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RESEARCH PAPER

Nematode Diversity Associated with Grapevines in İzmir, Manisa, Çanakkale, Balıkesir, and Bilecik Provinces in Türkiye

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Abstract

The study was conducted in İzmir, Manisa, Çanakkale, Balıkesir, and Bilecik provinces to determine nematode diversity and community structure. Thirty-six genera (İzmir 34 genera; Manisa 32 genera; Bilecik 21 genera; Çanakkale 28 genera) with different trophic groups were recorded: fungivores (3 genera; e.g., *Aphelenchoides* spp.), bacterivores (9 genera, e.g., *Achromadora* Cobb, 1913 and *Plectus* Bastian 1865 spp.), omnivore (4 genera; e.g., *Aporcelaimus* Thorne, 1936 and *Dorylaimus* Thorne & Swanger, 1936 and *Eudorylaimus* Andrassy, 1959 spp.), predators (3 genera; e.g., *Clarkus* spp.), herbivores (17 genera; e.g., *Boleodorus tylactus* Thorne, 1941). Twenty-six species of herbivores were identified, and the most common species were from the genera *Filenchus* Andrassy, 1954, *Geocenamus* Thorne & Malek, 1968; *Pratylenchus* Filipjev, 1934, and *Helicotylenchus* Steiner, 1945. *Dorylaimus* Dujardin, 1845; *Mesorhabditis* Osche, 1952; *Cephalobus* Bastian, 1865; *Acrobeloides* Cobb, 1924; *Mesodorylaimus* Andreassy, 1959; *Aphelenchus* Bastian, 1865, and *Ditylenchus* Filipjev were other commonly found nematode genera. *Meloidogyne incognita, M. javanica, Mesocriconema xenoplax, Longidorus elongatus, Xiphinema index*, *X. italiae, Praylenchus thornei*, and *P. neglectus* identified constitute a severe threat to grape production by causing crop damage or transmitting virus diseases.

1. Introduction

Grapevine (*Vitis vinifera* L.) is a perennial plant from the Vitaceae family, originating from Western Asia and Europe. The genus *Vitis* has more than 80 described species and consists of two subspecies, Muscadinia (2n = 40 chromosomes) and Euvit (2n = 38 chromosomes). More than 6,000 *V. vinifera* species are grown in different countries (Agulheiro-Santos et al., 2022. Grapevine adapted to semi-tropical or even tropical conditions from temperate climatic conditions, is among the world's most widely grown cultivated plants due to not being selected for soil requirements and being easily reproduced and consumed in different ways. In addition to consuming fresh fruits, their seeds are processed to produce jam, juice, jelly, vinegar, wine, plant extracts, and oil. Annual grape production worldwide is 7.8 million tons, of which 57% is processed, 36% is consumed fresh, and 7% is dried (Küpe et al., 2021). In Türkiye, where 1450 differentgrape varieties are grown, grape production contributes to 28% of fruit production, and vineyards constitute 15% of horticultural areas. While China, France, Spain, Italy, and Türkiye are the leading countries regarding production, the grapevine is grown in more than 90 countries (OIV, 2022).

Vineyard soil fauna maintains many beneficial or harmful organisms such as nematodes, fungi, viruses, algae, and protozoa. Nematodes with different feeding habitats, like fungal or plant feeding, takes an important place in the soil fauna. For instance, 300 plant feeder (herbivore) species and dozens from other trophic groups have been

described in vineyards, and the total number of nematodes distributed in agricultural areas in the world is estimated at more than 500.000 (Hoschitz, 2004; Kennedy and Luna, 2005; Singh et al., 2013).

Herbivore plant-parasitic nematodes, one of the major pests that damage the underground parts of plants, play a significant role in transmitting some viral diseases to plants (Taylor and Brown, 1997). Herbivores damage vine roots by feeding, thereby affecting the plant's uptake of water and nutrients from the soil. *Xiphinema* spp., *Longidorus* spp., *Criconemoides* spp., *Pratylenchus* spp., and *Meloidogyne* spp. are known as the most important herbivore genera in vineyards (Abd Elgawad and Askary, 2015). In contrast to herbivores, free-living species are involved in the mineral cycle of soil and are foremost contributors to the soil food webs (Bongers and Ferris, 1999). As a result of consuming organic residues, they promote the release of nitrogen and mineralization of phosphorus and sulphur. Additionally, some fungal and bacterial feeder nematodes are able to feed on plant pathogens, reduce their populations, and serve as prey and food source for nematode-trapping fungi (Taher et al., 2017). Predator nematodes, on the other hand, feed on other nematode species and affect the nematode population in vineyard areas (Ingham et al., 1985).

Nematode distiribution in vineyards is increasing day by day as a result of the uncontrolled planting of infected rootstocks, the inadequacy of quarantine procedures, and the increase in precipitation and flooding due to global warming. Many plant-parasitic nematode species have been identified in vineyards in some locations in the country, and dozens of unidentified ones still remain in other provinces. Dozens of nematodes, including free-living species, can also be found in other provinces, and nematode-infested areas continue to increase. Therefore this research focused on determining the nematode fauna of vineyards in İzmir, Manisa, Çanakkale, and Bilecik provinces in the western part of Türkiye. The diversity and community structure (trophic groups of nematodes, abundance, classification) in vineyards were discussed and compared by calculating some diversity indices.

2. Material and Methods

2.1. Survey area information

İzmir and Manisa are located in the Aegean Region of Türkiye. Çanakkale and Bilecik are located in the Marmara Region in Türkiye. Many fruit trees, such as olives and cherries, and cultivated plants, such as corn, tomatoes, and sunflower, are grown in these provinces. On the other hand, vineyard areas have an important position in agricultural production in many districts of Manisa, especially in terms of the area they cover. While the grape is produced on a small scale in İzmir, Çanakkale, and Bilecik, production is carried out in more extensive areas in Manisa. During the field studies, the temperature in İzmir, Manisa, Bilecik, and Çanakkale ranged between 26-36°C, and the annual precipitation in the provinces was around 600-713 mm.

2.2. Survey and soil sample collection

A survey was conducted in September 2021 and June 2022 in vineyards in Manisa, Çanakkale, Bilecik, and İzmir provinces (Figure 1). During the study, randomly selected commercial vineyards were sampled, and 105 soil samples were collected at 0-60 cm soil depth from the rhizosphere of the grapevines (Table 1). Sampling was done at randomly selected vineyards at a distance of at least 1 km between them. The mean size of vineyards was 1.0-2.0 ha in İzmir, 1.0-4.5 ha in Manisa, 0.5-1.2 ha in Çanakkale, and 0.5-0.9 ha in Bilecik. The sampled location was recorded. Sampling in each vineyard was conducted by moving in a zigzag pattern between the rows and collecting soil from the rhizosphere of randomly selected vines at different points. Soil cores were collected from at least 7 points in each vineyard,

Figure 1. The study area map with the names of provinces marked.

Table 1. Sampling details of Manisa, İzmir, Çanakkale, and Bilecik provinces.

Provinces	Total vineyard area (ha)	Locations	Collected samples
İzmir	10 385	Kemalpaşa, Bayındır, Torbalı	25
Manisa	86 849	Saruhanlı, Akhisar, Turgutlu, Şehzadeler, Yunusemre	52
Çanakkale	4 565	Bayramiç, Bozcaada, Merkez	16
Bilecik	1 048	Söğüt	12

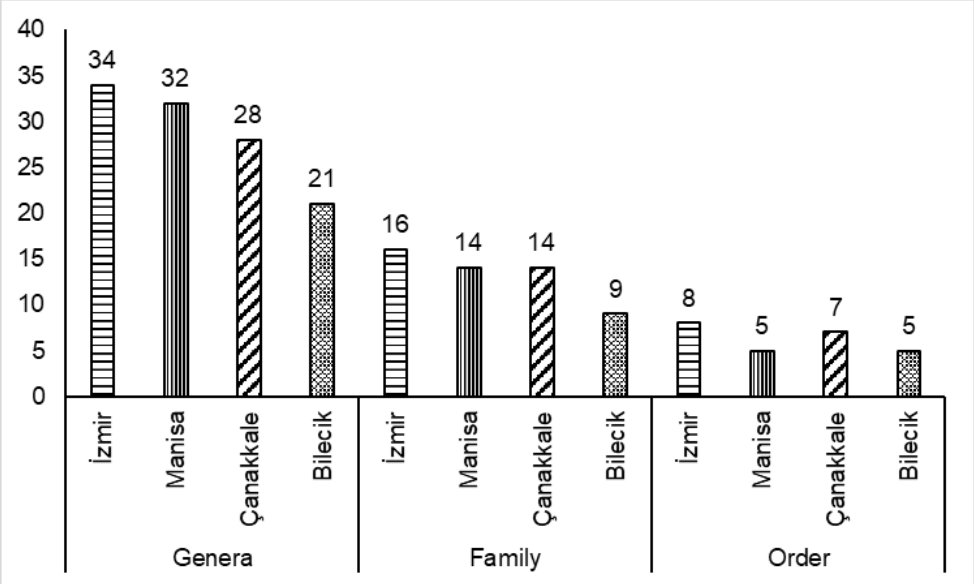

Figure 2. Genera, family, and order richness of İzmir, Manisa, Çanakkale and Bilecik.

and all were mixed to obtain 1 kg of soil. Collected soil samples were labelled, and transferred to the laboratory.

2.3. Extraction of nematodes from soil and identification

Soil nematodes were extracted by combining Cobb's (1913) decanting-sieving and centrifuge flotation methods of Jenkins (1964). Extracted nematodes were classified at the genus level by examining the morphology of females in nematode slides. Herbivores and Aphelenchids were identified at the species level. To prepare slides, extracted females were heat-killed, fixed in double-strengthened TAF solution, and mounted by the wax-ring method (Seinhorst, 1959). Root-knot nematodes were identified from the perineal pattern of females. The classifications of specimens were conducted based on Siddiqi (2000). Extracted nematodes were grouped based on feeding habitat and colonizer-persister values (c-p value 1-5) calculated based on life strategy (Bongers, 1990; Yeates et al., 1993; Neher et al., 2004).

3. Results

3.1. Nematode diversity of vineyards in İzmir, Manisa, Çanakkale, and Bilecik

In the nematode fauna of vineyards in İzmir, Manisa, Çanakkale, and Bilecik districts, species from eight orders, 17 families, and 36 genera were identified, and these were divided into two groups of plant-parasitic herbivore and free-living (bacterivore, fungivore, predator, and omnivore) nematodes (Figure 2).

Depending on the number of genera and identified families, the provinces ranked from higher to lower as İzmir, Manisa, Çanakkale, and Bilecik. Herbivores took first place with 17 genera, followed by bacterivores (9 genera), omnivores (4 genera), fungivores (3 genera), and predators (3 genera) (Figure 3).

Extracted nematodes belonged to five colonizer-persister (c-p1-5) functional groups. Nematodes from c-p2 were dominant, occurring in all sampled vineyards. (Figure 4).

Acrobeloides (90%), *Aphelenchus* (76.1%), *Aphelenchoides* (72.7%), and *Ditylenchus* (81.8%) were highly distributed in Manisa. The same genera were also frequent and abundant in İzmir and Çanakkale. The abundance of nematodes from these genera ranged between 6-45 individuals/100 cm^3 soils. In Bilecik, bacterivore *Cephalobus* and fungivore *Aphelenchus* were extracted from all sampled vineyards, and other common free-living genera were *Acrobeles* and *Aphelenchoides*. The least frequent nematodes in all survey areas belonged to predator *Clarkus* (2.5 ± 0.5 and 2 individuals 100 cm^3 soil) and *Plectus* (2 individuals 100 cm^3 soil) genera, which were only found in 4 vineyards in İzmir.

The classification of identified nematodes based on Siddiqi (2000) is given in Table 2.

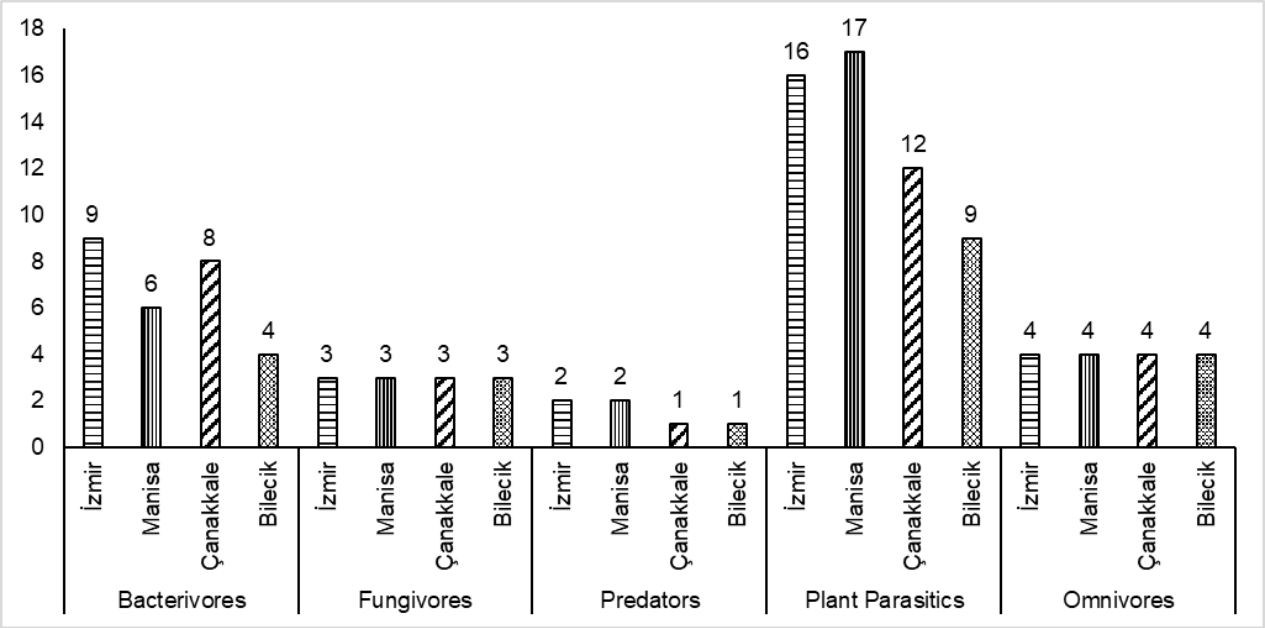

Figure 3. The composition of nematode genera in the point of feeding habitat in vineyards in four provinces.

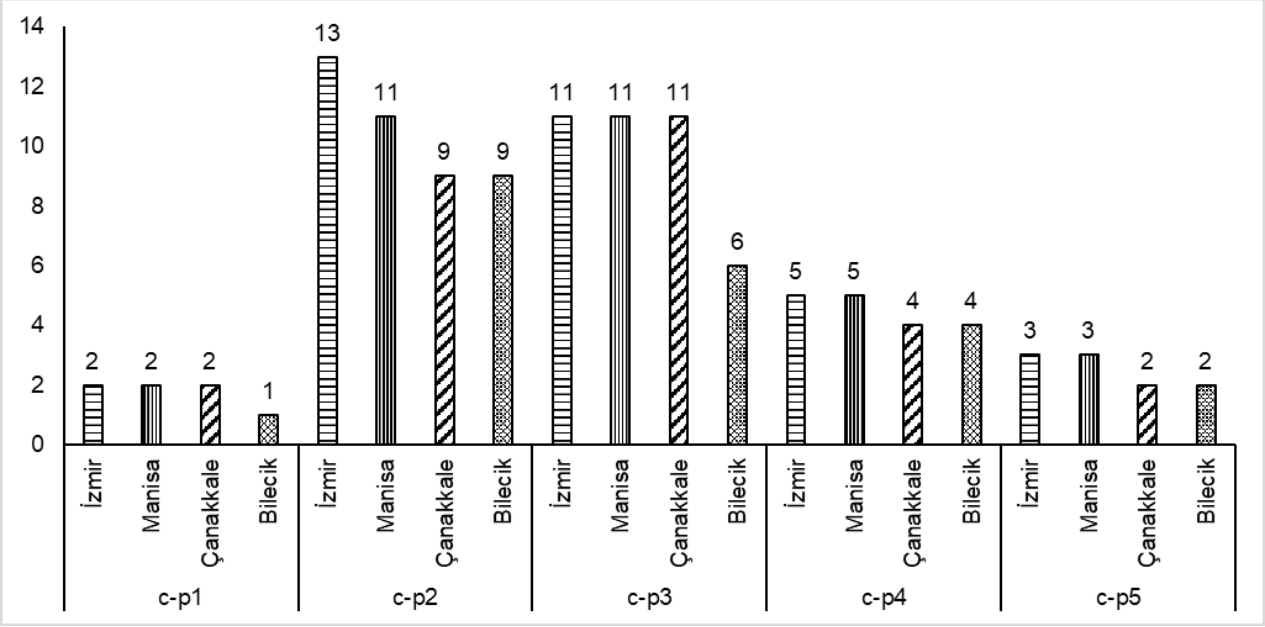

Figure 4. The number of nematode genera according to c-p classes.

3.2. Plant-parasitic nematodes in vineyards in İzmir, Manisa, Çanakkale and Bilecik

In this study, 17 herbivores nematode species belonging to the genera of *Boleodorus, Filenchus, Geocenamus, Helicotylenchus, Longidorus, Macroposthonia, Meloidogyne, Mesocriconema, Paratylenchus, Pratylenchus, Pratylenchoides, Psilenchus, Rotylenchus, Rotylenchulus, Tylenchus, Tylenchorhynchus,* and *Xiphinema* were identified. Sixteen were found in İzmir, 17 in Manisa, 14 in Çanakkale, and nine in Bilecik. At least one specimen of ectoparasite was found in all sampled vineyards, while endoparasites and semi-endoparasites were extracted from 51.8% of vineyards. Additionally, herbivores were classified into three colonizer-persister groups (c-p2, 3 and 5), and in all provinces, c-p3 species were leading (Figure 5). Considering the number of plant-parasitic species in provinces, 20 species were counted in Izmir, 23 species in Manisa, 14 species in Çanakkale, and 10 species in Bilecik. Table 3 represents the classification and distribution of plant parasitic nematode species.

Filenchus (occurrence: İzmir 95%; Manisa 97.7%; Çanakkale %100, Bilecik 57.1%) was widespread in survey areas. *Meloidogyne* spp., one of the most damaging plant parasites, was found in 9 vineyards in Manisa and two vineyards in İzmir. In addition, *Meloidogyne* was also found in two vineyards in Bozcaada, Çanakkale. The abundance in 100 cm^3 soil was 33 ± 6 individuals 100 cm^{-3} soil.

Table 2. Taxonomic classification of nematode genera and species and occurrence in İzmir, Manisa, Çanakkale, and Bilecik vineyards.

Genus	Order	Family	Functional guild/ c-p class	İzmir	Manisa	Çanakkale	Bilecik
Achromadora	Chromadorida	Achromadoridae	ba/c-p3	+	-	+	-
Acrobeloides	Rhabditida	Cephalobidae	ba/c-p2	+	+	+	+
Acrobeles	Rhabditida	Cephalobidae	ba/c-p2	+	+	+	+
Alaimus	Dorylaimida	Alaimidae	ba/c-p4	+	+	+	-
Aphelenchus avenae	Aphelenchida	Aphelenchoididae	fu/c-p2	+	+	+	+
Aphelenchoides sacchari	Aphelenchida	Aphelenchoididae		-	+	-	-
Aphelenchoides obtusus	Aphelenchida	Aphelenchoididae	fu/c-p2	+	+	+	+
Aporcelaimus	Dorylaimida	Aporcelaimidae	om/c-p5	+	+	+	+
Basiria	Tylenchida	Tylenchidae	pp/c-p2	+	+	-	-
Boleodorus	Tylenchida	Boleodorinae	pp/c-p2	+	+	+	+
Cephalobus	Rhabditida	Cephalobidae	ba/c-p2	+	+	+	+
Clarkus	Mononchida	Mononchidae	pr/c-p4	+	-	-	-
Ditylenchus myceliophagus	Tylenchida	Anguinidae	fu/c-p2	+	+	+	+
Dorylaimus	Dorylaimida	Dorylaimidae	om/c-p4	+	+	+	+
Eudorylaimus	Dorylaimida	Dorylaimidae	om/c-p4	+	+	+	+
Filenchus	Tylenchida	Tylenchidae	pp/c-p2	+	+	+	+
Geocenamus	Tylenchida	Merliniidae	p-p/c-p3	+	+	+	+
Helicotylenchus	Tylenchida	Hoplolaimidae	pp3	+	+	+	+
Longidorus	Dorylaimida	Longidoridae	pp/c-p5	+	+	-	-
Macroposthonia	Tylenchida	Criconematidae	pp/c-p3	+	+	+	-
Meloidogyne	Tylenchida	Heteroderidae	pp/c-p3	+	+	+	-
Mesodorylaimus	Dorylaimida	Dorylaimidae	om/c-p4	+	+	+	+
Mesorhabditis	Rhabditida	Rhabditidae	ba/c-p1	+	+	+	-
Paratylenchus	Tylenchida	Paratylenchidae	pp/c-p3	+	+	-	-
Plectus	Plectida	Plectidae	ba/c-p2	+	-	-	-
Pratylenchoides	Tylenchida	Pratylenchidae	pp/c-p3	+	+	+	-
Pratylenchus	Tylenchida	Pratylenchidae	pp/c-p3	+	+	+	+
Psilenchus	Tylenchida	Tylenchidae	pp/c-p2	+	+	-	-
Rhabditis	Rhabditida	Rhabditidae	ba/c-p1	+	+	+	+
Rotylenchus	Tylenchida	Hoplolaimidae	pp/c-p3	+	+	+	+
Rotylenchulus	Tylenchida	Rotylenchulidae	pp/c-p3	-	+	+	-
Seinura	Aphelenchida	Aphelenchoididae	pr/c-p4	-	+	-	-
Tripyla	Triplonchida	Tripylidae	pr/c-p3	+	+	+	+
Tylenchus	Tylenchida	Tylenchidae	pp/c-p2	+	+	-	+
Tylenchorhynchus	Tylenchida	Telotylenchidae	pp/c-p3	+	+	+	+
Xiphinema	Dorylaimida	Longidoridae	pp/c-p5	+	+	+	+
Wilsonema	Plectida	Plectidae	ba/c-p2	+	-	+	-

ba: bacterivore, fu: fungivore, om: omnivore, pr: predator, pp: plant parasitic.

In this study, many nematode species with different trophic groups were detected in İzmir, Manisa, Çanakkale, and Bilecik provinces. Of these plant-parasitic and bacterivore species were the most dominant. Some of the species that we identified have been found in vineyards in many studies. Species belonging to free-living nematode genera, such as *Acrobeles, Acrobeloides, Aphelenchus, Clarkus*, and *Plectus*, were found in California, the USA, and Austria. Likewise, in our study, *Clarkus, Plectus*, and *Wilsonema* were the least frequent in survey areas (All-Banna and Gardner, 1996; Hoschitz, 2004).

Several bacterivore genera were present in soil samples in İzmir, Manisa, Çanakkale, and Bilecik. They are highly tolerant to extreme soil conditions, are widely reported in agricultural areas in Türkiye. In the research conducted by Yıldız et al. (2017) in Bolu, *Cephalobus* and *Acrobeloides* species were found in all sampled fields. Again, the prevalence of these two genera was 100% in another study conducted by Akyazı et al. (2012) in the potato fields in the Ordu province. Similarly to these studies, in our study in İzmir, Manisa, Çanakkale, and Bilecik, species from *Acrobeloides* and *Cephalobus* came to the fore in vineyards regarding prevalence. For instance, in Bilecik Söğüt, İzmir Kemalpaşa, Çanakkale Bozcaada, and Bayramiç, most of the surveyed vineyards were found to be infested with *Acrobeloides*. Bacterivores consume and decompose the bacteria in the soil and release valuable nitrogen into the soil. Bacterivore nematodes can consume 10^6 bacterial cells daily (Blanc et al., 2006). Although they have shorter life spans than other group nematodes. These species have a higher reproduction rate. For example, *Acrobeloides nanus* from *Acrobeloides* genera can produce $2\text{-}3\times10^5$ new nematodes in one month (Wasilewska et al., 2011). Morever, *Cephalobus litoralis* of the genus *Cephalobus* can reproduce

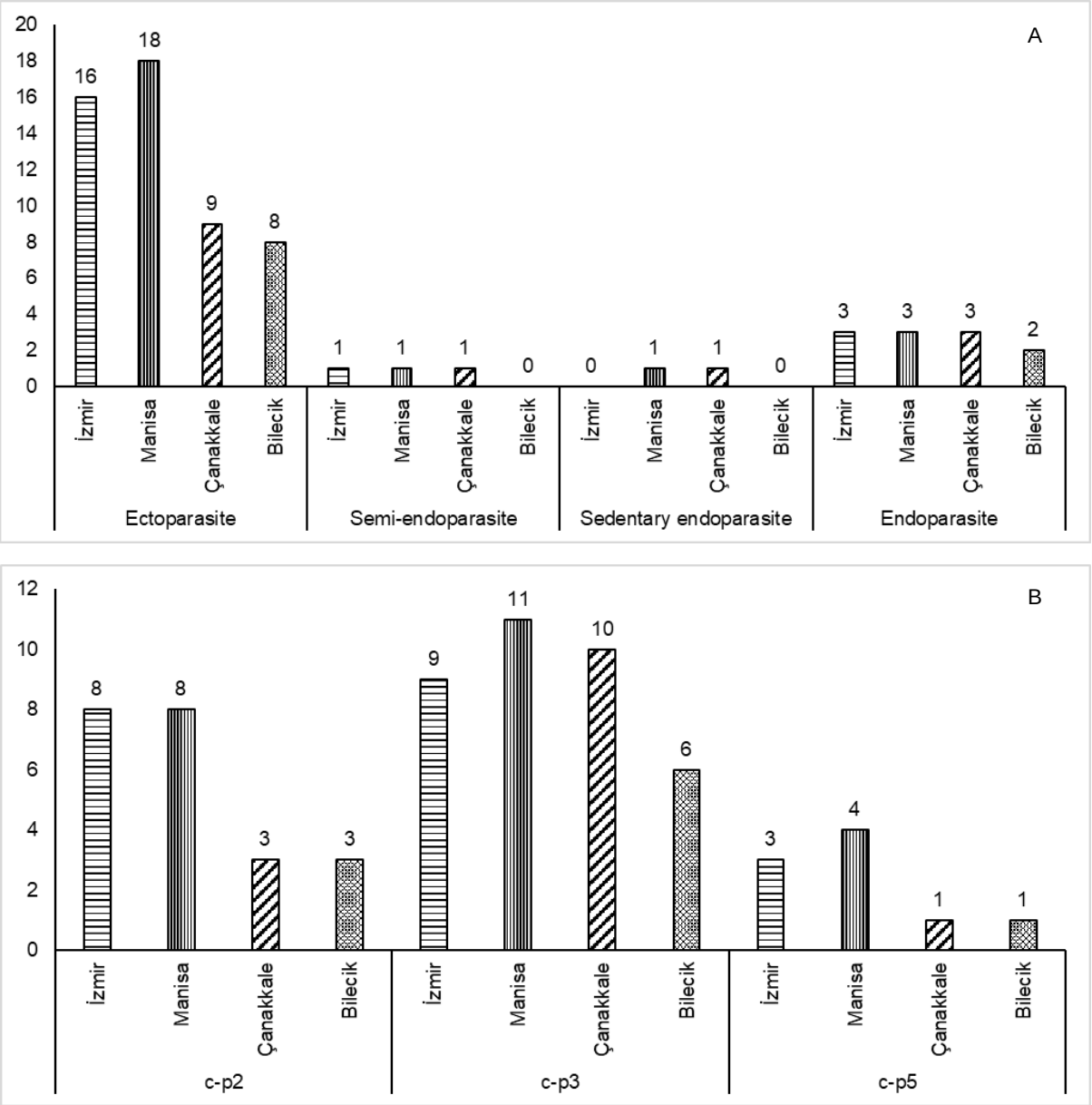

Figure 5. The number of identified genera of herbivore nematodes with different feeding strategies in İzmir, Manisa, Çanakkale, and Bilecik (A) and the number of herbivore nematode genera in three c-p values in İzmir, Manisa, Çanakkale and Bilecik (B).

very quickly parthenogenetically, can complete its life cycle in 72-90 days, and a female can lay 200-300 eggs (Saeed et al., 1988). Another species found widespread in vineyards were fungal feeders, especially *Aphelenchus avenae,* which was found in 80 of 105 soil samples. Considered as mostly fungi and mushroom feeder, there are few records of *A. avenae* being a plant parasite (Kumari, 2012). The nematode can feed on more than 90 fungal species belonging 50 genera (Mankau and Mankau, 1963). *Ditylenchus myceliophagus* and *Aphelenchoides* spp., commonly found in our study, can also feed on many pathogenic and non-pathogenic fungi, including *Agaricus bisporus* (Arrold and Blake, 1966).

Seventeen genera of plant-parasitic nematode with different feeding strategy were identified in survey area. Migratory ectoparasite species were found to be more predominant in four provinces. Among the herbivore nematodes in İzmir, Manisa, Çanakkale, and Bilecik, economically important species were *Meloidogyne* spp., *Pratylenchus thornei, P. neglectus, Longidorus elongatus, Xiphinema index, X. italiae,* and *Mesocriconema xenoplax*. *Xiphinema pachtaicum* was found in all provinces, but other species were not in detected in Çanakkale and Bilecik. *Longidorus elongatus* was extracted only from one vineyard in Akhisar, Manisa and one vineyard in Kemalpaşa, İzmir. All these species have been found in vineyards in many countries, including Spain, Iran, the USA, and Türkiye (Pinkerton et al., 1999; Téliz et al., 2007; Deimi and Mitkowski, 2010). *Meloidogyne* and *Xiphinema* species were reported in vineyards in

Table 3. Plant-parasitic nematode species extracted from soils collected from vineyards in İzmir, Manisa, Çanakkale, and Bilecik provinces.

Species	c-p	Feeding strategy	İzmir	Manisa	Çanakkale	Bilecik
Basiria graminophila	2	Migratory ectoparasite/ root fungal feeder	+	+	-	-
Boleodorus thylactus	2	Migratory ectoparasite	+	+	+	+
Filenchus sheri	2	Migratory ectoparasite	+	+	+	-
Filenchus thornei	2	Migratory ectoparasite	+	+	+	+
Filenchus cylindricus	2	Migratory ectoparasite	+	+	-	-
Geocenamus brevidens	3	Migratory ectoparasite	+	+	+	+
Helicotylenchus digonicus	3	Migratory ectoparasite	+	+	+	+
Helicotylenchus varicaudatus	3	Migratory ectoparasite	-	+	-	-
Longidorus elongatus	5	Migratory ectoparasite	+	+	-	-
Meloidogyne	3	Sedentary endoparasite	+	+	+	-
Mesocriconema xenoplax	3	Migratory ectoparasite	+	+	+	-
Paratylenchus nainianus	2	Migratory ectoparasite	+	+	-	-
Pratylenchoides alkani	3	Migratory endoparasite	+	+	+	-
Pratylenchus neglectus	3	Migratory endoparasite	+	+	+	+
Pratylenchus thornei	3	Migratory endoparasite	+	+	+	+
Psilenchus hilarulus	2	Migratory ectoparasite/ root fungal feeder	+	+	-	-
Rotylenchus cypriensis	3	Migratory ectoparasite	+	+	+	+
Rotylenchulus macrosoma	3	Semi-endoparasite	-	+	+	-
Tylenchorrhynchus cylindricus	3	Migratory ectoparasite	+	+	+	+
Tylenchus davainei	2	Migratory ectoparasite/ root fungal feeder	+	+	-	+
Xiphinema pachtaicum	5	Migratory ectoparasite	+	+	+	+
Xiphinema index	5	Migratory ectoparasite	+	+	-	-
Xiphinema italiae	5	Migratory ectoparasite	-	+	-	-

previous studies in Manisa and İzmir (Mistanoğlu et al., 2015).

Among all plant-parasitic nematodes identified in this study, *Meloidogyne incognita* and *M. javanica* were reported to be the most damaging on grapevines. Due to the galls formed on the vine root by these pests' damage, the vascular bundles are blocked, and the plant cannot uptake water and nutrients from the soil. Although many rootstocks such as Richter 110R, Salt Creek, and SO_4 have been reported as resistant to *Meloidogyne* species, resistance can vary depending on climatic conditions, the abundance of nematode populations, and soil conditions (Vega-Callo et al., 2021).

Xiphinema index, X. italiae, and *L. elongatus* are considered as other harmful nematodes because they can transmit virus diseases like grapevine fanleaf virus (GFLV) to healthy vines (Taylor and Brown, 1997). In this study these species were found in different locations of Türkiye. Elekçioğlu et al., (1994) stated *X. italieae* infection of the roots of grapevine in the southern part of Türkiye, while Mistanoğlu et al. (2015) revealed a 9.5% prevalence in western provinces. However, including this recent study, in none of these studies, the nematode population was found to be at a level that would cause economic damage.

Mesocriconema xenoplax was one of the other damaging ectoparasitic species found in four provinces. In this study's research area, the nematode was found in İzmir (4 vineyards), Manisa (5 vineyards), and Bilecik (one vineyard). Controversially, the prevalence rate of this species in vineyard areas in Thrace was previously reported as 52% in Türkiye (Öztürk et al., 2018). The species is known to cause root damage and 58% pruning weight reduction in grapevines (Forge et al., 2020). *Pratylenchus* species are also very damaging to the vine at high population level. In the sampling areas, the number of individuals in 100 cm^3 soil was 22±12, but the abundance in the roots was not examined.

Geocenamus brevidens was another nematode distributed in all provinces with a 68% occurrence rate. Furthermore, *Filenchus* species were highly distributed. These species and other tylenchid genera are species that do not cause severe grapevine damage even under heavy populations. In addition to feeding on plant roots, it has been stated in the literature that they also feed on fungi (Okada et al., 2005; Munawar et al., 2022).

In this study, the colonizer persister (c-p) values of nematodes ranged between 1-5. Of these Rhabditis, a c-p1 group nematode was found in four provinces, and was abundant in some locations. The c-p1 group include species with a short life cycle, tolerant to adverse environmental conditions, and abundant in soil due to its ability to multiply several times (Bongers and Ferris, 1999). The species population was counted as >70 individuals in 100 cm^3 in İzmir. The c-p5, on the other hand, is another group rarely found in survey areas and, includes species with a long life cycle, which are sensitive to adverse soil conditions, and reproduce very slowly and in small numbers (Bongers and Bongers, 1998). The number of individuals of *Longidorus* and *Xiphinema* species with c-p5 values in İzmir and Manisa was 1-10 in 100 cm^3 soil.

4. Conclusion

This study indicated the presence of free-living and plant parasitic nematode species in the

vineyards located in the western part of Türkiye. Bacterial and fungal feeders and plant feeders were highly distributed in İzmir, Manisa, Çanakkale, and Bilecik, and in contrast, a rare occurrence of predator species was observed. The nematode fauna of vineyards covered 37 genera of nematode species, including three plant parasitic nematodes vectoring viruses; *Xiphinema index, X. italiae,* and *Longidorus elongatus.* There are several economically damaging plant parasitic species such as *Meloidogyne* and *Mesocriconema xenoplax*. Several species like *Helicotylenchus varicaudatus, Rotylenchus cypriensis, and Tylenchorhynchus cylindricus* were also extracted, and these are considered not of economic importance due to low abundance.

In this study, several nematode species were identified from the western part of Türkiye. In more vineyards, extensive studies must be carried out periodically to determine nematode reproduction status to prevent infestation, especially of *Meloidogyne* spp., to new areas through infected rootstocks or soil, and apply sanitation in case of infestation.

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