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NOSEMATOSIS IN BEEKEEPING IN UKRAINE (2022–2024):

THE ONLY POLLINATOR HEALTH PROBLEM IN THE FOCUS OF RESEARCH

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Abstract. *This article presents the results of a monitoring study on the spread of nosematosis among honey bees in Ukraine from 2022 to 2024. This parasitic disease, caused by *Nosema apis* and *Nosema ceranae*, significantly disrupts bee physiology, reduces immunity and lifespan, weakens colonies, and leads to substantial losses in beekeeping. The article analyzes veterinary reports and laboratory data, allowing researchers to trace the dynamics of infection and identify regional patterns. The highest infection rates were observed in Kherson, Khmelnytskyi, and Volyn regions. It was found that *Nosema ceranae* is gradually displacing *Nosema apis* in bee populations, complicating disease control strategies. The study emphasizes the need to improve diagnostic systems, ensure regular laboratory monitoring, develop effective preventive programs, and conduct educational outreach for beekeepers. The authors stress the importance of the «One Health» approach in protecting pollinators as a vital component of agroecosystems. Directions for future research are proposed, including adapting control measures to climate change, local environmental conditions, and the biological characteristics of the pathogens.*

Keywords: nosematosis, *Nosema ceranae*, *Nosema apis*, honey bees, disease, monitoring, infestation, biosecurity, pollinators, diagnostics, prevention

Introduction. Ukraine is one of the countries with developed beekeeping, ranking third in the world in honey production (Agro Perspektiva, 2025). However, the effective development of beekeeping is hampered by infectious and invasive bee diseases.

Nosematosis is a slow invasive disease of bee colonies caused by the microsporidia *Nosema apis* and *Nosema ceranae*, which infects the epithelial cells of the midgut, causing intestinal disorders, weakening of bee colonies and their death.

Nosematosis is an urgent disease of adult European honey bees, including queen bees. According to scientific data, the disease reduces honey collection by 36-50% and negatively affects the reproductive capacity of bee colonies, which emphasizes its economic and environmental significance. For example, Neuman P. (2010) emphasizes the global nature of bee mortality, linking it to pathogens such as *Nosema* and other factors that exacerbate the problem. Thus, the study of nosematosis, its diagnosis and prevention, as emphasized by modern authors, is critical for the preservation of beekeeping and food security.

The disease is caused by the spore-forming microsporidia *Nosema apis* and *Nosema ceranae*. Morphologically, the spores are difficult to distinguish between these two species, and this synergy ensures the pathogen's persistence and the form of disease spread (Palazzetti, 2007). The causative agent of *neomatosis* *N. apis* and *N. ceranae* have a stable spore, with stressors acting in association and all of them having an important synergistic or complementary effect on the occurrence of parasitic infection (Galajda, 2021).

Numerous studies by Ukrainian scientists show that «Asian» nosematosis is predominantly registered in Ukraine, with *N. ceranae* being the causative agent, which was detected in 74.5% of the analyzed samples (Odnosum, 2023).

Nosema ceranae spores are very resistant to the environment: they can withstand very low temperatures (down to minus 20 °C) and high temperatures (up to 60 °C), which contributes to the re-infection of bee colonies and the recurrence of the disease after a long time (Efimenko, 2014). Spores can remain infectious for several days to five years at temperatures below 0 °C (in particular, at minus 12 °C for up to 5 years). *N. apis* spores are less resistant to the environment.

In contrast to the Ukrainian researchers, colleagues from Germany showed that in their territory there is no dominance of *N. ceranae* over *N. apis* and a general replacement of *N. apis* with *N. ceranae* in the studied honey bee population (Gisder, 2017).

Transmission occurs mainly by fecal-oral route (Martin-Hernandez, 2007). Within the family, the spores are spread mainly by worker bees, which clean the combs, feed the queen, drones, and exchange food with each other. Spores of nosema contaminate hives and all equipment.

Mostly, nosematosis manifests itself in late winter, spring and autumn. In summer, the disease is asymptomatic. Infection of bees occurs when they consume honey, perga, water, which are infected with nosema spores, as well as kept on fallen honey. The development of the disease is facilitated by sharp temperature fluctuations, high humidity inside the hives, lack of perga, and late bee flight. Important factors are pesticide exposure and nutritional stress, which impair the immunity of bees (Galajda, 2021).

The disease can occur in overt and latent forms.

Among adult bees infected with nosema, an increase in the incidence of dysentery is recorded (Agriculture Victoria Connect, 2025).

Neomatosis does not have any distinct symptoms, but is accompanied by slow depopulation and a decrease in bee productivity. Bees that cannot fly appear in the hives, and they have a wing defect with a «K» shape. Paralyzed individuals can also be found, while other bees gather in small groups (Chemurot, 2017).

The latent form is unnoticeable, with no obvious signs of the disease.

In the overt form, the disease is observed:

- Nurse bees lose the ability of their hypopharyngeal glands to produce royal jelly, which is used to feed the honey bee brood.
- A significant portion of the eggs laid by the diseased queen may not produce mature larvae.
- Young infected queen bees stop raising brood and switch to guarding and foraging, usually done by older bees.
- Reduced life expectancy of infected bees. In spring and summer, infected bees live half as long as uninfected bees.
- Infected queens stop laying eggs and die within a few weeks.

The study on the epizootic situation with nosematosis is relevant and helps to control the spread of the disease, the importance of its diagnosis, treatment and prevention, as well as the development of bee species that will be resistant to pathogen spores. The loss of bee colonies due to nosematosis will lead not only to economic losses but also to an environmental disaster, as the agricultural sector, which is directly dependent on bee pollination of crops, is a priority for our country.

The aim of the study. Monitoring of bee infestation with nosematosis spores in the regions of Ukraine by analyzing veterinary reports for the period 2022 – 2024.

Materials and methods. Statistical analysis was performed on the basis of annual reporting forms No. 2-Vet. Report on the work of the laboratories of the State Service of Ukraine for Food Safety and Consumer Protection, which was analyzed using standard epizootological and biostatistical approaches. The laboratories of the State Service of Ukraine for Food Safety and Consumer Protection conducted microscopy tests in compliance with DSTU ISO/IEC 17025:2019 General requirements for competence of testing and calibration laboratories.

Results. Control and supervision of the spread of nosematosis in Ukraine is carried out by the State Service of Ukraine on Food Safety and Consumer Protection in accordance with the Plan of Anti-Epizootic Measures for the Prevention of Major Infectious and Parasitic Animal

Section 3

Diseases in Ukraine. Planning is carried out in the amount of 10% of the total number of bee colonies of registered market operators.

Diagnostic tests for bee nosema are carried out microscopically and only by authorized laboratories of the State Service of Ukraine for Food Safety and Consumer Protection that are accredited in the ISO 17025 system. The results of the research are submitted to 2-VET Report on the work of state laboratories of veterinary medicine, quarterly, and recorded in the passport for the apiary.

According to this report, the staff analyzed the dynamics of the epizootic process of nosematosis in bees. During 2022 – 2024, 315141 bee samples were tested. Of these, a positive result was obtained in 4664 cases, which is 2.05% of the invasiveness (Fig. 1). during the study period, an increase in the number of positive samples for the pathogen of nosema was observed. In 2022, the laboratories of the State Service of Ukraine for Food Safety and Consumer Protection examined 140362 samples, which is 1.3% of the invasiveness rate. In 2023, 170988 samples were examined, the percentage of infection was 1.9%, in 2024 52034 studies were conducted, 2.9% (Fig. 1).

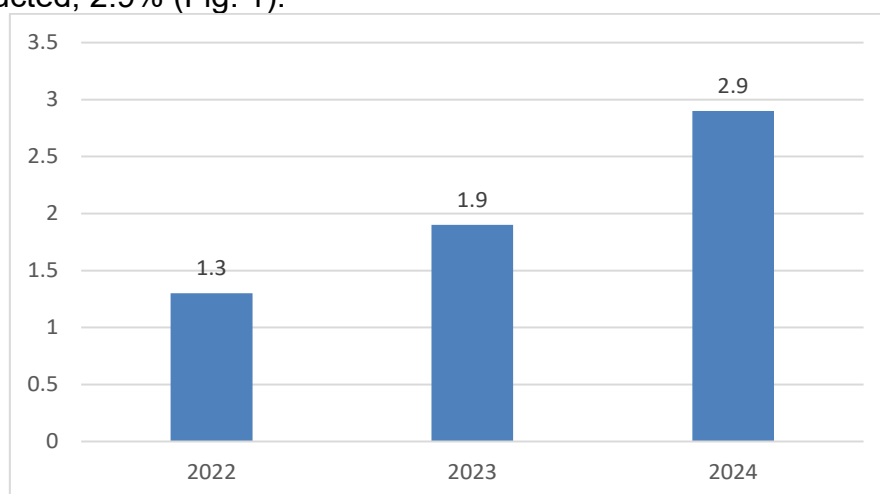


Fig. 1. Percentage of bees infected with nosematosis for the period 2022 –2024

These statistics are not complete due to the occupation of a large part of our country. The obtained indicators indicate an increase in nosematosis infection in the regions of Ukraine.

The distribution of nosematosis infection by region is shown in Fig. 2.

Discussion of the results. Based on the above map of the spread of bee nosematosis in Ukraine, it is possible to analyze the situation, taking into account regional characteristics and the level of bee colonies' susceptibility. The map shows the percentage of bees affected by nosema in different regions of Ukraine, where the values vary from 0.1% to 28% (Fig. 3).

The highest rate of damage is recorded in Kherson region – 28%. This may be due to the climatic conditions of the region, in particular high humidity and warm winters, which favor the development of *Nosema ceranae*, which is better adapted to such conditions than *Nosema apis*. It may also be due to insufficient use of preventive measures at local apiaries.

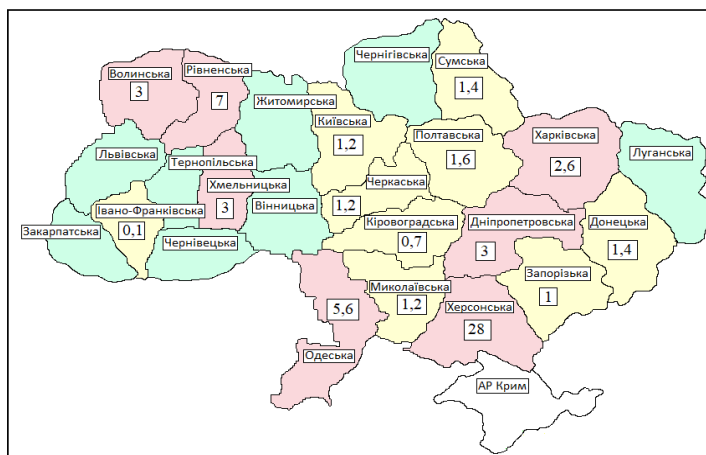


Fig. 2. Registration of bee nosematosis by regions of Ukraine for the period 2022 – 2024 (%)

Khmelnytskyi region (5.6%) and Volyn region (3%) also show high levels of infestation. These regions have developed beekeeping, but are likely to face problems in managing bee health, possibly due to insufficient timely treatment of bee colonies.

Regions with low levels of incidence include: Ivano-Frankivsk region, where only 0.1% is recorded (Fig. 3). This may indicate effective preventive measures, such as timely treatment of bees with drugs (e.g., fumagilin), or favorable environmental conditions that reduce the risk of disease spread.

Kirovohrad (0.7%), Cherkasy (1.2%), and Poltava (1.6%) regions also have relatively low rates. This may be the result of a lower density of bee colonies in these regions or better control over the condition of apiaries.

Average level of damage. Most regions, such as Vinnytsia (1.2%), Dnipropetrovs'k (3%), and Zhytomyr (1.2%), have an average level of damage (1-3%). This indicates a typical situation for Ukraine, where nosema is widespread but not critical. In such regions, basic preventive measures are likely to be applied, but they may not be sufficient to fully control the disease.

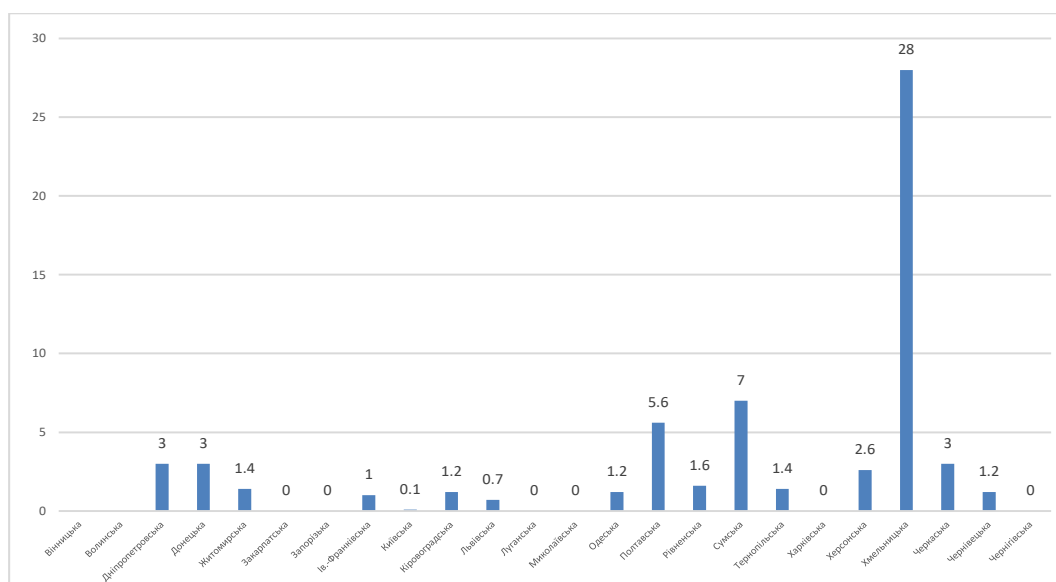


Fig. 3. Percentage of bees infected with nosema in the regions of Ukraine for the period 2022 – 2024

Higher rates of infestation (Kherson, Khmelnytsky, Volyn) are observed in different geographical zones – south, west and north, which indicates that there is no clear dependence

on climatic zones. High infestation rates may be associated with *Nosema ceranae* infestation, which, unlike *Nosema apis*, is more active throughout the year and less dependent on seasonal fluctuations. This may indicate that the main factor in the spread is not climate, but the level of beekeeping practices and awareness of beekeepers.

Eastern regions, such as Kharkiv and Donetsk oblasts, have an average level of infestation, which may be due to the smaller number of apiaries due to the difficult socio-economic situation in the region. Thus, nosematosis is a serious problem for the Ukrainian beekeeping industry, as the disease is present even in regions with low levels of infection. This confirms its endemic nature.

Nosematosis is mainly transmitted by the fecal-oral route. The causative agent of nosematosis is easily spread through the droppings of diseased bees, especially in the hive. Spread from hive to hive and from apiary to apiary can occur through: movement of infected worker bees; high humidity inside the hive; moving infected combs from one hive to another; feeding infected honey to bees; use of infected materials or beekeeping equipment; frequent inspections of hives in unfavorable weather conditions (e.g., winter season, windy or rainy weather) can trigger the onset of the disease and its spread due to stress; the presence of other diseases (e.g., varroa, amoebiasis, or viruses) exacerbates the symptoms of nosema (Martin-Hernandez, et al., 2007; Galajda, et al., 2021; Galatyk, 2022). Lack of awareness among beekeepers, limited access to modern diagnostic and prevention methods, and the possible use of contaminated honeycombs or feed may contribute to the spread of the disease.

It is not easy to diagnose the disease in the early stages; the only suspicious sign is the presence of liquid excrement on the hive floor. A field test is to examine the color of the end part of the digestive system of some bees: in healthy bees it is reddish, while in diseased bees it is milky white. This sign, however, is observed only when the disease has already reached a certain severity. The main method of diagnosis is microscopy of spores at the intestinal level or directly in the feces (Galatyk, 2022, Forsgren & Fries, 2010).

Conclusions. The results of the study indicate a gradual increase in the level of nosematosis in bees in Ukraine during 2022 – 2024, which is confirmed by official veterinary statistics. The most affected regions are Kherson, Khmelnytsky and Volyn regions, which indicates an uneven spread of the disease and the need for regionally focused preventive measures.

The peculiarities of the nosematosis pathogen, its ability to survive in adverse conditions and the complexity of early diagnosis pose serious challenges for beekeeping. Risk factors, such as climatic conditions, non-compliance with sanitary and preventive standards, nutritional stress and comorbidities, contribute to the spread of the infestation.

Effective control of nosematosis requires an integrated approach: strengthening laboratory control, informing beekeepers, improving diagnostic methods and developing safe treatment alternatives. The preservation of beekeeping in Ukraine directly depends on a timely response to the challenges posed by this invasive disease.

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НОЗЕМАТОЗ У БДЖІЛЬНИЦТВІ УКРАЇНИ (2022–2024): ЄДИНА ПРОБЛЕМА ЗДОРОВ'Я ЗАПИЛЮВАЧІВ У ФОКУСІ ДОСЛІДЖЕНЬ

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Резюме. У статті подано результати моніторингового дослідження поширення нозематозу серед медоносних бджіл в Україні у 2022–2024 рр. Це паразитарне захворювання, зумовлене збудниками *Nosema apis* та *Nosema ceranae*, що викликає серйозні порушення фізіологічних процесів у бджіл, призводить до зниження імунітету, скорочення тривалості життя, ослаблення бджолиних сімей, а також до економічних втрат у бджільництві. У статті проаналізовано ветеринарну звітність та результати лабораторних досліджень, що дозволило простежити динаміку захворюваності та виділити регіональні особливості розповсюдження інфекції.

Найвищі показники виявлено у Херсонській, Хмельницькій і Волинській областях. У роботі акцентовано увагу на потребі вдосконалення системи діагностики, регулярного лабораторного контролю, розробки профілактичних програм і просвітницьких заходів для бджолярів. Автори підкреслюють важливість підходу «Єдине здоров'я» у контексті захисту запилювачів як невід'ємного компонента агроєкосистем. Запропоновано напрями подальших досліджень щодо адаптації протиепізоотичних заходів до змін клімату, регіональних умов та біологічних особливостей збудників.

Ключові слова: нозематоз, *Nosema ceranae*, *Nosema apis*, бджоли, захворювання, моніторинг, інвазійність, біобезпека, запилювачі, діагностика, профілактика.

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