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Formation Patterns of Acridid Communities in Urban Landscapes of Turkmenistan

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ABSTRACT

Acridid communities of urbanized landscapes in Turkmenistan are described for the first time. General peculiarities of formation of acridid communities in urban landscapes are studying for the desert zone. The structure of the communities is determined by soil conditions, types of plant cover and the level of anthropogenic impact on the different urban biotopes. Acridid communities of different urban biotopes are distinguished one from the other by taxonomic and ecological diversity. Many acridid species are associated with tugai (riparian woodlands) and Kopetdag foothills and plain. Special conditions of urban landscapes are promoting the penetration of some acridids, usually described as desert species.

Keywords: *acridid communities, urban landscape, desert zone, abundance, tugai, life form, positive phototaxis;*

INTRODUCTION

The study of change on ecological and taxonomic structures of insect communities in anthropogenic landscapes is one of the most actual problem all over the world (Sergeev, 1984, 1987; Sobolev, Sergeev, 1985; Klausnitser, 1990; Selikhovkin, 1994; Yaroshenko, 1994). According to the international classification the geological ecosystems relative to the level of human activity and disturbing are divided on natural, modified, cultivated, built and degraded ones (Caring for the Earth, 1991). M.G. Sergeev (1997) suggested separating all anthropogenic landscapes on the following types: primitive anthropogenic, forest exploitation, pyrogenous, agricultural, grazing and recreation ones. The author marked out the urban landscapes among the anthropogenic landscapes, as far as urbanized geological systems typically combine components of local origin and various alien species of plants and animals. In particular, urban area includes grasslands, city plantings, technogeneous sections, buildings and ornamental forest plantings. At the same time microclimatic conditions of urbanized landscapes significantly distinguished from natural ones.

Urban landscape is one of the most widely distributed anthropogenic landscapes in the world. In Turkmenistan the areas of this type of landscape have been expansion greatly during last year's and they are varied by using targets. Starting from 1997 we have been carried out extensive field work for studying of acridid communities4 in the range of Ashgabat - the largest city of Turkmenistan. The city is situated on the northern foothill plain of Central Kopet Dagh Mountains. Northern borderlands of Ashgabat adjoin with Garagum desert. The annual precipitation is 250-300 mm a year. Arid conditions of the region are required intensive territory gardening of urban areas. So, around and in the Ashgabat and other cities of Turkmenistan have been created conditions for expansion the area under grow of recreational forests, ornamental forest plantings and grass plots provided with drip and spray irrigation. The city are provided with modern system for illumination. As the result, human activity in arid zone changes local natural landscapes in a way being more attractive for certain species of acridids.

BACKGROUND OR RELATED WORK

The orthopteran insects on anthropogenic landscapes, particularly, on agricultural fields of Central Asia and Kazakhstan have been described by many scientists. For example, investigations were provided in Tajikistan (Mishenko, 1949), Turkmenistan (Tokgayev, 1965, 1973; Gullyev,

1965), Uzbekistan (Medetov, 2012), Kazakhstan and Kyrgyzstan (Sobolev, Sergeev, 1985; Kopaneva, Nasyrova, 1986). Referred above articles contains the data about orthopteran insects both on fruit trees and cotton, wheat and alfalfa fields. Some information on the papers is regards to ecological aspects of orthopteran insects, like distribution patterns, abundance, injurious ness and population dynamics. At the same time we have no any information on acridid communities in urban landscapes of desert zone. In South Turkmenistan was carried out investigations for studying the gnawing (Coleoptera, Lepidoptera, Hymenoptera) insects and their parasites (Hymenoptera, Diptera) in ornamental plantings and protective forest belts (Kokanova, 1995; Kokanova, Tokgaev, Myartseva, 2000). Human activities such as expansion of urban and recreational forest planting areas, improvement of the lighting system in the cities, usage of drip irrigation system in forest plantings, that have took place during last years in Turkmenistan have been changing microclimatic conditions of local natural landscapes. Thereby, ecological conditions of urban landscapes being more attractive for certain species of acridids that use changed landscapes successfully. This situation lets us to decide the goal of our researches.

Presentation of the Main Contribution of the Paper / Scope of Research

Acridids are important taxonomic group of insects in natural and disturbed ecosystems in Turkmenistan These insects are abundant in anthropogenic landscapes of desert zone. General peculiarities of formation of original acridid communities in urban landscapes of Turkmenistan are studied for the first time. Species diversity and ecological structure of acridid communities on different types of urban biotopes are vary on depend of adjoining natural landscapes, vegetation cover and the level and type of human activities. Irrigation of ornamental forest plantings in urban landscapes have resulted the extending the distribution areas of mesophile species acridids, associated with riparian woodlands.

Proposed Methodology and Discussion

The samples of acridids have been collected from 1997 to 2017 in urban landscapes of Turkmenistan. The investigations were performed by standard methods (Bey-Bienko, 1932; Kozhanchikov, 1961; Sergeev, 1986). Acridid communities were investigated quantitatively and qualitatively in different urban biotopes. For abundance estimation insects were caught with a standard net over a period of one hour (Gause, 1930). Densities of acridids were estimated in small plots over an area of 1 m^2. The structure of acridid communities was analyzed taking into account their species composition, the spectrum of life forms, the seasonal aspects, abundance, distribution patterns on biotopes and dominant species (Pravdin, 1978). This paper mainly include the results of the investigations were conducted in different biotopes of Ashgabat, such as grass plots, ornamental forest plantation, roadside vegetation, buildings and the most illuminated at night sites of the city.

Experimental Results

The Tree locust *Anacridium aegyptium* of African origin in urban landscapes of Turkmenistan is wintered in buildings, window spaces of the buildings, etc. (See table 1). Early in the spring this species is generally found in areas of grass plots, scattered bushs and trees, between the sticks and leaves. The most common trees and bushes in such biotops being various species of mulberry (*Morus* sp.), poplar (*Populus* sp.), acacia (*Acacia* sp.), willow (*Salix babylonica*), roses (*Rosa* sp.), oleander (*Nerium oleander*), etc. Egyptian Tree locust feed mainly on ornamental trees such *Morus* sp., *Pistacia vera*, *Acacia* sp. and bushes of *Rose* sp.

The meadow-like biotopes or grass plots are provided with spray irrigation system. Therefore, the vegetable cover are mowed down and refreshed in regular way. Grass plots on urban landscapes consists of perennial herbs as *Cyperus rotundus*, *Cynodon dactylon*, *Medicago sativa*, *Lotus sergievskiae*, *Convolvulus arvensis*, *Taraxacum officinale*, annual plants as *Erigeron canadensis*, *Lactuca serriola*, *Crepis rhoeadifolia*, *Malva neglecta*, *Milium vernale* and scattered bushs and trees. Near 80% of vegetable cover here on the plots are weeds. Mesophytic conditions of this biotop are attractive for 5 species of acridids, such as *Duroniella gracilis*, *Aiolopus thalassinus*, *A. simulatrix simulatrix*, *Chorthippus macrocerus assimilis* and *Anacridium aegyptium* (see table 1). While, first 4 species among them are predominate on the grass plots, their population density are 0,5-1,0 ind./m^2, abundance - 80-95 ind./h. The ecological structure of the acridid community was characterized by 3 types of life forms, such as thamnobiont, facultative and grass or true hortobionts.

The acridid community of the ornamental forest plantings in urban landscapes was characterized

by high species diversity and ecological composition (see table 1). This biotope in urban landscapes of desert zone are provided with drip irrigation systems. The vegetable cover of the biotop are comprised by plants of different ecobiotic morphs. So, the 1-st layer of the ornamental forest plantings are consisted of the broad-leaved trees by local origin, such as willows (*Salix babylonica, S. excelsa*), poplar (*Populusalba*), elms (*Ulmus carpinifolia, U. androssowii)*, oleaster (*Elaeagnus orientalis*), ash (*Fraxinuslanceolata*), mulberry (*Morus alba*), plane (*Platanus orientalis*) and introduced pine (*Pinus eldarica*), eastern biota (*Biota orientalis*), palms (*Palma sp.*), acacia (*Acacia* sp.). The 2-nd layer of the forest plantings was formed by bushes of roses (*Rosa* sp.), tamarisks (*Tamarix sp.*), black saxauls (*Haloxylon aphyllum),* seepweeds (*Suaeda microphylla*), long blooming asters (*Asteraceae*). The grass cover was formed at the expence of perennial (*Cyperus rotundus*, *Cynodon dactylon, Medicago sativa, Alhagi persarum*) and annual (*Erigeron canadensis*, *Lactuca serriola*, *Crepis rhoeadifolia*, *Malva sp.*) herbs.

Table1. *The distribution of acridid communities on different types of urban biotopes in desert zone (1997-2017 y.)*

Life form, species	Biotope				
	Grass plots	Ornamental forest plantings	Roadside vegetations	Most illuminated city sites	Buildings
Thamnobionts					
Dericorys albidula Aud.-Serv.				4	
Anacridium aegyptium L.	2	1	3		2
Eyprepocnemis plorans (Charp.)		3			
Heteracris adspersa (Redt.)		2			
H. littoralis (Rambur)		3	1		
Microthamnobionts					
Egnatius apicalis Stal.		1			
Grass or true hortobionts					
Duroniella gracilis Uv.	2	2			
D. kalmyka Ad.		3			
Chorthippus macrocerus assimilis Mistsh.	2	2			
Sedge-grass hortobionts					
Acrida oxycephala (Pall.)		2	3		
Truxalis eximia Eichw.		2	2		
Oxya fuscovittata (Marsch.)				1	
Facultative hortobionts					
Pyrgomorpha bispinosa deserti B.-Bienko		3	3		
Calliptamus turanicus Serg.Tarb.				2	
C. italicus italicus L.		2			
C. barbarus cephalotes F.-W.		3	3	4	
Aiolopus thalassinus (F.)	3	3			
A.simulatrix simulatrix (Walk.)	2	2			
Dociostaurus tartarus Stshelk.		2	3		
D. maroccanus (Thunb.)		1	1		
Specialized phytophiles					
Ochrilidia mistshenkoi B.-Bienko		1	2		
Epigeic geophiles					
Acrotylus insubricus inficitus (Walk.)		2	3	2	
Mioscirtus wagneri rogenhoferi (Sauss.)		2	3		
Oedipoda miniata atripes B.-Bienko		2	3		
Sphingoderus carinatus (Sauss.)		1	2	2	
Sphingonotus satrapes (Sauss.)			3	4	
Sp.rubescens rubescens (Walk.)			2	2	
Sp.maculatus maculatus Uv.				2	
Total: 28	5	22	15	9	1

Note: *The abundance points were determined as follows (Pravdin, 1978): 1 point: 1- 3 ind. per 1 h. of collection; 2 points: 3- 20 ind.; 3 points: 20 - 100 ind.; 4 points: over 100 ind. per 1 h. of collection.*

The diversity of ecobiotic morphs of plants and microclimatic conditions allows to exist here for different species of acridids. Of the 22 species and subspecies belonging to 7 life forms recorded on areas of ornamental forest plantings in Ashgabat (see table 1). The species and ecological diversity of acridid communities may vary on depend of location of this biotope in the territory

of urban landscapes, particularly of the soils of adjoining natural landscapes and type of vegetation (see table 2).

Table 2. *The composition of acridid communities on different types of ornamental forest plantings in desert zone (1997-2017 y.)*

Life form, species	Landscape		
	Light gray desert soils of the Kopet Dagh foothill		Sandy desert soils of the foothill plane
	Ornamental forest plantings		
	Conifers	Broad-leaved	Mixed
Thamnobionts			
Anacridium aegyptium L.		1	1
Eyprepocnemis plorans (Charp.)	3	1	1
Heteracris adspersa (Redt.)		2	3
H. littoralis (Rambur)	3	2	
Microthamnobionts			
Egnatius apicalis Stal.			1
Grass or true hortobionts			
Duroniella gracilis Uv.	2	2	
D. kalmyka Ad.			3
Chorthippus macrocerus assimilis Mistsh.	1	2	
Sedge-grass hortobionts			
Acrida oxycephala (Pall.)	2	2	2
Truxalis eximia Eichw.	2	2	3
Facultative hortobionts			
Pyrgomorpha bispinosa deserti B.-Bienko	3	2	3
Dociostaurus tartarus Stshelk.	2	2	1
D. maroccanus (Thunb.)	1		
Calliptamus italicus italicus L.	2	2	
C. barbarus cephalotes F.-W.	3	2	3
Aiolopus thalassinus (F.)	2	3	1
A. simulatrix simulatrix (Walk.)	2		
Specialized phytophiles			
Ochrilidia mistshenkoi B.-Bienko		1	1
Epigeic geophiles			
Acrotylus insubricus inficitus (Walk.)	2	3	2
Mioscirtus wagneri rogenhoferi (Sauss.)	2	2	2
Oedipoda miniata atripes B.-Bienko	2	2	
Sphingoderus carinatus (Sauss.)			1
Total**: 22**	**16**	**17**	**15**

Note: *The abundance points were determined as follows (Pravdin, 1978): 1 point: 1- 3 ind. per 1 h. of collection; 2 points: 3- 20 ind.; 3 points: 20 - 100 ind.; 4 points: over 100 ind. per 1 h. of collection.*

The change in the age of the vegetations, the rate of crown closure and the density of grass covers are affected to the species composition of the community. Drought tolerance makes oleaster, tamarisk and black saxaul attractive ornamental forest plantings in areas with limited irrigation, such as urban areas, bordering with Karakum desert.

At the same time pine trees, willows (*Salix excelsa*) provided with irrigation, have also been planted with that of xerophilous trees on sandy desert soils of the foothill plane. Of the 15 species and subspecies belonging to 7 life forms recorded on areas of mixed ornamental forest plantings, about 4-5 are considered predominate (see table 2). Most species have a low level of abundance. For primary planted period (near the first 5 years), when the height of the seedlings about and more than 1 m, there are more herbs on the foothill plane, for the same reason, the

facultative hortobionts, belonging to *Pyrgomorpha, Dociostaurus, Calliptamus, Duroniella* and sedge-grass hortobionts as *Truxalis eximia, Acrida oxycephala* are predominated on perennial and annual vegetation of this planting. With increasing of the rate of crown closure, the microclimatic conditions of the planting have been state more moist, that is way abundant shrubs of wormseed (*Chenopodium vulvaria*) and seepweed (*Suaeda microphylla*) increased too and be attractive for *Heteracris adspersa*. At the same time abundance of xerophilous species, belonings to genera *Dociostaurus* and *Calliptamus* step-by step have been reduced and they mainly found on the edges of mixed plantings. The microthamnobiont *Egnatius apicalis* has also been recorded on the edges, where there are more bushes of *Artemisia scoparia* and *A. turanica*. In summer (June-July) the abundance of acridid communities on the mixed ornamental forest plantings reached 158 ind./h.

The acridid community of the conifers on light gray desert soils on the Kopet Dagh foothill was characterized by high species diversity (16 species and subspecies) and ecological composition (6 life forms). About 3-4 species are considered predominate (see table 2). Most species have a low level of abundance. After passing primary planted period (near the first 5 years later) microclimatic conditions, particularly the rate of the air and soil humidity of the conifer plantings are changed. For the same reasons the herb layer have been changed by increasing of *Anisantha tectorum, Eremopyrum orientale, Hordeum bulbosum* etc. As the result, the abundance of species as *Acrida oxycephala* and *Truxalis eximia* has also increased on the plantings. However, substantial change of acridid community has been recorded on its ecological structure and abundance at the expence of increasing of such thamnobionts as *Eyprepocnemis plorans* and *Heteracris littoralis*, which associated with tugai (riparian woodlands). Both these species are mainly found feeding on the herbs, whereas the copulating pairs and resting individuals are mostly on sticks of the conifers. These tugai species moved very easy and successfully on the whole crown of the conifers. The ecological conditions of the conifer plantings in urban landscapes of desert zone have also been attractive for *Calliptamus italicus italicus*. At the same time *Dociostaurus maroccanus* were recorded on ephemeral sedge-bluegrass association in the foothill plane of Kopet Dagh during only first years of planting. In summer (June-July) the abundance of acridid communities on the conifer ornamental forest plantings reached 194 ind./h.

The acridid community of the broad-leaved ornamental forest plantings on light gray desert soils of the Kopet Dagh foothill was also characterized by high species diversity (17 species and subspecies) and ecological composition (6 life forms) (see table 2). The thamnobionts (4 species) are mainly found in low abundance in areas where there are more trees and bushes. The mesophytic conditions allows to penetrate into this planting for tugai species as *Aiolopus thalassinus, Calliptamus italicus italicus, Eyprepocnemis plorans, Heteracris littoralis*. Most species have a low level of abundance. In summer (June) the abundance of acridid communities on the broad-leaved forest plantings by local origin reached 108 ind./h. Thus, of the 22 species and subspecies of acridids are recorded on different types of ornamental forest plantings in desert zone, about 9 are considered as common plant-feeders for them (see table 2).

The roadsides with ruderal vegetations and the presence of open sites of gray desert and sandy desert soils in an urban landscapes of arid areas are attractive for epigeic geophiles (see table 1). At the same time the presence of scattered ornamental forest and fruit trees and bushes, ruderal vegetations on the 3-rd layer have resulted migration here for sedge-grass and facultative hortobiont species. Of the 15 species and subspecies of acridids recorded on roadsides. About 9 are considered predominate, among them *Calliptamus barbarus cephalotes, Sphingonotus satrapes, Oedipoda miniata atripes* and *Acrotylus insubricus inficitus* are relatively abundant on the light gray desert soils of the Kopet Dagh foothill. The adults and hoppers of Tree locust *Anacridium aegyptium* are mainly found feeding on bushes of *Rosa* sp. Such habitats are created by human activity being important for expansion of some species of acridids as *Mioscirtus wagneri rogenhoferi, Dociostaurus tartarus, Calliptamus barbarus cephalotes*. In summer (June) the abundance of acridid communities on the roadsides reached 139 ind./h.

The broad and open lands of desert zone allows to some species of acridid, being in possession of positive phototaxis, come flying in evening twilight and at night to the most illuminated city

sites. These species are concentrated in large numbers on the ground under the powerful sources of electric lighting. It is interesting to note the penetration in urban landscapes some acridids, usually described as desert species. During the 1998 - 2017 y. in summer season (3 decade of May – 1-2 decades of June) we have been recorded night flying such species as *Calliptamus barbarus cephalotes, Dericorys albidula, Sphingonotus satrapes, Sp. maculatus maculatus, Sp. rubescens rubescens, Sphingoderus carinatus, Calliptamus turanicus, Acrotylus insubricus inficitus* and *Oxya fuscovittata* to the most illuminated sites of Ashgabat. It is important to note, that in the years of mass breeding in their natural habitats, abundance of the first 3 species and subspecies can be extremely high in the most illuminated sites in urban landscapes of desert zone.

CONCLUSIONS

- The acridid communities of urban landscapes of Turkmenistan are characterized by original and high species diversity (22 species and subspecies) and ecological structure (7 life forms).
- The species diversity of the communities depends on location of specific biotopes in an urban area, particularly, on soils of adjoining natural landscapes, vegetation cover and the level and type of human activities.
- Human activity (ornamental forest plantings) in desert zone changes composition of dominant species of acridid communities local natural landscapes in a way of increasing mesophile species, associated with tugai (riparian woodlands) and step-by step displacement of xerophily ones.
- Acridid communities on urban landscapes in desert zone are forming at the expence of depletion the species diversity of the communities of dominate plant associations and penetration acridids, possessed by polyzonal distribution areas and few specialized life forms.

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