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# BIODIVERSITY AND SPATIAL DISTRIBUTION OF ORTHOPTEROID INSECTS IN THE STEPPE ECOSYSTEMS OF CENTRAL KAZAKHSTAN

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## SUMMARY

The succeeding study comprised a comparative analysis of three-year research (2020–2022) on the fauna and ecological distribution of orthopteroid insects (*Orthoptera*, *Mantodea*, and *Dermaptera*) in the Korgalzhyn State Nature Reserve, Central Kazakhstan. Field surveys proceeded at 23 monitoring sites representing major habitat types, including wetlands, coastal zones, steppe, wormwood-grass communities, solonchaks, and stony biotopes. Overall, the recorded species totaled 46 belonging to eight taxonomic groups. The highest species richness resulted in the locust family Acrididae (25 species) and the bush-cricket family Tettigoniidae (12 species). Species distribution and abundance displayed considerable association with vegetation structure, moisture conditions, and the degree of anthropogenic impacts. In some habitats, population density reached up to 300 individuals per hour. The most widespread and dominant species were *Chorthippus karelini*, *Euchorthippus pulvinatus*, *Chorthippus biguttulus*, and *Eremippus comatus*, while the species *Myrmeleotettix pallidus* and *Omocestus petraeus* were dominating locally. An increase in the population of the potentially harmful species (*Calliptamus italicus*, *Locusta migratoria*, and *Oedaleus decorus*) also emerged. However, the documentation of several species occurred for the first time in the Korgalzhyn Reserve, including *Roeseliana roeselii*, *Phaneroptera falcata*, and *Conocephalus dorsalis*.

**Keywords:** Orthopteroid insects (*Orthoptera*, *Dermaptera*, *Mantodea*), Korgalzhyn reserve, ecological distribution, biodiversity, population, steppe stations, fauna of Kazakhstan

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**Key findings:** With three years of study, identifying 46 species of orthopteroid insects succeeded in the Korgalzhyn Reserve, demonstrating the highest biodiversity across steppe and wetland habitats. Dominant species, such as *Chorthippus karelini* and *Euchorthippus pulvinatus,* revealed considerable adaptability to variations in vegetation structure and moisture conditions.

## INTRODUCTION

Orthopteroid insects (*Orthopteroidea*), including the orders *Orthoptera*, *Dermaptera*, and *Mantodea*, represent a viable group of terrestrial invertebrates in the biocenoses of temperate and arid zones (Sergeev, 2021b). Recent studies detailed these insects to be important bioindicators of ecosystem health, demonstrating the highest sensitivity to climate change and anthropogenic landscape transformation (König *et al*., 2024; Stefanidis *et al*., 2025). Their ecological role is multifaceted, playing a vital role in the transformation of energy in trophic chains by being primary consumers of the vegetation (Sergeev, 2021a; Nurjanov *et al*., 2024) and participating in processes of organic matter decomposition and soil formation (Ozment *et al*., 2021). They also serve as a crucial food resource for various vertebrate species (Nurgaziyev *et al*., 2024), with the individual species potentially becoming major phytophagous pests.

The family Acridoidea is particularly significant due to their ability to develop mass reproduction outbursts (Popova *et al*., 2022; Sergeev *et al*., 2025). Studies showed Eurasian steppes have become home to more than 440 *Orthoptera* species, and species richness gradually increased from forest steppes to semi-deserts (Sergeev, 2021b; Ogan *et al*., 2022). Climate change can substantially expand the habitat of many species, including desert locusts (*Schistocerca gregaria*) (Borodulin and Maksimenko, 2023), which necessitates new approaches to monitoring and forecasting (Karynbayev *et al*., 2023).

On the orthopteroid fauna, research relevance is growing in the face of global environmental variations (Bennett *et al*., 2025; Riede and Balakrishnan, 2025). Climate change also causes shifts in the distribution of species, communities' structure variations, disruptions of phenological cycles (Nasiyev *et al*., 2023; Olzhabayeva *et al*., 2024), and variations in trophic interactions (Rafikov *et al*., 2024). Furthermore, Ogan *et al*. (2022) explored the biotic homogenization of orthopteroid communities, which is much more pronounced in Central Europe and Kazakhstan. Morgacheva *et al*.'s (2025) findings revealed the effectiveness of modern acoustic monitoring approaches for studying the population dynamics of these insects.

The Korgalzhyn State Nature Reserve, part of the UNESCO World Network of Biosphere Reserves, is a unique natural complex of Central Kazakhstan (Cherchesova and Maltsagov, 2023). Its territory, spanning 1.6 million ha, includes various ecosystems, from wetlands to rocky steppes, which develop ideal conditions for studying ecological patterns of orthopteroid population distribution and dynamics (Schori *et al*., 2020). However, Sergeev (2021a) reported the reserve's entomofauna, especially the orthopteroid insects, remains understudied. Tuleyeva *et al*. (2024) also emphasized the importance of applying modern GIS technologies and multidimensional statistical analyses in such types of research.

The presented study aimed to carry out the comparative analysis of three-year research (2020–2022) on the fauna and ecological distribution of orthopteroid insects (*Orthoptera*, *Mantodea*, and *Dermaptera*) using traditional and advanced methods in the Korgalzhyn State Nature Reserve, Central Kazakhstan (Bennett *et al*., 2025; Stefanidis *et al*., 2025). Particular attention focused on identifying patterns of the spatial distribution of insect species based on biotopic conditions (Ozment *et al*., 2021) and analyzing anthropogenic factors' effect on communities' structure (Ogan *et al*., 2022). Additionally, it sought to evaluate the reserve's role as refugia for rare species under climate change (Riede and Balakrishnan, 2025). Similar past research in other regions showed protected areas play a key role in preserving orthopteroid biodiversity (Kuanbay *et al*., 2025).

The acquired results will provide a sound scientific base for developing strategies about the conservation of this important group of insects (Cherchesova and Maltsagov, 2023), improving monitoring methods (Bennett *et al*., 2025), forecasting variations under the influence of global factors, and drawing comparisons with other regions (Sergeev, 2021a; Ogan *et al*., 2022). In this way, this timely study will make a significant contribution to understanding the ecology of orthopteroid insects in the steppe ecosystems of Central Asia in the context of current global change.

## MATERIALS AND METHODS

### Study location and procedure

The studies progressed in 2020–2022 in the Korgalzhyn State Nature Reserve (Akmola and Karaganda Regions, Kazakhstan), included in the UNESCO World Heritage List as part of the Saryarka–Steppe and Lakes of Northern Kazakhstan site. In the course of the study, authors examined 23 monitoring sites representative of the main ecosystems of the reserve: a) wetlands (lakes Teniz, Yesei, and Sultan Keldy) with diverse hydrological characteristics and coastal vegetation; b) steppe and wormwood-grass communities at different stages of succession with varying projective coverage; and c) anthropogenically disturbed areas (river floodplains, overflowing areas, and roadsides) selected based on representativeness criteria for the main ecosystems, the diversity of plant associations, and the gradient of anthropogenic factors' effects (Ozment *et al*., 2021; Dutbayev *et al*., 2022).

### Insect collection and counting methods

The study employed both standard and advanced methods for the collection of orthopteroid insects in the steppe and wetland landscapes. Standardized time counts conducted for one hour per site (30 minutes in large biotopes) included recording abundance, sex, age structure (adults/larvae), and key behavioral traits (singing, feeding, and mating). For phenological variations, surveys continued repeating three times during the growing season: early summer (June), peak activity (July-August), and late summer (September). Reconnaissance surveys comprised short standardized collections (5–10 minutes per site) to rapidly assess species composition, with particular attention to ecotones and biotope boundaries characterized by elevated biodiversity (Bennett *et al*., 2025). These surveys provided preliminary estimates of the insect species richness before detailed sampling.

With an entomological net, sweeping ensued following a standardized protocol of 100 sweeps per 100 m² plot (Stefanidis *et al*., 2025). Sampling efficiency evaluation has species yield per unit effort. This method was primarily applicable in dense and tall vegetation (grass-forb steppes and coastal thickets), where visual detection was limited. Collections transpired in the morning (08:00–11:00) under favorable weather conditions (18 °C–25 °C, no precipitation, and strong wind) to reduce seasonal and diurnal variability.

Visual detection took place to target the large and inactive species poorly represented in net samples (mantises and mole crickets) (Schori *et al*., 2020). Each site incurred inspections for 15–20 minutes, recording behavioral traits, microhabitat association, and interspecific interactions. The use of binoculars (8–10×) in open areas aided all observations for documentation with time, weather conditions, and plants phenological stage.

Collected insect specimens underwent preservation in 70% ethanol with 5% glycerol. Species identification used morphological keys (Sergeev, 2021b), with molecular confirmation of cryptic taxa via COI barcoding (Riede and Balakrishnan, 2025). For taxonomically complex groups, detailed microscopic analysis (male genitalia, cuticle sculpture, and wing venation) succeeded in using a Leica M205C stereomicroscope (40–100×) (Popova *et al*., 2022). All the collected specimens received labels comprising GPS coordinates, collection date, and biotope characteristics before being deposited in the scientific collection at the Institute of Zoology, Kazakhstan (KZ-ENT-2023-001–500).

Orthopteroid communities with quantitative analysis include the calculation of relative abundance (ind./hour), occurrence (% of surveyed sites), and dominance using a modified Braun–Blanquet scale (Ogan *et al*., 2022). The assessment of β-diversity between biotopes employed the Jaccard distance adjusted for incomplete sampling. Community structure characterization used the Shannon (H′), Simpson (D), and Pielou (J′) indices. All analyses utilized the PAST 4.03 with 1000 bootstrap replicates. Survey sites georeferencing engaged a Garmin GPSMAP 64s (±5 m; WGS84), recording coordinates, altitude, and sampling time. Spatial analyses and species distribution mapping took place in QGIS 3.28.

Meteorological and phytocenotic data collection concurrently followed standardized protocols (König *et al*., 2024). Recordings of microclimate parameters had 15-minute intervals using a Kestrel 5500 weather station. Vegetation characteristics included NDVI derived from Landsat 8 imagery (30 m) with ground validation, projective cover estimated by the Braun–Blanquet method (1 × 1 m plots), and dominant species composition within standard geobotanical sites. For integrated analysis, all the environmental data's linkage to insect sampling points prevailed.

Statistical data processing utilized specialized software: PAST 4.03 for multivariate analysis and R 4.3.0 for complex modeling. The main analytical methods included a) cluster analysis (unweighted pair group method with arithmetic mean [UPGMA] algorithm) with dendrograms of site similarity by species composition based on the Bray-Curtis distance matrix; b) non-metric multidimensional scaling (NMDS) in two-dimensional space with a stress factor < 0.15 to visualize structural differences between communities; c) generalized linear models (GLM) with stepwise variable selection to assess the significance of abiotic factors' influence (temperature, humidity) and anthropogenic load on biodiversity parameters; and d) student's t-test with Bonferroni correction for pairwise comparisons between biotopes. The reliability of the results received confirmation by the bootstrap analysis (1000 replicates) and comparison with (a) historical data, (b) global GBIF databases via the API, and (c) reference collections of the Institute of Zoology of the Republic of Kazakhstan (with the $x^2$ test to determine sample representativeness).

## RESULTS

In the monitoring of orthopteroid insects in the Korgalzhyn Biosphere Reserve during 2020–2022, comprehensive counts occurred at the 23 representative sites covering various types of biotopes. As a result, 46 species of orthopteroid insects belonging to eight different families succeeded in their documentation. The complete species composition, relative abundance, and occurrence of orthopteroid insects across all monitoring sites are available in Tables 1a and 1b.

The most numerous dominant were the individuals of the superfamily Acridoidea (25 species) and the family Tettigoniidae (12 species). All other taxa represented by individual families comprised Gryllidae, Gryllotalpidae, Tridactylidae, Tetrigidae, and Pamphagidae, as well as representatives of the orders *Mantodea* and *Dermaptera*. Additionally, the species *Anechura bipunctata* was notable outside the monitoring points.

### Species diversity and biotopic confinement

The insect species with greater richness was prevalent in wormwood-grass-forb meadows and coastal sand stations with more than 20 species (sites 14–16) (Table 2). In the less productive and simpler phytocenoses (sites 3, 4, and 7), the survey recorded 4–10 insect species. The average number ranged from 50 to 300 ind./hour, appearing to be associated

**Table 1a.** Species composition of orthopteroid insects (*Orthopteroidea*) found in monitoring sites, their relative abundance, and occurrence (part 1).

| Species | Site No. | Relative abundance, ind./hour (min-max; mean) | Occurrence (%) |
|---|---|---|---|
| Order *Orthoptera* | 16, 19, 22 | 1–4; 2.0 | 13.0 |
| Family *Tettigoniidae* | | | |
| *1. Phaneroptera falcata* | | | |
| *2. Tettigonia caudata* | 14, 16, 17, 21, 22 | 1–3; 1.8 | 21.7 |
| *3. Gampsocleis glabra* | 13-16 | 1.0 | 17.4 |
| *4. Decticus verrucivorus* | 1, 2, 9, 11, 13, 15, 16, 18, 22 | 1–4; 1.7 | 39.1 |
| *5. Montana eversmanni* | 2, 6, 7, 9, 11-16, 20, 21, 23 | 1–10; 4.0 | 82.6 |
| *6. Platycleis intermedia* | 8, 13-15 | 1–2; 1.5 | 17.4 |
| *7. Tessellana vittata* | 2, 6, 9, 10, 12-16, 20, 23 | 1–21; 5.6 | 47.8 |
| *8. Bicolorana bicolor* | 13, 14, 19, 22 | 1–4; 2.2 | 17.4 |
| *9. Roeseliana roeselii* | 15 | 15.0 | 4.3 |
| *10. Miramiola pusilla* | 2, 12-15, 17, 20 | 1–19; 5.8 | 30.4 |
| *11. Conocephalus dorsalis* | 22 | 1.0 | 4.3 |
| *12. Conocephalus fuscus* | 22 | 1.0 | 4.3 |
| Family *Gryllidae* | 16, 17, 19 | 1–6; 3.0 | 13.0 |
| *13. Modicogryllus frontalis* | | | |
| Family *Gryllotalpidae* | 1, 12 | 1–7; 4.2 | 8.7 |
| *14. Gryllotalpa unispina* | | | |
| Family *Tridactylidae* | 11, 16 | 3–11; 7.0 | 8.7 |
| *15. Bruntridactylus tartarus* | | | |
| Family *Tetrigidae* | 16, 19 | 12–82; 36.7 | 8.7 |
| *16. Tetrix bipunctata* | | | |
| *17. Tetrix subulata* | 11, 16 | 2.0 | 8.7 |
| Family *Pamphagidae* | 1, 5, 9, 11, 12, 14-18, 21, 23 | 1–8; 2.1 | 52.2 |
| *18. Asiotmethis muricatus* | | | |
| Family *Acrididae* | 3, 8, 9, 12-19, 21-23 | 3–92; 16.1 | 60.9 |
| *19. Calliptamus italicus* | | | |
| *20. Arcyptera microptera* | 11, 13, 14, 15, 16, 18, 20 | 1–20; 8.0 | 30.4 |
| *21. Dociostaurus brevicollis* | 1, 2, 6, 8, 11-23 | 2–34; 12.4 | 73.9 |
| *22. Dociostaurus kraussi* | 9, 11, 14-16, 18, 20, 23 | 1–8; 3.4 | 34.8 |
| *23. Eremippus comatus* | 1, 2, 5, 6, 12, 14, 15, 23 | 1–38; 17.6 | 34.8 |

Note: * — species detected outside the monitoring sites.

**Table 1b.** Species composition of orthopteroid insects (*Orthopteroidea*) found in monitoring sites, their relative abundance, and occurrence (part 2).

| Species | Site No. | Relative abundance, ind./hour (min-max; mean) | Occurrence (%) |
|---|---|---|---|
| *1. Eremippus costatus* | 2 | 6–36; 21.0 | 4.3 |
| *2. Stenobothrus fischeri* | 11, 15, 20 | 1–16; 7.0 | 13.0 |
| *3. Stenobothrus eurasius* | 12-17, 20-23 | 1–44; 12.0 | 43.5 |
| *4. Omocestus haemorrhoidalis* | 2, 4-7, 9, 12-17, 19-23 | 1–49; 10.9 | 73.9 |
| *5. Omocestus petraeus* | 5, 6, 12, 13, 15, 16, 18, 20-22 | 1–88; 25.0 | 43.5 |
| *6. Myrmeleotettix pallidus* | 2, 5, 17-19, 21, 23 | 1–143; 34.8 | 30.4 |
| *7. Aeropedellus baliolus* | 2, 5, 6, 11, 14, 17 | 1–4; 2.0 | 26.1 |
| *8. Chorthippus karelini* | 1-10, 11-17, 19-22 | 2–188; 34.9 | 91.3 |

Note: * — species detected outside the monitoring sites.

**Table 1b.** (cont'd.)

| Species | Site No. | Relative abundance, ind./hour (min-max; mean) | Occurrence (%) |
|---|---|---|---|
| *9. Chorthippus* (s. str.) *dichrous* | 1, 2, 8-10, 13-16, 23 | 1–16; 6.1 | 43.5 |
| *10. Chorthippus biguttulus* | 1-3, 5, 6, 9, 11, 14-17, 19, 21-23 | 1–40; 6.4 | 65.2 |
| *11. Euchorthippus pulvinatus* | 1-4, 6, 7, 9, 12-23 | 1–256; 31.6 | 82.6 |
| *12. Epacromius pulverulentus* | 3, 6, 10, 22 | 1–2; 1.7 | 17.4 |
| *13. Locusta migratoria* | 3, 6, 11, 16, 22 | 1–6; 3.2 | 21.7 |
| *14. Oedaleus decorus* | 7, 11, 17-19 | 1–38; 12.1 | 21.7 |
| *15. Pyrgoderaarmata* | 1, 3, 12, 13, 16, 17 | 1–5; 2.4 | 26.1 |
| *16. Celes variabilis* | 1, 11, 13, 14, 16-18, 23 | 1–6; 3.5 | 34.8 |
| *17. Oedipoda caerulescens* | 4, 18, 19 | 1–12; 6.4 | 13.0 |
| *18. Oedipodaminiata* | 1-4, 6, 7, 9, 11, 13-16, 18, 23 | 1–23; 6.1 | 60.9 |
| *19. Angaracris barabensis* | 18 | 12–30; 18.7 | 4.3 |
| *20. Sphingonotus coerulipes uvarovianus* | 1-5, 18, 23 | 2–36; 13.0 | 30.4 |
| Order *Mantodea* | 9, 13-15 | 1–6; 2.6 | 17.4 |
| Family Mantidae | | | |
| *21. Mantis religiosa beybienkoi* | | | |
| Order *Dermaptera* | | | |
| Family Forficulidae | | | |
| *22. Anechura bipunctata* * | | | |
| Family Labiduridae | 3, 6, 11 | 1–10; 5.0 | 13.0 |
| *23. Labidura riparia* | | | |

Note: * — species detected outside the monitoring sites.

**Table 2.** Species diversity and relative abundance of orthopteroid insects in monitoring sites.

| Site No. | Number of species | | | | Relative abundance (ind./hour) | Dominant species |
|---|---|---|---|---|---|---|
| | *Orthoptera* | *Mantodea* | *Dermaptera* | Total | | |
| 1 | 14 | - | - | 14 | 48 | *Asiotmethis muricatus, Oedipoda miniata, Dociostaurus brevicollis, Eremippus comatus* |
| 2 | 17 | - | - | 17 | 70 | *Eremippus costatus, Euchorthippus pulvinatus, Chorthippus dichrous, Sphingonotus coerulipes* |
| 3 | 9 | - | 1 | 10 | 56 | *Euchorthippus pulvinatus, Labidura riparia, Locusta migratoria* |
| 4 | 6 | - | - | 6 | 300 | *Euchorthippus pulvinatus, Chorthippus karelini, Sphingonotus coerulipes* |
| 5 | 9 | - | - | 9 | 132 | *Eremippus comatus, Sphingonotus coerulipes, Omocestus petraeus* |
| 6 | 13 | - | 1 | 14 | 83 | *Eremippus comatus, Dociostaurus brevicollis, Oedipoda miniata, Chorthippus karelini* |
| 7 | 6 | - | - | 6 | 126 | *Chorthippus karelini, Euchorthippus pulvinatus, Oedipoda miniata* |
| 8 | 5 | - | - | 5 | - | *Chorthippus karelini, Dociostaurus brevicollis* |
| 9 | 13 | 1 | - | 14 | 76 | *Calliptamus italicus, Chorthippus dichrous, Chorthippus karelini* |
| 10 | 4 | - | - | 4 | - | *Chorthippus karelini, Chorthippus dichrous* |
| 11 | 16 | - | 1 | 17 | 65 | *Chorthippus karelini, Dociostaurus kraussi, Dociostaurus brevicollis* |
| 12 | 13 | - | - | 13 | 160 | *Chorthippus karelini, Euchorthippus pulvinatus, Omocestus haemorrhoidalis, Tessellana vittata* |

**Table 2.** (cont'd.)

| Site No. | Number of species | | | | Relative abundance (ind./hour) | Dominant species |
|---|---|---|---|---|---|---|
| | *Orthoptera* | *Mantodea* | *Dermaptera* | Total | | |
| 13 | 18 | 1 | - | 19 | 187 | *Chorthippus karelini, Euchorthippus pulvinatus, Calliptamus italicus, Chorthippus biguttulus* |
| 14 | 20 | 1 | - | 21 | 135 | *Euchorthippus pulvinatus, Chorthippus karelini, Omocestus haemorrhoidalis* |
| 15 | 22 | 1 | - | 23 | 112 | *Chorthippus karelini, Eremippus comatus, Montana eversmanni, Dociostaurus brevicollis* |
| 16 | 26 | - | - | 26 | 141 | *Oedipoda miniata, Tetrix bipunctata, Dociostaurus brevicollis, Calliptamus italicus* |
| 17 | 16 | - | - | 16 | 86 | *Dociostaurus brevicollis, Omocestus haemorrhoidalis, Myrmeleotettix pallidus* |
| 18 | 14 | - | - | 14 | 234 | *Myrmeleotettix pallidus, Oedaleus decorus, Dociostaurus brevicollis, Angaracris barabensis* |
| 19 | 13 | - | - | 13 | 266 | *Chorthippus karelini, Dociostaurus brevicollis, Tetrix bipunctata* |
| 20 | 12 | - | - | 12 | 314 | *Omocestus petraeus, Euchorthippus pulvinatus, Stenobothrus eurasius, Chorthippus karelini* |
| 21 | 12 | - | - | 12 | 262 | *Euchorthippus pulvinatus, Omocestus haemorrhoidalis, Calliptamus italicus, Chorthippus karelini* |
| 22 | 16 | - | - | 16 | 89 | *Euchorthippus pulvinatus, Omocestus haemorrhoidalis, Chorthippus karelini, Calliptamus italicus* |
| 23 | 16 | - | - | 16 | 136 | *Chorthippus biguttulus, Euchorthippus pulvinatus, Eremippus comatus* |

with the vegetation cover density, moisture content, and micro-relief in the existing area.

**Spatial distribution by biotope type**

Detailed species composition and abundance for the sites on Lake Sultankeldy and Lake Yessey appear in Tables 3 and 4.

- Wetlands and coastal areas (Lake Bozaral, site 1): observed with poor faunal composition (five species), dominated by the species *Chorthippus karelini* and *Euchorthippus pulvinatus* (Figure 1).
- Solonchak stations (Lake Teniz, site 3): recorded with vast species of *Sphingonotus coerulipes* and *Labidura riparia*.
- Wormwood-tipchak steppes (site 18): observed with mass development of *Myrmeleotettix pallidus* (up to 143 ind./hour).
- Rocky and gravelly slopes (site 5): dominated by *Eremippus comatus* (28.8%) and *Sphingonotus coerulipes* (27.3%).
- Disturbed pasture areas (site 7): depleted species composition (six species) with a predominance of *Chorthippus karelini*.
-

**Numerically dominant species**

- *Chorthippus karelini* —identified on 91.3% of the sites, and the number reached 188 ind./hour in grass biotopes.
- *Euchorthippus pulvinatus* —massively developed in dry steppes (up to 256 ind./hour).
- *Chorthippus brunneus*, *Podisma pedestris*, and *Aiolopus thalassinus*—frequently occurring and widely distributed species.
- Individual stations had the dominance of *Omocestus petraeus* (up to 88 ind./hour) and *Myrmeleotettix pallidus* (up to 143 ind./hour).

**Table 3.** Species composition and abundance of orthopteroid insects in Lake Sultankeldy.

| Species | Female | Male | Larva | Total | % |
|---|---|---|---|---|---|
| *Montana eversmanni* | - | 1 | - | 1 | 0.8 |
| *Tessellana vittata* | 1 | 4 | - | 5 | 3.9 |
| *Chorthippus karelini* | 13 | 41 | 40 | 94 | 73.4 |
| *Euchorthippus pulvinatus* | - | - | 16 | 16 | 12.5 |
| *Dociostaurus brevicollis* | 7 | 1 | - | 8 | 6.2 |
| *Omocestus haemorrhoidalis* | - | 2 | 2 | 4 | 3.1 |
| Total | 21 | 49 | 58 | 128 | 100 |

**Table 4.** Species composition and abundance of orthopteroid insects in the northeast shore of Lake Yessey.

| Species | Female | Male | Larva | Total | % |
|---|---|---|---|---|---|
| *Montana eversmanni* | 1 | 2 | - | 3 | 2.8 |
| *Platycleis intermedia* | 1 | 1 | - | 2 | 1.9 |
| *Tessellana vittata* | 7 | 3 | - | 10 | 9.5 |
| *Bicolorana bicolor* | - | 1 | 1 | 2 | |
| *Gampsocleis glabra* | - | 1 | - | 1 | 0.9 |
| *Miramiola pusilla* | 1 | 10 | - | 11 | 10.5 |
| *Asiotmethis muricatus* | 1 | - | - | 1 | |
| *Arcyptera microptera* | 1 | - | - | 1 | |
| *Celes variabilis* | 2 | 1 | 2 | 5 | 4.8 |
| *Oedipoda miniata* | 6 | 4 | - | 10 | |
| *Stenobothrus eurasius* | 1 | 1 | - | 2 | |
| *Omocestus haemorrhoidalis* | 1 | - | 4 | 5 | |
| *Chorthippus biguttulus* | - | 2 | - | 2 | |
| *Dociostaurus brevicollis* | 3 | 4 | - | 7 | 6.7 |
| *Dociostaurus kraussi* | 1 | - | - | 1 | |
| *Chorthippus karelini* | 3 | 4 | 2 | 9 | 8.6 |
| *Euchorthippus pulvinatus* | - | 2 | 22 | 24 | 22.8 |
| *Chorthippus* sp. | - | - | 9 | 9 | |
| Total | 29 | 36 | 40 | 105 | 100 |

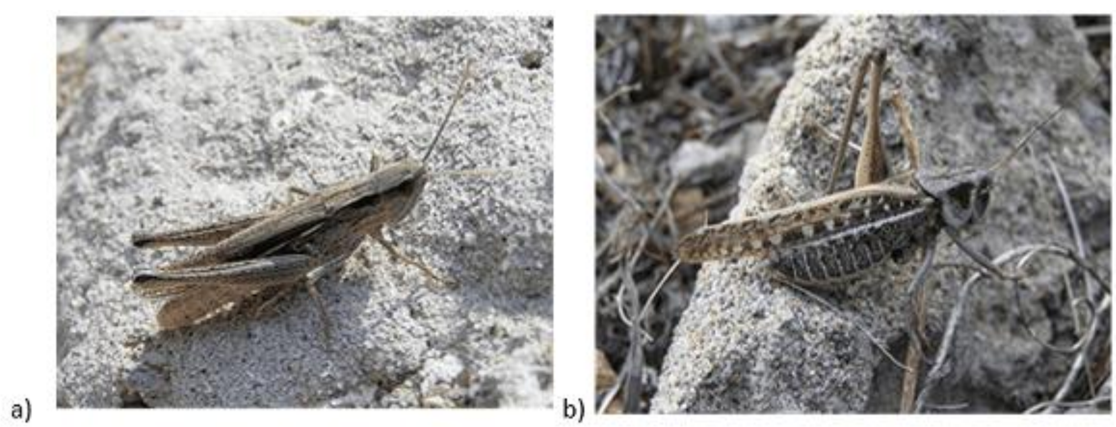


**Figure 1.** a) Karelin's Dancing Grasshopper — *Chorthippus karelini*, b) Eversmann's parnassian.

**Population dynamics by years**

A comparative analysis by years showed an increase in the number of the species *Chorthippus karelini*, *Euchorthippus pulvinatus*, and such economically significant species as *Oedaleus decorus*, *Calliptamus italicus*, and *Locusta migratoria*. The latter species reached a density of 10 ind./hour in 2013.

**New and rare species**

Several species documentation in the reserve emerged for the first time, such as *Roeseliana roeselii* (site 15), *Phaneroptera falcata,* and *Conocephalus dorsalis* (site 22), characteristic of humid habitats with tall grass-sedge vegetation. Thus, the orthopteroid fauna of the reserve demonstrated the pronounced habitat-related differentiation and high sensitivity to climatic and environmental variations. In study years with favorable moisture conditions, the population of numerous species increased markedly, particularly among potential crop pests (*Calliptamus italicus*, *Locusta migratoria*, and *Oedaleus decorus*). However, this pattern highlighted their ecological role as an important food resource for avifauna and underscores the need for regular and systematic monitoring.

## DISCUSSION

The three-year study comprising monitoring of orthopteroid insect pests (*Orthoptera*, *Dermaptera*, and *Mantodea*) in the Korgalzhyn Biosphere Reserve, Azerbaijan, clearly recognized the faunal composition (46 species) and explored the important patterns of spatial distribution and ecological confinement. The obtained results proved particularly valuable in the context of ongoing environmental influences in the steppe and coastal ecosystems of Central Kazakhstan and confirming the status of biosphere reserves as reference areas for monitoring the biodiversity (Sergeev *et al*., 2024).

Differences in species composition among the biotopes, expressed by a Jaccard index of 0.4–0.6, emerged as associated with variations in the structure of plant communities within the reserve. The contrast between the population of saline depressions and adjacent steppe areas, with differences in species composition reaching up to 60%–70%, which exceeds similar indicators for other regions of Kazakhstan, is especially indicative (Olzhabayeva *et al*., 2024). The species greater richness (28–32 species) and numerical abundance (up to 300 ind./hour) were evident in forb-grass communities with projective coverage of 70%–80%. These results were greatly analogous to the classical research work of Uvarov (1938) and modern studies by Sergeev (2021b).

Among the studied taxa, the most pronounced environmental plasticity was demonstrative of the representatives of the genus *Chorthippus* (*C. karelini*, *C. brunneus*), which were dominant in the majority of the surveyed biotopes. Their exceptional adaptive potential was remarkable through a complex of morphophysiological and behavioral mechanisms: a) a wide range of trophic preferences allowing the use of various plant resources, b) an extended phenological cycle with a prolonged egg-laying period, and c) a pronounced ability to microbiotopic segregation for effective thermoregulation. The results add a significant contribution to modern knowledge about the mechanisms of ecological adaptation of steppe locusts (Nurjanov *et al*., 2024), confirming the key role of physiological flexibility in maintaining their population stability.

The valuable study revealed alarming trends that require special attention from environmental organizations. First, a significant increase in the number of potentially harmful species has progressed, such as *Calliptamus italicus* (+38%), *Locusta migratoria* (+25%), and *Oedaleus decorus* (+41%). Second, the sustainable emergence of new mesophilic species (*Roeseliana roeselii*, *Phaneroptera falcata*, and *Conocephalus dorsalis*) was prevalent in the region. These changes have revealed the highest correlation ($r = 0.72$-$0.85$) with climatic parameters: an increase in temperature of the growing season by 1.2 °C–1.5 °C, a change in the moisture regime, and a reduction in natural biotopes (Sergeev *et al*., 2025). Of particular concern was the synchronization of these processes with global trends in the transformation of arid ecosystems (Kuts *et al*., 2024).

## CONCLUSIONS

In the three-year study (2020–2022), 46 insect species of orthopteroid insects from eight taxonomic groups succeeded in their recording in the Korgalzhyn Biosphere Reserve, Azerbaijan. Species richness was highest in the families Acrididae and Tettigoniidae, reflecting habitat diversity. The dominant insect species across most of the studied sites were *Chorthippus karelini*, *Euchorthippus pulvinatus*, *Chorthippus brunneus*, and *Podisma pedestris*, particularly abundant in grass-forb and wormwood-fescue habitats. The orthopteroid distribution and population density showed close associations with vegetation structure and moisture conditions. An increase in economically important species (*Calliptamus italicus*, *Locusta migratoria*, and *Oedaleus decorus*) highlighted the need for regular monitoring, with their outbreak potential and their viable role as a food resource for waterfowl. Future studies should extend monitoring beyond 2022 and integrate standardized field surveys with newer tools to better predict climate- and disturbance-driven shifts in orthopteroid communities and forecast outbreak risk of pest species.

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