A STUDY OF THE DIVERSITY OF USEFUL AND HARMFUL EPIGEAN INSECTS IN AN HOUSEHOLD FROM CRISTIAN VILLAGE, SIBIU COUNTY (ROMANIA), IN 2021

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Abstract. The purpose of this study was to identify useful and harmful insect species collected using soil traps, during the year 2021 from a household in Cristian village, Sibiu County. The 11 traps were placed in different corp pannts and during a vegetation season 58 species of insects from 31 families and seven orders (Coleoptera, Orthoptera, Hymenoptera, Lepidoptera, Diptera, Dermaptera and Hemiptera) were captured, conserved, and determined, totaling 634 specimens. The dominant species belong to the order Coleoptera, of which 34 species were inventoried, which represented 58.62% of the total species collected. The useful species within the analyzed ecosystems represented 73.4%, being the mots abundant ones and having the highest share, while the identified harmful species represented only 26.6%. The captured harmful insects are specific to agricultural crops and were represented by: *Leptinotarsa decemlineata* Say, 1824; *Gryllotalpa gryllotalpa* Linnaeus 1758; *Chrysochraon dispar* Germar, 1834; *Melolontha melolontha* Fabricius, 1775; *Gomphocerippus rufus* Linnaeus, 1758; *Hylobius abietis* Linnaeus, 1758; *Forficula auricularia* Linnaeus, 1758; *Cetonia aurata* Linnaeus, 1758.

Key words: epigean insects; useful fauna; harmful fauna; ecosystems.

INTRODUCTION

The biocenotic structure of ecosystems has been over time a concern in applied ecological research, being published papers based on certain principles of biocenosis management [24].

Ecosystems are dynamic systems, in a continuous transformation. Their dynamics consist of arrhythmic changes, rhythmic changes and sequences. Arrhythmic (accidental) changes are produced by variations in physical factors, such as late frosts in the spring months, cold rains in the summer months and floods, which cause mass mortality of insect populations in an ecosystem. Rhythmic changes are structural variations of ecosystems that repeat at different time intervals [12]. These changes are circadian determined by the regular sequence of days and nights within 24 hours and are manifested by changes in the micropedoclimatic conditions of the biocenosis. The different species of phytophagous, zoophagous and saprophagous insects form temporary functional units, which are replaced according to the dark and light phases of the day. The seasonal rhythms of the agricultural ecosystems are determined by the seasons of the year and are manifested by the seasonal changes of the macroclimate and biocenosis [19]. They are evident in the temperate regions, as is the case of the study area, in the structure of the biocenosis, succeeding each other in a reversible order, seasonal functional units. In each season of the year, the structure of the agricultural ecosystems are presented in a special way due to the change in the composition and the degree of dominance of the species [12, 21].

The epigean fauna consists of micro and macro invertebrates that live in the upper layers of the soil or on its surface [9]. The functions of an ecosystem are supported by invertebrate organisms with a role in soil formation by converting organic matter in the soil and on its surface [13, 20]. The structure of communities of soil microorganisms and invertebrates is influenced by different factors like vegetation, the distribution and quality of organic resources produced in time and space, all these influencing species abundance [11, 14]. Studies on soil fauna have found that it is much more limited in soil depth compared to soil surface one [1-4, 8].

In Romania, in recent years, studies on epigean fauna have been published for different ecosystems. Research on the various parameters that characterize the structure and composition of epigean fauna in agricultural crops as well as pests of agricultural ecosystems have been published over time in various specialized journals [5, 6, 12, 16, 17, 22, 23, 26, 27]. The aim of this study was to identify epigean insects, harmful and useful, captured from different ecosystems using soil traps, from a household in Cristian village, Sibiu County in the climatic conditions of 2021.

MATERIAL AND METHODS

Cristian village is located in the depression of Sibiu, at 440 m altitude, at a distance of 10 km from the city of Sibiu. The climate is temperate continental, with maximum temperatures of 30^{o}C in July-August and absolute minimum temperature of -28^{o}C in January. The multiannual average temperature is 9^{o}C. The average annual precipitation is 600 mm. The most abundant precipitation falls in the months of spring and autumn. In spring and early summer, the rains can be accompanied by sudden drops in temperature, which influences the activity of insects, but can also cause damage to agricultural crops.

In a household of 4800 m^2 located in the southeast of Cristian village at a distance of 9 km from the city of Sibiu, on IVth street, (Fig. 1) there was installed on May 1, 2021 with the establishment of agricultural crops, a set of 11 soil traps for collecting insect from the following ecosystems: ornamental shrubs, fruiting shrubs (raspberries, red currants, strawberries), eggplants, peppers, as well as tomatoes, potatoes and

corn, one trap for each crop, which serves 436.36 m^2 of the total surface of the household. In the vicinity of the garden, according to the geographical coordinates, there are the following areas: N-a stream and swamp; E–animal breeding farm; S-vegetable gardens; V-vegetable garden and crops.

Figure1. Marking the study area, the household from Cristian village, Sibiu County (Google Earth)

The traps used in setting up the experiment were made of two sizes PET-type containers: a 2 L container was the protective vessel to which holes were made for water drainage, and a 1.5 L container the collector vessel, that was inserted into it. The collection vessel formed from the 1.5 l container was filled with a 16% solution of detergent in water. The two containers forming the trap were placed in a hole dug in the ground (Fig. 2.), then the soil was arranged as well as possible to avoid bypassing the small area by insects.

The coordinates of the traps were the following: Trap 1 - under a cherry tree (45°46'44"N, 24°02'02"E, altitude 436m); Trap 2 - rose bushes (45°46'45"N, 24°02'02"E, 436m); Trap 3- red currant (45°46'45"N, 24°02'00"E, 436m); Trap 4- eggplants (45°46'45"N, 24°02'01"E, 436m); Trap 5- peppers (45°46'46"N, 24°02'01"E, 436m); Trap 6,- strawberries (45°46'46"N, 24°02'01"E, 436m); Trap 7- raspberry (45°46'47"N, 24°02'01"E, 435m); Trap 8 - corn (45°46'48"N, 24°02'02"E, 434m), Trap 9 - corn (45°46'48"N, 24°02'02"E, 434m), Trap 10 - potato (45°46'47"N, 24°02'02"E, 435m); Trap 11 - tomatoes (45°46'47"N, 24°02'02"E, 435m).

The captured material was picked weekly (Fig. 3), taking the specimens from each trap in the collecting jar, with the corresponding label. The traps were functional from the beginning of May to the end of September in 2021. In order to determine ecological indices (abundance, dominance, trophic regime), a series of statistical calculations, dominance, abundance and systematic classification of the collected species were made.

Figure 2. Traps manufacturing (original photo)

Figure 3. Sampling (original photo)

The main objective of the present study was the inventory of the entomofauna from the different cultures in order to establish the interspecific relationships between plants and insects and their role in the ecosystem. As a specific objective, we set out to identify useful species for crops and harmful species that damage them. Also, following the inventory of the captured species, we drew up a list with a systematic classification in order, genera and species, in order to establish the abundance and numerical dominance of the species in the climatic conditions of 2021. For each picking, the following data were recorded: date, time, air temperature, atmospheric humidity, wind direction and speed. The climatic parameters for the study period were provided by the Meteorological Station in Sibiu (Table 1).

RESULTS

Following the research (at the end of each sampling week), on the insects caught between May 1st and September 31st of 2021, using 11 soil traps located in a household of Cristian village, Sibiu County, we have obtained the results presented below.

From trap 1, located under the cherry tree (Fig. 4), there were collected insects on 14 collection days. (May-23 specimens, June-8 specimens, July-4 specimens, August-9 specimens and September-15 specimens. The insect species belong to 4 orders (*Hymenoptera, Coleoptera, Diptera* and *Lepidoptera*), totaling a number of 59 specimens. Of these we have noted 11 useful (Table 2) and 1 harmful species, *M.*

Table 1. Weather conditions in 2021

Month	Minimum temperature (°C)	Medium temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Humidity (%)	Wind Direction	Wind speed
Sum of temperatures	267.6	445.3	634.4	109.5	53	Northeast / Northwest	Light air blowing (2 m/s)
May							
Monthly average	**8.63**	**14.36**	**20.46**	**3.53**			
Sum of temperatures	376.6	565.4	752.3	76.4	58	West-North / Southeast / North	Light breeze (3 m/s)
June							
Monthly average	**12.55**	**18.85**	**25.08**	**2.55**			
Sum of temperatures	477	695.9	893.4	91.7	52	Northwest / Southeast / East / South	Light breeze (3 m/s)
July							
Monthly average	**15.39**	**22.45**	**28.82**	**2.96**			
Sum of temperatures	413.6	616.9	830.2	57.1	48	Northwest/ North/ Northeast	Light breeze (2 m/s)
August							
Monthly average	**13.34**	**19.9**	**16.78**	**1.84**			
Sum of temperatures	250.5	429.2	648.6	62.4	57	North/ Southeast/ West	Light breeze (4 m/s)
September							
Monthly average	**8.35**	**14.31**	**21.62**	**2.08**			

Figure 4. Traps installed in the following ecosystems: 1 - under cherry tree; 2 - bushes of roses, 3 - bushes of red currants

melolontha. The best represented is the order *Coleoptera*, of which 6 species were identified, from 3 families, i.e. 37.5% of the total captured families, followed by the orders *Diptera* and *Hymenoptera* with 2 families, representing 25% each, and the order *Lepidoptera*, with a family, representing 12.5%. The dominant species are beetles which are useful insects in this ecosystem. Regarding the climatic factors (Table 1), the fewest specimens caught are in June and July, when the average temperature was 30°C, the insects entering summer diapause, then the number of captured specimens starts to increase in August and September (Table 2).

Table 2. Insect species captured in trap 1-under the cherry tree, in the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
0	**1**	**2**	**3**	**4**	**5**	**6**
8.V.	**COLEOPTERA**	Carabidae	*Leistus rufomarginatus* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	3
8, 15, 22.V., 7.VIII. 25.IX.			*Harpalus rufipes* Degeer, 1774	Predator, attack the larvae or pupae of other insects	useful	11
15.V.			*Leistus rufomarginatus,* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	2
19.VI.			*Carabus nemoralis* Műller, 1764	Predator, attack the larvae or pupae of other insects	useful	4
21.VIII.			*Pterostichus niger* Schaller, 1783	Predator, attack the larvae or pupae of other insects	useful	4
11.IX.			*Carabus auratus* Latreille, 1802	Predator, attack the larvae or pupae of other insects	useful	4

0	1	2	3	4	5	6
15.V., 19.VI., 29.V.		Staphylininae	*Ocypus olens* Műller, 1764	Predator, coprophag	useful	7
		Scarabaeidae	*Melolontha melolontha* Fabricius, 1775	in the adult stage it is phytophagous, in the larval stage it attacks plant roots	harmful	3
8, 22.V.	**HYMENOPTERA**	Apidae	*Bombus terrestris* Linnaeus, 1758	in the adult stage it is nectarivorous	useful	2
5.VI.			*Apis mellifera* Linnaeus, 1758	Nectarivorous, Pollen	useful	1
25.IX.		Vespidae	*Vespa crabro* Linnaeus, 1758	Nectarivorous	useful	2
15.V., 18.VII., 7.VIII.	**DIPTERA**	Muscidae	*Musca domestica* Linnaeus, 1758	in the adult stage it is omnivorous	useful	7
25.VII., 28.VIII., 11.IX., 18.IX.		Calliphoridae	*Lucilia caesar* Linnaeus, 1758	in the adult stage it is phytophagous	useful	8
18.VII.	**LEPIDOPTERA**	Erebidae	*Amata phegea* Linnaeus, 1758	Phytophagous	useful	1
					TOTAL	**59**

Insects from 15 collection dates (May-13 specimens, June-15 specimens, July-6 specimens, August-13 specimens and September-14 specimens) were collected from trap 2 located between the rose bushes (Fig. 4). The insect species belong to 5 orders (*Coleoptera, Orthoptera, Diptera, Hymenoptera* and *Lepidoptera)*, totaling a number of 61 specimens. We found a total amount of 14 spcies of which 12 are useful and 2 hamful (Table 3). The best represented is the *Coleoptera* order with 4 families and 8 species, which represents 40% of the total captured families. The order *Diptera* with 3 families represented 30% and

Table 3. Insect species captured in trap 2-rose bush, in the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
8.V.	**COLEOPTERA**	Staphylininae	*Ocypus olens* Műller, 1764	Predator, coprophag	useful	2
8.V.			*Creophilus maxillosus* Linnaeus, 1758	Predator, coprophag	useful	3
22.V.		Carabidae	*Leistus rufomarginatus* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	3
11.VII.			*Carabus nemoralis* Műller, 1764	Predator, attack the larvae or pupae of other insects	useful	3
18.IX.			*Harpalus latus* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	5
5.VI.		Scarabaeidae	*Melolontha melolontha* Fabricius, 1775	Phytophagous	harmful in the larval stage	4
19.VI.			*Cetonia aurata* Linnaeus, 1758	Pollen, Nectar, Rose Flowers	larval stage pest	5
26.VI.		Coccinellidae	*Coccinella septempunctata* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	6
15.V.	**ORTHOPTERA**	Acrididae	*Gomphocerippus rufus* Linnaeus, 1758	Phytophagous	harmful	2
21.VIII.	**HYMENOPTERA**	Apidae	*Apis mellifera,* Linnaeus, 1758	Nectarivorous	useful	2
22.V.; 7,14.VIII.	**DIPTERA**	Muscidae	*Musca domestica* Linnaeus, 1758	Omnivorous, Nectarivorous	useful	6
25.VII., 14.VIII, 11.IX.		Calliphoridae	*Lucilia caesar* Linnaeus, 1758	Phytophagous	useful	7
18,25.IX.		Syrphidae	*Chrysotoxum elegans* Loew, 1841	adult phytophagous, larvae are saprotrophs and insectivores	useful	8
15.V.	**LEPIDOPTERA**	Geometridae	*Abraxas sylvata* Scopoli, 1763	Pollen, Nectar	useful	1
			Siona lineata Scopoli, 1763	Nectarivorous	useful	4
					TOTAL	**61**

the orders *Lepidoptera, Orthoptera* and *Hymenoptera* with one family each, 10% respectively. The dominant and mots abundant species are beetles having an important role in this ecosystem, being predatory species. Consequently, the biological material sampled in July was poor since the average temperature was 25.72 °C and this can induce estivation in insects (Table 3).

Insects from 14 collection days (May-13 specimens, June-5 specimens, July-7 specimens, August-16 specimens and September-6 specimens) were collected from trap 3, located between the red currant bushes (Fig. 4). Insect species belong to 4 orders (*Coleoptera, Diptera, Dermaptera* and *Hymenoptera)*, totaling a number of 49 specimens. Of these, we reported 11 useful and one harmful species, *F. auricularia* (Table 4). The best represented is the *Coleoptera* order with 7 families and 10 species, which represents 66.4% of the total captured families, then the orders *Diptera, Dermaptera* and *Hymenoptera* with one family each, which represents 11.3%, respectively. The greatest abundance has the species of beetles with an important role in the studied ecosystem, being predatory ones. Two protected species were also captured in this ecosystem: *L. cervus* and *C. cerdo*. Considering the climatic factors (Table 1), the fewest specimens captured are in June and July when the average temperature was 25°C, the insects entering in summer diapause, but the number of caught specimens starts to increase in August and September (Table 4).

From trap 4 located in the eggplant culture (Fig. 5) there were collected insects on 10 collection days (May-27 specimens, June-6 specimens, July-4 specimens, August-17 specimens and September-3 specimens). The insect species belong to 3 orders (*Coleoptera, Diptera* and *Ortopthera)*, totaling a number of 57 specimens. Of these, we reported 6 useful and 2 harmful species. The main harmful species in this culture is *L. decemlineata*. The best represented is the *Coleoptera* order with 3 families with 7 species, which represents 60% of the total captured species, then *Diptera* and *Hymenoptera* orders, with one family each, which represents 20% respectively.

From trap 5 located in the pepper culture (Fig. 5) there were collected insects on 9 collection days (May-19 specimens, July-3 specimens, August-5 specimens and September-9 specimens). The insect species belong to 3 orders (*Coleoptera, Hemiptera* and *Orthoptera)*, totaling a number of 36 specimens. In this ecosystem, a harmful species *G. rufus* was reported, with a phytophagous diet (Table 6). The best represented is the *Coleoptera* order with 3 families and seven species, which represents, 60%, followed by

Table 4. Insect species captured in trap 3-bushes of red currant, in the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
8.V.	**COLEOPTERA**	Carabidae	*Leistus rufomarginatus* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	2
7.VIII., 21.VIII., 28.VIII.			*Carabus nemoralis* Műller, 1764	Predator, attack the larvae or pupae of other insects	useful	8
15.V.			*Leistus rufomarginatu,* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	3
11.VII.			*Carabus auratus* Latreille, 1802	Predator, attack the larvae or pupae of other insects	useful	2
11.IX., 18.IX.			*Harpalus rufipes* Degeer, 1774	Predator, attack the larvae or pupae of other insects	useful	9
15.V.		Coccinellidae	*Coccinella septempunctata* Linnaeus, 1758	Predator, aphidophage	useful	4
5.VI.		Lucanidae	1♂, *Lucanus cervus* Linnaeus, 1758	Phytophagous (Protected Species)	useful	1
19.VI.		Lucanidae	1♀, *Dorcus parallelipipedus,* Linnaeus, 1758	Phytophagous, Rotten Wood	useful	
19.VI.		Cerambycidae	1♂, *Cerambyx cerdo* Linnaeus, 1758	Phytophagous (Protected Species)	useful	1
15.V., 26.VI., 14.VIII.		Staphylininae	*Ocypus olens* Műller, 1764	Predator, coprophag	useful	9
11.VII.		Melandyidae	*Melandya caraboides* Linnaeus, 1761	Predator	useful	2
8.V., 19. VI., 25.VII., 25.IX.	**HYMENOPTERA**	Apidae	*Apis mellifera* Linnaeus, 1758	Nectarivorous	useful	6
7.VIII.	**DERMAPTERA**	Forficulidae	*Forficula auricularia* Linnaeus, 1758	Phytophagous	harmful	2
					TOTAL	**49**

Figure 5. Traps installed in the following ecosystems: 4-eggplant culture; 5-culture of peppers, 3-culture of strawberries

Table 5. Insect species captured from trap 4-eggplant, in the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
8, 15, 22, 29.V.	**COLEOPTERA**		*Leistus rufomarginatus, Duftschmid,* 1812	Predator, attack the larvae or pupae of other insects	useful	12
29.V., 11.IX.			*Harpalus rufipes* Degeer, 1774	Predator, attack the larvae or pupae of other insects	useful	5
7.VIII., 2.VIII., 28.VIII.		Carabidae	*Carabus nemoralis* Műller, 1764	Predator, attack the larvae or pupae of other insects	useful	7
7.VIII.			*Pterostichus niger* Schaller, 1783	Predator, attack the larvae or pupae of other insects	useful	3
22.V.		Staphylininae	*Ocypus olens* Műller, 1764	Predator, coprophag	useful	3
29.V., 26.VI., 11.VII., 7.VIII.		Chrysomelidae	*Leptinotarsa decemlineata* Say, 1824	Phytophagous	harmful	22
8, 29.V.	**ORTOPTHERA**	Gryllotalpidae	*Gryllotalpa gryllotalpa* Linaeus 1758	Phytophagous	harmful	2
11.IX.	**DIPTERA**	Muscidae	*Musca domestica* Linnaeus, 1758	Adult omnivorous, nectarivorous	useful	3
					TOTAL	**57**

Table 6. Insect species captured from Trap 5-pepper culture, in the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
8,15, 22, 29.V.	**COLEOPTERA**	Carabidae	*Leistus rufomarginatus* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	9
22.V., 25.IX.			*Harpalus affinis* Schrank, 1781	Predator, attack the larvae or pupae of other insects	useful	4
25.IX.			*Harpalus rufipes* Degeer, 1774	Predator, attack the larvae or pupae of other insects	useful	2
14.VIII., 18.IX.			*Carabus auratus* Latreille, 1802	Predator, attack the larvae or pupae of other insects	useful	5
28.VIII.			*Carabus nemoralis* Műller, 1764	Predator, attack the larvae or pupae of other insects	useful	3
15, 29.V.		Staphylininae	*Ocypus olens* Műller, 1764	Predator, coprophag	useful	5
18.VII.		Tenebrionidae	*Palorus ratzeburgii* Wissmann, 1848	Omnivorous	useful	3
15.V.	**ORTHOPTERA**	Acrididae	*Gomphocerippus rufus* Linnaeus, 1758	Phytophagous	harmful	3
18.IX.	**HEMIPTERA**	Pyrrhocoridae	*Pyrrhocoris apterus* Linnaeus, 1758	Seedeater (Lime Trees)	useful	2
					TOTAL	**36**

Hemiptera, and *Orthoptera* orders, each with a family, which represents 20% respectively. Considering the climatic factors (Table 1), the fewest caught specimens are in July, while in June no insects were caught. The average temperature was 25.72°C, the insects entering summer diapause. The number of caught specimens starts to increase in August and September (Table 6).

From trap 6 located in the strawberry culture (Fig. 5) there were collected insects on 14 collection days (May-22 specimens, June-6 specimens, July-4 specimens, August-14 specimens and September-10 specimens). Insect species belong to 4 orders (*Coleoptera, Diptera, Orthoptera* and *Hymenoptera)*, totaling a number of 56 specimens. Three harmful species have been reported in this ecosystem: *H. abietis*, *G. rufus* and *C. aurata* (Table 7). The best represented is the *Coleoptera* order with 5 families with 7 species, which represents 50%, then the *Hemiptera* and *Diptera* orders, with 2 families each, which represents 20% and the *Ortopthera* order with 10%. The dominant and mots abundant species are beetles. Considering the climatic factors (Table 1), the fewest caught specimens are in June and July, when the average temperature was 25.72°C, the insects entering summer diapause. The number of caught specimens starts to increase in August and decreases in September (Table 7).

Table 8. Insect species captured from Trap 6-strawberry culture, in the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
8,15.V., 5.VI., 11.IX.	**HYMENOPTERA**	Apidae	*Apis mellifera* Linnaeus, 1758	Pollen Nectar	useful	5
22.V.		Apoidea	*Stelis signed* Latreille, 1809	Nectarivorous	useful	1
15.V.	**COLEOPTERA**	Curculionidea	*Hylobius abietis* Linnaeus, 1758	Phytophagous	harmful	7
22.V.		Cantharidae	*Cantharis fusca* Linnaeus, 1758	Predator	useful	2
22.V., 28.VIII., 18,25.IX.		Carabidae	*Harpalus affinis* Schrank, 1781	Predator, attack the larvae or pupae of other insects	useful	9
29.V.		Carabidae	*Leistus rufomarginatus* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	2
26VI.		Carabidae	*Carabus auratus* Latreille, 1802	Predator, attack the larvae or pupae of other insects	useful	2
8, 28.VIII.		Carabidae	*Carabus violaceus* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	5
14,21,28. VIII.		Carabidae	*Carabus nemoralis* Műller, 1764	Predator, attack the larvae or pupae of other insects	useful	7
19.VI.		Scarabaeidae	*Cetonia aurata* Linnaeus, 1758	Pollen, Nectar, Rose Flowers	harmful	3
18.VII.		Coccinellidae	*Coccinella septempunctata* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	4
22,29.V.	**ORTHOPTERA**	Acrididae	*Gomphocerippus rufus* Linnaeus, 1758	Phytophagous	harmful	5
14.VIII., 11.IX.	**DIPTERA**	Calliphoridae	*Lucilia caesar* Linnaeus, 1758	Phytophagous	useful	4
					TOTAL	**56**

Figure 6. Traps installed in the following ecosystems: 7-raspberry culture; 8 and 9 - maize culture

From trap 7 located in the raspberry culture (Fig. 6) there were collected insects on 13 collection days (May-6 specimens, June-4 specimens, July-10 specimens August-14 specimens and September-4 specimens). The insect species belong to 4 orders (*Coleoptera, Hemiptera, Hymenoptera* and *Ortopthera)*, totaling a number of 38 specimens. There are the following harmful species: *M. melolontha*, *C. dispar*, *G. rufus*. The best represented is the *Coleoptera* order, with 3 families and 6 species, which represents 42.87%, then *Hymenoptera* order with 2 families representing 28.57% and two orders with one family - *Hemiptera,* and *Ortopthera,* representing 14.28%, respectively. The dominant species are beetles. Considering the climatic factors (Table 1), the fewest caught specimens are in June and September (Table 8).

From trap 8 located in the corn crop (Fig. 6) there were collected insects on 15 collection days (May-20 specimens, June-9 specimens, July-11 specimens August-27 specimens and September-15 specimens). The insect species belong to 4 orders (*Coleoptera, Diptera, Orthoptera* and *Hemiptera)*, totaling a number of 82 specimens. Of these, we have found 2 harmful species: *G. rufus* and *L. decemlineata*. It should be noted that the corn crop is located next to the potato one and this explains the collection of Colorado potato beetle. The best represented order is the *Hemiptera*, with 4 families and 5 species, representing 44.44% of the total caught species, followed by the orders: *Coleoptera* and *Orthoptera* with two families each, representing 22.22% and the order *Diptera* with a single family which represents 11.12%. The dominant species belong to the order *Hemiptera.* Considering the climatic factors (Table 1), the fewest caught specimens are in June and July, when the insects are in diapause (Table 9).

From trap 9 located in the corn crop (Fig. 6) there were collected insects on 16 collection days (May-21 specimens, June-7 specimens, July-5 specimens, August-18 specimens and September-11 specimens). The insect species belong to 3 orders (*Coleoptera, Hemiptera* and *Ortopthera*), totaling a number of 62 specimens. There are 15 useful and one harmful species, *C. dispar*. The best represented is the *Coleoptera* order, with 3 families and 8 species, representing 60%, i.e. the highest abundance, then the orders *Hemiptera* and *Orthoptera* each with a family, representing 20% respectively. Considering the climatic factors (Table 2), the fewest caught specimens are in June and July, the period when insects are in diapause (Table 10).

From the trap 10 placed in the potato culture (Fig. 7) there were collected insects on 14 collection days (May-32 specimens, June-9 specimens, July-6 specimens August-18 specimens and September-12 specimens). The insect species belong to 4 orders (*Coleoptera, Hemiptera, Ortopthera* and *Hymenoptera)*, totaling a number of 77 specimens. There are 15 useful and one harmful species, *Leptinotarsa decemlineata* Say, 1824. The best represented is the *Coleoptera* order with 3 families and five species, which represents, 42.86% of the total

Table 8. Insect species captured from Trap 7-raspberry culture, in the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
8.V.	**COLEOPTERA**	Cantharidae	*Cantharis fusca* Linnaeus, 1758	Predator	useful	3
5.VI.		Scarabaeidae	*Melolontha melolontha* Fabricius, 1775	Phytophagous	harmful in the larval stage	3
7.VIII.		Carabidae	*Carabus violaceus* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	3
21.VIII.		Carabidae	*Carabus nemoralis* Műller, 1764	Predator, attack the larvae or pupae of other insects	useful	3
21.VIII.		Carabidae	*Carabus auratus* Latreille, 1802	Predator	useful	2
11.IX.		Carabidae	*Carabus violaceus* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	3
21.VIII.		Silphidae	*Nicrophorus vespillo* Linnaeus, 1758	Necrophagous, coprphagous	useful	4
22.V	**HYMENOPTERA**	Apoidea	*Nomada flava* Panzer, *1798*	Pollen, Nectar	useful	1
May 22,29.V., 26.VI., 11,18.VII., 18.IX.		Apidae	*Apis mellifera* Linnaeus, 1758	Pollen, Nectar	useful	6
11.VII., 14.VIII.	**ORTHOPTERA**	Acrididae	*Chrysochraon dispar* Germar, 1834	Phytophagous	harmful	6
25.VII.		Acrididae	*Gomphocerus rufus* Linnaeus, 1758	Phytophagous	harmful	2
18.VII.	**HEMIPTERA**	Coreidae	*Coreus marginatus* Linnaeus, 1758	Phytophagous	useful	2
					TOTAL	**38**

Table 9. Insect species captured from Trap 8-corn crop, in the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
8,29.V.	**COLEOPTERA**	Carabidae	*Leistus rufomarginatus* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	5
8,22.V.			*Platynus assimilis* Paykull 1790	Predator, attack the larvae or pupae of other insects	useful	7
26.V., 7.VIII.			*Carabus auratus* Latreille, 1802	Predator, attack the larvae or pupae of other insects	useful	5
7.VIII., 14, 21, 28.VIII.			*Harpalus latus* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	10
11,25.IX.			*Harpalus rufipes* Degeer, 1774	Predator, attack the larvae or pupae of other insects	useful	5
21,28.VIII.			*Pterostichus niger* Schaller, 1783	Predator, attack the larvae or pupae of other insects	useful	6
19,26.V.		Chrysomelidae	*Leptinotarsa decemlineata* Say, 1824	Phytophagous	harmful	7
15,22.V., 11, 18.VII.	**HEMIPTERA**	Pyrrhocoridae	*Pyrrhocoris apterus* Linnaeus, 1758	Seedeater (Lime Trees)	useful	11
22.V.		Coreidae	*Enoplops scapha* Fabricius, 1794	Seedeater (Lime Trees)	useful	1
29.V.	**ORTHOPTERA**	Acrididae	*Gomphocerippus rufus* Linnaeus, 1758	Phytophagous	harmful	3
25.VII., 18.IX.		Gryllidae	*Gryllus campestris* Linnaeus, 1758	Phytophagous	useful	3
21.VIII.		Tettigoniidae	*Tettigonia viridissima* Linnaeus, 1758	Phytophagous	useful	2
25.VII.	**HEMIPTERA**	Acanthosomatidae	*Elasmucha grisea* Linnaeus, 1758	Phytophagous	useful	3
21.VIII.		Pentatomidae	*Picromerus bidens* Linnaeus, 1758	Phytophagous	useful	4
11,25.IX.		Pyrrhocoridae	*Pyrrhocoris apterus* Linnaeus, 1758	Seedeater (Lime Trees)	useful	6
18.IX.		Pentatomidae	*Pentatoma rufipens* Linnaeus, 1758	Phytophagous	useful	2
14.VIII.	**DIPTERA**	Calliphoridae	*Lucilia caesar* Linnaeus, 1758	Phytophagous	useful	2
					TOTAL	**82**

Table 10. Insect species captured from Trap 9-corn crop, under the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimenss
8.V.	**COLEOPTERA**	Staphylinidae	*Syntomium aeneus* Muller, 1821	Predator, coprophag	useful	3
15,29.V.		Carabidae	*Leistus rufomarginatus* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	8
22.V.		Carabidae	*Leistus rufomarginatus* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	2
19.VI., 18.IX.		Carabidae	*Carabus auratus* Latreille, 1802	Predator	useful	4
7,14.VIII., 11,18,15.IX.		Carabidae	*Harpalus latus* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	9
21, 8.VIII, 25.IX.		Carabidae	*Pterostichus niger* Schaller, 1783	Predator, attack the larvae or pupae of other insects	useful	12
21.VIII.		Silphidae	*Nicrophorus vespillo* Linnaeus, 1758	Necrophagous	useful	4
15,22,29.V.,5,26.VI	**HEMIPTERA**	Pyrrhocoridae	*Pyrrhocoris apterus* Linnaeus, 1758	Seedeater (Lime Trees)	useful	11
18.VII.	**ORTHOPTERA**	Acrididae	*Chrysochraon dispar* Germar, 1834	Phytophagous	harmful	2
25.VII., 14,28.VIII		Acrididae	*Gomphocerus rufus* Linnaeus, 1758	Phytophagous	useful	7
					TOTAL	**62**

Figure 7. Traps installed in the following ecosystems: 10-potato culture; 11-tomato culture

Table 11. Insect species captured from Trap 10-potato crop, in the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
8,22,29.V., 6,26.VI.	**COLEOPTERA**	Carabidae	*Leistus rufomarginatus* Duftschmid, 1812	Predator, attack the larvae or pupae of other insects	useful	13
26.VI.			*Carabus auratus* Latreille, 1802	Predator, attack the larvae or pupae of other insects	useful	4
11.IX.			*Harpalus latus* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	3
15.V.		Scarabeidae	*Tropinota hirta* Poda 1761	Phytophagous	harmful	4
8,15,29.V., 11.VI., 7,28.VIII., 11.IX.		Chrysomelidae	*Leptinotarsa decemlineata* Say, 1824	Phytophagous	harmful	39
14,21.VIII.		Pentatomidae	*Picromerus bidens* Linnaeus, 1758	Phytophagous	useful	5
18.IX.	**HEMIPTERA**	Pyrrhocoridae	*Pyrrhocoris apterus* Linnaeus, 1758	Seedeater (Lime Trees)	useful	2
21.VIII.		Pentatomoidae	*Dolycoris baccarum* Linnaeus, 1758	Phytophagous	useful	2
14.VIII., 18.IX.	**ORTHOPTERA**	Gryllidae	*Gryllus campestris* Linnaeus, 1758	Phytophagous	useful	2
28.VIII.	**HYMENOPTERA**	Vespidae	*Vespa crabro* Linnaeus, 1758	Nectarivorous	useful	2
25.IX.		Apidae	*Apis mellifera,* Linnaeus, 1758	Nectarivorous	useful	1
					TOTAL	**77**

insects captured, followed by the *Hymenoptera* order with two families which represents 28.57% and the *Hemiptera* and *Orthoptera* orders, each with one family, i.e. 14.29% respectively. The dominant species are beetles. Considering the climatic factors (Table 1), the fewest caught specimens are in June and July, when the average temperature of the months was 25°C (Table 11).

From trap 11 located in the tomato crop (Fig. 7) there were collected insects on 16 collection days (May-16 specimens, June-7 specimens, July-4 specimens, August-17 specimens and September-13 specimens). The insect species belong to 4 orders (*Coleoptera, Hemiptera, Ortopthera* and *Diptera)*, totaling a number of 57 specimens. Only one harmful species have been found, i.e. *G. gryllotalpa*. The best represented are the *Coleoptera* and *Orthoptera* orders, each with 2 families i.e. 33.33% of the total caught families respectively, followed by the *Diptera* and *Hemiptera* orders, with one family each, which represents 16.67% respectively. The dominant species belong to *Orthoptera* and *Coleoptera* orders. Considering the climatic factors (Table 1), the fewest caught specimens are in June and July (Table 12).

During twenty collections performed mots of time from beginning of May to the end of September to study insects caught in the ecosystems mentioned above there have been found insects belonging to seven orders: *Coleoptera, Diptera, Dermaptera, Hemiptera, Hymenoptera, Lepidoptera* and *Orthoptera* (Fig. 8).

Mots of the captured insects belong to the *Coleoptera*, i.e. 13 families represented by 33 species (Table 18). Among the identified species we mention the Predator insects from the *Coccinellidae* family (*Hyperaspis campestris* Herbst, 1783, *Adalia bipunctata* Linnaeus, 1758, *Coccinella septempunctata* Linnaeus, 1758) which feed on various species of aphids, small insects (mites), and insect eggs.

Table 12. Insect species captured from Trap 11-tomato crop, under the conditions of 2021

Date of collection	Order	Family	Species	Type of diet	Role in ecosystem	Number of specimens
8,15.V.	**COLEOPTERA**	Carabidae	*Poecilus cupreus* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	5
22,29.V., 7.VIII., 18, 21.IX.			*Pterostichus niger* Schaller, 1783	Predator, attack the larvae or pupae of other insects	useful	16
5.VI., 26.VI.25. VII.			*Leistus rufomarginatus Duftschmid, 1812*	Predator, attack the larvae or pupae of other insects	useful	6
7,14,21,28 .VIII., 25,28.IX.			*Harpalus latus* Linnaeus, 1758	Predator, attack the larvae or pupae of other insects	useful	16
29.V.		Staphylininae	*Creophilus maxillosus* Linnaeus, 1758	Predator, coprophag	useful	3
15.V.	**ORTOPTHERA**	Gryllotalpidae	*Gryllotalpa gryllotalpa* Linaeus 1758	Phytophagous	harmful	1
28.VIII.		Acrididae	*Gomphocerus rufus* Linnaeus, 1758	Phytophagous	useful	3
19.VI., 11.VII.	**HEMIPTERA**	Pyrrhocoridae	*Pyrrhocoris apterus* Linnaeus, 1758	Seedeater (Lime Trees)	useful	5
7.VIII.	**DIPTERA**	Calliphoridae	*Lucilia caesar* Linnaeus, 1758	Phytophagous	useful	2
					TOTAL	**57**

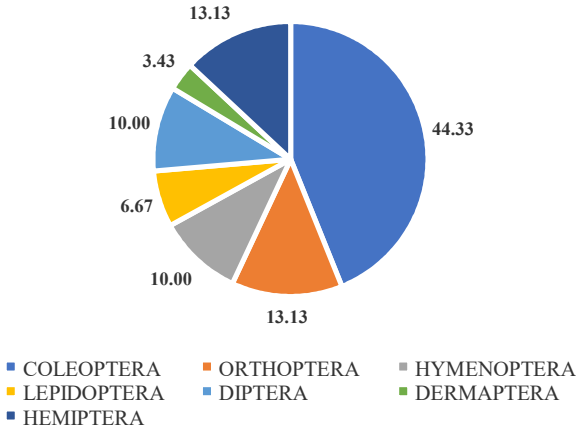

Figure 8. The structure of the entomofauna of the fauna in the studied ecosystem, the weight of the orders

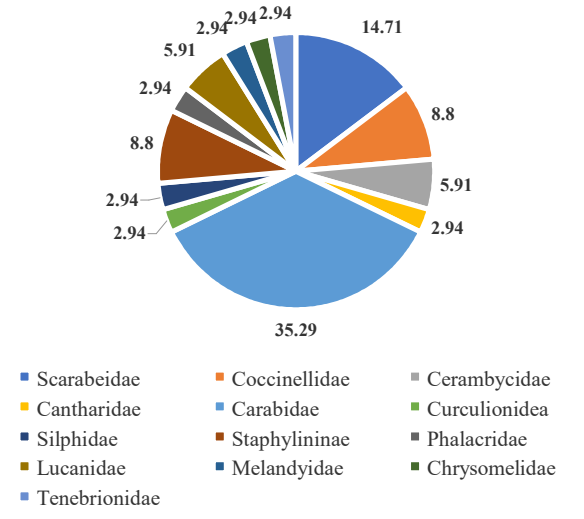

Figure 9. Dominance of coleopteran families in the studied ecosystem

Following the determination of the collected insects, we found that the Coleoptera Order, the *Carabidae* family were the best represented, species from this order being captured in all sampled sites. The species belonging to the orders Hymenoptera and Diptera were present in 6 of the 11 investigated sites, and the species of the Orthoptera order were present in 8 of the 11 sites. Species from the Order Hemiptera were present in 4 sites out of the 11 investigated. The fewest specimens captured were from the Lepidoptera Order, only in 3 of the 11 investigated sites (Fig. 9). Insects from the Order Dermaptera were captured from a single site, from the eggplant culture.

DISCUSSIONS

Following the study, the useful fauna was characterized by different species of insects from the orders: Coleoptera, Hymenoptera, Lepidoptera, Dermaptera, Orthoptera, Diptera and Hemiptera. The majority of them are predators and can be found in a wide variety of habitats inside the soil as well as agricultural crops [10].

The analyzed ecological indices helped us to identify the abundance of the *Coleoptera* order which it is well represented in terms of the number of families (13) and species (34) but also its role in the ecosystem. Mots of the coleopterans identified are entomophagous species that feed on small insects, the larvae and eggs of other insects, or they are mixophagous, necrophagous and saprophagous species with an essential role in the studied ecosystem, being considered important ecological indicators.

As it results from the list of species, the best represented is the *Coleoptera* order, which includes 13 families, mots of which are useful species. The

dominant species are the polyphagous predators very common in agroecosystems and are considered to have an important role in natural pest control, the species of this order being present in all the 11 studied habitats [7]. The *Leistus* beetle is a predator, preferring especially the *Collembola* species, *Ocypus* and *Creophilus* (escrements and carcasses), but usually as predators of fly larvas and other invertebrates.

The Ortopthera order is represented by four families and five species, being phytophagous insects (crickets), with a useful role in the ecosystem, but there are also harmful species (grasshoppers), and some of them are predatory species.

Another order encountered within the analyzed ecosystem are the useful species from the Hymenoptera order, which are omnivorous species with a wide spectrum of food which includes other insects, pollen and nectar [18].

From the Hymenoptera Order, five species belonging to three families have been identified, most of the species are phytophagous, the species from the *Apidae* and *Apoidea* superfamily feed on nectar, pollen, leaves and sweet juices, while species of the Viespidae family are predators and feed on larvae or are egg parasites. *Vespa crabro* adults useful as nectarivorous, but also as predators, to feed their larvas. But it can also damage ripe fruits and gnaw the bark to build the nest, becoming in these cases harmful.

The captured insect species belonging to the Lepidoptera Order are represented by two families (Sphingidae and Geometridae) which include three species, all of which feed on nectar and pollen, being the pollinators of garden crops. Geometrid moths *Abraxas* are as harmful as the caterpillars attack fruit plants. These butterfly species belonging to the Geometridae family are not always pollinators and we can consider them neutral species.

The Diptera order was represented by three families and three species, in the adult stage they are important pollinators after bees, and these species have a useful role in the studied ecosystem.

The order Dermaptera was represented by a family and a species, *F. auricularia*, this being a myxophagous species that feeds on a wide variety of insects and plants. The captured species is considered to be harmful to some crops in the studied ecosystem.

The seventh order analyzed is *Hemiptera*, represented by four families and seven species, being the dominant one after the *Coleoptera* order. The majority of species are phytophagous and are harmful to agricultural crops in the studied ecosystem.

Following the analysis and determination of the 634 specimens caught in the studied garden we can conclude that the mots of specimens are found in the corn field, totaling 139 specimens.

Following the centralization of all species of collected insects, we can conclude that they belong to 31 families and 58 species, respectively. Of the total number of species, eight are harmful to crops (26.6%) and 50 are useful insects (73.4%). Of the 58 species of insects, 34 species belong to the *Coleoptera* order, which has the highest abundance and dominance and represents 58.62% of the total number of collected insect species, being present in all 11 studied habitats. Among the species collected from the studied ecosystems, two protected species were also identified: *L. cervus* and *C. cerdo*. The harmful insects identified were: *Leptinotarsa decemlineata* Say, 1824 pest specific to the potato crop; *Gryllotalpa gryllotalpa* Linaeus 1758; *Chrysochraon dispar* Germar, 1834; *Melolontha melolontha* Fabricius, 1775; *Gomphocerippus rufus* Linnaeus, 1758; *Hylobius abietis* Linnaeus, 1758; *Forficula auricularia* Linnaeus, 1758; and *Cetonia aurata* Linnaeus, 1758.

The main abiotic components of the environment in the studied ecosystem that influenced the time and space of the distribution of the insects [25] were the average temperature of the collection months 20.96 ^{o}C, the humidity 53.6% and the light and air currents 2.8 m/s data processed after the observations Meteorological Station in Sibiu.

The distribution and abundance of species in the studied ecosystem was influenced by environmental conditions: precipitation temperature, atmospheric humidity and the wind direction, from the year 2021 (Table 1). The sum of the minimum temperatures of May-September was 1785.3°C, the sum of the average temperatures in the same period was 2752.7°C and the sum of the maximum temperatures was 3758.9°C.

Humidity played an important role in the life and dynamics of insects in the analyzed ecosystem, water being indispensable for the vital processes of the body [28]. We found that the insects' resistance to the high temperatures of June-August was higher due to the high air humidity. The relative air humidity fell within an optimal range of between 48-58%, thus confirming the conclusions of other specialists [19].

The amount of precipitations from the capture period, the months of May-September of 2021, was 397.1 mm. Large amounts of precipitations were reported in the months of May, June and July, thus favoring the development of insects and the abundance of species (Table 2-12). The precipitations that fell during this period contributed to the increase in atmospheric humidity and the amount of water in the soil, the number of captured specimens being higher during this period. The small amounts of precipitations in the months of August and September in relation to the increasingly low temperatures influenced the entry of the insects into the hyena diapause.

Along with temperature and humidity, light played an important role among the insect populations in the studied ecosystem and we noticed that in the periods when the light intensity started to decrease starting from September, the number of the collected insects was smaller, mots of the species being dependent in their activity by this factor.

The temporary distribution of the identified insect species was directly related to the air temperature. In the time period between July, when the average air

temperature minimum 15.39°C, medium 22,45°C and maximum 28,82°C, the number of specimens captured was smaller,for their activity being to a lesser extent. Each species has an optimal temperature range, thus explaining the fact that in certain collection data the number of species was reduced or there were no traps set. The abundance and dominance of insect species being directly influenced by the environmental factors of temperature, humidity and precipitation, as well as by climatic changes during a growing season [28].

Conflict of interest. There is no actual or potential conflict of interest in relation to this article.

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