

Morphometric characteristics of the nematode *Oesophagostomum venulosum* (Nematoda, Strongylida) isolated from the domestic goat

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The nematodes of the genus *Oesophagostomum* Molin, 1861 parasitize in the large intestine of ruminants and are widely represented in the terrestrial ecosystems of many countries of the world. One of the most common species of this genus in small ruminants is *Oesophagostomum venulosum* Rudolphi, 1809. The validity of this species was established using morphological and molecular genetic methods, the importance of which is still relevant. The aim of our research was to determine the morphological and metric characteristics of *O. venulosum* nematodes isolated from domestic goats in Ukraine. The differential parameters of mature males and females of nematodes of this species are described and illustrated, and the obtained data is analyzed in the context of the findings of other authors. The taxonomic morphological characters of *O. venulosum* include the presence of a pronounced cuticular vesicle at the head end, inner and external corona radiata, cervical papillae located behind the esophagus; in males, the presence of prebursal papillae in front of the tail bursa and features of its structure, thin and tubular spicules and features of the structure of their proximal and distal ends; in females, features of the structure of the tail end, vulva and its location. 35 morphometric indicators were determined and proposed to be used in the identification of *O. venulosum* in males, and 29 indicators in females. Of these, 20 parameters characterize the general body structure (the length and width of the nematode, the dimensions of the mouth capsule, cervical vesicle, esophagus, the length of the inner and outer radial crowns, the location of the nerve ring and cervical papillae, as well as their sizes). In male nematodes of this species, 15 indicators characterize the metric parameters of the reproductive system (the size of the spicules in their various parts, gubernaculum, genital cone, genital papillae and their location, the width of the copulatory bursa). In females, 7 indicators are described that characterize the length of the vagina, the ovipositor, the location of the vulva and anus, the width of the body in the area of the vulva and anus, as well as two metric parameters of eggs. The identified and described morphometric characters of *O. venulosum* males and females based on microscopic studies can be an economical and effective method for researchers to accurately identify nematodes of this species. The information obtained in this study can contribute to the timely planning of control and prevention strategies for the parasitism of these nematodes on goat farms.

Keywords: oesophagostomosis; helminths; species identification; morphological features.

Introduction

Gastrointestinal *Strongyloides* of ruminants cause diseases leading to worldwide economic losses to livestock, especially goats (van Houtert & Sykes, 1996; Alberti et al., 2014; Boyko & Brygadyrenko, 2017, 2019, 2021; Sharma, 2018; Boyko et al., 2020; Matsepe et al., 2021). The causative agents of these infestations effect a decrease in growth and milk productivity of goats, deterioration of the quality and value of milk obtained from sick animals. The death of goats, especially young ones, is often recorded due to high levels of infestation intensity. In adult animals, infestations are mostly asymptomatic, but the negative impact of nematodes on the digestive process in the gastrointestinal tract has been proven, manifesting as a decrease in the assimilation of nutrients, macro- and microelements (Di Cerbo et al., 2006; Guimarães et al., 2011; Ratanapob et al., 2012; Suarez et al., 2017). Goats can be significantly more infected with gastrointestinal strongylids than sheep, and the expression of the immune response against the parasites is less pronounced in goats than in sheep (Hoste et al., 2010).

The nematodes of the genus *Oesophagostomum*, the most prominent species of which are *O. venulosum*, *O. radiatum*, *O. columbianum*, are

among the most widespread gastrointestinal strongylids in domestic and wild small ruminants (Horak & Louw, 1977; Tariq et al., 2010; Mehlhorn, 2016; Halvarsson et al., 2022). *Oesophagostomum radiatum* and *O. venulosum* have been found in domestic sheep and wild goats in Australia (Francis & Šlapeta, 2023). Nematodes of the species *O. venulosum* have been found in moose (*Alces alces*), red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*) in the Belarusian Polissia (Shimalov & Shimalov, 2003). Field studies of intestinal nematodes in goats and sheep in Imo State, Nigeria, showed parasitism of *O. columbianum* (in goats) and *O. venulosum* (in sheep). In India, *O. columbianum*, *O. asperum* and *O. venulosum* were found in domestic sheep (Okafor, 1987; Gaddam et al., 2017).

It is believed that *O. venulosum* is more prevalent than the other species of *Oesophagostomum* in sheep and goats in some areas and is less pathogenic, and also does not always form nodules on the intestinal mucosa. At the same time, at high rates of invasion intensity, it can cause enteritis and reduced productivity (Goldberg, 1952; Anderson, 1980; Rehbein & Haupt, 1994). In Serbia, the incidence of goats with this nematode species was 28.4%, and a study conducted in Valle d'Aosta, Italy, showed the presence of only the species *O. venulosum* (Balbo et al., 1977; Pavlović et al., 2012). The incidence of *O. venulosum* in sheep in the Central

and South-Eastern regions of Ukraine reached 42.5% (Melnychuk et al., 2020). This prevalence of *Oesophagostomum* is associated with its cycle of development. The host animals become infected mainly on pastures by ingesting invasive larvae along with grass, fodder, and water. Sick hosts produce feces with parasite eggs, which contaminate the external environment. After about 24 hours, L₁ hatch from the egg and in 3–5 days become invasive larvae (L₃) which morphologically contain 32 intestinal cells. After infection of animals with this parasitic stage of development, helminths reach sexual maturity in the intestines in 24–31 days, and eggs first appear in feces 28 days after infection. This cycle of development ensures the rapid spread of the pathogen through the active release of eggs from re-infected animals (Goldberg, 1951; Dash, 1981; Koprivnikar & Randhawa, 2013).

The validity of one or another species of parasite, including the genus *Oesophagostomum*, is established on the basis of research using morphological and molecular genetic methods. Although molecular methods are considered more reliable for accurate identification of nematodes, the morphometric-based identification is more cost-effective and is still a relevant research method (Snábel et al., 1998; De Sousa et al., 2019; Nath et al., 2021; Hodda, 2022). In particular, there are reports of morphological and metric differences between the imaginal and larval stages of *O. venulosum* found in sheep and goats and those described in the literature. The great plasticity in morphological characters should be taken into account when identifying species belonging to this genus (Badrie, 1982). Similar data were obtained by another author who analyzed the morphological identification keys of the nematodes *O. columbianum*, *O. radiatum*, and *O. venulosum* and revealed certain discrepancies regarding the details of the structure, which indicates the need for further research on the peculiarities of the morphometric structure of the parasites (Goodey, 1924).

In view of the above, the aim of the research was to determine the morphological and metric characteristics of nematodes of the *O. venulosum* species isolated from goats in Ukraine.

Materials and methods

The research was conducted in the laboratories of the Department of Parasitology and Ichthyopathology of the Lviv National Stepan Gzhytsky

University of Veterinary Medicine and Biotechnology, as well as the Department of Parasitology and Veterinary-Sanitary Examination of the Poltava State Agrarian University (Poltava) and on the basis of private households and farms that keep domestic goats in Poltava and Lviv regions, in 2019–2023. The research protocol of the current study was approved by the Ethics Committee of the Lviv National University of Veterinary Medicine and Biotechnologies named after S. Z. Gzhytskyj (Approval number: 2022/13).

The helminths were collected during the autopsy of the large intestine of 128 goats obtained from slaughterhouses. After the helminths were isolated from the large intestines, they were washed in distilled water, then fixed with 70% ethyl alcohol. Species identification of *O. venulosum* was carried out according to the identification keys (Skrjabin et al., 1952; Popova, 1958; Ivashkin et al., 1998). 4,753 nematode specimens of this species were obtained, including 1,849 males and 2,904 females.

Determination of morphometric parameters of sexually mature males and females of *O. venulosum* nematodes (n = 15) was carried out using the software ImageJ for Windows[®] (version 2.00) in interactive mode. Photomicrographs were taken using a Sigeta M3CMOS 14000 14.0 MP digital camera (China). Standard deviation (SD) and average values (x) were calculated.

Results

Morphological studies of *O. venulosum* nematodes show that the head end is straight and bears a well-defined cuticular cervical vesicle, which is separated from the body by a ventral (cervical) groove. A nerve ring is located at the level of the cervical groove (Fig. 1a). The mouth capsule is ring-shaped, its width is much greater than its length. The mouth opening contains inner and external corona radiata of cuticular petals (Fig. 1b). The esophagus is well defined and club-shaped. Cervical papillae are located behind its end (Fig. 1a, 1c).

The males of *O. venulosum* have a three-lobed caudal bursa typical for strongylids. Its dorsal rib gradually narrows and divides into two branches, which also contain outer branches that are shorter and thicker than the inner branches. Close to the base of the dorsal rib, the extermordorsal ribs depart.

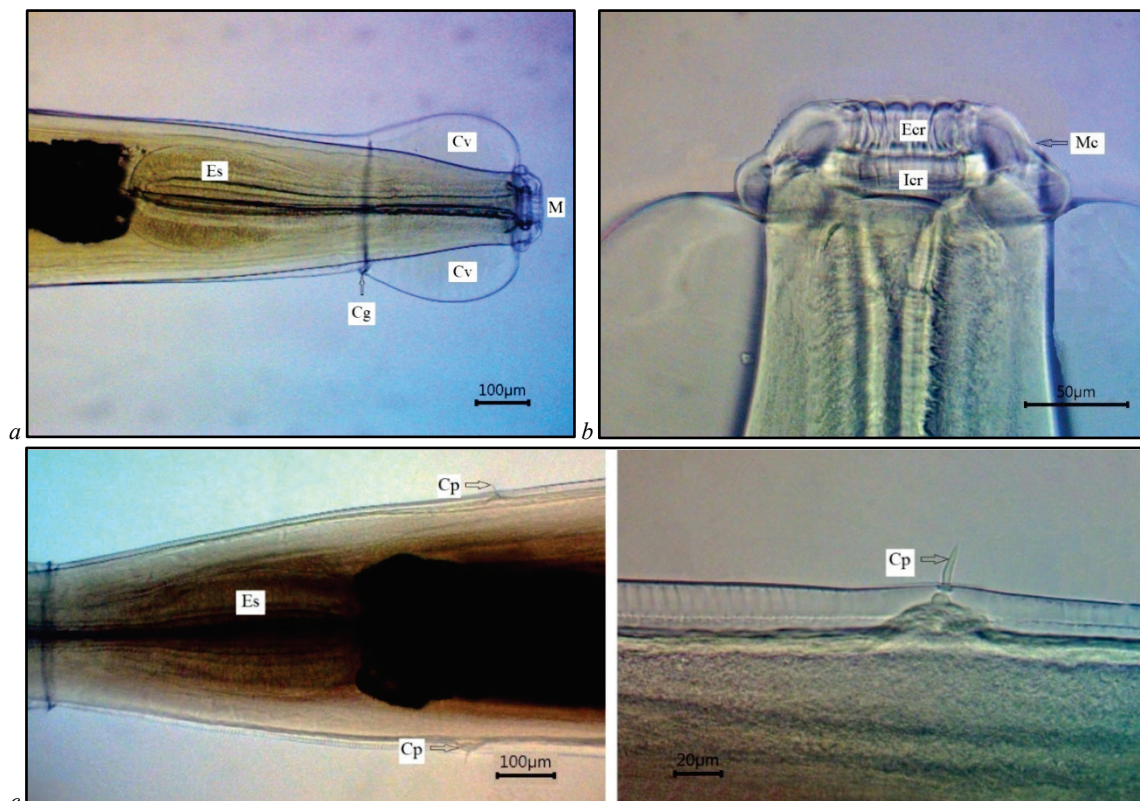


Fig. 1. Head end of the *Oesophagostomum venulosum*: a – cervical vesicle (Cv), cervical groove (Cg), esophagus (Es); b – mouth capsule (Mc), internal corona radiata (Icr), external corona radiata (Ecr); c – cervical papillae (Cp), esophagus (Es)

The externodorsal rib is separated from the posterolateral rib by a relatively wide gap. Both ventral ribs are thin and long, close together, separated only by a thin gap. Three lateral ribs depart from one trunk; the medial and posterolateral ribs are close together and only their ends are separated from each other. The antero-lateral rib is separated from the other two ribs by a small gap. There are well-defined prebursal papillae (Fig. 2a). Spicules are tubular, their proximal ends are blunt with a slight expansion (Fig. 2a, 2b). The distal parts of the spicules are pointed and shaped like a boat (Fig. 2c). The gubernaculum has a blade-like shape and contains a small handle (Fig. 2b, 2d). The genital cone is located at the bottom of the

tail bursa and contains a pair of spherical cuticular appendages (Fig. 2e). 35 indicators were determined in the morphometric features of *O. venulosum* males, of which 20 describe the general structure of the body (the length and width of the nematode, the dimensions of the mouth capsule, cervical vesicle, esophagus, the length of the inner and external corona radiata, the location of the nerve ring and cervical papillae, as well as their sizes). 15 other indicators characterize the metric parameters of the copulatory system: the size of the spicules in their various parts, the gubernaculum, genital cone, genital papillae and their location, the width of the copulatory bursa (Table 1).

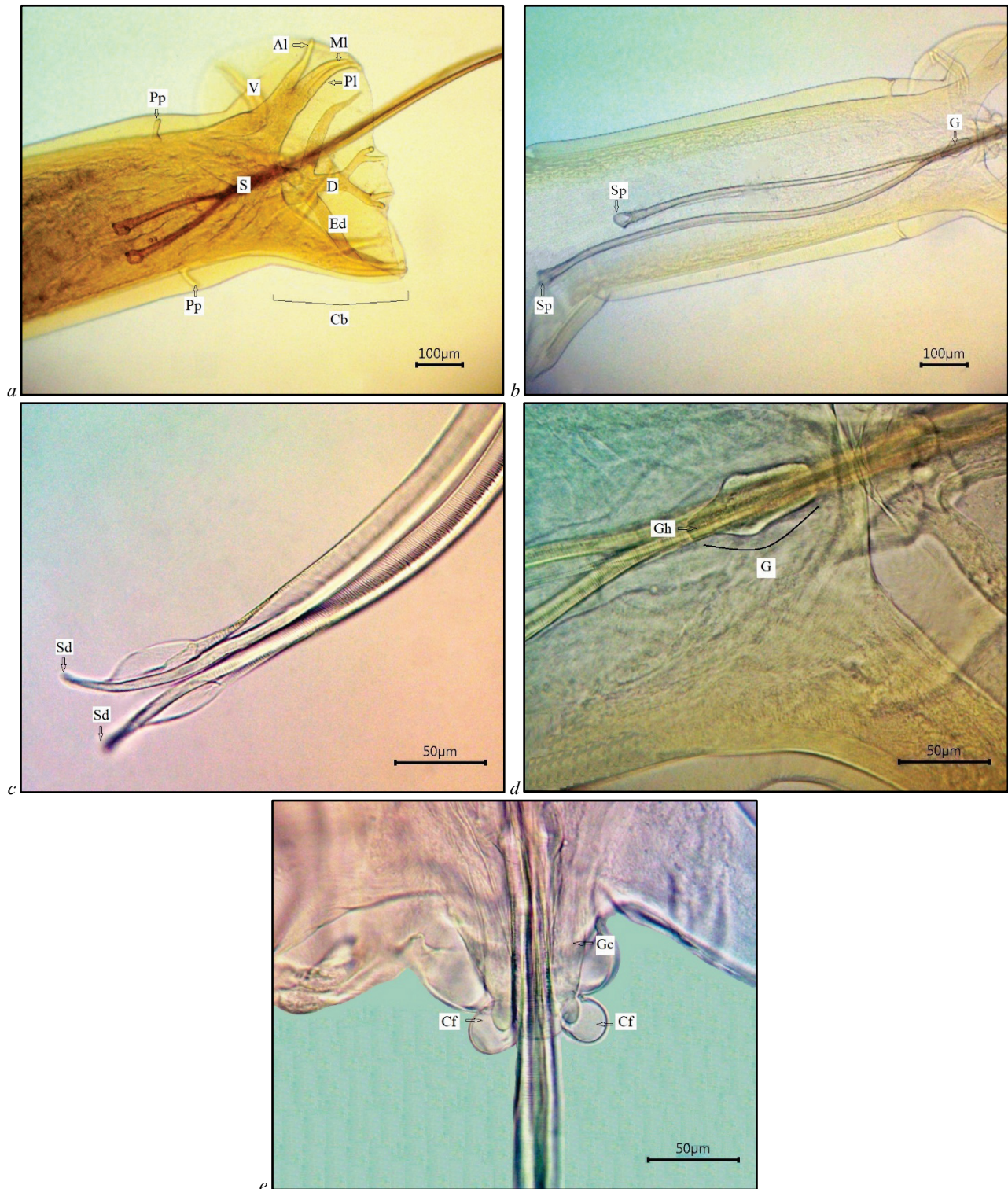


Fig. 2. Tail end of male *Oesophagostomum venulosum*: *a* – caudal bursa (Cb), dorsal ray (D), posteriolateral ray (Pl), mediolateral ray (Ml), externodorsal ray (Ed), ventral ray (V), spicules (S), prebursal papillae (Pp); *b* – proximal end of the spicule (Sp), gubernaculum (G); *c* – distal end of the spicule (Sd); *d* – gubernaculum (G), handle of gubernaculum (Hg); *e* – genital cone (Ge), cuticular formations (Cf)

Table 1Morphometric parameters of males *Oesophagostomum venulosum* nematodes (n = 15, x ± SD, min–max)

Parameter	Present specimens	Ransom, 1911	Gebauer, 1932	Trach, 1986	Melnychuk, 2017a	Ghimire & Bhattarai, 2022
Body length, mm	13.4 ± 0.9 12.0–15.2	11–16	12–14	12.5–14.5	13.55 ± 0.31 12.0–15.0	12.23 11.35–13.1
Max width body, mm	0.4 ± 0.1 0.3–0.5	–	0.3–0.4	–	0.41 ± 0.02 0.30–0.49	0.45 0.4–0.49
Width at start of esophagus, µm	131.1 ± 20.2 90.1–153.2	–	–	–	–	130 100–150
Width at the nerve ring area, µm	253.7 ± 14.5 230.2–281.4	–	–	–	–	–
Width at end of esophagus, µm	360.2 ± 18.3 321.0–384.1	–	–	–	–	260 240–270
Cervical vesicle:						
– length till the area of cervical groove, µm	288 ± 23.9 241.4–315.7	–	–	–	390 ± 0.01 370–420	–
– width, mm	376.6 ± 18.1 340.1–397.7	–	–	–	370 ± 0.01 350–400	–
– length to width ratio	0.8 : 1 0.6 : 1–0.8 : 1	–	–	–	1.04 ± 0.01 1.02–1.09	–
Mouth capsule, µm:						
– length	152.2 ± 8.5 143.3–170.8	–	–	–	183.03 ± 2.42 173.66–198.35	–
– height	53.7 ± 3.3 47.8–59.0	–	–	–	52.79 ± 0.82 50.13–57.16	–
– length to height ratio	2.8 : 1.0 2.5 : 1.0–3.1 : 1.0	–	–	–	3.47 ± 0.06 3.23–3.94	–
Length of external corona radiata, µm	67.8 ± 3.4 61.2–72.8	–	–	–	56.73 ± 0.9 52.09–60.9	–
Length of inner corona radiata, µm	59.8 ± 2.5 56.6–64.1	–	–	–	–	–
Esophagus, µm:						
– length	867.2 ± 39.2 789.9–912.8	–	–	–	770.76 ± 24.45 688.16–879.35	850 800–900
– maximum width	225.8 ± 18.3 201.0–267.2	–	–	–	210.34 ± 3.52 198.53–235.03	120 110–120
– width at cervical groove area	110.9 ± 8.8 100.6–127.2	–	–	–	129.53 ± 2.26 120.57–141.04	–
Distance from head end to nerve ring, µm	358.7 ± 21.2 325.0–400.3	–	–	–	298.12 ± 4.78 267.98–322.03	–
Cervical papillae, µm						
– length	8.3 ± 0.9 6.6–9.7	–	–	–	–	–
– width	2.7 ± 0.4 2.1–3.3	–	–	–	–	–
Distance from head end to cervical papillae, µm	1253.1 ± 136.6 1092.6–1495.3	–	–	–	–	–
Width of body at the caudal papillae area, µm	383.5 ± 25.1 310.9–414.4	–	–	–	354.48 ± 9.05 310.35–395.22	–
Distance from caudal papillae to copulatory bursa, µm	177 ± 26.3 128.6–212.4	–	–	–	428.02 ± 6.81 402.50–477.36	–
Length of caudal papillae, µm	58.5 ± 3.8 51.5–63.5	–	–	–	41.29 ± 0.51 39.06–44.04	–
Width of copulatory bursa, µm	502.6 ± 53.8 422.5–621.5	–	–	–	501.05 ± 3.90 486.47–519.92	–
Genital cone, µm:						
– width	100.3 ± 10.2 86.4–125.9	–	–	–	148.64 ± 2.52 133.94–158.32	–
– height	41.5 ± 3.1 34.9–46.9	–	–	–	53.27 ± 0.73 50.36–57.25	–
Spicules, µm:						
– length	1368.3 ± 45.8 1284.7–1459.8	1100–1500	1100–1200	1096–1315	1234.84 ± 20.50 1132.85–1327.03	880 600–1200
– width of proximal end	31.7 ± 2.2 27.6–35.0	–	–	–	14.38 ± 0.58 12.45–18.47	–
– width in the middle	10.5 ± 1.1 8.3–12.1	–	–	11.5	–	–
– width of distal end	4.2 ± 0.5 3.5–5.2	–	–	–	6.42 ± 0.14 5.92–7.04	–
– width of sheath of proximal end	44.3 ± 5.1 38.3–57.8	–	–	–	14.15 ± 0.21 13.11–15.24	–
– width of sheath expansion of distal end	21.5 ± 1.8 18.7–24.4	–	–	–	–	–
Gubemaculum, µm:						
– length	77.8 ± 2.4 73.7–81.2	90–100	–	–	–	–
– width	36.9 ± 0.9 35.5–38.8	–	–	–	–	–
– length of handle	23.2 ± 2.6 19.5–28.2	–	–	–	–	–

Note: parameters were not defined.

From 3 to 25 parameters that characterize the general structure of the body have been described, including overall measurements (length, width in individual parts of the body), dimensions of the cervical vesicle, mouth capsule, esophagus, length of the external radial crown, location of the nerve ring and cervical papillae. The metric parameters of the male genitalia have also been studied: the size of the spicules, genital cone, tail papillae and their location, the width of the copulatory bursa. In addition to these indicators, we have established the parameters of the width of the body in the region of the nerve ring (230.2–281.4 μm), the length of the inner radial crown (56.6–64.1 μm), the width of the expansion of the sheath at the spicule's distal end (18.7–24.4 μm), the width of the gubernaculum and the length of its handle (35.5–38.8 and 19.5–28.2 μm , respectively), the length and width of the cervical papillae (6.6–9.7 and 2.1–3.3 μm , respectively) and the distance from the head end to these (1092.6–

1495.3 μm). *Oesophagostomum venulosum* females have a thin and pointed tail end. The vulva is located in the area of the tail end in front of the anus. It is weakly highlighted as a slight protrusion (Fig. 3a). The vagina is connected to the ovipositor (Fig. 3b), and the latter is connected to the parallel uteri. The uteri are filled with eggs of the stronglylid type, e.g. oval, with a thin shell, transparent. In some females, eggs were found in the vaginal cavity (Fig. 3c).

When studying the morphometric features of *O. venulosum* females, 29 indicators were determined, of which 20 also describe the general structure of the body, as in males. The other seven parameters characterize the length of the vagina, the ovipositor, the location of the vulva and anus, the width of the body in the area of the vulva and anus. The size of the eggs located in the cavity of the uterus and vagina was determined (Table 2).

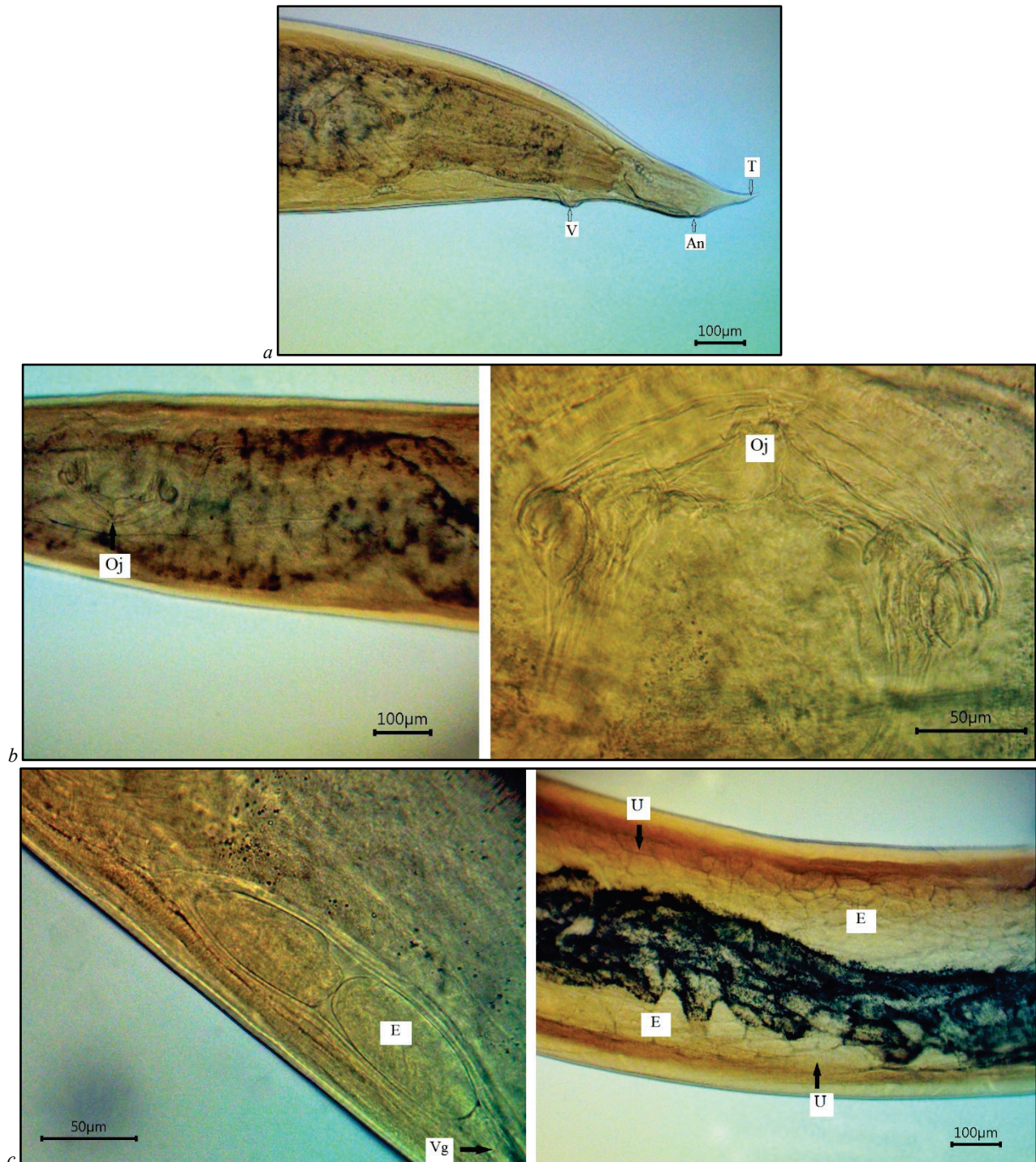


Fig. 3. Morphology of *Oesophagostomum venulosum* females: a – tail (T), vulva (V), anus (An); b – ovijector (Oj); c – vagina (Vg), uteri (U), eggs (E)

Table 2Morphometric parameters of females *Oesophagostomum venulosum* nematodes (n = 15, x ± SD, min–max)

Parameter	Present specimens	Ransom, 1911	Gebauer, 1932	Trach, 1970	Melnychuk, 2017b	Jhimire & Bhattarai, 2023
Body length, mm	19.3 ± 1.3 17.0–22.4	13–24	16–21	14.238	18.75 ± 0.58 16.5–21.5	14.88 12.48–17.78
Max width body, mm	0.4 ± 0.1 0.3–0.6	–	0.3–0.5	21.018	0.48 ± 0.04 0.30–0.64	0.50 0.42–0.6
Width at start of esophagus, µm	169.3 ± 6.4 159.7–179.7	–	–	–	–	0.12 0.10–0.17
Width at the area of nerve ring, µm	259.7 ± 31.4 152.4–280.6	–	–	–	–	–
Width at end of esophagus, µm	445.2 ± 16.0 420.8–480.2	–	–	0.316–0.396	–	0.36 0.3–0.42
Cervical vesicle:						
– length to the area of cervical groove, µm	361.3 ± 18.8 320.8–395.5	–	–	–	0.43 ± 0.01 0.38–0.46	–
– width, mm	398.6 ± 23.3 388.0–436.9	–	–	–	0.39 ± 0.01 0.34–0.43	–
– length to width ratio	0.9 : 1.0 0.8 : 1.0–1.1 : 1.0	–	–	–	1.10 ± 0.02 1.02–1.32	–
Mouth capsule, µm:						
– length	186.1 ± 8.0 170.4–196.5	–	–	–	185.07 ± 1.62 117.26–191.35	–
– width	60.3 ± 1.9 57.0–63.1	–	–	–	61.94 ± 0.81 58.18–65.45	–
– length to height ratio	3.1 ± 0.2 2.9 : 1–3.3 : 1	–	–	–	2.99 ± 0.04 2.72–3.27	–
Length of external corona radiata, µm	70.2 ± 0.1 68.6–72.4	–	–	–	58.10 ± 0.95 54.26–62.31	–
Length of internal corona radiata, µm	61.9 ± 1.5 59.4–64.0	–	–	–	–	–
Esophagus, µm:						
– length	911.6 ± 16.4 880.2–936.5	–	–	825	895.77 ± 12.98 817.34–948.32	0.87 0.83–0.94
– maximum width	253.4 ± 14.1 229.0–271.4	–	–	316	252.12 ± 2.69 237.84–264.23	0.12 0.10–0.13
– width at the cervical groove area	116.4 ± 8.8 99.9–128.6	–	–	–	144.11 ± 1.28 137.35–149.36	–
Distance from head end to the nerve ring, µm	413.0 ± 12.0 393.4–433.6	–	–	–	349.76 ± 1.18 344.38–356.24	–
Cervical papillae, µm						
– length	21.3 ± 2.1 18.6–26.5	–	–	–	–	–
– width	4.1 ± 0.4 3.3–4.9	–	–	–	–	–
Distance from head end to cervical papillae, µm	1296.6 ± 92.1 1119.0–1422.9	–	–	1.119–1.492	–	–
Distance from vulva to tail end, µm	427.8 ± 13.4 404.0–448.7	–	–	0.305–0.542	603.41 ± 13.19 530.36–649.54	0.76 0.70–0.80
Width of body at vulva area, µm	224.1 ± 6.0 211.9–234.7	–	–	0.181–0.316	270.02 ± 7.73 238.39–308.49	–
Length of vagina, µm	441.8 ± 17.5 416.2–475.6	600	400	421–573	470.79 ± 15.17 398.26–538.18	0.05 0.05–0.06
Length of ovjector with sphincters, µm	284.4 ± 15.1 260.5–307.8	250–300	–	198–243	–	–
Distance from anus to tail end, µm	188.6 ± 14.8 163.0–212.4	–	–	0.147–0.238	222.23 ± 3.87 207.87–246.43	0.35 0.30–0.43
Width of body at anus area, µm	74.2 ± 3.8 69.0–80.1	–	–	0.079–0.113	105.55 ± 1.43 97.15–111.26	–
Distance from anus to vulva, µm	272.4 ± 13.9 244.0–293.6	375–500	–	–	384.44 ± 12.44 318.70–430.02	–
Egg, µm:						
– length	91.4 ± 5.5 79.5–99.2	85	–	–	95.91 ± 1.17 89.88–101.70	–
– width	38.7 ± 1.4 36.5–41.8	45	–	–	51.66 ± 1.30 45.95–56.81	–

Note: parameters were not defined.

In previous studies, from 3 to 25 indicators that characterize the general structure of the body were identified, including overall dimensions (length, width in individual parts of the body), dimensions of the cervical vesicle, mouth capsule, esophagus, length of the outer corona radiata, location of the nerve ring and cervical papillae. Other authors also established the metric parameters of the location of the vulva and anus, the width of the body in the area of the vulva and anus, the length of the vagina, the ovipositor, as well as the length and width of the eggs. In addition to these indicators, we have established the parameters of body width in the area of the nerve ring (152.4–280.6 µm), the length of the inner corona radiata (59.4–64.0 µm), the length and width of the cervical papillae (18.6–26.5 and 3.3–4.9 µm, respectively). Therefore, microscopic studies of *O. venulosum* nematodes obtained from goats, with the determination of

their metric parameters, prove the need for conducting such studies, because the analysis of the results of other scientists and in this study shows the possibility of variability in the size of nematodes due to their parasitism in different hosts.

Discussion

Oesophagostomosis is an invasive disease caused by nematodes of various species, which is widespread throughout the world. Pathogens parasitize in the large intestine of cattle such as sheep, goats, deer, camels and many other ruminants and can lead to a decrease in productivity in domestic ruminants and economic losses of livestock farms (Ratanapob et al., 2012; Roeber et al., 2013; Gaddam et al., 2017). Species identification of

nematodes is based on morphological and molecular genetic studies, among which morphometrics still remains an effective method (Snábel et al., 1998; De Sousa et al., 2019; Nath et al., 2021; Hodda, 2022). Taking into account the significant intraspecific plasticity of morphological features in nematodes of the genus *Oesophagostomum*, isolated from different animals, it is important to establish the morphological and metric characteristics of nematodes of the *O. venulosum* nematodes isolated from goats from Ukraine.

We established that the head end of the parasite contains a well-defined cuticular vesicle, which is well demarcated by a groove, and the mouth capsule contains internal and external corona radiata. There are cervical papillae behind the esophagus. In males, characteristic morphological features are the presence of prebursal papillae in front of the tail bursa, thin and tubular spicules. A peculiarity of the structure of the tail bursa is the branching of the dorsal rib, well-defined external-dorsal ribs, which are separated from the postero-lateral ones by a wide gap, convergent ventral and medial and postero-lateral ribs. Males also have a shovel-shaped gubernaculum, as well as a genital cone containing a pair of spherical cuticular appendages. These results confirm the data obtained by most authors who studied the morphological structure of nematodes of this species using SEM (Ivashkin et al., 1998; Lapage, 2000; Khanmohammadi et al., 2013; Gaddam et al., 2017a, 2017b). We also described in more detail the morphological features of the distal and proximal ends of the spicules. In females, the main characteristic morphological features are the location of the vulva in the posterior part of the body in front of the anus. The tail end behind the anus is sharply narrowed, and the vulva is located on a small rise. Most researchers testify to such taxonomic characters (Ivashkin et al., 1998; Gaddam et al., 2017a; Amuzie et al., 2022). At the same time, some authors note the impossibility of studying the vulva region due to the presence of genital cement in the tail part (Khanmohammadi et al., 2013; Gaddam et al., 2017b).

We determined 35 morphometric parameters for males and 29 for females of nematodes of the species *O. venulosum*. In male nematodes, 20 of the determined indicators describe the general structure of the body, and 15 are the metric parameters of spicules in their various parts, the gubernaculum, genital cone, genital papillae and their location, the width of the copulatory bursa. Studies of other authors note from 3 to 25 indicators (Ransom, 1911; Gebauer, 1932; Trach, 1986; Melnychuk, 2017a; Ghimire & Bhattarai, 2023). We have additionally determined and described the parameters of the width of the body in the region of the nerve ring, the length of the inner corona radiata, the width of the expansion of the distal end of the spicule sheath, the width of the gubernaculum and the length of its handle, the length and width of the cervical papillae and the distance from the head end to them. Moreover, it can be noted that the parameters of nematodes determined by researchers differ among themselves, as well as with the values obtained by us according to some of the indicators (Ransom, 1911; Gebauer, 1932; Trach, 1986). Several indicators of nematodes of this species isolated from sheep and goats also differ (Melnychuk, 2017a; Ghimire & Bhattarai, 2023).

20 indicators are used for both male and female nematodes to characterize the general structure of the body. The other seven metric parameters used to describe females here are the length of the vagina, ovijector, location of the vulva and anus, body width in the area of the vulva and anus. Two other indicators characterize the width and the length of the eggs found in the uterine cavity and vagina. Analyzing the data of the authors who studied the metric parameters of females of this species, it can be noted that they determined from 3 to 25 indicators (Ransom, 1911; Gebauer, 1932; Trach, 1970; Melnychuk, 2017b; Ghimire & Bhattarai, 2023). We have additionally established and described indicators of body width in the region of the nerve ring, length of the inner corona radiata, and length and width of the cervical papillae. A certain difference in several parameters was established between our data and the data from other studies, as well as between the values for *O. venulosum* isolated from different species of hosts, such as sheep and goats, as evidenced by other scientists (Goodey, 1924; Badrie, 1982; Melnychuk, 2017b; Ghimire & Bhattarai, 2023).

Therefore, the morphometric characters of males and females of *O. venulosum* described by us can be an effective method for researchers to accurately identify nematodes of this species. The information obtained

in this study can contribute to the timely planning of control and prevention strategies for the parasitism of these nematodes in goat farms.

Conclusion

Oesophagostomum venulosum Rudolphi, 1809 was identified in domestic goats (*Capra hircus*) in Ukraine. Morphological features and metric parameters of male and female nematodes of this species are described. 35 morphometric indicators are established in males and 29 in females, including 20 indicators that characterize body length and width in different areas, sizes of esophagus, cervical papillae, mouth capsule, main vesicle, length of corona radiata, location of nerve ring and cervical papillae. In addition, 15 metric parameters in males characterize the size of the spicules in their various parts, especially the proximal and distal ends, gubernaculum, genital cone, genital papillae and their location, the width of the copulatory bursa. The measurements of the eggs located in the cavity of the uterus and vagina are determined. The results of our study can have a significant impact on the epidemiology, taxonomy, and population dynamics of nematodes of this species, as well as on the effectiveness of timely diagnosis and the quality of control of esophagostomosis in goats caused by *O. venulosum* parasitism.

The research was carried out within the framework of the initiative topic of scientific work "Monitoring, the implementation of advanced diagnostic techniques, treatment and preventive measures of invasion diseases of animals" (state registration № 0121U100644).

The authors state that there is no conflict of interest.

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