Taxonomic and ecological data on the Hemiptera fauna from Berati region habitats in Albania

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Abstract

This study provides taxonomic and ecological data on Hemiptera (Insecta) order prevalence in Berati region habitats in Southern Albania. Diverse natural environments, fields, and hilly and mountainous habitats characterize this region. The expeditions for the biological material collection were organized during 2018-2020 in six stations from May to September. Our study refers to 38 species, representing 28 genera and 10 families of the order Hemiptera. Taxonomical results on the family distribution indicate that the highest belonged to Pentatomidae, with 12 species or 31.5%, followed by Miridae, with 9 species and 23.6%. Regarding species diversity, the Lybesha station had the highest diversity, with 16 species or 42.1%, while the Lapardha station had the lowest diversity, with six species or 15.7%. Estimating species similarity by the Jaccard coefficient indicates the Lybesha and Peshtani stations, with four common species and a species similarity coefficient of 16.6%, reflecting the ecological factors' similarity between these stations.

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Introduction

Insects are known as the most diverse group of the animal kingdom and represent more than half of all known living organisms, comprising more than a million described species.The Hemiptera is globally distinguished as a diverse order, comprising approximately 50 thousand species.[1] Their name derives from the old Greek: *ἡμι-* (*hemi*; "half") and *πτερόν* (*pteron*; "wing") due to the type of wings, where half of the first wing is strong, while the other half is membranous.[2] They represent the most significant order of hemimetabolous insects inhabiting terrestrial environments. Still, some families are fully aquatic (Belostomatidae, Nepidae, Notonectidae, etc.) or semiaquatic (Gerridae, Hydrometridae, etc.) during their life stages. Their dimensions range from 1 mm to about 15 cm. Hemiptera are recognized as semi-flatfoot. Like all Insecta class representatives, Hemiptera consist of three main parts: the head, the thorax, and the abdomen.[3] Their head color and shape differ and serve as systematic features in their taxonomic determination.[4] The male sexual organs serve the taxonomic determination, whereas the ninth segment is often used for determination because of its different placement in different families.[5] In most cases, the female is easily distinguished from the male, as some last abdomen segments have a vertical slit.[6]

Hemiptera have a range of mouthparts adapted to particular modes of feeding.[7] They feed on plant lymph, but some species feed on the blood of aquatic organisms (fish, amphibians) and mammals or humans. The secretion glands found in metathorax are important for taxonomic determination, the biology of these species, and their relationship with the environment and humans.[8] Unlike their exclusively plant-feeding subordinate allies, the Hemiptera have food preferences rivaling any insect suprageneric group, feeding on animal (primarily invertebrate), fungal (mostly

mycelia), and plant (vegetative and reproductive) tissues.[9-11] On land, Hemipterans are found from soil to canopy, with hemipteran communities that include predaceous and herbivorous lineages.[9,12] On plants, there has been an explosive radiation of herbivorous lineages, including those that feed mainly on either leaf and stem (Cimicomorpha: Miroidea in part), fruits and seeds (Pentatomomorpha) and specialized root feeding (Cydnidae).[12,13] Plant feeding is not only specialized in tissue type, as many land bug lineages display host plant conservatism, or preferential host switching, indicative of coevolution in the broad sense.[14]

Significant pests include the cottony cushion scale, a pest of citrus fruit trees, and jumping plant lice which are often host plant-specific. Hemipterans can dramatically cut the mass of affected plants, especially in significant outbreaks. They sometimes also change the mix of plants by predation on seeds or feeding on roots of certain species.[15] Some predatory Hemiptera, especially species of the families Miridae, Reduviidae, and Nabidae, play an essential role as biological controllers of phytophagous species in agriculture because they affect the reduction of the number of pests in crops.[10] Herbivorous insects on plants are subject to predation by independently derived heteropteran lineages (*e.g.*, Miridae: Deraeocorinae, Cimicoidea, Naboidea, Geocoridae, Pentatomidae: Asopinae).[16]

This study presents data on the species belonging to the Hemiptera order in the Berati region, Southern Albania. Through biological material study, we aim to contribute to this order recognition.

Materials and Methods

Biological materials were collected between 2018 and 2020 during the warming period from May to September, which coincides with their flight and life cycle.[17] We have collected biological material in the Berati region. Six stations: Poshnja, Lapardha, Uznova, Vodica, Peshtani, and Lybesha (Figure 1), represent habitats with fields, hilly, and mountainous vegetation.

Geographic coordinates were identified through the Google EarthVersion 7.1 location system. Poshnja, with coordinates 40° 48’ 00” N and 19° 50’ 00” E, geography is mainly dominated by plain terrains and a mild winter climate favoring greenhouse cultivation. Farming practices have influenced greenhouse vegetation by introducing Hemiptera species, well-known as agricultural pests. In the Lapardha area, the relief is mainly plain with lands planted with crops, with coordinates 40° 45’ 00” N and 19° 57’ 00” E. The Uznova relief is flat-hilly, with lands transformed into terraces and planted with olive orchards with geographical coordinates 40° 41’ 46.22” N and 19° 59’ 4.50” E. The Vodica relief is plain-hilly, with coordinates 40° 40’ 36.15” N and 20° 1’ 10.76” E. Meanwhile, the Peshtani’s geography is hilly mountainous, and a belt of Mediterranean vegetation, 40° 38’ 46.95” N and 20° 2’ 29.40” E. The Lybesha relief is typically hilly mountainous, 750-800m above sea level, with Mediterranean shrubs and oak belt, coordinates 40° 36’ 40.19” N and 20° 4’ 35.84” E. Expeditions were carried out by visiting each station three times, lasting 4-5 days, with sunny weath-

Figure 1. Map of collection stations (Google Earth, Version 7.1).

er conditions during 10:00 to 14:00 daytime and randomly gathering in the station habitats. During the COVID-19 pandemic in 2020, we encountered difficulties in expeditions; between May and June, only one team member conducted expeditions due to the official isolation conditions. This may have influenced the assemblage of Hemiptera individuals.

The biological material collection was applied using an entomological sweep net, considering the life cycle of semi-falcons.[18] Sampling was performed along the diagonal of equal surfaces for all stations in the study, 100 m^2 (10 m × 10 m) passing five times along each square diagonal.[18]

Plastic bottles labeled with the date and collection site were employed for insect depositing. The insects were stored in bottles containing 95% ethyl alcohol, acetic acid, distilled water in the (80:5:20) solution, and a few drops of ether. After being removed from storage bottles, insects were placed into the refrigerator for 24 hours.[18] The taxonomical determination was conducted through a ZEISS stereomicroscope (Uzi Seria 240/3 Model 50240003) using the definition keys for semi-flats,[2,19] and publications of other authors in Albania for this order.[20-23]

We have calculated the species percentage for each family and station based on the total number of species determined after their taxonomic analysis.

We have used this mathematical formula:

$$\text{Species \%} = \frac{X}{N} \times 100$$

where X is the species' number for each family or each station and N is the total number of determined species.

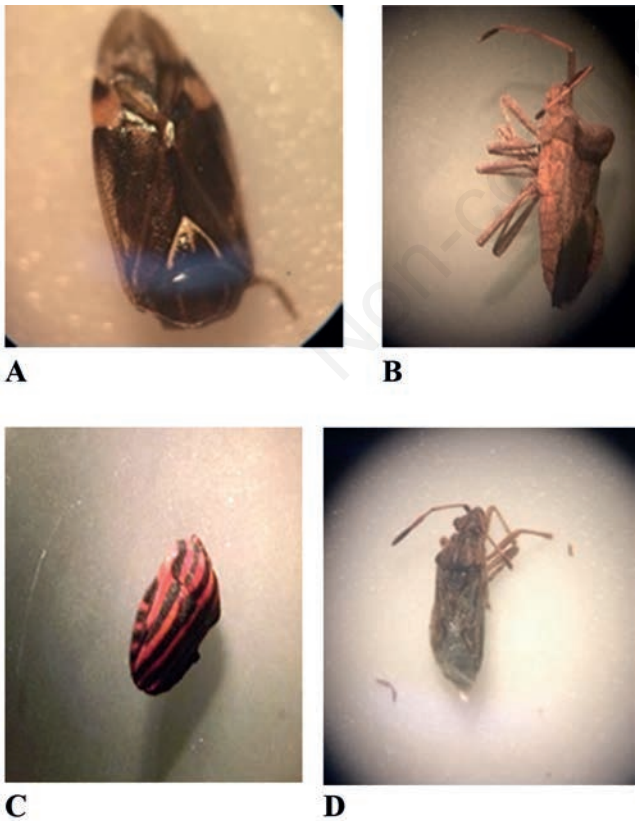

Figure 2. Insects identified in the study: A) *A. amygdali*, B) *C. marginatus*, C) *G. lineolatum*, D) *S. nysioides*.

Results

This study determines the list of all species referred to Hemiptera order in the Berat area (Table 1). Photos of some of these species taken with a stereomicroscope camera are shown in Figure 2.

From the definition of the collected material, we refer that the order Hemiptera in this study is represented by10 families, 28 genera, and 38 species.[24-29] Figure 3 presents the determined species according to each family. We have calculated the percentage of species based on the total number (38) of species.

We have given the number of species we determined for each station. We calculated the percentage of species at each station based on the total number of species, 38 (Table 2).

We analyzed the species composition between the collection stations, comparing the same species. To determine the species similarity, we used the Jaccard formula for two areas.[30] In Table 3, we have given the number of the same species between each of the two stations and compared the similarity coefficient between them.

Discussion

Based on our results, for the number of species by family, the highest diversity is noted in Pentatomidae (with 31.58% of the species), followed by the Miridae (23.68% of the species) and Lygaeidae (10.53% of the species). The lowest family diversity was recorded for Coreidae and Scutelleridae (7.90% of the species each), Rhyparochromidae and Rhopalidae (5.26% of the species), and Reduviidae, Alydidae, and Geocoridae (2.63% of the species each). According to our data, the natural habitats in the Berat area are more suitable for the species of the Pentatomidae and Miridae families.

The analysis of the species according to each station's collection was based on bio-ecological conditions, habitats, abiotic, and biotic factors and shows that Lybesha station has the highest diversity (with 42.10% of the species), followed by Peshtani (31.57% of the species). The lowest diversity is observed in Vodica and Uznova stations (26.31% of the species), Poshnja (21.05% of the species), and Lapardha (15.78% of the species). Lybesha and Peshtani stations have hilly-mountainous relief, mostly uncultivated lands with spontaneous vegetation, environments far from human activity, and, consequently, minimal or absent application of the insecticides. These

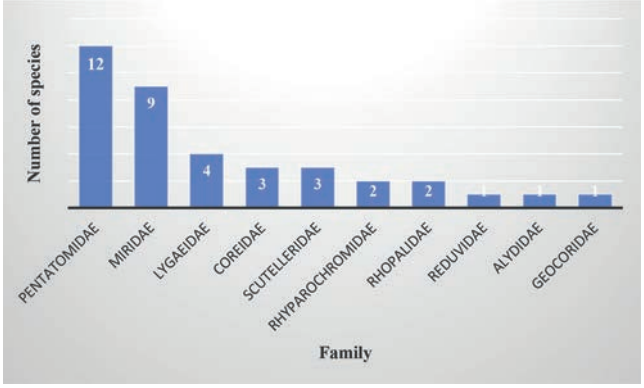

Figure 3. Distribution of species according to family.

Table 1. List of species by collection station.

Species	S1	S2	S3	S4	S5	S6
Apodiphus amygdali						x
Aelia acuminata				x	x	x
Carpocoris purpureipennis					x	x
Carpocoris melanocerus					x	
Codophila varia		x	x			
Dolycoris baccarum			x			x
Eurydema ornate		x				x
Graphosoma lineatum			x	x	x	x
Graphosoma semipunctata	x		x			
Nezara viridula			x			x
Rhaphigaster nebulosa	x			x		
Staria lunata				x		x
Adelphocoris lineoleatus			x	x		x
Deraeocoris schach				x	x	
Deraeocoris ruber					x	
Lygus punctatus			x			
Lygus patensis		x		x		
Macrolophus pygmaeus			x			
Polymerus cognatus				x		
Polymerus vulneratus	x					
Stenodema calcarata			x			x
Centrocoris variegatus				x		
Centrocoris spiniger	x	x				
Coreus marginatus					x	
Kleidocerys resedae			x			
Lygaeus pandurus		x		x		
Lygaeus saxatilis	x				x	x
Lygaeus equestris					x	
Eurygaster maura						x
Eurygaster austriaca						x
Odontotarsus robustus					x	
Corizus hyoscyami	x					
Stictopleurus nysioides						x
Rhyparochromus pini						x
Rhyparochromus confusus					x	
Campotus lateralis	x					x
Rhynocoris iracundus	x	x				
Geocoris erythrocephalus					x	

S1, Poshnja; S2, Lapardha; S3, Uznova; S4, Vodica; S5, Peshtani; S6, Lybesha.

Table 2. Number of species per station and percent value of species encountered in each station concerning the total number of observed species (38).

Station	Encountered species	Species percentage (%)
Uznova	10	26.31
Vodica	10	26.31
Poshnja	8	21.05
Lapardha	6	15.78
Lybesha	16	42.10
Peshtani	12	31.57

Table 3. Number of common species and similarity coefficient.

Stations	No. of common species	Coefficient of similarity (%)
Lybesha-Peshtani	4	16.6
Uznova-Vodica	2	11.1
Poshnja-Lapardha	2	11.1

factors may explain the highest number of species in these areas. The collections carried at Poshnje and Lapardha stations were made on lands planted with crops and close to inhabited centers. The relief has allowed the inhabitants to create many agricultural lands, many of which turned into greenhouses, where pesticides are used. It may explain the low number of species in these areas. Based on our findings, Lybesha and Peshtani present habitats with plants suitable for Hemiptera and are of interest for their collection in the future.

To analyze the species similarity, we have paired the stations, starting from the physical-geographical construction of the relief of each station. We compared the similarity between the stations of Lybesha and Peshtani as two hilly-mountainous areas, Uznova and Vodica stations as two plain-hilly areas and the similarity between the stations of Poshnje and Lapardha as two plain areas.

The above data shows that the highest species similarity belonged to the stations of Lybesha and Peshtani (16.6% similarity coefficient) and the lowest in the two stations of Uznova and Vodica and Poshnja with Lapardha (11.1% similarity coefficient).

The similarity comparison also shows the individuality of their hemipterofauna. The differences between the stations may be mainly due to the environmental conditions because the climatic conditions of these stations do not have significant changes. The compared areas are grouped by representing all the physical-geographic features (hilly-mountainous, lowland-mountainous, lowlands). They are similar and at close distance, indicating that climate does not present significant differences. The differences belong to vegetation cultivated by farmers, spontaneous vegetation, or the stations' environmental habitats.

From the analysis of these data, the number of determined species, 38 species, and the representation of families of the Hemiptera order, the area of Berat represents an essential habitat for the diversity of Hemiptera species. Studying these species is essential as they are pests of plants and crops. Our reference to the presence of these species in this area will help farmers to use defensive techniques for crops.

Despite its implementation, this study had some limitations, such as the expedition days or the difficulties of the hilly terrain. In the future, we aim to eliminate these difficulties and provide a list with more species and more complete data on the hemipterans of this area. We recommend expeditions in the summer and spring months, primarily to stations Lybesha and Peshtani, where we encountered more species. We also recommend, in the future, carrying out expeditions in a more significant number of stations in this area referring to Hemiptera species collection, especially in the stations characterized by mountain habitats, representing exploration difficulties. That would enable a full recognition of the Hemiptera for the region.

Conclusions

In the Berati region, we have met 38 species of the Hemiptera order, representing 28 genera and 10 families. The family Pentatomidae is the most widespread, with 12 species or 31.58%, followed by the family Miridae, with 9 species or 23.68%. Lybesha station has the highest diversity, with 16 species or 42.10%; we assume that most of the area is non-arable, has spontaneous vegetation (cosmopolitan mixture of species that grow and reproduce without human care or purpose),[31] and is situated away from human settlements. Lybesha and Peshtani stations refer to the highest number of four common species, and the species similarity coefficient is 16.6%.

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