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Ecological Structure of the Harmful Entomocomplex of Apple Orchards of the Central Forest-Steppe of Ukraine

Svitlana Mostoviak[1*], Andrii Berezovskyi[2], Ihor Krykunov[1]

[1] Department of Plant Protection and Quarantine, Uman National University of Horticulture, Institutska 1, Uman, Ukraine, 20300

[2] Department of Applied Engineering and Labor Protection, Uman National University of Horticulture, Institutska 1, Uman, Ukraine, 20300

* Corresponding author's e-mail: s.mostoviak@gmail.com

ABSTRACT

The most widespread culture in the structure of fruit plantations in Ukraine is the apple tree. An important factor in the highly efficient production of apples is ensuring proper phytosanitary state of plantations and observing agrotechnological methods of growing, which is possible only with constant and long-term monitoring of the species composition, population dynamics, biological and ecological features of the entomoplex. The aim of the study conducted in 2005–2020 was to determine the ecological structure of the harmful entomocomplex of apple orchards under the conditions of the Central Forest-Steppe of Ukraine. Field, laboratory and chamber research methods generally accepted in ecology and entomology were used to fulfill the tasks. In the study, 52 species of phytophagous insects from 25 families and 7 orders were identified; 5 species of phytophagous mites from 3 families of Tetranychidae (*Panonychus ulmi* Koch., *Tetranychus urticae* Koch., *Scizotetranychus pruni* Oudms.), Bryobiidae (*Bryobia redikorzevi* Reck., syn: *Bryobia praetiosa* Koch.), Eriophyoidae (Eriophyes mali Nal.) were also found. The taxonomic structure of phytophagous insects was dominated by representatives of the orders of Lepidoptera (24 species), Coleoptera (14 species) and Homoptera (9 species), the portion of which collectively amounted to 90%. A range of Lepidoptera represented by 13 families was characterized by wide species diversity: Tortricidae, Gracillariidae, Yponomeutidae, Lyonetiidae, Cossidae, Sesiidae, Coleophoridae, Lasiocampidae, Geometridae, Pieridae, Arctiidae, Noctuidae, Orgyidae, which accounted for 46% of the harmful entomocomplex. The most numerous (dominant) species for the period 2005-2020 were three species of aphids (*Aphis pomi* De G, *Dysaphis devecta* Walk, *Dysaphis mali* Ferr.), apple moth (*Carpocapsa pomonella* L.) and leaf rollers (*Archips rosana* L.). In terms of trophic specialization, polyphages dominated 75% (39 species) of apple tree agrocenoses, 10% (5 species) of oligophagous insects, 15% (8 species) – monophages. The life forms were dominated by phytophiles – dendrobiotes, the percentage of which in the total structure of insect pests was about 90%. The species composition of harmful entomofauna and ecologically constant species of phytophagous insects in apple plantations in the Central Forest-Steppe of Ukraine were specified. A promising study is to clarify the features of the biology of the most harmful phytophagous insects under the conditions of climate change and to develop environmentally safe means of protecting apple plantations from pests.

Keywords: apple orchard, pests, species diversity, dominant species, ecologically constant species.

INTRODUCTION

The natural and climatic conditions of Ukraine are favorable for the cultivation of not only traditional field crops (cereals, legumes, industrial crops), but also perennial fruit and berry crops. With the aim of wider development of the horticulture industry, the sectoral Horticulture Development Program of Ukraine for the period until 2025 was approved back in 2008, which provided for the stabilization and further increase of fruit and berry production; saturation of the domestic food market with competitive products and expansion of their export, expansion of the production

of ecologically safe products through the transition from industrial-chemical methods of farming to biological ones; intensive management by improving technologies and organizing production based on the use of scientific achievements and best practices (Concept and sectoral Program, 2008).

The most common crop in the structure of perennial fruit plantations in Ukraine is the apple tree, the production of fruits among grain crops on average for 2015–2020 was about 90% or 1227.7 thousand tons/year. According to the State Statistics Service of Ukraine in 2020, the total area of apple tree plantations at the fruit-bearing age was 85 thousand hectares, and in the territory of the Central Forest Steppe – 19.72 thousand hectares (or 23.2%) (State Statistics Service of Ukraine). In general, Ukraine ranks eleventh in global apple production and fourth in Europe and has all the signs of market stability (Salo, 2020)

One of the important factors of highly efficient production of apples is ensuring proper phytosanitary status of plantations and compliance with agrotechnological methods of cultivation. Thus, for example, the productivity of fruit crops decreases by 35–45%, and the marketability of fruits by 45–60% due to the harmful effects of pests and due to untimely or incorrect selection of drugs for carrying out protective measures against harmful types of mites and insects (Yanovskyi, 2021).

PREVIOUS RESEARCH

The peculiarity of perennial fruit plantations is that specific agrocenoses with a relatively stable complex of living organisms are formed. According to O. Balykina (2016), a modern industrial orchard is both a complex natural biological system with characteristic features of functioning and development and an artificially created phytoassociation with its own characteristics. Despite the fact that the garden is a monoculture agrocenosis, leveled by age and breed-varietal composition, the system "fruit trees – pests – predators and parasites" is not sustainable (Vasilev & Livshits, 1984)]. The influence of biotic and anthropogenic factors constantly introduces an imbalance into the structure and functioning of the biocenosis, including changing the structure of the complex of harmful organisms, their number and harmfulness (Mazzi & Dorn, 2012; Garcia et al., 2021; Pelissie et al., 2018).

Long-term monitoring studies in the Crimea have shown the most labile and prone to change order of lepidoptera (Lepidoptera) – in more than 40 years, the species composition of the dominant species has almost completely changed. At the same time, representatives of beetles (Coleoptera) and homopterous insects (Homoptera) are much more stable. In phytophagous mites, interspecies fluctuations in numbers occur during one growing season (Balyikina &Yagodinskaya, 2019)

Different types of pests in agroecosystems often show rapid evolution to the influence of environmental factors and agricultural technologies, in particular new varieties and hybrids and pesticides (Pelissie et al., 2018; Morales-Hojas et al., 2020).

With changes in the structure of crops, the introduction of intensive varieties and hybrids, the use of significant amounts of chemical plant protection agents, and changes in the climate, there is an inevitable change in the status of the pest. Many pests expanded the limits of their existence, developed resistance to pesticides and acquired the status of dominants (Rathee, 2018). As a result, the harmfulness of most insect pests and pathogens usually increases at all stages of development, which causes significant economic losses to producers, also due to an increase in financial costs for plant protection products (Altaf et al., 2019; Galinato, 2018).

One of the decisive factors affecting the formation of the entomoacarocomplex in an apple orchard is the use of insectoacaricides. In recent decades, the range of insecticides and the system of their use have been almost completely updated. It has been established that their repeated use leads to the complete destruction of both harmful arthropods and entomoacaryphages, disruption of trophic relationships that stabilize the garden agrocenosis, as well as a change in the dominant species composition of insects and mites (Balyikina & Yagodinskaya, 2019).

It has been proven that the violation of crop cultivation technologies leads to changes in the microclimate in agrocenoses, and thus to the conditions for the development of harmful organisms. At the same time, there are changes in the structure of pest populations in agrocenoses, increased development and harmfulness of phytophages, which previously had no economic importance. Thus, the scientific work of M. Arya and F. Farooq reports on the increase in the number and harmfulness of the woolly aphid (*Eriosoma lanigerum*

Hausmann), which has acquired the status of a dominant species (Arya & Farooq, 2019).

Climate change is also a powerful environmental factor. It was found that the warming caused an extension of the growing season of the apple tree and, accordingly, a change in the phenology of phytophages. The peculiarities of biology and the dynamics of the number of some species have changed. Due to the warming of the climate in agrocenoses, the restructuring of the "crop plant – pests" system occurs as a result of changes in the productivity, physiological state, and phenology of organisms. An imbalance in the system of phenological and biochemical co-adaptations of insects to the host plant can also cause a change in the dominant species in the harmful entomocomplex (Moinina et al., 2019; Qu et al., 2016; Sofi, 2017).

Numerous studies of Ukrainian (Kravets & Adamenko, 2014; Kravets et al., 2016; Krykunov et al., 2018; Yanovskyi, 2021) and foreign (Arya & Farooq, 2019; Balykina, 2016; Balyikina & Yagodinskaya, 2019; Rathee, 2018; Qu, 2016) scientists proved that the species and quantitative composition of harmful organisms in perennial fruit plantations cultures is not the same and depends on the age of the garden, breed and variety composition, weather conditions and agrotechnical measures. However, for the development of effective and environmentally safe measures to control the number of pests in agrocenoses of perennial plantations, monitoring their number, clarifying the species composition, and their biological and ecological features is constantly relevant. Such knowledge is of great importance for the development and improvement of ecological agricultural practices of pest control in apple orchards, preservation of biodiversity and obtaining ecologically safe products.

The aim was to determine the ecological structure of the harmful entomocomplex of apple plantations under the conditions of the Central Forest-Steppe of Ukraine.

MATERIALS AND METHODS

Complex monitoring studies on the species composition of harmful entomofauna were conducted in the commercial apple orchards of Uman National University of Horticulture during 2005–2020. For this purpose, the methods generally accepted in entomology were used: visual inspection of plants, sweep-net method, soil excavation, Petliuk's box, Barber's traps (Litvinov, 2009; Omeliuta et al., 1986.)

Petliuk's box, which resembles a truncated pyramid without a bottom and a top, with a layer of cotton wool attached to the inner surface of its walls, was used to catch and record small jumping insects (Omeliuta et al.,1986). The surface area was 0.1 m² (the size of the side wall at the bottom – 316 mm, at the top – 800 mm, with a height of 350 mm).

For the study of terrestrial entomofauna, Barber's traps were used – polyethylene glasses, filled to one third with a fixative (ethylene glycol) and dug in so that their upper part was at the level of the soil and tightly adjoined to it. The diameter of the upper part of the glass was 7 cm, its height was 9.5 cm. Pests were removed from the traps once every 10 days, placed on cotton mattresses and labeled. Identification of the species of insects was carried out using binoculars and markers.

The establishment of taxonomic affiliation of insects and ticks was carried out using appropriate identifiers and reference books (Krykunov et al., 2018). The number of pests was recorded during route surveys during the apple tree vegetation in the main phases of development (the Ecological constancy class of pests was determined by using the Du Rienz method (Du Rienz., 1931), the distribution by life forms – taking into account their developmental stage, which was the most harmful to plants (Lisovyi & Chaika, 2017).

RESULTS AND DISCUSSION

Studies of the agrocenoses of apple plantations proved that phytophages are present in the entomocomplex – representatives of 52 species of insects from 25 families.

The composition of harmful entomofauna in the apple plantations of the Central Forest-Steppe of Ukraine includes representatives of:

Coleoptera (beetles):

- Attelabidae (Rhynchitidae) – *Rhynchites bacchus* L., *Coenorrhinus pauxillus, Coenorrhinus aequatus* L.Germ.;
- Curculionidae – *Anthonomus pomorum* L., *Sciaphobus squalidus* Gyll., *Magdalis ruficornis* L.;
- Ipidae – *Xyleborus dispar* F., *Scolytus mali* Bechst., *Scolytus rugulosus* Ratz.;
- Scarabaeidae (пластинчастовусі) – *Epicometis hirta* Poda, *Melolontha melolontha* L., *Melolontha hippocastani* F., *Lethrus apterus* Laxm., *Oxythyrea funesta* Poda.

Lepidoptera (butterflies and moths):

- Arctiidae – *Hyphantria cunea* Dr.;
- Coleophoridae – *Coleophora hemerobiella* Scop.;
- Cossidae – *Zeuzera pyrina* L., *Cossus cossus* L.;
- Geometridae – *Operophtera brumata* L., *Eranhis defoliaria* Cl.;
- Gracillariidae – *Lithocollectis corylifoliella* Hw., *Lithocollectis pyrifoliella* Grsm.;
- Lasiocampidae – *Malacosoma neustria* L.;
- Lyonetiidae – *Leucoptera scitiella* L., *Lyonetia clerckella* L.;
- Noctuidae – *Epsilia transversa* Hfn., *Diloba coeruleocephala* L.;
- Orgyidae – *Euproctis chrysorrhoesa* L., *Ocneria dispar* L.;
- Pieridae –*Aporia crataegi* L.;
- Sesiidae – *Aegeria myopaeformis* Bkh.;
- Tortricidae – *Archips rosana* L., *Hedya nubiferana* Haw., *Adoxophyes orana* F., *Pandemis ribeana* Hb., *Carpocapsa pomonella* L., *Grapholitha molesta* Busck.;
- Yponomeutidae – *Yponomeuta malinellus* Zell.

Hymenoptera (hymenopterans):

- Tenthredinidae – *Hoplocampa testudinea* Klug.

Homoptera (homopterous insects):

- Aphididae – *Aphis pomi* Deg., *Rhopalosiphum insertum* Walk., *Dysaphis devecta* Walk., *Dysaphis mali* Ferr., *Eriosoma laniqerum* Hausm.;
- Cicadellidae –*Edwardsiana rosae* L., *Cicadella viridis* L.;
- Mordellidae – *Stictocephala bubalus* F.;
- Psyllidae – *Psylla pyri* L.

Hemiptera (bugs):

- Diaspididae – *Lipidosaphes ulmi* L., *Quadraspidiotus perniciosus* Comst.

Orthoptera (orthopteroid insects):

- Gryllotalpidae – *Gryllotalpa gryllotalpa* L.

Diptera (dipterous insects or flies):

- Cecidomyiidae – *Dasyneura mali* Kieff.

Taxonomic structure of the harmful entomocomplex of the apple orchard is dominated by representatives of Lepidoptera (24 species), Coleoptera (14 species) and Homoptera (9 species) (Fig. 1). In total, representatives of these three ranks occupied 90% of the structure of the harmful entomocomplex.

Butterflies and moths (Lepidoptera), represented by 13 families, were characterized by a wide species diversity: leaf rollers (Tortricidae), blotch miners (Gracillariidae), ermine moths (Yponomeutidae), bentwings (Lyonetiidae), earthworms (Cossidae), glass moths (Sesiidae), leaf rollers (Coleophoridae), cocoon insects (Lasiocampidae), pollinators (Geometridae), whiteflies (Pieridae), bears (Arctiidae), owlet moths (Noctuidae), waveflies (Orgyidae), which occupied 46% in the structure of the harmful entomocomplex.

Beetles (Coleoptera) consisted of 14 species from 4 families: rollers (Attelabidae (Rhynchitidae)), weevils (Curculionidae), bark beetles (Ipidae), plate beetles (Scarabaeidae). Their portion in the structure of the entomocomplex was 27%.

Homopterous insects (Homoptera) included 9 species from 4 families: humpbacks (Mordellidae), leafhoppers (Cicadellidae), jumping lice

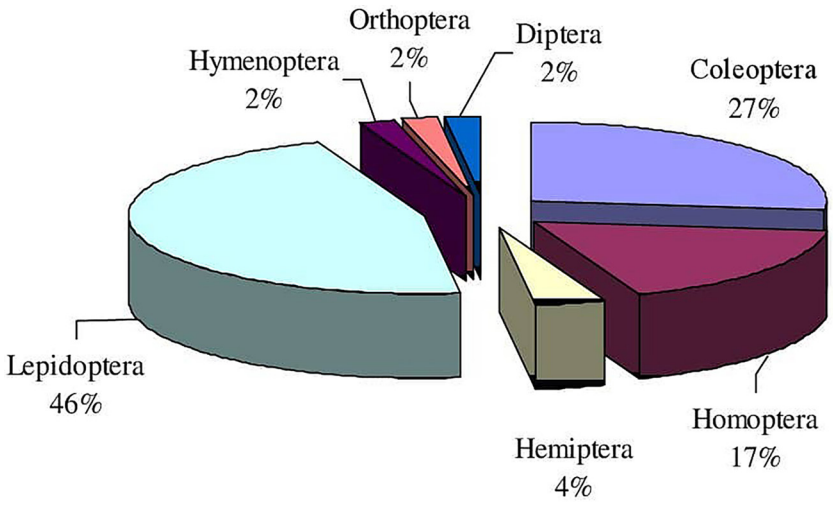

Figure 1. Taxonomic structure of harmful entomocomplex in apple tree plantations, 2005–2020

(Psyllidae) and aphids (Aphididae). Their portion in the structure of the complex of harmful phytophagous insects was 17%.

Representatives of bugs (Hemiptera) were represented by only two species from the armored scales (Diaspididae) family and accounted for 4% of the entomocomplex structure.

The least species diversity (1 family, 1 species) was found in the representatives of flies (Diptera), orthopteroid insects (Orthoptera), and hymenopterans (Hymenoptera), which collectively occupied 6% of the structure of the entomocomplex of the agrocenosis of the apple orchard and, accordingly, were representatives of the families: gall gnats (Cecidomyiidae), mole crickets (Gryllotalpidae) and sawflies (Tenthredinidae).

Among other pests, representatives from the class of arachnids (Arachnida) were found from:

- families of spider mites Tetranychidae – European red mite (*Panonychus ulmi* Koch.), red spider mite (*Tetranychus urticae* Koch.), garden spider mite (*Scizotetranychus pruni* Oudms.);
- family of brown mites Bryobiidae – brown fruit mite (*Bryobia redikorzevi* Reck., syn: Bryobia praetiosa Koch.);
- families of four-legged gall mites Eriophyoidae – apple gall mite (*Eriophyes mali* Nal.).

It is worth noting that invasive species pose a significant danger in biocenoses. A species such as wooly aphid (*Eriosoma laniqerum* Hausm.) needs special attention in Ukraine – a typical insect species that has a spiny-sucking oral apparatus. Currently, the range of distribution of this dangerous pest has also expanded under the conditions of the Central Forest-Steppe. It has been established that the pest reproduces on apple trees from early spring to late autumn. Larvae of the first and second generations and wingless females hibernate on the roots of trees, in the cracks of skeletal branches and trunks. In the territory of Cherkasy and Vinnytsia regions, the share of the wintering population of wooly aphids on the roots of trees was within 65–80%.

Among the multispecies diversity of phytophagous insects, the most numerous (dominant) species in the studied agrophytocenoses were three species of aphids (green apple aphid (*Aphis pomi* De G), red-galled (gray) apple aphid (*Dysaphis devecta* Walk), apple-plantain aphid (*Dysaphis mali* Ferr.)), apple borer (*Carpocapsa pomonel la* L.) and leaf beetle (*Archips rosana* L.).

Among the ecologically constant species, which were found in 71–100% of cases, the agrocenosis of the apple orchard of the Central Forest-Steppe of Ukraine included 10 species of phytophagous insects (Table 1). In particular, gray bud weevil (*Sciaphobus squalidus* Gyll.), the fluffy (hairy) deer (Epicometis hirta Poda), the apple fruit eater (Carpocapsa pomonella L.), and the green apple aphid (*Aphis pomi* Deg.) are assigned to the X class of ecological constancy of the species.

Changes in the species composition of phytophagous insects in the agrocenosis of an apple orchard were noted. Compared with the results of the research by Kravets & Adamenk, 2014, over

Table 1. Ecologically constant species of phytophagous insects in apple plantations, 2005–2020

Kind of Phytophagous insect	Class of ecological constancy of the species according to Durier*
Sciaphobus squalidus	X
Codling moth (*Epicometis hirta* Poda)	X
Codling moth (*Carpocapsa pomonella* L.)	X
Green apple aphid (*Aphis pomi* Deg.)	X
Maybug (*Melolontha melolontha* L.)	IX
Apple blossom weevil (*Anthonomus pomorum* L.)	IX
European leaf roller (*Archips rosana* L.)	VIII
Summer fruit tortrix (*Adoxophyes orana* F.)	VIII
Currant moth (*Pandemis ribeana* Hb.)	VIII
Apple sawfly (*Hoplocampa testudinea* Klug.)	VIII

Note: Ecological constancy of a species is the constancy of a species' presence in different parts of the biotope, due to the type of placement of its individuals in space. At the same time, the species that were detected in insect samples from 0 to 10% of cases in the process of phytosanitary monitoring of winter crops belonged to the first class of ecological constancy, to the second class – 11–20%, to the third class – 21–30%,... to the X class – 100% of cases (Du Rienz, 1931).

the past seven years, 22 new species of harmful insects have been discovered and, on the contrary, 12 species that were not encountered at all. These are small apple leafhopper (*Psylla costalis* Flor.), hawthorn leafhopper (*Psylla pyri* L.), oyster-like, or false Californian scale (*Diaspidiotus ostreaformis* Curt.), false acacia scale (*Parthenolecanlum corni* Bouche), false hawthorn scale (*Palaeolecanium bitubercularum* Targ.), false apple scutellum (*Eulecanium mali* Schr.), gray beet weevil (*Tanymecus palliatus* F.), budworm (*Spilonota ocellana* F.), golden-spotted leafworm

Table 2. Phytophagous insects in ecological niches of an apple orchard of the Central Forest-Steppe of Ukraine, 2005–2020

Ecological niches	Coadaptive complexes of insect-phytophages
I. Vegetative parts of trees	
Trunk, skeletal branches, shoots	Coccidae (*Zeuzera pyrina* L., *Cossus cossus* L.) Sesiidae (*Aegeria myopaeformis* Bkh.) Diaspididae (*Lipidosaphes ulmi* L., *Quadraspidiotus perniciosus* Comst.) Aphidinea (*Eriosoma laniqerum* Hausm.) Cicadellidae (*Cicadella viridis* L.) Mordellidae (*Stictocephala bubalus* F.) Tortricidae (*Grapholitha molesta* Busck.) Ipidae (*Xyleborus dispar* F., *Scolytus rugulosus* Ratz., *Scolytus mali* Bechst.) Curculionidae (*Magdalis ruficornis* L.)
Growth buds	Curculionidae (*Magdalis ruficornis* L., *Sciaphobus squalidus* Gyll., *Anthonomus pomorum* L.) Attelabidae (Rhynchitidae) (*Coenorrhinus aequatus* L., *Coenorrhinus pauxillus* Germ., *Rhynchites bacchus* L.) Scarabaidae (*Lethrus apterus* Laxm.) Aphidinea (*Rhopalosiphum insertum* Walk.) Noctuidae (*Diloba coeruleocephala* L.) Psyllidae (*Psylla mali* Schm.) Orgyidae (*Euproctis chrysorrhoesa* L.)
Leaves	Tortricidae (*Archips rosana* L. *Hedya nubiferana* Haw., *Adoxophyes orana* F., *Pandemis ribeana* Hb.) Curculionidae (*Magdalis ruficornis* L., *Sciaphobus squalidus* Gyll.) Attelabidae (Rhynchitidae) (*Coenorrhinus aequatus* L., *Coenorrhinus pauxillus* Germ., *Rhynchites bacchus* L.) Scarabaidae (*Melolontha melolontha* L., *Melolontha hippocastani* F., *Lethrus apterus* Laxm.) Pieridae (*Aporia crataegi* L.) Gracillariidae (*Lithocollectis pyrifoliella* Grsm., *Lithocollectis corylifoliella* Hw.) Arctiidae (*Hyphantria cunea* Dr) Yponomeutidae (*Yponomeuta malinellus* Zell.) Coleophoridae (*Coleophora hemerobiella* Scop.) Lyonetiidae (*Lyonetia clerckella* L., *Leucoptera scitiella* L.) Lasiocampidae (*Malacosoma neustria* L.) Geometridae (*Eranhis defoliaria* Cl., *Operophtera brumata* L.) Noctuidae (*Diloba coeruleocephala* L., *Epsilia transversa* Hfn.) Orgyidae (*Ocneria dispar* L., *Euproctis chrysorrhoesa* L.) Cicadellidae (*Edwardsiana rosae* L.) Psyllidae (*Psylla mali* Schm.) Aphidinea (*Aphis pomi* Deg., *Rhopalosiphum insertum* Walk., *Dysaphis devecta* Walk., *Dysaphis mali* Ferr., *Eriosoma laniqerum* Hausm.) Cecidomyiidae (*Dasyneura mali* Kieff.)
II. Generative organs of trees	
Generative buds, inflorescence	Tortricidae (*Archips rosana* L., *Hedya nubiferana* Haw., *Pandemis ribeana* Hb.) Curculionidae (*Sciaphobus squalidus* Gyll., *Anthonomus pomorum* L.) Scarabaidae (*Epicometis hirta* Poda, *Oxythyrea funesta* Poda) Attelabidae (Rhynchitidae) (*Coenorrhinus pauxillus* Germ., *Rhynchites bacchus* L. Aphidinea (*Dysaphis mali* Ferr.) Noctuidae (*Epsilia transversa* Hfn.) Geometridae (*Operophtera brumata* L.) Coleophoridae (*Coleophora hemerobiella* Scop.)
Ovary, fruit	Tortricidae (*Archips rosana* L., *Pandemis ribeana* Hb., *Carpocapsa pomonella* L., *Grapholitha molesta* Busck.) Scarabaidae (*Melolontha melolontha* L.) Attelabidae (Rhynchitidae) (*Coenorrhinus aequatus* L., *Rhynchites bacchus* L.) Tenthredinidae (*Hoplocampa testudinea* Klug.) Geometridae (*Operophtera brumata* L.) Noctuidae (*Diloba coeruleocephala* L., *Epsilia transversa* Hfn.) Aphidinea (*Dysaphis devecta* Walk.)
III. Soil cover	
Soil, grass cover, fallen leaves	Scarabaidae (*Melolontha melolontha* L., *Melolontha hippocastani* F., *Oxythyrea funesta* Poda) Gryllotalpidae *(Gryllotalpa gryllotalpa* L.) Aphidinea (*Eriosoma laniqerum* Hausm.)

(*Archips xylosteana* L.), brown-striped silkworm (*Biston hirtaria* Ichiff.), antique brushtail (*Orgya antigua* L.), pear-leafed sedge (*Dasyneura puri* Bouche). Two new species of phytophagous mites were also discovered: the apple gall mite (*Eriophyes mali* Nal.) and the garden spider mite (*Scizotetranychus pruni* Oudms.), which until 2013 had not been recorded in industrial apple plantations in Cherkasy region (Kravets &Adamenko, 2014).

The analysis of the trophic specialization of the identified phytophagous insects showed that polyphages dominated 75% (39 species) in the investigated agrocenoses of apple trees. Oligophagous insects, which damage only plants of the Rosaceae family, had a portion of 10% (5 species) and 15% (8 species) – monophagous – specific pests of apple trees.

The life forms were dominated by phytophiles –dendrobiotes, the percentage of which in the overall structure of the harmful entomocomplex was about 90%.

According to the theory of Balykina (2016), the apple agrocenosis should be considered as a set of ecological niches, which represent a multidimensional space within which different species coexist, including phytophagous insects (Balykina, 2016). Taking into account the above, the species of phytophagous insects discovered during 2005–2020 were distributed among the main groups of ecological niches of the investigated agrocenosis of the apple orchard (Table 2).

According to the data in the Table 2, the largest number of pest insect species lives in the first group of ecological niches. In almost 90% of the species of harmful insects found in the agrocenosis of an apple orchard, certain stages of development and vital activity occur on the vegetative parts of apple trees.

CONCLUSIONS

Monitoring studies of the phytosanitary status of industrial apple plantations of Uman National University of Horticulture revealed 52 species of phytophagous insects from 25 families of 7 orders and 5 species of phytophagous mites from 3 families.

The taxonomic structure of phytophagous insects was dominated by the representatives of the orders Lepidoptera (24 species), Coleoptera (14 species) and Homoptera (9 species), the portion of which collectively amounted to 90%. The least species diversity (1 family, 1 species) was among the representatives of Diptera, Orthoptera, and Hymenoptera, which collectively accounted for 6% of the entomocomplex structure.

A range of Lepidoptera represented by 13 families was characterized by wide species diversity: Tortricidae, Gracillariidae, Yponomeutidae, Lyonetiidae, Cossidae, Sesiidae, Coleophoridae, Lasiocampidae, Geometridae, Pieridae, Arctiidae, Noctuidae, Orgyidae, which accounted for 46% of the harmful entomocomplex.

The most numerous (dominant) species for the period 2005–2020 were three species of aphids (*Aphis pomi* De G, *Dysaphis devecta* Walk, *Dysaphis mali* Ferr.), codling moth (*Carpocapsa pomonella* L.) and European leaf roller (*Archips rosana* L.).

In terms of trophic specialization, polyphages dominated 75% (39 species) of apple tree agrocenoses, 10% (5 species) of oligophagous insects, 15% (8 species) – monophages. The life forms were dominated by phytophiles – dendrobiotes, the percentage of which in the total structure of insect pests was about 90%.

Changes in the species composition of phytophagous insects in the agrocenosis of the apple tree were noted – 22 new species of harmful insects were discovered, whereas 12 species disappeared from the agrocenosis. Two new species of phytophagous mites were also discovered: the apple gall mite (*Eriophyes mali* Nal.) and the garden spider mite (*Scizotetranychus pruni* Oudms.), which had not been recorded under the conditions of industrial apple plantations in Cherkasy region until 2013.

Phytophagous insect species found during 2005–2020 were distributed among the main groups of ecological niches of the studied agrocenosis, and it was established that 90% of harmful insect species spend certain stages of their development and life on the vegetative parts of apple trees.

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