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Seasonal abundance of insects from a vineyard in southern Romania

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Abstract: A field experiment was undertaken in a vineyard in southern Romania to evaluate the insect species abundance in this temperate climate area, over a period of 24 consecutive weeks, starting from April 2nd to September 27th, 2019. A total number of 19 303 insects were collected. After their morphological analysis, 89 species of insects were identified (nine orders and 28 families), of which 52 came from beneficial fauna (six orders and 14 families, 1 316 individuals) and 37 came from pest fauna (six orders and 26 families, 17 987 individuals). The beneficial species richness of the Coleoptera and Hymenoptera orders were the best represented. The pest insects of the Coleoptera and Hemiptera orders registered a high number of families, while the Thripidae family had the highest number of individuals. The highest diversity of insect species was found in the middle of April, and the lowest was found in the middle of August. The Bray–Curtis analysis revealed the stability of the insect community in the studied grapevine growing area. Grouping insects based on their similarities revealed the highest similarity (91.05–97%) in the warmest periods (June–August) and the lowest similarity (33%) in the spring (April).

Keywords: viticulture; arthropods; richness; diversity; similarity

A viticultural biocenosis consists of populations including green plants (grapevines, intercrops, weeds), fungi, bacteria, viruses, insects and other living things of plant or animal in nature. Such groups of territorially linked populations are functionally independent. The simplicity of a grapevine biocenosis makes it vulnerable to both climatic adversities and those caused by diseases, insects, bacteria, and viruses (Oprea 2001). The members of these heterogenous communities are influenced by environmental conditions, especially the temperature and precipitation (Bois et al. 2017).

A viticultural biocenosis includes both pest and beneficial entomofauna. Insects can cause serious economic damage to the grapes' quality and quantity (Goussard 2013). The biodiversity needs to be protected, and eventually enriched, for its enormous ecological, agronomical and economic value (Mania et al. 2015).

The present paper presents a survey of insect fauna in a vineyard (*Vitis vinifera* L.) in southern

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Romania, with the aim to obtain information on the species diversity in this area and to implement a programme of integrated pest management to protect the useful fauna.

MATERIAL AND METHODS

The insect fauna survey was performed in a vineyard belonging to National Research and Development Institute for Biotechnology in Horticulture Stefanesti-Arges in 2019, starting from April 2nd to September 27th. The vineyard plantation was established in 2010 with a distance of 2.40 m between the rows and a distance of 1 m between the plants/row. The applied cutting system is short, with short production elements (2–3 eyes/spur), and 4–8 spurs of fruit/hub, depending on its vigour. Natural cover grassing between the grapevine rows was present from the vineyard's establishment. The presence of the useful and pest insect fauna was monitored using sticky traps only.

The labelled traps with insects were stored in plastic bags at 12 °C until examination. Subsequently, the insect traps were examined four times a month under an IPM-scope digital microscope (Spectrum Technologies, USA) and an Optika SZM-2 trinocular stereomicroscope equipped with an Optika CP-8 photo camera (Optika, Italy), for 24 consecutive sampling events across the mentioned period as follows: 1: April 2–10; 2: April 10–19; 3: April 19–25; 4: April 25–May 2; 5: May 2–10; 6: May 10–16; 7: May 16–23; 8: May 23–31; 9: May 31–June 6; 10: June 7–14; 11: June 14–21; 12: June 21–July 1; 13: July 1–9; 14: July 9–16; 15: July 16–23, 16: July 23–30; 17: July 30–August 6; 18: August 6–13; 19: August 13–20; 20: August 20–28; 21: August 28–September 5; 22: September 5–12; 23: September 12–20; 24: September 20–27.

The insecticide treatments were carried out in May–September against grapevine pests with: 18 g/L abamectin 0.75–1 L/ha (May 27, 2019; June 20, 2019), 25% thiamethoxam 0.16 kg/ha (July 25, 2019), 200 g/kg acetamiprid 0.250 kg/ha (August 9, 2019), 480 g/L thiacloprid 300 mL/ha (August 21, 2019); and the fungicide treatments were carried out with: 250 g/kg folpet + 500 g/kg aluminium fosetyl (May 27, 2019; July 25, 2019), 4.4 fluopicolide + 66.67 aluminium fosetyl and 53 g/L prothioconazole + 224 g/L spiroxamine + 148 g/L tebuconazole (July 4, 2021), 90 g/L diametomorph + 600 g/L mancozeb, 500 g/L chlorothalonil and 240 g/L myclobutanil (August 21, 2021).

The species richness, alpha diversity index (rarefaction which was used to assess species richness from the results of sampling), SHE analysis (used to examine the relationship between S – species richness; H – information, the Shannon-Wiener diversity index and E – evenness as measured using the Shannon-Wiener evenness index) in the samples. Shannon index, Simpson index, Bray–Curtis analysis were calculated with the BioDiversity Professional 2 program.

Also, the environmental factors, such as the temperature, relative air humidity and precipitation, were monitored throughout the study with an iMETOS 3.3 weather station located close to the vineyards (at 44°85' latitude, 24°90' longitude and 268.1 m altitude).

RESULTS AND DISCUSSION

After the morphological analysis, 89 species of insects were identified (nine orders and 28 families), of which 52 came from beneficial fauna (six orders and 14 families) and 37 came from pest fauna (six orders and 26 families). They were classified depending on their usefulness for agriculture using the information found in the literature. In total, 19 303 individuals were collected. Within the insect orders, the beneficial species richness of Coleoptera and Hymenoptera were the best represented. Also, the pest insect orders Coleoptera and Hemiptera registered a high number of families, but the Thripidae family (Thysanoptera order) had the highest number of individuals (Tables 1 and 2). The identified insects are included in eight orders. In the Coleoptera and Hymenoptera orders, the useful insects predominated, in the Hemiptera and Diptera orders, the harmful insects predominated, in the Neuroptera and Mecoptera orders, there were only useful insects, and in the Lepidoptera and Thysanoptera orders, there were only harmful insects (Figure 1).

The species richness is the most commonly used measure of diversity (Batáry et al. 2015). The highest number of individuals was registered in the May 23–31, 2019 period (2 594 individuals), followed by the June 7–14, 2019 period (2 508 individuals). The lowest number of individuals was registered in the April 2–10, 2019 period (58 individuals). The species richness showed an increasing number of insects throughout the survey period (Figure 2).

The best represented weeds between the grapevine rows were from the families Equisetaceae (*Equisetum*

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Table 1. Beneficial fauna insects monitored during April to September 2019

Order	Family	Species (*n*)	Species/*n*	Individuals total (*n*)
Coleoptera	Amphizoidae	1	*Amphizoa insolens*/1	1
	Coccinellidae	9	*Anisosticta novemdecipunctata*/3 *Coccinella magnifica*/1 *C. quatuordecimpunctata*/14 *C. septempunctata*/18 *Harmonia axyridis*/209 *Hippodamia variegata*/2 *Psyllobora vigintiduopunctata*/7 *Scymnus frontalis*/2 *Tytthaspis sedecimpunctata*/5	261
	Buprestidae	3	*Anthaxia chevrieri*/2 *A. fulgurans*/1 *A. nitidula signaticollis*/3	6
	Staphylinidae	2	*Anthobium atrocephalum*/2 *Batrisodes* sp./2	4
	Scarabaeidae	1	*Caccobius schreberi*/1	1
	Cantharidae	2	*Cantharis rustica*/11 *Cantharis* sp./46	57
	Hydrophilidae	1	*Cryptopleurum minutum*/599	599
	Carabidae	1	*Stenolophus teutonus*/10	10
	Melyridae	2	*Malachius aeneus*/1 *Malachius bipustulatus*/15	16
	Oedemeridae	1	*Oedemera croceicollis*/6	6
	Erotylidae	1	*Triplax scutellaris*/1	1
	Mordellidae	1	*Mordella aculeata*/58	58
Hymenoptera	Sphecidae	2	*Ammophila* sp./3 *Spex* sp./3	6
	Andrenidae	5	*Andrena cineraria*/10 *A. ovulata*/7 *A.* sp./27 *A. subopaca*/14 *A. wilkella*/7	65
	Apidae	2	*Apis melifera*/20 *Bombus terrestris*/2	22
	Braconidae	1	*Cenocoelius analis*/4	4
	Chrysididae	1	*Chrysis ignita*/1	1
	Ichneumonidae	2	*Diphyus quadripunctorius*/2 *Ichneumon gracilentus*/12	14
	Formicidae	1	*Lasius niger*/2	2
	Vespidae	3	*Polistes dominula*/40 *Vespula germanica*/1 *Vespula vulgaris*/5	46
Hemiptera	Pentatomidae	1	*Zicrona caerulea*/36	36
	Aphrophoridae	1	*Philaenus spumarius*/3	3

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Table 1 to be continued

Order	Family	Species (n)	Species/n	Individuals total (n)
Diptera	Chaoboridae	1	*Chaoborus flavicans*/5	5
	Tachinidae	2	*Gymnocheta viridis*/12 *Voria ruralis*/21	33
	Sarcophagidae	1	*Sarcophaga* sp./34	34
	Syrphidae	1	*Syrphus knabi*/2	2
Neuroptera	Chrysopidae	2	*Chrysoperla carnea*/17 *Mallada* sp./4	21
Mecoptera	Panorpidae	1	*Neopanorpa lipingensis*/2	2
Total				1 316

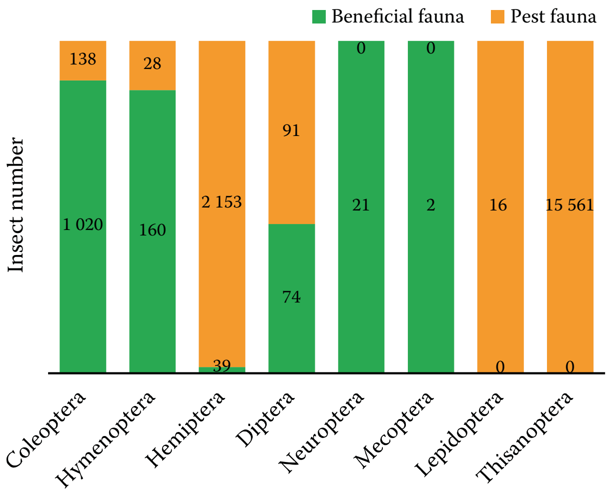

Figure 1. Number of useful and harmful insects identified in the vineyard from April 2 to September 27, 2019

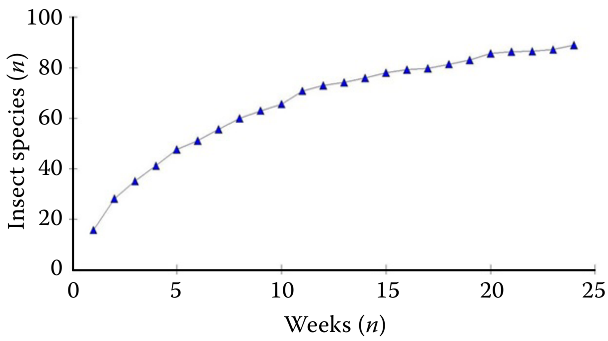

Figure 2. The insect species richness in the monitored vineyards from April 2 to September 27, 2019

arvense), Poaceae (*Agropyron repens*, *Alopecurus myosuroides*, *Apera spica-venti*, *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria glauca*, *S. viridis*, *Sorghum halepense*), Lamiaceae (*Lamium album*, *L. purpureum*), Fabaceae (*Trifolium pratense*). Also, an alfalfa culture (*Medicago sativa*) is located close to the experimental field.

During the studied period, the main climatic factors varied as follows: the amplitude of the air temperature varied between 21.33 °C and 31.36 °C; the air temperature (average) varied between 11.11 °C and 23.25 °C; the air temperature (maximum) varied between 27.49 °C and 35.39 °C; the air temperature (minimum) varied between –0.06 °C and 11.34 °C; the rainfall varied between 3.2 mm and 188.4 mm (Figure 3). The highest number of insect individuals from this period was represented by *Trips* sp. (15 561), *Corythucha ciliata* (913), *Myzus cerasi* (855), *Cryptopleurum minutum* (599), *Myzus persicae* (268), and *Harmonia axyridis* (209). The number of individuals of the other identified insect species ranged from one to 61 (Figure 4; Tables 1 and 2).

To characterise the structural diversity, the Shannon index was calculated, showing that the best distribution of insect fauna was in the April 10–19, 2019 and April 19–25, 2019 periods, and the weakest distribution was in the August 13–20, 2019 and July 30–August 6, 2019 periods (Figure 5).

The vegetation (spontaneous plants, seeded cover crops) had a good influence on the abundance and diversity of beneficial arthropods in the vineyards (Buchholz et al. 2017).

Regarding the Simpson index, the data in Figure 6 shows that the highest diversity of insect species was found in the April 10–19, 2019; April 19–25, 2019 and April 2–10, 2019 periods, and the lowest diversity was found in the August 13–20, 2019 period. The diversity (H) and ratio between the species evenness and richness (LnE/LnS) varied from one week to another, but the evenness (LnE) shows a constant pattern from the beginning to the end of the studied period. The SHE analysis reflected the stability of the insect community in the studied grapevine growing area (Figure 7).

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Table 2. Pest fauna insects monitored during April to September 2019

Order	Family	Species (*n*)	Species/*n* of individuals	Individuals total (*n*)
Coleoptera	Chrysomelidae	5	*Altica foliaceae*/1 *Coleoptera chrysomelidae*/14 *Cryptocephalus* sp./3 *Diabrotica virgiferavirgifera*/2 *Gastrophysa viridula*/18	38
	Buprestidae	1	*Cylindromorphus filum*/2	2
	Staphylinidae	2	*Nudobius lentus*/2 *Paederus fuscipes*/2	4
	Curculionidae	1	*Anthonomus rubi*/27	27
	Attelabidae	1	*Byctiscus betulae*/1	1
	Cerambicinae	1	*Clytus lama*/12	12
	Dermestide	1	*Dermestes murinus*/4	4
	Carabidae	2	*Diachromus germanus*/1 *Harpalus rubripes*/1	2
	Melyridae	1	*Melyridae* sp./2	2
	Brentidae	1	*Protapion fulvipes*/38	38
	Cerambycidae	2	*Stenocorus meridianus*/1 *Stenocorus vestitus*/4	5
	Cleridae	2	*Trichodes apiarius*/2 *Trichodes crabroniformis*/1	3
Hymenoptera	Argidae	1	*Arge ochropus*/28	28
Hemiptera	Membracidae	2	*Centrotus cornutus*/39 *Ceresa bubalus*/3	42
	Cicadellidae	1	*Cicadella viridis*/41	41
	Tingidae	1	*Corythucha ciliata*/913	913
	Pentatomidae	2	*Eysarcoris inconspicuus*/5 *Graphosoma lineatum*/1	6
	Lygaeidae	1	*Lygaeus equestris*/1	1
	Miridae	1	*Lygus spinolai*/27	27
	Aphididae	2	*Myzus cerasi*/855 *Myzus persicae*/268	1 123
Diptera	Anthomyiidae	1	*Anthomyia procellaris*/30	30
	Muscidae	1	*Musca domestica*/61	61
Lepidoptera	Papilionidae	1	*Iphiclides podalirius*/2	2
	Hesperiidae	1	*Ochlodes sylvanus*/7	7
	Zygaenidae	1	*Zygaena filipendulae*/7	7
Thisanoptera	Thripidae	1	*Thrips* sp./15 561	15 561
Total				17 987

The highest similarity was registered between the periods: 16 and 19 (97%), followed by 11 and 17 (96%), eight and 10 (91.29%), 11 and 18 (91.05%) and the lowest between the periods: one and four (33%). The Bray–Curtis cluster analysis showed that the highest similarity (97%) was registered between the July 23–30, 2019 and August 13–20, 2019 periods (Figure 8).

The presence of both beneficial and pest insects could be influenced, on one hand, by the inter-row flora (spontaneous or seeded cover plants) and the proximity of the other crops to the vineyard,

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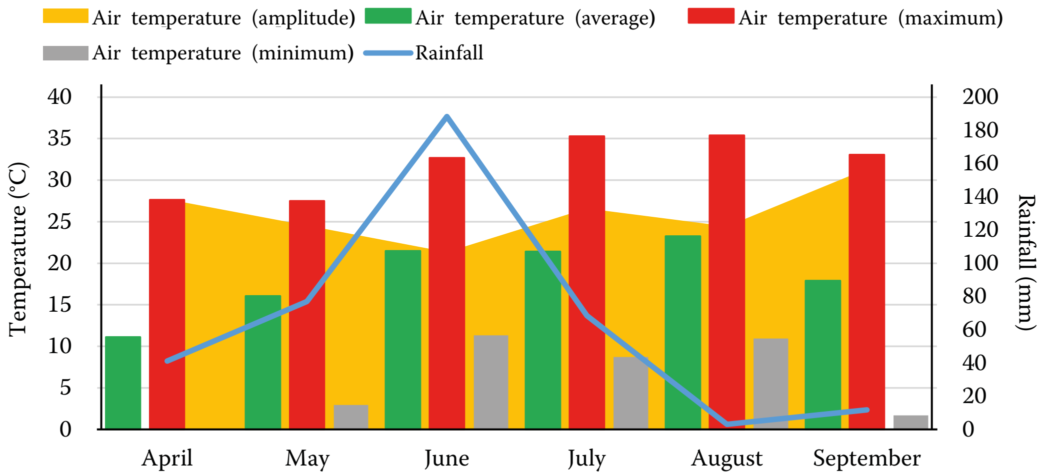

Figure 3. Evolution of the temperature and precipitation from April 2 to September 27, 2019

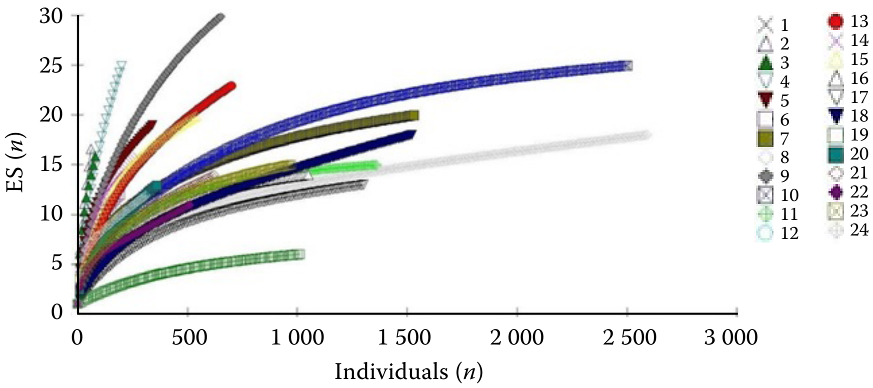

Figure 4. Rarefaction, the assessment of the species richness in the monitored vineyards from April 2 to September 27, 2019 Individuals (n) – number of individuals of all the species in each period of about a week; ES (n) – number of species/every week

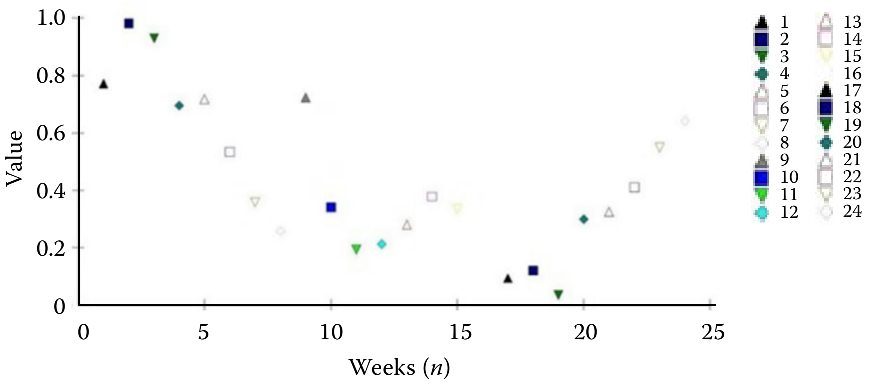

Figure 5. Shannon index, the structural diversity of the insect species in the monitored vineyards from April 2 to September 27, 2019

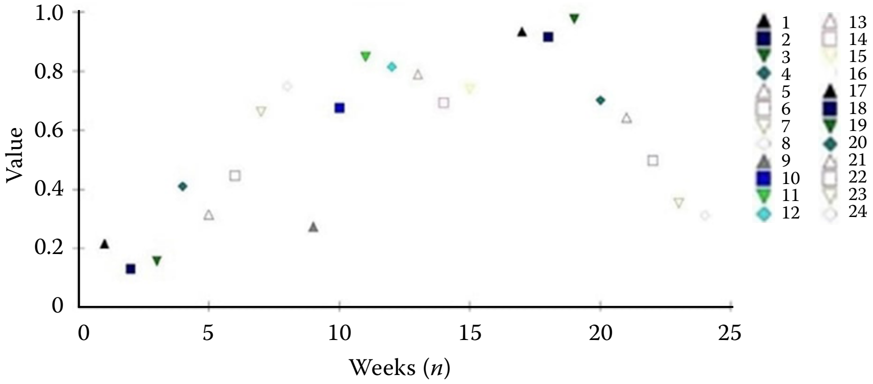

Figure 6. Simpson index in the monitored vineyards from April 2 to September 27, 2019

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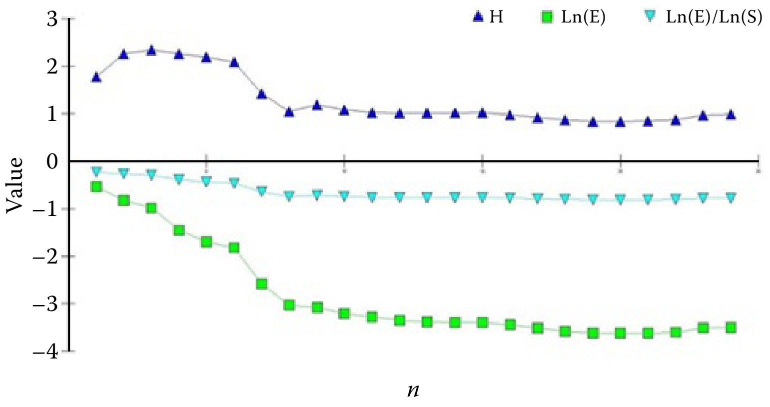

Figure 7. SHE analysis, relationship between the species richness (S), Shannon-Wiener diversity index (H), evenness (E) from April 2 to September 27, 2019
Ln – logarithm

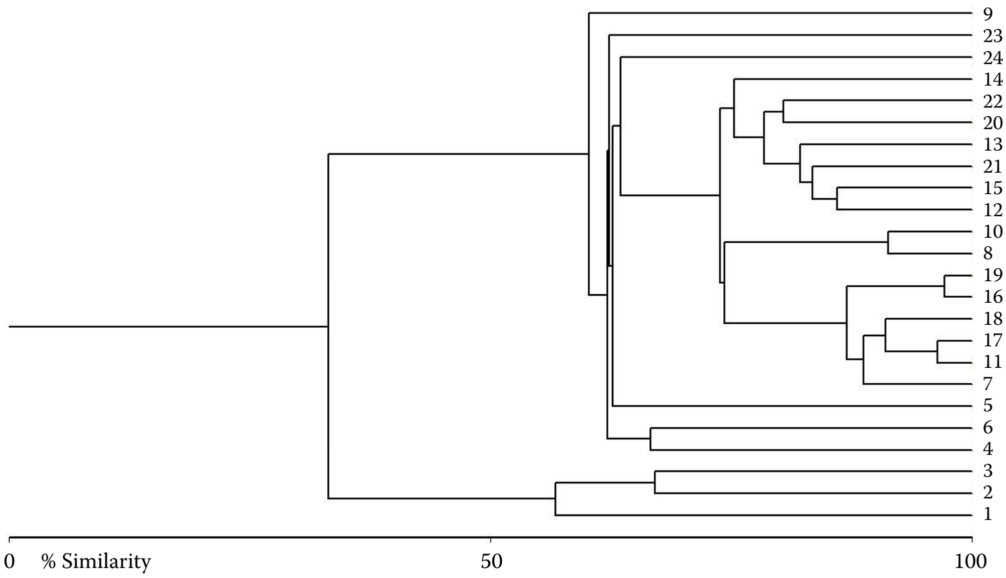

Figure 8. Insect grouping based on their similarities, from April 2 to September 27, 2019 (1–24 periods), Bray–Curtis cluster analysis (single link)

and, on the other hand by the climatic evolution observed by the temperature and precipitation values.

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