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## OVERVIEW OF REPORTS ON PLANT NEMATOLOGY IN MONTENEGRO UNTIL 2012

### SUMMARY

Relatively little is known about the role of plant-parasites, and nematodes in general, in relation to crop production in Montenegro. As the main source for this overview, we considered published scientific papers with topics covering nematodes and nematosis from Montenegro. We considered all the extension reports connected with nematodes in Montenegro. Above all, we used data gleaned from a survey of twenty greenhouses in the Zeta-Bjelopavlici valley.

This paper constitutes an historical overview by years of publication, papers or reports. As we consider this report to be the very first inventory of Montenegrin nematodes, we describe all the nematodes species or taxons of nematodes that are determinate in Montenegro, by crops.

In total, 65 different plant-parasites, nematofiders, bacteriofiders, free living species, and taxons of nematodes have been reported.

**Keywords:** Overview, nematode species, nematode taxons.

### INTRODUCTION

Relatively little is known about the role of plant-parasites, and nematodes in general, in relation to crop production in Montenegro.

Montenegro is situated in south-east Europe on the Balkan peninsula. The country can be divided into several regions according to climate, geology, water supply, population, and other factors. Taking into account the agricultural factors, we can divide it into four distinct regions: the Coastal area, the Karst area, the Zeta-Bjelopavlici valley, and the region of high mountains and deep valleys. Among them, the Zeta-Bjelopavlici valley is the most significant in terms of agricultural production.

Montenegro has a Mediterranean/Continental climate. The average monthly temperature throughout the country during the year is 13.1°C, with an average annual precipitation of 1,436.03 mm. There are 140 rainy days per annum and the average air humidity is 71 (SYM, 2009; Pavićević, 1983).

The area of the country developed for agriculture is 516,219 hectares. There are 189,300 hectares of arable area, 324,269 hectares of pasture, and 2,650 ponds, including fishponds and marshes. Arable fields and gardens are on 45,237

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hectares, orchards on 11,885, vineyards on 4,325, and meadows on 127,853 hectares. In 2008, the forests covered 627,000 hectares (SYM, 2009).

This report is the first comprehensive inventory of nematodes from Montenegro. Therefore, it is important to at least mention every nematode species or taxon of plant parasite and free living nematode that has been described in Montenegro up to the year 2012.

## MATERIAL AND METHODS

This overview is sourced mainly by published scientific papers on the topic of nematodes and nematosis in Montenegro. We also considered all extended reports connected with Montenegrin nematodes from other institutions outside the country, not just published materials.

What follows is primarily an historical overview of papers and reports, going by years of publication. Since we consider this report to be the very first inventory of Montenegrin nematodes, we present all nematode species or taxons of nematodes currently found in Montenegrin crops. While documenting native species is naturally the focus of this paper, it has become increasingly important to mention imported parasitic- and non-parasitic nematodes for each crop.

Above all, we use data taken from a survey of 20 greenhouses in the Zeta-Bjelopavlici valley. We surveyed various types of greenhouses from the valley. Soil and root tissue samples were collected from these 20 sites in 2006 and 2007. The soil was mixed in the laboratory and a 200g sub-sample was taken for nematode extraction. Each sub-sample was processed for nematodes using decanting techniques. Whenever a plant was observed to show system symptoms of a possible nematode problem (stunting, wilting, yellowing) during the soil sampling process, the root system was removed from the soil, assigned a root-knot nematode gall index number (0-5) and returned to the laboratory for mechanical extraction of root-knot nematode females for species identification.

## RESULTS AND DISCUSSION

### *Historical overview*

The oldest data is from a 1968 paper published by Krnjajić, which provided information about *Xiphinema americanum* from Herceg Novi on vineyards, *Macroposthonia annulata* and *M. ferniae* from Meljine on wild hosts, and *Oxydirus oxycephalus* in the same locality of vineyards and citruses.

In 1975, Grujičić published information about *Meloidogyne* spp. from Kotor, where for the first time in Montenegro the non-determined species was found on a spinach crop.

Some ten years later, in 1985, authors Dimitrijević and Ivezić reported a significant number of nematode taxa in potato fields near the city of Pljevlja. The following taxa were reported in a plant protection extension report: *Aphelenchus* spp, *Criconemoides* spp, *Diphterophora* spp, *Ditylenchus* spp, *Ditylenchus intermedius*, *Dorylaimus* spp, *Heterodera trifolii*, *Helicotylenchus* spp, *Longidorus* spp, *Mononchus* spp, *Paratylenchus* spp, *Pratylenchus* spp,

*Psilenchus* spp, *Rotylenchus* spp, *Rotylenchulus* spp, *Trichodorus* spp, *Tylenchorhynchus* spp, *Tylenchus* spp and *Xiphinema* spp. In the same year, a book about nematodes in ex Yugoslavia was published. The book-atlas (Alphey *et al*, 1985) is an important source for phytoparasitic species with important, but incomplete data. The book is essentially a map of nematode species found in the ex-federal state, but it lacks precise collection data and information detailing the herbs attacked by these nematodes.

In 1988, two extension reports were done by two groups of scientists: the first was done by Dimitrijević and Ivezić and the second by Jovičić and Stamenković. A scientific paper was published by Vučinić and Todorović, and it is the first and only collection of data about presence of *Tylenchulus semipenetrans* in Montenegro on citrus. In the first extension report Dimitrijević and Ivezić observed species of *Ditylenchus mycelophagus*, *Heterodera* spp, *Hoplolaimus* spp, *Meloidogyne* spp, *M. nassi*, *M. arenaria* and *Rhabditis* spp. In the second, Jovičić and Stamenković found *Aphelenchus* spp, *Criconemoides* spp, *Ditylenchus* spp, *Dorylaimus* spp, *Enoplida* spp, *Helicotylenchus* spp, *Hoplolaimus* spp, *Longidorus* spp, *Meloidogyne* spp, *Mononchus* spp, *Pratylenchus* spp, *Rhabditis* spp, *Tylenchorhynchus* spp and *Tylenchus* spp.

However, in total, there have been 20 reports or publications about the nematodes of Montenegro. The majority of these, during the 1990s to the early 2000s, have been accounted for under the occurrence, taxonomy, and morphology of *Longidorus* and *Xiphinema* spp. Barsi produced a diligent series of papers on the Longidoridae species from Montenegro. In 1989, Barsi wrote the first report on Longidoridae, detailing it throughout Yugoslavia and parts of Montenegro. In 1994, the same author reported the discovery of *Xiphinema pachtaicum* in Ulcinj and Valdanos on *P. aquilinum*, *X. diversicaudatum* from Stoliv on vineyards and *X. simile* from Ulcinj on *P. aquilinum*. In 1996, that same author reported once more the presence of *X. diversicaudatum* in Stoliv on vineyards, but in 1998 he reported the presence of *X. varium* from Crkvine on oak trees and *X. montenegrinum* from Morinj on the wood samples. In 1999, Barsi discovered *X. illyricum* in Danilovgrad on *Carpinus orientalis*, and during the year 2000, Barsi and Krnjajić *et al* made research contributions on the topic of Longidoridae, with a report of *X. index* and *X. diversicaudatum* in Morinj on vineyards. Over the next couple years, *Longidorus piceicola* were reported in Žabljak on *Abies alba* (Barsi 2001), and *Xiphinema pachtaicum* in Lazi-Budva, Morinj and Petrovac on grassland (Barsi 2002); *L. intermedius* was reported in Lazi-Budva on *Quercus* spp (Barsi 2004) and *X. pachtaicum* in Ulcinj and Podgorica on vineyards by Pajović *et al* in the year 2007.

Between 2006 and 2010, a survey of greenhouses in Zeta-Bjelopavlici valley was carried out by the author of this article. Published data was primarily restricted to plant-parasitic nematodes, but data related to free-living taxons has not yet been published. Through the survey of greenhouses the following nematodes have been found: *Meloidogyne* spp, *M. incognita*, *M. javanica*, *M.*

*arenaria*, *M. hapla*, *M. ardeniensis*, *Aphelenchoides* spp, *Acrobeloides* spp, *Cephalobus* spp, *Dorylaimus* spp, *Eucephalobus* spp, *E. oxyuroides*, *Gracilacus* spp, *Helicotylenchus pseudorobustus*, *H. platyurus*, *H. vulgaris*, *Mesodorylaimus* spp, *Panagrellus* spp, *Plectus* spp, *P. tenuis*, *Poikilolaimus oxycerca*, *Pratylenchus neglectus*, *Rhabditis* spp and *Rotylenchulus macrodoratus* spp.

#### *Nematodes by plants*

This section will be organised by the importance of plants in production and by the importance of the described nematodes.

#### *- On Vineyards-*

Production of grapes and grape products, primarily wine and brandy, is of critical importance in Montenegro. Vineyards cover some 4,325 hectares, with 18,166,311 plants and 2.61 kilograms of yield per plant. Of the total number of plants, 50.93% are on private farms and 49.07% are on enterprises or collective farms (SYM, 2009). For the grapevine, all growing systems can be divided into traditional – pergola and conventional – trellis systems. Production is entirely market oriented, mainly for export, and it comprises a quite significant share of the GDP.

As of 2012, there were several cases of nematodes reported on the vineyards in Montenegro, as presented in Table 1.

Table 1. Nematodes found in vineyards in Montenegro until year 2012.

Nematodes	Location	Year	Reporter/s
<i>Oxydirus oxycephaloides</i> ( <i>Oxydirus oxycephalus</i> ) DeMan, 1921	Meljine	1968	Krnjajić
<i>Xiphinema americanum</i> Cobb, 1913	Herceg Novi	1968	Krnjajić
<i>Xiphinema diversicaudatum</i> (Micoletzky, 1927) Cohn & Sher, 1972	Stoliv, Stoliv, Morinj	1994; 1996; 2000	Barsi; Barsi; Barsi and Lamberti
<i>Xiphinema pachtaicum</i> (Tulaganov, 1938) Kirjanova, 1951	Ulcinj Podgorica	2007	Pajović, Urek, Širca

There has been no regular monitoring of the Montenegrin vineyards, so all data have been collected sporadically. There is no nematode management, either. Up to now there has been no recorded crop loss due to nematosis, or any other problems in production caused by nematodes.

#### *- On Potatoes-*

By 2008, potatoes covered 10,233 hectares, with 13.11 t/ha of yield (SYM, 2009). The entire production is market-oriented using conventional production methods on private properties.

Table 2. Nematodes found in potato crops in Montenegro until year 2012.

Nematodes	Loc.	Year	Reporter/s
<i>Aphelenchoides</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Aphelenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Criconemoides</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Diphtherophora</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Ditylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Ditylenchus intermedius</i> (DeMan, 1880) Filipjev, 1936	Pljevlja	1985	Dimitrijević, Ivezić
<i>Ditylenchus myceliophagus</i> Goodey, 1958	Ulcinj	1988	Dimitrijević, Ivezić
<i>Dorylaimus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Heterodera trifolii</i> Goffart, 1932	Pljevlja	1985	Dimitrijević, Ivezić
<i>Helicotylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Longidorus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Mononchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Paratylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Pratylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Psilenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Rotylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Rotylenchulus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Trichodorus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Tylenchorhynchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Tylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić
<i>Xiphinema</i> spp	Pljevlja	1985	Dimitrijević, Ivezić

As demonstrated in Table 2, previous research has been carried out on Montenegrin potato fields. All data presented are taken from unpublished reports from the Ministry of Agriculture, Forestry and Water Management, produced by scientists of other ex-Yugoslav republics.

Since 2007, the Government of Montenegro has made an effort to reduce the importation of potatoes from abroad, for both consumption as well as seed. For this reason, among others, a nematological monitoring of domestic seeding potato production has been established. The monitoring is focused on tracing and detecting potato cyst nematodes (PCN): *Globodera pallida* (Stone) Behrens and *G. rostochiensis* (Wollenweber) Behrens, on the basis of the Council Directive 2007/33/EC and Directive 69/465/EEC. As of 2011, PCN has not been discovered in Montenegro.

#### - On Vegetable Crops-

We consider open field vegetable production, and vegetable production in greenhouses in particular, to be crucial to Montenegro's agricultural production.

Compared to all other plants grown in Montenegro, vegetable production in greenhouses and in the open field is certainly the most vulnerable to nematological attack. According to statistical data, there were 45,237 hectares of arable fields and gardens and 18,145 hectares of vegetable crops in 2008 (SYM, 2009). Unfortunately, it is not possible to distinguish participation among

different crop systems in vegetable production, but it is interesting to note that the fields used for vegetable production are very small, suggesting that this type of production is more likely to be small scale conventional farming.

According to our knowledge and experience, the most important plant in the parasitic nematodes genus, in open field vegetable production, is the *Meloidogyne*, as Grujičić (1975) noted for the first time in Montenegro on spinach, in the town of Kotor, in the coastal region.

What we have noticed is that in this kind of production, parasitic nematodes are not as destructive as they are in greenhouses. Our opinion is that open field living conditions in Montenegro are not optimal for nematodes, and that is why we do not see a significant increase in its population. In the course of a year, temperature increase, precipitation, and soil and air humidity decrease until the end of the summer, as is the case in other Mediterranean countries. With pure irrigation systems, nematodes cannot reach population levels high enough to become a significant plant health problem. On the other hand, in the greenhouses, they are one of the main limitations of production.

#### - On Vegetable Crops in Greenhouses-

The production of vegetables in greenhouses in Montenegro has increased significantly in recent years. Since 2003, 50 hectares of new vegetable greenhouses have been constructed and put into operation. It is estimated that an additional 200 hectares will be developed within the next few years. As before, we can consider the whole production to be market oriented with conventional production on private properties. The production is significant, but it is not as vast as it can be in the other countries of the region. Even so, we can consider this production to be the most affected by nematosis in Montenegro, meaning that it has been previously scrutinised. We will present the data of other authors and the results of surveys conducted during 2006-2010 in greenhouses near Podgorica.

The most important plant-parasitic nematodes were recovered from all but one of the 20 vegetable greenhouses sampled. *Meloidogyne incognita* was the most common plant-parasitic nematode species detected in the Montenegro greenhouses, recovered from 11 of the 19 greenhouses infested with root-knot nematodes. *Meloidogyne arenaria* was recovered from three of the locations, while *M. javanica*, *M. hapla* and *M. ardeniensis* were only detected in one location each. Multiple species of *Meloidogyne* were recovered from three locations. The result of the nematode survey indicates that *Meloidogyne* spp are common in Montenegro vegetable greenhouses and can result in major losses in crop productivity. *M. incognita* can cause major losses of tomato, cucumber, pepper and lettuce under greenhouse conditions. Although it was the most common root-knot nematode species detected, the greenhouse with the most consistent root gall index equal to or above value of 3.0 (Pajović et al, 2007 b).

Among the plant parasitic nematodes we registered were nematodes from the genus *Gracilacus* (Raski, 1962); *Pratylenchus neglectus* (Rensch, 1924)

Filipjev & Schuurmans Stekhoven, 1941; *Rotylenchus macrodoratus* Dasgupta, Raski & Sher, 1968; *Helicotylenchus pseudorobustus* (Steiner, 1914) Golden, 1956; *H. platyurus* (Perry, Darling & Thorne, 1959); *H. vulgaris* Yuen, 1964 and nematodes from the genus *Aphelenchoides*. All infestations with other parasitic species were concomitant with one or more species of *Meloidogyne* spp (Pajović, 2010) (Table 03.).

Among the free living nematodes we registered were nematodes from the genus *Cephalobus* Bastian, 1865; *Eucephalobus* Steiner, 1963, *E. oxyuroides* (de Man, 1895) Steiner 1936; *Acrobeles* Linstow, 1877; *Chiloplacus* Thorne, 1937; *Panagrellus* Thorne, 1936; *Rhabditis* Dujardin, 1845; *Poikilolaimus* Fuchs, 1930, *P. oxyerca* de Man, 1895; *Plectus* Bastian, 1865, *P. tenuis* Bastian, 1865; *Dorylaimus* Dujardin, 1845 and *Mesodorylaimus* Andrassy, 1959 (Table 3.).

Table 3. Nematodes found in greenhouses in Montenegro by 2012.

Nematode	Location	Date	Authors/Reporters
<i>Acrobilus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Aphelenchoides</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Aphelenchus</i> spp	Podgorica	1988	Jovičić, Stamenković
<i>Acrobeloides</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Cephalobus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Chiroplacus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Criconemoides</i> spp	Podgorica	1988	Jovičić, Stamenković
<i>Cuticularia oxyerca</i>	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Ditylenchus</i> spp	Podgorica	1988	Jovičić, Stamenković
<i>Dorylaimus</i> spp	Podgorica	1988 2006/2007	Jovičić, Stamenković Pajović, Quintanilla, Bird
<i>Enoplida</i> spp	Podgorica	1988	Jovičić, Stamenković
<i>Eucephalobus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Eucephalobus oxyuroides</i>	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Gracilacus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Helicotylenchus</i> spp	Podgorica	1988 2010	Jovičić, Stamenković Pajović
<i>Helicotylenchus pseudorobustus</i> (Steiner, 1914) Golden, 1956	Podgorica	2010	Pajović
<i>Helicotylenchus platyurus</i> Perry in Perry, Darling & Thorne, 1959	Podgorica	2010	Pajović
<i>Hoplolaimus</i> spp	Podgorica	1988	Jovičić, Stamenković
<i>Longidorus</i> spp	Podgorica	1988	Jovičić, Stamenković
<i>Meloidogyne</i> spp	Sutomore, Bar Podgorica	1988 2010	Jovičić, Stamenković Pajović
<i>Meloidogyne hapla</i> Chitwood, 1949	Podgorica	2006/2007	Pajović, Urek, Širca
<i>Meloidogyne incognita</i> (Kofoid & White, 1919)	Podgorica	2007	Pajović, Urek, Širca

Chitwood, 1949			
<i>Meloidogyne javanica</i> (Treub, 1885) Chitwood, 1949	Podgorica	2007	Pajović, Urek, Širca
<i>Meloidogyne arenaria</i> (Neal, 1889) Chitwood, 1949	Podgorica	2007	Pajović, Urek, Širca
<i>Meloidogyne ardenensis</i> de Santos, 1968	Podgorica	2006/2007	Pajović, Urek, Širca
<i>Mesodorylaimus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Mononchus</i> spp	Podgorica	1988	Jovičić, Stamenković
<i>Panagrellus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Plectus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Plectus tenuis</i>	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Poikilolaimus oxycerca</i>	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Pratylenchus</i> spp	Podgorica	1988	Jovičić, Stamenković
<i>Pratylenchus neglectus</i> (Rensch, 1924) Filipjev & Schuu. Stek., 1941	Podgorica	2010	Pajović
<i>Rhabditis</i> spp	Podgorica	1988 2006/2007	Jovičić, Stamenković Pajović, Quintanilla, Bird
<i>Rotylenchulus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird
<i>Rotylenchulus macrodoratus</i> Dasgupta, Raski & Sher, 1968	Podgorica	2010	Pajović
<i>Tylenchorhynchus</i> spp	Podgorica	1988	Jovičić, Stamenković
<i>Tylenchus</i> spp	Podgorica	1988	Jovičić, Stamenković

Based on the results of these findings, plans are underway to facilitate accurate nematode problem identification, the use of nematode-free transplants, the proper use of resistant varieties, nematocides, and the enhancement of the overall soil quality in greenhouse environments. On-farm research, nematode management demonstrations, and on-farm education programs must be used in these initiatives.

- *On Agrumes/Citrus Fruits-*

Intensive production of fruits is less important than production of other plants in Montenegro. In 2008, some 11,885 hectares were under different types of orchards (SYM, 2009). The majority of them use an extensive production system, not intended for market, mainly for the home-made production of natural brandies. There is no data about nematodes or problems connected with them in these types of orchards. We still have no data dealing with nematosis in strawberry production, but with regard to tangerine and orange production, data



do exist. In 2008, there were 390,585 citrus trees in Montenegro, and several nematodes cases were reported in these orchards, as is presented in Table 4.

Table 4. Nematodes in orange and tangerine orchards in Montenegro until 2012.

Nematodes	Location	Year	Reporter/s
<i>Oxydirus oxycephaloides</i> DeMan, 1921	Meljine	1968	Krmjajić
<i>Tylenchulus semipenetrans</i> Cobb 1914	Ulcinj	1988	Vučinić & Todorović

- *Forests and Forest Nurseries-*

There are no data about nematodes in the forests or forest nurseries in Montenegro. However, in the light of the Commission Decision 2006/133/EC connected with possible appearance of *Bursaphelenchus xylophilus* (Steiner et Buhner) Nickle et al we are working to begin monitoring *Pinus* forests, as well as taking other steps in accordance with the Directive.

It is important to note that some 627,000 hectares in Montenegro are covered by forests. Forests susceptible to *B. xylophilus* can be pure stands of conifers - 58,000 ha; mixed stands of conifers - 45,000 ha and mixed stands of deciduous trees and conifers 93,000 ha (SYM, 2009).

Some other nematodes, in terms of risk from *B. xylophilus*, pose a significant risk for the forests in Montenegro. As of 2012, several nematode cases have been reported in the forests of Montenegro (Table 5.).

Table 5. Nematodes found in forests in Montenegro as of 2012.

Nematodes	Location	Year	Herb species	Reporter/s
<i>Xiphinema variurum</i> Barsi & Lamberti, 1998	Crkvine	1998	Oak tree	Barsi
<i>Xiphinema montenegrinum</i> Barsi, Lamberti & Agostinelli, 1998	Morinj	1998	wood	Barsi
<i>Xiphinema illyricum</i> Barsi & Lamberti, 1999	Danilovgrad	1999	<i>Carpinus orientalis</i>	Barsi
<i>Longidorus intermedius</i> Kozłowska and Seinhorst, 1979	Žabljak	2001	<i>Abies alba</i>	Barsi
<i>Longidorus piceicola</i> Liskova et al., 1997	Budva, Lazi	2004	<i>Quercus</i> sp	Barsi

- *On Flowers, Meadows, Pastures and Weeds-*

Nematosis on flowers, meadows, pastures and weeds can be considered the least significant of Montenegro's plant production. We do not have any data for flower production in Montenegro as it is very small. However, there are some 127,853 ha of meadows and 324,269 ha of pastures (SYM, 2009). Several taxa of nematodes have been recorded in Montenegro on these plants (Table 6.).

Table 6. Nematodes found on flowers, meadows, and other wild plants in Montenegro as of 2012.

Nematodes	Location	Year	Herb spec.	Reporter/s
<i>Heterodera</i> spp	Ulcinj	1988	Gladiola bulbs	Dimitrijević, Ivezić
<i>Hoplolaimus</i> spp	Ulcinj	1988	Gladiola bulbs	Dimitrijević, Ivezić
<i>Meloidogyne</i> spp	H. Novi, Petrovac	1988	Gladiola bulbs	Dimitrijević, Ivezić
<i>Meloidogyne naasi</i> Franklin, 1965	Ulcinj	1988	Gladiola bulbs	Dimitrijević, Ivezić
<i>Meloidogyne arenaria</i> (Neal, 1889) Chitwood, 1949	Ulcinj	1988	Gladiola bulbs	Dimitrijević, Ivezić
<i>Rhabditis</i> spp	Ulcinj	1988	Gladiola bulbs	Dimitrijević, Ivezić
<i>Xiphinema simile</i> Lamberti & al., 1983	Ulcinj	1994	<i>P. aquilinum</i>	Barsi
<i>Xiphinema pachtaicum</i> (Tulaganov, 1938) Kirjanova, 1951	Ulcinj Lazi, Morinj, Petrovac	1994 2002	<i>P. aquilinum</i> Grassland	Barsi Barsi and Lamberti

A couple of sources have incomplete data (Table 7.), but they must be mentioned, as they are legitimately sourced and connected with plant nematode research.

Table 7. All other plant nematodes found in Montenegro as of 2012.

Nematode	Location	Year	Reporter/s	Herb spec.
<i>Ditylenchus dipsaci</i>	unknown	1985	Alphey T.J.W. at all	unknown
<i>Heterodera achilleae</i>	unknown	1985	Alphey T.J.W. at all	unknown
<i>Macroposthonia annulata</i>	Meljine	1968	Krnjajić	<i>Pitosporum scienensis</i>
<i>Macroposthonia ferniae</i>	Meljine	1968	Krnjajić	<i>Hidrogenta hortensis</i>
<i>Meloidogyne</i> spp	unknown	1985	Alphey T.J.W. at all	unknown
<i>Meloidogyne hapla</i>	unknown	1985	Alphey T.J.W. at all	unknown
<i>Meloidogyne incognita</i>	unknown	1985	Alphey T.J.W. at all	unknown
<i>Meloidogyne javanica</i>	unknown	1985	Alphey T.J.W. at all	unknown
<i>Xiphinema index</i>	Morinj	2000	Barsi and Lamberti	unknown

Table 8. Overview of all plant nematodes, parasitic and free living, found in Montenegro as of 2012.

No.	Nematodes	Location	Date	Authors/Reporters	Herb. Species
1	<i>Aphelenchoides</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
1	<i>Aphelenchoides</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
2	<i>Aphelenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
2	<i>Aphelenchus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
3	<i>Acrobolus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
4	<i>Acroboloides</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
5	<i>Cnemonemoides</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
5	<i>Cnemonemoides</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
6	<i>Cephalobus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
7	<i>Chiroplacus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
8	<i>Cuticularia oxycerca</i>	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
9	<i>Ditylenchus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
9	<i>Ditylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
10	<i>Ditylenchus dipsaci</i>	unknown	1985	Alphey T.J.W. at all	unknown
11	<i>Diphtherophora</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
12	<i>Ditylenchus intermedius</i>	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
13	<i>Ditylenchus myceliophagus</i>	Ulcinj	1988	Dimitrijević, Ivezić	Potato field
14	<i>Dorylaimus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
14	<i>Dorylaimus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
15	<i>Enopliida</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
15	<i>Eucephalobus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
17	<i>Eucephalobus oxyuroides</i>	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
18	<i>Gracilacus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
19	<i>Heterodera</i> spp	Ulcinj	1988	Dimitrijević, Ivezić	Gladiola bulbs
20	<i>Heterodera achilleae</i>	unknown	1985	Alphey T.J.W. at all	unknown
21	<i>Heterodera trifolii</i>	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
22	<i>Helicotylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
22	<i>Helicotylenchus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
23	<i>Helicotylenchus pseudorobustus</i>	Podgorica	2010	Pajović	Greenhouse
24	<i>Helicotylenchus platyurus</i>	Podgorica	2010	Pajović	Greenhouse
25	<i>Hoplolaimus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
25	<i>Hoplolaimus</i> spp	Ulcinj	1988	Dimitrijević, Ivezić	Gladiola bulbs
26	<i>Longidorus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
27	<i>Longidorus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
27	<i>Longidorus piceicola</i>	Zabljak	2001	Barsi	<i>Abies alba</i>
28	<i>Longidorus intermedius</i>	Budva, Lazi	2004	Barsi	<i>Quercus</i> sp
29	<i>Mononchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
30	<i>Meloidogyne</i> spp	Kotor	1975	Gavrilović Grujičić	Spinach
30	<i>Meloidogyne</i> spp	Sutomore, Bar	1988	Jovičić, Stamenković	Greenhouse
30	<i>Meloidogyne</i> spp	Podgorica	2010	Pajović	Greenhouse
30	<i>Meloidogyne</i> spp	H. Novi, Petrovac	1988	Dimitrijević, Ivezić	Gladiola bulbs
30	<i>Meloidogyne</i> spp	unknown	1985	Alphey T.J.W. at all	unknown
31	<i>Meloidogyne naasi</i>	Ulcinj	1988	Dimitrijević, Ivezić	Gladiola bulbs
32	<i>Meloidogyne arenaria</i>	Ulcinj	1988	Dimitrijević, Ivezić	Gladiola bulbs
32	<i>Meloidogyne arenaria</i>	Podgorica	2007	Pajović, Urek, Sirca	Greenhouse
33	<i>Meloidogyne hapla</i>	unknown	1985	Alphey T.J.W. at all	unknown
33	<i>Meloidogyne hapla</i>	Podgorica	2006/2007	Pajović, Urek, Sirca	Greenhouse
34	<i>Meloidogyne incognita</i>	Podgorica	2007	Pajović, Urek, Sirca	Greenhouse
34	<i>Meloidogyne incognita</i>	unknown	1985	Alphey T.J.W. at all	unknown
35	<i>Meloidogyne javanica</i>	Podgorica	2007	Pajović, Urek, Sirca	Greenhouse
35	<i>Meloidogyne javanica</i>	unknown	1985	Alphey T.J.W. at all	unknown
36	<i>Meloidogyne ardensensis</i>	Podgorica	2006/2007	Pajović, Urek, Sirca	Greenhouse
37	<i>Mesodorylaimus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
38	<i>Mononchus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
39	<i>Macroposthonia annulata</i>	Meljine	1968	Krnjajić	<i>Pilosporum scienseis</i>
40	<i>Macroposthonia ferriiae</i>	Meljine	1968	Krnjajić	<i>Hydrogentia hortensis</i>
41	<i>Oxydurus oxycephalus</i>	Meljine	1968	Krnjajić	Vineyards
41	<i>Oxydurus oxycephalus</i>	Meljine	1968	Krnjajić	Citruses
42	<i>Pratylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
42	<i>Pratylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
42	<i>Pratylenchus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
43	<i>Pratylenchus neglectus</i>	Podgorica	2010	Pajović	Greenhouse
44	<i>Psilenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
45	<i>Panagrellus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
46	<i>Plectus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
47	<i>Plectus tenuis</i>	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
48	<i>Poikilolaimus oxycerca</i>	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
49	<i>Rhabditis</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
49	<i>Rhabditis</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
49	<i>Rhabditis</i> spp	Ulcinj	1988	Dimitrijević, Ivezić	Gladiola bulbs
50	<i>Rotylechus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
51	<i>Rotylechus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
51	<i>Rotylechus</i> spp	Podgorica	2006/2007	Pajović, Quintanilla, Bird	Greenhouse
52	<i>Rotylechus macrodoratus</i>	Podgorica	2010	Pajović	Greenhouse
53	<i>Tinchoodus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
54	<i>Tylenchorhynchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
54	<i>Tylenchorhynchus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
55	<i>Tylenchulus semipenetrans</i>	Ulcinj	1988	Vučinić and Todorović	Citruses
56	<i>Tylenchus</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
56	<i>Tylenchus</i> spp	Podgorica	1988	Jovičić, Stamenković	Greenhouse
57	<i>Xiphinema</i> spp	Pljevlja	1985	Dimitrijević, Ivezić	Potato field
58	<i>Xiphinema varium</i>	Krkvine	1998	Barsi	Oak tree
59	<i>Xiphinema montenegrinum</i>	Morinj	1998	Barsi	wood
60	<i>Xiphinema ilyricum</i>	Danilovgrad	1999	Barsi	<i>Carpinus orientalis</i>
61	<i>Xiphinema simile</i>	Ulcinj	1994	Barsi	<i>P. aquilinum</i>
62	<i>Xiphinema index</i>	Morinj	2000	Barsi and Lamberti	unknown
63	<i>Xiphinema diversicaudatum</i>	Stoliv, Stoliv, Morinj	1994, 1996, 2000	Barsi, Barsi, Barsi and Lamberti	Vineyards
64	<i>Xiphinema americanum</i>	Herceg Novi	1968	Krnjajić	Vineyards
65	<i>Xiphinema pachtaicum</i>	Ulcinj, Valdanos	1994	Barsi	<i>P. aquilinum</i>
65	<i>Xiphinema pachtaicum</i>	Lazi, Morinj, Petrovac	2002	Barsi and Lamberti	Grassland
65	<i>Xiphinema pachtaicum</i>	Ulcinj, Podgorica	2007	Pajović, Urek, Sirca	Vineyards

## CONCLUSIONS

Quite little is known about the presence and role of plant-parasitic nematodes, or nematodes at all, in relation to crop production in Montenegro.

Beside other plant parasitic nematodes reported from the Montenegro and mentioned above, the results of the nematode survey indicate that *Meloidogyne* spp. are the most destructive and common nematode taxa in Montenegro. They can result in major losses to crop productivity. Among them is *M. incognita*, which can cause major losses of tomato, cucumber, pepper and lettuce, and is the most common root-knot nematode species detected in the country. The other root-knot nematodes detected, namely *M. arenaria*, *M. ardeniensis*, *M. javanica* and *M. hapla*, are harmful, but not as wide-spread as *M. incognita*.

Considering these issues, attention must be paid to present and new root-knot nematodes before climate changes force them into vegetable as well as fruit production.

Climate change has the same effect on other nematode genera in plant production. For efficient management of parasitic nematodes, it is crucial to keep monitoring agricultural progress while maintaining full interaction with farmers. On-farm research/nematode management demonstrations and on-farm education programs are likely to be the most effective initiatives.

Apart from the present species or taxa of parasitic nematodes, there is the high possibility that some usually quarantined pests, such as potato cyst nematodes or *B. xylophilus* might be accidentally introduced, and that they would then adapt to Montenegro's agriculture. Considering such risks, a phytosanitary sector in Montenegro should take steps to prevent, or at least detect, the introduction of new species as soon as possible.

Such a sector may eventually implement bacterial-feeding species and other free living species. These species may eventually be used as indicators of soil quality, which is important for sustainable plant production. They can be also be used as living space competitors against parasitic nematodes in soil agro-ecosystems.

In this report we have presented data collected from a myriad of external sources to buttress the results of our survey, which was administered during 2006-2007 in greenhouses.

Most of the data that have been summarized in this report are found in non published extension service reports. Most of the service reports are the results of analyses done by other institutions at the request of the Ministry of Agriculture of Montenegro, or they were done through inter-institutional cooperation at a previous time. Some of the data are taken from published scientific papers done by scientists from ex Yugoslavia, and then more recently from Montenegro.

In total, we reported 65 different species and taxons of nematodes in plant production in Montenegro. Alongside the results of survey, all of the known literature was assembled, reviewed and summarized in Table 08, which was designed to include information about the taxa, collection location, publication date, and the authors-reporters.

In vineyards as of 2012, 4 species have been reported (*Oxydirus oxycephaloides*, *Xiphinema americanum*, *X. diversicaudatum* and *X. pachtaicum*). In potato fields, 18 genuses and 3 species (*Ditylenchus intermedius*,

*D. myceliophagus* and *Heterodera trifolii*) have been found. In open field vegetable production only the genus *Meloidogyne* has been reported, but in the greenhouses 25 genera and 13 species have been detected (*Cuticularia oxycerca*, *Eucephalobus oxyuroides*, *Helicotylenchus pseudorobustus*, *H. platyurus*, *Meloidogyne hapla*, *M. incognita*, *M. javanica*, *M. arenaria*, *M. ardenensis*, *Plectus tenuis*, *Poikilolaimus oxycerca*, *Pratylenchus neglectus* and *Rotylenchulus macrodoratus*). In orange and tangerine orchards, as of 2012, only two species have been reported (*Oxydirus oxycephaloides* and *Tylenchulus semipenetrans*). Quite a small number of species have been reported from forests, including some new species from the Longidoridae family (*Xiphinema variorum*, *X. montenegrinum*, *X. illyricum*, *Longidorus intermedius* and *L. piceicola*). Finally, in the case of flowers, meadows, pastures and weeds, a total of 4 genera and 4 species have been reported (*Meloidogyne naasi*, *M. arenaria*, *Xiphinema simile* and *X. pachtaicum*).

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### REFERENCES

- Anuradha, S. & Rao, S. R. (2007): The effect of brassinosteroids on radish (*Raphanus sativus* L.) seedlings growing under cadmium stress. *Plant Soil and Environment*, 53: 465-472.
- Alphey, T.J.W. & Ivezić, M. 1985: *Atlas of Plant Parasitic Nematodes of Yugoslavia*. - Scottish Crop Research Institute, Dundee; Agricultural Faculty of the Osijek, pp: 56.
- Barsi, L. 1989: The Longidoridae (Nematoda: Dorylaimida) in Yugoslavia. – *Nematologia Mediterranea*, 17: 97-108.
- Barsi, L. 1994: Species of the *Xiphinema americanum*-group (Nematoda: Dorylaimida) on the territory of the former Yugoslavia. – *Nematologia Mediterranea*, 22: 25-34.
- Barsi, L. 1996: Occurrence of *Xiphinema* species in the former Yugoslavia. Supplement to the “Atlas of Plant Parasitic Nematodes of Yugoslavia” – *Nematologia Mediterranea*, 24: 195-199.
- Barsi, L. & Lamberti, F. 1998: *Xiphinema variurum* sp.n. (Nematoda: Dorylaimida) from Montenegro, Yugoslavia. – *Nematologia Mediterranea*, 26: 151-156.
- Barsi, L., Lamberti, F. & Agostinelli, A. 1998: *Xiphinema densispinatum* sp.n., from Bosnia and Herzegovina and *X. montenegrinum* sp.n. from Montenegro, Yugoslavia (Nematoda: Dorylaimida). – *Nematologia Mediterranea*, 26: 67-77.
- Barsi, L. & Lamberti, F. 1999: Five undescribed species of *Xiphinema* (Nematoda: Dorylaimida) from the former territory of Yugoslavia. – *Nematologia Mediterranea*, 27: 127-150.
- Barsi, L. & Lamberti, F. 2000A: Uterine differentiation of four *Xiphinema* species (Nematoda: Dorylaimida) recently described from the former territory of Yugoslavia. – *Nematologia Mediterranea*, 28: 135-138.
- Barsi, L. & Lamberti, F. 2000B: Morphometric variation and juvenile stages of *Xiphinema diversicaudatum* (Micoletzky, 1927) Thorne, 1939 and of *X.*

- index* Thorne et al, 1950 (Nematoda: Dorylaimida) from the former territory of Yugoslavia. – *Nematologia Mediterranea*, 28: 171-187.
- Barsi, L. & Lamberti, F. 2001: Morphometric variation and juvenile stages of *Longidorus piceicola* Liskova et al, 1997 (Nematoda: Longidoridae) from the former territory of Yugoslavia. – *Russian Journal of Nematology*, 9: 77-83.
- Barsi, L. & Lamberti, F. 2002: Morphometrics of three putative species of the *Xiphinema americanum* group (Nematoda: Dorylaimida) from the territory of the former Yugoslavia. – *Nematologia Mediterranea*, 30: 59-72.
- Barsi, L. & Lamberti, F. 2004: Morphometric variation and juvenile stages of *Longidorus intermedius* Kozłowska & Seinhorst, 1979 (Nematoda: Dorylaimida) from the former territory of Yugoslavia. – *Russian Journal of Nematology*, 12: 107-114.
- Dimitrijević & Ivezić 1985: *Extension service report*. – Ministry of agriculture, forestry and water management, Montenegro, Podgorica. (non published data on Serbo-Croatian language).
- Dimitrijević & Ivezić 1988: *Extension service report*. – Ministry of agriculture, forestry and water management, Montenegro, Podgorica. (non published data on Serbo-Croatian language).
- Grujičić, G. 1975: Nematodes of root system (*Meloidogyne* spp.) on vegetable plants and opportunity of plant protection by non phytotoxic pesticides. – *Agronomic courier*, XXXVII:1-4, 23-34. (in Serbo-Croatian language)
- Jovičić & Stamenković 1988: *Extension service report*. – Ministry of agriculture, forestry and water management, Montenegro, Podgorica. (non published data in Serbo-Croatian language).
- Krnjajić, Đ. 1968: Supplement to fauna of nematodes in Yugoslavia. – *Plant protection*, 98: 75-95. (in Serbo-Croatian language)
- Krnjajić, Đ., Lamberti, F., Krnjajić, S., Agostinelli, A. & Radicci, V. 2000: Three new longidorids (Nematoda: Dorylaimida) from Montenegro. – *Nematologia Mediterranea*, 28: 235-248.
- Pajović, I., Quintanilla, M., Bird, G.W. 2006-2007. Non published data.
- Pajović, I., Širca, S., Gerić-Štare, B., Urek, G. 2007: The incidence of Root-Knot Nematodes *Meloidogyne arenaria*, *M. incognita* and *M. javanica* in Montenegro. – *Plant disease*, 91:11, 1514.
- Pajović, I., Urek, G., Širca, S. 2007: *Xiphinema pachtaicum* in vineyards in Montenegro. – *XIII Symposium of plant protection*, Zlatibor, Serbia, book of abstract, 60-61. (in Serbo-Croatian language)
- Pajović, I. 2010: *Phytoparasitic nematodes in greenhouses in Zeta valley*. – University of Novi Sad, Agriculture faculty, Ph.D. thesis, pp. 97. (in Serbo-Croatian language)
- Pavićević, Lj. 1983: *Agriculture in Skadar Lake valley*. – Montenegrin academy of science and art, Symposium Skadar Lake, Podgorica, pp. 373-383. (in Serbo-Croatian language)
- Statistical Yearbook 2009. *Montenegro Statistical Office*, Podgorica, pp. 355. (in Serbo-Croatian language)
- Vučinić, Z. & Todorović, J. 1988: Appearance of *Tylenchulus semipenetrans* Cobb, 1913 on citrus on Montenegro coast part. – *Agriculture and Forestry*, XXXIV, 2-3: 33-42. (in Serbo-Croatian language).

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**PREGLED IZVJEŠTAJA IZ BILJNE NEMATOLOGIJE  
DO 2012 GODINE**

**SAŽETAK**

Relativno malo se zna o ulozi fitoparazitnih i nematoda generalno u biljnoj poljoprivrednoj proizvodnji u Crnoj Gori. Glavni izvor podataka za rad su bili publikovani naučni radovi koji su za temu imali nematode i nematozna oboljenja, a koji se odnose na Crnu Goru. Uzeti su u obzir kao veoma značajni izvori informacija nepublikovani savjetodavni i izvještajno-prognozni bilteni vezani za nematode u našoj poljoprivrednoj proizvodnji. Pored navedenog kao noviji izvor podataka koristili smo rezultate monitoringa dvadeset objekata zaštićenog prostora u Zetsko-Bjelopavličkoj ravnici.

Napravljen je istorijski pregled publikacija, radova i biltena. A kako je ovo, koliko je nama poznato, prvi pregledni rad o nematodama u biljnoj proizvodnji u Crnoj Gori, dat je i pregled svih do sada utvrđenih vrsta i taksona nematoda po biljnim vrstama.

Ukupno 65 različitih štetnih, nematofagnih, bakteriofagnih i slobodno živećih vrsta i taksona nematoda je nađeno do 2012 godine u Crnoj Gori.

**Ključne riječi:** pregled, vrste nematoda, taksoni nematoda