

The prevalence of gastrointestinal nematodes in sheep (*Ovis aries*) in the central and south-eastern regions of Ukraine

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Abstract: The article investigates into the species composition of agents causing gastrointestinal tract nematodes in sheep. It determines the forms of nematodes communities. For this purpose, 710 sheep were examined, 79.58% of which were infected. The fauna of nematodes was represented by 15 species of helminths from 12 genera: *Bunostomum*, *Oesophagostomum*, *Nematodirus*, *Chabertia*, *Cooperia*, *Trichostrongylus*, *Ostertagia*, *Haemonchus*, *Trichuris*, *Aonchotheca*, *Strongyloides*, and *Skrjabinema*. The indicators of infestation intensity in sheep ranged from 1 to 93 specimens per animal, and the abundance index ranged from 0.01 to 16.96 specimens per animal. The most common nematodes are *H. contortus* (prevalence, 61.97%), *O. circumcincta* (59.58%), *T. colubriformis* (57.35%), *T. ovis* (55.21%), *N. spathiger* (49.01%), *Oe. venulosum* (42.54%), *S. ovis* (41.13%), *Ch. ovina* (36.76%), and *T. skrjabini* (26.34%). Gastrointestinal nematodes in the body of 99.12% of the infected sheep proceeded as parasitic communities. Most frequently, coinvasions were represented by parasitic communities which consisted of five (prevalence, 14.51%), six (19.44%), or seven (15.92%) species. The study revealed 361 varieties of mixed coinvasions. The most frequent comembers were *H. contortus*, *O. circumcincta*, *T. colubriformis*, *T. ovis*, *N. spathiger*, *S. ovis*, and *Ch. ovina*. The data obtained provide an opportunity to increase the effectiveness of measures to combat and prevent gastrointestinal tract nematodes in sheep farms.

Key words: Sheep, nematodes, parasite community, Ukraine

1. Introduction

Sheep breeding is an important sector of productive livestock worldwide. It is able to provide the human population with a variety of products which have high consumer and health-improving properties such as lamb, milk, cheese, and wool [1,2].

It is possible to ensure successful development of sheep husbandry and to create satisfactory conditions for exporting products to international markets with a favorable epizootic situation in the country, in particular for helminth infections of sheep [3,4]. Digestive tract nematodes in sheep cause significant economic damage to sheep breeding, which is expressed in a decrease of body weight gain, the birth of weak offspring, and sometimes the death of young animals [5]. At the same time, the influence of anthropogenic factors on the epizootic situation of sheep helminthoses poses a risk of increasing the number of parasite populations and increases the risk of infestations among animals as well as humans [6,7].

The authors note that the most common causative agents of sheep gastrointestinal nematodes in different countries of the world are representatives of the orders Strongylida, Trichurida, Rhabditida, and Oxyurida [8,9]. Moreover, the invasion of sheep, especially young animals, by gastrointestinal nematodes is often significant and can affect up to 100% of the livestock [10]. It is judged that digestive tract strongylatoses in domestic sheep are the most diverse group of diseases in terms of species composition in comparison with other digestive tract nematodes. Among the strongylatoses agents, the representatives of *Haemonchus*, *Trichostrongylus*, *Ostertagia*, *Cooperia*, *Bunostomum*, *Oesophagostomum*, *Chabertia*, *Marshallagia*, and *Nematodirus* are most often diagnosed [11,12].

Also, the results of helminthological studies carried out by a number of authors indicate that sheep gastrointestinal nematodes can occur both in the form of monoinvasion and mixed coinvasion. Two, three, or more species of helminths are found in coinvasions [13].

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It should be considered that parasites and diseases caused by them are an integral part of ecological systems. Parasitic nematodes belong to the structural elements of such ecosystems, including those that parasitize in the gastrointestinal tract. Also, the increasing intensity of human exposure to natural processes is inevitably associated with diverse environmental consequences, which affect the species composition of parasitic nematodes [14].

Therefore, the species composition study of animal helminthoses is the basis for predicting adversity in parasitic etiology of diseases at state and regional scales. It can be used in the development of monitoring programs to assess the epizootic situation of invasive diseases.

2. Materials and methods

2.1. Animal materials and study design

This study was conducted to determine the prevalence of gastrointestinal nematodes (GIN) of sheep in the Laboratory of Parasitology of the Poltava State Agrarian Academy as well as in 11 agricultural enterprises and 354 different productivity level farms at the Kiev, Poltava, and Zaporizhzhia regions (central and south-eastern Ukraine) between 2015–2019. In total, 710 sheep were studied aged 2 months to 5 years belonging to Romanovska, Askanian fine-fleece, and fat-tail breeds.

2.2. Parasitological study

For the complete collection of helminths, a helminthological study was carried out on abomasum, small and large intestines, of sheep that were killed or slaughtered at specialized slaughterhouses according to the generally accepted method [15]. After extraction from the intestines, the nematodes were washed in a 0.9% NaCl solution and fixed with 70% ethanol according to the standard method [16]. The species affiliation of nematodes was specified by morphological features using determinants [17–21].

2.3. Statistical analysis

The standard rates of sheep infection with GIN were calculated according to:

a. the prevalence of infection (prevalence (P), %) – the ratio of the number of infected sheep to the number of examined sheep,

b. the infestation intensity (intensity (I), specimens per animal) – the number of parasites of a certain species per one infected host,

c. the abundance index (abundance (A), specimens per animal) – the number of parasites of a certain species per one studied host (including noninfected).

All intensity (I) datasets were expressed as mean \pm standard error (SE) of the mean. Statistical processing of the experimental results was carried out using Microsoft Excel software.

3. Results

According to studies, 79.58% of sheep were affected by GIN pathogens. In total, 15 species of nematodes were found, which belong to 4 orders (Strongylida, Trichurida, Rhabditida, and Oxyurida) and 12 genera (*Bunostomum*, *Oesophagostomum*, *Nematodirus*, *Chabertia*, *Cooperia*, *Trichostrongylus*, *Ostertagia*, *Haemonchus*, *Trichuris*, *Aonchotheca*, *Strongyloides*, and *Skrjabinema*). In the large intestine, 6 species were found: *Trichuris ovis* (Abildgaard, 1795), *T. skrjabini* (Baskakov, 1924), *T. globulosa* (Linstow, 1901), *Skrjabinema ovis* (Skrjabin, 1915), *Oesophagostomum venulosum* (Rudolphi, 1809), and *Chabertia ovina* (Fabricius, 1788). Exclusively in the small intestine, 3 species of nematodes were detected: *Bunostomum trigonocephalum* (Rudolphi, 1808), *Nematodirus spathiger* (Railliet, 1896), and *Strongyloides papillosus* (Wedl, 1856). At the same time, simultaneous localization in both the small intestine and the abomasum was typical for 6 species: *Aonchotheca bovis* [= *Capillaria bovis*] (Schnyder, 1906), *N. abnormalis* (May, 1920), *Cooperia* sp. (Ransom, 1907), *Trichostrongylus colubriformis* (Giles, 1892), *Ostertagia circumcincta* (Stadelmann, 1894), and *Haemonchus contortus* (Rudolphi 1803, Cobb 1898).

The most common nematodes were *H. contortus* (P, 61.97%), *O. circumcincta* (59.58%), *T. colubriformis* (57.35%), *T. ovis* (55.21%), *N. spathiger* (49.01%), *Oe. venulosum* (42.54%), *S. ovis* (41.13%), *Ch. ovina* (36.76%), and *T. skrjabini* (26.34%) (Figure 1).

More rarely, species *S. papillosus* (P, 14.37%), *T. globulosa* (13.80%), *A. bovis* (7.61%), *N. abnormalis* (1.55%), *Cooperia* sp. (0.99%), and *B. trigonocephalum* (0.28%) were registered in sheep (Figure 2).

The I indicator in the infected sheep ranged from 1 to 93 specimens. Moreover, the average animal infection rates with different species of nematodes differed significantly (Figure 3).

Thus, the maximum number of the species *T. colubriformis* (29.58 ± 0.96 specimens per animal), *O. circumcincta* (27.69 ± 0.98), *Oe. venulosum* (26.84 ± 0.86), *T. ovis* (25.61 ± 0.74), *T. skrjabini* (25.02 ± 0.93), *Ch. ovina* (23.32 ± 0.83), and *H. contortus* (23.12 ± 0.81) nematodes was revealed in sheep. Lower values of the I indicator were established by species *S. ovis* (19.60 ± 0.77 specimens per animal), *N. spathiger* (18.93 ± 0.65), *T. globulosa* (12.84 ± 0.68), and *N. abnormalis* (10.18 ± 1.62). Helminths of species *B. trigonocephalum*, *S. papillosus*, *Cooperia* sp., and *A. bovis* were found in single copies (from 2.00 ± 1.00 to 9.61 ± 0.65 specimens per animal).

The A indicator of GIN was characterized by the greatest distribution of species *T. colubriformis* (16.96 specimens per animal), *O. circumcincta* (16.50), *H. contortus* (14.33),

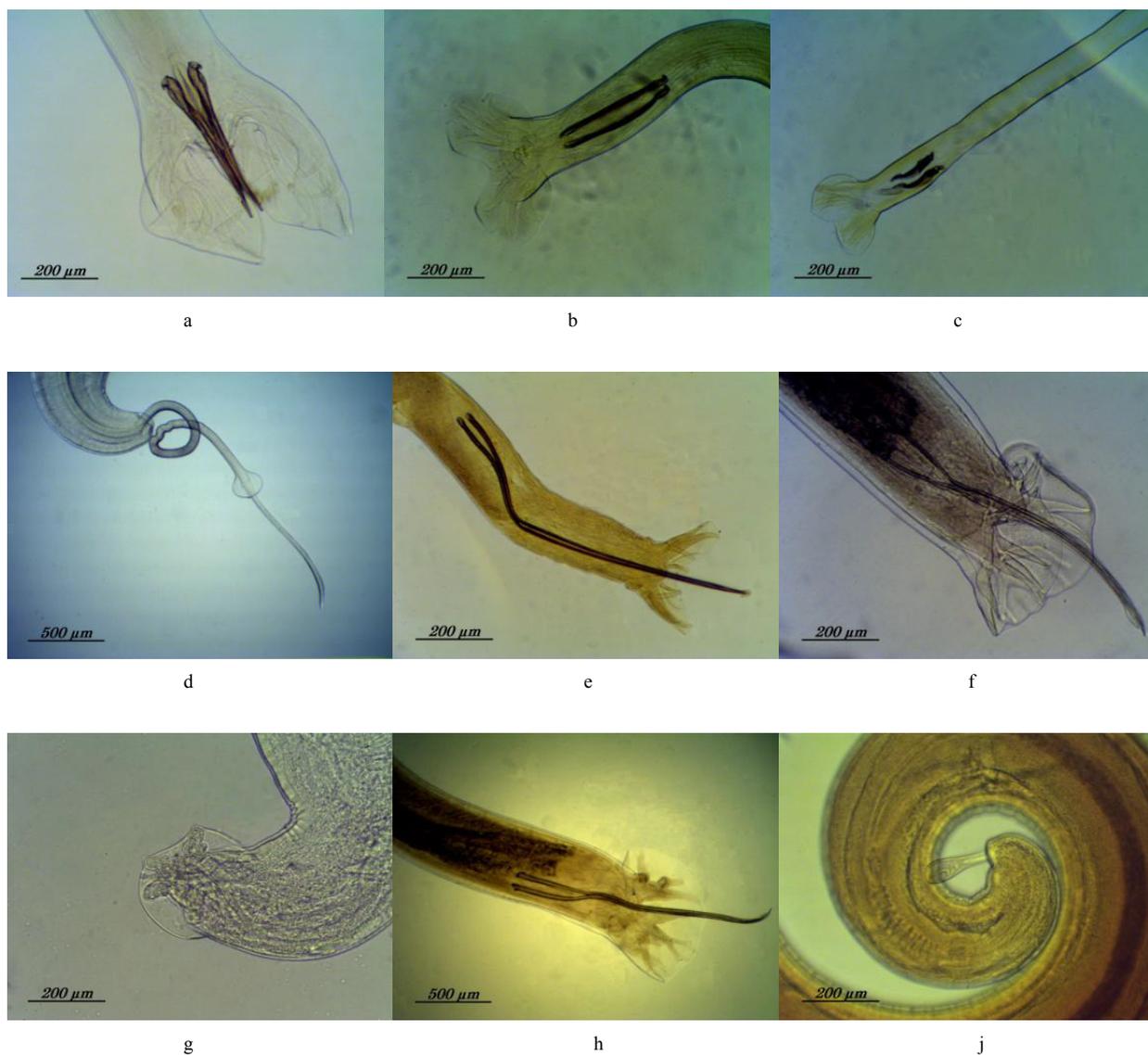


Figure 1. The most common nematodes of sheep gastrointestinal tract in the central and south-eastern regions of Ukraine (caudal end ♂): a – *H. contortus*, b – *O. circumcincta*, c – *T. colubriformis*, d – *T. ovis*, e – *N. spathiger*, f – *Oe. venulosum*, g – *S. ovis*, h – *Ch. ovina*, j – *T. skrjabini*.

T. ovis (14.14), and *Oe. venulosum* (11.42) among the domestic sheep population. The A indicator of species *T. globulosa*, *T. skrjabini*, *S. ovis*, *Ch. ovina*, and *N. spathiger* was insignificant and ranged from 1.77 to 9.28 specimens per animal. The least numerous were nematodes of such species as *A. bovis*, *B. trigonocephalum*, *N. abnormalis*, and *Cooperia* sp., where the A indicator did not exceed 0.73 specimens per animal.

GIN proceeded in the form of parasitic communities in the body of 99.12% of the infected sheep; the prevalence of mixed coinvasion was 65.63%. Monoinvasions were rarely recorded (P, 0.70%) and were caused by nematodes

of 4 species: *H. contortus* (0.28%), *O. circumcincta* (0.14%), *T. skrjabini* (0.14%) and *S. ovis* (0.14%) (Figure 4).

The number of helminths species in the parasitic community of each animal varied from 1 to 10 (Table 1).

The most often mixed coinvasions were represented by parasitic communities, which consisted of five (P, 14.51%), six (19.44%), and seven (15.92%) species of nematodes. Infections of sheep caused by other forms of parasitic communities varied between 1.41–9.15%. In total, 361 varieties of parasitic communities were revealed in sheep, where the prevalence of the most common coinvasions ranged from 0.70 to 1.77%.

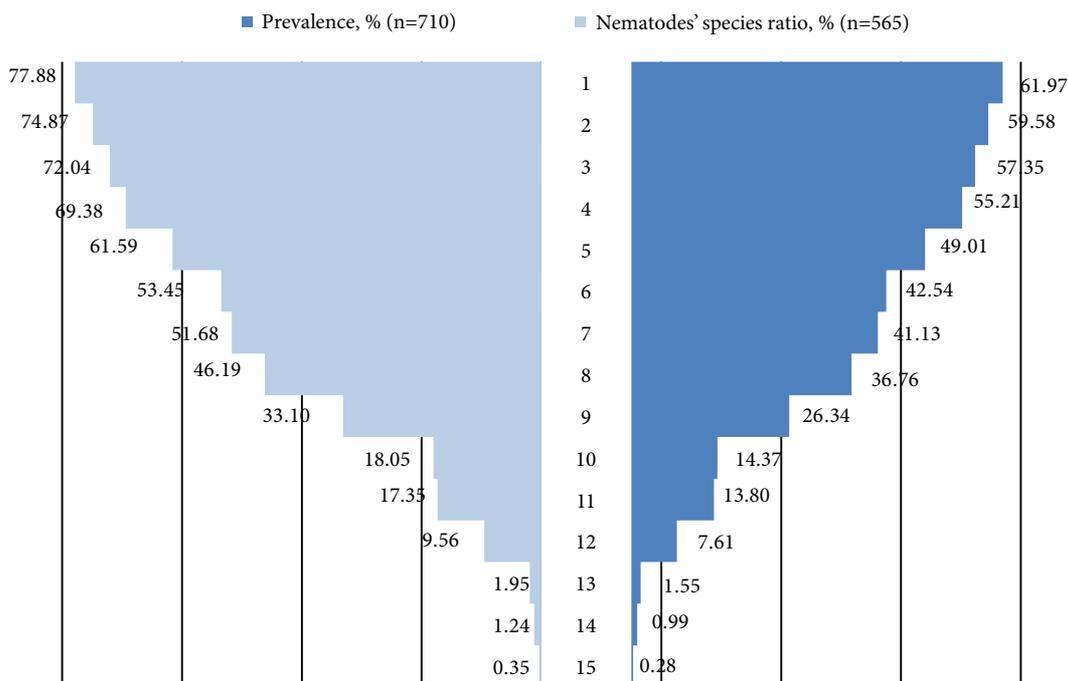


Figure 2. The community structure of sheep gastrointestinal nematodes in the central and south-eastern regions of Ukraine: 1–*H. contortus*, 2–*O. circumcincta*, 3–*T. colubriformis*, 4–*T. ovis*, 5–*N. spathiger*, 6–*Oe. venulosum*, 7–*S. ovis*, 8–*Ch. ovina*, 9–*T. skrjabini*, 10–*S. papillosus*, 11–*T. globulosa*, 12–*A. bovis*, 13–*N. abnormalis*, 14–*Cooperia* sp., 15–*B. trigonocephalum*.

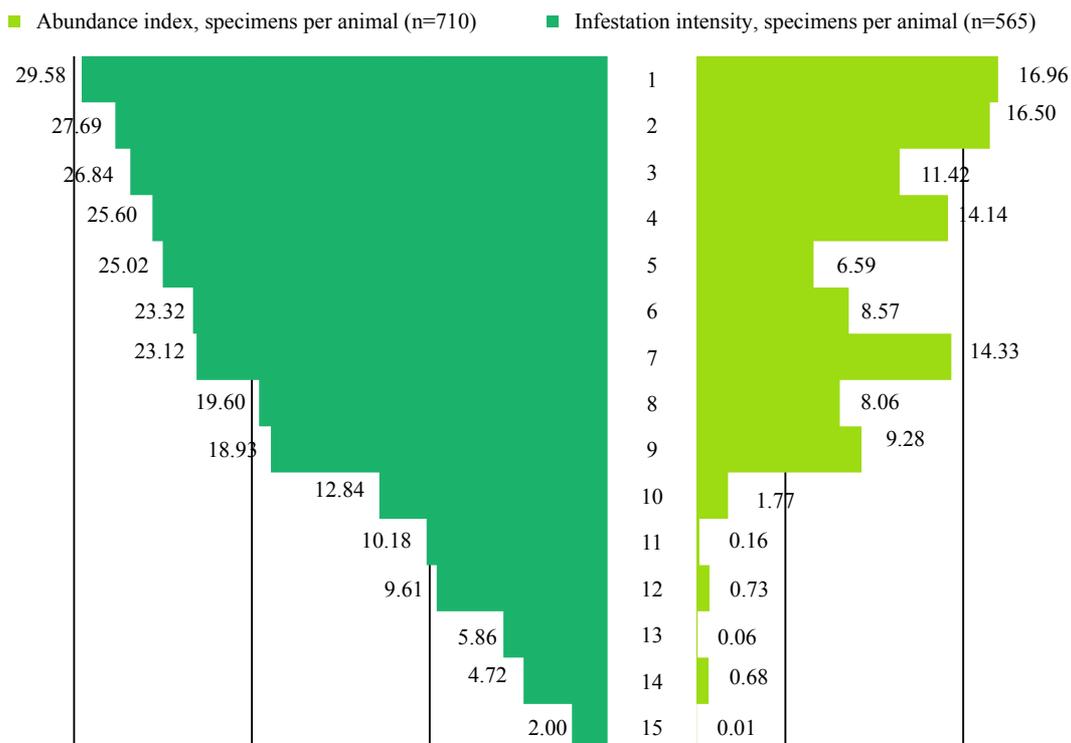


Figure 3. Gastrointestinal nematodes' infection rates in sheep: 1–*T. colubriformis*, 2–*O. circumcincta*, 3–*Oe. venulosum*, 4–*T. ovis*, 5–*T. skrjabini*, 6–*Ch. ovina*, 7–*H. contortus*, 8–*S. ovis*, 9–*N. spathiger*, 10–*T. globulosa*, 11–*N. abnormalis*, 12–*A. bovis*, 13–*Cooperia* sp., 14–*S. papillosus*, 15–*B. trigonocephalum*.

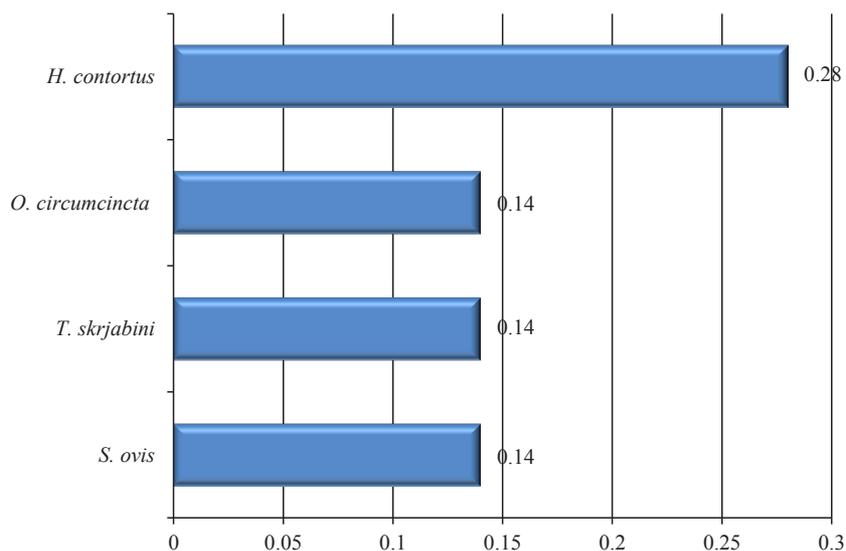


Figure 4. Species composition of monoinvasions and their prevalence of sheep.

Table 1. The occurrence of mono- and coinvasions of the gastrointestinal tract in sheep in the central and south-eastern regions of Ukraine.

Forms of the parasitic community	Infected animals, n	Prevalence, % (n = 710)	The ratio of parasitic communities' forms, % (n = 565)
1-component	5	0.70	0.88
2-component	13	1.83	2.30
3-component	34	4.79	6.02
4-component	65	9.15	11.50
5-component	103	14.51	18.23
6-component	138	19.44	24.42
7-component	113	15.92	20.00
8-component	57	8.03	10.10
9-component	27	3.80	4.78
10-component	10	1.41	1.77

It was found that 14 mixed coinvasions were the most common among sheep, where frequent comembers were *H. contortus*, *O. circumcincta*, *T. colubriformis*, *T. ovis*, *N. spathiger*, *S. ovis*, and *Ch. ovina*. Thus, among the 10-membered coinvasions, the maximum prevalence (0.70%) was revealed with simultaneous parasitization of *H. contortus*, *T. ovis*, *T. skrjabini*, *Ch. ovina*, *Oe. venulosum*, *T. colubriformis*, *O. circumcincta*, *N. spathiger*, *S. ovis*, and *S. papillosus* in sheep. Among the 9-membered mixed coinvasions, 2 varieties with the highest prevalence rates were identified as *H. contortus*, *T. ovis*, *Ch. ovina*, *Oe. venulosum*, *T. colubriformis*, *O. circumcincta*, *N. spathiger*, *S. ovis*, and *S. papillosus* (P, 1.27%) and *H. contortus*, *T. ovis*, *T. skrjabini*, *Ch. ovina*, *Oe. venulosum*,

T. colubriformis, *O. circumcincta*, *N. spathiger*, and *S. ovis* (P, 0.70%) (Table 2).

Also, 2 varieties of 8-membered parasitic communities were classified as the most common coinvasions: *H. contortus*, *T. ovis*, *Ch. ovina*, *Oe. venulosum*, *T. colubriformis*, *O. circumcincta*, *N. spathiger*, and *S. ovis* (P, 1.41%) and *H. contortus*, *Ch. ovina*, *Oe. venulosum*, *S. ovis*, *T. colubriformis*, *O. circumcincta*, *N. spathiger*, and *S. papillosus* (0.70%). Among the 7-membered most frequently encountered coinvasions, 4 were identified (*H. contortus*, *T. ovis*, *Ch. ovina*, *Oe. venulosum*, *T. colubriformis*, *O. circumcincta*, *N. spathiger*, *T. skrjabini*, and *S. ovis*), where the pathogens were in various combinations (P, 0.70–1.27%) (Table 3).

Table 2. Parasitic communities of GIN pathogens in sheep, most commonly found in the central and south-eastern regions of Ukraine, consisting of 9 and 10 species of nematodes.

Species structure of parasitic communities	Infected animals, n	Prevalence, % (n = 710)	% (n = 565)
<i>H. contortus</i> + <i>T. ovis</i> + <i>Ch. ovina</i> + <i>Oe. venulosum</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. spathiger</i> + <i>S. ovis</i> + <i>S. papillosus</i>	9	1.27	1.59
<i>H. contortus</i> + <i>T. ovis</i> + <i>T. skrjabini</i> + <i>Ch. ovina</i> + <i>Oe. venulosum</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. spathiger</i> + <i>S. ovis</i>	5	0.70	0.88
<i>H. contortus</i> + <i>T. ovis</i> + <i>T. skrjabini</i> + <i>Ch. ovina</i> + <i>Oe. venulosum</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. spathiger</i> + <i>S. ovis</i> + <i>S. papillosus</i>	5	0.70	0.88

Table 3. Parasitic communities of GIN pathogens in sheep, consisting of 7 and 8 species of nematodes.

Species structure of parasitic communities	Infected animals, n	Prevalence, % (n = 710)	% (n = 565)
<i>H. contortus</i> + <i>T. ovis</i> + <i>Ch. ovina</i> + <i>Oe. venulosum</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. spathiger</i> + <i>S. ovis</i>	10	1.41	1.77
<i>H. contortus</i> + <i>T. ovis</i> + <i>Ch. ovina</i> + <i>Oe. venulosum</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. spathiger</i>	9	1.27	1.59
<i>H. contortus</i> + <i>T. ovis</i> + <i>T. skrjabini</i> + <i>Ch. ovina</i> + <i>Oe. venulosum</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i>	6	0.85	1.06
<i>H. contortus</i> + <i>T. ovis</i> + <i>Ch. ovina</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. spathiger</i> + <i>S. ovis</i>	5	0.70	0.88
<i>H. contortus</i> + <i>T. ovis</i> + <i>Oe. venulosum</i> + <i>S. ovis</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. spathiger</i>	5	0.70	0.88
<i>H. contortus</i> + <i>Ch. ovina</i> + <i>Oe. venulosum</i> + <i>S. ovis</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. spathiger</i> + <i>S. papillosus</i>	5	0.70	0.88

Among the 6-membered parasitic communities, 3 varieties of coinvasions were more often recorded: *H. contortus*, *T. ovis*, *Ch. ovina*, *T. colubriformis*, *O. circumcincta*, and *N. spathiger* (P, 1.13%), *H. contortus*, *T. ovis*, *Oe. venulosum*, *S. ovis*, *T. colubriformis*, and *O. circumcincta* (0.99%), and *H. contortus*, *T. ovis*, *O. circumcincta*, *Oe. venulosum*, *T. colubriformis*, and *N. spathiger* (0.70%). Moreover, among the 5-membered parasitic communities, 2 varieties of mixed coinvasions were more often recorded: *H. contortus*, *T. ovis*, *T. colubriformis*, *O. circumcincta*, and *N. spathiger* (P, 0.85%) and *H. contortus*, *Oe. venulosum*, *T. colubriformis*, *O. circumcincta*, and *S. ovis* (0.70%) (Table 4).

Other varieties of coinvasions were observed less often (P, 0.14–0.56%).

4. Discussion

Sheep farming is one of the most important agricultural sectors in many countries of the world. Helminthoses

cause significant damage to this livestock industry, and gastrointestinal nematodes are the most common of them [1]. It should be noted that the biodiversity of helminth fauna in sheep and other animals depends on species characteristics, biotic, abiotic, and technological factors in different regions [22]. Thus, the prevalence of sheep raised in Botucatu, the state of São Paulo, Brazil, by individual GIN species reached 100% [23]. According to the study of Pavlovic [11] in Northern Serbia, the rates of GIN lesion in sheep ranged from 13.66 to 71.22%.

Our studies have shown that in central and south-eastern Ukraine (Kiev, Poltava, and Zaporizhzhia regions) 79.58% of the sheep were affected by GIN. The fauna was represented by 15 species of nematodes, which belong to 4 orders and 12 genera. For the first time in this territory, species *Trichuris globulosa* (Linstow, 1901) and *Aonchotheca bovis* [= *Capillaria bovis*] (Schnyder, 1906) were discovered, although their prevalence in sheep was low—13.80 and 7.61%, respectively. Such a low occurrence

Table 4. Parasitic communities of GIN pathogens in sheep, consisting of 5 and 6 species of nematodes.

Species structure of parasitic communities	Infected animals, n	Prevalence, % (n = 710)	% (n = 565)
<i>H. contortus</i> + <i>T. ovis</i> + <i>Ch. ovina</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. Spathiger</i>	8	1.13	1.42
<i>H. contortus</i> + <i>T. ovis</i> + <i>Oe. venulosum</i> + <i>S. ovis</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i>	7	0.99	1.24
<i>H. contortus</i> + <i>T. ovis</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>N. Spathiger</i>	6	0.85	1.06
<i>H. contortus</i> + <i>Oe. venulosum</i> + <i>T. colubriformis</i> + <i>O. circumcincta</i> + <i>S. ovis</i>	5	0.70	0.88
<i>H. contortus</i> + <i>T. ovis</i> + <i>O. circumcincta</i> + <i>Oe. venulosum</i> + <i>T. colubriformis</i> + <i>N. spathiger</i>	5	0.70	0.88

of these species and the dominance of *T. ovis* and *T. skrjabini* over *T. globulosa* is explained by the authors in terms of features in their development cycle [24,25].

Nematodes *H. contortus* (P, 61.97%), *O. circumcincta* (59.58%), *T. colubriformis* (57.35%), *T. ovis* (55.21%), *N. spathiger* (49.01%), *Oe. venulosum* (42.54%), *S. ovis* (41.13%) *Ch. ovina* (36.76%), and *T. skrjabini* (26.34%) were the most common in sheep among the ones we isolated. Other species (*S. papillosus*, *N. abnormalis* (1.55%), *Cooperia* sp. (0.99%), *B. trichocephalum* (0.28%)) were less common (P, 0.28–14.37%). Moreover, it should be noted that the isolated species *H. contortus* and *T. colubriformis*, which are zoonoses, were the most common species in the territory of certain regions of Ukraine. This fact confirms the relevance of the studies once again.

According to the authors' data, the number, the ratio of GIN species, and sheep infestation rates in a particular biocenosis depend on the helminth-faunistic complex which is typical for this ecosystem as well as on the favourable climatic conditions for the development of the invasive principle in the external environment at the parasitic link of the chain "egg-invasive egg" or "egg-larva-invasive larva" [26].

Undoubtedly, from an epizootological point of view, it is correct to consider not only the indices of the prevalence, but also the indices of the infestation intensity and the abundance of parasites. It is known that infestation intensity determines the degree of pathological changes in organs and tissues as well as the duration of the restoration of disturbed physiological functions in the host body after the expulsion of the pathogen. In addition, based on these indicators, the veterinarian determines the dominant types of pathogens in associated helminthoses, which is highly important for the selection of a therapeutic agent. The success of the fight against helminthoses ultimately depends on this [27,28].

We found that the rates of infestation intensity in the infected sheep ranged from 1 to 93 specimens per animal, and the abundance index ranged from 0.01 to 16.96 specimens per animal. Moreover, the maximum

number of nematodes from species *T. colubriformis*, *O. circumcincta*, *Oe. venulosum*, *T. ovis*, *T. skrjabini*, *Ch. ovina*, and *H. contortus* was revealed in sheep, where the I indicator ranged from 23.12 ± 0.81 to 29.58 ± 0.96 specimens per animal. The I indicator did not exceed 19.60 ± 0.77 specimens per animal in *S. ovis*, *N. spathiger*, *T. globulosa*, and *N. abnormalis*, and 9.61 ± 0.65 specimens per animal in *B. trichocephalum*, *S. papillosus*, *Cooperia* sp., and *A. bovis*. At the same time, the A indicators of GIN were characterized by the highest distribution of species *T. colubriformis*, *O. circumcincta*, *H. contortus*, *T. ovis*, and *Oe. venulosum* (11.42–16.96 specimens per animal) among the sheep population. The A indicator did not exceed 9.28 specimens per animal in species *T. globulosa*, *T. skrjabini*, *S. ovis*, *Ch. ovina*, and *N. spathiger*, and 0.73 specimens per animal in *A. bovis*, *B. trichocephalum*, *N. abnormalis*, and *Cooperia* sp. In our opinion, such a distribution of indicators is associated with the fitness of various nematode species, especially during their exogenous stages of development, to the environmental conditions as well as their resistance to adverse abiotic factors.

Many authors point out that most sheep helminthoses occur in pastures where animals become infected with alimentary pathogens through contaminated grass or water, mainly in stationary contaminated pastures. This is especially true for geohelminths, where the formation of nematodes' invasive eggs and larvae occurs in biotopes in the environment where livestock is grazed. At the same time, a significant potential accumulates in pasture biotopes for the invasive onset of helminths with which sheep become infected during the entire pasture period. Therefore, most often animals are infected with mixed invasions and, as a rule, regardless of their age or season, monoinvasions are very rarely recorded [13]. The results of our research confirm this. It was found that in 99.12% of the infected sheep, the selected GIN pathogens proceeded in the form of parasitic communities. The number of helminth species inside them in each animal varied from 1 to 10, where five- (P, 14.51%), six- (19.44%), and seven-component (15.92%) parasitic communities were most frequently diagnosed. Monoinvasions were

recorded in 0.88% of the infected sheep. In total, we identified 361 varieties of parasitic communities. Moreover, the prevalence of sheep with the most common coinvasions ranged from 0.70 to 1.77%. It was revealed that 14 coinvasions were the most common among sheep, where nematodes *H. contortus*, *O. circumcincta*, *T. colubriformis*, *T. ovis*, *N. spathiger*, *S. ovis*, and *Ch. ovina* were frequent comembers. The following coinvasions refer to them: 1 variety of 10-membered invasion, 2 varieties of 9-membered invasion, 2 varieties of 8-membered invasion, 4 varieties of 7-membered invasion, 3 varieties of 6-membered invasion, and 2 varieties of 5-membered invasion.

Domestic animals in anthropogenic ecosystems are exposed to intense helminth infections. Therefore, in the

study area, we recorded the presence of multicomponent parasitic communities of GIN pathogens in sheep. This is due to the fact that sheep have been in contaminated pastures with a high number of exogenous GIN stages for a long time. A similar pattern can be seen in Lindqvist et al. [29].

Conflict of interest

The authors declare the absence of any conflict of interest.

Informed consent

The research protocol of the current study was approved by the Ethic Committee of the Poltava State Agrarian Academy (Approval number: 2020/02).

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