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Diversity of woody plant nematodes in specially protected biocenosis of Zarafshan Mountain, Uzbekistan

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Abstract. *Narzullayev S, Kambarov S, Mirzaev U, Tursunova S. 2023. Diversity of woody plant nematodes in specially protected biocenosis* of *Zarafshan Mountain, Uzbekistan. Biodiversitas 24: 3145-3151.* Very little information exists on nematodes' diversity and ecological characteristics in small artificial forests. This article provides information on the diversity of the nematode fauna, bioecological characteristics, and species distribution by biotopes of fruit trees growing in the biocenoses of the Omonkutan National Nature Park in the Western Zarafshan mountain range. As a result of the research, 62 species of nematodes were recorded in the nematode fauna of fruit trees. These species were analyzed taxonomically and ecologically. It was determined that the species in the fauna belong to two classes and five orders of the Nematoda type. They are divided into five large and several small groups according to their ecological characteristics. Among the ecological groups, omnivorous and plant-feeding nematodes are the dominant groups in terms of the number of species. The diversity of nematodes was high in the 0-15 and 15-30 cm soil layers. It turned out that the diversity in different biotopes is related to the ecological characteristics of nematodes. In particular, herbivorous nematodes accounted for 72.2% of nematodes in the root system. An increase in the diversity of nematodes was observed in the rhizosphere soil layers. A sharp increase in the number of species and individuals of omnivorous nematodes and bacteriotrophs was observed in the 0-15 cm soil layer, and this trend was also preserved in the 15-30 cm layer. The species richness and diversity (according to the Shannon and Simpson indices) were the lowest in vegetative parts of plants. As a result of the research, it became clear that the diversity of soil nematodes is completely dependent on their trophic characteristics.

Keywords: Biocenosis, Dorylaimida, nematode fauna, Tylenchida, walnut (*Juglans*), wild almond (*Amygdalus*), wild pistachios (*Pistacia*)

INTRODUCTION

Most of the territory of Uzbekistan (21.2%) includes mountainous regions (Alibekov 1982). The mountainous regions of Uzbekistan have rich flora and fauna. Mountain regions range from extensive grasslands containing annuals and perennials to woodlands with shrubs and trees. In Uzbekistan's mountain and sub-mountain regions, we can find large and small groves of walnuts, wild almonds, and wild pistachios, established in the middle of the 20th century. These groves provide mountainous regions' unique climates, shelter, and food for many living organisms. Among such living organisms, invisible and microscopic nematodes are important in the soil food chain. Nematodes are the most common soil multicellular organisms and play an important role in assimilating plant residues (Wilschut and Geisen 2021) because these organisms are widespread and relatively easy to isolate from the soil. Therefore, nematodes are often studied as indicators of soil organic and mineral properties (Suyadi et al. 2021). As it is known, fungi form ectotrophic mycorrhizae in the roots of woody plants, increase the surface area of the root for absorbing water and salts mineral, and prevent various pathogenic microorganisms from entering the root inside. Since mycophagous fungi in the rhizosphere soil affect this protective shell (Yeates 2007), it indirectly opens the way for pathogenic microorganisms to enter the root. Unlike them, ectoparasitic nematodes open the way for pathogenic microorganisms to enter the root directly due to mechanical damage to the root (Özturk et al. 2018; Xue et al. 2019; Archidona-Yuste et al. 2020). That makes it important to study the effect of nematodes in establishing new plantations in the current period when the forest area is intensively decreasing worldwide. In recent years, extensive research has been conducted on nematode community composition and diversity changes under the influence of deforestation (Kalinkina et al. 2019).

Phytohelminthological studies conducted in this direction in Central Asia did not study the diversity of the nematode community but only the distribution of some systematic groups (family, genus). In particular, the family Hoplolaimidae (Kankina and Klishina 2011), the subfamily Tylenchinae and the large family Criconematoidea, the family Tylenchorhynchidae (Ivanova 1987), the distribution of nematodes (Mirzoyans 2014) were studied. Furthermore, in some works, only the nematode fauna of certain fruit (cultivated) trees was studied. In particular, parasitic nematodes belonging to the genera *Tylenchorhynchus*, *Merlinius*, *Quinisulcius*, *Rotylenchus*, *Helicotylenchus*, *Pratylenchus*, *Paratylenchus*, *Macroposthonia*, *Labocriconema*, and *Xiphinema* were found to be widespread in subtropical woody plants grown

in Uzbekistan. Furthermore, the level of damage caused to trees due to parasitic species has been studied (Khurramov and Bekmuradov 2021).

The investigations conducted on the fauna of fruit trees, nematodes belonging to the genera *Helicotylenchus*, *Bursaphelenchus*, *Xiphinema*, *Meloidogyne*, and *Tylenchorhynchus* were found to be widespread (Ivanova 1981; Mirzoyans 2014; Cai et al. 2020). In most of the studies in distant foreign countries, the nematode fauna of trees that make up forests in tropical and subtropical or taiga regions (Volkova and Kazachenko 2018; De Ramos et al. 2022) detailed forests studied.

In East Asia, *Bursaphelenchus xylophilus* is one of the most investigated species and causes serious damage to forest trees (Futai 2013). *Meloidogyne*, *Hoplolaimus*, *Pratylenchus*, *Tylenchorhynchus*, *Xiphinema*, *Longidorus*, *Helicotylenchus*, and *Rotylenchus* (Pokharel et al. 2015) genera were noted as nematodes causing the most damage in forest nurseries.

The climate in Central Asia, including Uzbekistan, is dry and sharply continental (Alibekov 1982). Naturally, due to the sharp difference in climatic conditions, it can be assumed that the community of nematodes in this area will be unique. Also, although there is some information on the dependence of the variety of species and morphometric parameters of organisms on altitude regions in biocenoses of mountainous, sub-mountainous, and deserts regions of Central Asia (Narzullayev 2022; Zokirova and Khalimov 2022; Alikulov et al. 2023; Khalimov 2023), biotopes there is no information on diversity. Based on the above considerations, we aimed to study the biodiversity and ecological characteristics of the Nematoda fauna by genera and species of small forests established by humans (for example, fruit trees) in mountain biocenoses.

MATERIALS AND METHODS

Study area

Endless plains and deserts border the Zarafshan mountain range in Central Asia (Figure 1). The western part of the Zarafshan mountain range is located in the Zarafshan valley, which is part of the Republic of Uzbekistan and is the area between the Zarafshan and Kashkadarya rivers (Alibekov 1982). These areas are included in the territory of protected National Nature Parks (https://lex.uz/docs/-5892355#-5893207).

Soil sampling and nematode extraction

Material collection from fruit trees was carried out in March to October from 2018 to 2020. Walnut (*Juglans regia* L.), wild almond (*Amygdalus bucharica* Korsh.), and wild pistachio (*Pistacia vera* L.) were selected for research from fruit trees in biocenoses. Therefore, to take samples from these selected plants, the perimeter was dug up to a width of 1 meter and a depth of 50 cm, and the thinnest roots were extracted from the soil. Next, a total of 0.5 kg of soil was taken from the 0-15, 15-30, and 30-50 cm layers around each plant's root. The received samples were processed on the same day.

The soil particles stuck to the vegetative parts of the plant were cleaned by washing them in tap water. Next, Baermann's funnel method (Coyne et al. 2018) and flotation method (Coyne et al. 2018) were used to isolate nematodes from the root system of the vegetative part of the plant and rhizosphere soil samples. Baermann's funnel method is that a glass funnel with a thin tube on one side is fitted with a rubber hose, each is mounted on a multi-seat wooden tripod, and the funnel hose is clamped with an iron clamp; clean tap water is poured into it halfway, and each funnel is labeled with will be determined.

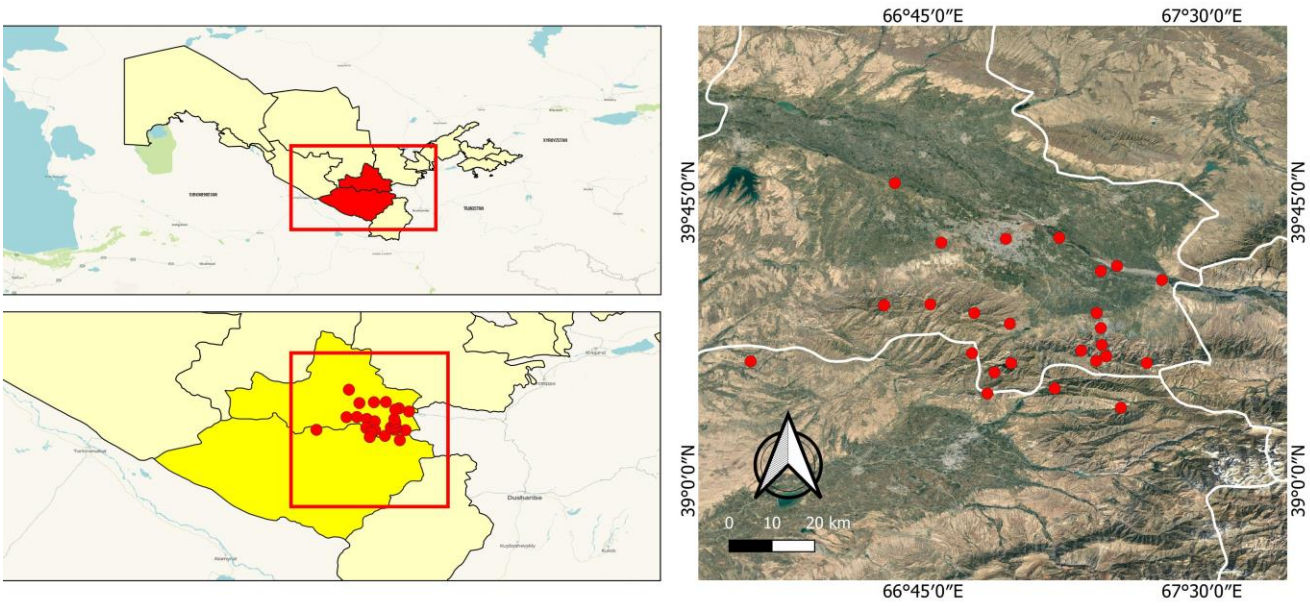

Figure 1. The study area in Zarafshan Mountain range part of Uzbekistan, Central Asia

After that, the plant's root system is chopped into pieces 0.5 cm long. Since one of the goals of the research is to determine the distribution of species of nematode fauna in fruit trees across biotopes, the underground parts of the plant are separated, crushed, and 10-15 grams are measured and placed in a 15x15 cm^2 gauze napkin. Next, the gauze with soil is tied and dipped in labeled funnel water. In this way, after the plant samples are immersed in the water of the funnels, they are transferred to the next rhizosphere soil samples.

Each soil sample is thoroughly mixed separately, stones and other foreign objects are removed, and 20 g is measured and tied in a gauze napkin measuring 15x15 cm^2. Before these samples are placed in the water funnel, a wire mesh is placed in the funnel. The purpose is that the earthen napkin should not cover the bottom of the funnel. Next, the specified funnel is gently dipped in water. After all the plant and rhizosphere soil samples collected for one day are placed in the funnels, they are left in the funnels with water for 14-15 hours. During this time, the vegetative organs of the plant in the water funnels or the nematodes in the rhizosphere soil come out into the water and collect in the tube at the bottom of the funnel. Now the test tubes are specially labeled for the isolation of nematodes. It should be said that the nematodes contained in the samples immersed in water are still alive when they are collected at the bottom of the hose.

After the plant and soil samples have been left in the water funnel, it is necessary to fix (kill) the nematodes and keep them for further work. For this purpose, according to the number of plant and soil samples, the same number of test tubes are prepared, washed thoroughly, and provided with a cover, and 40% formalin liquid is placed in each of them to a tenth of its volume. For this purpose, 40% formalin is poured into the test tube 1/10th of its volume, and then the tube of the nematode funnel is gently opened into this test tube; due to the water in the tube mixing with formalin, a 4-5% formalin solution is formed. We can keep and use this fixed sample for as long as possible.

Nematodes were isolated from soil samples by the flotation method. For this purpose, several 300-500 mL containers are taken, and 10-15 (20) grams of soil from one sample are dissolved in the water in them and shaken. Then, the liquid part of the shaken solution is poured into the next container. This process is repeated 5-6 times. Nematodes are lighter than the soil and come to the solution's surface. This method is particularly useful for isolating larger nematodes (*Mononchus*, *Xiphinema*, *Criconemoides*) (Coyne et al. 2018).

Thus, 616 samples were collected during the spring and autumn months using the route method. In particular, 54 samples were taken from the vegetative parts of wild almonds, while 162 were taken from the rhizosphere soil layers. On top of that, 44 samples were taken from the vegetative parts of the wild pistachio, while 132 samples were taken from the rhizosphere soil. The next samples were taken from the vegetative parts of walnut plants, of which 56 and 168 samples were taken from the soil layer of the rhizosphere, and gained results were analyzed.

Nematode analysis

Moreover, to determine the species composition and the number of individuals of nematodes isolated from plant and soil samples, nematodes are collected from all samples using an MBC-1 or MBC-2 binocular microscope, and temporary micro preparations with glycerin or permanent micro preparations with glycerin are prepared from them. Therefore, to carry out this work, nematodes in the samples are picked one by one. After collecting all the nematodes of one sample, collect them in a watch glass and add 15-20 drops of the glycerin-alcohol mixture. Nematodes are kept in this mixture for 18-20 hours. During the allotted time, the nematode's cuticle is cleaned and becomes clear and translucent.

In a micro preparation prepared from such a nematode, the structure, shape, and size of all its internal and external organs and systems, sometimes very small and delicate organs, are visible through the cuticle. First, their species are determined from the nematode whose cuticle is cleaned in a glycerin-alcohol mixture. Individuals in the larval stage are not used to determine the species because some of its organs and systems (first of all, organs of the reproductive system) are not yet fully developed. For this reason, an adult female individual (rarely a male individual) was used to determine the species of nematodes.

When determining the type of nematode, its external and internal organs are first generally examined. After that, the size and characteristics of some organs and systems are studied using light microscopes (MBI-1, MBI-2, MBI-3 or AS ONE 1-1927-21 SL-700-LED Biological Microscope). In particular, systematic features such as the length of the body of the nematode, the outermost sexual characteristics in the middle part of the body, the length and shape of the tail and the foregut (esophagus), then the bulb, the shape of the ovary of the female nematode, the length and shape of the uterus are determined with the ocular-micrometer. De Man (de Man 1921) recommended formula was used to identify nematode species in addition to paying attention to the systematic signs mentioned above. Classical and modern phylogenetic systematics of nematodes (De Ley and Blaxter 2002; Hodda 2022) were used to analyze species systematically.

When classifying nematodes ecologically into groups, the Yeates (Yeates et al. 1993) classification, the similarity coefficient (S') of the plant nematode fauna complex is used by the Sorensen-Chekanovsky method (Gorodnichev 2019), and the Margalef index when calculating the species richness of plants. Shannon and Simpson indices (Gorodnichev 2019; Konopiński 2020) were used to determine and compare the diversity of ecological groups.

RESULTS AND DISCUSSION

Taxonomic diversity

When the samples collected from the trees selected for the study were analyzed, 62 species of nematodes were identified. It became known that these identified species belong to 2 classes (Adenophorea, Secernentea) and five orders of Nematoda (Nematodes) phylum (Hodda 2022).

Tylenchida was distinguished by the number of families, genera, and species contained in it, not only in terms of orders of the class scale but also in terms of taxonomic units and species in comparison to other classes and orders in the nematode fauna. It is dominated by the number of species in its composition (30 species, 48.38% of the fauna). In addition, 7 species (11.29%) of nematode fauna belong to the Rhabditida order, 20 species (32.25%) belong to the Dorylaimida order, 4 species (6.45%) belong to the Mononchida order, and 1 species belong to the Araeolaimida order (1.61%) (Table 1).

It was also known that the genera in the nematode fauna of fruit trees differ with different numbers of their species. In the biocenoses, the genera *Merlinius* belonging to the Tylenchida order and *Eudorylaimus* of the Dorylaimida order were distinguished by their superiority over all other genera, with 5 and 10 species in their composition. In the taxonomic list, such genera were also noted that in the biocenoses, each was represented by 3 or 4 species. Such genera include *Mononchus, Mesodorylaimus, Xiphinema, Aphelenchoides, Tylenchus, and Pratylenchus*. Also, most of the genera listed are 2 (*Dorylaimoides, Discolaimus, Panagrolaimus, Aphelenchus, Ditylenchus, Helicotylenchus, Criconemoides*) or 1 (*Plectus, Clarcus, Drepanodorus, Mesorhabditis, Cephalobus, Eucephalobus, Macrolaimus, Bursaphalenchus, Aglenchus, Tetylenchus, Boleodorus, Rotylenchus, Hoplolaimus, Paratylenchus*) were found to have species. Analyzing the species distribution by biotopes, 18 species were found in the root system, 44 in the 0-15 cm rhizosphere layer, 40 in the 15-30 cm layer, and 23 in the 30-50 cm layer.

Eco-trophic diversity

Some diversity was observed in the ecological structure of the species identified in the study area, including bacterial feeding (7 species), animal predation (6 species, omnivorous (16 species), hyphal-feeding nematodes (3 species), and plant feeders (30 species). In turn, nematodes that feed on plant products were further divided into several subgroups. Ectoparasitic phytonematodes were distinguished by their diversity (14 species). Also, 1 species of sedentary endoparasites (*R. robustus*), 5 species of migratory endoparasites, 3 species of semi-endoparasites, 3 species that feed on root epidermis or root hairs, and nematodes that feed on algal or lichens they consisted of 4 species.

When we analyze the ecological groups of nematodes by biotopes, it becomes clear that their distribution is directly related to nutrition characteristics. In particular, herbivorous nematodes were the species in the root system (72.2%). An increase in the diversity of nematodes was observed in the rhizosphere soil layers. A sharp increase in the number of species and individuals of omnivorous nematodes and bacteriotrophs was observed in the 0-15 cm soil layer, and this trend was also preserved in the 15-30 cm layer (Figure 2).

Table 1. Distribution of species of nematode fauna of fruit trees by biotopes. (The sign + indicates the presence of the species in this biotope, and the empty space indicates that the species is not recorded)

Species*	Ecological groups**	Soil			
		Root system	0-15 cm	15-30 cm	30-50 cm
Plectus parietinus	BF	+	+		
Mononchus flektus	AP				+
M. papillitus	AP				+
M. truncatus	AP	+	+	+	
Clarcus parvus	AP		+		
Dorylaimus elegans	O		+	+	+
D. similis	O		+	+	
Eudorylaimus kirjanovae	O		+	+	+
E. labiatus	O		+	+	+
E. lautus	O		+	+	+
E. microdorus	O		+	+	+
E. monhystera	O		+	+	+
E. obtusicaudatus	O		+	+	+
E. paraobtusicaudatus	O		+	+	+
E. parvus	O		+	+	+
E. pratensis	O		+	+	+
E. skrjabini	O		+	+	+
Discolaimus cylindricum	AP		+	+	+
D. texanus	AP				+
Mesodorylaimus bastiani	O			+	+
M. meyli	O		+	+	
M. musae	O			+	+
Xiphinema americanum	PF-d			+	+
X. index	PF-d			+	
X. elongatum	PF-d			+	+
Paraxonichium laetificans	O		+	+	
Mesorhabditis irregularis	BF		+		
Cephalobus persegnis	BF	+			
Eucephalobus oxuroides	BF		+	+	
Panagrolaimus subelongatus	BF		+	+	+
Panagrolaimoides multidentatus	BF		+	+	
Macrolaimus crucis	BF		+		
Aphelenchus avanae	HF		+	+	+
A.cylindricaudatus	HF		+	+	
Aphelenchoides parietinus	PF-d	+	+		
A. pusillus	PF-d		+	+	
A. zeravschanicus	PF-d	+			
Bursaphalenchus talonus	HF	+	+		
Tylenchus davainei	PF-f		+	+	
T. filiformis	PF-f		+	+	
T. minumus	PF-f	+			
T. polyhypnus	PF-f		+	+	
Aglenchus Agricola	PF-e		+	+	+
Ditylenchus dipsaci	PF-b	+	+	+	+
D. intermedius	PF-b	+	+		
Pratylenchus pratensis	PF-b	+			
P. coffee	PF-b	+	+		
P. vulnus	PF-b	+	+		
Tetylenchus clavicandatus	PF-e			+	
Boleodorus thylactus	PF-e		+		
Helicotylenchus digitiformis	PF-c		+	+	
H. multicinctus	PF-c	+	+	+	
Rotylenchus robustus	PF-a	+	+		
Hoplolaimus tylenchiformis	PF-c			+	
Paratylenchus macrophallus	PF-d		+		
Merlinius bagdanovi-katjakovi	PF-d	+	+		
M. quadrifer	PF-d	+	+	+	
M. mirabilis	PF-d		+	+	
M. socialis	PF-d	+			
M. dubius	PF-d	+	+	+	
Criconemoides pullus	PF-d			+	
C. similis	PF-d		+		

Note: *: Species names are given in taxonomic order, **BF: Bacterial Feeding, AP: Animal Predation, O: Omnivorous, PF-a: Sedentary endoparasites, PF-d: Ectoparasites, PF-e: Epidermal cell and root hair feeders, PF-b: Migratory endoparasites, PF-c: Semi-endoparasites, HF: Hyphal Feeding, PF-f: Algal, lichen or moss feeders that feed by piercing

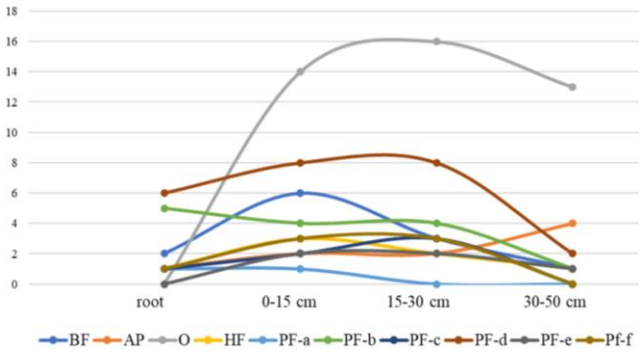

Figure 2. Distribution status of ecological groups of nematodes in biotopes (in the figure, the x-axis is the number of species; the y-axis is biotopes where nematodes are distributed). ** Note: Conventional abbreviations of ecological groups are explained in Table 1

When we checked the richness of species by biotopes, it was observed that diversity increases from vegetative parts of plants to soil layers (for example, in pistachio, Shannon's index is 1.593≤2.873≤2.92≥2.362; Simpson's index is 0.795≤0.937≤0.94≥0.89). The highest diversity corresponded to the 0-15 and 15-30 cm soil layers (Table 2). Diversity in these layers was mainly due to omnivorous nematodes; that is, 31.8 and 40% of the species corresponded to representatives of this group, respectively). The species richness and diversity levels (according to the Shannon and Simpson indices) were the lowest in plants' vegetative parts. When analyzing species richness based on the Margalef index for each plant, D_{Mg}=6.2 in walnut; D_{Mg}=5.5 in almonds; and D_{Mg}=4.8 in pistachio plants. The similarity coefficient (S′) changed from 0.61 to 0.78 when plant Nematoda fauna complexes were compared (Table 3). The greatest similarity was observed between almond and pistachio fauna (S′=0.78).

Discussion

When systematically analyzing the nematode fauna identified as a result of the research, it was found that the composition of species in the taxonomic units of the class, genus, and family does not differ from other studies in this direction (Kankina and Klishina 2011; Yan et al. 2018; Khurramov and Bekmuradov 2021). Also, the systematic composition of the nematode fauna of perennial plants in the research area corresponds to our research (Narzullayev 2022).

When we analyzed the level of distribution of the nematode fauna of the studied trees by genera, as in previous studies, it was found that representatives of the genera *Eudorylaimus, Xiphinema, Aphelenchoides, Tylenchus, Helicotylenchus* are widespread (Ali et al. 2014; Karmezi et al. 2022). The chlorosis and curling of the leaves in some of the fruit trees of the genus *Xiphinema* in the study area can be said to be the direct harmful effect of nematodes through the transmission of viruses (Özturk et al. 2018; Xue et al. 2019; Archidona-Yuste et al. 2020). However, in some studies, only one species (*B. talonus*) of the genus *Bursaphelenchus*, recognized as a serious pest of trees, was found (Jones et al. 2013; Akbulut et al. 2015). This situation can be explained by the artificial creation of tree groves in the research area and the absence of coniferous forests. However, during the research, it is noteworthy that the *Bursaphelenchus* genus, which has a quarantine risk for the region, was found (Yeates 2007).

It is known that certain characteristics of the soil, as well as environmental variables, affect the nematode community (Dong et al. 2017; Kamath 2022). The diversity of the nematode community is visible, especially when analyzing ecological groups. The information obtained on the ecological composition of tree nematode fauna partially differed from some previous studies (Panesar et al. 2001; Matveeva and Sushchuk 2016; Puneet and Irfan 2022). For example, in our research, bacteriotrophs made up 11.3%, plant feeders, 48.38% (dominant ecological group), while in the data of Panesar (Panesar et al. 2001), bacteriotrophs indicator was 38% (dominant ecological group), plant parasites were only 2%. According to Sushchuk, bacteriotrophs accounted for 42%, while representatives of the plant-feeding nematode community were found very little, or not at all (Sushchuk and Matveeva 2021). It has been noted that the nematode community in the soil of temperate and coniferous forests is mainly free-living nematodes (Kitagami 2018).

Table 2. Effect of biotope change on the nematode diversity index (numerical data are presented as mean ± standard error of the mean)

Plants	*Diversity indices*	Vegetative system	0-15 cm	15-30 cm	30-50 cm
Juglans regia	Shannon index, H′	1.593 ±0.1	2.873 ± 0.1	2.92 ± 0.2	2.362 ± 0.1
	Simpson index, D	0.795 ± 0.01	0.937 ± 0.02	0.94 ± 0.02	0.89 ± 0.01
Amygdalus bucharica	Shannon index, H′	2.280 ±0.1	3.35 ± 0.2	3.20 ± 0.2	2.67 ± 0.2
	Simpson index, D	0.91 ± 0.02	0.933 ± 0.03	0.955 ± 0.02	0.932 ± 0.02
Pistacia vera	Shannon index, H′	1.69 ± 0.1	2.929 ± 0.2	2.65 ± 0.1	2.159 ± 0.1
	Simpson index, D	0.81 ± 0.01	0.93 ± 0.02	0.91 ± 0.02	0.872 ± 0.01

Table 3. Similarity coefficient (S′) of plant nematode fauna (According to Sorensen-Chekanovsky)

Plants	*Amygdalus bucharica*		*Pistacia vera*	
	Common species	S′	Common species	S′
Juglans regia	26	0.61	28	0.7
Amygdalus bucharica	X	X	29	0.78

In the studies conducted in Central Asia, it was noted that ectoparasites and devisaprobionts are more common in nematode fauna of trees (up to 64.1%) (Norbutayeva and Abdurakhmonova 2011). It can be said that such diversity in the ecological composition of nematodes is primarily related to soil composition because the amount of organic matter in the soil in the biocenoses of the Western Zarafshan Mountain does not exceed 3-8% (Alibekov 1982). For example, the average organic matter content in the Vihorlat Mountains was 8.8% (Háněl and Čerevková 2010); in the Beskydy Mountains (Háněl 1996), it was 3.5-21.5%. This limits the number of people who feed on saprobiotic products and microorganisms (bacteria, fungal hyphae) in the soil. This condition, in turn, prevents the increase in the number of predatory nematodes (animal predation), which mainly feed on free-living nematodes in the soil (in our research, the percentage of predatory nematodes was 9.6%). It was observed that the diversity of herbivorous nematodes decreases in the lower layers of the soil. In particular, 20 species of herbivorous nematodes were recorded in the soil's 0-15 and 15-30 cm layers and only 4 species were found in the 30-50 cm layer. This situation can be attributed to the decrease of plant products in the lower layers of the soil (Wilschut and Geisen 2021).

It became known that the diversity index of nematodes varies according to biotopes. In general, according to the Shannon index, the degree of diversity was in the range of 1.593-3.35. This diversity corresponds to the indicators of the nematode fauna of medium-altitude mountains (Afzal et al. 2021; Narzullayev 2022) and is higher than that of relatively high mountains (Kumar and Ahmad 2017). The decrease in the diversity of species in the lower layers of the soil (15-30 and 30-50 cm) is a direct effect of the decrease in the amount of nutrients (humus, microorganisms) (Hemmerling et al. 2021). Because the increase in the density of nematodes is primarily related to the abundance of their food (food resources) (David et al. 2017; Wang et al. 2019; Dietrich et al. 2021).

In conclusion, it was found that the fauna of fruit trees, whose nematode fauna was studied, is quite diverse. Most of the identified species were found to be distributed in the 0-15 and 15-30 cm layers of the rhizosphere soil. It was noted that the species found in the root system of fruit trees mainly belong to the genera *Aphelenchoides, Ditylenchus, Pratylenchus, Helicotylenchus,* and *Merlinius* and are directly related to the plants living tissue. It turned out that soil nematodes' diversity completely depends on their trophic characteristics. Most previous studies on the nematode fauna of trees in biocenoses were carried out in coniferous natural forest areas. In this regard, our research work expands the understanding of the nematode fauna of small forest groves, artificially created by man in harsh continental climate conditions and then formed for many years without human intervention.

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