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On the status and origin of the endemic to the South Urals soldier beetles (Coleoptera: Cantharidae)

О статусе и происхождении эндемичных для Южного Урала жуков-мягкотелок (Coleoptera: Cantharidae)

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КЛЮЧЕВЫЕ СЛОВА: Coleoptera, Cantharidae, таксономия, Палеарктическая область.

ABSTRACT. The article looks at the status of the three soldier beetles confined to the South Urals mountains, *Autosilis olschwangi* Kazantsev, 1994, *Rhagonycha atrovaria iremelica* Kazantsev, 1994 and *Malthodes trifurcatus uralicus* Kazantsev, 1995, and considered to be local endemics of the mountain tundra of the Bolshoy and Maliy Iremel massive. The re-examination of the type material of *Malthodes trifurcatus uralicus* leads to considering *Malthodes uralicus* **stat.n.** a distinct species, to be included in the West European *Malthodes trifurcatus* Kiesenwetter, 1852 species group. On the other hand, *Rhagonycha atrovaria iremelica* Kazantsev, 1994, **syn.n.** on the re-examination of *Rh. atrovaria* Wittmer, 1971 is found to represent a younger synonym of the latter species distributed in separate patches from Altai to the Pacific coast. The possible origin of these endemic and sub-endemic to the South Urals soldier beetles is discussed with reference to distribution patterns of other coleopterans and invertebrates in general.

РЕЗЮМЕ. В статье рассмотрен статус трех эндемичных для Южного Урала жуков-мягкотелок *Autosilis olschwangi* Kazantsev, 1994, *Rhagonycha atrovaria iremelica* Kazantsev, 1994 и *Malthodes trifurcatus uralicus* Kazantsev, 1995, которые считаются локальными эндемиками горной тундры массива Большой и Малый Иремель. Переизучение типового материала *Malthodes trifurcatus uralicus* заставляет считать *Malthodes uralicus* **stat.n.** отдельным видом, входящим в западноевропейскую группу видов *Malthodes trifurcatus* Kiesenwetter, 1852. С другой стороны, на основании переизучения *Rhagonycha atrovaria* Wittmer, 1971, было обнаружено, что *Rh. a. iremelica* Kazantsev, 1994, **syn.n.**, является младшим синонимом последнего вида, распространенного отдельными участками от Алтая до тихоокеанского побережья. Обсуждено возможное происхождение этих эндемичных и субэндемичных для Южного Урала жуков-мягкотелок в связи с закономерностями распространения других жесткокрылых и беспозвоночных в целом.

Introduction

Soldier beetle species in Eastern Europe are generally widespread and characterised by vast distribution areas, in most cases coinciding with the European or East European broad-leaved/mixed forest zones or forest-steppe zones. Local endemics are actually unheard of, as they are usually confined to the highest mountain range systems, such as the Caucasus, which lie beyond the limits of East Europe. However, there are three cantharids that are confined to just one summit area in the South Urals. All three were collected among other, common and widespread soldier beetles by the Ekaterinburg entomologist Dr. Vladimir Olshvang in the summit tundra of Bolshoy and Maliy Iremel peaks at the altitude of 1,200–1,400 m asl during the 1984–1986 expedition of the Institute of Plant and Animal Ecology of the RAN Ural Scientific Centre to the South Urals highlands.

These endemic soldier beetles were found to belong to three different genera of three different subfamilies of Cantharidae — *Rhagonycha* Eschscholtz, 1830

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(Cantharinae), *Autosilis* Kazantsev, 2011 (Silinae) and *Malthodes* Kiesenwetter, 1852 (Malthininae) — and described shortly afterwards [Kazantsev, 1994a, b, 1995]. One of the three taxa, *Autosilis olschwangi* Kazantsev, 1994, was introduced as a separate species, as apparently very distinct from the congeners, while the other two, *Rhagonycha atrovaria iremelica* Kazantsev, 1994 and *Malthodes trifurcatus uralicus* Kazantsev, 1995, were described as subspecies, as differing only in minor details from their nominative or other subspecies, but separated from them by thousands of kilometres, with the other subspecies of the former occurring in the Far East and South Siberia, and of the latter in the Alps and farther west to Spain [Kazantsev, Brancucci, 2007; Kazantsev, 2011].

Since that time no other forms of the respective *Rhagonycha* and *Malthodes* taxa have been found between the distribution areas of the nominative and the South Urals subspecies. Meanwhile, the other two subspecies of *Malthodes trifurcatus* Kiesenwetter, 1852, from Western Europe, were found to be synonymous, one with the nominative subspecies, the other with the West European *M. atratus* Baudi di Selve, 1859 [Liberti, 2017]. This necessitated a closer look at our subspecies. The re-examination of the taxa described from the Iremel highlands showed that the status of two of them needs to be changed.

The present study introduces the new status of these two South Urals taxa, along with additional information on all three of them.

Material and Methods

The studied specimens were pinned or glued on cardboard plates. For examination the abdomina were detached from the relaxed specimens and treated for several hours in 10% KOH at room temperature, then, with the extracted terminalia and genitalia, placed in a microvial with glycerin for photography.

MSP-1 zoom stereoscopic dissecting microscope with x8–x80 magnification range were used. Photographs were taken with a Canon EOS 6D camera and Canon MP-E 65 mm lens.

The following acronym is used in this paper: ICM — Insect Center, Moscow.

Taxonomy

Family Cantharidae Imhoff, 1856 (1815)
Subfamily Cantharinae Imhoff, 1856 (1815)
Tribe Cantharini Imhoff, 1856 (1815)

Rhagonycha Eschscholtz, 1830

Rhagonycha Eschscholtz, 1830: 64.
Type species: *Cantharis fulva* Scopoli, 1763.

Rhagonycha atrovaria Wittmer, 1971
Figs 1, 4–6.

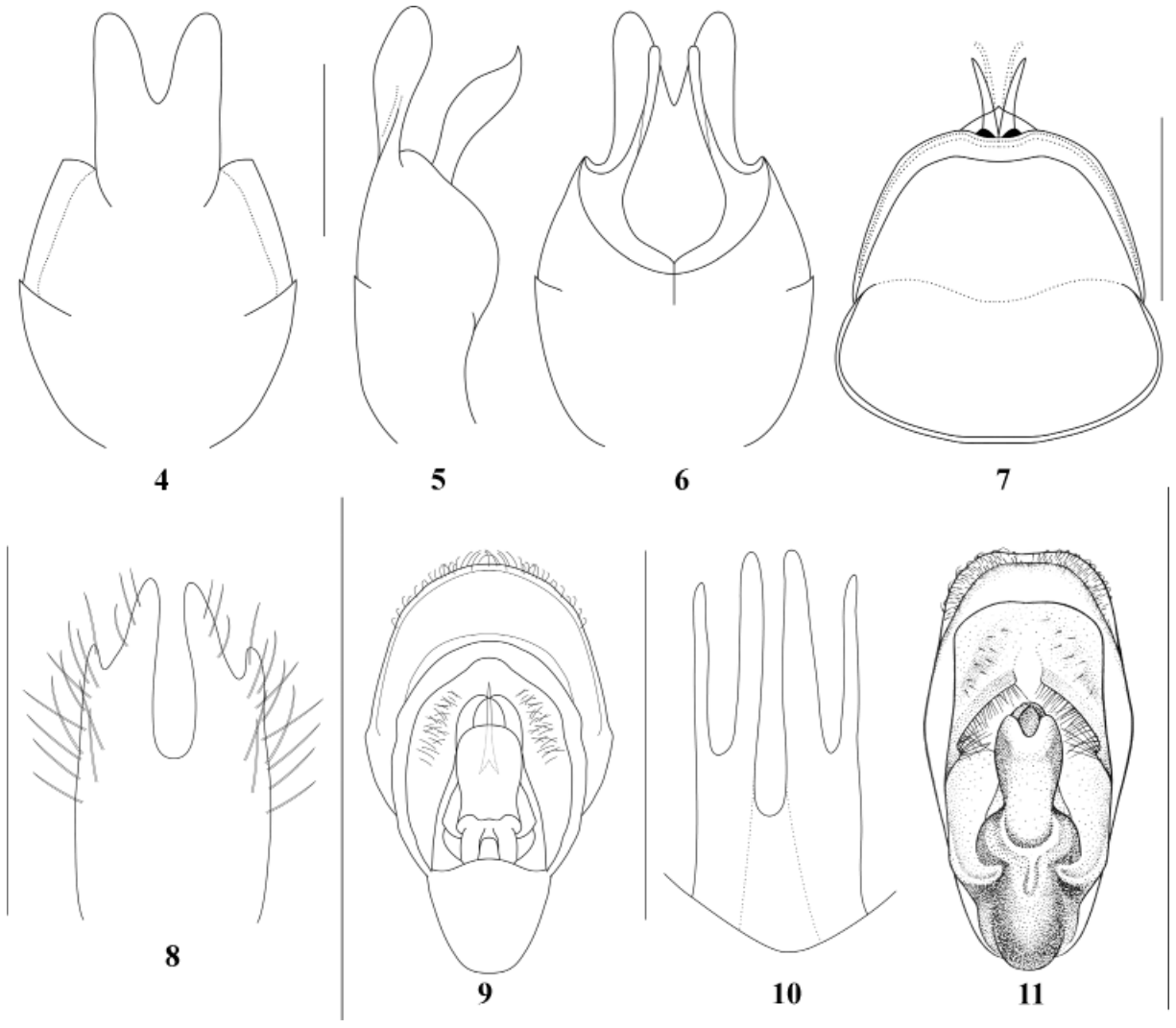
Rhagonycha atrovaria Wittmer, 1971: 196.
Rhagonycha atrovaria iremelica Kazantsev, 1994: 95, **syn.n.**
MATERIAL. Holotype, ♂, South Urals, Mt. M. Iremel, tundra VI, 30.VII.1985 [V. Olschwang leg.]; '*Rhagonycha atrovaria*

Figs 1–3. General view of South Urals endemic and sub-endemic soldier beetles, males: 1 — *Rhagonycha atrovaria*; 2 — *Autosilis olschwangi*; 3 — *Malthodes uralicus* **stat.n.** [after Kazantsev, 2022].
Рис. 1–3. Общий вид эндемичных для Южного Урала жуков-мягкотелок, самцы: *Rhagonycha atrovaria*; 2 — *Autosilis olschwangi*; 3 — *Malthodes uralicus* **stat.n.** [по: Kazantsev, 2022].

iremelica ssp.n. des. S. Kazantsev 1993' (printed); 'Holotype' (red rectangle) (ICM); paratypes, 4 ♂♂ and ♀, same labels, but 'Paratype'; 2 ♂♂ South Urals, Mt. M. Iremel, tundra V, 30.VII.1985 [V. Olschwang leg.]; '*Rhagonycha atrovaria iremelica* ssp.n. des. S. Kazantsev 1993' (printed); 'Paratype' (red rectangle) (ICM).

REMARKS. The examination of longer series of *Rhagonycha atrovaria atrovaria* Wittmer, 1971 in the course of preparation of a paper on the Siberian *Rhagonycha* Eschscholtz, 1833 [Kazantsev, 2023] demonstrated that the morphological peculiarities of *Rhagonycha a. iremelica* [1994] actually fall within the infraspecific variability of *Rh. atrovaria*. Therefore, *Rhagonycha atrovaria iremelica* Kazantsev, 1994, **syn.n.** is considered to be a younger synonym of the latter.

The species is registered in East Siberia (Tuva, Transbaikalia) and the Far East (Primorskij Kraj), as well as in Kazakhstan and Mongolia [Kazantsev, 2011]. The indication of the species for Altai [Kazantsev, 2011] needs to be verified on additional material, as the only known specimen from the region ('Altai, Kurai'), identified as '*Rh. atrovaria*' (in ICM collection), seems to differ slightly in the shape of pronotum and some of the aedeagal structures. The same refers to the indication of *Rh. atrovaria* for Kazakhstan [Kazantsev, Brancucci, 2007; Kazantsev, 2011], as it is based on literature data and not confirmed by studied material. Thus, the South Urals patch appears to be separated from the nearest part of the distribution area of *Rh. atrovaria* by roughly 2,200 km, or 1,750 –2,000 km, should the Altai and east Kazakhstan occurrence of *Rh. atrovaria* be confirmed. Notably, the species was found only in Maliy Iremel tundra, but not on Bolshoy Iremel, at the same altitude just some 2.5 km away.



Figs 4–11. Ultimate sternite and aedeagi of soldier beetles, males: 4–6 — *Rhagonycha atrovaria*; 7 — *Autosilis olschwangi*; 8, 9 — *Malthodes uralicus* **stat.n.**; 10, 11 — *Malthodes trifurcatus*. 4–7, 9, 11 — aedeagus; 8, 10 — ultimate sternite; 4, 7 — dorsal view; 5 — lateral view; 6, 8–11 — ventral view. Scale bar: 0.5 mm (4–6 — after Kazantsev, 1994a; 7 — after Kazantsev, 1994b; 10 — after Liberti, 2011; 11 — after Wittmer, 1970).

Рис. 4–11. Вершинный стернит и эдеагусы жуков-мягкотелок, самцы: 4–6 — *Rhagonycha atrovaria*; 7 — *Autosilis olschwangi*; 8, 9 — *Malthodes uralicus* **stat.n.**; 10, 11 — *Malthodes trifurcatus*. 4–7, 9, 11 — эдеагус; 8, 10 — вершинный стернит; 4, 7 — сверху; 5 — сбоку; 6, 8–11 — снизу. Масштаб: 0,5 мм (4–6 — по Kazantsev, 1994a; 7 — по Kazantsev, 1994b; 10 — по Liberti, 2011; 11 — по Wittmer, 1970).

Subfamily Silinae Mulsant, 1862

Autosilis Kazantsev, 2011

Autosilis Kazantsev, 2011: 28.
Type species: *Cantharis nitidula* Fabricius, 1792.

Autosilis olschwangi (Kazantsev, 1994)
Figs 2, 7.

Silis olschwangi Kazantsev, 1994: 99.

MATERIAL. Holotype, ♂, South Urals, Mt. B. Iremel, tundra, 23.VII.1986 [V. Olschwang leg.]; '*Silis olschwangi* sp.n. des. S. Kazantsev 1991' (printed); 'Holotype' (red rectangle) (ICM); paratypes: ♂, South Urals, Mt. B. Iremel, 1.VIII.1985 [V. Olschwang leg.]; '*Silis olschwangi* sp.n. des. S. Kazantsev 1991' (printed); 'Paratype' (red rectangle); ♂, South Urals, Mt. Iremel, VII.1984 [V. Olschwang leg.]; '*Silis olschwangi* sp.n. des. S. Kazantsev 1991' (printed); 'Paratype' (red rectangle) (ICM).

REMARKS. This South Urals *Autosilis* species seems to be rare, as even the intensive collecting in its exclusive biotopes was yielding just one specimen a year, one in 1984, another in 1985 and the third in 1986. There are actually two *Autosilis* species distributed in relatively close proximity to *A. olschwangi*: the European *A. nitidula* (Fabricius, 1792), registered in Ryazan and Yaroslavl Oblasts west of Iremel, as well as in Tomsk Oblast east of it, and *A. dzungarica* (Kazantsev, 1994) known only from the Saur and Tarbagatai mountain ranges in Kazakhstan. The shortest distance between the distribution areas of *A. olschwangi* and *A. nitidula* is thus roughly 1,000 km in the west and 1,600 km in the east, while that between *A. olschwangi* and *A. dzungarica* is about 2,000 km. The remaining six *Autosilis* species of the Russian Federation and adjacent territories are come across much farther away in the east: in East Siberia [*A. bianchii* (Barovskij, 1926); *A. jacutica* (Barovskij, 1926); *A. tuvensis* (Kazantsev, 2008); *A. urjanhaica* (Kazantsev, 1997)] and the Far East [*A. amurensis* (Kazantsev, 2008) and *A. triimpressa* (Pic, 1926)] [Kazantsev, 1994, 1997, 2008, 2011].

The division of the genus into species groups, however, is yet to be carried out: it is therefore difficult to say what the closest relatives of *A. olschwangi* are.

Subfamily Malthininae Kiesenwetter, 1852
Tribe Malthodini Böving et Craighead, 1930

Malthodes Kiesenwetter, 1852

Malthodes Kiesenwetter, 1852: 242.
Type species: *Malthinus marginatus* Latreille, 1806.

Malthodes uralicus Kazantsev, 1995, **stat.n.**
Figs 3, 8, 9.

Malthodes trifurcatus uralicus Kazantsev, 1995: 99.

MATERIAL. Holotype, ♂, South Urals, Mt. Iremel, VII.1984 [V. Olschwang leg.]; '*Malthodes trifurcatus uralicus* ssp.n. des. S. Kazantsev 1994' (printed); 'Holotype' (red rectangle) (ICM).

REMARKS. *Malthodes uralicus* is the only Russian representative of the genus *Malthodes* which has bifurcate lobes of the ultimate sternite on each side (Fig. 8). Such structure of terminalia is characteristic of the *M. trifurcatus* group, which includes three species: *M. trifurcatus*, the most widespread, registered from France in the West to Slovakia, Hungary and Serbia in the East, *M. penninus* from Austria, Italy and Switzerland and *M. atratus* from Spain, France and Italy. Back in the nineties, when *M. trifurcatus uralicus* was described, *M. trifurcatus* included two subspecies, with rather differently organised bifurcation of lateral lobes of the ultimate sternite [Wittmer, 1970]. For this reason the new taxon, although also differing in the bifurcation, was considered to represent yet another subspecies of *M. trifurcatus*, whereas its aedeagus was not examined.

The examination of the above mentioned structures has revealed that the shape of terminal sternite in *M. uralicus* (Fig. 8) is quite different from that of all members of the *M. trifurcatus* group: its inner lobes are noticeably shorter and more robust compared to *M. trifurcatus* and other members of the group [Liberti, 2011] and its lateral lobes are distinctly shorter than those of *M. trifurcatus* (Fig. 10). The aedeagus of *M. uralicus* is characterised by the rounded distally basal part of the median lobe (Fig. 9) compared to distinctly emarginate one in *M. trifurcatus* (Fig. 11) and other members of the group. Therefore, as there is little doubt that *Malthodes uralicus* Kazantsev, 1995, **stat.n.** is not conspecific with any of the members of the *M. trifurcatus* group, it is raised to the species level.

Discussion

In the South Urals endemics are registered in most of the large taxa of terrestrial invertebrates. Among the earthworms, e.g., there is one mountain endemic — *Perelia diplotetratheca* (Perel, 1976), which is widespread in the region [Vsevolodova-Perel, 1997]. Additionally, two more species of the genus *Eisenia* are endemic or sub-endemic to the low-mountain forests of the South Urals [Perel, 1979]. Three species of endemic spiders are confined either to the steppes [Esyunin, 1996], or to the relict nemoral forests [Efimik, Esyunin, 1996] of the area. On the contrary, among the chilopods, South Ural endemics are not known, although the role of this territory as a refugium for the fauna of deciduous forests has been documented [Zalesskaya, Golovatch, 1996].

Among insects, only few high-mountain species are truly endemic; relict forms, however, are more numerous, among which stand out tertiary (4 species with a trans-Asian disjunction of range) and several dozen glacial species. The majority of the glacial relicts are in Tipulidae, which have three distribution patterns: northern Europe – South Urals pattern; Altai and Sayan mountains – South Urals pattern; and Caucasus – South Urals pattern [Korobeinikov *et al*., 1990].

Quite a few of the endemic Coleoptera belong to the ground beetle family (Carabidae). This is *Nebria* (*Boreonebria*) *uralensis* Glasunov, 1901, which is known only from the largest mountains of the South Urals [Korobeinikov, 1988; Mikhailov, Ermakov, 2016] and is close to the Siberian *N. subdilatata* (Shilenkov, 1974). *Carabus* (*Morphocarabus*) *karpinskii* Kryzhanovskij et Matveev, 1993, another endemic of the area, is a relatively young derivative of the *Carabus odoratus* Motschulsky, 1844 complex, formed after the Last Glacial Maximum [Kryzhanovskij, Matveev, 1993]. The sub-endemic *Pterostichus urengaicus* Jureček, 1924 is distributed in the South Urals from the forest belt to alpine tundra [Mikhailov, Erma-

kov, 2016]; the position of this species in the system of the genus *Pterostichus* Bonelli, 1810, however, has yet to be clarified. In other words, the closest relatives of ground beetles that are endemic to the highlands of the South Urals, live either in Siberia or have a boreomontane range [Korobeinikov, 1991]. Notably, many species of ground beetles, which have relict patches of their habitats in the South Urals, have a similar distribution pattern [Korobeinikov, 1988, 1991, Korobeinikov *et al*., 1990; Mikhailov, Ermakov, 2018].

In Chrysomelidae, the endemics and sub-endemics of the Urals are exclusively species of the genus *Chrysolina* Motschulsky, 1860, the Urals are the southern border for its three Siberian subgenera [Mikhailov, 2006, 2018]. In the rich fauna of high-mountain weevils, on the other hand, there are no endemic South Urals forms; there are species only with a boreomontane and Ural-Siberian distribution pattern [Mikhailov, Ermakov, 2016].

It is clear that the formation of coleopteran taxa endemic to the highlands in South Urals is associated with the migration of faunal complexes, members of which have a predominant boreomontane or Siberian distribution. One of the reasons for the breadth of ranges of high-latitude species could be a decrease in the degree length as one approaches the pole [Chernov, 1978]. Due to this, climatic fluctuations, in which the distribution area shifts to the north, contribute to the rapid expansion of species in western and eastern directions.

The two cantharid species confined to the high mountains of the South Urals, *Autosilis olschwangi* and *Malthodes uralicus*, thus represent a valuable addition to the list of true endemics of the area. At the same time, they apparently belong to groups with different distribution patterns: while *Autosilis olschwangi* (as well as the sub-endemic *Rh. atrovaria*) is to be placed in the group with the most widespread Ural-Siberian pattern, *Malthodes uralicus*, with the other members of its species group known from the mountains of Central and Western Europe, at first glance, may seem to represent a group of its own. However, the Central European mountains – Northern Europe distribution pattern is not that uncommon in insects. Numerous examples can be found in Lepidoptera, *Parnassius phoebus* (Fabriciua, 1793) species group, 1758, *Erebia ligea* Linnaeus, 1758, *E. epiphron* Knoch, 1783, *E. pandrose* Borkhausen, 1788, *Coenonympha hero* Linnaeus, 1761, *Lassiomata petropolitana* Fabricius, 1787 are distributed in high mountains of Central and Western Europe and Fennoscandia, with *Erebia euryale* Esper, 1805 even having almost the same distribution as the *Malthodes trifurcatus* species group, confined to 'mountains of Europe from N Spain to Balkans, Urals, Kanin Peninsula' [Tolman, 2002; Elias, 2020]. In Coleoptera, quite a number of beetles, in Western and Central Europe confined to the Alps and other high mountains, are also known to occur in Northern Europe, e.g., *Pterostichus adstrictus* (Eschscholtz, 1823) [Carabidae] [Paill *et al*., 2021], *Syncalypta cyclolepidia* (Münster, 1902) [Byrrhidae], *Helophorus glacialis* (A.Villa et G.B.Villa, 1833) [Helophoridae] [Elias, 2020], as well as the soldier beetle *Podistra rufotestacea* Letzner, 1845, *P. schoenherri* Dejean, 1836 [Kuśka, 1995; Kazantsev, Brancucci, 2007]. Therefore, it seems reasonable to allow the occurrence of at least some of the species referred to as 'northern European' by Korobeinikov and his co-authors [1990], in the high mountains of Central Europe, which would allow *Malthodes uralicus* to fit in a group with the Northern Europe – Central Europe mountains – South Urals distribution pattern, only with the Northern Europe link missing.

Competing interests. The authors declare no competing interests.

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References

Chernov Yu.I. 1978. Structure of the animal population of the Subarctic. Moscow: Nauka. 167 pp. [In Russian]

Elias S.A. 2020. Alpine Insect Distribution Patterns // Encyclopedia of the World's Biomes. Vol.1. Elsevier. P.430–440. https://doi.org/10.1016/B978-0-12-409548-9.11859-7

Esyunin S.L. 1996. [New wolf-spider species (Lycosidae) from the Urals] // Zoologicheskij Zhurnal. Vol.75. No.8. P.1149–1158 [in Russian, with English summary].

Esyunin S.L., Efimik V.E. 1997. Remarks on the Urals spider fauna, 6. New data on the taxonomy and faunistics of gnaphosid spiders of the South Urals (Arachnida Aranei Gnaphosidae) // Arthropoda Selecta. Vol.5. Nos.3/4 [for 1996]. P.105–111.

Kazantsev S.V. 1994a. [A review of *Rhagonycha* species (Coleoptera, Cantharidae) of the Asian part of Russia] // Zoologicheskij Zhurnal. Vol.73. Nos.7–8. P.71–100 [in Russian with English summary]. [Translated into English: Entomological Review. 1996. Vol.75. No.3. P.121–153]

Kazantsev S.V. [Kasantsev S.] 1994b. The Palaearctic species of the genus *Silis* Charpentier with the description of *Crudosilis* n. gen. (Coleoptera, Cantharidae) // Elytron. Vol.8. P.93–115.

Kazantsev S.V. 1997. [A new species of the genus *Silis* (Coleoptera, Cantharidae) from Siberia with notes on zoogeography of the genus] // Zoologicheskij Zhurnal. Vol.76. No.10. P.1214–1217 [in Russian with English summary]. [Translated into English in: Entomological Review. 1998. Vol.77. No.9. P.1229–1232]

Kazantsev S.V. 1995. New taxons of Palaearctic *Malthodes* (Coleoptera, Cantharidae) // Entomologica Basiliensia. Vol.18. P.99–108.

Kazantsev S.V. 2008. [New soldier beetles (Coleoptera, Cantharidae) from Amurskaya Oblast and Tuva] // Eurasian Entomological Journal. Vol.7. No.4. P.337–338 [in Russian with English summary].

Kazantsev S.V. 2011. An annotated checklist of Cantharoidea (Coleoptera) of Russia and adjacent territories // Russian Entomological Journal. Vol.20. No.4. P.387–410.

Kazantsev S.V. 2022. Identification key to soldier-beetles (Coleoptera, Cantharidae) of the European part of Russia and the Northern Caucasus. 'Digital identification keys to beetles of the European part of Russia' Series. Issue 2. Livny: Muhametov G.B. 110 pp.

Kazantsev S.V. 2023. A review of soldier beetles of the genus *Rhagonycha* Eschscholtz, 1833 (Coleoptera: Cantharidae) of Siberia, with description of a new species // Russian Entomological Journal Vol.32. No.3. P.271–296. https://doi.org/10.15298/rusentj.32.3.03

Kazantsev S.V., Brancucci M. 2007. Cantharidae // Catalogue of Palaearctic Coleoptera. Vol.4. Elateroidea – Derodontoidea – Bostrichoidea – Lymexyloidea – Cleroidea – Cucujoidea. Stenstrup: Apollo Books. P.234–298.

Korobeinikov Yu.I. 1991. [Ground beetles of the mountain tundras of the Urals] // Ekologicheskiye gruppirovki zhuzhelits (Coleoptera, Carabidae) v estestvennykh i antropogennykh landshaftakh Urala. Sverdlovsk: Uralskoe otdelenie AN SSSR. P.51–60 [in Russian].

Korobeinikov Yu.I. 1988. [To the fauna of ground beetles (Coleoptera, Carabidae) of the highlands of the South Urals] // Entomologicheskoe Obozrenie. Vol.67. No.4. P.738–740 [in Russian].

Korobeinikov Yu.I. 1990. [Fauna of ground beetles of the South Urals in connection with the history of its development] // Zhivotnyi mir Yuzhnogo Urala. Sverdlovsk: Uralskoe otdelenie AN SSSR. P.19–21 [in Russian].

Korobeinikov Yu.I., Olshvang V.N., Erokhin N.G. 1990. [Geographical analysis of the entomofauna of mountain forests of the South Urals in connection with the history of its development] // Istoricheskaya ekologiya zhivotnykh gor Yuzhnogo Urala. Sverdlovsk: Uralskoe otdelenie AN SSSR. P.45–67 [in Russian].

Kryzhanovskij O.L., Matveev A.B. 1993. A new species of *Carabus* from the South Urals (Coleoptera, Carabidae) // Zoosystematica Rossica. Vol.2. No.1. P.143.

Kuśka A. 1995. Omomilki (Coleoptera, Cantharidae): Cantharinae i Silinae Polski. Krakow: Wydawnictwa Instytutu Systematyki i Evolucii Zwierzat Polskiej Akademii Nauk. 201 pp.

Liberti G. 2011. Le specie di *Malthodes* Kiesenwetter, 1852 delle Alpi Marittime e Liguri (Coleoptera, Cantharidae) // Annali del Museo Civico di Storia Naturale Giacomo Doria. Vol.103. P.147−246.

Liberti G. 2017. Le specie Appenniniche di *Malthodes* Kiesenwetter, 1852 (Coleoptera, Cantharidae) (*Malthodes* d'Italia peninsulare: 4° contributo alla conoscenza del genere *Malthodes* in Italia) // Annali del Museo Civico di Storia Naturale Giacomo Doria. Vol.110. P.33−164.

Mikhailov Yu.E. 1997. Leaf beetles of the Urals (Coleoptera, Chrysomelidae): history and prospects for study // Uspekhi entomologii na Urale. Ekaterinburg: Aerocosmoecology. P. 68–75 [in Russian].

Mikhailov Yu.E. 2006. [On the leaf beetles endemic to the Urals, or what is *Chrysolina poretzkyi* Jacobson (Coleoptera, Chrysomelidae)] // Izvestiya Chelyabinskogo nauchnogo tsentra. Vol.1. No.31. P.114–118 [in Russian].

Mikhailov Yu.E. 2018. [About two little-known species of leaf beetles (Coleoptera, Chrysomelidae) from the South Urals] // Zoologicheskij Zhurnal. Vol.97. No.3. P.286–298 [in Russian].

Mikhailov Yu.E., Ermakov A.I. 2016. [Composition and structure of communities of herpetobiont arthropods in the mountain peaks of the South Urals] // Fauna Urala i Sibiri. Vol.1. P.61–74 [in Russian].

Paill W., Koblmüller S., Friess T., Gereben-Krenn B.-A., Mairhuber C., Raupach M.J., Zangl L. 2021. Relicts from Glacial Times: The Ground Beetle *Pterostichus adstrictus* Eschscholtz, 1823 (Coleoptera: Carabidae) in the Austrian Alps // Insects. Vol.12. Art.84. https://doi.org/ 10.3390/insects12010084

Perel T.S. 1979. [Distribution and patterns of distribution of earthworms of the USSR fauna (with identification tables of Lumbricidae and other Megadrili)]. Moscow: Nauka. 272 pp. [In Russian]

Tolman T. 2002. Butterflies of Europe. Princeton and Oxford: Princeton University Press. 320 pp. + 104 tbs.

Vsevolodova-Perel T.S. 1997. [Earthworms of Russia: cadastre and key]. Moscow: Nauka. 102 pp. [In Russian]

Wittmer W. 1970. Zur Kenntnis der Gattung *Malthodes* (Coleoptera, Cantharidae) (49. Beitrag zur Kenntnis der palaearktischen Cantharidae) // Entomologische Arbeiten aus dem Museum G. Frey Tutzing bei München. Bd.21. S.13–107.

Zalesskaja N.T., Golovatch S.I. 1996. Some patterns in the distribution and origin of the lithobimorph centipede fauna of the Russian Plain (Chilopoda: Lithobiomorpha) // Mémoires du Muséum national d'Histoire naturelle. Vol.169. P.265–268.