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Heteroptera present in two different plant mixtures (*)

Abstract - Heteroptera in two different plant mixtures are considered. The first plot is a mixture of species with different flowering periods, the second one presents mainly Gramineae. As foreseen, the first plot presents a higher number of species of Heteroptera and in the second one the species are mainly phytophagous rather than predaceous.

Riassunto - *Rilevanza degli Eterotteri (Insecta, Heteroptera) in due fasce inerbite differenti.*

Sono stati considerati gli Eterotteri presenti in due frutteti con inerbimento differente; il primo costituito da una miscela di diverse essenze erbacee a fioritura scalare, il secondo presenta in prevalenza graminacee annuali. Si è riscontrata, come prevedibile, una maggior ricchezza faunistica nel campo con inerbimento caratterizzato da un numero elevato di essenze, inoltre, in quello con prevalenza di graminacee annuali è stata rilevata una predominanza delle specie fitofaghe rispetto alle predatrici.

Key words: Heteroptera, plants, biodiversity.

INTRODUCTION

Agroecosystems are rather simplified environments, unfit for natural enemies that, due to the lack of alternative preys and of shelters, are less efficient in controlling pests. Food sprays or flowering perennial plants can be used in order to favour predators and parasitoids.

Phytophagous and zoophagous Heteroptera form an important section of entomofauna in crops and orchards (Fauvel, 1999). The presence of numerous species of Heteroptera is particularly efficacious in the control of Arthropod pests, as predation increases from spring to summer (Fauvel, op. cit.). Moreover the main part of phytophagous Heteroptera colonizes non cultivated plants and trees and represent an economic problem when the host plant dries up, due to the lack of water or to herbicide treatment or to mowing; only in these cases they start feeding on cultivated plants (Fauvel, 1985; Cravedi, 1988; Tavella *et al*., 1996; Lozzia *et al*., 2000).

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In this work two different group of plants are considered, in order to compare the population of Heteroptera and to evaluate the level of biodiversity.

MATERIALS AND METHODS

The survey was carried out in Ponte in Valtellina in two plots of "Fondazione Fojanini di Studi Superiori" (Sondrio).

The first plot (plot A) is north-south oriented, 55m long and 12m wide, with three rows of cherries. The second plot, (plot B), triangle shaped, has the longest side, north-

Table 1 - Plant species in Buntbrache mixture.

Species	Family	Sowing density (g/m^2)*
Achillea millefolium L.	Asteraceae	0,2
Agrostemma githago L.	Caryophyllaceae	6
Anthemis tinctoria L.	Asteraceae	0,2
Centaurea cyanus L.	Asteraceae	5
Centaurea jacea L.	Asteraceae	2
Cichorium intybus L.	Asteraceae	1,2
Daucus carota L.	Apiaceae (Umbelliferae)	1,5
Dipsacus fullonum L.	Dipsacaceae	0,05
Echium vulgare L.	Boraginaceae	2
Fagopyrum esculentum Moench	Polygonaceae	77,6
Hypericum perforatum L.	Guttiferae (Hypericaceae)	0,6
Legousia speculum-veneris (L.)	Asteraceae	0,3
Leucanthemum vulgare Lam.	Asteraceae	1
Malva moscata L.	Malvaceae	0,2
Malva sylvestris L.	Malvaceae	0,6
Melilotus alba Med.	Fabaceae (Leguminosae)	0,2
Onobrychis vicifolia Scop.	Fabaceae (Leguminosae)	6
Origanum vulgare L.	Boraginaceae	0,6
Papaver rhoeas L.	Papaveraceae	1,5
Pastinaca sativa L.	Apiaceae (Umbelliferae)	1
Reseda lutea L.	Resedaceae	0,4
Silene alba (Miller)	Caryophyllaceae	1
Tanacetum vulgare L.	Asteraceae	0,05
Verbascum densiflorum Bertol.	Scrophulariaceae	0,5
Verbascum lychnitis L.	Scrophulariaceae	0,3
Total sowing density		110 g/m^2

Table 2 - Plant species in plot B surveyed with Daget-Poissonet method (1969).

Species	%
Setaria viridis (L.)	41,67
Digitaria sanguinalis (L.)	21,67
Equisetum arvense L.	10
Amaranthus spp.	8,33
Trifolium repens L.	8,33
Lotus corniculatus L.	3,33
Artemisia vulgaris L.	1,67
Vicia spp.	1,67
Rumex spp.	1,67
Convolvolus spp.	1,67
Total	100

south oriented, of 19m and the base, east-west oriented, of 4m. Also in this plot there are rows of cherries.

In 1997 in plot A the mixture of species "Buntbrache"(1) (flowered fallow), whose composition is in tab. 1, was sowed: it is mainly formed by perennial dicotyledons, grade flowering from spring to autumn. Plants present in plot B (table 2) were surveyed with Daget and Poissonet method (1969): the number of species is lower and annual monocotyledonous plants prevail.

Samples were collected with a suction device (a garden Blower-vac, whose direction of rotation was reversed).

Samples on plants lasted two minutes each and were carried out every twenty days, from June to October included, in 1998 and in 1999. Each month two samples were taken, except for June, when a single sample was done.

The following indices were used to value biodiversity: number of species (N_0), dominance index of Simpson (D); Simpson index of diversity (1-D); reciprocal of dominance index of Simpson (N_2); Shannon-Wiener index (H'); Pielou eveness index (J') (Krebs, 1989).

Moreover percentage cumulative curves were used to define the role of the different species in the environment.

RESULTS

In table 3 biological and chorological characteristics of species surveyed in 1998 and in 1999 in plot A and plot B are reported.

Species and number of adults collected in 1998 are shown in table 4.

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(1) Commercialized by Schweizer Samen AG (Thun-CH).

Tab. 3 - Main characteristics of Heteroptera surveyed in plots A and B.

Classification	Diet	Pabulum	Chorology	A	B
Anthocoridae					
Orius niger Wolff, 1811	Zoophagous	Prey Insects and Mites on *Artemisia*, *Achillea* and *Verbascum* [1]	Olomediterranean	*	*
Nabidae					
Nabis brevis Scholz, 1847	Zoophagous	Prey Insect adults and larvae [3]	Eurosiberian-mediterranean	*	*
Nabis punctatus A.Costa, 1847	Zoophagous	Prey Insect adults and larvae [3]	South-european	*	*
Nabis rugosus (L., 1758)	Zoophagous	Prey Insects mainly on *Artemisia*[2]	Eurosiberian-mediterranean	*	*
Miridae					
Deraeocoris punctulatus (Fallèn, 1807)	Zoophytophagous	Prey little Insects and eggs	Eurosiberian	*	*
Deraeocoris serenus Douglas & Scott, 1868	Zoophytophagous	Prey little Insects[1]	Mediterranean-macaronesian	*	*
Dicyphus errans (Wolff, 1804)	Zoophytophagous	Prey whiteflies and aphids	European	*	
Dicyphus globulifer (Fallén, 1829)	Zoophytophagous	Predator on Cariofillaceae[2]	Euromaghrebinian	*	*
Halticus apterus (L., 1758)	Phytophagous	*Ononis* and *Galium*[1]	Olomediterranean	*	*
Adelphocoris lineolatus (Goeze, 1778)	Phytophagous	*Artemisia*, *Verbascum* and *Achillea* [1]	European	*	*
Adelphocoris seticornis (Fabricius, 1775)	Phytophagous	Leguminosae: *Trifolium* and *Vicia* [1]	Euroasiatic	*	*
Capsus ater (L., 1758)	Phytophagous	Poaceae[1]	Olartic	*	*
Lygus pratensis (L., 1758)	Phytophagous	*Urtica, Artemisia* and *Stachys*[1]	Olartic	*	*
Lygus rugulipennis Poppius, 1911	Phytophagous	Ruderal plants and uncultivated meadows	Olartic	*	*
Notostira elongata (Geoffroy, 1758)	Phytophagous	Poaceae[1]	European	*	*
Notostira erratica (L., 1758)	Phytophagous	Poaceae[1]	Eurosiberian	*	
Orthops kalmi (L., 1758)	Phytophagous	Apiaceae: *Daucus* and *Pastinaca* [1]	Paleartic	*	*
Trigonotylus ruficornis (Geoffroy, 1758)	Phytophagous	Poaceae[1]	Olartic	*	*
Chlamydatus pulicarius (Fallén, 1807)	Phytophagous	*Artemisia* and *Achillea*	Eurosiberian	*	
Chlamydatus pullus Reuter, 1870	Phytophagous	*Achillea*, *Trifolium*[2]	Paleartic	*	*

Classification	Diet	Pabulum	Chorology	A	B
Reduvidae					
Rhynocoris rubricus (Germar, 1814)	Zoophagous	Prey Insects on Apiaceae and *Artemisia*	Southeuropean	*	
Alydidae					
Alydus calcaratus (L., 1758)	Phytophagous	Various plants[1]	Olartic	*	
Coreidae					
Coreus marginatus (L., 1758)	Phytophagous	*Rumex* [1]	Euroasiatic	*	
Rhopalidae					
Liorhyssus hyalinus (Fabricius, 1794)	Phytophagous	Ruderal plants	Cosmopolitan	*	*
Rhopalus subrufus (Gmelin, 1790)	Phytophagous	*Trifolium, Urtica, Salvia pratensis*[1]	Cosmopolitan	*	
Stictopleurus abutilon (Rossi, 1790)	Phytophagous	*Abutilon, Artemisia* and *Achillea* [1]	Eurosiberian-mediterranean	*	*
Stictopleurus crassicornis (L., 1758)	Phytophagous	*Artemisia* and *Achillea* [1]	European	*	
Stictopleurus punctatonervosus (Goeze, 1778)	Phytophagous	*Cirsium*, *Artemisia* and *Erigeron* [1]	European	*	*
Lygeidae					
Geocoris megacephalus (Rossi, 1790)	Detritivorous-Phytophagous	debris of *Artemisia* [1]	Olomediterranean	*	*
Nysius graminicola (Kolenati, 1845)	Detritivorous-Phytophagous	Various plants[2]	Olomediterranean	*	
Nysius senecionis (Schilling, 1829)	Detritivorous-Phytophagous	*Artemisia* [2]	Euromediterranean	*	
Stygnocoris rusticus (Fallén, 1807)	Detritivorous-Phytophagous	Various plants	Euromaghrebinean		
Pentatomidae					
Dolycoris baccarum (L., 1758)	Phytophagous	Polifagous[1]	Olartic	*	*
Pyrrhocoridae					
Pyrrhocoris apterus (L., 1758)	Detritivorous-Phytophagous	Mainly on broad leave plants: lime and birch	Olartic	*	*

1: Dioli, 1997;
2: Tamanini, 1988;
3: Dioli, 1980.
A: plot A, sowed with Buntbrache mixture.
B: plot B with prevailing annual monocotyledonous.

Table 4 - Heteroptera species collected in 1998 and number of adults.

Species*	**Plot A**	**Plot B**
Orius niger Wolff	**25**	19
Nabis brevis Scholz	3	2
Nabis punctatus A.Costa	21	6
Nabis rugosus (L.)	8	3
Deraeocoris punctulatus (Fallén)	14	45
Deraeocoris serenus Douglas & Scott	-	10
Dicyphus errans (Wolff)	2	-
Dicyphus globulifer (Fallén)	9	5
Halticus apterus (L.)	1	-
Adelphocoris lineolatus (Goeze)	2	2
Adelphocoris seticornis (F.)	3	3
Capsus ater (L.)	1	-
Lygus rugulipennis Poppius	**38**	**63**
Notostira elongata (Geoffroy)	5	-
Notostira erratica (L.)	1	-
Orthops kalmi (L.)	1	-
Trigonotylus ruficornis (Geoffroy)	**71**	**294**
Chlamidatus pulicarius (Fallén)	3	-
Chlamidatus pullus Reuter	17	**48**
Rhynocoris rubricus (Germar)	1	-
Alydus calcaratus (L.)	1	-
Liorhyssus hyalinus (F.)	7	3
Stictopleurus abutilon (Rossi)	2	1
Stictopleurus crassicornis (L.)	2	-
Stictopleurus punctatonervosus (Goeze)	1	-
Geocoris megacephalus (Rossi)	3	3
Nysius graminicola (Kolenati)	1	-
Nysius senecionis (Schilling)	16	-
Dolycoris baccarum (L.)	7	2
Pyrrhocoris apterus (L.)	10	-
TOTAL	**276**	**509**

* Number in bold identify more common species.

Although the greater number of adults was collected in plot B, it emerges that the composition of the two environments is different: in plot A 29 species are present, in plot B 16. Values of more frequent species show the predominance in both environments of *Trigonotylus ruficornis* (Geoffroy), which is present in plot B with 223 adults more than in plot A.

The composition of the two plots is shown in figure 1: the cumulative curve of plot B results to be shifted left and upward and the first part is more steep than the curve of plot A. It means that plot A has a better distribution of species. In fact the most common species , definitely higher in plot B, is almost 58%, while in plot A is about 26%.

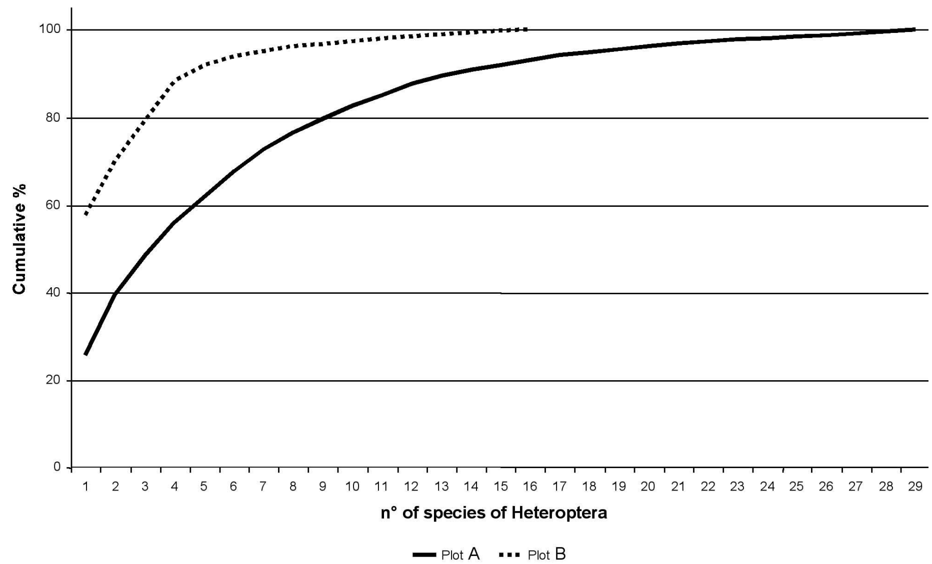

Fig. 1 - Cumulative curves of Heteroptera species in 1998 in plot A and plot B.

In table 5 values of D, 1-D and N_2 show that in plot A it's more probable to collect sequentially two individuals belonging to different species. The difference between values of index N_2 of the two plots is 6; plot A index *1-D* point out a 25% more probability to collect sequentially individuals belonging to different species.

Index *H'* (1,14) is very high in plot A and is close to the maximum value of this index (1,46) while in plot B, the value is 0,65, half the value it can reach, equal to the common logarithm of N_0. Value of *J'* proves the same: in plot A 78% of possible biodiversity is reached while in plot B it's only 54,4%. In plot B the species are unevenly distributed.

Species and number of adults collected in 1999 are reported in table 6. As in the

Table 5 - Diversity index values of Heteroptera collected in 1998.

	N_0	D	1-D	N_2	H'	J'
Plot A	29	0,11	0,89	8,76	1,14	0,78
Plot B	16	0,37	0,63	2,72	0,65	0,54

previous year in plot B there are more adults than in plot A. The number of species is higher in plot A, 23; while in plot B are 17.

Figure 2 confirms also for 1999 the difference between the two plots, although plot B has a higher number of adults than plot A, the number of species is higher in plot A; besides the prevailing species in plot B is almost equal to 40% of the total while in plot A is only about 20%.

Table 6 - Heteroptera species collected in 1999 and number of adults.

Species*	**Plot A**	**Plot B**
Orius niger Wolff	**15**	17
Nabis brevis Scholz	-	4
Nabis punctatus A.Costa	1	3
Deraeocoris punctulatus (Fallén)	2	**39**
Deraeocoris serenus Douglas & Scott,	1	1
Dicyphus globulifer (Fallén)	1	1
Halticus apterus (L.)	-	8
Adelphocoris lineolatus (Goeze)	1	4
Adelphocoris seticornis (F.)	1	2
Capsus ater (L.)	-	1
Lygus pratensis (L.)	2	-
Lygus rugulipennis Poppius	**19**	**153**
Notostira elongata (Geoffroy)	-	8
Orthops kalmi (L.)	3	1
Trigonotylus ruficornis (Geoffroy)	8	**158**
Chlamidatus pullus Reuter	**9**	8
Alydus calcaratus (L.)	1	-
Coreus marginatus (L.)	1	-
Rhopalus subrufus (Gmelin)	1	-
Stictopleurus abutilon (Rossi)	1	-
Stictopleurus crassicornis (L.)	1	-
Stictopleurus punctatonervosus (Goeze)	3	-
Geocoris megacephalus (Rossi)	1	-
Nysius graminicola (Kolenati)	2	1
Nysius senecionis (Schilling)	2	-
Stygnocoris rusticus (Fallén)	1	-
Dolycoris baccarum (L.)	2	-
Pyrrhocoris apterus (L.)	-	1
total	79	410

*Numbers in bold refer to the most common species.

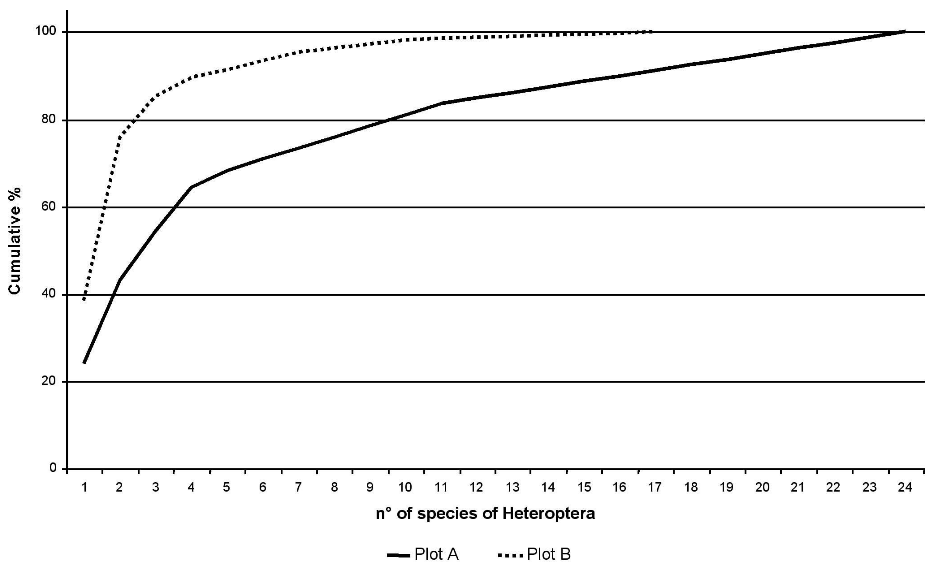

Fig. 2 - Cumulative curves of Heteroptera species in 1999 in plot A and plot B.

Table 7 - Diversity index values of Heteroptera collected in 1999.

	N_0	D	1-D	N_2	H'	J'
Plot A	23	0,12	0,88	8,03	1,10	0,81
Plot B	17	0,3	0,7	3,34	0,68	0,55

Indexes in table 7 attest the highest biodiversity in plot A, as it is more probable to collect in sequence two individuals belonging to different species; in plot A the probability is 88%, in plot B is 70% (1-D). In plot A index *H'* is higher than 1 while in plot B is half the possible value.

In 1999 in plot A 81% of possible biodiversity for such environment was reached; in plot B it was only 55% (*J'*).

Comparing species present in plot A in the two years, it can be noticed that in 1998 there are 6 species more than in 1999, they are phytofagous as well as zoophagous, while in 1999 there are 4 different phytophagous species. In plot B the results of the two years present differences but, except for the predator *Nabis punctatus*, catched only in 1998, all the species are phytophagous.

CONCLUSIONS

During the two years 1274 adults of Hemiptera were collected. They belong to 34 species, divided in 10 families.

They are mainly anthropophylous species, that colonize crops or weeds. In fact, in table 3, species sensible to environmental changes, caused by man activity, are not present. In Valtellina orchards were planted during '900 on the alluvial cone of the torrent Rhon, eliminating woods and changing the natural environment. This situation prevents migration of insects between the orchard and weeds and wood as it happens in vineyards (Lozzia *et al.*, 2000) or in low-land forests of some areas in the north-east of Italy (Paoletti *et al.*, 1992). In these studies area exchanges are limited between plants and trees of the orchard, and this fact explains the least number of collected species compared to the ones collected in other areas of the same Province.

Considering the type of diet, there are 20 phytophagous species, 5 detritivorous-phytophagous, 5 zoophagous and 4 zoophytophagous. As far as chorology is concerned, there are 7 Olartic species, 5 European, 4 Olomediterranean, 2 Euroasiatic, 3 Eurosiberian, 2 Paleartic 2 Euromagrebinian, 3 Eurosibiric-mediterranean, 1 Euromediterranean, 2 Southeuropean, 2 Cosmopolitan, 1 Mediterranean-macaronesian.

Trigonotylus ruficornis (Geoffroy) presents the highest percentage frequency among the species in plot B in 1998 and in 1999. This fact can be justified by biological and ethological characteristics of this species, that colonizes Poaceae (Dioli, 1997) forming 63% of plants. In the two years the frequency percentage of *T. ruficornis* decreases from 57,76% in 1998 to 38,54% in 1999. *Lygus rugulipennis* Poppius instead increases from 12,4% to 37%. Also in plot A *T. ruficornis* decreases by 16%, while *L. rugulipennis* increases by 10% reaching a frequency percentage of 24%, becoming the most common species in 1999.

L. rugulipennis generally lives on ruderal plants and in uncultivated meadow. Two generation a year, it overwinters as adult, it can be a pest in orchards, causing red spot on fruits. Damages were recorded on apples in Valtellina, in 1991 at the end of the season, following a dry summer that caused the drying up of grasses, favouring the migration of the Heteroptera on apples, lacking the usual host (Culatti *et al.*, 1992). To prevent this kind of damages it is important the management of grass mowing: it is preferable strip harvesting in order to leave host plants of phytophagous, as without hosts they colonize crops and orchards (Tavella *et al.*, 1994).

Deraeocoris punctulatus (Fallèn) is worth to mention among Miridae. It presents a zoophytophagous diet and it was collected in plot B (10%); in plot A it reaches only 2%. *Deraeocoris serenus* Douglas & Scott, present only in plot B with a lower percentage, has the same behaviour.

Also the genus *Dicyphus* Fieber includes zoophytophagous species. *D. errans* (Wolff) and *D. globulifer* (Fallèn) were collected in plot A; the second species was surveyed also in plot B, but with a percentage lower than in plot A.

Nabis punctatus A. Costa was present in both the plots; in 1998 the frequency percentage in plot A was 8%; the following year it was absent. In plot B it was scarce in both years. Parasitic mimicry is peculiar to *N. punctatus*, as it resembles *Stenodema* *calcaratum* (Fallèn). Thank to this strategy it cheats victims that he can approach without warning. Together with *N. punctatus*, adults of *Notostira elongata* (Geoffroy), a Myrid similar to *Nabis*, were collected.

The predator *Orius niger* Wolff was frequently recorded in plot A during both the years. In 1998 it was the third most abundant species, with a frequency percentage of 9%; in 1999 it was the second one after *Lygus rugulipennis* Poppius, with 18%. In plot B such species was present only in 1998, with 2%. Preferred victims are insects that colonize *Artemisia*, *Achillea* and *Verbascum*.

Data concerning Heteroptera in 1998 and 1999 shows that in plot B more adults were catched in both years. Actually plot A presented a higher number of species and a better distribution of the comunity, without dominance of more abundant species.

The greater eterogeneity was recorded in plot A and it improves from 1998 to 1999; this notwithstanding the reduction in plant species observed the second year. Plot A preserves the best distribution of species as indicated by *J'* whose value increases from 0,78 to 0,81.

It is noticeable that while indexes *J'*, *H'* and N_2 increase or remain the same, N_0, decreases in plot A from 29 to 23. N_0 represents the number of species collected in the environment and, by decreasing, it confirms hypothesis that diversity of species present in an environment is linked to the diversity of plants (RDH: resource diversity hypothesis): a reduced number of botanical species is equivalent to a reduced diversity of Heteroptera (Szentkiralyi & Kozar, 1991), in fact from 1998 to 1999 the number of plant species decreased.

Worth to observe is the amount of entomophagous species. In plot A in both years the number of predator species is equal to a third of phytophagous species, while in plot B the phytophagous species are five times the predator species.

On the whole Heteroptera prove the efficiency of mixture "Buntbrache" in favouring an ecosystem with a good level of biodiversity and a balance between the species. This confirms results of other researches (Thomas & Marshall, 1999; Pasek, 1988; Meriggi, 1998; Zalom, 1997; Lo Verde *et al.*, 1997; Lozzia *et al.,* 2000), that pointed out that abundance and number of species of insects can be increased augmenting the number of botanical species in uncultivated area. The highest percentage of Dicotiledons, instead of wild Poaceae, resulted to be more attractive, thank to olfactive and visual stimulus, as observed by Pasek (1988).

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