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# FAUNA OF ACARID MITES IN THE NESTS OF *APIS MELLIFERA CARPATICA* IN THE FOOTHILLS OF THE UZHHOROD DISTRICT OF THE TRANSCARPATHIAN REGION

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*The work is devoted to the study of the structure of acarid mite communities in the nests of Carpathian honey bees and changes in their numbers under the influence of various factors. Purpose: research on the species composition of acarid mites and their abundance in the nests of Carpathian honey bees in the foothills of the Uzhhorod district of the Transcarpathian region based on private apiaries (the villages of Khudlyovo and Antalovtsi), as well as the apiary of Uzhhorod National University (the village of Nyzhne Solotvyno). Research objects. Storage mites from the Acaridia group. Research material – honeycomb debris, pollen, and other organic impurities collected from hives in the studied apiaries. Methods: analytical review of research topics by domestic and foreign scientists, analysis of the biological characteristics of acarid mites; experimental – microscopy to identify mites and their abundance; determination of biodiversity indicators: dominance, density, and frequency indices; mathematical-statistical – using computer mathematical functions built into Microsoft Excel 2010. Results. Under the conditions studied, eight species of acarid mites were identified. Of these, 4 species (Glycyphagus domesticus, Tyrophagus similis, Carpoglyphus lactis, and Tyrophagus longior) corresponded to the category of "dominant species"; 3 species (Acarus siro, Tyrophagus putrescentiae, and Neoacotyledon redikorzevi) were classified as "subdominant species," and one species (Neoacotyledon sokolovi) was classified as a "subdominants of the 1st order." The low biodiversity of acarid fauna in the studied apiaries of the Uzhhorod district is explained by the dominance of a limited number of species due to their high total density. Conclusions. The largest number of acarid mites in the nests of Carpathian honey bees was observed in "weak bee colonies" in the period from April to June. The highest density was found in Gl. domesticus, and the highest frequency of occurrence was observed in T. similis and C. lactis. The relevance of the next stages of the work is determined by the need to establish the patterns of distribution of acarid mites in bee colonies depending on the altitude zone. This requires a detailed faunistic analysis in the lowland, foothill, and mountain zones of the Transcarpathia region.*

***Key words:*** *acarids, dominant species, mite density, biodiversity indices, apiaries.*

***Дудинська, А. Т., Романко В. О., Адамчук Л. О. Фауна акаридієвих кліщів у гніздах карпатської медоносної бджоли в умовах передгір'я Ужгородського району Закарпатської області***

*Робота присвячена дослідженню структури угруповань акаридієвих кліщів у гніздах карпатської медоносної бджоли та зміни їх чисельності під впливом різних чинників. Мета: дослідження видового складу акаридієвих кліщів та їх чисельності у гніздах карпатської медоносної бджоли в умовах передгір'я Ужгородського району Закарпатської області на базі приватних пасічних господарств (с. Худльово та с. Анталовці), а також пасіки Ужгородського Національного університету (с. Нижнє Солотвино). Об'єкти досліджень. Комірні кліщі з групи Acaridia. Матеріал досліджень – крихти стільників, пилку та інші органічні домішки зібраних із на вуликів на досліджуваних пасіках. Методи: аналітичний огляд по тематиці досліджень вітчизняних та зарубіжних науковців, аналіз біологічних особливостей акаридієвих кліщів; експериментальний – мікроскопіювання для ідентифікації кліщів та їх чисельності; визначення показників біорізноманіття: індексів домінування, щільності та частоти трапляння; математико-статистичний – за допомогою комп'ютерних математичних функцій, вбудованих у програму Microsoft Excel 2010. Результати. В досліджуваних умовах виявляли 8 видів акаридієвих кліщів. З них 4 види (Glycyphagus domesticus, Tyrophagus similis, Carpoglyphus lactis та Tyrophagus longior), які відповідали категорії «види-домінанти»; 3 види (Acarus siro, Tyrophagus putrescentiae та Neoacotyledon redikorzevi) віднесли до категорії «види субдомінанти» і один вид (Neoacotyledon sokolovi) – до «субдомінантів 1 порядку». Низькі показники біорізноманіття акаридофауни на досліджуваних пасіках Ужгородського району пояснюються домінуванням обмеженої кількості видів за їх високої сумарної щільності. Висновки. Найбільше акаридієвих кліщів у гніздах карпатської медоносної бджоли відмічали у «слабких бджолосім'ях» у період з квітня по червень. Найвищу щільність виявляли Gl. domesticus, а найбільшу частоту трапляння спостерігали у T. similis та C. lactis. Актуальність наступних етапів роботи зумовлена необхідністю встановлення закономірностей розподілу акаридієвих кліщів у бджолосім'ях залежно від висотної поясності. Це передбачає детальний фауністичний аналіз у низовинній, передгірській та гірській зонах Закарпатської області.*

***Ключові слова:*** *акариди, види-домінанти, щільність кліщів, індекси біорізноманіття, пасіки.*

**Relevance of the research topic and problem statement.** Acaroid and glycyphagoid mites (superfamilies Acaroidea and Glycyphagoidea) are among the most numerous superfamilies of the suborder Sarcoptiformes Reuter, 1909, belonging to the order Acariformes. They are also called synanthropic or storage pests (mites). Some representatives of these superfamilies are associated with the nests of homoeothermic vertebrates or hymenopteran insects and other invertebrates [1].

From a practical point of view, interest in acarid mites is mainly because many of them are pests of plant products, especially in storage conditions (grain storage facilities, vegetable storage facilities, and other warehouses) [2, 3, 4]. In particular, species of the genus *Acarus* and *Tyrophagus*, when they reproduce masse, can cause significant damage to grain seeds and grain products (flour, cereals, mixed feed, etc.) [3, 5, 6].

In addition, acarid mites play an important role in many biocenoses. The ecological characteristics of storage mites have always attracted the attention of researchers due to their prevalence and harmfulness. As a rule, studies have focused primarily on certain features of the ecological niches of storage mites, their trophic habits, and dependence on abiotic and biotic conditions in various physical and geographical zones of Ukraine [1, 2].

An analysis of recent studies and publications has shown that research is mainly conducted on the biology and development of acarid mites, their harmfulness, and control using various methods and preparations. In particular, the toxic effect of preparations that are alternative to chemical disinfection, such as inert powders, is being studied; determining the effectiveness of heat treatments against pests; increasing the range of fumigants and their preparative forms, including chemical ones, for disinfection of plant products.

Thus, Sally Abbar et al. (2016) demonstrated that treatment with extreme temperatures can cause the mortality of *T. putrescentiae* mite eggs [7].

The results of studies by Christos G. et al. (2025) on inert powders showed that zeolite was more effective than kaolin, regardless of dosage. 100 % mortality of *T. putrescentiae* mites was determined at a concentration of 1000 ppm of zeolite in 72 hours. In contrast, survival of *T. putrescentiae* was observed at all doses of kaolin [8].

According to Nihal Kilic (2022), inert powders such as diatomite (obtained from fossilized remains of diatoms) were noted to have acaricidal properties for 24 hours and 25 °C against *T. putrescentiae* [9].

Maria Boukouvala et al. (2025) demonstrate the acaricidal efficacy of two inert diatomite-type powders, tested against different stages of development of *A. siro* and *T. putrescentiae* on wheat at two dose options. Both preparations demonstrated a dependence of efficacy (within the range of 84.4–97.0 %) on dosage and duration of treatment against acarid mites at all stages of development [10].

According to Zhao Y. et al. (2015), fumigation of dry-cured ham with phosphine against *T. putrescentiae* resulted in 99.8 % mortality at the post-embryonic stages [11].

Md. Mahbub Hasan et al. (2019) prove that *T. putrescentiae* eggs were more resistant to both fumigants compared to the mobile stages of mites [12].

According to Sally Abbar et al. (2018), a 36-hour fumigation at 1400 h*g (the product of concentration and fumigation duration) provided 100 % mortality of all stages of the mite life cycle at 40 °C. Mite eggs, which were identified as the most resistant to the fumigant, were found to be more resistant to the fumigant [13]. However, further lowering of temperature negatively affected the effectiveness of sulfuryl fluoride. Thus, Md. Mahbub Hasan et al. (2021) demonstrate a slight mortality of mites when treated with sulfuryl fluoride for 48 hours at 23 °C [14].

A similar opinion was expressed by Romanko V. and Dudynska A. (2025), who prove that the lethal norms of sulfuryl fluoride at different temperatures are optimal for ensuring 100 % mortality of the mobile stages of acarid mites [15].

Literature data on the study of acarofauna in synanthropic conditions, including in honey bee nests, are limited. The presence of *C. lactis* in bee colonies on old combs and in honey was noted only in the following studies [16, 17]. In particular, Thi-Thu Nguyen et all. (2024) note that *Apis mellifera* colonies, especially weak ones, are very vulnerable to *C. lactis* mites, which can quickly infect and consume accumulated pollen, which leads to the weakening of colonies and their potential collapse [16]. Vijayakumar K. et all. (2013) draw attention to the fact that infection of *Trigona iridipennis* colonies with mites usually begins on honeycombs with pollen, and then spreads to honeycombs with brood. They believe that the nutritional component of brood food quickly stimulates the growth of mites [17].

Dudynska A. et al. (2025) studied the influence of various factors on the presence and abundance of *C. lactis* in honey during storage. Different numbers of mites were observed depending on the research options proposed. Depending on the different botanical origins of honey, its moisture content, and storage duration, the number of mites varied from 0 to 20.11 ± 2.667 individuals in one sample. The authors prove that mites are capable of colonizing only the surface of honey to a depth of 1–10 mm. In samples taken from the lower layers of honey, regardless of the study options, *C. lactis* was not detected [18].

The presence of *C. lactis*, *Gl. domesticus* and *T. longior* in hives in Great Britain was noted by Bowman, Clive (2023) [19].

Darliane Evangelho Silva et al. (2024) identified the mites' fauna in different environments of the chocolate production system in southern Brazil. In total, mites belonging to the families Acaridae, Anystidae, Blattisociidae, Cheyletidae, Glycyphagidae, Laelapidae, Pyemotidae, Tarsonemidae, Tetranychidae, Tydeidae, as well as Oribatida and Uropodina were found [20].

Henszel Ł. et al. (2011) determined the composition of acarofauna in samples of litter and animal feed taken from agricultural buildings in northwestern Poland. The results confirmed the high frequency of mites in the studied farm buildings [21].

Nickolas Palyvos et al. (2008) conducted a faunistic study of mites in synanthropic conditions in Greece. The study was conducted on grain crops (wheat, corn, oats, barley), flour, bran, industrial agricultural food products, dried fruits (walnuts, raisins), residues, and dust stored in warehouses. The highest levels and percentages of mite infestation were found in residual samples [22].

Kučerová Z. & Horák P. (2018) studied acarofauna on seed samples mainly of vegetable crops. Of these, 60 % were found to be infected with 14 species of mites [23].

It should be noted that this group of mites is also found in many biocenoses. Thus, 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 Ya. et al. (2022) studied species groups of acarid mites in agricultural and industrial areas in the Polissya region (Zhytomyr region) [24].

Zhovnerchuk O.V. et al. (2024) studied other groups of mites, namely the Tetranychidae and Phytoseiidae families, in the conditions of the studied region (Transcarpathia) in different vertical zones. It was proved that the species composition of mites was significantly influenced by vertical zonation [25].

The above shows that the absence of comprehensive information in scientific literature on the species composition of acarid mites in Carpathian bee nests, taking into account the vertical zonality of the region, makes research in this area particularly important.

Therefore, the aim of our research was to study the fauna of acarid mites in the nests of Carpathian honey bees in the foothills of the Uzhgorod district of the Transcarpathian region.

**Research methodology.** The research was conducted between 2023 and 2025 at apiaries located in the Uzhhorod district of the Transcarpathian region (foothills zone: low-mountain volcanic region in the Makovetsky landscape area): in the village of Nyzhne Solotvyno (apiaries of Uzhhorod National University) location – 48°33'47"N 22°27'14"E altitude 224 meters above sea level;

Khudlyovo village 48°35'16"N 22°29'12"E altitude 211 meters above sea level;

Antalovtsi village 48°37'09"N 22°30'12"E altitude 276 meters above sea level (Fig. 1).

To study the composition of acarocomplexes in the nests of Carpathian honey bees in the foothills of the Uzhgorod district, a total of 480 samples were collected and processed (160 samples in each apiary, or 8 studied hives, where five samples were taken from each hive). The research material consisted of honeycomb crumbs, pollen, and other organic impurities collected from the hives in the studied apiaries. The mass of one sample was 10 gram. The material collection and analysis were performed in accordance with methods having been adapted to acarological studies. The eclection method of Berlese with Tullgren modification was used for quantitative collection. All mite counts were performed using an Omax binocular microscope. The collected material was stored in entomological tubes in a 70 % alcohol solution. To determine the species composition


Apiary village of Khudlyovo Apiary village of Nyzhne Solotvyno

*Fig. 1. Location of the studied apiaries in the foothills within the Uzhhorod district*

of acarid mites, permanent total preparations were made using Hoyer's mounting fluid [2]. The identification of acarids was carried out under a microscope using an acarian identification keys [1]. The data obtained was subjected to statistical processing, as well as using mathematical functions built into Microsoft Excel. To characterize species biodiversity, density, frequency of occurrence, and indices such as dominance, Menkhinik, Margalef, and Shannon were determined.

**Research results.** As a result of analyzing the collected material, eight species of mites were identified. These are six species, namely *Acarus siro, Tyrophagus longior, Tyrophagus similis, Tyrophagus putrescentiae, Neoacotyledon sokolovi, Neoacotyledon redikorzevi*, which belong to the Acaridae family; and two species – *Glycyphagus domesticus, Carpoglyphus lactis*, which belong to the Glycyphagidae family. All of the mentioned acarid mite species were identified at each of the studied apiaries. However, their biodiversity parameters varied under the influence of various factors.

In total, 67,753 acarid mites were detected. Of these, 19,649 were found in the apiary near the village of Nyzhne Solotvyno, 23,127 in the village of Khudlyovo, and 24,977 in the village of Antalovtsi. In our opinion, the observed discrepancy in mite abundance is presumably attributed to the higher humidity levels in the villages of Khudlyovo and Antalovtsy compared to Nyzhne Solotvyno. Such environmental conditions favored the population growth of storage mites in these locations.

In general, during the annual cycle, the abundance of synanthropic mites followed a seasonal pattern: from April to June, the highest number was recorded – 34.0 ± 5.35 mites (or 48.22 % of the total number); from January to March, 18.4 ± 4.29 individuals (or 26.09 %); from October to December, 13.4 ± 4.73 individuals (or 19.05 %). The minimum abundance occurred from July to September – 4.7 ± 1.03 individuals (or 6.63 %).

This significant variation in population density is primarily attributed to climatic factors and the seasonal biological cycle of the bees, particularly their hygienic behavior in removing organic debris from the hive bottom. In the Uzhhorod district, the period from July to September appears to be the least favorable for acarid mite development. This is likely due to the synergistic effect of high temperatures and low humidity, which restrict mite proliferation, combined with the bees' intensified cleaning activity on the bottom boards, where mites are predominantly localized during this season.

Analysis of the species composition of acarids revealed uneven dynamics in the population density of these pests throughout the annual cycle. Thus, during the period from January to March (first quarter), the highest density was determined in *Gl. domesticus* – 76.8 ± 6.56 individuals (or 52.1 % of the total number of mites detected during this period). The lowest density index for this period was observed in *N. sokolovi* – only 0.7 ± 0.13 (Fig. 2).

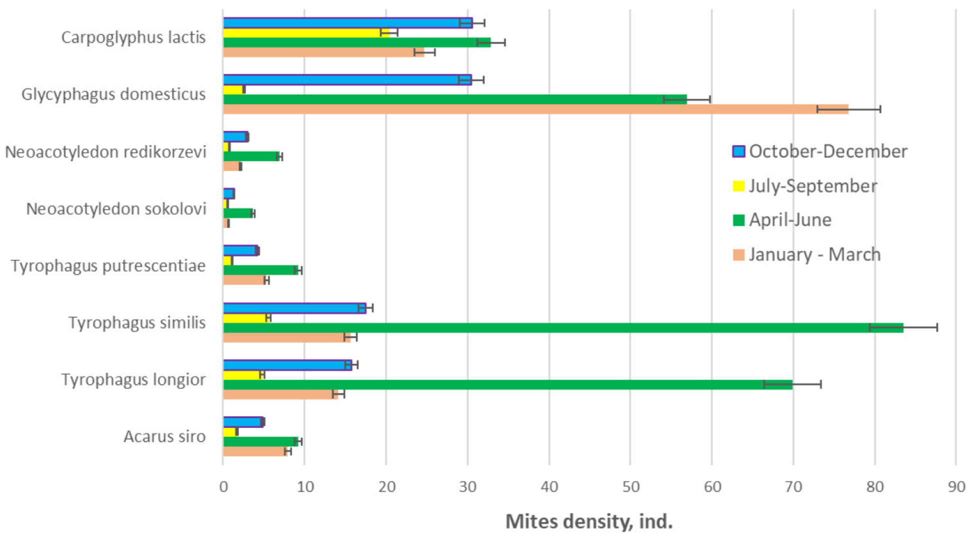



*Fig. 2. Dynamics of acarid density in* Apis mellifera carpatica *nests throughout the annual cycle*

In contrast to the previous period, the second quarter (April–June) showed the maximum population density for *T. similis* (83.5 ± 3.78 individuals, representing 30.7 % of all mites detected during this time). In addition, it should be noted that, unlike the first quarter, significant species dominance was not observed during the second quarter (the difference between indicators *T. similis*, *T. longior* and *Gl. domesticus*). Similar to the previous period, the minimum density was recorded for *N. sokolovi* (3.6 ± 0.69 individuals.

From July to September (third quarter), the highest density was found in *C. lactis* (20.4 ± 2.37 individuals) or 54.5 % of the total number of identified mites during this period, indicating its high dominance in the third quarter of the year. As in the previous case, the lowest density was observed in *N. sokolovi* (3.6 ± 0.69 individuals).

During the period from October to December (fourth quarter), the maximum density was determined in *Gl. domesticus* and *C. lactis* – 30.5 ± 5.83 and 30.6 ± 2.57 individuals, respectively. The minimum density index for this period, as in previous cases, was observed in *N. sokolovi* – only 1.3 ± 0.37 (рис. 2).

In general, higher density indicators were found in *Gl. domesticus* (41.71 ± 4.38), *T. similis* (30.54 ± 4.27), *C. lactis* (27.15 ± 2.49) and *T. longior* (26.14 ± 2.83 individuals) (Fig. 3). However, the dynamics of population density of individual mite species throughout the year in hives for each species had certain characteristics. Thus, the largest amplitude of mite density during the year was observed in *Gl. domesticus* (ranging from 76.8 ± 6.56 individuals in the first quarter, especially in March, to 2.6 ± 0.74 individuals in the third quarter).

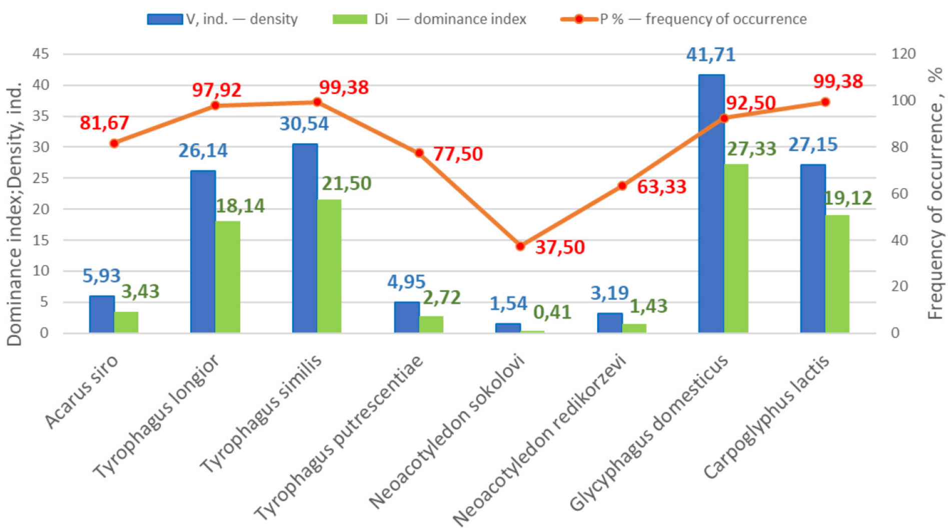



*Fig. 3. Biodiversity parameters of acarid mites at apiaries in the foothill zone of the Uzhhorod district*

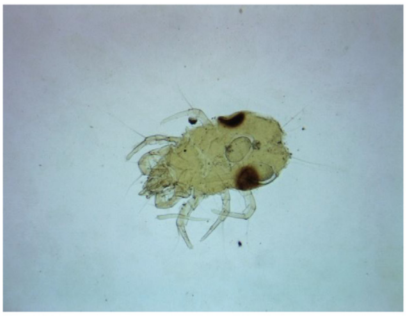
For *T. longior* and *T. similis* mites, the maximum density peak was recorded from April to June (69.9 ± 4.87 and 83.5 ± 3.38 individuals, respectively). The minimum density indicators for these two species were determined at 4.8 ± 1.03 and 5.6 ± 0.84 individuals, which were 1.87 and 2.15 times higher than the lowest density indicator for *Gl. domesticus*. The population of *C. lactis* remained relatively stable throughout the season, with density values between 20.4 ± 1.64 and 32.9 ± 1.13 individuals, showing no marked fluctuations compared to the other three acarid species (Fig. 2).

The highest frequency of occurrence, 99.38 % (477 out of 480 samples), was recorded for *C. lactis* and *T. similis*. It is worth noting that, *Gl. domesticus* showed a frequency only of 92.5 % (444 samples), despite having the highest population density among all detected acarids. The lowest occurrence frequency (37.5 %) was observed in *N. sokolovi* (Fig. 3).

According to dominance analysis, four of the eight identified acarid species (*Gl. domesticus*, *T. similis*, *C. lactis*, and *T. longior*) were identified as dominant. Three species were classified as subdominant (*A. siro*, *T. putrescentiae* та *N. redikorzevi*), while *N. sokolovi* represented the lowest dominance class “subdominants of the 1st order” (Fig. 4).

Analysis of the distribution of mites in bee colonies of varying strength showed that the highest abundance of acarid mites was observed in “weak” and “very weak” bee colonies – 24.95 % and 23.99 %, respectively, of the total number of individuals detected. The lowest rates were recorded in “strong” and “very strong” bee colonies – 16.56 % and 16.43 %, respectively.

***Carpoglyphus lactis*** ***Glycyphagus domesticus***



***Acarus siro*** ***Tyrophagus putrescentiae***

*Fig. 4. General view of acarid mites*

As shown in Fig. 5, *Gl. domesticus* was the dominant species of acarids in “weak” and “very weak” bee colonies. At the same time, *C. lactis* was less abundant than species such as *T. similis* and *T. longior*. Certain features were observed in the acarid fauna of “strong” and “very strong” bee colonies: the dominance of *Gl. domesticus* was less pronounced, and the minimum population density was observed in *T. longior* (Fig. 5).

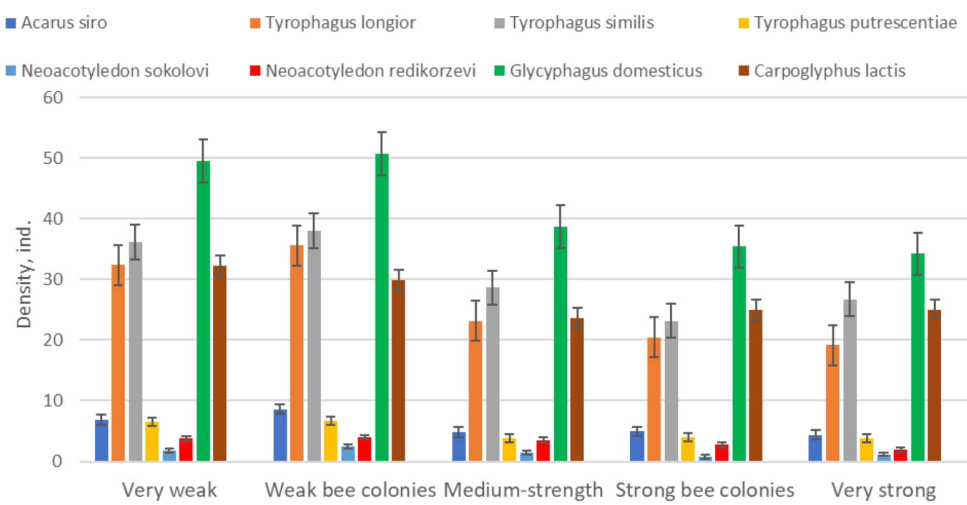



*Fig. 5. Density of acarid mites in the nests of Apis mellifera carpatica bees of varying colony strength*

In general, a comparison of our results with existing literature reveals both certain discrepancies and similarities. For instance, in a study of Acaridae and Glycyphagidae fauna within various industrial facilities in the Zhytomyr region, Oksentiuk et al. (2022) also identified eight species in honey bee hives [24]. However, only four of these (*A. siro*, *T. putrescentiae*, *T. longior*, and *Gl. domesticus*) match the species recorded in the foothills of the Uzhhorod district (Transcarpathian region).

Chaopin Li et al. (2015) identified the following species composition of acarids in honey and bee products during storage: 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 *Tyrolichus casei* [26].

Analysis of biodiversity indices for acarid mites in apiaries of the Uzhhorod district (foothill zone) revealed minor fluctuations in values, reflecting a generally low level of species diversity. Specifically, the Shannon index ranged from 1.68 (Antalovtsi apiary) to 1.72 (Nyzhne Solotvyno). These metrics indicate limited species richness and low evenness within the community, where the dominance of a few species reduces overall ecological stability (Fig. 6).

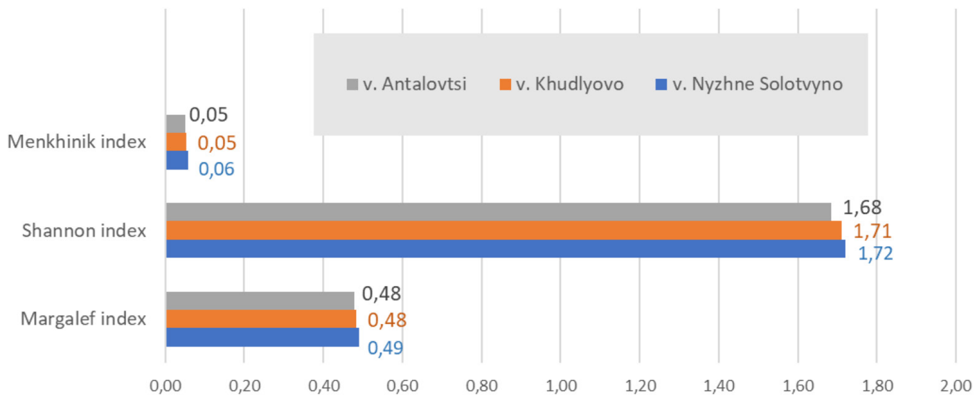



*Fig. 6. Species diversity indices of acarid mites in apiaries in the Uzhhorod district of Transcarpathia (foothill zone)*

The Margalef index values (0.48–0.49) indicate exceptionally low species richness within the acarid communities of *Apis mellifera carpatica* hives. This is explained by the fact that the development of acarids and their potential increase in species richness in hives is influenced by a limiting factor. That is, worker bees actively clean the bottom board of the hive from organic debris, which is a substrate for the development of acarid mites.

Unlike the above indices, the Menkhinik index was the lowest, ranging from 0.05 to 0.06, which is due to the high number of mites, at the same time, their insignificant species diversity.

For comparison, a study of the species diversity and abundance of acarid mites found that farm buildings (barns, chicken coops, storage rooms, and haylofts) in various areas of Transcarpathia provide suitable conditions for the development 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 [2].

Consequently, this study establishes the species diversity and abundance of acarid mites within *Apis mellifera carpatica* colonies in the foothills of the Uzhhorod district, Transcarpathia. These findings provide a critical baseline for future research on acarofauna across diverse altitudinal zones and varying climatic conditions.

**Conclusions and prospects for further research**

1. Eight species of acarid mites were found in the study area, classified as "dominant species," "subdominant species," and "subdominants of the 1st order".

2. During the annual cycle, the dynamics of the number of storage mites in the hives of Carpathian honey bees changed in the following sequence: the highest indicators were registered in April–June (34.0 ± 5.35 ind.), slightly lower in January–March (18.4 ± 4.29 ind.) and October–December (13.4 ± 4.73 ind.). The minimum number of individuals was found in July–September – 4.7 ± 1.03 individuals.

3. The highest density indicators were recorded in the species *Gl. domesticus* (41.71 ± 4.38), *T. similis* (30.54 ± 4.27), *C. lactis* (27.15 ± 2.49), and *T. longior* (26.14 ± 2.83 individuals). At the same time, the annual dynamics of the population of each species of acarids in hives was characterized by individual features.

4. A correlation was established between bee colony strength and mite abundance. The highest infestation levels were recorded in weak and very weak colonies, accounting for approximately 49 % of the total mite population. Conversely, strong and very strong groups exhibited the lowest values, at 16.56 % and 16.43 %, respectively.»

5. An analysis of biodiversity indices for acarid mites in apiaries in the Uzhhorod district of Transcarpathia (foothill zone) showed low values, which is explained by the high mite population and, at the same time, their low species richness.

6. In our opinion, further research in this area is relevant, in particular, the species diversity of acarid mites and their abundance in the nests of Carpathian honey bees in conditions of different vertical zonation (mountain, foothill, and lowland zones) in the Uzhhorod district of Transcarpathia.

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