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THE DIVERSITY OF INSECT SPECIES AT GROUND LEVEL IN THE ȘTEFĂNEȘTI VITICULTURAL CENTER

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Abstract

The paper aimed to present the evolution of the insect that were active on the ground surface during the 2020-2021 period collected from 3 plantations from the Stefanesti viticultural center. By the end of the study, 37 species of insects caught in pitfall traps had been identified. Of these, in 2020, 20 species with a total of 2429 individuals were collected and in 2021, 28 species with a total of 395 individuals. Of all the species identified, only 11 are repeated in both years. The data obtained were processed using the BioDiversity Professional 2 program. Thus, were calculated: Rarefaction, Simpson index, Shannon index, SHE analysis and Bray - Curtis analysis. The insect species identified in the period 2021-2022 did not cause damage in the monitored vineyards.

***Key words**: biodiversity, grapevine, pests, arthropod, Lasius.*

INTRODUCTION

Control pathogens and pests measures needed to increase production and income can have negative effects on biodiversity from viticultural ecosystems (Tabaranu G. et al., 2018).
Biodiversity management in the face of climate change is recommended to be achieved by monitoring the evolution of species, expanding and maintaining monitoring programs (Ernst et al., 2015). Therefore, choosing the most efficient sampling method is crucial (Csaszar et al., 2018). Pitfall traps are most often used for environmental studies and monitoring programs (Southwood & Henderson, 2000; Babin-Fenske & Anand, 2010; Da Silva et al., 2011; Isaia et al., 2015; Brown & Matthews, 2016; Boetzl et al., 2018). Originally described by Barber (1931), pitfall traps are inexpensive, easy to use and operate round-the-clock, resulting in large, species-rich samples (Schmidt et al., 2006).

MATERIALS AND METHODS

Pitfall traps, filled 2/3 with formalin solution 4%, have been installed on the vineyard rows (on the intervals between the grapevine rows the soil was kept grass cover) in order to establish the structure of entomofauna from the soil surface.
These were placed in 3 vineyards and collected once every two weeks. 14 collections were made and the monitoring has been done between July-October for 2020 and 2021, as follows:
06.07.2020-17.07.2020,17.07.2020-03.08.2020, 03.08.2020-17.08.2020,17.08.2020-31.08.2020, 31.08.2020-14.09.2020,14.09.2020-30.09.2020, 30.09.2020-12.10.2020,07.07.2021-21.07.2021, 21.07.2021-04.08.2021,04.08.2021-18.08.2021, 18.08.2021-01.09.2021,01.09.2021-16.09.2021, 16.09.2021-29.09.2021,29.09.2021-13.10.2021.
The collected insects were transported to the laboratory and identified using the IPM-scope digital microscope (Spectrum Technologies, USA) and an Optika SZM-2 trinocular stereomicroscope equipped with an Optika CP-8 photo camera (Optika, Italy).
The obtained results have been processed with the BioDiversity Professional 2 program, thus being calculated: Rarefaction, Shannon index, Simpson index, SHE analysis and Bray - Curtis analysis.

RESULTS AND DISCUSSIONS

Biodiversity loss it has become an international problem (Thukral, 2017). Thus, the biodiversity monitoring is important because helps with restoration and conservation.

In the July - October 2020 period, 2429 individuals were collected that are belonging to 20 species: *Gnaphosidae* sp., *Heliophanus* sp., *Hydrotaea diabolus*, *Metcalfa pruinosa, Graphosoma lineatum, Apis mellifera, Camponotus* sp., *Cardiocondyla* sp., *Formica* sp., *Lasius* sp., *Vespula germanica, Vespula vulgaris, Opilio* sp., *Opiliones* sp., *Calliptamus italicus, Calliptamus* sp., *Acheta domesticus, Melanogryllus desertus, Modicogryllus frontalis, Modicogryllus truncatus*. *Lasius* sp. (1255), *Formica* sp. (597), *Camponotus* sp. (244) and *Melanogryllus desertus* (124) recorded the highest number of individuals (Table 1).

In the same period, but in 2021, 28 species were identified (with a total of 395 individuals): *Acheta domesticus, Anthomyia procellaris, Caliptamus* sp., *Calliptamus italicus, Camponotus* sp., *Carabus coriaceus, Cardiocondyla* sp., *Chorthippus brunneus, Corythucha* sp., *Cyphophthalmus duricorius, Gryllus campestris, Ichneumon gracilentus, Lasius sp., Melanogryllus desertus, Micrommata virescens, Modicogryllus frontalis, Modicogryllus truncatus, Opilio* sp., *Opiliones sp., Oxycarenus lavaterae, Pezotettix giornae, Phaneroptera falcata, Platycleis albopunctata albopunctata, Pterostichus melanarius, Raglius alboacuminatus, Scaphoideus titanus, Scymnus* sp., *Tomoxia bucephala*. Of these, the highest number of individuals was in the case of *Modicogryllus* truncatus (125), *Opilio* sp. (71), *Lasius* sp. (56) (Table 1).

The largest number of individuals during the entire study period were registered in the case of ant from *Formica* and *Lasius* genres.

So far, at the international level have been discovered over 17,500 ant specimens belonging to nearly 220 extinct species from 73 genera (34 extinct and 39 extant) and 12 subfamilie
s (Radchenko, 2021).

Table 1. Species richness collected in pitfall traps

No	Species	Year	
		2020	2021
1.	*Acheta domesticus*	9	31
2.	*Anthomyia procellaris*	0	1
3.	*Apis mellifera*	3	0
4.	*Calliptamus italicus*	4	1
5.	*Calliptamus* sp.	1	1
6.	*Camponotus* sp.	244	11
7.	*Carabus coriaceus*	0	5
8.	*Cardiocondyla* sp.	69	4
9.	*Chorthippus brunneus*	0	1
10.	*Corythucha* sp.	0	2
11.	*Cyphophthalmus duricorius*	0	2
12.	*Formica* sp.	597	0
13.	*Gnaphosidae*	1	0
14.	*Graphosoma lineatum*	1	0
15.	*Gryllus campestris*	0	1
16.	*Heliophanus* sp.	1	0
17.	*Hydrotaea diabolus*	1	0
18.	*Ichneumon gracilentus*	0	1
19.	*Lasius* sp.	1255	56
20.	*Melanogryllus desertus*	124	36
21.	*Metcalfa pruinosa*	1	0
22.	*Micrommata virescens*	0	1
23.	*Modicogryllus frontalis*	21	3
24.	*Modicogryllus truncatus*	48	125
25.	*Opilio* sp.	2	71
26.	*Opiliones* sp.	7	5
27.	*Oxycarenus lavaterae*	0	3
28.	*Pezotettix giornae*	0	24
29.	*Phaneroptera falcata*	0	1
30.	*Platycleis albopunctata albopunctata*	0	1
31.	*Pterostichus melanarius*	0	2
32.	*Raglius alboacuminatus*	0	2
33.	*Scaphoideus titanus*	0	1
34.	*Scymnus* sp.	0	1
35.	*Tomoxia bucephala*	0	2
36.	*Vespula germanica*	9	0
37.	*Vespula vulgaris*	31	0
	Total	**2429**	**395**

Lasius species bring benefits to the soil changing its profile and texture, favoring drainage, being able to handle well in unstable and disturbed habitats (Quque & Bles, 2020). This explains the large number of individuals in 2020 when periods of drought alternated with periods of excess rainfall.

The genus *Formica* includes about 180 species, distributed almost exclusively in the Holarctic Region (Radchenko, 2021). Half of the species of the genus *Formica* are confirmed or suspected social parasites (Borowiec et al., 2021).

The ants from the genus *Formica* have effect on soil qualities and the presence of some flora, also strongly influences the surrounding zoocenosis. The apparition of ants is dependent on the quantity of light, the structure and quantity of vegetation and the quantity of food supplies relating to it. Also, air and soil temperatures are important for the activity of workers (Véle et al., 2009). This may explain the lack of individuals in 2021, when lower temperature values were recorded in January, February, March, April, September and December compared to 2020 (Figure 1).
Five treatments were applied each year (Table 2), of which only sulfur, abamectin and spirodiclofen (first treatment of the year) were applied to control mites. Therefore, no insecticides were applied and the evolution of the insects was not influenced by them.

Table 2. Pesticides applied in the two years of study

Nt*	Phytosanitary treatment	
	2020	**2021**
1	Metiram 70 %	Metiram 70 %
	Sulf 80 %	Sulf 80 %
	Abamectin 18 g/l	Spirodiclofen 240g/l
2	Fosetil de aluminiu 50 % + folpet 25 %	Penconazol 100 g/l
	Penconazol	Oxatiapiprolin 100 g/l
	Fluopicolid 4,44 % + fosetil-Al 66,7 %	Mancozeb 64 % + Mefenoxam 4 %
		Miclobutanil 240 g/l
4	Azoxistrobin 93,5 gr/litru + folpet 500 gr/litru	Folpet 250 g/kg + Fosetil de aluminiu 500 g/kg
		Tebuconazol 500 g/kg + Trifloxistrobin 250/kg
5	Sulfat de cupru 20 %	Cupru 200 g/kg
	Sulf 80 %	Sulf 80 %

*Nt = Number of treatments

The insect species identified in the 2021-2022 years did not cause damage in the monitored vineyards. Of all the species identified, only 11 are found in both years. The others were probably affected by the non-uniformity of temperatures and precipitation recorded in 2020 and 2021.
Compared to the multiannual averages for the period 1979-2011, in 2020 there were higher increases in average temperatures in January (+1.81°C), February (+3.51°C), March (+3.20), April (+1.53°C), July (+1.89), August (+3.06°C), September (+3.92°C), October (+2.09°C) and December (+2.08°C). In 2021, there were temperature increases of more than 1.5°C compared to the multiannual average only in February (+2.60°C), July (+3.5°C), August (+2.64°C), November (+2.24°C) and a decrease of 1.85°C in April (Figure 1).

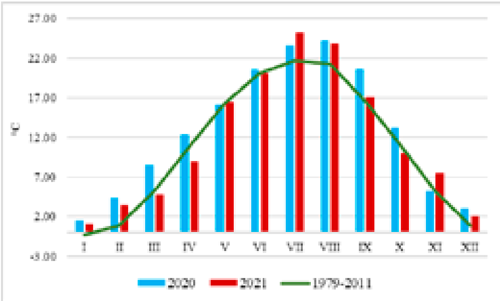

Figure 1 The temperature evolution in 2020 and 2021

The vineyards water consumption it is between 500 and 700 mm (Dejeu, 2010; Medrano et. al., 2015) of which at least 250-300 mm evenly distributed during the growing period of the vine (Dejeu, 2010).
The multiannual amount of rainfall for the period 1979-2011 was 665.89 mm with 8.69 mm more than that recorded in 2020 (657.2 mm) and with 104.91 mm less than the amount recorded in 2021 (770.8 mm) (Figure 2).

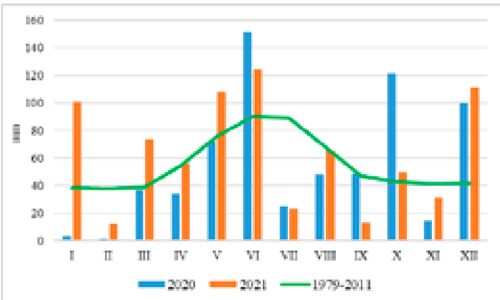

Figure 2 The precipitation evolution in 2020 and 2021

The relationship between the total number of insects counted (as individuals) from 2020 and 2021 and the total number of different species of which they belong is presented in Figure 3. It can be seen that the largest number of individuals was collected during the 17.07.-31.07.2020, 6.07.-17.07.2020, 03.08.-17.08.2020, 17.08.-31.08.2020 periods.

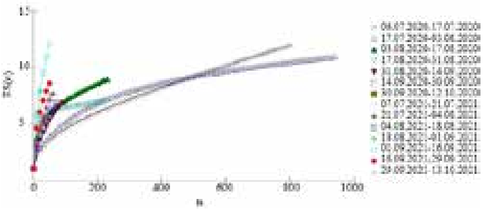

Figure 3. Rarefaction plot

The Simpson and Shannon indices measure species diversity on the basis of species richness and evenness in abundance (Santini et al., 2017).

One difference between the Shannon and Simpson indices is their relative sensitivity to rare species. The Simpson Index calculate the weighted dominance over common species, while the Shannon Index is an equally weighted informational statistic for rare and ordinary species (Magurran 1988).

The Shannon Index is the most preferred of all diversity indices. Its values are between 0.0 and 0.5 (Kocatas, 1992). The values above 3.0 suggest that the habitat structure is stable and balanced and the values under 1.0 indicate that there is a degradation of habitat structure (Türkmen and Kazanci, 2010). Also, 1.0 means a low diversity and 5.0 a high diversity (Gering et. al, 2003). For both years (2020 and 2021) the Shannon index shows values below 1 (Figure 4), the highest value (0.910) being registered in the 01.09.2021-16.09.2021 period and the lowest (0.509) in the 06.07.2020-17.07.2020 period. Therefore, the diversity of insects at ground level was reduced over the entire study.

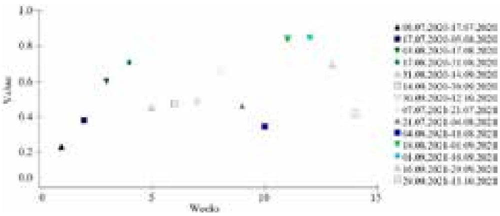

Figure 4. Shannon Index Results

Simpson index (D) measures the dominance strength and varies inversely with species diversity (Sagar & Sharma, 2012). The Simpson index always has values less than 1 (Pielou, 1969, Gering et al, 2003). Thus, the species diversity for this index, varies from 0-1; where, zero means no diversity and 1, maximum diversity (Sagar and Sharma, 2012). Therefore, during the 2 years of study the maximum diversity was recorded in the 06-17.07.2020 and 4-18.08.2021 periods and the lowest in 18 -01.09.2021 and 01-16.09.2021 periods (Figure 5).

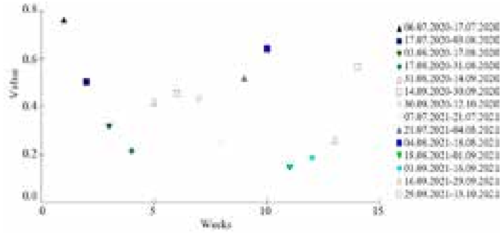

Figure 5. Simpson index

Examination of the relationship between S (species richness), H (information), and E (evenness) was performed through SHE analysis. When in the SHE analysis the Ln(E)/Ln(S) fraction is the most constant, it means that there is a balance between species richness and evenness (Zamfirescu & Zamfirescu, 2005). During insect monitoring was observed that the Ln(E)/Ln(S) fraction has become constant from the fourth collecting and lasted until the end of the monitoring (Figure 6). Therefore, in the 17.08.2020-31.08.2020, 31.08.2020-14.09.2020,14.09.2020-30.09.2020,30.09.2020-12.10.2020,07.07.2021-21.07.2021,21.07.2021-04.08.2021,04.08.2021-18.08.2021,18.08.2021-01.09.2021,01.09.2021-16.09.2021,16.09.2021-29.09.2021,29.09.2021-13.10.2021 periods was a balance between species richness and evenness.

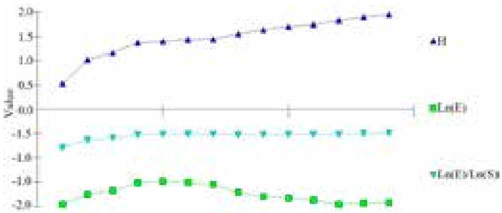

Figure 6. She analysis

Bray-Curtis index was used to determine the degree of similarity in species composition between 14 insects collecting periods. As you can see in Figure 7, there is no similarity between the two years in which the insects were monitored. There were similarities only between the periods of the same year. Thus, for the 2020 year the highest similarity was between the 17.08.2020-31.08.2020 and 31.08.2020-14.09.2020 periods (56%); for 2021, 21.07.2021-04.08.2021 and 4.08.2021-18.08.2021 periods (80%).

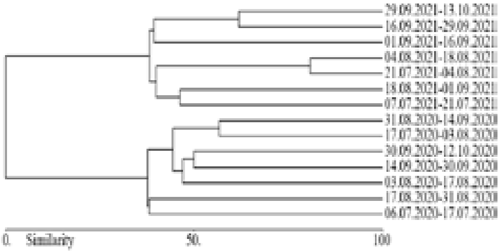

Figure 7. Bray-Curtis Cluster Analysis between insect collection periods

The insects compose the biggest group of organisms on earth about 66% of all animal species. They form an important part of ecosystems, provides valuable ecosystem services and can be found almost everywhere. Herbivorous insects damage 18% of worldwide agricultural production. Despite these damages fewer than 0.5 % are considered pests (Jankielsohn A., 2018).

CONCLUSIONS

In 2020, 20 species of insects were identified (a total of 2429 individuals) and in 2021, 28 species (a total of 395 individuals).

According to the Simpson Index, the greatest diversity took place in the 06.-17.07.2020 and 04.-18.08.2021 periods.

From 17.08.2020 until 13.10.2021 there was a balance between species richness and evenness.

There was similarity in species composition only between the periods of the same year, not between years.

The insect species identified in the 2021-2022 years did not cause damage in the monitored vineyards.

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REFERENCES

Ernst, C.M., Loboda, S. & Buddle, C.M. (2015). Capturing northern biodiversity, diversity of arctic, subarctic and north boreal beetles and spiders are affected by trap type and habitat. *Insect Conservation and Diversity, 9*, 63–73.

Babin-Fenske, J. & Anand, M. (2010). Terrestrial insect communities and the restoration of an industrially perturbed landscape: assessing success and surrogacy. *Restoration. Ecology*, *18*, 73–84.

Boetzl, FA, Ries, E, Schneider & G, Krauss J. (2018). It's a matter of design—how pitfall trap design affects trap samples and possible predictions. *PeerJ* - 6:e5078 https://doi.org/10.7717/peerj.5078.

Borowiec, M., Cover, S. & Rabeling, C., (2021). The evolution of social parasitism in *Formica* ants revealed by a global phylogeny. *Proceedings of the National Academy of Sciences*. U.S.A. *118*(38), e2026029118, https://doi.org/10.1073/pnas.2026029118.

Brown, G.R. & Matthews, I.M. (2016). A review of extensive variation in the design of pitfall traps and a proposal for a standard pitfall trap design for monitoring ground-active arthropod biodiversity. *Ecology and evolution, 6*(12), 3953-64, https://doi.org/10.1002/ece3.2176.

Császár, P., Torma, A., Gallé-Szpisjak, N., Tölgyesi, C. & Gallé, R. (2018). Efficiency of pitfall traps with funnels and/or roofs in capturing ground-dwelling arthropods. *European Journal of Entomology, 115*, 15–24, 2018 doi:10.14411/eje.2018.003

Dejeu, L.C. (2010). *Viticultura*. Bucharest, RO: Ceres Publishing House, 480 pp.

Gering, J.C, Crist T.O. & Veech, J.A. (2003). Additive Partitioning of Species Diversity across Multiple Spatial Scales: Implications for Regional. *Conservation Biology*, *17*(2), 488–499, DOI: 10.1046/j.1523-1739.2003.01465.x.

Isaia, M., Paschetta, M., Gobbi, M., Zapparoli, M., Chiarle, A. & Taglianti, A.V. (2015). Stand maturity affects positively grounddwelling arthropods in a protected beech forest. *Annals of Forest Science*, *72*, 415–424.

Jankielsohn, A. (2018). The Importance of Insects in Agricultural Ecosystems. *Advances in Entomology*, *6*, 62-73. https://doi.org/10.4236/ae.2018.62006.

Kocatas, A., (1992). *Ekoloji ve Çevre Biyolojisi* (Ecology and Environmental Biology). Ege Üniversity Matbaasi, Izmir, Turkey, 564s.

Magurran, A.E. (1988). *Ecological diversity and its measurement*. Princeton University Press. Princeton, New Jersey, USA: Springer, Dordrecht, pp. 179, https://doi.org/10.1007/978-94-015-7358-0

Medrano, H., Tomás, M., Martorell, Martorell, S., Escalona J.-M, Pou, A., Fuentes, S., Flexas. J. & Bota J. (2015). Improving water use efficiency of vineyards in semi-arid regions. A review. *Agronomy for Sustainable Development, 35*, 499–517. https://doi.org/10.1007/s13593-014-0280-z

Pielou, E.C. (1969). *An introduction to Mathematical Ecology.* New York, USA: Wiley.

Quque, M. & Bles, O. (2020). *Lasius*. In: Starr C. (eds) Encyclopedia of Social Insects. Springer, Cham. https://doi.org/10.1007/978-3-319-90306-4_169-1

Radchenko, A.G., Perkovsky, E.E. & Vasilenko D.V. (2021). *Formica* species (Hymenoptera, Formicidae, Formicinae) in late Eocene Rovno amber. *Journal of Hymenoptera Research, 82,* 237-251. https://doi.org/10.3897/jhr.82.64599

Sagar, R., & Sharma, G.P. (2012). Measurement of alpha diversity using Simpson index (1/Lamda): the jeopardy. *Environmental Skeptics and Critics*, *1*(1), 23.

Da Silva, P.M., Aguiar, C.A.S., Silva, I.D.F.E. & Serrano A.R.M. (2011). Orchard and riparian habitats enhance ground dwelling beetle diversity in Mediterranean agro-forestry systems. *Biodiversity and Conservation*, *20*, 861–872.

Santini, L., Belmaker, J., Mark, J., Costello, M.J., Pereira, H.M., Rossberg, A.G., Schipper, A.M., Ceaușu, S., Dornelas, M., Hilbers, J.P., Hortal, J., Huijbregts, M.A.J., Navarro, L.M., Schiffers, K.H., Visconti, P. & Rondinini, C. (2017). Assessing the suitability of diversity metrics to detect biodiversity change. *Biological Conservation*, *213*, 341–350, https://doi.org/10.1016/j.biocon.2016.08.024

Schmidt, M. H., Clough, Y., Schulz, W., Westphalen, A., & Tscharntke, T. (2006). Capture efficiency and preservation attributes of different fluids in pitfall traps. *Journal of Arachnology, 34(1), 159–162.* doi:10.1636/t04-95.1

Southwood, T.R.E. & Henderson, P.A. (2000*). Ecological Methods*. Oxford, United Kingdom: Blackwell Science, 575 pp.

Tabaranu, G., Enache V., Donici, A. & Bîrliga, N., (2018). Research on biodiversity conservation and management in the viticultural agroecosystem in the Dealul Bujorului vineyard. *Scientific papers - Horticulture*, USAMV Iași, RO, *61*(2).

Thukral, A.K. (2017). A review on measurement of Alpha diversity in biology. *Agricultural Research Journal,* 54(1), 1-10. DOI: 10.5958/2395-146X.2017.00001.1

Türkmen, G. & Kazanci N., 2010, Applications of various biodiversity indices to benthic macroinvertebrate assemblages in Streams of a National park in Turkey. *Review of Hydrobiology*, *3*(2), 111-125.

Véle, A., Holusa, J. & Frouz, J. (2009). Ecological requirements of some ant species of the genus *Formica* (Hymenoptera, Formicidae) in spruce forests. *Journal of Forest Science, 55,* 32-40, https://doi.org/10.17221/56/2008-JFS

Zamfirescu O. & Zamfirescu S.R. (2005). Diversity analysis of *Festuco rubrae-agrostetum capillaris* horv. 1951 grasslands from the Stanisoara mountains SW slopes, *Revue roumaine de Biologie. Serie Biologie vegetale, 48*, 105-113.

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