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First Results on Heteroptera (Hemiptera) of Dry Grassland in Malpaga-Basella Nature Reserve (Italy)

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Abstract: The Nature Reserve Malpaga-Basella, located along the Serio River in Lombardy, was recently established in 2017. It is interesting as it presents plant species typical in dry grassland habitats, not present in the surrounding area. In this study, Heteroptera were surveyed in the Nature Reserve and in a bordering giant Miscanthus crop in 2019. The biodiversity of the reserve was well characterized by the presence of species linked to arid environments with steppe or Mediterranean characteristics, like *Antheminia lunulata*. Four species new for Lombardy were collected, *Lygus italicus*, *Drymus pilipes*, *Ortholomus punctipennis*, and *Arenocoris waltlii*. Giant Miscanthus hosted only a few ubiquitous species, also collected in the Nature Reserve.

Keywords: Insecta; faunistics; chorology; true bugs; biodiversity; dry grassland; *Miscanthus x giganteus* crop; Lombardy; Italy

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1. Introduction

The Nature Reserve Malpaga-Basella was established in 2017 (D.C.R. 4/10/2017 n. X/1643) along the Serio River in Lombardy. Even though the rainfall average is 1200 mm/year, dry grassland characterizes the area, as the soil is gravelly and sandy, with high permeability. The reserve was created to protect this type of environment, once widespread in several areas of the Bergamo high plain and which, today, has almost totally disappeared. The dry grassland habitat is interesting as the plant community presents "the highest specific richness in the world, with densities reaching 89 species per m^2" [1]. Malpaga-Basella dry grassland counts 257 vascular plant species, *Bromus erectus* Huds. (Poaceae) is the predominant species [2]. A wide variety of plant species that are unusual at this latitude are represented: there are steppe species originating from the arid plains of Asia and Eastern Europe, vestiges of the flora of the end of the Quaternary glaciations, typical species of the Mediterranean area settled thanks to the particular habitat, and mountain species transported by the river to the reserve.

In this paper, the results of the first survey of Heteroptera carried out in 2019 in this recently established Nature Reserve and in a nearby *Miscanthus x giganteus* (Greef & Deuter ex Hodkinson & Renvoize) (Poaceae) crop are reported.

2. Materials and Methods

This study constitutes a preliminary survey with the aim to highlight the diversity of Heteroptera in the Nature Reserve Malpaga-Basella, an interesting threatened habitat. Because of limitations imposed by the Nature Reserve management policies and the conservation status of the habitat remnants, a quantitative survey was currently prohibited. The guidelines of the Reserve are severe, and our permits only allowed us to collect individuals when strictly necessary for identification. We thus did not collect species that were easy to identify or which were previously recorded. As a consequence of these limitations,

sampling efforts varied slightly among the habitat types surveyed. Here we, therefore, present the data as species lists and discuss the occurrences of species of different origins or taxonomic groups. The survey was carried out from the beginning of March to the end of September 2019; four stations were considered, three in the Malpaga Basella Nature Reserve (DD 45.617320386803236, 9.74027222923243), the fourth in a contiguous *Miscanthus x giganteus* crop (Figure 1). Heteroptera surveys were made fortnightly with a sweep net and beating sheet on herbaceous and shrubby essences without a precise pattern. The collected material was classified using the recent book about Pentatomidae [3] and "Faune de France" [4–7] for the other families. Accurate checks were conducted through direct comparison with the biological collections of the Museum of Natural History of Milan and of one of the authors (P.D.). The names of species and the chorological analysis were provided by using the online edition of the Catalogue of the Heteroptera of the Palaearctic Region [8], which sometimes enlarges the distribution even to the cosmopolitan category.

(A) **(B)**

Figure 1. Map of the studied area: (**A**) Parco del Serio border (red line) and Malpaga-Basella Nature Reserve (green area); (**B**) Surveying stations in the Malpaga-Basella Nature Reserve (station 1: yellow line, station 2: purple line, station 3: orange line), and in the *Miscanthus x giganteus* crop (station 4: green line). https://www.cartografia.servizirl.it/arcgis2/services/BaseMap/Ortofoto2018/ImageServer/WMSServer (accessed on 16 October 2019).

Station 1 (Figure 2) was bordered by shrubs of *Rubus* spp. (Rosaceae) and a small wood occupied mainly by allochthonous species such as *Robinia pseudoacacia* L. (Fabaceae), *Ailanthus altissima* (Mill.) (Simaroubaceae), *Swinglea glutinosa* Blanco (Merr.) (Rutaceae) and *Amorpha fruticosa* L. (Fabaceae), with temporary ponds, which derive from the waters of the Borgogna irrigation channel, colonized by elms and white willows. Recently, between the wood and the meadow, native species *Corylus avellana* L. (Betulaceae), *Rosa canina* L. (Rosaceae), and *Crataegus monogyna* Jacq. (Rosaceae), were planted with the aim of strengthening their presence within the reserve and combating the establishment of allochthonous

species that compromise the biodiversity of the area [9]. Among the three dry grassland stations, this presented the highest stone content, and lack of water, few shrubs of *R. canina* and *Rubus* spp., and the soil had the lowest plant cover.

Figure 2. Malpaga-Basella Nature Reserve, station 1, characterized by high stone content and low plant cover (photo P. Gaini).

Station 2 (Figure 3) was on a terrace close to the river, bordered by a forest, mainly composed of elms and elders, crossed by the excess water of the temporary ponds that flow into the river. Compared to the first station, the soil was slightly richer in humus; there was a greater presence of Poaceae, *Ulmus* spp. (Ulmaceae), and *A. fruticosa*.

Figure 3. Malpaga-Basella Nature Reserve, station 2, with the predominance of Poaceae (photo P. Gaini).

Station 3 (Figure 4) was within the largest meadow, close to the river Serio, and almost completely surrounded by groves of *Ulmus* spp., one of which in recent years had been flooded for long periods. It had the largest number of plant species, a higher number of shrubs and a greater intrusion by invasive species.

Figure 4. Malpaga-Basella Nature Reserve, station 3, with the largest number of plant species, a higher number of shrubs and invasive species (photo P. Gaini).

Station 4 (Figure 5) was in the *Miscanthus x giganteus* (Poaceae) crop, separated from the dry grassland by a wood with temporary ponds. The crop has been cultivated since 2012.

Figure 5. *Miscanthus x giganteus* crop, station 4 (photo P. Gaini).

3. Results and Discussion

Fifty-one species of Heteroptera were collected in the Natural Reserve Malpaga-Basella and in the neighboring Miscanthus crop (Table 1).

Twenty-five species were found in Station 1, characterized by a high stone content and the lowest plant cover. *Carpocoris* (*Carpocoris*) *purpureipennis*, *Stenodema* (*Brachystira*) *calcarata*, *Palomena prasina*, *Geocoris* (*Geocoris*) *megacephalus*, *Arenocoris waltlii* (Figure 6), *Orius* (*Orius*) *niger*, *Polymerus* (*Poeciloscytus*) *cognatus* and *Coranus griseus* were collected at this station only.

Station 2 presented several Hemiptera in common with the other stations, except for *Dolycoris baccarum*, *Beosus quadripunctatus*, *Graptopeltus lynceus*, *Lygaeosoma sardeum*, *Melanocoryphus albomaculatus*, *Nysius cymoides*, *Ceraleptus obtusus* and *Stictopleurus punctatonervosus*.

Station 3 presented the highest number of collected species (33), including both phytophagous and predatory species. *Apolygus spinolae*, *Antheminia lunulata* (Figure 7), *Rhaphigaster nebulosa*, *Zicrona caerulea*, *Drymus (Drymus) pilipes*, *Heterogaster artemisiae*, *Nysius ericae*, *Nysius senecionis*, *Corizus hyosciami*, *Prostemma (Prostemma) guttula* and *Peirates hybridus* were found only at this station.

Table 1. Heteroptera species collected in Malpaga-Basella Nature Reserve (1, 2, 3) and in the giant Miscanthus crop (4).

Family	Species	1	2	3	4
Miridae	*Adelphocoris lineolatus* (Goeze 1778)		x	x	x
	Apolygus spinolae (Meyer-Dür 1841)			x	
	Lygus italicus (Wagner 1950)				x
	Polymerus (Poeciloscytus) cognatus (Fieber 1858)	x			
	Stenodema (Brachystira) calcarata (Fallén 1807)	x			
	Trigonotylus caelestialium (Kirkaldy 1902)	x	x	x	x
Pentatomidae	*Aelia acuminata* (Linnaeus 1758)	x	x	x	
	Antheminia lunulata (Goeze 1778)			x	
	Carpocoris (Carpocoris) purpureipennis (DeGeer 1773)	x			
	Dolycoris baccarum (Linnaeus 1758)		x		
	Eysarcoris ventralis (Westwood 1837)	x	x	x	
	Graphosoma italicum (O.F. Müller 1758)			x	x
	Nezara viridula (Linnaeus 1758)	x	x		x
	Palomena prasina (Linnaeus 1761)	x			
	Rhaphigaster nebulosa (Poda 1761)			x	
	Sciocoris (Sciocoris) cursitans (Fabricius 1794)	x	x	x	
	Stagonomus (Dalleria) bipunctatus (Linnaeus 1758)		x	x	
	Zicrona caerulea (Linnaeus 1758)			x	
Lygaeidae (s.l.): Rhyparochromidae	*Aellopus atratus* (Goeze 1778)	x	x	x	
	Beosus quadripunctatus (Müller 1778)		x		x
	Drymus (Drymus) pilipes (Fieber 1861)			x	
	Emblethis griseus (Wolff 1802)	x	x	x	
	Graptopeltus lynceus (Fabricius 1775)		x		
	Melanocoryphus albomaculatus (Goeze 1778)		x		
	Paromius gracilis (Rambur 1839)	x	x	x	
Geocoridae	*Geocoris (Geocoris) megacephalus* (Rossi 1790)	x			
Heterogastridae	*Heterogaster artemisiae* (Schilling 1829)			x	
Lygaeidae	*Lygaeosoma sardeum* (Spinola 1837)		x		
Orsillidae	*Nysius cymoides* (Spinola 1837)		x		
	Nysius ericae (Schilling 1829)			x	
	Nysius graminicola (Kolenati 1845)			x	x
	Nysius helveticus (Herrich–Schäffer 1850)	x	x	x	
	Nysius senecionis (Schilling 1829)			x	
	Ortholomus punctipennis (Herrich–Schäffer 1838)		x	x	
Nabidae	*Himacerus (Aptus) mirmicoides* (O. Costa 1834)		x	x	
	Prostemma (Prostemma) guttula (Fabricius 1787)			x	
Coreidae	*Arenocoris waltlii* (Herrich–Schäffer 1834)	x			
	Ceraleptus obtusus (Brullé 1838)		x		
	Coreus marginatus (Linnaeus 1758)	x		x	x
	Syromastus rhombeus (Linnaeus 1767)	x		x	x
Rhopalidae	*Corizus hyoscyami* (Linnaeus 1758)			x	
	Liorhyssus hyalinus (Fabricius 1794)	x		x	
	Rhopalus (Aeschyntelus) maculatus (Fieber 1837)	x	x	x	
	Rhopalus (Rhopalus) parumpunctatus Schilling 1829	x	x	x	
	Rhopalus (Rhopalus) subrufus (Gmelin 1790)	x	x	x	x
	Stictopleurus punctatonervosus (Goeze 1778)		x		
Tingidae	*Copium clavicorne* (Linnaeus 1758)	x	x	x	
	Dictyla echii (Schrank 1782)	x	x	x	
Reduviidae	*Coranus (Coranus) griseus* (Rossi 1790)	x			
	Peirates hybridus (Scopoli 1763)			x	
Anthocoridae	*Orius (Orius) niger* (Wolff 1811)	x			

Figure 6. *Arenocoris waltlii* (Herrich-Schäffer 1834; photo M. Zilioli).

Figure 7. *Antheminia lunulata* (Goeze 1778) (photo P. Perino).

The lowest number of species (10) was collected in the Miscanthus crop (Station 4). The species were ubiquitous and also found in the reserve, except for the uncommon *Lygus italicus* (Wagner, 1950). This last species is a Mediterranean one, scattered along the peninsula and the two main islands on *Salicornia fruticosa* (L.) L. (Chenopodiaceae), *Inula* sp. (Asteraceae), *Artemisia vulgaris* L. (Asteraceae), and *Xanthium spinosum* L. (Asteraceae) rare in the Northern region, and a new record for Lombardy, it gradually increases southwards [10]. Its presence was scarce and occasional in the crop. This species probably came from the reserve, as common *Lygus* pests, such as *L. pratensis* and *L. rugulipennis*, were absent in the crop.

On the whole, in the reserve, 18 anthropophilous species were also recorded, often present in different crops: *Adelphocoris lineolatus*, *Trigonotylus caelestialium*, and *Stenodema* (*Brachystira*) *calcarata*, *Aelia acuminata*, *Carpocoris* (*Carpocoris*) *purpureipennis*, *Dolycoris baccarum*, *Graphosoma italicum*, *Nezara viridula*, *Palomena prasina*, *Rhaphigaster nebulosa*, *Nysius cymoides*, *Nysius graminicola*, *Coreus marginatus*, *Syromastus rhombeus*, *Coryzus hyoscyami*, *Rhopalus* (*Rhopalus*) *parumpunctatus*, *Rhopalus* (*Rhopalus*) *subrufus*, and *Stictopleurus punctatonervosus*.

Twenty-one species are typical of dry grassland. Three species belonging to Pentatomidae, *Sciocoris* (*Sciocoris*) *cursitans*, *Stagonomus* (*Dalleria*) *bipunctatus* and *Antheminia lunulata* (Figure 7), a rare species, recorded in Italy in undamaged continental dry-grassland on different *Artemisia* species. It is endangered by progressive anthropization in German and French plains [3].

Twelve out of the sixteen species of Lygaeidae (s.l.) (Rhyparochromidae, Geocoridae, Heterogastridae, Orsillidae, Lygaeidae) are typical of dry areas: *Aellopus atratus*, *Beosus quadripunctatus*, *Drymus* (*Drymus*) *pilipes*, *Geocoris* (*Geocoris*) *megacephalus*, *Graptopeltus lynceus*, *Heterogaster artemisiae*, *Lygaeosoma sardeum*, *Nysius ericae*, *Nysius helveticus*, *Nysius senecionis*, *Ortholomus punctipennis* (Figure 8), *Paromius gracilis. B. quadripunctatus* is widespread in Italy, with the exception of Sardinia. Phytophagous on grass seeds fallen on the ground [3], adults overwinter. The European *D. pilipes* is occasional in Italy, not recorded in the main islands and a new record for Lombardy; it lives under moss and in the humus of xeric land, at the base of *Hieracium* (Asteraceae) and *Artemisia* plants [4]. *Heterogaster artemisiae* is Mediterranean, recorded in peninsular Italy and in Sicily. Steppe-xerophilous species were recorded on *Artemisia campestris*, *Scabiosa canescens* (Dipsacaceae), *Lavandula multifida* (Lamiaceae), *Micromeria varia* (Lamiaceae), *Trifolium procumbens* (Fabaceae), *Cytisus scoparius* (Fabaceae), *Origanum vulgare* (Lamiaceae) [11]. Some authors list as the host mainly *Thymus serpyllum* (Lamiaceae), but *Mentha* (Lamiaceae) and *Origanum* are also recorded among the host species [3]. *Nysius helveticus* is widespread in Italy in dry habitats; in Western Europe, it was recorded on Ericaceae but also on Asteraceae, such as *Tanacetum* and *Senecio*; it was observed on a *Hypericum perforatum* crop (Hypericaceae) [3].

Figure 8. *Ortholomus punctipennis* (Herrich-Schäffer 1838; photo F. Luthi).

Another species typical of dry areas are the Nabidae *Prostemma* (*Prostemma*) *guttula*, a Mediterranean species recorded throughout Italy in dry, rocky or sandy soil under stones during the day. It preys on Lygaeidae (s.l.) and Pentatomidae [3] and overwinters as an adult; among Coreidae, *Ceraleptus obtusus* and *Arenocoris waltlii* (Figure 8), a Mediterranean species, widespread in Italy and a new record for Lombardy. The preferred host plants are *Erodium cicutarium* (Geraniaceae), *Sarothamnus scoparius*, *Trifolium*, *Calluna vulgaris* (Ericaceae) and *Thymus serpyllum*. Adults are recorded from March to August [5].

In the Rhopalidae are listed five species, all of them ubiquitous.

Dictyla echii and *Copium clavicorne* (Tingidae) are widespread in Italy on sunny, stony, rather calcareous slopes. *C. clavicorne* produces galls on the host plant, *Teucrium* spp. (Lamiaceae). In Central Europe, it was detected in *Teucrium chamaedrys*. It is a bivoltine species, the overwintering adults start feeding between April and May, and eggs are laid before flowering [6].

In the reserve and close to the temporary pools were recorded *Polymerus* (*Poeciloscytus*) *cognatus*, *Eysarcoris ventralis*, and *Rhopalus* (*Aeschyntelus*) *maculatus*, typical of wet areas.

Entomophagous species are well represented by *Geocoris megacephalus*, *Zicrona caerulea*, *Coranus* (*Coranus*) *griseus*, *Himacerus* (*Aptus*) *mirmicoides*, *Prostemma* (*Prostemma*) *guttula*, *Peirates hybridus*, and *Orius niger*. Notably, adults and nymphs of *H. mirmicoides* were recorded; this species inhabits the lower layer of vegetation.

According to the distribution of chorotypes of Vigna Taglianti et al. [12], 50% of the species are Euroasiatic (Figure 9), and 20% are Palearctic. Mediterranean species (14%) are more abundant than European species (10%). This is relevant, as Mediterranean Heteroptera are unknown in the areas surrounding the reserve, as the environmental conditions are unsuitable for these species. Cosmopolitan and sub-cosmopolitan species (6%) (*Liorhyssus hyalinus*, *Rhopalus* (*Rhopalus*) *subrufus*, *Nezara viridula*) are few. Endemic species were not recorded.

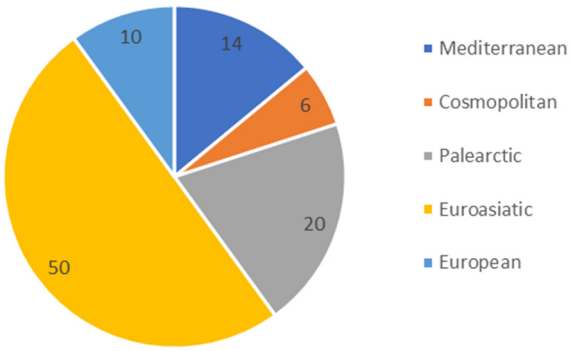

Figure 9. The chorological distribution (%) of Hemiptera Heteroptera species collected in Malpaga-Basella Nature Reserve.

4. Conclusions

The survey in the Nature Reserve Malpaga-Basella and in the nearby *Miscanthus x giganteus* crop recorded fifty-one Hemiptera Heteroptera species from nine families. The number of species for each family gives interesting results: Lygaeidae s.l. comprised the most species, followed by Pentatomidae. In the Italian Heteroptera, Miridae is the largest family with 480 species, that sum up to 34% of the order species, but in the Nature Reserve, they represent only 12%. This can be explained by the low vegetation that characterizes the habitat preferred by lygeids and pentatomids.

Miscanthus x giganteus crop showed no influence on the entomofauna collected in the dry grassland, and few polyphagous species, sometimes pests of anthropized habitats, were collected, such as *Nysius graminicola* and *N. cymoides*, recorded in Italy on several crops, among which are soy, rapeseed and the newly introduced quinoa [13]. The Miscanthus crop, established in 2012, seems not to be attractive to Heteroptera, even though Stefanovska et al. [14] recorded various pests on it. However, the concern that this crop could attract or introduce alien pests accidentally in the Mediterranean is well-founded. In the eastern Palearctic area (China, Korea, Japan), in fact, pest species that are recorded on Miscanthus could infest wild plants or crops. *Gonopsis affinis* (Uhler, 1860) (Pentatomidae, Phyllocephalinae) was recorded on Miscanthus and damaged adjacent sugarcane cultivation [15]. *G. affinis* was also recorded on *Quercus* sp. [16], *Oryza sativa* and *Saccharum officinarum* [17]. Another economically important pest recorded on Miscanthus in China and India is *Cavelerius excavatus* (Distant 1901; Lygaeidae), associated with reed and sugar

cane [18]. The crop was carefully checked, but these pest species were absent. The Miscanthus crop and the plants in the Natural Reserve were also carefully observed to try to detect *Halyomorpha halys* (Stål, 1855), recorded on several crops in Italy since 2007, but it was absent, as, probably, this species has found more attractive host plants in the surrounding crops. In this respect, the strict protection guidelines of the dry grassland area, established by the Nature Reserve management policies, are important. At the same time, the interruption of the cultivation of the Miscanthus crop removes the danger of introduction not only of alien species linked to this plant but also of native species that could thrive on it, as it has already happened for *Nysius cymoides* on quinoa [13]. This species, in fact, can cause secondary infestations and annoying summer swarms in dwellings. For these reasons, the cultivation of alien plants (Miscanthus, soy, quinoa, etc.) in the areas adjacent to the reserve must be strongly discouraged to avoid intrusion of species that would conflict with the protection purposes of the Nature Reserve.

On the whole, although the Reserve was recently established, management and protection practices foster the presence of a high number of Heteroptera species typical of the dry grassland not previously recorded in the surrounding area.

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