STRUCTURE, DYNAMICS, AND ABUNDANCE OF BEETLE SPECIES FROM A CORN CROP FROM THE WESTERN AREA OF ROMANIA

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Abstract

The observations regarding the useful and harmful fauna belonging to the Coleoptera order were made in the western part of Romania in a corn crop in Arad county.

For these observations, 12 pitfall traps were used, and they were placed in the culture in two rows of 6 per row from the beginning of the emergence of the plants until harvesting at intervals of about 2 weeks per during the year 2022 on the following calendar dates: 15.05, 29.05, 12.06, 26.06, 24.07, 7.08, 21.08, 4.09, and 18.09.

Only carabid species were retained from the collected material. The experience was organized in two variants:

Variant 1 is represented by an ecological corn culture where no chemical treatment was done to combat pathogens and pests. Variant 2, represented by a corn crop grown in a conventional system where chemical treatments were applied both to the seed and to the crop to combat pathogens and pests. Among the carabid species collected, I mention *Pterostichus pubescens, Harpalus distinguendus, Ophonus azureus, Anysodactilus signatus*, etc.

In general, a greater diversity and an important number of carabids are found in the corn crop cultivated in an ecological system (variant 1).

Key words: corn, abundance, trap, carabids

Maize is one of the world's main food sources, both for human consumption and for animal feed. In many regions, maize is a staple food, being used in the form of flour, sorghum, or other food products (Staller *et al*, 2010).

Corn is also an important source of energy due to its high starch content. Due to the large volume of biomass produced, the corn crop plays a role in capturing carbon dioxide. It is used in the production of biofuels (ethanol), starch, corn syrup, and other industrial derivatives. It contributes to various industries, from food production to chemical and pharmaceutical (Norton *et al*, 2022).

Maize also proves to be a versatile crop that can be grown in various climatic conditions and on varied soils, making it accessible in a wide range of agricultural regions around the world, with a relatively high yield per hectare compared to other crops, offering consistent production, essential for food safety (Spînu, 2018).

Carabids are effective predators of various species of insect pests that affect maize crops, such as wireworm (*Agriotes spp*.), *Diabrotica virgifera virgifera*, etc. (Losey and Vaughan, 2006)

Due to their ability to naturally control pest populations, carabids help reduce the use of chemical pesticides. This is an essential practice for sustainable agriculture because it reduces the impact on the environment and biodiversity, maintains soil and water health by reducing contamination with substances and chemicals, and favors the development of a balanced agroecosystem (Landis *et al*, 2000).

MATERIAL AND METHOD

The observations regarding the useful and harmful fauna belonging to the order Coleoptera were made in the western part of Romania in a corn crop in Arad city.

For these observations, 12 pitfall traps were used, and they were placed in the culture in two rows of 6 per row from the beginning of the emergence of the plants until harvesting, harvesting at intervals of about 2 weeks per during the year 2022 on the following calendar dates: 15.05, 29.05, 12.06, 26.06, 24.07, 7.08, 21.08, 4.09, and 18.09.

From the collected material, only carabid species were retained.

The experience was organized in two variants:

Variant 1 is represented by an ecological corn crop where no chemical treatment was done to combat pathogens and pests.

Variant 2, represented by a corn crop grown in a conventional system where chemical

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treatments were applied both to the seed and to the crop to combat pathogens and pests.

Pitfall traps are a collection method used in the study of insects. These traps are often used in ecology to assess species diversity and abundance, particularly in biodiversity and population monitoring studies (Thorne and Williams, 1988).

Pifall traps are traps dug into the ground, designed to capture organisms that move across the surface of the land. They work on the principle that insects that move on the ground fall into the trap, where they remain captive. They can be constructed from various materials, including plastic, metal, or glass. They are shaped like a container (usually cylindrical) that is dug into the ground (Fig. 1). Sometimes the traps are covered with a lid or a net to prevent water or other plant debris from entering (Lang, 2000).

Pifall traps are an efficient and relatively simple method for collecting terrestrial organisms, with important applications in ecological research. Using this method allows ecologists to obtain data essential to understanding biodiversity and ecosystem dynamics.

Figure 1. The inventory of the entomological material collecte

RESULTS AND DISCUSSIONS

In 2022, treatments against pathogens and pests were applied to the corn crop, V2 variant:

- Premis 700 WS insecticide and Lebosol growth stimulator were used to treat corn seeds;

- during the vegetation period, the herbicides Dicopur D, Elumis, and the systemic insecticide Mospilan 20 SG were used.

On 15.05.11 carabid species (77 specimens) were collected (table 1) at the V1 variant and 1 species, *Pseudophonus pubescens* (66 specimens), at the V2 variant. The species with only one specimen collected were *Pterostichus niger, Harpalus aeneus, Ophonus azureus, Pterostichus koyi, Ophonus puncticollis,* and *Harpalus rufus.*

On May 29, 2022, 10 carabid species were collected at the V1 variant (100 specimens) and 4 species (65 specimens) at the V2 variant (table 2). The species with the highest abundance was *Pseudophonus pubescens* (58 specimens) in both variants, variant V1-58 specimens, respectively 44 specimens in variant V2. In total, a total of 165 specimens of carabids were collected in the two experimental variants

Tabel 1

The beetles collected in the corn crop on 15.05.2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V1-untreated														
1.	Pseudophonus pubescens	4	4	4	3		1	3	3	3	3	6	1	**35**
2.	Pterostichus niger	1												1
3.	Pseudophonus griseus	3	2	3	2									**20**
4.	Harpalus distinguendus	1	1		1							1		**4**
5.	Nebria brevicollis	1									1			**2**
6.	Pterostichus cylindricus			1	2		1		1	2		2	1	**10**
7.	Harpalus aeneus				1									**1**
8.	Ophonus azureus							1						**1**
9.	Pterostichus koyi								1					**1**
10.	Ophonus puncticollis										1			**1**
11.	Harpalus rufus										1			**1**
Total V 1		**10**	**7**	**8**	**9**	**0**	**3**	**13**	**5**	**5**	**6**	**9**	**2**	**77**
Variant V2 - treated														
1.	Pseudophonus pubescens	5	5		9	7	11	7	12	4	4	2		**66**
Total V2		**5**	**5**	**0**	**9**	**7**	**11**	**7**	**12**	**4**	**4**	**2**	**0**	**66**

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Tabel 2

Carabids collected in the corn crop on 29.05.2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V1- untreated														
1.	Carabus coriaceus	1												1
2.	Carabus intricatus	1												1
3.	Pterostichus cylindricus	3	1					7						10
4.	Harpalus aeneus	1							1					2
5.	Pseudophonus pubescens	15	5	5	10	3		8	3	3	2	2	1	58
6.	Ophonus azureus		2		1									3
7.	Pseudophonus griseus		4	2			2	2	2	2	7	1		22
8.	Harpalus distinguendus				1									1
9.	Ophonus puncticollis				1									1
10.	Pterostichus vulgaris								1					1
Total V1		**21**	**12**	**7**	**13**	**3**	**2**	**17**	**7**	**5**	**9**	**3**	**1**	**100**
Variant V2 - treated														
1.	Pterostichus cylindricus								4				1	5
2.	Pseudophonus pubescens	3	4	2	6	6	8	5	6	2	1		1	44
3.	Pseudophonus griseus	4				3	3		3		1		1	15
4.	Harpalus distinguendus	1												1
Total V2		**8**	**4**	**2**	**6**	**9**	**11**	**5**	**13**	**2**	**2**	**0**	**3**	**65**

On 12.06.2022, 55 carabid specimens belonging to 11 species were collected in the V1 variant using pitfall traps (table 3), and in the V2 variant a number of 64 specimens belonging to 2 carabid species: *Pseudophonus griseus* (25 specimens) and *Pseudophonus pubescens* (39 specimens). In total, in the two experimental variants, a total of 119 carabid specimens were collected.

Tabel 3

The beetles collected in the corn crop on 12.06.2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V1-untreated														
1.	Pterostichus melas	1												1
2.	Harpalus distinguendus	1							2					3
3.	Pterostichus vulgaris	1												1
4.	Pseudophonus griseus	3		1	3			3						10
5.	Pseudophonus pubescens	9	2	4	6			2			2	6		31
6.	Amara crenata	1												1
7.	Harpalus aeneus				1									1
8.	Abax carrinatus				1									1
9.	Pterostichus cylindricus					1								1
10.	Calatus fuscipes							1						1
11.	Pterostichus niger								1					1
Total V1		**16**	**2**	**5**	**11**	**1**	**0**	**8**	**2**	**1**	**3**	**6**	**0**	**55**
Variant V2 - treated														
1.	Pseudophonus griseus	4	3		2	2	5	1	2	2	2	1	1	25
2.	Pseudophonus pubescens		5	2	2	2	4	4	6	4	5			39
Total V2		**9**	**8**	**2**	**4**	**4**	**9**	**5**	**8**	**6**	**7**	**1**	**1**	**64**

On 26.06.2022 (table 4), in the untreated variant (V1) 13 carabid species (73 specimens) were collected, the most abundant species being *Pseudophonus pubescens* with 39 specimens, representing 53.42% of the total, and in V2 only 2 species (39 specimens) - *Pseudophonus pubescens* and *Pseudophonus griseus.*

Tabel 4.

The beetles collected in the corn crop on 26.06.2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V 1- untreated														
1.	Pterostichus niger	1												1
2.	Pseudophonus pubescens	6	4	4	5	4	5	4		1		5	1	39
3.	Harpalus distinguendus	1			2									3

4.	Ophonus azureus	1						1						2
5.	Ophonus puncticollis	1						1						2
6.	Harpalus aeneus	1						1						2
7.	Amara aenea	1												1
8.	Pseudophonus griseus		2		2		2	3				3		12
9.	Pterostichus cylindricus			1				3		1	1		1	7
10.	Carabus cancellatus							1						1
11.	Amara apricaria							1						1
12.	Harpalus tardus							1						1
13.	Calatus fuscipes											1		1
Total V 1		**12**	**6**	**5**	**9**	**4**	**7**	**16**	**0**	**2**	**1**	**9**	**2**	**73**
Variant V 2 - treated														
1.	Pseudophonus pubescens	1			2	2	7	2	5	4	2			**25**
2.	Pseudophonus griseus	1	1	1	2	1	4			3	1			**14**
Total V 2		**2**	**1**	**1**	**4**	**3**	**11**	**2**	**5**	**7**	**3**	**0**	**0**	**39**

On 10.07, 56 carabid specimens were collected in the V1 variant and 63 specimens in the V2 variant belonging to the species *Pterostichus cylindricus, Pseudophonus pubescens* and *Pseudophonus griseus* (table 5). The species with the largest number of specimens collected was *Pseudophonus pubescens* (27 specimens) in the V1 variant, respectively *Pseudophonus griseus* (36 specimens) in the V2 variant.

Tabel 5

Carabids collected in the corn crop on 10.07.2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V1- untreated														
1.	Pterostichus cylindricus	1			2		1		2	1	1	2	1	**11**
2.	Harpalus distinguendus	2	1					2						**5**
3.	Pseudophonus pubescens	2	3	4	2	0	1	5	2	1	3	3	1	**27**
4.	Pseudophonus griseus		2	3								1		**6**
5.	Harpalus aeneus		1											**1**
6.	Ophonus puncticollis			1										**1**
7.	Harpalus tardus			1										**1**
8.	Aniysodactylus signatus			1										**1**
9.	Calatus fuscipes							1						**1**
10.	Pterostichus niger									1				**1**
11.	Amara aenea										1			**1**
Total V1		**5**	**7**	**10**	**4**	**0**	**2**	**8**	**4**	**3**	**5**	**6**	**2**	**56**
Variant V2 - utreated														
1.	Pterostichus cylindricus								2					**2**
2.	Pseudophonus pubescens		1	1	2	3	2		4	6	4	2		**25**
3.	Pseudophonus griseus		2	2	4	1	7	2	8	4	3	1	2	**36**
Total V2		**0**	**3**	**3**	**6**	**4**	**9**	**2**	**14**	**10**	**7**	**3**	**2**	**63**

On 24.07.2022, 12 carabid species (62 specimens) were collected with the help of the pitfall traps at the V1 variant and 7 species (53 specimens) at the V2 variant (table 6). The species with the highest abundance were *Pseudophonus pubescens* for both variants: 17 specimens at V1, respectively 44 specimens at V2.

Tabel 6

The beetles collected in the corn crop on 24.07.2022

No.	Name of speccies	Capcana												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V1- untreated														
1.	Pterostichus cylindricus	2	2	1	1	1		2		1	1	2		**13**
2.	Pterostichus niger	1	1											**2**
3.	Abax carrinatus	1				1								**2**
4.	Amara aenea	1												**1**
5.	Bembidion properans	1			3									**4**
6.	Nebria brevicollis	1			0									**1**
7.	Pseudophonus griseus	3			4	3		2						**12**
8.	Pseudophonus pubescens	4	1			3	1	2	1	2	1	2		**17**
9.	Harpalus distinguendus		2	1	1	1		1				1		**7**
10.	Pterostichus marginalis			1										**1**
11.	Ophonus azureus				1									**1**
12.	Pterostichus vulgaris							1						**1**
Total V1		**14**	**6**	**3**	**10**	**9**	**1**	**8**	**1**	**3**	**2**	**5**	**0**	**62**
Variant V2 - treated														

1.	Pterostichus cylindricus						3							**3**
2.	Pterostichus niger						1							**1**
3.	Pseudophonus griseus								1					**1**
4.	Pseudophonus pubescens	2	2	1	9	2	9	3	8	4	2	1	1	**44**
5.	Pterostichus marginalis						1							**1**
6.	Ophonus azureus						1							1
7.	Calatus fuscipes								2					**2**
Total V2		**2**	**2**	**1**	**9**	**2**	**15**	**3**	**11**	**4**	**2**	**1**	**1**	**53**

On 07.08.2022 (table 7), 37 specimens of carabids were collected in the V1 variant and 25 specimens in the V2 variant belonging to the species *Pterostichus cylindricus, Pseudophonus pubescens* and *Pseudophonus griseus*. The species with the largest number of specimens collected was *Pseudophonus griseus* in both variants, with 15 specimens in the V1 variant, and 17 specimens in the V2 variant.

Tabel 7

Carabids collected in the corn crop on 07.08.2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V1- untreated														
1.	Pterostichus cylindricus	1			2			1	2		1	2		**9**
2.	Harpalus aeneus	1			1									2
3.	Pseudophonus griseus	1	4	1	2	1	1	3	1		1			**15**
4.	Pterostichus niger		1	1			1				1			**4**
5.	Pseudophonus pubescens				1				1	1		1		**4**
6.	Harpalus distinguendus				1			1	1					**3**
Total V1		**3**	**5**	**2**	**7**	**1**	**2**	**5**	**5**	**1**	**3**	**3**	**0**	**37**
Variant V2 - treated														
1.	Pterostichus cylindricus			1	1									**2**
2.	Pseudophonus griseus	1		1	5		2	2	3		2		1	**17**
3.	Pseudophonus pubescens				2		1	2	1					**6**
Total V2		**1**	**0**	**2**	**8**	**0**	**3**	**4**	**4**	**0**	**2**	**0**	**1**	**25**

On 21.08.2022, 5 carabid species (29 specimens) were collected at the V1 variant and 4 species (22 specimens) at the V2 variant (table 8). The species with the highest abundance were *Pterostichus cylindricus* with 10 specimens collected at V1 and *Pseudophonus griseus* with 14 specimens at V2.

Tabel 8

Carabids collected in the corn crop on 21.08.2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V1- untreated														
1.	Pterostichus cylindricus	1	1		2		1	2	1		1	1		**10**
2.	Pseudophonus griseus	2			1		1		1	1	1	1	1	**9**
3.	Harpalus distinguendus	1	1											**2**
4.	Pseudophonus pubescens		1	1	1		2		1					**6**
5.	Pterostichus niger						1		1					**2**
Total V1		**4**	**3**	**1**	**4**	**0**	**5**	**2**	**4**	**1**	**2**	**2**	**1**	**29**
Variant V2 - treated														
1.	Pterostichus cylindricus				2									**2**
2.	Pseudophonus griseus		1	2	1	1		2	3	1	1	1	1	**14**
3.	Pseudophonus pubescens	1		1	1		2							**5**
4.	Pterostichus niger				1									**1**
Total V2		**1**	**1**	**3**	**5**	**1**	**2**	**2**	**3**	**1**	**1**	**1**	**1**	**22**

On 04.09.2022, 17 carabid specimens were collected belonging to 5 species in the V1 variant and 15 specimens in the V2 variant, belonging to 3 species (table 9). The species that recorded only one specimen were *Pseudophonus pubescens* (V 1) and *Pterostichus cylindricus* (V2). In total, 32 specimens of carabids were collected; the untreated variant (V1) recorded the highest abundance with 17 specimens.

Tabel 9

Carabids collected in the corn crop on 04.09.2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V1- untreated														
1.	Pseudophonus griseus	2								3		1	1	**7**
2.	Pterostichus cylindricus				1				1			1		**3**
3.	Pterostichus niger	1							2		1			**4**
4.	Harpalus distinguendus								1	1				**2**
5.	Pseudophonus pubescens									1				**1**
Total V1		**3**	**0**	**0**	**1**	**0**	**0**	**0**	**4**	**5**	**1**	**2**	**1**	**17**
Variant V2 - treated														
1.	Pseudophonus griseus		2		2		2				3			**9**
2.	Pterostichus cylindricus				1									**1**
3.	Pseudophonus pubescens	1			1					1	2		1	**5**
Total V2		**1**	**2**	**0**	**4**	**0**	**2**	**0**	**0**	**1**	**5**	**0**	**1**	**15**

On 18.09.2022, 5 carabid species (14 specimens) were collected at the V1 variant and one species, *Pseudophonus pubescens* (7 specimens), at the V2 variant. A total of 21 specimens of carabids were collected in the two experimental variants (table 10), the V1 variant representing 66.7% of the total specimens.

Tabel 10

The beetles collected in the corn crop on 18.09.2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Variant V1- untreated														
1.	Pterostichus cylindricus	1			1				1	1				**4**
2.	Pseudophonus pubescens	2			1				2					**7**
3.	Pseudophonus griseus				1									**1**
4.	Harpalus distinguendus								1					**1**
5.	Brachynus crepitans								1					**1**
Total V1		**3**	**0**	**0**	**3**	**0**	**0**	**0**	**5**	**1**	**0**	**0**	**2**	**14**
Variant V2 - treated														
1.	Pseudophonus pubescens	1	1					1		2			2	**7**
Total V2		**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**2**	**7**

The most specimens collected were of the species *Pseudophonus pubescens* (484 specimens), *Pseudophonus griseus* (235 specimens), *Pterostichus cylindricus* (94 specimens), *Harpalus distinguendus* (32 specimens), and *Pterostichus niger* (188 specimens); nine carabid species recorded only one specimen (Tabel 11).

Tabel 11

Carabid species collected in the corn crop in 2022

No.	Name of speccies	Trap												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
1.	Pseudophonus pubescens	56	38	29	63	32	54	48	55	39	31	30	9	**484**
2.	Pseudophonus griseus	24	23	16	31	12	29	20	24	16	22	10	8	**235**
3.	Pterostichus cylindricus	9	4	4	15	2	6	15	14	6	5	10	4	**94**
4.	Harpalus distinguendus	7	5	1	6	1		4	5	1		2		**32**
5.	Pterostichus niger	4	2	1	1		3		4	1	2			**18**
6.	Harpalus aeneus	3	1		3			1	1					**9**
7.	Ophonus azureus	1	2		2		1	2						**8**
8.	Calatus fuscipes							2	2			1		**5**
9.	Ophonus puncticollis	1		1	1			1			1			**5**
10.	Bembidion properans	1			3									**4**
11.	Abax carrinatus	1			1	1								**3**
12.	Amara aenea	2									1			**3**
13.	Nebria brevicollis	2									1			**3**
14.	Pterostichus vulgaris	1						1	1					**3**
15.	Harpalus tardus			1				1						**2**
16.	Pterostichus marginalis			1			1		1					**3**
17.	Amara apricaria							1						**1**
18.	Amara crenata	1												**1**

19.	Aniysodactylus signatus			1										**1**
20.	Brachynus crepitans								1					**1**
21.	Carabus cancellatus							1						**1**
22.	Carabus coriaceus	1												**1**
23.	Carabus intricatus	1												**1**
24.	Harpalus rufus										1			**1**
25.	Pterostichus melas	1												**1**
TOTAL		**116**	**75**	**54**	**126**	**48**	**94**	**97**	**108**	**61**	**64**	**53**	**21**	**917**

CONCLUSIONS

In the treated variant (V2), the treatments with insecticides and herbicides had a significant impact on the carabid biodiversity. Compared to the untreated variant (V1), the treated variant recorded a lower number of carabid species, but a higher abundance of some dominant species.

The species *Pseudophonus pubescens* dominated the collections in both variants, but in the treated variant it was less abundant than in the untreated variant.

In the untreated variant, species diversity was significantly higher, with between 10 and 13 species recorded in several stages of the experiment (for example, 13 species on 26.06 and 12 species on 24.07). Instead, in the treated variant, only two or three species were frequently recorded (except for 24.07, when 7 species were collected). Also, species collected in small numbers, such as *Pterostichus niger* or *Harpalus distinguendus*, have were present especially in the untreated version, indicating their sensitivity to the chemical treatments applied in V2.

Although the treated variant had a lower diversity of species, certain species recorded a large number of specimens. For example, the species *Pseudophonus griseus* was the most abundant in the treated variant at the end of the experiment (36 specimens at 10.07 and 14 specimens at 21.08). In the untreated variant, the species *Pseudophonus pubescens* was frequently the most abundant (with a peak of 58 specimens at 29.05).

In both variants, the number of carabids collected fluctuated throughout the experiment. At the beginning of the collection period, the treated variant had fewer specimens collected, but from 24.07 until August, the treated variant began to record an increasing number of carabids, especially from the species *Pseudophonus pubescens* and *Pseudophonus griseus*.

In general, species diversity was lower in the treated variant (V2) compared to the untreated variant (V1), suggesting that the use of chemical treatments negatively affected the presence of more sensitive carabid species.

In conclusion, the treatments applied in variant V2 led to a reduction in carabid diversity, favoring the presence of dominant species, such as *Pseudophonus pubescens* and *Pseudophonus griseus,* at the expense of other species less tolerant to chemical interventions.

REFERENCES

Landis D.A., Wratten S.D., & Gurr G.M., 2000 - *Habitat Management to Conserve Natural Enemies of Arthropod Pests in Agriculture*, Annual Review of Entomology, 45, 175-201.

Lang A., 2000 - *Use of pitfall traps for monitoring ground-dwelling arthropods in agricultural ecosystems*. Journal of Applied Ecology, 37(1), 158-167.

Losey J. E., & Vaughan M., 2006 - *The Economic Value of Ecological Services Provided by Insects*. Bioscience, 56(4), 311-323.

Norton G.W., Alwang J., Masters W.A., 2022 - *Economics of Agricultural Development: WorldFood Systems and Resource Use, AgrekonAgricultural Economics Research*, Policy and Practice in Southern Africa

Spînu A., 2018 - The study of corn hybrids according to some morphological and biometric characters. In: Agronomy and agroecology.52(1), Chişinău, Centrul editorial UASM, 296-299. ISBN 978.

Staller J.E., Tykot R. H., Benz B. F., 2010 - Maize: Origin, Domestication, and Its Role in the Development of Culture.

Thorne J. H., & Williams M. C., 1988 - *Pitfall traps: a methodology for collecting ground-dwelling invertebrates*. In: Ecological Entomology, 13(1), 1-9.