ABS ACTA BIOLOGICA SIBIRICA
A journal on the biodiversity of Siberia and the adjacent lands

Acta Biologica Sibirica 11: 463–475 (2025)
doi: 10.5281/zenodo.15165627
http://journal.asu.ru

RESEARCH ARTICLE

The grasshopper *Eremippus simplex* (Eversmann) (Orthoptera, Acrididae) in South Siberia: Rediscovery of a rare species

Michael G. Sergeev[1, 2], Olesya G. Buleu[1, 2], Marya N. Kim-Kashmenskaya[1], Vladimir V. Molodtsov[1], Oxana V. Yefremova[1]

1 *Novosibirsk State University,1 Pirogova Street, Novosibirsk, 630090, Russia*
2 *Institute of Systematics and Ecology of Animals, Siberian Branch, Russian Academy of Sciences, 11 Frunze Street, Novosibirsk, 630091, Russia*

Corresponding author: Michael G. Sergeev (mgs@fen.nsu.ru; mgsergeev@aol.com)

Academic editor: R. Yakovlev | Received 25 March 2025 | Accepted 31 March 2025 | Published 9 April 2025

http://zoobank.org/DEED9B42-8E75-4BC2-BCC5-021743C84B29

Citation: Sergeev MG, Buleu OG, Kim-Kashmenskaya MN, Molodtsov VV, Yefremova OV (2025) The grasshopper *Eremippus simplex* (Eversmann) (Orthoptera, Acrididae) in South Siberia: Rediscovery of a rare species. Acta Biologica Sibirica 11: 463–475. https://doi.org/10.5281/zenodo.15165627

Abstract

The general distribution of the grasshopper *Eremippus simplex* (Eversmann, 1859) is described. Its taxonomic position and ecological peculiarities are characterized. It is one of the most widespread representatives of the genus and is the only species crossing the 52nd parallel in the north direction. The species is associated with dry steppes, semi-deserts and northern deserts and prefers habitats with dominance of different low sagebrushes (*Artemisia* spp.) and salinized soils. In the southern parts of Siberia and in the south-eastern parts of European Russia, its populations were and are very rare and insular. The MaxEnt models generated for the contemporary period and for 2021–2040 and 2041–2060 according the Shared Socioeconomic Pathway 3-7.0 and the global climate model CNRM-ESM2-1 provide an opportunity to evaluate the suitability of conditions for the species and show that, in the future, the general character of its distribution may change quite slightly, but its populations may become more prosperous in the future.

Keywords

Caelifera, Acrididae, rare species, modelling, forecast

Introduction

The genus *Eremippus* Uvarov includes about 40 species distributed from Anatolia and the Syrian Desert to the eastern parts of the Gobi Desert (Cigliano et al. 2025) and mainly associated with various deserts, semi-deserts and very dry steppes (Pravdin and Mistshenko 1980; Sergeev 1986; Savitsky 2007; Terskov 2020). Mistshenko (1974) included the genus *Eremippus* in the tribe Dosiostaurini on the basis of a comparative analysis of the external morphology and structure of the male genitalia. According to Mistshenko, this tribe includes the genera *Dociostaurus* Fieber, *Notostaurus* Bey-Bienko, *Mizonocara* Uvarov, *Kazakia* Bey-Bienko, *Bodenheimerella* Uvarov, *Eremippus* Uvarov, and *Xerohippus* Uvarov. Over the decades since Mistshenko's revision, views on the composition of this tribe have changed. The cytogenetic analysis showed clear differences between members of the genus *Eremippus* and other studied species of the tribe (Bugrov et al. 1993). This conclusion is partially supported by a molecular phylogenetic analysis (Guliaeva et al. 2005). Jago (1996) revised the acridids close to the genera *Dnopherula* Karsch and *Aulacobothrus* I. Bolívar and suggested to include three other genera, namely *Bodenheimerella* (= *Leva* I. Bolívar), *Eremippus* and *Xerohippus*, in this complex. It corresponds to the tribe Aulacobothrini, first identified as a taxonomically distinct group by Johnston (1956) (Latchininsky et al. 2002; Sergeev et al. 2019).

Almost half of the described species of the genus *Eremippus* are known only from their type localities (e.g. *E. opacus* Mistshenko, 1951 (Terskov 2020) and *E. sobolevi* Sergeev et Bugrov, 1990 (Sergeev and Bugrov 1990; Savitsky 2007)), and, therefore, can be qualified as the rare ones. Several species are endemics of the arid mountains of the Eastern Caucasus (*E. sobolevi*), Kopet Dag (*E. onerosus* Mistshenko, 1951), the Pamiro-Alay Mts. (*E. veltistshevi* Miram, 1935, *E. nudus* Mistshenko, 1951, *E. luppovae* Mistshenko, 1951), the Saryjaz Range (*E. hemipterus* Malkovskiy, 1968), and the Kunlun Mts. (*E. heimahoensis* Zhang et Hang, 1974), where they inhabit the mountain deserts as well. A few species occur at the southern parts of the steppe life zone of the East European Plain (*E. costatus* Serg. Tarbinsky, 1927, *E. miramae* Serg. Tarbinsky, 1927, *E. opacus*, *E. simplex* (Eversmann, 1859)) (Savitsky 2007; Terskov 2020), but only the last one is known from the steppes of the West Siberian Plain (Zubowsky 1898; Berezhkov 1956; Sergeev 2021a). In addition, it was mentioned for the southern part of Tuva as well (Sergeev 1985). Despite the wide distribution of *E. simplex* across the southern steppes and the semi-deserts, its local populations are normally sparse and its abundance is usually low (Savitsky 2007; Savitsky et al. 2013; Popova et al. 2020, 2021). Moreover, the first and last findings of this species in West Siberia *per se* were at the end of the 19th century (Zubowsky 1898), though, in the 1970s, it was caught in North-East Kazakhstan (Popova et al 2020). Thus, *E. simplex* remains the very rare species in the steppes of South Siberia. The aim of this article is to estimate its possible distribution in the region now and in the future.

Materials and methods

Original materials were gathered from 1976 until 2024 in the southern parts of Siberia and in the northern, north-eastern and central parts of Kazakhstan. The quantitative and qualitative samples of grasshoppers from natural and transformed ecosystems were commonly used to reveal the species distribution patterns. Samples collected during a certain period of time were done in each habitat examined (Gause 1930; Sergeev 1986, 1992). Using this approach, grasshoppers were caught with a standard net over a period of 10-30 minutes. Some old materials, basically from the field trips of Novosibirsk State University (1972-1980), were exploited as well. We employed the Glonass/GPS handheld gadgets to find geographical coordinates. For localities known until the end of 20th century, we used Google Earth Pro (©Google, 2020) to estimate the same parameters. We have also used some data on general distribution of the species from the collections of Zoological Institute (Saint Petersburg) and from several publications (Zubowsky 1898; Bey-Bienko and Mistshenko 1951; Tzyplenkov 1960; Lehr 1962; Malkovskiy 1964; Descamps 1967; Stolyarov 1972; Tokgaev 1972; Chogsomzhav 1974; Pravdin 1978; Gorochov et al. 1989; Childebaev 1999; Savitsky 2007). Some localities mentioned in the articles published before the middle of the 20th century were excluded from our analysis, because they could belong to other species of the genus.

In June, 2024, we arranged the special field trip to check some possible localities of Orthoptera commonly associated with the semi-deserts and the dry steppes and discovered the population of *E. simplex* in the south-western part of the Altai Krai: S Kulunda Steppe, Uzkaya Steppe, W Uglovskoye, dry steppe with salinized soil (Figures 1 and 2), 51.37°N, 80.11°E, 05.06.2024, 9 larvae.

Figure 1. The central part of the Uzkaya Steppe (Altai Krai) (Photo M.G. Sergeev).

Figure 2. The habitat of *Eremippus simplex* in the Uzkaya Steppe (Photo M.G. Sergeev).

Our database of the *E. simplex* occurrences includes 79 records (See Suppl. material 1: Table S1). The QGIS 3.18.3 software (QGIS, 2024) was used to produce maps based on a Lambert conformal conic projection. The Maxent 3.4.4 software (Phillips et al. 2006, 2017; Elith et al. 2011) based only on species occurrence data was utilized to model the species ecological and geographic distribution. The filled sets of the applicable bioclimatic variables at the 30 arcsecond spatial resolution (Fick and Hijmans 2017; WorldClim 2022) were handled to generate the models. The "Future climate data" for 2021-2040 and 2041-2060 downscaled from the global climate model CNRM-ESM2-1 (Séférian 2018) at the 30 arcsecond spatial resolution and for the Shared Socioeconomic Pathway 3-7.0 (Meinshausen et al. 2020) were used to foretell some possible shifts in the species distribution. The accuracy of these models was estimated by the AUC (the area under the receiver operating characteristic curve) values for a set of 25 replicates with cross-validation. The significance of bioclimatic variables was rated on the basis of their predictive contributions and Jackknife tests.

Results

E. simplex was described as *Stenobothrus simplex* from "Kirgisensteppen" (mainly corresponding to the steppe and semi-desert territories of contemporary Kazakhstan) (Eversmann 1859). Later, Uvarov (1926) erected the new genus *Eremippus* for this species and noted its main distinguishing traits from the tribe Stenobothrini. All other species of the genus were described later. Moreover, identification of many species is not too simple. This means some published data on the *E. simplex* distribution may refer to its relatives (Savitsky 2007). In any case, the species is one of the most widespread forms of the genus. The first data on the species distribution in the southern part of the West Siberian Plain were published by Zubowsky (1898). He mentioned *E. simplex* for several local points, namely Schtschedrucha (now Shadrukha in the Altai Krai), Omsk, Balapan (the Balapan Steppe near the contemporary state border between Kazakhstan and Russia), and Pleschtscheev sav. (now in Semey, the Abai Region, Kazakhstan). However, his notice concerning Omsk is questionable, because the city is in the forest-steppe life zone, i.e. too north for the species (Berezhkov 1956).

Ecological and geographic peculiarities of the species

The known range of *E. simplex* occupies the semi-arid and arid areas of Inner Asia, from the Volga River on the west up to the Uvs Nuur Basin and the Gobi-Altai Mts. on the east and from the southern steppes of the West Siberian Plain on the north up to the mountains of North-East Iran and Hindu Kush on the south (Figure 3). These territories include mainly the southern steppes of both the Ural Region and the West Siberian Plain and the semi-deserts and the northern deserts of Kazakhstan, Xinjiang, West Mongolia, and Tuva. In the southern parts of its range, *E. simplex* is normally distributed across local mountain slopes with xerophilous vegetation.

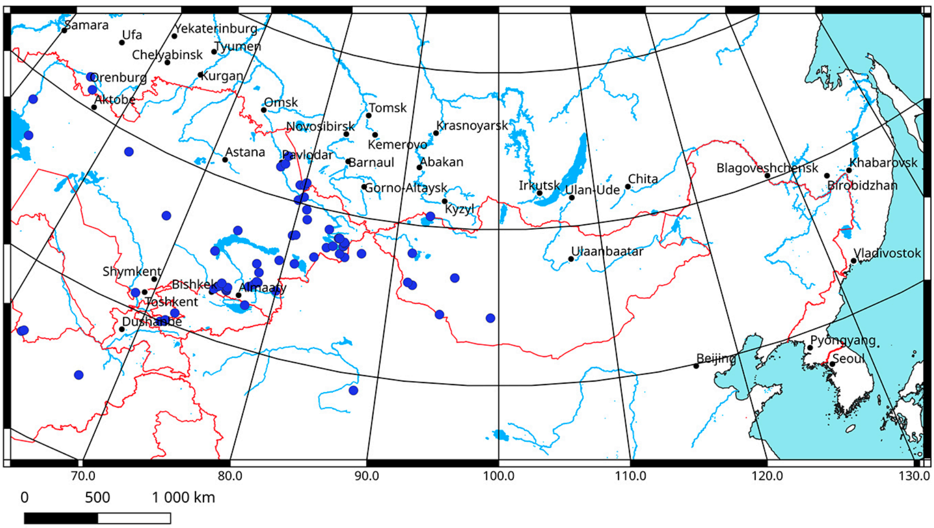

Figure 3. Distribution of *Eremippus simplex*.

The species prefers dry habitats with short and sparse vegetation, in which low sagebrushes (e.g. *Artemisia frigida* Willd., *A. lerheana* Weber ex Stechm., *Artemisia nitrosa* Weber ex Stechm., *A. turanica* Krasch.), *Atriplex verrucifera* M. Bieb., *Camphorosma monspeliaca* L., *Tanacetum vahlii* DC., *Poa bulbosa* L., and *Festuca rupicola* Heuff. (Tokgaev 1972; Pravdin 1978; Savitsky 2007) may be the common dominants (Figure 2). According Savitsky (2007), the species feeds mainly on the members of the genus *Artemisia* L. Its abundance is usually low (Savitsky 2007) and, according our data, normally varies between 2 and 60 adults per hour, but, in some cases, it can increase up to 344–642 per hour (at piedmont hills and plains of Ile (Trans-Ili) Alatau). Its populations are commonly insular, because it settles limited types of habitats. However, in the dry steppes of North-East Kazakhstan, *E. simplex* occurs also in some transformed ecosystems, from the old fields of the crested wheat grass (*Agropyron cristatum* (L.) Gaertn.) up to local verges. In 2024, in the dry steppe with salinized soil at the south-western part of the Altai Krai, the orthopteran assemblage included not only *E. simplex*, but also widely distributed orthopterans, *Decticus verrucivorus* (Linnaeus, 1758), *Bicolorana bicolor* (Philippi, 1830), and insects naturally associated with the steppes, namely *Montana montana* (Kollar, 1833), *Asiotmethis jubatus* (Uvarov, 1926), *Arcyptera microptera* (Fischer de Waldheim, 1833), and *Dociostaurus brevicollis* (Eversmann, 1848) (cf. Baturina et al. 2024).

Ecological models of the species distribution

The model generated for the climatic conditions of the end of the last century unveils that the main part of the species range is in the eastern part of Kazakhstan and includes the territories occupied by the dry steppes, the semi-deserts and the northern deserts of Jetisu (Figure 4). In addition, relatively small areas with optimal combination of climatic factors are in the Tien Shan Mts. and Hindu Kush. Less suitable territories are at the steppes of the Volga River Basin, the South Ural Region and in North-West Kazakhstan. The model is well supported statistically (AUC = 0.925).

The main bioclimatic variables explaining the species distribution are precipitations of the warmest quarter, annual mean temperatures, precipitations of the driest quarter, the mean diurnal range of temperatures, and the precipitation seasonality (Table 1). The Jackknife test gives some opportunity to add maximum temperatures of the warmest month, mean temperatures of the warmest quarter, and precipitation amounts of the wettest quarter. Almost all important variables reflect the characteristics of the arid temperate climate.

The models generated for the climatic conditions in the future prognosticate some noticeable changes (Figure 5), especially in the western parts of the *E. simplex* range. The areas with the optimal conditions may expand north and south and the level of suitability can significantly increase across the northern and central areas of the species distribution. In West Siberia, almost all territory of the Kulunda steppe can become applicable for *E. simplex*.

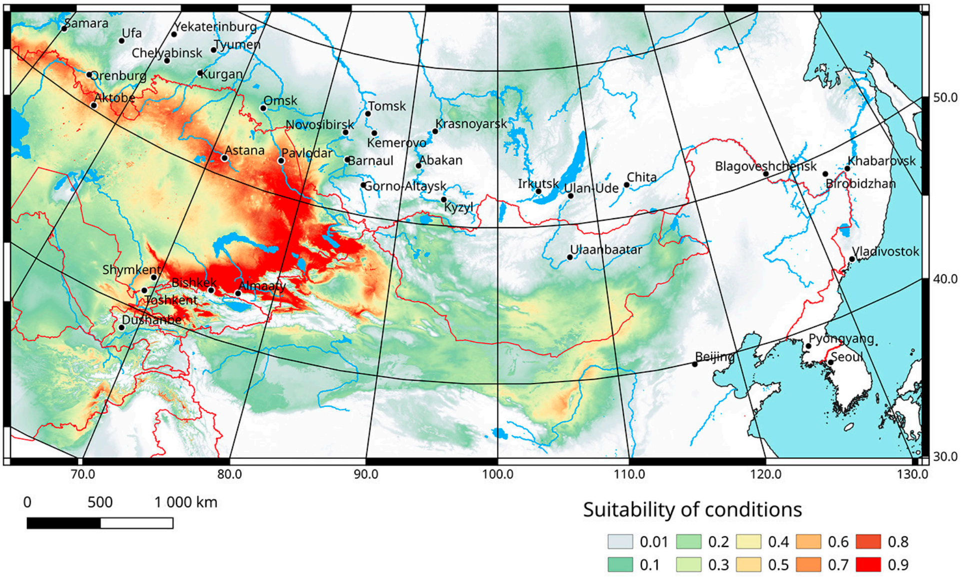

Figure 4. Predicted probabilities of suitable conditions for *Eremippus simplex* (all bioclimatic variables for 1970–2000; point-wise means for 25 replicates with cross-validation).

Table 1. Predictive contributions for all data

Bioclimatic variable	Percent contribution	Permutation importance
1 – Annual mean temperature	**22.3**	10.3
2 – Mean diurnal range	**8.7**	0.2
3 – Isothermality	4	3.4
4 – Temperature seasonality	2.8	5.1
5 – Max temperature of warmest month	0.7	3.8
6 – Min temperature of coldest month	0	0
7 – Temperature annual range	0.5	0.1
8 – Mean temperature of wettest quarter	0.1	0.5
9 – Mean temperature of driest quarter	0	0
10 – Mean temperature of warmest quarter	2.7	4.3
11 – Mean temperature of coldest quarter	0.2	0
12 – Annual precipitation	0.9	9.2
13 – Precipitation of wettest month	6	1.4
14 – Precipitation of driest month	0.2	0
15 – Precipitation seasonality	**6.1**	0.5
16 – Precipitation of wettest quarter	0.2	0.1
17 – Precipitation of driest quarter	**13.7**	0.2

Bioclimatic variable	Percent contribution	Permutation importance
18 – Precipitation of warmest quarter	**30.3**	55.3
19 – Precipitation of coldest quarter	0.6	5.5

Note: The most significant variables are marked in bold.

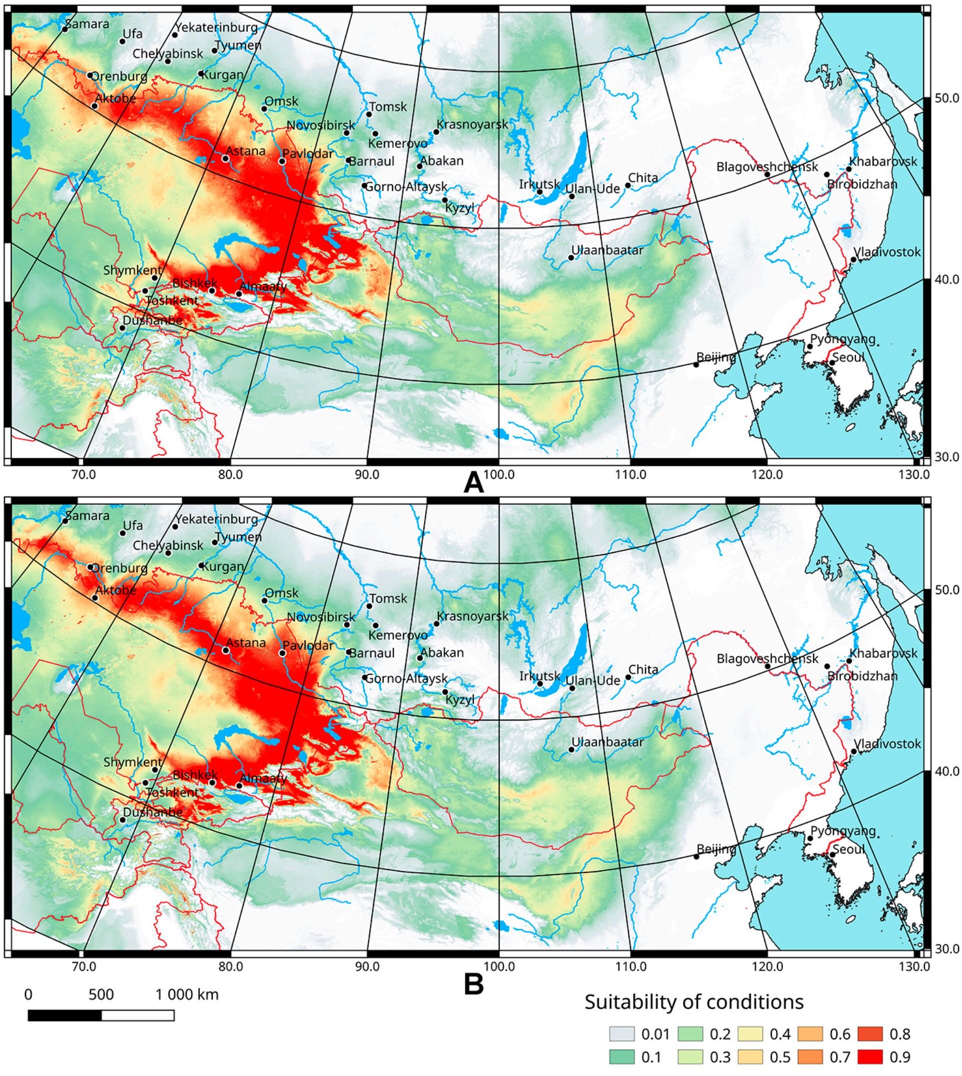

Figure 5. Predicted probabilities of suitable conditions for *Eremippus simplex* (forecasts of bioclimatic variables for 2021-2040 (**A**) and 2041-2060 (**B**) according the global climate model CNRM-ESM2-1 (Séférian 2018); point-wise means for 25 replicates with cross-validation) and the 3-7.0 Shared Socioeconomic Pathway based on high greenhouse gas emissions (Meinshausen et al. 2020).

Conclusions

The rediscovery of *E. simplex* at the south of West Siberia more than a century after its first and last reliable records has stimulated the analysis of the species' general distribution. It is one of the most widespread representatives of the genus and is the only species crossing the 52nd parallel in the north direction. However, in the southern parts of Siberia and in the south-eastern parts of European Russia, the populations of *E. simplex* were and are very rare and insular, and they are not always able to find. As a result, the species can be included in regional Red Books. The northern part of its range, the distribution of optimal areas and the predicted changes are similar to those for the katydid *Miramiola pusilla* (Miram, 1927) naturally associated with the steppes and the semi-deserts (Sergeev and Molodtsov 2024). In addition, *E. simplex* also resembles two grasshoppers mainly distributed across the southern parts of the Kulunda Steppe and the steppes and semi-deserts of the eastern parts of Kazakhastan, namely *A. jubatus* and *Mesasippus arenosus* (Bey-Bienko, 1930) (Baturina et al. 2024).

However, across the adjacent territories, the situation with this species does not cause alarm and some populations are in good conditions now and may become more prosperous in the future, although it is forecasted that the general character of its distribution may change quite slightly. Moreover, the species populations can exist in the several nature reserves (including some biosphere ones), namely Bogdo–Baskunchak, Orenburg, Ubsunorskaya Kotlovina (Russia), Naurzum, Korgalzhyn, Ustyurt, Alakol (Kazakhstan), Badhyz, Sünt–Hasardag, Köpetdag (Turkmenistan), Uvs Nuur Basin and Great Gobi (Mongolia). Nevertheless, the areas where the bioclimatic conditions are very suitable for *E. simplex* overlap significantly with the similar areas for several very important pests, primarily the Italian locust *Calliptamus italicus* (Linnaeus, 1858) (Sergeev et al. 2025). This means some treatments against the Italian locust may lead to the extinction of the local *E. simplex* populations (Sergeev 1996, 1998, 2021b).

Acknowledgements

We wish to express our thanks to the late L. L. Mistshenko (St. Petersburg) for his advices and cooperation and to all collectors of specimens. We are also indebted to all companions of our numerous field trips to the region studied (especially A. V. Lopatkin). We also thank reviewers for their valuable comments and suggestions.

Our researches were financially supported by the grant of the Russian Science Foundation 22-66-00031 (https://rscf.ru/en/project/22-66-00031).

References

Baturina NS, Kim-Kashmenskaya MN, Molodtsov VV, Popova KV, Sergeev MG (2024) Endemic grasshoppers (Orthoptera, Acridoidea) of the steppes of West Siberia and North-East Kazakhstan: How can we estimate their future? Acta Biologica Sibirica 10: 819–834. https://doi.org/10.5281/zenodo.13379288

Berezhkov RP (1956) The grasshoppers of West Siberia. Tomsk University Publ., Tomsk, 175 pp. [In Russian]

Bey-Bienko GYa, Mistshenko LL (1951) Locusts and grasshoppers of the USSR and adjacent countries. Vol. 1–2. USSR Academy of Science Publ., Moscow-Leningrad, 667 pp. [In Russian]

Bugrov AG, Sergeev MG, Vysotskaya LV (1993) The phylogenetic status of the grasshopper genus *Eremippus* Uv. (Orthoptera, Acrididae). Cytogenetic analysis. In: Chubareva LA, Kuznetsova VG (Eds) Karyosystematics of Invertebrate Animals. Vol. 2. Zoological Institute, Saint-Petersburg, 18–21. [In Russian]

Childebaev MK (1999) Fauna and ecological distribution of acridids in the southern part of Turgay depression. Tethys. Entomological Research 1: 81–86. [In Russian]

Chogsomzhav L (1974) Orthopteroidea of West and South Mongolia. Insects of Mongolia 2: 23–33. [In Russian]

Cigliano MM, Braun H, Eades DC, Otte D (2025) *Eremippus* Uvarov, 1926. Orthoptera Species File. Available from: http://orthoptera.speciesfile.org/otus/ 812267/overview (Accessed on 01 March 2025).

Descamps M (1967) Revue et diagnose préliminaire de quelques Pamphagidae et Acrididae d'Iran [Orth. Acridoidea]. Bulletin de la Société entomologique de France 72 (1–2): 27–37. https://doi.org/10.3406/bsef.1967.20917

Elith J, Phillips SJ, Hastie T, Dudík M, Chee YE, Yates CJ (2011) A statistical explanation of MaxEnt for ecologists. Diversity and Distributions 17: 43–57. https://doi.org/10.1111/j.1472-4642.2010.00725.x

Eversmann E (1859) Orthoptera Volgo-Uralensia. Bulletin de la Société Impériale des Naturalistes de Moscow 32: 121–146.

Fick SE, Hijmans RJ (2017) WorldClim 2: New 1 km spatial resolution climate surfaces for global land areas. International Journal of Climatology 37: 4302–4315. https://doi.org/10.1002/joc.5086

Gause GF (1930) Studies on the ecology of the Orthoptera. Ecology 11: 307–325. https://doi.org/10.2307/1930266

Gorochov AV, Mistshenko LL, Podgornaja LI (1989) Materials on the fauna and ecology of Orthoptera of the Transaltai Gobi. Insects of Mongolia 10: 97–117. [In Russian]

Guliaeva ON, Vysotskaya LV, Sergeev MG (2005) Taxonomic and phylogenetic relationships of the Holarctic grasshoppers (Orthoptera, Acrididae): A new view on old problems. Euroasian Entomological Journal 4(2): 87–94. [In Russian]

Jago ND (1996) Review of western and eastern African genera of the *Dnopherula* complex (Orthoptera, Acridoidea, Gomphocerinae) with description of new genera and species. Journal of Orthoptera Research 5: 69–124. https://doi.org/10.2307/3503585

Johnston HB (1956) Annotated catalogue of African grasshoppers. Cambridge University Press, Cambridge, 833 pp.

Latchininsky AV, Sergeev MG, Childebaev MK, Chernijakhovskij ME, Lockwood JA, Kambulin VE, Gapparov FA (2002) The grasshoppers of Kazakhstan, Middle Asia and adjacent territories. Association for Applied Acridology International & University of Wyoming, Laramie, 387 pp. [In Russian]

Lehr PA (1962) Data on biology of the Turan and desert locusts (Orthoptera, *Calliptamus*) in the Chimkent [Shymkent] Oblast. Trudy Nauchno-Issledovatelskogo Instituta Zastshity Rastenij KazSSR 7: 3–56. [In Russian]

Malkovskiy MP (1964) Grasshoppers of the Mangistau County of the Guryevsk Region. Trudy Nauchno-Issledovatelskogo Instituta Zastshity Rastenij KazSSR 8: 260–266. [In Russian]

Meinshausen M, Nicholls ZRJ, Lewis J, Gidden MJ, Vogel E, Freund M, Beyerle U, Gessner C, Nauels A, Bauer N, Canadell JG, Daniel JS, John A, Krummel PB, Luderer G, Meinshausen N, Montzka SA, Rayner PJ, Reimann S, Smith SJ, van den Berg M, Velders GJM., Vollmer MK, Wang RHJ (2020) The shared socioeconomic pathway (SSP) greenhouse gas concentrations and their extensions to 2500. Geoscientific Model Development 13: 3571–3605. https://doi.org/10.5194/gmd-13-3571-2020

Mistshenko LL (1974) On the knowledge of grasshoppers of the genus *Dociostaurus* Fieb. (Orthoptera, Acrididae). I. Revue d;ENtomologie de l'URSS 53(2): 335–342. [In Russian]

Phillips SJ, Anderson RP, Schapire RE (2006) Maximum entropy modeling of species geographic distributions. Ecological Modelling 190: 231–259. https://doi.org/10.1016/j.ecolmodel.2005.03.026

Phillips SJ, Anderson RP, Dudík M, Schapire RE, Blair B (2017) Opening the black box: An open-source release of Maxent. Ecography 40: 887–893. https://doi.org/10.1111/ecog.03049

Popova KV, Molodtsov VV, Sergeev MG (2020) Rare grasshoppers (Orthoptera, Acridoidea) of the Baraba and Kulunda steppes (South Siberia). Acta Biologica Sibirica 6: 595–609. https://doi.org/10.3897/abs.6.e59519

Popova KV, Molodtsov VV, Efremova OV, Sergeev MG (2021) Grasshoppers in steppe areas of the south-eastern West Siberian Plain: Centennial transformations of biodiversity. IOP Conference Series: Earth and Environmental Science 817: 012088. https://doi.org/10.1088/1755-1315/817/1/012088

Pradvin FN (1978) Ecological geography of insects of Middle Asia. Orthopteroidea. Nauka Publ., Moscow, 271 pp. [In Russian]

Pravdin FN, Mistshenko LL (1980) Formation and evolution of insects' ecological faunas in Middle Asia. Nauka Publ., Moscow, 156 pp. [In Russian]

QGIS (2024) QGIS. A free and open source geographic information system. https://www.qgis.org

Savitsky VYu (2007) New data on acoustic communication and ecology of grasshoppers of the genera *Eremippus* and *Dociostaurus* (Orthoptera, Acrididae) and notes on the use of bioacoustic data in supraspecific taxonomy of the subfamily Gomphocerinae. Entomological Review 87: 631–649. https://doi.org/10.1134/S0013873807060012

Savitsky VYu, Prosvirov AS, Gusakov AA (2013) Fauna, features of separation of ecological niches and reproductive isolation of grasshoppers (Orthoptera: Acridoidea) in the southern part of Astrakhan Region (Russia) in environs of the Dosang station. Caucasian Entomological Bulletin 9(1): 7–29. [In Russian]

Séférian R (2018) CNRM-CERFACS CNRM-ESM2-1 Model Output Prepared for CMIP6 CMIP Amip. Version 20211010. Earth System Grid Federation. https://doi.org/10.22033/ESGF/CMIP6.3924

Sergeev MG (1985) New records of Orthoptera in Siberia and their possible zoogeographical consequence. Part. 2. In: Zolotarenko GS (Ed.) Arthropods of Siberia and the Far East. Nauka Publ., Novosibirsk, 47–49 p. [In Russian]

Sergeev MG (1986) Distribution patterns of Orthoptera in North Asia. Nauka Publ., Novosibirsk, 237 pp. [In Russian]

Sergeev MG (1992) Distribution patterns of Orthoptera in North and Central Asia. Journal of Orthoptera Research 1: 14–24. https://doi.org/10.2307/3503557

Sergeev MG (1996) La sécheresse et les schémas de distribution des criquets en Asie centrale et septentrionale. Sécheresse 7(2): 129–132.

Sergeev MG (1998) Conservation of orthopteran biological diversity relative to landscape change in temperate Eurasia. Journal of Insect Conservation 2: 247–252. https://doi.org/ 10.1023/A:1009620519058

Sergeev MG (2021a) Distribution patterns of grasshoppers and their kin over the Eurasian steppes. Insects 12: 77. https://doi.org/10.3390/insects12010077

Sergeev MG (2021b) Ups and downs of the Italian locust (*Calliptamus italicus* L.) populations in the Siberian steppes: On the horns of dilemmas. Agronomy 11: 746. https://doi.org/10.3390/agronomy11040746

Sergeev MG, Bugrov AG (1990) A new species of the genus *Eremippus* (Orthoptera: Acrididae) from Daghestan. Vestnik Zoologii 1: 59–61. [In Russian]

Sergeev MG, Childebaev MK, Ji R, Molodtsov VV, Baturina NS, Van'kova IA, Kim-Kashmenskaya MN, Popova KV, Zharkov VD, Yefremova OV (2025) Ecologo-geographic distribution patterns of the Italian locust *Calliptamus italicus* (Linnaeus) (Orthoptera: Acrididae) in the easternmost part of its range. Insects 16: 211. https://doi.org/10.3390/insects16020211

Sergeev MG, Molodtsov VV (2024) New data on distribution of *Miramiola pusilla* (Miram, 1927) (Orthoptera: Tettigoniidae). Far Eastern Entomologist 496: 16–24. https://doi.org/ 10.25221/fee.496.4

Sergeev MG, Storozhenko SYu, Benediktov AA (2019) An annotated check-list of Orthoptera of Tuva and adjacent regions. Part 2. Suboder Caelifera. Tridactylidae, Tetrigidae, Acrididae: Melanoplinae, Calliptaminae, and Gomphocerinae (except Gomphocerini). Far Eastern Entomologist 389: 7–44. https://doi.org/10.25221/fee.389.2

Stolyarov MV (1972) New data on grasshoppers (Orthoptera, Acrididae) of Afghanistan. Revue d'Entomologie de l'USSR 51(1): 98–101. [In Russian]

Terskov EN (2020) A review of the fauna and bionomics of grasshoppers (Orthoptera: Acridoidea) of the Ciscaucasia. Caucasian Entomological Bulletin 16: 103–123. https://doi.org/10.23885/181433262020161-102123 [In Russian]

Tokgaev T (1972) Fauna and ecology of grasshoppers of Turkmenistan. Ylym Publ., Ashgabat, 220 pp. [In Russian]

Tzyplenkov EP (1960) Acrididae (Orthoptera) of Sinkiang, NW China. Revue d'Entomologie de l'USSR 39(3): 610–616. [In Russian]

Uvarov BP (1926) New or less known Acrididae from Central Asia. Eos, Revista española de Entomología 2: 321–359.

WorldClim (2022) WorldClim https://worldclim.org/data/index.html

Zubowsky N (1898) Zur Acridiodea-Fauna des asiatischen Russlands. Annuaire du Musée Zoologique de l'Académie Impériale des Sciences de St.-Pétersbourg 1: 68–110.

Supplementary material 1

Table 1S. The geographic coordinates of known localities of the model species

Authors: Michael G. Sergeev, Olesya G. Buleu, Marya N. Kim-Kashmenskaya, Vladimir V. Molodtsov, Oxana V. Yefremova

Data type: table

Link: https://journal.asu.ru/biol/article/view/17211/14882