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THE DIVERSITY, MITE COMMUNITIES, AND HOST SPECIFICITY OF PYGMEPHOROID MITES (ACARI: PYGMEPHOROIDEA) ASSOCIATED WITH ANTS IN WESTERN SIBERIA, RUSSIA

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ABSTRACT: This work discusses the diversity of mite communities along with host and attachment site specificities of myrmecophilous pygmephoroid mites (Acari: Pygmephoroidea) associated with most abundant ants (Hymenoptera: Formicidae) of Western Siberia. The researchers provide keys to myrmecophilous pygmephoroid mites of the families Neopygmephoridae and Scutacaridae of the Palaearctic and the keys to world species of the genera *Caesarodispus* Mahunka, 1977, and *Unguidispus* Mahunka, 1977 (Microdispidae). *Petalomium aggtelekiensis* Mahunka, 1977 and *P. simplisetum* Mahunka, 1986 are synonymized to *P. chmelnickensis* (Sevastianov, 1969), and *P. carelitschensis* (Sevastianov, 1967), respectively.

KEY WORDS: Acari, Neopygmephoridae, Microdispidae, Scutacaridae, phoresy, key, SEM microscopy.

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INTRODUCTION

Myrmecophiles—organisms that live alongside ants—are able to enter ant nests and gain access to the resources therein, while remaining relatively undetected by their hosts. Mites (Acari) are probably the most abundant and little-studied group of myrmecophiles. Pygmephoroid mites (Acari: Pygmephoroidea) comprise of the most numerous and poorly studied group of myrmecophilous Acari.

The superfamily *Pygmephoroidea* Cross, 1965 includes more than 1200 species in four families: Pygmephoridae Cross, 1965, Neopygmephoridae Cross, 1965, Microdispidae Cross, 1965, and Scutacaridae Oudemans, 1916 (Zhang *et al*. 2011). All pygmephoroid mites are probably fungivorous (Khaustov 2008), but some species of the family Microdispidae might be parasitoids of insects (Kaliszewski *et al*. 1995). Many pygmephoroid mites are associated with various insects and utilize them for phoresy (Kaliszewski *et al*. 1995). Members of Pygmephoridae, the early derivative family of Pygmephoroidea, are usually phoretic on Coleoptera and Diptera (Rahiminejad *et al*. 2015a), while Neopygmephoridae, Microdispidae, and Scutacaridae, which form a monophyletic group of derived pygmephoroid mites, are mainly phoretic on Hymenoptera, especially on various ants (Ebermann and Moser 2008; Khaustov 2008, 2014a, b). The pygmephoroid mites associated with particular species of ants are poorly studied. There is only one comprehensive study of pygmephoroid mites associated with the red imported fire ant, *Solenopsis invicta* Buren (Ebermann and Moser 2008; Khaustov and Moser 2008). There are numerous publications with the descriptions of various myrmecophilous pygmephoroid mites.

Berlese (1903) was the first who described several myrmecophilous pygmephoroid mites. Paoli (1911) in his review of the family Scutacaridae described several myrmecophilous species and redescribed Berlese's species. He also illustrated phoresy of *Scutacarus longisetus* on tibia I of worker of *Lasius flavus* (see figure 3 in Paoli 1913). Štorkán (1936) described two myrmecophilous species of *Scutacarus* from Bulgaria. Karafiat (1959) and Krczal (1959) described several myrmecophilus mites from Central Europe. Cross (1965) created myrmecophilous pygmephoroid genera *Acinogaster*, *Petalomium*, *Myrmecodispus*, *Perperipes*, *Glyphidomastax* and described several species from North and South America. Mahunka described numerous myrmecophilous pygmephoroid mites from Europe (Mahunka 1965, 1967, 1970a, b, 1977a, 1981; Mahunka and Mahunka-Papp 1980), North and South America (Mahunka 1970d; 1977b, c, 1983). Ebermann (1979) documented phoresy of *Scutacarus* sp. on the head of *Lasius flavus* worker using the SEM microscopy. He also described *Imparipes brevitarsus* associated with *Lasius flavus* in Austria (Ebermann 1981). Ebermann and Rack (1982) were the first to describe the biology of myrmecophilous mite *Petalomium fimbrisetum*. In these experiments, the mite was reared under laboratory conditions, and it could be observed that larvae and adult females feed by sucking the contents of hyphae of different fungi, which used to grow inside the ant nests (Ebermann and Rack 1982). Ebermann (1980) recorded a myrmecophilous scutacarid mite *Lophodispus irregularis* and described new species of *Thaumatopelvis* from North America. Metwali (1981) described several myrmecophilous pygmephoroid mites from

Poland. Kurosa described myrmecophilous scutacarid genus *Lophodispus* (Kurosa 1972), three new species of *Unguidispus* (Kurosa 1979), and two species of *Petalomium* (Kurosa 1986) from Japan. Ross and Cross (1979) provided a revision of myrmecophilous genus *Acinogaster*. Dobrev (1991, 1992) described several myrmecophilous scutacarid mites from Bulgaria. Ebermann and Krisper (2014) provided a list of myrmecophilous scutacarid mites associated with 22 ant species in Austria. During last years, several myrmecophilous pygmephoroid mites were described and recorded from Iran (Hajiqanbar and Khaustov 2013; Loghmani *et al*. 2014; Rahiminejad *et al*. 2015b; Abbasi-Moqadam *et al*. 2016). Khaustov (2015a) described two species of *Petalomium* from Ethiopia.

In the former USSR myrmecophilous pygmephoroid mites were studied by Sevastianov. He described mite community associated with *Lasius fuliginosus* (Sevastianov 1965). He also described numerous new species (Sevastianov 1967, 1969, 1974, 1981, 1983) and provided a key to pygmephoroid mites, including myrmecophilous species (Sevastianov 1978). Khydyrov (2007) described several myrmecophilous pygmephoroid mites from Turkmenistan. Khaustov (2006, 2008) described many species of myrmecophilous scutacarid mites from Crimea and Ukraine. He also described and recorded several species of *Petalomium* and *Caesarodispus* from Crimea (2005, 2009). Khaustov and Trach (2013) described a new species and redescribed two little-known species of *Petalomium* from Ukraine.

The pygmephoroid mites associated with ants are now intensively studied in Western Siberia, Russia (Khaustov 2014a, b, 2015b, c, 2016b, c). Pygmephoroid mite communities are already described for 3 species of ants, *Lasius flavus*, *L. fuliginosus* and *Formica fusca* (Khaustov 2015d, e, 2016a).

Based on this study, here we provided a list of myrmecophilous species of Western Siberia, their host specificity, mite communities associated with 12 species of ants, and keys to myrmecophilous pygmephoroid mites of the families Neopygmephoridae and Scutacaridae of the Palaearctic and keys to world species of the genera *Caesarodispus* Mahunka, 1977 and *Unguidispus* Mahunka, 1977 (Microdispidae).

MATERIAL AND METHODS

Ants were collected in vials with 96% ethanol. Thereafter, alcohol sediments from the vials were inspected for phoretic mites. Mites from ant nests were collected using Berlese funnels. All collected mites were mounted in Hoyer's medium. For SEM microscopy live ants were extracted from the soil using an aspirator, placed into a refrigerator and frozen at a temperature of -250°C; after that, ants with phoretic mites were selected and scanned without dusting. The terminology of the idiosoma and legs follows Lindquist (1986); the nomenclature of subcapitular setae and the designation of cheliceral setae follow Grandjean (1944, 1947), respectively. The system of Pygmephoroidea follows Khaustov (2004, 2008). All measurements are given in micrometres (μm). SEM photos were made with the aid of a JEOL–JSM-6510LV SEM microscope. Mite morphology was studied using a Carl Zeiss AxioImager A2 compound microscope with DIC and phase contrast objectives. Photomicrographs were taken with an AxioCam ICc5 digital camera. The comparison of mite communities was made using Sørensen index calculated by the formula $Qs=2a/b+c$, where *a*—number of common species in two compared communities, *b*—number of species in one community, *c*—number of species in another community.

Abbreviations

L. n.—*Lasius* (*Lasius*) *niger* (Linnaeus, 1758); L. f.—*Lasius* (*Cautolasius*) *flavus* Fabricius, 1781; L. u.—*Lasius* (*Chthonolasius*) *umbratus* Nylander, 1846; L. fu.—*Lasius* (*Dendrolasius*) *fuliginosus* (Latreille, 1798); T. c.—*Tetramorium caespitum* (Linnaeus, 1758); M. r.—*Myrmica ruginodis* Nylander, 1846; F. p.—*Formica* (*Formica*) *polyctena* Forster, 1850; F. r.—*Formica* (*Formica*) *rufa* Linnaeus, 1761; F. pr.—*Formica* (*Formica*) *pratensis* Retzius, 1783; F. f.—*Formica* (*Serviformica*) *fusca* Linnaeus, 1758; F. rb.—*Formica* (*Serviformica*) *rufibarbis* Fabricius, 1793; F. s.—*Formica* (*Raptiformica*) *sanguinea* Latreille, 1798.

RESULTS

During the study of pygmephoroid mites associated with ants in Western Siberia, 75 species of 6 genera and 3 families were recorded (Table 1). Among these species, 16 were described as new for science and 29 species are recorded in Russia for the first time (Table 1). Most of myrmecophilous pygmephoroid mites belong to the family Scutacaridae (55 species or 73%); Neopygmephoridae represented by 13 species (17%) and Microdispidae by 7 species (10%) (Fig. 1).

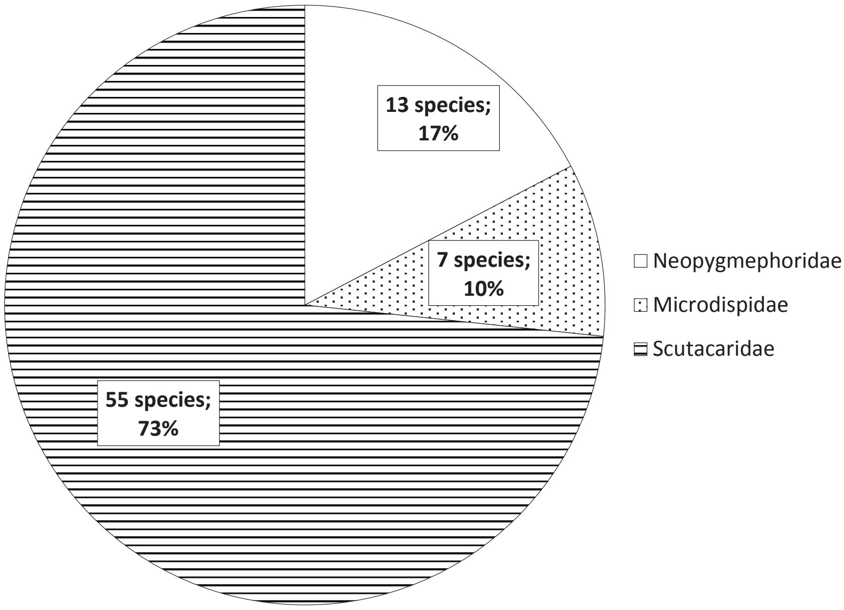

Fig 1. Number of known species of myrmecophilous pygmephoroid mites in Western Siberia.

The mite communities associated with particular species of ants are highly variable. Among the 12 most abundant species of ants of Western Siberia, the richest mite communities are associated with soil-nesting species of the genus *Lasius* (Table 1; Fig. 2). The maximum number of species in mite community is found in association with *Lasius niger* (24), while the minimum number of species (4) is associated with two species: *Formica rufibarbis* and *F. sanguinea*. The reasons, why there is an uneven distribution of species in mate communities associated with particular ant species, are not yet clear. Probably nests of soil-nesting *Lasius* species provide optimal conditions for growth of various fungi, the source of food for the pygmephoroid mites.

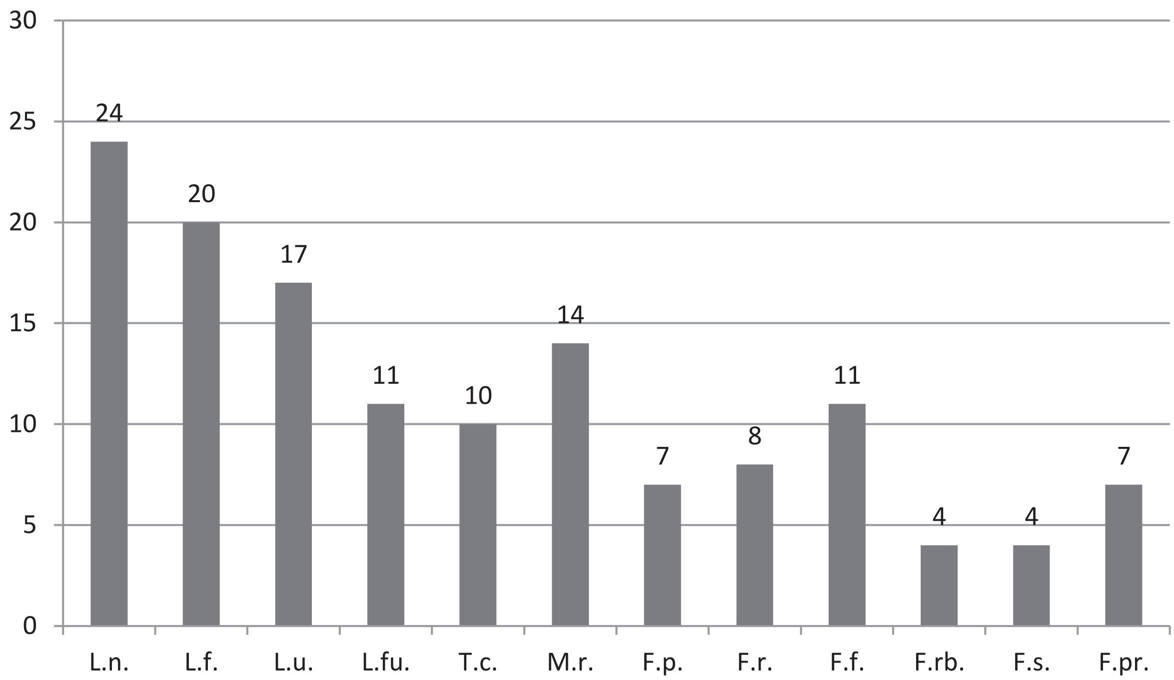

Fig. 2. Number of species of myrmecophilous pygmephoroid mites associated with most abundant species of ants of Western Siberia.

Comparison of mite communities and host specificity

In this study we provided a comparison of mite communities associated with 12 most abundant ant species of Western Siberia using Sørensen index (Table 2). The comparison revealed high specificity of mite communities for most ant species. The highest indices are found when compared mite communities associated with *Formica* species (0.55–0.80). Relatively high indexes are found when compared mite communities associated with *Lasius* species, especially between *L. flavus* and *L. umbratus* (0.43). Mite communities associated with *Tetramorium caespitum* and *Myrmyca ruginodis* are highly specific and share some similarities only with mite community of *Lasius niger*. High specificity of mite communities associated with ants suggests coevolution between some lineages of mites and host ants.

Many of recorded mite species are currently known as monospecific: *Unguidispus japonicus*, *Petalomium crinitus*, *Scutacarus expectatus* associated with *Lasius niger*; *Petalomium tothi*, *Imparipes brevitarsus*, *Scutacarus insolitus*, *S. molnari*, *S. moseri*, *S. ponticulus*, *S. sibiriensis*, *S. tutus* associated with *Lasius flavus*; *Caesarodispus brevipes*, *Petalomium brevicaudus*, *P. kurganiensis*, *Imparipes tomentosus*, *Scutacarus aequalis*, *S. flexisetosimilis* associated with *Lasius umbratus*; *Unguidispus contematosus*, *Imparipes brevibasis*, *I. fuliginosophilus*, *I. sevastianovi*, *Scutacarus flexisetus* associated with *Lasius fuliginosus*; *Imparipes hortobagyensis*, *I. imaginatus*, *I. parapicolasimilis*, *Scutacarus claviger* associated with *Tetramorium caespitum*; *Scutacarus myrmicinus* associated with *Myrmica ruginodis*; *Scutacarus karafiati* associated with *Formica fusca*. Monospecificity among myrmecophilous pygmephoroid mites is probably rare phenomenon. More studies of these mites revealed association of previously “monospecific” species with other ants. For example, *Unguidispus lasii* is highly specific to *Lasius niger* in Japan and Western Siberia (Khaustov 2014b), but recently was recorded in Crimea on *Lasius flavus* (Khaustov 2015d); *Scutacarus heterotrichus* described from *Ladius flavus* in Western Siberia (Khaustov 2015d) recently recorded on *Lasius fuliginosus* (present study), etc. So monospecific myrmecophilous pygmephoroid mites are potentially oligospecific. Most of myrmecophilous pygmephoroid mites are oligospecific to several, usually closely related, phoretic hosts. For example some of species recorded in this study as associates of *Myrmica ruginodis* (*Imparipes charkoviensis*, *I. comatosimilis*, *Scutacarus latus*, *S. myrmecophilus*, *S. ovoideus*) are associated with several species of *Myrmica* (Metwali 1981; Khaustov 2008; present study). *Caesarodispus samsinaki* and *Unguidispus polyctenus* are associated with *Formica* s. str. (*F. polyctena*, *F. pratensis*, *F. rufa*, *F. aquilonia*); *Imparipes nescius*, *Scutacarus pilatus*, *S. rotundus* and *S. atypicus* are associated with several *Formica* species (Table 1). *Imparipes robustus* is associated with *Formica* and *Camponotus* species (Khaustov 2008). *Scutacarus lasiophilus* and *S. longisetus* are associated with ants of the genus *Lasius* (Table 1). Some myrmecophilous pygmephoroid mites explore a wide range of phoretic hosts. This group of mites includes most species of *Petalomium*, *Imparipes obsoletus*, *Lophodispus irregularis*, *Scutacarus pseudospinosus* (Table 1).

Attachment site specificity

It was found that only adult females of pygmephoroid mites are phoretic on ants. Mites are phoretic on winged ants and workers. Some pygmephoroid mites have specific sites of attachment on ants during phoresy. *Petalomium*, most of *Imparipes* and some *Scutacarus* species are usually attached between coxae of ants (Figs. 3D, F). Microdispid mites of the genera *Unguidispus* and *Caesarodispus* are usually located on lateral surfaces of ant thorax (Figs. 3A, B) as recorded for *Unguidispus contematosus* Sevastianov, 1981 on ant *Lasius fuliginosus* (Khaustov 2015d, 2016a). *Scutacarus atypicus* is phoretic on anterior surface of the ant abdomen (Figs. 4C–F). *Scutacarus sibiriensis* attaches to head of *Lasius flavus* (Figs. 5C, D); similar attachment of *Scutacarus* sp. was documented by Ebermann (1979). Some species have no specific attachment sites. For example, *Imparipes obsoletus* and *Scutacarus longisetus* attach to various parts of the ant body (legs, abdomen, coxae, etc) (Figs. 3C, E, 5A, B). *Scutacarus pseudospinosus* is found phoretic on tibia of leg I of *Lasius niger* (Fig. 6A, B). Many scutacarid species are phoretic on lateral parts of ant abdomen. Such phoretic attachment found in *Scutacarus spinosus*, *S. molnari*, *S. lasiophilus* (Figs. 5E, F, 6C–F). Specificity of site attachment is unknown for most recorded mites and its clarification requires further studies.

Notes on synonymy of *Petalomium* species.

The study of female paratype of *Petalomium chmelnickensis* (Sevastianov, 1969) revealed that it

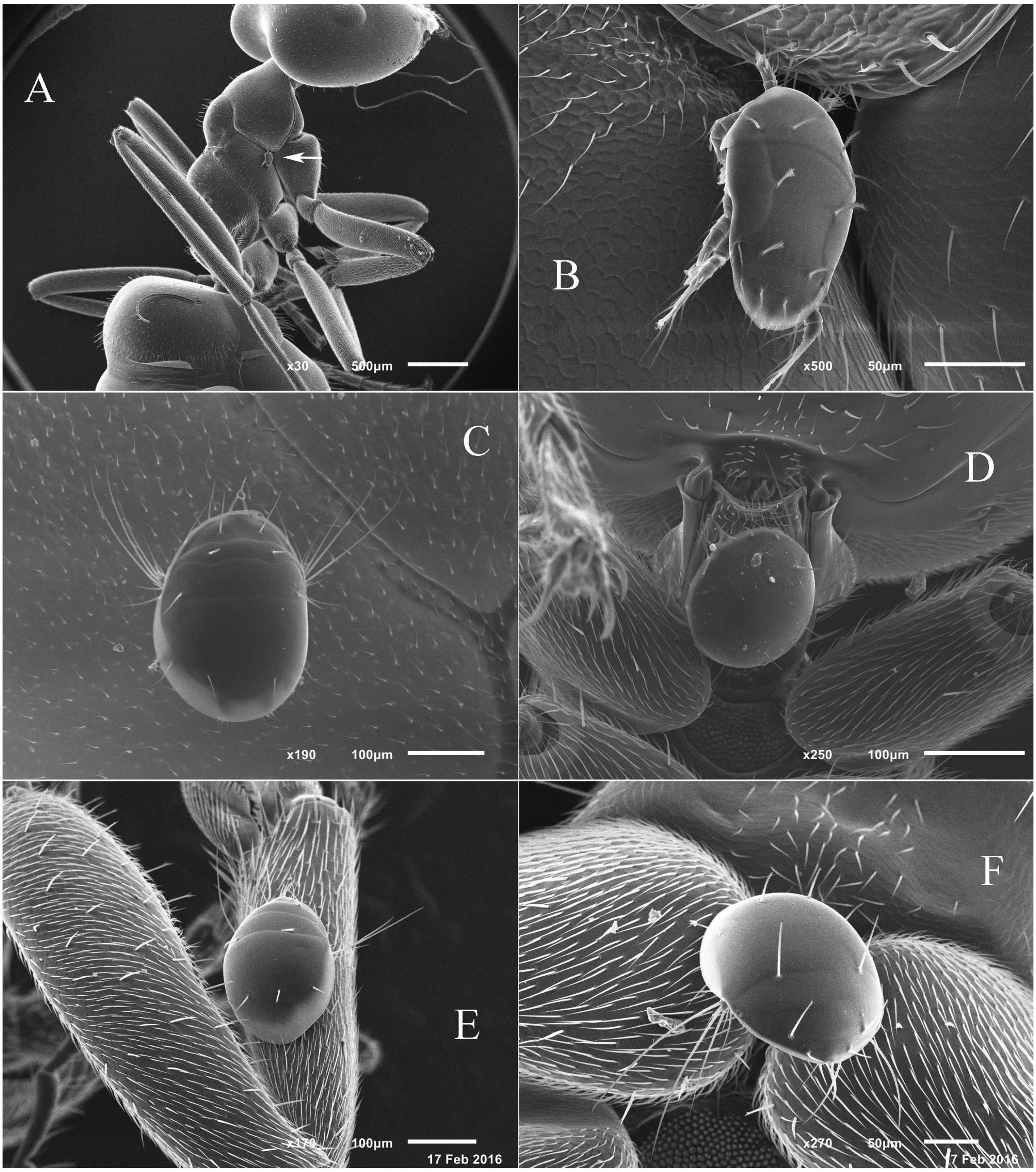

Fig. 3. SEM photos of females of pygmephoroid mites phoretic on ants: A—*Unguidispus contematosus* Sevastianov, 1981 on worker of *Lasius fuliginosus*, general view, B—*Unguidispus contematosus* on worker of *Lasius fuliginosus*, detailed view, C—*Imparipes obsoletus* Rack, 1966 on the wing of male of *Lasius flavus*, D—*Scutacarus ponticulus* Mahunka, 1981 between coxae of worker of *Lasius flavus*, E—*Scutacarus longisetus* (Berlese, 1904) on tibia I of worker of *Lasius umbratus*, F—*Scutacarus longisetus* (Berlese, 1904) on coxae of worker of *Lasius umbratus*.

is conspecific to *P. aggtelekiensis* Mahunka, 1977. Both species are characterized by smooth and thickened basally setae 3*a*, 3*b*, 4*a,* and unusual position of solenidion φ_2 distinctly anterior to φ_1. In spite of relatively bad condition of the paratype of *P. chmelnickensis*, location of the solenidion φ_2 (Fig. 7), shape and lengths of idiosomal setae and leg setation are visible. We found that female paratype of *P. chmelnickensis* does not differ from description of *P. aggtelekiensis,* and here we consider *P. aggtelekiensis* as junior synonym of *P. chmelnickensis.*

The study of numerous specimens of *Petalomium carelitschensis* (Sevastianov, 1967), including one female paratype, revealed that it is conspe-

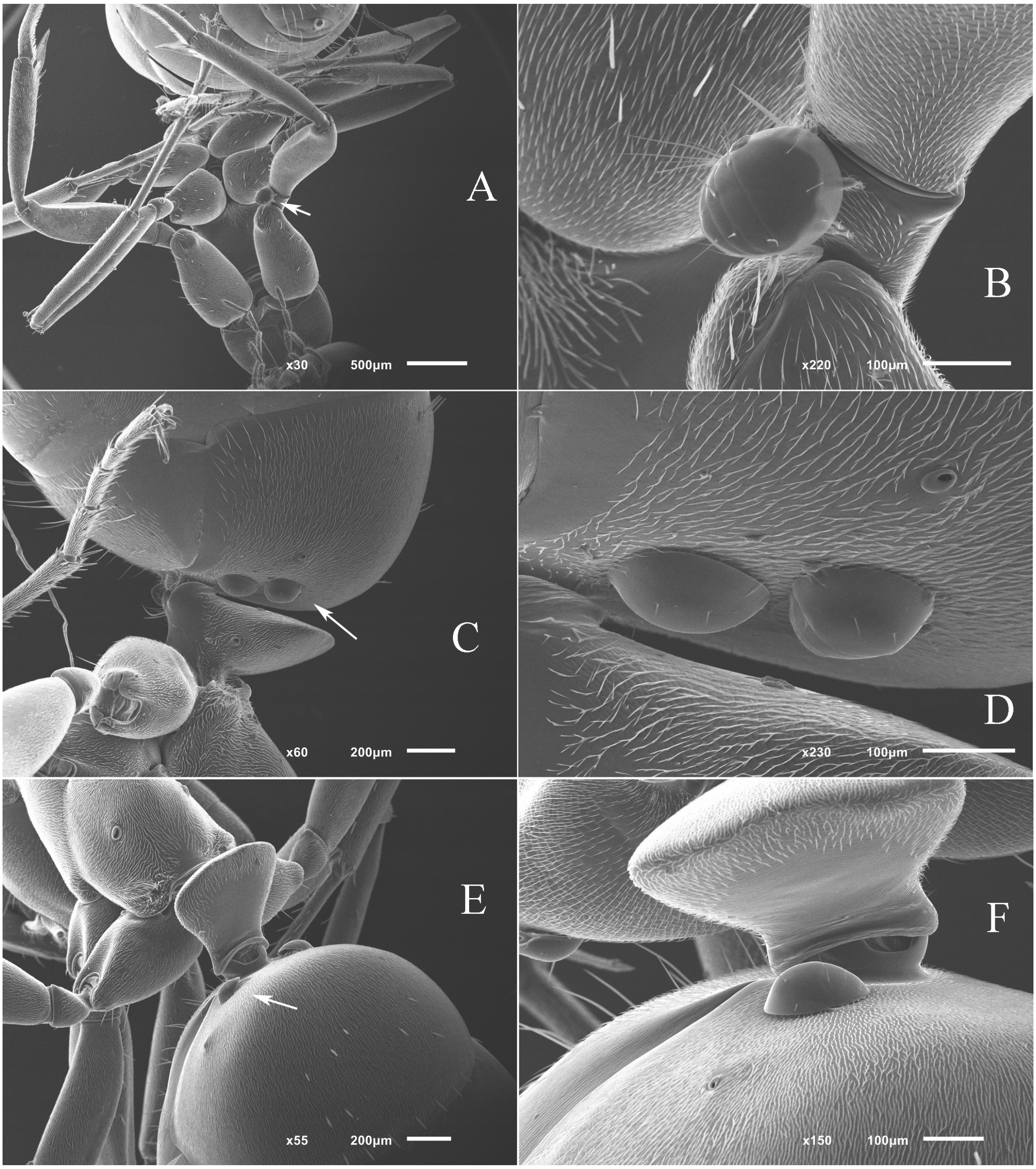

Fig. 4. SEM photos of females of scutacarid mites phoretic on workers of *Formica fusca*: A—*Imparipes* sp. on coxa, general view, B—*Imparipes* sp. on coxa, detailed view, C–F—*Scutacarus atypicus* (Karafiat, 1959) on anterior surface of the abdomen, C, E—general view, D, F—detailed view.

cific to *P*. *simplisetum* Mahunka, 1986. We found that female paratype of *P. carelitschensis* does not differ from the description of *P*. *simplisetum,* and here we consider *P*. *simplisetum* as junior synonym of *P. carelitschensis.*

Key to families of the superfamily Pygmephoroidea (females)

1. Femur I with 4 setae; prodorsum usually with 3 pairs of setae; cupules *im* present; eupatidium *p′* on tarsus I present; coxal fields I with 3 pairs of setae, very rarely, with 1–2 pairs; in the latter case, prodorsum with 3 pairs of setae. Tarsus and tibia I frequently divided .... Pygmephoridae Cross, 1965 (= Siteroptidae). Only 1 species, *Dudichiana foveolata* Mahunka, 1970 has been recorded in ant nest in Hungary (Mahunka 1970b).

— Femur I with 3 or less setae; prodorsum with 1–2 pairs of setae; cupules *im* absent; eupatidium

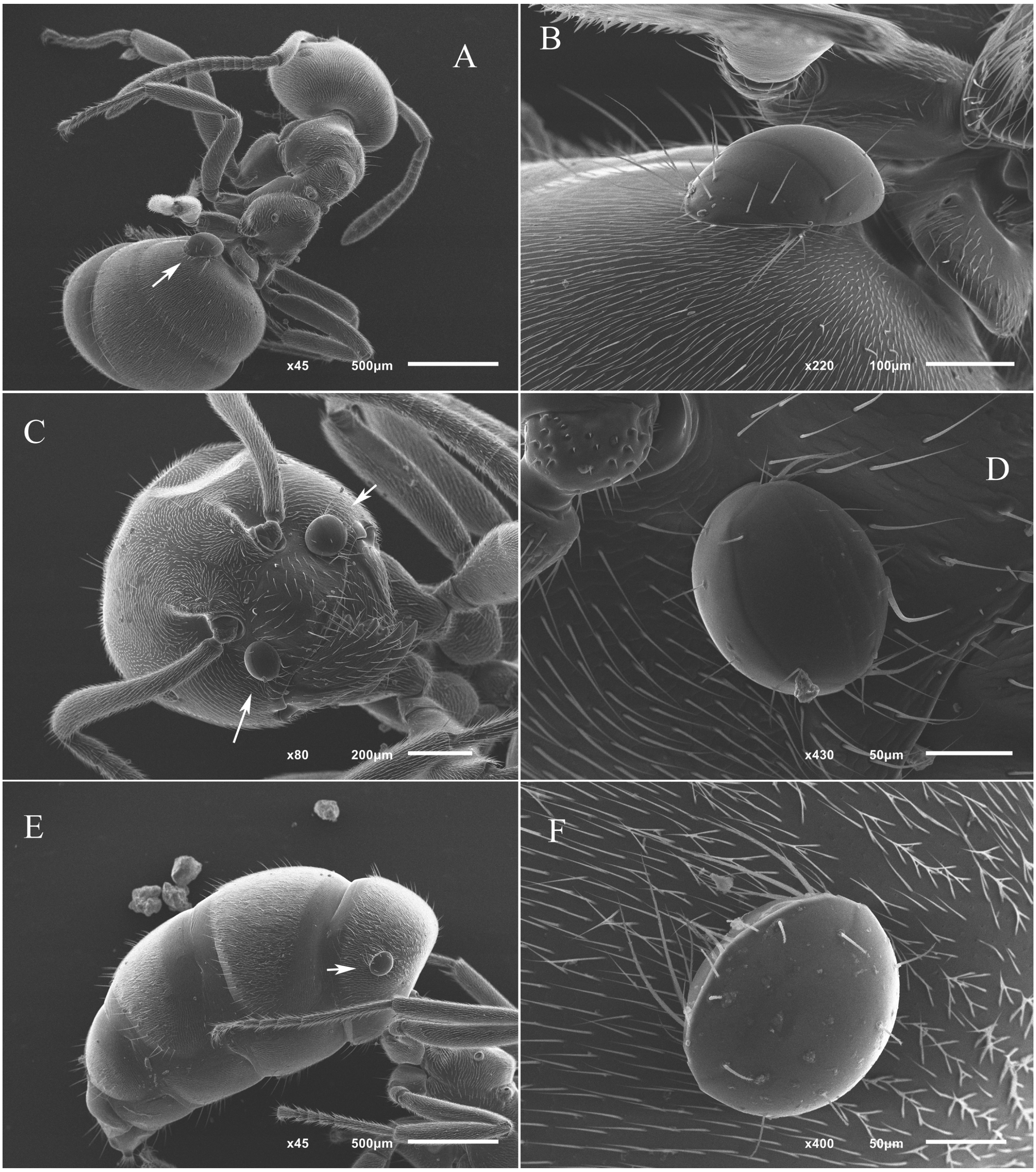

Fig. 5. SEM photos of females of scutacarid mites phoretic on workers of *Lasius flavus*: A, B—*Imparipes obsoletus* Rack, 1966 between petioles and abdomen, A—general view, B—detailed view, C, D—*Scutacarus sibiriensis* Khaustov, 2015 on anterior surface of the head, C—general view, D—detailed view, E, F—*Scutacarus molnari* Mahunka, 1981 on lateral surface of the abdomen, E—general view, F—detailed view.

p′ on tarsus I absent; coxal fields I with 2 pairs of setae. Tarsus and tibia I always fused into tibiotarsus ....2.

2. Tergite C strongly expanded, forming longitudinally striated free margins covering prodorsum; prodorsum usually with lateral spine-like outgrowth posterior to trichobothria .... Scutacaridae Oudemans, 1916.

— Tergite C not expanded, without free margins; prodorsum without lateral spine-like outgrowth posterior to trichobothria...................................3.

3. Prodorsum with a single pair of setae sc_2; occasionally, alveoli of setae v_2 also present; seta *d* on femur I unmodified ....Microdispidae Cross, 1965.

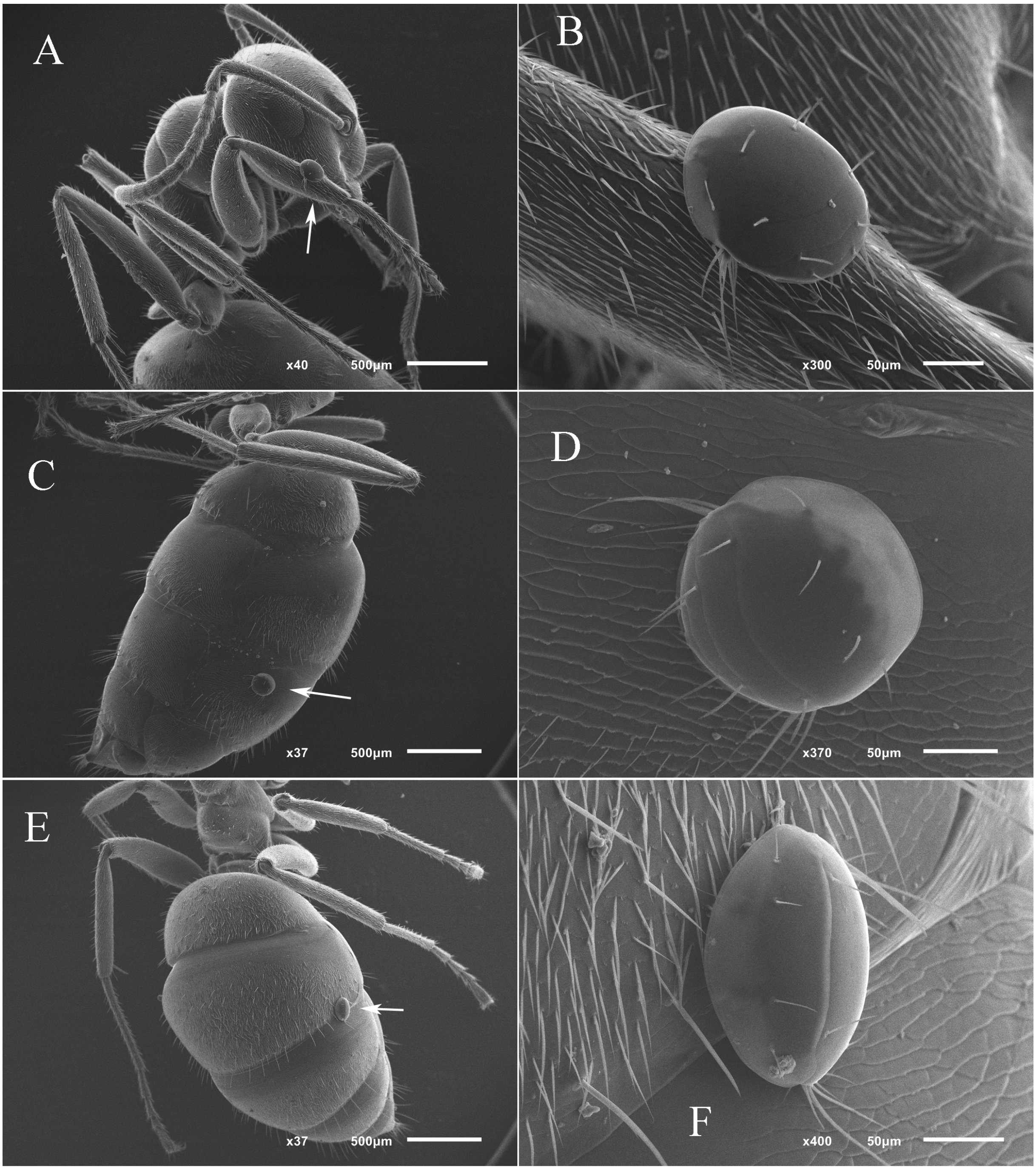

Fig. 6. SEM photos of females of scutacarid mites phoretic on workers of *Lasius niger*: A, B—*Scutacarus pseudospinosus* Khaustov, 2008 on tibia I, A—general view, B—detailed view, C, D—*Scutacarus spinosus* Štorkán, 1936 on lateral surface of the abdomen, C—general view, D—detailed view, E, F—*Scutacarus lasiophilus* Khaustov, 2015 on lateral surface of the abdomen, E—general view, F—detailed view.

— Prodorsum with 2 pair of setae v_2 and sc_2, vary rarely (in genus *Allopygmephorus* seta v_2 absent), seta *d* on femur I usually modified, hook-like or spatulate, vary rarely (in genus *Zambedania*) elongated and roughly serrate .... Neopygmephoridae Cross, 1965.

Key to myrmecophilous genera of Microdispidae of the Palaearctic (females)

1. Tibiotarsus I with claw, trochanter IV anterodorsally with short spine-like process .... *Unguidispus* Mahunka, 1970

— Tibiotarsus I without claw, trochanter IV anterodorsally rounded .... *Caesarodispus* Mahunka, 1977

Fig. 7. DIC photo of leg I of female paratype of *Petalomium chmelnickensis* (Sevastianov, 1969).

Key to world species of the genus *Unguidispus* (females)

1. All dorsal hysterosomal setae unmodified 2
— At least setae on tergites C and D widened distally, flattened and heavily barbed 3
2. Setae c_1, *d*, and *f* thin and smooth, without arch-like ridges anteriorly to setae *f*............................. .... *U. okumurai* Kurosa, 1979. Japan. On *Lasius hayashi.*
— All dorsal hysterosomal setae strongly barbed, with arch-like ridges anteriorly to setae *f*............. .... *U. polyctenus* (Sevastianov, 1969). Ukraine, Austria, Hungary, Russia. On *Formica rufa*, *F. polyctena, F. aquilonia.*
3. Seta *s* of tibiotarsus I present 4
— Seta *s* of tibiotarsus I absent............................ .... *U. contematosus* Sevastianov, 1981. Ukraine, Russia. On *Lasius fuliginosus.*
4. Setae *e* distinctly thickened, subequal to or longer than *f* 5
— Setae *e* not thickened, distinctly shorter than *f* ....*U. lasii* Kurosa, 1979. Japan, Russia. On *Lasius niger*, *L. flavus*, *L. hayashi.*
5. Setae h_2 pointed, setae *d* distinctly thicker than *f*, trichobothria sphaerical..................................... ....*U. japonicas* Kurosa, 1979. Japan, Russia. On *Lasius niger.*
— Setae h_2 widened distally, setae *d* as thick as *f*, trichobothria pointed distally..................................... ....*U. stammeri* Mahunka, 1970. Hungary. In ant nest.

Key to world species of the genus *Caesarodispus* (females)

1. Hysterosomal tergites not reticulated, femur II with 3 setae 2
— Hysterosomal tergites distinctly reticulated, femur II with 2 setae (*v″* absent) .... *C. samsinaki* (Mahunka, 1967). Czech Republic, Ukraine, Belarus, Russia. On *Formica rufa, F. polyctena, F. pratensis*.
2. Setae *v′* of genu I not thickened, pointed 3
— Setae *v′* of genu I distinctly thickened, widened distally, strongly barbed .... *C. pusillus* Khaustov, 2009. Crimea. In the nest of *Crematogaster schmidti*.
3. Setae *d* no more than 1.5 times longer than *f* 4
— Setae *d* about 4 times longer than *f* ....*C. klepzigi* Khaustov and Moser, 2008. USA. On *Solenopsis invicta*.
4. Seta *d* of tibia IV long, reaching beyond tip of pretarsus IV 5
— Seta *d* of tibia IV shorter, not reaching beyond tip of pretarsus IV 7
5. Solenidion ω_2 of tibiotarsus I present, setae ps_2 absent 6
— Solenidion ω_2 of tibiotarsus I absent, tiny setae ps_2 present .... *C. brevipes* Mahunka, 1986. Hungary, Russia. In ant nest, on *Lasius umbratus*.
6. Posterior part of aggenital plate smooth 7
— Posterior part of aggenital plate with distinct reticulate microsculpture .... *C. pheidolei* Rahiminejad and Hajiqanbar, 2015. Iran. On *Pheidole* sp.
7. Seta *d* of femur IV subequal to or longer than *tc″* of tarsus IV 8
— Seta *d* of femur IV more than 2 times shorter than *tc″* of tarsus IV ..... *C. gaius* Mahunka, 1977. France. On *Myrmica sabuleti*.
8. Seta *d* of femur IV subequal to *tc″* of tarsus IV, seta *d* of tibia IV sparsely barbed .... *C. nodijensis* Rahiminejad and Hajiqanbar, 2015. Iran. On *Tetramorium* sp.
— Seta *d* of femur IV distinctly longer than *tc″* of tarsus IV, seta *d* of tibia IV densely barbed ....*C. modestus* (Berlese, 1903). Italy, Russia (Crimea). On *Messor* spp.
9. Posterior part of aggenital plate smooth 10
— Posterior part of aggenital plate distinctly reticulated .... *C. shandizensis* Loghmani and Hajiqanbar,2014. Iran. On *Temnothorax* sp.
10. Setae *f* distinctly longer than distance *f–f* ... 11
— Setae *f* shorter than distance *f–f* .... *C. acuminatus* (Sevastianov, 1981). Ukraine. On *Tetramorium caespitum*.
11. Distance between setae h_1 subequal to distance h_1–h_2 .... *C. minutus* (Sevastianov, 1981). Ukraine, Iran, Russia. On *Tetramorium caespitum*, *Lasius flavus*, *Temnothorax* sp.
— Distance between setae h_1 about 2.5 times longer than distance h_1–h_2 .... *C. khaustovi* Rahiminejad and Hajiqanbar, 2015. Iran. On *Tetramorium* sp.

Key to Palaearctic myrmecophilous genera of the family Neopygmephoridae (females)

1. At least setae 1*a* and 2*a* on anterior sternal plate modified: with swollen base, sword-like, etc. .... *Acinogaster* Cross, 1965
— Setae of anterior sternal plate not modified, sometimes 1*b* bifurcate .... *Petalomium* Cross, 1965

Key to Palaearctic subgenera and species of the genus *Acinogaster* (females)*

1. Bases of setae c_1 swollen .... subgenus *Formicisocius* Ross and Cross, 1979. In Palaearctic 1 species: *A.* (*F.*) *microchaetosus* (Sevastianov, 1967). Ukraine, Iran, Russia (Crimea). On *Tetramorium caespitum*.
— Setae c_1 not modified....................................... ...subgenus *Archacinogaster* Ross and Cross, 1979. In Palaearctic 1 species: *A.* (*A.*). *tumidisetosus* (Willmann, 1951) **comb. nov**. Central Europe, Russia (Crimea). On *Lasius* sp.

Key to Palaearctic myrmecophilous species of the genus *Petalomium* (females)

1. Setae 4*b* not modified 4
— Setae 4*b* sword-like or with swollen basal part 2
2. Setae 4*b* sword-like 3
— Setae 4*b* and other setae of posterior sternal plate with distinctly swollen basal part, distally pointed .... *P. messori* Khydyrov, 2007. Turkmenistan.
On *Messor excursionis*, *M. variabilis*.

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*We did not include *Petalomium genavensium* Mahunka, 1977, which is a potential synonym of *Acinogaster tumidisetosus* having similar modified setae. In *P. genavensium* setae 1*a* and 2*a* thickened basally, but not triangularly. The study of the type material of *Petalomium genavensium* is required.

3. Other setae of posterior sternal plate not modified .... *P. camponoti* Hajiqanbar and Khaustov, 2013. Iran. On *Camponotus buddhae*.
— Setae 3*c* and 4*c* also sword-like .... *P. margushensis* Khydyrov, 2007. Turkmenistan.
4. Seta *v′* of tibia IV modified, lanceolate 5
— Seta *v′* of tibia IV not modified 6
5. Setae h_1 and h_2 densely covered by numerous and thin barbs (pubescent), other dorsal setae sparsely barbed .... *P. crinitus* Khaustov and Trach, 2013. Ukraine, Russia. On *Lasius niger*.
— All dorsal setae sparsely barbed .... *P. lancetochaetosus* Sevastianov, 1974. Ukraine. On *Lasius umbratus*.
6. Setae h_2 densely barbed, differ from other sparsely barbed dorsal hysterosomal setae 7
— Setae h_2 sparsely barbed 11
7. Setae ps_1 and ps_2 subequal 8
— Setae ps_1 distinctly longer and thicker than ps_2 .... *P. heterotrichus* Mahunka, 1970. Czech Republic. On *Camponotus vagans*.
8. Setae *f* subequal or longer than h_1 and distinctly longer than *e* 9
— Setae *f* distinctly shorter than h_1 and slightly longer than *e* ..... *P. nataliae* (Sevastianov, 1967). Ukraine, Byelorussia, Russia, Switzerland, Hungary, Japan. Mainly on *Lasius niger*.
9. Setae 1*b* bifurcate 10
— Setae 1*b* not bifurcate .... *P. rarus* (Sevastianov, 1967). Ukraine, Russia. On *Lasius* sp., *Formica rufibarbis*.
10. Setae *d* and c_2 subequal, setae *d* shorter than distance between their bases .... *P. kurosai*, Khaustov, 2014. Russia. On *Lasius niger*, *L. flavus*, *Tetramorium caespitum*, *Myrmica ruginodis*.
— Setae *d* distinctly longer than c_2, setae *d* distinctly longer than distance between their bases .. .. *P. formicarum* (Berlese, 1903). Palaearctic. On various *Formica*.
11. Setae 3*b* and 4*b* usually not thickened, if slightly thickened in basal half than relatively long, 3*b* reaching beyond bases of 4*b* 12
— Setae 3*b* and 4*b* short and swollen in basal half, 3*b* not reaching bases of 4*b* ....*P. sawtschuki* (Sevastianov, 1967). Palaearctic. On *Myrmica ruginodis*, *M. rubra*.
12. Setae 1*b* bifurcate 13
— Setae 1*b* not bifurcate 21
13. Setae ps_1–ps_3 very short, at least 3 times shorter than 4*b* 14
— At least setae ps_1 long, subequal to 4*b* or slightly shorter 15
14. Setae ps_1–ps_3 widened, foliate; solenidion ω_1 with swollen basis ....*P. foliiger* (Mahunka and Mahunka-Papp, 1980). Hungary, Russia (Crimea).
— Setae ps_1–ps_3 thin, not modified; solenidion ω_1 not swollen .... *P. brevisetum* Khaustov, 2005. Russia (Crimea). On *Formica gagates*.
15. Setae ps_1 and ps_2 subequal, setae ps_3 very short, vestigial 16
— Setae ps_1 distinctly longer and thicker than ps_2, setae ps_3 not vestigial 17
16. Setae ps_1 and ps_2 with long, rough barbs ....*P. aleinikovae* (Sevastianov, 1967). Ukraine, Russia. On *Lasius flavus*, *Myrmica ruginodis*.
— Setae ps_1 and ps_2 with short, thin barbs .... *P. scyphicum* (Sevastianov, 1967). Palaearctic. On *Lasius niger*, *L. fuliginosus*, *L. alienus*.
17. Setae sc_2 distinctly shorter than h_2 18
— Setae sc_2 subequal to h_2 .... *P. gottrauxi* Mahunka, 1977. Switzerland, Hungary, Iran, Russia (Crimea). On *Myrmica ruginodis*, *Camponotus aethiops*.
18. Setae ps_2 distinctly shorter than ps_3 19
— Setae ps_2 and ps_3 subequal .... *P. tauricum* Khaustov, 2006. Russia (Crimea). On *Formica gagates*.
19. Setae *e* longer than h_2 20
— Setae *e* shorter than h_2 .... *P. hauseri* Mahunka, 1972. Greece.
20. Setae ps_1 about two times longer than ps_3 .... *P. podolicus* (Sevastianov, 1967). Palaearctic. On *Lasius fuliginosus*, *L. niger*, *Formica rufa*, *Myrmica rubra*, *M. ruginodis*.
— Setae ps_1 about three times longer than ps_3 .... *P. macrotrichosum* Mahunka, 1971. Korea.
21. Hysterosomal tergites smooth 22
— Hysterosomal tergites with scale-like microsculpture .... *P. volgini* (Sevastianov, 1967). Ukraine. On *Lasius* sp.
22. Setae ps_3 very short, vestigial 23
— Setae ps_3 well developed 25
23. Setae $ps_{1,2}$ smooth 24
— Setae $ps_{1,2}$ strongly barbed .... *P. myrmecophilus* (Mahunka, 1965). Hungary.

24. Setae *f* and h_1 subequal .... *P. chaetosus* (Krczal, 1959). Germany. On *Lasius flavus*.
— Setae *f* distinctly longer than h_1 ....*P. fimbrisetum* Ebermann and Rack, 1982. Austria, Hungary, Russia. On *Lasius flavus*, *L. umbratus*.
25. All pseudanal setae smooth 26
— At least setae ps_1 distinctly barbed 27
26. Setae ps_1 and ps_2 subequal, solenidion ω_2 about 2 times shorter than ω_1 .... *P. kurganiensis* Khaustov, 2016. Russia. On *Lasius umbratus*.
— Setae ps_1 distinctly longer than ps_2, solenidion ω_2 almost as long as ω_1 ....*P. brevicaudus* Khaustov, 2016. Russia. On *Lasius umbratus*.
27. Setae 3*a*, 3*b* and 4*a* smooth, widened in basal half 28
— Setae 3*a*, 3*b,* and 4*a* barbed, not widened in basal half 29
28. Solenidion φ_2 situated on the same level as φ_2 .... *P. fuliginosum* Khaustov, 2016. Russia. On *Lasius fuliginosus*.
— Solenidion φ_2 situated distinctly anteriad to φ_2.. .... *P. chmelnickensis* (Sevastianov, 1969) (=*P. aggtelekiensis* Mahunka, 1977 **syn. nov**.). Ukraine, Hungary. On *Lasius fuliginosus*.
29. Setae ps_1 and ps_2 subequal 30
— Setae ps_1 distinctly longer than ps_2 31
30. Bases of setae ps_1 situated very close to each other, setae *f* very long, about three times longer than *e* ...... *P. carelitschensis* (Sevastianov, 1967) (=*P. simplisetum* Mahunka. 1986 **syn. nov**.). Palaearctic. On *Myrmica ruginodis*, *Lasius niger*, *L. flavus*, *L. umbratus*, *L. fuliginosus*, *L. alienus*.
— Bases of setae ps_1 well separated, setae *f* shorter than *e* .... *P. tothi* Mahunka and Zaki, 1984. Hungary, Russia. On *Lasius flavus*.
31. Solenidia ω_1 and ω_2 subequal 32
— Solenidion ω_1 more than 2 times longer than ω_2 .... *P. pseudomyrmecophilus* Mahunka, 1970. Hungary, Ukraine.
32. Setae ps_1 about 2 times longer than ps_2 .... *P. aculeatum japonicum* Kurosa, 1986. Japan. On *Camponotus abscuripes hemichlaena*.
— Setae ps_1 about 3 times longer than ps_2 .... *P. kurosawai* Kurosa, 1986. Japan. On *Formica japonica*.

Key to Palaearctic myrmecophilous genera of the family Scutacaridae (females)

1. Leg IV 5-segmented (tibia and tarsus separated) 2
— Leg IV 4-segmented (tibia and tarsus fused) .. .. *Scutacarus* Gros, 1845
2. Anterior margin of anterior sternal plate with "crown" of thin processes .... *Lophodispus* Kurosa, 1972
— Anterior margin of anterior sternal plate smooth 3
3. Tarsus IV gradually tapering to the apex, phoretic females with massive tibiotarsus I and large claw ....*Archidispus* Karafiat, 1959. In Palaearctic only 1 species, *A. intermissus* (Karafiat, 1959) recorded on *Lasius fuliginosus* in Germany.
— Tarsus IV with expanded base and abruptly becoming thin distally*,* claw on tibiotarsus I usually of middle size .... *Imparipes* Berlese, 1903

Key to Palaearctic myrmecophilous species of the genus *Lophodispus* (females)

1. Solenidion of tibia IV very long, reaching beyond tip of pretarsus IV .... *L. bulgaricus* Dobrev, 1992. Bulgaria, Austria, Ukraine.
— Solenidion of tibia IV very short, difficult to discern .... *L. irregularis* (Mahunka, 1971). Holarctic. On *Lasius niger*, *L. alienus*, *L. brunneus*, *Tetramorium caespitum*.

Key to Palaearctic myrmecophilous species of the genus *Imparipes* (females)

1. Tarsus IV distally very short, pretarsus IV absent 2
— Tarsus IV distally long and thin, pretarsus IV present 3
2. Setae c_1, c_2, *d*, and *f* widened distally, setae 4*a* and 4*b* situated on the same transverse level ....*I. brevibasis* (Sevastianov, 1983). Ukraine, Russia. On *Lasius fuliginosus*.
— Setae c_1, c_2, *d*, and *f* not modified, setae 4*a* situated distinctly anteriorly to 4*b* .... *I. obsoletus* Rack, 1966. Holarctic. On *Lasius niger*, *L. flavus*, *L. umbratus*, *L. fuliginosus*, *L. alienus*, *Formica rufibarbis*, *F. fusca*, *Messor* sp.
3. Posterior sternal plate at least with 1 pair of pinnate setae 4
— Posterior sternal plate without pinnate setae 5

4. Only setae 3*a* pinnate .... *I. pennatus* Karafiat, 1959. Central Europe. On *Formica rufa*.
— All setae of posterior sternal plate pinnate .... *I. mordax* Khaustov, 2008. Russia (Crimea). On *Lasius* sp.
5. Setae 4*b* present 6
— Setae 4*b* absent .... *I. bisetus* Khaustov, 2008. Russia (Crimea). On *Lasius alienus*.
6. Posterior margin of tergite C evenly rounded, setae ps_3 longer or subequal to ps_2 7
— Posterior margin of tergite C straight, setae ps_3 almost 2 times shorter than ps_2 .... *I. robustus* Karafiat, 1959. Palaearctic. On *Lasius fuliginosus*, *Formica rufa*, *F. fusca*, *F. polyctena*, *F. patensis*, *F. aquilonia*, *F. rufibarbis*, *F. sanguinea*, *F. gagates*, *Camponotus aethiops*, *Tetramorium caespitum*.
7. Setae 4*a* smooth 8
— Setae 4*a* barbed 13
8. Distance between setae h_1 longer or equal to distance between setae *f* 9
— Distance between setae h_1 distinctly shorter than distance between setae *f* 10
9. Setae *d*, *f* and h_1 very long, *d* reaching far beyond posterior margin of the body .... *I. obstinatus* Khaustov, 2008. Russia (Crimea). On *Aphaenogaster* sp.
— Setae *d*, *f* and h_1 much shorter, *d* not reaching posterior margin of the body................................ .... *I. quaesitus* Khaustov, 2008. Russia (Crimea), Ukraine (Odessa province). On *Myrmica* sp.
10. Setae 4*b* barbed 11
— Setae 4*b* smooth ..... *I. nugax* Khaustov, 2008. Ukraine, Russia (Crimea). On *Formica rufa*.
11. Setae *f* longer than h_1, apodemes 5 not fused with poststernal apodeme 12
— Setae *f* subequal to h_1, apodemes 5 fused with poststernal apodeme .... *I. comatus* Mahunka, 1970. Hungary, Russia (Crimea). On *Tapinoma erraticum*, *Myrmica rubra*, *Tetramorium caespitum*, *Lasius niger*.
12. Setae ps_1 and ps_2 subequal .... *I. hortobagyensis* Mahunka, 1981. Hungary, Russia. On *Tetramorium caespitum*.
— Setae ps_1 about 2 times longer than ps_2 ....*I. imaginatus* Mahunka, 1981. Hungary, Austria, Russia. On *Tetramorium caespitum*, *Lasius flavus*.
13. Pretarsus IV with minute claws, seta *u′* of tarsus IV not reaching beyond pretarsus IV 14
— Pretarsus IV without claws, seta *u′* of tarsus IV reaching beyond pretarsus IV .... *I. brevitarsus* Ebermann, 1981. Austria, Russia. On *Lasius flavus*.
14. Setae 4*a* situated on the same transverse level with 4*b* 15
— Setae 4*a* situated distinctly anteriorly to 4*b*...16
15. Setae *e* and h_2 subequal, posterolateral margin of tergite C with small incision............................ ....*I. paucus* Khaustov, 2008. Russia (Crimea). On *Tetramorium* sp.
— Setae *e* distinctly shorter than h_2, posterolateral margin of tergite C without incision .... *I. lentus* Khaustov, 2008. Russia. On *Tetramorium caespitum*.
16. Seta *u′* of tarsus IV short, not reaching distal end of tarsus IV 17
— Seta *u′* of tarsus IV longer, reaching distal end of tarsus IV 27
17. Seta *pv′* of tarsus IV not reaching beyond tip of pretarsus IV 18
— Seta *pv′* of tarsus IV reaching beyond tip of pretarsus IV... ....*I. kataglyphi* Khaustov and Chydyrov, 2004. Turkmenustan. On *Cataglyphus emery*.
18. Setae *f* distinctly longer than distance between their bases 19
— Setae *f* slightly shorter than distance between their bases... ...*I. kugitangensis* Khaustov and Chydyrov, 2004. Turkmenustan. On *Pheidole pallidula*.
20. Setae *f* densely barbed (pubescent), distinctly differ from other sparsely barbed dorsal setae ..21
— Setae *f* not pubescent, similar to other sparsely barbed dorsal setae 22
21. Solenidion ω_2 about 2 times shorter than φ_2 .. .. *I. sevastianovi* Khaustov, 2008. Ukraine, Russia. On *Lasius fuliginosus*.
— Solenidion ω_2 slightly longer than φ_2.............. ....*I. tomentosus* Khaustov, 2016. Russia. On *Lasius umbratus*.
22. Setae *e* subequal or longer than h_2, h_1 longer than h_2 23
— Setae *e* distinctly shorter than h_2, h_1 shorter than h_2 .... *I. parapicolosimilis* Metwali, 1981. Poland, Russia. On *Tetramorium caespitum*.
23. Posterolateral margin of tergite C without incision, setae 4*b* situated close to median end of apodemes 5 24
— Posterolateral margin of tergite C with small incision, setae 4*b* situated far behind median end of apodemes 5 ...... *I. moderatus* Khaustov, 2005. Russia (Crimea). On *Messor* sp.

24. Setae *f* longer or subequal to *d* 25
— Setae *d* longer than *f* ....
.... *I. fuliginosophilus* Khaustov, 2016. Ukraine, Russia. On *Lasius fuliginosus*.
25. Setae h_1 no more than 1.5 times longer than h_2 26
— Setae h_1 2 times longer than h_2.........................
....*I. ursus* Khaustov, 2008. Russia (Crimea). On *Aphaenogaster* sp.
26. Setae *d* subequal to *f*, setae 4*a* situated on the same horizontal level with point of connection of apodemes 4 with poststernal apodeme ....
.... *I. sklyari* Khaustov, 2008. Ukraine, Russia. On *Lasius umbratus*, *L. flavus*, *L. alienus*, *L. niger*, *Tetramorium caespitum*.
— Setae *d* distinctly shorter than *f*, setae 4*a* situated posteriorly to point of connection of apodemes 4 with poststernal apodeme ....
.... *I. malus* Khaustov, 2008. Russia (Crimea). On *Ponera coarctata*.
27. Setae *f* not pubescent, similar to other sparsely barbed dorsal setae 28
— Setae *f* densely barbed (pubescent), distinctly differ from other sparsely barbed dorsal setae .....
.... *I. lasii* Khaustov, 2008. Russia (Crimea). On *Lasius brunneus*, *L. flavus*.
28. Setae h_1 longer than c_1 29
— Setae h_1 shorter than c_1 ....
.... *I. cunicularius* Khaustov, 2008. Russia (Crimea). On *Formica cunicularia*.
29. Setae h_1 longer than h_2 30
— Setae h_1 and h_2 subequal ....
.... *I. longicaudus* Khaustov, 2008. Russia (Crimea). On *Messor* sp.
30. Setae *d* and *f* subequal (difference no more than 5 μm) 31
— Setae *f* longer than *d* 36
31. Setae h_2 longer than *e* 32
— Setae h_2 and *e* subequal 33
32. Dorsal setae long (*d* 104, *f* 109, h_1 119) ....
.... *I. morosus* Khaustov, 2008. Ukraine, Russia (Crimea). On *Messor* sp.
— Dorsal setae shorter (*d* 79, *f* 82, h_1 82) ....
.... *I. ignotus* Khaustov and Chydyrov, 2004. Turkmenistan. In the nest of *Messor* sp.
33. Setae c_1 pointed 34
— Setae c_1 blunt-ended ....
....................................*I. nescius* Khaustov, 2008. Ukraine, Russia. On *Formica rufa*, *F. pratensis*, *F. fusca*, *F. polyctena*.
34. Setae *f* about 2 times longer than *e* 35
— Setae *f* about 1.4 times longer than *e* ....
.... *I. gagati* Khaustov, 2008. Russia (Crimea). On *Formica gagates*.
35. Bases of setae 3*a* and 3*b* thickened and curved .... *I. charkoviensis* Khaustov, 2008. Ukraine, Russia. On *Myrmica ruginodis*, *M. rubra*.
— Bases of setae 3*a* and 3*b* not thickened ....
.... *I. comatosimilis* Metwali, 1981. Poland, Austria, Russia. On *Myrmica ruginodis*, *M. laevinodis*, *M. rubra*.
36. Posterolateral margin of tergite C with small incision, setae *f* and h_1 subequal ....
.... *I. histricinus* (Berlese, 1903). Palaearctic. On *Tetramorium caespitum*, *Messor* sp.
— Posterolateral margin of tergite C without incision, setae *f* distinctly longer than h_1 ....
.... *I. placidus* Khaustov and Chydyrov, 2004. Turkmenistan. In the nest of *Messor excursionis*.

Key to Palaearctic myrmecophilous species of the genus *Scutacarus* (females)

1. Tibiotarsus IV with 5–6 setae 2
— Tibiotarsus IV with 7 setae 21
2. Setae 4*b* present 3
— Setae 4*b* absent ....
.... *S. subterraneus* (Oudemans, 1913). Palaearctic. On *Lasius fuliginosus*, *Formica rufa*, *F. pratensis*, *Myrmica ruginodis*.
3. Setae *e* and h_2 distinct 4
— Setae *e* and h_2 vestigial....................................
.................................*S. berdyevi* Chydyrov, 2000. Turkmenistan. On *Cataglyphus aenescens*.
4. Trichobothria sphaerical, tibiotarsus IV with 6 setae 5
— Trichobothria baculiform, tibiotarsus IV with 5 setae .... *S. insolitus* Khaustov, 2015. Russia. On *Lasius flavus*.
5. Setae h_1 at least 3 times shorter than *f*, setae c_1 and c_2 widened distally 6
— Setae h_1 if shorter than *f*, then less than 2 times, if h_1 shorter than *f* more than 3 times, than setae c_1 and c_2 not widened distally 9
6. Setae h_1 needle-like, with few weak barbs 7
— Setae h_1 widened distally, strongly barbed ......
.... *S. moseri* Khaustov, 2015. Russia. On *Lasius flavus*.
7. Setae *d* thickened distally, strongly barbed 8
— Setae *d* not thickened distally, weakly barbed
......................................*S. gratus* Karafiat, 1959. Germany, Ukraine. On *Lasius fuliginosus*.
8. Setae 3*a* thickened, strongly barbed ....
.... *S. hortobagyensis* Mahunka, 1981. Hungary, Bulgaria, Austria, Russia. On *Lasius niger*.
— Setae 3*a* not thickened, sparsely barbed ....
.........................*S. velutinosus* Sevastianov, 1983. Ukraine, Bulgaria, Russia. On *Lasius niger*.

9. Setae 2*b* smooth 10
— Setae 2*b* barbed.... *S. kassaii* Mahunka, 1965. Hungary, Czech Republic, Ukraine, Russia. On *Caqmponotus vagans*, in the nests of *Lasius niger*, *Myrmica ruginodis*.
10. Setae *f* if short, needle-like, than subequal to h_1 11
— Setae *f* very short, needle-like, many times shorter than h_1 .... *S. expectatus* Karafiat, 1959. Germany, Hungary, Japan, Ukraine, Russia. On *Lasius niger*.
11. If setae h_1 shorter than *f*, than less 2 times .. 12
— Setae h_1 more than 2 times shorter than *f* .... *S. stammeri* Karafiat, 1959. Germany, Hungary, Italy, Russia (Crimea). On *Formica fusca*, *F. cunicularia*.
11. Setae h_2 if longer than *f*, then less than 2 times 12
— Setae h_2 about 3 times longer than *f*, setae c_1, c_2, *d,* and *f* distinctly thickened distally and densely barbed .... *S. hauseri* Mahunka, 1977. France, Austria, Bulgaria, Hungary, Russia. On *Myrmica sabuleti*, *Lasius niger*.
12. Setae c_1 3 times longer than *f* 13
— Setae c_1 if longer *f*, then no more than 2 times 14
13. Setae *d* barbed as strong as c_1, setae 4*b* far not reaching posterior margin of body .... *S. atypicus* (Karafiat, 1959). Germany, Austria, Russia. On *Formica rufa*, *F. fusca*, *F. pratensis*, *F. sanguinea*, *Myrmica ruginodis*.
— Setae *d* smooth, setae 4*b* reaching posterior margin of body .... *S. rarissimus* Sevastianov, 1983. Ukraine. On *Camponotus piceus*.
14. Setae 4*b* distinctly longer than 4*a* 15
— Setae 4*a* and 4*b* subequal .... *S. longisetus* (Berlese, 1904). Palaearctic. On *Lasius flavus*, *L. niger*, *L. umbratus*, *L. fuliginosus*, *L. alienus*, *Tetramorium caespitum*, *Myrmica laevinodis*.
15. Setae 4*a* situated distinctly posterior to setae 4*b* 16
— Setae 4*a* situated on the same level or anterior to setae 4*b* 17
16. Seta *d* of tibiotarsus lV several times shorter than *tc''* of tibiotarsus lV .... *S. levis* Mahunka, 1981. Hungary, Russia. On *Lasius umbratus*.
— Seta *d* of tibiotarsus lV the longest on tibiotarsus IV .... *S. pilatus* Khaustov, 2008. Ukraine, Russia. On *Formica rufa*, *F. pratensis*, *F. polyctena*, *F. fusca*, *F. sanguinea*.
17. Setae 4*b* pointed 18
— Setae 4*b* blunt-ended .... *S. subquadratus* Khaustov and Chydyrov, 2004. Turkmenistan. In the nest of *Tetramorium schneideri*.
18. Bases of setae ps_2 and ps_3 well separated.... 19
— Bases of setae ps_2 and ps_3 situated close to each other .... *S. sabinaesimilis* Khaustov and Chydyrov, 2004. Turkmenistan. In the nest of *Tapinoma simrothy*.
19. Setae *f* and h_1 subequal 20
— Setae *f* distinctly longer than h_1 ....*S. carsticus* Mahunka and Mahunka-Papp, 1980. Hungary, Russia. On *Formica cunicularia*, *F. polyctena*, *F. fusca*, *Lasius niger*.
20. Seta *d* of tibiotarsus IV much shorter than *tc''* of tibiotarsus IV ..... *S. apodemi* Mahunka, 1964. Hungary, Bulgaria, Ukraine, Turkmenistan, Russia (Crimea). On *Camponotus aethiops*.
— Seta *d* and *tc''* of tibiotarsus IV subequal .... *S. bugacensis* Mahunka, 1986. Hungary. In ant nest.
21. Setae 4*b* absent 22
— Setae 4*b* present 24
22. Setae *e* and h_2 short, spine-like, smooth 23
— Setae *e* and h_2 longer, curved and barbed .... *S. tutus* Khaustov, 2008. Russia. On *Lasius flavus*.
23. Setae c_1, *d,* and *f* distinctly thickened distally, setae *d* of tibiotarsus IV shorter than *v'* of tibiotarsus IV .... *S. pseudospinosus* Khaustov, 2008. Ukraine, Russia. On *Lasius alienus*, *L. flavus*, *L. niger*, *L. umbratus*, *Formica sanguinea*, *Tetramorium caespitum*, *Myrmica ruginodis*.
— Setae c_1, *d,* and *f* not thickened distally, setae *d* of tibiotarsus IV distinctly longer than *v'* of tibiotarsus IV .... *S. spinosus* Štorkán, 1936. Cosmopolitan. On *Lasius flavus*, *L. niger*, *L. umbratus*, *Myrmica ruginodis*.
24. Setae *3b* situated slightly posterior to *3a* 25
— Setae *3b* situated far posterior to *3a* and close to apodemes 4 ....*S. yuliae* Khaustov, 2006. Ukraine. On *Myrmica* sp.
25. Setae *e* and h_2 vestigial 26
— Setae *e* and h_2 sometimes short, but distinct..35
26. Setae *d* at least 2 times longer than *f* 27
— Setae *d* less than 2 times longer than *f* 28
27. Setae *f* and h_1 subequal 28
— Setae h_1 distinctly longer than *f* .... *S. suavis* Khaustov, 2008. Russia (Crimea). On *Lasius flavus*.
28. Setae c_1 and c_2 distinctly blunt-ended or needle-like 29

— Setae c_1 and c_2 pointed .... *S. remissus* Khaustov, 2008. Russia (Crimea). On *Messor* sp.
29. Secondary transverse sclerotized line present on posterior sternal plate 30
— Secondary transverse sclerotized line absent..... .... *S. sibiriensis* Khaustov, 2015. Russia. On *Lasius flavus*.
30. Setae c_1 and c_2 distinctly thickened distally, strongly barbed .... *S. crinitus* Khaustov, 2015. Russia. On *Lasius niger*.
— Setae c_1 and c_2 needle-like, sparsely barbed ... . *S. ellipticus* Karafiat, 1959. Palaearctic. On *Myrmica ruginodis*, *M. rubra*, *Lasius niger*.
31. Setae *f* subequal or shorter than h_1 32
— Setae *f* at least 4 times longer than h_1 .... *S. tacitus* Khaustov, 2008. Russia (Crimea). On *Aphaenogaster* sp.
32. Aggenital plate with transverse sclerotized line 33
— Aggenital plate without transverse sclerotized line 34
33. Secondary transverse sclerotized line present on posterior sternal plate .... *S. lasiophilus* Khaustov, 2015. Russia. On *Lasius niger*, *L. flavus, L. umbratus*.
— Secondary transverse sclerotized line absent... ....*S. myrmecophilus* Metwali, 1981. Poland, Ukraine, Russia. On *Myrmica ruginodis*, *M. laevinodis*, *M. rubra*.
34. Dorsal hysterosomal setae longer (41–55 long), setae 4*a* and 4*b* shorter (15–16 and 45–48 long respectively) ...... *S. myrmicinus* Khaustov, 2015. Russia. In the nest of *Myrmica ruginodis*.
— Dorsal hysterosomal setae shorter (32–33 long), setae 4*a* and 4*b* longer (34 and 73 long respectively) ....*S. suborbiculatus* Rack, 1964. Germany, Hungary, Poland, Ukraine, Russia. On *Formica rufa*, *F. aquilonia*.
35. Setae *f* and h_1 at least 3 times shorter than *d*... 36
— Setae *f* and h_1 if shorter than *d,* then no more than 2 times 40
36. Setae *tc''* of tibiotarsus lV very short, spine-like 37
— Setae *tc''* of tibiotarsus lV long, filiform 38
37. Distance between setae *f* longer than between *d,* setae 4*a* about 3 times shorter than *4b* .... *S. novellus* Khaustov, 2008. Russia (Crimea). On *Camponotus aethiops*.
— Distance between setae *f* shorter than between *d,* setae 4*a* less than 2 times shorter than *4b* .... *S. spinisetus* Mahunka, 1986. Hungary. In ant nest.
38. Setae *e* and h_2 about five times longer than *f* and h_1, setae 4*a* distinctly thickened and strongly barbed 39
— Setae *e* and h_2 about 2 times longer than *f* and h_1, setae 4*a* not thickened and sparsely barbed .... *S. rotundulus* Khaustov and Chydyrov, 2004. Turkmenistan. In the nest of *Camponotus fedtschenkoi*.
39. Setae (*tc*) of tibiotarsus IV with thin, flexible tips .... *S. flexisetus* Karafiat, 1959. Germany, Austria, Ukraine, Russia. On *Lasius fuliginosus*.
— Setae (*tc*) of tibiotarsus IV distinctly blunt-ended .... *S. flexisetosimilis* Khaustov, 2016. Russia. On *Lasius umbratus*.
40. Apodemes 5 well developed, very thick, joint with poststernal apodeme 41
— Apodemes 5 if developed, than thin, diffuse 43
41. Setae *e* several times shorter than *d* 42
— Setae *e* distinctly longer than *d* ....*S. pleurotricha* Mahunka, 1970. Hungary. In ant nest.
42. Setae h_2 short, subequal to *e* .... *S. ponticulus* Mahunka, 1981. Hungary, Austria, Ukraine, Russia. On *Lasius flavus*.
— Setae h_2 long, several times longer than *e* .... *S. molnari* Mahunka, 1981. Hungary, Russia. On *Lasius flavus*.
43. Distance between setae *f* distinctly shorter than between setae *d* 44
— Distance between setae *f* distinctly longer than between setae *d* ....*S. calcaratus* Štorkán, 1936. Bulgaria. In ant nest.
44. Setae *e* at least 3 times shorter than h_2 45
— Setae *e* if shorter than h_2, than less than 3 times 46
45. Setae *f* and h_1 subequal .... *S . ovoideus* Karafiat, 1959. Palaearctic. Om *Myrmica ruginodis*, *M. rufa*, *Lasius niger*, *L. flavus*.
— Setae *f* distinctly longer than h_1 .... *S. amoenus* Khaustov, 2008. Russia (Crimea). On *Aphaenogaster* sp.
46. Setae *f* at least 3 times shorter than h_1 47
— Setae *f* if shorter than h_1, then less than 2 times 49
47. Setae *e* and h_2 distinctly longer than h_1 48
— Setae *e* and h_2 several times shorter than h_1 .... *S. latifrons* Mahunka, 1964. Hungary, Russia (Crimea). On *Lasius flavus*.

48. Seta *tc''* of tibiotarsus IV short, spine-like .... *S. tyrrhenicus* Ebermann, 1986. Italy, Russia (Crimea). On *Camponothus aethiops*.
— Seta *tc''* of tibiotarsus IV long, filiform .... *S. transfusionis* Mahunka, 1986. Hungary, Bulgaria. In ant nest.
49. Setae c_1, *d,* and *f* clavate, strongly barbed... 50
— Setae c_1, *d,* and *f* not clavate 51
50. Setae h_1 clavate ..... *S. claviger* (Paoli, 1911). Italy, Russia. On *Tetramorium caespitum*.
— Setae h_1 not modified .... *S. hystrichocentrus* Sevastianov, 1983. Ukraine, Russia. On *Lasius niger*, *L. alienus*, *Myrmica ruginodis*.
51. Anterior part of free margin of tergite C with straight striae 52
— Anterior part of free margin of tergite C with obliquely aligned striae ....*S. pegazzanoae* Ebermann, 1986. Italy, Austria, Hungary, Ukraine. On *Myrmica rubra*, *M*. sp.
52. Setae h_1 at least 2.5 times shorter than *f* 53
— Setae h_1 longer, subequal or slightly shorter than *f* 55
53. Setae h_1 much shorter than *d* 54
— Setae h_1 longer than *d* ....*S. latus* Karafiat, 1959. Central Europe, Russia. On *Myrmica ruginodis*.
54. Setae *f* about 2 times longer than *d*, setae h_1 sparsely barbed and curved, seta *tc''* of tibiotarsus IV much longer than *pv'* of tibiotarsus IV, setae 4*c* not thickened, sparsely barbed and reaching far beyond posterior margin of poststernal plate, solenidion ω_2 longer than φ_2 .... *S. rotundus* (Berlese, 1903). Italy, Germany, Austria, Hungary, Ukraine, Russia. On *Formica fusca*, *F. rufa*, *F. polyctena*, *Lasius niger*.
— Setae *f* less than 1.5 times longer than *d*, setae h_1 needle-like and smooth, seta *tc''* of tibiotarsus IV shorter than *pv'* of tibiotarsus IV, setae 4*c* not distinctly thickened, heavily barbed and not reaching beyond posterior margin of poststernal plate, solenidia ω_2 and φ_2 subequal .... *S. karafiati* Khaustov, 2015. Russia. On *Formica fusca*.
55. Setae h_1 subequal or slightly shorter than *f* 56
— Setae h_1 distinctly longer than *f*...................... .... *S. subcomosus* Mahunka, 1970. Hungary. In ant nest.
56. Setae ps_3 present 57
— Setae ps_3 absent.....*S. silvestri* (Berlese, 1903). Italy, Hungary. On *Formica fusca*, *Solenopsis fugax*.
57. Setae *e* subequal or longer than *f* 58
— Setae *e* shorter than *f* 61
58. Setae *d*, *f* and h_1 not very short, subequal or longer than c_1 59
— Setae *d*, *f* and h_1 very short, about 2 times shorter than c_1 .. *S. heterotrichus* Khaustov, 2015. Russia. On *Lasius flavus*, *L. fuliginosus*.
59. Setae 4*a* subequal or longer than distance between their bases 60
— Setae 4*a* very short, about 4 times shorter than distance between their bases .... *S. rakonczayi* Mahunka, 1981. Hungary. In ant nest.
60. Setae *d* thickened distally, subequal to *f* .... *S. avarus* Khaustov, 2008. Russia (Crimea). On *Formica cunicularia*.
— Setae *d* not thickened distally, shorter than *f* ... . *S. aequalis* Khaustov, 2016. Russia. On *Lasius umbratus*.
61. Setae h_2 slightly longer than h_1 .... *S. bursula* (Berlese, 1903). Italy, Germany, Ukraine, Russia (Crimea). On *Tetramorium caespitum*.
— Setae h_2 about 2 times shorter than h_1 .... *S. paolii* Mahunka, 1965. Hungary, Austria. In the nest of *Tetramorium caespitum*.

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Table 1.

List of pygmephoroid mites associated with most abundant ant species of Western Siberia

N	Taxa of mites	L. n.	L. f.	L. u.	L. fu.	T. c.	M. r.	F. p.	F. r.	F. f.	F. rb.	F. s.	F. pr.
	Microdispidae												
1	*Unguidispus contematosus* Sevastianov, 1981[*]				+								
2	*Unguidispus japonicus* Kurosa, 1979[*]	+											
3	*Unguidispus lasii* Kurosa, 1979[*]	+											
4	*Unguidispus polyctenus* (Sevastianov, 1969)							+	+				
5	*Caesarodispus brevipes* Mahunka, 1981[*]			+									
6	*Caesarodispus minutus* (Sevastianov, 1981)[*]		+										
7	*Caesarodispus samsinaki* (Mahunka, 1967)[*]							+	+				+
	Neopygmephoridae												
8	*Petalomium brevicaudus* Khaustov, 2016			+									

9	*Petalomium carelitschensis* (Sevastianov, 1967)	+	+	+	+								
10	*Petalomium crinitus* Khaustov and Trach, 2013*	+											
11	*Petalomium fimbrisetum* Ebermann and Rack, 1982		+	+									
12	*Petalomium fuliginosum* Khaustov, 2016			+	+								
13	*Petalomium kurganiensis* Khaustov, 2016			+									
14	*Petalomium kurosai* Khaustov, 2014	+	+			+	+						
15	*Petalomium nataliae* (Sevastianov, 1967)*	+				+							
16	*Petalomium podolicus* (Sevastianov, 1967)	+			+				+	+			
17	*Petalomium rarus* (Sevastianov, 1967)										+		
18	*Petalomium sawtschuki* (Sevastianov, 1967)						+						
19	*Petalomium scyphicus* (Sevastianov, 1967)	+											
20	*Petalomium tothi* Mahunka and Zaki, 1984		+										
	Scutacaridae												
21	*Lophodispus irregularis* (Mahunka, 1971)	+				+							
22	*Imparipes brevibasis* (Sevastianov, 1983)*				+								
23	*Imparipes brevitarsus* Ebermann, 1981*		+										
24	*Imparipes charkoviensis* Khaustov, 2008*						+						
25	*Imparipes comatosimilis* Metwali, 1981*						+						
26	*Imparipes fuliginosophilus* Khaustov, 2016				+								
27	*Imparipes hortobagyensis* Mahunka, 1981					+							
28	*Imparipes histricinus* (Berlese, 1903)					+							
29	*Imparipes imaginatus* Mahunka, 1981*					+							
30	*Imparipes lentus* Khaustov, 2008					+							

31	*Imparipes nescius* Khaustov, 2008							+	+	+			+
32	*Imparipes obsoletus* Rack, 1966	+	+	+	+					+	+		
33	*Imparipes parapicolosimilis* Metwali, 1981*					+							
34	*Imparipes robustus* Karafiat, 1959							+	+	+	+	+	+
35	*Imparipes sevastianovi* Khaustov, 2008*				+								
36	*Imparipes sklyari* Khaustov, 2008	+	+										
37	*Imparipes tomentosus* Khaustov, 2016			+									
38	*Imparipes* sp.									+	+		
39	*Scutacarus aequalis* Khaustov, 2016			+									
40	*Scutacarus atypicus* Karafiat, 1959*									+		+	+
41	*Scutacarus carsticus* Manunka and Mahunka-Papp, 1980	+						+		+			
42	*Scutacarus claviger* (Paoli, 1911)*					+							
43	*Scutacarus crinitus* Khaustov, 2015	+											
44	*Scutacarus ellipticus* Karafiat, 1959	+					+						
45	*Scutacarus expectatus* Karafiat, 1959*	+											
46	*Scutacarus flexisetosimilis* Khaustov, 2016			+									
47	*Scutacarus flexisetus* Karafiat, 1959*				+								
48	*Scutacarus hauseri* Mahunka, 1977*	+											
49	*Scutacarus heterotrichus* Khaustov, 2015		+		+								
50	*Scutacarus hortobagyensis* Mahunka, 1981*	+											
51	*Scutacarus hystrichocentrus* Sevastianov, 1983	+					+						
52	*Scutacarus insolitus* Khaustov, 2015		+										
53	*Scutacarus karafiati* Khaustov, 2015									+			

54	*Scutacarus kassaii* Mahunka, 1965[*]	+					+						
55	*Scutacarus lasiophilus* Khaustov, 2015	+	+	+									
56	*Scutacarus latus* Karafiat, 1959						+						
57	*Scutacarus levis* Mahunka, 1981[*]			+									
58	*Scutacarus longisetus* (Berlese, 1904)	+	+	+	+								
59	*Scutacarus molnari* Mahunka, 1981[*]		+										
60	*Scutacarus moseri* Khaustov, 2015		+										
61	*Scutacarus myrmecophilus* Metwali, 1981[*]						+						
62	*Scutacarus myrmicinus* Khaustov, 2015						+						
63	*Scutacarus ovoideus* Karafiat, 1959						+						
64	*Scutacarus pilatus* Khaustov, 2008[*]							+	+	+		+	+
65	*Scutacarus ponticulus* Mahunka, 1981		+										
66	*Scutacarus pseudospinosus* Khaustov, 2008[*]	+	+	+		+	+					+	
67	*Scutacarus rotumdus* (Berlese, 1903)[*]							+	+	+			
68	*Scutacarus sibiriensis* Khaustov, 2015		+										
69	*Scutacarus spinosus* Štorkán, 1936	+	+	+			+						
70	*Scutacarus suborbiculatus* Rack, 1964								+				
71	*Scutacarus subterraneus* (Oudemans, 1913)						+			+			+
72	*Scutacarus tutus* Khaustov, 2008		+										
73	*Scutacarus velutinosus* Sevastianov, 1983[*]	+											
74	*Scutacarus* sp. 1		+	+									
75	*Scutacarus* sp. 2			+									

[*]—first record in the fauna of Russia.

Table 2.

Comparison of mite communities associated with 12 ant species in Western Siberia based on Sørensen indices

	L. n.	**L. f.**	**L. u.**	**L. fu.**	**T. c.**	**M. r.**	**F. p.**	**F. r.**	**F. f.**	**F. rb.**	**F. s.**	**F. pr.**
L. n.	1	0.36	0.29	0.23	0.24	0.32	0.06	0.06	0.17	0.07	0.07	0
L. f.	0.36	1	0.43	0.26	0.13	0.17	0	0	0.06	0.08	0.08	0
L. u.	0.29	0.43	1	0.29	0.07	0.13	0	0	0.07	0.10	0.10	0
L. fu.	0.23	0.26	0.29	1	0	0	0	0.10	0.18	0.13	0	0
T. c.	0.24	0.13	*0.07*	0	1	0.17	0	0	0	0	0.14	0
M. r.	0.32	0.17	0.13	0	0.17	1	0	0	0.08	0	0.11	0.10
F. p.	0.06	0	0	0	0	0	1	0.80	0.56	0.18	0.36	0.57
F. r.	0.06	0	0	0.10	0	0	0.80	1	0.52	0.17	0.33	0.53
F. f.	0.17	0.06	0.07	0.18	0	0.08	0.56	0.52	1	0.40	0.40	0.56
F. rb.	0.07	0.08	0.10	0.13	0	0	0.18	0.17	0.40	1	0.25	0.18
F. s.	0.07	0.08	0.10	0	0.14	0.11	0.36	0.33	0.40	0.25	1	0.55
F. pr.	0	0	0	0	0	0.10	0.57	0.53	0.56	0.18	0.55	1