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Checklist of small ruminant gastrointestinal nematodes and their geographical distribution in Turkey

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Abstract: This review presents a search of the literature about gastrointestinal nematodosis of small ruminants. The search was performed on 58 articles published on necropsied sheep and goats between 1937 and 2011 in Turkey. This review identified 43 nematode species belonging to sheep and goats, assessed the prevalence of infection in different regions of Turkey, and evaluated the effect of age, sex, race, nutrition, and seasonal condition. This is the first review that specifically evaluated the gastrointestinal nematodes of small ruminants for 74 annual periods in Turkey.

Key words: Gastrointestinal nematodes, small ruminant, Turkey

1. Introduction

Small ruminants are an important livestock in Turkey. Sheep and goat populations of Turkey from 1991 to 2010, according to 2010 data of the Turkish Statistical Institute (1), are shown in Figure 1. Gastrointestinal (GI) nematode infections in small ruminants are a cause of considerable economic loss in Turkey (2–4). These parasites are particularly insidious and lead to reductions in weight gain, milk yield, wool production, and carcass quality of the animals, especially in those with poor nutrition. The pathogenic effect of GI nematode infections may be subclinical or clinical. In particular, *Ostertagia* spp., *Haemonchus contortus*, *Trichostrongylus* spp., *Nematodirus* spp., *Oesophagostomum* spp., and *Chabertia ovina*, which are widespread in Turkey, cause morphological and functional damage in abomasum gastric glands, hemorrhage in the abomasum mucosa, villous atrophy in the small intestine, ulceration, and hemorrhage in the large intestine (5–6).

The purpose of the current review was to contribute to the ongoing research on the GI nematodes of small ruminants in Turkey. A search of the literature on the GI nematodosis of sheep and goats in Turkey was conducted examining papers published between 1937 and 2011. All published papers were found by searching CAB Abstracts, JSTOR, MEDLINE, ScienceDirect, ULAKBİM, Web of Science, PubMed, locally published articles, reference lists from relevant publications, and other electronic databases.

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The prevalence of GI nematodosis in sheep and goats varies from region to region in Turkey and the prevalence of infections is shown in Figure 2.

2. Gastrointestinal nematodes of small ruminants in Turkey

A total of 42 articles on sheep, 12 articles on goats, 3 articles and 1 review (7) on both sheep and goats were found to be related to the topic investigated for 74 annual periods in Turkey (Figure 3).

Cooperia oncophora (8), *C. mcmasteri* (9), and *C. curticei* (10) from sheep and *Ostertagia podjapolski* (*O. kolchida*), *O. leptospicularis*, *O. aegagri, Marshallagia orientalis*, *Trichostrongylus brevis*, *Trc. retortaeformis* (11), *Teledorsagia davtiani*, and *Trichuris skrjabini* (12) from goats are the first reported species in the investigated articles. Additionally, *Trc. longispicularis* (12,13), *Trc. skrjabini* (12,14), *O. lyrata*, *Capillaria bovis*, *Trichuris discolor* (12,15), *Parabronema skrjabini* (16,17), and *Nematodirus lanceolatus* (12,18) were first reported from both sheep and goats and a total of 43 GI nematode species have been determined up to now (Table 1).

The prevalence of GI nematode infections changes among regions in Turkey. The general prevalence according to region (minimum and maximum values) in sheep and goats and the nematode species found in these regions are shown in Figure 2 and Table 1, respectively. The results of some papers are not included in Table 1 because, in those

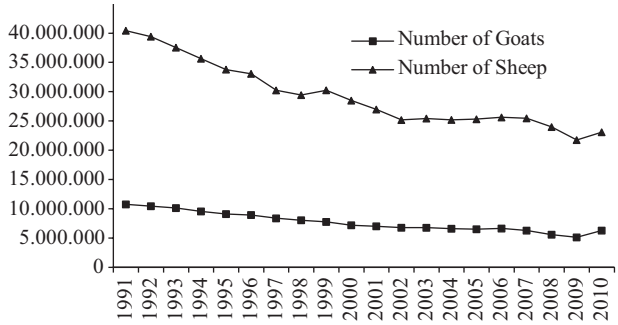

Figure 1. Population of sheep and goats in Turkey, by year.

papers, infection was not stated by region (19–25), but instead the prevalence of infection was given according to total worm counts (2,26–29) or an infection result was only reported for sheep and goats combined (30).

The different articles cover the major risk factors for GI nematodosis that have been found in Turkey, such as breed (33), nutrition (34), age, sex (11,12,35), and season (15,17,36–38). These factors were particularly evaluated as follows.

2.1. Breed

Güralp et al. (33) reported that the sensitivity and resistance of Texel, Merino, and Kıvırcık breeds of sheep to Trichostrongylidae infections was not statistically significant. No other study on breeds in Turkey could be found.

2.2. Nutrition

Girişgin et al. (34) found a significant worm count discrepancy between naturally fed and intensively fed lambs. They reported the prevalence of *Nematodirus abnormalis* (50%), *N. filicollis* (16%), *S. papillosus* (8.3%), *T. ovis* (50%), *T. discolor* (50%), *T.* (*O.*) *circumcincta* (100%), *T.* (*O.*) *trifurcata* (50%), and *H. contortus* (41.6%) in naturally fed lambs, although only *T. ovis* (33.3%) was found in intensively fed lambs.

2.3. Host age and sex

In Turkey, it was reported that while GI nematode infection was more common in adults (11,12,35,39,40), young animals had higher nematode species and worm counts than adults (11,38,39). Burgu et al. (41) observed high levels of *Skrjabinema*, Trichostrongylidae, and *Nematodirus* spp. in older goats, and *M. marshalli* and *Trichuris* spp. in young animals. However, an important statistical difference was not found. In another study, high percentages of nematode species were reported in the large intestines of young sheep and older goats (42).

In various studies, it was observed that female animals had a higher prevalence of infection as well as higher nematode species and worm counts than males (11,38,43). High levels of *Skrjabinema*, *M. marshalli*, and *Trichuris* spp. infections were observed in female goats, while Trichostrongylidae and *Nematodirus* spp. were more common in male goats (41). In 2 studies (41,44), the difference in GI nematode infection was not significant between the sexes.

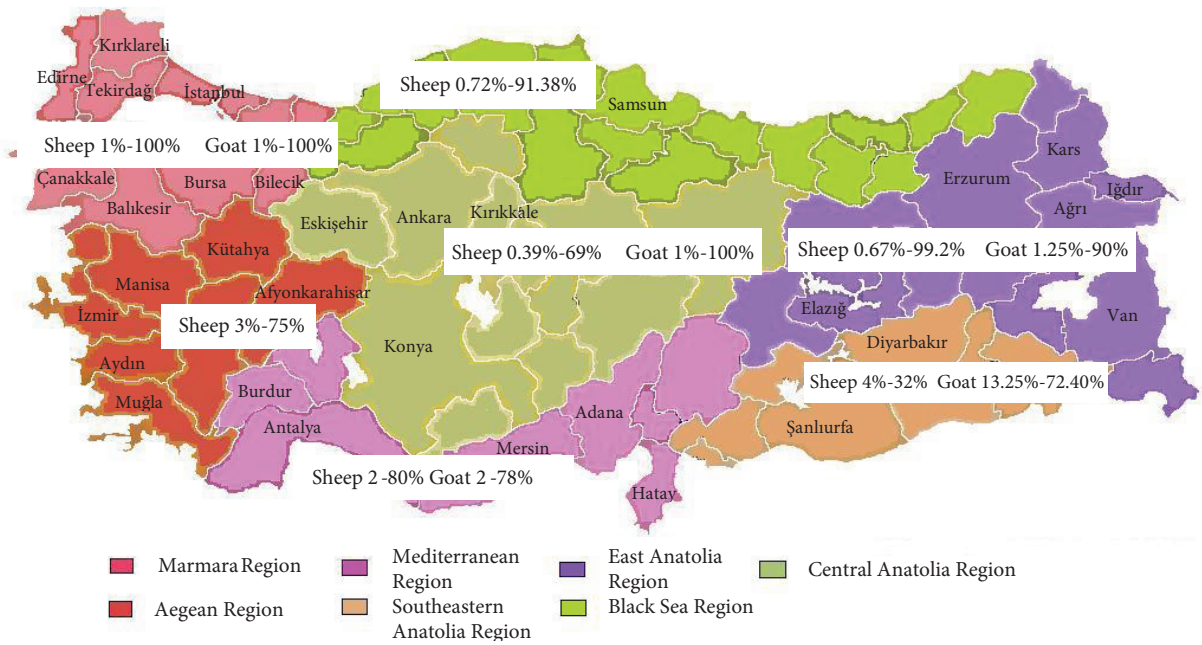

Figure 2. General prevalence (min-max) of GI nematodosis of small ruminants according to studied provinces and regions in Turkey.

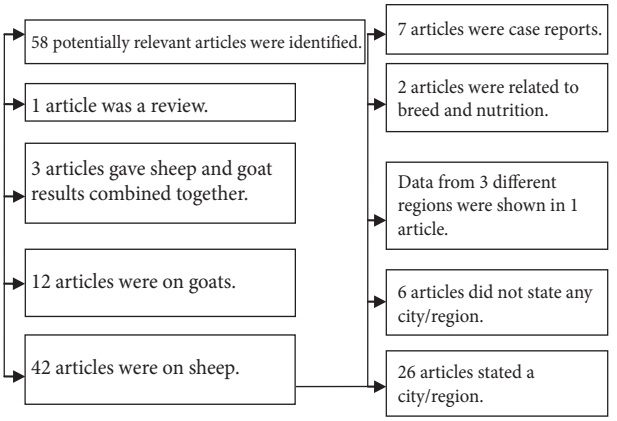

Figure 3. Categorization of published articles.

2.4. Geographical and seasonal distribution

The seasonal activity of the parasites differs according to animal species and age, parasite species, and geographic locality (15,17,36,37). The most effective factors are temperature and relative humidity on the seasonal activity of GI nematode species and development of eggs and larvae (6,36). Several studies done at different times in the same region show that the variety of GI nematode genus/species and their maximum levels result from different climate conditions in the study period (Table 2) (17,37,45–47).

There has been no study on the seasonal distribution of GI nematodes in small ruminants in the Aegean Region. However, studies (31,32) related to GI nematode genus/species in this region are shown in Table 1.

In the Marmara Region, the most common genus was *Teledorsagia* (mainly *T.* (*O.*) *circumcincta*) (11,37,40,48), followed by *Trichostrongylus* (*T. axei*, *T. capricola*, *T. colubriformis*, and *T. vitrinus*), *Nematodirus* (*N. spathiger*, *N. filicollis*, and *N. abnormalis*) (11,35,48–49), and *H. contortus* (Table 1). In the southern Marmara Region, Tinar et al. (37) reported that an increase in egg shedding was observed in October and November and maximum worm counts were detected during midsummer. *Haemonchus contortus* was found only during the first 3 months on pasture, and in autumn only *Teledorsagia* spp. and *Nematodirus* spp. were recorded in same study (Table 2).

Teledorsagia (O.) circumcincta, *Trichuris* spp. (*T. ovis*, *T. skrjabini*), *M.* (*O.*) *marshalli*, *Nematodirus* spp. (*N. abnormalis*, *N. spathiger*), and *Trichostrongylus* spp. (*Trc. vitrinus*) were commonly identified (17,47,50) (Table 1) during all seasons of the year in 2 different studies (17,47) done during the same period on small ruminants in the Mediterranean Region. The parasite counts in the sheep and goats reached maximum levels in autumn (17,47). While parasite counts were at minimum levels in sheep in winter (47), they increased again in goats in midwinter (17). The seasonal activity of important nematode genus/species according to month in sheep and goats are shown in Table 2.

In the Central Anatolia Region, Güralp et al. (36) observed that the risk of infection of sheep in grassland was higher from November to the end of the spring in Ankara. In the fecal cultures and necropsies of sheep and goats, *Teledorsagia (O.)* (mainly *T.* (*O.*) *circumcincta* and *T.* (*O.*) *occidentalis*), *M.* (*O.*) *marshalli*, *Trichostrongylus* spp. (mainly *T. colubriformis* and *T. probolurus*), and *Nematodirus* spp. (mainly *N. abnormalis* and *N. filicollis*) were dominant (12,51–53) (Table 1). While some differences in study periods were observed, in general more activity was noticed in nematode larvae during late autumn, winter, and spring months than in early fall and summer months (36). In another study, the highest incidence of GI nematodes of sheep in Konya Province were found in the autumn and winter seasons, while their incidence was the lowest in the spring and summer season (54).

According to some researchers (3,55), GI nematode infections increased in the beginning of autumn, winter, and spring in Samsun Province in the Black Sea Region. Similarly, Zeybek (46) reported that parasite counts in sheep reached the highest levels between December and March. The most common genus/species in this region were determined to be *Ostertagia* spp., *H. contortus*, *Nematodirus* spp., *Trichostrongylus* spp. (mainly *T. axei*), *C. ovina*, and *B. trigonocephalum* (Table 1).

In studies of GI nematode infections in the East Anatolia Region (15,38,56) it was emphasized that GI nematode infections were observed in all seasons (15). However, the highest rates were at the end of summer and in the middle of autumn (38) (Table 2). Important genus/species are shown in Table 2. *Teledorsagia* (*O.*) (mainly *T.* (*O.*) *circumcincta* and *T.* (*O.*) *occidentalis*), *M.* (*O.*) *marshalli*, *Trichostrongylus* spp. (mainly *T. axei* and *T. colubriformis*), and *H. contortus* (57–60) were the predominant species in this region (Table 1).

In the Southeastern Anatolia Region, Altaş et al. (61) reported that the highest percentages of GI nematode infection were observed in sheep during autumn and spring, while the number of infected goats especially increased in November to May (43). In this region, *T.* (*O.*) *circumcincta*, *M.* (*O.*) *marshalli*, *H. contortus*, and *Nematodirus* spp. (mainly *N. spathiger*) were commonly identified (Table 1).

3. Conclusion

The present review evaluated articles published on the GI nematodes in the sheep and goats of Turkey from 1937 to 2011. From 58 papers, a total of 43 GI nematode species were recorded. It appears that the GI nematode fauna of small ruminants showed diversity according to year, region of study, and study design. From the investigated

Table 1. Prevalence of infection, detection methods, study references, and distribution (%) of gastrointestinal nematode species in small ruminants according to regions in Turkey.

Nematodes	Marmara Region		Aegean Region		Mediterranean Region		Central Anatolia Region		Black Sea Region		East Anatolia Region		Southeastern Anatolia Region	
	G	S	G	S	G	S	G	S	G	S	G	S	G	S
***Ostertagia* sp.**	-	**20*** (31) **100**^{x} (45)	-	**20*** (31)	-	**4**$^{x,(a)}$ (47) **21.6*** (31)	-	**4.16**^{x} (54) **7.23*** (31)	-	**80.8**^{x} (46) **82.29**^{x} (3)	-	-	-	-
O. ostertagi	**10**$^{x,(a,b)}$ (11)	**5**$^{x,(a,b)}$ (35) **30**^{x} (40)	-	-	-	**2**$^{x,(a)}$ (47)	**19**$^{x,(a,b)}$ (12)	-	-	-	**27.50**$^{x,(a,b)}$ (39)	**6**$^{x,(a)}$ (15) **7.33**$^{x,(a)}$ (58)	-	**10.6**^{x} (61)
O. lyrata	-	-	-	-	-	-	**1**$^{x,+,(a)}$ (12) **60**$^{x,(a)}$ (53)	-	-	-	**7.50**$^{x,(a)}$ (39)	**2**$^{x,+,(a)}$ (15) **5.33**$^{x,(a)}$ (58)	-	-
O. kolchida (*O. podjapolski*)	**2**$^{x,+,(a)}$ (11)	-	-	-	-	-	-	-	-	-	-	-	-	-
O. leptospicularis	**4**$^{x,+(a,b)}$ (11)	-	-	-	-	-	-	-	-	-	-	-	-	-
O. aegagri	**1**$^{x,+,(a)}$ (11)	-	-	-	-	-	-	-	-	-	-	-	-	-
Teledorsagia davtiani	-	**13**$^{x,(a,b}$)(35)	-	-	-	**6**$^{x,(a)}$ (47)	**3**$^{x,+,(a)}$ (12)	-	-	-	**15**$^{x,(a)}$ (39)	**6**$^{x,(a)}$ (15) **14**$^{x,(a)}$ (58) **15**$^{x,(a)}$ (38)	-	-
T. (O.) occidentalis	**14**$^{x,(a,b)}$ (11)	**2**$^{x,(a)}$ (35)	-	-	**38**$^{x,(a)}$ (17)	**38**$^{x,(a)}$ (47)	**100**$^{x,(a)}$ (51) **68**$^{x,(a,b)}$ (12) **60**$^{x,(a)}$ (52)	**39.58**^{x} (54)	-	-	**63.75**$^{x,(a)}$ (39)	**32**$^{x,(a)}$ (15) **36**$^{x,(a,b)}$ (38) **42**$^{x,(a)}$ (58)	**14.45**^{x} (43)	**14.6**^{x} (61)
T. (O.) circumcincta	**100**$^{x,(a,b)}$ (11) **88**^{x} (48)	**54**$^{x,(a,b)}$ (35) **78**^{x} (40)	-	-	**78**$^{x,(a,b)}$ (17)	**80**$^{x,(a,b)}$ (47)	**100**$^{x,(a,b)}$ (51) **89**$^{x,(a,b)}$ (12) **13.52**$^{x,(a)}$ (52) **34**$^{x,(a,b)}$ (53)	**33.33**^{x} (54)	-	-	**90**$^{x,(a,b)}$ (39)	**50**$^{x,(a)}$ (57) **56**$^{x,(a,b)}$ (15) **62.67**$^{x,(a)}$ (58) **75**$^{x,(a,b)}$ (38)	**72.40**^{x} (43)	**26.6**^{x} (61)
T. (O.) trifurcata	**84**$^{x,(a,b)}$ (11) **44**^{x} (48)	**32**$^{x,(a,b)}$ (35) **20**^{x} (40)	-	-	**26**$^{x,(a)}$ (17)	**22**$^{x,(a)}$ (47)	**70**$^{x,(a)}$ (51) **38**$^{x,(a,b)}$ (12) **26.47**$^{x,(a)}$ (52)	**10.41**^{x} (54)	-	-	**66.25**$^{x,(a,b)}$ (39)	**33**$^{x,(a)}$ (15) **24.67**$^{x,(a)}$ (58) **10**$^{x,(a)}$ (38)	**45.78**^{x} (43)	**4**^{x} (61)
Marshallagia* (*O.*) *marshalli	**55**$^{x,(a,b)}$ (11) **16**^{x} (48)	**7**$^{x,(a)}$ (35)	-	-	**72**$^{x,(a,b)}$ (17) **6.92*** (50)	**64**$^{x,(a,b)}$ (47)	**100**$^{x,(a,b)}$ (51) **84**$^{x,(a,b)}$ (12) **15.1*** (41) **93.52**$^{x,(a)}$ (52) **74**$^{x,(a,b)}$ (53)	**68.77**^{x} (54)	-	-	**76.25**$^{x,(a,b)}$ (39)	**53**$^{x,(a,b)}$ (15) **66.67**$^{x,(a,b)}$ (58) **85**$^{x,(a,b)}$ (38)	**54.21**^{x} (43)	**32**^{x} (61)
M. orientalis	**22**$^{x,+,(a)}$ (11)	-	-	-	-	-	-	-	-	-	-	-	-	-
Camelostrongylus mentulatus	-	-	-	-	-	-	-	-	-	**0.72**^{x} (3)	-	**1**$^{x(a)}$ (38)	-	-

Table 1. (Continued).

Haemonchus sp.	-	**44*** (31)	-	**36.66*** (31)	-	**40.8*** (31)	-	**23.4*** (31)	-	-	-	-	-	-
H. contortus	**18**$^{x,(a)}$ (11) **4**^{x} (48)	**32**$^{x,(a,b)}$ (35) **38**^{x} (40) **8.33**^{x} (45)	-	-	**12**$^{x,(a)}$ (17)	**10**$^{x,(a)}$ (47)	**90**$^{x,(a)}$ (51) **62**$^{x,(a)}$ (12) **70**$^{x,(a)}$ (52) **12**$^{x,(a)}$ (53)	**37.50**^{x} (54)	-	**53.1**^{x} (46) **54.06**^{x} (3)	**30**$^{x,(a)}$ (39)	**50**$^{x,(a)}$ (57) **8**$^{x,(a)}$ (15) **7.33**$^{x,(a)}$ (58) **40**$^{x,(a)}$ (38)	**39.79**^{x} (43)	**9.3**^{x} (61)
Cooperia sp.	-	-	-	-	-	-	-	**2.08**^{x} (54)	-	**26**^{x} (46) **27.27**^{x} (3)	-	-	-	-
C. curticei	-	-	-	-	-	$^{+,\circ}$ (10)	-	-	-	-	-	-	-	-
C. oncophora	-	**3**$^{x,(b)}$ (35)	-	-	-	-	**20.58**$^{x,(b)}$ (52)	-	-	-	-	$^{+,\circ}$ (8) **1**$^{x,(a)}$ (15) **0.67**$^{x,(b)}$ (58)	-	-
C. punctata	-	-	-	-	-	**2**$^{x,(b)}$ (47)	-	-	-	-	-	-	-	-
C. surnabada (*C. mcmasteri*)	-	+,$^{\circ}$ (9) **2**$^{x,(b)}$ (35)	-	-	-	-	-	-	-	-	-	-	-	-
***Nematodirus* sp.**	-	**20*** (31) **32*** (49) **54.16**^{x} (45)	-	**16.66*** (31)	**13.07*** (50)	**25.6*** (31)	**1**$^{x,+,(b)}$ (12) **33.7*** (41)	**15.31*** (31)	-	**87**^{x} (46) **91.38**^{x} (3)	-	-	-	-
N. spathiger	**60**$^{x,(b)}$ (11)	**41**$^{x,(b)}$ (35) **12**^{x} (40)	-	-	**52**$^{x,(b)}$ (17)	**44**$^{x,(b)}$ (47)	**40**$^{x,(b)}$ (51) **44**^{x} (12) **20**$^{x,(b)}$ (53)	**4.16**^{x} (54)	-	-	**57.5**$^{x,(b)}$ (39)	**28**$^{x,(b)}$ (15) **8**$^{x,(b)}$ (58) **65**$^{x,(b)}$ (38)	**33.73**^{x} (43)	**14.6**^{x} (61)
N. filicollis	**26**$^{x,(a,b)}$ (11) **4**^{x} (48)	**35**$^{x,(a,b)}$ (35) **32**^{x} (40)	-	-	**14**$^{x,(b)}$ (17)	-	**60**$^{x,(b)}$ (51) **41**^{x} (12) **54.79**$^{x,(b)}$ (52) **78**$^{x,(b)}$ (53)	**25**^{x} (54)	-	-	**26.25**$^{x,(b)}$ (39)	**1**$^{x,(b)}$ (15) **13.33**$^{x,(b)}$ (58)	**13.25**^{x} (43)	**16**^{x} (61)
N. helvetianus	-	**5**$^{x,(b)}$ (35)	-	-	-	-	-	-	-	-	-	-	-	-
N. abnormalis	**80**$^{x,(a,b)}$ (11) **36**^{x} (48)	**46**$^{x,(b)}$ (35) **18**^{x} (40)	-	-	**66**$^{x,(b)}$ (17)	**40**$^{x,(b)}$ (47)	**90**$^{x,(b)}$ (51) **70**$^{x,(b)}$ (12) **60**$^{x,(b)}$ (52) **60**$^{x,(b)}$ (53)	-	-	-	**57.5**$^{x,(b)}$ (39)	**3**$^{x,(b)}$ (15) **18.67**$^{x,(b)}$ (58) **19**$^{x,(b)}$ (38)	-	-
***N. lanceolatus* (*N. oiratianus*)**	-	-	-	-	**6**$^{x,(b)}$ (17)	**30**$^{x,(b)}$ (47)	**9**$^{x,+}$ (12)	-	-	-	**1.25**$^{x,(b)}$ (39)	**8.64**$^{+}$ (18) **34**$^{x,(b)}$ (15) **0.67**$^{x,(b)}$ (58) **75**$^{x,(a,b)}$ (38)	-	-

Table 1. (Continued).

Parabronema skrjabini	-	-	-	-	**2**$^{x,+(a)}$ (17)	-	-	$^{+,\circ}$ (16) **2.08**^{x} (54)	-	-	**40**$^{x,(a)}$ (39)	**1**$^{x,(a)}$ (15) **6**$^{x,(a)}$ (58)	-	-
Strongyloides papillosus	-	**6*** (31) **54.16**^{x} (45) **2**^{x} (40)	-	**3.38*** (32) **16.66*** (31)	**9.23*** (50)	**15.2*** (31)	-	**5.43*** (44) **6.8*** (31)	-	**26.5**^{x} (46) **27.27**^{x} (3)	**8.75**$^{x,(b)}$ (39)	-	-	-
***Trichostrongylus* sp.**	-	**18*** (31) **100**^{x} (45) **61.5*** (40) **94*** (49)	-	**75.21*** (32) **8.33*** (31)	**43.07*** (50)	**8.8*** (31)	**53.4*** (41)	**38.65*** (44) **11.91*** (31)	-	**87.8**^{x} (46) **86.12**^{x} (3)	-	**85.4**^{x}**-99.2*** (59) **55.46*** (60)	-	-
T. axei (*T. extenuatus*)	**77**$^{x,(a,b)}$ (11) **4**^{x} (48)	**42**$^{x,(a,b)}$ (35) **100**^{x} (45) **46**^{x} (40)	-	-	**6**$^{x,(a)}$ (17)	**4**$^{x,(a)}$ (47)	**50**$^{x,(a,b)}$ (51) **39**$^{x,(a,b)}$ (12) **54.70**$^{x,(a)}$ (52)	-	-	**80.4**^{x} (46) **77.51**^{x} (3)	**5**$^{x,(a)}$ (39)	**41**$^{x,(a,b)}$ (15) **33**$^{x,(a)}$ (38)	-	-
T. capricola	**99**$^{x,(a,b)}$ (11) **36**^{x} (48)	**35**$^{x,(a,b)}$ (35) **6**^{x} (40)	-	-	**10**$^{x,(a,b)}$ (17)	-	**30**$^{x,(b)}$ (51) **22.35**$^{x,(b)}$ (52)	-	-	-	**7.50**$^{x,(b)}$ (39)	**3**$^{x,(b)}$ (15) **0.67**$^{x,(b)}$ (58)	-	-
T. colubriformis	**28**$^{x,(a,b)}$ (11)	**35**$^{x,(a,b)}$ (35) **18**^{x} (40)	-	-	**4**$^{x,(a)}$ (17)	**6**$^{x,(a,b)}$ (47)	**70**$^{x,(a,b)}$ (51) **19**$^{x,(a,b)}$ (12) **10.58**$^{x,(b)}$ (52) **2**$^{x,(b)}$ (53)	-	-	-	**7.50**$^{x,(b)}$ (39)	**66**$^{x,(a,b)}$ (15) **2**$^{x,(a,b)}$ (58)	-	-
T. longispicularis	-	-	-	-	-	-	**1**$^{x,+,(b)}$ (12)	-	-	-	**1.25**$^{x,(b)}$ (39)	**1.92-9.9** $^{+}$ (13)	-	-
T. probolurus	-	**2**$^{x,(b)}$ (35)	-	-	-	-	**70**$^{x,(a,b)}$ (51) **32**$^{x,(a,b)}$ (12) **6**$^{x,(b)}$ (53)	**2.08**^{x} (54)	-	-	**7.50**$^{x,(b)}$ (39)	**23**$^{x,(a,b)}$ (15) **4.67**$^{x,(b)}$ (58) **19**$^{x,(b)}$ (38)	-	-
T. skrjabini	-	-	-	-	**2**$^{x,(a)}$ (17)	-	**5**$^{x,+,(b)}$ (12)	-	-	-	-	$^{+,\circ}$ (14) **63**$^{x,(a,b)}$ (15)	-	-
T. vitrinus	**98**$^{x,(a,b)}$ (11) **28**^{x} (48)	**44**$^{x,(a,b)}$ (35) **34**^{x} (40)	-	-	**40**$^{x,(a,b)}$ (17)	**42**$^{x,(a,b)}$ (47)	**40**$^{x,(a,b)}$ (51) **24**$^{x,(a,b)}$ (12) **28.23**$^{x,(b)}$ (52)	**2.08**^{x} (54)	-	-	**18.75**$^{x,(b)}$ (39)	**1**$^{x,(a)}$ (15) **8**$^{x,(b)}$ (58)	**13.25**^{x} (43)	-
T. brevis	**1**$^{x,+,(b)}$ (11)	-	-	-	-	-	-	-	-	-	-	-	-	-
T. retortaeformis	**1**$^{x,+,(b)}$ (11)	-	-	-	-	-	-	-	-	-	-	-	-	-
Bunostomum sp.	-	**6*** (31)	-	**3.33***(31)	-	**2.4*** (31)	-	-	-	-	-	-	-	-
B. trigonocephalum	-	**1**$^{x,(b)}$ (35) **16.66**^{x} (45) **14**^{x} (40)	-	-	-	**2**$^{x,(b)}$ (47)	**20**$^{x,(b)}$ (52)	**2.55*** (31)	-	**44.8**^{x} (46) **40.19**^{x} (3)	**10**$^{x,(b)}$ (39)	**18**$^{x,(b)}$ (15) **1.33**$^{x,(b)}$ (58)	-	-
Capillaria bovis	-	-	-	-	-	-	**2**$^{x,+,(b)}$ (12)	-	-	-	**5**$^{x,(b)}$ (39)	**2**$^{x,+}$ (15) **0.67**$^{x,(b)}$ (58)	-	-
Trichuris sp.	-	**10*** (31) **58.33**^{x} (45) **4.6*** (40) **34*** (49)	-	**4.50*** (32) **11.66*** (31)	**3.07*** (50)	**13.6*** (31)	**16.1*** (41)	**27.79*** (44) **5.1*** (31)	-	**88.1**^{x} (46) **90.43**^{x} (3)	-	**5.04*** (60)	-	-

Table 1. (Continued).

T. ovis	**16**[x] (48)	**28**[x] (40)	-	-	**60**[x,(c)] (17)	**72**[x,(c)] (47)	**70**[x,(c)] (51) **39**[x,(c)] (12) **57.05**[x,(c)] (52) **54**[x,(c)] (53) **64**[x,(c)] (42)	**47.91**[x] (54) **58**[x,(c)] (42)	-	-	**61.25**[x,(c)] (39)	**30**[x,(c)] (15) **28.67**[x,(c)] (58) **7.2**[*] (59)	**22.88**[x] (43)	**13.3**[x] (61)
T. discolor	**8**[x] (48)	**2**[x] (40)	-	-	**20**[x,(c)] (17)	**36**[x,(c)] (47)	**20**[x,+,(c)] (12) **10**[x,(c)] (53)	**4.16**[x] (54) **4**[x,(c)] (42)	-	-	**17.50**[x,(c)] (39)	**8**[x,+,(c)] (15) **4.67**[x,(c)] (58)	-	-
T. globulosa	**4**[x] (48)	**8**[x] (40)	-	-	**26**[x,(c)] (17)	**22**[x,(c)] (47)	**28.82**[x,(c)] (52)	-	-	-	-	**3**[x,(c)] (15)	-	-
T. skrjabini	**16**[x] (48)	**6**[x] (40)	-	-	**50**[x,(c)] (17)	**74**[x,(c)] (47)	**34**[x,+,(c)] (12) **57.05**[x,(c)] (52) **10**[x,(c)] (53) **46**[x,(c)] (42)	**12.50**[x] (54) **30**[x,(c)] (42)	-	-	**36.25**[x,(c)] (39)	**55**[x,(c)] (15) **20.67**[x,(c)] (58)	**34.93**[x] (43)	**16**[x] (61)
Chabertia ovina	**16**[x] (48)	**4**[*] (31) **79.16**[x] (45) **28**[x] (40)	-	**3.33**[*] (31)	**8**[x,(c)] (17)	**12**[x,(c)] (47) **4**[*] (31)	**100**[x,(c)] (51) **55**[x,(c)] (12) **28.82**[x,(c)] (52) **18**[x,(c)] (53) **48**[x,(c)] (42)	**20.83**[x] (54) **14**[x,(c)] (42) **3.4**[*] (31)	-	**66.9**[x] (46) **67.94**[x] (3)	**58.75**[x,(c)] (39)	**4**[x,(c)] (15) **6.67**[x,(c)] (58)	**25.30**[x] (43)	-
***Oesophagostomum* sp.**	-	**6**[*] (31)	-	**8.33**[*] (31)	-	**14.4**[*] (31)	-	**7.23**[*] (31)	-	-	-	-	-	-
Oe. venulosum	**32**[x] (48)	**14**[x] (40) **75**[x] (45)	-	-	**10**[x,(c)] (17)	**10**[x,(c)] (47)	**40**[x,(c)] (51) **34**[x,(c)] (12) **14.11**[x,(c)] (52) **26**[x,(c)] (42)	**10.41**[x] (54) **8**[x,(c)] (42)	-	**70.4**[x] (46) **72.42**[x] (3)	**20**[x,(c)] (39)	**14**[x,(c)] (15) **4**[x,(c)] (58)	-	-
Oe. columbianum	-	-	-	-	-	-	-	-	-	-	-	**1**[x,(c)] (15)	-	-
Skrjabinema ovis	-	-	-	-	**34**[x,(c)] (17)	-	**21.15–42.30**[*] (62) **30**[x,(c)] (51) **14**[x,(c)] (53) **32.8**[s] (41) **22**[x,(c)] (12) **46**[x,(c)] (42)	**0.39**[*] (62)	-	-	**8.75**[x,(c)] (39)	-	-	-

G = goat, S = sheep, [*] = fecal examination results, [X] = necropsy results, [+] = first report, [o] = prevalence rates are not given, [a] = abomasum, [b] = small intestine, [c] = large intestine, [s] = cellophane band, - = unreported genus/species, and ( ) = reference number.

Table 2. Seasonal activity of important gastrointestinal nematode genus/species in small ruminants in Turkey.

Genus/species	Spring			Summer			Autumn			Winter		
	March	April	May	June	July	August	September	October	November	December	January	February
Ostertagia sp.	-	X (45)	X (*45)	X (45, 46)	X (45,46)	X (46)	X (45,46)	X (45)	X (45)	X (45)	X (45)	X (45)
Teledorsagia (*O.*)	X (17,47)	X (17,47)	X (*15,17,37,47)	X (*15,17,37,47)	X (*15,17,37,47)	X (17,*37,38, 47)	X (*17,37,38,*47)	X (17,37,47)	X (17,37,47)	X (17,47)	X (17,47)	X (17,47)
Marshallagia (*O.*) *marshalli*	X (17,47)	X (17,47)	X (*17,47)	X (17,47)	X (17,47)	X (17,47)	X (17,38,47)	X (17,*47)	X (*15,17,47)	X (*15,17,47)	X (*15,*17,47)	X (*15,17,47)
H. contortus	-	-	X (37)	X (*37)	X (37)	X (*38)	-	-	-	-	-	-
Nematodirus	X (17,47)	X (17,47)	X (17,37,47)	X (17,37,46,47)	X (17,*37, *47)	X (*15,17,37,47)	X (*17,37,38,46,47)	X (17,37,47)	X (17,37,47)	X (17,46,47)	X (17,47)	X (17,47)
Trichostrongylus	X (17,47)	X (17,45,47)	X (17,37,45,47)	X (17,37,45,47)	X (17,*3745,47)	X (17,37,45,47)	X (17,37,45,47)	X (*15,17,45,*47)	X (*15,17,*45,47)	X (17,45,47)	X (17,45,47)	X (*15,17,45,47)
Chabertia ovina	-	X (*45)	X (45)	X (37,45)	X (37,45)	X (*37,45)	X (37,45)	X (45)	X (45)	X (45)	X (45)	X (45)
Oesophagostomum	-	X (45)	X (*45)	-	X (37,45)	X (*15,*37)	X (*15)	-	X (45)	X (45)	-	X (45)

- = unreported genus/species, X = reported genus/species, ( ) = reference number, * = picked level.

literature, it appeared that GI nematodosis was found at different rates in each region of Turkey. However, higher infection prevalence in terms of important genera and species was observed in the Marmara, Central Anatolia, Mediterranean, and East Anatolia regions. This is the first review that specifically evaluated the GI nematodes of small ruminants for 74 annual periods in Turkey. Therefore, the current study may contribute to the knowledge of researchers investigating GI nematodes in small ruminants in Turkey.

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