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RESEARCH ARTICLE

Orthoptera and Mantodea in the Continental biogeographical region and adjacent areas of European Russia (data paper)

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Abstract

Orthoptera is one of the most conspicuous groups of insects in any landscape. However, limited data on this group of insects have been published for European Russia. This article describes an occurrence dataset providing primary data on Orthoptera and Mantodea in European Russia, covering areas from the Kaluga region to Tatarstan and from the Nizhny Novgorod region to the Saratov region. A notable aspect of the dataset is the using of a wide range of sample methods, including acoustic observation, sweep net, pitfall traps, Malaise traps, pan traps, window traps, and beer traps. In total, 64.238 specimens were sampled across 1,186 plots. The dataset includes 7.095 occurrences representing 91 species of Orthoptera and 1 species of Mantodea. The number of plots, occurrences, and specimens is provided for each species in the article. The contribution of different sampling methods to insect identification is discussed. The latitudinal and longitudinal distributions of the species within the study area are analyzed.

Keywords
Broadleaved forests, forest steppe, meadows, katydids, crickets, mole crickets, grasshoppers, mantids, distribution, meridional gradient, sweepnet, pitfall traps

Introduction

Orthoptera is a highly prominent group of insects. Some of the most serious agricultural pests belong to this group (Uvarov 1977, Latchininsky et al. 2011, 2023, Sergeev et al. 2022, Riaz and Hakeem 2023). Conversely, many Orthoptera are recognized as charismatic species and landscape indicators, and are frequently used as model organisms in ecological studies and modeling (Sergeev 1986, Samways and Lockwood 1998, Fartmann et al. 2012). Many species are considered threatened or near-threatened on the IUCN Red List, as well as on European and individual country red lists (Hochkirch et al. 2016, Raghavendra et al. 2022, Starka et al. 2022, Hochkirch et al. 2023). Therefore, the collection and systematization of data on the distribution, abundance, and phenology of these insects is of great scientific and practical importance.

Meanwhile, open data on Orthoptera are very unevenly distributed geographically. For instance, as of June 28, 2024, the GBIF portal presents 4,108,410 observations of Orthoptera for Europe. Within Europe, a substantial volume of observations has been published for some countries in Western and Central Europe (Lock et al. 2021, Inventaire National... 2022, Biological Records Centre 2023, Monnerat and Gonseth 2024), whereas data for Eastern Europe remain scarce. For Russia (both European and Asian parts combined), GBIF, excluding the described dataset, presents 18,891 observations of Orthoptera as of June 28, 2024. Most of these observations (14,051) are from iNaturalist (GBIF 2024). While citizen science observations from iNaturalist have scientific value, they are insufficient for comprehensive distribution analysis due to their unsystematic nature and the selectivity in species identification (for example, conspicuous insects are more frequently recorded, while species primarily captured by traps are rarely noted).

The largest databases for European Orthoptera, Observation.org and Xeno-canto, have minimal or no coverage of Russia (Observation.org 2024, Vellinga 2024). Besides iNaturalist, information about Russian orthopterans is found in seven museum datasets. The largest of these, Minor Insect Orders (Luomus), provides only 210 observations, mostly of conspicuous and rare species (Finnish Biodiversity Information Facility 2024). Many observations in museum datasets lack geographical coordinates, excluding them from full use in analysis and modelling. The only specialized dataset recently published covers one region (the Republic of Mordovia) (Ruchin et al. 2023).

Middle zone of European Russia presents a highly promising area for studying Orthoptera. The convergence of boreal, continental, and steppe biogeographical regions creates a unique environment conducive to high biodiversity (Dedyukhin, 2023; Dvořák et al., 2023; Fardeeva, Chizhikova, 2023). Recently, climate change has significantly impacted this area, leading to shifts in species ranges. The Orthoptera of European Russia have a long history of study (Assmuss 1857, Ulyanin 1869, Jacobson and Bianki 1905, Ikonnikov 1911, Pylnov 1916). However, there is a paucity of detailed and up-to-date data on species distribution and biology. While comprehensive monographs have been published for several relatively small subfamilies and families of Orthoptera (Bey-Bienko 1954, Mishchenko 1965, Podgornaya 1983), these works describe species distribution with low details. In biogeographic books, Orthoptera of the studied area have been analysed within two natural zones: forest and steppe (Bey-Bienko 1950, 1953). In recent decades, the distribution of certain notable Orthoptera and Mantodea species has been examined (Bolshakov et al. 2010, Karmazina et al. 2020). However, most of the data collected by researchers has been published in small-scale studies focused on individual regions (e.g., Chernyakhovsky 1988, Zinenko et al. 2005, Adakhovsky 2006, Prisny 2007, Mikhailenko 2008, Karmazina and Shulaev 2015, Egorov 2017, Aleksanov 2019, Aleksanov et al. 2023), making comparative analysis problematic. Consequently, in terms of systematizing and generalizing information, the European part of Russia currently lags behind the Asian part, where comprehensive species distribution analyses have been conducted (Stebaev and Sergeev 1983, Sergeev 1986, Storozhenko 2004). So the last major work summarizing the distribution of all Orthoptera species in the European part of Russia remains Bey-Bienko's Key (1964). Although the Check-list of European Orthoptera (Heller et al. 1998) is more recent, it lacks sufficient detail regarding longitudinal distribution, as it amalgamates the territories of European Russia with several more western Eastern European states into a single region.

Materials and methods

Geographic coverage

Coordinates: Latitude ranged between 49.6131 and 56.2339. Longitude ranged between 33.7351 and 56.6668.

The described dataset contains data on findings of Orthoptera and Mantodea species in the territories of Russia belonging to the Continental biogeographical region, as classified by the European Environment Agency (2016). The Continental region is the transition zone on the N–S axis between the woodland-dominated coniferous Boreal region and the open Steppic region. It extends in a central east-west band over most of Europe. It has some of the continent's most productive ecosystems. Major pressures on biodiversity are high degree of habitat fragmentation by transport and urban infrastructures, industry and mining. Russia has 32% of its area (European Environment Agency 2002).

In Russian natural zoning schemes, the Continental region roughly corresponds to the nemoral broad-leaf forest and forest-steppe biomes (Ogureeva et al. 2020). In the more well-known Russian vegetation and landscape zoning schemes, this area is typically considered part of different zones or areas, specifically the broad-leaf forest and forest-steppe zones (e.g., Lavrenko 1947, Milkov and Gvozdeksii 1976). According to the Check-list of European Orthoptera, the study area roughly corresponds to region 6 (Heller et al. 1998). Additionally, the study area partially overlaps with the category 'middle zone' (Central Russia) used in many Russian studies (e.g., Bey-Bienko 1964), occupying its southern part.

The material was collected primarily from the north-western to central parts of the Russian Continental biogeographical region, as well as from the southeast of this territory (Fig. 1). The southwestern parts of the Continental biogeographical region within Russia are insufficiently covered in the dataset, but this is partly compensated for by the relatively high level of study in the area (e.g., Benediktov and Mikhailenko 2023). Given the indistinct boundaries between biogeographical regions on the plains, the dataset includes collections from adjacent areas belonging to the Boreal and Steppic regions. Administratively, studies were conducted mainly in the Kaluga, Ryazan, Republic of Mordovia, Ulyanovsk, Samara, Tatarstan, Tambov, and Saratov regions. To a lesser extent, studies were also conducted in the Bryansk, Tula, Moscow, Lipetsk, Penza, Voronezh, Nizhny Novgorod regions, and Chuvash Republics.

A total of 1,186 sample plots or points were studied. Each sample plot is characterized by unique combination of geographic latitude and longitude.

To assess the longitudinal trend in species distribution, the middle part of the study area (450 km long from north to south), which is most densely covered with sample plots, was divided into four equal sectors, each 550 km wide (Fig. 1).

Methods

The dataset material includes both the results of targeted surveys of Orthoptera and collections obtained during the counting of various animal groups. The sampling effort is specified for each occurrence within the dataset. Below, we briefly characterize the sample methods used.

Sweepnet: Sweepnetting was performed according to standard methods (Golub et al. 2012). The typical sampling effort was 100 strokes, where two consecutive sweeping strokes – to the right and left sides during translational movement – were considered as one sweep. For smaller biotope fragments, the sampling effort was reduced. In cases where large and diverse habitats were studied, repeated counts were made over a short period, or multiple collectors were involved, the sampling effort exceeded 100 strokes. Occasionally, the sampling effort was not normalized.

Pitfall traps: Soil pitfall traps were 0.5 l transparent plastic cups with a mouth of 85 mm in diameter filled to about a third (150 ml) with 4% formalin solution, with covers made of transparent polyethylene film. The number of traps per test area ranged from 10 to 30, depending on the size and complexity of the biotope, as well as the level of detail required for the sample plots. The number of traps for each observation is indicated in the samplingEffort field. The trap exposure period between samples typically ranged from two weeks to a month, though in some cases it was as short as 7 or 10 days. The duration of trap exposure can be determined by the EventDate or startDayOfYear and endDayOfYear fields.

Pan traps: Yellow plastic plates with a diameter of 21 cm and a volume of 1.25 l were used as pan traps. At the beginning of the exposition, they were filled two-thirds with water and a detergent. Six to ten traps were installed in a line on the ground surface, spaced 3 meters apart. The average trap exposure period between samples was 5 days.

Malaise traps: Homemade Malaise traps in the style of Townes (Townes 1972) were used. The front screen frame was made of wooden uprights, and the main material of the trap was polyester. The collection tanks were filled with 70% ethanol.

Beer traps: Each beer trap consisted of a plastic 5- l container with a window cut out on one side. These traps were placed on tree branches or special tripods at heights ranging from 1.5 to 12 meters above the ground. Fermenting beer with added sugar was used as bait (Ruchin et al. 2020, Ruchin and Egorov 2024). The average exposure period of the traps between samples was 10 days.

Window traps: Window traps consisted of criss-crossed blades made of transparent polyethylene film on a wire frame, with a 0.5 l transparent plastic cup as a trap container filled with 2% formalin as a fixative. Typically, 10 traps were installed per test area at a height of 1.5 meters above the ground, primarily in woody vegetation biotopes. The trap exposure period between samples was generally two weeks.

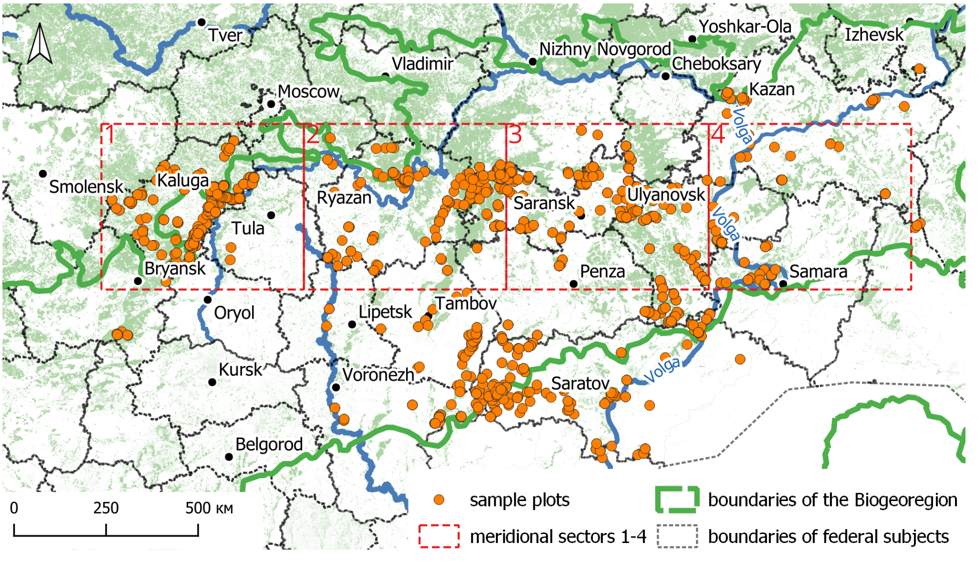

Figure 1. Map of the study area with indication of sample plots.

Groove traps for vertebrate trapping: In some biotopes, Orthoptera were collected incidentally during surveys for amphibians and small mammals. This method used 20-meter-long grooves with two 10 l buckets containing 4% formalin buried at the bottom.

Acoustic observation: Orthoptera were primarily counted by their songs in the field, often identified by ear. In some instances, the songs were recorded using a voice recorder and the oscillograms were compared with reference recordings. Occasionally, insects were placed in a cage and their songs were recorded in a laboratory setting. Frequently, acoustic observations were complemented by visual confirmation, and these combined observations are labeled as "acoustic and visual observation."

Hand collection and visual observation: This method was primarily used for large, conspicuous Orthoptera species, as well as for those not adequately sampled by sweepnetting. Additionally, opportunistic sightings of easily recognizable and common species are included in this category.

UV light: Orthoptera were extremely rare and seemingly accidental among insects attracted by UV light. However, this method is included in the dataset.

In addition to the material collected by the authors, the analysis includes collections from the Parks Directorate of Kaluga Region, Kaluga State Pedagogical University, Mordovia State Nature Reserve, Sergey Alekseev, Mikhail Bakanov, and other researchers and institutions. In many cases, especially for older collections, the collection method is undefined.

Species identification using the acoustic method was based on song characteristics, while for most other material, identification relied on morphological features. The primary identification key used was Bey-Bienko's book for this region (Bey-Bienko 1964). More extensive keys were employed for specific groups (Bey-Bienko and Mistshenko 1951). Identification of some complex groups was based on modern works (Bukhvalova 1995, Benediktov 1999, Çiplak et al. 2002, Willemse et al. 2009, Tarasova et al. 2021, Roesti and Rutschmann 2023).

The identification of females from the *Chorthippus biguttulus* group was determined by the presence of males of the corresponding species. If males of more than one species were found in the sample, the females were recorded as *Chorthippus* Fieber, 1852. Larvae (nymphs) were identified only if there were no similar species in the studied area. For some morphologically poorly distinguishable species, expert opinions on their range were considered (Korsunovskaya 2016, Benediktov 2017).

A total of 64,238 specimens belonging to 91 species of Orthoptera and 1 species of Mantodea were recorded. The species nomenclature follows the Orthoptera Species File (Cigliano et al. 2024).

To assess species representation in the studied area, the following metrics were calculated: the number of sample plots (unique combinations of geographic latitude and longitude), occurrences (the total number of records for each species, with observations on different dates at the same sample plot counted separately), and specimens. Data processing was conducted using the R environment (R Core Team

2022). During processing, errors in coordinates, dates, and species names were manually corrected using MS Excel. Spatial calculations were performed in QGIS 3.

Description of the Data in the Dataset

Data set name: Orthoptera and Mantodea in the Continental biogeographical region and adjacent areas of European Russia

Resource link: https://www.gbif.org/dataset/3fc98fe4-d3d6-4185-95b3-4f86c-859c8b7

Alternative identifiers: http://gbif.ru:8080/ipt/resource?r=orthoptera_mantodeaeurorussia

Data format: Darwin Core Archive format

Usage licence: CC BY 4.0

Description: This occurrence dataset includes 7095 occurrences (Aleksanov et al. 2024). The table consists of 21 fields (Table 1).

Table 1. Description of the data in the dataset

Column label	Column description
occurrenceID	An identifier for the occurrence. https://dwc.tdwg.org/terms/#dwc:occurrenceID. Numerical, integer counter with values between 1 and 7095.
basisOfRecord	The specific nature of the record. https://dwc.tdwg.org/terms/#dwc:basisOfRecord. Categorical according to vocabulary, constant: "HumanObservation".
scientificName	Scientific name according to GBIF Backbone. https://dwc.tdwg.org/terms/#dwc:scientificNameCathegorical based on checklist, example: *Bicolorana bicolor* (Philippi, 1830)
kingdom	The full scientific name of the kingdom in which the taxon is classified. https://dwc.tdwg.org/terms/#dwc:kingdomCategorical according to GBIF Backbone checklist, constant: "Animalia".
decimalLatitude	The geographic latitude of location in decimal degrees. https://dwc.tdwg.org/terms/#dwc:decimalLatitude Numerical variable of decimal type with a precision of 6 and scale of 4 ranged between 49.6131 and 56.2339.
decimalLongitude	The geographic longitude of location in decimal degrees. https://dwc.tdwg.org/terms/#dwc:decimalLongitude Numerical variable of decimal type with a pre cision of 6 and scale of 4 ranged between 33.7351 and 56.6668.
geodeticDatum	Spatial reference system (SRS) upon which the geographic coordinates are given in decimalLatitude and decimalLongitude are based. https://dwc.tdwg.org/terms/#dwc:geodeticDatum. Categorical, constant: "WGS84".
coordinateUncertaintyInMeter	The maximum uncertainty distance in metres. https://dwc.tdwg.org/terms/#dwc:coordinateUncertaintyInMeters Numerical, 50 or 1000.

Column label	Column description
georeferenceSources	A list of maps, gazetteers, or other resources used to georeference the Location. https://dwc.tdwg.org/terms/#dwc:georeferenceSources. Categorical, “Geolocate” or “Google Earth”.
country	The name of the country in which the location occurs. https://dwc.tdwg.org/terms/#dwc:countryCode. Categorical, constant: “Russian Federation”.
countryCode	The standard code for the Russian Federation according to ISO 3166-1-alpha-2. https://dwc.tdwg.org/terms/#dwc:countryCode. Categorical, constant: "RU".
individualCount	The number of individuals represented present at the time of the occurrence. https://dwc.tdwg.org/terms/#dwc:individualCount. Numerical, ranged between 1 and 2507.
lifeStage	The life stage of the organism at the time. https://dwc.tdwg.org/terms/#dwciri:lifeStage. Categorical, “adult”, “nymph”, or “not divided”.
Sex	The sex of the biological individual(s) represented in the occurrence. https://dwc.tdwg.org/terms/#dwc:sex. Categorical, “male”, “female”, or “not divided”.
eventDate	Trap period (YYYY-MM-DD/YYYY-MM-DD). https://dwc.tdwg.org/terms/#dwc:eventDate, 1237 unique values, example: '2007-05-29/2007-06-05'.
startDayOfYear	The earliest integer day of the year on which the Event occurred. http://rs.tdwg.org/dwc/terms/startDayOfYear. Numerical, ranged between 69 and 306.
endDayOfYear	The latest integer day of the year on which the Event occurred. http://rs.tdwg.org/dwc/terms/endDayOfYear. Numerical, ranged between 69 and 329.
samplingProtocol	The names of the methods or protocols used during an event. http://rs.tdwg.org/dwc/terms/samplingProtocol. Categorical, 13 unique values, examples: ‘pitfall traps’, ‘sweepnet’.
samplingEffort	The amount of effort expended during a dwc:Event. https://dwc.tdwg.org/terms/#dwc:samplingEffort. Textual description, example: "15 pitfall traps ", “100 strokes”, “1 hour”.
recordedBy	A person, group, or organization responsible for recording the original occurrence. https://dwc.tdwg.org/terms/#dwciri:recordedBy. Categorical, 64 unique values, example: “Mikhail Esin”.
identifiedBy	A list of names of people who assigned the taxon to the subject. https://dwc.tdwg.org/terms/#dwciri:identifiedBy. 14 unique values, example: “Andrey Mikhailenko”.

Results

The contribution of the dataset to the knowledge of patterns of Orthoptera and Mantodea species distribution in the region

Occurrences of Orthoptera and Mantodea species

The list of species, including the number of sample plots, observations, and individuals, is presented in Table 2.

Table 2. Species list of Orthoptera and Mantodea in the dataset with quantitative features

Species	Numbers of		
	Plots	Occurrences	Specimens
Order Mantodea			
Mantidae			
Mantis religiosa (Linnaeus, 1758)	63	85	99
Order Orthoptera			
Suborder Ensifera			
Rhaphidophoridae			
Tachycines asynamorus Adelung, 1902	2	3	3
Tettigoniidae			
Barbitistes constrictus Brunner von Wattenwyl, 1878	16	19	34
Bicolorana bicolor (Philippi, 1830)	163	250	1076
Conocephalus dorsalis (Latreille, 1804)	10	10	12
Conocephalus fuscus (Fabricius, 1793)	116	175	402
Decticus verrucivorus (Linnaeus, 1758)	202	326	1994
Gampsocleis glabra (Herbst, 1786)	8	8	11
Gampsocleis shelkovnicovae Adelung, 1916	1	1	2
Isophya modesta rossica Bey-Bienko, 1954	1	1	1
Leptophyes albovittata (Kollar, 1833)	47	50	125
Metrioptera brachyptera (Linnaeus, 1761)	65	106	338
Montana eversmanni (Kittary, 1849)	1	1	1
Montana montana (Kollar, 1833)	4	4	8
Onconotus laxmanni (Pallas, 1771)	16	16	33
Onconotus servillei Fischer von Waldheim, 1846	20	24	53
Phaneroptera falcata (Poda, 1761)	205	307	1080
Pholidoptera griseoaptera (De Geer, 1773)	114	228	596

Species	Numbers of		
	Plots	Occurrences	Specimens
Platycleis albopunctata (Goeze, 1778)	5	5	6
Poecilimon intermedius (Fieber, 1853)	56	68	177
Roeseliana roeselii (Hagenbach, 1822)	120	193	560
Saga pedo (Pallas, 1771)	25	29	35
Tessellana veyseli (Koçak, 1984)	11	11	24
Tettigonia cantans (Fuessly, 1775)	78	112	166
Tettigonia caudata (Charpentier, 1845)	14	14	16
Tettigonia viridissima (Linnaeus, 1758)	40	44	70
Gryllidae			
Acheta domesticus (Linnaeus, 1758)	4	7	8
Eumodicogryllus bordigalensis (Latreille, 1804)	1	1	1
Gryllus bimaculatus De Geer, 1773	26	35	214
Gryllus campestris Linnaeus, 1758	11	13	44
Melanogryllus desertus (Pallas, 1771)	6	6	8
Modicogryllus frontalis (Fieber, 1844)	57	94	692
Oecanthus pellucens (Scopoli, 1763)	74	82	147
Myrmecophilidae			
Myrmecophilus acervorum (Panzer, 1799)	7	9	11
Gryllotalpidae			
Gryllotalpa gryllotalpa (Linnaeus, 1758)	41	70	168
Gryllotalpa stepposa (Zhantiev, 1991)	1	1	1
Suborder Caelifera			
Trydactylidae			
Xya variegata (Latreille, 1809)	3	3	4
Tetrigidae			
Tetrix bipunctata (Linnaeus, 1758)	91	118	455
Tetrix fuliginosa (Zetterstedt, 1828)	1	1	1
Tetrix subulata (Linnaeus, 1758)	158	279	878
Tetrix tenuicornis (Sahlberg, 1891)	97	257	1836
Pamphagidae			
Asiotmethis tauricus (Tarbinsky, 1930)	1	2	2
Acrididae			
Aeropus sibiricus (Linnaeus, 1767)	1	1	1
Aiolopus thalassinus (Fabricius, 1781)	3	3	3
Arcyptera fusca (Pallas, 1773)	4	4	26
Arcyptera microptera (Fischer von Waldheim, 1833)	5	5	5

Species	Numbers of		
	Plots	Occurrences	Specimens
Bryodema tuberculatum (Fabricius, 1775)	5	5	6
Calliptamus barbarus (Costa, 1836)	2	2	3
Calliptamus italicus (Linnaeus, 1758)	134	146	598
Celes variabilis (Pallas, 1771)	2	2	8
Chorthippus albomarginatus (De Geer, 1773)	17	17	41
Chorthippus apricarius (Linnaeus, 1758)	194	401	3140
Chorthippus biguttulus (Linnaeus, 1758)	250	518	5071
Chorthippus brunneus (Thunberg, 1815)	144	228	2343
Chorthippus dichrous (Eversmann, 1859)	2	2	10
Chorthippus dorsatus (Zetterstedt, 1821)	207	403	3795
Chorthippus macrocerus (Fischer von Waldheim, 1846)	51	51	168
Chorthippus mollis (Charpentier, 1825)	99	199	20654
Chorthippus pullus (Philippi, 1830)	11	11	23
Chorthippus saxatilis Bey-Bienko, 1948	1	1	1
Chorthippus uvarovi Bey-Bienko, 1929	1	1	1
Chorthippus vagans (Eversmann, 1848)	3	3	8
Chrysochraon dispar (Germar, 1834)	114	188	547
Dociostaurus brevicollis (Eversmann, 1848)	18	18	50
Duroniella gracilis Uvarov, 1926	1	1	1
Epacromius pulverulentus (Fischer von Waldheim, 1846)	1	1	1
Euchorthippus pulvinatus (Fischer von Waldheim, 1846)	45	48	271
Euthystira brachyptera (Ocskay, 1826)	265	453	2994
Gomphocerippus rufus (Linnaeus, 1758)	22	32	170
Locusta migratoria (Linnaeus, 1758)	12	12	16
Megaulacobothrus aethalinus (Zubovski, 1899)	1	1	1
Myrmeleotettix antennatus (Fieber, 1853)	3	3	5
Myrmeleotettix maculatus (Thunberg, 1815)	9	9	29
Myrmeleotettix pallidus (Brunner-Wattenwyl, 1882)	1	1	1
Oedaleus decorus (Germar, 1825)	6	6	11
Oedipoda caerulescens (Linnaeus, 1758)	120	155	445
Omocestus haemorrhoidalis (Charpentier, 1825)	74	131	1596
Omocestus petraeus (Brisout de Barneville, 1856)	9	9	10

Species	Numbers of		
	Plots	Occurrences	Specimens
Omocestus rufipes (Zetterstedt, 1821)	8	8	36
Omocestus viridulus (Linnaeus, 1758)	66	111	523
Podisma pedestris (Linnaeus, 1758)	10	28	97
Pseudochorthippus montanus (Charpentier, 1825)	13	17	37
Pseudochorthippus parallelus (Zetterstedt, 1821)	212	519	9115
Psophus stridulus (Linnaeus, 1758)	44	55	151
Sphingonotus caerulans (Linnaeus, 1767)	6	7	17
Stauroderus scalaris (Fischer von Waldheim, 1846)	12	12	18
Stenobothrus eurasius Zubovskii, 1898	7	10	10
Stenobothrus fischeri (Eversmann, 1848)	3	3	3
Stenobothrus lineatus (Panzer, 1796)	75	139	482
Stenobothrus nigromaculatus (Herrich-Schäffer, 1840)	10	10	31
Stenobothrus stigmaticus (Rambur, 1838)	4	4	10
Stethophyma grossum (Linnaeus, 1758)	17	21	61

E. brachyptera, *Ch. biguttulus*, and *P. parallelus* are the most frequently encountered species based on the number of sample plots and observations in the study area. They are closely followed by *Ch. dorsatus*, *Ph. falcata*, *D. verrucivorus*, and *Ch. apricarius*. These species are also the most numerous in terms of specimens counted, though *Ch. brunneus* and *Ch. mollis* are notably abundant in specific localities.

Fourteen species were recorded at only a single location: thirteen were observed only once, and twelve were represented by a single specimen.

The contribution of different sampling methods to the inventory of Orthoptera

Sweepnetting and pitfall traps contribute approximately equally to the number of occurrences in the dataset (Table 3). In terms of the number of individuals counted, pitfall traps vastly outnumber other sampling methods. However, they are slightly less effective than sweepnetting when it comes to the number of species recorded. Species frequently captured by sweepnetting, such as *O. pellucens*, *D. brevicollis*, and *P. pedestris*, were not captured by pitfall traps. Other species absent from pitfall traps were rarely captured by sweepnetting, suggesting that this 'selectivity' might be caused by its living in the plots surveyed by only sweepnet.

Specialized phytophiles, such as *Ph. falcata*, *L. albovittata*, *C. fuscus*, and *E. brachyptera*, were captured much less frequently in pitfall traps compared to sweepnetting. Additionally, it is noteworthy that geophiles such as *P. stridulus* and *O. caerulescens* were poorly represented in soil traps. This low capture rate may be related to their locomotion habits, which rely predominantly on jumping, thereby reducing their likelihood of being trapped by pitfall traps.

At the same time, pitfall traps were more effective than sweepnetting for recording certain species. *M. acervorum* and *P. montanus* were repeatedly recorded using pitfall traps but were not captured by sweepnetting. The former species is associated with anthills, which pitfall traps can target more effectively (Franc et al. 2015), while the latter species exhibits stenotopy in bogs, where sweepnetting may be less effective or has been used with small effort. Pitfall traps were also the preferred method for counting herpetobiont species such as *Tetrix* spp. and *D. verrucivorus*, as well as various crickets (Gryllidae). *P. griseoaptera* was predominantly detected using pitfall traps, likely due to its preference for forest habitats where sweepnetting is less feasible.

Pan traps revealed a significant number of Orthoptera species from various life forms. Although the overall quantitative contribution of pan traps was low, this method captured a substantial proportion of *G. rufus* and a significant number of *Tetrix* specimens.

Table 3. Contribution of different sampling methods to the collection of data in the dataset

Method	Numbers		
	occurrences	**specimens**	**species**
Sweepnet	2665	12102	66
Pitfall traps	2596	45662	52
Pan traps	240	1305	33
Malaise traps	170	789	27
Groove for vertebrate trapping	42	1432	14
Window trap	44	61	12
Beer trap	3	3	2
UV light	1	8	1
Acoustic and visual observation	195	312	21
Visual observation	37	64	13
Hand collection	188	549	42
Indefined	915	1952	86

Malaise traps proved effective in identifying a substantial number of species inhabiting grasslands and the crowns of trees and shrubs. This method made the most significant contribution to the collection of *O. haemorrhoidalis*, accounting for 7% of all counted individuals.

Window traps were moderate effective for some insects active on the soil surface in gardens and forests, such as *T. subulata* and *P. griseoaptera*. However, they were less effective for species inhabiting the crowns of plants. Notably, window traps also detected some stenotopic species, such as *O. caerulescens* and *S. grossum*.

Beer traps yielded only occasional findings of katydids *Tettigonia* spp., while UV light traps produced only a single record of *T. subulata*.

The species detected by the greatest number of methods include *Ch. biguttulus*, *Ch. apricarius*, *T. cantans*, *T. subulata*, *P. griseoaptera*, *C. dispar*, *P. parallelus*, *Ch. dorsatus*, *R. roeselii*.

The contribution of the dataset to the knowledge of the latitudinal distributions of Orthoptera and Mantodea

The dataset provides a valuable opportunity to compare contemporary findings with the latitudinal distribution information presented in Bey-Bienko's work (Bey-Bienko 1964). In Bey-Bienko's study, species distributions are categorized within the 'middle zone' (Central Russia) or 'southern' regions of European Russia, roughly demarcated by latitudes 50-52° N or the line from Kiev to Kharkov to Saratov. The distribution is described in terms of natural zones (south of the forest zone, forest-steppe, and steppes) and geographical parallels.

The increased species richness of Orthoptera in the steppe zone compared to more northern ecoregions is well known fact (Bey-Bienko 1950). According to our data, certain species are exclusively found in the southern part of the Continental biogeographical region, near the boundary with the Steppic biogeoregion. These species include *A. thalassinus*, *A. microptera*, *A. tauricus*, *D. gracilis*, *M. aethalinus*, *M. antennatus*, *S. pedo*, and *G. stepposa*.

At the same time, steppe species such as *Onconotus* spp., *G. glabra*, *O. pellucens*, *C. italicus*, *Ch. macrocerus*, *E. pulvinatus* penetrate far enough to the north, into the range of forest-steppe and even broad-leaved forests (Fig. 2). Northern occurrences of many of these species have been discussed in the literature (e.g., Ruchin and Mikhailenko 2013, Aleksanov et al. 2023), but the collected material allows us to speak more reasonably about the stability of this phenomenon. Compared to the mid-20th century, the northern limits of the ranges of *Ph. falcata* and *M. religiosa* have noticeably shifted northwards, which has already been sufficiently emphasised in the literature (Bolshakov et al. 2010, Belyaev 2019, Karmazina et al. 2020, Rimšaitė et al. 2022). In recent years, the forest-steppe species *L. albovittata*, which was absent in previous collections in the studied areas (Pylnov 1916, Aleksanov 2019), seems to have dispersed to the zone of broad-leaved forests, which is consistent with the results obtained by other authors (Benediktov et al. 2022).

Numerous records of *G. bimaculatus* (Fig. 3) warrant special attention regarding the potential dispersal of southern species. This species, which lived in the Mediterranean and Caucasus regions (Heller et al. 1998), has been documented in various parts of Europe (Mito and Noji 2008, Kulessa et al. 2023). In some European countries, its occurrences are considered casual (non-established) (Essl and Zuna-Kratky 2021). In the study area of European Russia, we have observed substantial groupings of *G. bimaculatus*, including both adults and nymphs, regularly throughout the year. However, the stability of these groupings over multiple years remains unclear due to a lack of long-term data for these locations. Given its distance from its native range and the potential threat it poses to the native cricket species G. campestris, *G. bimaculatus* merits orderly monitoring.

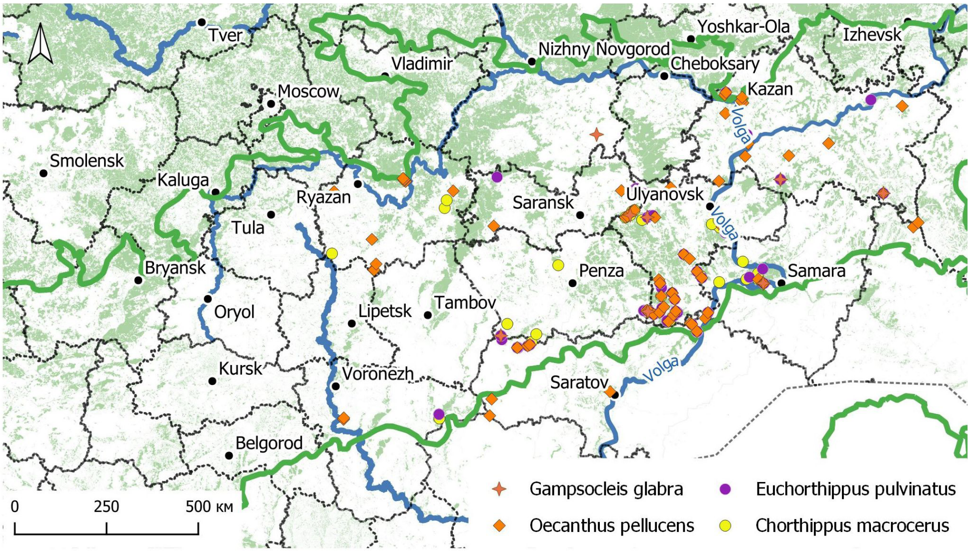

Figure 2. Findings of some "steppic" species across studied area. To legend see Fig. 1.

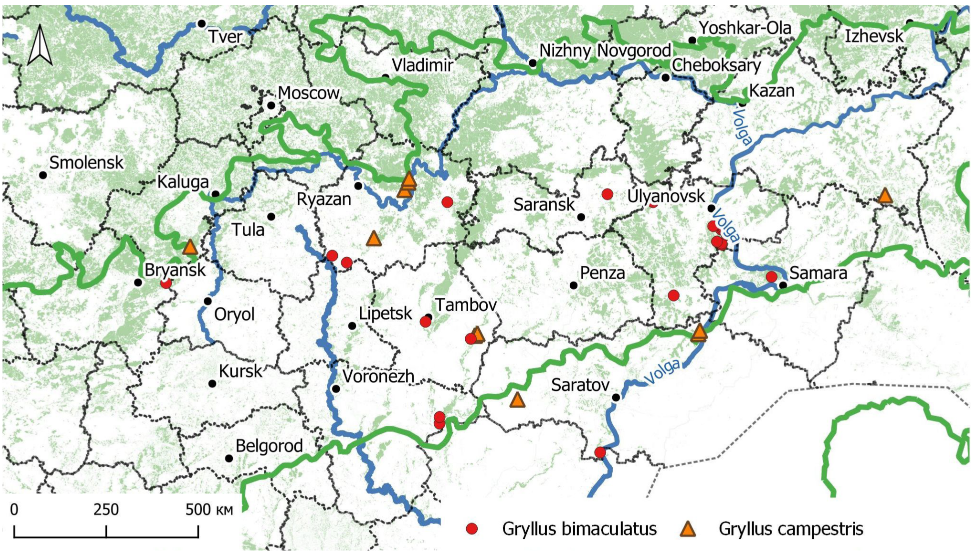

Figure 3. Findings of alien and native species of crickets across studied area.

The contribution of the dataset to the knowledge of the distribution over meridional gradient

The meridional gradient, characterized by increasing continentality of the climate, is a significant factor influencing the distribution of Orthoptera species. The dataset, which covers a belt between 53.0° and 55.4° E with a width of 450 km, provides an opportunity to examine how Orthoptera distribution varies from west to east in the absence of major orographic barriers (Table 4).

Overall, the number of Orthoptera species increases from west to east. The easternmost sector (No. 4), which extends along the Volga River, is the most diverse and unique despite having fewer sampling plots. In contrast, the westernmost sector (No. 1) is the least diverse. The two central sectors exhibit similar species richness.

Grasshopper species such as *Ch. macrocerus*, *D. brevicollis*, *E. pulvinatus*, the cricket *O. pellucens*, and the katydids *Onconotus* spp. become increasingly prevalent from west to east, with none of these species found in the westernmost sector. The locust *C. italicus* and the katydid *L. albovittata* have the same trend, but these species are distributed across all study belt. Additionally, steppe species such as the katydids *G. glabra* and *S. pedo* are present only in the two easternmost sectors.

Conversely, certain species that are belonging to the European meadow-forest group (according to Bey-Bienko 1953) are more prevalent in the westernmost sector. These include the katydids *C. fuscus*, and *R. roeselii*, grasshoppers *Ch. dorsatus, C. dispar*, and *P. parallelus*. Additionally, *B. constrictus* is entirely absent from the eastern sectors, a finding that aligns with previous literature (Bey-Bienko 1954).

Some species exhibit a non-monotonic pattern in their distribution along the meridional gradient. For instance, *Ch. brunneus* and *P. intermedius* reach their highest occurrence in Sector 3 (Fig. 4). Similarly, *G. rufus* and *T. bipunctata* are most frequently encountered in Sector 2.

Table 4. Occurrences of Orthoptera and Mantodea species in four meridional sectors of European Russia (frequency are percent of plots where a species found)

Frequency, %	Numbers of Sectors			
	1	2	3	4
Barbitistes constrictus	0.8	0.1	0.0	0.0
Bicolorana bicolor	4.0	4.4	5.1	2.4
Bryodema tuberculatum	0.0	0.0	0.0	0.5
Calliptamus italicus	0.7	1.3	2.7	3.4
Celes variabilis	0.0	0.0	0.0	0.2
Chorthippus albomarginatus	0.0	0.6	1.5	0.5
Chorthippus apricarius	6.3	6.0	3.9	1.9
Chorthippus biguttulus	9.4	4.6	5.5	1.2
Chorthippus brunneus	0.5	5.0	8.6	4.6

Frequency, %	Numbers of Sectors			
	1	2	3	4
Chorthippus dichrous	0.0	0.0	0.2	0.2
Chorthippus dorsatus	8.5	2.9	2.6	1.7
Chorthippus macrocerus	0.0	0.4	1.5	4.1
Chorthippus mollis	3.5	1.9	2.9	0.7
Chorthippus pullus	0.0	0.7	0.5	0.2
Chorthippus vagans	0.0	0.1	0.2	0.0
Chrysochraon dispar	3.9	2.9	1.9	0.7
Conocephalus dorsalis	0.3	0.3	0.0	0.2
Conocephalus fuscus	4.6	1.0	1.2	0.7
Decticus verrucivorus	3.8	3.7	5.8	4.1
Dociostaurus brevicollis	0.0	0.3	0.9	1.0
Epacromius pulverulentus	0.0	0.1	0.0	0.0
Euchorthippus pulvinatus	0.0	0.1	1.7	1.9
Eumodicogryllus bordigalensis	0.0	0.0	0.2	0.0
Euthystira brachyptera	6.2	7.7	8.2	5.6
Gampsocleis glabra	0.0	0.0	0.5	0.7
Gampsocleis shelkovnicovae	0.0	0.0	0.0	0.2
Gomphocerippus rufus	0.2	1.9	0.2	0.7
Gryllotalpa gryllotalpa	0.6	0.6	0.3	1.0
Gryllus bimaculatus	0.1	0.4	0.3	3.4
Gryllus campestris	0.1	0.6	0.0	0.2
Isophya modesta	0.0	0.0	0.2	0.0
Leptophyes albovittata	0.3	0.6	1.0	3.1
Locusta migratoria	0.1	0.3	0.0	0.2
Mantis religiosa	0.2	0.4	1.4	1.0
Metrioptera brachyptera	2.5	0.6	0.5	1.9
Modicogryllus frontalis	0.3	1.3	2.4	2.2
Montana eversmanni	0.0	0.0	0.2	0.0
Montana montana	0.0	0.1	0.2	0.5
Myrmecophilus acervorum	0.2	0.0	0.0	0.0
Myrmeleotettix maculatus	0.1	0.6	0.2	0.2
Oecanthus pellucens	0.0	1.8	2.2	3.1
Oedaleus decorus	0.0	0.0	0.0	1.0
Oedipoda caerulescens	2.1	4.0	2.1	2.9
Omocestus haemorrhoidalis	2.0	2.5	1.0	0.7
Omocestus petraeus	0.0	0.0	0.5	1.0

Frequency, %	**Numbers of Sectors**			
	1	**2**	**3**	**4**
Omocestus rufipes	0.0	0.1	0.0	0.0
Omocestus viridulus	2.9	1.0	0.3	0.2
Onconotus laxmanni	0.0	0.1	0.5	1.2
Onconotus servillei	0.0	0.1	1.0	2.2
Pararcyptera microptera	0.0	0.0	0.0	0.5
Phaneroptera falcata	5.1	2.4	5.5	3.6
Pholidoptera griseoaptera	3.0	2.5	3.1	4.1
Platycleis albopunctata	0.0	0.0	0.0	1.0
Podisma pedestris	0.1	0.4	0.0	1.0
Poecilimon intermedius	0.7	1.3	2.7	1.7
Pseudochorthippus montanus	0.1	0.6	0.5	0.5
Pseudochorthippus parallelus	8.5	4.1	2.2	1.5
Psophus stridulus	1.1	0.6	0.3	1.5
Roeseliana roeselii	4.7	1.9	1.4	1.7
Saga pedo	0.0	0.0	0.2	1.0
Sphingonotus caerulans	0.0	0.1	0.2	0.2
Stauroderus scalaris	0.0	0.1	0.0	2.2
Stenobothrus eurasius	0.0	0.3	0.3	0.5
Stenobothrus fischeri	0.0	0.0	0.2	0.2
Stenobothrus lineatus	1.6	1.8	2.4	2.9
Stenobothrus nigromaculatus	0.0	0.0	0.0	1.0
Stenobothrus stigmaticus	0.0	0.0	0.2	0.0
Stethophyma grossum	0.4	0.3	0.3	0.7
Tessellana veyseli	0.0	0.0	0.7	0.5
Tetrix bipunctata	0.4	6.9	4.1	1.9
Tetrix subulata	4.0	5.6	1.0	1.5
Tetrix tenuicornis	3.6	1.5	1.7	1.0
Tettigonia cantans	2.3	1.6	1.2	1.5
Tettigonia caudata	0.1	0.1	0.3	1.2
Tettigonia viridissima	0.2	2.1	0.9	1.2
Xya variegata	0.0	0.0	0.0	0.2
Total species	**43**	**57**	**59**	**69**
Total number of plots	**1884**	**678**	**583**	**413**

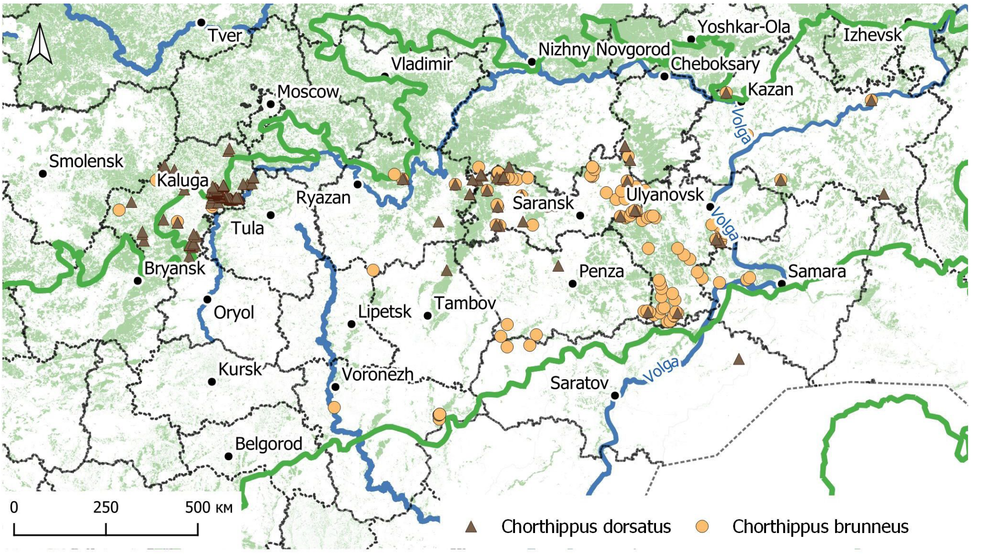

Figure 4. Findings of two *Chorthippus* species across studied area. To legend see Fig. 1.

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