St1 length 1.5-2 times longer anal shields …..… *Eyndhovenia* Rudnick

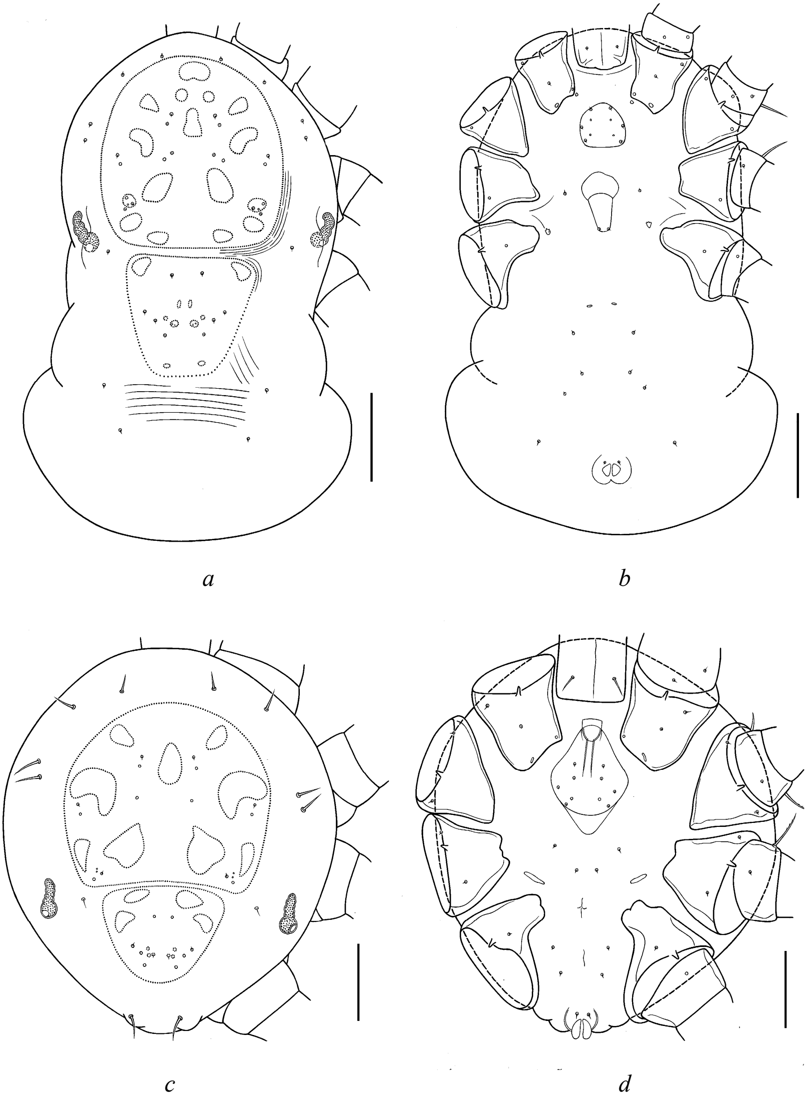
   Peritremes curved. Between coxae II and III bending from dorsal to ventral surface. Seta St1 length never exceeds and often 2-3 times less anal shield length …...........… *Spinturnix* von Heyden

Genus *Paraperiglischrus* Rudnick, 1960

Paraperiglischrus rhinolophinus (Koch, 1841)

Distribution: temperate and subtropical latitudes of Palaearctic (United Kingdom, France, the Netherlands, Czech Republic, Bulgaria, Romania, Ukraine, Moldova, Egypt, Korea, India, Japan) (Kim et al., 1992; Gadzhiev, Dubovchenko, 1976; Stanyukovich, 1997).

Host preference: oligoxenous (species of genus *Rhinolophus*): *Rhinolophus ferrumequinum*, *R. mehelyi*, *R. hipposideros*, *Rhinolophus blasii* Peters, 1866, *R. euryale*, *Rhinolophus clivosus* Cretzschmar, 1828, *Rhinolophus rouxi* Temminck, 1835, *Rhinolophus cornutus* Andersen, 1918, *Eptesicus serotinus*.



a *b*

c *d*

Fig. 2. *Paraperiglischrus rhinolophinus* (Koch, 1841): *a* – ♀, dorsaly; *b* – ♀, ventraly; *c* – ♂, dorsaly; *d* – ♂, ventraly. Scale 200 μm

Genus *Eyndhovenia* Rudnick, 1960

Females

Tritosternum massive with two expressed projections on posterior margin. Integument near sternal shield has lanceolate pattern ……………………... *Eyndhovenia euryalis euryalis* (Canestrini, 1884)

Tritosternum not large, without expressed projections. Integument near sternal shield has reticulate pattern. Near pattern is lanceolate .... *Eyndhovenia euryalis oudemansi* (Eyndhoven, 1941)

Males

10 setal pairs on dorsal unsclerotized surface. Integument near sternal shield has lanceolate pattern ….......... *E. euryalis euryalis* (Canestrini)

11 setal pairs on dorsal unsclerotized surface. Integument near sternal shield has reticulate pattern …....................................... …………………………..… *E. euryalis oudemansi* (Eyndhoven)

Protonymphs

2 setal pairs on dorsal opistosomal surface, posterior setae pair in 2 times less then front pair. Integument near sternal shield has lanceolate pattern …………………………..... *E. euryalis euryalis* (Canestrini)

1 setal pairs and 1 microsetal pair on dorsal opistosomal surface. Integument has reticulate pattern .... …………………………….. *E. euryalis oudemansi* (Eyndhoven)

Eyndhovenia euryalis euryalis (Canestrini, 1884)

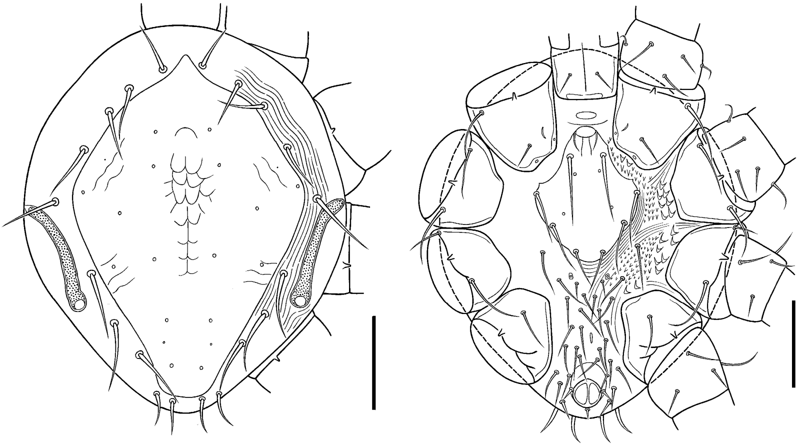
Distribution: Central Europe, the Mediterranean and Transcaucasian states (Armenia, Azerbaijan) (Gadzhiev, Dubovchenko, 1976; Stanyukovich, 1997).

Host preference: probably oligoxenous (*R. euryale*, *R. mehelyi*, *Miniopterus schreibersi* (Kuhl, 1817)).

Eyndhovenia euryalis oudemansi (Eyndhoven, 1941)

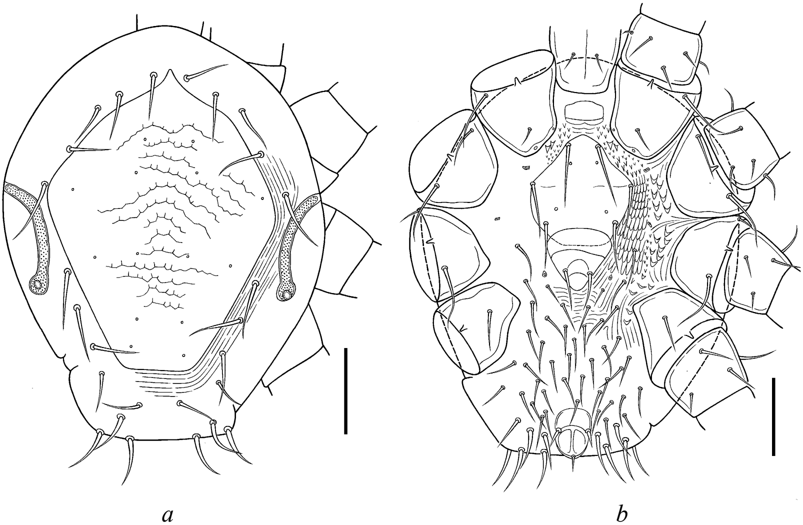
Distribution: Trans-Palaearctic subboreal (Stanyukovich, Malinovskiy, 1992).

Host preference: polyxenous, hosts are bats of fam. Rhinolophidae and Vespertilionidae (*R. ferrumequinum*, *R. hipposideros*, *M. schreibersi*, *Pipistrellus pipistrellus*, *E. serotinus*, *Myotis blythii*).



a *b*

Fig. 3. *Eyndhovenia euryalis euryalis* (Canestrini, 1884):
a – ♂, dorsaly; *b* – ♂, ventraly. Scale 200 µm



a *b*

Fig. 4. *Eyndhovenia euryalis oudemansi* (Eyndhoven, 1941):
a – ♂, dorsaly; b – ♀, ventraly. Scale 200 µm

Key for the genus Genus *Spinturnix* Heyden, 1826 of the boreal Palaearctic region

Females

1. Not more then 7 pairs of setae are on the dorsal opistosomal surface 2

Dorsal opistosomal setae more then 20 4

2. 6-7 pairs dorsal opistosomal setae; lanceolate setae on dorsal tip of tarsi II-IV .... *S. plecotinus* (Koch, 1839)

3-4 pairs on the end of opistosoma; lanceolate setae is absent 3

3. Two long setal pairs and two short setal pairs on opistosomal end; tritosternum is disk-shaped .... *S. kolenatii* Oudemans, 1910

Three pairs of the short setae on the dorsal surface of opistosoma; tritosternum jar-shaped .... *S. bakeri* Rudnick, 1960

4. Dorsal opistosomal setae not more then 50 5

Dorsal opistosomal setae more then 50 10

5. Tritosternum invisible, setae of legs smooth 6

Tritosternum large, mushroom-shaped; some dorsal setae of I-II legs serrated .... *S. psi* (Kolenati, 1856)

6. Dorsal opistosomal setae not less 40 7

Dorsal opistosomal setae less 40 8

7. Sternal shield with large reticulate pattern; 3 sternal setal pairs on shield; tritosternum invisible .... *S. bregetovae* Stanyukovich, 1995

Sternal shield with small reticulate; sternal setae is not on shield; tritosternum is small and rounded .... *S. helvetiae* Deunff, Keller, Allen, 1990

8. Dorsal shield egg-shaped; posterior margin of sternal shield almost straight 8

Dorsal shield diamond-shaped, rounded; posterior margin of sternal shield rounded .... *S. nobleti* Deunff, Volleth, Keller, Allen, 1990

9. Dorsal shield with two large rounded projections at the front and at the back; podosomal setae about 2 times shorter then opistosomal .... *S. acuminatus* (Koch, 1836)

Dorsal shield with one large rounded projections at the front; at the back shield is smoothly narrowing; length of podosomal and

opistosomal setae nearly equal ....
.... *S. barbastelli* (Kolenati, 1856)

10. Sternal shield rounded or pear-shaped …….................……. 11
Sternal shield pentagonal ……………...…………………………..
.... *S. maedai* Uchikawa, Wada, 1979

11. Dorsal opistosomal setae 80-130 ...….............................. 12
Dorsal opistosomal setae 70-90 ……...………......…………. 13

12. Dorsal opistosomal setae 90-130. Dorsal shield large (more than 800 µm) …………...................................... *S. myoti* (Kolenati, 1856)
Dorsal opistosomal setae 80-100. Dorsal shield small (less than 800 µm) ……....…………………...……………………...........…
.... *Spinturnix uchikawai* Orlova, Zhigalin, Zhigalina, 2015

13. Marginal dorsal opistosomal setae longer then other opistosomal setae; trirosternum is clearly seen …… *S. emarginatus* (Kolenati, 1856)
Marginal dorsal opistosomal setae and other opistosomal setae nearly equal ..……...…………… *S. mystacinus* (Kolenati, 1857)

Males

1. Two setae are on the end of the opistosoma; lanceolate seta are on dorsal tip of tarsi II-IV ….......................……… *S. plecotinus* (Koch)
4-46 setae on the end of opistosoma ...…...…………………… 2

2. Dorsal opistosoma have 4 setae …...………...………………….. 3
On dorsal opistosoma 14-46 setae ……………..……………… 4

3. Sternogenital shield with sharp processus at back; pattern of shield is small reticulate; 6 setal pair on ventral integument between II-IV coxae ……………………………………..………….. *S. bakeri* Rudnick
Sternogenital shield is smoothly rounded at the back; pattern of the shield is large reticulate; 8 setal pairs on ventral integument between II-IV coxae ………...……...…….. *S. kolenatii* Oudemans

4. 3 pairs setae on sternoginital shield ………………......………….. 5
4-5 pair setae on sternoginital shield ……....………….....…… 12

5. Sternogenital shield bottle-shaped ………….....…...………………. 6
Sternogenital shield spade-shaped ……...………………..……… 9

6. Dorsal opistosoma have 29-38 setae ………………………..……….. 7
On dorsal opistosoma 18-20 setae …...…..………………………. 8

7. Dorsal shield diamond-shaped with rounded corners ....……………………………… *S. maedai* Uchikawa, Wada

Dorsal shield egg-shaped with two projections at front and at back, two pairs of pores on border of dorsal shield with integument ………….....…..……. *S. helvetiae* Deunff, Keller, Allen

8. Dorsal shield with dotting pattern; setal pair near back margin of sternogenital shield ……….....……………….…. *S. acuminatus* (Koch)

Dorsal shield without dotting pattern; near back margin of sternogenital shield there are no closely plased setae ……………...………….....…..…. *S. barbastelli* (Kolenati)

9. Pattern of sternogenital shield small reticulate …………………...……. .... *S. nobleti* Deunff, Volleth, Keller, Allen

Pattern of sternogenital shield large reticulate ....……………. 10

10. Sternogenital shield with as if cut on back ...... *S. mystacinus* (Kolenati)

Sternogenital shield with as if not cut on back ………..……….. 11

11. On dorsal opistosomal surface 32-34 setae; tritosternum undiscernible …...................................….…….. *S. bregetovae* Stanyukovich

On dorsal opistosomal surface 6-16 setae; tritosternum developed …......................................…….. *S. emarginatus* (Kolenati)

12. On sternogenital shield 4 setal pairs …………………………….. 13

On sternogenital shield 5 setal pairs …………. *S. psi* (Kolenati)

13. Posterior margin of sternogenital shield smooth (fig. 20g); on ventral opistosoma more than 20 setae. Soft integument around shield with scaled sculpturing (fig. 20e) ….....…..……………….. *S. myoti* (Kolenati)

Posterior margin of sternogenital shield with small irregular projection (fig. 20h); on ventral opistosoma 15-19 setae. Soft integument around shield with denticle sculpturing (fig. 20f) ....……….. *Spinturnix uchikawai* Orlova, Zhigalin, Zhigalina

Spinturnix acuminatus (C.L. Koch, 1836)

Distribution: boreal and subboreal zone of Western and Central Palaearctic (United Kingdom, Germany, Czech Republic, Slovakia, the Baltic republics, Moldova, Ukraine, Caucasus, Central Asia) (Rudnick, 1960; Vshivkov, 1963; Juvara, 1967; Gadgiev, Dubovchenko, 1967; Pinchuk, 1971; Dusbábek, 1972; Beron, 1974; Uchikawa, Wada, 1979; Rybin, 1983; Schmidt, 1987; Senotrusova, 1987; Stanyukovich, 1990; Stanyukovich, Malinovskiy, 1992; Stanyukovich, 1997; Medvedev et al., 2000; Haitlinger, Łupicki, 2008).

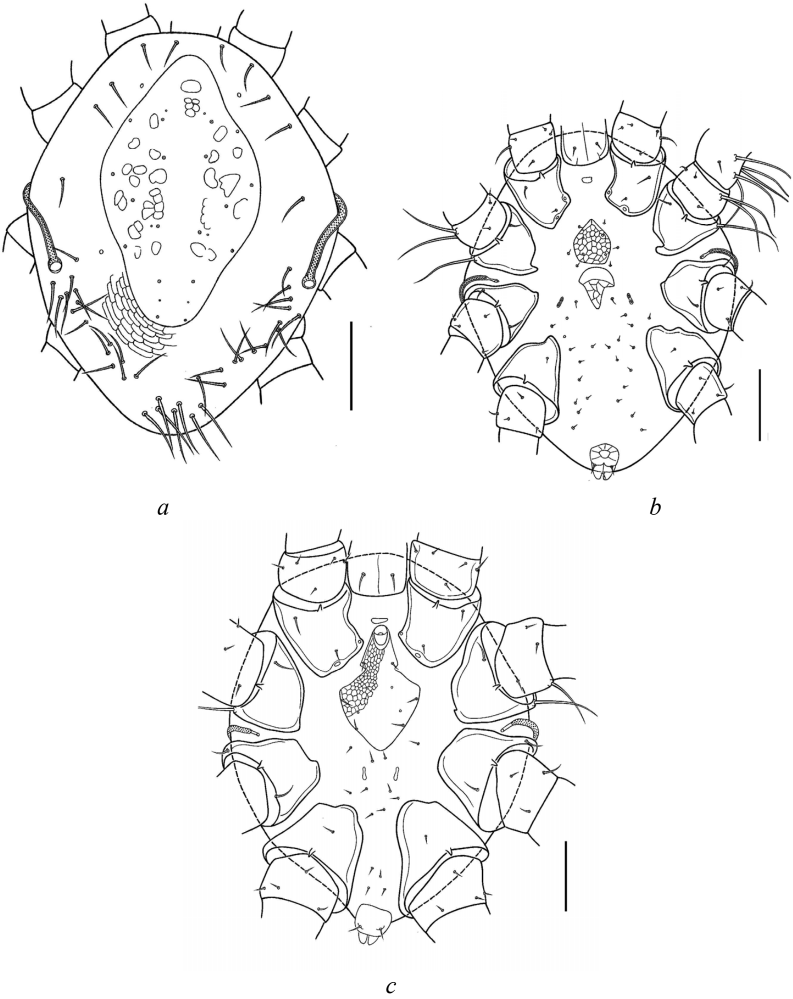


Fig. 5. *Spinturnix acuminatus* (C.L. Koch, 1836):
a – ♀, dorsaly; *b* – ♀, ventraly; *c* – ♂, ventraly. Scale 200 µm

Host preference: pleoxenous (bats of fam. Vespertilionidae): *M. blythii*, *M. dasycneme*, *M. daubentonii*, *Nyctalus noctula*, *Pipistrellus pipistrellus*, *P. nathusii*, *Hypsugo savii*, *E. serotinus*, *Murina* *hilgendorfi*, *Barbastella darjelingensis*, *Scotophilus temminckii* Allen, Harrison, 1893.

Material: 11 ♀♀, 13 ♂♂, 3 N1, 3 N2 ex *Nyctalus noctula* (Warmia-Mazury and Pomerania, Poland; VI.2011, VII.2012).

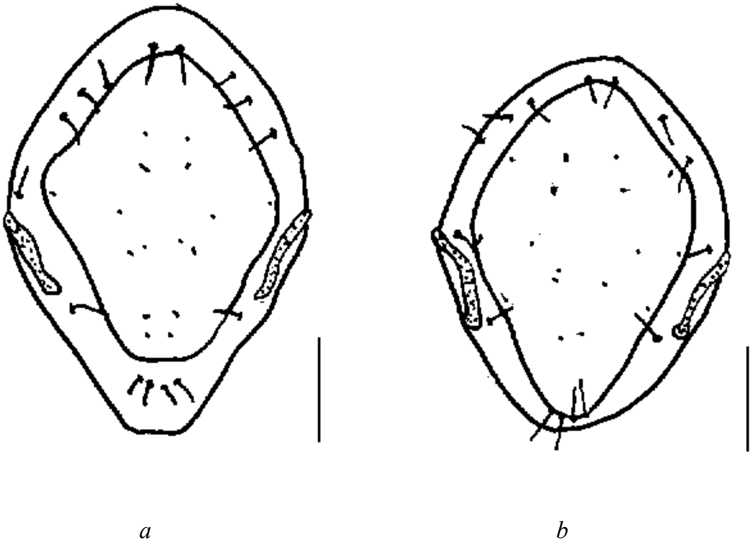


Fig. 6. *Spinturnix bakeri* Rudnick, 1960:
a – ♀, dorsaly; *b* – ♂, dorsaly. Scale 250 μm

Spinturnix bakeri Rudnick, 1960

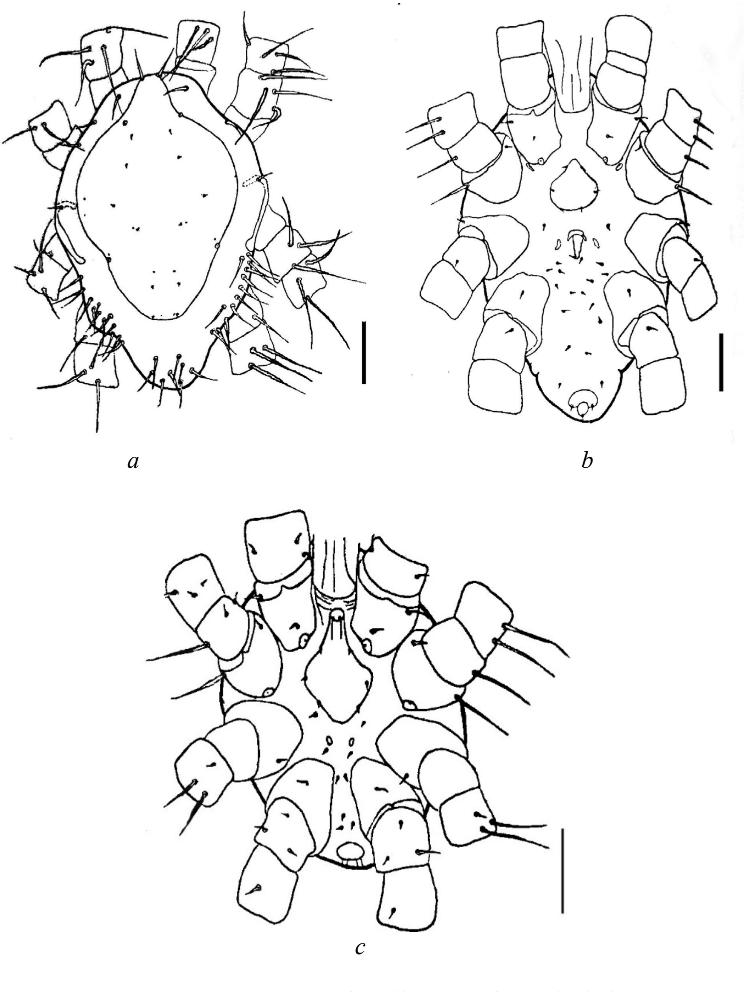
Distribution: holarctic species, finds are rare (Azerbaijan, United States, Canada, Cuba) and do not allow conclusions about the range configuration (Herrin, Tipton, 1975; Stanyukovich, 1997).

Host preference: probably pleoxenous (bats of fam. Vespertilionidae): *Eptesicus fuscus* (Palisot de Beauvois, 1796), *E. serotinus*, *Pipistrellus kuhlii*.

Spinturnix barbastelli (Kolenatii, 1856)

Distribution: Trans-Palaearctic (Western Europe, the Baltic states, the Caucasus, Central Asia, the Far East) (Rudnick, 1960; Dusbábek, 1972; Haitlinger, 1978; Pinchuk, 1971; Arutyunyan, Ogadganyan, 1974a; Rybin, 1983; Stanyukovich, 1990).

Host preference: probably oligoxenous (bats of genus *Barbastella*): (*Barbastella barbastellus*, *B. darjelingensis*).



a *b*

c

Fig. 7. *Spinturnix barbastelli* (Kolenatii, 1856) (from Pinchuk, 1971): *a* – ♀, dorsaly; *b* – ♀, ventraly; *c* – ♂, ventraly. Scale 200 μm

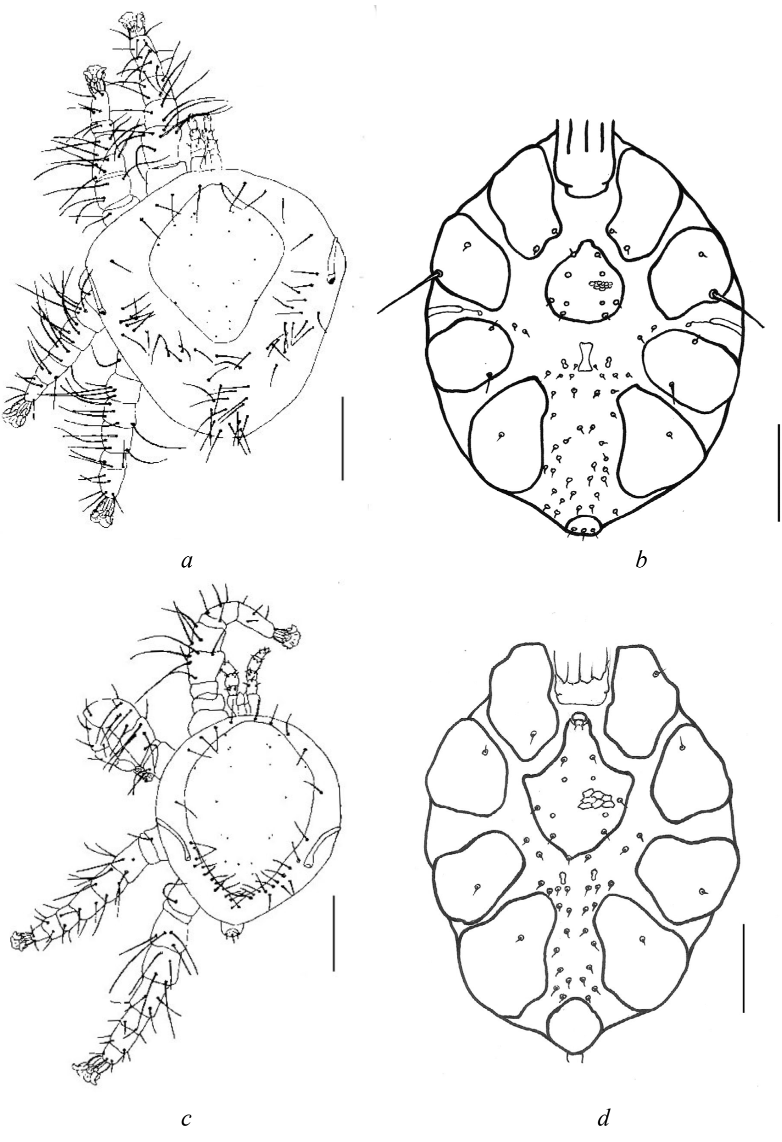


Fig. 8. *Spinturnix bregetovae* (*a, c* – from Stanyukovich, 1995; *b, d* – Orlova et al., 2015): *a* – ♀ dorsaly (scale 200 μm); *b* – ♀, ventraly (scale 150 μm); *c* – ♂, dorsaly (scale 200 μm); *d* – ♂, ventraly (scale 150 μm)

Spinturnix bregetovae Stanyukovich, 1996 (fig. 8)

Distribution: Central and Eastern Palaearctic (Tuva, Far East). Described in the Far East (Primorsky Krai, Suputinsky Reserve (now Komarov Ussuri Nature Reserve)) with an unidentified species of bats (Stanyukovich, 1995). Probably, the area covers the Far East, Central, Eastern, and possibly Western Siberia.

Material: 4 ♀♀, 5 ♂♂ex Myotis petax (r. Uyuk, Tuva; VIII.2013).

Spinturnix emarginata (Kolenati, 1856)

Distribution: Western, Eastern and Southern Europe, Central Asia (Stanyukovich, 1997; Kristofik et al., 2012).

Host preference: *Myotis emarginatus*.

Spinturnix helvetiae Deunff, Keller et Aellen, 1986 (fig. 9)

Distribution: Western Palaearctic (Belarus, Moldova, Switzerland) (Deunff et al., 1986; Stanyukovich, 1997).

Host preference: *Nyctalus leisleri*.

Spinturnix kolenatii Oudemans, 1910 (fig. 10)

Distribution: Holarctic species (USA, UK, Central and Eastern Europe, the Caucasus, Central Asia, the Far East) (Rudnick, 1960; Dusbábek, 1962; Vshivkov, 1963; Pinchuk, 1971; Deunff, 1977; Uchikawa, Wada, 1979; Rybin, 1983; Medvedev et al, 1991; Stanyukovich, 1997; Baker, Craven, 2003).

Host preference: oligoxenous (bats of genus *Eptesicus*): *Eptesicus serotinus*, *E. nilssoni* (Baker, Craven, 2003; Stanyukovich, 1997; Orlova, 2013a). Some mites were collected on other species of Vespertilionidae bats (*Myotis mystacinus*, *Myotis daubentonii*, *Myotis brandtii*, *M. blythii*, *N. noctula*, *Plecotus auritus*, *P. nathusii*, *Vespertilio murinus*, *V. sinensis*, *M. hilgendorfi*). MI of *S. kolenatii* for *E. nilssoni* is 5,0 (from 3,7 in winter shelters to 6,0 in summer (nursely) colonies).

Material (table 3).

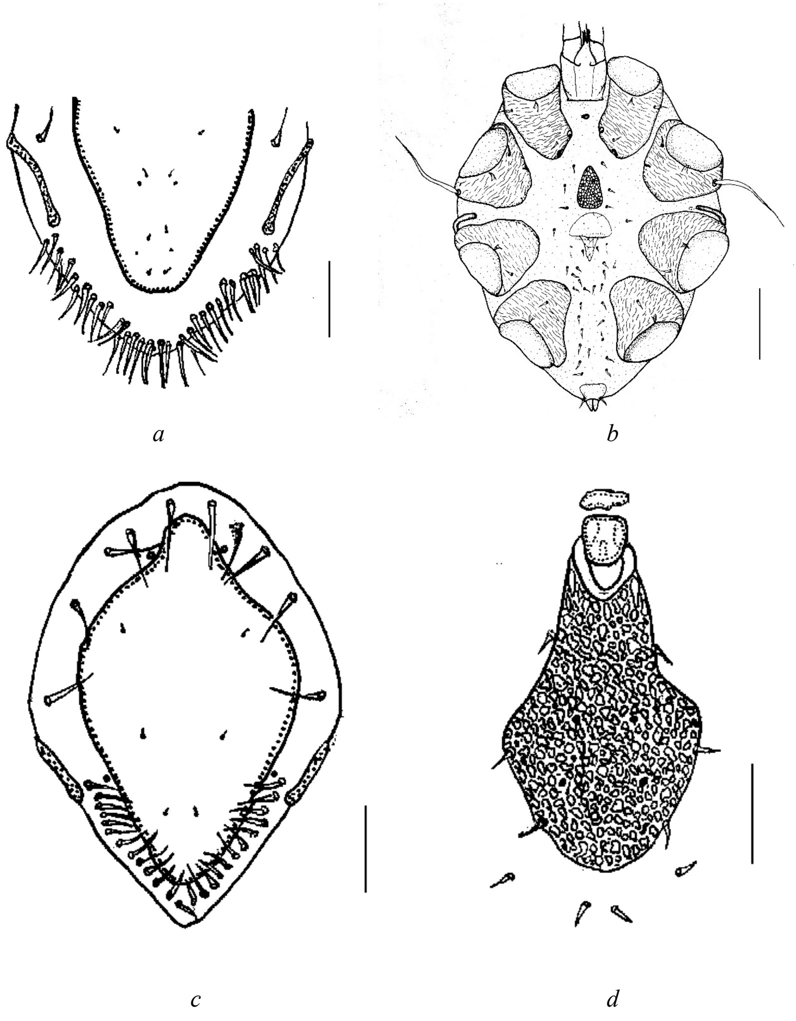


Fig. 9. *Spinturnix helvetiae* (*b* – from Deunff et al., 1986):
a – ♀, opistosoma dorsaly (scale 200 µm); *b* – ♀, ventraly (scale 200 µm);
c – ♂ dorsaly (scale 200 µm); *d* – ♂, sternal shield (scale 100 µm)

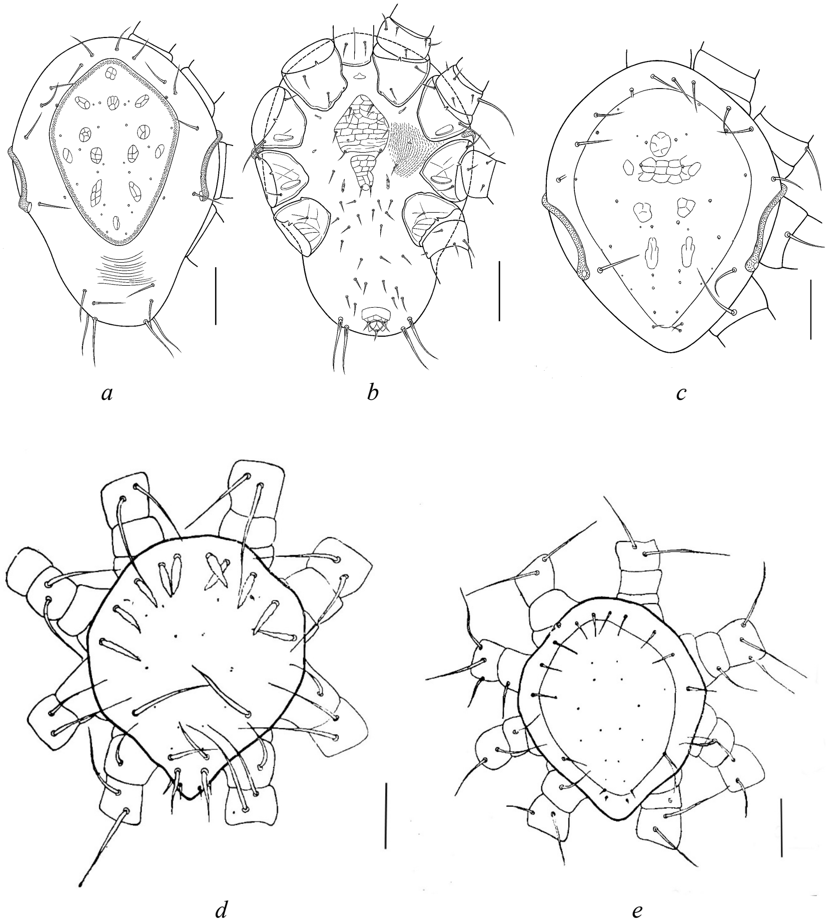


Fig. 10. *Spinturnix kolenatii* Oudemans, 1910 (*d, e* – from Pinchuk, 1971): *a* – ♀ dorsaly; *b* – ♀, ventraly; *c* – ♂, dorsaly; *d* – protonymph, dorsaly; *e* – deytonymph, dorsaly. Scale 200 μm

Table 3

Findings of *S. kolenatii* (Orlova, 2013)

	Poland	Ural		Western Siberia	Total
Shelters	Summer	Winter	Summer	Summer	
Host	*E. serotinus*	*E. nilssoni*			
♀♀	4	29 (1)	39 (12)	35 (12)	107 (25)
♂♂	5	33	30	44	112
N1	2	-	1	6	9
N2	-	-	24	12	36
Total	11	62	94	97	264

Note. The brackets indicate the number of females with intrauterine larvae in total number of females

Spinturnix maedai Uchikawa, Wada, 1979 (fig. 11)

Distribution: Central and Eastern Palaearctic (Japan, Russian Far East, Krasnoyarsk territory) (Uchikawa, Wada, 1979; Medvedev et al., 1991).

Host preference: oligoxenous (bats of genus *Murina*): *Murina hilgendorfi sibirica*, *M. ussuriensis*.

Material: 11♀♀, 6♂♂ ex *M. h. sibirica* (Novosibirsk region, III.2014); 3♀♀, 2♂♂ ex *M. h. sibirica* (Altai, XII.2012); ♂ex *M. fratter* (Krasnoyarsk territory, VII.2011).

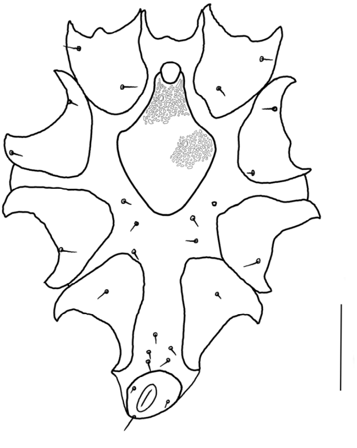


Fig. 11. *Spinturnix maedai* Uchikawa, Wada, 1979 (from Orlova et al., 2014): ♂ ventraly. Scale 300 μm

Spinturnix myoti (Kolenati, 1856) (fig. 15)

The new literature and data received by the authors on the species *Spinturnix myoti* sensu Rudnick (Deunff, 1977; Uchikawa et al., 1994; Haitlinger, Piksa, 2012; Kristofik et al., 2012; Pocora et al., 2013) demonstrate that it is a complex including 7 species: *Spinturnix andegavinus* (Kolenati, 1857); *Spinturnix bechsteinii* (Deunff, Walter, Bellido & Volleth, 2004); *Spinturnix dasycnemi* Kolenati, 1856; *Spinturnix emarginata* (Kolenati, 1856); *Spinturnix myoti* (Kolenati, 1856), *Spinturnix mystacina* (Kolenati, 1857) and *Spinturnix uchikawai* (Orlova, Zhigalin, Zhigalina, 2015). The two species from this group show a very close resemblance: *S. andegavina* parasitizing *Myotis daubentonii*, *S. dasycnemi* (the principal host is *Myotis dasycneme*) and *S. myoti*. *S. andegavinus*, which was redescribed by Deunff (1977) based on the smaller body size in combination with ecological and biological characteristics of the host species.

The species status of *S. andegavinus* (fig. 12) is of a particular interest. This mite is distributed in the boreal and subboreal zone of Western Palaearctic (Spain, Portugal, Czech Republic, Romania, Moldova, Ukraine, the Baltic states, Russia (European part)), the eastern border of distribution is not found (Deunff, 1977; Dietz, Walter, 1995; Giorgi et al., 2004; Pocora et al., 2013). The host preference is monoxenous (*Myotis daubentonii*), it was also found on *Myotis dasycneme*, *M. nattereri*.

In our opinion, further research is needed to clarify the relationship between *Spinturnix myoti* and *S. andegavinus* because dimensional differences cannot be the primary basis for the description of a new species and, perhaps, *S. andegavinus* is a subspecies (morph).

Spinturnix myoti sensu stricto is characterized by a wide Trans-Palaearctic range and a considerable number of hosts, so we can conclude that this species is mostly morphologically homogeneous (tab. 4, 5), which can be discovered using the method of principal components.

The principal component analysis of four measurements of shields of females belonging to *Spinturnix myoti* s. stricto from different regions of the boreal Palaearctic showed that the first principal component explains 46.64% of the variance of data and the second one accounts for 27.45%. The strong correlation with the first component is typical for indicators such as DL and SW (contributions are 35.51 and

26.06% respectively). As figures 13 and 14 show, due to these variables the first principal component separates Altai mites from other parasites both territorially and by host species (*M. blytii*).

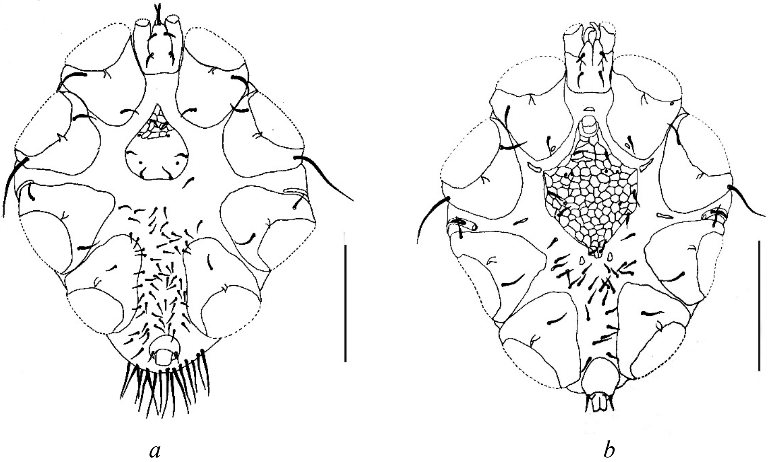

a *b*

Fig. 12. *Spinturnix andegavinus* Kolenati, 1857 (from Deunff, 1977): *a* – ♀, ventraly; *b* – ♂, ventraly. Scale 300 µm

The second principal component strongly correlates with the DW and CW (the total contribution is about 70%). It does not allow to separate either regional species or clusters of species. Most likely the second principal component carries information about a rather expressed variation of mite's shields (in the picture – large confidence ellipses). We can conclude (fig. 13, 14) that the parasites of the Baltic region are slightly different by measurements from those from the most studied area (essentially parasites of other regions form one group). Observing host-parasite relations we can notice that the second component separates about one-third of the pond bats from the other host species.

Therefore, our revision of the previously collected material (table 6, 7) and analysis by the method of principal components showed that individuals of *S. myoti* from different bat species show a significant unity of the mite species throughout the Palaearctic boreal (fig. 13, 14). The differences between the parasites caused by host species are weak although it can be assumed that there are some differences of individuals of *Spinturnix myoti* parasitizing pond bats (fig. 13a). During the analysis it was found out that a mite group collected from the mouse-eared bat (including those from the North-West of the Altai) has obvious differences. A smaller mouse-eared bat, unlike all the others, belongs to the large *Myotis* species group and subboreal species, perhaps, *Spinturnix myoti* parasitizing *M. blytii* belongs to another subboreal form (a larger dimension). To clarify this issue a comprehensive Trans-Palaearctic study of *S. myoti* infrapopulation of boreal and subboreal bats should be carried out.

The total identity of the parameters of *S. myoti* parasitizing water bats and eastern water bats is of a particular interest because this species belongs to different faunal complexes and has non-overlapping ranges.

Table 4

Comparison of basic metric data of body parts of adult females of *Spinturnix myoti* (own data on Eurasia and literature data)

Locality	Species	DL	DW	SL	SW	
Baltic region (25)	*Myotis dasycneme, M. nattereri, M. daubentonii*	783-868	581-688	192-244	191-216	Own data
European part of Russia (3)	*M. dasycneme, M. daubentonii*	795-840	600-650	223-235	193-216	Own data
Ural and Pre-Ural (19)	*M. dasycneme, M. daubentonii*	797-864	605-682	212-248	190-228	Own data
Western Siberia (12)	*M. petax*	775-841	588-629	194-243	183-223	Own data
Altai (17)	*M. blythii*	850-891	612-661	221-251	223-262	Own data
Eastern Siberia and Far East (12)	*M. petax*	799-871	583-688	201-261	197-221	Own data
Nothern Caucasus (2)	*M. blythii*	812, 842	610, 642	213, 214	221, 243	Own data
Central Asia (30)	*M. blythii*	787-894	544-739	192-248	192-244	Own data
Romania (30)	*M. blythii, M. myotis*	800-900	571-657	189-229	186-229	Pocora et al., 2013

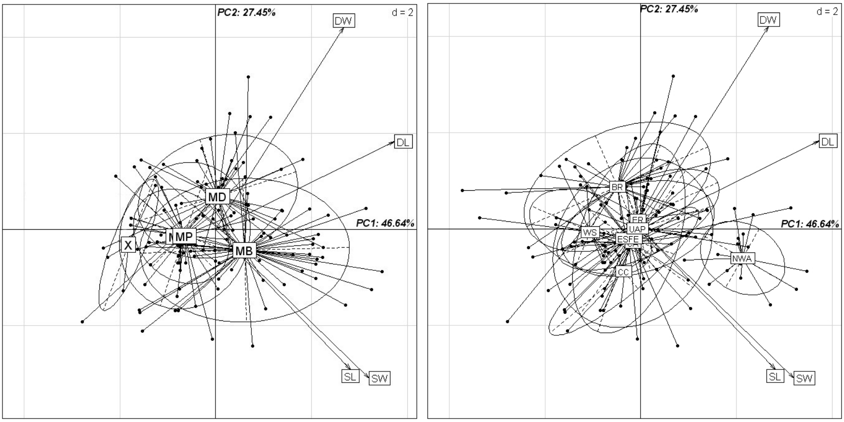
Note. In brackets is the number of studied mite individuals; DL – dorsal shield length DW – dorsal shield width, SL – sternal shield length and SW – sternal shield width

Table 5

Comparison of basic metric data of body parts of adult males of *Spinturnix myoti* (own data on Eurasia and literature data)

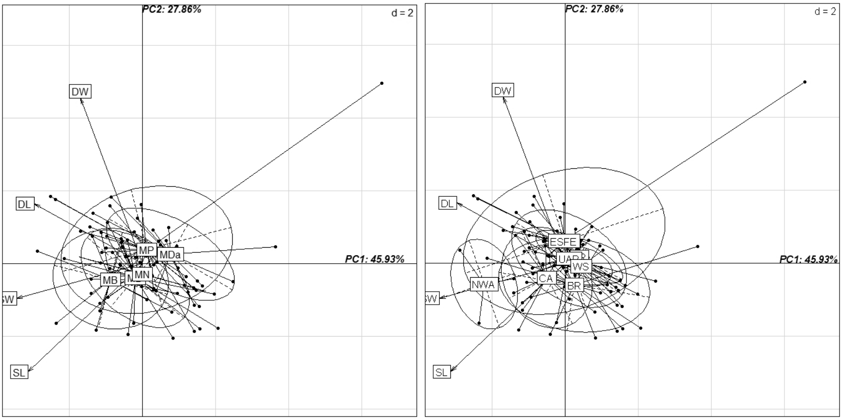
Locality	Species	DL	DW	SL	SW	
Baltic region (7)	*Myotis dasycneme*	698-756	530-564	395-409	264-284	Own data
European part of Russia (13)	*M. dasycneme,* *M. daubentonii*	662-757	520-586	361-401	242-270	Own data
Urals (15)	*M. dasycneme,* *M. daubentonii*	690-742	518-581	366-421	258-290	Own data
Western Siberia (10)	*M. petax*	698-742	517-562	369-400	241-269	Own data
Altai (3)	*M. blythii*	752-796	518-554	389-446	283-291	Own data
Eastern Siberia and Far East (21)	*M. petax*	659-791	502-608	330-406	249-293	Own data
Romania (30)	*M. blythii,* *M. myotis*	643-771	450-600	364-443	243-286	Pocora et al., 2013

Note. In brackets is the number of studied mite individuals; DL – dorsal shield length DW – dorsal shield width, SL – sternal shield length and SW – sternal shield width.



a *b*

Fig. 13. Principal components analysis (PCA) of females of gamasid mite *S. myoti* from 4 palaearctic *Myoti* species: a – species (MB – *M. blytii*, MD – *M. dasycneme*, MDa – *M. daubentonii*, MP – *M. petax;* X – host species is unknown); b – regions (BR – Baltic region; CA – Central Asia; CC – Central Caucasus; ER – European part of Russia; ESFE – Eastern Siberia and Far East; NEA – North-Western Altai; UAP – Ural and Pre-Ural; WS – Western Siberia). Ovals are 95% inertia ellipses



a *b*

Fig. 14. Principal components analysis (PCA) of males of gamasid mite *S. myoti* from 4 Palaearctic *Myoti* species: a – species (MB – *M. blytii*, MD – *M. dasycneme*, MDa – *M. daubentonii*, MP – *M. petax*); b – regions (BR – Baltic region; CA – Central Asia; CC – Central Caucasus; ER – European part of Russia; ESFE – Eastern Siberia and Far East; NEA – North-Western Altai; UAP – Ural and Pre-Ural; WS – Western Siberia). Ovals are 95% inertia ellipses

Table 6

Correlation matrix of *S. myoti* female shield dimensions (several bat species, several regions) computed across two scales

	PC1		*PC2*	
	Load (%)	p	Load (%)	p
DL	**35,51**	**$5,1*10^{-31}$**	**8,57**	**0,001**
DW	**18,21**	**$8*10^{-13}$**	**45,31**	**$3*10^{-20}$**
SL	**20,22**	**$2*10^{-14}$**	**21,66**	**$7*10^{-9}$**
SW	**26,06**	**$1,2*10^{-19}$**	**24,46**	**$5,1*10^{-10}$**

Note: statistically significant parameters were marked in bold.

Table 7

Correlation matrix of *S. myoti* male shield dimensions (several bat species, several regions) computed across two scales

	PC1		*PC2*	
	Load (%)	p	Load (%)	p
DL	**26,37**	**$3,71*10^{-14}$**	**8,21**	**0,004**
DW	**8,63**	**0,0001**	**62,43**	**$3,42*10^{-24}$**
SL	**29,46**	**$2,2*10^{-16}$**	**26,59**	**$3,5*10^{-8}$**
SW	**35,55**	**$1,03*10^{-21}$**	2,77	–

Note: statistically significant parameters were marked in bold.

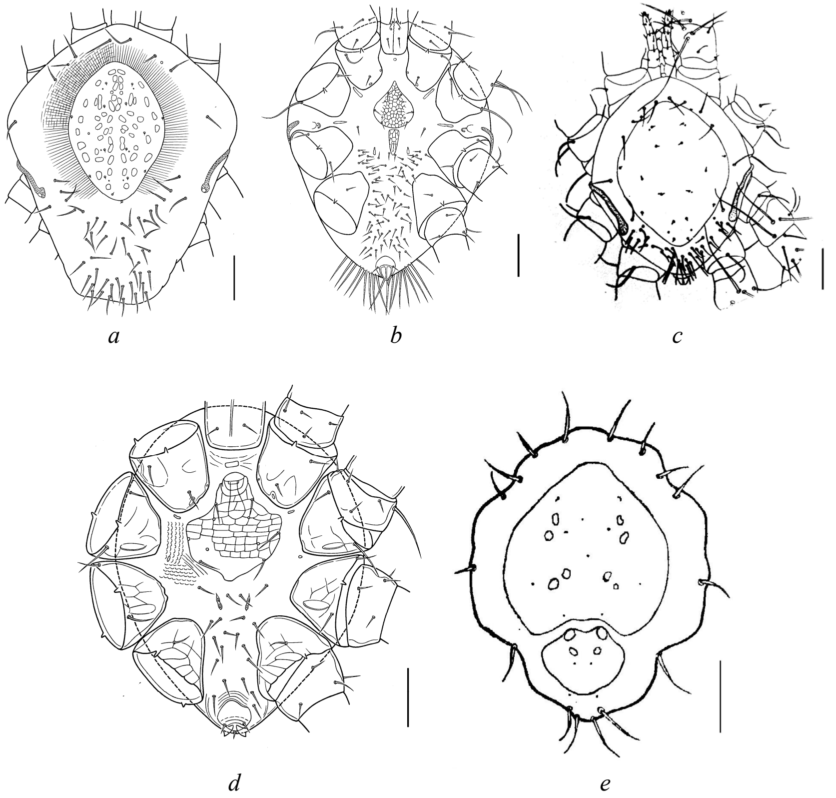


Fig. 15. *Spinturnix myoti* (Kolenati, 1856) (*c* – from Rudnick, 1960; *e* – from Pinchuk, 1971): *a* – ♀ dorsaly; *b* – ♀, ventraly; *c* – ♂, dorsaly; *d* – ♂, ventraly; *e* – protonymph, dorsaly. Scale 200 µm

Distribution: Trans-Palaearctic (from the UK to the Far East) (Rudnick, 1960; Dusbábek, 1962; Stanyukovich, 1990; Medvedev et al., 1991; Stanyukovich, 1997; Rupp et al., 2004; Bobkova, 2005; Jaunbauere et al., 2008, Orlova, 2011).

Host preference: oligoxenous (bats of the genus *Myotis*): *Myotis myotis* (Borkhausen, 1797), *M. blythii*, *Myotis dasycneme* (Boie, 1825), *Myotis nattereri* (Kuhl, 1817), *Myotis capaccinii* (Bonaparte, 1837), *M. blythii*, *M. daubentonii*, *M. petax*, *M. mystacinus*, *M. brandtii*, *Myo-*

tis sibiricus Kastschenko, 1905, *Myotis ikonnikovi* Ognev, 1912, *M. emarginatus*, *Pipistrellus nathusii* (Keyserling, Blasius, 1839), *Murina hilgendorfi* Peters, 1880, *Otonycteris leucophaea*, *R. ferrumequinum*, *R. mehelyi*, *R. euryale*; Dusbábek, 1962, 1972; Uchikawa, Wada, 1979; Stanyukovich, 1993; Uchikawa et al., 1994; Stanyukovich, 1997; Imaz et al., 1999).

Material (tab. 8).

Table 8

Findings of *S. myoti* (Orlova, 2013; Orlova, Zappart, 2012; Orlova et al., 2014)

	The Baltic Sea Region (Germany, Poland, Leningrad Region)		Ural		Western Siberia		Russian Far East	Total
Shelters	Winter	Summer	Winter	Summer	Winter	Summer	Summer	
Host	*Myotis dasycneme*, *M. nattereri*, *M. daubentonii*, *P. nathusii*		*M. dasycneme*, *M. daubentonii*, *M. mystacinus*, *M. brandtii*		*M. petax*, *M. hilgendorfi*, *M. blythi*		*M. petax*	
♀♀	3	43 (23)	63 (1)	194 (72)	55	68 (31)	7 (1)	416
♂♂	5	55	47	147	24	74	15	364
N1	-	28	-	110	-	44	12	194
N2	-	56	-	116	-	23	16	211
Total	8	182	110	567	59	209	50	1185

Note: The brackets indicate the number of females with intrauterine larvae in total number of females.

Spinturnix mystacina (Kolenatii, 1857) (fig. 16)

Distribution: Palaearctic from the UK to Tajikistan (Rudnick, 1960; Pinchuk, 1971; Dusbábek, 1972; Beron, 1974; Uchikawa, Wada, 1979; Senotrusova, 1987; Schmidt, 1987; Stanyukovich, 1990; Stanyukovich, Malinovskiy, 1992; Stanyukovich, 1997).

Host preference: pleoxenous (bats of the fam. Vespertilionidae): *Myotis* spp., *E. serotinus*, *V. murinus*, *N. noctula*, *P. auritus*.

Material: 2♀♀ ex *M. mystacinus* (Middle Urals; X.1993, VII.2011); ♀ (with intrauterine egg) ex *M. daubentonii* (Udmurt republic; VI.1993).

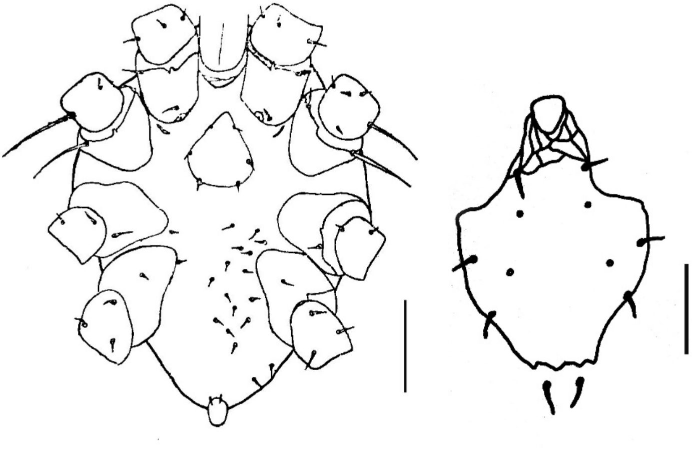

a *b*

Fig. 16. *Spinturnix mystacina* (from Deunff, 1977): a – ♀ ventraly (scale 200 μm); *b* – ♂, sternal shield (scale 100 μm)

Spinturnix nobleti Deunff, Volleth, Keller, Allen, 1990 (fig. 17)

Distribution: probably Palaearctic (Switzerland, France and Russian Far East) (Deunff et al., 1990; Medvedev et al., 1991).

Host preference: *Hypsugo savii*.

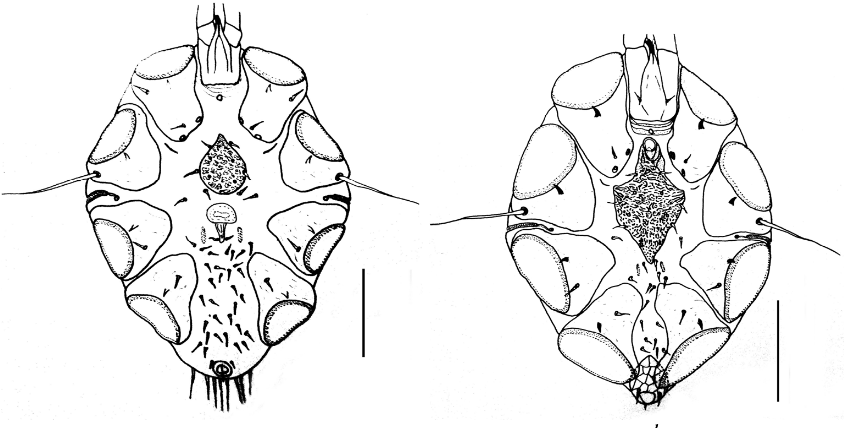

a *b*

Fig. 17. *Spinturnix nobleti* (from Deunff et al., 1990): a – ♀ ventraly (scale 200 μm); b – ♂ ventraly (scale 300 μm)

Spinturnix plecotinus (Koch, 1839) (fig. 18)

Distribution: Palaearctic (UK, Western, Central and Eastern Europe, the Baltics, Central Asia, the Far East) (Rudnick, 1960; Pinchuk, 1971; Uchikawa, Wada, 1979; Stanyukovich, 1990; Medvedev et al., 1991; Imaz et al., 1999; Baker, Craven, 2003).

Host preference: oligoxenous (bats of the genus *Plecotus*): *Plecotus auritus*, *Plecotus austriacus*, *Plecotus strelkovi*, *Barbastella darjelingensis* (Stanyukovich, 1990; Stanyukovich, 1997; Baker, Craven, 2003).

Material (tab. 9).

Table 9

Findings of *S. plecotinus* (Orlova, 2013)

	Poland	Urals		Total
Shelters	Summer	Winter	Summer	
Hosts	*Plecotus auritus*	*P. auritus*		
♀♀	9 (1)	15	14	38
♂♂	6	13	6	25
N2	5	-	-	5
Total	20	28	20	68

Note: The brackets indicate the number of females with intrauterine larvae in total number of females.

Spinturnix psi (Kolenatii, 1856) (fig. 19)

Distribution: Trans-Palaearctic subboreal (Russia, Ukraine, the Caucasus, Europe, South-East Asia (Japan, Korea, Thailand, India), Madaskar) (Rudnick, 1960; Uchikawa, Wada, 1979; Stanyukovich, 1997). Findings in the boreal zone, apparently, are random.

Host preference: pleoxenous (bats of the fam. Vespertilionidae): *Miniopterus schreibersii*, *Vespertilio murinus*, *Myotis myotis*, *M. blythii*, *M. capaccini*, *Hypsugo savii*, *E. serotinus*, *R. ferrumequinum*.

Spinturnix uchikawai Orlova, Zhigalin, Zhigalina, 2015 (fig. 20)

Distribution: species was described in Kunashiri island (Kuril Islands) (Orlova et al., 2015), range probably coincides with the range of the principal host (*M. macrodactylus*) and covers Japan (Uchikawa, Wada 1979), Kuril Islands, Russian Far East (?).

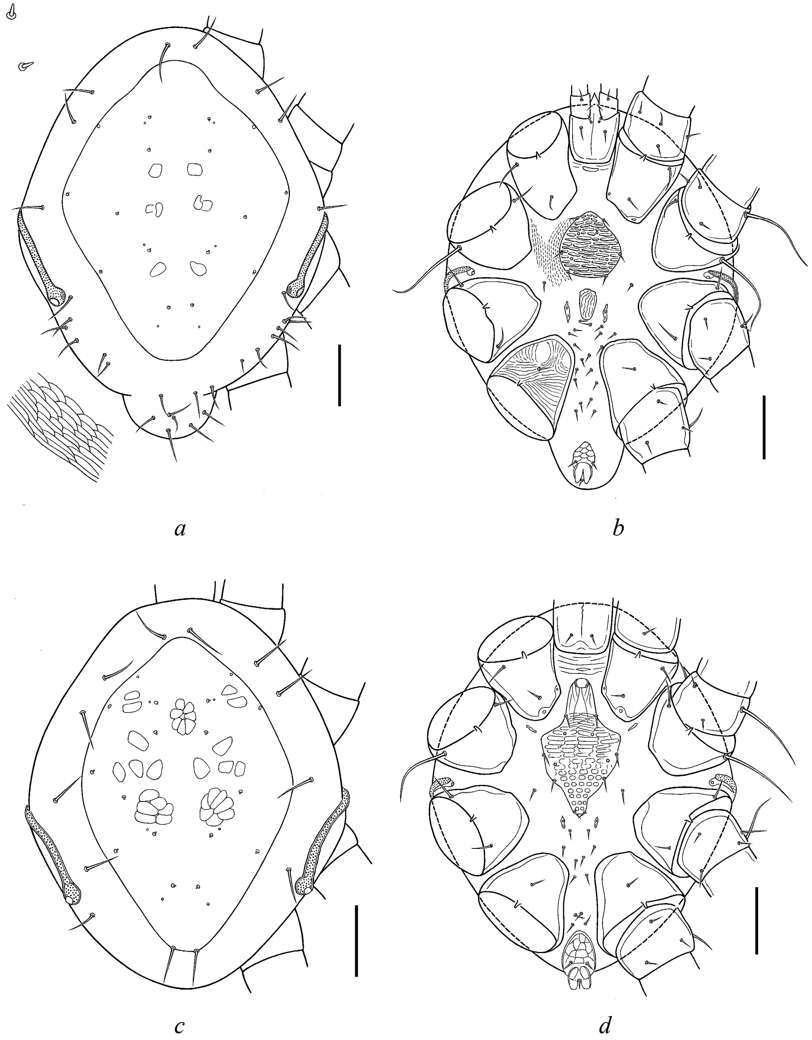
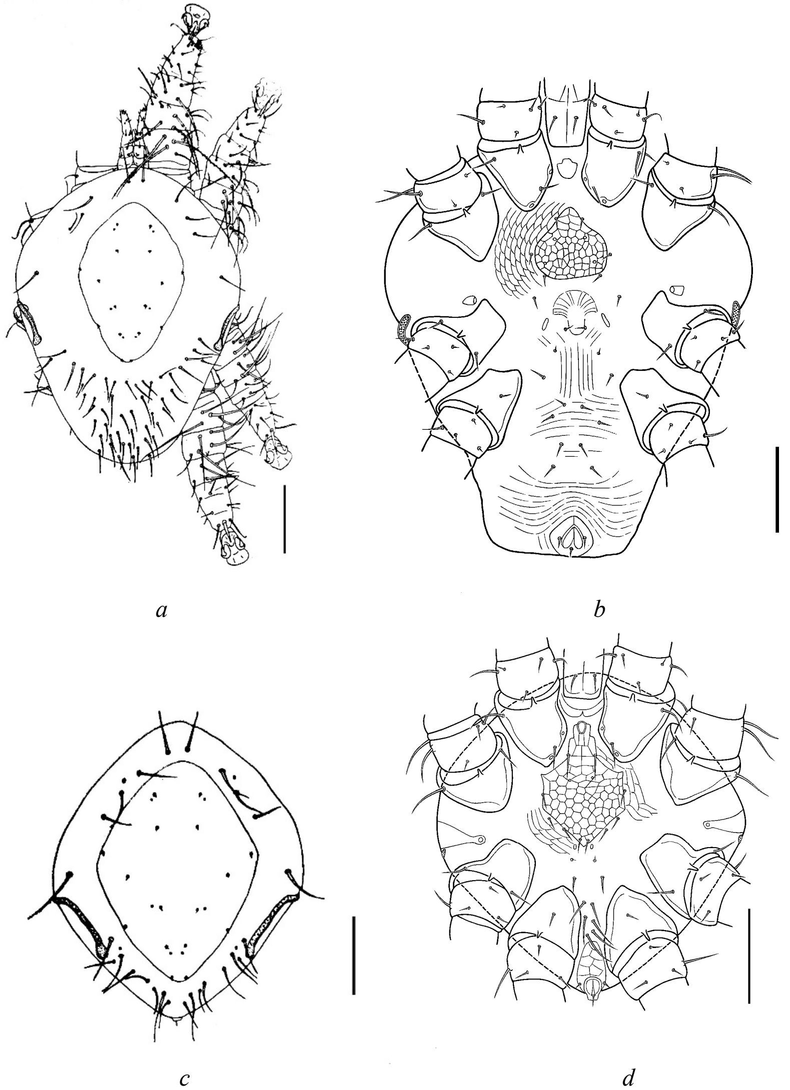


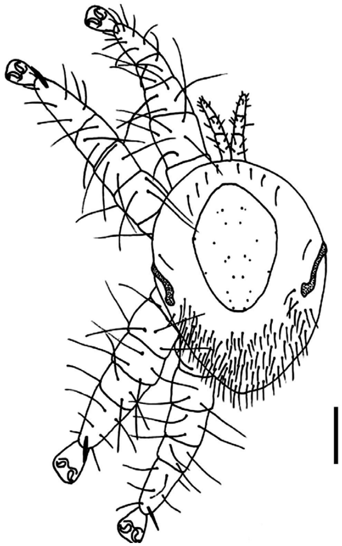
Fig. 18. *Spinturnix plecotinus* (Koch, 1839): *a* – ♀ dorsaly; *b* – ♀, ventraly; *c* – ♂, dorsaly; *d* – ♂, ventraly, dorsaly. Scale 200 µm



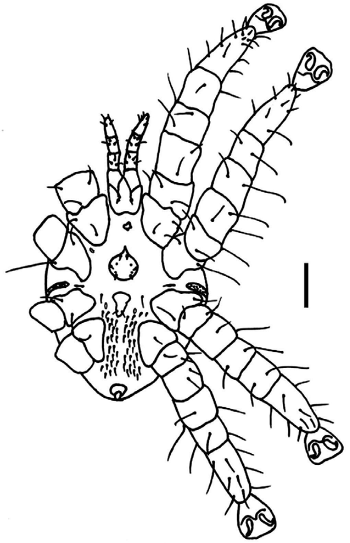
a *b*

c *d*

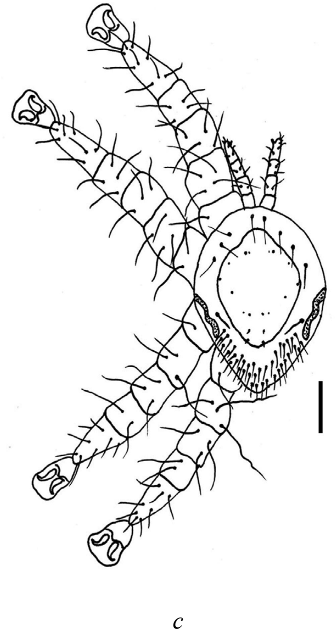
Fig. 19. *Spinturnix psi*: *a* – ♀ dorsaly (scale 200 µm); *b* – ♀, ventraly (scale 150 µm); *c* – ♂, dorsaly (scale 200 µm); *d* – ♂, ventraly (scale 200 µm)



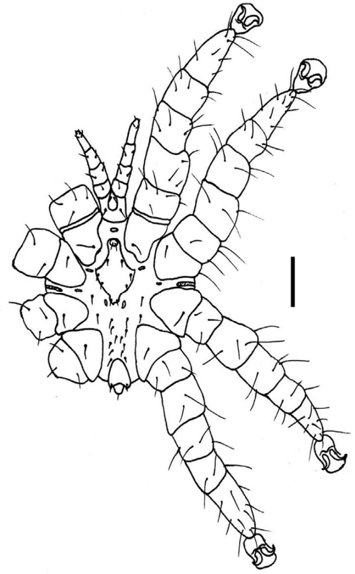
a



b



c



d

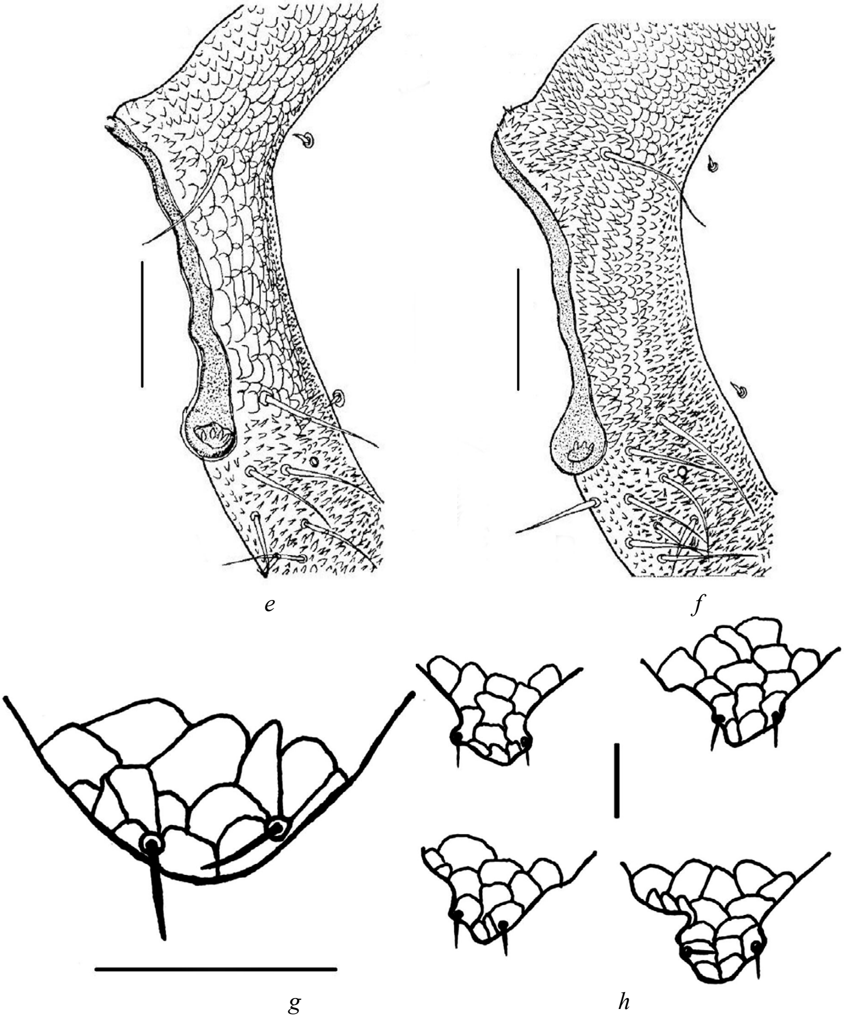


Fig. 20. *Spinturnix uchikawai* (*a, b, c, d, g, h* – from Orlova et al., 2015; *e, f* – from Uchikawa, Wada, 1979): *a* – ♀ dorsaly (scale 200 µm); *b* – ♀, ventraly (scale 150 µm); *c* – ♂, dorsaly (scale 200 µm); *d* – ♂, ventraly (scale 200 µm); *e* – integumental striation of male (*Spinturnix myoti*) (scale 100 µm); *f* – integumental striation of male (*Spinturnix uchikawai*) (scale 100 µm); *g* – posterior margin of sternogenital shield of male (*Spinturnix myoti*) (scales 50 µm); *h* – posterior margin of sternogenital shield of male (four variants) (*Spinturnix uchikawai*) (scales 50 µm)

Material: 102♀♀, 103♂♂ ex *M. macrodactylus* (Kunashiri island; VII.2014). Perhaps 76 N1 and 66 N2 also belong to *Spinturnix uchikawai* (preimaginal stages have not described).

Note. *S. uchikawai* belongs to the *Spinturnix myoti* species group and is closely allied to *Spinturnix myoti*.

Family Macronyssidae

Weakly sclerotized mites pale yellow or reddish brown in color. The body length of adults is from 300 to 900 µm, depending on gender (females are usually larger than males) and blood filling (engorged ticks larger hungry) (Stanyukovich, 1993).

Most of the adult mites belonging to family Macronyssidae were collected from interfemoral membrane (uropatagium), or from hair part of body, while protonymph were often localized on the wing membrane.

In the study area we found 31 species of 4 genera: *Ichoronyssus*, *Macronyssus*, *Steatonyssus* and *Ornithonyssus*.

Key to genera of Macronyssidae

Females

1. Two dorsal plates; sternal plate with differentiated band on posterior margin .... *Steatonyssus* Kolenatii, 1858

Sole dopsal plate; sternal plate without sclerotized band on posterior margin 2

2. Legs 1 is stout and short; legs IV longer then other .... *Ichoronyssus* Kolenatii, 1858

Four pairs of legs almost similar 3

3. Ventral process of palpal trochanter ridge-like. Sternal shield with pattern in two anterior corners .... *Macronyssus* Kolenatii, 1858

Palpal trochanter without ridge-like process; sternal shield without sculpturing .... *Ornithonyssus* Sambon, 1928

Males

1. Ridge-like process on palps well developed .... *Macronyssus* Kolenatii, 1858

Ridge-like process on palps absent ………………………………… 2

2. I-III legs are short and thick; IV legs are long and thin …………………………………………………… *Ichoronyssus* Kolenatii, 1858

Legs not thick, long ………………………………………………………… 3

3. Spur on II coxa well developed; dorsal shield narrowing to back …………………………………………………… *Steatonyssus* Kolenatii, 1858

Spur on II coxa well small; dorsal shield wide at front and back ………………………………………………… *Ornithonyssus* Sambon, 1928

Protonymphs

1. Three pairs of long setae and pair of microsetae on pigidial plate …………………………………………………… *Steatonyssus* Kolenatii, 1858

On pigidial shield 4-7 setae pairs ………………………………… 2

2. First pair of legs thicker then other three pairs …………………………………………………… *Ichoronyssus* Kolenatii, 1858

First pair of legs similar to other three pairs …………………… 3

3. Setae S8 absent; ridge-like process on palps hardly discerniable …………………………………………………… *Ornithonyssus* Sambon, 1928

Setae S8 present; ridge-like process on palps well developed ………………………………………………… *Macronyssus* Kolenatii, 1858

Subfamily Macronyssinae

Genus *Ichoronyssus* Kolenatii, 1858

Ichoronyssus scutatus (Kolenatii, 1856) (fig. 21)

Distribution: widely in Palaearctic subboreal zone (Western and Central Europe, Moldova, the Caucasus, Central Asia, Lebanon, Japan) (Pinchuk, 1970; Medvedev et al., 1991).

Host preference: *Miniopterus shreibersii*. Also recorded from *Myotis myotis*, *M. blythii*, *M. macrodactylus*, *Vespertilio murinus*, *Rhinolophus euryale*, *R. ferrumequinum*.

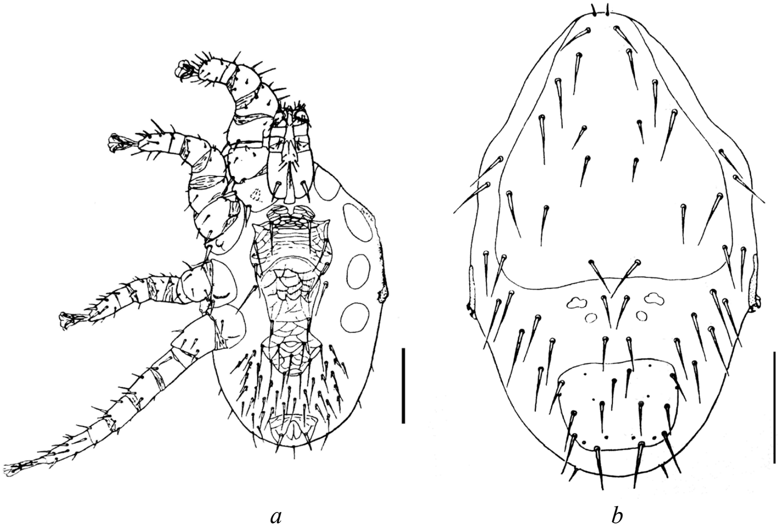


Fig. 21. *Ichoronyssus scutatus* (Kolenatii, 1856) (from Radovsky, 2010): *a* – ♀ ventraly; *b* – protonymph, dorsaly. Scale 100 µm

In our material there are 16 species of the genus *Macronyssus* Kolenati, 1858.

Key for the genus *Macronyssus* Kolenati, 1858 of the boreal Palaearctic region

Female

1. Dorsal plate with 30 setal pairs ….…….. *M. hosonoi* Uchicawa, 1979
   Dorsal plate with no more than 28 setal pairs …..………………. 2
2. Setae St1 do not reach the posterior margin of the sternal plate …... 3
   Setae St1 reach the posterior margin of the sternal plate ……… 9
3. Dorsal plate with 26-28 setal pairs ……….....…………….……… 4
   Dorsal plate with 20-25 setal pairs ……......……….…………….. 7
   4. Dorsal plate with 28 setal pairs ……….....……….…………… 5
   Dorsal plate with 26 setal pairs ……………....……………..….... 6
5. Sternal setae and most of other ventral idiosomal setae with marked subbasal inflations. Sternal glands with striae enclosed in regular elliptical zone …...….………….....………… *M. kolenatii* (Oudemans, 1902)

Sternal setae and most of the other ventral idiosomal setae without subbasal inflations. Sternal glands with 3 cells and (sometimes) striae …….……………… *M. crosbyi* Ewing, Stover, 1915

6. Sternal glands with 5-6 cells .... *M. flavus* (Kolenati, 1856)

Sternal glands with short lines forming 3 unequal cells, were covered dot-and-dash lines ………………………………........ .... *M. sibiricus* Orlova, Zhigalin, 2015

7. Dorsal plate with 25 setal pairs. Sternal glands with short lines and points, forming rounded zones ……………………………………… ……...................……….... *M. stanyukovichi* Orlova, Zhigalin, 2015

Dorsal plate with 20-24 setal pairs ……….........……………….. 8

8. Dorsal plate with 20 setal pairs. Seta Z5 are long. Sternal glands with striae resembling a fingerprint ……………………………………… ……………………………..………. *M. ellipticus* (Kolenatii, 1856)

Dorsal plate with 22-24 setal pairs. Setae Z5 are not long. Sternal glands with many wavy striae …………………………………… …………….....………………. *M. cyclaspis* (Oudemans, 1906)

9. Dorsal plate with 28 setal pairs ……….........………………….. 10

Dorsal plate with 25-27 setal pairs ……….........…………….… 13

10. The posterior margin of the sternal plate is concave to the level of the setae St2 12

The posterior margin of the sternal plate is slightly concave ………………………………………………………………….. 11

11. Sternal glands with striae and crosspieces within an oval zone …....……………………………… *M. charusnurensis* Dusbábek, 1966

Sternal glands with 2 cells, covered distinct, irregular, wrinkled folds-like striae; common for *M. dasycneme* ……....………....……… *M. corethroproctus* (Oudemans, 1902)

12. Sternal glands with V-shaped striae; 6 deutosternal teeth with 1 denticle in a row ……………………………………………………… ……………….....………… *M. barbastellinus* Dusbábek, Pinchuk, 1971

Sternal glands resemble cells, some of which exhibiting dot-and-dash lines; 10 deutosternal teeth with 1 denticle in a row (may be 2 denticles in lower row) …………………………………………… …....………….. *M. heteromorphus* Dusbábek and Radovsky, 1972

13. Dorsal plate with 25 setal pair; setae J3 are absent …………………………………….. *M. rhinolophi* (Oudemans, 1902)

Dorsal plate with 26-27 setal pair; setae J3 are present ……....................…………………………..………………… 14

14. Dorsal plate with 26. Sternal glands are well developed and consist of curved wavy lines that form closed figures ……..…………………………….…. *M. tigirecus* Orlova, Zhigalin, 2015

Dorsal plate with 27 setal pair. Sternal glands with some cells ……...............................……………………………………… 15

15. Sternal glands composed of 4 curved granular lines in a regular pattern; setae j–J-seria are the same length as microsetae ……....……………………………..…. *M. granulosus* (Kolenatii, 1856)

Sternal glands small and oval; lengths of setae j–J-seria increase from j3 to J3 ………………… *M. diversipilis* (Vitzthum, 1920)

Males

1. Dorsal plate with 29 setal pairs ……….……….. *M. hosonoi* Uchicawa

On dorsal plate no more then 27 setal pairs …........…………… 2

2. Spermatodactyl is greatly enlarged as long as second segment of chelicerae …...…… *M. ellipticus* (Kolenatii)

Spermatodactiyl is clearly shorter then the second segment of chelicerae ….………………..........................…..……………… 3

3. Three setal pairs are very long and spur-like, flanking dorsal plate about middle of idiosoma ……....................................………….... ………...………………………..……………… *M. rhinolophi* (Oudemans)

Spines are absent ……..……… 4

4. Setae J5 and Z5 on four cylindrical processes; two clusters of long and thick caudal setae on end of opistosoma with small hollow …....……………………………….. *M. corethroproctus* (Oudemans)

Cylindrical processes are absent; not long caudal setae at the end of opistosoma without a hollow ....… 5

5. Setae Z5 thick (like claw), opistosomal setae on unarmed integument very long (100-120 µm) ….….… *Macronyssus crosbyi* (Ewing et Stover)

Setae Z5 and opistosomal setae usual …….............................… 6

6. Dorsal plate with 26-27 setal pairs ……………..…..………..…… 7

Dorsal plate with 28-29 setal pairs ………...……….……..……. 8

7. Peritreme ending over coxa II; dorsal plate narrowing between ventral and anal parts ………………………………………………………………………… ………………………………………… *M. granulosus* (Kolenati)

Peritreme reaching posrterior half coxa II; dorsal plate without narrowing …………………………… *M. cyclaspis* (Oudemans)

8. Peritreme reaching front margin or middle coxa I ………………… 9

Peritreme reaching a middle or front margin of coxa II ……. 10

9. Ventral setae with marked subbasal inflation; ventral part of dorsal plate is broad and armed with 13-22 setae ……………………………………………… *M. kolenatii* (Oudemans)

Ventral setae without inflation; ventral part of dorsal plate is not enlarged and armed with 13-15 setae ……… *M. flavus* (Kolenati)

10. Dorsal plate with 28 setal pairs ……………………………… 11

Dorsal plate with 27 setal pairs ………………………………… 12

11. Ten thick and long setal pair on opistosoma with hollow; base of tritosternum is thickened ………………………………………………… …………………………………………… *M. charusnurensis* Dusbábek

Opistosoma without hollow, armed by ordinary setae; base of tritosternum is not thickened ……………………………………………… ……………………………………………… *M. diversipilis* (Vitzthum)

12. Three pairs of rather long spine-like setae on posterior tip of dorsal plate .... *M. heteromorphus* Dusbábek and Radovsky

Setae of dorsal plate ordinary ……………………………………... .... *M. barbastellinus* Dusbábek, Pinchuk

Protonymphs

1. Pygidial plate with 5 setal pairs ……………... *M. ellipticus* (Kolenatii)

Pygidial plate with 6-7 setal pairs 2

2. Pygidial plate with 6 setal pairs 3

Pygidial plate with 7 setal pairs 6

3. Setae D 7 absent; anterior margin of pygidial plate is convex but without projection ……………………………… *M. rhinolophi* (Oudemans)

Setae D7 are present; anterior margin of pygidial plate with small projection ……………………………………………………......... 4

4. Podosomal plate with dotted pattern … *M. charusnurensis* Dusbábek

Podosomal plate without dotted pattern 5

5. Coxal ridges are absent …………………. *M. diversipilis* (Vitzthum)
Coxal ridges are present …......……… *M. granulosus* (Kolenati)
6. Pygidial plate with 4 microsetal pairs ....
.... *M. heteromorphus* Dusbábek and Radovsky
Pygidial plate with 1-3 microsetal pairs ………..…………… 7
7. Coxal ridges are absent .... *M. cyclaspis* (Oudemans)
Some coxae with ridges 8
8. Length of pygidial setae is slightly mor then a half length of setae Ml
.... *M. hosonoi* Uchicawa
Length of pygidial setae is not more then a half length of setae M 11 ……...…………………… 9
9. Four pairs of setae between sternal and anal plates; opisthosomal setae are not numerous ……..……………
…………………………......…..……… *M. kolenatii* (Oudemans)
Three pairs of setae between sternal and anal plates; opisthosomal setae are numerous ………...………...………..…… *M. flavus* (Kolenati)

Macronyssus barbastellinus Dusbábek, Pintshuk, 1971 (fig. 22)

Distribution: Western Europe, Moldova and Kyrgyzstan (Dusbábek, Pintshuk, 1971; Rybin, 1983).

Host preference: oligoxenous (bats of the genus *Barbastella*).

Macronyssus charusnurensis Dusbábek, 1966 (fig. 23)

Distribution: Central and Eastern Palaearctic, the Urals (including the western slopes) (Senotrusova, Tagil'tsev, 1968; Medvedev et al., 1991, Orlov, 2014; Orlova et al., 2014; own data).

Host preference: monoxenous (*Myotis petax*) (Orlova et al., 2014), also recorded on *M. blytii*, *M. brandtii*, *M. sibiricus*, *Murina hilgendorfi sibirica*, *Plecotus ognevi* (Stanyukovich, 1997).

Material (tab. 10).

Macronyssus corethroproctus (Oudemans, 1902) (fig. 24)

Distribution: Western Palaearctic (Western and Central Europe, Baltic States, the Urals, Altai and Western Siberia).

Host preference: monoxenous (very common on *Myotis dasycneme*) (Vitzthum et al., 1929; Radovsky, 1967; Dusbábek, 1972; Haitlinger, 1978b; Stanyukovich, 1990, 1993; Orlova, 2011; Orlova, Orlov, 2011; Orlova, Zappart, 2012; own data).

Note: MI *M. corethroproctus* for *M. dasycneme* is 38.7 (from 50.2 in winter shelters to 8.3 in nurserycolonies), prevalence reaches 100% (Orlova et al., 2012).

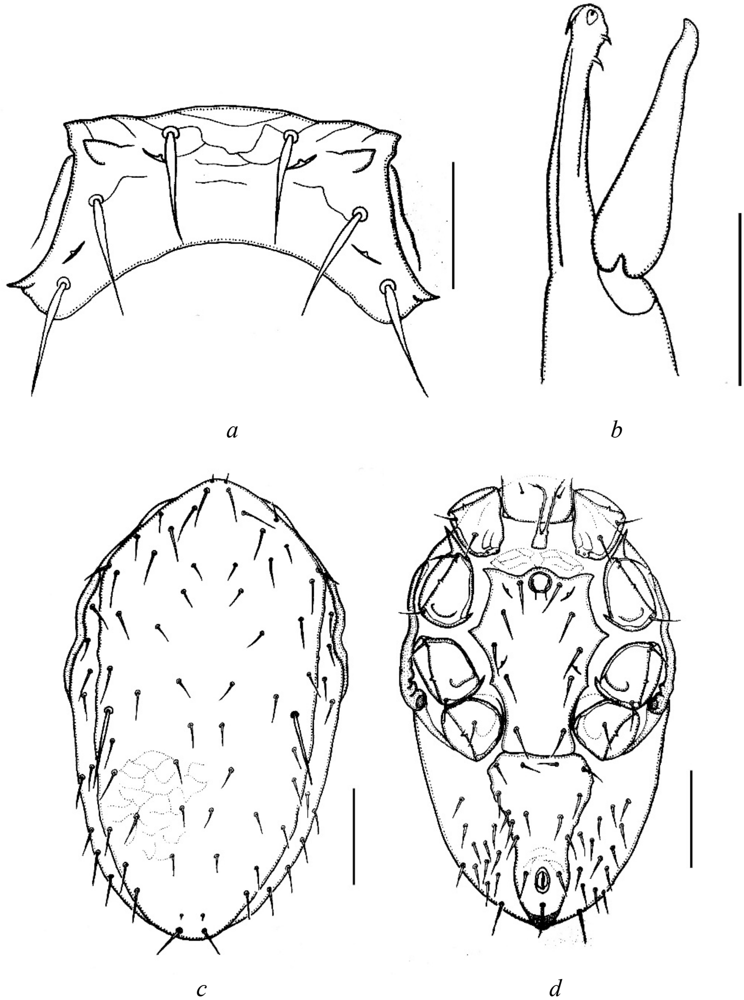


Fig. 22. *Macronyssus barbastellinus* (from Dusbábek, Pintshuk, 1971):
a – ♀, sternal shield (scale 40 µm); *b* – ♀, chelicera (scale 20 µm);
c – ♂ dorsaly (scale 100 µm); *d* – ♂ ventraly (scale 100 µm)

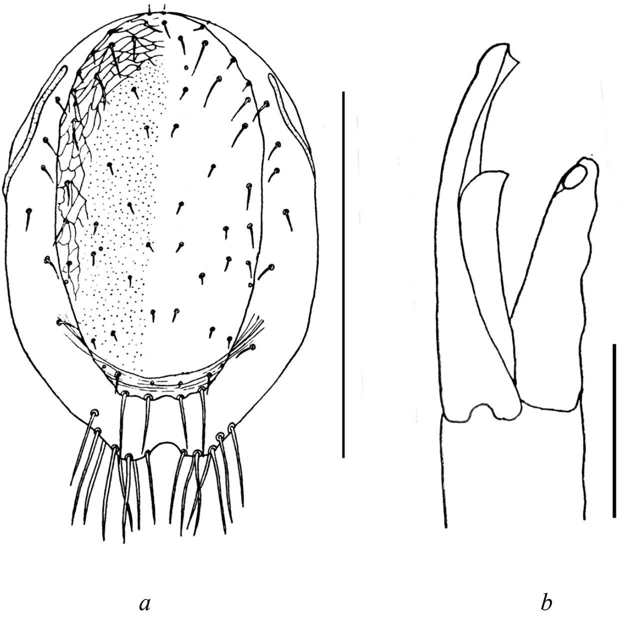


Fig. 23. *Macronyssus charusnurensis* (from Dusbábek, 1966):
a – ♂ dorsaly (scale 500 µm); *b* – ♂, chelicera (scale 20 µm)

Table 10

Findings of *M. charusnurensis*
(Orlova, 2014; Orlova et al., 2014; Orlova et al., 2015)

	Urals	Western Siberia		Central and Eastern Siberia	Far East	Total
Shelters	Summer	Winter	Summer	Summer	Summer	
Hosts	*M. brandtii*, *M. nattereri*	*M. petax*, *M. blythi*, *Murina hilgendorfi sibirica*		*M. petax*, *M. sibiricus*	*M. petax*	
♀♀	1	20	15 (11)	63 (54)	45 (12)	144
♂♂	-	1	-	31	3	35
N1	19	523	5	313	102	962
N2	-	-	-	4	-	4
Total	20	544	31	411	150	1145

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

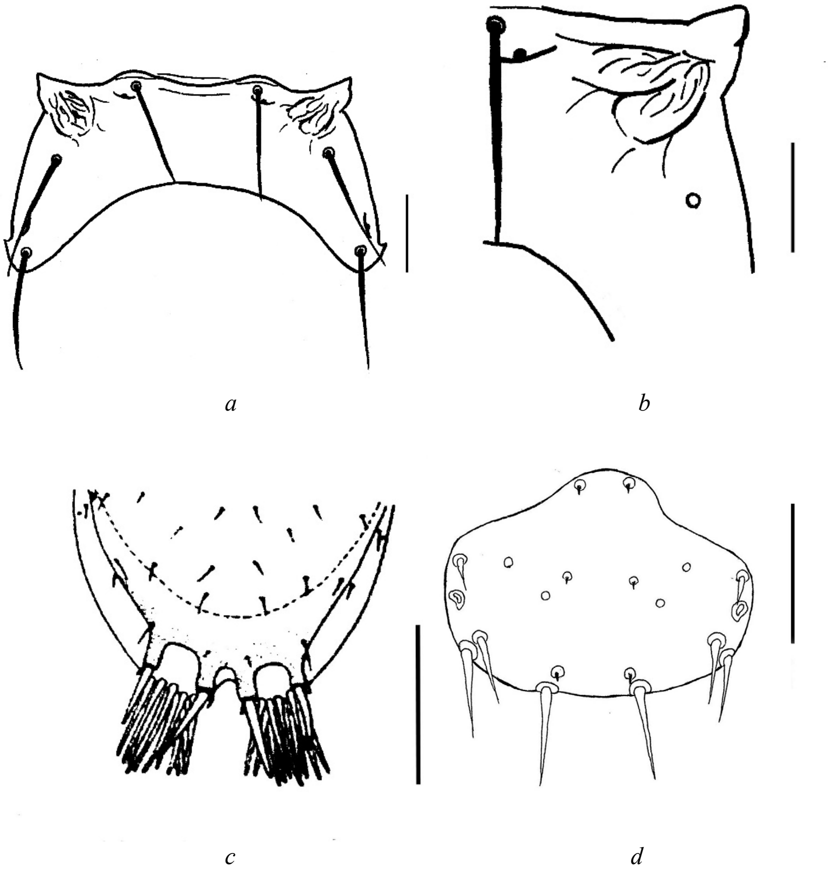


Fig. 24. *Macronyssus corethroproctus* (c – from Radovsky, 2010):
a – ♀, sternal shield (scale 25 μm); b – ♀, sternal gland (scale 20 μm);
c – ♂, opistosoma (scale 200 μm); d – protonymph, pigidial shield (scale 50 μm)

Material (tab. 11).

Table 11

Findings of *M. corethroproctus* (Orlova et al., 2012; Orlova, Zappart, 2012; Orlova, 2013b; Orlova et al., 2014)

Region	Baltic States		Urals		Western Siberia		Total
Shelters	Winter	Summer	Winter	Summer	Winter	Summer	
Hosts	*Myotis dasycneme*		*M. dasycneme, M. daubentonii, M. brandtii, M. mystacinus, Pipistrellus nathusii, Vespertilio murinus*		*M. dasycneme, Eptesicus nilssonii, V. murinus*		
♀♀	9	101 (32)	182	165 (77)	1	18 (15)	476
♂♂	1	17	7	34	-	2	61
N1	669	3	4521	232	28	5	5458
N2	-	-	-	9	-	-	9
Total	679	121	4710	346	29	25	6004

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

Macronyssus crosbyi (Ewing et Stover, 1915) (fig. 25)

Distribution: Holarctic (USA, Mexica, Baltic States, Urals, Altai, Russian Far East (Radovsky, 1967; Host and distribution lists ..., 2007; Stanyukovich, 1990, Medvedev et al., 1991; Jaunbauere et al., 2008; Czenze, Broders, 2011).

Host preference: pleoxenous, associated with various hosts of fam. Vespertilionidae (Radovsky, 1967).

Note: MI for *E. nilssonii* is 7,0 (from 4,3 in summer to 7,6 in winter), MI for *M. brandtii* – 2,4 (from 2,2 in winter to 2,5 in summer).

Material (tab. 12).

Macronyssus diversipilis (Vitzthum, 1920) (fig. 26)

Distribution: Described in Germany, findings are known from Czechia, Slovakia, Hungary, the Baltic States, Udmurtia, in the Urals and Trans-Urals (Radovsky, 1967; Pinchuk, 1970; Dusbábek, 1972; Haitlinger, 1978b; Stanyukovich, 1990; Bobkova, 2005; Orlova et al., 2011; Orlova et al., 2013).

Host preference: *Myotis daubentonii* (Dusbábek, 1964; Haightlinger, Walter, 1997), the vast majority of our findings (257 out of 270) exist from this host. High extensity of infestation in *Myotis nattereri* and *M. brandtii* was also found in some region (Haightlinger, Walter, 1997).

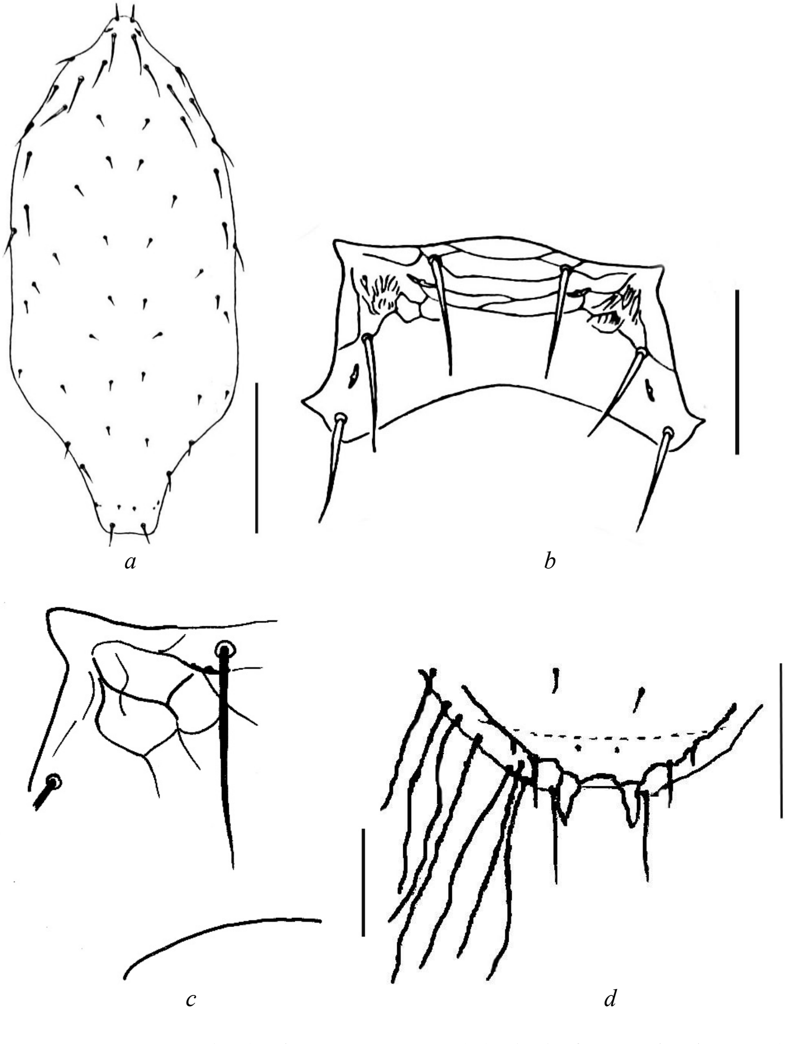


Fig. 25. *Macronyssus crosbyi* (Ewing et Stover, 1915) (*a, b, d* – from Radovsky, 2010): *a* – ♀, dorsal shield (scale 200 µm); *b* – ♀, sternal shield (scale 100 µm); *c* – sternal gland (scale 20 µm); *d* – ♂, opistosoma (scale 100 µm)

Table 12

Findings of *M. crosbyi* (Orlova, 2013)

Region	Pre-Urals and Urals		Total
Shelters	Winter	Summer	
Hosts	*Myotis dasycneme, M. daubentonii, M. brandtii, M. mystacinus, Eptesicus nilssonii, Plecotus auritus, Vespertilio murinus*		
♀♀	18	7 (4)	25
♂♂	18	3	21
N1	190	28	118
Total	226	38	264

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

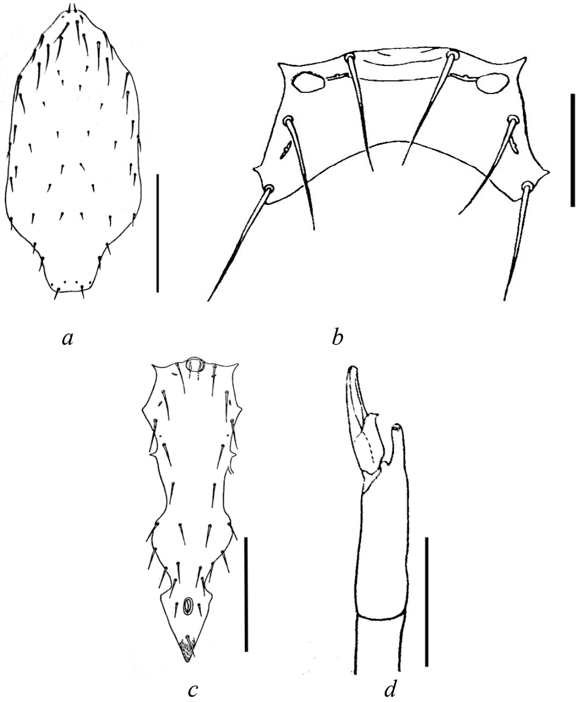


Fig. 26. *Macronyssus diversipilis* (Vitzthum, 1920) (from Radovsky, 2010):
a – ♀, dorsal shield (scale 200 µm); *b* – ♀, sternal shield (scale 50 µm);
c – ♂, ventrogenital shield (scale 200 µm); *d* – ♂, chelicerae (scale 50 µm)

Material (tab. 13).

Table 13

Findings of *M. diversipilis* (Orlova, 2013)

Region	Poland and Europe part of Russia	Pre-Urals and Urals		Total
Shelters	Summer	Winter	Summer	
Hosts	*Myotis daubentonii, Plecotus auritus*	*M. dasycneme, M. daubentonii, M. brandtii, Eptesicus nilssonii, P. auritus*		
♀♀	16(9)	4(1)	9(3)	29
♂♂	4	5	5	14
N1	4	4	219	227
Total	24	13	233	270

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

Macronyssus ellipticus (Kolenati, 1856) (fig. 27)

Distribution: Czechia, Slovakia, Poland, the Baltic States, Russia (Leningrad Region, the Urals and the Altai); findings out the boreal zone are known (Portugal, Bulgaria) (Radovsky, 1967; Pinchuk, 1970; Dusbábek, 1972; Beron, 1974; Haitlinger, 1979; Stanyukovich, 1990; own data). The eastern boundary of range are not found.

Host preference: polyxenous (speleobiont bat species) (Stanyukovich, 1990).

Material (tab. 14).

Macronyssus flavus (Kolenati, 1856) (fig. 28)

Distribution: Western Europe (UK, Germany, Czechia, Slovakia, Bulgaria, Romania, Ukraine, the Baltic States), China (Radovsky, 1967; Juvara, 1967; Dusbábek, 1972; Beron, 1974; Gu, Wang, 1985; Pintschuk, 1976; Stanyukovich, 1990; Bobkova, 2005; Medvedev et al., 2000; Haitlinger, Łupicki, 2008).

Host preference: oligoxenous (mainly associated with bats of the genus *Nyctalus*). Moreover it was obtained from *B. barbastellus*, *M. myotis*, *M. daubentonii*, *M. nattereri*, *M. mystacinus*.

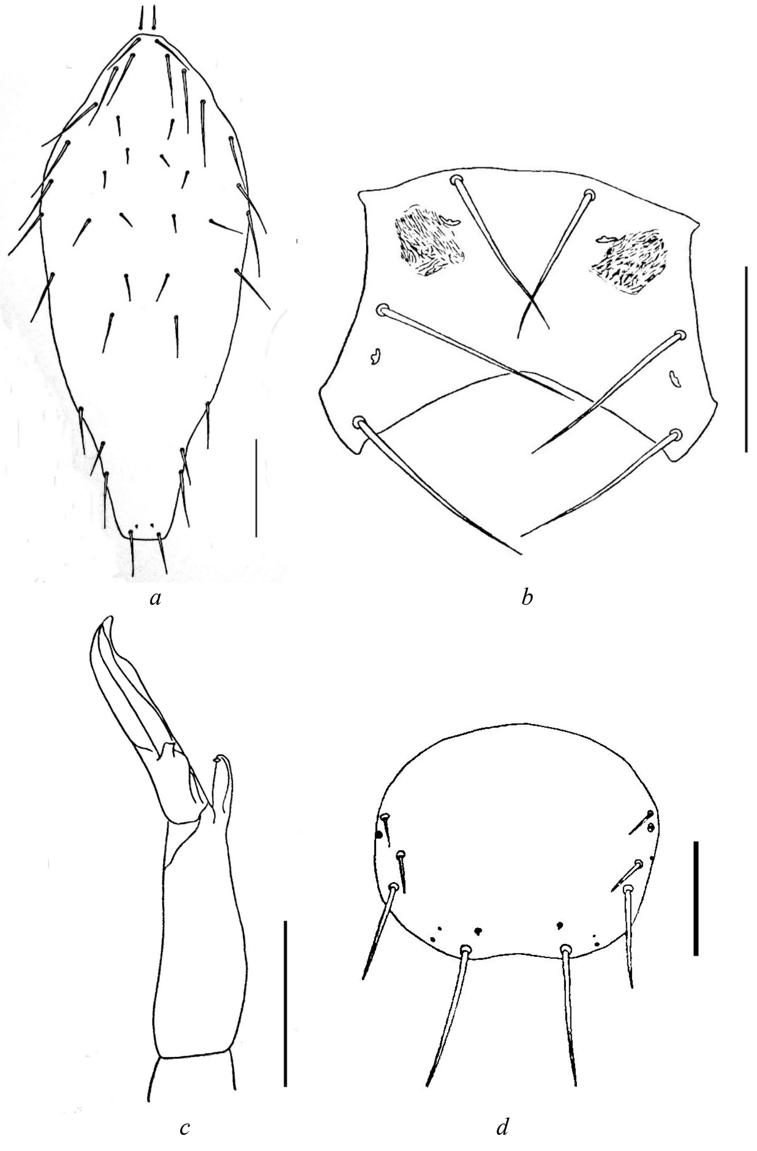


Fig. 27. *Macronyssus ellipticus* (Kolenati, 1856) (from Radovsky, 2010):
a – ♀, dorsal shield (scale 200 μm); *b* – ♀, sternal shield (scale 100 μm);
c – ♂, chelicerae (scale 50 μm); *d* – protonymph, pigidial shield (scale 50 μm)

Table 14

Findings of *M. ellipticus* (only winter shelters) (Orlova, 2013)

Region	Baltic States	Pre-Urals and Urals	Altai	Total
Hosts	*Myotis dasycneme, M. daubentonii*	*M. dasycneme, M. daubentonii, M. brandtii, M. mystacinus, Plecotus auritus*	*M. blythi, Murina hilgendorfi sibirica*	
♀♀	-	-	-	-
♂♂	7	3	-	10
N1	7	34	3	44
Total	14	37	3	54

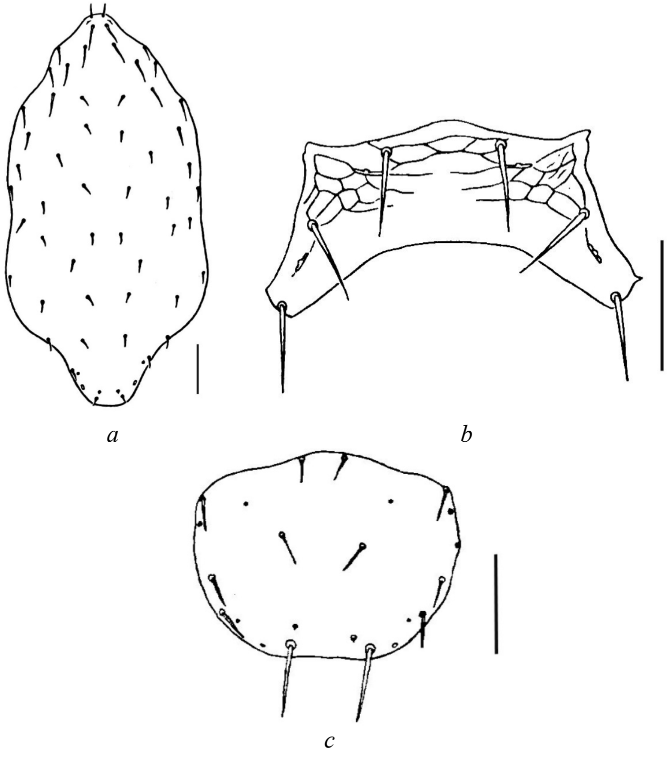


Fig. 28. *Macronyssus flavus* (Kolenati, 1856) (from Radovsky, 2010): *a* – ♀, dorsal shield (scale 100 µm); *b* – ♀, sternal shield (scale 100 µm); *c* – protonymph, pigidial shield (scale 50 µm)

Material: 2♂♂, 32♀♀ (including 23 females with intrauterine eggs), 90 N1 ex *N. noclula* (Polish Pomerania; VI.2011, VII.2012); N1 ex *M. daubentonii* (Udmurtia, VI.1992).

Macronyssus granulosus (Kolenatii, 1856) (fig. 29)

Distribution: circumpolar subboreal: Eurasia (Romania, Hungary, Bulgaria, Portugal, Italy, Russia (Altai, Far East), Turkey, Lebanon, Japan), Africa (Congo, Kenya), Central America (Mexico) (Stanyukovich, 1997).

Host preference: polixenous: Rhinolophidae (*Rhinolophus euryale*, *R. clivosus*), Vespertilionidae (*Myotis myotis*, *M. blythi, M. macrodactylus*, *M. nattereri*, *Myotis capaccinii* (Bonaparte, 1837), *M. daubentonii*, *M. petax*, *M. brandtii*, *M. mystacinus, Murina hilgendorfi sibirica*, *Miniopterus schreibersi*, *Miniopterus fraterculus* Thomas and Schwann, 1906, *Barbastella barbastella*, *Plecotus auritus*, *Murina hilgendorfi sibirica*, *Nyctalus leisleri*, *Rousettus aegiptiacus*, *Triaenops persicus* Dobson, 1871).

Note: In hibernation colonies prevalence of *M. blythi* reaches 100% (MI>60), in summer shelters on *M. macrodactylus* prevalence is 85%, MI up to 4.8.

Material (tab. 15).

Table 15

Findings of *M. granulosus* (Orlova et al., 2015)

Region	Altai	Kunashiri island	Total
Shelters	Winter	Summer	
Hosts	*Myotis blythi, Murina hilgendorfi sibirica*	*Myotis macrodactylus, M. petax*	
♀♀	3	23 (13)	26
♂♂	6	7	13
N1	310	23	333
Total	319	53	372

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

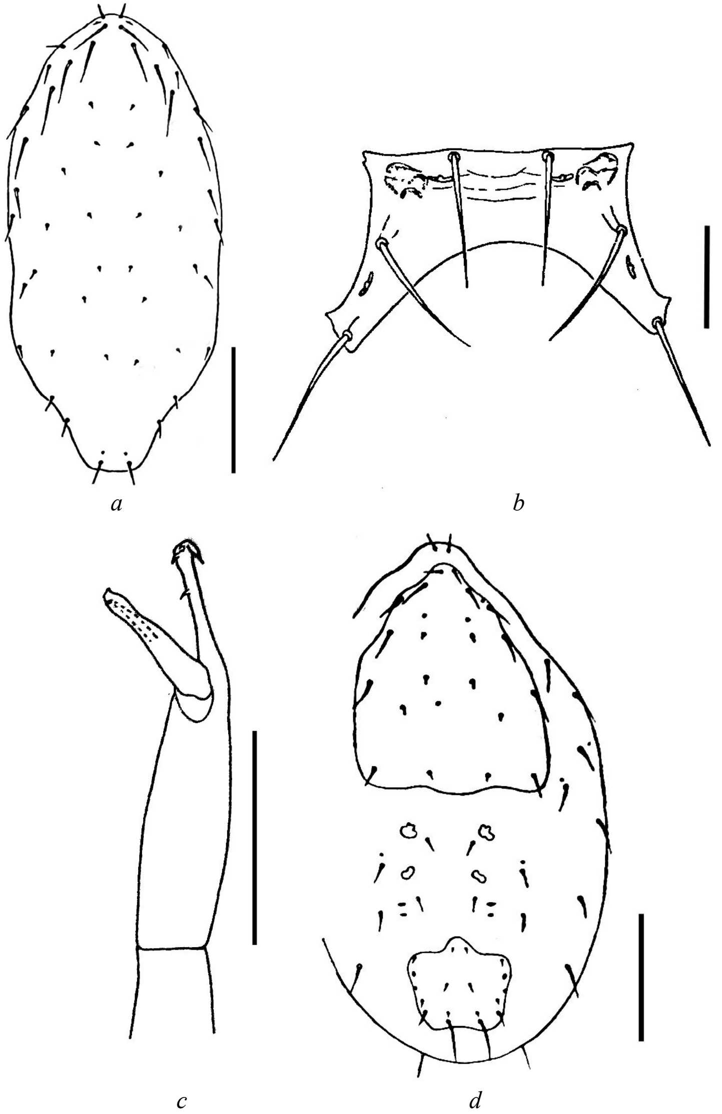


Fig. 29. *Macronyssus granulosus* (Kolenatii, 1856) (from Radovsky, 2010): *a* – ♀, dorsal shield (scale 200 µm); *b* – ♀, sternal shield (scale 50 µm); *c* – ♀, chelicera (scale 50 µm); *d* – protonymph dorsaly (scale 100 µm)

Macronyssus heteromorphus Dusbábek et Radovsky, 1972 (fig. 30)

Distribution: Central and Eastern Palaearctic: species was described in the Kuril Islands on unusual host – a gray rat (*Rattus norvegicus* (Berkenhout, 1769)); recorded in Western Siberia, Krasnoyarsk territory, Russian Far East (Dusbábek, Radovsky, 1972; Medvedev et al., 1991; own data).

Host preference: has not been studied. Findings exist from *Myotis petax*, *M. sibiricus*, *E. nilssonii*, *Murina hilgendorfi*.

Material: 2 ♀♀ (both with intrauterine eggs) ex *Myotis petax* (Tuva; VIII.2013); ♀, ♂, N2 ex *M. sibiricus* (Novosibirsk region; XI.2014).

Macronyssus hosonoi Uchikawa, 1979 (fig. 31)

Distribution: Central and Eastern Palaearctic from Altai to Kamchatka and Japan (Uchikawa, 1979; Medvedev et al., 1991).

Host preference: probably pleoxenous (bats of fam. Vespertilionidae): *Myotis gracilis* Ognev, 1927, *M. macrodactylus*, *M. ikonnikovi*, *M. sibiricus*, *Barbastella darjelingensis*, *Plecotus auritus*.

Material: ♀ ex *M. sibiricus* (Altai; XII.2012), 4♀♀ ex *Myotis petax* (Tuva; VIII.2013), ♀ ex *Myotis petax* (Buryatia; VII.2014), ♂ ex *M. macrodactylus* (Kunashiri island; VII.2014).

Macronyssus kolenatii (Oudemans, 1902) (fig. 32)

Distribution: Western Palaearctic (Czechia, Slovakia, Hungary, Moldova, Baltic States, Russia (Pskov region, Urals), Kazakhstan, Uzbekistan, Egypt) (Radovsky, 1967, Pinchuk, 1970; Dusbábek, 1972; Arutyunyan, Ogadjanyan, 1974a; Stanyukovich, 1990; Medvedev et al., 2000; Orlova, 2013).

Host preference: oligoxenous (bats of the genus *Pipistrellus*), also obtained from *M. dasycneme*, *M. brandtii*, *M. mystacinus*, *V. murinus*.

Material (tab. 16).

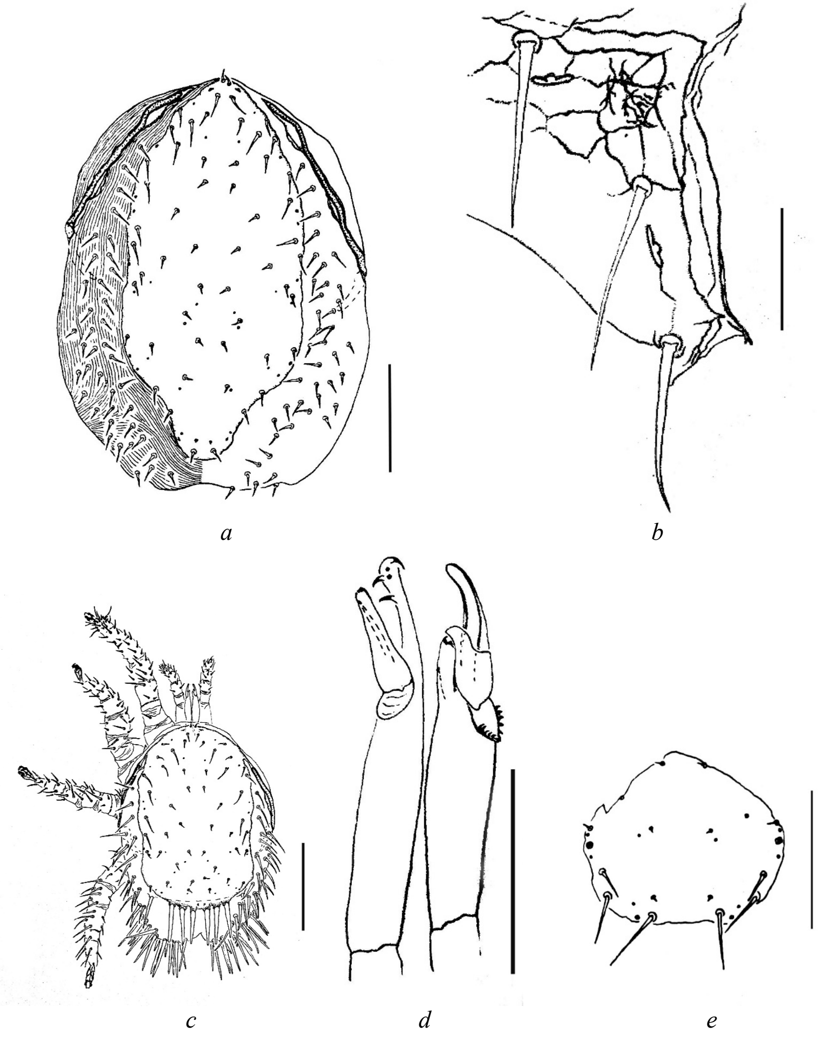


Fig. 30. *Macronyssus heteromorphus* Dusbábek et Radovsky, 1972 (from Dusbábek, Radovsky, 1972): *a* – ♀ dorsaly (scale 200 μm); *b* – ♀, sternal shield (part) (scale 20 μm); *c* – ♂ dorsaly (scale 200 μm); *d* – chelicerae (♀, ♂) (scale 50 μm); *e* – protonymph, pigidial shield (scale 50 μm)

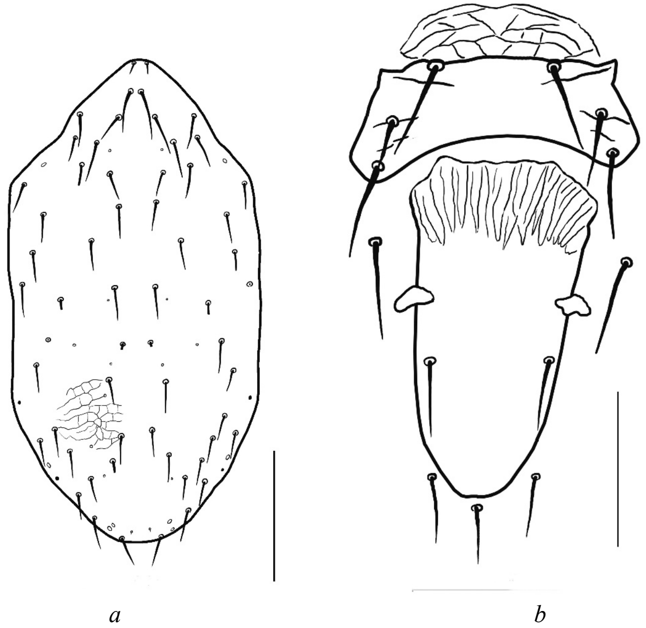
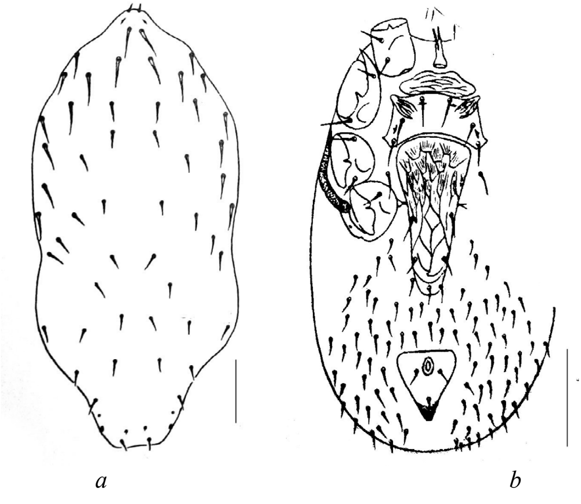


Fig. 31. *Macronyssus hosonoi* Uchikawa, 1979, ♀:
a –dorsal shild; *b* – ventral shilds. Scale 100 µm



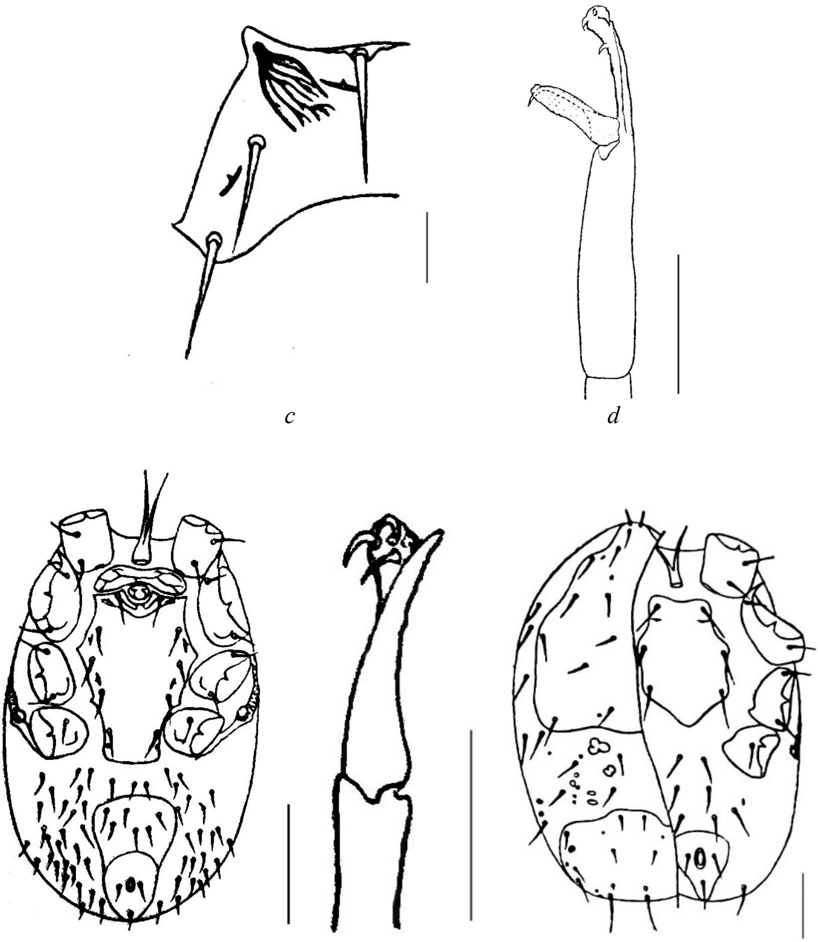


Fig. 32. *Macronyssus kolenatii* (Oudemans, 1902) (from Arutyunyan, Ogajanyan, 1974a): *a* – ♀, dorsal shild (scale 100 µm); *b* – ♀, ventraly (scale 200 µm); *c* – ♀, sternal shield (scale 50 µm); *d* – ♀, chelicerae (scale 50 µm); *e* – ♂, ventraly (scale 200 µm); *f* – ♂, chelicerae (scale 50 µm); *g* – protonymph, dorsaly and ventraly (scale 50 µm)

Table 16

Findings of *M. kolenatii* (only summer shelters, because preferred hosts doesn't hibernates in boreal zone) (Orlova, Zappart, 2012)

Region	Poland	Pre-Urals and Urals	Total
Hosts	*Pipistrellus nathusii*	*P. nathusii*, *V. murinus*	
♀♀	2 (2)	87 (71)	89
♂♂	-	16	16
N1	-	40	40
N2	-	1	1
Total	2	144	146

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

Macronyssus rhinolophi (Oudemans, 1902) (fig. 33)

Distribution: Western and Southern Europe (UK, France, Italy, Czechia, Slovakia, Hungary, Bulgaria, Greece), Ukraine, the Caucasus (Armenia, Azerbaijan) and Central Asia (Uzbekistan, Tajikistan, Kyrgyzstan).

Host preference: oligoxenous (bats of the genus *Rhinolophus*), also has been found on *Myotis emarginatus*, *Miniopterus schreibersi*, *Pipistrellus pipistrellus* (Radovsky, 1967; Arutyunyan, Ogadjanyan, 1974a; Stanyukovich, Malinovsky, 1992; Stanyukovich, 1997).

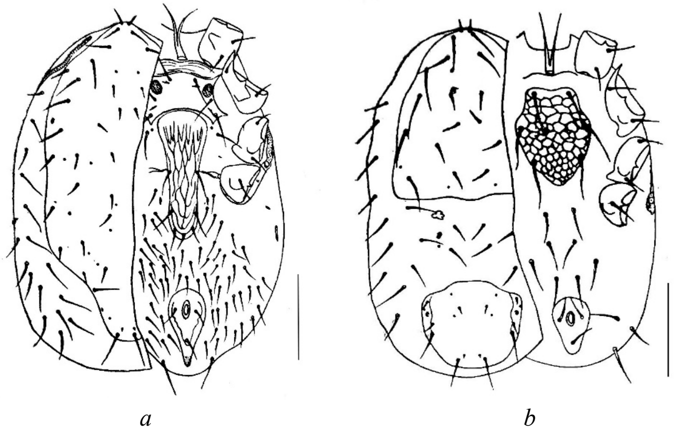


Fig. 33. *Macronyssus rhinolophi* (Oudemans, 1902) (from Arutyunyan, Ogajanyan, 1974): *a* – ♀ dorsaly and ventraly (scale 200 µm); *b* – protonymph, dorsaly and ventraly (scale 100 µm)

Macronyssus sibiricus Orlova, Zhigalin, 2015 (fig. 34)

Distribution and hosts: it has been described in Western Siberia (Novosibirsk region, Barsukovskaya cave) on *Myotis dasycneme* and *M. petax*.

Material: 28 ♀♀ (including 8 ♀♀ with intrauterine eggs) (Barsukovskaya cave; XI.2013, I.2014, III.2014).

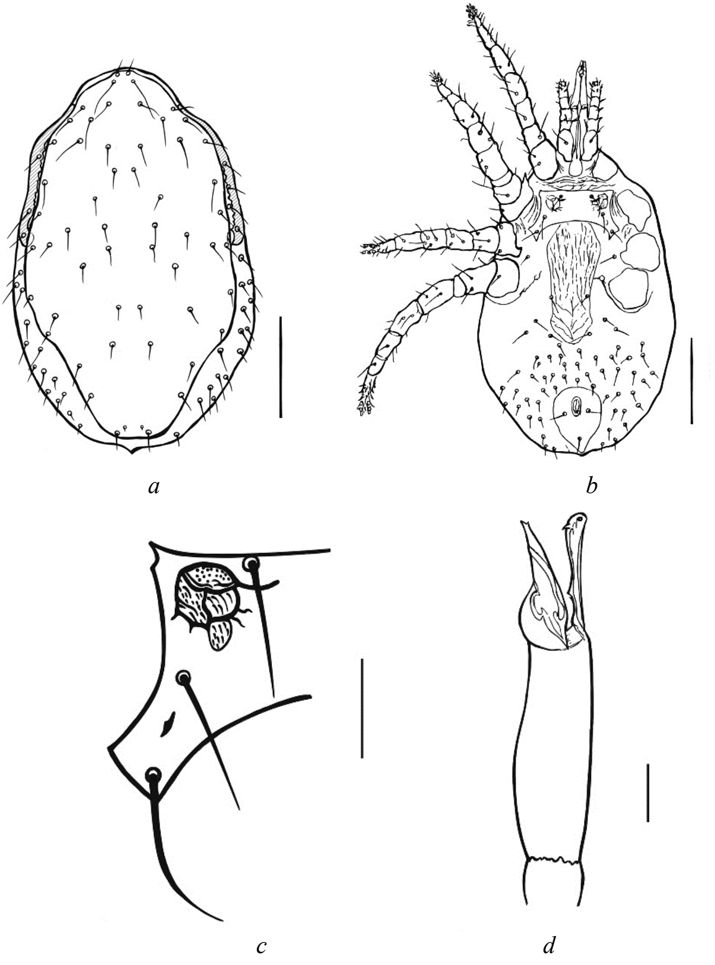


Fig. 34. *Macronyssus sibiricus* Orlova et A. V. Zhigalin, 2015, ♀:
a – dorsaly (scale 200 µm); *b* – ventraly (scale 200 µm); *c* – sternal shield (scale 50 µm); *d* – chelicerae (scale 20 µm)

Macronyssus stanyukovichi Orlova, Zhigalin, 2015 (fig. 35)

Distribution and hosts: it has been described in Western Siberia (Novosibirsk region, Barsukovskaya cave) and Altai (Tigirek State Natural Reserve caves); findings recorded on *Murina hilgendorfi sibirica*, *Myotis petax*, *M. dasycneme*.

Material (tab. 17).

Table 17

Findings of *M. stanyukovichi* (only winter shelters) (Orlova, Zhigalin, 2015)

Region	Western Siberia	Altai	Total
Hosts	*Myotis petax, M. dasycneme, Murina hilgendorfi sibirica*	*Murina hilgendorfi sibirica*	
♀♀	38(16)	5	42
♂♂	12	-	12
N1	85	-	84
N2	5	-	5
Total	140	5	145

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

Macronyssus tigirecus Orlova, Zhigalin, 2015 (fig. 36)

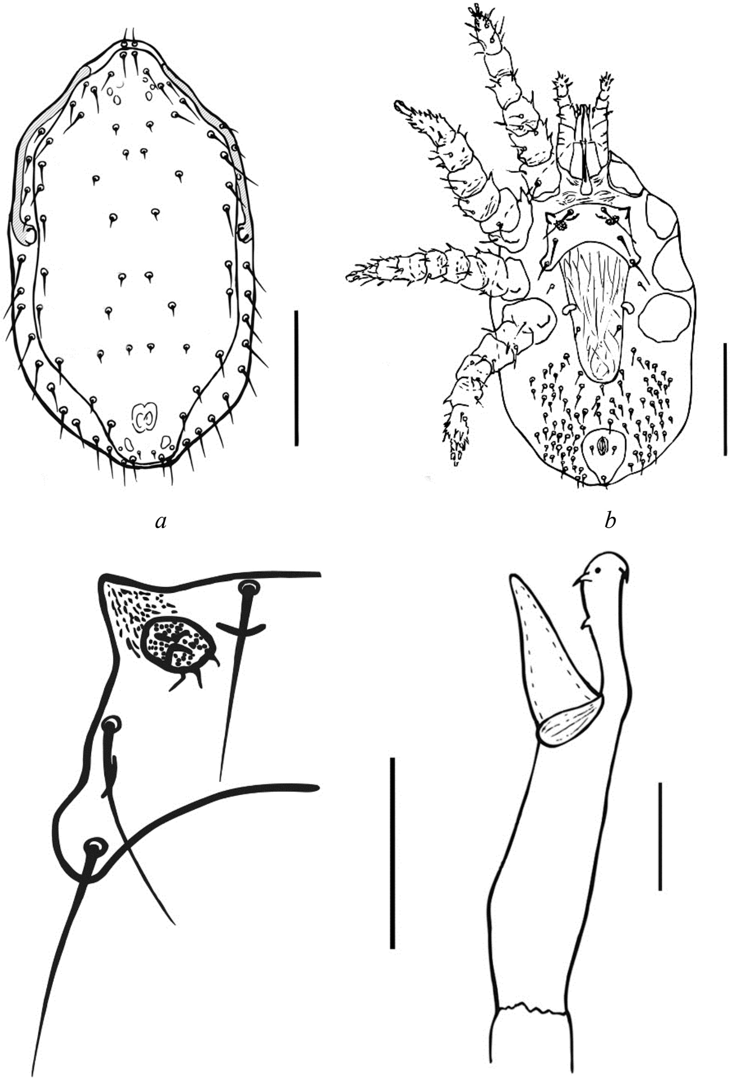
Distribution and hosts: species was described in Altai (Tigirek State Natural Reserve caves) from *Murina hilgendorfi sibirica*.

Material: 7 ♀♀ (XII.2012).

Subfamily Ornithonyssinae

Genus *Steatonyssus* Kolenati, 1858

The adults are light brown (beige) to a dark brown color with highly stretchable unsclerotized alloscutum. From the other genera of the family representatives of the *Steatonyssus* different by two dorsal shields and strongly sclerotized posterior margin of sternal shield in females.



a *b*

c *d*

Fig. 35. *Macronyssus stanyukovichi* Orlova et A. V. Zhigalin, 2015, ♀: *a* – dorsaly (scale 200 µm); *b* – ventraly (scale 200 µm); *c* – sternal shield (scale 50 µm); *d* – chelicerae (scale 20 µm)

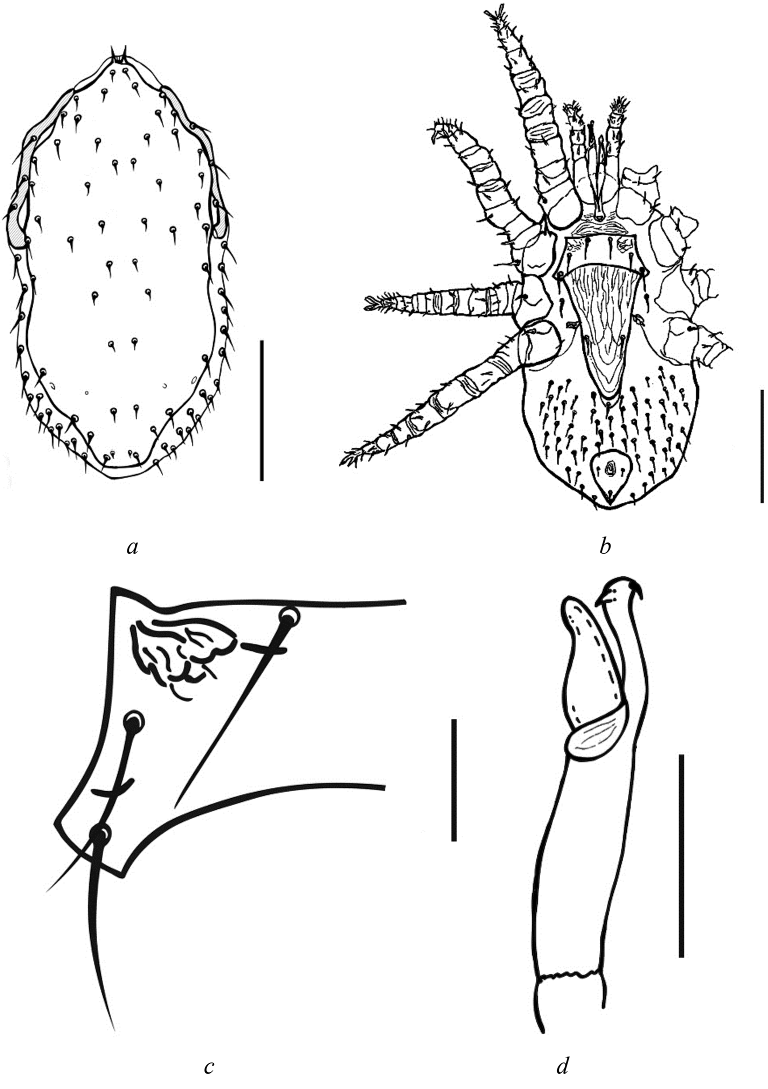


Fig. 36. *Macronyssus tigirecus* Orlova et A. V. Zhigalin, 2015, ♀:
a – dorsaly (scale 200 µm); *b* – ventraly (scale 200 µm); *c* – sternal shield (scale 50 µm); *d* – chelicerae (scale 50 µm)

Key to the genus *Steatonyssus* Kolenati, 1858 of the boreal Palaearctic region

Females

1. Setae M 11 on opisthosomal plate long 2
Setae M 11 short 3

2. Setae M 11 1.5-2 times shorter then D 5-7 .... *S. spinosus* Willmann, 1936
Length of setae M 11 and D 5-7 equal .... *S. noctulus* Rybin, 1992

3. Peritreme short and not reaching the posterior margin coxa II 4
Peritreme longer, reaching the posterior margin or the middle coxa II 6

4. Setae St 1-3 are approximately equal in length; four pairs of short setae on posterior tip of opisthosomal plate are equal in length (D 8 – microsetae) 5
Setae St 1 are 2 times shorter then St 3; setae S 8 are approximately 3 times longer then S 7 and M 11 ………..………………………. *S. mongolicus* Dusbábek, 1962

5. Peritreme reaching middle coxa III; sternal plate with strong sclerotized posterior margin ………...…….…… ……………………………. *S. occidentals evansi* (Micherdzinski, 1980)
Peritreme almost reaching front margin coxa III; sternal plate with weak sclerotized band ……...............................………… ……………..……………………. *S. desertorus* Rybin, 1992

6. Setae St 1 are very short, almost 3 times shorter than St 3 ………………………...…………… *S. periblepharus* Kolenati, 1858
Setae St 1 are slightly shorter then St3 7

7. On posterior end of body there are 10-12 pairs of thick knife-liked setae ………….……………..……….. *S. superans* Zemskaya, 1951
Thick knife-liked setae are absent 8

8. Peritreme reaching the middle of coxa II; anterodorsal spur on coxa II with 5 denticles, sometime undiscernable; setae S 7-8 and M 11 approximately equal in length .... *S. aglaiae* Stanyukovich, 1991
Peritreme reaching the posterior margin of coxa II; large anterodorsal spur on coxa II; setae S 8 are slightly shorter then S 7 ……….......……………………..………. *S. cavus* Rybin, 1992

Males

1. Two dorsal plates .... *S. superans* Zemskaya
   Sole dorsal plate 2
2. Setae M 11 are long 3
   Setae M 11 are short 4
3. Dorsal plate with 23-24 setal pairs; holoventral plate sligthtly broading behind coxa IV; anterior seta on coxa III resembles a fish tail .... *S. spinosus* Willmann
   Dorsal plate with 25 setal pairs; holoventral plate narrow, without broading behind coxa IV; anterior seta on coxa III is ordinary .... *S. noctulus* Rybin
4. Peritreme reaching middle of coxa III 5
   Peritreme reaching anterior margin coxa III or posterior margin coxa II 6
5. Dorsal plate with 18 setal pairs; anterior seta on coxa III is ordinary ………..… *S. desertorus* Rybin
   Dorsal plate with 19 setal pairs; anterior seta on coxa is III spur-like, floated with ridge-like thickening .... *S. occidentals evansi* (Micherdzinski)
6. Dorsal plate is clearly divided into podosomal and opisthosomal parts closely connected with one another by a transverse furrow .... *S. mongolicus* Dusbábek
   Dorsal plate is undivided 7
7. Dorsal plate with 16 setal pairs; anterior seta on coxa III ist not floated .... *S. cavus* Rybin
   Dorsal plate with 19-20 setal pairs; anterior seta on coxa III is floated and looks like a fish tail .... *S. periblepharus* Kolenati

Protonymphs

1. Four pairs of intermediate sclerits between podosomal and opisthosomal plates …….. *S. spinosus* Willmann
   Two pairs of intermediate sclerits between podosomal and opisthosomal plates 2
2. Posterior seta on coxa III floated near base, the tip is pointed and becoming a thin thread .... *S. superans* Zemskaja

Posterior seta on coxa III is ordinary 3

3. Podosomal plate is small (length about 80, width about 55) ……..................................… *S. occidentalis evansi* (Micherdzinski)

Length of podosomal plate is more then 100, width is more then 80 ….................................……………………………...… 4

4. Length of tarsi I and IV are equal 5

Length of tarsi I is more then that of tarsi IV 6

5. Tarsi I and IV are very short (near 64); the length of sternal setae is about 21 .... *S. desertorus* Rybin

Lengths of I and IV tarsi are about 80-100; lengths of sternal setae are 37-38 …..……....………………..…….. *S. noctulus* Rybin

6. Length of tarsi I and IV is not larger then 110 ……………..............….....…………….. *S. periblepharus* Kolenati

Length of tarsi I and IV is much larger 7

7. Basal width of tarsi is 27-32; length of tarsi IV is 145-161 ……………..........................……………..……………. *S. cavus* Rybin

Basal width of tarsi is 37-38; length of tarsi IV is 134-135 ……...………… *S. aglaiae* Stanyukovich

Steatonyssus aglaiae Stanyukovich, 1991 (fig. 37)

Distribution and hosts: species has been described in Crimea from *Rhinolophus ferrumequinum* (Stanyukovich, 1991).

Steatonyssus cavus Rybin, 1992 (fig. 38)

Distribution and hosts: species has been described in Kyrgyzstan from *Rhinolophus ferrumequinum* and *Barbastella darjelingensis* (Stanyukovich, 1991).

Steatonyssus desertorus Rybin, 1992 (fig. 39)

Distribution and hosts: it has been described in Kyrgyzstan from *Eptesicus bottae* Peters, 1869.

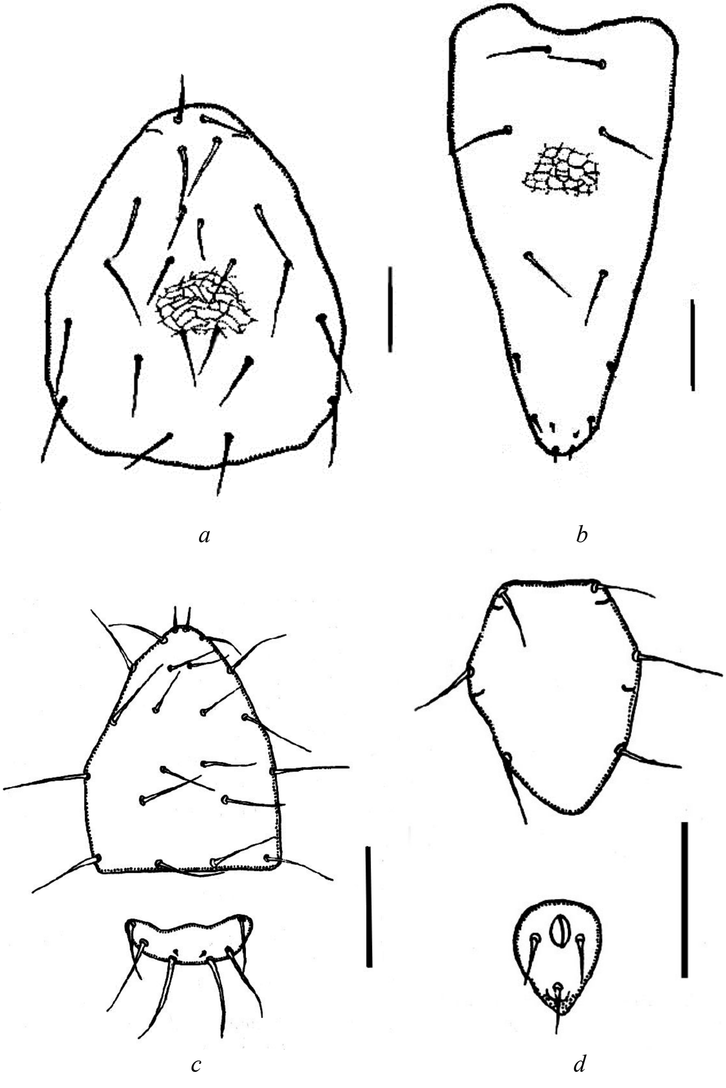


Fig. 37. *Steatonyssus aglaiae* Stanyukovich, 1991. ♀: *a, b* – dorsal shields; *c* – protonymph dorsaly; *d* – protonymph ventraly. Scales 100 µm

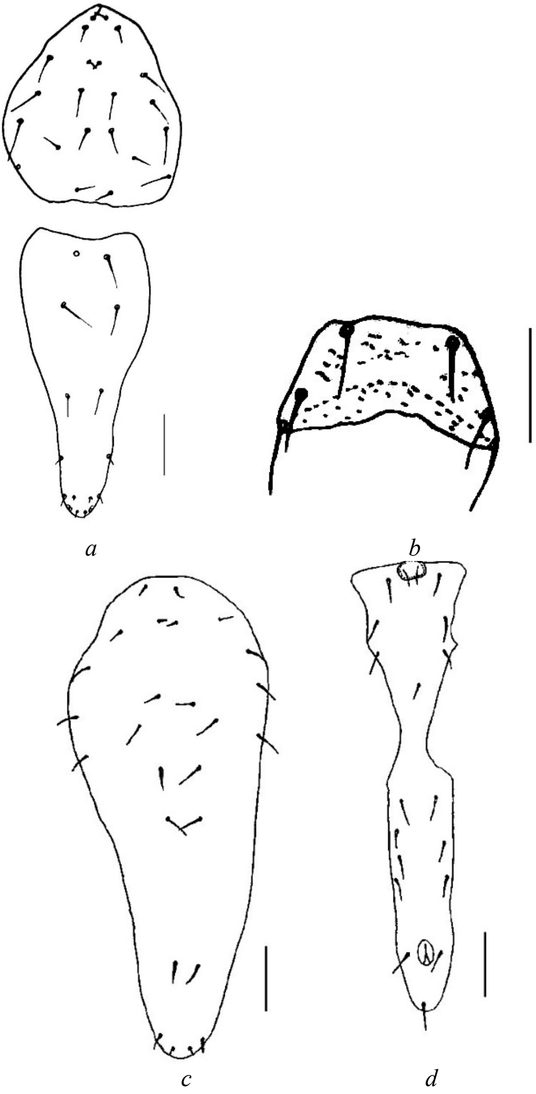


Fig. 38. *Steatonyssus cavus* Rybin, 1992 (from Rybin, 1992; Stanyukovich, 1997). ♀: *a* – dorsal shields (scale 100 µm); *b* – sternal shield (scale 50 µm). ♂: *c* – dorsal shield; *d* – ventral shield. Scales 100 µm

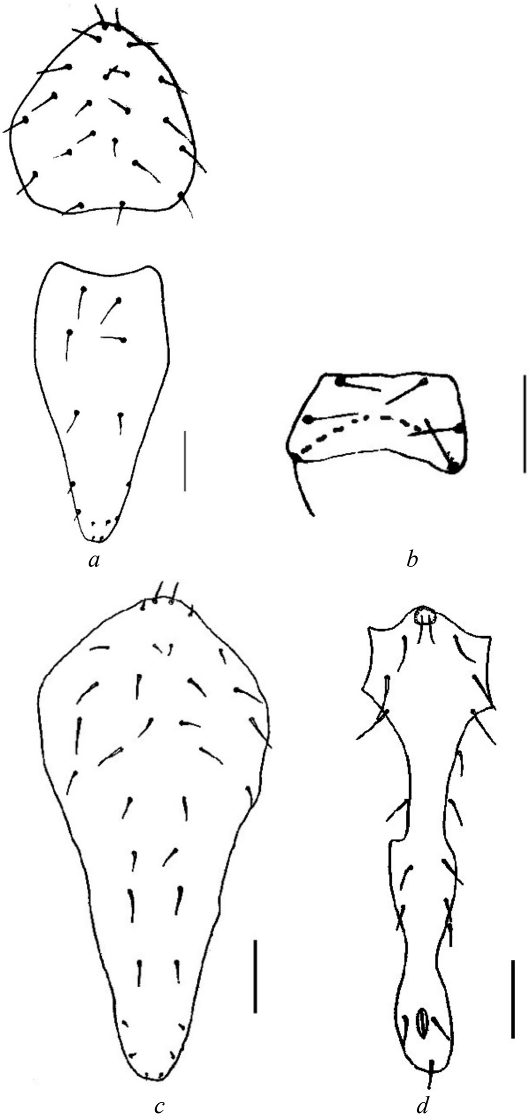


Fig. 39. *Steatonyssus desertorus* Rybin, 1992 (from Rybin, 1992; Stanyukovich, 1997). ♀: *a* – dorsal shields (scale 100 µm); *b* – sternal shield (scale 50 µm). ♂: *c* – dorsal shield; *d* – ventral shield. Scales 100 µm

Steatonyssus mongolicus Dusbábek, 1966 (fig. 40)

Distribution: probably palaearctic subboreal: it has been descibed in Mongolia, recorded in Tajikistan (Dusbábek, 1966; Stanyukovich, 1997).

Host preference: bats were first identified as *M. mystacinus*, but according current data on vespertilionid bat taxonomy, this species don't inhabit Central Asia; probably host of *S. mongolicus* is *Myotis davidi.*

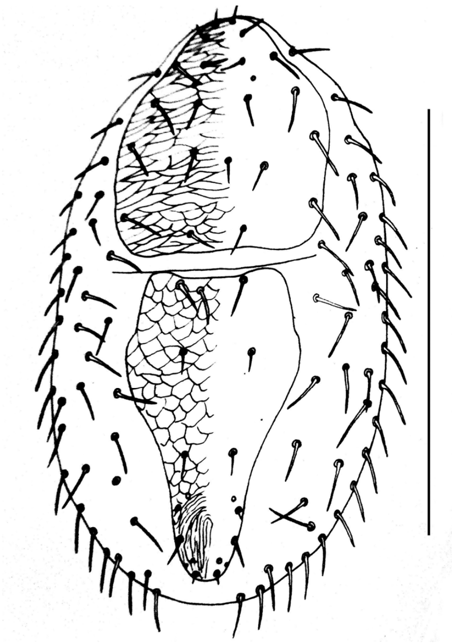


Fig. 40. *Steatonyssus mongolicus* (from Dusbábek, 1966).
♀ dorsaly (scale 500 μm).

Steatonyssus noctulus Rybin, 1992 (fig. 41)

Distribution: Russia, Latvia, Belarus, Moldova, Ukraine, Azerbaijan, Kazakhstan, Kyrgyzstan (Rybin, 1992; Stanyukovich, 1997; Medvedev et al., 2000).

Host preference: *Nyctalus noctula*, *Miniopterus schreibersi.*

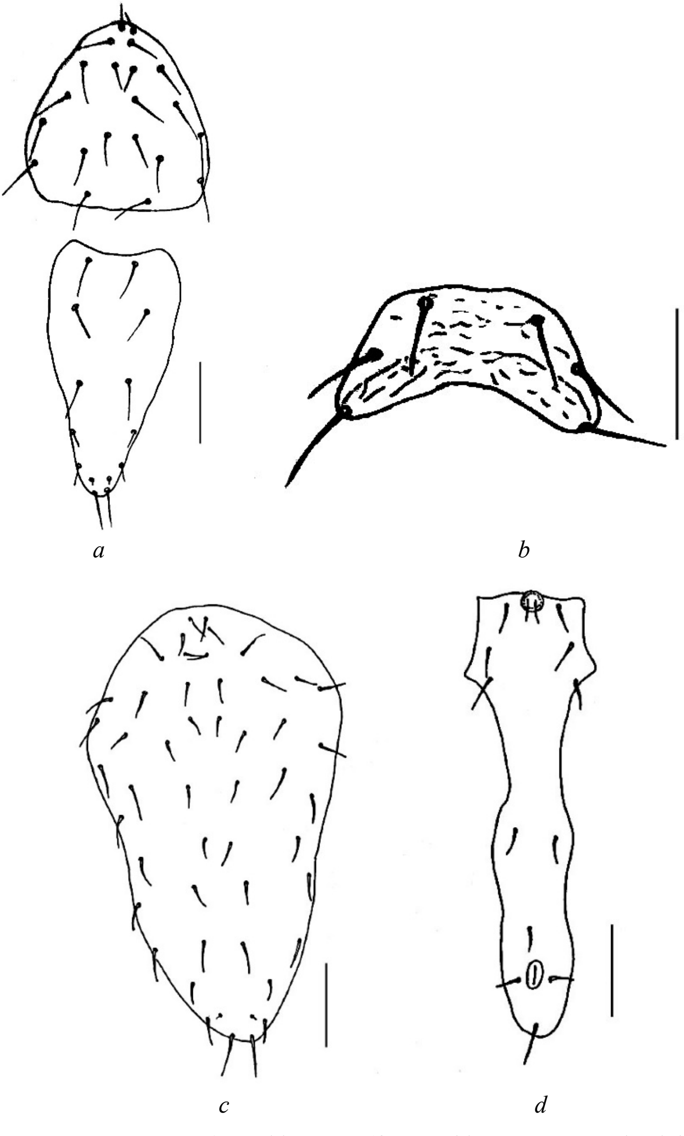


Fig. 41. *Steatonyssus noctulus* Rybin, 1992 (from Rybin, 1992; Stanyukovich, 1997). ♀: *a* – dorsal shields (scale 100 µm); *b* – sternal shield (scale 50 µm). ♂: c – dorsal shield; *d* – ventral shield. Scales 100 µm

Steatonyssus occidentalis evansi (Micherdzinski, 1980) (fig. 42)

Distribution: Western and Central Palaearctic (UK, Germany, Czechia, Slovakia, Russia, Belarus, Georgia, Kazakhstan, Tajikistan, Kyrgyzstan).

Host preference: *Myotis davidii*, *M. blythii*, *Eptesicus serotinus*.

Steatonyssus periblepharus Kolenati, 1858 (fig. 43)

Distribution: Palaearctic (Czechia, Poland, Baltic states, Germany, Bulgaria, Moldova, Armenia, Kyrgyzstan, Algeria, Egypt, Lebanon, Afghanistan, Mongolia and China) (Till, Evans, 1964; Pinchuk, 1971a; Dusbábek, 1972; Arutyunyan, Ogadganyan, 1974a; Haitlinger, 1978; Micherdzinski, 1980; Teng, 1980; Rybin, 1983; Schmidt, 1987; Stanyukovich, 1990; Rupp et al., 2004).

Host preference: polyxenous (Vespertilionidae, Rhinolophidae), however, it occurs most frequently on pipistrelles (very common on *P. pipistrelli*) (Till, Evans, 1964; Haitlinger, 1978; Stanyukovich, 1990; Orlova, Zappart, 2012).

Material. 648 individuals of *S. periblepharus* (tab. 18), most of them – from Baltic coast of Germany and Poland (only summer shelters).

Table 18

Findings of *S. periblepharus* (Orlova, Zappart, 2012)

	Baltic region				Pre-Urals	Total
Hosts	*Pipistrellus nathusii*	*P. pygmaeus*	*Myotis dasycneme*	*M. daubentonii*	*E. nilssonii*	
♀♀	30(4)	24	69(15)	-	1	124(19)
♂♂	4	6	22	-	-	32
N1	85	8	391	11	-	492
Total	119	38	482	11	1	648

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

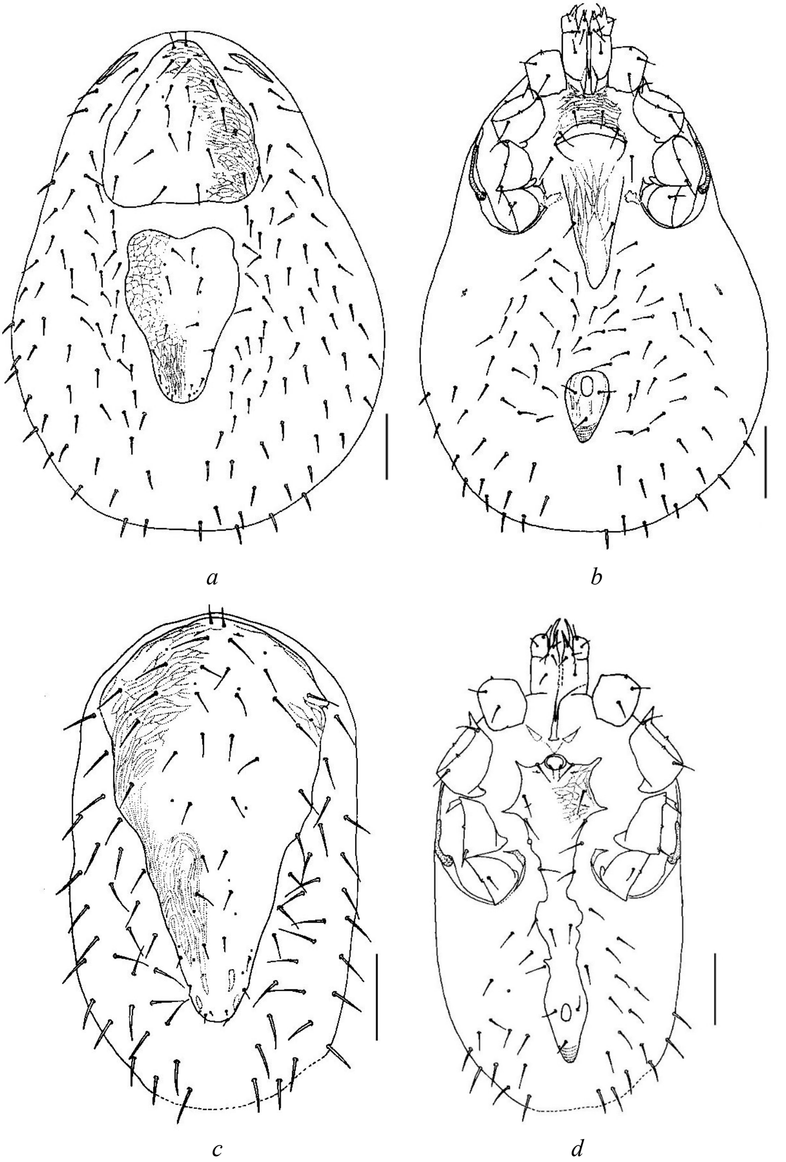
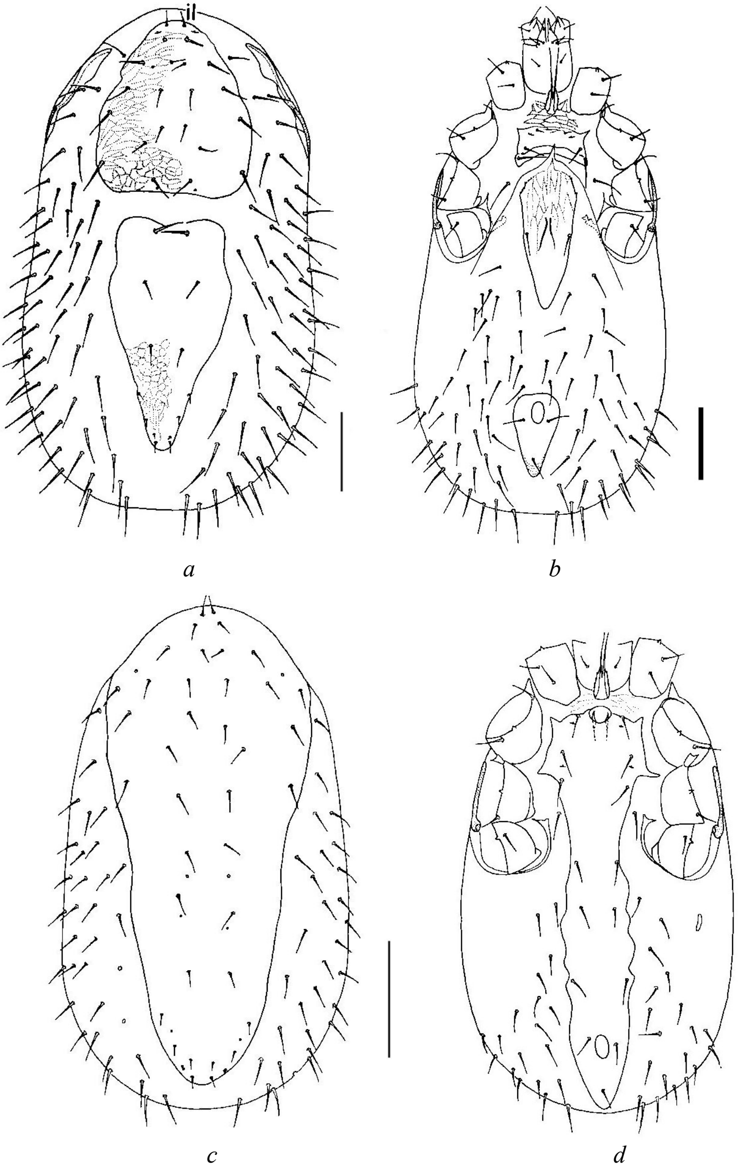


Fig. 42. *Steatonyssus occidentalis evansi* (from Micherdzinski, 1980). ♀: *a* – dorsaly; *b* – ventraly. ♂: *c* – dorsaly; *d* – ventraly. Scales 100 μm



a

b

c

d

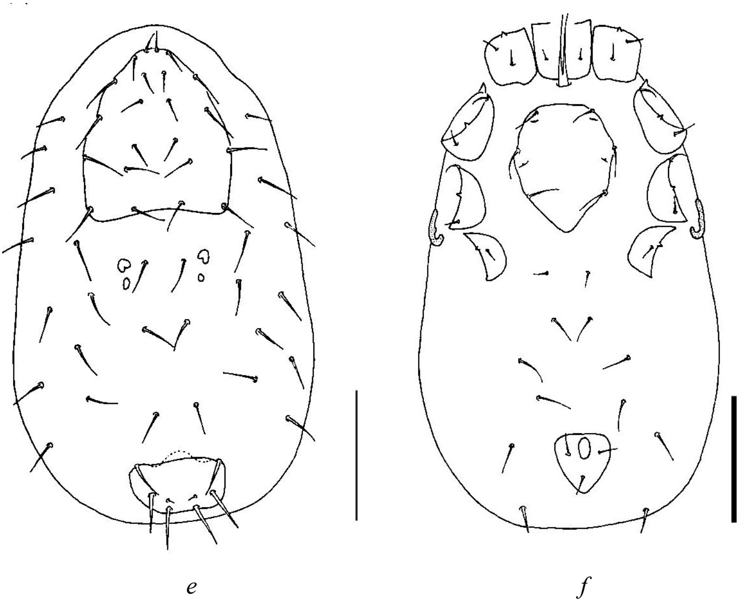


Fig. 43. *Steatonyssus periblepharus* Kolenati, 1858 (from Till, Evans, 1964):
a – ♀ dorsaly; b – ♀ ventraly; *c* – ♂ dorsaly; *d* – ♂ ventraly; *e* – protonymph dorsaly;
f – protonymph ventraly. Scale 100 μm

Steatonyssus spinosus Willmann, 1936 (fig. 44)

Distribution: Palaearctic from Britain to Far East and Japan.

Host preference: polyxenous (Vespertilionidae, Rhinolophidae) (Till, Evans, 1964; Pinchuk, 1971a; Dusbábek, 1972; Arutyunyan, Ogadganyan, 1974a; Uchikawa, Kumada, 1977; Haitlinger, 1978; Micherdzinski, 1980; Teng, 1980; Rybin, 1983; Stanyukovich, 1990; Rupp et al., 2004), however, it occurs most frequently on bats of genus *Vespertilio* (*V. murinus*, *V. superans*).

Material. 482 *S. spinosus* specimens: summer findings are represented in table 19, 3 protonymphs (2 from *M. petax* in Novosibirsk region, 1 from *M. dasycneme* in Southern Ural) were found in winter shelters.

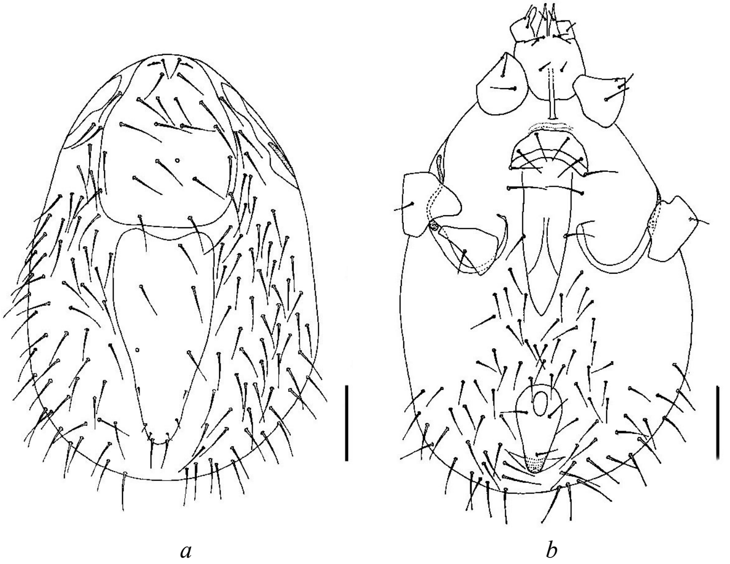


Fig. 44. *Steatonyssus spinosus* Willmann, 1936 (from Till, Evans, 1964): *a* – ♀ dorsaly; *b* – ♀ ventraly. Scale 100 µm

Table 19

Findings of *S. spinosus* (only summer shelters) (Orlova, Orlov, 2013; Orlova et al., 2015)

	Ural				Tuva	Total
Hosts	*M. dasycneme*	*V. murinus*	*E. nilssonii*	*P. nathusii*	*M. petax*	
♀♀	5	111(32)	-	1(1)	10(1)	127(34)
♂♂	4	31	-	-	3	38
N1	26	271	4	13	-	314
Total	35	413	4	14	13	479

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

Steatonyssus superans Zemskaya, 1951 (fig. 45)

Distribution: Central and Western Palaearctic (Ural, Western Siberia, Kazakhstan, Tajikistan, Korea, Far East, Japan (Till, Evans, 1964; Ah, Radovsky, 1967; Uchikawa, Kumada, 1977; Teng, 1980; Medvedev et al., 1991; Orlova, 2013; Orlova, 2014).

Host preference: *S. superans* recorded on *Vespertilio murinus*, *V. superans*, greater noctule *Nyctalus lasiopterus* (Schreber, 1780).

Material. 59 individuals were collected from *V. murinus* (only summer roosts) (tab. 20).

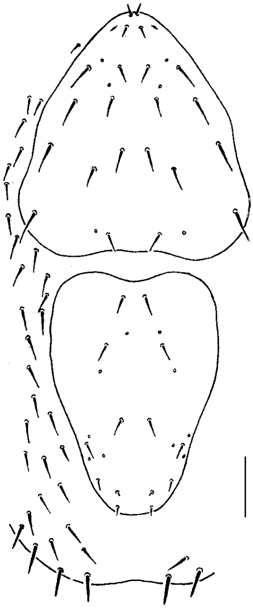


Fig. 45. *Steatonyssus superans* Zemskaya, 1951 (from Zemskaya, 1951), ♀ dorsaly. Scale 100 µm

Table 20

Findings of *S. superans* (only summer shelters) (Orlova, Orlov, 2013; Orlova et al., 2015)

	Ural	Western Siberia	Tuva	Total
Hosts	*Vespertilio murinus*		*Myotis petax*	
♀♀	13(9)	13(8)	6(3)	32(20)
♂♂	10	-	-	10
N1	16	1	-	17
Total	39	14	6	59

Note: The brackets indicate the number of females with intrauterine eggs in total number of females.

Род Genus *Ornithonyssus* Sambon, 1928

Large mites with highly stretchable unsclerotized alloscutum. Palaearctic bats harbor 5 species, belonging to this genus.

Key to the genus *Ornithonyssus* Kolenati, 1858 of the boreal Palaearctic region

Females

1. Dorsal shield with 16-19 pairs of setae ……………..………………. 2

Dorsal shield with 20-23 pairs of setae. Peritremes reach the middle or anterior margin of base of second pairs of legs ...…... 3

2. The dorsal shield has 16 pairs of setae. Peritremes reach anterior margin of the base third pairs of legs .... *Ornithonyssus flexus* (Radovsky, 1967)

Dorsal shield with 19 setal pairs. Peritreme reach middle of the base 3 pairs of legs. .... *Ornithonyssus guzlonicus* sp. nov.

3. Dorsal shield with 20 setal pairs. Z5 bristles at the rear end shield longest. The length of the dorsal shield 3 times the width ….......……………………. *Ornithonyssus pipistrelli* (Oudemans, 1904)

Dorsal shield with 21-23 pairs of setae ………...……………... 4

4. The dorsal shield has 21 pairs of setae. Z5 setae shorter than the other setae on the shield. The maximum width of the dorsal shield on the half its length …................... *Ornithonyssus hoogstraali* (Keegan, 1956)

Dorsal shield with 23 setal pairs. The setae on posterior margin of shield – the longest .... *Ornithonyssus olesovi* sp. nov.

Males

Holoventral plate with 17 setae. Peritreme reach middle of coxa II ……..……...…... *O. hoogstraali* (Keegan)

Holoventral plate with 13 setae. Peritreme reach middle of coxa III ……......................................……..... *O. pipistrelli* (Oudemans)

Protonymphs

1. Pygidial plate with 6 setal pairs …………...………………………... 2

Pygidial plate with 4-5 setal pairs …………………........……………. 3

2. Pygidial shield length in 2-2.5 times smaller than the width, setae thin ….............................. *Ornithonyssus pipistrelli* (Oudemans 1904)

Pygidial plate length almost equal to the width, and Z5 and S5 setae thick and lanceolate .... *Ornithonyssus guzlonicus* sp. nov.
3. Pygidial plate with 4 setal pairs: two pairs short and two ones – thick, knife-like .... *Ornithonyssus hoogstraali* (Keegan, 1956)
Pygidial plate with 5 pairs: one pair short setae and four pairs long setae ……………..…………………… *Ornithonyssus flexus* (Radovsky, 1967)

Ornithonyssus flexus (Radovsky, 1967) (= *Cryptonyssus flexus* (Radovsky, 2010)) (fig. 46)

Distribution: Holarctic species (USA, Tajikistan, Mongolia, Crimea)

Hosts: descripted from *Myotis lucifugus* (Le Conte, 1831); *M. mystacinus*; *M. davidii.*

Material: 2 ♀♀ ex *E. nilssonii* (Southern Urals; 07.2010).

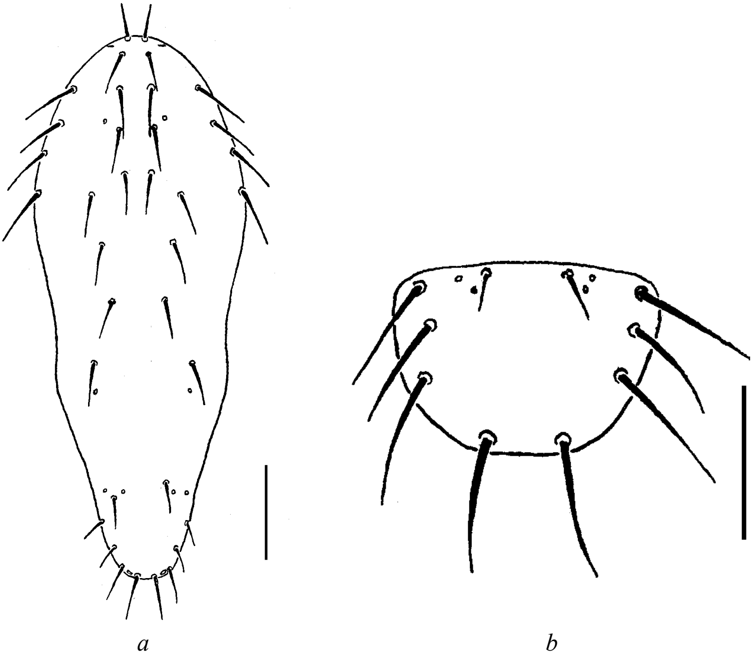


Fig. 46. *Ornithonyssus flexus* (Radovsky, 1967) (from Micherdzinsky, 1980): *a* – ♀, dorsal shield (scale 200 μm); *b* – protonymph, pigidial shield (scale 100 μm)

Ornithonyssus hoogstraali (Keegan, 1956) (fig. 47)
(= *Parasteatonyssus hoogstraali* (Keegan, 1956) (Radovsky, 2010))
Distribution: Cenral Asia (Kyrgyzstan), Canar Island, Egypt
Hosts: *Tadarida teniotis*.

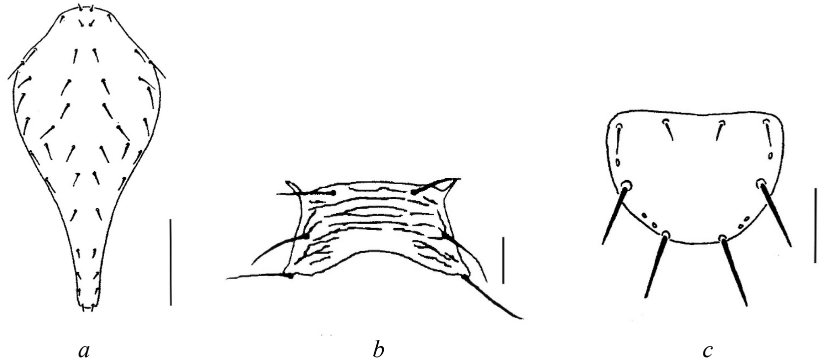


Fig. 47. *Ornithonyssus hoogstraali* (Radovsky, 1967) (from Micherdzinsky, 1980): *a* – ♀, dorsal shield (scale 200 µm); *b* – ♀, sternal shield (scale 20 µm); *c* – protonymph, pigidial shield (scale 20 µm)

Ornithonyssus pipistrelli (Oudemans, 1902) (= *Cryptonyssus pipistrelli* (Oudemans, 1902) (Radovsky, 2010)) (fig. 48)

Distribution: range has complicated configuration (Mexica, Britain, Romania, the Baltic States, Georgia, Russia (Leningrad region, Kirov region, Altai) (Zemskaya, 1966; Radovsky, 1967; Micherdzinski, 1980; Stanyukovich, 1990; Villegas-Guzman et al., 2005; Marchenko, 2007).

Host preference: pleoxenous (bats of fam. Vespertilionidae): *M. dasycneme*, *M. daubentonii*, *M. ikonnikovi*, *M. petax*, *M. sibiricus*, *P. nathusii*, *N. noctula*, *P. auritus*, *P. austriacus*, *E. nilssonii*.

Material: 4 N1 ex *M. dasycneme* (Baltic region (Kiel); 07-08.2004); ♀ and 2 N1 ex *E. nilssonii* (07.2012; Middle Urals); 4 N1 ex *E. nilssonii*, 4 N1 ex *M. petax*, 16 N1 ex *M. sibiricus* (07.2014; Baicalian region).

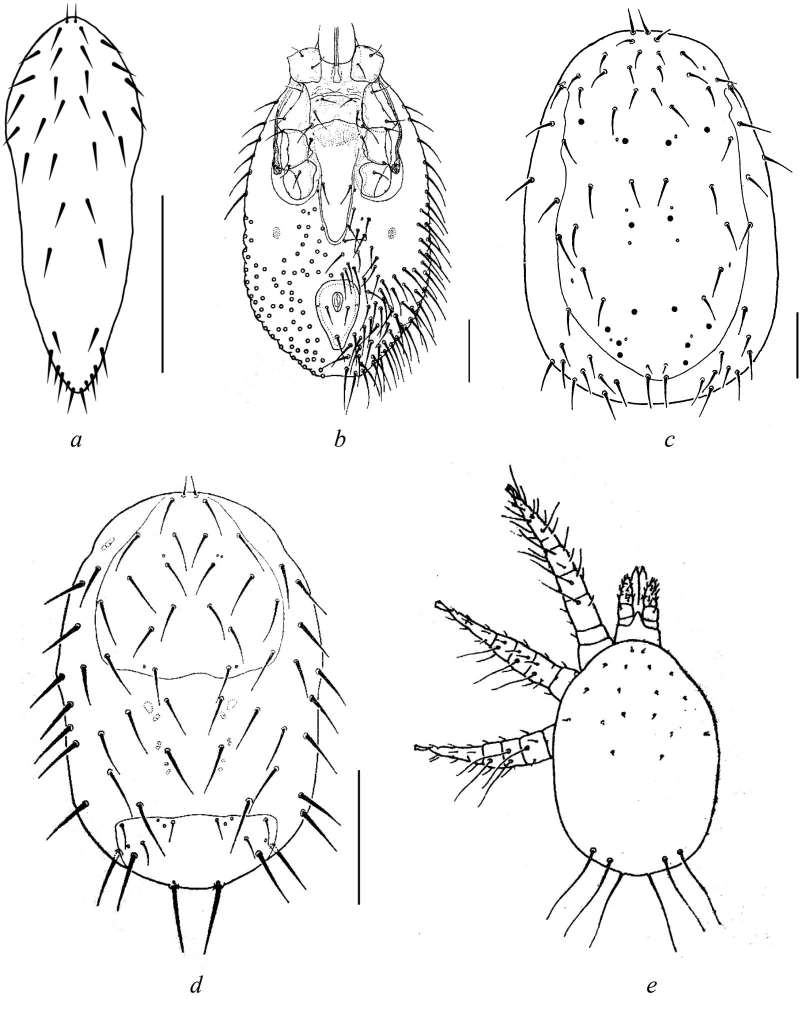


Fig. 48. *Ornithonyssus pipistrelli* (Oudemans, 1902)
(*b, c, d* – from Micherdzinsky, 1980; *e* – from Zemskaya, 1966):
a – ♀, dorsal shield (scale 300 μm); *b* – ♀ ventraly (scale 200 μm);
c – ♂ dorsaly (scale 200 μm); *d* – protonymph dorsaly (scale 200 μm);
e – larva dorsaly (scale lacked in the primary source)

Ornithonyssus olesovi sp. n. (fig. 49)

Type material: ♀ holotype, 4 ♀♀ paratypes from Smolinskaya cave, 23.11.2010, coll. O.L. Orlov and M.V. Orlova. Other specimens are known from Baltic region, Staraya Ladoga galleries (9 ♀♀), Northern Urals, Bol'shaya Konovalovskaya cave (♀) and North-West Altai, State Natural Reserve «Tigirekskiy» (6 ♀♀).

Diagnosis

Female. White, weak sclerotized mites. Idiosoma oval about 1 200 microns long and 900 microns wide.

Dorsum. Dorsal shield elongated, leaf-like 951 (923-1002) length of 451 (432-461) width, relatively narrow (length to width ratio about 3:1), similar to those in *O. pipistrelli*, has a maximum width at the level of S4 setal pair, then tapering evenly. Dorsal shield has a sculptural drawing in the form of spots of irregular shape, as well as drawing vertical shading in caudal part of shield between setae S5. Chaetotaxy: 23 setal pairs (22 long needle-like pairs, 1 microsetal pair J5). Setae s-S number the longest (139-151), a number of setae i-I increase to the posterior margin of shield (from 25-28 to 72-77), the length of the setae I6 87-101. The dorsal side opisthosoma has 49-56 long (54-79) needle-like setae.

Venter. Sternal shield trapezoidal 135 (122-141) long and 248 (235-259) wide, with deep groove and poorly marked sternal glands (in the form of rounded shaded areas). Ventral side opisthosoma is 36-42 long, needle-like setae 83-99 long.

Epiginial plate (332 (321-356) long and 151 (136-159) wide) does not differ from that of *O. pipistrelli*, is 1 setal pair of long setae at the level of the fourth pair of coxae.

Anal shield 182 (152-169) long, 122 (119-128) wide, adanal setae 49-54, postanal seta 73-80.

Peritremes medium length, reaching the middle of the second pair of coxae.

Gnathosoma. Length (without palps) 338 (312-366), width 169 (152-197). Tritosternum with slightly inflated base. Chelicerae configuration is normal for the genus *Ornithonyssus*. Chelicerae 254 (249-271) long: movable digit 74 (71-75), fixed digit 80 (77-82).

Males, protonymphs, deutonymphs and larvae not found.

Typical host. Pond bat (probably the main host). Some findings were made on the lesser mouse-eared bat, Daubenton's bat, Brandt's bat, whiskered bat, and Ognev's long-eared bat.

Distribution. Taiga zone of Russia from the Leningrad region to Altai.

Notes on life history. Most items wintering made, it being noted that most species found in this period had intrauterine eggs. This suggests that the reproduction *Ornithonyssus olesovi* sp. n. occurs both in summer and in winter, but protonymphs were not found. All new species individuals were fond in the caves (galleries) and, despite a large number of surveyed anthropogenic shelters (attics of wooden houses, etc.) (Orlov, Orlov, 2011), *Ornithonyssus olesovi* sp. n. specimens have never been found, so we can conclude that new mite is troglofile species.

Etymology. Mite is named in honor of the scientist V.G. Olesov, first descriptor of Smolinskaya cave (Olesov, 1891).

Ornithonyssus guzlonicus sp. n. (fig. 50, 51)

Typical material: holotype ♀ and 4 paratypes, holotype N1 from Guzlon mountains, 05.17.2013, leg. M.V. Orlova.

Diagnosis

Female. Mites are dark brown, strongly sclerotized. Idiosomal oval (approximately 1800 x 1400).

Dorsum. Dorsal shield (length 983 (966-1018), width 242 (221-251)) is narrow, the sheet-like (the ratio of length to width ratio of about 4: 1) has a maximum width at level of a seta S3, then tapers evenly. Chaetotaxy: 19 setal pairs (14 pairs of short setae on anterior margin of shield, 5 microsetal pairs (J4, Z3, Z4, S5, Z5) on posterior margin of plate).

Dorsal opisthosoma has 120-130 relatively thick knife-like setae (65-71).

Ventrum. Sternal shield trapezoidal (182 (171-198) long, 268 (255-281) wide), without sculpturing, slightly concave, with three pairs of short setae. Genitoventral shield triangular (352 (342-367) long, 205 (199-210) wide) with vertical striations, has one pair of short setae. Anal plate thin, obovoid (262 (252-280) long, 129 (127-133) wide) has 3 short hair-like setae. Ventral side idiosomal with approximately 13-16 short setae (between genitoventral and anal plates) and 33-41 long (59-76) setae.

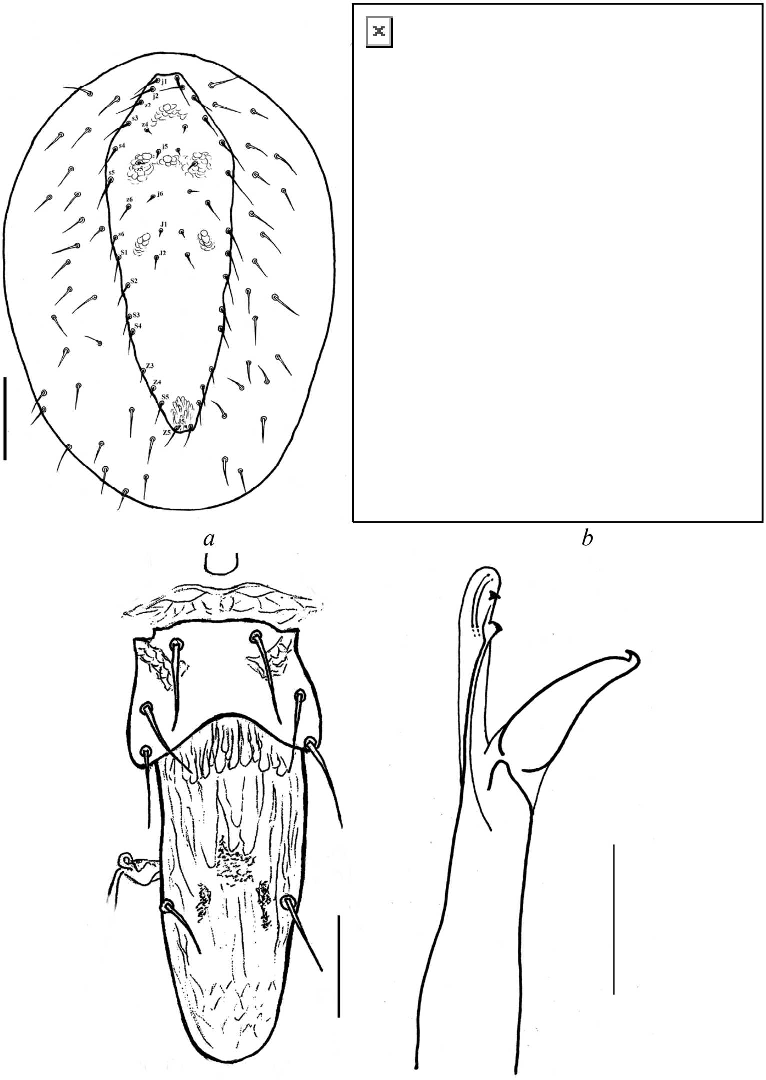
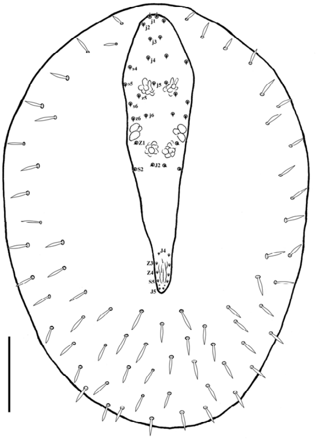


Fig. 49. *Ornithonyssus olesovi* sp. n., ♀: *a* – dorsaly (scale 150 µm); *b* – ventraly (scale 250 µm); *c* – ventral shields (scale 100 µm); *d* – chelicera (scale 50 µm)

Peritremes short, reach the middle of the third pair of coxae.

Gnathosoma. Length (without palps) 421 (401-437), the width of 262 (251-272). Tritosternum base slightly widened. Chelicerae configuration characteristic of the genus *Ornithonyssus*. Chelicera 344 (249-271) long, movable digit 74 (71-75), fixed digit 80 (77-82).

Type host. Eastern barbastelle *B. darjelingensis*.



a

b

c

Fig. 50. *Ornithonyssus guzlonicus* sp. n., ♀: *a* – dorsaly (scale 150 µm); *b* – ventraly (scale 300 µm); *c* – ventral shields (scale 100 µm)

Diagnosis. Protonymph. Idiosoma oval: length 869, width 532.

Dorsum. Dorsal side has 12 pairs of setae of varying lengths and thickness. Setae of R-seria thick, lanceolate (43-52), other – thin and relatively short (18-23). Podosomal shield length 212, width 191, has eight pairs of relatively short setae (17-21).

Pygidial shield semi-circular shape (length 115, width 163) with 6 pairs of setae: J3, Z3, Z4 and J5 short (12-16), S5 and Z5 long, thick, lanceolate, length 78-83.

Ventrum. Sternal shield pentagonal (length 151, width 157) slightly striated. Anal plate obovoid (length 87, width 59). The ventral side of idiosoma 7 pairs of setae (19-25 microns), 2 pairs around the anal shield thick, lanceolate.

Gnatosoma. Length (without palps) 236, width 89. Chelicera 196 long (fixed digit 78, movable digit 40). Tritosternum well developed with inflated base.

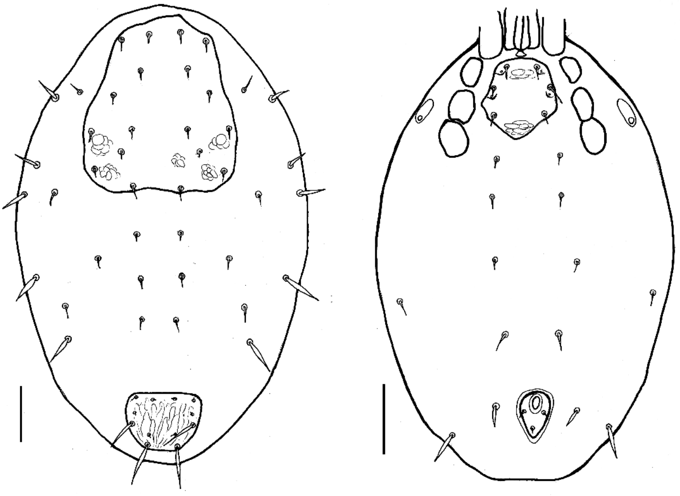


Fig. 51. *Ornithonyssus guzlonicus* sp. n., protonymph: *a* – dorsaly (scale 150 μm); *b* – ventraly (scale 250 μm); *c* – ventral shields (scale 100 μm)

Type host. David's Myotis *M. davidi*. Previously it was reported about the findings mites of the genus *Ornithonyssus*, the diagnosis of which does not coincide with one of the earlier described, in the central and southwestern Tajikistan. The specimens were collected from *Myotis* defined as the whiskered (*Myotis mystacinus* s. lato), as well as an unidentified species of bats (Stanyukovich, Malinovskiy, 1992). Later it was found whiskered bat does not inhabit the territory of Central Asia (Tsytsulina et al., 2012). Possibly, the mites in the literature data were removed from *M. davidi*.

Distribution. All of the findings of *Ornithonyssus guzlonicus* sp. n. are located in Tajikistan. Bat ectoparasites fauna of Central Asia is poorly studied, and it is difficult to define thepotential area of distribution of this new species.

Etymology. Named after the type locality.

2.3. Distribution features of bat gamasid mites in the boreal Palaearctic

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

Western Siberia is an extensive accumulative plain, swampy and devoid of karst landforms. Until the mid-XXth century 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 Western Palaearctic species to the east and Eastern Palaearctic species to the west (Orlova, 2014) and «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 natural roosts for wintering bats and this area does not prevent distribution of these animals. That is why the presence of two chiropteran complexes is applicable 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.

The study does not include rare and poorly known species the distribution and host range of which is difficult to identify taking into account the available data (gamasid mites of the genus *Ornithonyssus*). The random findings of specific ectoparasites from nemoral and subboreal bat species (the noctule bat *Nyctalus noctula*, Leisler's bat *N. leisleri*, the small pipistrelle *Pipistrellus pygmaeus*, the common pipistrelle *P. pipistrellus*, David's bat *Myotis davidii*, the serotine bat *Eptesicus serotinus* etc.) on the boreal species were not considered.

We attributed Daubenton's bat *Myotis daubentonii*, Brandt's bat *M. brandtii*, Natterer's bat *M. nattereri*, the whiskered bat *M. mystacinus*, the brown long-eared bat *Plecotus auritus*, Nathusius' pipistrelle *Pipistrellus nathusii* to the European-Ural boreal chiropteran fauna complex (Horaček et al., 2000; Ilyin, Smirnov, 2000; Bol'shakov et al., 2005). The Siberian-Far Eastern fauna complex includes the eastern water bat *Myotis petax*, the siberian bat *M. sibiricus*, the amur bat *M. bombinus*, the asian particoloured bat *Vespertilio sinensis*, Hilgendorf's tube-nosed bat *Murina hilgendorfi*, the ussuri tube-nosed bat *M. ussuriensis* and *Plecotus ognevi* (Tiunov, 1997; Matveev et al., 2005; Vasenkov, 2009; Bazhenov, 2013; Orlova et al., 2013; Ruedi et al., 2013). Only Trans-Palaearctic species that manage to cross the territory (or possibly "bypass" it from the south) are the pond bat *Myotis dasycneme* (the range extends from central Europe to the east up to the Yenisey river) (Kuzyakin, 1950), the particoloured bat *Vespertilio murinus* (lives on the territory from the Atlantic to the Pacific coast) (Kuzyakin, 1950; Tiunov, 1997), the northern bat *Eptesicus nilssonii* (the range is similar to the particoloured bat).

The study of fauna of ectoparasites in the boreal zone of Central and Eastern Palaearctic carried out in recent years helped to clarify the distribution of many species of parasitic arthropods bats. Most of them are territorially confined to the European Ural or Siberia and the Far East.

The total fauna of bat ectoparasites of the boreal zone consists of 30 species (Orlova, Orlov, 2015), including 16 species of gamasid mites (tab. 21).

1. Gamasid mites belonging to the European-Ural boreal ectoparasite complex. This complex of ectoparasites covers the taiga zone of Eurasia from the Atlantic coast to the Trans-Urals. The complex includes two species of gamasid mites: *Macronyssus diversipilis* and *M. kolenatii*, the eastern boundary of the range lies in the Urals (*M. kolenatii*) and Trans-Urals (*M. diversipilis*) (Orlova, 2013).

2. Gamasid mites of the Siberian-Far Eastern boreal ectoparasite complex. Three gamasid mite species (*Spinturnix bregetovae*, *Macronyssus heteromorphus*, *Macronyssus hosonoi*) were recorded only in Central and Eastern Palaearctic.

3. Gamasid mites of the Trans-Palaearctic boreal ectoparasite complex. Despite the natural barrier separating the faunal complexes there is contact between them (Orlova, 2014) as evidenced by the Trans-Palaearctic (sometimes Holarctic) distribution of some species of ectoparasites. Mites *Spinturnix myoti*, *S. kolenatii*, *S. plecotinus*, *Macronyssus crosbyi*, *Steatonyssus spinosus* were found on the territory from the Atlantic to the Pacific Ocean. The trans-Palaearctic distribution of ectoparasites is a consequence of two factors: the wide distribution of the host species, the oligo- and polyxenous feeding pattern.

4. Gamasid mites irregularly distributed in the Palaearctic. Species with an unequal distribution on both sides of the "chiropterological desert" are allocated into a separate category: *Macronyssus charusnurensis*, *M. corethroproctus*, *M. ellipticus*, *Steatonyssus periblepharus*, *S. superans*.

Obviously, *Macronyssus charusnurensis* and *Steatonyssus superans* can be combined into a separate group with the Siberian-Far East species penetrating the west. Perhaps *Macronyssus charusnurensis* tends towards oligoxeny on several species of the genus *Myotis* and it gives them an opportunity to penetrate into the territory of the Urals through Kazakhstan but its main host has been rarely found and is mainly represented by immature individuals (Orlova, 2014). Numerous findings of *Steatonyssus superans* in the Urals indicate the active expansion of this species to the west. The transfer of *S. superans* through the "chiropterological desert", apparently, is related to its preferred host — particoloured bat (op. cit.).

Macronyssus corethroproctus, *M. ellipticus* and *Steatonyssus periblepharus* can be united into a group of European-Ural species penetrating to the east. *M. corethroproctus* penetrate to Siberia with the pond bat as a main host.

T a b l e 21

Distribution of gamasid mites, associated with bats in the boreal Palaearctic Region (after Orlova, Orlov 2015)

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
	European-Ural boreal ectoparasite complex									
Macronyssus diversipilis	+	+	+	+	+	+	-	-	-	
Macronyssus kolenatii	+	+	+	+	+	+	-	-	-	
	Siberian-Far Eastern boreal ectoparasite complex									
Spinturnix bregetovae	-	-	-	-	-	-	?	+	+	
Spinturnix maedai	-	-	-	-	-	-	+	+	+	
Macronyssus heteromorphus	-	-	-	-	-	-	?	+	+	
Macronyssus hosonoi	-	-	-	-	-	-	+	+	+	
	Trans-Palaearctic boreal ectoparasite complex									
Spinturnix myoti	+	+	+	+	+	+	+	+	+	
Spinturnix kolenatii	+	+	+	+	+	+	+	+	+	Holarctic species

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
Spinturnix plecotinus	+	+	+	+	+	+	+	+	+	
Macronyssus crosbyi	+	+	+	+	+	+	+	+	+	Holarctic species
Steatonyssus spinosus	+	+	+	+	+	+	+	+	+	
	European-Ural species penetrating to the east									
Macronyssus corethroproctus	+	+	+	+	+	+	+	-	-	
Macronyssus ellipticus	+	?	+	+	?	+	+	?	-	
Steatonyssus periblepharus	+	+	+	+	+	+	-	-	-	Species is found in Central and Eastern Palaearctic region, but not in the boreal zone
	Siberia-Far East species penetrating the west									
Macronyssus charusnurensis	-	-	-	-	-	+	+	+	+	
Steatonyssus superans	-	-	-	-	-	+	+	+	+	

But its status in the parasitic community is undergoing significant changes: from the species of the “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 by few examples. The reasons for this phenomenon are not possible to establish but we can assume that it cannot compete with the East Palaearctic species complex (in particular, rare findings of pond *Myotis* in the Barsukovskaya cave indicate that the ectoparasites’ community of these bats includes mainly two species of gamasid mites of the genus *Macronyssus* that are unknown to science) (our own data). In addition, the pond bat does not form large colonies to the east of the Ural mountains. The low host numbers also reduce the number of its specific ectoparasites. *M. ellipticus* and *S. periblepharus* may bypass the south «chiropterological desert» with the species of bats that live in steppes and semi-deserts. *S. periblepharus* is further distributed in the subboreal belt of Eastern Palaearctic on different species of hosts. The degree of penetration of *M. ellipticus* into Siberia is difficult to ascertain because of the absence of findings which may be due to the scarcity of the species.

Almost two thirds of gamasid mites (10 species) have the Trans-Palaearctic or similar distribution.

CHAPTER 3. BIOLOGY OF GAMASID MITES PARASITIZING BATS

The life cycle of gamasid mites includes several phases: egg – larva – N I (protonymph) – N II (deutonymph) – imago, however, parasitic life mostly transforms this pattern. The absence of bats' nests caused spinturnicids and macronyssids (partially) mites' permanent parasitism on the host's body. As a result, the number of pre-imago stages is greatly reduced: the egg and larval stages take place within an adult female (intrauterine) which gives birth directly to the protonymph (sometimes larvae immediately molting to protonymph).

Among spinturnicids all independent life stages (protonymph, deutonymph and imago) feed on blood and possibly lymphatic fluids. A protonymph has well-developed dorsal shields without intermediate sclerites. A deutonymph (N II) is similar to imago in size and exterior. Thus, spinturnicid's lifecycle is extremely shortened for protection of posterity (Bregetova, 1956).

Most of macronyssids, similar to spinturnicids, generate active blood-feeding protonymphs but a deutonymph represents a short non-feeding stage. A macronyssid deutonymph is weekly sclerotized and armed with short setae; leg hooks and suckers are poorly developed (Radovsky, 1967).

3.1. The history of investigations of life cycle of gamasid mites parasitizing bats

The first detailed phenological study of *Spinturnix* species was carried out by Jean Deunff and Jean-Claude Beaucournu (1981) who investigated the influence of abiotic factors on ectoparasites' infrapopulation. In the article of Agustin Estrada-Peña with co-authors (1991) dynamics of the number of mites *Spinturnix psi* throughout the year was described.

The peak of infestation with mites of various groups (Gamasina, Sarcoptidae) is during the period of pregnancy and lactation of the bats, and both the proportion of infested individuals and the average number of parasites per the host individual considerably decrease by November (Zahn, Rupp, 2004). Species of the genus *Macronyssus* typically reach the highest abundance by October or November, but the authors have not studied their population dynamics during winter. Prior to the onset of overwintering the prevalence of ectoparasites' infestation showed no dependence on host's body condition (op. cit.).

A higher prevalence of infestation by the gamasid mite *Spinturnix andegavinus* (Kolenati, 1857) was observed among bat females and immature individuals in summer (Lučan, 2006). Further studies carried out in summer on several bat species (Christe et al., 2000; Christe et al., 2007) demonstrated that adult bat females are more strongly infested with a mite of the genus *Spinturnix* than adult bat males while immature individuals have shown no sex-related differences in infestation prevalence. Gamasid mites' reproductive activity is synchronized with their hosts' reproductive activity: the highest proportion of pregnant mites was observed during the nursing season of bats, the reproduction of mites during this season was doubled compared to that one of the other seasons. The numbers then declined towards autumn; pregnant mites were found during most of the year but not in the bats' hibernation season (Lourenço, Palmeirim, 2008).

The earliest studies on the ectoparasites of bats through hibernation in temperate regions (Markova, 1938; Beck, 1966; Reisen et al., 1976) recorded a decrease in the abundance of ectoparasites through hosts' hibernation, a considerable shift in the sex structure of *Macronyssus* populations (in favor of females), and a higher abundance of the parasites on hosts' females *Myotis velifer*. At the same time European authors indicated an increase of infestation of bats by ectoparasites during hibernation in the Central and Southern Europe caves. Thus, F. Dusbábek (1972) and R. Haitlinger (1978b) pointed out that during hosts' hibernation time three generations of ticks of these species appear (fig. 52).

According to the data provided by A. Estrada-Peña and H. Serra-Cobo (1991), it is winter shelters where the process of reproduction of two species of macronyssids (*Macronyssus granulosus* (Kolenati, 1856) and *Macronyssus longimanus* (Kolenati, 1856) the host being a common bent-wing bat *Miniopterus schreibersi* (Kuhl, 1817)) is actively taking place in the north-west of Spain. The authors explained the presence of the "winter" peak of ectoparasites numbers by hatching, which happened in very large winter colonies formed by common bent-wing bat (op. cit.).

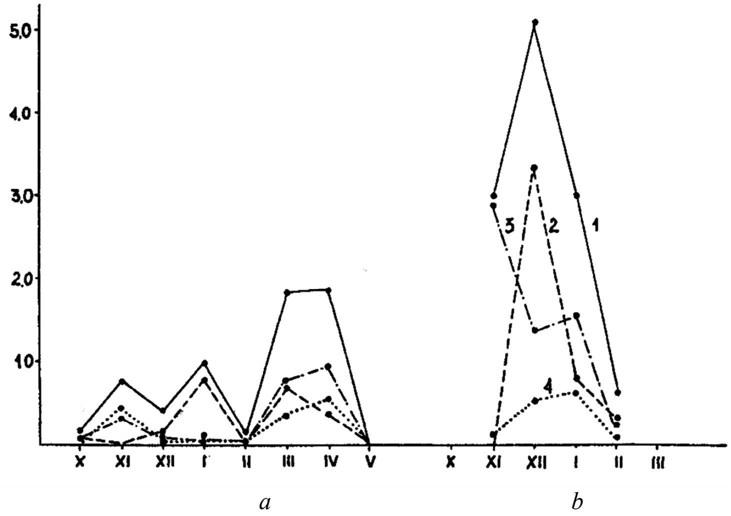


Fig. 52. Mean intensity (MI) of gamasid mites of *Macronyssus* genus during the hibernation of bats-hosts (according to Haitlinger (1978b)), abscissa axis – the months, ordinate axis – the meaning of Index of abundance. Letters are marked: *a. Macronyssus cyclaspis* Oudemans, 1906 (the host – European barbastelle *Barbastella barbastellus* Schreber, 1774); *b. M. ellipticus* (hosts: brown long-eared bat, Natterer's bat, Daubenton's bat, pond bat, Brant's bat, whiskered bat). Numerals are marked: 1. Population of mite as a whole; 2. Females; 3. Protonymphs; 4. Males

The prevalence of mites of the genus *Steatonyssus* in the fauna of ectoparasites is observed in many migratory bat species: the asian particoloured bat (*V. superans*), on which *S. superans* was recorded (Medvedev et al, 1991), and Nathusius' pipistrelle (*Pipistrellus nathusii*), from which *S. periblepharus* was collected (Stanyukovich, 1990; own data). *S. noctulus* is a specific ectoparasite of migratory tree-dwelling bat species – the common noctule *Nyctalus noctula* as pointed out by European authors (Rupp, Ludwig, 2000). Actually the most of polyxenous species of the genus *Steatonyssus* prefer migratory bat species as hosts.

S.N. Rybin (1983) marked that *S. spinosus* is a summer-autumn parasite. Individuals of this mite did not appear on the mouse-eared bat until June whereas the reproduction of these bats takes place already in May. He also pointed out that the intensive reproduction of *Steatonyssus occidentalis* took place in summer and autumn months which also coincides with the reproduction period of common serotine and common pipistrelle on which this parasite was discovered. (Rybin, 1983).

3.2. Peculiarities of life cycle of the genus *Spinturnix* boreal species

The investigation of the sex-age structure of spinturnicids' infrapopulations in winter and summer roosts showed that all our findings of the species belonging to the genus *Spinturnix* are presented only by imago mite individuals during the host's hibernation, while females with intrauterine larvae and preimago stages were abundantly represented only in nursery colonies (fig. 53). Mature mite individuals predominate during the whole year.

The most mass species of the genus *Spinturnix* findings of which were numerous in summer and winter shelters in our material are the following: *Spinturnix myoti* (the main hosts are bat species of the genus *Myotis*), *Spinturnix uchikawai* (described as the parasite of the eastern long-fingered bat), *S. kolenatii* (parasitize bats of the genus *Eptesicus*) and *S. plecotinus* (the hosts are the species of the genus *Plecotus* and *Barbastella*) (Radovsky, 1967; Stanyukovich, 1997).

MI of the mite *S. myoti* considerably differs for various *Myotis* species (fig. 54).

The share of the infected individuals during the hibernation in the Smolinskaya and Barsukovskaya caves for *S. myoti* amounts to about 50%. The mean intensity of *S. myoti* varies from 2 (for pond bats) up to 4 (for eastern water bats) during this period. The prevalence rises to 100% during the summer period (June-July) when hosts' females nurse their youngs until they are nearly of the adult size. The mean intensity increases up to10 (for pond bats), the maximum number of ectoparasites of this species on one host reaches 34 (the colony of *M. dasycneme* in the recreation centre “Berezka”) in our collections.

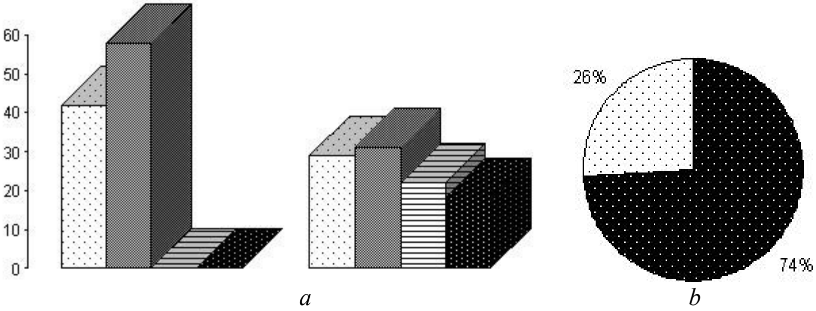


Fig. 53. a: sex-age structure of the genus *Spinturnix* in winter (at the left) and summer (at the right) roosts. Columns (from left to right): males, females, protonymphs, deutonymphs. *b*: the share of females with intra-uternal larva (marked by light colour) in the total quantity of females (summer roosts)

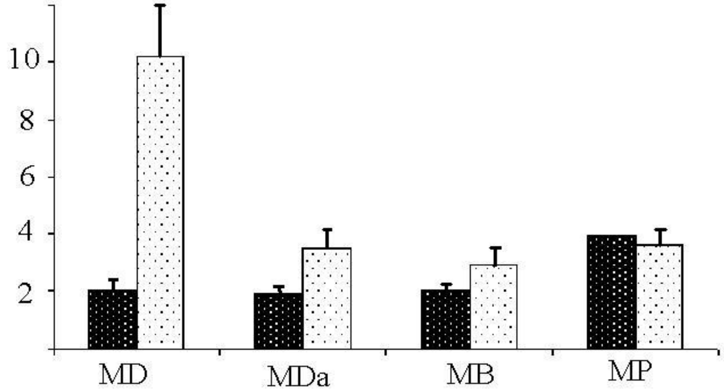


Fig. 54. MI *S. myoti* from Myotis spp. in winter (dark columns) and summer (light columns) roosts (adduced average meanings with the mistake). MD – *M. dasycneme*, MDa – *M. daubentonii*, MB – *M. brandtii*, MP – *M. petax*

The infestation of eastern long-fingered bats by the mite *S. uchikawai* is of a particular interest because it is anomalously high: MI=30.5 (the prevalence is 100%), the maximum number of mite individuals reaches 67 on one bat specimen. The investigated bat population described above is small and insular and both these factors can influence the infestation and cause its extraordinary increase.

As soon as bat juveniles begin to take flight the number of mite females with intrauterine larvae, proto- and deutonymphs declines in the collections and almost completely disappears towards October (the sole autumn finding of females with intrauterine larva was made on the 20th of October, 2010 in the settlement Slyudorudnik).

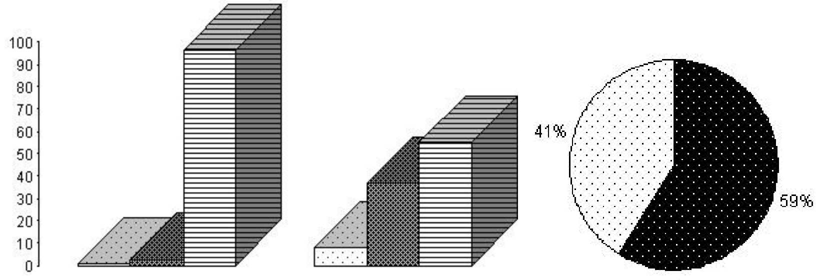
A similar pattern is observed in infrapopulations of *S. kolenatii* (populations inhabiting one host individual (Balashov, 2009)) which is also represented by all phases of development in nursery colonies (June-July), and during the hosts' hibernation period *S. kolenatii* is represented only by adult mites. The number of collected mites *S. plecotinus* is not enough and does not allow to make conclusions about the sexual-age structure of infrapopulation of this species.

To summarize, the life cycle of mites of the genus *Spinturnix* is synchronized with their hosts' life cycle. That was earlier shown for the mite *Spinturnix andegavinus* (Lučan, 2006) and some other species of this genus (Deunff, Becournu, 1981; Estrada-Peña et al., 1991).

Peculiarities of life cycles of boreal species belonging to genus *Macronyssus*

General data on the age and sex structure of this genus species in summer and winter shelters demonstrate permanent domination of immature specimens (fig. 55).

The collected data allowed us to investigate in detail the annual dynamic in the abundance of gamasid mites *Macronyssus corethroproctus* (a specific ectoparasite of the pond bat, a representative of the group of European-Ural species) penetrating to the east. The population dynamics of ectoparasites throughout the year is adequately described by a simple sine wave (Orlova et al., 2014), and the infestation maximum (the highest P and MI) takes place in the beginning of wintering (November).



a *b*

Fig. 55. *a*: sex-age structure of species belonging to the genus *Macronyssus* in hibernation (on the left) and summer (on the right) roosts. Columns (left to right): males, females, protonymphs (%). *b*: the proportion of females with intrauterine larva (marked light) in the total number of females (summer roosts only)

The prevalence and abundance of *M. corethroproctus* reduces during the period when bats stay in winter roosts (Orlova et al., 2012) and the infestation minimum is likely to fall in April – May, i.e. at the end of hibernating, when the bat colony disbands and some individuals of the pond bat (especially females) leave winter shelters. The curve for the number of parasites in one infested host decreases in November and December, which may indicate a mating period of pond bats. Then the number of parasites on the same host and the proportion of infested individuals remain constant for nearly the entire period of hibernation. The sharp decrease in these parameters was observed only at the end of winter (fig. 56). Our data indicate a correlation with sex, which is most likely incorrect, and prove the fact that during hibernation ectoparasites prefer a well-fed host that moves (Orlova et al., 2012).

The principal change in the demographic structure of superpopulation of *M. corethroproctus* after the end of hibernation should be also mentioned. In winter shelters more than 95% of ectoparasites' superpopulation is presented by an immature stage (protonymphs), which is in agreement with the data of other European authors (Dusbábek, 1972; Reisen et al., 1976; Estrada-Peña et al., 1991) as well as our own data on other species of the genus *Macronyssus* (Orlov, 2013).

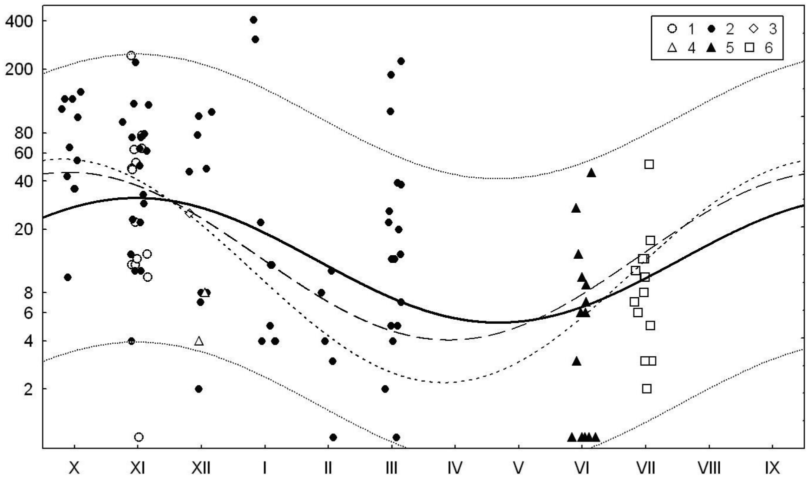


Fig. 56 (from Orlova et al., 2014a). Dynamics of density (bold line – the expected value E (y), dotted - 95% PI – prediction interval) gamasid mites *Macronyssus corethroproctus* in infested pond bat species (n>0). On the horizomtal axis are months, the vertical axis represents the number of mites. Long and short bar – fitting for the average values, thick line – the observed abundance. Legend – location: *1* – Staraya Ladoga galleries; *2* – Smolinskaya cave; *3* – Tigireksky Reserve; *4* – Most Konovalovskaya cave; *5* – neighborhood of town Kyshtym; *6* – recreation department «Berezka» (Chelyabinsk region). Small number was added to abscess

Females with intrauterine eggs and deutonymphs were not recorded in this period, the males are extremely rare, and a decrease in the number of protonymphs is not accompanied by an increase in the number of adults, which means that the reproduction of mites as well as their molt does not occur on wintering bats in the caves of the Ural (tab. 22).

In summer shelters protonymphs also dominate (almost 50% of superpopulation) but the share of males increased over the period of wintering (8%), the number of females also significantly increased (41%, more than half of them have intrauterine eggs). Thus, the process of reproduction of the species *Macronyssus* takes place during summer, it coincides with the beginning of the bat breeding season, the proportion of immature stages does not decrease during summer. Obviously, during summer months several mite generations appear as evidenced by our repeated findings of deutonymphs (a short non-feeding stage in macronyssids). But the process of the reproduction of the mites *Macronyssus corethroproctus* is the most active in late summer – early autumn (Orlova et al., 2014).

The rest of species of the genus *Macronyssus* belonging to the European-Ural complex (*Macronyssus diversipilis*, *M. ellipticus*) and Holarctic species *Macronyssus crosbyi* studied by us show similar dynamics of number and sex-age structure during hibernation.

Table 22

Infestation in bats by gamasid mites of genus *Macronyssus* in the Ural and Western Siberian caves

Territory	Estoparasite species	Visiting time			Host species
		November	January	Mart	
Western Siberia	*Macronyssus charusnurensis*	103 11.4 60	437 39.7 79	No data	*Myotis petax* (n=34)
	Macronyssus sibiricus	6 1.5 27	7 1.8 29	3 3 20	*Myotis petax* (n=34)
	Macronyssus stanyukovichi	No data	1	139 6 100	*Myotis petax* (n=19) *Murina hilgendorfi* (n=18)
Urals	*Macronyssus corethroproctus* (Orlova et al., 2012)	640 64.0 100	407 45.2 100	407 50.9 100	*Myotis dasycneme* (n=29)
	Macronyssus crosbyi	102 5.3 56	No data	65 3.4 66	*Myotis dasycneme* (n=2) *Myotis brandtii* (n=24) *Eptesicus nilssonii* (n=38)

Note. For each estoparasite species: the first line – number of individuals, the second line – MI, the third line – prevalence (%).

Thus, the process of reproduction of European-Ural species of the genus *Macronyssus* occurs throughout the summer, it coincides with the beginning of the host breeding season. However, unlike the spinturnicids, whose reproduction decreases as their young hosts grow, and in autumn pregnant and immature specimens almost never occur, the share of immatures among the mites of the genus *Macronyssus* is not reduced during the summer (tab. 22) and reaches its maximum by the beginning of hibernation. The absence of the ectoparasites' population growth and the lack of evidence of metamorphosis in winter such as females with intrauterine eggs, laid eggs, and larvae, indicate the absence of reproduction during the host's winter hibernation.

Contradictory data on the European-Ural faunistic complex are of particular interest for studying of the bats of the Siberian – Far Eastern chiropteran complex. Therefore, the eastern water bat, *Myotis petax* Hollister, 1912, that is widely spread in the boreal zone of the Eastern Palaearctic but poorly studied, was chosen as the subject for this study. The eastern water bat and pond bat belong to different faunal complexes so that the adaptation of ectoparasites to the prolonged hibernation occurred in the two species independently. However, for the bat flies of the family Nycteribiidae, specifically, the ectoparasites *M. dasycneme* and *M. petax*, the dynamics of the host infestation during the hibernation are completely identical (Orlova et al. 2014b; the authors' own data).

The eastern water bat, despite the fact of dwelling in the conditions similar to the habitat conditions of *Myotis* in the Ural region, has a fundamentally different pattern of infestation by gamasid mites that is similar to that of bats in Central Europe (Dusbábek, 1972).

The abundance of the gamasid mite *Macronyssus charusnurensis* significantly increases by the middle of winter (fig. 57). It should be noted, the only individuals of the eastern water bat free from parasites were detected at the end of March (tab. 22). However, this does not indicate the complete collapse of the superpopulation of gamasid mites in the cave but does indicate a significant decrease in infestation of the bats during this period.

A high index of occurrence and abundant amount of ectoparasites in the middle of winter was accompanied by two other interesting findings of the gamasid mites *Macronyssus sibiricus* and *M. stanyukovichi* (tab. 22): female mites with intrauterine eggs and larvae (short non-feeding stage) were collected from bats. Thus, macronyssid reproduction and metamorphosis occurs in the period of the host's hibernation, despite an extremely low (not higher than +4 °C) temperature in their shelters. These results disprove our previous suppositions (Orlova et al. 2012) that the macronyssid mite's reproduction during the host's hibernation is limited by the temperature of shelters and that the ectoparasites reproduce intensively before the hibernation. (September – October) but reproduction is terminated before the end of the hibernation (April – May). Obviously, macronyssid mite species parasitizing the species of the Siberian – Far Eastern chiropteral faunistic complex are capable of reproduction at the temperature critically low for arthropods. This peculiarity is extremely interesting as it shows disunity in the parasite and its host's life cycles, previously described for a few ectoparasites (except for macronyssids, only some species of the bat flea fam. Ischnopsyllidae were described).

Data on host-parasite preferences also contradict the earlier observations. In November, there is a trend towards greater infestation by gamasid mites on the *M. charusnurensis* Eastern water bat females than males (0.35 ± 0.16 infestation for males, 0.82 ± 0.26 for females, F-Fisher test (F_1, 13 = 2.6), p = 0.13). The null hypothesis that male and female eastern water bats are equally infested by gamasid mites is rejected by us with a probability of 87% (Fig. 3). In January, the same female eastern water bats were significantly more parasitised than males (0.81 ± 0.27 infestation for males, 1.54 ± 0.18 for females, F-Fisher test ($F_{1,\ 11} = 5.42$), p = 0.04) (Fig. 3). A direct relationship with the body condition previously elicited for the pair "pond bat – *M. corethroproctus*" (Orlova et al. 2012), is absent (the increased infestation of the eastern water bat specimens is accompanied by a decline in their body condition) (fig. 57).

Therefore, the temperature of both shelters are equally harsh, but the ectoparasite species of the European – Ural chiropteral complex do not reproduce during hibernation, and parasite species of the Siberian – Far Eastern complex reproduce and undergo metamorphosis. The host preferences of the ectoparasites of the two complexes are also different. The mite *M. corethroproctus* prefers well-fed hosts of both sexes, whereas the mite *M. charusnurensis* prefers female hosts, independent of body conditions.

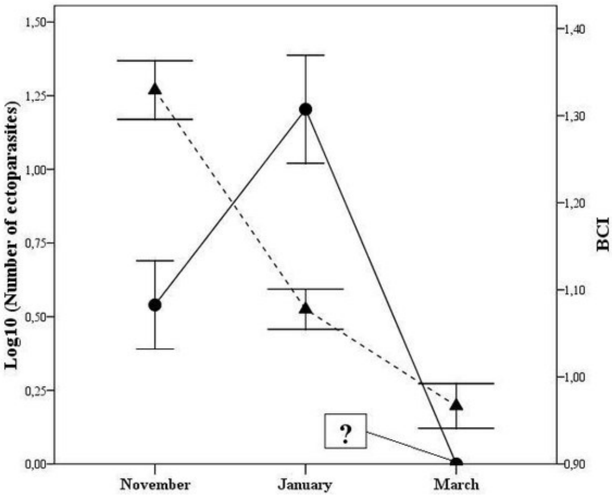


Fig. 57. The general dynamics of eastern water bat infestation by ectoparasite *Macronyssus charusnurensis* during hibernation (univariate analysis, solid line – number of ectoparaites; dashed lines – BCI)

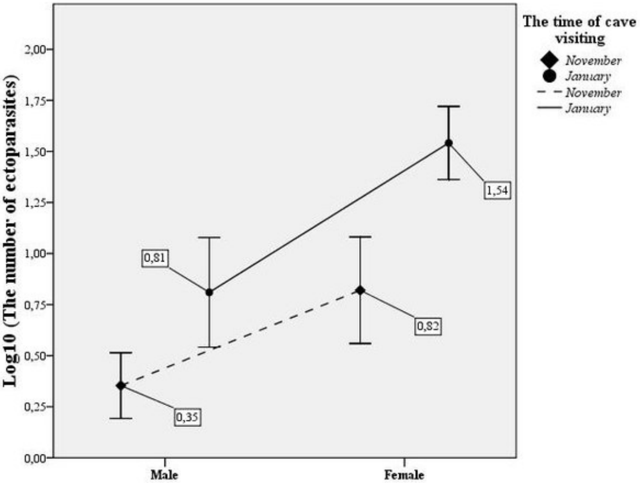


Fig. 58. The dynamics of infestation of eastern water bat (males and females) by ectoparasite *Macronyssus charusnurensis* during hibernation (bivariate analysis, independent variables: host sex and time of visiting cave; dependent variable – infestation (log-transformed))

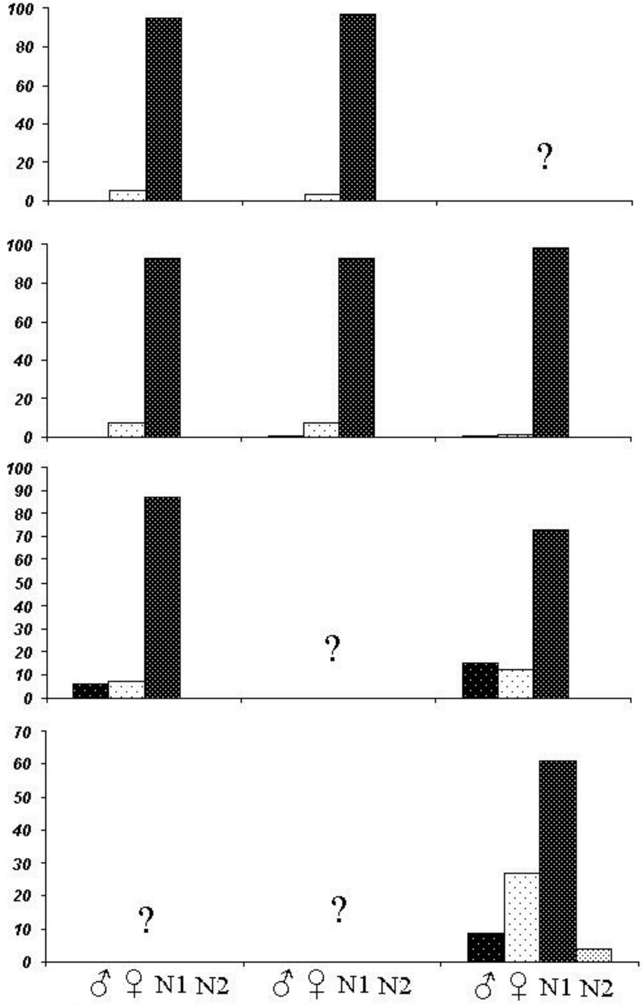


Fig. 59. The dynamics of demographic structure of gamasid mites (genus *Macronyssus*) in the Urals and Western Siberia during the hibernation of hosts (%). From top to bottom: *Macronyssus charusnurensis*, *M. corethroproctus* (Orlova et al., 2012), *M. crosbyi*, *Macronyssus stanyukovichi*. Question marks periods for which data are not available or very few

Despite differences in the preferences for host parameters, the mite species *Macronyssus corethroproctus* and *M. charusnurensis* are characterized by high abundance, and in both complexes, they have a similar sex and age structure, in which immature specimens (protonymphs) dominate, the proportion of females is a few percent, and the males are rare specimens (< 1%). The structure of species with low abundance, such as *M. stanyukovichi* and *Macronyssus crosbyi*, are also similar and characterized by a significant proportion of adults, of which approximately half are males and the *M. stanyukovichi* specimens include larvae. During wintering, protonymphs dominate the age-sex structure of all ectoparasite species of (61-99%) (fig. 59).

Thus, macronyssids belonging European-Ural and Siberian-Far Eastern complexes demonstrate a different strategy of experience of winter hibernation. The data obtained are related to the history of bat settlements in Eurasia. Caves of the Ural region are the most low-temperature in the Western Palaearctic and were likely settled later than other caves by bats adapted to soft winter conditions, as confirmed by the data on the phylogeny of the bat fam. Vespertilionidae (Ruedi et al. 2013). The occurrence of adaptations for reproduction at critically low temperatures are likely to require more time and have not yet occurred.

Furthermore, the Eastern Palaearctic is generally characterized by low temperatures in winter shelters (+ 3°- 5°C, consistent with the temperature in the caves of the Urals) because of its continental climate. Therefore, the eastern bat, as well as many other species of the Siberian and Far Eastern complex, lived and settled in this territory (Ruedi et al., 2013). These species originally adapted to the severe conditions of hibernation, which is likely reflected in the physiology of their ectoparasites that can reproduce under conditions unfavourable to arthropods.

3.4. Peculiarities of life cycles of boreal species of the genus *Steatonyssus* and *Ornithonyssus*

Ectoparasites of the genus *Steatonyssus* occupy the intermediate position between nesting-burrow and transient ectoparasites characterized with short-term feeding (Stanyukovich, 1993).

These ectoparasites depend on shelters to a greater extent than the mites of the genera *Macronyssus* and *Spinturnix* so that they show ecological specificity by preference for certain types of shelters (Balashov, 2001). As long as the mites were accessible for observation only in summer shelters it's difficult to debate on their whole life cycle of them.

The sex-age structure of the most mass species of the genus *Steatonyssus* (*S. periblepharus* and *S. spinosus*) in summer shelters is similar and characterized by the prevalence of protonymphs (86 and 65% respectively) and a small share of males (not more than 10%) (fig. 60). The share of females with intrauterine eggs comprises 15% and 17% respectively.

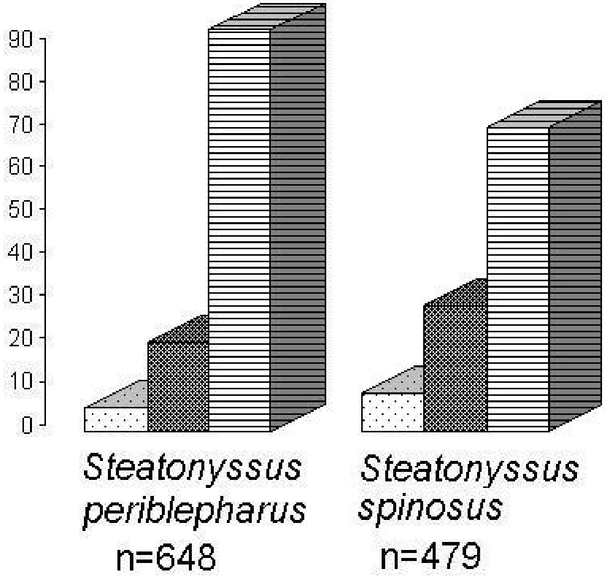


Fig. 60. Sex-age structure of g. *Steatonyssus* species in summer shelters. Columns (left to right): males, females, protonymphs

Only 3 protonymphs of *Steatonyssus spinosus* were found during the hibernation that once again confirms the ectoparasites' preference for migratory bat species which leave the investigated territory for winter. The subsequent development of *Steatonyssus spinosus* individuals probably takes place in *Vespertilio murinus* hibernation shelters (Central Asia) (Khabilov, 1992) and it couldn't be observed by us.

The number of the collected samples of species of the genus *Ornithonyssus* didn't allow us to make reliable conclusions about its biology. However, as the majority of samples were found on wintering bats and 2 females of *Ornithonyssus olesovi* that were discovered by us in November and March had intrauterine eggs, it can be assumed that the reproduction of this species takes place not only in the summer period but also during the host's hibernation. The findings of *Ornithonyssus olesovi* which were made during different seasons of the year in several different caves (Chertovo Gorodishche, Malaya Arakaevskaya, Smolinskaya, Bol'shaya Konovalovskaya) presumably indicate this parasite's preference for wintering bat species.

CHAPTER 4. BAT INFESTATION BY GAMASID MITES AND PARASITOCENOSIS STRUCTURE

The most of moderate and northern latitude bat species makes migrations connected with the roost switching. P.P. Strelkov (1970) distinguished two groups of bats: sedentary and migratory. The first group makes short migrations during the spring from winter shelters to summer roosts and move backwards in the autumn. Prolonged meridional migrations are peculiar to the second group as this species' hibernation places are considerably distanced (1.5 thousand kilometers) from the summer roosts. These groups are sufficiently segregated ecologically and prefer different types of shelters. Sedentary bat species are traditionally attributed to so-called troglophilic (cave-dwelling) species because they prefer caves and galleries as winter and sometimes summer roosts. The findings of migratory species in caves are rare that is why in European literature such species are usually called tree-dwelling. The main habitats of these bats are tree hollows, garrets, rock cracks and crevices, etc.

Previously it was described that permanent ectoparasites of the genera *Spinturnix* and *Macronyssus* are inherent to cave-dwelling bats to a greater extent than to tree-dwelling ones. Ectoparasites taking their position between nest-burrow and transient ectoparasites with short-term type of feeding (the genus *Steatonyssus*) prefer to parasitize migratory bat species (Stanyukovich, 1993; Orlova, 2013).

The following species belong to the boreal Palaearctic migratory species group: the particoloured bat *Vespertilio murinus*, the Nathusius' pipistrelle *Pipistrellus nathusii*, the common pipistrelle *P. pipistrellus* and the soprano pipistrelle *P. pygmaeus*. Three of the named are represented in our collections (*V. murinus*, *P. nathusii* and *P. pygmaeus).*All the findings of the particoloured bat took place in the summer period as this species' hibernation places are located on the territory of Middle Asia (Khabilov, 1992).

On the whole, the infestation ranges from 77% in Brant's bats up to 100% in eastern long-fingered bats (fig. 61). The parasite load of gamasid mites varies more considerably: from 1,8 in whiskered bats up to 56,2 in eastern long-fingered bats. High infestation of *Myotis macrodactylus,* as it was mentioned before, might be the consequence of the island effect but as long as quantitative data on ectoparasites on the continental part of the area of this species are absent it can't be affirmed. Any considerable distinctions between sedentary and migratory species weren't discovered.

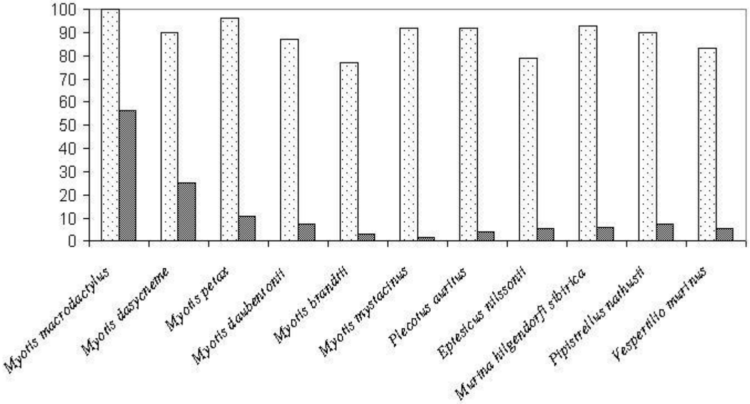


Fig. 61. Persentage of bat specimens, infested by gamasid mites (%, light columns) and parasitic load (darc columns)

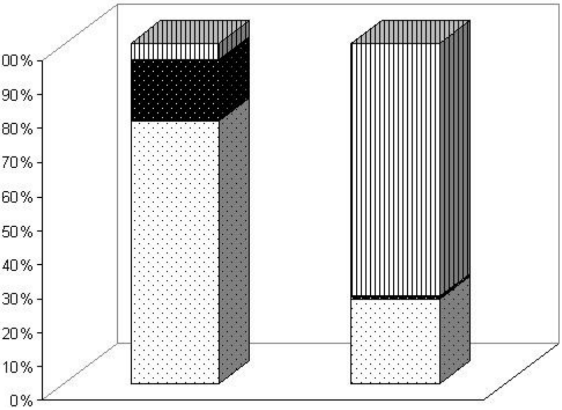


Fig. 62. General parasitocoenosis structure for cave-dwelling (left column) and migrating (right column) bats. Ectoparasites (from top to down in each column): *Steatonyssus* sp., *Spinturnix* sp., *Macronyssus* sp.

The share of individuals of species of the genus *Spinturnix* in parasitocoenosis varies in the course of the year on average from 8% in pond bats up to 62% in northern bats, and doesn't exceed 3% in migratory bat species (fig. 62).

The findings of spinturnicids on migratory bat species are accidental in the boreal zone, whereas some species of the genus *Spinturnix* are specific for migratory bats in the subboreal zone: *S. acuminatus* (the principal host – the common noctule), *S. helvetiae* (?) (was described on the Leisler's bat). Oligoxenous *Spinturnix myoti* is the most abundant and widely widespread species on the investigated territory that is related to its parasitizing the most presented group of hosts – bats of the genus *Myotis*. However, its share doesn't exceed 35% in their parasitocoenosis that is lower than the share of oligoxenous *S. kolenatii* and *S. plecotinus* in parasite communities of the northern bat (61%) and brown long-eared bat (76%) respectively. The mites of the genus *Macronyssus* take 30-91% in parasitocoenosis of hibernating bats. Its share is especially high in the *Myotis* species that form large colonies (the pond bat, the eastern water bat) (fig. 62). The highest indexes of abundance and occurrence belong to monoxenous *Macronyssus corethroproctus* (the Western and Central Palaearctic) and *M. charusnurensis* (the Central and Eastern Palaearctic).

Every species dominates in the territory of its habitation in the most part of the investigated parasite communities. The mites of the genus *Macronyssus* (in particular *M. kolenatii*) in some migratory bat species (*Pipistrellus* sp.) are also included in the parasitocoenosis core (MI reaches 11, and P counts 92%). High indexes of P and MI among the parasites of the genus *Macronyssus* are peculiar to monoxenous and oligoxenous species (*M. flavus*, *M. diversipilis*, *M. granulosus*, *M. kolenatii*), lower indexes are characteristic of pleioxenous species (*M. ellipticus*, *M. crosbyi*, *M. hosonoi*) (fig. 63).

On the whole, the core of parasite fauna of wintering bat species as shown in the fig. 6 is presented by one olygoxenous species of the genus *Spinturnix* and one monoxenous (rarely oligo- or pleioxenous) species of the genus *Macronyssus*, other gamasides amount to less than 10% of findings in the most of hosts (except for Brant's bats in which this parameter reaches 16%).

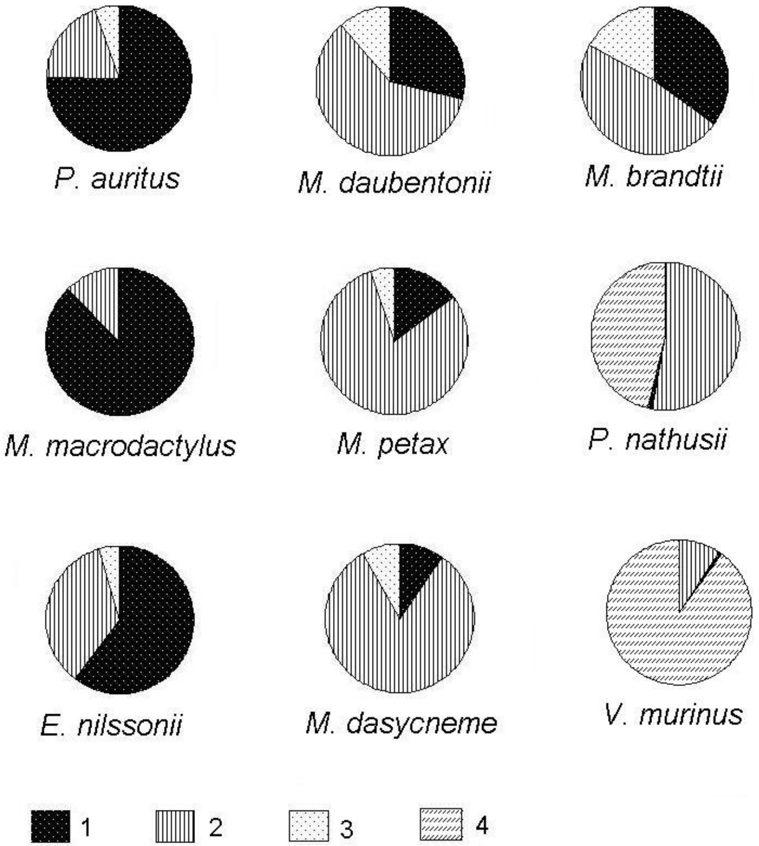


Fig. 63. Parasitocenosis structure of nine bat species.

Notes:
P. auritus: 1. *S. plecotinus*; 2. *M. crosbyi*; 3. other mite species;
M. macrodactylus: 1. *S. uchikawai*; 2. *M. granulosus*;
E. nilssonii: 1. *S. kolenatii*; 2. *M. crosbyi*; 3. other mite species;
M. daubentonii: 1. *S. myoti*; 2. *M. diversipilis*; 3. other mite species;
M. petax: 1. *S. myoti*; 2. *M. charusnurensis*; 3. other mite species;
M. dasycneme: 1. *S. myoti*; 2. *M. corethroproctus*; 3. other mite species;
M. brandtii: 1. *S. myoti*; 2. *M. crosbyi*; 3. other mite species;
P. nathusii: 1. *S. myoti*; 2. *M. kolenatii*; 4. *S. periblepharus*;
V. murinus: 1. *S. myoti*; 2. species of g. *Macronyssus* (*M. corethroproctus*, *M. crosbyi*, *M. kolenatii*); 4. species of g. *Steatonyssus* (*S. spinosus*, *S. superans*)

According to our data, ectoparasites that occupied the intermediate position between nest-dwelling and transient ectoparasites with short-term type of feeding (the genus *Steatonyssus*), prefer migratory bat species as hosts (Stanyukovich, 1993; Orlova, Orlov, 2013) and its share varies from 35 up to 99% in parasitecoenosis of particoloured bat and Nathusius' pipistrelle; more to the point, the parasite fauna of *V. murinus* is almost entirely presented by mites of the genus *Steatonyssus*.

The mite *Steatonyssus spinosus* is the most widespread parasite of the particoloured bat in the Central Palaearctic and, first of all, in the Urals. The mite *S. spinosus* is replaced by another species *S. periblepharus* to the West from the Ural Mountains. To the East from the Ural range the mass species parasitizing particoloured bat is *S. superans* and the mite *S. spinosus* is known only by rare findings (Medvedev et al., 1991; the authors' own data). This successive change of dominant species of the genus *Steatonyssus* from the West to the East may be explained by preferable hosts of these mites (despite of their polyxenic features): pipistrelles for *S. periblepharus* and Asian parti-colored bat for *S. superans*. Probably the preferable host for the *S. spinosus* is *V. murinus* as this species is registered on the particoloured bat in many locations where other migratory bat species are absent. The preference for migratory bats by species of the genus *Steatonyssus* is explained by their hosts' mode of life.

CHAPTER 5. EVALUATION OF EPIDEMIOLOGICAL SIGNIFICANCE OF GAMASID MITES

Bats of the family Vespertilionidae are described as vectors of a sufficiently large number of pathogen human diseases (14) (Emchuk, 1963; Medical theriology…, 1989), but the chiropterans are involved in the transmission of most of these diseases extremely rare and accidentally.

The greatest epidemiological significance is ascribed to rabies and histoplasmosis that are transmitted by bats, but it doesn't involve ectoparasites' participation.

A. A. Tagil'tsev (1970) who investigated the routes of transmission of dangerous infections by bat ectoparasites denoted that bats because of their migrations have the opportunity to transfer transient ectoparasites over long distances and therefore to contribute to the expansion of some diseases.

Mites of the family Spinturnicidae are permanent and specific ectoparasites of bats, therefore previously they were of only theoretical interest and weren't regarded as a possible vector of transmissions of feral herd infections. However the first investigations on the possibility of transmission of dangerous pathogenic organisms from these ectoparasites to humans confirmed this possibility: several strains (*Bartonella*, *Rickettsia*, *Anaplasma*) were isolated from gamasid mites of the genus *Spinturnix*y by Polish researchers in 2006-2008 years (Szubert-Kruszynska et al., 2009).

The family Macronyssidae originally parasitized chiropterans but some of its representatives switched to parasitizing other groups of hosts (reptiles, birds, some mammals) (Balashov, 2009). The subfamily Ornithonyssinae settled on a wide spectrum of hosts and its representatives are capable of active spread of pathogens because of their developed hematophagia (Zemskaya, 1967). The greatest medical significance has the mite *Ornithonyssus bacoti* Hirst, 1913 (rat mite) attacking humans and causing acute dermatitis (Medical theriology…, 1989; Balashov, 2009). Furthermore *O. bacoti* is a vector of pathogenic organism of vesicular ricketsiosis and endemic rat spotted fever (typhus) and also probably participates in circulation of lymphocytic choriomeningitis virus (Zemskaya, 1967).

Ecological isolation of chiropterans determined the high specificity this group's ectoparasites. The bats of the Northern Palaearctic have a very limited number of common ectoparasites with other groups of animals and human. However, the exchange of ectoparasites between chiropterans and other mammals exists. The findings of alien parasitic species on bats has aroused a great theoretical interest (the clarification of some phylogenic questions, ecosystem investigations) and has practical significance because many of them are involved in the circulation of dangerous feral herd infections (tularemia, anaplasmosis, lymphocytic choriomeningitis and so on).

An annotated list of mites' species found not on their principal hosts is given below.

Family Laelapidae Berlese, 1892

This family includes both mammal ectoparasites and free-living (predatory) mites. Only two genera of the family (*Notolaelaps* spp. and *Neolaelaps* spp.) with a small number of species are specific parasites of the megabats family (Old World fruit bats) (Megachiroptera: Pteropodidae) (Womersley, 1957; Radovsky, 1967; Strandtmann, Garrett, 1967; Prasad, 1974; Domrow, 1988; Fain, 2002; Shaw, 2011).

Androlaelaps casalis (Berlese, 1887)

Material: ♀ from a parti-colored bat *Vespertilio murinus* caught near Lake Laginkul' (the Omsk region) (VII/1990).

Non-exclusive hematophagous, are distributed around the world (Bregetova, 1956). A nest parasite of several species of birds (Fam. Passeriformes, Columbiformes, Apodiformes) in the north of Eurasia, is found in anthills in Western Siberia (Davydova, Nikolskiy, 1986), was also often noted in human dwellings. Registered on bats (Stanyukovich, 1993), in particular, the common pipistrelle *Pipistrellus pipistrellus* in Afghanistan (Dusbábek, 1970), the parti-colored bat in the Chita region (Zhovtiy et al., 1962), northern myotis (*Myotis septentrionalis*) (Czenze, Broders, 2011). Encephalitis virus, the West Nile virus and Omsk hemorrhagic fever virus are isolated from *A. casalis* (from the nests of colonial birds) in Western Siberia.

Laelaps multispinosus Banks, 1909

Specific ectoparasite of the muskrat *Ondatra zibethicus* (Linnaeus, 1766), this mite is distributed throughout the host's area (North America and Eurasia) (Bregetova, 1956; Davydova, Shilo, 1980).

An accidental find of *L. multispinosus* was described on the common pipistrelle (Stanyukovich, Malinovskiy, 1992).

L. muris (Ljungh, 1799)

A specific ectoparasite of the water vole *Arvicola terrestris* Linnaeus, 1758, the nhabited range of *L. muris* covers a large part of the Palaearctic (from the Atlantic coast to the East of Yakutia, including the Baltic States, the Northern Caucasus, the steppe zone of Kazakhstan, Asia Minor, Siberia, Northern Mongolia and Northern China). Acts as a vector of tularemia pathogen *Francisella tularensis* (McCoy and Chapin 1912) Dorofeev 1947. The only finding on a bat was described (Stanyukovich, 1993).

Echinonyssus talpae (Zemskaya, 1955)

It is predominantly found in association with the European mole *Talpa europaea* Linnaeus, 1758 and occasionally on other insectivores and rodents. Five specimens (male, female and three nymphs) were removed from serotine bat *Eptesicus serotinus* in London Zoo (Britain) (Baker, Kraven, 2003).

Family Hirstionyssidae Evans & Till, 1966

Parasites of small vertebrates, especially rodents and insectivores, these mites are often found on small predators, feeding with these groups of animals (Bregetova, 1956).

Hirstionyssus arcuatus (Koch, 1839)

Cosmopolitan, parasitizing different species of the hedgehogs *Erinaceus* sp. (Mammalia: Erinaceomorpha) (Bregetova, 1956; Strandtmann, Hunt, 1951). Registered on the northern bats *Eptesicus nilssoni*, and serotine bats *E. serotinus* in the Czech Republic (Kolenati, 1858).

Hirstionyssus isabellinus Oudemans, 1913

Material: ♀ from a parti-colored bat caught near Lake Laginkul' (the Omsk region) (VII/1990).

H. isabellinus parasitizes rodents (mostly voles), less predators, widespread in the tundra, forest and steppe zones of the Palaearctic (*Mustela nivalis* Linnaeus, 1766) (Bregetova, 1956; Zemskaya, 1973); findings on bats are registered (Stanyukovich, 1993). *H. isabellinus* – a vector of lymphocytic choriomeningitis virus and tularemia (Bregetova, 1956).

Hirstionyssus sp.

39 individuals (10 ♀, 2 ♂, 27 nymphs) without species determination were collected in the vicinity of Krasnoyarsk city from several bat species: the Hilgendorf's tube-nosed bats *Murina hilgendorfi*, the Ognev's long-eared bats *Plecotus ognevi* (identified by the authors as the common long-eared bat *Plecotus auritus* although this species does not inhabit Siberia); the northern bat *Eptesicus nilssoni* (Emel'yanova, Vysokovskiy, 1962).

Foreign authors also reported about findings of unidentified species of the genus *Hirstionyssus* on bats (Tenorio, Radovsky, 1979).

Family Haemogamasidae Oudemans, 1926

Haemogamasus kitanoi Asanuma, 1948

Material: ♀ from a lesser mouse-eared bat *Myotis blythii* caught in the North-West Altai (the Krasnoshchekovskiy district) (VII/1978).

A parasite of steppe rodents (squirrels *Spermophilus* spp., gerbils *Meriones* spp.) and some lagomorphs (pikas *Ochotona* spp.), was distributed in Siberia, northern China, Kazakhstan (Bregetova, 1956; Senotrusova, 1973; She et al., 2011).

Haemogamasus ambulans (Thorell, 1872)

Holarctic species can be cosmopolitan, its range extends from the tundra to the desert, but most of findings were noted in the boreal zone; actively occupies different landscape zones. A parasite of several species of small mammals; the nidikol of small mammals and some birds' nests.

The Subarctic *H. ambulans* forms the basis of gamasid mites population in the voles' nests (Middendorf's *Microtus middendorffi* (Poliakov, 1881), the narrow-skulled *Microtus gregalis* (Pallas, 1779), the tundra vole *Microtus oeconomus* Pallas, 1776), lemmings (siberian *Lemmus sibiricus* (Kerr, 1792), collared *Dicrostonyx torquatus* Pallas, 1778) and sand martins' nests (*Riparia riparia* Linnaeus, 1758). In the forest and steppe zones *H. ambulans* was found on rodents and in their nests (mostly the vole g. *Microtus*, *Miodes*, *Clethrionomys*). Mites were registered on muskrats, water vole nests. Findings on water voles, chipmunks *Tamias sibiricus* Laxmann, 1769, wharf rats *Rattus* *norvegicus*, house mouses *Mus musculus* Linnaeus, 1758, striped field mouses *Apodemus agrarius* (Pallas, 1771), Japanese field mouses *Apodemus speciosus* (Temminck, 1844), the Baraba hamster *Cricetulus barabensis* (Pallas, 1773), the northern pikas *Ochotona hyperborean* (Pallas, 1811), on insectivores (mole *Talpa* spp., shrew *Sorex* spp.), in sable nests (*Martes zibellina* (Linnaeus, 1758)), in bird nests (sand martins, the hen harrier *Circus cyaneus* (Linnaeus, 1766)) are registered.

H. ambulans was found on the Daubenton's bat *Myotis daubentotii* in a cave (Bregetova, 1956).

Encephalitis virus, Japanese encephalitis group virus, flavivirus group virus were isolated from *H. ambulans*; parasite can receive the tick-borne encephalitis virus from newborn mice. Hantavirus antigen was detected in *H. ambulans* using enzyme-linked immunosorbent assay; tularemia bacterium is able to live in a mite's body for 4 days; *Francisella tularensis* was found using bacteriological methods (Nikulina, 2006).

It should be mentioned that the parasites exchange between bats and other mammal groups is reciprocal, as evidenced by the first description of gamasid mite *Macronyssus heteromorphus* (specific ectoparasite of bats fam. Vespertilionidae (Medvedev et al., 1991; Stanyukovich, 1997)) on a rat (unusual host) (Dusbábek, Radovsky, 1972); findings of other specific bats gamasid mites on rodents: *Ornithonyssus pipistrelli* (Oudemans, 1902) on the common dormouse *Muscardinus avellanarius* (Linnaeus, 1758) in the Southern Carpathians (obviously, bats and dormouses used one shelter; an attempt to feed this mite on mouse in a laboratory was ineffectual) (Lange, 1959; Zemskaya, 1966), *Steatonyssus spinosus* Willmann, 1936 on the field vole *Microtus agrestis* (Linnaeus, 1761) in the Sudetenland (Poland) (Haitlinger, 2007).

It should be supposed that the findings of non-specific ectoparasites on some bat species is explained by peculiarities of the bats ecology: shelter locations and places of reproduction.

In particular, the species with the elements of synantropia (particoloured bats, pipistrelles) has a high probability of contact with ectoparasites and nest nidicols of synanthropic birds (for example with *A. casalis*). The species that habituate tree hollows and rock crevices for the can contact with ectoparasites and nest nidicols of nestling birds and mammals there (for example *H. ambulans, H. kitanoi*). It's more difficult to explain the findings of specific permanent ectoparasites of some terrestrial mammals (*L. multispinosus*) on bats.

Although these findings are accidental, they confirmed the theoretical possibility of transmission of dangerous infections in such a way. The active implication of synanthropic species of the particoloured bat exchanging the parasites with rodents caused a particular anxiety because this species plentifully inhabits buildings in cities and in residential areas during summer months.

In that case collective usage of the shelters by bats and rodents may become a factor of transmission of infections between these groups with the subsequent opportunity to transmit these infections to humans. From the standpoint of a great number of publications about the range of expansion of arboviral deseases that are dangerous for humans and the appearance of new units in the circulation of pathogenic organisms especially in the antropogenic changed ecosystems (one of the consequence of the anthropogenic impact is including of man in new parasitogenic systems), the role of chiropterans in maintenance of the infection streams can't be underestimated.

Besides, as was mentioned by S. A. Bear (2004): "The rates of evolution processes that pass in parasitogenic systems have accelerated on the current historical stage. Moreover, the character of its entropy is also changing that is stipulated by a powerful and at the same time chaotic impact of anthropogenic factors various in their character and the power of effect. From the more or less ordered members of parasitogenic systems that were achieved by prolonged coevolution they have turned into unbalanced that contribute to decceleration of natural coadaptation of parasites and their hosts. As a result of such changes one of the fundamental principles of parasitology connected with reciprocal "selection on compatibility" in coevolution of a parasite and a host is being violated. The violation of this principle in transformed biocenoses may bring to the opposite, in other words, to increasing of the parasites' pathogenicity and to decreasing of the hosts' resistance".

Moreover, S.A. Bear designate the inclusion of man in new parasitogenic systems as one of the consequences of the anthropogenic impact (as it happened in Shidertinsk isolate of endoparasite *Opisthorchis felineus* (Rivolta, 1884)) (Bear, 2004).

One more factor increasing the danger of infection transmissions by bat ectoparasites is climate changes. Accidental drift of species that were earlier ascribed to considerably warmer regions is probably related to the occurring warming and the increasing of average winter temperatures (Vinarskaya, Orlova, 2012).

Therefore further investigations, which will allow to explore the possibility of inclusion of man in the host spectrum of bat ectoparasites (for example, during a prolonged period of collective dwelling), are necessary. Particularly, it is necessary to investigate the role of collective dwelling of chiropterans and rodents in exchange of ectoparasites and transmission of dangerous infections pathogens in such a way. Besides, it is important to realize investigations, which will allow to make a conclusion on the epidemiological meaning of species of the genus *Ornithonyssus* parasitizing bats.

LITERATURE

1. Ah H.S., Radovsky F.J. Notes on Steatonyssus Kolenati in Korea with description of a new species (Acarina: Macronyssidae) // The Journal of parasitology, 1967. Vol. 53, issue 2. P. 419-431.
2. Arutyunyan E.S., Ogadganyan A.M. Mites of fam. Macronyssidae Oudemans, 1936 (Parasitiformes, Gamasoidea) parasitizing bats of Armenia // Biological Journal of Armenia. 1974a. V. 27(10). P. 75-82.
3. Arutyunyan E.S., Ogadganyan A.M. Parasitic mites of fam. Spinturnicidae Oudemans, 1901 (Parasitiformes, Gamasoidea) from Armenian bats // Biological Journal of Armenia. 1974b. V. 27(4). P. 72-81.
4. Atkinson A., Riani M. Robust diagnostic regression analysis. Springer series in statistics. New York, Springer-Verlag. 2000. 328 P.
5. Baker E.W., Delfinado M.D. Spinturnicidae of South East Asia and the Pacific region // Pacific insects. 1964. Vol. 6. P. 571-591.
6. Baker A.S. Craven J.C. Checklist of the mites (Arachnida: Acari) associated with bats (Mammalia: Chiroptera) in the British Isles // Systematic & Applied Acarology Special Publications. 2003. Vol. 14. P. 1-20.
7. Balashov Y.S. The specificity of parasite-host relations of arthropods with terrestrial vertebrates // Parasitology. 2001. N 6. P. 473-489.
8. Balashov Y.S. 2009. Parasitism of ticks and insects on vertebrates. Nauka, Sankt-Petersburg (in Russian). 358 p.
9. Baulechner D., Becker N.I., Encarnação J.A. Host specificity in spinturnicid mites: do parasites share a long evolutionary history with their host? // Journal of zoological systematics and evolutional research, 2013. V. 51(3). P. 203-212.
10. Bazhenov Y.A. New data on bats in Daurian steppes // Plecotus et al., 2013. V. 15–16. P. 59-63. (In Russian with English summary).
11. Beacournu J.C. Ectoparasites des Chiropteres de L'Oest de la France. 1a partie: Ixodoides-Cimicides et Nycteribiides // Bul. de la Soc. Scientifique de Bretagne. 1961. Vol. 36. P. 315-338.
12. Bear S.A. Theoretical parasitology: how to understand it, what is included in its mission? // Modern problems of zoology, ecology and parasitology: Proceeding of the 1st and 2nd International readings memory and 85th anniversary of the S.S. Shul'man. Kaliningrad, 2004. P. 45-66.
13. Beck A.J. Factors affecting the density and occurrence of ectoparasites of bats: Ph.D. Dissertation. Davis, California: University of California, 1966. 98 p.

14. Bregetova N.G. Gamasid mites. Leningrad : Izdatel'stvo AN SSSR, 1956. 248 p.
15. Berlese A. 1882-1892. Acari, Myriapoda et Scorpiones hucusque in Italia reperta: Mesostigmata. Patavic, Fasc. 52, No. 2. 143 p.
16. Beron P. Catalogue des acariens parasites et commensaux des mammiferes en Bulgarie // Proceeding of Institute of Zoology of Bulgarian Academy of Sciences. 1973. T. 57. C. 167-199.
17. Bobkova O.A. Mites and Ticks (Acari) as Bats' (Chiroptera) Ectoparasites of Eastern Part of Ukraine. Vestnik zoologii. 2005. 39(2). P. 73–78. Russian, with a summary in English.
18. Bolshakov V.N., Orlov O.L. 2000. The species composition of bats hibernating in caves in the Central Ural region // Approaches to biogeography and ecology of bats: Proc. of 8-th EBRS, Kracow, Poland, 23 - 27 Aug. Kracow, 1999. P. 175-180.
19. Bol'shakov V.N., Orlov O.L., and Snit'ko V.P., Bats of the Urals, Yekaterinburg: Akademkniga, 2005.
20. Borisenko A.V. Mobil trap for bat catching // Plecotus et al., 1999. V 2. P. 10-19.
21. Bregetova N.G. Gamasid mites (Gamasoidea): a short identification key. Izdatel'stvo Akademii Nauk, Moscow (in Russian), 1956. 243 p.
22. Bruyndonckx N., Dubey S., Ruedi M., Christe P. Molecular cophylogenetic relationships between European bats and their ectoparasitic mites (Acari, Spinturnicidae) // Molecular phylogenetic evolution, 2009. V. 51. P. 227-237.
23. Burnham K.P., Anderson D.R. Model Selection and Multimodel Inference: A Practical Information-Theoretical Approach. 2d ed. New York: Springer-Verlag, 2002. 488 p.
24. Chambers J.M., Hastie T.J. (eds). Statistical models in S. New York : Chapman & Hall, 1992. 502 p.
25. Chessel D., Dufour A. B., Thioulouse, J. 2004. The ade4 package-I- One-table methods // R News. V. 4. P. 5-10.
26. Christe P., Arlettaz R., Vogel P. Variation in intensity of a parasitic mite (*Spinturnix myoti*) in relation to the reproductive cycle and immunocompetence of its bat host (*Myotis myotis*) // Ecology Letters. 2000. Vol. 3. P. 207-212.
27. Christe P. Glaizot O., Evanno G., Bruyndonckx N., Devevey G., Yannic G., Patthey P., Maeder A., Vogel P., Arlettaz R. Host sex and ectoparasites choice: preference for, and higher survival on female hosts // Journal of Animal Ecology, 2007. V. 76. P. 703-710.

28. Czenze Z.J., Broders H.G. Ectoparasite community structure of two bats (*Myotis lucifugus* and *M. septentrionalis*) from the Maritimes of Canada. J. Parasitol. Res., 2011. P. 1-9.
29. Davydova M.S., Shilo A.V. Gamasid mites of muskrat and its nests in the forest-steppe zone of Western Siberia. In the book: Biotechnia. The theoretical basis and practical work in Siberia. Novosibirsk : Nauka, 1980. P. 124-132. (In Russian).
30. Davydova M.S., Nikol'skiy V.V. Gamasid mites of Western Siberia. Novosibirsk : Nauka, 1986. 124 p.
31. Deunff J. Observations sur Spinturnicidae de la region palearctique occidentale (Acarina, Mesostigmata): Specificite, repartition et morphologie // Acarologia, 1977. V. 18. P. 602-617.
32. Deunff J., Beaucournu J.-C. Phenologie et variations du dermecos chez quelques especes de Spinturnicidae (Acarina: Mesostigmata) // Ann. Parasitol. Hum.Comp. 1981. Vol. 56. P. 203–224.
33. Deunff J., Keller A., Aellen V. 1986. Decouverte en Suisse d'un parasite nouveau, *Spinturnix helvatiae* n. sp. (Acarina, Mesostigmata, Spinturnicidae) specifique de *Nyctalus leisleri* (Chiroptera, Vespertilionidae). Revue Suisse de Zoologie 93: 803-812.
34. Deunff J., Volleth M., Keller A. 1990. Description de *Spinturnix nobleti* (Acari: Mesostigmata: Spintur- nicidae) parasite specifique de *Pipistrellus savii* (Chiroptera, Vespertilionidae) // Revue suisse de Zoologie, 97(2): 477-488.
35. Deunff J., Valter G., Bellido A., Volleth M. Description of cryptic species *Spinturnix bechsteini* n. sp. (Acari, Mesostigmata, Spinturnicidae), parasite of *Myotis bechsteinii* (Kuhl, 1817) (Chiroptera, Vespertilionidae) by using ecoethology of host bats and statistical methods // Journal of Medical Entomology, 2004. V. 41. P. 826-832.
36. Dietz M., Walter G. 1995. Zur Ektoparasitenfauna der Wasserfledermaus (*Myotis daubentoni* Kuhl, 1819) in Deutschland unter besonderer Berucksichtigung der saisonalen Belastung mit der Flughautmilbe *Spinturnix andegavinus* Deunff, 1977. Nyctalus. 5(5). P. 451-468.
37. Domrow R. Acari Mesostigmata parasitic on Australian vertebrates: an annotated checklist, keys and bibliography // Invertebrate Taxonomy, 1988. V. 1. P. 817-948.
38. Dusbábek F. Parasitische Fledermausmilben der Tschechoslowakei I. Fam. Spinturnicidae Oudms. 1910 // Ceskoslov Spolec. Ent. Casopis. 1962. V. 59(4). P. 357-380.
39. Dusbábek F. Parasitische Fledermausmilben der Tschechoslovakei. II. Familie Dermanyssidae Kol. 1859 (Acarina; Gamasides) // Cs. parasitologic., 1964. V. 11. P. 77-125.

40. Dusbábek F. Contribution to the knowledge of parasitic mites from Mongolia (Acarina, Gamasides) // Mitt. Mus. Berl., 1966. V. 42(1). P. 43-58.
41. Dusbábek F. Mite parasites (Acarina) of bats from Afghanistan // Folia Parasitologica, 1970. V. 17. P. 61-76.
42. Dusbábek F. The zone of bat acarinia in Central Europe // Folia parasitologica. 1972. T. 19. P. 139-154.
43. Dusbábek F., Pinchuk L.M. The new species *Macronyssus barbastellinus* sp. n. (Parasitiformes: Gamasoidea) from bats // Parazitologiya, 1971. V. 5. P. 401-404. (In Russian with English summary).
44. Dusbábek F., Radovsky F.J. *Macronyssus heteromorphus* (Acarina, Macronyssidae) a new species from the Kuril Islands // Journal of Medicine Entomology. 1972. V. 9(6). P. 575-579.
45. Emchuk E.M. Epizootological importance of bats and their ectoparasites // Problems of parasitology. Kyiv, 1963. P. 341-343.
46. Emelyanova N.D., Vysokovskiy N.N. On the issue of wintering bats and their ectoparasites in the vicinity of Krasnoyarsk // Reports Irkutsk Anti-Plague Institute. Khabarovsk. 1962. Vol. 3. P. 146-148. (In Russian).
47. Esch G.A., Bush A.O., Aho J.M. Parasite communities: patterns and processes. L.; New York, 1990. 325 p.
48. Estrada-Peña A., Balcells E., Serra-Cobo J. Los artropodos ectoparásitos de murciélagos en España // Los Murciélagos de España y Portugal / J. Benzal, O. de Paz, Eds. Madrid, 1991. P. 253-279.
49. Estrada-Peña A., Serra-Cobo J. The acarinia and nycteribidia zones of *Miniopterus schreibersi* Kuhl (Mammalia: Chiroptera) in the northeast of Spain // Folia Parasitologica, 1991. V. 38(4). P. 345-54.
50. Evans G.O., Till W.M. Studies on the British Dermanyssidae (Acari: Mesostigmata). Pt. 2. Classification // Bull. Br. Mus. Nut. Hist. Zool. 1966. V. 14(5). P. 8-370.
51. Fain A. Notes on a small collection of mites parasitic on bats in the Philippines // Acarologia, 2002. V. 42(1). P. 67-74.
52. Fonseca F. A monograph of the genera and species of Macronyssidae Oudemans, 1936 (synon: Liponyssidae Vitzthum, 1931) (Acari) // Proc. Zool. Soc. Lond. 1948. Vol. 118. P. 249–334.Gadzhiev A.T., Dubovchenko T.A. Bats – hosts of immature phase of ixodid ticks // Materials of II acarological meeting. Kiev : Naukova Dumka, 1970. P. 122-124.
53. Gadzhiev A.T., Dubovchenko T.A. Fauna of bat gamasid mites of Azerbaijan. Proceedings of the Academy of Sciences of Azerbaijan SSR. Series of Biological Sciences, 1966. V. 6. P. 49-54.

54. Gadzhiev A.T., Dubovchenko T.A. Gamasid mites (Parasitiformes, Gamasoidea) of chiroptera in Azerbaijan // Zoological zhournal, 1967. V. 46(11). P. 1716-1719.
55. Gadzhiev A.T., Dubovchenko T.A. Ectoparasites of Mehely horseshoe bat in USSR // Vestnik zoologii, 1976. V. 2. P. 24-28.
56. Giorgi M.S., Arlettaz R., Guillaume F., Nussle S., Ossola C., Vogel P., Christe P. 2004. Causal mechanisms underlying host specificity in bat ectoparasites. Oecologia. Volume 138, Issue 4, pp 648-654.
57. Gorodkov K.B. The type of insect areals of tundra and forest zones of the European part of the USSR / Areas of insects of the European part of the USSR, the cards 179-221. 1984 L . : Nauka. P. 3-20.
58. Gu Y.M., Wang J.S. Notes of the Genera Macronyssus and Ichoronyssus in China (Acari: Macronyssidae) // Acta Zootaxonomica Sinica. 1985. Issue 2. P. 156-161.
59. Haitlinger R. Pasozyty zewnetrzne nietoperzy Dolnego Slaska. III. Spinturnicidae, Argasidae, Ixodidae (Acarina) // Wiadomosci parazitologiezne. 1978. Vol. 24. P. 475–490.
60. Haitlinger R. Pasozyty zewnetrzne nietoperzy Dolnego Slaska. IV. Macronyssidae, Dermanissidae, Veigaiaidae // Wiadomosci parazitologiezne. 1978. Vol. 24. P. 707-718.
61. Haitlinger R., Łupicki D. Arthropods (Acari, Siphonaptera, Heteroptera, Psocoptera) associated with *Nyctalus noctula* (Schreber, 1774) (Chiroptera: Vespertilionidae) in Southern Poland // Wiadomosci Parazytologiczne, 2008. V. 54(2). P. 123–130.
62. Haitlinger R., Ruprecht A. Staworogi zebrane na nietoperzach z Kujaw (Acari i Siphonaptera) // Bull. Entomol. de Pol. Wroclaw, 1985. 55. P. 615–618.
63. Haitlinger R., Ruprecht A. Parasitic arthropods (Siphonaptera, Diptera, Acari) of bats from western part of the Bialowieza Primeval Forest // Nyctalus (N. F.). 1992. Vol. 4, N 3. P. 315–319.
64. Haitlinger R., Walter G. Data relating to the distribution and host-specifity of bat-infesting mites (Acari, Mesostigmata, Prostigmata, Astigmata) in Germany // Drosera, 1997. Vol. 2. P. 95–112.
65. Haitlinger R. Arthropods (*Siphonaptera*, *Anoplura*, *Acari*) of small mammals of Karkonosze Mts. (Sudetes) // Zeszyty Naukowe Uniwersytetu Przyrodniczego we Wrocławiu – Biologia i Hodowla Zwierzat. 2007. Vol. 55, N. 559. P. 23-43.
66. Haitlinger R., Piksa K. First record of *Spinturnix bechsteini* (Acari: Mesostigmata: Spinturnicidae) from Poland with remarks on the diagnostic value of some characters // Annals of Parasitology, 2012. V. 58. P. 15-18.

67. Hanski I. Dynamics of regional distribution: the core and satellite species hypothesis // Oikos. 1982. Vol. 38. P. 210–221.
68. Herrin C.S., Tipton V.J. 1975. Spinturnicid mites of Venezuela (Acarina: Spinturnicidae). Brigham Young University Bulletin, Biological Series, 20, 1–72.
69. von Heyden C. H. G. Versuch einer systematichen Einteilung der Acariden. Isis : 1826. V. 18. P. 608-613.
70. Hirst S. Note on Acari, mainly belonging to the Genus *Spinturnix* von Heyden // Proc. of the Zoological Society of London. 1927. Vol. 97, Issue 2. P. 323-338.
71. Horaček I., Hanák V., Gaisler J. Bats of the Palaearctic region: a taxonomic and and biogeographic review // Proceedings of the VIIIth EBRS 1. Publication of CIC ISEZ PAN, 2000. P. 11-157.
72. Host and distribution lists of mites (Acari), parasitic and phoretic, in the hair or on the skin of North American wild mammals north of Mexico: records since 1974 / Whitaker J.O. et al. Lincoln: University of Nebraska, 2007. 173 p.
73. Ilyin V.Y., Kurmaeva N.M. By the spread of migratory bat species in the Southern Urals // Abstracts of the jubilee scientific and practical conference "Local history research and environmental education." Penza, 1996. P. 38-39.
74. Ilyin V.Y. Bats (Chiroptera, Vespertilionidae) south-east of the Russian plain: abstract dis. ... Doctor of Biology. Penza, 1999. 49 p.
75. Ilyin V.Y., Smirnov D.G. Specific features of distribution of resident bat species (chiroptera: Vespertilionidae) in the eastern East European plain and adjacent regions // Russian Journal of Ecology, 2000. V. 31(2). P. 101–107.
76. Imaz E., Aihartza J.R., Totorika M.J. Ectoparasites on bats (Gamasida, Ixodida, Diptera) in Biscay (N Iberian peninsula) // Miscel-lania Zoologica. 1999. Vol. 22. P. 21-30.
77. Jaunbauere G., Salmane I., Spungis V. Occurence of Bat Ectoparasites in Latvia // Latv. Entomol. 2008. Vol. 45. P. 38-42.
78. Juvara I. Acarieni din fam. Spinturnicidae si Dermanyssidae (Mesostigmata: Gamasina) parasiti pe chiroptere din Romania // Emil. Racovita. 1967. Vol. 6. P. 183-192.
79. Kennedy C. R., Bakke T. A. Diversity patterns in helminth communities in common gulls, *Larus canus*. Parasitology, 1989. V. 98. P. 431-445.
80. Khabilov T.K. Mammals. Bats. Dushanbe : Donish, 1992. 351 p.
81. Kim M.H., Bying C.K. 1991. Studies on mites parasitic on bats in Korea (Acari: Macronyssidae). Korean Arachnology, 6(2). P. 269-273.

82. Kim M.H., Hai P.L., Bying C.K. 1992. Studies on mites parasitic on bats in Korea (Acari: Mesostigmata, Spinturnicidae). Korean Arachnology, 7(2). P. 195-200.
83. Koch C.L. Deutsche Crustacea, Myriapoda, Arachnida. Regensburg, 1836. Fasc. I.
84. Koch C.L. Deutsche Crustacea, Myriapoda, Arachnida. Regensburg, 1838. Fasc. 17.
85. Kolenati F.A. Europa's Chiroptern. II. Beschreibung der europaischen lebenden Chiroptern // Allg. Deutsche Naturk. Ztg. 1856. Bd. 2. P. 161-192.
86. Kolenati F.A. Synopsis prodroma der auf Chiroptern als Epizoën vorkommenden Lausmilben, Carida Kolenati // Wiener Entomologische Monatschrift. 1858. V. 2: P. 4-6.
87. Kristofik J., Piksa K., Sachanovicz K. 2012. Two spinturnicid mites new to the fauna of Poland (Acari: Spinturnicidae). Polish Journal of Entomology, 81: 101-106.
88. Kuzyakin A.P. Bats. M . : Sov. Nauka, 1950. 444 p.
89. Lange A.B. A new gamazid mite species *Ornithonyssus pavlovskii* sp. n. (Gamasoidea, Dermanyssidae) from hazel dormouse from Southern Carpathians // Zool. Zh., 1959. V. 38(3). P. 483-485.
90. Linnæus C. Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Holmiæ, 1758. (Salvius). T. I: Editio decima, reformata. 824 p.
91. Lourenço S., Palmeirim J. M. Which factors regulate the reproduction of ectoparasites of temperate-zone cave-dwelling bats? // Parasitology Res. 2008. Vol. 104, Issue 1. P. 127-134.
92. Lučan R.K. Relationships between the parasitic mite *Spinturnix andegavinus* (Acari: Spinturnicidae) and its bat host, *Myotis daubentonii* (Chiroptera: Vespertilionidae): seasonal, sex- and age-related variation in infestation and possible impact of the parasite on the host condition and roosting behaviour // Folia Parasitologica. 2006. Vol. 53. P. 147–152.
93. Mammals of the USSR / Compilers Gromov I.M. et al. M . ; L . : Izdatel'stvo AN SSSR, 1963. Part 1. 639 p.
94. Markova L.I. Influence of hibernation on parasite fauna of bats // Zool. Zh., 1938. V. 17(1). P. 133-145.
95. Marchenko I.I. Gamasid mites (Parasitiformes, Mesostigmata) from the Altaiskiy State Nature Reserve. Euroasian entomological journal, 2007. V. 6(4). P. 373–378. Russian, with English summary.
96. Matveev V.A., Kruskop S.V., Kramerov D.A. Revalidation of *Myotis petax* Hollister, 1912, and its new status in connection with *M. dauben-*

tonii (Kuhl, 1817) (Vespertilionidae, Chiroptera) // Acta Chiropterologica. 2005. Vol. 7, N1. P. 23-37.

97. Medical theriology / editor in charge Kucheruk V.V. M . : Nauka, 1989. 269 p.
98. Medvedev, S.G., Stanyukovich, M.K., Tiunov, M.P., Farafonova, G.V. Ectoparasites of Bats of the Russian Far East. Parazitologiya, 1991. V. 25 (1). P. 27–37.
99. Medvedev S.G., Chistyakov D.V., Stanyukovich M.K., Paskhina M.V. Bat ectoparasites fauna of Sebezh National Park // Nature of the Pskov region, 2000. V. 11. P. 22-25.
100. Micherdzinsky W. Eine Taxonomische Analyse der Familie Macronyssidae, Oudemans, 1936. I: Subfamilie Ornithonyssinae, Lange, 1958 (Acarina: Mesostigmata). Warszawa: Polska Akad. Nauk, 1980. 254 p.
101. Mrciak M., Nyholm E. C. Beitrag zur Kenntnis der Milben der Familie Spinturnicidae im Gebiet von Rantalampi (Finnland) // Lounais-Hameen Luonto. 1967. N25. P. 12-13.
102. Nikulina N.A. Epizoological and epidemiological importance of gamasid mites (fam. Haemogamasidae, Oudms., 1926, g. *Haemogamasus* Berl., 1889) from small mammals in the Baikal region // Bulletin of East Siberian Scientific Center of SB RAMS, 2006. V. 2. P. 111-114.
103. Orlov O.L. Bats (Mammalia, Chiroptera) of the Middle Urals: abstract dis. ... PhD. Ekaterinburg, 2000. 16 p.
104. Orlov O.L., Smagin A.I., Tarasov O.V. Research of zoogenic transfer of radionuclides by bats // Problems of radiation safety, 2005. V. 4. P. 12-20.
105. Orlova M.V. Ectoparasite associations of bats from the Urals (Russia) // Hystrix Italian J. of Mammalogy, 2011. V. 22(1). P. 105-110.
106. Orlova M.V., Orlov O.L. Ectoparasites of the pond bat *Myotis dasycneme* (Boie, 1825) (Chiroptera, Vespertilionidae) in the Urals // Euroasian entomological journal, 2011. V. 10(4). P. 517–521. (In Russian, with English summary).
107. Orlova M.V., Kapitonov V.I., Griror'ev A.K., Orlov O.L. Bat ectoparasites in Kama-Vyatka interfluves. Bulletin of Udmurt University, 2011. V. 2. P. 134–138. (In Russian, with English summary).
108. Orlova M.V., Orlov O.L., Kshnyasev I.A. Changes in the abundance of parasitic gamasid mite Macronyssus corethroproctus (Oudemans, 1902) during the overwintering period of its host, the Pond bat *Myotis dasycneme* (Boie, 1825) // Russian Journal of Ecology, 2012. V. 43(4). P.328-332.
109. Orlova M.V., Zapart A. Interaction of ectoparasites in cohabitating colonies of pond bats *Myotis dasycneme* (Boie, 1825) and species of genus *Pip-*

istrellus from Northern Poland // Annals of Parasitology, 2012. 58(4). P. 211-215.

110. Orlova M.V. Ectoparasites of the particolored bat (*Vespertilio murinus* Linnaeus, 1758, Chiroptera, Mammalia) in the Urals and adjacent regions // Entomological Review, 2013. V. 93(9). P. 1236-1242.
111. Orlova M.V. Ectoparasites of the particolored bat (*Vespertilio murinus* Linnaeus, 1758, Chiroptera, Mammalia) in the Urals and adjacent regions // Entomological Review, 2013. V. 93(9). P. 1236-1242.
112. Orlova M.V., Chistiakov D. V., Orlov O. L., Kruger F., Kshnyasev I. A. Ectoparasite fauna of pond bat *Myotis dasycneme* (Boie, 1825), (Chiroptera, Vespertilionidae) in Northern Eurasia // Vestnik St. Petersburg State University. Ser. 3. Biology, 2014a. V. 1. P. 24–38.
113. Orlova M.V., Orlov O. L., Zhigalin A. V. New records of ectoparasites of the eastern water bat *Myotis petax* Hollister, 1912 (Vespertilionidae, Chiroptera) and the revision of the material previously collected from *Myotis daubentonii* s. lato in the eastern Palaearctic // Entomological Review, 2014b. V. 94(9). P. 1306-1312.
114. Orlova M.V., Orlov O.L. Attempt to define the Complexes of Bat Ectoparasites in the Boreal Palaearctic Region // Vestnik zoologii, 2015. 49(1). P. 75–86.
115. Orlova M.V., Zhigalin A.V. Three New Bat Ectoparasite Species of the Genus *Macronyssus* from Western Siberia (with an Identification Key for Females of the Genus *Macronyssus* from the Palaearctic Boreal Zone) // Journal of Parasitology, 2015. V. 101(3). P. 314-319.
116. Orlova M.V., Zhigalin A.V., Zhigalina D.I. Parasitic gamasid mites (Acari: Mesostigmata) associated with bats (Chiroptera: Vespertilionidae) on Kunashiri Island, with a description of a new species *Spinturnix uchikawai* sp. nov. // Acta arachnologica, 2015. V. 64(1). P. 27-31.
117. Oudemans A.C. New list of Dutch Acari. Second Part. With remarks on known and descriptions of a new subfamily, new genera and species // Tijdschr. Ent. 1902. V. 45(1/2). P. 1-52.
118. Oudemans A.C. Acarologische Aanteekeningen X // Ent. Ber. Amst. 1904. Vol. 1, N16. P. 140-141.
119. Peribañez-Lopez M. A., Sánchez-Acedo C., Estrada-Peña A. Estudio morfológico de los àcaros de la familia Spinturnicidae (Acarina, Gamasidae) del Norte y Levante español // Revista Ibérica de Parasitologia, 1989. V. 49. P. 357-373.
120. Pinchuk L.M. Mites of the genus *Ichoronyssus* (Gamasoidea: Dermanyssidae) from bats of Prut-Dnestr interfluve // Animal and plant parasites. Kishinev, 1970. V. 5. P. 73-87. (In Russian).

121. Pinchuk L.M. Parasitic mites of fam. Spinturnicidae (Parasitiformes: Gamasoidae) from bats of Moldova // Animal and plant parasites. Kishinev, 1971a. V. 7. P. 93-110. (In Russian).
122. Pinchuk L.M. Mites of the genus *Steatonyssus* (Parasitiformes: Macronyssidae) from bats of Moldova // Animal and plant parasites. Kishinev. 1971b. V. 7. P. 110-115. (In Russian).
123. Pinchuk L.M. Gamasid mites of mammals in Dniester and Prut interfluve // Chisinau : Shtiintsa, 1976. 288 p. (In Russian).
124. Pocora I., Ševčik M., Uhrin M., Bashta A.-T., Pocora V. 2013. Morphometric notes and nymphal stages description of mite species from the *Spinturnix myoti* group (Mesostigmata: Spinturnicidae) from Romania and Ukraine. International Journal of Acarology. V. 39(2). P. 153-159.
125. Prasad V. Parasitic mesostigmatic mites from Nepal (Acarina: Mesostigmata) // Oriental Insects, 1974. V. 8(1). P. 63-70.
126. R Development Core Team. R: a language and environment for statistical computing. R Foundation for Statistical Computing. Austria, Vienna, 2011.
127. Radovsky F. J. The Macronyssidae and Laelapidae (Acarina: Mesostigmata) parasitic on bats. Barkeley: Univ. of Califor., 1967. 288 p.
128. Radovsky, F. J. 1994. The evolution of parasitism and the distribution of some dermanyssoid mites (Mesostigmata) on vertebrate hosts. In M.A. Houck (Ed.), Mites, ecological and evolutionary analyses of life-history patterns (pp. 186–217). New York: Chapman & Hall.
129. Radovsky F. J. 2010. Revision of Genera of the Parasitic Mite Family Macronyssidae (Mesostigmata: Dermanyssoidea) of the World // Indira Publishing House. 170 p.
130. Reisen W. K., Kennedy M. L., Reisen N. T.. Winter ecology of ectoparasites collected from hibernating *Myotis velifer* (Allen) in southwestern Oklahoma (Chiroptera: Vespertilionidae) // J. Parasitol. 1976. Vol. 62. P. 628-635.
131. Rudnick A. A revision of the mites of the family Spinturnicidae // Univ. Calif. Publ. Ent. 1960. Vol. 17, N2. P. 157-248.
132. Ruedi M., Stadelmann B., Gager Y., Douzery E. J. P., Francis C. M., Lin L.-K., Guillen-Servent A., Cibois A. Molecular phylogenetic reconstructions identify East Asia as the cradle for the evolution of the cosmopolitan genus *Myotis* (Mammalia, Chiroptera) // Molecular Phylogenetics and Evolution, 2013. V. 69. P. 437–449.
133. Rupp D., Zahn A., Ludwig P. Actual records of bat ectoparasites in Bavaria (Germany) // Spixiana, 2004. V. 27(2). P. 185-190.
134. Rupp D., Ludwig P. First records of *Steatonyssus noctulus* Rybin, 1992 in Central Europe // Spixiana, 2000. V. 23. P. 275-278.

135. Rybin S.N. Gamasid mites of bats and their shelters in South Kyrgyzstan // Parasitologiya. 1983. V.17(5). P. 355-360. (In Russian with English summary).
136. Rybin S.N. New species of mites of the genus *Steatonyssus* (Mesostigmata: Macronyssidae) // Parasitologia, 1992. V. 26(2). P. 157-161. (In Russian with English summary).
137. Saunders R.C. 1975. Venezuelan Macronyssidae (Acarina: Mesostigmata). Brigham Young University Science Bulletin, Biological Series 20 (2):75-90.
138. Schmidt E. Nachweise von Acari bei Chiropteren im Bezirk Neubrandenburg (DDR) // Angew. Parasitol. 1987. Vol. 28. P. 103-107.
139. Senotrusova V.N. Biology and distribution of mites *Haemogamasus kitanoi* Asan. in Kazakhstan. Parasitologiya, 1973. V. 7(4). P. 307-11. (In Russian with English summary).
140. Senotrusova V.N. Gamasid mites – parasites of wild animals in Kazakhstan. Alma-Ata : Science, 1987. 220 p. (In Russian).
141. Senotrusova V.N., Tagil'tsev A.A. New species of gamasid mite *Ichoronyssus mirabilis* Senotrusova et Tagiltsev (Acariformes, Gamasoidea) from whiskered bats of Zaysan basin // Zool. Journ. 1968. V. 47, pt. 1. P. 134-136. (In Russian).
142. Shaw M.D. Laelapidae (Acari: Mesostigmata) on megachiropteran bats: new records and a new species of Neolaelaps Hirst // Zootaxa, 2011. V. 2807. P. 41–56.
143. She J., Fan S., Ruan C., Sun Y. 2011. Investigation on gamasid mites in a plague region of Dingbian county, Shaanxi province // Chines Journal of Vector Biology and Control. 22(2): 165-167.
144. Shitikov V.K. Rosenberg G.S. Randomization and bootstrap: a statistical analysis in biology and ecology using R. Togliatti : Cassandra, 2014. 314 p.
145. Smagin A.I., Tarasov O.V., Lyubashevsky N.M., Orlov O.L. The role of bats in zoogenic // Problems of radionuclide migration // Problems of radiation safety, 2000. V. 3 (19). P. 64-70.
146. Snit'ko V.P. Fauna of bats (Mammalia, Chiroptera) Southern Urals: abstract diss. … PhD. Yekaterinburg, 2004. 25 p.
147. Stanyukovich M.K. Gamasid mites and argasid ticks of bats from Pribaltica and Leningrad district // Parasitologiya. 1990. V. 24, pt. 3. P. 193-199. (In Russian with English summary).
148. Stanyukovich M.K. New species of the genus *Steatonyssus* (Parasitiformes: Gamasina) from bat // Parasitologiya, 1991. V. 25(3). P. 270-273. (In Russian with English summary).

149. Stanyukovich M.K., Malinovskiy K.Yu. (1992) Gamasid mites and argasid ticks from bats of Tajikistan. Reports of the Tajik Academy of Sciences, 35, 68–75. (In Russian with English summary).
150. Stanyukovich M.K. Gamasid mites of bats from Russia and adjunct countries (Gamasina: Spinturnicidae, Macronyssidae): abstr. diss.… PhD. St. Petersburg, 1993. 16 p. (In Russian).
151. Stanyukovich M.K. A description of the males and protonymphs of three species of the genus *Steatonyssus* (Gamasina: Macronyssidae) from bats // Parasitologiya, 1995. 29 (1). P. 47-54. (In Russian with English summary).
152. Stanyukovich M.K. *Spinturnix bregetovae* sp. nov. (Gamasina: Spinturnicidae), a New Species of Parasitic Mite from Bats. Acarina, 1996. V.3(1/2). P. 105–122.
153. Stanyukovich M.K. Keys to the gamasid mites (Acari: Parasitiformes, Mesostigmata, Macronyssoidea et Laelaptoidea) parasiting bats (Mammalia, Chiroptera) from Russia and adjacent countries // Rudolst. natur. histor. Schriften. 1997. V. 7. P. 13-46.
154. Starikov V.P., Men'shikov A.I., Lomakin A.A. The current state of knowledge of bats Kurgan region // Proceeding of Vth All-union bat conference (Chiroptera). Penza, 1990. P. 60-62.
155. Strandtmann R.W., Hunt O.E. Two new species of Macronyssidae, with notes on some established genera (Acarina) // Journal of Parasitology, 1951. V. 37. P. 460-470.
156. Strandtmann R.W., Garrett L.E. *Neolaelaps palpispinosus*, a new species of laelapid mite from fruit bats in New Guinea (Acarina: Laelapidae) // Journal of Medical Entomology, 1967. V. 4. P. 237-239.
157. Strelkov P.P. Wintering and migratory bat species in the European part of the USSR. Message 1 // Bulletin of Moscow Society of Naturalists, Department of Biology, 1970. V. 75(2). P. 38-52. (In Russian with English summary).
158. Szubert-Kruszyńska A., Michalika J., Stańczak J., Cieniuch S., Podsiadły E. Molecular survey of haematophagous spinturnicid mites (Acari: Spinturnicidae) and their bat hosts for rickettsial agents in Poland // Proceeding of X International Jena Symposium on Tick-born deseases, 2009. P. 38.
159. Tagil'tsev A.A. About life patterns of mites and insects, related with bats in the territory of the Soviet Union // Parasitologiya. 1970. V. 4, pt. 3. P. 283-287. (In Russian with English summary).
160. Teng K.F. Notes on the genus Steatonyssus in China (Acarina: Macronyssidae) // Acta Zootaxonomica Sinica. 1980. Vol. 5, N 1. P. 59-62.
161. Tenorio J. M., Radovsky F. J. Review of the Subfamily Hirstionyssinae, Synonymy of *Echinonyssus* Hirst and *Hirstionyssus* Fonseca, and descrip-

tions of four new species of *Echinonyssus* (Acari: Laelapidae) // Journal of Medical Entomology, 1979. V. 16(5). P. 370-412.

162. Till W.M., Evans G.O. The genus Steatonyssus Kolenati (Acari: Mesostigmata) // Bull. Br. Mus. nut. Hist. 1964. Vol. 11. P. 511-582.
163. Tiunov M.P. Bats of the Russian Far East. Vladivostok : Nauka, 1997. 134 p. (In Russian with English summary).
164. Uchikawa K., Kumada N. Studies on mesostigmatid mites parasitic on mammals and birds in Japan: VI. Bat mites of the genus Steatonyssus Kolenati, with redescription of *Steatonyssus longispinosus* Wang, 1963 // Medical entomology and zoology. 1977. Vol. 28, N4. P. 423-429.
165. Uchikawa K. 1979. Bat mites of the Genus *Macronyssus* Kolenati (Acari, Macronyssidae) // Annotationes zoologicae japonenses. Vol.52. Is.4. P.246-256.
166. Uchikawa K., Wada Y. Studies on mesostigmatid mites parasitic on mammals and birds in Japan. IX. Bat mites of the genus Spinturnix von Heyden, 1829 (Part I) (Spinturnicidae) // Jap. J. Sanit. Zool. 1979. Vol. 30, N 2. P. 121-125.
167. Uchikawa K., Zhang M.-Y., O'Connor B.M., Klompen H. Contribution to the taxonomy of the genus Spinturnix (Acari: Spinturnicidae), with the erection of a new genus, Emballonuria // Folia Parasitologica, 1994. V. 41. P. 287-304.
168. Vasen'kov D.A., Potapov M.A. Using body condition index in a study of bat ecology // Plecotus et al. 2007. V. 10. P. 21-31. (In Russian with English summary).
169. Vasen'kov D.A. Bats of the low hills of the south-east of Western Siberia. Abstract of dissertation … PhD. Novosibirsk, 2009. 20 p. (In Russian).
170. Villegas-Guzman G.A., López-González C., Vargas M. Ectoparasites associated to two species of *Corynorhinus* (Chiroptera: Vespertilionidae) from the Guanaceví mining region, Durango, Mexico // J. Med Entomol., 2005. V. 42(2). P. 125-127.
171. Vinarskaya N.P. Orlova M.V. Ectoparasites of pond bat *Myotis dasycneme* (Boie, 1825) and particolored bat *Vespertilio murinus* (Linnaeus, 1758 non Schreber, 1775) of the Middle Urals // Science dialogue: Biology. Ecology. Natural. Earth sciences, 2012. V. 2. Ekaterinburg. P. 23-30. (In Russian with English summary).
172. Vitzthum H. Milben, Acari // Die Tierwelt Mitteleuropas. 1929. Vol. 111, Pt. 3. S. 1-112.
173. Vitzthum H. Acarina. Bronn's Klassen und Ordnungen des Tierreichs. 1942. V. 2. P. 5. 1011 S.

174. Vshivkov F.N. Gamasid mites of bats and reptiles of Crimea // Problems of parasitology. Kyiv. 1963. P. 324-326.
175. Whitaker J. O. Jr. Collecting and preserving ectoparasites for ecological study // Ecological and Behavioral Methods for the Study of Bats / T. H. Kunz (ed.). Washington: Smithsonian Inst. Press, 1988. P. 459–474.
176. Womersley H. New genera and species of Acarina from bats from New Guinea, Phillipines and Australia // Transactions of the Royal Society of South Australia, 1957. V. 80. P. 67–72.
177. Zahn A., Rupp D. Ectoparasite load in European vespertilionid bats // J. Zool., Lond. 2004. Vol. 262, N4. P. 1–9.
178. Zhovtiy I.F., Zarubina V.N., Prokopiev V.N., Shvedko L.P. About bat ectoparasites of Southeast Transbaikalia and adjacent areas of the Mongolian People's Republic // Proceedings of Irkutsk State Scientific Anti-Plague Institute of Siberia and the Far East, 1962. V. 24(9). P. 338-343. (In Russian).
179. Zemskaya A. A. A new form of gamasoid mites for the fauna of the USSR – *Ornithonyssus pavlovskii* Lange, 1959, and the diagnostics of mites of the subfamily Ornithonyssinae // Zool. Jour., 1966. V. 45. P. 50–58. (In Russian).
180. Zemskaya A.A. Gamasid mites (Gamasoidea) as vectors of pathogens // Zool. Zh., 1967. V. 46(12). P. 1771-1784. (In Russian).
181. Zemskaya A.A. Parasitic gamasid mites and their medical importance. M . : Meditsina, 1973. 167 p. (In Russian).

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