Morphological characteristic of *Skrjabinema ovis* (Nematoda, Oxyuridae) obtained from domestic sheep

V. V. Melnychuk*, O. I. Reshetylo**

*Poltava State Agrarian Academy, Poltava, Ukraine
**Sumy National Agrarian University, Sumy, Ukraine

Introduction

The main aim of sheep farming is a full utilization of the biological potential of meat, wool and dairy productivity of sheep breeds (Rasalli et al., 2006; Banerjee et al., 2009; Anteneh & Yadav, 2017). One of the approaches used is careful monitoring and prediction of the parasitological situation, the implementation of measures for the prevention and treatment of invasive diseases, especially nematodes of the gastrointestinal tract of sheep. It is well-known that the biotic, abiotic and technological factors directly affect the activity of epizootic processes of animal helminthiases, including those of sheep (Vlassoff et al., 2001; Tariq et al., 2008; Roeber et al., 2013; Ibrahim et al., 2014; Boyko et al., 2016; Zazharska et al., 2018).

Sheep helminths are widely prevalent and form parasitic systems with multiple levels of protection. They cause infectious diseases that are stable and endemic in various countries in most of the natural climatic zones. There are reports of significant prevalence of the parasite *Skrjabinema ovis* (Skrjabin, 1915) nematodes in sheep. Thus, the prevalence of *S. ovis* in sheep ranged 2.2–12.0%. The maximum infection rates were found in the 1.0–1.5 year old age group (Bahadori et al., 2007; Naem & Gorgani, 2008). In total, 5723 adult *S. ovis* nematodes were collected, 1981 of which were males and 3742 were females. Sexual dimorphism was found in both in metric and morphological parameters. The size dimorphism is characterized by values larger by 43.9–64.6% of 11 parameters in females compared to males. The differential characters of mature *S. ovis* males and females are morphological specifics of the mouth organ complex and the distribution of cuticular formations on the head end of the parasite. The lips of the female nematodes are anchor-shaped and adorned with tooth-like lamellae, and the lips of the males are oval and lack the tooth-like lamellae. Cuticular nodes on the head ends of the females are considerably longer and wider than in the males. The species-specific morphological characters of the males are the features of morphology and sizes of the pseudo-bursa, the shape and length of the spicule and gubernaculum, and their width parameters in different areas. In the identification of females, the morphology of the vulva and tail end, and the metric parameters of the location of the vulva, anus, and sizes of eggs in the uterus should be considered. Additional metric and morphological parameters are presented for use in the differentiation of males and females for better identification.

Keywords: skrjabinemiosis; helminths; differential characters; metric parameters.

**Regulatory Mechanisms in Biosystems**

ISSN 2519-8521 (Print)
ISSN 2520-2588 (Online)
Regul. Mech. Biosyst., 2020, 11(3), 378–383. doi:10.15421/022058
valva location and egg size while in the uterus are taken in consideration. There are also suggestions for using the length and width of the body, bulb, esophagus, and wing-like formations on the head end. However, the reported data on the metric parameters of *S. ovis* are scarce and rather variable (Abdussalam, 1938; Skrjabin et al., 1960; Andrews, 1969). Thus, a morphometric study of *S. ovis*, obtained from sheep, would have scientific and practical value, because of the new data on the species identification of these parasites, and enhanced diagnostics of skrjabinemosis.

The aim of the present work was to study the differential morphological and metric parameters of the adult males and females of *S. ovis* nematodes, obtained from sheep (*Ovis aries*).

Materials and methods

Parasitological analysis of *S. ovis* nematodes was conducted in 2015–2020. The helminths were obtained during helminthological investigation of the large intestine of 710 domestic sheep (Skrjabin, 1928) from sheep farms in Kyiv, Poltava and Zaporizhzhia regions (Central and South-Eastern Ukraine). After collection from the intestine, the nematodes were washed in 0.9% solution of NaCl and fixed according to standard technique in 70% ethanol (Ivashkin et al., 1971). Roundworm species were identified by morphological features according to (Skrjabin et al., 1960; Ivashkin et al., 1998). In total, 5723 adult *S. ovis* nematodes were collected, 1981 of which were males and 3742 were females.

The metric parameters of adult *S. ovis* roundworms were measured using ImageJ for Windows® (version 2.00) in interactive mode using ×5, ×10, ×40, ×100 objectives and ×10 photo eyepiece. To calibrate the image analyzer, the ruled scale of an ocular micrometer was coincided with the scale of the stage micrometer included in a MikroMed microscope kit. Photomicrographs were taken using a 5 Mpx digital camera mounted on the MikroMed (China) microscope.

Standard deviation (SD) and mean values (x) were calculated. Reliability of the differences in mean values for the studied groups of nematodes was determined by the method of one-way analysis of variance using the Fisher test, with P < 0.05 level of significance.

Results

The nematodes of the species *S. ovis* (Skrjabin, 1915) are characterized by significant morphological sexual dimorphism. The body of the female nematode is white, filiform, slightly tapered to the head end and more tapered to the tail end. The male roundworms have hook-shaped bodies, with a straight anterior part and bent posterior part (Fig. 1).

![Fig. 1. General view of *Skrjabinema ovis*](image)

The head end of male and female *Skrjabinema* nematodes has two lateral wing-shaped cuticular nodes. Their bases are located at the lip bases, and their ends at the esophagus area. More narrow cuticular wings are located posterior to them. Those run along the lateral lines of the body and end in the area between the anus and the tail end. The mouth opens into the esophagus, which is divided into two clearly distinct parts: cylindrical anterior and behind that the spherical bulbus. We have observed that the wing-shaped nodes are significantly narrower and shorter in males than in females (Fig. 2).

The head end of *S. ovis* is adorned with a complex formation of mouth organs. The mouth opening is surrounded by three symmetrical large lips. Each lip consists of the median and two lateral parts. The median part of each lip extrudes above the mouth ring and branches into anterior and posterior wedges. These wedges are divided by a deep indentation, hence the illusion of six lips. The anterior wedge of each lip consists of two parts which make up a pyramid, pointed anteriorly. The narrow sides of pyramids face outwards, and the wider sides are positioned to the inside and laterally to mouth opening. The lips of males and females are morphologically different. In females, lips are anchor-shaped, and there are single pairs of tooth-like lamellae, pointed to the centre of the mouth opening, on their inner sides. The lips of males are oval and lack the tooth-like lamellae (Fig. 3).

Aside from the morphological specifics, there are significant metric differences in the sexual dimorphism of *S. ovis*. By 11 parameters, the females were significantly (F < 0.001) larger than males (Table 1).

| Parameters                                         | ♂     | ♀     |
|----------------------------------------------------|-------|-------|
| Length of body, mm                                  | 3.1 ± 0.2 | 6.3 ± 0.5*** |
| Length of the lateral cuticular nodes, μm           | 100.1 ± 7.1 | 282.9 ± 12.6*** |
| Width of body in the area of, μm                    | 552.6 ± 35.2 | 552.6 ± 35.2*** |
| Total length of esophagus, μm                       | 379.0 ± 10.5 | 731.1 ± 22.6*** |
| Length of anterior cylindrical part of esophagus, μm| 279.1 ± 7.5 | 552.6 ± 35.2*** |
| Width of anterior cylindrical part of esophagus in  | 36.6 ± 2.8 | 71.1 ± 3.4*** |
| the middle, μm                                      |       |       |
| Length of esophagus at the transition from the      | 23.9 ± 19 | 54.9 ± 4.1*** |
| anterior cylindrical part to the posterior bulbous  |       |       |
| part, μm                                            |       |       |
| Length of bulbus, μm                                | 99.8 ± 10.4 | 178.4 ± 29.4*** |
| Width of bulbus, μm                                 | 86.5 ± 29 | 154.2 ± 58.8*** |
| Ratio of the lengths of the anterior cylindrical    | 2.8 : 1 | 3.2 : 1   |
| part of esophagus to the posterior bulbous part     |       |       |

Note: ***- P < 0.001 – compared to values of ♂ *S. ovis*.

Thus, the body length of females was 6.3 ± 0.5 mm, which was larger by 50.7% than in males (6.3 ± 0.5 mm). Accordingly, the females were wider in the lip area, at the cuticular node area and in the middle of body by 52.9-57.4% than males. The parameters of length of lateral cuticular nodes at the head end of the nematodes were larger in females by 64.6%, which is confirmed by morphological studies, too. The esophagus was significantly larger in females than in males. It was longer by 48.1%. The length of the anterior cylindrical part of the esophagus in females was 552.6 ± 35.2 μm (longer by 49.4% than in males), and the length of the posterior bulbous part of the esophagus in females was 178.4 ± 29.4 μm (longer by 44.0% than in males). The width parameters of esophagus in females were also higher than in males, in the middle of the anterior cylindrical part by 48.5%, at the transition of that part into the bulbous part by 56.4%, and in the middle of the bulbus by 43.9%. Thus, the ratio of the length of anterior part of esophagus to the posterior one was 3.2 : 1 in males, and 2.8 : 1 in females.

The specific morphological characters of *S. ovis* males include the morphological features of pseudobursa, spicule, gubernaculum (Fig. 4), and their metric parameters (Table 2).

The tail end of *Skrjabinema* males ends with the pseudobursa, which consists of membrane, terminal tail protrusion, and one pair of pre-anal and one pair of post-anal ribbed papillae. Their apexes are shaped like coronas with three conic processes. The parameters of length and width of pseudobursa were 185.6 ± 15.5 and 120.7 ± 8.0 μm, respectively, their ratio was 1.5 : 1, i.e. pseudobursa is elongated. The morphological features of males also include the presence of one pair of elongated, stalk-shaped post-anal papillae between the tail protrusion and the anus. There are small spicule in the cloacal area, which support pseudobursa. There is one spicule 94.4 ± 4.6 μm in length, arrow-shaped. The spicule lies in the groove of the gubernaculum, the mean length of which was 24.4 ± 2.1 μm. In the identification of this species, we also suggest using the parameters of width at the proximal end of the spicule (5.7 ± 0.2 μm) and in the middle of the spicule (4.4 ± 0.2 μm), and the parameters of width of the proximal end of the gubernaculum (5.3 ± 0.1 μm) and in its middle (4.0 ± 0.4 μm).

Regul. Mech. Biosyst., 2020, 11(3)
Fig. 2. Head end of *Skrjabinema ovis*: a – ♀, b – ♂; CN – cuticular nodes, LW – lateral wings, CE – cylindrical part of esophagus, BE – posterior part of esophagus, spherical bulbus.

Fig. 3. Mouth organs of *Skrjabinema ovis*: a – ♀, b – ♂; L – lips, AS – anchor-shaped lips, I – indentation between the anterior and posterior lip wedges, TL – tooth-like lamella.

Fig. 4. Head end of ♀ *Skrjabinema ovis*: Pb – pseudobursa, RP – ribbed papilla, S – spicule, Sp – proximal end of spicule, Sd – distal end of spicule, G – gubernaculum, PP – post-anal papilla, CP – conic protrusions on the ribbed papilla, TP – tail protrusion.
The specific morphological characters of the females include the specific metrics of the vulva area, tail end, and shape of eggs in the uterus (Fig. 5), and their metric parameters (Table 3).

The tails of females are pointed and conical. Their copulatory apparatus is unpaired, and consists of one ovary, uterus, vagina and vulva. The vulva is slit-like, positioned as a pyramid on a slight elevation. The uterus (Fig. 5), and their metric parameters (Table 3).

The specific morphological characters of S. ovis females include the specific metrics of the vulva area, tail end, and shape of eggs in the uterus (Fig. 5), and their metric parameters (Table 3).

The tails of females are pointed and conical. Their copulatory apparatus is unpaired, and consists of one ovary, uterus, vagina and vulva. The vulva is slit-like, positioned as a pyramid on a slight elevation. The uterus (Fig. 5), and their metric parameters (Table 3).
In our study, additional parameters were found that will help better identification of S. ovis by males and females. The sexual dimorphism in S. ovis nematodes is significant, and the females are significantly (P < 0.0001) larger by 11 parameters than males. We also described the morphological differences between the male and female roundworms. They are found in the structure of mouth organs: lips of females are anchor-shaped and have one pair of tooth-like lamellae on their inner side. The lips of males are oval and lack the tooth-like lamellae. Similar morphological differences of the lips have been described in another study (Skjabin et al., 1960). We also suggest taking into account the shape and size of cuticular nodes at the head end: they are notably wider and longer in females than in males. We have not found any reports of such differences in S. ovis in previous publications.

We also suggest taking into account the metric parameters of S. ovis. Nine parameters are of interest in males, namely: length and width of the pseudobursa, ratio of these parameters, length of the spicule, width of the spicule at the proximal end and in the middle, length of the gubernaculum, width of the gubernaculum at the proximal part and in the middle. In females, seven parameters are notable: width of the body in the vulva area and anus area, distances from vulva to head end and from vulva to tail end and the ratio of these distances, distance from anus to tail end, and distance from vulva to anus. Scientific publications mention only a few scarce parameters, including the morphometric specifics of males and females. Those include length and width of body, length of esophagus, diameter of bulbus, distance from vulva to head and tail ends, lengths of spicule and gubernaculum (Shahlapoor, 1965; Ivashkin et al., 1998). We suggest also measuring the egg length and width, and eggshell thickness. The specific morphology of eggs is given in the identification keys, which mention the elliptical asymmetric shape of eggs (Andrews, 1969; Anderson, 2000), confirmed in our studies too.

The conducted morphological studies show that the morphological specifics of the pseudobursa, the presence and number of papillae that support the membrane, the position and shape of spicule and gubernaculum can be considered as differential characteristics of the species. In females, the morphology of the vulva and shape of the tail end should be considered. The importance of such parameters in identification of S. ovis nematodes has been pointed out in several publications where a number of differential features of the copulatory apparatus have been described for male and female roundworms (Schad, 1957; Skjabin et al., 1960; Ivashkin et al., 1998).

The additional suggested morphometric parameters that can be used in differentiation of male and female S. ovis will enhance the efficiency of their identification.

Conclusion

It is established that the morphological and metric parameters of males and females should be considered in the species identification of Skrjabininae ovis Skjabin, 1915 nematodes. The sexual dimorphism in S. ovis is significant and distinct, the females are larger by 11 parameters than males. We also found differences in the morphology of the mouth organs and cuticular nodes at the head ends of the male and female parasites.

Nine metric parameters are suggested in males, characterizing the structure of the pseudobursa, spicule, gubernaculum and the body sizes in the area of the copulatory apparatus. The morphology of the pseudobursa, which includes a complex structure of papillae as its base, is typical. In females, seven parameters are suggested relating to the position of vulva, anus, and body sizes at those areas. The morphological criterion of differentiation of females is the specifics of vulva and tail end shapes. Additional characters for the taxonomical examination of S. ovis may include the metric and morphological parameters of their eggs, such as shape, structure, length, width and eggshell thickness.

References

Abdelnabi, G. H., Elwasi, E. E., & Abdalla, H. S. (2005). Some helminths from the gastrointestinal tract of sheep in the Sudan. Sudan Journal of Veterinary Research, 20, 87–88.
Abdissalam, M. (1938). On the occurrence of Skrjabininae ovis (Skrjabin, 1915) in India. Proceedings of the Indian Academy of Sciences, 8, 15–17.

Anderson, R. C. (2000). Nematode parasites of vertebrates: Their development and transmission. 2nd ed. CAB International, Wallingford, Oxford.
Andrews, J. R. H. (1969). A guide to the identification of helminth parasites recorded from wild ruminants in New Zealand. Transactions of the Royal Society of New Zealand, 97(2), 67–81.
Antonchine, W., & Yadav, K. R. (2017). A review of sheep production system, yield, quality and preservation methods in Ethiopia. Greener Journal of Agricultural Sciences, 7(9), 243–254.
Arifjanarvankian, A. V., Nachimuthu, S., Tang, T. Y., Courtney, E. D., Harris, S. A., & Harris, A. M. (2010). Enterostrongylus vermiformis: infestation of the appendix and management at the time of lraposcopic appendectomy: Case series and literature review. International Journal of Surgery, 8, 466–469.
Baldahori, S., Elamin, A., & Aghabehrami-Samani, R. (2007). Study on parasitic infection of the domestic ruminants in Golestan province. Journal of Veterinary Research, 62(5), 303–307.
Balbo, T., Costantini, R., Gallo, M. G., & Lianfunchi, P. (1977). Sulla diffusione dei nematodi parassiti dell'apparato digerente in pecore (Ovis aries) e in capre (Capra hircus) dell'arco alpino piemontese e valdostano. Parasitologia, 19(1–2), 59–61.
Banerjee, R., Mandal, P. K., Bose, S., Banerjee, M., & Manna, B. (2009). Quality evaluation of meat, skin and wood from Garole sheep – a promising breed from India. Asian Journal of Animal Sciences, 3, 39–46.
Bellem, A., Kaboby, A., & Besoin, R. (2005). Gastrointestinal helminthes of sheep in the central, eastern and northern parts of Burkina Faso. Bulletin of Animal Health and Production in Africa, 53(1), 13–23.
Boydo, O. O., Zuzhanka, N. M., & Brygadyenskij, V. V. (2016). The influence of the extent of infestation by helminthes upon changes in body weight of sheep in Ukraine. Visnyk of Dnipropetrovsk University, Biology, Ecosy, 24(1), 3–7.
Carreno, R. A. (2014). The systematics and evolution of pinworms (Nematoda: Oxyurida: Thelostomatoidea) from invertebrates. Journal of Parasitology, 100(5), 553–560.
Castagnone-Sereno, P., & Danchin, E. G. (2014). Parasitic success without sex – the nematode experience. Journal of Evolutionary Biology, 27(7), 1332–1333.
De Souza, M., Pimentel-Neto, M., da Silva, R. M., Farias, A. C., & Guimaraes, M. P. (2012). Gastrointestinal parasites of sheep, municipality of Lajes, Rio Grande do Norte, Brazil. Revista Brasileira de Parasitologia Veterinaria, 21(1), 71–73.
Farooq, Z., Mustaq, S., Iqbal, Z., & Altar, A. (2012). Parasitic helminthes of domicitized and wild ruminants in Cholistan desert of Pakistan. International Journal of Agriculture and Biology, 14(1), 63–68.
Hugot, J. P., Gardner, S. L., & Morand, S. (1996). The Enterobiniae subfam. nov. (Nematoda, Oxyurida) pinworm parasites of primates and rodents. International Journal for Parasitology, 26(2), 147–159.
Ibrahim, N., Teften, M., Bekele, M., & Alemu, S. (2014). Prevalence of gastrointestinal parasites of small ruminants in and around Jimma Town Western Ethiopia. Acta Parasitologica, 5, 26–32.
Ivashkin, V. M., Korotminovichus, V. L., & Nazarova, N. S. (1971). Methods for collection and study of helminthes of terrestrial mammals [Metody sbora i izucheniya gel'mintov nazemnyh pozvonochnyh]. Nauka, Moscow (in Russian).
Ivashkin, V. M., Oripov, A. O., & Sonin, M. D. (1998). The key to helminthes of small cattle [Oprereditel' gel'mintov malykh rogatykh skotov]. Nauka, Moscow (in Russian).
Kim, D. H., Cho, M. K., Park, M. K., Kang, S. A., Kim, B. Y., Park, S. K., & Yu, H. S. (2013). Environmental factors related to enterobiasis in a southeast region of Korea. The Korean Journal of Parasitology, 51, 139–142.
Li, Y., Chen, H. X., Yang, X. L., & Li, L. (2019). Morphological and genetic characterization of Syphacia obvelata (Akhuba, 1962) (Nematoda: Oxyuridae), with phylogenetic position of Syphacia in Oxyuridae: Infection, Genetics and Evolution, 67, 159–166.
Lok, J. B. (2016). Signaling in parasitic nematodes: Physiocommunication between host and parasite and endogenous molecular transduction pathways governing worm development and survival. Current Clinical Microbiology, 3(4), 186–197.
Naem, S., & Gorgani, T. (2011). Gastrointestinal parasitic infection of slaughtered sheep (Zel breed) in Ferioudokener city, Iran. Veterinary Research Forum, 2(4), 238–241.
Poppikole, M., Hildebrand, J., & Zalesky, G. (2009). Morphology and taxonomy of Rodentostomys australis (Quentin et Terwast, 1974) (Nematoda: Oxyurida: Enterostrongylinae) with notes on molecular phylogeny. Annales Zoologici, 59(4), 415–421.
Rassai, D. P., Shrestha, J. N. B., & Crow, G. H. (2006). Development of composite sheep breeds in the world: A Review. Canadian Journal of Animal Science, 86(1), 1–24.
Roeber, F., Jex, A. R., & Gasser, R. (2013). Impact of gastrointestinal parasitic nematodes of sheep, and the role of advanced molecular tools for exploring epidemiology and drug resistance – an Australian perspective. Parasites and Vectors, 6, 153.
Ruiz de Ybarrol, M. R., Guarro, M. J., Balanza, P., & Alonso, F. (1999). Parasitos del intestino grueso del ganado ovino en la region de Murcia. Anales de Veterinaria de Murcia, 15, 25–36.
Schad, G. A. (1957). Preliminary observations of the life history of the sheep pinworm, *Skrjabinema ovis*. Journal of Parasitology, 43, 13.

Shahlapoor, A. A. (1965). A note on the identification of *Skrjabinema ovis* (Skrjabin, 1915) and *Trichostrongylus* spp. in sheep and goats in Iran. Journal of Helminthology, 39(2), 273–276.

Skjabin, K. I., Shikhobalova, N. P., & Lagodovskaya, E. A. (1960). Fundamentals of nematodology. Oxyurata of animals and man [Osnovy nematodologii. Oksiturty zhivotnyh i cheloveka]. Nauka, Moscow (in Russian).

Skjabin, K. I. (1928). Method of complete helminthological autopsy of vertebrates, including humans. Moscow State University, Moscow (in Russian).

Tariq, A. K., Chishti, M. Z., Ahmad, F., & Shafi, A. S. (2008). Epidemiology of gastrointestinal nematodes of sheep managed under traditional husbandry system in Kashmir valley. Veterinary Parasitology, 158(1), 138–143.

Theodoridis, Y., Himonas, C., & Papazahariadou, M. (2000). Helminths parasites of digestive tract of sheep and goats in Macedonian region. Journal of the Hellenic Veterinary Medical Society, 51(3), 195–199.

Viney, M. (2017). How can we understand the genomic basis of nematode parasites? Trends in Parasitology, 33(6), 444–452.

Vlassoff, A., Leathwick, D. M., & Heath, A. C. (2001). The epidemiology of nematode infections of sheep. New Zealand Veterinary Journal, 49(6), 213–221.

Zazharska, N., Boyko, O., & Brygodyrenko, V. (2018). Influence of diet on the productivity and characteristics of goat milk. Indian Journal of Animal Research, 52(5), 711–717.