Study on fauna, biology and ecology of Miridae (Hemiptera-Heteroptera) in agro-biocenosis and natural ecosystems of Uzbekistan

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Abstract. Agricultural production is a critical asset contributing to the economic development of numerous countries with arid and semi-arid climatic characteristics. In recent years, however, the world has witnessed significant losses in agriculture due to the negative impact of pests on crops. Therefore, the accurate assessment impact of agricultural pests on crop production is necessary. However, this could be challenging without proper investigations on their biological and ecological characteristics in data scarce regions, including Uzbekistan. To fulfill this scarcity, this study explores the fauna, biology and ecology of Miridae (*Hemiptera-Heteroptera*) species prevalent in agro-biocenosis and natural ecosystems of Uzbekistan. To better understand their biological and ecological characteristics, we performed field observations on 8 regions of Uzbekistan. The results indicated that three families (*Miridae* Hahn 1833, *Nabidae* Costa 1852, *Antocoridae* Fiber 1837), 6 generas and 20 species of blind (Miridae) are widespread in the selected regions.

1 Introduction

Many changes in everyday life, culture, technology, science, the economy, and agricultural production have accompanied human population growth throughout history. In addition, there have been numerous significant shifts in agricultural production known as "agricultural revolutions," which have been impacted by the expansion of technology, civilization, and humankind in general. Nevertheless, the remarkable surge in population over the past century has resulted in numerous unfavorable outcomes that, when combined with alterations in the surroundings, affect the stability of the food supply. The needs for crop production are rising due to the growing worldwide population, and by 2050, global agricultural production would probably need to double in order to keep up with that level of demand [1].

Over the past few decades, however, global environmental and agricultural challenges, including disruption of ecosystems, agricultural pollution and mismanagement, and changing

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climate scenarios, have triggered an expansion of the geographic range of agricultural pests [2, 3]. These challenges, in turn, might cause undesirable consequences leading to unexpected diseases for agricultural crops worldwide [4]. Currently, the adverse effects of pests on the world agriculture are estimated at 1.4 trillion dollars, which is equal to 5% of the global gross domestic product (GDP) [5, 6]. This figure could be further increased in the upcoming years unless proper pest management strategies are developed from local to global scales [7]. The destructive effect of agricultural insects in crop production, particularly, could have a devastating and long-lasting impact on countries located in drylands, including Uzbekistan. [8, 9]. This is because local economy in those nations is highly dependent on agricultural development [10]. The growth in the number of insect pests leads to unprecedented destruction by devastating crops and agricultural fields [11].

Miridae, sometimes referred as plant bugs or mirids, is usually overlooked and its impact on agriculture is underestimated. Most mirids eat plants and some are agricultural pests. Miridae is the largest family of Heteroptera. According to Henry and Wheeler, the number of species reaches 20,000 in the world faunas. While the majority of known species are phytophagous, the Miridae family includes at least 25 genera that contain species primarily recognized as generalized predators [12].

By sucking sap, mite bugs harm fruits, flowers, and plant terminal bugs. Plants may lose their terminal bud if attacked prior to fruit formation, which would result in stunted and branching growth. Within three to four days, feeding harm to young blooms might result in drying and blasting. Flowers that are little to medium-sized are most vulnerable to permanent harm. When flowers do open up, they frequently have black anthers and twisted, wrinkled petals. Black marks on the outside and smaller, discolored seeds within are the results of feeding damage to bolls. If there are several infestations, yield and quality may suffer significantly [13].

Located in the heartland of the Central Asia, Uzbekistan stands out with its arid and semi-arid climatic characteristics and is a dry, double-landlocked country of which 11 percent consists of intensely cultivated, irrigated river valleys [14]. The country relies on cotton production as the major source of export earnings [15]. Other major earners include gold, natural gas and oil. It is bordered in the west by Kazakhstan, in the northeast by the Aral Sea, in the north by Kazakhstan, in the east by Kyrgyzstan and Tajikistan, and in the south by Afghanistan and Turkmenistan [16]. The agriculture is an integral part of the economy and industrial development. However, in the context of climate change, Uzbekistan has become prone to several environmental challenges [17].

Particularly, the damage of agricultural pests is significant, leading to decreased crop yield. Thus, extensive research on understanding the impacts of insect pests on agricultural crops is required. Therefore, it could be essential to develop and improve a research-based system for crop protection from pests and also ensuring food security. In Uzbekistan, the major insect type presenting vast damage to crop production is the species belonging to Miridae insect family [18]. They are, particularly, widespread in agricultural fields (such as: wheat, alfalfa, and vegetable fields) and benefit by consuming the eggs, larvae, and imago of Phytophagous insects in agro-biocenoses and natural ecosystems. They are as follows: *Nabis ferus* Linnaeus, *Oris niger*, *Campylomma verbasci* Meter-Dur. Currently, the divison of entomophagy bugs (*Hemiptera-Heteroptera*: *Miridae, Nabibae, Antocoridae*), according to the food type they consume and their morphology, biology, and ecology are being investigated on a scientific basis [4]. Furthermore, in Uzbekistan, special attention is given to implementing preventive measures for agricultural pests [17].

As the population grows and export volume expands in the country, the development and application of modern technologies remain urgent and necessary. In this case, it is essential to protect the major agricultural crops (cotton, alfalfa, and domestic vegetables) from insects and develop breeding methods and using entomophagy insects against harmful pests that cause serious damage to crops should be critical. To achieve this goal, however, their biology and ecology should be thoroughly studied. Thus, taking this into consideration, we purpose to study the fauna, biology and ecology of Miridae (Hemiptera-Heteroptera) species in Uzbekistan.

2 Materials and methods

2.1 Research area description

Our field observations were carried out on 8 regions of Uzbekistan (Khorezm, Bukhara, Navoi, Samarkand, Jizzakh, Syrdarya, Tashkent, and the Republic of Karakalpakstan) over the course of 8 years (from 2015 to 2023). The selected regions have diverse agro-cenoses, natural and artifical ecosystems ranging from agricultural crops to apple orchards. Most predominant sector is irrigated agriculture, particularly crop, wheat, rice and other water-intensive crops are cultivated. In this research, we utilized two methods proposed by (1) V.F. Paliy [19] and (2) N.N. Vinakurov [20]. Following the first method, the samples were collected from the plants fed by the blind Miridae. Then, herbariums were prepared after the plant types were identified [A]. According to the second methodology, the samples of blind Miridae distributed throughout the region were collected and their species were determined [A].

3 Results and discussion

3.1 The description and taxonomic index

As soon as completing the observation and collecting the data, we divided the species into family, generation. Based on our observation, 3 families, 6 genera and 20 species of blind (*Miridae*) entomophagous species were found in the selected areas. Their full description and the taxonomic composition of the entomophagous species of ants (*Hemiptera-Heteroptera: Miridae, Nabidae, Antocoridae*) are shown in the table 1.

Tabe 1. The description and taxonomic index of species observed in the research areas

№	Plant family name	Generation name	Species name
I	***Miridae* Hahn,1833**	*Campylomma*	*Verbasci* Meyer – Dur (1843)
			Annulicarne Sigoretn (1865)
			Diversicornis Reuter (1878)
		Megacoelum	*Breviostre* Reuter (1879)
		Deraeocoris	*Punctulatus* Linnaeus (1807)
			Ruber Linnaeus (1758)
			Ventralis Linnaeus (1758)
			Serenus Douglus &Scot (1868)
II	***Nabidae* Costa,1852**	*Nabis*	*Nabis ferus* Linnaeus (1758)
			Nabis rugosus Linnaeus (1758)
			Nabis palifer Seidensticker (1954)
			Nabis vridis Brule, (1839)

			Nabis remanei Kerxhner (1962)
			Nabis sareptanus Dohrn (1862)
			Prostemma Sanguneum Rossi (1790)
III	***Antocoridae,* Fieber,1837**	*Anthocoris*	*Pilosus* Jakovlev, (1877)
		Orius	*Horvathi* Reuter, (1884)
			Niger Wolff (1811)
			Ribauti Wagner (1952)
			Albidennis Reder (1884)
Total number:	*3*	6	*20*

Species that belonging to ***Miridae* Hahn family** are as follows: *Campylomma Verbasci* Meyer – Dur, *Campylomma Annulicarne* Sigoretn , *Campylomma Diversicornis* Reuter, *Megacoelum Breviostre* Reuter, *Deraeocoris Punctulatus* Linnaeus, *Deraeocoris Ruber* Linnaeus, *Deraeocoris Ventralis* Linnaeus, *Deraeocoris Serenus* Douglus &Scot. ***Nabidae* Costa** oilasiga *Nabis ferus* Linnaeus, *Nabis rugosus* Linnaeus, *Nabis palifer* Seidensticker, *Nabis viridis* Brule, *Nabis remanei* Kerxhner, *Nabis sareptanus* Dohrn, *Prostemma Sanguneum* Rossi. Species that belonging to ***Antocoridae,*Fieber** family are *Anthocoris Pilosus* Jakovlev, *Orius Horvathi* Reuter , *Orius Niger* Wolff, *Orius Ribauti* Wagner, *Orius Albidennis* Reder.

Furthermore, the divison of entomophagous bugs (*Hemiptera-Heteroptera: Miridae, Nabidae, Antocoridae*) found in the same areas as above and natural ecosystems, has been made based on the type of food they consume. The precise data is given in the table 2.

Table 2. The division of entomophagous bugs according to food type.

№	**Family and types**	**Polyp hage**	**Wide polyp hage**	**Small polyp hage**	**Zoop hage**	**Zophyto phagous**
I	***Family.NABIDAE COSTA 1852***					
1	*Nabis ferus* (Linnaeus, 1758)				+	
2	*Nabis rugosus* (Linnaeus, 1758)				+	
3	*Nabis palifer (*Seidensticker*,* 1954*)*				+	
4	*Nabis vridis (*Brule, 1839*)*				+	
5	*Nabis remanei* (Kerxhner,1962)				+	
6	*Nabis sareptanus* (Dohrn,1862*)*				+	
7	*Prostemma sanguneum* (Rossi,				+	

	17 90)					
II	***Family.ANTHOCORIDAE FIEBER,1837***					
8	*Anthocoris pilosus* (Jakovlev, 1877)				+	
9	*Orius horvathi* (Reuter, 1884)				+	
10	*Orius niger* (Wolff, 1811)				+	
11	*Orius ribauti* (Wagner,1952)				+	
12	*Orius albidennis* (Reder,1884)				+	
III	***Family.MIRIDAE*** **Hahn,1833**					
13	*Deraeocoris punctulatus* (Fallen, 1807)					+
14	*Deraeocoris ventralis* Reuter, 1904					+
15	*Deraeocoris rube* (Linnaeus, 1758)					+
16	*Deraeocoris Serenus* (Douglus &Scot,1868)					+
17	*Campylomma verbasci* (Meyer-Dur, 1843)					+
18	*Campylomma annulicarne* (Sigoretn1865)					+
19	*Campylomma diversicornis* (Reuter,1878)					+
20	*Megacoelum brevirostre* *(*Reuter, 1879)					+
	Total:				12	8

As a result of the research, 12 zoophages and 8 zoophytophage from blind bugs family *(Miridae, Antocoridae, Nabidae*) were indentified. **The Miridae Hahn** family includes 8 zoophytophagous species, including *Campylomma Verbasci Meyer-Dur, Campylomma Annulicarne Sigoretn, Campylomma Diversicornis Reuter, Megacoelum Breviostre Reuter, Deraeocoris Punctulatus Linnaeus, Deraeocoris Ruber Linnaeus, Deraeocoris Ventralis Linnaeus, Deraeocoris Serenus Douglas* & Scott. **The Nabidae Costa** family included 7 species of zoophages: *Nabis ferus* Linnaeus, *Nabis rugosus* Linnaeus, *Nabis palifer* Seidensticker, *Nabis vridis* Brule, *Nabis remanei* Kerchhner, *Nabis sareptanus* Dohrn, *Prostemma Sanguneum* Rossi. **Antocoridae Fieber** family included 5 zoophages, including *Anthocoris pilosus* Jakovlev, *Orius Horvathi* Reuter, *Orius Niger* Wolff, *Orius Ribauti* Wagner, *Orius Albidennis* Reder.

3.2. Morphology, biology of entomophagous species and classification.

This section deals with the biology of entomophagous species namely Oris niger (Wolff, 1811), Nabis ferus (Linnaeus, 1758) and Campylomma verbassi Maeyr DUR – (1843). These species are the common ones among the other species in the selected regions and have been captured during the field observation. Their most essential parameters and pictures are shown in the Figure 1.

3.2.1. Morphology and biology of the entomophagous species Oris niger (Wolff, 1811).

Type: Antphopoda ;
Class: Inesta;
Order: Hemiptera;
Suborder: Antochoridae;
Family: *Orius;*
Genus: *Niger*;
Species: *Orius niger* (Wolff, 1811).

3.2.2. Morphology and biology of the entomophagous species Nabis ferus (Linnaeus, 1758).

Type:Arthopoda;
Class: Inecta;
Order: Hemiptera;
Suborder: Heteroptera
Family: Nabidae;
Genus; Nabis;
Species: *Nabis ferus* (Linnaeus, 1758).

3.2.3. Morphology and biology of the species Campylomma verbassi Maeyr DUR – (1843)

Type:Avthoropoda;
Family: Insecta;
Order: Hemiptera:
Suborder: Phylinae;
Family: *Miridae;*
Genus: *Campylomma* Reute*r* 1878;
Species: *Campylomma verbasci* Meyer- Dur 1843.

Fig. 1. *Oris niger* (Wolff, 1811) (left), *Nabis ferus* (Linnaeus, 1758) (middle) and *Campylomma verbasci* (Meyer-Dur.1843) (right).

According to the distribution of entomophagous species, Nabis ferus was dominant type accounting for 10%. When we analyzed phytophagous and entomophagous species, phytophagous species accounted for 25%, and entomophagous species accounted for 24% respectively.

4 Conclusion

Agriculture is a major sector that is facing diverse environmental challenges worldwide, including climate change, agricultural pollution, and overuse of pesticides. Warming climate, however, enables agricultural pests to expand their geographical areas, further increasing in numbers. Particularly, the detrimental impact of agricultural pests is significant, leading to nationwide decreased crop yield. Therefore, a detailed study on the biological and ecological characteristics of agricultural pests is necessary for those countries that are heavily dependent on agricultural development. In this research, we explored the fauna, biology, and ecology of Miridae species in 8 regions where agriculture is dominant. The final results reveal that 3 families, 6 genus and 20 species were identified in the agro-cenoses and natural ecosystems of the selected regions between 2015 and 2023. Of them, 12 species are zoophagous and 8 species belong to zoophytophagous. Our results and presented data in this study could be important in implemeting preventive measures in the future.

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