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FOREST DORMOUSE (*DRYOMYS NITEDULA*, RODENTIA, GLIRIDAE) – A HIGHLY CONTAGIOUS RODENT IN RELATION TO ZOONOTIC DISEASES

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Abstract

Republic of Mordovia in Russia is a historical focus for hemorrhagic fever with renal syndrome and tularemia. This study aimed at assessing the current status of these foci by studying their rodent reservoirs. Among the small rodents in Mordovia, the red bank vole, the common vole and the house mouse play an important role as carriers of zoonotic diseases. However, it is necessary to take into account the role of such a small species as forest dormouse (*Dryomys nitedula*), which has a high percentage of infection. Of all examined dormice, 66.7 % were found to have antigens of hemorrhagic fever with renal syndrome viral pathogen, and 33.3 % - to have antigens of tularemia pathogen. Only one specimen (16.7 %) was found to have no antigens of zoonotic diseases. Our study concluded that the forest dormouse in the Republic of Mordovia was incriminated as a pathogen reservoir causing infectious diseases in human.

Key words: hemorrhagic fever, Mordovia, rodents, tularemia.

Introduction

Hemorrhagic fever with renal syndrome (HFRS) is the most common natural rodent borne disease of viral etiology in the Republic of Mordovia. The intensive rate of morbidity per 100,000 population of the Mordovia Republic during the period from 2001 to 2006, varied from 10.5 to 18.0, and the average long-term rate for this period was 14.4±1.1, which exceeded the same value in the Russian Federation by 2.8 times. Broad-leaved forests and agricultural lands are predominant in all areas of HFRS infection (Churbanova 2008). A similar situation is shown for another region of Middle Volga (Ulyanovsk region) (Nafeev et al. 2009). Small mammals are the most incriminated reservoirs for viral pathogen agents causing human HFRS in the natural environments (Tsvirko and Kozlov 2012).

In addition to HFRS, small rodents in this region are reservoirs in the circulation and the transmission of widespread human infectious diseases like tularemia and leptospirosis. In the natural foci of HFRS, epizootics occur periodically. Thus, small rodents perform one of the main roles in the spread of the zoonotic diseases.

The red bank vole (*Myodes glareolus*) has been considered the main reservoir

among rodents in the zoonotic circulation in Mordovia and throughout Volga region (Trankvilevsky et al. 2015, Andreychev et al. 2019). The yellow-necked mouse (*Apodemus flavicollis*), the striped field mouse (*Apodemus agrarius*), and the red bank vole (*M. glareolus*) play an important role in zoonotic circulation of HFRS in the Balkan Peninsula (Stanko et al. 2004, Rogozi et al. 2013, Papa et al. 2016).

Ergeshbayev (2018), in the Kyrgyz Republic mentioned the high degree of ectoparasite infestation of forest dormouse *Dryomys nitedula* (Pallas, 1778) (18 species), as well as its contact with numerous representatives of the rodent order. The researcher noted that it carried only one species-specific parasite and 17 species peculiar to marmots, voles, mice, gray hamster, Turkestan rat and other rodents. Among them, five flea's species *Callopsylla caspia*, *Amphipsylla phaiomydis*, *A. anceps*, *A. asiatica* and *Leptopsylla nemorosa* were identified. Cultures of the plague pathogen from these flea's species were isolated for this territory. This causes an important epizootological significance of this rodent species. The importance of forest dormice as carrier of parasites was also reported in Russia. In Central Russia, ectoparasites were found in 90–95 % of forest dormice, and endoparasites were found in 50–70 % of small animals (Rossolimo et al. 2001).

Some small mammals are breeding in the grounds among other species. In particular, such reports about the yellow-necked mouse are known. Dobrava-Belgrade virus strain (DOBV), causing in humans HFRS has been reported to be originated by *A. flavicollis*, *A. sylvaticus* and *M. musculus* (Weidmann et al. 2005). A previous study in Greece showed that approximately 10 % of *A. flavicollis* carried DOBV (Papa et al. 2000).

The report on the presence of tularemia in forest dormouse in Mordovia is of interest, since previously in the domestic and international literature it was not detected in this species, for example in Bulgaria (Pavlov et al. 1978). The results of standard tube agglutination test in Western Iran showed seropositive cases among 4.8 % of the rodents, including *D. nitedula* (Mostafavi et al. 2017). Positive results on tularemia in the Republic of Moldova were recorded in the following species: *M. glareolus, Apodemus uralensis, A. sylvaticus, A. flavicollis, M. musculus, M. spicilegus,* and *Crocidura suaveolens* (Chicu et al. 2010).

The forest dormice has not been reported infected with tularemia and HFRS, for example in Turkey (Laakkonen et al. 2006), and Ukraine (Demchyshyna et al. 2020).

The dynamics of identifying the causative agent of tularemia in Mordovia should be noted in 2015, 2017 and 2018, which are characterized by peak values (Andreychev, Boyarova and Kuznetsov 2016). Mostly, the tularemia microbe antigen was most often detected in areas along the middle rivers (Sura, Alatyr), rather than in areas that do not have such water arteries. In pellets of prey birds, the causative agent of tularemia was detected in the districts more often than in the biomaterial from rodents. This circumstance can be explained from the position that the remains of the hunted preys can contain several prey species at once. This is evidenced by the results of studies of osteological material (Andreychev et al. 2014, Andreychev, Lapshin and Kuznetsov 2016, Andreychev and Lapshin 2017). Therefore, the probability of detecting tularemia microbe antigen here is higher (Andreychev et al. 2019).

The purpose of this article is to study

the role of the forest dormouse as carrier or reservoir of rodent-borne diseases. In addition to the red bank vole, there is a high probability in the circulation of zoonotic diseases in the forest dormouse.

Material and Methods

Small mammals capturing and testing for different possible pathogen agents, are the material for this study in the territory of the Republic of Mordovia (53º38'–55º11'N and 42º11'–46º45' E) (Fig. 1) for epizootological research purposes. Coniferous forest, broad-leaved forests, shrub steppe and meadow steppe compose the rodents' habitat structure in the territory of Mordovia. The main forests are composed by pine *Pinus sylvestris* (L.), spruce *Picea abies* (L.) Karst., European larch *Larix decidua* (Mill.), oak *Quercus robur* (L.), common ash *Fraxinus excelsior* (L.), Norway maple *Acer platanoides* (L.), European white elm *Ulmus laevis* (Pall.), silver birch *Betula pendula* (Roth.), white birch *Betula pubescens* (Ehrh.), common alder *Alnus glutinosa* (L.), small-leaved lime *Tilia cordata* (Mill.), black poplar *Populus nigra* (L.).

The research was conducted in June and July 2018 and 2019. The live traps were set in the typical habitats of the forest dormouse for several days and then transferred to the next site. We used four trap lines. The number of traps in each line was 25. Snap traps were set for no more than 1 or 2 days. Salami and apple were used as baits. Traps were set mainly in mixed and broad-leaved forests. The latter biotope is a favourite habitat (Grigoryeva et al. 2015, Andreychev and Kiyaykina 2020). The material of the forest dormouse (dead animals) was obtained in small quantities, since this rare species in the region. This is due to the peculiarities of its distribution. Forest dormouse occurs from Western Europe across Asia Minor, Caucasus, reaching to Central Russia and Central Asia. In this extensive area, the species is rare in many parts of its native range, especially in Western Europe and Russia (Batsaikhan et al. 2008, Markov et al. 2017).

All animal carcasses were used as a result of basic research on population genetics (Grigoryeva et al. 2015) and homing (Andreychev and Kiyaykina 2020). During the research period of 2009-2019, a total of 1995 individuals of the following rodent species were trapped: red bank vole (*M. glareolus*) – 30.9 %, common vole (*M. arvalis*) – 23.8 %, Ural field mouse (*A. uralensis*) – 18.7 %, yellow-necked mouse (*A. flavicollis*) – 11.5 %, striped field mouse (*A. agrarius*) – 10.4 %, house mouse (*M. musculus*) – 4.4 %, and forest dormouse (*D. nitedula*) – 0.3 %. The captured rodents were transported to the laboratory of the Center for Hygiene and Epidemiology in the Republic of Mordovia. Enzyme-linked immune sorbent assay (ELISA), using the 'Huntagnost' test system for the presence of the pathogen, was the main method used to detect the HFRS antibodies in homogenized rodent's lungs. Studies on tularemia were performed using serological and bacteriological methods. For leptospirosis and yersiniosis, studies were conducted by serological method (Methodical Instructions 2012).

Results and Discussion

Of the six examined dormice, four individuals (66.7 %) were found to have antigens of the pathogen causing HFRS, and two individuals (33.3 %) were found to have antigens of tularemia pathogen. Only one

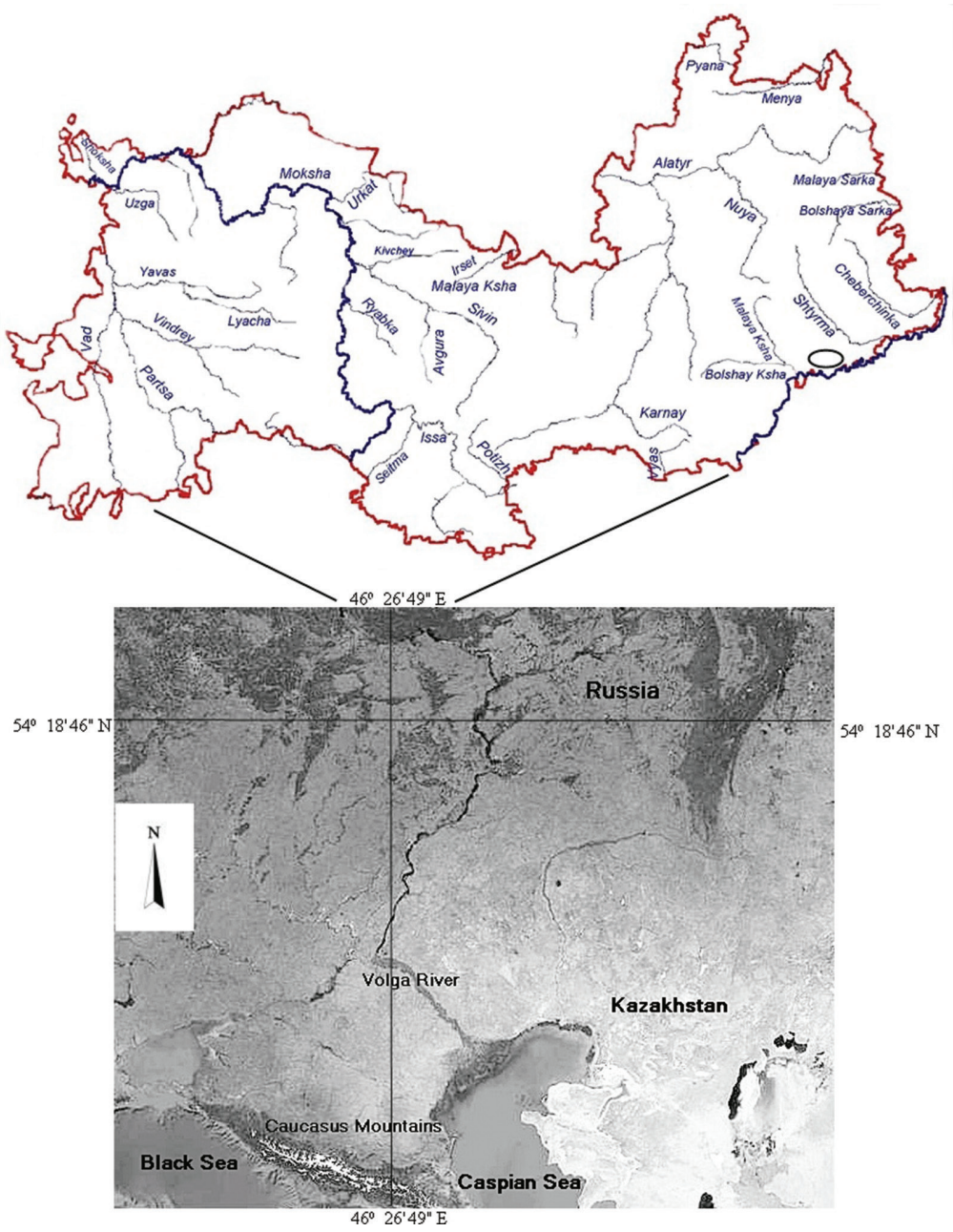

Fig. 1. Map of the Republic of Mordovia – oval – where animals were trapped.

individual of the forest dormouse was found to have no antigens of zoonotic diseases.

Comparing the results obtained in Mordovia by the spectrum of mouse rodent species infected with tularemia (Fig. 2)

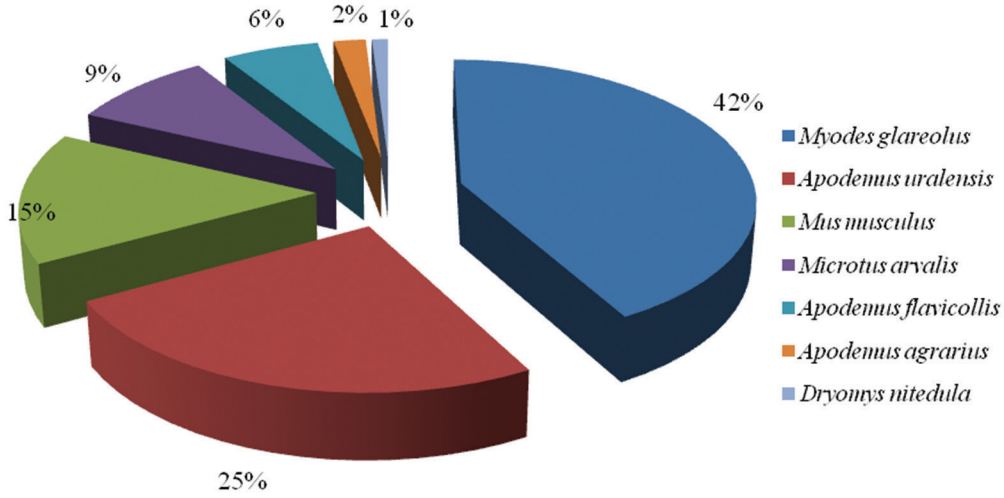

Fig. 2. Rodents' population structure involved as the reservoirs of tularemia and its circulation in 2019.

with the data obtained for the entire Volga Federal district (Trankvilevsky et al. 2015), a similar picture should be noted in the primary role of the carrier of this disease, the red bank vole (*M. glareolus*) (in Mordovia – 42 %, in Volga Federal district – 56.2 %) and Ural field mouse (*A. uralensis*) (in Mordovia – 25 %, in Volga Federal district – 21.9 %).

M. musculus, the house mouse, was the third rodent species found positive for the presence of tularemia bacteria (15 %); meanwhile, the field mouse, *A. agrarius*, was found positive for the same bacteria (15.6 %) in Volga Federal district area.

Analyzing the results of infection of rodents with hantavirus for 1997–2001 by Chumakov (2003) and 2007 by Churbanova (2008), as well as the results obtained by our study a change in the role of the main carrier of this disease could be stated. Thus, in 1997-2001, a high proportion of infected individuals were observed among the yellow-necked mouse, field mouse, red bank vole and the common vole captured, meanwhile in 2007, the common vole was found positive as well (21.4 %). Our study showed that the house mouse (41 %) was of primary importance, while the red bank vole (23 %) and the common vole (23 %) were highly infected (Fig. 3). Perhaps the reason for this is that a large number of animals were captured near settlements. Our study showed as well, that the field mouse was not infected with the pathogen causing HFRS among common small mammals in the region, although this species may be active in the epizootic process in Russia (Trankvilevsky et al. 2011).

The highest rate of infection with the leptospirosis pathogen was observed in the common vole. The field mouse was the second most infected (34 %). To a lesser extent, infection was detected in the house mouse. In other captured rodents' species, the pathogen was not detected.

Thus, among small mammals in Mordovia, the red bank vole, the common vole and the house mouse have an important role as carriers of zoonotic diseases. This

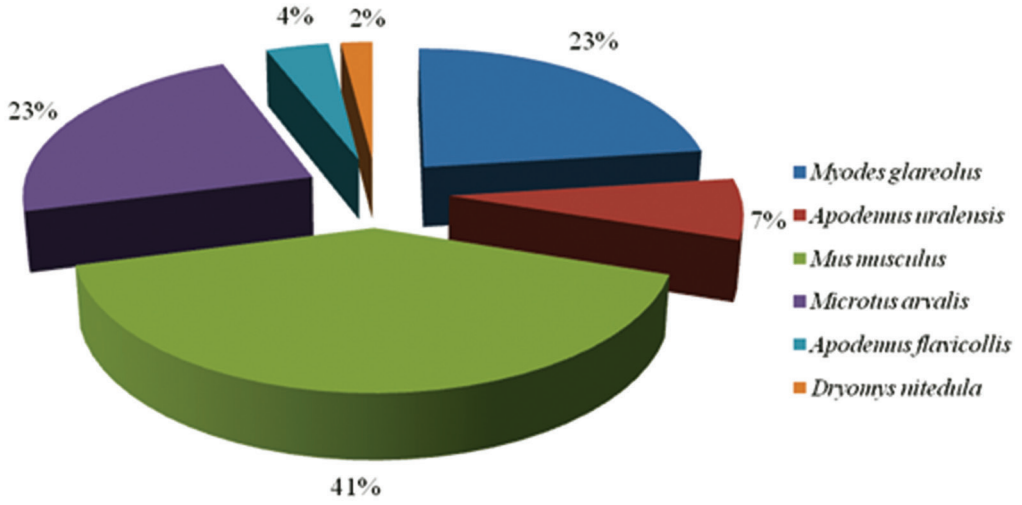

Fig. 3. Rodents' population structure involved as reservoirs of HFRS and its circulation in 2019.

circumstance is due to the high number of these species representing the rodent fauna of each region. However, it is necessary to take into account the role of such species like the forest dormouse, which has a high percentage of the tularemia and hantavirus pathogen. High diversity of small mammals' species in Mordovia with positive infection results is ensuring the persistence and circulation of the tularemia agents in the natural foci, which maintain a high risk of human disease cases.

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