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*ORIGINAL ARTICLE*

# Trends in the abundance and helminthic fauna of the wild boar (*Sus scrofa* Linnaeus, 1758) in the subtaiga zone in the South of the Northern Trans-Urals

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The population of the wild boar in the Yarkovsky district varied from 0 in 2004 and 2005 to 252 in 2011. In Nizhnetavdinsky district, the minimum population of the wild boar was recorded in 2005 and amounted to 15 animals, and the maximum in 2015 was 180 individuals. The wild boar population in the studied territories is characterized by a small number and an unstable balance. The invasion of the wild boar by the causative agents of nematodes (ascridosis, esophagostomosis, metastrongylatosis) and trematodes (echinochasmosis) was found. On the territory of Nizhnetavdinsky district, eggs of the causative agent of ascariasis (*Ascaris suum* ) were found in the wild boar in 2015; the invasion rate (IR) was 100.0% and in 2017 the IR was 11.1%. The eggs of the causative agent of esophagostomosis (*Oesophagostomum spp*) were identified only in 2017. with IR-11.1%. Parasitizing of metastrongylatosis-*Metastrongylus spp.* causative agents in the wild boar were recorded from 2016 to 2018; the IR in 2016 and 2018 was 20.0%, and in 2017 it was 22.2%. The causative agents of echinochasmosis (*Echinochasmus spp.)* and esophagostomosis (*Oesophagostomum spp.*) were identified on the territory of Yarkovsky district in 2016 with an IR of 7.7%, as well as ascariasis (*A. suum*) with an IR of 46.2%. The causative agents of metastrongylatosis ( *Metastrongylus spp.*) were detected only in 2018, while the extensis invasion of animals was 25.0%. In 2015 and 2017 the prevalence of the wild boar with pathogens of helminthiases was not revealed. Due to the short observation period, the influence of parasites on the wild boar population was not established, further research is required.

**Keywords:** Wild boar, Abundance, Helminths, Tyumen region, Russia.

## Introduction

Wild boar (*Sus scrofa* Linnaeus, 1758) are widespread throughout the world and, being a member of biocoenosis are characterized by high ecological plasticity. (Kulpin, A.A., 2008). The Wild boar inhabiting vast territories belongs to one of the main hunting commercially exploited species. Being omnivorous, it consumes everything, including vegetables, mushrooms, seeds, larvae, reptiles, mammals, birds and their eggs, and even carrion and carcasses of animals, it can show both positive and negative effects on the environment (Danilkin, A.A. 2002). Wild boar can play an important role in the epidemiology of some zoonotic helminths, acting as reservoir hosts and supporting helminths in the parasite's forest cycles, independent of domesticated animals (Mansouri, M.et al., 2016). In turn, helminths affect the number and structure of animal populations, as they cause a decrease in body weight, fertility, and developmental delays. The most severe helminthiases occur in young animals (Poloz, S.V., et al., 2014).

The study of the wild boar helminths was carried out by researchers in different climatic regions of the world, there was noted a wide species diversity of parasites. The most studied the distribution of the nematode respiratory (*Metastrongylus spp*) and digestive system (A*scaris suum, Trichuris suis, Oesophagostomum dentatum, Hyostrongylus rubidus, Globocephalus urosubulatus* et al.), Larval stages cestodes (*Taenia hydatigena, Echinococcus granulosus*) and thorny-headed worms (*Macracanthorynchus hirudinaceus*.). So in Iran, 13 species of helminths were identified (Eslami, A., Farsad-Hamdi, S., 1992; Solaymani-Mohammadi, S. et al., 2003; Mansouri, M., et al., 2016; Dodangeh, S., et al., 2018; Sarkari, B., et al., 2018), in Poland-11 (Popiołek M. et al., 2010; Nosal, P. et al., 2010; Nosal, P. et al., 2020; Strokowska, N., et al., 2020), Croatia-14 (Rajković-Janje R. et al., 2002; Rajković-Janje R. et al. 2004), Italy-12 (Moretta, I.. et al., 2011; Di Nicola, U., et al., 2015; Poglayen, G., et al., 2016; Migliore, S., et al., 2021), Mexico-8 (De-la-Rosa-Arana J.L. et al., 2021), USA-6 (Shender, L.A., et al., 2002). In Russia, on the territory of the Voronezh reserve «Usmansky Bor», 12 species of helminths were recorded (Ryzhikov, K.M., et al., 1983), in Losiny Ostrov National Park-9 (Samoilovskaya, N.A., 2011). V.A. Scholl (Schol, V.A., 1963) gives 72 species of helminths parasitizing wild boar, and the monograph of A.A. Mozgovoy indicated that the world fauna accounts for 139 species of pig helminths. Moreover, by 1967, 78 species of worms were registered on the territory of the former USSR: 53 in domestic pigs and 33 in the wild boar (Mozgovoy, A.A., 1967). Today's wild boar population in the Tyumen region got its start as a result of the introduction of individuals in the 80s of the 20$^{th}$ century. The introduction of the wild boar to the West Siberian region was carried out from 1980 to 1987 in the south of the

Tyumen region, in the Omsk and Novosibirsk regions. In the Tyumen region, animals were brought from the Moscow, Kaluga, Bryansk, Smolensk and Voronezh regions, as well as from Kyrgyzstan and Belarus. In total, 326 individuals were brought to two Federal State Nature Reserves: Belozersky, which is located in the Armizonsky District and Tyumensky, located in the Nizhnetavdinsky District (Kassal, B. Yu., 2015).

The goal of this study was to assess the population of wild boar and some biological factors, including the spread of parasites, which may affect the number of wild boar in the territory of Nizhnetavdinsky and Yarkovsky districts of the Tyumen region.

## Materials and Methods

The studies were carried out in the subtaiga zone of the Northern Trans-Urals on the territory of the Yarkovsky and Nizhnetavdinsky districts of the Tyumen region, and on the basis of the analysis of the data of the Department for the protection, control and regulation of the use of wildlife objects and their habitat in the Tyumen region for 2004-2018, as well as on the basis of the laboratory of animal entomoses of the All-Russian Scientific Research Institute of Veterinary Entomology and Arachnology-Branch of Tyumen Scientific Center SB RAS.

To count the wild boar, the methods of counting individuals at feeding points and counting by hikes on contours of the areas were used.

The method of counting the wild boar at feeding sites is carried out as follows: in the recommended period, namely at the end of February, when the trace activity falls due to a high layer of snow (from 50 cm), the checker climbs onto a well-camouflaged observation tower, near which there is additional feed on the ground or in special feed bins. When wild boar go out for feeding, the checker enters the number of wild boar and their sex and age into a book, special tools can also be used that will facilitate the counting, for example, binoculars or a video camera. For more accurate accounting at each feeding point, it is necessary to observe for 3 days in a row. This method can quite accurately determine the number of individuals living in a given territory, provided that all wild boar living in this territory come to this feeding point. This accounting implies a 30% accuracy error (Mirutenko, V.S., 2009).

The method of re-survey by hikes on contours of the areas has a slightly different algorithm. The territory, in which it is required to determine the number of wild boar, shall be walked over along its borders or compartment lines and traces shall be erased. On the first day, new animal tracks are counted, after which these tracks are again erased. The same procedure is carried out on the second day of accounting (Mashkin, V.I., 2007).

From 2004 to 2015, the method of accounting for wild boar at feeding points was used, from 2016 to 2017, the method of accounting for wild boar through the re-survey by hikes on contours of the areas was used, and in 2018 the accounting was again carried out by the method of counting at feeding points.

Parasitological studies of pathological material from wild boar were carried out in the autumn-winter periods of 2015-2018. Samples of feces of wild boar of various age and sex groups and sets of internal organs (heart, lungs, intestines, liver, kidneys, intercostal muscles and diaphragmatic peduncles) taken after hunting served as the material for the study. Fecal samples (n 26) were investigated by Fülleborn and ether-acetic sedimentation methods, internal organs (n 42) were analysed by methods of complete and incomplete helminthological dissections (Kotelnikov, G.A., Hrenov, V.M. 1975; Borzunov, V.M., et al, 2004).

Fulleborn's method. Feces are mixed in a laboratory mortar with a saturated solution of sodium chloride. Then the fecal solution is filtered through gauze or a sieve, poured into a glass cylindrical vessel and left for settlement. The eggs of parasitic worms, which have a lighter specific gravity, float to the surface of the liquid. This method is simple, effective for detecting the eggs of most nematodes and cestodes.

The principle of ether-acetic precipitation of helminth eggs is the sequential treatment of fecal samples with a 10% aqueous solution of acetic acid and ether. Helminth eggs, especially trematode eggs, are well detected.

Due to the fact that the wild boar is a wild animal, it is necessary to take into account the climatic features of the study region, namely the territories of the Nizhnetavdinsky and Yarkovsky districts. These areas are located on the territory of the West Siberian Lowland, in a continental climate. The prevailing wind direction is southwest. The minimum air temperature reaches in some periods up to -50°C, the maximum goes up to +36°C. Average annual precipitation is about 400 mm. The average day of snow cover is 30 October, the number of days with snow cover is 164, the depth of soil freezing is down to 150 cm (Karetin, L. N., 1990).

## Results

The number of wild boar resources in the Tyumen region on the example of Nizhnetavdinsky and Yarkovsky districts in the period from 2004 to 2018 is given in Table 1.

**Table 1.** The number of wild boar according to the results of the ZMU and the data of accounting works in the Yarkovsky and Nizhnetavdinsky districts of the Tyumen region (2004-2018).

| Year | Yarkovsky district | Nizhnetavdinsky district |
|---|---|---|
| 2004 | 0 | 20 |
| 2005 | 0 | 15 |
| 2006 | 12 | 58 |
| 2007 | 5 | 189 |
| 2008 | 28 | 102 |
| 2009 | 117 | 98 |

| | | |
|---|---|---|
| 2010 | 164 | 80 |
| 2011 | 252 | 99 |
| 2012 | 218 | 90 |
| 2013 | 202 | 95 |
| 2014 | 203 | 170 |
| 2015 | 160 | 180 |
| 2016 | 124 | 135 |
| 2017 | 79 | 126 |
| 2018 | 74 | 120 |

The table shows that the number of wild boar in the Yarkovsky district varied from 0 in 2004 and 2005 to 252 in 2011. In Nizhnetavdinsky district, the minimum population of the wild boar was recorded in 2005 and amounted to 15 animals, and the maximum in 2015 was 180 individuals.
A more clear change in the number is shown in Fig. 1.

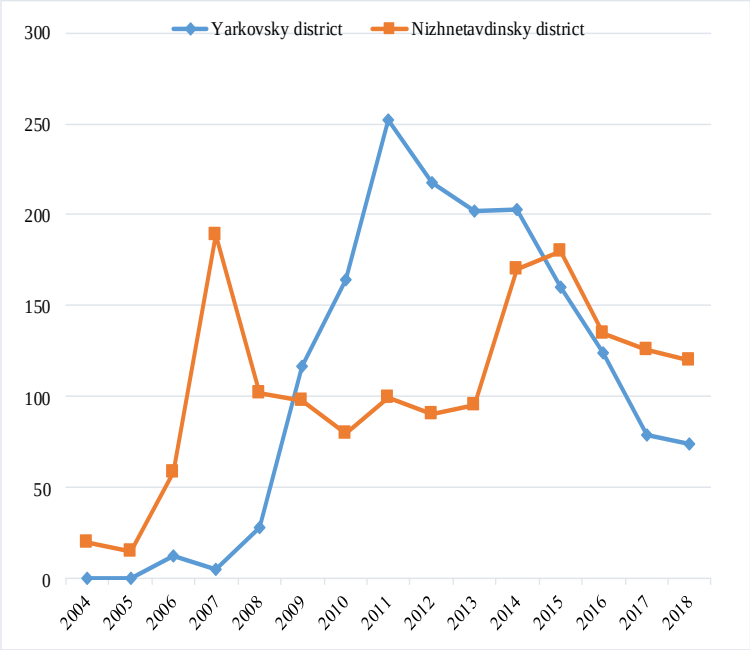


**Fig. 1.** The dynamics of the wild boar population in the south of the Tyumen region on the example of the Nizhnetavdinsky and Yarkovsky districts.

Analyzing the data of the counts presented in Fig. 1, it can be stated that over the studied period of time, there was a negative trend in the dynamics of the number of the wild boar. The wild boar population in the Tyumen region, and in particular in the Nizhnetavdinsky and Yarkovsky districts, is characterized by a small number and an unstable balance (Fig. 1). The jump in numbers in the period from 2010 to 2012 in the Yarkovsky district is possibly associated with favorable weather conditions and the result of increased biotechnical measures, which were carried out by the GUTO «Wildlife Conservation Service» and hunting providers in the period from 2004 to 2016. Biotechnical measures were also carried out on the territory of the Nizhnetavdinsky district, but due to the larger area of the land, the results are less noticeable. In 2016-2017, the decrease in the number may have been caused by geodetic works in the territory of Nizhnetavdinsky district (2016-2017), which could have caused the disturbance of wild boar and their migration to other territories. During the period of research, accounting methods changed, in 2004-2015 and 2018, the method of accounting for wild boar at feeding points was used, and in 2016 and 2017; the method of accounting for the wild boar through the re-survey by hikes on contours of the areas was used. These methods may have statistical deviations, but since the observation period for their comparison is insignificant, we can only make this assumption. Also, since 2016, all biotechnical measures aimed at increasing the number of animals have been discontinued.
According to a number of researchers (Poloz, S.V., et al., 2014), the population of wild boar is influenced by the infection of animals with pathogens of infectious etiology, including invasive, in this regard, in the period from 2015 to 2018, a study of the parasitic fauna of the wild boar on the territory of Nizhnetavdinsky and Yarkovsky districts was started.
Parasitological studies of the wild boar were carried out by methods of complete and incomplete parasitological research according to K.I. Scriabin (internal organs, muscles), Fulleborn and ether-acetic sedimentation (fecal samples). Over the study period, 26 sets of internal organs and 42 samples of feces were examined. The survey results are given in Table 2.

**Table 2.** The results of a parasitological study of pathological material from wild boar on the territory of Nizhnetavdinsky and Yarkovsky districts of the Tyumen region 2015-2018.

| **Research year** | **Districts and research results, extensiveness of invasion (IR,%)** | |
|---|---|---|
| | **Nizhnetavdinsky district** | **Yarkovsky district** |
| 2015 | *Ascaris suum*, 100,0 | - |
| | | *Echinochasmus spp.*, 7,7 |
| 2016 | *Metastrongylus spp.*, 20,0 | *Oesophagostomum spp.*, 7,7 |
| | | *Ascaris suum*, 46,2 |
| | *Metastrongylus spp*, 22,2 | |
| 2017 | *Oesophagostomum spp.*, 11,1 | - |
| | *Ascaris suum,* 11,1 | |
| 2018 | *Metastrongylus spp.*, 20,0 | *Metastrongylus spp.*, 25,0 |

During the study period, the invasion of the wild boar by the causative agents of nematodes was revealed, namely ascridosis, esophagostomosis, metastrongylatosis and trematodoses-echinochasmosis (Fig. 2 and 3).

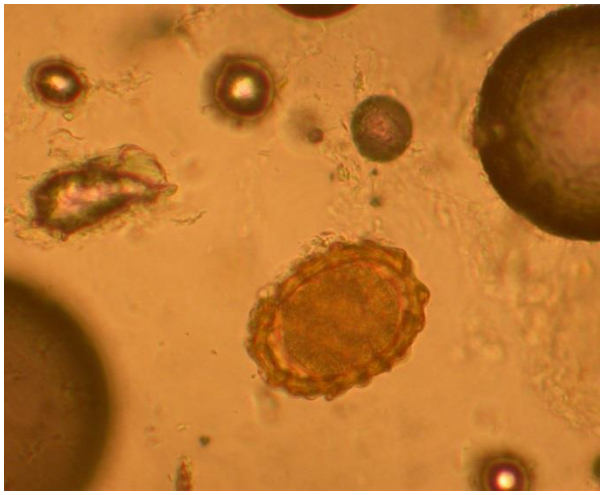

**Fig. 2.** Egg *Ascaris suum.*

**Fig. 3.** Egg *Oesophagostomum spp.*

On the territory of Nizhnetavdinsky district, eggs of the causative agent of ascariasis (*Ascaris suum*) were found in the wild boar in 2015; the invasion rate (IR) was 100.0% and in 2017 the IR was of 11.1%. The eggs of the causative agent of esophagostomosis (*Oesophagostomum spp*.) were identified only in 2017. with IR-11.1%. Parasitizing of metastrongylatosis-*Metastrongylus spp.* causative agents in the wild boar were recorded from 2016 to 2018; the IR in 2016 and 2018 was 20.0%, and in 2017 it was 22.2%.

The causative agents of echinochasmosis (*Echinochasmus spp.)* and esophagostomosis (*Oesophagostomum spp*.) were identified on the territory of Yarkovsky district in 2016 with an IR of 7.7%, as well as ascariasis (*Ascaris suum*) with an IR of 46.2%. The causative agents of metastrongylatosis (*Metastrongylus spp.) were* detected only in 2018, while the extensis invasion of animals was 25.0%. In 2015 and 2017 the prevalence of the wild boar with pathogens of helminthiases was not revealed.

## Discussion

Wild boar (*Sus scrofa* Linnaeus, 1758) are widespread. These animals are considered potential reservoirs of some zoonotic diseases. This study aimed to assess the population of the wild boar and some biological factors, including the spread of parasites, which may affect the number of wild boar in the territory. The research area is Nizhnetavdinsky and Yarkovsky districts of the Tyumen region of Russia in the period from 2004 to 2018. The study of wild boar populations in Nizhnetavdinsky and Yarkovsky districts revealed a negative trend in population dynamics. The wild boar population is characterized by a small number and unstable balance. The jump in numbers from 2010 to 2012 in the Yarkovsky district is possibly associated with favorable weather conditions and the result of enhanced biotechnical measures, similar procedures on the territory of the Nizhnetavdinsky district did not give tangible results, due to the larger area of land. In 2016-2017, the decrease in the number was due to the disturbance of animals, as a result of active geodetic work in the habitat and a change in accounting methods. Parasitic diseases are of great importance in the dynamics of the number of wild ungulates. As the number of animals grows, so does their parasite infestation (Samoilovskaya, N.A., et al., 2013). Nematodes, *Metastrongylus spp.* and *Ascaris suum*, were the most common wild boar helminthiases in our study. Parasitism of these helminths is observed in almost all regions of wild boar areas, namely in Iran (Eslami, A., Farsad-Hamdi, S., 1992; Solaymani-Mohammadi, S. et al., 2003; Mansouri, M., et al., 2016; Dodangeh, S., et al., 2018; Sarkari, B., et al., 2018), the Netherlands (Jansen, Jr.J.,1964), Spain,Poland (De-La-Muela, N., et al., 2001; García-González, Á. M., et al., 2013), Switzerland (Spieler, N., and Schnyder, M.,2021) etc. Our research also revealed the parasitization of *Oesophagostomum spp.*, which is also noted in Iran (Eslami, A., Farsad-Hamdi, S., 1992), Poland (Popiołek M. et al., 2010), Hungary (Molnár, L., et al., 2016), Croatia (Rajković-Janje R. et al., 2002), Slovakia (Ondrejková, A., et al., 2015), Serbia (Tamara I. et al., 2021), Brazil (Silva, DSD, and Müller, G., 2013), Japan ( Sato, H., et al., 2008) etc. The parasitism of *Echinochasmus spp.*, was identified by our study only in 2016, it was also noted in Croatia (Rajković-Janje R. et al., 2002). Parasites with a high intensity of invasion cause massive death of animals, with a low intensity of invasion, organic lesions of the lung tissue and small gut are observed. Due to the fact that our study found the causative agents of ascariasis, metastrongylatosis, esophagostomosis and echinochamosis, further research and development of measures are needed to reduce the invasion of wild boar by pathogens of helminthiasis.

## Conclusion

The population of the wild boar in the Yarkovsky district varied from 0 in 2004 and 2005 to 252 in 2011. In the Nizhnetavdinsky district, the minimum number of wild boar was recorded in 2005 and amounted to 15 individuals, and the maximum was recorded in 2015-180 individuals, thus the wild boar population in the Tyumen region, namely in the Nizhnetavdinsky and Yarkovsky districts, is characterized by a small number and an unstable balance. There was found the invasion of the wild boar by the causative agents of nematodes, namely ascridosis, esophagostomosis, metastrongylatosis and trematodes-echinochasmosis. Due to the short observation period, the influence of parasites on the wild boar population was not established, further research is required.

## Appreciation

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