Russian J. Theriol. 25 (2): 244–252 © RUSSIAN JOURNAL OF THERIOLOGY, 2026

Abomasal nematodes of white-tailed deer (*Odocoileus virginianus*) from game farm in European Russia

Dmitry N. Kuznetsov

ABSTRACT. A parasitological study of white-tailed deer (*Odocoileus virginianus*) from Russia was carried out for the first time. During the necropsies of 27 farmed white-tailed deer from European part of Russia their digestive tracts were examined using helminthological methods. Twenty white-tailed deer of the 27 examined found to be infected with nematodes. No worms belonging to Cestoda or Trematoda were found. All of the nematodes were found only in abomasa. The intensity of infection with all species of detected nematodes ranged from 15 to 1469 specimens. No pronounced lesions in the digestive tracts, as well as severe emaciation of examined white-tailed deer were detected. Identification of the nematodes was based on morphology of males. Five species of nematodes were found: *Ashworthius sidemi, Ostertagia leptospicularis* (including a minor morph "*Ostertagia kolchida*"), *Ostertagia mossi, Spiculopteragia asymmetrica* and *Teladorsagia circumcincta*. Asian blood-sucking nematode *A. sidemi* was found in white-tailed deer for the first time, and the nematodes *O. leptospicularis, S. asymmetrica* and *T. circumcincta* are rarely reported from this host. This may suggest that examined white-tailed deer were infected with these four species of nematodes on the game farm sharing pasture with other ruminants. The nematode *O. mossi* was found in Russia for the first time. Considering that *O. mossi* is a parasite, which associated only with white-tailed deer, it can be concluded that this nematode was introduced to Russia with it.

How to cite this article: Kuznetsov D.N. 2026. Abomasal nematodes of white-tailed deer (*Odocoileus virginianus*) from game farm in European Russia // Russian J. Theriol. Vol.25. No.2. P.244–252. doi: 10.15298/rusjtheriol.25.2.10

KEY WORDS: wild ruminants, introduced cervids, digestive tract, parasites, Russia.

Dmitry N. Kuznetsov [dkuznetsov@mail.ru], A.N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences, 33 Leninsky prosp., Moscow 119071, Russia.

Нематоды сычуга белохвостых оленей (*Odocoileus virginianus*) из охотничьего хозяйства в европейской части России

Д.Н. Кузнецов

РЕЗЮМЕ. Впервые в России проведено паразитологическое исследование белохвостых оленей (*Odocoileus virginianus*). При патологоанатомических вскрытиях 27 белохвостых оленей из охотничьего хозяйства в европейской части России их пищеварительный тракт был исследован с использованием гельминтологических методов. У двадцати белохвостых оленей из 27 обследованных обнаружено заражение нематодами. Паразитических червей, относящихся к Cestoda или Trematoda, обнаружено не было. Все нематоды обнаружены только в сычуге. Интенсивность инвазии нематодами всех обнаруженных видов варьировала от 15 до 1469 особей. У обследованных белохвостых оленей не выявлено выраженных поражений пищеварительного тракта, а также сильного истощения. Идентификация нематод была основана на морфологии самцов. Обнаружено пять видов нематод: *Ashworthius sidemi*, *Ostertagia leptospicularis* (включая минорную морфу "*Ostertagia kolchida*"), *Ostertagia mossi*, *Spiculopteragia asymmetrica* и *Teladorsagia circumcincta*. Азиатская кровососущая нематода *A. sidemi* обнаружена у белохвостого оленя впервые, а нематоды *O. leptospicularis*, *S. asymmetrica* и *T. circumcincta* редко встречаются у этого хозяина. Это может свидетельствовать о том, что обследованные белохвостые олени были заражены этими четырьмя видами нематод в охотничьем хозяйстве, при использовании общего с другими жвачными пастбища. Нематода *O. mossi* обнаружена в России впервые. Учитывая, что *O. mossi* является паразитом, который ассоциирован только с белохвостым оленем, можно сделать вывод, что эта нематода была завезена в Россию вместе с ним.

КЛЮЧЕВЫЕ СЛОВА: дикие жвачные, интродуцированные олени, пищеварительный тракт, паразиты, Россия.

Introduction

The white-tailed deer, *Odocoileus virginianus* (Zimmermann, 1780), is an American species, which was introduced to a number of European countries, and the most successful introduction was in Finland (Poutanen *et al.,* 2022). In Russia, *O. virginianus* was first noted in the 1990s in the territories adjacent to Finland (Maslennikov, 2025). Currently, white-tailed deer are bred on some game farms in Russia. The introduction of white-tailed deer poses a risk of new diseases, including parasitic infections, being brought into Russia (Samoylovskaya *et al*., 2014; Maslennikov, 2025). On the other hand, white-tailed deer could get local infections in Russia, potentially hindering their breeding on game farms. Recent studies of some cervids noted changes in the parasitofauna, both in terms of hosts and area (Kuznetsov *et al*., 2020, 2024, 2025a, b; Pyziel-Serafin *et al*., 2023; Davidson *et al*., 2025; Rehbein *et al*., 2025; Skorpikova *et al*., 2025). Moreover, the survey of selected cervids supposed the discovery of new helminth species (Loginova *et al*., 2025). The study of farmed common fallow deer, which is non-indigenous species for Russia, found new nematode species for this host (Kuznetsov, 2024). In this connection, studying the parasite fauna of other introduced cervids on Russian game farms would be useful as well. To date, there are no published data on parasites of the white-tailed deer in Russia. The only publication concerning parasites of white-tailed deer in Russia is, in fact, a discussion of the potential introduction of the trematode *Fascioloides magna* (Bassi, 1875), which is not found in Russia (Samoylovskaya *et al*., 2014). Given the above, studies concerning the parasite fauna of white-tailed deer in Russia appear highly relevant. The aim of the present study was to identify and quantify parasitic worms found during post-mortem examinations of the digestive tracts of white-tailed deer from game farm in European Russia and to compare the results with the data on helminths of *O. virginianus* from other countries.

Material and methods

Collection of samples

The nematodes were collected during the post-mortem examinations of 27 white-tailed deer from game farm in Tver' Region (European part of Russia). The digestive tracts of the white-tailed deer were dissected and examined using helminthological methods (Ivashkin *et al*., 1971; Kuznetsov, 2020). Four of the studied white-tailed deer were imported from abroad (the deer numbered 1, 3, 4, 11 in Table 2), but there is no precise information concerning the country of their origin. The causes of death of the studied white-tailed deer were mainly accidental injuries. Information on the age of the white-tailed deer is given in accordance with the data provided by the staff of the game-farm.

Taxonomical identification

Identification of detected nematodes was based on morphology of the males due to big similarity of their females. All of the detected specimens of nematode males were prepared as temporary whole mounts, processed with glycerol solution (two parts of glycerol and eight parts of water) and then studied using light microscopy at magnification of 40 to 400. Species identification was mainly based on the peculiarities of the spicules and bursa morphology presented in literature (Drozdz, 1965, 1973, 1995; Hoberg et al., 1993, 2002; Drozdz *et al*., 1998; Demiaszkiewicz *et al*., 2013; Lehrter *et al*., 2016).

Descriptive statistics

To assess the infection by certain species of gastrointestinal nematodes the prevalence and mean intensity (with males of nematodes) are used. These indicators were computed using Quantitative Parasitology (QPweb) online application (https://www2.univet.hu/qpweb/qp10/index.php) (Reiczigel *et al*., 2019; Klaschka & Reiczigel, 2021). All intervals were calculated with 95% confidence level. The prevalence was computed using Sterne's method, and mean intensity was estimated using the bias-corrected and accelerated (BCa) method with 2000 bootstrap replications. For small samples (fewer than 3 infected hosts), BCa is not available.

Results

Helminthological dissections of the digestive tracts revealed nematodes in 20 of the 27 examined white-tailed deer. Thus, the prevalence of infection with all

Table 1. The prevalence and mean intensity of infection in *Odocoileus virginianus* (*n*=27) by the species of abomasal nematodes.

Nematode species	The number of infected animals	Prevalence (%) with intervals	Mean intensity of infection with intervals
Ashworthius sidemi	1	3.7 (0.2–18.1)	1.0
Ostertagia leptospicularis	16	59.3 (40.2–76.3)	30.0 (10.8–100.0)
Ostertagia mossi	2	7.4 (1.3–23.7)	2.0
Spiculopteragia asymmetrica	16	59.3 (40.2–76.3)	31.9 (11.5–108.0)
Teladorsagia circumcincta	1	3.7 (0.2–18.1)	1.0



Fig. 1. *Ashworthius sidemi*, posterior end of male (bursa and spicules).



Fig. 3. *Ostertagia leptospicularis*, posterior end of male (bursa and spicules, ventral view).



Fig. 2. *Ashworthius sidemi*, anterior end with the neodont in buccal cavity (indicated by the arrow).

species of detected nematodes was 74.1%. All of the nematodes were found only in abomasa. The intensity of infection with all species of detected nematodes ranged from 15 to 1469 specimens. No worms belonging to Cestoda or Trematoda were found in any of the cases. There were no pronounced lesions in the digestive tracts, as well as severe emaciation of examined white-tailed deer. The detected nematodes are classified into five species. All of the detected species belong to the Trichostrongyloidea superfamily (according to classification by Durette-Desset *et al*., 1999): *Ashworthius sidemi* Schulz, 1933; *Ostertagia leptospicularis* Assadov, 1953; *Ostertagia mossi* Dikmans, 1931; *Spiculopteragia asymmetrica* (Ware, 1925) and *Teladorsagia circumcincta* (Stadelman, 1894) (Table 1, Figs 1–7). In seven of the 16 cases where *O. leptospicularis* was found, the minor morphs of this species ("*Ostertagia kolchida*") were also detected (Fig. 8). The detailed results of the study of each of the 27 white-tailed deer are presented in Table 2. Voucher specimens of the detected nematodes were deposited in the Museum of Helminthological Collections of the IEE RAS (Moscow, Russia): *A. sidemi* (accession number 14562, collected from deer number 2 in Table 2), *T. circumcincta* (accession number 14563, collected from deer number 2 in Table 2), *O. mossi* (accession number 14564, collected from deer number 3 in Table 2), *O. leptospicularis* (accession number 14566, collected from deer number 3 in Table. 2), "*O. kolchida*" (accession number 14567, collected from deer number 3 in Table 2) and *S. asymmetrica* (accession number 14565, collected from deer number 12 in Table 2).

Table 2. The intensity of infection with abomasal nematodes in studied individuals of *Odocoileus virginianus* and the list of detected species. Major and minor morphs are separated by slash.

ID number of deer	Month and year of sampling	Sex and age of hosts	Number of detected nematodes			Species of detected nematodes and number of males (in brackets)
			Total	Males	Females	
1	December 2016	male, 9 months	35	15	20	*Ostertagia leptospicularis* (9) / "*Ostertagia kolchida*" (1), *Spiculopteragia asymmetrica* (5)
2	January 2017	female, 9 months	1469	572	897	*Ashworthius sidemi* (1), *O. leptospicularis* (245) / "*O. kolchida*" (36), *S. asymmetrica* (289), *Teladorsagia circumcincta* (1)
3	January 2017	female, 9 months	144	58	86	*O. leptospicularis* (18) / "*O. kolchida*" (8), *Ostertagia mossi* (1), *S. asymmetrica* (31)
4	January 2017	male, 9 months	341	134	207	*O. leptospicularis* (49) / "*O. kolchida*" (6), *S. asymmetrica* (79)
5	January 2017	male, 9 months	–	–	–	–
6	January 2017	female, 9 months	–	–	–	–
7	January 2017	male, 2 years	–	–	–	–
8	March 2017	female, 3 years	20	8	12	*O. leptospicularis* (7) / "*O. kolchida*" (1)
9	March 2017	male, 9 months	–	–	–	–
10	October 2017	male, 1 year	45	21	24	*S. asymmetrica* (21)
11	November 2017	female, 1 year	126	53	73	*O. leptospicularis* (34) / "*O. kolchida*" (5), *O. mossi* (3), *S. asymmetrica* (11)
12	November 2017	male, 1 year	26	9	17	*O. leptospicularis* (1), *S. asymmetrica* (8)
13	March 2018	female, 2 years	18	7	11	*O. leptospicularis* (3), *S. asymmetrica* (4)
14	October 2018	female, 1 year	27	8	19	*S. asymmetrica* (8)
15	November 2018	male, 1 year	–	–	–	–
16	January 2019	female, 9 months	39	10	29	*O. leptospicularis* (4), *S. asymmetrica* (6)
17	November 2019	female, 1 year	35	14	21	*O. leptospicularis* (9), *S. asymmetrica* (5)
18	February 2020	male, 10 months	–	–	–	–
19	December 2020	female, 9 months	52	19	33	*O. leptospicularis* (8), *S. asymmetrica* (11)
20	February 2021	female, 9 months	–	–	–	–
21	March 2021	female, 2 years	20	6	14	*O. leptospicularis* (1), *S. asymmetrica* (5)
22	November 2021	female, 1 year	33	12	21	*S. asymmetrica* (12)
23	March 2022	male, 2 years	23	9	14	*O. leptospicularis* (9)
24	October 2022	female, 1 year	24	9	15	*O. leptospicularis* (8) / "*O. kolchida*" (1)
25	February 2023	male, 10 months	47	18	29	*O. leptospicularis* (8), *S. asymmetrica* (10)
26	November 2023	male, 1 year	15	5	10	*S. asymmetrica* (5)
27	January 2024	male, 9 months	29	9	20	*O. leptospicularis* (9)



Fig. 4. *Ostertagia leptospicularis*, posterior end of male (bursa and spicules, lateral view, the arrow indicates proconus).



Fig. 5. *Ostertagia mossi*, posterior end of male (bursa and spicules, ventral view).

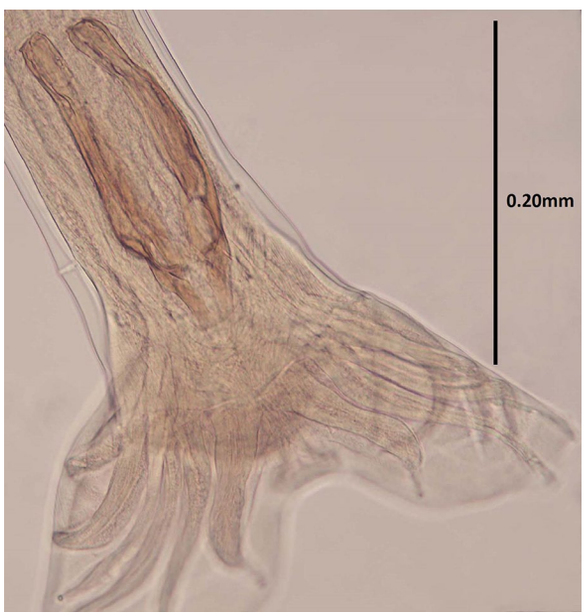


Fig. 6. *Spiculopteragia asymmetrica*, posterior end of male (bursa and spicules, ventral view).



Fig. 7. *Teladorsagia circumcincta*, posterior end of male (bursa and spicules, ventral view).



Fig. 8. "*Ostertagia kolchida*", posterior end of male (bursa and spicules, ventral view).

Discussion

The present study showed a relatively low species diversity of helminths parasitising farmed white-tailed deer in Russia, as well as relatively low levels of the intensity of infection (Tables 1, 2). It can be assumed that the season had an influence, since all the samples were collected during the period October–March (Table 2). However, it should be noted that a low level of the intensity of infection with gastrointestinal nematodes is often for cervids, both in game farms and in the wild (Santin-Duran *et al*., 2004; Kowal *et al*., 2012; Kuznetsov, 2024; Kuznetsov *et al*., 2024, 2025a, b). As noted by Hoberg *et al.* (2001), intensities of infection in *Odocoileus* spp. rarely exceed several hundred, with a maximum near 4000 for *Ostertagia* spp., and, in general, specific morbidity and mortality were not associated with these nematodes in cases of wild ruminants. At the same time, study of red deer conducted by Irvine *et al.* (2006) showed that abomasal nematodes, in association with other parasitic worms, able to reduce body condition in cervids even when the intensity of infection is low. Folstad *et al.* (1996) showed that infection with parasites, especially with gastrointestinal nematodes, can cause asymmetry in antlers. Thus, it can be assumed that even a low-level infection with parasitic worms can reduce the value of deer specimen as an object for hunting.

Spiculopteragia asymmetrica and *O. leptospicularis* were most often found in this study. These two species were found in 16 of the 27 white-tailed deer examined (Table 1). The intensity of infection with *S. asymmetrica* and with *O. leptospicularis* also turned out to be very similar (Tables 1, 2). *S. asymmetrica* is a fairly common parasite of wild ruminants. In Europe, this nematode is most often registered in *Dama dama* (Linnaeus, 1758) (Wyrobisz-Papiewska *et al.*, 2018). Besides, in several European countries, *S. asymmetrica* has also been recorded in *Cervus elaphus* Linnaeus, 1758, *Cervus nippon* Temmink, 1838, *Capreolus capreolus* (Linnaeus, 1758), *Alces alces* (Linnaeus, 1758), as well as in *Bison bonasus* (Linnaeus, 1758) and *Ovis musimon* (Pallas, 1811) (Wyrobisz-Papiewska *et al.*, 2018; Pyziel-Serafin *et al.*, 2023). In European Russia, *S. asymmetrica* noted as the dominant species among gastrointestinal nematodes of *D. dama* and *C. elaphus* (Kuznetsov, 2024; Kuznetsov *et al*., 2025b). Besides, there are several reports that *S. asymmetrica* has been found in other parts of the world. In Asian part of Russia, *S. asymmetrica* was found in *Capreolus pygargus* (Pallas, 1771) and *C. nippon* (Kuznetsov *et al*., 2024, 2025a). Youssefi *et al.* (2014) found *S. asymmetrica* in *C. elaphus* from Iran. Suarez *et al.* (1991) found *S. asymmetrica* in closed herd of *C. elaphus* in Argentina, where the imported red deer population has been kept isolated for more than 60 years. As noted by Rickard *et al.* (1993), the known geographic distribution of *S. asymmetrica* in North America includes a few specific localities in eastern Canada and the United States, and this distribution likely coincides with areas of residence of introduced populations of red deer and fallow deer. Rickard *et al.* (1993) list fallow deer, red deer, and captive woodland caribou (*Rangifer tarandus* (Linnaeus, 1758)) as hosts of *S. asymmetrica* in North America. Interestingly, *S. asymmetrica* has not been found in white-tailed deer or other cervids and bovids sympatric with fallow deer or caribou in these localities in North America (Rickard *et al.*, 1993). In introduced white-tailed deer, *S. asymmetrica* was noted in New Zealand by Andrews (1973) and in Czechoslovakia by Kotrla & Kotrly (1977).

Ostertagia leptospicularis is a common parasite of cervids in Europe (Wyrobisz-Papiewska *et al.*, 2018; Kuznetsov *et al*., 2020, 2025b; Kuznetsov, 2024). Similar to the cases with *S. asymmetrica*, *O. leptospicularis* has also been found in some areas outside Europe (Andrews, 1973; Suarez *et al.*, 1991; Hoberg *et al.*, 2001). The ways of introduction of *O. leptospicularis* into these areas are not clear enough, but it is assumed that this is related with the introduction of ruminants. It is important to note that *O. leptospicularis* is also found in bovids, both wild and domestic (Wyrobisz-Papiewska *et al*., 2018, 2021). Moreover, *O. leptospicularis* was reported as a pathogen and a parasite of economic importance in cattle (Saqur *et al.*,

1980; Bisset, 1994). In turn, Dunn (1983) supposed that *O. leptospicularis* was implicated in winter mortality in red deer. At the same time, the study by Wyrobisz-Papiewska *et al.* (2021) allowed to suggest that there are different strains of *O. leptospicularis* in cattle and cervids. Kotrla & Kotrly (1977) noted that white-tailed deer introduced into Czechoslovakia has become susceptible to *O. leptospicularis*. There is no data concerning the detection of *O. leptospicularis* in white-tailed deer in any other areas.

Ostertagia mossi was found in single specimens, in 2 of the 27 deer studied (Tables 1, 2, deer with numbers 3 and 11). According to Hoberg *et al.* (2001), the geographic distribution of *O. mossi* is restricted to eastern North America. Besides, it is assumed that *O. mossi* has a limited host distribution, associated only with white-tailed deer (Hoberg *et al.*, 1993). It should be noted that *O. mossi* was also reported from other cervids, but eventually these identifications were found to be erroneous (Hoberg *et al*., 1993, 2001). In Europe, *O. mossi* has been found by Kotrla & Kotrly (1977) in white-tailed deer introduced into Czechoslovakia. To date, there are no new reports that *O. mossi* has been found in any other regions. Thus, this is the first time this parasite has been detected in Russia.

Ashworthius sidemi has never been found in white-tailed deer before. In recent decades, this Asian species of nematode has spread among wild ruminants in Europe (Drozdz *et al*., 1998, 2003; Kowal *et al*., 2012; Demiaszkiewicz *et al*., 2013; Lehrter *et al*., 2016; Kuznetsov *et al*., 2018; Kuznetsov, 2022; Rehbein *et al*., 2025; Skorpikova *et al*., 2025). It should be noted that Carreno *et al.* (2001) found a species of *Ashworthius* in white-tailed deer from Costa-Rica, and Hoberg *et al.* (2002) described this previously unrecognised species as *Ashworthius patriciapilittae*. Besides, Hoberg *et al.* (2002) note that prior to the publication by Carreno *et al.* (2001) there was no record for species of *Ashworthius* among ruminants from the Western Hemisphere. During the present study, a single specimen of *A. sidemi* (male) was found (Table 2, the deer with number 2), and the condition of this specimen was not very good (Figs 1, 2). Nevertheless, it is safe to say that this specimen belongs to the species *A. sidemi*. This conclusion was made by comparing the morphological features of male reproductive system of the specimen found during the present study with the descriptions, as well as drawings and photos of *A. sidemi* provided by Drozdz (1973), Drozdz *et al.* (1998), Demiaszkiewicz *et al.* (2013) and Lehrter *et al.* (2016). In particular, *A. sidemi* lacks a gubernaculum, and the spicules have well-defined morphological and size features. The male found during the present study lacks a gubernaculum, and the length of the spicules is 0.760 mm, which is close to the values of *A. sidemi* by Drozdz *et al.* (1998) (0.709–0.817 mm) and Lehrter *et al.* (2016) (> 0.750 mm). In contrast, *A. patriciapilittae* has a gubernaculum, and the spicules of *A. patriciapilittae* are trifurcate and much shorter (0.351–0.356 mm) (Hoberg *et al*., 2002). Thus, the detection of *A. sidemi* in white-tailed deer adds to the list of hosts of this parasite and once again confirms the continuing spread of this Asian nematode in Europe.

Teladorsagia circumcincta was found in only one of the examined white-tailed deer, and was represented by single specimen only (Table 2, the deer with number 2). This species is more typical for Bovidae, and is especially common in domestic and wild Caprinae (Wyrobisz-Papiewska *et al.*, 2018; Movsesyan *et al.*, 2019). In particular, *T. circumcincta* is a common parasite of mouflons, which are often bred on game farms (Wyrobisz-Papiewska *et al.*, 2018). Thus, it can be supposed that the examined white-tailed deer was infected with *T. circumcincta* when shared pasture with mouflons on the game farm. It should be noted that *T. circumcincta* has a cosmopolitan distribution, however, there is a hypothesis that it is actually a complex of cryptic species (Hoberg *et al.,* 2001; Wyrobisz *et al.,* 2016). *Teladorsagia circumcincta* was reported from white-tailed deer in the USA (New York), and from introduced white-tailed deer in New Zealand and Czechoslovakia (Andrews, 1973; Kotrla & Kotrly, 1977; Hoberg *et al.,* 2001).

Conclusion

The first parasitological study of white-tailed deer in Russia revealed five species of abomasal nematodes: *A. sidemi, O. leptospicularis* (including a minor morph "*O. kolchida*"), *O. mossi, S. asymmetrica* and *T. circumcincta*. The levels of the intensity of infection were relatively low. The study was conducted on farmed white-tailed deer, which obviously influenced the data obtained. *O. leptospicularis, S. asymmetrica* and *T. circumcincta* are rarely recorded in white-tailed deer, and *A. sidemi* was found in white-tailed deer for the first time. This suggests that the white-tailed deer were likely to be infected with these four species of nematodes on the game farm sharing pasture with other ruminants. *O. mossi* was found in Russia for the first time. Considering that *O. mossi* is a parasite, which associated only with white-tailed deer, it can be concluded that this nematode was introduced to Russia with it. This is the initial study of helminths of white-tailed deer in Russia, so further studies in this field are advisable.

ACKNOWLEDGEMENTS. The author expresses his deep gratitude to veterinary pathologist Alexander Khutoryanskyi, as well as for Anton Aksyonov for the sampling from white-tailed deer on the game farm. Thanks also go to Natalia Esaulova and Anton Danilkin for their participation in examination of the matrixes and preparing temporary whole mounts of the nematodes in the lab. The author is grateful to the reviewers for their time, expertise and helpful recommendations.

References

Andrews J.R.H. 1973. A host-parasite checklist of helminths of wild ruminants in New Zealand // New Zealand Veterinary Journal. Vol.21. No.3. P.43–47. DOI: 10.1080/00480169.1973.34071

Bisset S.A. 1994. Helminth parasites of economic importance in cattle in New Zealand // New Zealand Journal of Zoology. Vol.21. No.1. P.9–22. DOI: 10.1080/03014223.1994.9517972

Carreno R.A., Durden L.A., Brooks D.R., Abrams A. & Hoberg E.P. 2001. *Parelaphostrongylus tenuis* (Nematoda: Protostrongylidae) and other parasites of white-tailed deer (*Odocoileus virginianus*) in Costa Rica // Comparative Parasitology. Vol.68. No.2. P.177–184.

Davidson R.K., Dembereldagva S., Nymo I.H., Mork T., Sanchez Romano J., Porarinsdottir R., Utaaker K.S., Porisson S.G. & Tryland M. 2025. An update on gastrointestinal nematodes in reindeer (*Rangifer tarandus tarandus*) in Iceland // International Journal for Parasitology: Parasites and Wildlife. Vol.28. P.1–11. DOI: 10.1016/j.ijppaw.2025.101163

Demiaszkiewicz A.W., Kuligowska I., Lachowicz J., Pyziel A.M. & Moskwa B. 2013. The first detection of nematodes *Ashworthius sidemi* in elk *Alces alces* (L.) in Poland and remarks of ashworthiosis foci limitations // Acta Parasitologica. Vol.58. No.4. P.515–518. DOI: 10.2478/s11686-013-0164-4

Drozdz J. 1965. Studies on helminths and helminthiases in Cervidae. I. Revision of the subfamily Ostertagiinae Sarwar, 1956 and an attempt to explain the phylogenesis of its representatives // Acta Parasitologica Polonica. Vol.13. No.44. P.445–481.

Drozdz J. 1973. Materials contributing to the knowledge of the helminth fauna of *Cervus* (*Russa*) *unicolor* Kerr and *Muntjacus muntjak* Zimm.of Vietnam including two new nematode species: *Oesophagostomum labiatum* sp.n. and *Trichocephalus muntjaci* sp.n. // Acta Parasitologica Polonica. Vol.21. No.33. P.465–474.

Drozdz J. 1995. Polymorphism in the Ostertagiinae Lopez-Neyra, 1947 and comments on the systematics of these nematodes // Systematic Parasitology. Vol.32. P.91–99. DOI: 10.1007/BF00009507

Drozdz J., Demiaszkiewicz A.W. & Lachowicz J. 1998. *Ashworthius sidemi* (Nematoda, Trichostrongylidae) a new parasite of the European bison *Bison bonasus* (L.) and the question of independence of *A. gagarini* // Acta Parasitologica. Vol.43. No.2. P.75–80.

Drozdz J., Demiaszkiewicz A.W. & Lachowicz J. 2003. Expansion of the Asiatic parasite *Ashworthius sidemi* (Nematoda, Trichostrongylidae) in wild ruminants in Polish territory // Parasitology Research. Vol.89. No.2. P.94–97. DOI: 10.1007/s00436-002-0675-7

Dunn A.M. 1983. Winter deaths in red deer: A preliminary report on abomasal parasite burdens. // Publication of the Veterinary Deer Society. Vol.1. No.5. P.17–25.

Durette-Desset M.C., Hugot J.P., Darlu P. & Chabaud A.G. 1999. A cladistic analysis of the Trichostrongyloidea (Nematoda) // International Journal for Parasitology. Vol.29. No.7. P.1065–1086. DOI: 10.1016/S0020-7519(99)00028-4

Folstad I., Arneberg P. & Karter A.J. 1996. Antlers and parasites // Oecologia. Vol.105. P.556–558. DOI: 10.1007/BF00330020

Hoberg E.P., Lichtenfels J.R. & Pilitt P.A. 1993. Comparative morphology of *Ostertagia mossi* and *Ostertagia dikmansi* (Trichostrongylidae) from *Odocoileus virginianus* and comments on other *Ostertagia* spp. from the Cervidae // Systematic Parasitology. Vol.24. P.111–127. DOI: 10.1007/BF00009596

Hoberg E.P., Kocan A.A. & Rickard L.G. 2001. Gastrointestinal strongyles in wild ruminants // Samuel W., Pubis M. & Kocan A.A. (eds.). Parasitic Diseases of Wild Mammals. Ames: Iowa State University Press. P.193–227.

Hoberg E.P., Abrams A. & Carreno R. 2002. *Ashworthius patriciapilittae* n. sp. (Trichostrongyloidea: Haemonchinae), an abomasal nematode in *Odocoileus virginianus* from Costa Rica, and a new record for species of the genus in the Western Hemisphere // The Journal of Parasitology. Vol.88. No.6. P.1187–199. DOI: 10.2307/3285493

Irvine R.J., Corbishley H., Pilkington J.G. & Albon S.D. 2006. Low-level parasitic worm burdens may reduce body condition in free-ranging red deer (*Cervus elaphus*) // Parasitology. Vol.133. No.4. P.465–475. DOI: 10.1017/S0031182006000606

Ivashkin V.M., Kontrimavichus V.I. & Nazarova N.S. 1971. [Methods of Terrestrial Mammals' Helminths Collection and Study]. Moscow: Nauka. 124 p. [In Russian]

Klaschka J. & Reiczigel J. 2021. On matching confidence intervals and tests for some discrete distributions: methodological and computational aspects // Computational Statistics. Vol.36. P.1775–11790. DOI: 10.1007/s00180-020-00986-0

Kotrla B. & Kotrly A. 1977. Helminths of wild ruminants introduced into Czechoslovakia // Folia Parasitologica. Vol.24. P.35–40.

Kowal J., Nosal P., Bonczar Z. & Wajdzik M. 2012. Parasites of captive fallow deer (*Dama dama* L.) from southern Poland with special emphasis on *Ashworthius sidemi* // Annals of Parasitology. Vol.58. No.1. P.23–26.

Kuznetsov D.N. 2020. [Methodical recommendations for sampling and preserving of gastrointestinal nematodes of ruminants] // Russian Journal of Parasitology. Vol.14. No.2. P.120–124 [in Russian, with English summary]. DOI: 10.31016/1998-8435-2020-14-2-120-124

Kuznetsov D. 2022. The first detection of abomasal nematode *Ashworthius sidemi* in fallow deer (*Dama dama*) in Russia // Acta Parasitologica. Vol.67. P.560–563. DOI: 10.1007/s11686-021-00452-x

Kuznetsov D.N. 2024. Gastrointestinal nematodes of common fallow deer (*Dama dama*) in game farms in European Russia // Russian Journal of Theriology. Vol.23. No.2. P.178–186. DOI: 10.15298/rusjtheriol.23.2.07

Kuznetsov D.N., Maksimova D.A., Moskvin A.S. & Esaulova N.V. 2025a. [Parasites of sika deer in the Land of the Leopard National Park and neighboring territories] // Russian Journal of Parasitology. Vol.19. No.2. P.151–163 [in Russian, with English summary]. DOI: 10.31016/1998-8435-2025-19-2-151-163

Kuznetsov D., Romashova N. & Romashov B. 2018. The first detection of *Ashworthius sidemi* (Nematoda, Trichostrongylidae) in roe deer (*Capreolus capreolus*) in Russia // Veterinary Parasitology: Regional Studies and Reports. Vol.14. P.200–203. DOI: 10.1016/j.vprsr.2018.11.003

Kuznetsov D.N., Romashova N.B. & Romashov B.V. 2020. Gastrointestinal nematodes of European roe deer (*Capreolus capreolus*) in Russia // Russian Journal of Theriology. Vol.19. No.1. P.85–93. DOI: 10.15298/rusjtheriol.19.1.09

Kuznetsov D.N., Romashova N.B. & Romashov B.V. 2022. Species composition of gastrointestinal nematodes of moose (*Alces alces*) in European Russia // Russian

Journal of Theriology. Vol.21. No.2. P.162–168. DOI: 10.15298/rusjtheriol.21.2.07

Kuznetsov D.N., Romashova N.B., Romashov B.V. & Vlasov E.A. 2025b. Gastrointestinal nematodes of red deer (*Cervus elaphus*) in European Russia // Russian Journal of Theriology. Vol.24. No.2. P.142–153. DOI: 10.15298/rusjtheriol.24.2.07

Kuznetsov D.N., Seryodkin I.V. & Maksimova D.A. 2024. [Nematode fauna of the digestive tract of Siberian roe deer in Primorsky Krai] // Russian Journal of Parasitology. Vol.18. No.1. P.23–30 [in Russian, with English summary]. DOI: 10.31016/1998-8435-2024-18-1-23-30

Lehrter V., Jouet D., Lienard E., Decors A. & Patrelle C. 2016. *Ashworthius sidemi* Schulz, 1933 and *Haemonchus contortus* (Rudolphi, 1803) in cervids in France: integrative approach for species identification // Infection, Genetics and Evolution. Vol.46. P.94–101. DOI: 10.1016/j.meegid.2016.10.027

Loginova O.A., Spiridonov S.E., Mohagan A.B., Tolstenkov O.O. & Alieva D.S. 2025. Coprological survey of helminths in selected cervids of Southeast Asia // Russian Journal of Theriology. Vol.24. No.2. P.133–141. DOI: 10.15298/rusjtheriol.24.2.06

Maslennikov A.V. 2025. [The white-tailed deer] // Lissovsky A.A., Stakheev V.V., Saveljev A.P., Ermakov O.A., Smirnov D.G., Glazov D.M., Obolenskaya E.V., Sheftel B.I. & Titov S.V. (eds.). [Atlas of Mammal Distribution in the European Part of Russia]. Moscow: KMK Scientific Press. P.250–251 [in Russian].

Movsesyan S.O., Nikoghosian M.A., Petrosian R.A., Voronin M.V. & Kuznetsov D.N. 2019. Species diversity of nematodes in domestic and wild ruminants of Armenia // Annals of Parasitology. Vol.65. No.2. P.113–120. DOI: 10.17420/ap6502.190

Poutanen J., Wikstrom M. & Brommer J.E. 2022. White-tailed deer *Odocoileus virginianus* (Zimmermann, 1780) // Corlatti L. & Zachos F.E. (eds.). Terrestrial Cetartiodactyla. Cham, Switzerland: Springer Nature. P.277–288.

Pyziel-Serafin A., Vetter W., Klich D. & Anusz K. 2023. Exchanged communities of abomasal nematodes in cervids with a first report on *Mazamastrongylus dagestanica* in red deer // Journal of Veterinary Research. Vol.67. No.1. P.87–92. DOI: 10.2478/jvetres-2023-0015

Rehbein S., Velling M., Visser M., Heurich M. & Hamel D. 2025. Successful establishment of *Ashworthius sidemi* in red deer (*Cervus elaphus*) in Germany, with a summary of worldwide *A. sidemi* records // European Journal of Wildlife Research. Vol.71. No.1. P.1–15. DOI: 10.1007/s10344-024-01882-4

Reiczigel J., Marozzi M., Fabian I. & Rozsa L. 2019. Biostatistics for parasitologists — a primer to Quantitative Parasitology // Trends in Parasitology. Vol.35. No.4. P.277–281. DOI: 10.1016/j.pt.2019.01.003

Rickard L.G., Hoberg E.P., Allen N.M., Zimmerman G.L. & Craig T.M. 1993. *Spiculopteragia spiculoptera* and *S. asymmetrica* (Nematoda: Trichostrongyloidea) from red deer (*Cervus elaphus*) in Texas // Journal of Wildlife Diseases. Vol.29. No.3. P.512–515.

Samoylovskaya N.A., Maklakova L.P., Malakhova E.I. & Gorokhov V.V. 2014. [Effect of introduction of white-tailed deer (*Odocoileus virginianus)* on the formation of the fauna of parasites in wild ruminants] // Open Scientific Bulletin. No.1. P.1–4 [in Russian, with English summary]. DOI: 10.13140/2.1.1762.2720

Santin-Duran M., Alunda J.M., Hoberg E.P. & Fuente C. 2004. Abomasal parasites in wild sympatric cervids, red deer, *Cervus elaphus* and fallow deer, *Dama dama*, from three localities across central and western Spain: relationship to host density and park management // Journal of Parasitology. Vol.90. No.6. P.1378–1386. DOI: 10.1645/GE-3376

Saqur I., Armour J., Bairden K., Dunn A.M. & Jennings F.W. 1980. *Ostertagia leptospicularis* Asadov 1953 as a pathogen in British cattle // The Veterinary Record. Vol.107. No.22. P.511–512.

Skorpikova L., Vadlejch J., Ilgova J., Plhal R., Drimaj J., Mikulka O., Magdalek J., Kasny M. & Reslova N. 2025. Molecular uncovering of important helminth species in wild ruminants in the Czech Republic // Frontiers in Veterinary Science. Vol.12. P.1–13. DOI: 10.3389/fvets.2025.1544270

Suarez V.H., Busetti M.R., Fort M.C. & Bedotti D.O. 1991. *Spiculopteragia spiculoptera* and *Ostertagia leptospicularis* from *Cervus elaphus* in La Pampa, Argentina // Veterinary Parasitology. Vol.40. No.1–2. P.165–168.

Wyrobisz A., Kowal J. & Nosal P. 2016. Insight into species diversity of the Trichostrongylidae Leiper, 1912 (Nematoda: Strongylida) in ruminants // Journal of Helminthology. Vol.90. P.639–646. DOI: 10.1017/S0022149X15001017

Wyrobisz-Papiewska A., Kowal J., Nosal P., Chovancova G. & Rehbein S. 2018. Host specificity and species diversity of the Ostertagiinae Lopez-Neyra, 1947 in ruminants: a European perspective // Parasites & Vectors. Vol.11. No.369. P.1–10. DOI: 10.1186/s13071-018-2958-6

Wyrobisz-Papiewska A., Kowal J., Lopienska-Biernat E., Nosal P., Polak I., Paukszto L. & Rehbein S. 2021. Morphometric and molecular analyses of *Ostertagia leptospicularis* Assadov, 1953 from ruminants: species diversity or host influence? // Animals. Vol.11. No.182. P.1–17. DOI: 10.3390/ani11010182

Youssefi M.R., Hoseini S.H., Mobedi I., Hosseini S.M. & Behrang E. 2014. *Spiculopteragia asymmetrica* infection in *Cervus elaphus* from Iran // Veterinary Research Forum. Vol.5. No.1. P.77–79.