

## Ecological and geographical characteristics of aujeszky's disease among the wild pigs in Ukraine

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The article presents the results of monitoring studies on the detection of specific humoral antibodies against Aujeszky's disease virus in the blood serum of wild boar, shot in the territory of various hunting grounds of all regions of Ukraine for the six-year period 2014-2019. Visual mapping and statistical analysis were performed using GIS technology (ESRI ArcGIS 10.1 software). The detection of specific antibodies against Aujeszky's disease virus was performed by enzyme-linked immunosorbent assay using two commercial test systems. From 2014 to 2019 inclusive, 3608 serum samples of wild pigs were examined and 811 positive responses were obtained for Aujeszky's disease of wild pigs, representing 22.5% of the studied livestock of this species. Monitoring studies covered all regions of Ukraine. For the period 2014-2019, the largest number of serum samples from wild pigs was tested in seven regions: Zhytomyr (384 samples), Vinnytsia (310 samples), Cherkasy (299 samples), Chernivtsi (294 samples), Poltava (287 samples), Lviv (262 samples) and Sumy (249 samples). The least amount of research has been conducted in the following regions: Kyiv (69 samples), Kirovohrad (63 samples), Dnipro (57 samples), Luhansk (55 samples), Donetsk (53 samples), Zakarpattia (40 samples), Zaporizhia (36 samples) and Kherson (23 samples). For the analyzed period 2014-2019, the highest number of serum samples was examined in 2014 – 1935 and the smallest in 2016 – 2 samples.

The seropositivity of wild pigs to Aujeszky's disease during the analyzed period was highest in 2015 – 46.2% and lowest in 2017 – 12.5%. In general, during the analyzed period, from 2014 to 2019, there is a slight tendency to decrease of number of seropositivity cases of wild pigs to Aujeszky's disease. According to the results of the studies, it was found that the seroprevalence rate of wild pigs against Aujeszky's disease virus in different regions of Ukraine during the analyzed period ranged from 45.0% in Zakarpattia region to 8.3% in Zaporizhia region. According to the results of the study of ecological and geographical spread of Aujeszky's disease among the wild boar population in the territory of Ukraine, it was established that the epizootic situation of this disease in different regions of Ukraine is not uniform and has its own characteristics, so the highest rates of seroprevalence of wild boar to Aujeszky's disease were revealed in areas: Zakarpattia – 45.0%, Ternopil – 40.2, Kharkiv – 40.0, Rivne – 32.6 and Zhytomyr – 32.3%. In areas such as Mykolaiv, Volyn, Donetsk, Kherson and Zaporizhia, the lowest percentage of positively responding wild boar numbers was observed at 10.7%, 9.5, 9.4, 8, and 8.3% respectively, therefore, in these areas the risk of infection of domestic animals with the Aujeszky disease virus from wild animals is significantly lower.

**Keywords:** Aujeszky's disease; Wild pigs; Monitoring; Mapping; Antibodies

### Introduction

Aujeszky's disease (pseudorabies) – is an acutely and contagious infectious disease that proceeding in the form of epizootics and sporadic cases. It causes significant economic damage to livestock, especially in countries with intensively developed pig breeding and fur farming (Liu et al., 2019; Tong et al., 2015; Xia et al., 2018). There are reports of the cases of this disease in humans (Wang et al., 2020; Wong et al., 2019). The disease is caused by the Aujeszky disease virus (*SuidHerpesvirus 1*), which belong to the family Herpesviridae, a subfamily of *Alphaherpesvirinae*, of the genus *Varicellovirus* (Miller et al., 2019).

Aujeszky's disease is common in most countries of the world, including all European states, South and North America, Africa and Asia, except Australia and cause economic damage.

In recent decades, scientists from different countries pay more and more attention to wild animals. Studies of representatives of wild fauna are carried out from different angles – the study of the biology and ecology of species, biotope conditions, susceptibility to various diseases, and other. A detailed literature analysis showed that monitoring studies of wild fauna, including wild pigs, receive considerable attention, especially in the EU countries (Verpoest et al., 2018). This is confirmed by the OIE official information on the registration of various types of infectious diseases among various species of wild animals.

Concerning Aujeszky's disease among wild pigs, numerous serological and virological studies have been carried out and the formation of epizootic foci. Circulation of the virus in their populations has been proved. In particular, serological monitoring was carried out in Spain, the Netherlands (Dekkers & Elbers, 2000), France (Albina et al., 2000), Italy (Caruso et al., 2018; Moreno et al., 2015), Slovenia (Vengust et al., 2005), Croatia (Zupancić et al., 2002), Russia (Amirova & Strizhakov, 2008) and Ukraine (Sytiuk 2013; Ukhovskiy et al., 2017).

Given that there are few scientific publications on the study of infectious diseases among wild boars compared to domestic pigs, there is a need for their extensive study. The study of the infectious status of wild boars in Ukraine is an urgent issue and aims to determine the role of these representatives of wild fauna in the infectious pathology of domestic pigs. Therefore, the aim of our research was to conduct a retrospective epizootological monitoring of Aujeszky's disease among the wild pigs in Ukraine in 2014-2019.

## Materials and Methods

In order to determine the presence of specific humoral antibodies to the Aujeszky's disease virus, 1593 wild pig blood serum samples were examined, which were taken after wild pigs were shot during the hunting seasons of 2014-2019 from the territories of various hunting grounds in all regions of Ukraine.

Visual display and statistical analysis was performed using GIS technology (ESRI ArcGIS 10.1 software).

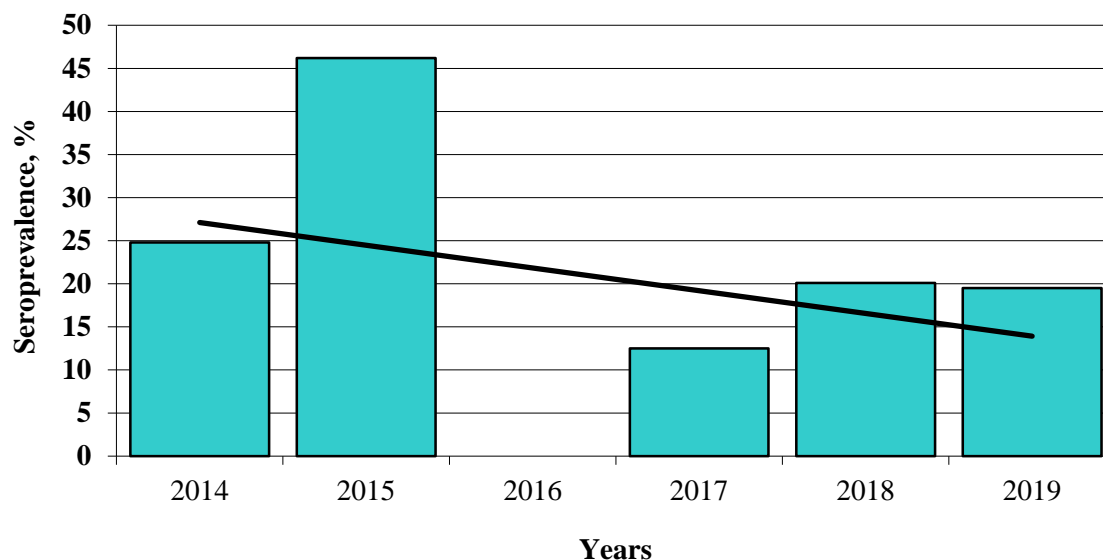
The study of the presence of specific humoral antibodies against Aujeszky's disease in the blood serum of wild pigs was carried out by enzyme-linked immunosorbent assay using two commercial test systems ID Screen® Aujeszky GE Competition manufactured by ID.vet (France) and Pseudorabies Virus gPI Antibody Test Kit manufactured by IDEXX (USA).

## Results and Discussion

We carried out an ecological and geographical analysis of the data on the identification of specific humoral antibodies against Aujeszky's disease among the wild pigs for the period 2014-2019 in the context of the regions of Ukraine. For the period from 2014 to 2019 inclusive, 3608 blood serum samples were studied and 811 positive responses for Aujeszky's disease of wild pigs were obtained, which is 22.5% of the studied population of this animal species. The obtained generalized results of the study of blood serum of wild pigs are set out in Table 1 and Figure 1.

**Table 1.** The results blood serum studies of the of wild pigs for the presence of specific humoral antibodies against Aujeszky's disease.

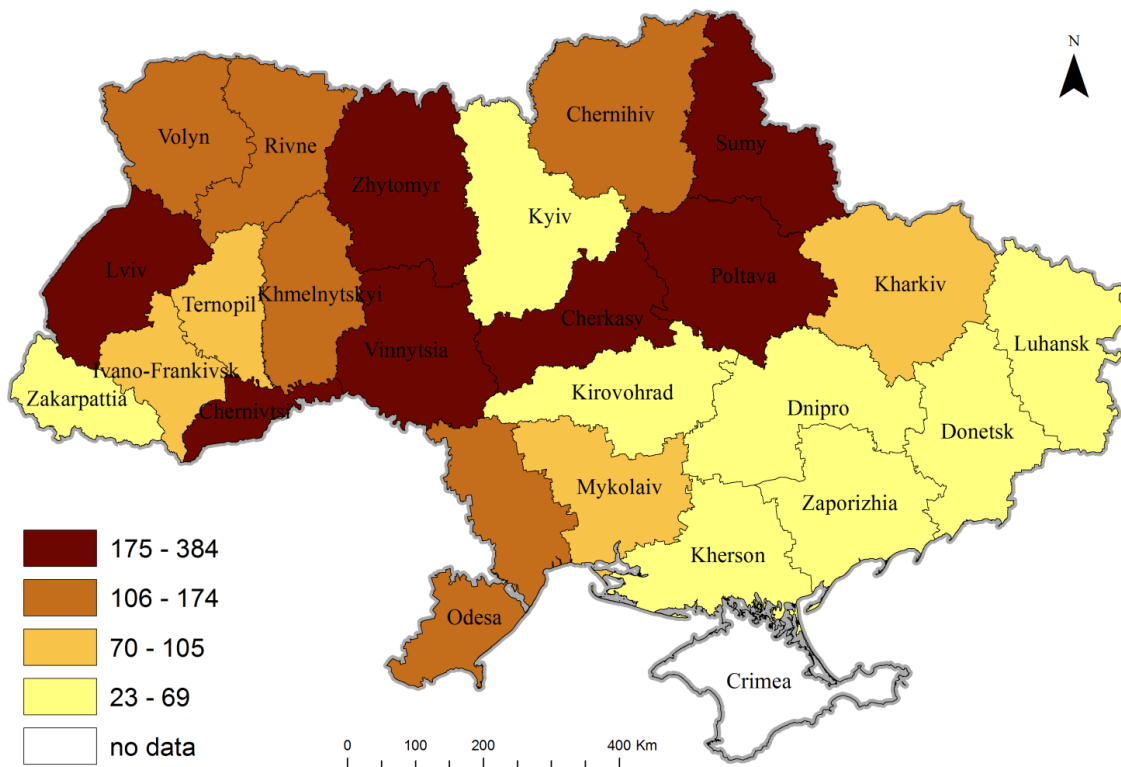
Year	Animals studied	Number of positively responding animals	% positive reactions from the investigated
2014	1935	480	24, 8
2015	106	49	46, 2
2016	2	0	0
2017	407	51	12, 5
2018	912	183	20, 1
2019	246	48	19, 5
Total	3608	811	22, 5



**Figure 1.** The seroprevalence dynamics of wild pigs to Aujeszky's disease virus in Ukraine, 2010-2019.

As shown in Figure 1, the seropositivity of pigs to Aujeszky's disease for the analyzed period was the highest in 2015 – 46.2%, and the lowest in 2017 – 12.5%. In 2018 and 2019, there was a slight increase in the number of positive animal samples, compared to the previous year, at 20.1% and 19.5%, respectively. In 2016, not a single serum sample was found with humoral antibodies to the Aujeszky disease virus, this is due to the very low number of samples studied – for the entire period of 2016 only 2 blood serum samples from the Kherson region were studied. In total, for the period under review, from 2014 to 2019, there is a slight tendency to a decrease in the cases of seropositivity of wild pigs to Aujeszky's disease.

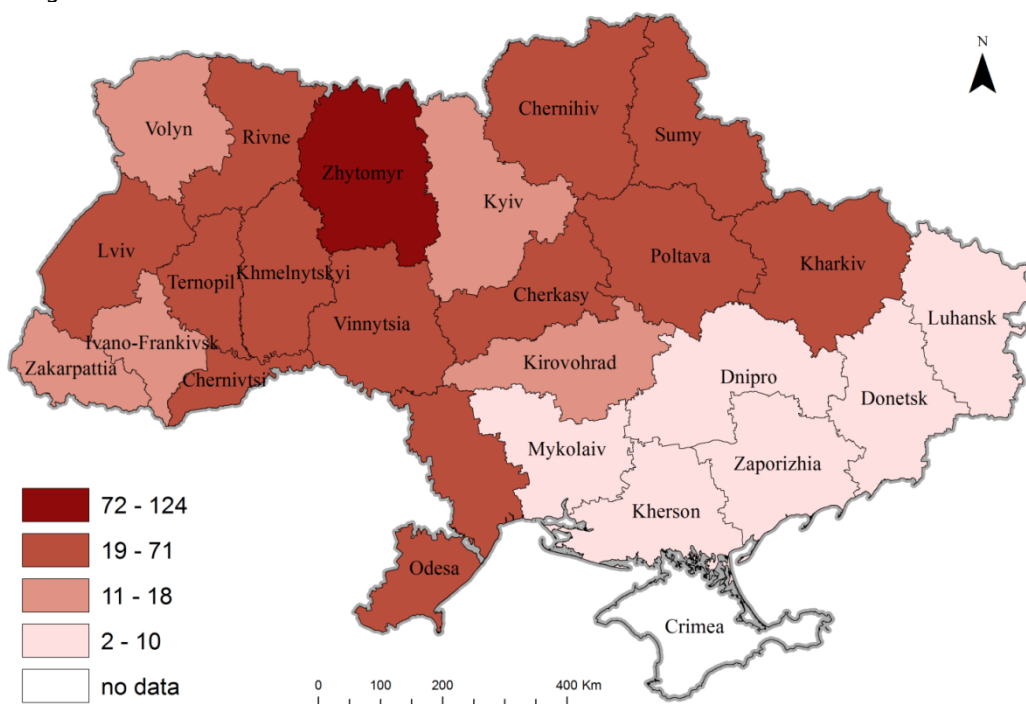
Serum of wild pigs for the study was selected from all regions of Ukraine. For the analyzed period 2014-2019, the highest number of serum samples was examined in 2014 – 1935 samples and the smallest in 2016 – 2 samples. Also, a small number of samples were studied in 2015 and 2019 – 106 and 246 respectively. Data of the serological diagnostics of wild pigs for the detection of specific humoral antibodies against Aujeszky's disease in the cross-section of the regions of Ukraine are presented in Fig. 2.



**Figure 2.** Quantity of wild boar serum samples tested for Aujeszky's disease virus 2014–2019.

Figure 2 indicate that monitoring studies covered all regions of Ukraine. For the period 2014-2019, the largest number of blood serum samples from wild pigs was studied in seven regions: Zhytomyr (384 samples), Vinnitsia (310 samples), Cherkasy (299 samples), Chernivtsi (294 samples), Poltava (287 samples), Lviv (262 samples) and Sumy (249 samples). The smallest number of studies was carried out in the following areas: Kyiv (69 samples), Kirovohrad (63 samples), Dnipro (57 samples), Luhansk (55 samples), Donetsk (53 samples), Zakarpattia (40 samples), Zaporizhia (36 samples) and Kherson (23 samples). In our opinion, it should be noted that for the analyzed period there is an uneven volume of serological studies of wild pig sera for different years of research, for example - in 2014, 1935 samples were examined, and in 2016 only 2 samples. In total, during the analyzed period, a decrease in the volume of serological studies of wild pigs for the presence of humoral antibodies to the Aujeszky's disease virus is observed.

The results of serological monitoring for the period 2014-2019 regarding the detection of specific humoral antibodies against Aujeszky's disease in the cross-section of the regions of Ukraine are presented in absolute terms (number of seropositive wild pigs) in Figure 3.

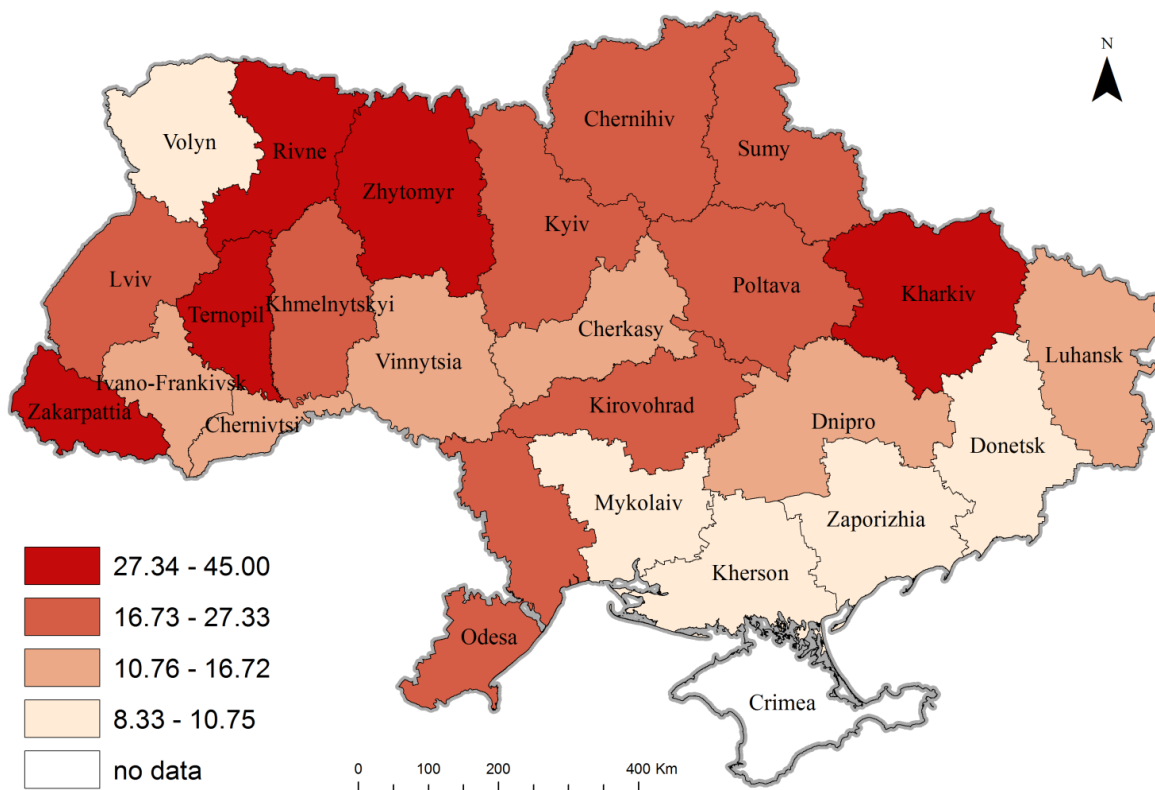


**Figure 3.** Density map of seropositive wild boar pigs for Aujeszky's disease virus in Ukraine 2014–2019.

According to Figure 3 the largest number of positive blood serums of wild pigs for Aujeszky's disease in Ukraine was detected in the Zhytomyr region – 124 positive samples. A significant number of positive samples were observed in five regions: Poltava – 71 samples, Sumy – 67, Lviv – 56, Cherkasy – 50 and Vinnytsia – 50 samples. In areas such as: Mykolaiv, Dnipro, Luhansk, Donetsk, Zaporizhia and Kherson, the number of detected positive blood serums of wild pigs was small: 10, 9, 7, 5, 3, and 2, respectively.

The seroprevalence indices of wild pigs for the Aujeszky's disease virus by regions of Ukraine for the period 2014-2019 are presented in the form of a map in Figure 4.

In general, the rate of wild pigs seroprevalence against the Aujeszky disease virus in Ukraine for the analyzed period ranged from 45% in the Zakarpattia region, to 8.3% in the Zaporizhia region. As can be seen from the data given in Figure 4, that the highest seroprevalence rates of wild pigs for Aujeszky's disease were found in five areas: Zakarpattia - 45.0%, Ternopil - 40.2, Kharkiv - 40.0, Rivne - 32.6 and Zhytomyr - 32.3%. In such areas as: Mykolaiv, Volyn, Donetsk, Kherson and Zaporizhia, the lowest percentage of wild pigs positive samples was 10.7%, 9.5, 9.4, 8, and 8.3% respectively, therefore, in these areas the risk of infection of domestic animals with Aujeszky's disease virus from wild animals is significantly lower.



**Figure 4.** Cartographic analysis of pigs seroprevalence to Aujeszky's disease virus in Ukraine 2011-2019.

It should be emphasized that in all regions of Ukraine there is a circulation of Aujeszky's disease virus in the wild fauna according to the results of the conducted studies.

## Conclusion

According to the results of six-year serological monitoring of wild pigs in Ukraine for Aujeszky's disease, it was established that the seroprevalence rate was 22.5% of the studied population of this species of animals.

It was found that the epizootic situation of Aujeszky's disease among wild pigs in different regions of Ukraine was not uniform and has its own characteristics, so the highest number of seropositive pigs was found in five regions: Zakarpattia (45.0%), Ternopil (40.2%), Kharkiv (40.0%), Rivne (32.6%) and Zhytomyr (32.3%).

In order to improve and optimize the planning and development of specific preventive measures against Aujeszky's pig disease, it is advisable to further study the territorial spread of this disease in Ukraine. In our opinion, the prospects for further scientific research are the isolation of Aujeszky's disease virus isolates from wild pigs biological material and comparative studies of their properties with viruses from domestic pigs using virological and molecular genetic methods.

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