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Data Descriptor

Diversity and Biology of Terrestrial Orthopteroids (Insecta) in the Republic of Mordovia (Russia)

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Abstract: Orthopteroidea is an ecologically diverse group of incompletely transformed insects that includes several insect orders similar in development and structure. Many species from Dermaptera, Orthoptera, Mantodea, and Blattodea are sensitive to anthropogenic influences and are indicators of the external environment. Some species cause damage to agriculture and forestry; others are inhabitants of human dwellings and pests of food supplies. The aim of this study is to describe fauna of some orders of Orthopteroidea in the Republic of Mordovia, in the central part of European Russia. This study was conducted in April–October 1971, 1984, 1995, 1996, 1998, 2000, 2001, and 2004–2023. All possible habitats were studied using a variety of methods (entomological traps, pitfall traps, pan traps, etc.). An acoustic method of species identification was also used. For each observation, the coordinates of location, abundance, and dates were recorded. The dataset contains 4865 occurrences. In total, 16,644 specimens of Orthopteroidea were studied. The dataset contains 71 species including Dermaptera (4), Orthoptera (62), Mantodea (1), and Blattodea (4). Of these, 13 species are identified for the first time in the region; these mainly inhabit steppe areas. The presence of two Orthoptera species has not been confirmed yet during our studies; these species are noted in this paper according an old published paper. The biodiversity of Mordovia includes 73 species from four orders. The biology of numerous species, their seasonal dynamics, and some descriptions of biotopes and number of new species are described.

Dataset: https://doi.org/10.15468/cmr3yy.

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Keywords: Dermaptera; Orthoptera; Mantodea; Blattodea; seasonal dynamics; data paper; occurrences; Republic of Mordovia

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Citation: Aleksanov, V.V.; Karmazina, I.O.; Ruchin, A.B.; Esin, M.N.; Lukiyanov, S.V.; Lobachev, E.A.; Artaev, O.N.; Ryzhov, M.K. Diversity and Biology of Terrestrial Orthopteroids (Insecta) in the Republic of Mordovia (Russia). *Diversity* **2023**, *15*, 803. https://doi.org/10.3390/d15070803

Academic Editor: Spyros Sfenthourakis

Received: 30 May 2023
Revised: 14 June 2023
Accepted: 23 June 2023
Published: 24 June 2023

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1. Summary

Orthopteroidea is an ecologically diverse group of incompletely metamorphosed insects that includes several developmentally and structurally similar insect orders. They are mainly thermophilic invertebrates that can constitute a significant part of the biomass in terrestrial ecosystems. The biological diversity of the four largest orders (Dermaptera, Orthoptera, Mantodea, and Blattodea) of this taxon is over 37,000 species [1]. Orthopteroidea is among the most important inhabitants of agroecosystems as well as human habitation. Among them, there are many species that actively reproduce, form mass aggregations,

and cause irreparable damage to forestry and agriculture, housing, and foods [2,3]. In natural ecosystems, they can consume a significant proportion of phytomass and are a food source for many vertebrates and invertebrates [4,5]. Orthopteroidea play an important role in nature; they are essential for maintaining ecological balance, transforming plant biomass, and are an important link in the formation of insectivorous animal populations [6–8]. Other species, with their activity, ability to reproduce rapidly, tolerance to adverse factors, and dispersal ability, break records of long-distance movements. Such species disperse due to human "support" [9,10]. In addition, some species are important objects of ecological research, as they reflect changes taking place in ecosystems [11,12]. Thus, despite their not very significant global species diversity, representatives of Orthoptera, Dermaptera, Mantodea, and Blattodea play a significant role in human life, as well as in all ecosystems [13–15].

In Europe, the majority of orthopterans are associated with grasslands which originated due to traditional farming systems (pasture, mowing). Orthoptera species are known to be sensitive to grassland management and are therefore considered suitable bioindicators for land use intensity [16]. Now, some Orthoptera species are endangered, especially inhabitants of steppes, dry grasslands, and pastures, because these habitats have declined owing to housing development, modern agriculture practices, and the growth of trees and tall herbs; these processes are favoured by modern climate change [17].

Local insect faunas have attracted the attention of scientists worldwide in recent years [16,17]. Local insect faunas include natural enemies of pests, pollinators, destructors, and other beneficial species, so they provide important ecosystem services and so have a high economic value. [18–20]. The anthropogenic impact is also important and is always easier to capture and study at the local level [21–23]. For example, the expansion of the range of individual species can enrich the local fauna, especially at higher latitudes, which can easily be seen at the local scale [24]. Due to low biodiversity of terrestrial Orthopteroidea in central Russia, this group is easily studied in a relatively local area. In the Republic of Mordovia, there are not many publications on Orthopteroidea. The first list of insects including orthopteroids for Mordovia State Nature Reserve was published in 1964 [25]. The next list was published in 2005 and included insect species known in the whole Republic of Mordovia [26]. Then, a list of insects of National Park "Smolny" was compiled in 2008 [27]. An updated list of orthopterans and mantids of Mordovia State Nature Reserve was published in 2018 [28]. However, since 2005, much time has passed, and modern studies have revealed a greater biodiversity of terrestrial Orthopteroidea. Therefore, the aim of our study was to describe the current dataset on fauna, finds, and biology of terrestrial Orthopteroidea in the Republic of Mordovia, recently published in GBIF as the Darwin Core Archive [29].

2. Data Description

2.1. Description of the Data in the Dataset

Each observation includes basic information: location (latitude/longitude), date of observation, observer name, and identifier name. The coordinates were determined on site using a GPS device or after the collection using Google Maps (Table 1). The dataset contains 4865 occurrences. In total, 16,644 specimens of Orthopteroidea were studied.

Table 1. Description of the data in the dataset.

Column Label	Column Description
eventID	An identifier for the set of information associated with an event (occurs in one place at one time).
occurrenceID	An identifier for the occurrence (as opposed to a particular digital record of the occurrence).
basisOfRecord	The specific nature of the data record: HumanObservation.

Table 1. *Cont.*

Column Label	Column Description
scientificName	The full scientific name including the genus name and the lowest level of taxonomic rank with the authority.
kingdom	The full scientific name of the kingdom in which the taxon is classified.
taxonRank	The taxonomic rank of the most specific name in the scientificName.
decimalLatitude	The geographic latitude of location in decimal degrees.
decimalLongitude	The geographic longitude of location in decimal degrees.
geodeticDatum	The ellipsoid, geodetic datum, or spatial reference system (SRS) upon which the geographic coordinates given in decimalLatitude and decimalLongitude are based.
country	The name of the country in which the location occurs.
countryCode	The standard code for the country in which the location occurs.
individualCount	The number of individuals represented present at the time of the occurrence.
eventDate	The date when material from the trap was collected or the range of dates during which the trap collected material.
year	The integer day of the month on which the event occurred.
month	The ordinal month in which the event occurred.
day	The integer day of the month on which the event occurred.
samplingProtocol	The names of, references to, or descriptions of the methods or protocols used during an event.
recordedBy	A person, group, or organization responsible for recording the original occurrence.
identifiedBy	A list of names of people who assigned the taxon to the subject.

2.2. Biodiversity of Terrestrial Orthopteroidea in the Republic of Mordovia

2.2.1. The Fauna of Terrestrial Orthopteroidea

In the dataset, 71 species of terrestrial Orthopteroidea from four orders (Dermaptera, Orthoptera, Mantodea, and Blattodea) are presented (Table 2). In addition, Table 2 includes two more Orthoptera species (*Bryodemella tuberculatum* and *Omocestus ventralis*) that were not found in our surveys but were previously reported [25]. These are parochial species, whose distribution range includes the republic, but there is no modern material on them. Thus, the total fauna of terrestrial Orthopteroidea of the Republic of Mordovia includes 73 species.

The majority of orthopterous insects are represented by species with wide trans-Palaearctic and European–Siberian ranges, distributed both in the European and Asian parts of Russia. Among relatively narrow-areal species located on the periphery of the range, *Isophya modesta*, *Barbitistes constrictus*, and *Chorthippus pullus* should be noted. Using M.G. Sergeev's scheme of zonality in orthopterans [30], the first place according to species diversity is occupied by the north-steppe species; they compete slightly with the polyzonal and steppe species. Polyzonal species (e.g., *Chorthippus biguttulus*, *Chorthippus apricarius*, and *Euthystira brachyptera*) prevail everywhere in numerical abundance, in most localities also north-steppe species (*Bicolorana bicolor* and *Stenobothrus lineatus*), and in many localities also forest-steppe species (*Roeseliana roeselii* and *Gomphocerippus rufus*). In some habitats, southern-steppe species occupy an important position: *Onconotus servillei*, *Oecanthus pellucens*, *Chorthippus macrocerus*, and *Euchorthippus pulvinatus*.

The species composition of terrestrial Orthopteroidea is similar in all habitat types we identified, except for human structures and partly agrocenoses. This can be explained by the mosaic nature of the landscape, due to which habitats of different types are adjacent, combined with the mobility of insects, as well as the similarity of environmental conditions.

Table 2. Biodiversity of terrestrial Orthopteroidea species in the Republic of Mordovia ("+" sign indicates the habitat of the species).

Order, Family, Species	Meadows	Steppe Communities	Ruderal Communities	Forest Ecosystems	Agroecosystems	Human Habitations
DERMAPTERA						
Forficulidae						
Forficula auricularia Linnaeus, 1758	+	+	+	+	+	+
Forficula tomis (Kolenati, 1846)	+	+		+	+	+
Spongiphoridae						
* *Labia minor* (Linnaeus, 1758)	+			+		
Labiduridae						
Labidura riparia (Pallas, 1773)				+		
ORTHOPTERA						
Tettigoniidae						
Barbitistes constrictus (Brunner von Wattenwyl, 1878)				+		
Bicolorana bicolor (Philippi, 1830)	+	+	+	+	+	
Conocephalus dorsalis (Latreille, 1804)	+		+	+		
Conocephalus fuscus (Fabricius, 1793)	+	+	+	+	+	
Decticus verrucivorus (Linnaeus, 1758)	+	+	+	+	+	
**Gampsocleis glabra* (Herbst, 1786)	+	+				
Isophya modesta (Frivaldszky, 1868)			+	+		
* *Leptophyes albovittata* (Kollar, 1833)		+				
Metrioptera brachyptera (Linnaeus, 1761)	+	+	+	+	+	
* *Montana montana* (Kollar, 1833)		+				
Onconotus servillei Fischer von Waldheim, 1846		+				
Phaneroptera falcata (Poda, 1761)	+	+	+	+	+	
Pholidoptera griseoaptera (De Geer, 1773)	+		+	+	+	
* *Platycleis albopunctata* (Goeze, 1778)		+		+		
* *Tessellana veyseli* (Koçak, 1984)		+		+		
Poecilimon intermedius (Fieber, 1853)	+	+		+		
Roeseliana roeselii (Hagenbach, 1822)	+	+	+	+	+	
Tettigonia caudata (Charpentier, 1845)	+	+	+	+	+	
Tettigonia cantans (Fuessly, 1775)	+	+	+	+	+	
Tettigonia viridissima (Linnaeus, 1758)	+	+	+	+	+	

Table 2. *Cont.*

Order, Family, Species	Meadows	Steppe Communities	Ruderal Communities	Forest Ecosystems	Agroecosystems	Human Habitations
Gryllidae						
Acheta domesticus (Linnaeus, 1758)						+
* *Eumodicogryllus bordigalensis* (Latreille, 1804)		+				
Gryllus campestris (Linnaeus, 1758)		+	+	+		
Melanogryllus desertus (Pallas, 1771)		+		+		
Modicogryllus frontalis (Fieber, 1844)	+	+	+	+	+	+
Oecanthus pellucens (Scopoli, 1763)	+	+	+	+	+	
Tetrigidae						
Tetrix bipunctata (Linnaeus, 1758)	+	+	+	+	+	
Tetrix subulata (Linnaeus, 1758)	+	+	+	+	+	
Tetrix tenuicornis (Sahlberg, 1893)	+	+	+	+	+	
Gryllotalpidae						
Gryllotalpa gryllotalpa (Linnaeus, 1758)			+	+	+	
Acrididae						
?*Bryodemella tuberculatum* (Fabricius, 1775)				+		
Calliptamus italicus (Linnaeus, 1758)		+	+	+		
Chorthippus albomarginatus (De Geer, 1773)	+	+	+	+	+	
Chorthippus apricarius (Linnaeus, 1758)	+	+	+	+	+	
Chorthippus brunneus (Thunbberg, 1815)	+	+	+	+	+	
Chorthippus biguttulus (Linnaeus, 1758)	+	+	+	+	+	
* *Chorthippus dichrous* (Eversmann, 1859)		+				
Chorthippus dorsatus (Zetterstedt, 1821)	+	+	+	+	+	
* *Chorthippus macrocerus* (Fischer von Waldheim, 1846)	+	+		+		
Chorthippus mollis (Charpentier, 1825)	+	+	+	+	+	
Chorthippus pullus (Philippi, 1830)				+		
* *Chorthippus vagans* (Eversmann, 1848)				+		
Chrysochraon dispar (Germar, 1834)	+	+	+	+	+	
Dociostaurus brevicollis (Eversmann, 1848)		+	+	+		
Epacromius pulverulentus (Fischer von Waldheim, 1846)			+	+		
* *Euchorthippus pulvinatus* (Fischer von Waldheim, 1846)		+		+		
Euthystira brachyptera (Ocskay, 1826)	+	+	+	+	+	
Gomphocerippus rufus (Linnaeus, 1758)	+	+	+	+		
* *Gomphocerus sibiricus* (Linnaeus, 1767)		+				
Locusta migratoria (Linnaeus, 1758)			+	+	+	
Myrmeleotettix maculatus (Thunberg, 1815)	+			+		
Oedipoda caerulescens (Linnaeus, 1758)	+	+	+	+		
Omocestus haemorrhoidalis (Charpentier, 1825)	+	+	+	+	+	

Table 2. *Cont.*

Order, Family, Species	Meadows	Steppe Communities	Ruderal Communities	Forest Ecosystems	Agroecosystems	Human Habitations
?*Omocestus rufipes* (Zetterstedt, 1821)				+		
Omocestus viridulus (Linnaeus, 1758)	+	+	+	+		
Podisma pedestris (Linnaeus, 1758)				+		
Pseudochorthippus parallelus (Zetterstedt, 1821)	+	+	+	+	+	
Psophus stridulus (Linnaeus, 1758)		+	+	+		
Stenobothrus lineatus (Panzer, 1796)	+	+	+	+	+	
Stenobothrus nigromaculatus (Herrich-Schaffer, 1840)		+				
* *Stenobothrus stigmaticus* (Rambur, 1838)	+	+				
Sphingonotus caerulans (Linnaeus, 1767)		+	+	+		
Stauroderus scalaris (Fischer von Waldheim, 1846)	+			+		
Stethophyma grossum (Linnaeus 1758)	+			+		
MANTODEA						
Mantidae						
Mantis religiosa (Linnaeus, 1758)	+	+	+	+	+	
BLATTODEA						
Blattidae						
Blatta orientalis Linnaeus, 1758						+
Blattella germanica (Linnaeus, 1767)						+
Ectobiidae						
Ectobius lapponicus (Linnaeus, 1758)	+	+	+	+	+	
Ectobius sylvestris (Poda, 1761)	+	+	+	+	+	
TOTAL	**43**	**53**	**43**	**61**	**33**	**6**

*—first record in the Republic of Mordovia.

The highest number of species is found in forest ecosystems. This is determined by a large number of counting points, a complex vertical structure of forests, and also by an appreciable share of open habitats in forest landscapes such as glades, clearings, and roads providing opportunities for meadow and steppe species. Katydids of the genus *Tettigonia* and, apparently, *Barbitistes constrictus* are associated with tree crowns. *Pholidoptera griseoaptera* and *Gomphocerippus rufus* are actually confined to the grass canopy. *Tetrix bipunctata* was a typical ground-dweller of forests and forest edges. *Forficula auricularia* is active in different layers. A number of species are associated with specific habitats within forested areas. For example, *Omocestus viridulus* inhabits damp glades. *Myrmeleotettix maculatus* inhabits dry sandy patches. The rare species *Podisma pedestirs*, *Stauroderus scalaris*, and *Chorthippus pullus* are discussed below. Most of the species found in forests are either eurytopic or meadow and steppe, penetrating into forest areas. It is interesting to note that typically forest-dwelling insects such as *Ectobius lapponicus* and *Ectobius sylvestris* are also common in other habitat types.

Steppes have the second-highest number of species but are notable for their specific species composition. There are five species that have only been found in this habitat: *Leptophyes albovittata*, *Montana montana*, *Onconotus servillei*, *Gomphocerus sibiricus*, and *Stenobothrus nigromaculatus. Gampsocleis glabra*, *Eumodicogryllus bordigalensis*, *Melanogryllus desertus*, *Oecanthus pellucens*, *Euchorthippus pulvinatus*, *Chorthippus dichrous*, *Chorthippus macrocerus*, *Sphingonotus caerulans*, and *Dociostaurus brevicollis* are typical steppe-dwellers, characteristic of more southern regions. Along with typical steppe species, meadow Orthoptera constitute a significant proportion.

Meadows in general are less species-rich and are characterized by the predominance of grass-consumers with large ranges. Compared to other habitat types, the moisture-loving species *Conocephalus dorsalis*, *Conocephalus fuscus*, and *Stethophyma grossum* are more typical. In terms of abundance, species associated with grasses are absolutely dominant. Species associated with forbs, e.g., *Poecilimon intermedius*, play a notable role in the population of direct moths. Inhabitants of the soil surface are few.

In ruderal habitats, there are mainly meadow species that can exist in various grass canopies. However, thermophilic species that tend to inhabit areas with sparse herb canopy (*Gryllus campestris*, *Modicogryllus frontalis*, *Oedipoda caerulescens*, and *Sphingonotus caerulans*) are also prominent.

Agrocenoses are species-poor, with the most widespread and abundant meadow and fringe species in the territory of the republic.

In buildings, there is a set of eusinanthropic species typical for Europe: two species of cockroaches and one cricket; additionally, three ecologically malleable species, living mainly in a natural environment, penetrate there.

No modern-living Orthoptera species of Mordovia is threatened in the world or in Europe as a whole (European Red List, see [31]; Bryodemella tuberculata is not found actually). No species is included in the Red Book of Russia. However, a bush-cricket *Gampsocleis glabra* is near-threatened in Europe. Some species (*Montana montana*, *Onconotus servillei*, *Poecilimon intermedius*, and *Chorthippus pullus*) are endangered or vulnerable in many European countries. Some species are rare and included in Red Lists (Red Books) of many regions in the European part of Russia. These are *Barbitistes conctrictus*, *Myrmeleotettix maculatus*, *Psophus stridulus*, *Oedipoda caerulescens*, and species mentioned above as endangered or vulnerable in some European countries. *Melanogryllus desertus* is included in the Red Book of Mordovia. The list of animal taxa requiring special attention to their condition in the natural environment in Mordovia includes *Poecilimon intermedius*, *Myrmeleotettix maculatus*, *Stauroderus scalaris*, *Psophus stridulus*, and *Oedipoda caerulescens*. Our research suggests that really rare and threatened species in the Republic of Mordovia include *Gampsocleis glabra*, *Leptophyes albovittata*, *Montana montana*, *Onconotus servillei*, *Platycleis albopunctata*, *Tessellana veyseli*, *Podisma pedestirs*, *Stauroderus scalaris*, and *Chorthippus pullus.* They are mainly inhabitants of steppes and other dry grassland; their habitats are located generally out of federal special protected areas such as Mordovia State Nature and National Park “Smolny”. Some

populations of rare orthopterans live in the regional-value natural monument "Calcareous slope" near the village of Gart. Many habitats of rare species have no special protected status, e.g., the calcareous hills near the village of Selishchi in Atyashevo District. Our research gives scientific base to conserve such habitats. The results will used to correct the Red List of species of the Republic of Mordovia and to plan some conservation actions.

2.2.2. Dermaptera

Dermaptera biodiversity in the Republic of Mordovia includes four species from three families (Table 2). The most numerous and frequent species is *Forficula auricularia*. It inhabits a wide range of habitats, occurring in natural ecosystems, agrolandscapes, and urbanized environments (Table 2). In the western part of central Russia, nymphs emerge in May and become imagoes in mid-July, and two population peaks are observed [32]. In the conditions of the republic, only one maximum imago abundance was observed in the in the second half of August (Figure 1). In spring and early summer, overwintered females and larvae are found.

Figure 1. Seasonal dynamics of the specimens of *Forficula auricularia* collected in the Republic of Mordovia.

When abundant, *Forficula auricularia* can damage orchards [33,34]. This species is well attracted to fermenting liquids (beer and wine with a mixture of sugar and honey) and has been observed at different heights in tree crowns [35,36]. Using fermental traps, we studied the vertical distribution of *Forficula auricularia* in forests (at altitudes from 1.5 to 12 m). This method of trapping resulted in the highest number of individuals of the species occurring between 1.5 and 7.5 m (Figure 2).

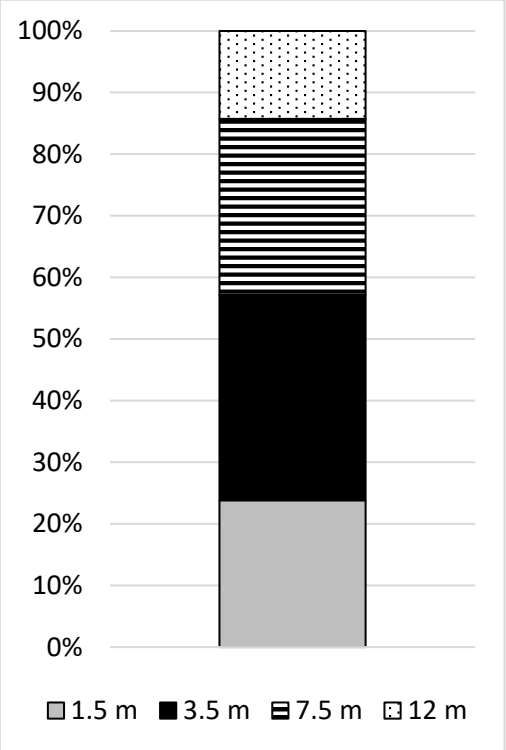

Figure 2. Altitudinal distribution of *Forficula auricularia* in forests of the Republic of Mordovia.

According to recent studies, *Forficula auricularia* in Western Europe represents a species complex of at least four species [37]. However, *Forficula auricularia* from Eastern Europe is not analysed in this publication. So far, we can only assume that *Forficula auricularia* occurs in the European part of Russia, as this species has been found using molecular-genetic methods in Central Europe.

Forficula tomis is a common species in the region. It lives in the natural environment as well as in agricultural lands, in fields, orchards, fruit gardens, and flower beds. We have noted it in vegetable gardens. According to other data, it can climb herbaceous plants and trees, penetrating into fruits (particularly apples) [38,39]. *Labidura riparia* prefers sandy beaches and riverbanks but may live away from these habitats [40,41]. Being a predator, it may feed on larvae of various insects [42]. This is the first time *Labia minor* has been found in the region. In total, five specimens have been found in grassland and forest ecosystems. It is likely that the species is much more widespread but is rarely encountered by researchers.

2.2.3. Orthoptera

Orthoptera biodiversity in the Republic of Mordovia includes 64 species from five families (Table 2). Tettigoniidae are represented by 20 species. Most species are widespread Palaearctic species that occur in many habitats. The rarest grasshopper species in the region are *Barbitistes constrictus*, *Isophya modesta*, and *Onconotus servillei*. The first two species are inhabitants of forest edges, and their numbers in biotopes are very low. *Onconotus servillei* inhabits steppe biotopes; it is a rare species.

Rare species with a local distribution in steppe habitats include another five species that we indicate for the first time (*Gampsocleis glabra*, *Leptophyes albovittata*, *Montana montana*, *Platycleis albopunctata*, and *Tessellana veyseli*). *Gampsocleis glabra* is found in seven localities. It prefers steppes and dry meadows with dense vegetation [43]. In Europe, this species is near-threatened [31]. *Leptophyes albovittata* is found only in one locality. This is an area of steppe vegetation on hillsides. Quite large areas are not covered with grasses and are bare limestone rocks. *Montana montana* is found in four localities. It occurs in biotopes similar to

those of the previous species. *Platycleis albopunctata* is found in seven localities. It occurs in steppe areas and sand dunes along edges of pine forests. This species requires bare soil for egg-laying [44]. Therefore, the projective vegetation cover in its habitat is lower than that of *Gampsocleis glabra*. *Tessellana veyseli* has been recorded in two localities. These are steppe remnants that are located at the outcrops of limestone rocks. All these species are stenotopic. They are found in restricted areas and are likely to become extinct. The numbers of these species are very low. Therefore, these species must be protected. Furthermore, it cannot be ruled out that all or some of these species are at the northern boundary of their ranges.

Seasonal activity was studied in the most numerous species of Tettigoniidae (Figure 3). These six katydids were found to be summer species, with imagoes appearing in June–July (sometimes in late May) and active until around October. In some years, there has been a shift in the timing of imago emergence to late May. Apparently, it depends on temperature regime, which gradually changes towards increase. The earliest-emerging species is *Bicolorana bicolor*, especially typical for warm meadow habitats. *Conocephalus fuscus*, which inhabits the wettest meadows, is the latest to emerge.

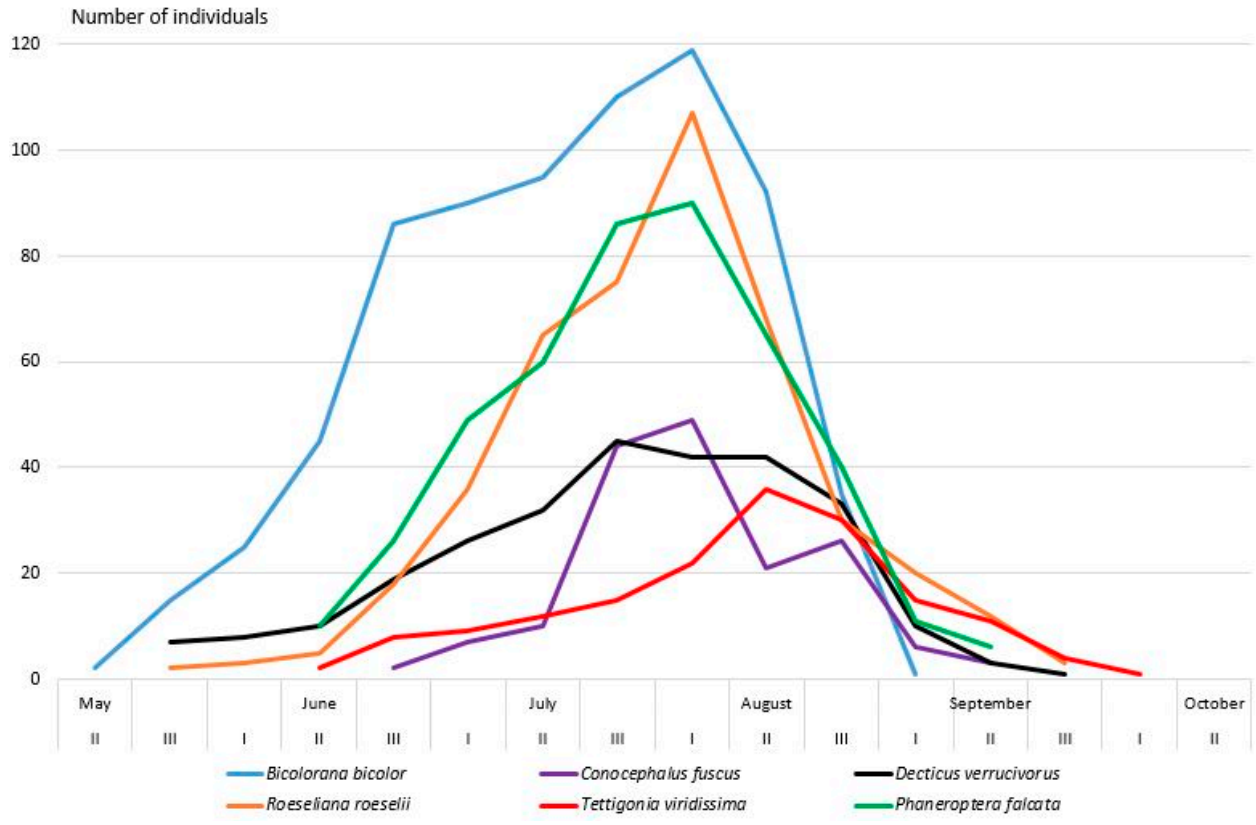

Figure 3. Seasonal dynamics of the specimens of Tettigoniidae collected in the Republic of Mordovia.

Gryllidae are represented by six species (Table 2), of which *Acheta domesticus* is found only in human habitation (basements, barns, and flats). *Melanogryllus desertus* inhabits steppe habitats. *Gryllus campestris* and *Modicogryllus frontalis* are more frequently found in a wide range of habitats. *Oecanthus pellucens* was first recorded in 2015 in the southern part of the region on the roadside. In the following years, the number of finds has increased, and it has been found in many habitats. The abundance of this species varies from year to year. For the first time, *Eumodicogryllus bordigalensis* was found in one biotope at a limestone quarry site.

Tetrigidae are represented by three species (Table 2). All species are common inhabitants of different habitats, preferring forest ecosystems. However, *Tetrix bipunctata* is more common in a wide range of habitats. *Tetrix subulata* tends to inhabit the banks of

water bodies, where it is abundant during the breeding season. The seasonal abundance of Tetrigidae in the biotopes differed for each species (Figure 4). The general trend was an increase in abundance of imagoes in May and the first half of June. In the following months, these species were also found in biotopes at the larval stage. A similar relation was obtained in the Volga region [45].

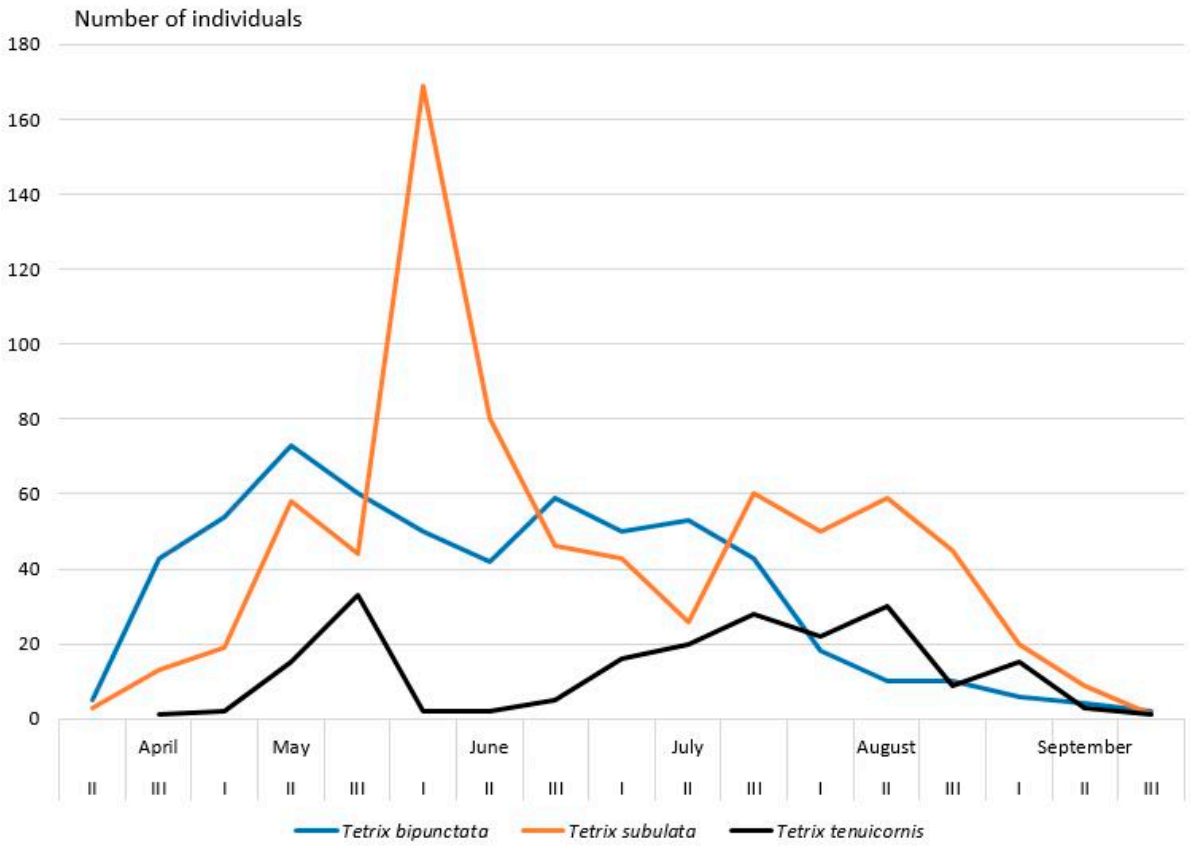

Figure 4. Seasonal dynamics of the specimens of Tetrigidae collected in the Republic of Mordovia.

Gryllotalpidae are represented by one widespread species, *Gryllotalpa gryllotalpa*. It lives in wet habitats and sometimes causes damage to cultivated plants grown by humans.

Acrididae are represented by 34 species. Relatively xerophilic cereal chortobionts are the most numerous and most common, inhabiting different types of habitats, but especially massive in meadows and ruderal communities. The sedge-grass chortobiont *Euthystira brachyptera* is also very common, inhabiting a variety of habitat types. Of note is the high abundance and occurrence of the psammophile species *Oedipoda caerulescens*, which is included in the Red Books in some regions of Russia.

The dynamics of species diversity and abundance of Acrididae in herbage is characterized by a pronounced seasonality. *Euthystira brachyptera* is the earliest, sometimes as early as the first half of June (Figure 5). The activity of this species lasts the longest. From the end of June, *Chorthippus apricarius* starts to fledge; it is usually considered a species of ruderal habitat, but in Mordovia, it occurs both in steppes and in meadows. In early July, *Pseudochorthippus parallelus*, considered a more water-loving species, appears. In general, locusts that remain on the soil surface fledge later than chortobionts, and the date of imago appearance significantly depends on habitat and year. For example, *Oedipoda caerulescens* appears in some localities and in some years as early as the 10 July, but often remains in a larval state until the end of July, occurring massively as imagoes in August and September.

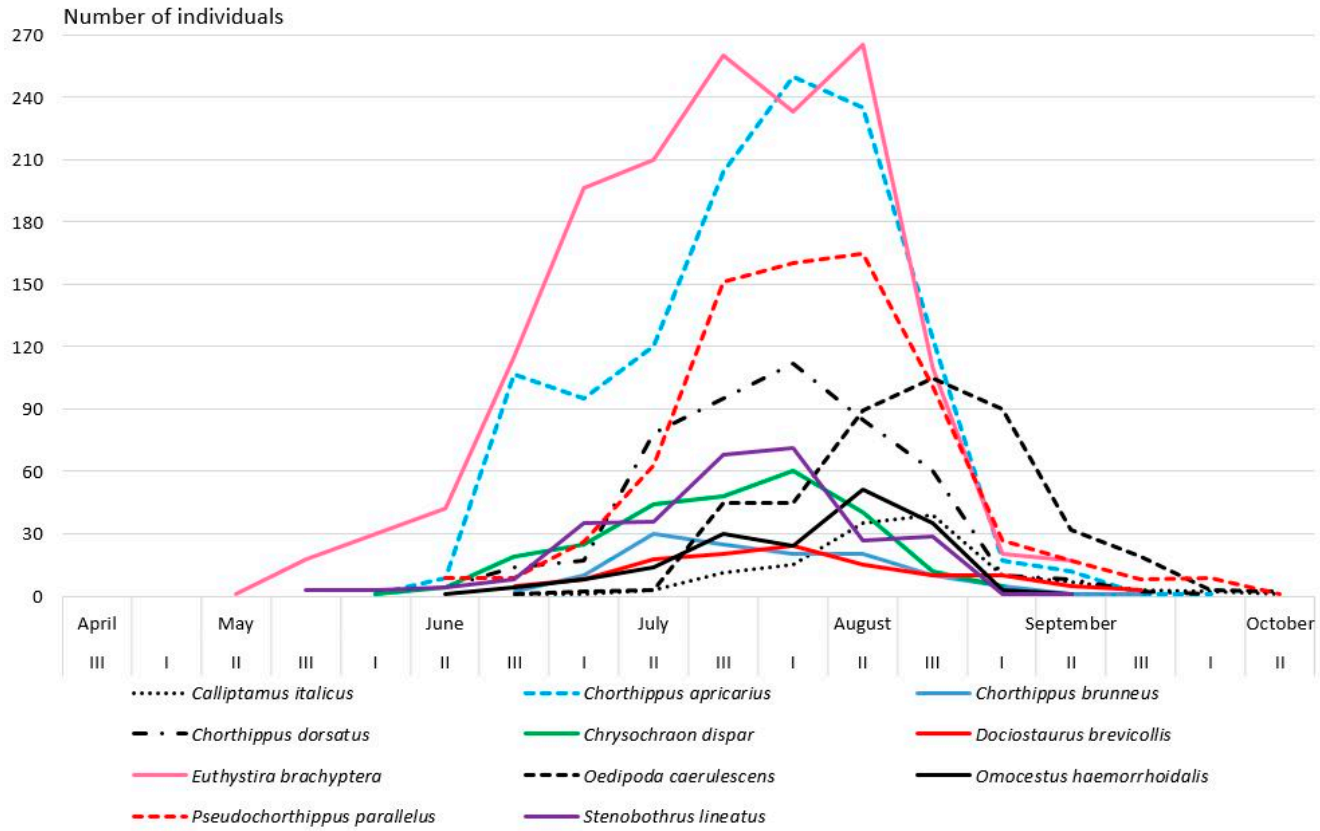

Figure 5. Seasonal dynamics of the specimens of Acrididae collected in the Republic of Mordovia.

A few rare species, for which few localities are known, and their numbers are low, are highlighted. *Podisma pedestris* in the region has been recorded only in Mordovia State Nature Reserve. All collection sites are sparse pine forests of various ages and areas affected by fire in 2021. Grass canopy in these conditions is rare, represented by thin-stemmed cereals, occasionally including lily of the valley, coupe de menthe, and other grasses. The species is mainly observed on roads, glades, bare sand, and rarely in grass. The species has a wide range but is sporadically distributed everywhere [46]. It is known that this species becomes more steadily thermophilic with increasing humidity of the climate [47]; therefore, its decline can be expected in connection with climatic changes (warming and increase of precipitations), leading to overgrowing of open spaces. *Stenobothrus nigromaculatus* has been recorded in only seven localities. The species is mainly native to steppes, where it is found in natural grassy associations with undisturbed herbage and in sparse pine forests. It stays on bare-soil plots and herbaceous plants. *Stauroderus scalaris* is found in five localities. It occurs in cereals and cereal-motley grasses, damp and steppe meadows near water bodies, as well as on forest edges. Numbers are not high. It stays on soil and plants. *Chorthippus pullus* is also found in five localities. However, this species is mostly confined to dry pine forests, where it occurs in sandy heathlands and forest clearings. It tends to stay on sand and lichens, less frequently climbing plants. *Epacromius pulverulentus* is found in eight localities. Mainly, these are edges of forests, as well as roadsides and pits. All these biotopes are characterized by sandy soil with sparse herbaceous vegetation, which alternates with bare patches of soil. *Locusta migratoria* has been recorded only four times in August and early September. This species was found in a mown field, wastewater treatment plant, pit, and quarry. In all localities, the grass canopy is poorly pronounced or almost absent.

Of the Acrididae, six species are new to the region. *Chorthippus macrocerus* is found in many localities. In the region, it occurs more often in steppe habitats, edges of thin forests, and in meadows. Numbers in some localities are rather high. This species is typical

for the steppe zone, though in Saratov Region, it does not occur in virgin lands but in young and medium-sized fallow lands [48]. Another typically steppe-dwelling species, *Euchorthippus pulvinatus*, is found in 10 localities. The majority of habitats are steppe areas with outcrops of limestone rocks, meadow steppes, and edges of forests, which were formed in the place of heathlands. It is a typical inhabitant of various steppes of the Volga Basin [49]. *Chorthippus vagans* has been recorded in only one locality. This habitat is a forest edge with adjacent sandy bare dunes with sparse grass vegetation. Such habitats are typical for this species in Europe as a whole [50]. *Gomphocerus sibiricus* is found in a single locality. This habitat is a grassland steppe growing on the outcrop of carbonate rocks. There, too, areas of dense herbage alternate with areas of low herbage, with areas of bare stony rock. In the same area, we observed *Onconotus servillei*, *Gampsocleis glabra*, *Platycleis albopunctata*, *Chorthippus dichrous*, and *Euchorthippus pulvinatus*. As far as we know, this is the northernmost occurrence of this species in the Volga River Basin. At the beginning of the 20th century, it was noted [51] in the city of Kuznetsk (now Penza Region) 165 km south of our find. *Stenobothrus stigmaticus* has been recorded in only two localities. The first habitat has steppe vegetation on a limestone bed; in the second habitat, meadow steppe is growing on a slight slope of southern exposure. Similar habitats are indicated for this species in other parts of the range [52]. The steppe species *Chorthippus dichrous* has been recorded in only one locality.

2.2.4. Mantodea

In the Republic of Mordovia, one family with one species, *Mantis religiosa*, is known. The first finds of this species in the region were made in 2010 at quite a considerable distance from each other: in Saransk and Temnikov District. During this year, there were abnormally high temperatures and a very dry summer. By 2013, it was already constantly found in Temnikov, Romodanovo, Ichalki, Kochkurovo, Chamzinka, Dubenki, Bolshie Berezniki, and Ruzayevka districts. *Mantis religiosa* dispersed actively northwards and is now found in the districts of the republic. The number of the species is usually low. *Mantis religiosa* is found in open biotopes. However, it can also be found in forest ecosystems, where it prefers glades, roadsides, and clearings. The activity of *Mantis religiosa* is single-peaked, with a maximum abundance in habitats in mid-August (Figure 6).

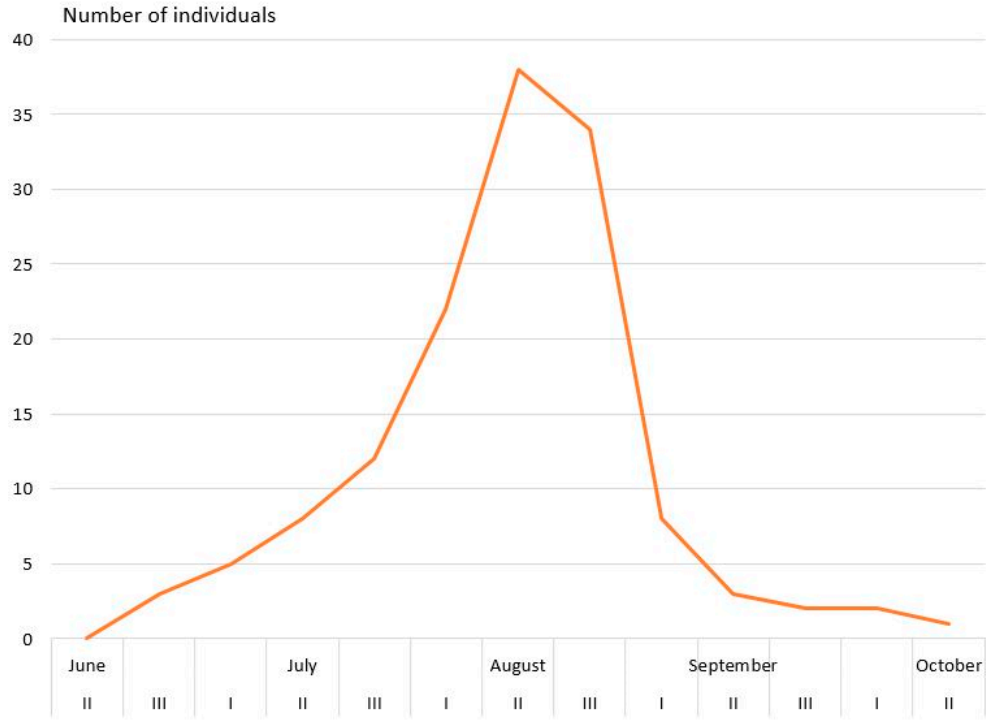

Figure 6. Seasonal dynamics of the specimens of *Mantis religiosa* collected in the Republic of Mordovia.

2.2.5. Blattodea

The biodiversity of Blattodea in the Republic of Mordovia includes four species from two families (Table 2). Of these, two species (*Blatta orientalis* and *Blattella germanica*) are exclusively inhabitants of human dwellings and do not occur in natural ecosystems. Both species were previously (until the 2000s) quite abundant in various dwellings. For example, *Blatta orientalis* preferred wooden buildings and single-storey houses and basements. In contrast, *Blattella germanica* was more often found in multi-storey buildings. In many cases, *Blattella germanica* replaced *Blatta orientalis* and became numerically dominant in towns and villages. However, in subsequent years, the numbers of both species in dwellings began to decline. This is probably due to the use of new-generation herbicides, various traps, and improvement in the general level of housekeeping [53,54].

The other two species (*Ectobius lapponicus* and *Ectobius sylvestris*) are species that are common in almost all natural habitats. Of these, *Ectobius sylvestris* is more confined to open habitats than *Ectobius lapponicus*, which is more often found in forest and near-forest ecosystems (margins, meadows). The findings change the traditional way of seeing *Ectobius sylvestris* as an exclusive forest-dweller [55], since it has penetrated open habitats. Adult males and nymphs of both cockroach species are usually found in low vegetation (grasses, bushes), while females are more often found in fallen leaves and decaying wood [56,57]. According to our data, these species are well attracted to beer traps [36]. At the same time, they are usually prevalent in traps located at 1.5 m, while at 7–12 m, Blattodea abundance decreases by 12.5 times. Seasonal activity of these species showed a single maximum observed in June and July (Figure 7).

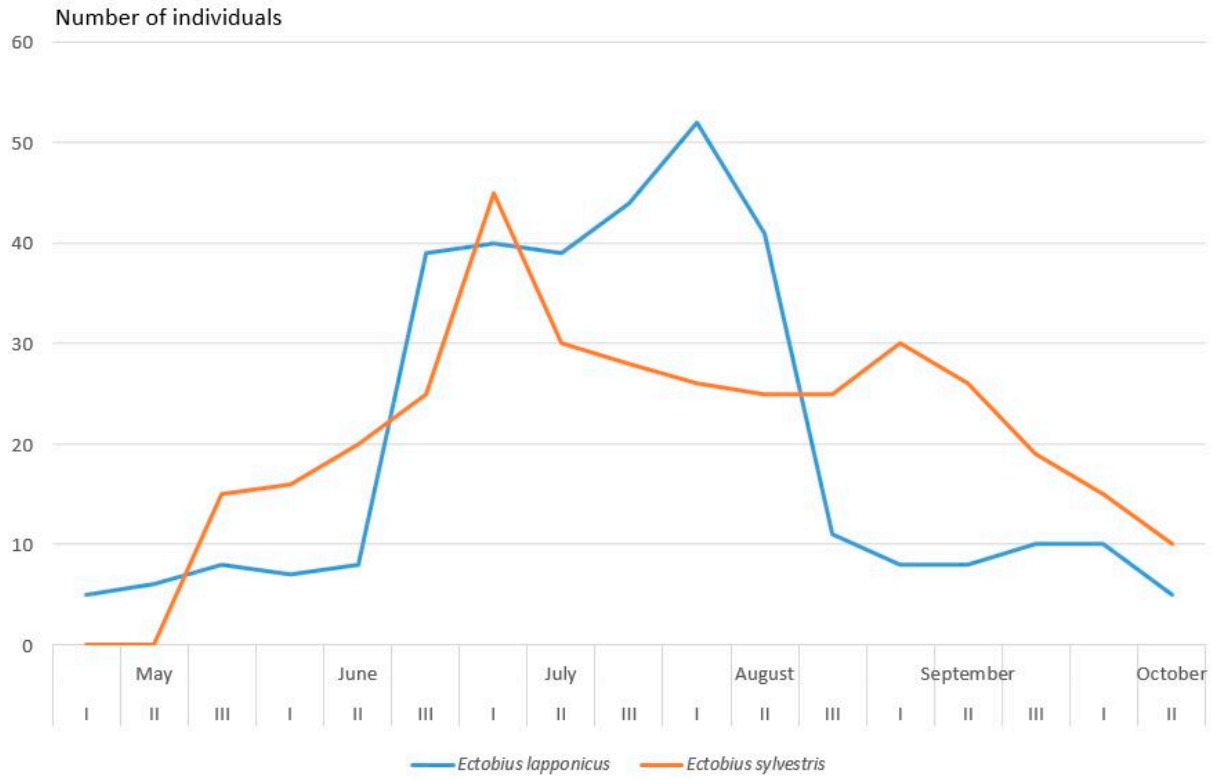

Figure 7. Seasonal dynamics of the specimens of *Ectobius lapponicus* and *Ectobius sylvestris* collected in the Republic of Mordovia.

3. Methods

3.1. Study Area

The territory of the Republic of Mordovia is located in the Volga Uplands (in the eastern part of the region) and the Oka–Don Lowlands (in the western part of the region) (Figure 8). The Volga Uplands are hilly with heights up to 320 m. This part of the republic

has many steppe remnants, which are formed on chalk outcrops, limestone and sandstone. The Oka–Don Lowlands are more lowland and less hilly, with heights up to 180 m. The lowlands have vast watersheds and gentle slopes with few ravines, gullies, and open areas. Meadows and forest ecosystems are more developed in this part of the country. The climate is temperate. Three types of air masses contribute to the climate: Arctic air masses, temperate air masses, and, to some extent, tropical air masses. Marine air masses contain large quantities of moisture and often cause thaws during the cold season and cool weather in the summer. The average annual amount of precipitation in the territory of Mordovia is 480 mm. Warm precipitation predominates during the year. The average amount of precipitation in July is about 65 mm, while the minimum monthly amount of precipitation is in February, at 15–30 mm [58].

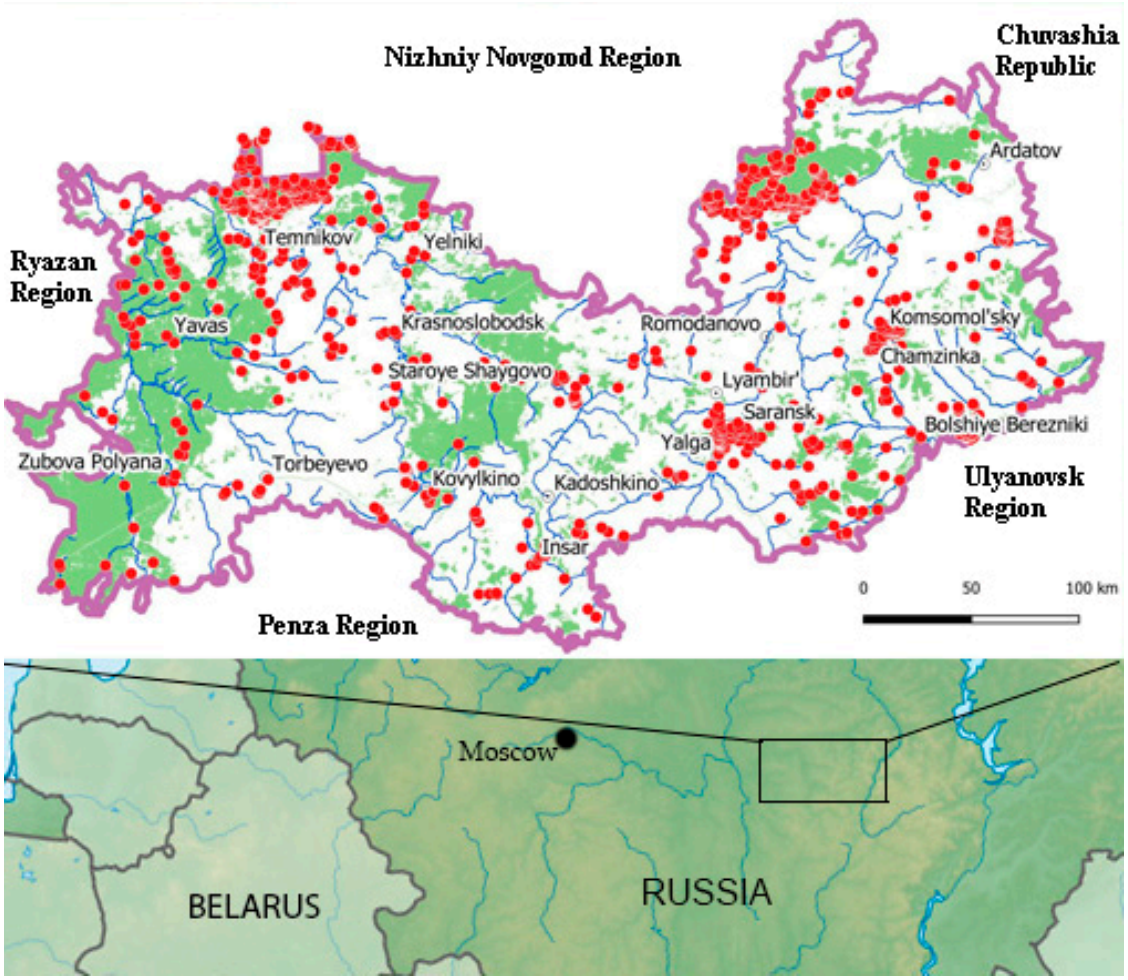

Figure 8. Study area and area to obtain information for the dataset. The red dots in the upper part of the figure indicate the localities of research, the black dot in the lower part of the figure indicates the city of Moscow.

In total, 1655 points of sampling or localities were achieved. In the dataset, each of them has a unique combination of latitude and longitude written to four decimal places. They are drawn as red dots in Figure 8. Some localities were surveyed many times in season or during many years and using various methods. As result, our net of sample plots targets all 25 districts of the Republic of Mordovia. We conditionally divided the studied ecosystems and habitats of terrestrial Orthopteroidea into 6 types:

Meadows—natural open biotopes varying in area and humidity. Usually, these are large, open, vast areas covered with herbaceous perennials (grasses, sedges, compositae). Such vegetation contributes to the fertility of the soil layer. Meadows are usually found in

river valleys (floodplain meadows), on the site of felled forests, and on the site of former fields (fallow land).

Steppe communities are natural steppe areas which have remained almost unchanged. Often, such biotopes are located on soils inconvenient for agriculture, on limestone and chalk outcrops. The vegetation cover is smaller in such areas than in meadows. Areas with vegetation alternate with areas of open ground or soil.

Ruderal communities are habitats that are not natural, associated with human settlements and located near houses, under fences, on road edges, in landfills, and in pits. Such areas are characterized by disturbed soil structure, a high content of organic residues, nitrate nitrogen, and often a low content of mineral nutrients, or vice versa. In such biotopes, there is a considerable amount of ruderal (weed), often invasive, plants.

Forest ecosystems are different ecosystems formed in different environments. Forest ecosystems can be of primary origin and have been growing in the same place for a long time. In the case of secondary origin, forests have emerged from clearcuts or abandoned fields. The main component of forests is a wide variety of plants which form the tiers. In forest ecosystems, there are open areas (glades, forest margins, clearings, and other habitats) that are home to many species.

Agroecosystems are large areas of open agricultural land. These ecosystems are maintained solely by humans. They are characterized by a small presence of native plants, a considerable number of weeds, and a monoculture of a cultural plant. Such ecosystems are characterized by constant cultivation, the use of pesticides, and the use of fertilizers.

Human habitations are places where people live or work (wooden constructions, high-rise buildings, and office buildings). They consist of a multitude of auxiliary service buildings, which are not frequently used by people, and are habitats for a wide range of species (cellars, power substations, latrines, etc.). In such areas, the temperature and humidity are kept constant.

3.2. Design of Research, Identification, and Taxonomic Position of Samples

We used traditional collection methods [36,59]. For this purpose, we used general entomological methods, as well as methods developed for collecting terrestrial Orthopteroidea. The main method to sample the insects was sweep netting. This method allowed us to find most of the families and species which occur among herbs on bushes during a day. Pitfall traps were used to collect inhabitants of the soil (Gryllotalpidae), litter- and ground-dwelling insects (Gryllidae, Tetrigidae, some Blattodea, Dermaptera, Acrididae, and Tettigoniidae), and many inhabitants of tree and herb layers were also collected with pitfall traps. Pan traps were exposed among herbs and on the soil surface in forests, meadows, and agrocenoses. Mainly herb inhabitants were sampled using pan traps. Beer traps were exposed in crowns of trees. These methods allowed us to collect flying or planning insects (e.g., *Tettigonia*) and species attracted with sugar-contained and fermented liquids (Dermaptera and Blattodea). Some species were identified using their songs, especially inhabitants of buildings (*Acheta*) and some species with morphological unclear diagnostics (e.g., some Chorthippus). In addition, we collected the insects by hand in places where standardized methods were poorly applicable.

Collections were conducted during April–October 1971, 1984, 1995, 1996, 1998, 2000, 2001, and 2004–2023. Identification of material was made according to field guides [60–64]. The collected material is stored in the collection of the Mordovia State Nature Reserve (Pushta, Russia). We followed the proposed modern nomenclature [65].

Author Contributions: Conceptualization, A.B.R. and V.V.A.; methodology, A.B.R., I.O.K. and V.V.A.; software, O.N.A.; validation, A.B.R.; formal analysis, A.B.R. and V.V.A.; investigation, A.B.R. and V.V.A.; resources, V.V.A., M.N.E., S.V.L., E.A.L., A.B.R. and M.K.R.; data curation, O.N.A.; writing—original draft preparation, A.B.R. and V.V.A.; writing—review and editing, A.B.R. and V.V.A.; visualization, I.O.K. and A.B.R.; supervision, A.B.R.; project administration, A.B.R.; funding acquisition, A.B.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Russian Science Foundation, grant number 22-14-00026.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The authors are grateful for numerous consultations, as well as for personal participation in the research of A.P. Mikhailenko (Moscow, Russia). The authors are grateful to G.B. Semishin (Saransk, Russia) for collecting samples.

Conflicts of Interest: The authors declare no conflict of interest.

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