Евразиатский энтомол. журнал 24(6): 318–323
doi 10.15298/euroasentj.24.06.04

Orthoptera in agricultural ecosystems of the Hissar Valley, Tajikistan: Patterns of assemblage formation

Прямокрылые насекомые (Orthoptera) в агроэкосистемах Гиссарской долины Таджикистана: закономерности формирования сообществ

A.A. Pokivailov*, Kh.S. Khayrov**

А.А. Покивайлов*, Х.С. Хайров**

* Borisoglebsk Branch, Voronezh State University, Narodnaya str. 43, Voronezhskaya Oblast, Borisoglebsk 397160 Russia. E-mail: apokivajlov@yandex.ru.

* Борисоглебский филиал Воронежского государственного университета, ул. Народная 43, Воронежская область, Борисоглебск 397160 Россия.

** E.N. Pavlovsky Institute of Zoology and Parasitology, Academy of Sciences of the Republic of Tajikistan, P.O. Box 70, Dushanbe 734025 Tajikistan. E-mail: khayrov.80@mail.ru.

** Институт зоологии и паразитологии им. Е.Н. Павловского АН Республики Таджикистан, п/я 70, Душанбе 734025 Таджикистан.

Key words: Grasshopper, locust, bush-cricket, cricket, ephemeral desert, riparian ecosystem, long-term dynamics, population, succession.

Ключевые слова: саранчовое, саранча, кузнечик, сверчок, эфемероидная пустыня, прибрежная экосистема, многолетняя динамика, популяция, сукцессия.

Abstract. A comparison of orthopteran assemblage distribution in the Hissar Valley was made for two periods, namely, the 1930s and the end of the 20th century - beginning of the 21st century. Anthropogenic factors that influenced the assemblage transformation are revealed. The irrigation changes are among the most important factors. The abundance and local distribution of Orthoptera depend on environmental alterations, especially those resulting from agrotechnical treatments. The local modern assemblages are rather uniform and include a few species that usually actively populate transformed ecosystems. They are distinguished by dynamic changes, the nature of which is determined not so much by seasonality and long-term changes but rather by very rapid changes in human activity.

Резюме. Сопоставлено распределение сообществ прямокрылых в Гиссарской долине на протяжении двух периодов: 1930-г гг. и в конце XX – начале XXI вв. Выявлены антропогенные факторы, влияющие на перестройку сообществ. Показано, что изменения системы орошения — один из самых важных факторов. Продемонстрировано, что обилие и распределение прямокрылых зависит от изменений окружающей среды, в первую очередь связанных с агротехникой. Установлено, что современные местные сообщества достаточно однородны и включают несколько видов, которые активно заселяют трансформированные экосистемы. Такие сообщества характеризуются динамическими изменениями, которые определяются не столько сезонностью и многолетними трендами, сколько очень быстрыми изменениями деятельности человека.

Introduction

Orthopteran insects constitute one of the most significant groups of consumers in the natural and seminatural ecosystems of the desert life zones [Pravdin, 1978]. Their ecological activity strongly affects the fluxes of energy and matter. However, in the 20th century, their role has changed substantially in many desert regions of Middle Asia, because countless natural arid ecosystems were transformed into agricultural fields and orchards, which are mainly irrigated, and under these conditions, desert pastures often became overgrazed. This is why, in the 20th century, the harmful activity of various species of Orthoptera became very important in the region [Latchininsky et al., 2002]. Moreover, these insects may serve as some useful indicators of different changes and stages of ecosystem dynamics including alterations associated with human activity. In this context, it is very important to understand how serious the changes in orthopteran diversity and populations have been against the background of significant restructuring of local transformed ecosystems, from various and very diverse types of agricultural fields in the first half of the 20th century to almost complete dominance of irrigated cotton fields in its second half and again to diverse and heterogeneous agricultural landscapes at the end of the 20th century and beginning of the 21st century. In addition, agricultural intensification has resulted in large-scale chemical treatments for pest management and defoliation, especially in cotton fields. These treatments undoubtedly affect the diversity, populations and assemblages of insects.

The arid Hissar (Gissar) Valley is located in Tajikistan between the Hissar Range in the north and several relatively low ridges in the south (Aktau, Babatag (Bobokuh), and Rangon). The bottom of this intermountain basin was originally occupied by typical subtropical arid landscapes in combination with the ecosystems of local

How to cite this article: Pokivailov A.A., Khayrov K.S. 2025. Orthoptera in agricultural ecosystems of the Hissar Valley, Tajikistan: Patterns of assemblage formation // Euroasian Entomological Journal. Vol.24. No.6. P.318–323. https://doi.org/10.15298/euroasentj.24.06.04
Published: 31.xii.2025.

river valleys. The Hissar Valley is more or less isolated from the main parts of the Turanian deserts. Many local ecosystems have long been transformed by humans. Noticeable changes in agriculture have occured during the past two decades. Cotton cultivation has gradually lost its dominant position, and the areas of orchards, vegetable gardens, melon and grain fields have increased, which has led to high water logging in terrains and further development of the irrigation network. The Valley is currently occupied by relatively uniform rural landscapes, where agricultural fields are commonly combined with orchards and human settlements.

Some data on the diversity, distribution and abundance of orthopteran insects in the Hissar Valley were obtained in the 1930s [Mistshenko, 1949] and 1970s [Fedotova-Seredina, 1985]. In combination with our materials from the late 20th and early 21st centuries, this allows us to identify long-term changes in Orthoptera distribution patterns, reveal their main stages and estimate the roles of human activity in these alterations.

Materials and methods

This paper is based on the data collected by the authors in the Hissar Valley from 1987–1991 and from 2007–2017 at altitudes of 700–900 m above sea level. The long-term and seasonal dynamics of orthopteran assemblages in agricultural landscapes were studied in 8 model plots distributed across local plains, terraces, and flood-plains. Orthopteran abundance was estimated via an approach developed by Gause [1930] (cf. [Kashkarov, 1933; Lopatkin, 1977]). According to this method, insects are sampled by an entomological net (in our studies, 40 cm in diameter) during time intervals from 10–40 min. The results are recalculated to one hour. Each model plot was investigated approximately every fortnight from May to September (1987–1989). In addition, from 1987–2017, species diversity was evaluated via qualitative examinations as well. Sampling was performed under good weather conditions (sunny, warm, and calm). In this article, the maximum abundance estimates for the entire period of quantitative data collection (1987–1989) are discussed. The main plant species dominating the vegetation of the model plots were also collected and subsequently identified by L.A. Bulyak (Institute of Botany, Academy of Sciences of the Republic of Tajikistan).

Our results are compared with published data on orthopteran distribution in the 1930s [Mistshenko, 1949]. In this work, four ranks were used to characterize the levels of species abundances in the habitats studied, namely, very abundant (A), abundant (F), rare (R) and extremely rare (S) species. The data on environmental characteristics including vegetation and agricultural ecosystem distributions in the first half of the 20th century were extracted from [Popov, 1925; Ghilarova, 1936; Mistshenko, 1949]. The names of the orthopteran taxa are given in accordance with the Orthoptera Species File [Cigliano et al., 2025].

According to Isakov et al. [1980] and Allen [1991], the studied ecosystems and their derivatives, including those associated with their successions, are classified into one of three types, namely natural ecosystems, seminatural (modified) ecosystems, and anthropogenic ecological complexes (or cultivated and built systems) as well.

The present work is registered in ZooBank (www.zoobank.org) under urn:lsid:zoobank.org:pub:85CCA40D-1F52-4297-856F-8F8B3DD747E4

Results and discussion

Ephemeral deserts

At the beginning of the 20th century, the ephemeral loess deserts occupied the largest part of the Hissar Valley [Popov, 1925; Ghilarova, 1936]. They were distributed over local plains and upper terraces. Their natural vegetation cover includes various spring desert ephemerals, mainly from the genera *Bromus* L., *Hordeum* L., *Poa* L., *Carex* L., and *Papaver* L. [Popov, 1925; Ghilyarova, 1936; Mistshenko, 1949]. According to Mistshenko [1949], in 1935, local orthopteran assemblages consisted of 19 species. The Italian locust *Calliptamus italicus* (Linnaeus, 1758) was the most abundant. *Platycleis albopunctata* (Goeze, 1778), the Moroccan locust *Dociostaurus maroccanus* (Thunberg, 1815), *Acrida oxycephala* (Pallas, 1771), and *Decticus albifrons* (Fabricius, 1775) were also abundant. At that time, the latter species was a pest of grain crops in the arid part of Tajikistan [Antova, 1949]. The species composition of the orthopteran assemblages discovered in the 1930s is similar to that described by Pravdin [1978] for the ephemeral desert, which is dominated by *Carex pachystylis* J. Gay, in the Fergana Valley.

In the 1930s, vast areas of local ephemeral deserts were transformed into overgrazed pastures and abandoned fields. These modified ecosystems can be considered one of the stages of desert restoration. Their settlement by Orthoptera was undoubtedly connected with assemblages of original desert ecosystems. The abandoned fields were commonly populated by 10 species. The Italian locust was the most abundant form as well. Several bush-crickets, namely, *D. albifrons* and *P. albopunctata,* were also relatively common. *A. oxycephala* and *Oedipoda miniata* (Pallas, 1771) were found frequently, but their abundances were lower than those in natural ecosystems. In the pasturelands, the assemblages described included only 6 species. Almost all were grasshoppers (Acrididae). Bush-crickets (Tettigoniidae) were not found. The densities of the Moroccan locust were very high, especially compared with those of deserts per se. The optimal character of such habitats for this species was noted earlier [Zhdanov, 1934]. Abundances of *Melanogryllus desertus* (Pallas, 1771), *Oedaleus decorus* (Germar, 1825), *Calliptamus barbarus* (Costa, 1836) and *Oe. miniata* remained at the same level as in ephemeral deserts. However, the Italian locust was relatively rare across local rangelands.

In recent decades, the ephemeral deserts of the Hissar Valley have noticeably transformed. There are some insular desert habitats. The structure of their orthopteran assemblages has changed, species diversity and abundance have decreased, and some previously unregistered species have been observed. *Dociostaurus tartarus* (Stshelkanovtzev, 1921) replaced the Italian locust as a dominant species. Its abundance was high (240 per hour). Several grasshoppers, namely, *Acrotylus insubricus* (Scopoli, 1786) (92), *C. barbarus* (42), *Oe. miniata* (36), *Glyptobothrus maritimus* (Mistshenko, 1951) (24 per hour), became abundant as well. *Phaneroptera falcata* (Poda, 1761), *Calliptamus turanicus* Serg. Tarbinsky, 1930, *Truxalis eximia* (Eichwald, 1830), *Ramburiella foveolata* Serg. Tarbinsky, 1931, *Oedaleus senegalensis* (Krauss, 1877), and *Oe. decorus* were not found at all. The Moroccan and Italian locusts became rare or even extremely rare. For example, the highest abundance of *D. maroccanus* detected was 4 per hour. However, the assemblages revealed on the local desert piedmont plains and at lower parts of mountain slopes were similar to those that were characteristics of the Hissar Valley in the 1930s. For instance, the Moroccan locust was very abundant (240 per hour) as well.

The assemblages of the local desert pasturelands were significantly transformed and became more xeromorphic (compared with those in the 1930s) — *Sphingonotus rubescens* (F. Walker, 1870) became the most abundant species (96 per hour), *C. barbarus* and *Oe. miniata* were rarely found. A similar pattern was also observed on the overgrazed rangelands of the piedmont plains, where *S. rubescens* was the most numerous (60 per hour). This means that, at present, the influence of orthopteran populations from natural ephemeral deserts on the formation of the assemblages in seminatural ecosystems is insignificant.

Riparian ecosystems

In the first half of the 20th century, floodplains of the Kofarnihon, Dushanbinka (Varzob) and Khanaka Rivers, and of small lakes were covered with mesohygrophytic vegetation with dominance of the common reed (*Phragmites australis (*Cav.) Trin. ex Steud.), *Arundo donax* L., *Euphorbia soongarica* Boiss., *Scirpus* Tourn. ex L., and various sedges (*Carex* spp.) [Popov, 1925; Ghilarova, 1936; Mistshenko, 1949]. The orthopteran assemblages associated with these habitats included 22 species. *Conocephalus concolor* (Burmeister, 1838), *Tetrix tartara* (Saussure, 1887), *Paratettix uvarovi* Semenov, 1915, the migratory locust (*Locusta migratoria* (Linnaeus, 1758)), *Mecostethus parapleurus* (Hagenbach, 1822), *Aiolopus thalassinus* (Fabricius, 1781), *Oxya fuscovittata* (Marschall, 1836), etc., were abundant. Notably, the last two species remain numerous in the modern disturbed ecosystems of the Hissar Valley with mesohygrophytic vegetation.

The higher parts of the local floodplains and the lower terraces were covered mainly with different meadows with mesophytic vegetation. *Erianthus ravennae* (L.) P. Beauv., *Calamagrostis pseudophragmites* (Haller f.) Koeler, *Dactylis glomerata* L., *Alhagi maurorum* Medik., *Cynodon dactylon* (L.) Pers., etc., were numerous. Thickets of *Tamarix* L. were also common. The local orthopteran assemblages included 17 species. *A. thalassinus*, *L. migratoria*, *A. insubricus*, *Duroniella brachyptera* Umnov, 1931 and several other species dominated among them. The grasshopper *D. brachyptera* was noted as an agricultural pest [Pest Animals, 1949].

In the 1930s, the natural assemblages of riparian habitats were the source of the formation of orthopteran populations across irrigated agricultural terrains. Their composition and species abundance were affected by habitat conditions including irrigation intensity. In these habitats, the orthopteran species preferring meadows were abundant. Some Orthoptera could use banks of irrigation channels with the mesohydrophytic vegetation for dispersal. These species formed assemblages similar to those in the local floodplains. Nineteen species were found in such habitats. *C. concolor* was the most abundant. In addition, there were several other abundant bush-crickets (*Tettigonia viridissima* (Linnaeus, 1758), *P. albopunctata*, *Ruspolia nitidula* (Scopoli, 1786)). The grasshoppers *Heteracris pterosticha* (Fischer de Waldheim, 1833), *D. brachyptera*, and *G. maritimus* were also common, whereas *Gonista sagitta* (Uvarov, 1912) and pygmy grasshoppers (Tetrigidae) were rare.

The orthopteran assemblages identified in irrigated fields of annual and perennial crops included fewer forms (10–12 species), depending on the cultivated crop and management. *O. fuscovittata* and *C. italicus* were the most abundant. The bush-crickets *C. concolor, Semenoviana tamerlana* (Saussure, 1874)*, D. albifrons*, and the grasshoppers *A. thalassinus, L. migratoria, Hilethera turanica* Uvarov, 1925*, Chorthippus turanicus* Serg. Tarbinsky, 1927*, Ch. angulatus* Serg. Tarbinsky, 1927 were also abundant. *Ch. turanicus* and *Ch. angulatus* were mentioned as local agricultural pests [Pest Animals, 1949].

At the middle and end of the 20th century, local natural floodplain ecosystems completely disappeared as a result of the development of irrigation systems, industry and cities. The volume of water in local rivers has decreased significantly. This led to the almost complete disappearance of river and lake floodplains per se. In addition, many meadows were overgrazed.

Modern analogs of floodplain ecosystems can be found in constantly irrigated abandoned fields, fields of perennial crops and man-made wetlands. In these habitats, *O. fuscovittata* is extremely abundant (up to 1776 per hour) and *A. thalassinus* is abundant (378). The number of species found in such habitats has been halved since 1935.

The orthopteran assemblages associated with mesophytic vegetation are still distributed along the local rivers and irrigation channels. However, they became more xeromorphic. More than a quarter of the species (29 %) that were observed in the 1930s were not found by the end of the 20th century. The abundance of many species (*C. italicus, A. oxycephala, T. eximia* etc.) decreased significantly. As a result, the structure of the assemblages noticeably changed. *A. thalassinus* became very abundant (858 per hour). *Duroniella gracilis* Uvarov, 1926 (366), *P. uvarovi* (108), *T. tartara* (84), *O. fuscovittata* (66), *G. maritimus* (66), and *A. insubricus* (36 per hour) are abundant. In addition, there were *P. albopunctata, S. tamerlana, M. desertus*, and *Eumodicogryllus bordigalensis* (Latreille, 1804). The expansion of an irrigation network and increased water consumption resulted in an increase in the territory covered by the mesophytic and mesohydrophytic vegetation. This transformation affected the serious changes in the orthopteran distribution. Most of the species that preferred deserts to some extent were replaced by moisture-loving orthopterans. More than 40 % of the species found in 1935 were missing from collections at the end of the 20th century, but species that are common in irrigated fields (*A. thalassinus*, *O. fuscovittata*) appeared.

The orthopteran assemblages associated with the local agricultural fields also changed significantly. The species diversity declined. Approximately 40 % of the species encountered in 1935 were no longer found. However, A. *thalassinus* and *O. fuscovittata* remained the most abundant because they are able to settle in areas with mesophytic vegetation. Their abundance depends on the height and closeness of vegetation, agrotechnical management and composition of cultivated crops. *D. albifrons*, *Pyrgomorpha bispinosa* F. Walker, 1870, *T. eximia*, *L. migratoria*, *H. turanica* and several other species were not found in such habitats at the end of the 20th century.

Human activity and orthopteran assemblage dynamics

At the end of the 20th century, the habitats with mesophytic vegetation, including human-dominated (especially irrigated) ones, became the main sources of the local orthopteran species that formed modern assemblages in the Hissar Valley. In general, irrigation and water use characteristics significantly affect water dynamics.

In cases where desert habitats are flooded as a result of water discharge from irrigation systems per se or from irrigated fields, the xeromorphic assemblages are beginning to change rapidly. For example, within one to two weeks, the abundance of *D. tartarus* decreases sharply (from 240 to 6 per hour). The abundance of *G. maritimus* also declined (from 24 to 12 per hour). Moreover, *C. barbarus*, *Oe. miniata* and *S. rubescens* completely disappear from flooded terrains. However, individuals of *A. insubricus* often accumulate on the periphery of such habitats.

After flooding, the mesophytic plants usually start growing very quickly. Initially, *Cynodon dactylon* developed. Later, *Agrostis* L. and some others started to grow. At this stage, *A. thalassinus* begins to populate such habitats. As the vegetation projective cover increases, its abundance multiplies as well and may become very high (up to 858 per hour). In addition, the pygmy grasshoppers *T. tartara* and *P. uvarovi*, the Italian locust, and the crickets *M. desertus* and *Eu. bordigalensis* were also found. Stronger and longer-lasting flooding can result in the development of associations consisting of *Sorghum halepense* (L.) Pers., *Echinochloa crus-galli* (L.) P. Beauv., *Paspalum distichum* L., and *Phragmites australis*. At this stage, the abundance of *O. fuscovittata* gradually increased (up to 1776 per hour). Sometimes, the bush-crickets *P. albopunctata* and *S. tamerlana* may be observed together with this grasshopper.

If the water stops flowing, the soil dries out and the mesophytic vegetation is gradually recovers. As a result, *A. thalassinus* becomes the most abundant species again. The long-term interruption of the water supply has led to the burning of grassy vegetation. With such changes, the abundance of orthopteran species preferring desert habitats can increase.

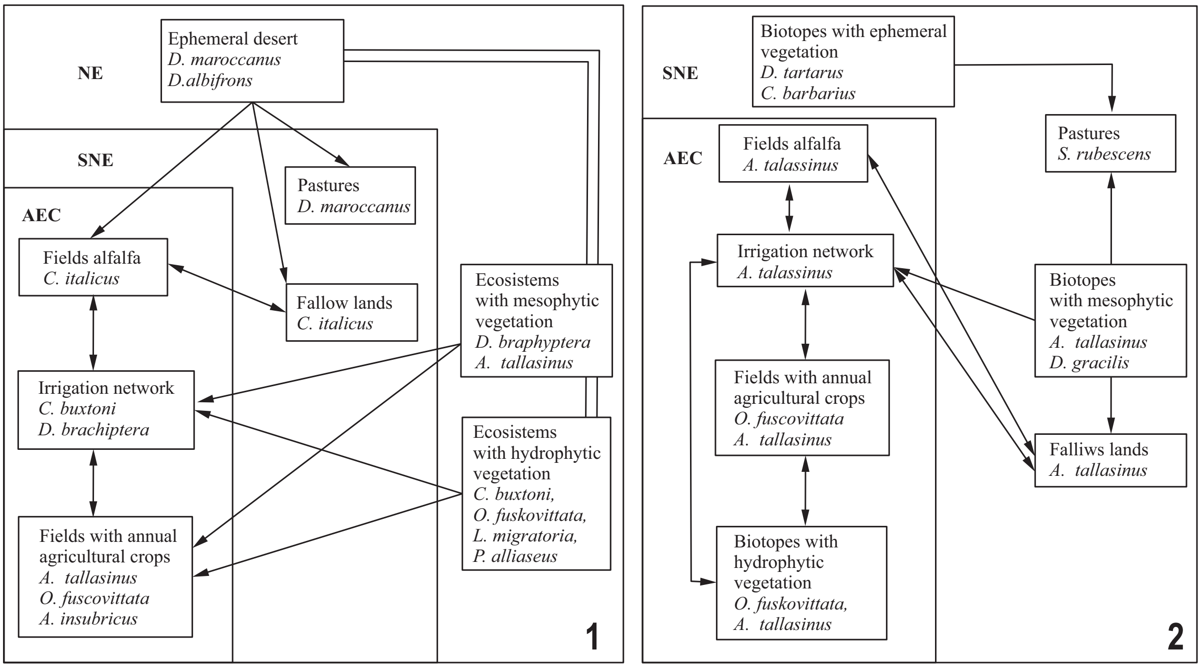
Conclusions

In the Hissar Valley, modern orthopteran assemblages are rather uniform because they include a few species that usually actively populate transformed ecosystems. At the same time, they are distinguished by clearly expressed and often fast dynamic changes, the nature of which is determined not so much by seasonality and long-term changes but rather by very rapid changes in human activity. The abundance and local distribution of all or almost all species depend on environmental alterations, especially those resulting from agrotechnical treatments over agricultural fields and their neighboring terrains. In the Valley, the irrigation changes are among the most important factors. As a result, some serious treatments (flooding, harvesting, and haymaking) can affect the local orthopteran habitats and cause movements of insects towards untreated areas or vice versa leading to very significant temporal fluctuations in abundance.

In the local cultivated systems (anthropogenic ecological complexes) across the irrigated and often flooded landscapes, the orthopteran assemblages commonly include *O. fuscovittata*, *A. thalassinus*, *D. gracilis*, and *G. maritimus,* which are usually characterized by very high or high abundances. In dry farming terrains or areas with water shortages, some xeromorphic assemblages are formed. They commonly consist of *C. barbarus*, *D. tartarus*, *A. insubricus*, *Oe. miniata*, and *S. rubescens*. These grasshoppers may replace each other well at different stages of successions associated with different degrees of humidity. We can hypothesize that some increase in the abundance of these species should be considered as indicators of ecosystem degradation and environmental destabilization in the Hissar Valley.

The main stages of orthopteran assemblage restructuring in the Hissar Valley associated with long-term and short-term human impacts are shown graphically (Figs 1, 2). In the 1930s, the natural or seminatural ecosystems with either xerophytic or mesohygrophytic vegetation were widely distributed across the region (Fig. 1). The orthopteran assemblages were characterized by high species diversity. These assemblages also were quite diverse. Some species could use the banks of irrigation channels with the mesohydrophytic vegetation to disperse.

At the end of the 20th century, in the Hissar Valley, the natural ecosystems (with both xerophytic and mesohygrophytic vegetation) were completely destroyed.



Figs 1–2. Schemes of the main ways and stages of the orthopteran assemblage restructuring in the Hissar Valley. 1 — in the 1930s; 2 — at the end of the 20th century. Designations: The most abundant species are indicated for each ecosystem type: NE — natural ecosystems, SNE — semi-natural ecosystems, AEC — anthropogenic ecological complexes (cultivated systems).

Рис. 1–2. Схемы основных направлений и этапов перестройки сообществ прямокрылых насекомых Гиссарской долины. 1 — в 1930-е годы; 2 — в конце XX века. Обозначения: указаны самые обильные виды: NE — природные экосистемы, SNE — полуприродные экосистемы, AEC — антропогенные экологические комплексы.

Currentlly, the main habitats of Orthoptera are the local irrigated terrains with various mesophytic vegetation, including agricultural fields of annual and perennial crops (Fig. 2). Such habitats can serve as the main source of dispersal of a few orthopteran species that form modern, relatively uniform assemblages, usually dominated by *A. thalassinus* and *O. fuscovittata.* Both species were and are the serious agricultural pests in the Hissar Valley [Pest Animals, 1949; Mistshenko, 1972].

This pattern is similar to that previously described for the arid regions of South-East Tajikistan [Sergeev, Bugrov, 1985; Sergeev, 1987], but the level of transformation of the original ecosystems is much greater in the Hissar Valley. This is particularly evident in the fact that in 1983, across the agricultural fields of South-East Tajikistan, a much larger number of species were totally found (cotton fields — 26 species and alfalfa fields — 25) [Sergeev, Bugrov, 1985]. However, just as in the Hissar Valley, in each specific field, only a few species were usually found and *A. thalassinus* was the most abundant grasshopper. In any case, the results of our studies can be used to assess the nature of the reorganization of insect communities in the subtopic desert regions of Middle Asia.

Acknowledgements

The authors are very grateful to M.G. Sergeev (Novosibirsk) for critical comments and help and to L.A. Bulyak (Dushanbe) for identification of plant species.

References

Allen R.P. 1991. Classification of ecosystem conditions // Caring for the Earth. A strategy for sustainable living. Gland. P.34.

Antova Yu.K. 1949. [Insect pest of cereals in the regions of South Tajikistan] // Trudy Tajikskogo Filiala AN SSSR. Vol.19. P.29–48. [In Russian].

Bey-Bienko G.Ya. 1961. [On some regularities in changes of the virgin steppe invertebrate fauna under cultivation] // Revue d'Entomologie de l'URSS. Vol.40. No.4. P.763–775. [In Russian].

Cigliano M.M., Braun H., Eades D.C., Otte D. 2025. Orthoptera species file. http://orthoptera.speciesfile.org/ Accessed 2.VIII.2025.

Fedotova-Seredina E.L. 1985. [Changes in the orthopteroid fauna of the Hissar Valley (TajikSSR) as a result of human activity] // Vliyanie antropogennyh factorov na structuru i funkcionirovanie biocenosov. Kalinin. P.3–23. [In Russian].

Gause G.F. 1930. Studies of the ecology of the Orthoptera // Ecology. Vol.11. No.2. P.307–325. https://doi.org/10.2307/1930266

Ghilarova M.A. 1936. [The Hissar Valley] // Tajikistan. Leningrad: Tajiksko-Pamirskaya Expediticiya. P.282–310. [In Russian].

Isakov Yu.A., Kazanskaya N.S., Panfilov D.V. 1980. [Classification, geography, and anthropogenic transformation of ecosystems]. Moscow: Nauka. 226 p. [In Russian].

Kashkarov D.N. 1933. [Environment and community (Basics of synecology)]. Moscow: Gosmedisdat. 244 p. [In Russian].

Latchininsky A.V., Sergeev M.G., Childebaev M.K., Chernijakhovskij M.E., Lockwood J.A., Kambulin V.E., Gapparov F.A. 2002. [The grasshoppers of Kazakhstan, Middle Asia and adjacent territories]. Laramie: Association for Applied Acridology International & University of Wyoming. 387 p. [In Russian].

Lopatkin A.V. 1977. [About a possible approach to the comparison of methods of acridid counts] // Etologiccheskie problemy ecologii nasekomyh Sibiri. Novosibirsk. P.77–81. [In Russian].

Mistshenko L.L. 1949. [Dermatoptera, Blattodea, Mantodea, Phasmotodea, and [Saltatoria (Orthoptera s. str.)] of the Hissar Valley (Tajik SSR)] // Trudy Zoologicheskogo Instituta AN SSSR. Vol.8. No.4. P.735–749. [In Russian].

Mistshenko L.L. 1972. [Orthoptera (Saltatoria)] // Nasekomye i klestshi — vrediteli selskohoziastvennyh kultur. Vol.1. Leningrad: Nauka. P.16–115. [In Russian].
[Pest Animals of Middle Asia]. 1949. Moscow, Leningrad: USSR Academy of Sciences. 404 p. [In Russian].
Popov M.G. 1925. [A brief outline of Tajikistan vegetation]. Tajikistan, Tashkent. P.45–62. [In Russian].
Pradvin F.N. 1978. [Ecological geography of insects of Middle Asia. Orthopteroidea]. Moscow: Nauka. 271 p. [In Russian].
Sergeev M.G. 1987. [Principal stages of Orthoptera communities reorganization in South-West Tajikistan desert agrocenosis] // Problemy osvoeniya pustyn. No.2. P.72–75. [In Russian].
Sergeev M.G., Bugrov A.G. 1985. [Orthoptera in agrocoenoses of South-West Tajikistan] // Antropogennye vozdeistvia na soobstshestva nasekomyh. Novosibirsk: Nauka. P.134–138. [In Russian].
Zhdanov S.P. 1934. [The Moroccan locust (*Dociostaurus maroccanus* Thunb.) in the Stavropol Region] // Trudy po zastshite rasteniy. Seriya entomologicheskaya. No.9. 71 p. [In Russian].

Поступила в редакцию 19.6.2025