Study on distributional pattern and faunal composition of the Miridae (Hemiptera) family in the Hulun Buir City, Inner Mongolia of China

Kai Shi [1, a *], Yuanyuan Li [1,b] and Yanqin Zhao [1,c]

[1] Agricultural College, Inner Mongolia University for the Nationalities, Tongliao, Inner Mongolia 028043, China

[a]nmshikai@126.com, [b]yuanyuan1102315@sina.com, [c]zhaoyanqin782828@qq.com

Keywords: Miridae, distributional pattern, fauna, region similarity

Abstract. Based on the field investigations in the past and all published literatures, we studied the faunal composition and distributional pattern of Miridae (Hemiptera) from the Hulun Buir City, Inner Mongolia of China. In total, 122 species, which belonging to 4 subfamilies 51 genera were recorded in there. In general, Miridae species were concentrated in the western areas of Hulun Buir City; where mainly was the Hulun Buir Grassland. From each subfamily distributional situation, Mirinae was distributed the most extensive, relatively the most dispersed; followed by Orthotylinae. The distribution of Phylinae was showed two transverse bands. And Deraeocorinae was the sparsest. The similarity coefficient of NDS and WDS is the highest (0.6143), which performance for medium similarity. And rest any two subregions all showed medium not similarity. The natural environment (climate, soil type, vegetation type), human disturbance and physiological characteristics of this family is likely influences the species composition and distribution.

Introduction

The Hulun Buir City is located in the northeast of Inner Mongolia Autonomous Region, China, ranging from 47° 05′ - 53°20′ N and 115° 31′ - 126° 04′ E, with a total area of 253 000 km^2 [1]. Daxinganling runs through the middle of Hulun Buir City in northeast- southwest direction. Politically, there are one district (Hailer), five cities, three autonomous banners and four banners. Fig. 1 shows the basic situation of Hulun Buir City. The Hulun Buir Grassland known as one of the world's best grasslands is located in the western of this city (administrative divisions include: the New Barag Right Banner, New Barag Left Banner, Manzhouli City, Hailar, the part of Evenki Autonomous Banner, the part of Chen Barag Banner). And eastern areas of Hulun Buir City is distributed hilly and valley plains, mainly farmland. On the whole, the Hulun Buir City not only has grassland, but also has the forest, wetland, farmland, sand and other various habitat, diverse climate, rich in biodiversity. In recent years, because of overgrazing, large-scale development of land, mineral and tourism resources, deforestation forest, there has showed vegetations destroyed, habitat fragmentation, biodiversity loss, even sandstorm phenomenon frequent. At present, the role of the ecological barrier for the Hulun Buir City is gradually decreasing, which has affected the ecological security of China. The Hulun Buir City is facing severe ecological security situation.

Miridae is the first largest family of Heteroptera of Hemiptera. Up to now, more than 1,400 genera, 11,139 species have been described worldwide in the family [2]. In China, there has recorded more than 150 genera 760 species of Miridae [3, 4]. Most species of Miridae are herbivorous (such as *Lygus* spp., *Trigonotylus* spp. and *Apolygus* spp.), easily become a kind of threatening pasture pest, also can cause damage on crops and forest. But, so far, there has still no systematic studies (taxonomy, biology, zoogeography or ecology etc.) on the Miridae of Hulun Buir City. Our study focuses on the following two aspects, studying the faunistic composition and distributional pattern of Miridae. On this basis, we will explore the zoogeographic distributional characteristics of Hulun Buir Miridae fauna, in order to provide some supporting data for further the relevant biodiversity, biogeography and ecology research.

Fig.1 Map of Hulun Buir City
Broken lines denote limits of sub-regions; NDS- the North DaXinganling subregion; DS- Daxinganling subregion; WDS- the meadow steppe of West Daxinganling subregion; IMS-the temperate typical steppe of Inner Mongolia plateau subregion. The same below.

Materials and Methods

Specimens and geographical data were compiled from three resources: from all the literatures published up to now; from all the collected records between June and September of 2011-2015 in Hunlun Buir City deposited in Inner Mongolia University for the Nationalities; from accumulation label records of specimens and/or types deposited in the Nonnaizab Entomology Research Center of Inner Mongolia Normal University. According to the literatures [5-8], all the specimens were sorting, classification, verification and identification.

Using Excel 2010 statistical software, we made funistic composition of Miridae from the Hulun Buir City. The sketch map of Hulun Buir City and details distributional pattern of Miridae were mapped by the PC programs ArcView GIS 9.3. Based on topography, vegetation, climate, soil and other characteristics [9, 10], the Hulun Buir City was divided into four subregions (refer to Fig. 1), namely the North DaXinganling subregion (NDS), Daxinganling subregion (DS), meadow steppe of the West Daxinganling subregion (WDS) and the temperate typical steppe of Inner Mongolia plateau subregion (IMS). The NDS refers to the northern of Hulun Buir City, where has developed forestry. The DS is a part of the Songnen Plain, where has developed agriculture. The WDS is the transition of forest and steppe zone, landscape forest and grassland on coexist. In the IMS, grassland accounts for absolute advantage, distribution of the typical steppe and drought grassland. Miridae community similarities of four subregions were compared using Sorensen similarity coefficient Cs (where w was the common species number to the two subregions, a as the species number distributed in subregion A, b as the species number distributed in subregion B) [11].

$$Cs = 2w/a + b. \quad (1)$$

Results and analysis

Funistic composition and distribution of Miridae from the Hulun Buir City. Species of the family Miridae of Hulun Buir City had 122 species, 51 genera, which was belonging to 4 subfamilies. In details, Mirinae had 18 genera 65 species, Phylinae16 genera 26 species, Orthotylinae 16 genera 22

species and Deraeocorinae 1 genus 9 species. Table1 shows the numbers of species in each subfamily and genus of Miridae from Hulun Buir City. So, Mirinae had the most abundant species diversity, accounting for about 53.3 % of the total number of species. From Miridae species distribution in each subregion, there were 46 species in the DS; 65 species in the NDS; 75 species in the WDS; 27 species in the IMS. Among of them, 9 species were dispersed species, distributed in all the four subregions.

Table 1 Funistic composition and distribution of Miridae from the Hulun Buir City

Note: Symbol + indicates distribution.

Subfamily	Genus	Species	Subregion Distribution			
			DS	NDS	WDS	IMS
Deraeocorinae	*Deraeocoris*	*D. annulipes* (Herrich-Schaeffer)	+			
		D. ater (Jalovlev)	+	+	+	+
		D. kerzhneri Josifov	+			
		D. morio (Boheman)	+			
		D. olivaceus (Fabricius)	+			
		D. pallidicornis Josifov	+			
		D. punctulatus (Fallén)	+			
		D. salicis Josifov	+			
		D. scutellaris (Fabricius)				+
Mirinae	*Adelphocoris*	*A. fasciaticollis* Reuter			+	
		A. ferrugineus Hsiao			+	
		A. laeviusculus Vinokurov			+	
		A. lineolatus (Goeze)	+	+	+	
		A. melanocephalus Reuter	+			
		A. nigritylus Hsiao			+	
		A. obliquefasciatus Lindberg	+	+		
		A. ponghvariensis Josifov	+			+
		A. quadripunctatus (Fabricius)		+	+	
		A. reicheli (Fieber)		+		
		A. rufescens Hsiao		+	+	
		A. tenebrosus (Reuter)		+	+	
		A. triannulatus (Stål)	+		+	
	Apolygus	*A. lucorum* (Meyer-Dür)	+		+	+
		A. nigronasutus (Stål)	+	+		
		A. nigrovirens (Kerzhner)	+	+		+
		A. spinolae (Meyer- Dür)	+	+	+	+
	Capsodes	*C. gothicus* (Linnaeus)	+	+	+	
	Capsus	*C. cinctus* (Kolenati)			+	
		C. pilifer Remane			+	+
		C. wagneri Remane		+	+	
	Lygidea	*L. illota* (Stål)		+		
	Lygocoris	*L. pabulinus* (Linneaus)		+	+	
	Lygus	*L. adspersus* (Schilling)	+	+	+	
		L. gemellatus (Herrich-Schaeffer)			+	+
		L. orientis Aglyamzyanov			+	
		L. pratensis (Linnaeus)			+	
		L. punctatus (Zetterstedt)			+	
		L. rugulipennis Poppius	+	+	+	+
		L. sibiricus Aglyamzyanov	+	+	+	
		L. wagneri Remane	+	+	+	
	Neolygus	*N. chinensis* (Lu and Yasunaga)		+	+	
	Orthops	*O. forelii* Fieber	+			

Table I continued.

Subfamily	Genus	Species	Subregion Distribution			
			DS	NDS	WDS	IMS
		O. mutans (Stål)				+
		O. scutellatus Uhler		+	+	+
	Phytocoris	*P. insignis* Reuter			+	
		P. nowickyi Fieber		+	+	+
	Polymerus	*P. brevicornis* (Reuter)	+	+	+	+
		P. carpathicus (Horvath)	+	+	+	
		P. cognatus (Fieber)	+	+	+	+
		P. funestus (Reuter)		+		
		P. palustris (Reuter)		+	+	
		P. pekinensis Horvath			+	
		P. unifasciatus (Fabricius)	+	+	+	+
	Actitocoris	*A. signatus* Reuter			+	
	Leptopterna	*L. albescens* (Reuter)			+	
		L. kerzhneri Vinokurov		+	+	
		L. xilingolana Jorigtoo and Nonnaizab			+	
	Myrmecoris	*M. gracilis* (Sahlberg)	+			
	Notostira	*N. sibirica* Golub		+	+	
	Stenodema	*S. calcarata* (Fallén)		+	+	
		S. holsata (Fabricius)		+	+	
		S. mongolia Nonnaizab and Jorigtoo	+	+	+	
		S. parvulum Zheng		+	+	
		S. pilosa (Jakovlev)			+	
		S. sericans (Fieber)		+	+	
		S. sibirica Bergroth		+	+	
		S. trispinosa Reuter		+		
		S. turanic Reuter		+		
		S. virens (Linnaeus)		+	+	
	Teratocoris	*T. saundersi* Douglas and Scott		+	+	
	Trigonotylus	*T. caelestialium* (Kirkaldy)	+	+	+	+
		T. cremeus Golub				+
		T. longitarsus Golub	+	+	+	+
		T. ruficornis (Geoffroy)	+	+	+	
Orthotylinae	*Anapus*	*A. kirschbanumi* Stål			+	
	Euryopicoris	*E. nitidus* (Meyer-Dür)	+	+	+	
	Halticus	*H. apterus* (Linnaeus)		+		
		H. pusillus (Herrich-Schaeffer)	+	+	+	
	Labops	*L. bami* Kulik		+	+	
		L. nivchorum Kerzhner			+	
		L. sahlbergi (Fallén)		+		
	Myrmecophyes	*M. alboornatus* (Stål)		+		
	Orthocephalus	*O. funestus* Jakovlev	+	+	+	+
	Strongylocoris	*S. leucocephalus* (Linnaeus)	+	+	+	
	Blepharidopterus	*B. angulatus* (Fallén)	+	+	+	
	Cyllecoris	*C. equestris* Stål			+	
	Cyrtorhinus	*C. caricis* (Fallén)	+	+		
	Excentricus	*E. planicornis* (Herrich-Schaeffer)			+	+
	Globiceps	*G. flavomaculatus* (Faricius)	+		+	

Table I continued.

Subfamily	Genus	Species	Subregion Distribution			
			DS	NDS	WDS	IMS
	Labopidea	*L. algens* (Vinokurov)	+			
	Mecomma	*M. dispar* (Boheman)		+		
	Orthotylus	*O. flavosparsus* (Sahlverg)			+	+
		O. interpositus Schmidt		+	+	
		O. oschanini Reuter	+	+		
		O. parvulus Reuter			+	
	Ulmocyllus	*U. virens* Seidenstucker	+			+
Phylinae	*Hallodopus*	*H. sibiricus* Poppius			+	
	Acrotelus	*A. pilosicornis* (Reuter)				+
	Atomoscelis	*A. asiatica* (Josifov)	+			
		A. onustus (Fieber)				+
	Chlamydatus	*C. pulicarius* (Fallén)		+		
		C. pullus (Reuter)				+
	Compsidolon	*C. pumilum* (Jakovlev)			+	
	Criocoris	*C. crassicornis* (Hahn)			+	
		C. quadrimaculatus (Fallén)		+		
		C. sibiricus Kerzhner				
	Europiella	*E. leucopus* (Kerzhner)	+			
	Eurycolpus	*E. flaveolus* (Stål)		+		
	Excentricoris	*E. pictipes* (Reuter)			+	
	Macrotylus	*M. mundulus* (Stål)				+
		M. zinovievi Kezhner				+
	Phaeochiton	*P. caraganae* (Kerzhner)			+	
	Plagiognathus	*P. chrysanthemi* (Wolff)		+	+	
		P. collaris (Matsumura)		+		
	Psallopsis	*P. kirgisicus* (Becker)			+	
	Psallus	*P. betuleti* (Fallén)		+		
		P. fallenii Reuter		+		
		P. ulmi Kerzhner and Josifov	+	+		
	Sacculifer	*S. picticeps* Kerzhner		+	+	
	Pilophorus	*P. cinnamopterus* (Kirschbaum)		+		
		P. clavatus (Linnaeus)			+	
		P. setulosus Horvath	+			
Total	51	122	46	65	75	27

From the perspective of subfamily, Fig.2 shows the distributional pattern of Miridae. The subfamily Mirinae was distributed the most extensive, relatively the most dispersed; followed by Orthotylinae. The distribution of Phylinae was showed two transverse bands. And Deraeocorinae was the sparsest. Such distributional pattern is likely relevant with the vegetation types, land use types, acquisition conditions and human interference. In the western areas of Hulun Buir City, the main land using types is grassland. Such as the 99.84% of total land area of New Barag Right Banner was grassland; 75% of Manzhouli City, 81.27% of New Barag Left Banner, 81.42% of Chen Barag Banner and 68.85% of Evenki Autonomous Banner also was grasslands [10]. These areas distributed a variety of grassland vegetation and human disturbance was relatively small, open environment, suitable for the Miridae to survive. While in the northern (refers to the northern areas Genhe City and Ergun City, forests and secondary forests) and eastern areas (refers to most areas Oroqen Autonomous Banner, Arun Banner, Zhalantun City, Morin Dawa Daur Autonomous Banner, mainly agricultural areas) of Hulun Buir City, the Miridae distribution was very scarce even no distribution records. The reason may be that these areas substantially woodland or farmland. In the woodland mostly is canopy

environment, sparsely populated, collecting difficult relatively. In agricultural areas, local farmers used some toxic pesticides in the process of agricultural production and management for the past few years, so insect species diversity in cultivated land greatly reduced. In addition, most researchers always focused on the western areas of Hulun Buir City; while had not paid enough attention to other areas.

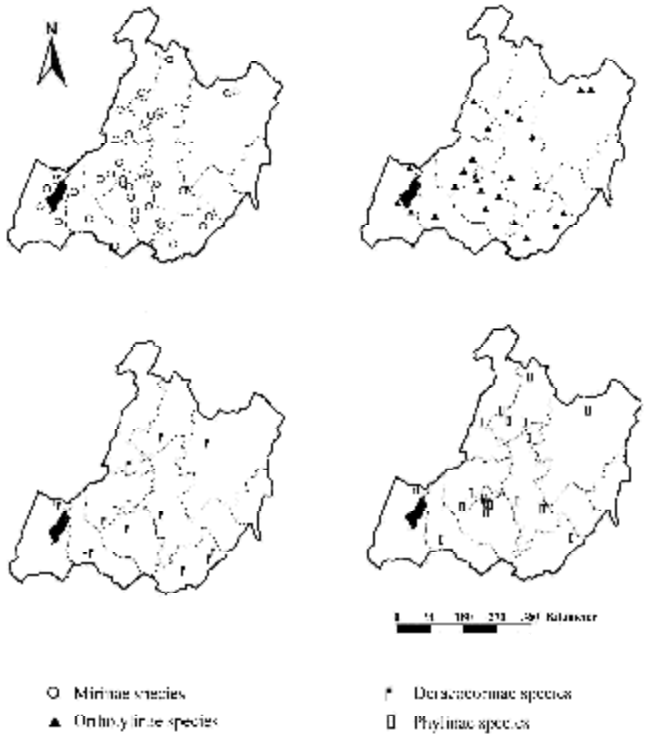

Fig. 2 Distributional pattern of all the subfamilies of Miridae from Hulun Buir City

Region similarity of Miridae. Region similarity analysis of Miridae from Hulun Buir City is shown in Table 2. The similarity coefficient of NDS and WDS is the highest (0.6143), which performance for medium similarity. The other two sub- regions show medium not similarity, their similarity coefficient all between 0.25 and 0.50. This may be associated with each subregion natural environment (climate, soil type, vegetation type etc.), human disturbance and physiological characteristics of this family.

Table 2 Region similarity analysis of Miridae from Hulun Buir City

Subregions	DS	NDS	WDS	IMS
DS	1.0000	0.4865	0.3967	0.3562
NDS		1.0000	0.6143	0.2609
WDS			1.0000	0.3137
IMS				1.0000

Conclusions

There were 4 subfamilies 51genera 122 species of Miridae distributed in Hulun Buir city. Among of them, Mirinae had the most abundant species (8 genera 65 species); and Deraeocorinae species was relatively simple (1 genus 9 species). Most of the species of Miridae concentrated in the western areas of Hulun Buir City; that mainly was the Hulun Buir Grassland. The subfamily Mirinae was the most widely distributed and dispersed, Orthotylinae followed. The distribution of Phylinae was roughly two transverse isolation strip. Deraeocorinae distribution area was the narrowest and sparsest. Similarity analysis results showed that the similarity coefficient of North DaXinganling subregion (NDS) and meadow steppe of West Daxinganling subregion (WDS) was the highest (0.6143), performance for medium similarity. And rest any two subregions all showed medium not similarity.

Our study reflects the basic situation and characteristics of Miridae from Hulun Buir City. But the Hulun Buir City is very vast, the habitat, the climate, the vegetation type is also complex and diverse. These factors may affect the composition and distribution of Miridae. At present, the research on Miridae of this city is still weak, on the further biological geography, biology and ecology research needs to strengthen.

Acknowledgements

The research work was supported by the funds of the National Natural Science Foundation of China (31301922).

References

[1] Rui Liu, Min Feng, Jiulin Sun *et al*., Sci. Geograph. Sin. 32 (2012) 1488-1495.

[2] Information on http: //research.amnh.org/pbi/catalog/

[3] Leyi Zheng, Nan Lv, Guoqing Liu and Binghong Xu, Fauna Sinica, Insecta (Hemiptera, Miridae, Miridae), Science Press, Beijing, 2004 (In Chinese).

[4] Guoqing Liu, Leyi Zheng, Fauna Sinica, Insecta (Hemiptera, Miridae, Orthotylinae), Science Press, Beijing, 2014 (In Chinese).

[5] G. Cassis, R.T. Schuh, Ann. Rev. Entomol. 57(2012) 377-404.

[6] I.M. Kerzhner, Key to the Insects of the Far East of the USSR, in: P.A. Lehr (Ed.), Family Miridae, Nauka, Leningrad, 1988, pp. 778-857.

[7] I.M. Kerzhner, M. Josifov, Catalogue of the Heteroptera of the Palaearctic Region, in: B. Aukema, R. Christian (Eds.), Cimicomorpha II, The Netherlands Entomological Society, Amsterdam, 1999, pp. 204-277.

[8] N.J. Tatarnic, G. Cassis, Zool. Journ. Linnean Soc. 164 (2012) 558-658.

[9] Hushan Wu, Nonnaizab, Grasshoppers of Hulunbeier Grassland, China Agricultural Press, Beijing, 2009. (In Chinese)

[10] Editorial Committee of the Mongolia Encyclopedia, Encyclopaedia of Mongolian Studies, Geography, Inner Mongolia people's Publishing House, Hohhot, 2012 (In Chinese).

[11] Hesheng Wang, Plant Floristic Geography, Science Press, Beijing, 1992 (In Chinese).