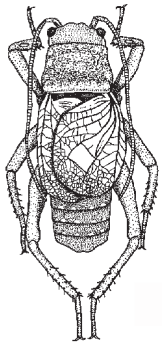

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THE THICK-BELLIED KATYDID *DERACANTHA ONOS* (ORTHOPTERA, TETTIGONIIDAE, ZICHYINI): DISTRIBUTION PATTERNS AND ECOLOGO-GEOGRAPHIC MODELLING

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Summary. The general distribution patterns and some peculiarities of bionomics are characterized for the katydid *Deracantha onos* (Pallas, 1772). Several ecologo-geographic models (regional and global) of the species distribution are produced by the Maxent algorithm for the first time. Some possible shifts in the species range are debated for the future periods (2021–2040 and 2041–2060).

Key words: fauna, new record, range, modelling, climate change, Siberia, Russian Far East, Mongolia, North China.

М. Н. Ким-Кашменская, С. В. Лаптева, В. В. Молодцов, С. Ю. Стороженко, М. Г. Сергеев. Кузнечик грузное гуло *Deracantha onos* (Orthoptera, Tettigoniidae, Zichyini): закономерности распространения и эколого-географическое моделирование // Дальневосточный энтомолог. 2025. N 530. С. 1-12.

Резюме. Характеризуется таксономическое положение, общее распространение и некоторые экологические особенности кузнечика грузное гуло *Deracantha onos* (Pallas, 1772). С использованием алгоритма Maxent впервые сгенерированы несколько эколого-географических моделей его распространения в регионе и в целом для мира. Обсуждаются возможные изменения ареала вида для будущих периодов (2021–2040 и 2041–2060 гг.).

INTRODUCTION

The bush-cricket *Deracantha onos* was described as *Gryllus onos* by P.S. Pallas (1772) from Transbaikalia (Dauria) without exact indication of the type locality. However, several specimens were probably collected in the region of Nerchinsky Zavod (Argun Mines) near the Argun River in the easternmost part of the modern Zabaikalsky Krai. Later, G. Fischer von Waldheim (Fischer de Waldheim, 1833) erected the genus *Deracantha* for *Locusta onos*, *Deracantha cinctus* F.d.W., *D. camelus* F.d.W. from Dauria, *D. antilope* F.d.W., and *D. aranea* F.d.W. from Dauria. In 1846, he synonymized this genus with the genus *Ephippiger* Berthold, 1827 and noted that *Ephippiger onos* was collected from the Baikal Region (Fischer de Waldheim, 1846). However, F.X. Fieber (1853) resurrected the independent status the genus *Deracantha*. Later, *Gryllus onos* was designated as the type species of the genus *Deracantha* (Kirby, 1906). Almost simultaneously I. Bolívar (1901) erected the new tribe Zichyini for several genera from Asia and G.G. Jacobson (1905) characterized the new family Deracanthidae for the same group of katydids. Now the genus *Deracantha* included four species from South Siberia, Mongolia, the Russian Far East, the Korean Peninsula, North and, probably, North-East China (Storozhenko, 2004; Cigliano *et al*., 2025). *D. onos* is the most widespread member of this genus.

The specific, monstrous appearance of *D. onos* as well as some of its relatives has long attracted the attention of people, including researchers. The main peculiarities of its ecology were carefully described by I.A. Dmitrieva-Jurgenson (1950). Later, some additional data including main characteristics of acoustic behavior were published by J. Shen and L. Guan (1988), N.F. Elaeva and N.A. Elaeva (2010), N.F. Elaeva and O.S. Korsunovskaya (2012), and J. Wang *et al.* (2013). The karyotype of this species was described by M.G. Sergeev and A.G. Bugrov (1988) and E. Warchalowska-Śliwa and A.G. Bugrov (1997). The data on the complete mitochondrial genome of *D. onos* (Zhou *et al*., 2009) most likely belong to another species of this genus, e.g., either *D. transversa* Uvarov, 1930 or *D. grandis* (Lucas, 1863), because the source materials used came from the southern part of Shanxi Province, located far from the known range of the *D. onos*.

Despite its predominantly herbivorous nature, there are no particular grounds for including this species in the list of pests (Anisimov, 2019). However, the species is included in some lists of possible invaders associated with fresh apples' import from China (Biosecurity Australia, 2010; Wistermann *et al*., 2016), although the real associations between this bush-cricket and apple fruits is highly questionable and is most likely based on misidentification of insects.

The goals of the article are to reveal the general patterns of the species distribution characterize some peculiarities of its ecological preferences and produce several models of its distribution for the current and future periods and for the its known range and for the whole world.

MATERIAL AND METHODS

The data on species occurrences were extracted from field notes of our expeditions (1975, 1977, 1982, 2007), from labels of specimens in the collections of the Federal Scientific Center of the East Asia Terrestrial Biodiversity (Vladivostok), the Institute of Systematics and Ecology of Animals (Novosibirsk), Novosibirsk State University, the Zoological Institute of the Russian Academy of Sciences (St. Petersburg), and Tomsk State University, and from different publications (Bey-Bienko, 1929; Dmitrieva-Jurgenson, 1950; Čejchan, 1967, 1968; Mistshenko, 1968; Bazyluk, 1969, 1970, 1972, 1993; Sergeev & Bugrov, 1988; Chogsomzhav, 1972; Dubatolov & Sergeev, 1999; Akulova, 2008; Jung, 2008; Elaeva & Elaeva, 2010; Elaeva & Korsunovskaya 2012; Korsun *et al.,* 2012; Sergeev *et al*., 2018; Lapteva, 2023). In the absence of data on geographic coordinates obtained using the Glonass/GPS receivers, we utilized Google Earth Pro (©Google, 2022) to evaluate them.

During field trips we used quantitative and qualitative methods to reveal local distribution patterns and abundance of orthopteran insects across natural, semi-natural and transformed habitats (Gause, 1930; Sergeev, 1986, 2011, 2021). The species abundance was estimated by samples collected during a fixed period of time in each habitat investigated. According this method, individuals were caught with a standard entomological net (40 cm diameter) during 10–30 minutes. Results for each habitat were recounted to one hour. We often simultaneously estimated insects' densities on randomly distributed plots 1 x 1 m^2.

Maps were produced by the QGIS 3.18.3. We used a Lambert conformal conic projection for the basic map for the main model region (southern parts of Asian Russia and adjacent territories) and a Mercator (conformal cylindrical) projection for the whole world. The maximum entropy software (Maxent 3.4.4) (Phillips *et al.,* 2006) was used to produce several models of ecologo-geographic distribution of *D. onos* with the following parameters: features – auto, output format – cloglog, regularization multiplier = 1. These models were based on the distribution of 19 standard annually averaged bioclimatic variables at the 30 arcsecond spatial resolution for the model region and 2.5 arcminute resolution for the world ("Historical climate data") (Fick & Hijmans, 2017; WorldClim, 2022). Some possible shifts in the species distribution in the future were revealed on the basis of the global climatic model CNRM-ESM2-1 (Séférian, 2018) for the 3–7.0 Shared Socioeconomic Pathway (Meinshausen *et al*., 2020).

Accuracy of modelling was estimated by using the AUC (the area under the receiver operating characteristic curve) for sets of 25 replicates with cross-validation. Roles of various bioclimatic variables were evaluated by their predictive contributions and Jackknife tests.

SYNONYMY AND GENERAL DISTRIBUTION

***Deracantha onos* (Pallas, 1772)**
Fig. 1

Gryllus onos Pallas, 1772: 17.
Ephippiger onos: Fischer de Waldheim, 1846: 190.
Deracantha onos: Fischer de Waldheim, 1833: 375; Jacobson, 1905: 423; Storozhenko, 2004: 170.
Deracantha onos onos: Čejchan, 1967: 612.
Deracantha cincta Fischer de Waldheim, 1833. Synonymized by Storozhenko (2004).
Ephippiger cinctus: Fischer de Waldheim, 1846: 192.
Ephippiger spinosus Fischer von Waldheim, 1846: 195. Synonymized by Storozhenko (2004).
Zichya spinosa: Jacobson, 1905: 425.
Deracantha klimaszewskii Bazyluk, 1969: 169. Synonymized by Storozhenko (2004).

MATERIAL EXAMINED. **Russia:** Republic of Buryatia: Gusinoe Lake, Baraty, 25-26.VII 2007, 4♂, 2♀ (Storozhenko); Naushki, Selenga River, 30.VII 2007, 3♂, 1♀ (Storozhenko); Kyakhta City, 28-29.VII 1977, 7♂, 1♀ (Storozhenko); neighborhood Kyra Village, 30-31.VII 1956, 1♂, 1♀ (Kurentsov and Kononov). Zabaykalsky Krai: 20 km S of Krasnokamensk, 04.VIII 2007, 6♂ (Storozhenko); Narasun Village, 26.VII 1956, 1♂, 1♀ (Kononov); Asma and Duldurga Rivers, 06.VIII 1956, 1♂ (Kononov); 35 km S Borzya, 20.VII 1977, 2♂ (Storozhenko); 10 km SW Borzya, Chindant-2 Village, 09.VI 1977, 1 nymph (Storozhenko). Amurskaya Oblast: Blagoveshchensk, Mokhovaya Pad, 25-29.VIII 2000, 4♂, 1♀ (Kuzmin); 20 km N Blagoveshchensk City, 15.VIII 2002, 2♂, 1♀ (Voronin); Dim Village, 16.VII 1975, 2♂ (Storozhenko).

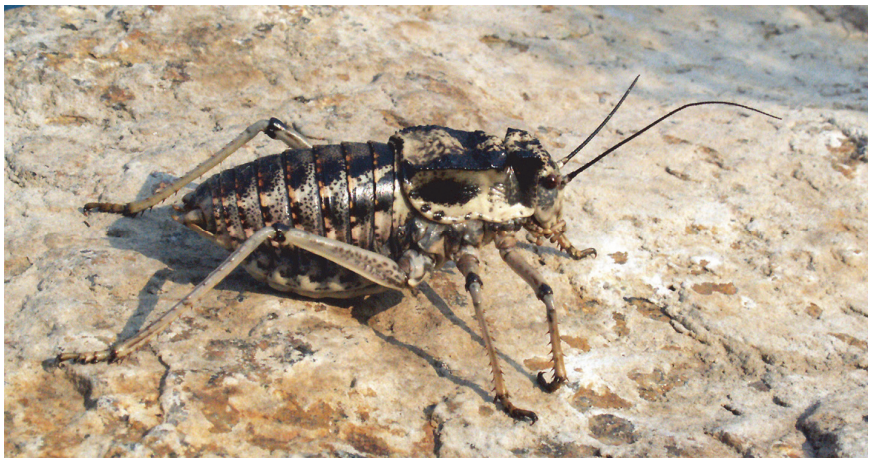

Fig. 1. Male *Deracantha onos* (the southern part of Zabaikalsky Krai near Krasnokamensk, 2007) (Photo S. Storozhenko).

REMARKS. *D. onos* is distributed from the Khangai Mts (in the central part of Mongolia) on the west and the Zeya-Bureya Plain (Amurskaya Oblast in Russia) and Northeast China (Manchurian) Plain (NE China) on the east and from the forest-steppes of Transbaikalia (Dauria) and the Amurskaya Oblast on the north and the Gurvan Saikhan Mts. (S Mongolia) (Fig. 2) on the south. It is relatively common in the steppes of Inner Mongolia as well (Ma *et al.*, 1991). The species was also listed for the Uvs-Nuur Intermountain Basin in Tuva (Sergeev & Bugrov, 1988), however, it is highly likely that these specimens were mislabeled (Sergeev *et al*., 2018).

DISTRIBUTION. Russia (Republic of Buryatia, Zabaikalsky Krai, Amurskaya Oblast), Mongolia, North China (Fig. 2).

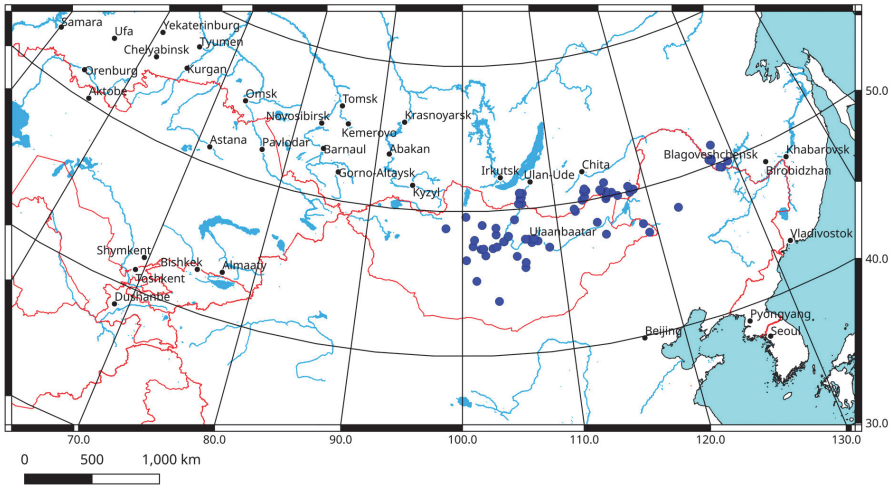

Fig. 2. Known localities of *Deracantha onos.*

ECOLOGICAL PREFERENCES

Deracantha onos prefers the relatively dry steppe ecosystems (Stebaev *et al*., 1989), often with *Caragana* shrubs and some open spaces between plants (Dmitrieva-Jurgenson, 1950; Medvedev & Chogsomzhav, 1978; Chogsomzhav, 1989; Storozhenko, 1997; Elaeva & Elaeva, 2010; Elaeva & Korsunovskaya 2012). However, our data show that the species populates also meadow steppes, openings and edges of oak and pine forests and even agricultural fields. The species density is commonly less than 2 individuals per sq m (Dmitrieva-Jurgenson, 1950; Elaeva & Elaeva, 2010; Elaeva & Korsunovskaya 2012) and its abundance usually varies between 1 and 16 per hour (Sergeev & Bugrov, 1988; Storozhenko 1997; Elaeva & Korsunovskaya 2012).

ECOLOGO-GEOGRAPGIC MODELS OF DISTRIBUTION

The ecologo-geographic model of the current species distribution (Fig. 3) describes well the known range of *D. onos*. Moreover, it shows that some areas with suitable conditions for this bush-cricket are in NW Mongolia (the so-called Great Lake Depression, including the Uvs-Nuur Basin) and in the southern parts of the Irkutskaya Oblast (Russia).

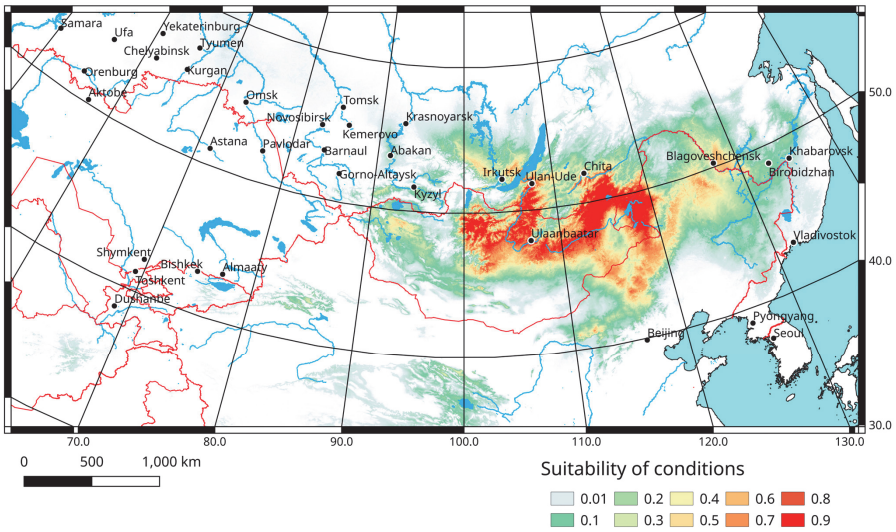

Fig. 3. Predicted probabilities of suitable conditions for *Deracanta onos* in the model region according the Maxent model (all distribution data and bioclimatic variables for 1970–2000; point-wise mean for 25 replicates).

The AUC value is high (0.976). Among the main parameters explaining the distribution of the species are a precipitation seasonality (variable contribution 34.6%), annual mean temperatures (20.8), and precipitations of the coldest quarter (19.7). Notably, the Jackknife test gives a very similar assessment and allows to add only precipitations of the driest quarter. This is interesting because in the monsoon climate of East Asia, the amount of winter precipitations is important, as the thickness of the snow cover affects the egg overwintering.

The predictive models of *D. onos* for the coming decades (Fig. 4) show that areas with optimal conditions for the species will shrink, especially in the westernmost and easternmost parts of the contemporary range, although the overall distribution pattern of the species will not change significantly.

The models generated for other orthopteran species studied, both rare and abundant, often display very different patterns. For instance, the models generated for the bush-crickets *Bicolorana bicolor* (Philippi) (Baturina *et al*., 2024b), *Montana striata*

(Kittary) (Sergeev & Molodtsov, 2022), and *Miramiola pusilla* (Miram) (Sergeev & Molodtsov, 2024), the grasshoppers *Oedaleus decorus* (Germar) (Popova *et al*., 2022), *Asiotmethis jubatus* (Uvarov) and *Mesasippus arenosus* (Bey-Bienko) (Baturina *et al.*, 2024a) show some opportunities of the northward shifts of the regions with very suitable conditions. Paradoxically, but the models created for two common species widely distributed across the Siberian steppes, namely *Angaracris barabensis* (Pallas) (Pashkova *et al*., 2024) and *Celes skalozobovi* Adel. (Allayarova *et al.*, 2024), show some opposite trends for each species: suitability decreasing in the western parts of their ranges and its increasing or inalterability in the central and eastern parts.

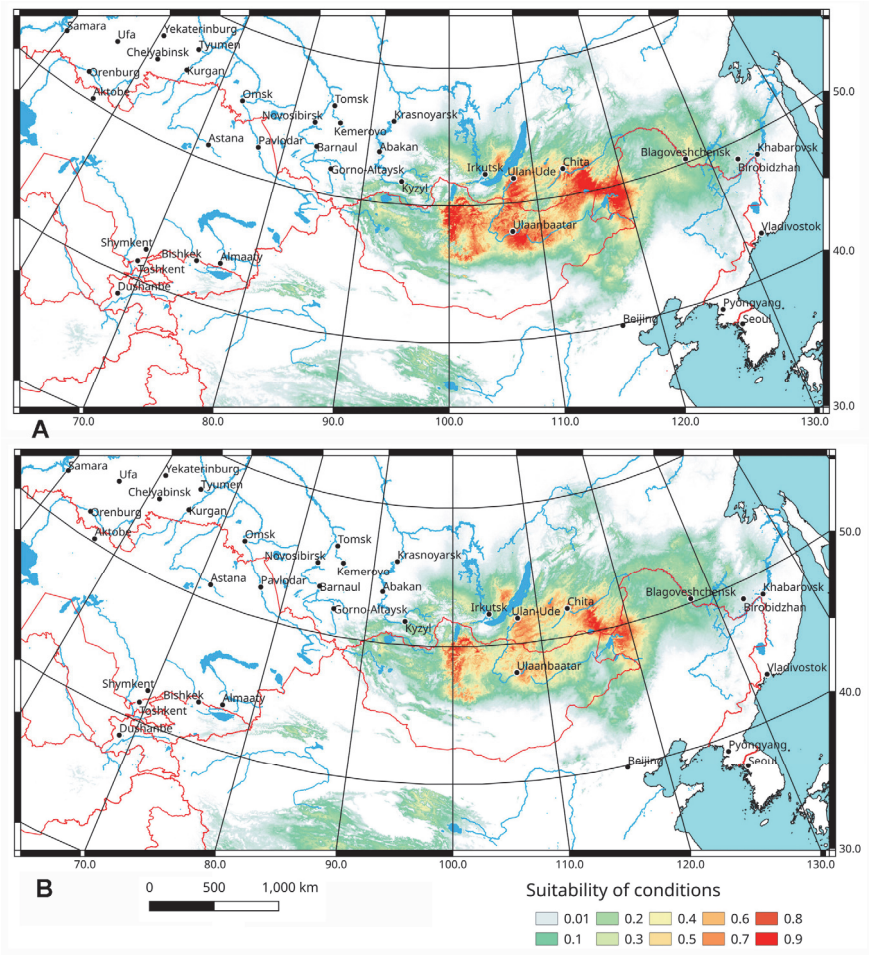

Fig. 4. Predicted probabilities of suitable conditions for *Deracanta onos* (forecasts of all bioclimatic variables for 2021–2040 (A) and 2041–2060 (B) according the global climate model CNRM-ESM2-1 (Séférian, 2018) and the 3–7.0 Shared Socioeconomic Pathway (Meinshausen *et al*., 2020), point-wise mean for 25 replicates).

The ecologo-geographic model of the current species distribution for the world (Fig. 5) specially generated to assess the possible invasive range of *D. onos* shows the almost complete absence of suitable habitats for a species outside its known range. This means that some proposals to consider this species as a potential invader are poorly substantiated.

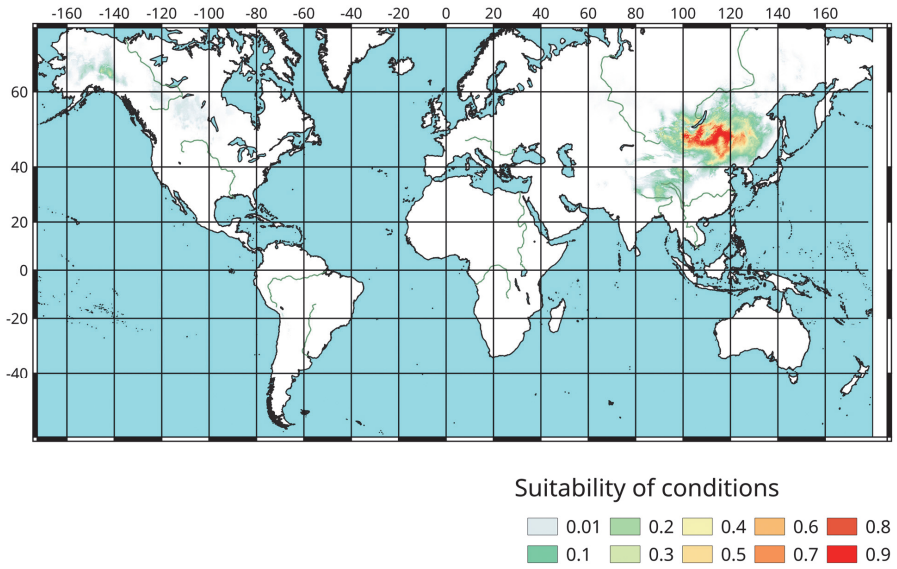

Fig. 5. Predicted probabilities of suitable conditions for *Deracanta onos* over the world according the Maxent model (all distribution data and bioclimatic variables for 1970–2000; point-wise mean for 25 replicates).

CONCLUSION

The range of the genus *Deracantha* F.d.W. occupies the north-easternmost parts of the general distribution area of the subfamily Zichyinae. Almost all other members of this taxon are distributed across the dry steppes, semi-deserts and deserts of Inner Asia. However, several species of the genus *Deracantha* (*D. onos*, *D. transversa,* and *D. grandis*) penetrate into the wetter regions of East Asia with the typical monsoon climate and original forest dominance. Based on our data on the distribution of *D. onos*, we can assume that in these regions, such bush-crickets can inhabit forest openings, clearings, and light forest edges. In addition, the species may occur in local agricultural landscapes, including fields of annual crops.

The forecasted distribution changes (some range contractions) are similar to those of a similarly distributed but much rarer the Daurian bush-cricket *Uvarovina daurica* (Uvarov) (Sergeev *et al.*, 2024) and the rare grasshopper *Aeropedellus baliolus* Mistshenko occured in the south-eastern parts of the West Siberian Plain and the Kazakh Uplands (Baturina *et al*., 2024a).

However, although the dispersal opportunities of *D. onos* are very limited because it is not only unable to fly, but also unable to jump (Dmitrieva-Jurgenson, 1950; Elaeva & Elaeva, 2010) and its abundance is commonly relatively low, the species wide distribution and its abilities to populate agricultural landscapes allow to assume that there is no need for any conservation measures, at least at the present time. In any case, some populations of *D. onos* are in the Daursky (Daurian) State Nature Biosphere Reserve.

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