



UDC 591.9:595.42

DOI <https://doi.org/10.32782/naturaljournal.17.2026.26>

**DYNAMICS OF BIODIVERSITY PARAMETERS OF ACARID MITES IN APIARIES  
OF THE UZHGOROD DISTRICT OF THE TRANSCARPATIA  
IN LOWLAND CONDITIONS**

**A. T. Dudynska<sup>1</sup>, V. O. Romanko<sup>2</sup>, L. O. Adamchuk<sup>3</sup>**

*The work is devoted to clarifying the peculiarities of the structural and functional organization of acarid mite communities in the nests of Carpathian honey bees and determining the ecological factors that determine the dynamics of their numbers. Purpose – characteristics of the species composition of acarid mites and their population in bee nests in the lowland zone of Transcarpathia (using private apiaries in the Uzhhorod district as an example). Research objects were hive mites from the Acaridia group. Research material – honeycomb fragments, pollen, and other organic impurities collected from hives in the studied apiaries within the villages of Mali Heivtsi, Tysaagtelek and Velyka Dobron. A set of methods was used in the study: systematic analysis of scientific literature, laboratory microscopy with identification of acarids, calculation of ecological indices (dominance, density, frequency of occurrence) and methods of variational statistics (MS Excel 2010). Nine species of acarid mites were identified within the studied region. Four ecological groups were identified based on the structure of dominance: “dominant species” (*Glycyphagus domesticus*, *Tyrophagus similis*, *Carpoglyphus lactis*); “subdominant species” (*Acarus siro*, *Tyrophagus putrescentiae*, *Tyrophagus longior*, *Neoacotyledon redikorzevi*); “subdominant species of the first order” (*Neoacotyledon sokolovi*) and “secondary members” (*Monieziella berlesiana*). The annual dynamics of the population of each species of acarids in hives was characterized by individual features. Depending on various factors, variations in the biodiversity parameters of acarid mites were*

<sup>1</sup> Candidate of Biological Sciences,  
Associate Professor at the Department of Zoology  
(State University "Uzhhorod National University", Uzhhorod)  
e-mail: andrea.dudinska@uzhnu.edu.ua  
ORCID: 0000-0001-7461-0512

<sup>2</sup> Candidate of Agricultural Sciences,  
Associate Professor at the Department of Geodesy, Land Management and Geoinformatics  
(State University "Uzhhorod National University", Uzhhorod)  
Part-time leading specialist  
(State Institution "Transcarpathian Phytosanitary Testing Laboratory of the State Service of Ukraine on Food Safety and Consumer Protection", Uzhhorod)  
e-mail: volodymyr.romanko@uzhnu.edu.ua, romankovlad@ukr.net  
ORCID: 0000-0002-5263-4190

<sup>3</sup> Doctor of Technical Sciences,  
Senior Research Fellow in the Sector of Bee Diseases, Institute of Veterinary Medicine  
(National Academy of Agrarian Sciences of Ukraine, Kyiv)  
e-mail: leonora.adamchuk@gmail.com  
ORCID: 0000-0003-2015-7956

observed in the studied apiaries of the Uzhgorod district. It has been proven that the minimum number of acarid mites is characteristic of “strong” and “very strong” bee colonies, especially in the third quarter of the year (July–September). The lowest biodiversity indicators (density, frequency of occurrence, and dominance index) were observed in mites of the species *M. berlesiana*. The rationale for the subsequent stages of the study is based on the need to establish the patterns of distribution of acarid mites depending on the altitude above sea level. The research focuses on a comparative analysis of the species composition and abundance of acarids in the lowland, foothill, and mountain zones of Transcarpathia.

**Key words:** pest, mite density, frequency of occurrence, dominance index.

## ДИНАМІКА ПАРАМЕТРІВ БІОРІЗНОМАНІТТЯ КЛІЩІВ-АКАРИД НА ПАСІКАХ УЖГОРОДСЬКОГО РАЙОНУ ЗАКАРПАТСЬКОЇ ОБЛАСТІ В УМОВАХ НИЗОВИНИ

А. Т. Дудинська, В. О. Романко, Л. О. Адамчук

Робота спрямована на з'ясування структурно-функціональної організації популяції акарид у гніздах карпатської медоносної бджоли та визначення екологічних чинників, що детермінують динаміку їхньої чисельності. Мета роботи – характеристика видового складу акаридівих кліщів та їх чисельності у бджолиних гніздах в умовах низовинної зони Закарпаття (на прикладі приватних пасік Ужгородського району). Об'єктом досліджень слугували комірні кліщі з групи *Acaridia*.

Матеріал досліджень був субстрат (пилік та інші органічні домішки зібраних із на вуликів на досліджуваних пасіках в межах сіл Малі Геївці, Тисаагтелек та Велика Добронь. У роботі застосовано комплекс методів: системний аналіз наукової літератури, лабораторне мікроскопіювання з ідентифікацією акарид, розрахунок екологічних індексів (домінування, щільності, частоти трапляння) та методи варіаційної статистики (*MS Excel 2010*). У межах досліджуваного регіону ідентифіковано 9 видів акаридівих кліщів. За структурою домінування виділено чотири екологічні групи: «види-домінанти» (*Glycyphagus domesticus*, *Tyrophagus similis*, *Carpoglyphus lactis*); «види-субдомінанти» (*Acarus siro*, *Tyrophagus putrescentiae*, *Tyrophagus longior*, *Neocotyledon redikorzevi*); «субдомінанти 1 порядку» (*Neocotyledon sokolovi*) та «другорядні члени» (*Monieziella berlesiana*).

В залежності від різних чинників спостерігали варіювання параметрів біорізноманіття кліщів-акарид на досліджуваних пасіках Ужгородського району. Доведено, що мінімальна чисельність акаридівих кліщів характерна групам «сильним» та «дуже сильним» бджолосім'ям особливо у третій квартал року (липень–вересень). Найменші показники біорізноманіття (щільність виявляли, частоту трапляння та індекс домінування) спостерігали у кліщів виду *M. berlesiana*. Обґрунтування наступних етапів роботи базується на необхідності встановлення закономірностей поширення акарид залежно від висоти над рівнем моря. Дослідження фокусується на порівняльному аналізі видового складу та чисельності акарид у низовинній, передгірній та гірській зонах Закарпаття.

**Ключові слова:** шкідники, щільність кліщів, частота трапляння, індекс домінування.

### Introduction

The study of acarofauna in *Apis mellifera* nests is mainly conducted in the direction of research and control of such ectoparasites as *Varroa destructor* (Imre et al., 2025; Philémon et al., 2026), *Acarapis woodi* (Koç Akpınar et al., 2023) and *Tropilaelaps* sp. (Shrestha et al., 2020).

However, along with the above-mentioned species of microarthropods, other groups of mites are also found in honey bee nests, forming an ecologically complex and multi-component acarocomplex. Acarid mites deserve special attention, as their species richness and abundance vary significantly under the influence of a number of abiotic and biotic factors. Entering into complex trophic and phoresic relationships with other arthropods,

acarids are capable of rapid population growth in a short period under favorable conditions. This leads to an increase in the harmfulness of these mites as destroyers of organic substrates during their storage (both of plant and animal origin) (Dudynska et al., 2023).

From an economic perspective, acarid mites are of significant concern due to their role as primary pests of plant-derived commodities in storage facilities, including granaries and vegetable warehouses (Hubert, 2012; Dudynska et al., 2023). Specifically, mass outbreaks of species within the genera *Acarus* and *Tyrophagus* can cause substantial degradation of grain seeds and processed products such as flour, cereals, and mixed feeds (Hubert, 2012; Романко, & Дудинська, 2025). Beyond their economic impact, acarid

mites are integral components of various biocenoses. Their ubiquity and pathogenicity have necessitated extensive research into their ecological parameters, with a historical emphasis on characterizing their ecological niches within synanthropic environments and storage systems (Dudynska et al., 2023). However, information on the species richness of acarid mites and the dynamics of their numbers in honey bee hives is presented in scientific literature in a fragmentary manner, which determined the direction of our research.

Purpose: characteristics of the fauna of acarid mites and their abundance in the nests of Carpathian honey bees in the lowland conditions of the Uzhgorod district of the Transcarpathian region.

To achieve the purpose, the following tasks were completed:

– To determine the species diversity of acarids in the studied apiaries.

– Study of the abundance of acarids in the nests of Carpathian honey bees during the annual cycle.

– Determining the relationship between mite abundance and bee colony strength.

#### Materials and methods

The research was conducted between 2023 and 2025 at apiaries located in the Uzhhorod district of the Transcarpathian region lowland zone: in the village of Mali Geyivtsi, location – 48°29'56"N 22°18'11"E altitude 104 meters above sea level;

– Tysaagtelek village 48°28'08"N 22°18'20"E altitude 103 meters above sea level;

– Velyka Dobron village 48°25'17"N 22°03'05"E altitude 104 meters above sea level.

To investigate the acarofauna composition within the nests of Carpathian honey bees (*Apis mellifera carnica*) in the lowland zone of the Uzhhorod district, 480 samples were collected and analyzed. The sampling design involved three apiaries, with 160 samples obtained per site. The research material comprised hive debris, including honeycomb fragments, pollen, and other organic impurities. Each sample had a standardized mass of 10 g.

Processing was conducted using established acarological techniques. Quantitative extraction of mites was performed using the Berlese-Tullgren funnel method. Specimen enumeration and morphological analysis were conducted with a binocular microscope. To facilitate taxonomic identification of acarid

mites, permanent whole-mount slides were prepared using Hoyer's medium (Dudynska et al., 2023).

Species identification was implemented through microscopic examination guided by specialized acarological taxonomic keys. Statistical analysis and data processing were implemented in Microsoft Excel. Biodiversity and population structure were characterized through indices of species richness (Margalef and Menhinick), diversity (Shannon) (Magurran, & McGill, 2011), density, frequency of occurrence, and dominance (D – dominant species (more than 10 %); SD – subdominant species (1–10 %); SD 1st level – subdominants of the 1st order manger (0,1–1 %); SM – secondary members (0,01–0,1 %)) (Gullan, & Cranston, 2014).

The strength of bee colonies was assessed by the number of beehive frames occupied by bees (Технологічні ..., 2015).

#### Results

As a result of analyzing the collected material, nine species of mites were identified. These are seven species, namely *Acarus siro*, *Tyrophagus longior*, *Tyrophagus similis*, *Tyrophagus putrescentiae*, *Neocotyledon sokolovi*, *Neocotyledon redikorzevi*, *Monieziella berlesiana*, which belong to the Acaridae family; and two species – *Glycyphagus domesticus*, *Carpoglyphus lactis*, which belong to the Glycyphagidae family. While all recorded acarid mite species were present across all investigated apiaries, their biodiversity indices exhibited fluctuations driven by various environmental factors.

In total, 63295 acarid mites were detected. Of these, 21546 ind. were found in the apiary in the village of Velyka Dobron, 21731 in the village of Mali Geyivtsi, and 19766 near the village of Tysaagtelek. That is, no significant difference in the overall indicators of acarid mites between apiaries was observed. Relatively high humidity and acceptable temperatures in the lowlands of Transcarpathia along the Latorica River create optimal conditions for the development of acarids.

Analysis of the annual cycle revealed a distinct seasonal periodicity in the abundance of synanthropic mites. The peak population density was observed between April and June, reaching 61.1±6.78 individuals (42.6 % of the total collection). A moderate presence was recorded from January to March (38.1±6.17 individuals; 26.6 %) and from October to December (24.2±2.62 individuals; 16.9%). The minimum numerical abundance

occurred during the July–September period, falling to  $20.1 \pm 3.45$  individuals (14.0 %).

Significant variability in the density of acarid populations is determined mainly by climatic factors and seasonal characteristics of the biological cycle of the bee colony, in particular the intensity of the bees' hygienic behavior in cleaning the bottom of the hive from organic debris. In the Uzhhorod district, the period from July to September is characterized as the least favorable for the development of acarids. This is due to the synergistic effect of high temperatures and low air humidity, which limit the development of mites, combined with the active cleaning activity of bees on the bottom boards, where the main part of microarthropods is localized during this season.

Taxonomic analysis of the acarid mites revealed significant fluctuations in population density across the annual cycle. During the first quarter (January–March), *Gl. domesticus* exhibited the highest density, reaching  $101.5 \pm 5.38$  individuals, which accounted for 55.2% of the total mite population recorded in this period. Conversely, the lowest density index was documented for *M. berlesiana*, totaling only  $0.7 \pm 0.28$  individuals (Fig. 1).

In the second quarter (April–June), as in the first, the maximum population density of *Gl. domesticus* was recorded ( $82.9 \pm 5.39$  indi-

viduals, accounting for 42.2 % of all mites detected during this period). However, it should be noted that, unlike in the first quarter, no significant pest dominance was observed. As in the previous period, the minimum density was recorded for *M. berlesiana* ( $0.7 \pm 0.23$  individuals).

Unlike the first and second quarters of the annual cycle, in the third quarter of the year the highest density was recorded in *C. lactis* ( $24.1 \pm 2.86$  individuals) or 52.0 % of the total number of mites identified during this period.

During the period from October to December (fourth quarter), the maximum density was determined in *Gl. domesticus* and *C. lactis* –  $26.6 \pm 6.23$  and  $24.1 \pm 3.83$  individuals, respectively. The minimum density index for this period, as in previous cases, was observed in *M. berlesiana* – only  $0.4 \pm 0.23$  (Fig. 1).

In general, the highest acarid density indicators in the studied apiaries were found in the following order: *Gl. domesticus* ( $53.5 \pm 6.82$ ), *C. lactis* ( $24.8 \pm 3.03$ ) *T. similis* ( $14.9 \pm 3.37$ ), *T. longior* ( $13.0 \pm 2.55$ ) *T. putrescentiae* ( $10.5 \pm 1.94$ ), *A. siro* ( $8.1 \pm 1.36$ ), *N. redikorzevi* ( $4.3 \pm 1.04$ ), *N. sokolovi* ( $2.4 \pm 0.77$ ) and *M. berlesiana* individuals ( $0.5 \pm 0.25$ ) (Fig. 2).

However, the population density dynamics of individual mite species within the hives exhibited distinct species-specific patterns throughout the annual cycle. The most sig-

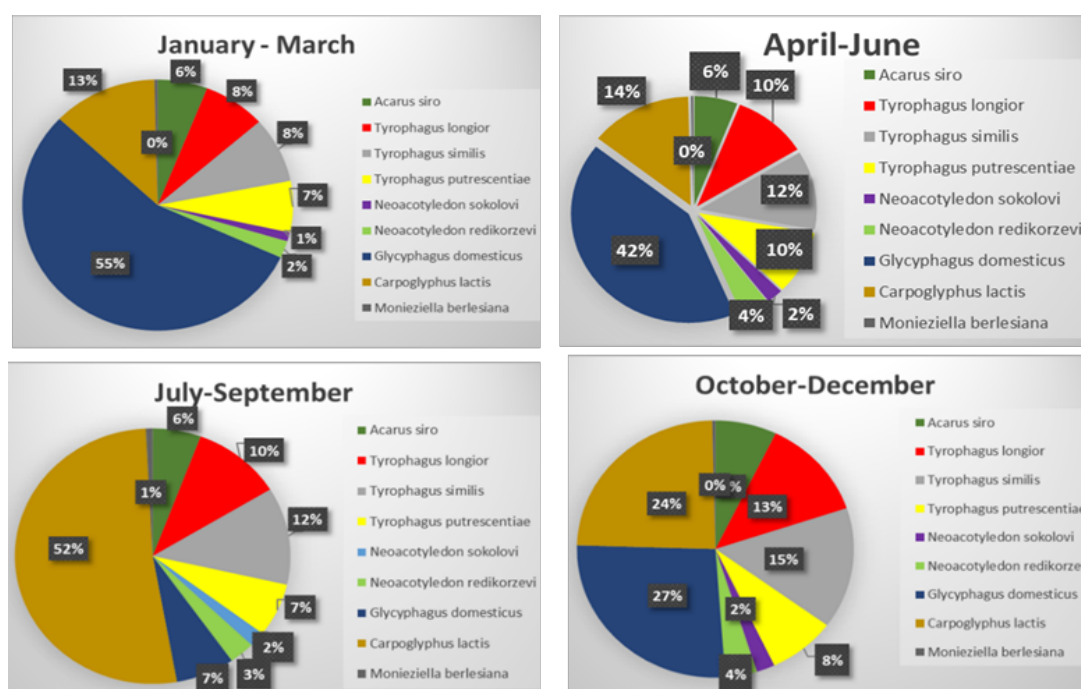


Fig. 1. Dynamics of acarid density in *Apis mellifera carpatica* nests during the annual cycle

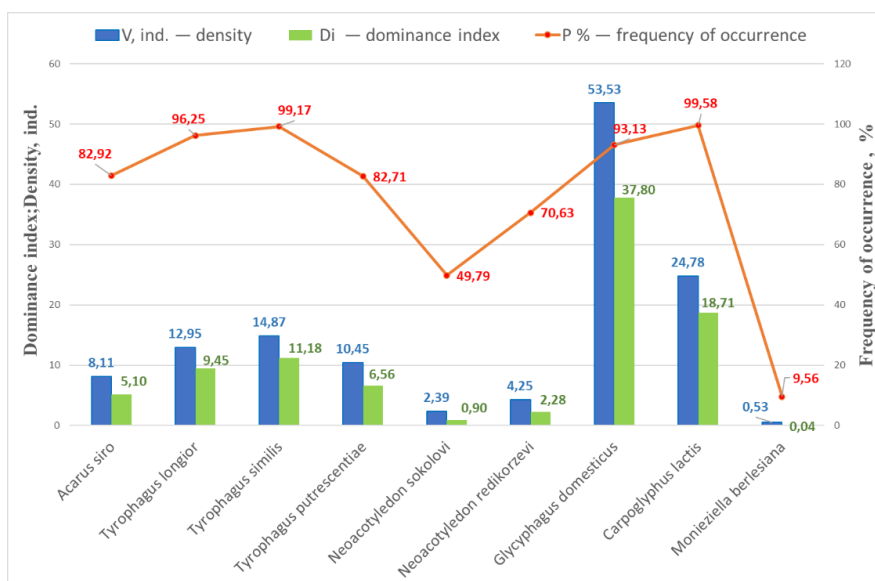


Fig. 2. Biodiversity indices of acarid mites in apiaries located within the lowland zone of the Uzhhorod district

nificant fluctuation in numerical abundance was documented for *Gl. domesticus*, which showed the widest amplitude: from a peak of  $101.5 \pm 7.16$  individuals in the first quarter (reaching maximum values in March) to a minimum of  $3.2 \pm 0.46$  individuals in the third quarter.

For *A. siro*, *T. longior*, *T. putrescentiae*, *T. similis*, *N. sokolovi*, and *N. redikorzevi*, the peak population density was documented between April and June. Conversely, these six acarid species exhibited their minimum density values during the third quarter of the year. In contrast, the *C. lactis* population maintained relative stability throughout the season, with density fluctuations constrained between  $27.8 \pm 1.88$  and  $21.3 \pm 1.47$  individuals, displaying no significant seasonal variations compared to the aforementioned taxa (Fig. 3).

The highest frequency of occurrence, 99.58 % (478 out of 480 samples), was recorded for *C. lactis*. It is worth noting that, *Gl. domesticus* showed a frequency only of 93.13 % (447 samples), despite having the highest population density among all detected acarids. The lowest occurrence frequency (9.56 %) was observed in *M. berlesiana*. A distinctive feature of *T. longior* and *T. similis* was that, despite their relatively low-density indices, they had high occurrence frequencies of 96.25 % (462 out of 480 samples) and 99.17 % (476 samples), respectively (Fig. 3).

According to the dominance analysis, three of the nine identified mite species (*Gl. domes-*

*ticus*, *C. lactis* and *T. similis*) were identified as dominant. Four species were classified as subdominant (*T. longior*, *A. siro*, *T. putrescentiae*, and *N. redikorzevi*). One species of acarid (*N. sokolovi*) was classified as “subdominants of the 1st order.” *M. berlesiana* represented the lowest class of dominance, “secondary members.” (Fig. 4).

An analysis of the distribution of mites in bee colonies of varying strength showed that the highest number of acarid mites was observed in “weak” colonies – 26.35 % of the total number of individuals detected. A slightly lower number was found in “very weak” colonies – 24.61 %. The lowest numbers were recorded in ‘strong’ and “very strong” bee colonies – 16.49 % and 16.30 %, respectively.

As shown in Fig. 5, *Gl. domesticus* was the dominant species among mites in all bee colonies. However, while in the mite fauna of “weak” and “very weak” bee colonies, the dominance index of *Gl. domesticus* compared to *C. lactis* was 2.3 and 2.7 times higher, respectively, in “strong” and “very strong” bee colonies, such dominance indices were not observed (1.8 and 2.0 times, respectively). In addition, in “weak bee colonies,” unlike others, a relatively high number of *T. putrescentiae* was recorded ( $19.5 \pm 1.65$  individuals) (Fig. 5).

An analysis of the biodiversity metrics for acarid mite communities within the apiaries of the Uzhhorod district (lowland zone) revealed minimal variation, indicative of a generally low level of species diversity. Specifically, the

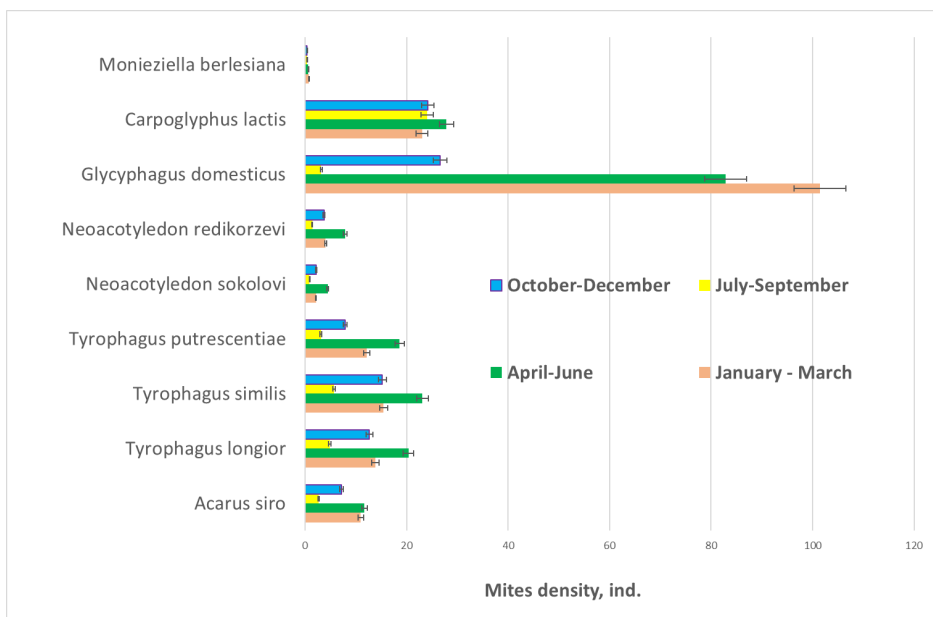


Fig. 3. Density of acarid species composition during the annual cycle

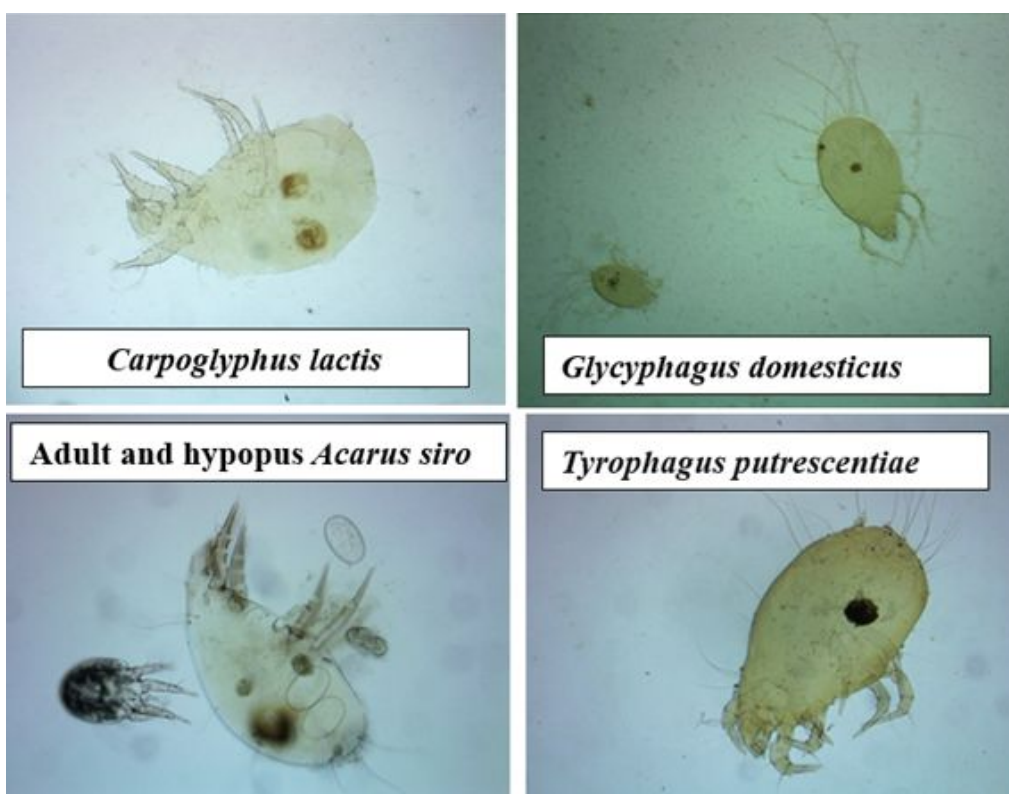


Fig. 4. General view of acarid mites

calculated Shannon index values ranged narrowly from 1.70 (Mali Geyivtzi apiary) to 1.75 (Tysaagtelek apiary). These metrics underscore a limited species richness and low evenness within the studied communities, where

pronounced species dominance especially impacts overall ecological stability.

Low values of the Margalef index (0.56) indicate an impoverished species composition of acarid mites in the studied hives. This eco-

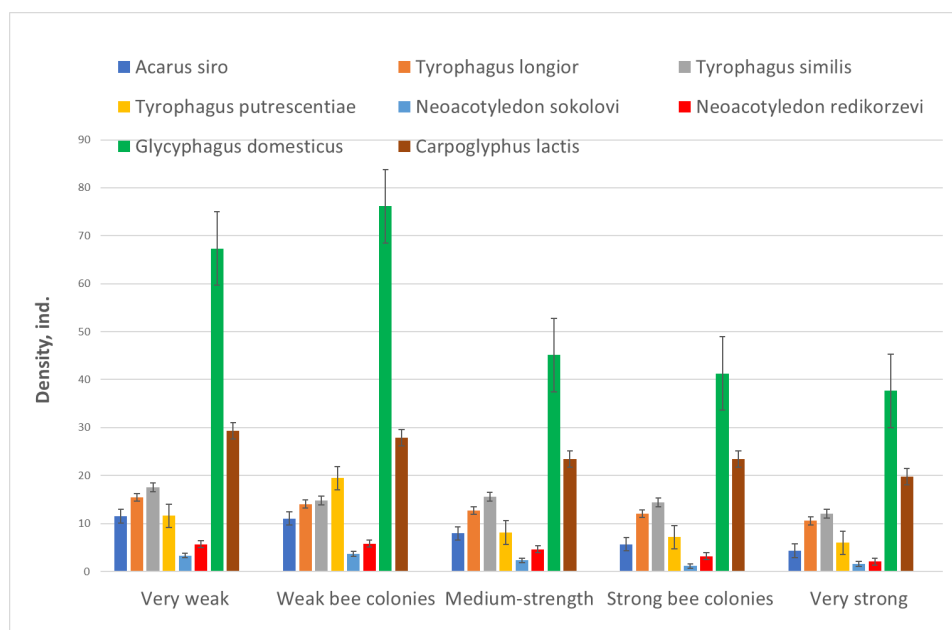


Fig. 5. Density dynamics of acarofauna in *Apis mellifera carnica* colonies of varying numerical strength

logical pattern is determined by the cleaning activity of worker bees, which limits the accumulation of organic matter required for mite proliferation.

In contrast to the aforementioned metrics, the Menhinick index reached its minimum value (0.06). This result is attributable to the high numerical abundance of mites coupled with relatively low species richness.

### Discussion

Contemporary research primarily focuses on the biological characteristics, developmental cycles, and pathogenicity of acarid mites, as well as the evaluation of various control strategies. Specifically, significant attention is directed toward investigating the toxicological effects of alternative non-chemical disinfection agents, such as inert dusts (Kilic, 2022; Athanassiou et al., 2025; Boukouvala et al., 2025). Furthermore, studies explore the efficacy of thermal treatments against these pests (Abbar et al., 2016) and the expansion of the fumigant repertoire, including the development of new chemical formulations for the disinfection of plant-based products (Hasan et al., 2019; Hasan et al., 2021; Романко & Дудинська, 2025).

Scientific literature regarding acarofauna within synanthropic environments, particularly in honey bee nests, remains sparse. The occurrence of *C. lactis* on aged combs and within honey stores has been documented in only a few studies. Notably, Nguyen et al.,

(2024) emphasized that *Apis mellifera* colonies, especially those with reduced numerical strength, exhibit high vulnerability to *C. lactis* infestations. These mites rapidly proliferate and consume stored pollen, resulting in significant colony weakening and potential collapse (Nguyen et al., 2024).

Dudynska et al. (2025) investigated the impact of various factors on the occurrence and numerical abundance of *C. lactis* in stored honey. The population density of mites fluctuated significantly depending on the experimental parameters. Specifically, the number of individuals varied from 0 to  $20.11 \pm 2.667$  per sample, influenced by the botanical origin of the honey, its moisture content, and the duration of storage. The authors demonstrated that mite colonization is restricted to the surface layer of the honey, reaching depths of only 1–10 mm. Notably, *C. lactis* was consistently absent in samples obtained from deeper layers, regardless of the experimental conditions (Dudynska et al., 2025).

According to research by Li et al. (2015), the taxonomic composition of acarid mites associated with stored bee products exhibits substrate-specific variations: in «Honey date» – *Gl. domesticus*, *C. lactis*; in «Honey lotus root dry» – *C. lactis*, *T. putrescentiae*, *Gl. ornatus*; in «Honey» – *C. lactis*, *Gl. domesticus* and *Tyrollichus casei* (Li et al., 2015).

The presence of *C. lactis*, *Gl. domesticus* and *T. longior* in hives in Great Britain was noted by Bowman (Bowman, 2023).

Henszel et al., (2011) evaluated the acarofauna composition within litter and animal feed samples collected from agricultural facilities in northwestern Poland. Their findings indicated a high prevalence of mites in the examined farm buildings. The dominant taxa identified included *Lepidoglyphus destructor* (72.3 %), *Cheyletus* sp. (52.7 %), *A. siro* (41.8 %), and *T. putrescentiae* (40.0 %) (Henszel et al., 2011). The last two species were also found in the apiaries we studied. Such species of acarids as *Gl. domesticus*, *T. longior* and *Chortoglyphus arcuatus* were also found in the studied samples, however, the percentage of detection was significantly lower compared to the above-mentioned species of mites, as emphasized by Henszel et al. (2011). Whereas in the hives, the number of *Gl. domesticus* significantly exceeded the number of *A. siro* and *T. putrescentiae*.

Palyvos et al. (2008) performed a faunistic survey of mites within synanthropic environments in Greece. The study encompassed a wide range of substrates, including cereal crops (wheat, maize, oats, barley), flour, bran, processed agricultural food products, dried fruits (walnuts, raisins), as well as organic residues and dust within storage facilities. The highest infestation rates and population densities were documented in samples of residual materials. *L. destructor*, *T. putrescentiae*, and *A. siro* were identified as either dominant or subdominant taxa across all examined storage facilities (Palyvos et al., 2008). Our research results also showed that the majority of acarids were found at the bottom of the hive, where frame fragments, pollen, and other organic matter accumulate.

Within Ukraine, little research has been conducted on the complexes of these pests in semi-natural and anthropogenic biotopes over the last two decades. In particular, Oksentiuk et al. (2022) studied species groups of acarid mites in agricultural and industrial areas in the Polissya region (Zhytomyr region) Agricultural environments exhibited higher taxonomic diversity, totaling 30 species: 21 species were recorded in barns containing fodder (grain, hay, straw), 12 in livestock and poultry outbuildings, 9 in beehives, and 13 in vegetable storage facilities (Oksentiuk et al., 2022). A comparative analysis of our findings with the aforementioned data revealed that only four out of the nine identified acarid species were identical. Specifically, these included *A. siro*, *T. longior*, *T. putrescentiae*, and *Gl. domesticus*.

Zhovnerchuk et al. (2024) investigated other mite taxa, specifically the families Tetranychidae and Phytoseiidae, across various altitudinal zones within the Transcarpathian region. Their findings demonstrated that vertical zonation exerts a significant influence on the species composition of these mite communities. The taxonomic diversity of tetranychid mites exhibited an altitudinal gradient: the highest species richness was documented in the lowlands (23 species), with a moderate decrease in the foothills (19 species), and the minimum values observed in the mountain zone (11 species) (Zhovnerchuk et al., 2024).

The impact of altitudinal zonation and various types of agricultural facilities on the species diversity and abundance of acarid mites is detailed in the study by Dudynska et al. (2023). Specifically, *A. siro* and *T. putrescentiae* were identified as dominant species in the foothills and mountain zones, whereas in the lowlands, *A. siro* was the sole dominant taxon. Among the examined farm buildings, the highest concentration of acarid mites (comprising dominant and subdominant species) was documented in cowsheds (33.72 %), while the minimum was recorded in haylofts (12.29 % of the total abundance). The highest biodiversity indices were observed in the foothill zone (mean abundance per sample: 7.86; density: 0.98; frequency of occurrence: 58.13; dominance index: 5.21). Conversely, the lowest quantitative indicators were recorded in the mountain area (mean abundance: 5.15; density: 0.64; frequency: 44.94) and in the lowlands (dominance index: 4.22) (Dudynska et al., 2023).

In a comparative context, ecological surveys of acarid mite distribution indicate that agricultural facilities (including barns, avian housing, storage units, and haylofts) across various Transcarpathian districts provide optimal substrates and microclimatic conditions for the proliferation of these pest populations. Thus, their species richness ranged from 16 to 24 species, and the abundance of mites ranged from 172.3 to 703.9 individuals. Accordingly, the Margalef, Shannon, and Menkhinik indices were higher and ranged from 1.57 to 2.12, 2.43 to 2.82, and 0.44 to 0.56, respectively (Dudynska et al., 2023). That is, we observed a difference in biodiversity indicators between apiaries and farm buildings within 1.43 and 7.67 times, which is due to the significantly higher species richness of acarids in various farm buildings than in apiaries.

Thus, the results of studies on the species diversity and abundance of acarid mites in *Apis mellifera carpatica* colonies in the lowlands of the Uzhhorod district of Transcarpathia are presented. These results will form part of the data on acarid biodiversity for future studies of the acarofauna in *Apis mellifera carpatica* nests at different altitudes and under different climatic conditions.

### Conclusions

1. A total of nine acarid mite species were identified within the study area. Based on their ecological significance, these were categorized into hierarchical groups: dominant species, subdominant species, first-order subdominants, and secondary members.

2. The seasonal dynamics of storage mite abundance within Carpathian honey bee nests exhibited a distinct annual pattern. The peak population density was recorded during the April–June period ( $21.9 \pm 4.74$  ind.), lightly lower rates were observed in January–March ( $20.4 \pm 3.89$  ind.) and a significant reduction in October–December ( $11.1 \pm 2.52$  ind.). The absolute minimum was observed between July and September –  $5.1 \pm 1.27$  individuals.

3. The highest density values were documented for *Gl. domesticus* ( $53.5 \pm 6.82$  individuals), whereas the average density of *C. lactis* was 2.2 times lower. Furthermore, the annual population dynamics for each acarid species were characterized by distinct, species-specific temporal patterns.

4. We observed a certain correlation between the number of mites and the strength of the bee colony. The highest level of infestation was recorded in weak and very weak colonies, which accounted for approximately 51 % of the total

number of mites. The strength of bee colonies did not affect the species richness of mites.

5. Biodiversity metrics calculated for acarid assemblages in apiaries of the Transcarpathian lowland zone indicate depauperate species richness. Such low index values result from the numerical dominance of a few species, where high absolute abundance offsets the overall taxonomic diversity.

6. Future studies will focus on a comprehensive comparative analysis within the lowland, foothill, and montane zones of the Transcarpathian region to determine the influence of vertical zonation on mite assemblages in *Apis mellifera carpatica* nests.

### Funding

This work was funded by the International Visegrad Fund under the Project ID 52510340 Title, 2025-2026.

Part of the research was funded by the National Scholarship Programme of the Slovak Republic (NSP), awarded to Leonora Adamchuk under application ID 57381.

Institutional Review Board Statement: Not applicable.

### Acknowledgments

The co-author, Andreia Dudynska, gratefully acknowledges the support of the International Visegrad Fund under Research Internship ID 52510340, within which new knowledge and scientific results were obtained.

The co-author, Leonora Adamchuk, gratefully acknowledges that the results presented in this article were achieved during a research stay in Slovakia supported by the National Scholarship Programme of the Slovak Republic (NSP), ID 57381.

### Bibliography

Романко В.О., Дудинська А.Т. Акарицидна дія фтористого сульфурилу. *Науковий прогрес та інновації*. 2025. Т. 28, №. 3. С. 91–97. DOI: <https://doi.org/10.31210/spi2025.28.03.15>

Технологічні вимоги до проведення селекційно-племінної роботи в галузі бджільництва: наказ Міністерства аграрної політики та продовольства України від 19 черв. 2015 р. № 234. [Електронний ресурс]. URL: <https://zakon.rada.gov.ua/laws/show/z0810-15#Text> дата звернення: 26.03.2024).

Abbar S., Schilling W., & Phillips T. Time–Mortality Relationships to Control *Tyrophagus putrescentiae* (Sarcoptiformes: Acaridae) Exposed to High and Low Temperatures. *Journal of Economic Entomology*. 2016. Vol. 109, Is. 5. P. 2215–2220. DOI: <https://doi.org/10.1093/jee/tow159>

Athanassiou Ch., Rumbos Ch., Agrafioti P., Sakka M. Acaricidal Effect of Zeolite and Kaolin Against *Tyrophagus putrescentiae* on Wheat. *Agronomy*. 2025. Vol. 15, Is. 4. DOI: <https://doi.org/10.3390/agronomy15040799>

Boukouvala M., Filintas C., Kavallieratos N. Acaricidal efficacy of diatomaceous earths on different Life Stages of *Acarus siro* L. and *Tyrophagus putrescentiae* (Schrank). *Insects*. 2025. Vol. 16, Is. 7. DOI: <https://doi.org/10.3390/insects16070693>

Bowman C. Variation in the trophic morphology of *Astigmatid mites* common in UK beehives. *Proceedings of the 9th Symposium of the EurAAC, Bari, July, 12th–15th*. 2023. Vol. 63. P. 4–16. DOI: <https://doi.org/10.24349/z9n6-u3t3>

Dudynska A., Adamchuk L., Romanko V., Dudynskiy T. Density *Carpoglyphus lactis* in honey during storage. *Ukrainian Science Hub Journal*. 2025, Vol. 1, №. 2. DOI: <https://doi.org/10.64378/iriush.journals.2025.2.3>

Dudynska A.T., Romanko V.O., Dudynsky T.T., Karabiniuk M.M., Zhovnerchuk O.V. Species Diversity and Distribution of Synanthropic Acarid Mites (Acariformes, Acaridia) in Transcarpathia. *Zoodiversity*. 2023. Vol. 57, №. 4. P. 283–292. DOI: <https://doi.org/10.15407/zoo2023.04.283>

Gullan P. J., Cranston P. S. The Insects: An Outline of Entomology. 5th ed. Wiley-Blackwell, 2014. 627 p. [Електронний ресурс]. [https://www.researchgate.net/profile/Peter-Cranston/publication/340428529\\_The\\_Insects\\_An\\_Outline\\_of\\_Entomology\\_Gullan\\_and\\_Cranston\\_5th\\_edition\\_2014\\_file\\_name\\_-\\_G-C\\_The\\_Insectsproof/links/614ffb28d2ebba7be74b2253/The-Insects-An-Outline-of-Entomology-Gullan-and-Cranston-5th-edition-2014-file-name-G-C-The-Insectsproof.pdf](https://www.researchgate.net/profile/Peter-Cranston/publication/340428529_The_Insects_An_Outline_of_Entomology_Gullan_and_Cranston_5th_edition_2014_file_name_-_G-C_The_Insectsproof/links/614ffb28d2ebba7be74b2253/The-Insects-An-Outline-of-Entomology-Gullan-and-Cranston-5th-edition-2014-file-name-G-C-The-Insectsproof.pdf) (дата звернення: 18.01.2026)

Hasan Md., Aikins M., Schilling W., Phillips T. Comparison of methyl bromide and phosphine for fumigation of *Necrobia rufipes* (Coleoptera: Cleridae) and *Tyrophagus putrescentiae* (Sarcoptiformes: Acaridae). Pests of high-value stored products. *Journal of Economic Entomology*. 2019. Vol. 113, Is. 1. P. 1008–1014. DOI: <https://doi.org/10.1093/jee/toz319>

Hasan Md., Aikins M., Schilling W., Phillips T. Sulfuryl fluoride as a methyl bromide alternative for fumigation of *Necrobia rufipes* (Coleoptera: Cleridae) and *Tyrophagus putrescentiae* (Sarcoptiformes: Acaridae), major pests of animal-based stored products. *Journal of Stored Products Research*. 2021. Vol. 91. DOI: <https://doi.org/10.1016/j.jspr.2021.101769>

Henszel Ł., Kalisińska E., Kosik-Bogacka D., Kuźna-Grygiel W. Preliminary Studies on Storage Mites in Litter and Animal Fodder Collected from Farm Buildings in Northwestern. *Poland Polish Journal of Environmental Studies*. 2011. Vol. 20, Is. 3. P. 795–800. [Електронний ресурс]. URL: [https://www.researchgate.net/publication/287282301\\_Preliminary\\_Studies\\_on\\_Storage\\_Mites](https://www.researchgate.net/publication/287282301_Preliminary_Studies_on_Storage_Mites) (дата звернення: 17.11.2025)

Hubert J. The Pest Importance of Stored Product Mites (Acari: Acaridida). Nova Publisher ISBN: 978-1-61942-086-1. 2012. [Електронний ресурс]. URL: <https://www.researchgate.net/publication/259470810> (дата звернення: 22.11.2025)

Imre M., Morariu S., Oprescu I., Mederle N., Ilie M., Imre K., Florea T., Badea C., Dregheciu C., Pocinoc A., Varga R., Dărăbuș G. Molecular identification and sequencing of *Varroa destructor* in western Romania. *Romanian Journal of Veterinary Sciences*. 2025. Vol. 58, Is. 1. DOI: <https://doi.org/10.59463/rjvs.2025.1.04>

Kilic N. Efficacy of dust and wettable powder formulation of Diatomaceous earth (Detech) in the control of *Tyrophagus putrescentiae* (Schrank) (Acari: Acaridae). *Insects*. 2022. Vol. 13, Is. 10. DOI: <https://doi.org/10.3390/insects13100857>

Koç Akpınar R., Sevim A., Sevim E., Kaya S., Türlek Ş.Ö., Aydın C., Karaoğlu Ş.A., Çelik S. N., Bozdeveci A., Güven G., Küçüköğlü B., Yaldız M., Aydın İ. PCR-based detection of the honeybee tracheal mite (*Acarapis woodi*) in Türkiye. *Parasitology Research*. 2023. Vol. 122, Is. 7. P. 1663–1670. DOI: <https://doi.org/10.1007/s00436-023-07871-x>

Li Ch., Zhan X., Sun E., Zhao J., Wang H., He J., Wang J. The density and species of mite breeding in stored products in China. *Nutr Hosp*. 2015. Vol. 31, Is. 2. P. 798–807. DOI: <https://doi.org/10.3305/nh.2015.31.2.8003>

Magurran A. E., Mc Gill B. J. Biological Diversity: Frontiers in Measurement and Assessment. Oxford: Oxford University Press, 2011. 368 p. [Електронний ресурс]. [https://faculty.fiu.edu/~trexlerj/Advanced\\_Ecology/Gotelli\\_Colwell.pdf](https://faculty.fiu.edu/~trexlerj/Advanced_Ecology/Gotelli_Colwell.pdf) (дата звернення: 29.01.2026)

Nguyen T.-T., Yoo M.-S., Lee H.-S., Youn S.-Y., Lee S.-J., Seo S.-K., Kim J., Cho Y.-S. Molecular Identification and Prevalence of the Mite *Carpoglyphus lactis* (Acarina: Carpoglyphidae) in *Apis mellifera* in the Republic of Korea. *Insects*. 2024. Vol. 15, Is. 4. DOI: <https://doi.org/10.3390/insects15040271>

Oksentiuk Ya.R., Liashevych A.M., Lupaina I.S. Acaridid mite species communities in agricultural and industrial objects of storing and concentration of nutritive substrates in Zhytomyr Polissia. *Zoodiversity*, 2022. Vol. 56, №. 4. 232–330. DOI: <https://doi.org/10.15407/zoo2022.04.323>

Palyvos N., Emmanouel N., Saitanis C. Mites associated with stored products in Greece. *Experimental and applied acarology*. 2008. Vol. 44, Is. 3. P. 213–226. DOI: <https://doi.org/10.1007/s10493-008-9145-y>

Philémon P., Kafle L., Joshi R. Field Evaluation of Oxalic Acid Vaporisation for Varroa Mite (*Varroa destructor*) Control in European Honey Bees (*Apis mellifera*) Colonies.

*Journal of apicultural science*. 2026. Vol. 70, №. 1. DOI: <https://doi.org/10.2478/jas-2026-0001>

Shrestha M., Wegener J., Gautam I., Singh M., Schwekendiek Ch., Bienefeld K. Individual-Level Comparisons of Honey Bee (Hymenoptera: Apoidea) Hygienic Behavior Towards Brood Infested with *Varroa destructor* (Parasitiformes: Varroidae) or *Tropilaelaps mercedesae* (Mesostigmata: Laelapidae). *Insects*. 2020. Vol. 11, Is. 8. DOI: <https://doi.org/10.3390/insects11080510>

Zhovnerchuk O.V., Kolodochka L.O., Dudynska A.T., Abrazhevych P.A., Romanko V.O. Ecologo-faunistic review of tetranychid (Acariformes: Tetranychoidae) and phytoseiid mites (Parasitiformes: Phytoseiidae) in the Transcarpathian Region, Ukraine. *Systematic and Applied Acarology*, 2024. Vol. 29, Is. 3. P. 411-433. DOI: <https://doi.org/10.11158/saa.29.3.5>

## References

Romanko, V.O. & Dudynska, A.T. (2025). Akarytsydna diia ftorystoho sudfurylu. [Acaricidal action of fluorinated sulfuryl]. *Naukovyi prohres ta innovatsii, [Scientific progress and innovation]*, 28 (3), 91–97. <https://doi.org/10.31210/spi2025.28.03.15> [in Ukrainian].

Ministry of Agricultural Policy and Food of Ukraine. (2015). Tekhnolohichni vymohy do provedennia selektsiino-pleminnoi roboty v haluzi bdzhilnytstva [Technological requirements for breeding and selection work in the field of beekeeping] (Order No. 234). [Electronic resource] URL: <https://zakon.rada.gov.ua/laws/show/z0810-15#Text> (access date 26.03.2024) [in Ukrainian]

Abbar, S., Schilling, W., & Phillips T., (2016). Time-Mortality Relationships to Control *Tyrophagus putrescentiae* (Sarcoptiformes: Acaridae) Exposed to High and Low Temperatures. *Journal of Economic Entomology*, 109 (5), 2215–2220. <https://doi.org/10.1093/jee/tow159> [in English]

Athanassiou, Ch., Rumbos, Ch., Agrafioti, P., & Sakka, M. (2025). Acaricidal Effect of Zeolite and Kaolin Against *Tyrophagus putrescentiae* on Wheat. *Agronomy*, 15(4). <https://doi.org/10.3390/agronomy15040799> [in English]

Boukouvala, M., Filintas, C., & Kavallieratos, N. (2025). Acaricidal efficacy of diatomaceous earths on different Life Stages of *Acarus siro* L. and *Tyrophagus putrescentiae* (Schrank). *Insects*, 16 (7). <https://doi.org/10.3390/insects16070693> [in English]

Bowman, C. (2023). Variation in the trophic morphology of *Astigmatid* mites common in UK beehives. *Proceedings of the 9th Symposium of the EurAAC, Bari, July, 12th–15th*. 63, 4–16. <https://doi.org/10.24349/z9n6-u3t3> [in English]

Dudynska, A., Adamchuk, L., Romanko, V., & Dudynskyi, T. (2025). Density *Carpoglyphus lactis* in honey during storage. *Ukrainian Science Hub Journal*, 1 (2). <https://doi.org/10.64378/iriush.journals.2025.2.3> [in English]

Dudynska, A.T., Romanko, V.O., Dudynsky, T.T., Karabiniuk, M.M. & Zhovnerchuk, O.V. (2023). Species Diversity and Distribution of Synanthropic Acarid Mites (Acariformes, Acaridia) in Transcarpathia. *Zoodiversity*, 57(4), 283–292. <https://doi.org/10.15407/zoo2023.04.283> [in English]

Gullan, P.J., & Cranston, P.S. (2014). *The insects: An outline of entomology* (5th ed.). Wiley-Blackwell. [Electronic resource] URL: [https://www.researchgate.net/profile/Peter-Cranston/publication/340428529\\_The\\_Insects\\_An\\_Outline\\_of\\_Entomology\\_Gullan\\_and\\_Cranston\\_5th\\_edition\\_2014\\_file\\_name\\_-\\_G-C\\_The\\_Insectsproof/links/614ffb28d2ebba7be74b2253/The-Insects-An-Outline-of-Entomology-Gullan-and-Cranston-5th-edition-2014-file-name-G-C-The-Insectsproof.pdf](https://www.researchgate.net/profile/Peter-Cranston/publication/340428529_The_Insects_An_Outline_of_Entomology_Gullan_and_Cranston_5th_edition_2014_file_name_-_G-C_The_Insectsproof/links/614ffb28d2ebba7be74b2253/The-Insects-An-Outline-of-Entomology-Gullan-and-Cranston-5th-edition-2014-file-name-G-C-The-Insectsproof.pdf) (date of application: 18.01.2026) [in English]

Hasan, Md., Aikins, M., Schilling, W., & Phillips, T. (2019). Comparison of methyl bromide and phosphine for fumigation of *Necrobia rufipes* (Coleoptera: Cleridae) and *Tyrophagus putrescentiae* (Sarcoptiformes: Acaridae). Pests of high-value stored products. *Journal of Economic Entomology*, 113 (1), 1008–1014. <https://doi.org/10.1093/jee/toz319> [in English]

Hasan, Md., Aikins, M., Schilling, W., & Phillips, T. (2021). Sulfuryl fluoride as a methyl bromide alternative for fumigation of *Necrobia rufipes* (Coleoptera: Cleridae) and *Tyrophagus putrescentiae* (Sarcoptiformes: Acaridae), major pests of animal-based stored products. *Journal of Stored Products Research*, 91. <https://doi.org/10.1016/j.jspr.2021.101769> [in English].

Henszel, Ł., Kalisińska, E., Kosik-Bogacka, D., & Kuźna-Grygiel, W. (2011). Preliminary Studies on Storage Mites in Litter and Animal Fodder Collected from Farm Buildings in Northwestern. *Poland Polish Journal of Environmental Studies*, 20 (3), 795–800. [Electronic resource] URL: [https://www.researchgate.net/publication/287282301\\_Preliminary\\_Studies\\_on\\_Storage\\_Mites](https://www.researchgate.net/publication/287282301_Preliminary_Studies_on_Storage_Mites) (access date 17.11.2025) [in English]

Hubert, J. (2012). The Pest Importance of Stored Product Mites (Acari: Acaridida). Nova Publisher ISBN: 978-1-61942-086-1. [Electronic resource] URL: <https://www.researchgate.net/publication/259470810> [in English]

Imre, M., Morariu, S., Oprescu, I., Mederle, N., Ilie, M., Imre, K., Florea, T., Badea, C., Dreghiciu, C., Pocinoc, A., Varga, R. & Dărăbuș, G. (2025). Molecular identification and sequencing of *Varroa destructor* in western Romania. *Romanian Journal of Veterinary Sciences*, 58(1). <https://doi.org/10.59463/rjvs.2025.1.04> [in English]

Kilic, N. (2022). Efficacy of dust and wettable powder formulation of Diatomaceous earth (Detech) in the control of *Tyrophagus putrescentiae* (Schrank) (Acari: Acaridae). *Insects*, 13(10). <https://doi.org/10.3390/insects13100857> [in English]

Koç Akpınar, R., Sevim, A., Sevim, E., Kaya, S., Türlek, Ş.Ö., Aydın, C., Karaoğlu, Ş.A., Çelik, S. N., Bozdeveci, A., Güven, G., Küçüköğlü, B., Yıldız, M., & Aydın, İ. (2023). PCR-based detection of the honeybee tracheal mite (*Acarapis woodi*) in Türkiye. *Parasitology Research*, 122 (7), 1663–1670. <https://doi.org/10.1007/s00436-023-07871-x> [in English]

Li, Ch., Zhan, X., Sun, E., Zhao, J., Wang, H., He, J., & Wang, J. (2015). The density and species of mite breeding in stored products in China. *Nutr Hosp.*, Vol. 31 (2), 798-807. <https://doi.org/10.3305/nh.2015.31.2.8003> [in English]

Magurran, A. E., & McGill, B. J. (Eds.). (2011). Biological diversity: Frontiers in measurement and assessment. Oxford University Press. [Electronic resource] URL: [https://faculty.fiu.edu/~trexlerj/Advanced\\_Ecology/Gotelli\\_Colwell.pdf](https://faculty.fiu.edu/~trexlerj/Advanced_Ecology/Gotelli_Colwell.pdf) [in English] (date of application: 29.01.2026)

Nguyen, T-T., Yoo, M.-S., Lee, H.-S., Youn, S.-Y., Lee, S.-J., Seo, S.-K., Kim, J., & Cho, Y.-S. (2024). Molecular Identification and Prevalence of the Mite *Carpoglyphus lactis* (Acarina: Carpocephalidae) in *Apis mellifera* in the Republic of Korea. *Insects*, 15 (4). <https://doi.org/10.3390/insects15040271> [in English]

Oksentiuk, Ya.R., Liashevych, A.M., & Lupaina, I.S. (2022). Acaridid mite species communities in agricultural and industrial objects of storing and concentration of nutritive substrates in Zhytomyr Polissia. *Zoodiversity*, 56 (4). 232–330. <https://doi.org/10.15407/zoo2022.04.323> [in English]

Palyvos, N., Emmanouel, N. & Saitanis, C. (2008). Mites associated with stored products in Greece. *Experimental and applied acarology*, 44 (3), 213–226. <https://doi.org/10.1007/s10493-008-9145-y> [in English]

Philémon, P., Kafle, L., & Joshi, R. (2026). Field Evaluation of Oxalic Acid Vaporisation for Varroa Mite (*Varroa destructor*) Control in European Honey Bees (*Apis mellifera*) Colonies. *Journal of apicultural science*, 70(1) <https://doi.org/10.2478/jas-2026-0001> [in English]

Shrestha, M., Wegener, J., Gautam, I., Singh, M., Schwekendiek, Ch., & Bienefeld, K. (2020). Individual-Level Comparisons of Honey Bee (Hymenoptera: Apoidea) Hygienic Behavior Towards Brood Infested with *Varroa destructor* (Parasitiformes: Varroidae) or *Tropilaelaps mercedesae* (Mesostigmata: Laelapidae). *Insects*, 11(8) <https://doi.org/10.3390/insects11080510> [in English]

Zhovnerchuk O.V., Kolodochka L.O., Dudynska A.T., Abrazhevych P.A. & Romanko V.O. (2024). Ecologo-faunistic review of tetranychid (Acariformes: Tetranychidae) and phytoseiid mites (Parasitiformes: Phytoseiidae) in the Transcarpathian Region, Ukraine. *Systematic and Applied Acarology*, 29 (3), 411-433. <https://doi.org/10.11158/saa.29.3.5> [in English]

Дата першого надходження статті до видання: 13.03.2026

Дата прийняття статті до друку після рецензування: 09.04.2026

Дата публікації (оприлюднення) статті: 29.05.2026

Стаття поширюється на умовах  
ліцензії відкритого доступу (CC BY 4.0)

