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ORIGINAL ARTICLE

Spread of infestations and infections of honey bees on apiaries of Tyumen region and other regions of Russia

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Samples of dead bees, live bees and brood from 220 bee colonies of the South of Tyumen Region, 39-Leningrad, 30-Omsk, 2-Chelyabinsk and 14 colonies of Crimea were studied. Studies have shown that all the apiaries under study were affected by varroatosis, and 52.7%-by nosematosis. In the identification process of the pathogen of nosematosis, mainly *N. ceranae* microsporidia was found (29.3%), *N. apis* was registered in only one sample from Leningrad Region (0.33%), mixed infection (*N. ceranae*+*N. apis*) was found in bees from Leningrad, Omsk and Tyumen Regions (2.6%). The fact that in Tyumen Region, *V. destructor* mites are found in samples from all districts which is 21.8% of the samples studied, has been established. However, 40% of the examined apiaries had a high level of (8.3-34.5%) infested bee colonies, resulting in the death of bees in autumn-winter period. The pathogen of nosematosis-*N. ceranae* was found in bee samples from apiaries of 6 districts, which is 23.6% of the 220 samples studied. The degree of damage to bee colonies ranged from 0.15 to 105 million spores. In Isetsky, Nizhnetavdinsky and Tyumensky Districts, both pathogens of nosematosis (*N. apis* and *N. ceranae*)were found, which corresponded to 8% of the samples studies. *N. apis* microsporidia, as the only pathogen of nosematosis, was not found on any of the apiaries examined, which indicates that the new pathogen of *N. ceranae* prevails in its spread among honey bees. Studies of bee samples obtained from apiaries of Leningrad, Omsk, Chelyabinsk, Tyumen Regions and Crimea made it possible to identify the infestation of bee colonies with *Varroa destructor* mites and *Nosema apis*, *Nosema ceranae* microsporidia. The fact that the pathogen of nosematosis *Nosema ceranae* is more widespread than *Nosema apis* has been established. Studies made in different regions of Russia are the basis for the development of a monitoring system of bee diseases in Tyumen Region. First of all, such studies should be made in districts where there is a large number of bee colonies.

Keywords: Bee colonies; infestations; infections; spread; Tyumen Region; Russia

Introduction

The expansion of trade between countries and regions, climate change, uncontrolled transportation of bees, queens, packages creates favorable conditions for the spread of honey bee pathogens, and a constant monitoring of bee colonies to identify pathogens is therefore required. Our analysis of the study results of bee colonies from 18 regions of Russia indicated that the studied apiaries were affected by acariasis, bacteriosis, virosis, mycosis, Microsporidia of bees. The following viruses were identified while studying the bees samples: deformed wing virus(DWV), acute bee paralysis virus (ABPV), chronic bee paralysis virus (CBPV), sacbrood virus (SBV), black queen cell virus (BQCV), Kashmir bee virus (KBV), Israeli acute paralysis virus (IAPV), bacteria: *Paenibacillus larvae* Larvae, *Melissococcus pluton, Escherichia coli, Ascosphaera apis* fungus, *Varroa destructor, Acarapis externus, Acarapis woodi Rennie* mites, *Nosema apis*, *Nosema ceranae* microsporidia . Given that in Russia 78 regions out of 85 are engaged in beekeeping, it is relevant to make similar studies in all territories (Zinatullina et al., 2018).

Tyumen Region has a favorable natural and climatic conditions and food supply for the development of beekeeping. According to the territorial body of the Federal State Statistics Service, 20014 bee colonies were kept in Tyumen Region as of 01.01.2018, while in personal part-time farms of citizens, there were 19615 bee colonies, in farm enterprises-399 bee colonies. The maximum number of bee colonies is kept in the following districts: Tyumensky (2307), Isetsky (1813), Vikulovsky (1755), Yalutorovsky (1557), Nizhnetavdinsky (1540). However, climate change, different biotic and anthropogenic factors have a negative impact on the industry, manifested primarily through decrease in the productivity of bee colonies, their quality, ability to resist diseases.Studies made by us in Tyumen Region in 2009-2016, enabled to identify apiaries affected by exoacarapidosis, varroatosis, nosematosis, ascospherosis, European foulbrood, sacbrood disease. Pathogens of American foulbrood and exoacarapidosis previously unrecorded in the region were registered for the first time on two apiaries. Of the

206 apiaries examined, 52.4% were marked as affected by varroatosis, where the degree of damage to bee colonies was more than 1%, although varroa mites were found in almost all samples. A significant degree of infection of bees with nosematosis was registered on 35.4% apiaries. Pathogens of exoacarapidosis, ascospherosis and European foulbrood present in bee colonies were found on 11% apiaries. The most common mixed infestation-infections of bees include the following: varroatosis-nosematosis, varroatosis-ascospherosis, varroatosis-nosematosis-ascospherosis, varroatosis-virosis (deformed wing virus), varroatosis-virosis (sacbrood), varroatosis-American foulbrood and European foulbrood. In 2010, two types of pathogens of nosematosi-*Nosema apis* and *Nosema ceranae* were registered for the first time in Russia (Zinatullina et al., 2011). The analysis of the sources of infection of bees by *Nosema ceranae* suggests that the pathogen is registered on apiaries, to which imported bee colonies and queen bees, as well as swarms from other apiaries are being added (Zinatullina, 2016; Zinatullina et al., 2017). The region has no general monitoring system of the bees health and causes of their death, and the study to identify pathogens of honey bees in some territories of Tyumen Region is therefore relevant.

Materials and methods

The aim of paper is to continue to study the spread of infestations-infections of honey bees on apiaries of Tyumen Region and other regions of the country. For study, samples of dead bees, live bees and brood from 220 bee colonies of the South of Tyumen Region, 39-Leningrad, 30-Omsk, 2-Chelyabinsk and 14 colonies of Crimea were studied. The studies were made in accordance with the regulatory documents for the identification of bee disease pathogens in the Russian Federation. A total of 305 samples from bee colonies of 36 apiaries were studied.

Results and discussion

Studies have shown that all the apiaries under study were affected by varroatosis, and 52.7%-by nosematosis (Table 1).

Table 1. Results of the apiaries examination.

Name of region	Number of apiaries examined	Number of apiaries affected by varroatosis	Number of apiaries affected by nosematosis
Leningrad Region	1	Not studied	1
Omsk Region	2	2	2
Chelyabinsk Region	1	1	0
Tyumen Region	28	28	12
Crimea	4	4	4
Total	36	35	19

In the identification process of the pathogen of nosematosis, mainly *N. ceranae* microsporidia was found (29.3%), *N. apis* was registered in only one sample from Leningrad Region (0.33%), mixed infection (*N. ceranae* + *N. apis*) was found in bees from Leningrad, Omsk and Tyumen Regions (2.6%) (Table 2).

Table 2. The study results of the bees samples test for varroatosis and nosematosis by regions.

Name of region	Number of samples studied	Samples with *V. destructor* mites, (samples/%),	Identified pathogens of nosematosis number of samples/(%)		
			N. ceranae	*N. apis*	*N. apis*+*N. cerana*
Leningrad Region	39	not studied	11/ (28.2)	1/ (2.6)	3/ (7.6)
Omsk Region	30	4/(13.3)	5/(16.6)	0	1/ (0.96)
Tyumen Region	220	48/(21.8)	52/(23.6)	0	4/(1.8)
Chelyabinsk Region	2	2/(100)	0	0	0
Republic of Crimea	14	6/(42.8)	5/(35.7)	0	0
Total	305	27/(19.6)	73/(29.3)	1/(0.33)	8/(2.6)

Note: the column *shows samples with *V. destructor* infection of more than 1.0%. Ectoparasites were found in all samples.

In Tyumen Region, during 2017-2018, 28 apiaries located in 7 districts of the region were examined. The fact that *V. destructor* mites are found in samples from all districts which is 21.8% of the samples studied, has been established. However, 40% of the examined apiaries had a high level of (8.3-34.5%) infested bee colonies, resulting in the death of bees in autumn-winter period. The pathogen of nosematosis-*N. ceranae* was found in bee samples from apiaries of 6 districts, which is 23.6% of the 220 samples studied. The degree of damage to bee colonies ranged from 0.15 to 105 million spores. In Isetsky, Nizhnetavdinsky and Tyumensky Districts, both pathogens of nosematosis (*N. apis* and *N. ceranae*)were found, which

corresponded to 8% of the samples studies . *N. apis* microsporidia, as the only pathogen of nosematosis, was not found on any of the apiaries examined, which indicates that the new pathogen of *N. ceranae* prevails in its spread among honey bees.The study results are presented in Table 3.

Table 3. The study results of bee colonies in Tyumen Region for 2017-2018 years.

Name of district	Number of samples studied	Samples * with *V. destructor mites,* (samples/%)	Identified pathogens of nosematosis, number of samples/(%)		
			N. ceranae	*N. apis*	N. apis+*N.cerana*
Aromashevsky	5	5/(100.0)	0	0	0
Vikulovsky	7	7/(100.0)	7(100.0)	0	0
Zavodoukovsky	5	3/(60.0)	3(60.0)	0	0
Isetsky	4	2/(50.0)	2/(50.0)	0	1/(25.0)
Nizhnetavdinsky	12	6 (50.0)	3/(25.0)	0	1/(8.3)
Tyumensky	150	24/(16.0)	34/(22.6)	0	2/(1.3)
Tyumen City	37	2/(7.4)	3/(11.1)	0	0
Total	220	48/(21.8)	52/(23.6)	0	4/(1.8)

Note: The column *shows samples with *V. destructor* infection of more than 1.0%.

The results of a two-year study of bee colonies show a wide spread of the mixed course of varroatosis and nosematosis on apiaries of the region. To obtain objective data on the epizootic state of apiaries of the region, not only the dead bees and live adult insects should be studied, but also the unsealed and sealed bee and drone brood. Special attention should be paid to finding of viral and bacterial diseases in bees and queens.The data we have obtained coincide with the study results of bee colonies in other regions of Russia and abroad. The examination of apiaries located in the natural and climatic zones of the Urals and Siberia, identified the disease in bee colonies with nosematosis and varroatosis. In Orenburg Region, during the period 2011-2013, bee colonies on apiaries of three districts were studied for the presence of pathogens of varroatosis and nosematosis of bees. The data obtained confirm a high degree of varroatosis and nosematosis spread, and 75% of the bees sampled were found to have *N. apis* microsporidia, and 100% *V. destructor* mites (Ilyina & Aladdina, 2014). The study of bees on apiaries of Tomsk Region and Krasnoyarsk Region identified *N. apis* microsporidia in 23.8% of cases, *N. ceranae*-in the same number, in other cases (52.4%)-both pathogens. On two isolated apiaries of Krasnoyarsk Region, both pathogens with a predominance of *N. ceranae* were found in most of the colonies studied. Based on the data obtained, the studiers suggest that *N. ceranae* is widespread in nature, which should be further studied (Ostroverkhova et al., 2018). Samples of bees for nosematosis from 19 apiaries of Kirov, Leningrad Regions, Altai, Krasnodar, Stavropol, Perm Regions have been studied. The studies revealed that apiaries of all the named regions were affected by infection. Having said so, *Nosema apis* was registered on 4 apiaries, *Nosema ceranae*-on 4 apiaries, both pathogens were marked from samples of 6 apiaries. Pathogens of nosematosis (*N. apis* and *N. ceranae*) have also been registered in Moscow Region and the Udmurt Republic. The studies results confirm that the *Nosema apis* pathogen is being forced out of the population of honeybees by *Nosema ceranae* pathogen (Maslennikova et al., 2017; Galatyuk et al., 2014; Fedoriak et al., 2017).

The use of molecular genetic methods to identify honeybee pathogens has allowed to register about 20 viruses that cause infections in bees developing against the background of varroatosis and nosematosis. On the territory of the Russian Federation, such studies have been made in the Northern, Central and Southern Federal Districts. There is mainly a predominance of four types of viruses in terms of degree of incidence: deformed wing virus, Israeli acute paralysis virus, black queen cell virus, Kashmir bee virus (Goblirsch, 2018). The analysis of literature data and the results of our own studies has shown a wide spread of infectious diseases of bees on apiaries of Tyumen Region and other regions of Russia. The results obtained are similar to the data available in other countries. The need for regular monitoring of bee health is evidenced by studies made in a number of European countries, including Ukraine (Chen et al., 2008;, Fries, 2010), Spain, France, Germany, Switzerland, Denmark, Finland, Greece, Hungary, Holland, the United Kingdom, Italy, Serbia, Poland, Slovenia, Bosnia and Herzegovina, Sweden, etc., where two types of nosema have been found that cause bee disease, accompanied by a sudden weakening and increased death of bees (Higes et al., ; Natsopoulou et al., 2016). Studies made in Slovenia have shown high mortality of bee colonies in mixed infections-infestation caused by *V. destructor* mite and deformed wing virus (DWV), chronic bee paralysis virus (CBPV), as well as *N. ceranae* and (DWV), *N. apis* and filamentous virus (FV) (Toplak et al., 2013).

Conclusion

Infestations and infections of honey bees are widespread on the apiaries of Tyumen Region and other regions of Russia. Studies of bee samples obtained from apiaries of Leningrad, Omsk, Chelyabinsk, Tyumen Regions and Crimea made it possible to identify the infestation of bee colonies with *Varroa destructor* mites and *Nosema apis*, *Nosema ceranae* microsporidia. The fact that the pathogen of nosematosis *Nosema ceranae* is more widespread than *Nosema apis* has been established. Studies made in different regions of Russia are the basis for the development of a monitoring system of bee

diseases in Tyumen Region. First of all, such studies should be made in districts where there is a large number of bee colonies.

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