



## Helminth infection in wild boars in Primorye, Russia

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### ABSTRACT

Wild boars have a worldwide distribution and also have major economic, veterinary, and medical importance. Due to a small amount of data on the parasitic fauna of wild boars in the Russian Far East, especially in Primorye territory, a post-mortem parasitic examination of 20 wild boars was provided. The general prevalence was 25%, and a total of six helminth species, including one larva stage, were found. The most prevalent helminth species were *Gnathostoma doloresi* (25%) and *Metastrongylus elongatus* (20%). Followed by *Trichuris suis* and *Ascaris suum* (15%). The lowest prevalence was registered for *Cysticercus tenuicollis* (the larvae stage of *T. hydatigena*). Parasites were found in each region, with the highest prevalence registered in the Chuguevskii region. Totally 100% of adult boars were positive for helminth infections, instead of 60% of young specimens. Some helminthes found (*G. doloresi*, *T. suis*, *A. suum*) have zoonotic potential and can be involved in the circulation of human parasitic diseases, especially in rural areas. Further research work on parasitic infections in wild boars in Primorye is necessary due to the high prevalence of helminthes in wild boars.

### 1. Introduction

The wild boar has a worldwide distribution, and it's also found both in European and Asian parts of Russia. In the Primorye wild boar found in the southern regions, its range is confined to oak and cedar-broad-leaved forests. The wild boar population in Russia, according to data on Okhotnadzor for 2013, is 398.53 thousand animals. In Primorye, the wild boar population accounts for 76.25 thousand specimens, or 19.1% of the total number of wild boar in Russia. The main predators hunting wild boar in Primorye are the brown bear *Ursus arctos lasiotus* (GRAY, 1867) and Himalayan bear *Ursus thibetanus ussuricus* (G. Cuvier, 1823). Wild boars have an important role in forest ecosystems, influencing plant and animal communities (Massei and Genov, 2004); wild boars are also a substantial part of the diet of the Amur tiger (*Panthera tigris altaica*) and Far Eastern leopard (*Panthera pardus orientalis*) which are the rarest felids in the world (Miquelle et al., 1996). The Amur tiger eats 30% of the population's wild boar (Economov and Kulpin, 2011; Ignatova et al., 2004). Wild boars are frequently infected by different parasitic, viral, and bacterial agents that have zoonotic potential. The major

zoonotic parasite species infecting wild boars include *Toxoplasma* spp., *Trichinella* spp., and the swine nematode *Ascaris suum* can infect humans and cause larvae migrans syndrome (Antolová et al., 2006; Fredriksson-Ahomaa, 2019; Gassó et al., 2014). Even though *Sus scrofa* populations are common and widely distributed in Primorye, the parasitic studies of these animals received little attention. The present study was aimed at.

- 1) Determining the parasitic fauna of wild boars in Primorye;
- 2) Evaluating the prevalence, intensity of helminth species;
- 3) Estimate the effect of age and sex on the helminth prevalence.

### 2. Materials and methods

#### 2.1. Study area

Between 2018 and 2019, the wild boars were investigated in the Primorye of Russia. This area is located in the south-eastern part of Russia (the Russian Far-East) and is characterized by warm and humid

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summers with rainfall. The altitude of the area is approximately 492 m above sea level. The mean annual temperature is  $-1$ – $+7$  °C with average minimum and maximum temperatures of  $-23$  °C and  $+41$  °C, respectively. The warmest months are August through September, and the coldest months are January and February. Total precipitation averages 550–920 mm/year, most of which is recorded in June; September has the least rainfall. The mean relative humidity is roughly 66–70%. The forest land is dominated by common oak, hornbeam, pine, beech, oak, linden, and chestnut trees. Wild boars were collected from four districts, including Hankaiskii, Anuchinskii, Ussuriiskii, and Chuguevskii (Fig. 1).

## 2.2. Sample collection and examination

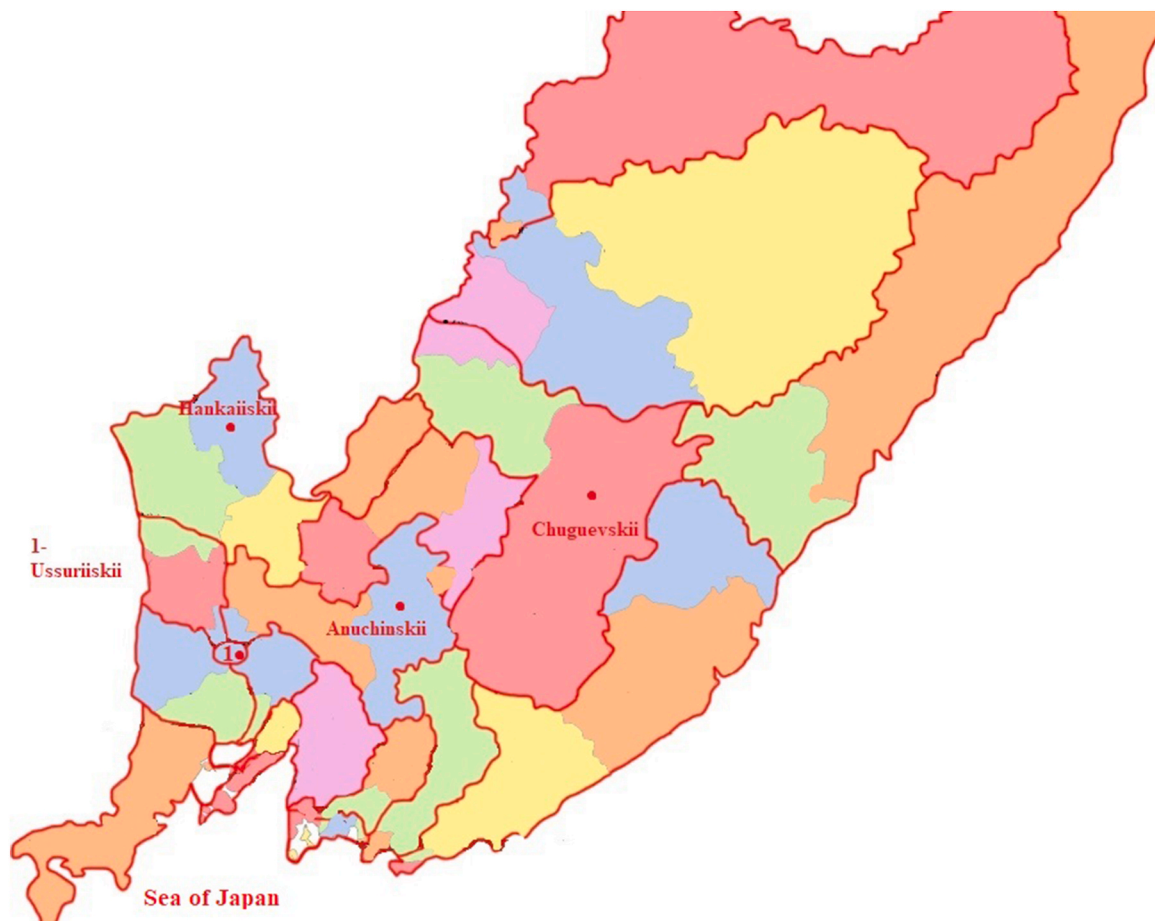
A total of 20 wild boars (8 females and 12 males; 15 juveniles and 5 adults) were collected by hunters during two consecutive hunting periods from 2018 to 2019. Areas of research were noticed on the map (Fig. 1). Data for each wild boar with respect to shooting site, sampling time, sex, and age were recorded. According to tooth development, and physical appearance, the wild boars were categorized into two age groups, juveniles ( $\leq 1$  year) and adults ( $> 1$  year) (Table 1). During the necropsy, the digestive tract, urinary bladder, spleen, liver, gall bladder, pancreas, kidneys, hearts, and lungs were extracted and examined for the presence of helminthes. The intestine, stomach, and esophagus were separated and examined macroscopically by the naked eye. Then, separate parts of the gastrointestinal tract were washed in warm water with continuous microscopic examination of their contents for the presence of small helminth species. The lungs, bronchi, and bronchioles were examined macroscopically and microscopically for the presence of lungworms. The liver and gall bladder were examined for the presence of trematodes and cestode cysts. All found helminth specimens were

**Table 1**

General parasites prevalence and intensity in wild boars from Prymorye.

	Examined	Prevalence	Intensity
<b>Age</b>			
1–2 years	15	9 (60%)	5,9 (2–11)
3 years	5	5 (100%)	10 (2–29)
<b>Sex</b>			
Female	8	5 (62,5%)	8,5 (3–29)
Male	12	9 (75%)	5 (2–8)
<b>Regions</b>			
Anuchinskii	7	5 (71,4%)	9,7 (3–29)
Chuguevskii	5	5 (100%)	5,7 (2–11)
Hankaiskii	5	2 (40%)	4
Ussuriiskii	3	2 (66,7%)	6 (4–8)

previously washed in NaCl solution and stored in 70% alcohol for later identification. All helminth species and cestode cysts were identified by morphological examination based on figures and descriptions provided by Ryshikov et al. (Ryzhikov et al., 1983). Samples of muscle tissues (20 tongues and diaphragm samples) except about 0.5 g were taken for trichoscopic examination. Trichinoscopy was provided according to the methodological recommendations of the Ministry of Agriculture and Industry in RF October 28, 1998 N 13-7-2/1428. The muscle pieces were compressed between two glasses and then examined under a stereomicroscope. This method is also used in similar studies (Mansouri et al., 2016; Senlik et al., 2011). All collected parasites were placed in 70% alcohol for preservation and later identification. The effects of sex and age on helminth prevalence were estimated by Fisher's Exact Test. Differences were considered significant when P value was  $< 0,05$ .



**Fig. 1.** Map of research area.

### 3. Results

Out of 20 boars, 14 (25%) had a positive helminth infection. Six helminth species were identified, including one cestode larva and five nematodes. The locations found and the general prevalence in different age and sex groups are shown in Table 1. Most parasites were found in wild boars aged 3 years (100%), followed by those aged 1–2 years (60%), males were more frequently infected than females, total number of infected males was 75% and females was 62,5% respectively. Parasites were found in boars from all locations, the highest percentage of infected specimens was registered in the Chuguevskii region (100%), followed by Anuchinskii (71,4%) and Ussuriiskii (66,7%). The most common parasite species were *Gnathostoma doloresi* (25%), followed by *Metastrongylus elongatus* (20%); two intestinal nematodes such as *Trichuris suis* and *Capillaria suis* have an equal prevalence (15%). The other parasites found were *Ascaris suum* (10%) and *Cysticercus tenuicollis* (5%) (Table 2). *Trichinella* specimens were not found in muscle samples. A positive correlation was found between parasite prevalence and age ( $p < 0.05$ ). Adult animals were more frequently and heavily infected than young animals. No correlations were found between prevalence and other parameters (sex and area investigated).

### 4. Discussion

The present study is a continuation of our previous report about wild boar parasites found using the fecal examination method. In the Russian Federation, several domestic and wild mammals are known to be the intermediate hosts of *T. hydatigena* (Thakachova et al., 2015). In addition, the high prevalence of strobilar stages in the canids in Russia is well documented (Bulashev et al., 2016; Tret'yakov et al., 2022). *Gnathostoma doloresi* is a roundworm mainly found in the stomachs of domestic pigs and wild boars. These helminthes are registered throughout southeastern Asia, including Japan, China, Vietnam, and Thailand (Dissamarn et al., 1966; Ishiwata et al., 1998; Le Thi Xuan et al., 2004). Primorye territory belongs to the Russian Far-East and the Russian part of southeastern Asia, and only a few local reports of *Gnathostoma* infection in Primorye were found. There is also a lack of data on wild boar parasites in Russia, especially in Primorye, where the highest levels of endemism appeared (Chabanenko, 1995). The first report about *G. doloresi* in the stomach of wild boars was published in the USSR in 1963 (Pigolkin, 1963), but it was a case study with the description of five *Gnathostoma* specimens from two wild boars. In the present study, we haven't seen a correlation between sex and *Gnathostoma* infection; our records were similar to Nawa and Imai (1989); Ishiwata et al., 1998; Ishiwata et al. (1998); Nawa and Imai (1989). The authors also mentioned that age wasn't influenced by *Gnathostoma* infection; contrary to the fact, adult wild boars were frequently infected in our study. The authors also reported that areas influenced by *Gnathostoma doloresi* prevalence were more, for example, wild boars from mountain regions were more heavily infected than boars from near the sea (Nawa and Imai, 1989). In our study, the highest number of infected animals was registered in wild boar hunting in the Chuguevskii region, located near the coast of the Sea of Japan. However, the small amount of data does not allow us to accurately assess the epizootological situation of *Gnathostoma* infection in wild boars from Primorye areas. Earthworms, which form part of the diet of wild boars, act as intermediate hosts for *Metastrongylus* species, and this, could result in a high prevalence of *M. elongatus* infection among *S. scrofa* (Nagy et al., 2015). Some *Metastrongylus* species have zoonotic potential and can cause metastrongylosis in humans; however, we have not found previous reports about cases of human infection in Russia. The prevalence of *Metastrongylus* in wild boars varies between 10.4 and 52.5% in different regions (García-González et al., 2013; da Silva and Müller, 2013). The most prevalent metastrongylid species were *M. apri*, *M. pudendodectus*, *M. salmi*, *M. confuses* and *M. asymmetricus* (García-González et al., 2013; Gassó et al., 2014; Spieler and Schnyder, 2021; Oliveira et al., 2023). In

**Table 2**

Parasite species and prevalence in wild boars from Primorye.

	Number of infected boars	Prevalence	Intensity
<i>Metastrongylus elongatus</i>	4	20%	4,7 (2–10)
<i>Ascaris suum</i>	2	10%	3,5 (2–5)
<i>Trichuris suis</i>	3	15%	5,3 (3–8)
<i>Capillaria suis</i>	3	15%	4,3 (3–4)
<i>Gnathostoma doloresi</i>	5	25%	14 (2–29)
<i>Cysticercus tenuicollis</i>	1	5%	21

our study, we detected *M. elongatus* according to its morphological features: a well-developed genital cone and single long spicule in males and the absence of prevulvular dilatation in females (Gassó et al., 2014; Yoon et al., 2010). *Metastrongylus elongatus* infection was frequently registered in Russia: in Moscow (Samojlovskaja, 2011); Ryazan (Andreyanov, 2013), Irtysh Region (Kassal, 2016). This species was also found in Far East Region: Japan (Sato et al., 2008), Korea (Yoon et al., 2010). Low prevalence rates can relate to cold hunting seasons (winter, early spring) when boars did not include worms in their diet. The swine parasites such as *Ascaris suum* and *Trichuris suis* are cosmopolitan intestinal roundworms of pigs and wild boars; both species have worldwide distribution and can infect humans (Nejsun et al., 2012). *Capillaria suis* is an intestinal roundworm that was first described by Pigolkin in 1958 from the small intestine of a wild boar from the Russian Far East (Pigolkin, 1958). Three roundworm species, *G. doloresi*, *T. suis* and *A. suum* can occasionally infect humans (Antolová et al., 2006; Liu et al., 2020; Nejsun et al., 2012). Nematodes from the genus *Metastrongylus* also cause pulmonary infections in humans (Calvopina et al., 2016).

### 5. Conclusions

Our study is the first mention of parasitic infection in wild boars in modern Russia. It is also a first step in large-scale research work in the field of wild boar parasitic fauna in the Russian Far East. This study demonstrates that wild boars are infected by *G. doloresi* – endemic roundworm that has zoonotic potential. Among 8 *Metastrongylus* species infected wild boars, we found only *M. elongatus*. The data obtained have opened up new questions about the peculiarities of the species composition of the wild boar parasitofauna in the Russian Far East. Further research using both classical and modern methods is needed.

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### Institutional review board statement

The present study was approved according to the guidelines of Ethical Committee of Far Eastern Federal University Protocol 3 from November 17, 2022.

### CRediT authorship contribution statement

**Tatyana V. Tabakaeva:** Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Yurii A. Belov:** Data curation. **Egor M. Shchelkanov:** Writing – original draft. **Dmitrii V. Pankratov:** Data curation. **Anon V. Tabakaev:** Writing – review & editing. **Irina V. Galkina:** Writing – original draft, Writing – review & editing. **Michael Y. Shchelkanov:** Project administration.

### Declaration of competing interest

Authors declare that they are no any conflict of interests. They also confirm that the MS was not published elsewhere.

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