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SYNANTHROPIC ACARIDIA MITES AND THEIR THE NUMBER IN FARM BUILDINGS IN THE TERRITORY OF THE TRANSCARPATHIAN REGION

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The work is devoted to the study of the structure of acarid mite communities in synanthropic conditions and changes in their numbers under the influence of environmental factors at different altitudes. Purpose: to study the influence of various climatic conditions, altitude, and farm buildings on the abundance of synanthropic storage mites of dominant and subdominant species from the Acaridia group in the Transcarpathian region. Research objects – synanthropic storage mites from the Acaridia group. Research material – litter and fodder for animal collected from various farm buildings: haylofts, chicken coops, cowsheds, storage rooms, and outbuildings. Methods: analytical review on the subject of research; analysis of the biological characteristics of storage mites; experimental – microscopy for identifying mites and their numbers; determination of biodiversity indicators: dominance index, density and frequency of occurrence; mathematical and statistical – using computer mathematical functions built into the Microsoft Excel program 2003. Results. In the synanthropic conditions studied, 10 species of acarid mites were identified, which corresponded to the categories «dominant species» and «subdominant species». Namely, eight species – Tyrolichus casei, Tyrophagus perniciosus, Neoacotyledon sokolovi, Chortoglyphus arcuatus, Gohieria fusca, Lepidoglyphus burchanensis, Glycyphagus domesticus, and Lepidoglyphus destructor were classified as «subdominant species», regardless of the type of farm buildings, vertical zoning, and climatic conditions. The «dominant species» in the foothills and mountainous conditions included A. siro and T. putrescentiae. Meanwhile in the lowlands, only A. siro was the «dominant species». Conclusions. Among farm buildings, the highest number of acarid mites (dominant and subdominant species) was observed in cowsheds – 33.72 %, and the lowest – in haylofts, 12.29 % of the total number. The highest biodiversity indicators of acarid mites were observed in the foothills (the average number of mites in 1 sample was 7.86, density – 0.98, frequency of occurrence – 58.13, dominance index – 5.21). The lowest indicators were in the mountainous area (the average number of mites in 1 sample was 5.15, density was 0.64, frequency of occurrence was 44.94) and in the lowlands (dominance index was 4.22). The variety *of farm buildings and altitudinal zoning had different effects on the diversity and the number of acarid mites. The indicators of some mite species differed significantly from the general values.*

Key words: *mites (dominant and subdominant species), altitudinal zonation, biodiversity indices.*

Дудинська, А.Т., Романко В.О., Адамчук Л.О. Синантропні акаридієві кліщі та їх чисельність в господарських будівлях на території закарпатської області

Робота присвячена дослідженню структури угруповань акаридієвих кліщів у синантропних умовах та зміни їх чисельності під впливом факторів навколишнього середовища за різної висотної зональності. Мета: дослідження впливу різних кліматичних умов, висотності та господарських будівель на чисельність синантропних комірних кліщів видів-домінантів та субдомінантів з групи Acaridia на території Закарпаття. Об'єкти досліджень. Синантропні комірні кліщі з групи Acaridia Матеріал досліджень – підстилка та корм для тварин, зібрані з різних господарських будівель: оборіг з сіном, курятники, хліви та складські приміщення домогосподарств. Методи: аналітичний огляд по тематиці досліджень вітчизняних та зарубіжних науковців, аналіз біологічних особливостей комах-шкідників; 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 2003. Результати. В синантропних досліджуваних умовах виявляли 10 видів акаридієвих кліщів, які відповідали категоріям «види-домінанти» та «види-субдомінанти». А саме 8 видів – Tyrolichus casei, Tyrophagus perniciosus, Neoacotyledon sokolovi, Chortoglyphus arcuatus, Gohieria fusca, Lepidoglyphus burchanensis, Glycyphagus domesticus та Lepidoglyphus destructor відносили до категорії «види-субдомінанти», незалежно від типу господарських будівель, вертикальної зональності та кліматичних умов. До «домінантних видів» у передгір'ї та гірських умовах відносили A. siro та T. putrescentiae. Тоді як на низовині до «домінантних видів» належав лише A. siro. Висновки. Серед господарських будівель найвищу чисельність акаридієвих кліщів (видів-домінантів та субдомінантів) спостерігали у хлівах – 33,72 %, а найнижчу – в оборогах з сіном 12,29 % від загальної кількості. Найвищі показники різноманіття акаридієвих кліщів спостерігали у передгір'ї (середня кількість кліщів в 1 пробі становила 7,86, щільність – 0,98, частота трапляння – 58,13, індекс домінування – 5,21). Найнижчі показники були у гірській зоні (середня кількість кліщів в 1 пробі становила – 5,15, щільність – 0,64, частота трапляння – 44,94.) та на низовині (індекс домінування – 4,22). Різновидність господарських будівель та висотна зональність ***по-різному*** *впливали на різноманіття та чисельності акаридієвих кліщів. Показники у деяких видів кліщів значно відрізнялися від загальних значень.*

Ключові слова: *кліщі (види-домінанти та субдомінанти), висотна зональність, показники різноманіття.*

Relevance of the research topic and problem statement

Acarid mites are among the most common pests found in food storage and processing environments. These species are cosmopolitan in distribution, inhabiting a wide range of plant products. According to Jan Hubert (2012) and D. Collins (2012), the ability of these to exploit conditions of and organic-rich substrates makes them particularly harmful in poorly ventilated areas [1, 2].

The economic damage caused by storage mites is determined by many factors Thus, the authors Patrcia Vogel et al. (2021) and A. Malik et al. (2018) argue that as a result of the vital activity of mites, the mass of products decreases and its quality decreases They acquire a musty smell, becoming lumpy and unsuitable for human consumption and animal feed. Seed germination is significantly reduced [3, 4].

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 *Tyrophagus putrescentiae* mite eggs [5].

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 [6].

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* [7].

Maria Boukouvala et al. (2025) demonstrate the acaricidal efficacy of two inert diatomite-type powders, tested against different stages of development of *Acarus 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 [8].

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 [9].

Md. Mahbub Hasan et al. (2019) prove that *T. putrescentiae* eggs were more resistant to both fumigants compared to the mobile stages of mites [10].

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 [11]. 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 [12].

A similar opinion was expressed by Romanko V. and Dudynska A. (2023) regarding the study of the toxic effect of phosphine, both individually and in combination with carbon dioxide. Unlike storage mites, when phosphine was used with carbon dioxide against insect pests of the genus *Sitophilus* and *Ephestia* at the same time, both the synergism of the gases and their effectiveness were noted [13].

There are a number of works on the features of the biology, development and harmfulness of *Carpoglyphus lactis.* This is a common species, which, according to Jan Hubert et all. (2014), is found in dried fruits, flour, wine, beer, dairy products, jams and honey [14]. Hamasen Aliakbarpouri, Qing-Hai Fan (2022) emphasize that *C. lactis* is cosmopolitan and has also been found on dead insects (mainly flies and beetle larvae), in bat roosts, beehives, and farm buildings [15]. However, according to Anar Bakr, et all. (2021), this species is primarily associated as a pest of stored products, which is successfully bred in laboratory conditions on dried apricots [16].

Literature data on the study of acarofauna in synanthropic conditions are limited. Thus, the presence of this mite in bee colonies on old honeycombs and in honey was noted in the works of a number of authors. 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 [17]. 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 [18].

The presence of *C. lactis*, *Glycyphagus domesticus*, and *Tyrophagus 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].

Dudynska A. et al. (2023) studied acarid mites in terms of fauna and ecology in the territory of Transcarpathia. However, the authors did not study in detail the species affiliation of mites and their abundance, depending on different farm buildings with reference to vertical zonation, which necessitated further scientific research in this direction [26].

Thus, the aim of the scientific research was to study and conduct a comparative analysis of the number of acarid mites of dominant and subdominant species in Transcarpathia under different climatic conditions, altitudinal zonation, and farm buildings.

Research methodology

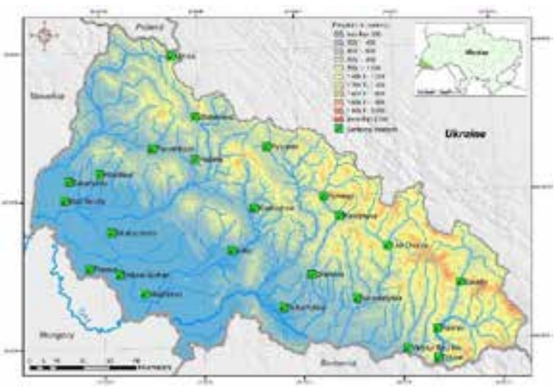
Observation and sampling of mites were carried out in chicken coops, cowsheds, storage rooms and haylofts during the summer period from 2018 to 2025. A total of 565 samples were collected and processed in synanthropic areas in the lowlands, foothills, and mountainous areas.

The material collection and analysis were performed in accordance with methods having been adapted to acarological studies. For quantitative collection, the Berleze method with Tulgren modification was used. 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 of acarid mites, permanent preparations were made using Hoyer's mounting fluid. Mathematical functions built into Microsoft Excel were used for statistical processing. To characterize species biodiversity, dominance, density, and frequency indices were determined [26].

A hypsometric and a climatic map were developed using modern geoinformation systems in the ArcGIS 10.4.1 software environment, showing the sampling points during the fi eld research period [27].

The choice of collection site was determined by the landscape and climatic characteristics of different altitude zones, as this could potentially affect the species diversity and distribution of mites. Also, within a single settlement, samples were collected from different farm buildings.

Thus, taking into account the indicators of vertical zonation (Fig. 1a), the average monthly temperature in July (Fig. 1b), and the average annual precipitation (Fig. 1c), the territory of the collection sites was conditionally divided into three parts (zones):



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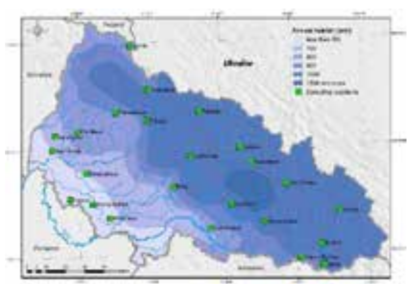

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Fig. 1. Map of acarid mites' collection sites in Transcarpathian Region: a – map of Transcarpathian Region by altitudinal zonation; b – air temperature map of Transcarpathian Region; c – precipitation map of Transcarpathian Region [26]

1. «Lowland» with parameters (from 100 to 200 meters above sea level; from "18" to "21 and above" °C; from "less than 700" to "800" mm). This zone included such settlements as: Velyka Beyhan, Mali Heyivtsi, Baranyntsi, Strabichovo, Khudlovo, Popovo, Muzhiyevo, and Sokyrnytsya.

2. «Foothills» (from 201 to 400 meters above sea level; within 16–17 °C; within 800– 1000 mm). This zone included such settlements as: Dilove, Polyana, Dragovo, Poroshkovo, Kushnytsya, Novoselytsya, Bilky and Velikiy Bychkiv.

3. «Mountain» zone with indicators (over 401 meters above sea level; within "17" and "less than 15" °C; within 900–1000 mm). This zone included such settlements as: Rakhiv, Synevyr, Zhdenievo, Pylypets, Uzhok, Kolochava, Ust-Chorna i Keveliv (fig. 1).

Thus, each zone was represented by 8 settlements where material was collected. In each settlement, farm buildings were selected in this way, in which, at the same time, it was possible to collect material (litter) of haylofts (1), chicken coops (2), of cowsheds (3) of storage rooms (4).

Research results

It should be noted that not all collection sites were subject to the parameters of the zones we have listed. For some settlements, it was necessary to apply an individual approach, which was based on the values of altitude zoning indicators and climatic conditions.

For example, the village of Uzhok was classified as a "mountainous area." Despite relatively high temperatures (16-17 °C), this settlement is located at a fairly high altitude (576 meters above sea level), which is why Uzhok was classified as a "mountainous area." Similarly, despite being located 173 meters above sea level, the village of Bilky was classified as a "foothill zone" because the average monthly precipitation and July temperature were only 800-900 mm and 17 °C, respectively. These values differ significantly from the climatic indicators of the "Lowlands".

In general, the amplitude of the vertical zonation of the collection sites ranged from 103 (Mali Heyivtsi) to 627 meters above sea level (Synevyr); temperature ranged from"21 °C and above" (Strabichovo, Mali Heyivtsi, Muzhiyevo, Velyka Beyhan, Popovo) to "less than 15 °C" (Pylypets); the amount of precipitation ranged from"less than 700" (Popovo, Velyka Beyhan, Mali Heyivtsi, Muzhiyevo) to 1000 mm (Dragovo, Kushnytsya, Novoselytsya, Rakhiv, Polyana, Pylypets, Synevyr, Ust-Chorna, Kolochava, Keveliv).

A correlation was ascertained between the above parameters: direct correlation between vertical zonation and precipitation (0.81); inverse correlation between vertical zonation and temperature (-0.87), as well as between temperature and precipitation (-0.92).

According to these studies, a total of 26 species of acarid mites were found in farm buildings in Transcarpathia (25 in the lowlands, 22 in the foothills, and only 17 in the mountainous areas). Of these, 10 species corresponded to the most numerous categories, namely "dominant species" and "subdominant species. These are five species, namely *Acarus siro*, *Tyrolichus casei*, *Tyrophagus putrescentiae, Tyrophagus perniciosus, Neoacotyledon sokolovi,* which belong to the Acaridae family; the species *Chortoglyphus arcuatus*, which belongs to the Chortoglyphidae family; and four species – *Gohieria fusca, Glycyphagus domesticus, Lepidoglyphus burchanensis, Lepidoglyphus destructor,* which belong to the Glycyphagidae family.

The difference in species composition and number of mites in different vertical zones is indicated by the research of Zhovnerchuk O.V. et al. (2024). The species composition of tetranychids was highest in the lowlands (23), slightly lower in the foothills (19), and lowest in the mountainous zone (11 species). For other mites – phytocide's – species richness was highest in the foothills (38 species), 25 in the lowlands, and lowest in the mountainous area with 21 species. The authors explain this difference by the significant differences in temperature and humidity regimes between altitude zones, as well as the different range of host plants that the studied groups of mites feed on [25].

In general, among farm buildings, the smallest number of synanthropic mites of dominant and subdominant species was found in haylofts – only 39.87 individuals per sample on average, or 12.29 % of the total number in farm buildings. Within the altitude zones, the number varied from 9.94 % (lowlands) to 14.99 % (mountainous areas) of the total number of mites in farm buildings.

Significantly higher mite numbers were observed of storage rooms – 78.39 individuals in one sample, or 23.74 % of the total number. That is, compared to haylofts, the number of acarid mites of storage rooms was 1.93 times higher. Within the altitude zones, the number mites ranged from 22.65 % (lowlands) to 25.80 % (mountainous areas) of the total number.

In chicken coops, the number of mites was 103.61 individuals, or 30.26 % of the total number. That is, the number of acarid mites was 2.46 times higher than in haylofts. Depending on the altitude above sea level, the number of mites ranged from 25.13 % (mountainous areas) to 34.98 % (lowlands) of the total number.

The highest mite numbers were observed in barns – 112.81 individuals, or 33.72 % of the total. That is, compared to haylofts, the number of acarid mites in barns was 2.74 times higher. Within the altitude zones, the number of mites ranged from 32.42 % (lowlands) to 34.66% (foothills) of the total number.

This sequence of values is probably due to the more optimal conditions for the development of mites of cowsheds, where relatively stable and high temperature and humidity levels are maintained, as well as a sufficient amount of nutritious substrate.

However, it should be noted that the number of some individual mites of dominant and subdominant species and their ratio in farm buildings differed significantly from the above-mentioned general values. In particular, *T. casei* was noted for its low number in haylofts and high numbers of these mites in storage rooms. Thus, the average number of *T. casei* and its percentage ratio in farm buildings was as follows: in haylofts – only 0.21 individuals, or 1.79 % of the total number; in chicken coops – 3.35 individuals, or 28.78 %; in storage rooms – 3.67 individuals, or 31.50 %; the highest indicator was in cowsheds – 4.42 individuals, or 37.94 % (Figs. 2, 3).

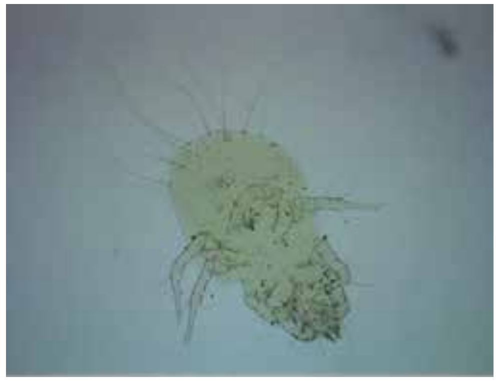
In contrast to the general indicators, *T. perniciosus* was noted for its low numbers in haylofts and high numbers in chicken coops and cowsheds. Thus, the average number of *T. perniciosus* and its percentage in farm buildings was as follows: in haylofts – only 0.20 individuals, or 1.59 % of the total number; in storage rooms – 3.55 individuals, or 28.27%; in chicken coops – 4.28 individuals, or 34.04 %; the highest indicator was in cowsheds – 4.53 individuals, or 36.10 % (Figs. 2, 3).

C. arcuatus did not show significant amplitude in numbers in different altitude zones and farm buildings. In addition, a high number of mites was observed in haylofts, at 3.78 individuals, or 18.66 %. In other farm buildings, the numbers of *C. arcuatus* were as follows: in chicken coops – 5.13 individuals, or 25.37%; in storage rooms – 5.33 individuals, or 26.36 %; the highest indicator was in cowsheds – 5.99 individuals, or 29.61 % (Fig. 2, 3).

Unlike the overall indicators, the highest number of *L. destructor* was found in storage rooms -7.57 individuals, or 37.27 %. In addition, a low number of mites was observed in haylofts – 0.94 individuals, or 4.64 %. In other farm buildings, the number of *L. destructor* was as follows: in chicken coops – 5.04 individuals, or 24.84 %; in cowsheds – 6.75 individuals, or 33.25 %.

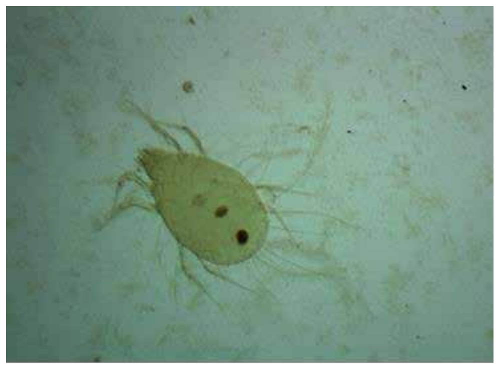
A distinctive feature of *G. fusca* was that their highest its numbers were found in storage rooms, amounting to 6.15 individuals or 44.27 %. In addition, a relatively low number of mites was observed in cowsheds and chicken coops, at 2.49 individuals, or 17.94 %, and 2.84 individuals, or 20.46 %, respectively. In contrast to the overall indicators, a high number of *G. fusca* was also noted in haylofts, at 2.41 individuals, or 17.34 %.

Tyrolichus casei



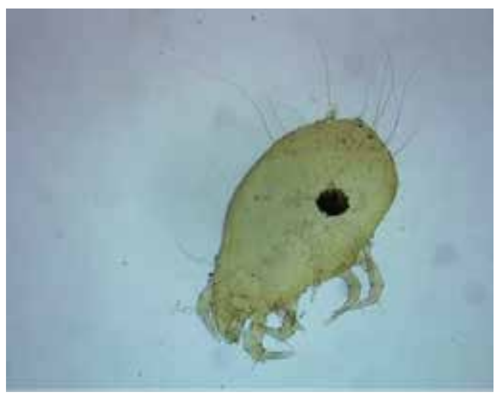
Tyrophagus perniciosus

Chortoglyphus arcuatus



Glycyphagus domesticus

hypopus and adult *Acarus siro*



Tyrophagus putrescentiae

Fig. 2. General view of acarid mites

Source: compiled by the authors

A special feature of *L. burchanensis* was that the highest its number was observed in chicken coops – 11.53 individuals or 40.07 %. Besides, they noted a low number of mites in haylofts – 0.73 individuals or 2.52 %. In other farm buildings, the number of *L. burchanensis* was as follows: in storage rooms – 5.61 individuals or 19.48 %; in cowsheds – 10.92 individuals or 37.93 % (Fig. 3).

In species such as *A. siro*, *T. putrescentiae*, *N. sokolovi*, *Gl. domesticus* (Figs. 2, 3), a similar distribution of mite numbers was observed in farm buildings with overall values.

Our research partially agrees with the data of a number of authors. Thus, Oksentiuk Ya. et al. (2022) found 30 species of mites in agricultural facilities (barns for storing animal feed, farm buildings, beehives, and vegetable storage facilities), while in our case, we found 26 species. For comparison, researchers found only 11 species of acarids in industrial facilities. The authors explain that the greater diversity of acarid species in agricultural facilities is due to more variable conditions, closer to natural ones, and less anthropogenic pressure compared to industrial facilities. The difference in the number of mites between them is due to compliance with sanitary and hygienic standards and methods of pest control in industrial facilities [24].

In Greece, Nickolas Palyvos et al. (2008) recorded the highest numbers in samples from bedding materials or residual materials in agricultural storage facilities [22].

The results of Henszel Ł. et al. (2011) confirm the significant number of mites in the studied farm buildings. The greatest species abundance was observed in animal feed samples and samples from chicken coops, and the least in cow barn bedding [21].

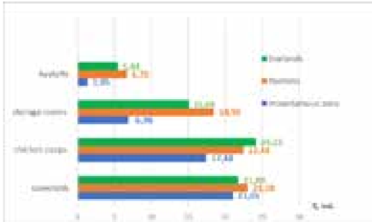
The general indicators of acarid mite diversity (dominant and subdominant species) in different areas of the Transcarpathia were as follows: in the lowlands, the average number of mites in 1 sample (further in the text $\bar{X}$*, ind.*) was 6.45, density (further in the text *V., ind.*) was 0.81, frequency of occurrence (further in the text *P., %*) was 50.75, and dominance index (further in the text *Di*) was 4.22. The diversity indicators of acarid mites in the foothills were higher than in the lowlands, which is probably due to more optimal climatic conditions for the development of mites. Thus, the $\bar{X}$ index was 7.86 *ind.*, *V.* – 0.98 *ind.*, *P.* – 58.13 %, *Di* – 5.21. The lowest indices were observed in the mountainous zone: $\bar{X}$ index – 5.15 *ind.*, *V.* – 0.64 *ind.*, *P.* – 44.94 %. The exception was *Di*, which was higher in the mountainous area (4.77) than in the lowlands.

However, it should be noted that the biodiversity indicators of some individual dominant and subdominant mites' species in different areas of the Transcarpathian region differed significantly from the above-mentioned general values. Thus, within the foothill zone, indicators such as $\bar{X}$ were 2.74 times higher for *T. casei*, 2.67 times higher for *V.*, 2.72 times higher for *P.*, and 4.25 times higher for *Di.* compared to the mountain zone. For comparison, the overall diversity indices of acarid mites in the foothills were 1.52, 1.53, 1.29, and 1.09 times higher than in the mountainous zone, respectively (Fig. 4).

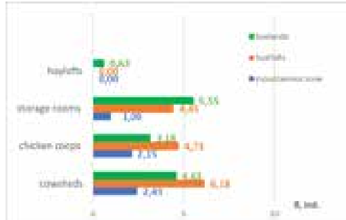
Unlike the overall values, in *T. perniciosus*, biodiversity indicators were highest in the lowlands ($\bar{X}$ – 3.94, *V.* – 0.49, *P.* – 33.75, *Di.* – 1.45). The corresponding indices in mountainous areas were significantly lower, namely 2.40, 2.33, 2.16, and 3.22 times lower, respectively.

Among *N. sokolovi* mites, the lowest diversity indices were found in the lowlands ($\bar{X}$ – 5.38, *V.* – 0.67, *P.* – 48.13, *Di.* – 2.81). In the foothills, these indicators were higher by 1.47, 1.48, 1.49, and 1.99 times, respectively.

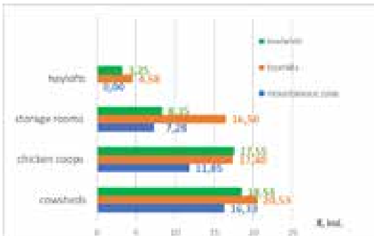
In terms of vertical zonation, analysis of quantitative indicators of *C. arcuatus* biodiversity showed that, unlike the above-mentioned species, there were no significant differences in their values. Thus, the highest indicators ($\bar{X}$ – 5.61, and *V.* – 0.7) were observed in the foothill zone; *P.* (51.88) – in the lowlands, and *Di.* (3.87) – in the mountain zone.



Acarus siro

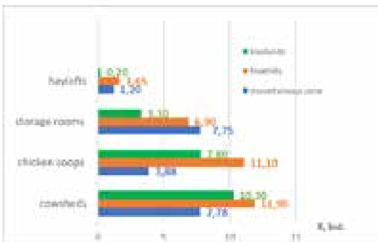


Tyrolichus casei



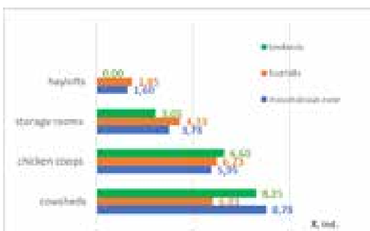
Tyrophagus putrescentiae

Tyrophagus perniciosus

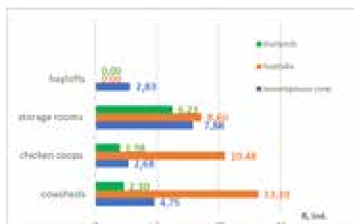


Neoacotyledon sokolovi

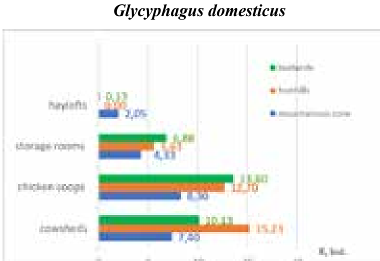
Chortoglyphus arcuatus



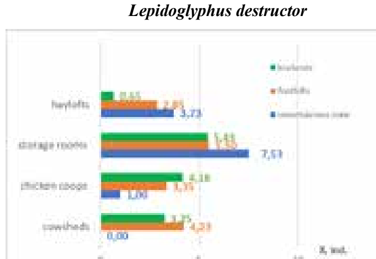
Glycyphagus domesticus



Lepidoglyphus destructor



Lepidoglyphus burchanensis



Gohieria fusca

Fig. 3. Number of acarid mites (dominant and subdominant species) in farm buildings in different areas of Transcarpathia

Note: X, ind. – the average number of mites in 1 sample
Source: compiled by the authors

Unlike the mentioned species, *Gl. domesticus* diversity indicators were highest in the mountainous area ($\bar{X}$ – 5.03, *V.* – 0.63, *P.* – 48.75, *Di.* – 4.26). Meanwhile, the lowest indices, $\bar{X}$ – 4.48 and V. – 0.56, were observed in the lowlands, and *P. (*40.0) and *Di.* (1.81) – in the foothills.

In *L. destructor*, biodiversity indicators were highest in the foothills ($\bar{X}$ – 8.07, *V.* – 1.01, *P.* – 66.88, *Di.* – 5.31). In contrast to the general indicators, the lowest diversity values for mites were observed in the lowlands, which were 3.07, 3.06, 1.95, and 5.04 times lower than in the foothills, respectively.

Analysis of biodiversity indicators for *G. fusca* in different areas of the Transcarpathian region showed insignificant differences in their values. Slightly lower values were found in the mountainous area. Thus, the value of $\bar{X}$ was 3.06, *P.* – 38.13, and *V.* – 0.38. However, *Di*. was the highest and was – 2.03. Another's highest indicators of diversity of *G. fusca* were determined in other zones. Thus, in the foothills, $\bar{X}$ was 3.98, and the indicator *V.* was 0.5. The indicator *P.* (42.5) was found in the foothills and lowlands.

In species such as *A. siro, T. putrescentiae*, and *L. burchanensis*, a similar distribution of mite diversity across vertical zonation was observed, with general values.

In general, among acarid mites, *A. siro* had the highest biodiversity indexes and number of mites, which was classified as a "dominant species" in all vertical zones. Thus, depending on the zone, the *Di* ranged from 13.1 to 15.02; *V.*–from 1.46 to 2.21; *P.*–from 64.38 to 86.25; and $\bar{X}$ – from 11.69 to 17.69. The number of individuals, depending on the farm buildings, varied from 1.35 to 24.15. The highest number of *A. siro* was observed in cowsheds and chicken coops–35.83 and 34.84 % of the total number, respectively (Fig. 2, 4).

T. putrescentiae should also be included in the category of "dominant species." However, in the lowlands, the *Di* was only 9.23, which is equivalent to "subdominant species." The highest biodiversity indices for this species of mites ($\bar{X}$ – 14.75, *V.* – 1.84, *P.* – 80, *Di.* – 11.62) were observed in the foothills. In farm buildings, the highest number of *T. putrescentiae* was observed in cowsheds – 38.96 of the total number (Fig. 2, 4).

The results of the study coincide with data from a number of works on biodiversity and dominance indicators in the acarofauna of species such as *A. siro* and *T. putrescentiae*. Thus, Henszel Ł. et al. (2011) prove that in samples taken from agricultural building bedding, the frequency of occurrence was 72.3 % for *Lepidoglyphus (Glycyphagus) destructor*, *Cheyletus* sp. (52.7), *A. siro* (41.8), and *T. putrescentiae* (40.0 %) [21].

Nickolas Palyvos et al. (2008) found that among acarid mites collected from synanthropic environments, *L. destructor*, *T. putrescentiae*, and *A. siro* were dominant [22].

When studying the mite fauna during chocolate production in southern Brazil, Darliane Evangelho Silva et al. (2024) found that *Brachytydeus oregonensis* and *T. putrescentiae* were the most numerous species [20].

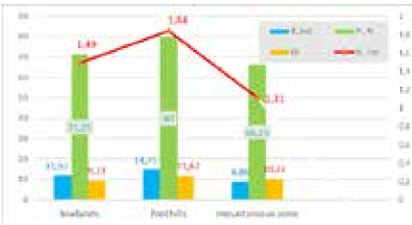
Kučerová Z., Horák P. (2018) demonstrated that in seed samples of predominantly vegetable crops, *A. siro* was the dominant pest mite in all indicators studied. Species such as *T. putrescentiae* and *L. destructor* also showed high indicators [23].

Oksentiuk Ya. et al. (2022) prove that in samples collected from various industrial facilities in the Zhytomyr region, the dominant species were *A. siro* (*Di*. – 17.76), *Gl. domesticus* (*Di*. – 10.6), and *L. destructor* (*Di*. – 7.22) [24].

Thus, based on the analysis of the collected material in various farm buildings, the diversity of acarid mites and their numbers in the Transcarpathian region have been determined.

Acarus siro

Tyrolichus casei



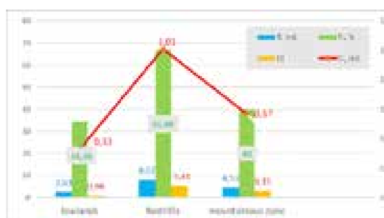
Tyrophagus putrescentiae

Tyrophagus perniciosus

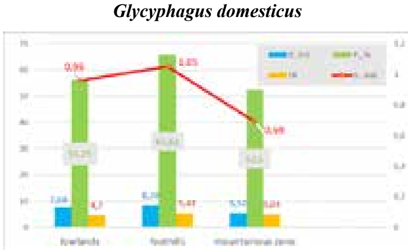
Neoacotyledon sokolovi

Chortoglyphus arcuatus

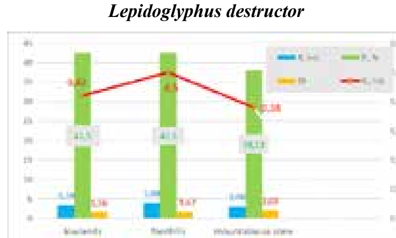
Glycyphagus domesticus



Lepidoglyphus destructor



Lepidoglyphus burchanensis



Gohieria fusca

Fig. 4. Biodiversity indicators of acarid mites (dominant and subdominant species) in different areas of Transcarpathian region

Note: Di – dominance index, V, ind. – density (individuals); P % – frequency of occurrence; X̄, ind. – the average number of mites in 1 sample

Source: compiled by the authors

Conclusions and prospects for further research

Ten species of acarid mites were found in farm buildings in the Transcarpathian region, corresponding to the categories “dominant species” and “subdominant species.”

In general, haylofts, independently of zoning, had the lowest numbers of acarid mites (only 39.87 individuals on average, or 12.29 % of the total number in farm buildings). Within the altitude zones, the abundance ranged from 9.94 % (lowlands) to 14.99 % (mountainous areas) of the total number of mites. The highest number of acarid mites was found in cowsheds – 112.81 individuals, or 33.72 % of the total number. Within the altitude zones, the number ranged from 32.42 (lowlands) to 34.66 % (foothills) of the total number.

The number of some singly collected mites of dominant and subdominant species and their proportion in farm buildings differed significantly from the above-mentioned general values. In particular, the highest numbers of *L. destructor* and *G. fusca* were found in storage rooms – 7.57 individuals, or 37.27 %, and 6.15 individuals, or 44.27 %, respectively. The highest number of *L. burchanensis* was observed in chicken coops – 11.53 individuals, or 40.07 %. A high number of *G. fusca* was found in haylofts – 2.41 individuals, or 17.34 %, and a very low number was in *T. perniciosus* and *T. casei* – only 0.20 individuals, or 1.59 %, and 0.21 individuals, or 1.79 %, respectively, of the total number.

The general indicators of acarid mite diversity (dominant and subdominant species) in different areas of the Transcarpathian region were as follows: in the lowlands, the average number of mites was 6.45, density was 0.81, frequency of occurrence was 50.75, and dominance index was 4.22. The highest biodiversity indicators for acarid mites were observed in the foothills, and the lowest in the mountainous zone.

Unlike the general values in *N. sokolovi* and *L. destructor*, the lowest biodiversity indicators were found in the lowlands; in *Gl. domesticus*, the highest were in the mountainous zone; in *T. perniciosus*, the highest were in the lowlands, and in *C. arcuatus* and *G. fusca*, no significant difference in biodiversity indicators was observed in different vertical zones.

In our opinion, further research in this area is also relevant in other territories of the Carpathian region, in particular in the Lviv and Ivano-Frankivsk regions.

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