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The millipede *Unciger foetidus* (C.L. Koch, 1838) in the Kaluga Region: Distribution and habitats (Diplopoda: Julida: Julidae)

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Abstract. The millipede *Unciger foetidus* is synanthropic in the northern parts of its range and is introduced to some regions. For Central Russia it has not been previously listed. In the Kaluga Region (European Russia) it was found along the Oka River from Kaluga to Tarusa and in urban settlements Kaluga, Kondrovo, and Tarusa and their nearby surroundings. It inhabits gardens, former quarries, as well as broadleaved, birch, aspen, willow-alder, willow, boxelder, and pine forests. It has a high abundance in forests in the Oka River valley and in gardens.

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Keywords: Diplopoda, distribution, synanthropic species, the East European Plain, the Oka River, broadleaved forest, garden

Многоножка *Unciger foetidus* (C.L.Koch, 1838) в Калужской области: распространение и местообитания (Diplopoda: Julida: Julidae)

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Аннотация. Кивсяк *Unciger foetidus* является синантропом в северных частях ареала, в некоторые регионы завезен. Для Центральной России этот вид ранее не указывался. В Калужской области (Европейская Россия) кивсяк выявлен вдоль р. Оки на участке от Калуги до Тарусы и в городах Калуга, Кондрово и Таруса и их ближайших окрестностях. Населяет сады, карьеры, широколиственные леса, березняки, осинники, иво-ольшаники, ивняки, заросли клена ясенелистного, сосняки. Высокого обилия достигает в широколиственных лесах и иво-ольшаниках в долине р. Оки и в садах.

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Ключевые слова: Diplopoda, распространение, синантропный вид, Восточноевропейская равнина, река Ока, широколиственный лес, сад

Introduction

Now, range boundaries of many species shift due to climate changes (Thomas 2010) and human activity (Hulme et al. 2008). So, we need to provide and analyse any data on species occurrence for modelling their distribution and for conservation. Many terrestrial arthropods are known as successful invasive species, because they are small, often reproduce quickly, and occupy many habitats (Roderick, Navajas 2015). Anthropochore expansion is known for many species of millipedes (Nefediev et al. 2014; Golovatch 2021). The millipede *Unciger foetidus* (C.L. Koch, 1838) (Diplopoda: Julida: Julidae) has a wide range in Europe, but it is synanthropic in the northern parts of its range (Kime, Enghoff 2017), and it is almost certainly introduced in some European countries (Jones 1985; Kime 1999; Roy et al. 2020). To the east, it is known from the Kaliningrad Region, Estonia, Latvia, Lithuania, and western Ukraine (Lokshina 1969; Chornyi, Golovatch 1993; Kime, Enghoff 2017). It is absent in the lists of millipedes of the

Moscow Region (Zalesskaja et al. 1982) and the oak woodlands of the East European Plain (Wytwer et al. 2009; Semenyuk, Tiunov 2011). So, its findings can be interesting. The Kaluga Region is located in the centre of the East European Plain, in the belt of temperate mixed (coniferous-broadleaved) and broadleaved forests. There is a high traffic from western and south-western countries across the region, so human-made appearance of alien species is probable.

Material and methods

The paper is based on samples of arthropods from 2020–2025 and occasional samples from 2009 and 2015–2019. Arthropods were collected using pitfall traps or by hand from forest litter, rotten wood, under stones, with litter sampling and cameral extraction of animals by hand. In total, we have 121 sample plots in 64 localities in different parts of the Kaluga Region (as separate localities we consider points with distances 2 km and more or divided by large rivers, roads and other barriers). Firstly, we distinguished localities where the species was found or not. Then we

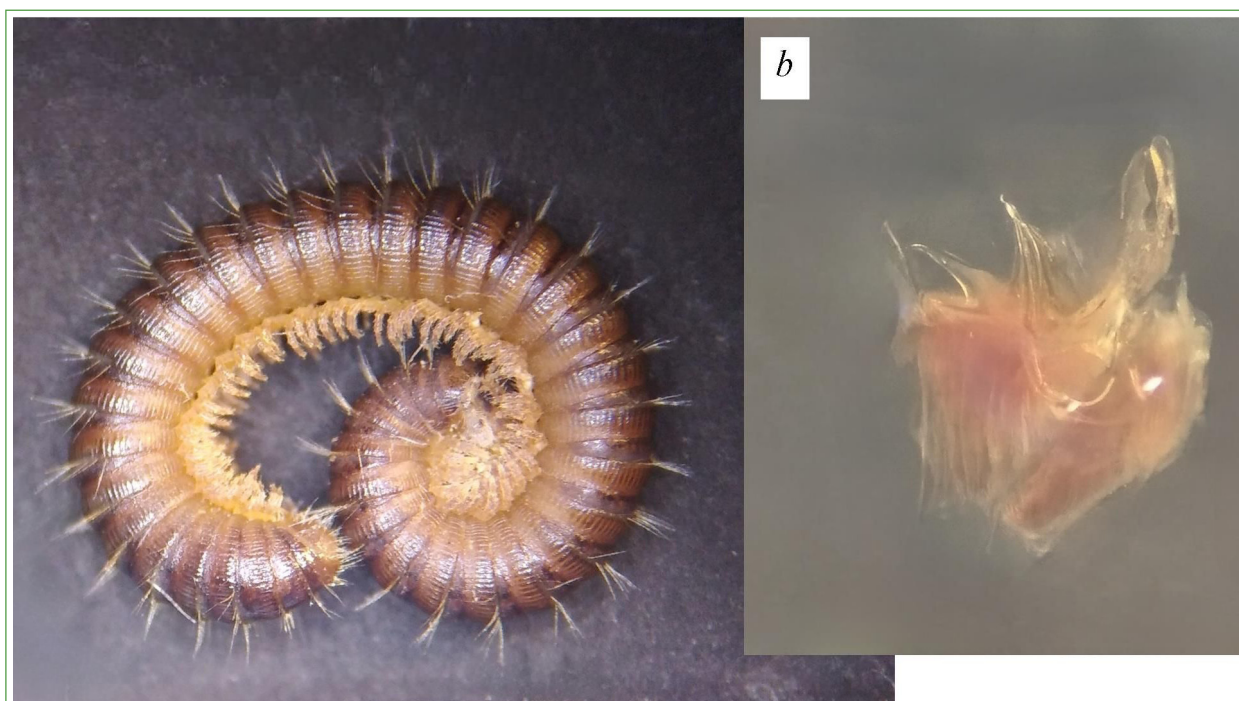


Fig. 1. *Unciger foetidus* from the Kaluga Region (Kaluga, broadleaved forest, N 54.524, E 36.169, in litter, June 2022): *a* — total male specimen, *b* — gonopods, mesal view

Рис. 1. *Unciger foetidus* из Калужской области (Калуга, широколиственный лес, N 54.524, E 36.169, в подстилке, июнь 2022 г.): *a* — общий вид самца, *b* — гоноподии, вид изнутри

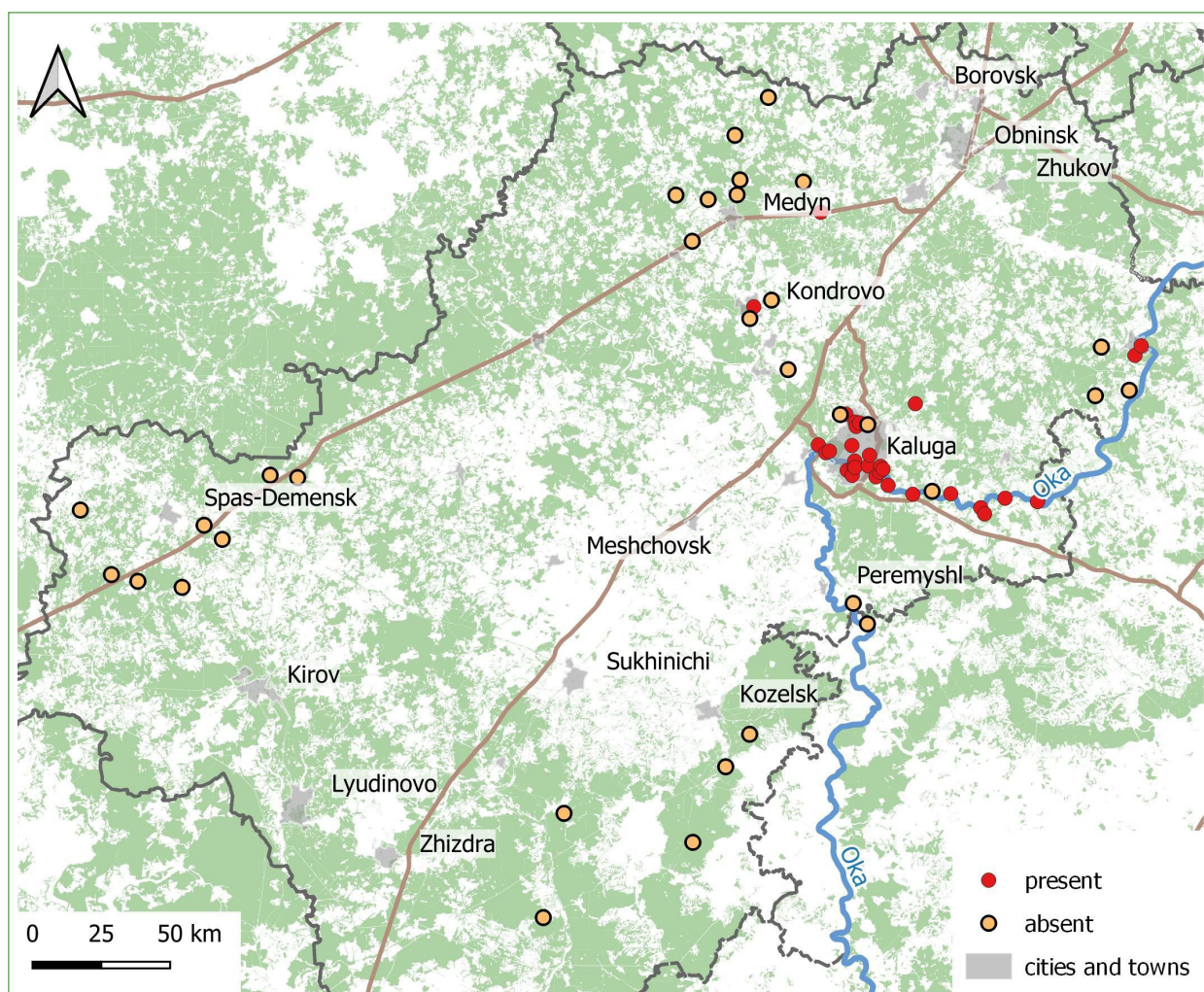


Fig. 2. Map of localities in the Kaluga Region where *Unciger foetidus* was found or not

Рис. 2. Карта локалитетов Калужской области, в которых *Unciger foetidus* был обнаружен или не обнаружен

analysed habitat distribution within localities where the species was found. Relative abundance was estimated for plots with pitfall traps exposed from May to September and measured in specimens per 100 trap days (ex./100 trap days). In some localities, relative abundance was estimated using hand collection and litter samples: abundant (3) — more than 10 specimens per 20 litres of forest litter; common (2) — 5–10 specimens; rare (1) — fewer than 5 specimens. Specimens were identified according to keys (Lokshina 1969; Chorny, Golovatch 1993). In total, we sampled 293 specimens using hand collection and extraction from litter and about 11,000 specimens using pitfall traps.

The following types of habitats were identified. A. Forests and woodlands: (1)

broadleaved (dominated by oak *Quercus robur* L., linden *Tilia cordata* Mill., maple *Acer platanoides* L., usually with *Aegopodium podagraria* L., *Mercurialis perennis* L., *Carex pilosa* Scop. in the herb layer); (2) birch (dominated by *Betula pendula* Roth); (3) aspen (dominated by *Populus tremula* L., usually with broadleaved trees in the undergrowth); (4) alder (dominated by *Alnus glutinosa* (L.) Gaertn., with nitrophilic weeds); (5) willow-alder (dominated by *Salix alba* L. and *Alnus incana* (L.) Moench, with sparse trees of *A. glutinosa*); (6) willow trees and shrubs (dominated by *S. alba* or *S. triandra* L.); (7) boxelder (almost pure *Acer negundo* L., an invasive tree); (8) pine (dominated by *Pinus sylvestris* L., usually with the common hazel *Corylus avellana* L. and other shrubs and

Table 1

The occupancy of sample plots of different types of habitats by *Unciger foetidus* in the Kaluga Region

Таблица 1

Заселенность *Unciger foetidus* пробных площадей различных типов местообитаний в Калужской области

Type of habitats	Numbers of sample plots		
	in localities where it was found		in localities where it was not found
	found	not found	
broadleaved forest	25	1	9
birch forest	3	—	4
aspen forest	7	1	4
alder forest	1	3	5
willow-alder	7	—	2
Willow	4	1	2
Boxelder	5	—	—
pine forest	10	3	5
spruce forest	—	2	8
Gardens	5	—	—
Quarries	2	—	—
Meadows	1	5	8
Bogs	—	1	8
Total	70	17	55

herbs of broadleaved forests); (9) spruce (dominated by *Picea abies* (L.) H. Karst.). B. Meadows. C. Bogs. D. Gardens — habitats with a mosaic of cultivated trees and shrubs (mainly fruit) and herbs (vegetable or ornamental). E. Quarries — spontaneously overgrowing former limestone quarries. Sample plots belonging to different types of habitats are located both in urban and rural areas (excluding boxelders appearing only in urban area). Some broadleaved forests are considered as quasi-climax ecosystems for this region. Some broadleaved forests have artificial origins (old (before 20th century) parks of estates in the vicinities of Spas-Demensk and Tarusa). Numbers of sample plots of each type are noted in the Results subsection.

Results

A typical specimen of *Unciger foetidus* is presented in Figure 1.

About half of the studied localities (31 of 64) are inhabited by *U. foetidus*. All findings are presented in the northern-east of the Kaluga Region (Fig. 2): Kaluga Gorsovet (Kaluga urban

district), Ferzikovskij, Tarusskij, Dzerzhinskij, and Maloyaroslavetskij Rayons (districts). Points of findings are located in the urban settlements of Kaluga, Tarusa, and Kondrovo and their nearby surroundings, or along the Oka River on both banks from Kaluga to Tarusa (in the river valley and within 5 km of this river on small rivers and streams up to 5 km). Exclusion is a rural settlement along a major trunk road in Maloyaroslavetskij Rayon.

Within localities where the species was found, the absolute majority of sample plots are inhabited by this species (Table 1). It was not found in the bogs or spruce forests, and was occasionally sampled in meadows and alder forests. *U. foetidus* inhabits almost all other forests and woodlands, all gardens, both quarries. Unoccupied plots were one dry oak grove on the slope of the river valley, three dry pine forests without the common hazel and other plants which are common to broadleaved forests, and a large aspen forest remote from intensively-managed habitats and the river. All points of findings are noted in Supplementary Table 1.

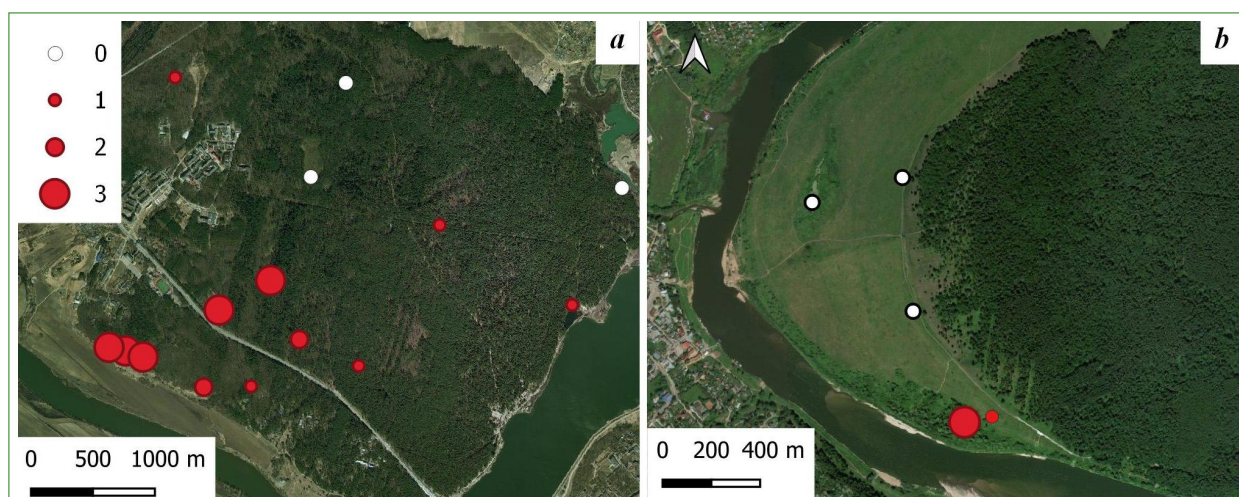


Fig. 3. Maps of sample plots with relative abundance *Unciger foetidus* for two localities: *a* — Kaluga, west suburb, the natural sanctuary ‘Gorodskoi Bor’, from N 54.524, E 36.167 to N 54.533, E 36.236; *b* — Tarusskij district, the right bank of the Oka River opposite the Tarusa town, from N 54.733, E 37.190 to N 54.725, E 37.201. Blank circles mean the absence of the species, red circles — the presence of it, size reflects its relative abundance

Рис. 3. Карты пробных площадей с относительным обилием *Unciger foetidus* для двух локалитетов: *a* — Калуга, западный пригород, памятник природы «Городской бор», от N 54.524, E 36.167 до N 54.533, E 36.236; *b* — Тарусский район, правый берег р. Оки напротив г. Тарусы, от N 54.733, E 37.190 до N 54.725, E 37.201. Белые кружки указывают на отсутствие вида, красные кружки — на его присутствие, размер кружков отражает относительное обилие

Some details of species distribution are seen on a smaller scale. In a large forest array within the Kaluga Urban District (the natural sanctuary ‘Gorodskoi Bor’), *U. foetidus* is less common further from the Oka River (Fig. 3a). On the right bank of the Oka River opposite the Tarusa town, the millipede is abundant in old floodplain willow-alder forest and occasionally occurs in a meadow neighboured by this forest (Fig. 3b). But it does not inhabit younger willow forest separated by meadows.

In all sample plots when *U. foetidus* was found there were also *Hyloniscus riparius* (C.L. Koch, 1838), Central-European woodlouse invading the east after 1990 (Gongalsky et al. 2013), and *Carabus nemoralis* O.F. Müller, 1764, a ground beetle inhabiting human-disturbed deciduous forests in Russia (Turin et al. 2003). However, both latter species occur in the Kaluga Region more frequently than *U. foetidus*. *U. foetidus* is a single species of Julida in willow and boxelder communities within urban areas and in all gardens. In other forests, it has co-occurred with *Leptoiulus proximus*

(Nemec, 1896) and *Ommatoiulus sabulosus* (Linnaeus, 1758).

A high abundance of *U. foetidus* was registered in gardens and forests (both broadleaved and willow-alder) in the Oka River valley (Fig. 4). In willow forests, its abundance was significantly lower than in three aforementioned types of habitats ($p < 0.05$ for each of the three Mann-Whitney pairwise). In other types of habitats, it also has a low abundance. All the broadleaved and willow-alder forests with low abundance of the millipede lay outside the Oka River valley.

Main plots with high abundance of *U. foetidus* are following (from west to east). (1) Kaluga city, west suburb, N 54.524, E 36.169, oak-linden forest on the slope of south exposure of the Oka River valley, 1094 specimens in pitfall traps, April – September 2021, 50 specimens hand collection, June, September 2022; (2) Kaluga city, Staroobryadcheskij pereulok, N 54.508, E 36.2636, garden surrounded by built area, 1937 specimens in pitfall traps, April – October 2016, 2017, 2018; (3) Ferzikovskij district, Borshchovka, N 54.437, E 36.754, linden forest

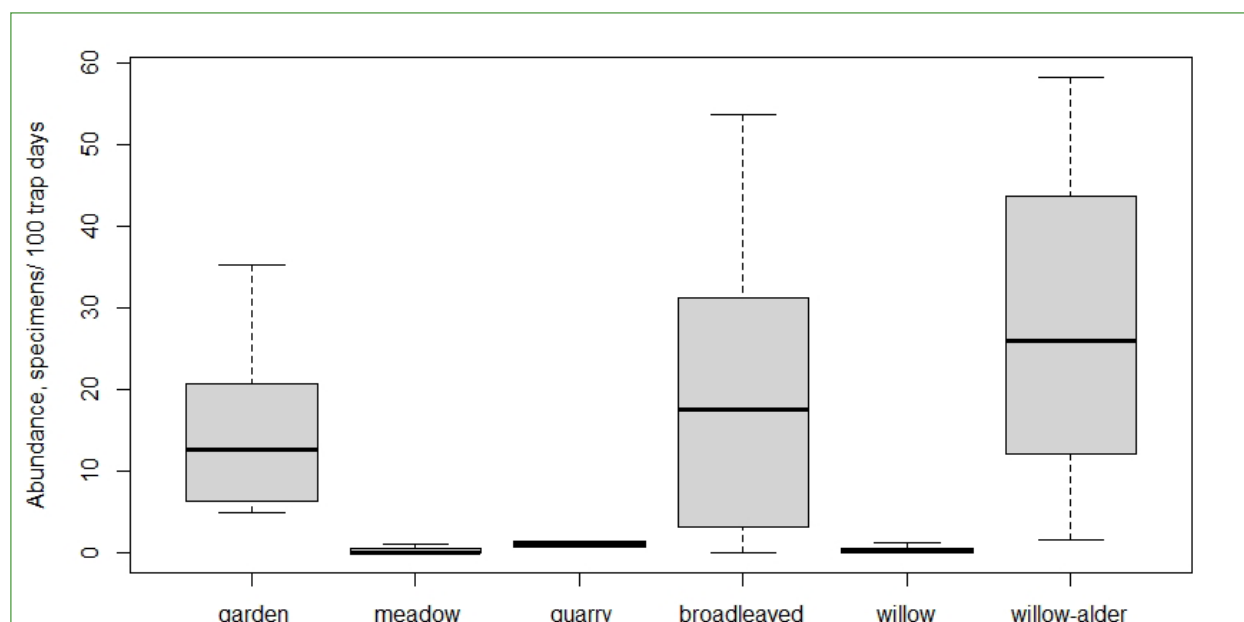


Fig. 4. Relative abundance of *Unciger foetidus* in different types of habitats in pitfall traps

Рис. 4. Относительное обилие *Unciger foetidus*, обнаруженного в почвенных ловушках, в разных типах местообитаний

on the slope of north exposure of the Oka River valley, 1943 specimens in pitfall traps, 14 specimens in litter, April – October 2023; (4) Tarusskij district, right bank of the Oka River opposite Tarusa town, N 54.7257, E 37.1989, floodplain willow-alder forest, 1924 specimens in pitfall traps, 7 specimens in litter.

Discussion

We can suggest an anthropochore origin of *Unciger foetidus* in the Kaluga Region, because this species has a limited distribution strictly associated with the Oka River and urban settlements, and lives in human-disturbed habitats. Its introduction is relatively recent, because it is absent in old estate parks outside the valley or outside cities. Downstream transportation of millipedes on floating debris is well-known (Golovatch, Kime 2009). This pathway explains the distribution of the species along the Oka River downstream to Kaluga. Its habitat preference in Kaluga region is similar to those in other parts of its range (Kime, Enghoff 2017). Its absence or low abundance in wet habitats (spruce and alder forests) can be caused by its thermophily (Kime 1999).

Conclusion

In the Kaluga Region, *Unciger foetidus* is probably anthropochore, limited-distributed,

but very abundant in some habitat species. We should expect its findings in other regions of Central Russia and its further expansion.

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