Gastrointestinal nematodes of European roe deer (Capreolus capreolus) in Russia

Dmitry N. Kuznetsov*, Natalya B. Romashova & Boris V. Romashov

ABSTRACT. The species composition of gastrointestinal nematodes parasitizing European roe deer Capreolus capreolus in Russia was studied. Fourteen individuals of C. capreolus from three regions of European Russia (Ryazan’, Tver’ and Voronezh) were examined at necropsy in the period of 2013–2019 for the nematode infections. Beside this, the species identification of nematodes collected from four individuals of C. capreolus in Voronezh State Nature Reserve in 1980s was performed. Fifteen species of nematodes were detected: Ashworthius sidemi, Bunostomum trigonocephalum, Chabertia ovina, Mazamastrongylus dagestanica, Nematodirus filicollis, Ostertagia antipini (including minor morph “Ostertagia lyrataeformis”), Ostertagia leptospicularis, Ostertagia ostertagi, Spiculopteragia asymmetrica (including minor morph “Spiculopteragia quadrispiculata”), Spiculopteragia spiculoptera, Teladorsagia circumcincta, Trichostrongylus axei, Trichostrongylus colubriformis, Trichostrongylus vitrinus and Trichuris globulosa. The biggest variety of nematodes (12 species) has been noted in abomasum. Four species (N. filicollis, T. axei, T. colubriformis and T. vitrinus) were detected both in abomasum and small intestines, but the first one prevailed in small intestines whereas Trichostrongylus spp. — in abomasum. This is the first detection of S. asymmetrica (as well as its minor morph “S. quadrispiculata”) in European roe deer in Russia. Asian nematode A. sidemi was found in two regions (Tver’ and Voronezh) in majority of roe deer individuals studied in 2013–2019, but was not found in the samples collected in 1980s, that confirms the trend for spreading of this parasite, noted in Europe last years.

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KEY WORDS: wild ruminants, Capreolus capreolus, digestive tract, parasitic nematodes, European Russia, Ashworthius sidemi, Spiculopteragia asymmetrica.

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Нематоды желудочно-кишечного тракта европейской косули (Capreolus capreolus) в России

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РЕЗЮМЕ. Определен видовой состав нематод желудочно-кишечного тракта, обнаруженных у европейской косули Capreolus capreolus в России. Нематоды были собраны в 2013–2019 гг. при вскрытиях 14 косуль из Рязанской, Тверской и Воронежской областей. Кроме того, определен видовой состав нематод от четырех косуль из сборов 1980-х гг., хранящихся в Воронежском государственном заповеднике. Обнаружены нематоды 15 видов: Ashworthius sidemi, Bunostomum trigonocephalum, Chabertia ovina, Mazamastrongylus dagestanica, Nematodirus filicollis, Ostertagia antipini (в том числе и минорная морфа этого вида — “Ostertagia lyrataeformis”), Ostertagia leptospicularis, Ostertagia ostertagi, Spiculopteragia asymmetrica (в том числе, минорная морфа — “Spiculopteragia quadrispiculata”), Spiculopteragia spiculoptera, Teladorsagia circumcincta, Trichostrongylus axei, Trichostrongylus colubriformis, Trichostrongylus vitrinus и Trichuris globulosa. Наибольшее количество видов нематод (12 видов) отмечено в сычуге. Четыре вида (N. filicollis, T. axei, T. colubriformis и T. vitrinus) были обнаружены как в сычуге, так и в тонком кишечнике, однако первый вид превалировал в тонком ки-
шечнике, а Trichostrongylus spp. — в сычуге. Впервые у европейской косули в России зарегистрирована нематода S. asymetriica (а также минорная морфа этого вида — “S. quadrispiculata”). Азиатская нематода A. sidemi обнаружена в двух областях (Тверской и Воронежской) у большинства косуль, исследованных в 2013-2019 гг, однако не была обнаружена в сборах 1980-х гг. Это подтверждает тенденцию к распространению этого паразита, отмеченную в последнее время в Европе.

КЛЮЧЕВЫЕ СЛОВА: дикие жвачные, Capreolus capreolus, пищеварительный тракт, паразитические нематоды, Европейская Россия, Ashworthius sidemi, Spiculopteragia asymetriica.

Introduction

European roe deer (Capreolus capreolus Linnaeus, 1758) is one of the most abundant species among wild ruminants in Europe (Grubb, 2005). Russia has a good potential for increasing of population of C. capreolus, but currently the population is relatively small and has about 92 thousand individuals (Danilkin, 2014). Helminth infection deteriorates the health conditions of wild ruminants (Stien et al., 2002; Irvin et al., 2006; Osinska et al., 2010) and occupies a significant place among the causes of mortality in roe deer (Aguirre et al., 1999). Data on the taxonomic composition of helminths parasitizing in C. capreolus in Russia remain insufficient. Some information on the helminths of roe deer from Russia was provided in compilations by Asadov (1960), Pryadko (1976) and Govorka et al. (1988). But these data need to be complemented and clarified because of happened changes in wildlife management and fluctuations with population of C. capreolus in Russia (Danilkin, 2014). Beside that Russian zoologists (Fleurov, 1952; Heptner et al., 1961) used to consider Siberian roe deer (Capreolus pygargus Pallas, 1771) as a subspecies of European roe deer. As a result, rather extensive information on helminths of roe deer detected in Russia during XX century (Pryadko, 1976) has been presented without separation between European and Siberian roe deers. Nowadays there was noted that populations of C. capreolus and C. pygargus overlap in European Russia (Zvyanychaya et al., 2011). Therefore, the data on helminths parasitizing C. capreolus and C. pygargus require the re-evaluation and subdivision. Some new information concerning the helminths of Siberian roe deer was obtained during study conducted in Russian Far East (Kuznetsov et al., 2014). In this context a similar study of European roe deer is useful for understanding the differences between the helminth faunas of these ruminants. Our study focused on gastrointestinal nematodes as these helminths are characterized with substantial taxonomic diversity. In addition, gastrointestinal nematodes are admitted as a group of big significance because of high rates of infection (Aguirre et al., 1999; Hoberg et al., 2001).

Material and methods

Sample collection

Nematodes were collected from 18 European roe deer in three regions of European Russia. The sampling was made in Tver’ (56°32’ N; 36°35’ E), Ryazan’ (54°20’ N; 40°50’ E) and Voronezh (51°51’ N; 39°40’ E) regions (Fig. 1). Some of the roe deer were shot licensed hunting, other were killed in road accidents or died from natural reasons. Species identification of the roe deer was conducted using morphological traits (Danilkin, 2014). Age of the animals was estimated based on teeth condition (Hoye, 2006). The roe deer were necropsied according to the method of partial helminthological dissection (Ivashkin et al., 1971). In each roe deer there were separately examined an abomasum, small and large intestine. These parts of the gastrointestinal tract were ligated at the level of pylorus, ileocecal junction and the rectum and then cut from each other. Then these parts of the gastrointestinal tract were opened and their contents together with washings of mucosa were placed into buckets. Then these matrixes were mixed with tap water (one part of matrix and 5–10 parts of water). When the precipitate has settled the supernatant was decanted. Then the precipitate was washed repeatedly with tap water until the supernatant become transparent. Finally the washed precipitate was conserved with 96% ethanol and then examined in the laboratory by small portions using binocular loupe. The precipitates have been examined in full volume. Detected nematodes were placed in vials with 96% ethanol. Beside this, we conducted the species identification of gastrointestinal nematodes from storage of Voronezh State Nature Reserve (the samples from four European roe deer collected in 1980s).

Taxonomical identification

In most cases an identification of detected nematodes was based on male’s morphology due to big similarity of the females. The nematodes were prepared as temporary whole mounts, cleared in glycerol solution (two parts of glycerol and eight parts of water) and then examined using light microscopy at magnification of 40 to 400. The species identification was carried out basing on morphological features presented in literature (Skrabin et al., 1954; Ivashkin et al., 1989; Drozd et al., 1995). The main morphological features used for the identification of gastrointestinal strongyles were the peculiarities of male reproductive system, in particular, the shape of spicules and dorsal ray. Trichuris nematodes were identified according to Ivashkin et al. (1989), Callejon et al. (2015) and Yevstafieva et al. (2018).

Molecular analysis

Several nematode specimens collected during the present study were used in molecular analysis. The DNA
study appeared successful for two males of *Ashworthius sidemi* and two males of *Spiculopteragia spiculoptera*, collected in Voronezh region and previously identified by morphological features. Genomic DNA was isolated from single specimens of nematodes using the procedure as described by Holterman *et al.* (2006). In all cases, DNA was extracted from individual specimens of the nematodes.

Polymerase chain reaction (PCR) was performed to obtain the ITS-domain of rDNA using a forward primer 18SF3 (5’-GAGAGGACTGCGGACTGCTGTATCG-3’), proposed by Yamada *et al.* (2012) and a reverse primer NC2 (5’-TTAGTTTCTTTTCCCGCT-3’), proposed by Gasser *et al.* (1993). The PCR was performed using Sileks-M DNA amplification kit (Sileks-M, Russia) in a 25 μl reaction volume according to the manufacturer’s protocol. The PCR cycling conditions consisted of an initial denaturation at 95°C for 5 min, followed by 40 cycles (95°C for 30 s, 50°C for 30 s, 72°C for 50 s) with a final extension at 72°C for 10 min. PCR products were visualised in agarose gel and then purified for sequencing using a Wizard SV Gel and PCR Clean-Up System (Promega, USA) according to the manufacturer’s protocol. Obtained PCR-products were sequenced using ABI PRISM Big Dye Terminator v.3.1 kit (Applied Biosystems, USA) with an analysis of the reaction products using automatic sequencer Applied Biosystems 3730 DNA Analyzer. Obtained sequences were compared with the NCBI GenBank nucleotide database using the BLASTn 2.8.1+ program (Morgulis *et al.*, 2008). Obtained sequences were deposited in GenBank (accession numbers are MT322612 and MT322613 for *A. sidemi*; MT322614 and MT322615 for *S. spiculoptera*).

**Results**

All studied individuals of *C. capreolus* appeared to be infected with nematodes. Rates of infection intensity and list of detected species are presented in Tab. 1. The species of nematodes are listed in alphabetical order. In total 15 species of gastrointestinal nematodes were found in the present study. Among them 11 species from the family Trichostrongylidae: *Mazamastrongylus dagestanica* (Altaev, 1953); *Ostertagia antipini* Matschulsky, 1950; *Ostertagia leptospicularis* Assadov, 1953; *Ostertagia ostertagi* (Stiles, 1892); *Spiculopteragia asymmetrica* (Ware, 1925); *Spiculopteragia spiculoptera* (Guschanskaja, 1931); *Teladorsagia circumcincta* (Stadelman, 1894); *Trichostrongylus aequi* (Cobbold, 1879); *Trichostrongylus colubriformis* (Giles, 1892); *Trichostrongylus vitrinus* Looss, 1905 and *Ashworthius sidemi* Schulz, 1933. For two of the aforementioned species (*S. asymmetrica* and *O. antipini*) their minor morphs (“*S. quadrispiculata*” and “*O. lyrataeformis*” respectively) were also detected. Besides that, there
Table 1. The intensity of infection with gastrointestinal nematodes in studied individuals of *Capreolus capreolus* and the list of detected species. A — abomasum, SI — small intestine, LI — large intestine; major and minor morphs are listed via slash.

| Sequence number of the studied European roe deer | Region of sampling | Month and year of sampling | Sex and age of hosts | Number of detected nematodes | Species of detected nematodes, localization and number of males (in brackets) |
|------------------------------------------------|--------------------|-----------------------------|----------------------|-----------------------------|---------------------------------------------------------------------|
| 1                                              | Ryazan'            | November 2013               | male, 2 years        | 71                          | Bunostomum trigonocephalum (SI-2), Chabertia ovina (LI-1), Mazamastronyulus dagestanica (A-24), Nematodirus filicollis (A-1, SI-3) |
| 2                                              | Ryazan'            | January 2014                | male, 4 years        | 57                          | B. trigonocephalum (SI-3), Ch. ovina (LI-2), M. dagestanica (A-12), N. filicollis (A-2, SI-3) |
| 3                                              | Ryazan’            | January 2019                | male, 6 years        | 1667                        | B. trigonocephalum (SI-7), Ch. ovina (LI-11), N. filicollis (A-5, SI-33), Ostertagia ostertagi (A-7), Teladorsagia circumcincta (A-21), Trichostrongylus axei (A-290, SI-27), Trichostrongylus colubriformis (A-205, SI-79), Trichostrongylus vitrinus (A-99, SI-11) |
| 4                                              | Tver’              | October 2016                | male, 1 year         | 491                         | Ashworthia sidemi (A-7), B. trigonocephalum (SI-2), Ch. ovina (LI-1), N. filicollis (A-3, SI-10), Ostertagia antipini (A-28), Ostertagia leptospicularis (A-130), Spiculopteragia asymmetrica (A-30) |
| 5                                              | Voronezh           | March 1985                  | male, years          | 392                         | B. trigonocephalum (SI-10), M. dagestanica (A-12), N. filicollis (SI-5), O. antipini (A-19), O. leptospicularis (A-113), S. asymmetrica (A-18) / “S. quadrispiculata” (A-1) |
| 6                                              | Voronezh           | April 1987                  | male, 3 years        | 510                         | B. trigonocephalum (SI-20), M. dagestanica (A-16), N. filicollis (SI-7), O. antipini (A-8), O. leptospicularis (A-56), S. asymmetrica (A-81) / “S. quadrispiculata” (A-20) |
| 7                                              | Voronezh           | April 1987                  | male, 4 years        | 1541                        | B. trigonocephalum (SI-1), M. dagestanica (A-12), N. filicollis (A-18, SI-266), O. antipini (A-129), O. leptospicularis (A-44), S. asymmetrica (A-38) / “S. quadrispiculata” (A-11), Trichuris globulosa (LI-1) |
| 8                                              | Voronezh           | December 1989               | female, 1 year       | 165                         | B. trigonocephalum (SI-1), M. dagestanica (A-10), N. filicollis (SI-2), O. antipini (A-9), O. leptospicularis (A-24), S. asymmetrica (A-6) / “S. quadrispiculata” (1) |
| 9                                              | Voronezh           | February 2017               | female, 3 years      | 143                         | M. dagestanica (A-1), N. filicollis (A-6, SI-11), O. antipini (A-34), O. leptospicularis (A-5), S. asymmetrica (A-2), Spiculopteragia spiculoptera (A-1) |
| 10                                             | Voronezh           | February 2017               | male, 2 years        | 159                         | A. sidemi (A-7), M. dagestanica (A-1), N. filicollis (A-4, SI-11), O. antipini (A-32) / “O. lyrataiformis” (A-3), S. asymmetrica (A-8), S. spiculoptera (A-5) |
| 11                                             | Voronezh           | January 2017                | male, 2 years        | 233                         | A. sidemi (A-28), M. dagestanica (A-1), N. filicollis (A-4, SI-14), O. antipini (A-13), O. leptospicularis (A-3), S. asymmetrica (A-30) / “S. quadrispiculata” (A-1) |
| 12                                             | Voronezh           | January 2018                | male, 4 years        | 156                         | A. sidemi (A-10), B. trigonocephalum (SI-1), N. filicollis (A-4, SI-37), O. antipini (A-1), T. globulosa (LI-1) |
were detected *Bunostomum trigonocephalum* (Rudolphi, 1808) (family Ancylostomatidae); *Chabertia ovina* (Fabricius, 1794) (Chabertiidae); *Nematodirus filicollis* (Rudolphi, 1802) (Molineidae) and *Trichuris globulosa* (Linstow, 1901) (Trichuridae).

For two of the detected species they taxonomic affiliation was confirmed by molecular analysis. Obtained sequences of *A. sidemi* (790 bp long contained partial 18S, complete ITS1 and 5.8S and partial ITS2 rDNA) and *S. spiculoptera* (908 bp long contained partial 18S, complete ITS1 and 5.8S and partial ITS2 rDNA) were compared with the GenBank nucleotide database using the BLAST. The sequences of *A. sidemi* showed 99.75% identity to *A. sidemi* sequence (accession number EF 467325.1) and sequences of *S. spiculoptera* showed 98.65% identity to *S. spiculoptera* sequence (accession number KP 984759.1). Additionally, before using in molecular analysis, the specimens of *S. spiculoptera* were differentiated from the morphologically close *Spiculopteragia houderemi*. The last one species has spicules joined at the end (Drozdz, 1965), whereas *S. spiculoptera* has separated spicules.

**Discussion**

Most of the studied individuals of *C. capreolus* showed rather big species diversity of nematodes (Tab. 1). The maximum number of the nematode species registered in one individual was eight, minimum number was four and mean was 5.7. The similar level of the diversity was noted in previous studies of *C. capreolus* conducted in various European countries (Dunn, 1965; Bernard et al., 1988; Borgensteede et al., 1990; Drozdz et al., 1992; Aguirre et al., 1999; Cisek et al., 2003; Kuzmina et al., 2010; Pato et al., 2013; Demiaszkiewicz et al., 2017). We tend to explain this diversity by the peculiarities of roe deer behavior, such as abilities for long-distance movements and co-pasturing with other ruminants (Danilkin, 2014). The intensity of infection varied from rather low numbers, such as 57 specimens of all detected species (in four-year age male from Ryazan’) to significant burden with 4896 specimens (in one-year age male from Voronezh).

*Nematodirus filicollis* (Rudolphi, 1802) showed the highest rates of the intensity and extensity of infection in the present study (Tabs. 1, 2). Similar data were obtained during studies of *C. capreolus* in Britain (Dunn, 1965), Belgium (Bernard et al., 1988), Spain (Pato et al., 2013) and Turkey (Bolukbas et al., 2012). It worth to mention, that Khristalev (2009) has revealed, based on revision of *Nematodirus* spp. from Russia, that *N. filicollis* is a typical parasite for roe deer, while in other hosts it was often reported erroneously.

The high prevalence has been detected as well for *Os tertagia antipini* Matschulski, 1950 and *Os tertagia leptospicularis* Assadov, 1953 (Tab. 2). The last one is widespread among wild and domestic ruminants in

| Sequence number of the studied European roe deer | Region of sampling | Month and year of sampling | Sex and age of hosts | Number of detected nematodes | Species of detected nematodes, localization and number of males (in brackets) |
|-------------------------------------------------|---------------------|---------------------------|----------------------|-----------------------------|------------------------------------------------------------------|
| 13                                              | Voronezh            | February 2018             | male, 3 years        | 387, 157, 230               | *A. sidemi* (A-39), *N. filicollis* (A-2, SI-17), *O. antipini* (A-3), *O. leptospicularis* (A-3), *S. asymmetrica* (A-10), *T. colubriformis* (A-70, SI-12), *T. globulosa* (LI-1) |
| 14                                              | Voronezh            | March 2018                | male, 1 year         | 4896, 2078, 2818            | *A. sidemi* (A-243), *N. filicollis* (A-65, SI-1710), *O. antipini* (A-5), *O. leptospicularis* (A-3), *T. colubriformis* (A-32, SI-10), *T. globulosa* (LI-10) |
| 15                                              | Voronezh            | March 2018                | female, 2 years      | 864, 210, 654               | *N. filicollis* (A-18, SI-138), *O. antipini* (A-30), *O. leptospicularis* (A-16), *T. globulosa* (LI-8) |
| 16                                              | Voronezh            | March 2018                | male, 4 years        | 210, 49, 161                | *A. sidemi* (A-2), *N. filicollis* (A-6, SI-17), *O. antipini* (A-15), *O. leptospicularis* (A-5), *T. globulosa* (LI-4) |
| 17                                              | Voronezh            | April 2018                | female, 3 years      | 95, 33, 62                  | *A. sidemi* (A-2), *N. filicollis* (A-3, SI-11), *O. antipini* (A-14), *O. leptospicularis* (A-3) |
| 18                                              | Voronezh            | April 2018                | male, 2 years        | 2578, 602, 1976             | *A. sidemi* (A-501), *N. filicollis* (A-19, SI-65), *O. antipini* (A-10), *O. leptospicularis* (A-4), *T. globulosa* (LI-3) |
Europe (Wyrobisz-Papiewska et al., 2018). In contrast with that, the data on occurrence of *O. antipini* limited with small number of countries and host species (Govorka et al., 1988; Kuznetsov et al., 2014; Wyrobisz-Papiewska et al., 2018). We believe that specimens of *O. antipini* and *O. leptospicularis* in some cases cannot be accurately differentiated from each other due to big morphological similarity. We agree with Wyrobisz-Papiewska et al. (2018), that *O. leptospicularis* may represent a potential species complex.

*Spiculopteragia asymmetrica* (Ware, 1925) was found in nine of the studied roe deer from Tver’ and Voronezh regions (Tab. 2). In five cases the minor morphs of this species (“S. quadruplicata”) were also detected. A small number of specimens of *Spiculopteragia spiculoptera* (Guschanskaja, 1931) were found in two roe deer from Voronezh, in both cases together with *S. asymmetrica* (Tabs. 1, 2). The males of these two species could be easily differentiated from each other based on morphology of distal parts of the spicules, therefore this detection is not on doubt. Thus, we note a possibility of simultaneous parasitizing of *S. asymmetrica* and *S. spiculoptera*. Zaffaroni et al. (2000) consider *S. spiculoptera* along with *O. leptospicularis* as a dominant species in Cervids. A survey by Rossi et al. (1997) also showed that *S. spiculoptera* and *O. leptospicularis* were the dominant abomasal species of European roe deer. Similar results have been got by Dunn (1965), Bernard et al. (1988), Bolukbas et al. (2012) and Pato et al. (2013). Our data confirm the high importance of *O. leptospicularis*, but the levels of prevalence and abundance of *S. spiculoptera* were low. On the other hand, we noted quite high prevalence of *S. asymmetrica* registered in two regions (Tver’ and Voronezh). In European roe deer *S. asymmetrica* was previously registered in Britain (Dunn, 1965), Belgium (Bernard et al., 1988) and Spain (Morrondo et al., 2010). Mazamastrongylus dagestanica (Altaev, 1952) was detected in 50% of the studied roe deer from two regions (Tab. 2). At the same time, the intensity of infection with *M. dagestanica* was rather low (Tab. 1). Apparently, roe deer were infected with *M. dagestanica* when sharing the territory with elk, which is the obligate host for this parasite (Wyrobisz-Papiewska et al., 2018). In European roe deer *M. dagestanica* was registered in Poland (Wyrobisz-Papiewska et al., 2018). Recently *M. dagestanica* was reported in Siberian roe deer from Russian Far East (Kuznetsov et al., 2014).

**Table 2.** The extensity of infection with gastrointestinal nematodes in studied individuals (*n*=18) of Capreolus capreolus.

| Nematode species                  | Regions of detection | The number of infected animals | Extensity of infection (%) |
|-----------------------------------|----------------------|--------------------------------|----------------------------|
| Ashworthius sidemi                | Tver’, Voronezh       | 9                              | 50.0                       |
| Bunostomum trigonocephalum        | Ryazan’, Tver’, Voronezh | 9                            | 50.0                       |
| Chabertia ovina                   | Ryazan’, Tver’        | 4                              | 22.2                       |
| Mazamastrongylus dagestanica      | Ryazan’, Voronezh     | 9                              | 50.0                       |
| Nematomorpha filicollis           | Ryazan’, Tver’, Voronezh | 18                            | 100.0                      |
| Ostertagia antipini               | Tver’, Voronezh       | 15                             | 83.3                       |
| Ostertagia leptospicularis        | Tver’, Voronezh       | 13                             | 72.2                       |
| Ostertagia ostertagi              | Ryazan’               | 1                              | 5.6                        |
| Spiculopteragia asymmetrica       | Tver’, Voronezh       | 9                              | 50.0                       |
| Spiculopteragia spiculoptera      | Voronezh              | 2                              | 11.1                       |
| Teladorsagia circumcincta         | Ryazan’               | 1                              | 5.6                        |
| Trichostrongylus asei             | Ryazan’               | 1                              | 5.6                        |
| Trichostrongylus colubriformis     | Ryazan’, Voronezh     | 3                              | 16.7                       |
| Trichostrongylus vitrinus          | Ryazan’               | 1                              | 5.6                        |
| Trichuris globulosa               | Voronezh              | 7                              | 38.9                       |

On the other hand, we noted quite high prevalence of *S. asymmetrica* registered in two regions (Tver’ and Voronezh). In European roe deer *S. asymmetrica* was previously registered in Britain (Dunn, 1965), Belgium (Bernard et al., 1988) and Spain (Morrondo et al., 2010).
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parts of the world (Govorka *et al.*, 1988). Yevstafieva *et al.* (2018) reported this nematode in south-eastern regions of Ukraine neighboring with Voronezh region.  

*Chabertia ovina* (Fabricius, 1788) noted in four roe deer from two regions (Tab. 2). The number of males of *C. ovina* ranged from 1 to 11, and the number of females ranged from 2 to 15 individuals. This nematode is known to be quite common in domestic and wild ruminants. In *Capreolus capreolus* this nematode reported in Sweden (Aguirre *et al.*, 1999), Britain (Dunn, 1965), Belgium (Bernard *et al.*, 1988), Netherlands (Borgsteede *et al.*, 1990), Poland (Drozdz *et al.*, 1992), Belarus (Shimalov & Shimalov, 2003), Ukraine (Kuzmina *et al.*, 2010), Spain (Pato *et al.*, 2013), Turkey (Bolukbas *et al.*, 2012), Armenia (Movsesyan *et al.*, 2019) and Romania (Horn *et al.*, 2017).  

We found three species of the genus *Trichostrongylus*, in all cases with rather high intensity (Tab. 1). *Trichostrongylus colubriformis* (Giles, 1892) was detected in two roe deer from Voronezh and one from Ryazan’ (Tabs. 1, 2). In Voronezh *T. colubriformis* was found only in recently collected samples, but was not found in the samples collected in 1980s. *Trichostrongylus axei* (Cobbold, 1879) and *Trichostrongylus vitrinus* (Looss, 1905) were found in one individual of *C. capreolus* which has been hunted near agricultural area in Ryazan’ region. This individual of *C. capreolus* showed the highest species diversity (eight species of nematodes) in the present study. We tend to explain it because of contacts among *C. capreolus* and domestic ruminants. The detected species of *Trichostrongylus* are widespread among domestic and wild ruminants, and have been reported from the areas with different climatic conditions (Skrijabin *et al.*, 1954; Govorka *et al.*, 1988). In particular, these three species of *Trichostrongylus* reported from *C. capreolus* in Sweden (Aguirre *et al.*, 1999), Italy (Zaffaroni *et al.*, 2000), Spain (Pato *et al.*, 2013), Turkey (Bolukbas *et al.*, 2012) and Armenia (Movsesyan *et al.*, 2019).  

*Ostertagia ostertagi* (Stiles, 1892) as well as *T. circumcincta* (Stadelmann, 1894) was detected in one individual of European roe deer only (Ryazan’ region). These species are more typical for Bovidae (Wyrobis-Papiewska *et al.*, 2018) and this roe deer was supposedly infected when sharing pastures with domestic ruminants. Interestingly, that Drozdz *et al*. (1992) in north-eastern Poland found *O. ostertagi* in roe deer in all seasons except winter, but our finding of *O. ostertagi* was made in January.  

Thus, all nematode species found in the present study have already been reported from *C. capreolus* in various European countries. Most species of nematodes detected in the present study were also previously noted in other wild ruminants (such as elk and red deer) inhabiting European Russia and neighboring countries (Govorka *et al.*, 1988). However, *S. asymmetrica*, as well as its minor morph (“*S. quadrispiculata*”) was never previously found in European roe deer in Russia. *Ashworthius sidemi* was detected in *Capreolus capreolus* in Russia for the first time by Kuznetsov *et al.* (2018) based on the necropsies of three roe deer conducted in 2016–2017. In the present study we supplement the data concerning *A. sidemi* with results of necropsies of *C. capreolus* conducted in 2018, and two of the studied roe deer appeared to be infected with rather high intensity numbering several hundred specimens of *A. sidemi*. Four species of gastrointestinal nematodes, which we found in the present study (*T. circumcincta*, *T. axei*, *T. colubriformis* and *T. vitrinus*) are considered to be zoontic (Skrijabin *et al.*, 1954; Mizani *et al.*, 2017).  

Four species of gastrointestinal nematodes (*N. filicollis*, *O. antipini*, *S. spiculoptera* and *M. dagestanica*) detected in the present study were reported for Siberian roe deer as well (Kuznetsov *et al.*, 2014). *M. dagestanica* showed similar infection rates both for *C. capreolus* and *C. pygargus*. *S. spiculoptera* was found in *C. pygargus* with an average of 173 specimens per animal, but in *C. capreolus* we found this nematode in low numbers. On the contrary, *N. filicollis* and *O. antipini* were found in low numbers in Siberian roe deer. In addition to the above mentioned, three other species of gastrointestinal nematodes (*Oesophagostomum venulosum* (Rudolph, 1809), *Pygarginema skrjabini* Kadenazii, 1948 and *Spiculopteragia schulzi* (Rajewskaja, 1930)) were reported from Siberian roe deer (Oshmarin & Parukhin, 1963; Kuznetsov *et al.*, 2014). Thus, the species composition of gastrointestinal nematodes of *C. pygargus* appears to be less diverse and coincides with that of *C. capreolus* in four species only.  

The biggest variety of nematode species we detected in an abomasum (Tab. 1). Here were found twelve species and two of these species (*S. asymmetrica* and *O. antipini*) were presented with their major and minor morphs. Four species (*N. filicollis*, *T. axei*, *T. colubriformis* and *T. vitrinus*) were detected both in abomasum and small intestines, but the first one prevailed in small intestines whereas *Trichostrongylus* spp. was more abundant in abomasum.  

**Conclusion**  

The helminthological study of *C. capreolus* from Russia detected rather high species diversity of gastrointestinal nematodes. Most of the detected nematode species are common both for European roe deer and other aboriginal wild ruminants (elk, red deer) habituating this area. In some cases the helminth fauna of *C. capreolus* was added with species more typical for domestic ruminants. One of the detected species, *Spiculopteragia asymmetrica* (as well as its minor morph “*S. quadrispiculata*”), has been reported in European roe deer in Russia for the first time. The detection of *Ashworthius sidemi* with rather high intensity and extensity of infection confirms the trend of spreading this Asian nematode among aboriginal ruminants in Europe. The presence of zoontic nematodes (*T. circumcincta*, *T. axei*, *T. colubriformis* and *T. vitrinus*) in the helminth fauna of *C. capreolus* deserves a special attention.  

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