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# NEW DATA ON DISTRIBUTION OF *MIRAMIOLA PUSILLA* (MIRAM, 1927) (ORTHOPTERA: TETTIGONIIDAE)

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**Summary**. The rare bush-cricket *Miramiola pusilla* (Miram, 1925) is distributed over the dry steppe and semi-desert territories of Eurasia from the southern parts of East European Plain up to the southern parts of West Siberian Plain and the Tarbagatai Mts. (E Kazakhstan). The species is strongly associated with short grass vegetation. Its abundance is usually low. The ecologo-geographic models of the species distribution over the eastern parts of its range are generated by the Maxent algorithm for the first time. The species conservation status is discussed.

**Key words**: bush-crickets, Ctenodecticini, diversity, new record, range, modelling, West Siberia, Kazakhstan.

**М. Г. Сергеев, В. В. Молодцов. Новые данные о распространении *Miramiola pusilla* (Miram, 1927) (Orthoptera: Tettigoniidae) // Дальневосточный энтомолог. 2024. N 496. С. 16-24.**

**Резюме**. Редкий кузнечик *Miramiola pusilla* (Miram, 1927) распространен в степях и полупустынях Евразии от юга Восточно-Европейской равнины до юго-востока Западно-Сибирской равнины и хр. Тарбагатай (Восточный Казахстан). Отмечено, что вид предпочитает стации с преобладанием невысоких злаков. Впервые созданы с использованием пакета Maxent эколого-географические модели распространения данного кузнечика в азиатской части России. Обсуждается охранный статус вида.

## INTRODUCTION

The bush-cricket *Metrioptera pusilla* was described by Miram (1927) from the famous Nature Reserve (Zapovednik) Askaniya-Nova (from 1985 – the Biosphere Reserve as well) in the southern steppes of East European Plain (46.46–46.47°N, 33.87–33.88°E) (Medevedev, 1928). Later, she characterized its male (Miram, 1928). A decade after, Uvarov (1939) erected the new genus *Miramiola* for this species. Subsequently, *M. pusilla* was also recorded from the steppes of the south-eastern parts of European Russia (Kritskaya, 1997; Zinenko *et al*., 2005), Kazakhstan (Bey-Bienko, 1964; Sergeev & Sergeeva, 1985; Guseva,

1986; Childebaev & Storozhenko, 2004; Childebaev, 2017; Kadyrbekov *et al*., 2017), and the southern parts of West Siberian Plain (Nefedov & Miram, 1939; Sergeev, 1982, 2019, 2021b). However, our knowledge about distribution and bionomics of this species remains very limited despite its relatively high abundance in some very suitable habitats (Kritskaya, 1997). One of the main reasons is associated with small size of adults (about 10 mm without an ovipositor and legs) and common dominance of the brachypterous form. This is why some collectors, especially inexperienced, might think that these tiny insects are nymphs. In the present paper, we try to summarize the published and original data on the species distribution and biology and to suggest ecologo-geographic models of its possible distribution over this territory.

## MATERIAL AND METHODS

The individuals of this small and rare species (Fig. 1) were mainly collected by M.G. Sergeev (MS). We studied also specimens stored in the collections of Novosibirsk State University and the Zoological Institute of the Russian Academy of Sciences (St. Petersburg). Nomenclature is given according to Cigliano *et al*. (2024).

We used the Maxent 3.4.4 package based on the machine-learning approach (Phillips *et al.,* 2006, 2017; Elith *et al*., 2011) and the resources of WorldClim 2 (Fick & Hijmans, 2017; WorldClim, 2022) (19 standard annually averaged bioclimatic variables at the 30 arcsecond spatial resolution for historical and future climate data) to model the actual species distribution and to predict some possible shifts of its distribution in the future. The Maxent models were produced on the basis of the full sets of applicable bioclimatic variables and following parameters: features – auto, output format – cloglog (Phillips *et al.*, 2006), regularization multiplier = 1. We estimated their accuracy by the AUC (the area under the receiver operating characteristic curve) values for sets of 25 replicates with cross-validation and significance of climatic variables by their predictive contributions and Jackknife tests. Maps of species distribution were produced with MapInfo 15.2.4. A Lambert conformal conic projection was used as the basic map.

Fig. 1. *Miramiola pusilla* male from the species usual habitat in the Kulunda steppe, Altaiskij Krai (Photo M. Sergeev).

## NEW RECORDS

***Miramiola pusilla* (Miram, 1927)**
Fig. 1

*Metrioptera pusilla* Miram, 1927: 181 (holotype: female, Askaniya Nova; kept in the Zoological Institute, St. Petersburg); Miram, 1928: 293–294 (male designated as "allotype", Askaniya Nova; kept in the Zoological Institute, St. Petersburg).

*Miramiola pusilla*: Uvarov, 1939: 135–136; Bey-Bienko, 1964: 233; Sergeev, 1982: 42; 1986: 182; Heller *et al*., 1998: 34; Storozhenko, 2004: 136; Childebaev & Storozhenko, 2004: 218.

MATERIAL EXAMINED. **Russia**: Orenburg Oblast (Region): Belyayevka settlement, 51.4°N, 56.39°E, 5.VIII 1932, 3♂, 1♀ (L. Zimin). Novosibirsk Oblast (Region): 40 km W Karasuk, Solenoye Lake 53.68°N, 77.62°E 9.VIII 1972, 1♂, 1♀; Karasuksky Raion (District), S Aleksandorvskij settelement, 53.67°N,78.25°E, steppes, including plots treated against the Italian locust *Calliptamus italicus* (L.), 27.VI–20.VII 2000, 2♂ (f. macroptera), 1♀ (f. macroptera), 2 nymphs (MS); the same locality, 5.VI–5.VII 2001, 5♂, 2♀, 3 nymphs (MS, M. Peshkova); the same locality, 11.VI–13.VII 2002, 3♂, 4♀, 1 nymph (MS, E. Kuznetsova, M. Schweigert, O. Shalimova); the same locality, 12.VII 2004, 1♀ (MS); the same locality, 14.VII 2007, 1♂ (MS); the same locality, 12.VII 2008, 1♂ (MS). Altai Krai (Region): Burla River, left side, NW Burla, 53.35°N, 78.28°E, southern slope, dry steppe and very old *Agropyron cristatum* field, 06.VIII 1980, 3♂ (MS); E Burlinskoye Lake, near Bursol settlement, 53.16°N, 78.01°E, dry steppe, 17.VII 2018, 1♂ (MS); W Bolshoye Yarovoe Lake, 52.85°N, 78.55°E, dry steppe (very old *Agropyron cristatum* field), 28.VII 1999, specimens observed (MS); the same locality, 10.VII 2006, 1♀ (MS); the same locality, 13.VII 2007, 1♀ (MS), the same locality, 14.VI 2015, 1♀, 1 nymph (MS); Blagovechensky Raion, Kuchuk River, lower course, 52.68°N, 80.06°E, 30.VI 2016, steppes including the transformed ones, 2♂, 1♂ (f. macroptera), 5♀, 1♀ (f. macroptera) (MS); Rodinsky Raion, near Kayaushka settlement, Kuchuk River, 52.53°N, 80.48°E, terrace, steppe with *Leymus*, 12 VII 1992, 1♀ (MS); Volchikhinsky Raion, near Novokormikha settlement, 52.15°N, 80.12°E, dry steppe, 9.VII 2004, 1♂ (MS); W Bor-Forpost settlement, 51.87°N, 80.03°E, dry steppe (very old *Agropyron cristatum* field), 14.VI 2015, 1♂, 1 nymph (MS). **Kazakhstan**: Pavlodar Oblast (Region): Trofimovka settlement, 53.5°N, 76.92°E, dry steppe, 17.VII 1972, 1♂ (I. Stebaev); near Matogul settlement, 53.4°N, 75.89°E, *Agropyron cristatum* field, 9.VIII 1980, 1♀ (A. Lee); near Osmeryzhsk settlement, 53.1°N, 75.92°E, plain and upper terrace, steppe with *Stipa* and *Spiraea*, 19.VII 1972, 2♂, 1♀ (A. Lopatkin, I. Stebaev); near Mamait Omarov (Griaznovka) settlement, 51.91°N, 77.07°E, hollow, steppe with *Stipa*, 4.VII 1975, 2♀ (S. Kovalenko, I. Stebaev). Akmola Oblast (Region): NE Turgai settelement, 51.8°N, 72.88°E, southern slopes and piedmont plain, dry steppe, 21.VII 1980, 1♂, 1♀ (MS). Abai Oblast (Region): Tchar River, 49.71°N, 80.81°E, low terrace and hollow, dry steppe, 28–30.VII 1972, 3♀ (A. Lopatkin, I. Stebaev); Ayagöz River, 26 km downstream Ayagöz, 47.88°N, 80.11°E, slopes and upper terraces, dry steppes, VI 1976, 1♂, 1♀ A. Lopatkin); the same locality, mountain dry steppe, 4.VII 1991, 1♀ (MS); Tarbagatai Mts., northern slope, Tebeske River, 47.42°N, 82.85°E, hollow, steppe with Stipa, 3.VIII 1972, 1♀ (I. Stebaev). Karaganda Oblast (Region): near Karagandy, Dolinskoe (Dolinka), 49.68°N, 72.69°E, 4.VIII 1934, experimental plot, dry steppe, 1♂ (A. Kazanskij).

REMARKS. The description of the species was based on the only female from the Nature Reserve Askaniya-Nova in the southern steppes of East European Plain (Miram, 1927). This female is the holotype (Storozhenko, 2004). Later Miram (1928) described the male of this species and designated it as the allotype. However, this specimen can't be considered as the member of the type series.

DISTRIBUTION. The steppe and semi-desert areas of Eurasia from the southern part of East European plain up to the south-eastern parts of West Siberian Plain and the northern slopes of the Tarbagatai Mts. in east Kazakhstan (Fig. 2).

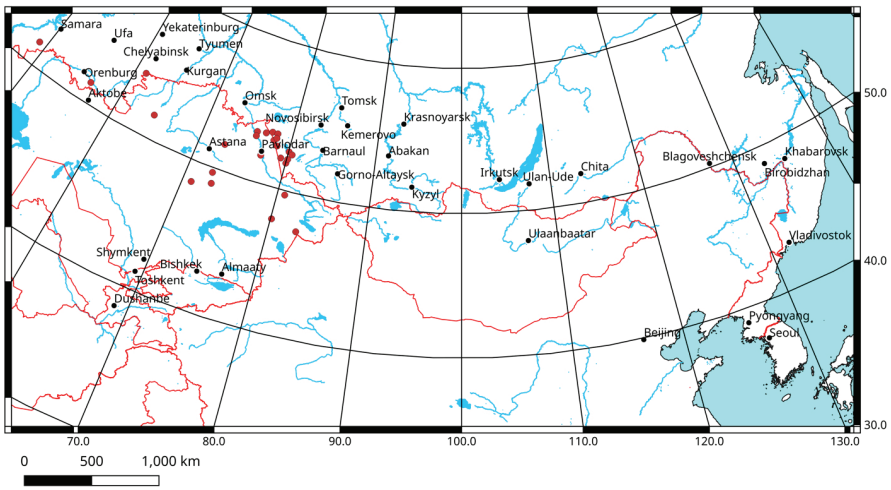


Fig. 2. *Miramiola pusilla* known localities in the Asian part of its range.

## ECOLOGICAL PREFERENCES

Almost all authors note that *Miramiola pusilla* prefers the dry steppes with presence of relatively short grasses, such as the Volga fescue (*Festuca valesiaca*), the crested wheat grass (*Agropyron cristatum*), and *Stipa* spp. However, the species individuals' distribution is very heterogeneous, and its more or less dense groups may be observed inside the grassy patches. The individuals often stay inside such patches and probably they feed on grasses.

*Miramiola pusilla* was very rare in the steppes of the Saratov Oblast (Zinenko *et al*., 2005) and in the Troitsk Forest-Steppe Reserve (now the so-called zakaznik in the Chelyabinsk Oblast) (Nefedov & Miram, 1939). Childebaev (2017; Kadyrbekov *et al*., 2017) also emphasized rarity and low abundance of this bush-cricket across the central parts of Saryarka (Kazakh Uplands) in Kazakhstan. However, in the dry steppes and the semi-deserts of the Zhanybek vicinities near the border of Kazakhastan and Russia, the species was distributed over almost all habitats studied and was very abundant, especially in June (Kritskaya, 1997).

Our data show that, in the central and eastern parts of Saryarka, in the Kulunda steppe, and in the Tarbagatai Mts., the abundance of this species is low and varies usually around 3–12 per hour (cf. Childebaev, 2017; Kadyrbekov *et al*., 2017). The maximal level of the abundance (30 individuals per hour) was fixed on the steppe plot near Aleksandorvskij settelement (SW Novosibirsk Oblast) in the end of June, 2001. The species density may be about 0.16–0.48/m$^2$. However, the species occurs not only in the steppe habitats per se, but also across the agricultural fields (especially in the old fields of *Agropyron cristatum*).

*Miramiola pusilla* could be found in the habitats where the Italian locust *Calliptamus italicus* (Linnaeus), the handsome cross grasshopper *Oedaleus decorus* (Germar) and some other possible pests may be extremely abundant (Sergeev, 2021; Popova *et al*., 2021). However, the treatments (particularly the barrier ones) against the Italian locust populations with different insecticides did not devastate the populations of the bush-cricket (Sergeev, 2021).

## ECOLOGO-GEOGRAPGICAL MODELS OF DISTRIBUTION

The Maxent ecologo-geographic model shows that the most suitable areas for this bush-cricket are distributed over the steppes and the semi-deserts between the Volga River in the west and the Altai Mts. in the east and border the northern boundaries of the steppes to the north and the southern edge of Saryarka and Tarbagatai Mts. to the south (Fig. 3).

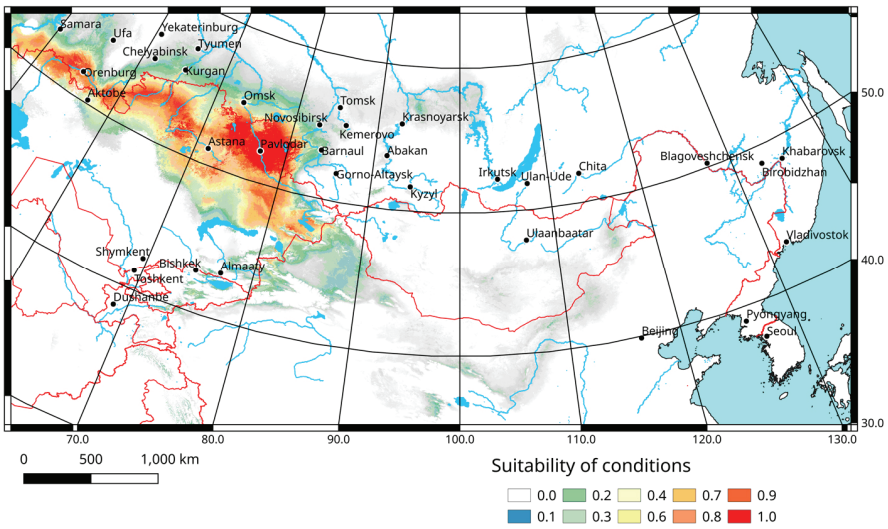


Fig. 3. Predicted probabilities of suitable conditions for *Miramiola pusilla* according the Maxent model (all distribution data and bioclimatic variables for 1970–2000; point-wise mean for 25 replicates).

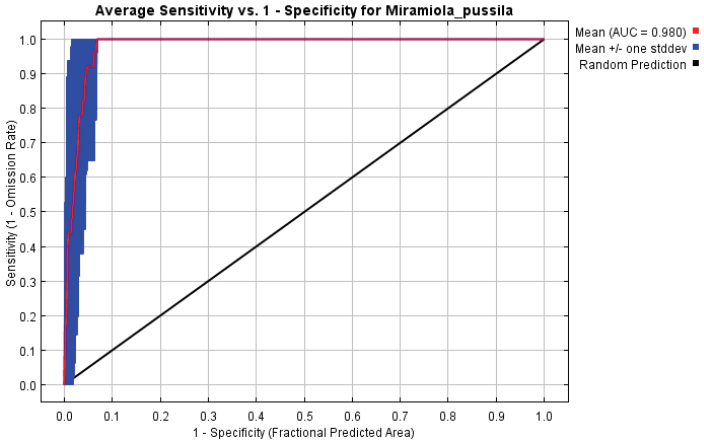


Fig. 4. Reliability test for the *Miramiola pusilla*. Maxent distribution model (bioclimatic variables for 1970–2000; 25 replicates with cross-validation).

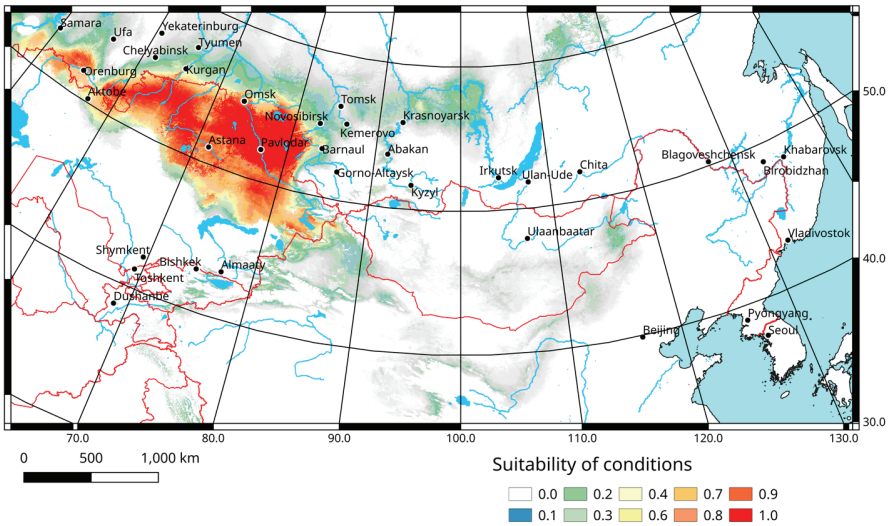


Fig. 5. Predicted probabilities of suitable conditions for *Miramiola pusilla* according the Maxent model for 2021–2040 (all distribution data and bioclimatic variables; point-wise mean for 25 replicates; CNRM-ESM2-1 (Séférian *et al*., 2019) climatic model for 3-7.0 Shared Socioeconomic Pathway (Meinshausen *et al*., 2020).

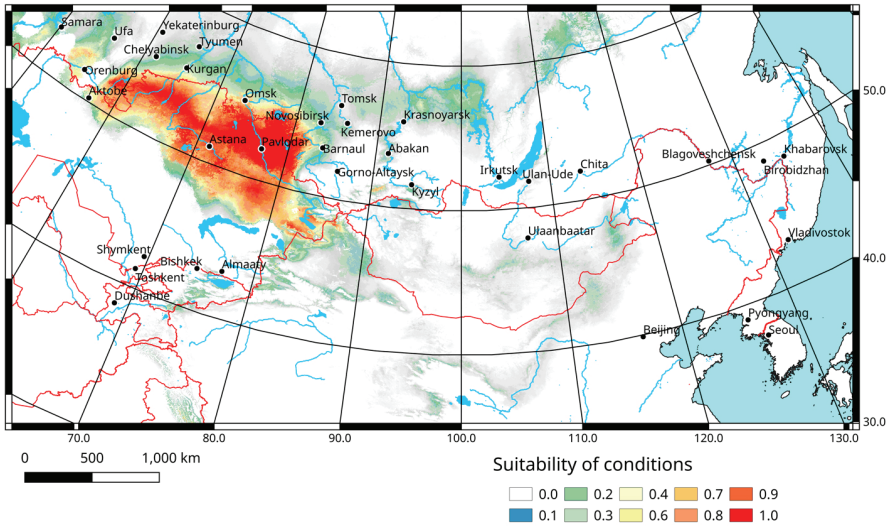


Fig. 6. Predicted probabilities of suitable conditions for *Miramiola pusilla* according the Maxent model for 2041–2060 (all distribution data and bioclimatic variables; point-wise mean for 25 replicates; CNRM-ESM2-1 (Séférian *et al*., 2019) climatic model for 3-7.0 Shared Socioeconomic Pathway (Meinshausen *et al*., 2020).

The Maxent model performance is almost perfect (especially taking into account a few samples), because the AUC value for 25 replicates equals 0.98 (Fig. 4). According the Maxent model, the precipitation of driest quarter is the most important factor (contribution – 20.5%). The precipitation of wettest quarter (19.7), the annual mean temperature (17.1), and the mean temperatures of driest quarter (10.3) are also significant. The Jackknife test allows to add the precipitation of warmest quarter and the mean temperature of wettest quarter as well.

The models for both 2021–2040 (Fig. 5) and 2041–2060 (Fig. 6) based on high rates of greenhouse gas emission forecast significant possible shifts in the species distribution. The optimal areas may cover territories from 55°N (Kurgan – Omsk – Novosibirsk), especially in the south-eastern parts of West Siberian Plain, up to the southern edge of Saryarka (Kazakh Uplands) and the Tarbagatai Mts.

However, across the territories between the Volga River and the south-western parts of West Siberian Plain, the conditions for *Miramiola pusilla* may become worse, especially in the middle of the 21st century (Fig. 6).

## CONCLUSION

The small bush-cricket *Miramiola pusilla* is one of the rare orthopteran species in the temperate Asia, but its whole range occupies about 1,800,000 km$^2$. Taking into account relatively low mobility of this insect, its range looks like severely fragmented and the number of its local insular populations can be estimated at least 50–60. However, in almost all cases, the species abundance is relatively low and its populations are usually stenotopic. Furthermore, they may be eliminated or destroyed as a result of the steppe transformation during ploughing and overgrazing. This is why the species may be characterized as Least Concern (LC) (IUCN, 2001). Now it is not included in the state and regional Red Books, but the species occurs or should occur in some steppe Nature Reserves (Askaniya-Nova, Korgalzhyn, Naurzum, Orenburg, Rostov etc.).

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