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State epizootic monitoring of contagious diseases of bees in the territory of the Volyn region

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Abstract

The well-being of apiaries is a priority in the state's economic, social, and environmental aspects. There is a state monitoring system to ensure proper control over the prevalence of infectious, invasive, and viral diseases. This system systematically monitors the spread of diseases that cause significant economic problems. Solving these problems will further shape the state's favorability to ensure the export of beekeeping products to European countries. Data on the spread of infectious and invasive diseases of bees from official departments of the State Production and Consumer Services of particular regions. In work, such data were processed in the Volyn region from 2017 to 2022, including a plan for determining the incidence and incidence rates in this region. The results show that nosemosis and varroosis were the most common diseases in the Volyn region during the studied period. It was established that the indicator of bee colonies with the Varroa destructor mite in all analyzed years exceeds the incidence of nosemosis by 8.03 % (2020) – 24.49 % (2021). Moreover, the highest incidence of both diseases during the studied period was registered in 2021. In 2017, American foulbrood (AFB), created by a bacterium, was recorded in this region. The spread of bacterial diseases in bees is given. From the analyzed data, it is possible to note the imperfection of the monitoring system, as the research plans include a wide range of invasive diseases, but a small share is allocated to bacterial infections. Unplanned beekeeping studies include invasive and infectious diseases: bee bacteriosis and viral pathologies. The main problem is the low percentage of certified private farms. As a result, it is challenging to analyze damage to apiaries by contagious bee diseases. Thus, it is necessary to improve the state monitoring system, owing to which it will be possible to diagnose planned not only infectious and invasive diseases but also other diseases of bees that cause massive destruction of hives in apiaries of our state.

Keywords: *Apis mellifera;* beekeeping; apiary; bees; state epizootic monitoring; bee diseases; infectious diseases; invasive diseases.

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1. Introduction

The well-being of bee farms is an ecological, economic, and social problem. The modern migration of biotic materials and biological objects worldwide contributes to the spreading of bee pathogens and pests. In addition, there is a contact method of transmission of pathogens of infectious diseases – this is the movement of honey bee hives to improve honey collection and reduce the distance to it (Nazarenko & Yevstafieva, 2019; Vishchur et al., 2019; Daisley et al., 2022). This is especially relevant for regions with dense placement of beehives for pollinating ecosystem components. However, despite a wide range of biological factors and natural-geographical factors that can reduce the resistance of bee colonies, the main reasons that affect the health of bee colonies and the spread of diseases in different regions are often not well understood.

The microflora of the bee organism can be non-pathogenic and acquire virulence under the influence of other factors – the manifestation of the action of specific causative agents of dangerous bee diseases – varroosis, tropilelapsosis, viral paralysis, and American foulbrood (AFB) (Odnosum et al., 2017; Yevstafieva & Nazarenko, 2018). In addition, the activation of conditionally pathogenic microflora can be under the influence of non-specific factors – hunger, cold, toxins, pesticides, or secondary pathogens

that reduce the resistance of the bee organism (Kovalskyi et al., 2018; Kovalchuk et al., 2019).

Relative indicators of the development of the epizootic process for different diseases in different periods of the existence of bee colonies often differ (Daisley et al., 2022). Thus, the apiary's location, the pathogen's type, and its number in the bee colony determine the bees' susceptibility to the first infectious agent and other secondary infections. Weak bee colonies are favorable to several pathogens and their synergistic interaction, which exhausts the bee organism and leads to death (Mayack et al., 2022; Giacomini et al., 2023).

The key to successful beekeeping is maintaining healthy and robust bee colonies capable of high productivity during the honey collection period, successful wintering, rapid growth of brood in the spring period, and the production of healthy offspring (Al Naggar et al., 2022; Pfeiffer & Crowder, 2022). Infectious diseases of bees inhibit the development of bee colonies and can cause fatalities (Al Naggar et al., 2022; Cohen et al., 2022; Zerek et al., 2022). Thus, an essential component of the development of "infectious-safe" beekeeping is the timely detection of these diseases, the application of etiotropic and pathogenetic therapy to bees, and the implementation of preventive measures in apiaries to increase the resistance of bee colonies to infectious diseases (Al Naggar et al., 2022; Tehel et al., 2022). In the beekeeping of Ukraine, the direction of mandatory diagnostic research on putrefactive diseases, nosemosis, acaraposis, varroosis, and braulosis determines the state of the epizootic situation of apiaries in a particular region.

The purpose of the work is to analyze the data of the state epizootic monitoring of infectious diseases of bees to determine the indicators of the development of the epizootic process in the period 2017–2022 in the territory of the Volyn region.

2. Materials and methods

The research materials were the reports of the regional laboratory of the Volyn region's State Production and Consumer Service. To determine the epizootic situation in this territory's apiaries, statistical analysis and data comparison methods were used from 2017 to 2022 inclusive (Galatiuk et al., 2022*b*). The development analysis, systematization, and analysis of the obtained results were done in the Microsoft Office Excel 2021 program (Petrie & Watson, 2013).

3. Results and discussion

The diagnosis of an infectious disease in bees by a veterinary medicine specialist is based on data on the spread of the disease in a specific population, the analysis of clinical signs of sick bees, and the results of laboratory studies. Laboratories of the State Service of Food Safety of each region examine certified apiaries only for a specific range of infectious and invasive diseases (American and European foulbrood, acaraposis, varroosis, nosemosis). In addition, it is difficult to analyze the prevalence of a specific disease based only on the data from regional laboratory reports. For example, in addition to bacterial diseases of bees, bee bacteriosis (infection with bacteria of the family Enterobacteriaceae of the genera *Salmonella, Klebsiella, Enterobacter, Citrobacter*, etc.) also causes a decrease in the productivity of bee colonies (Galatiuk et al., 2020*a*; Galatiuk et al., 2020*c*; Wu et al., 2022). Improving the state monitoring and analysis system regarding the occurrence of this or that bee disease is an essential step toward the European integration of Ukraine.

Analyzing the data of the annual documentation, we note that along with contagious diseases of worker bees, two cases of bee brood diseases – *Bacillus larvae* – were registered in the Volyn region in 2017. However, since 2018, apiaries in the Volyn region have been safe from bacterial diseases of bees, thanks to the owners' compliance with veterinary and sanitary measures in apiaries, regular high-quality sanitation of beehives, and timely preventive treatment of bee colonies.

During 2017–2022, accredited laboratories of the Volyn region systematically researched diseases caused by protozoa and mites – nosemosis, acaraposis, and varroosis, as well as bacteriological research on putrefactive diseases of bees. The dynamics of the detection of nosemosis and varroosis are presented in Fig. 1.

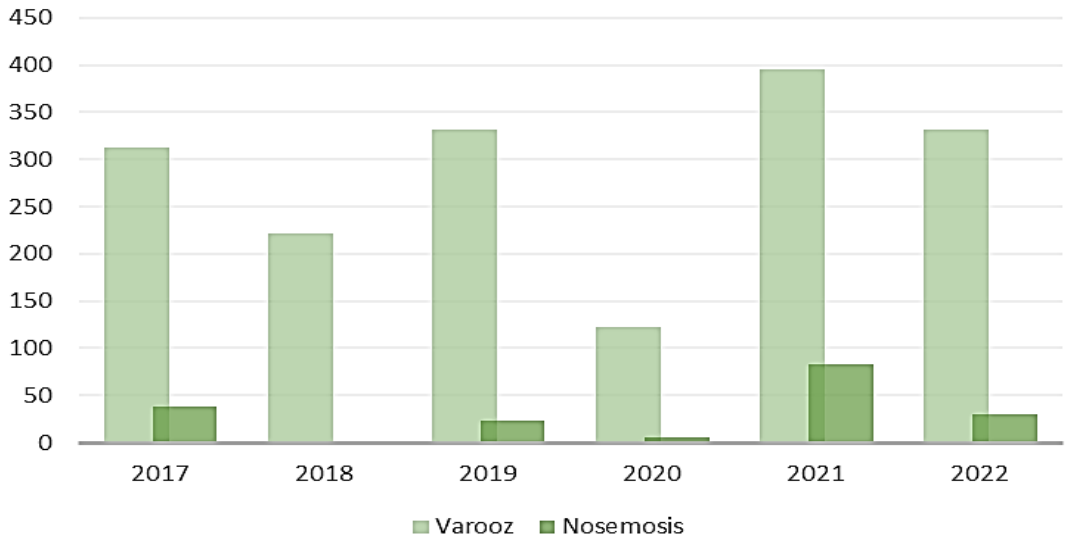

Fig. 1. The number of detected positive cases of invasive bee diseases in the Volyn region in 2017–2022

These diagrams indicate the stationary disadvantage of apiaries of the Volyn region concerning varroosis. On the region's territory, positive results of laboratory parasitological studies of bees for the presence of the Varroa destructor mite are registered annually. In addition, bee nosemosis was detected in all studied years except for 2018. The most significant number of cases of invasive bee diseases were recorded in 2021: 395 cases of varroosis and 83 cases of nosemosis.

Cases of varroosis and nosemosis of bees are registered annually in the Volyn region and other regions of Ukraine (Kisil & Fotina, 2018; Nazarenko, 2019). Varroa destructor has been one of the most dangerous pests of *Apis mellifera* in recent years, an etiological factor of other bee pathologies (Akimov & Korzh, 2012; Nazzi et al., 2012; Nazarenko & Yevstafieva, 2019). It should be noted that Ukrainian scientists have proven the presence of morphological variability of female V. destructor mites collected from the honeybee Apis mellifera at different times of the year. In particular, females of the summer generation are smaller, with a wider genitofemoral shield and short limbs. At the same time, females of the winter generation have a more elongated body, with a smaller genitofemoral shield, more pores on the sternal shield, and more elongated legs. These changes indicate the development of adaptive mechanisms in the mite for parasitizing bees at different times of the year. In particular, in winter – in sealed brood and in summer on bee adults (Yevstafieva et al., 2020). In addition, because of the toxic parasitic action of this mite, the resistance of the bee decreases, which in turn provokes the activation of other bacteria (activation of the opportunistic microflora of the hive and insects); in addition, the bee body becomes susceptible to damage by other pathologies (bacterial diseases, viral infections, diseases, caused by protozoa, etc.) (Cornman, 2017; Naggar et al., 2018; Nazarenko & Yevstafieva, 2019).

Absolute indicators do not allow us to reflect the dynamics of the development of the epizootic process in both varroosis and nosemosis, so we determined the infection (morbidity) of bee colonies with these diseases in different years (Fig. 2). These diagrams show that the rate of infection of bee colonies with the Varroa destructor mite in all years exceeds the incidence of nosemosis in the following range: by 8.03 % (2020) – 24.49 % (2021).

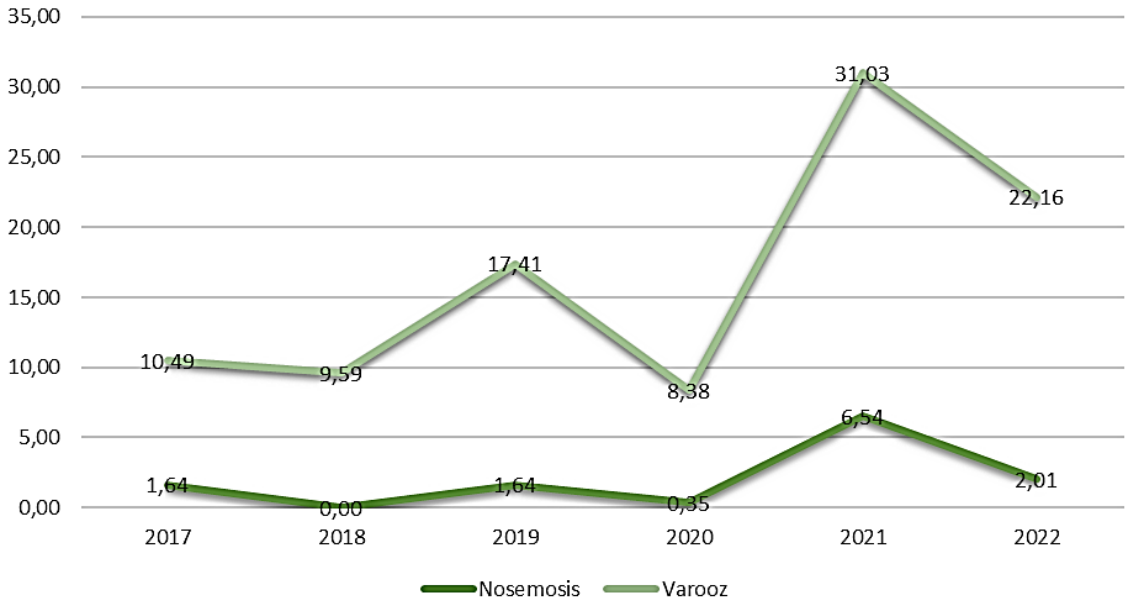

Fig. 2. Dynamics of infection with nosemosis and varroosis of bees in the Volyn region in 2017-2022

The annual percentage (2017–2022) ratio of the incidence of varroosis and nosemosis is shown in fig. 3, 4.

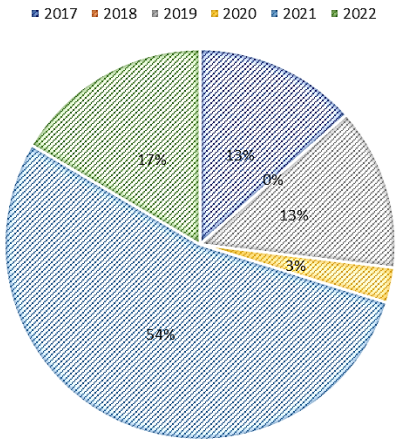

Fig. 3. The percentage ratio of the incidence of varus for 2017–2022

Thus, the highest incidence rate of both diseases during the studied period was registered in 2021 – 54 % (varroosis) and 31 % (nosemosis).

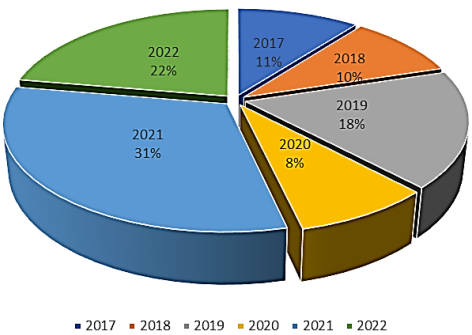

Fig. 4. The percentage ratio of the incidence of nosemosis for the years 2017–2022

The minimum incidence rates for nosemosis were registered during the period 2017–2018, which can be justified

by the decrease in the number of diagnostic studies: for varroosis – from 2973 in 2017 to 1494 in 2022, for nosemosis – from 2320 in 2017 to 1494 in 2022, probably due to economic factors and the low number of registered apiaries.

It is known that nosemosis is a slow disease of bees that occur due to non-compliance with veterinary and sanitary requirements when introducing beekeeping. This pathology leads to the massive destruction of hives in the apiary. In case of an untimely diagnosis of this disease, damage to the entire apiary is possible (Sinpoo et al., 2018; Odnosum & Yefimenko, 2022).

The timely diagnosis of bacterial diseases in bees is similar. One of the causes of the syndrome of the collapse of bee colonies, that is, their mass flight and death, are bacterioses. Bacteriosis is a group of bee diseases caused by opportunistic bacteria localized in the hive and the body of *Apis mellifera*. With untimely medical and preventive treatment of hives in apiaries, insects' resistance and immune status decrease, leading to disease as members of the opportunistic microbiota multiply (quantitatively) and acquire virulent features. In this way, the apiary becomes dysfunctional. Therefore, conducting systematic and timely laboratory studies of bees to diagnose infectious and invasive diseases is a priority for the beekeeper. In addition, studying the peculiarities of the prevalence of infectious and invasive diseases of honey bees in different regions of Ukraine remains a relevant issue today.

4. Conclusions

The data analysis of the state epizootic monitoring of infectious diseases of bees in the Volyn region shows the prevalence of varroosis and nosemosis during the years 2017–2022, with the highest incidence rate in 2021, which was 54 % for varroosis and 31 % for nosemosis. A comprehensive approach to diagnosing infectious diseases in bees will allow timely prevention of their morbidity, improving the system of state epizootic monitoring to comply with veterinary and sanitary measures in apiaries.

Prospects for further research

Improvement of the state monitoring system by encouraging beekeepers to carry out passporting. Such approaches will make it possible to diagnose planned not only infectious and invasive diseases but also other bee pathologies that provoke the syndrome of the collapse of bee colonies.

Conflict of interests

The authors declare no conflict of interest

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