



CSL PEST RISK ANALYSIS FOR *Paratrichodorus minor*

Abstract/ Summary

Paratrichodorus minor is a highly polyphagous plant pest, generally found in tropical or subtropical soils. It has entered the UK in growing media associated with palm trees and is most likely to establish on ornamental plants grown under protection. There is a moderate likelihood of the pest establishing outdoors in the UK through the planting of imported plants in gardens or amenity areas. However there is a low likelihood of the nematode spreading from such areas to commercial food crops, to which it presents a small risk of economic impact. *P. minor* is known to vector the *Tobacco rattle virus* (TRV), which affects potatoes, possibly strains that are not already present in the UK, but the risk of the nematode entering in association with seed potatoes is low. Overall the risk of *P. minor* to the UK is rated as low.

STAGE 1: PRA INITIATION

1. What is the name of the pest?

Paratrichodorus minor (Colbran, 1956) Siddiqi, 1974

Nematode: Trichodoridae

Synonyms:

Paratrichodorus christiei (Allen, 1957) Siddiqi, 1974

Paratrichodorus (Nanidorus) christiei (Allen, 1957) Siddiqi, 1974

Paratrichodorus (Nanidorus) minor (Colbran, 1956) Siddiqi, 1974

Trichodorus minor Colbran, 1956

Trichodorus christiei Allen, 1957

Nanidorus minor (Colbran, 1956) Siddiqi, 1974

Nanidorus christiei (Allen, 1957) Siddiqi, 1974

Trichodorus obesus Razjivin & Penton, 1975

Paratrichodorus obesus (Razjivin & Penton, 1975) Rodriguez-M. & Bell, 1978.

Paratrichodorus (Nanidorus) obesus (Razjivin & Penton, 1975) Rodriguez-M. & Bell, 1978.

Common names: English: a stubby-root nematode.

References: Decraemer, 1995

In Europe there has been some confusion between *P. minor* and *P. renifer*, with some records of *P. minor* now believed to be mis-identifications (see 6).

2. What is the pest's status in the Plant Health Directive (Council Directive 2000/29/EC¹)?

Paratrichodorus minor is not listed as a pest within the Plant Health Directive.

¹ http://europa.eu.int/eur-lex/en/consleg/pdf/2000/en_2000L0029_do_001.pdf

3. What is the recommended quarantine status of the pest in the lists of the European and Mediterranean Plant Protection Organisation (EPPO²)?

EPPO List: A1 regulated pest list A2 regulated pest list Action list Alert list

Paratrichodorus minor is not listed as a quarantine pest by EPPO, although it is currently being considered for addition to the EPPO Alert List (CSL, unpublished data).

4. What is the reason for the PRA?

Paratrichodorus minor has been confirmed five times in soil entering the UK since 1996, but there have been many other interceptions of stubby-root nematodes where diagnosis was only possible to the genus level, seventeen in 2007 alone (CSL, unpublished data). The most recent confirmed interception was on soil attached to palm trees from Chile, some of which were planted before the pest was identified (CSL, unpublished data). It is a highly polyphagous pest and its hosts include many crops grown commercially in the UK.

5. What is the PRA area?

The PRA area in this case is the UK. *Paratrichodorus minor* is not thought to be widely established in Europe, but has been found on a number of occasions. Two of the interceptions in the UK were on plants imported from the Netherlands (CSL, unpublished data), and the Dutch have themselves intercepted the pest (Sue Hockland, pers. comm.).

STAGE 2: PEST RISK ASSESSMENT

6. What is the pest's present geographical distribution?

P. minor has been mainly recorded in tropical and subtropical regions. It is not thought to be endemic to Europe, but has been found in Italy (Sicily) on orange trees, in Belgium on azalea and rhododendron, in Sweden on *Gardenia* and *Saintpaulia ionantha* (African violet), in Switzerland on *Anemone sp.*, in Portugal on *Triticum aestivum* (wheat) and in Greece on potato and melon (Decraemer, 1995; Karanastasi *et al.*, 2006). The records from Germany and the Netherlands are believed to be mis-identifications of *P. renifer* (Decraemer, 1995; Braasch & Sturhan, 1991) and Braasch and Sturhan (1991) suggest that all the records from northern and central Europe recorded as *P. minor* are in fact *P. renifer*. For this reason Belgium, Sweden and Switzerland are not included in Table 1.

The nematodes presence in French Guiana, Kenya, Mauritius and the Republic of Korea is mentioned in CABI (2008), but without any additional references, although *P. minor* has been intercepted in the UK on plants imported from Kenya (CSL, unpublished data).

² <http://www.eppo.org>

P. minor is likely to have been widely spread by human intervention and although its native distribution is unknown it is not thought to be indigenous to Central and South America (Hunt, 1993).

Table 1: Distribution of *Paratrichodorus minor*

North America:	Canada, USA (widely distributed)
South America:	Argentina, Brazil, Chile, Ecuador, French Guiana, Venezuela.
Central America:	Nicaragua.
Caribbean:	Cuba, Martinique, Puerto Rico, Trinidad and Tobago.
Europe:	Greece, Italy (Sicily), Portugal (including Madeira), Russia, Spain (including the Canary Islands).
Africa:	Burkina Faso, Cape Verde, Egypt, Ivory Coast, Kenya, Malawi, Mauritania, Mauritius, Morocco, Nigeria, Senegal, South Africa, Zambia, Zimbabwe.
Asia:	Afghanistan, China, India, Indonesia (Java), Israel, Japan, Korea (Republic of), Pakistan, Philippines, Saudi Arabia, Taiwan, Vietnam.
Oceania:	Australia, Fiji, New Zealand, Papua New Guinea.

References: Braasch & Sturhan, 1991; CABI, 2008; Decraemer, 1995; Hooper, 1977; Karanastasi *et al.*, 2006.

7. Is the pest established or transient³ in the PRA area?

No, *Paratrichodorus minor* is not considered established or transient in the PRA area but there has been little, if any, survey work carried out.

8. Is there any reason to suspect that the pest is already established in the PRA area?

No. In 2006 *P. minor* was discovered in soil attached to large palm trees imported from Chile. Half of the consignment had already been planted in an area close to agricultural land, and it was agreed that the soil should be sampled after winter to see if the nematodes had survived. Three follow-up inspections were made, but no nematodes were detected (CSL, unpublished data).

9. What are the pest's host plants?

Over 100 species of plants are known hosts of *P. minor*. Some economically important ones are: alfalfa, aubergine, avocado, azalea, barley, blueberry, boysenberry, broccoli, brussels sprouts, canary date palm, carrot, castor bean, cauliflower, celery, chayote, cotton, cowpea, cranberry, endive, grapefruit, lettuce, lima bean, millet, muskmelon, mustard, okra, onion, peach, peanut, persimmon, potato, radish, red beet, red clover, soybean, sugar beet, sugar-cane, sweet corn, sweet pepper, tomato, walnut, wheat and wine grape (Decraemer, 1995); but the nematode has also been found associated with many other plant species. A number of studies have looked at the host range of *P. minor* and tried to rate them according to preference, but preference

³ Transience: presence of a pest that is not expected to lead to establishment (ISPM 5)

seems to vary between geographic isolates of the nematode (Ayala *et al.*, 1970; Rohde & Jenkins, 1957b).

10. What hosts are of economic and/or environmental importance in the PRA area?

In terms of area grown, wheat, barley and potatoes have the greatest importance to the UK, with figures from the June 2007 census showing areas of 1,815,900 ha, 897,900 ha and 140,200 ha respectively (DEFRA and National Statistics, 2008). The UK export of wheat alone in 2005 was worth over \$361 million (US) (FAOSTAT, 2008). The area of other susceptible commodities grown in the UK may be less than that of wheat but many also have a high economic value, for example brassicas, carrots, lettuce, onions, red beet, sugar beet, sweet corn and tomatoes.

11. If the pest needs a vector, is it present in the PRA area?

No vector is required. This is a free-living organism.

12. Describe the pathway(s) considered by this PRA⁴.

P. minor is likely to enter the PRA area in soil associated with imported plant material. The most recent interception was associated with the import of large palm trees (*Jubaea chilensis*), but it has also been intercepted on *Rhododendron* and *Acer* (CSL, unpublished data).

13. How likely is the pest to enter the PRA area⁵?

Very unlikely Unlikely Moderately likely Likely Very likely

Paratrichodorus minor is widely found around the world and has a very wide range of potential hosts, including potatoes and ornamentals, which may enter the UK associated with soil or other growing media. The entry of soil is regulated, but unless a plant is showing symptoms or the growing media is suspected to fail to comply with phytosanitary regulations for some reason, soil sampling is not undertaken and *P. minor*, like other nematodes, may enter unnoticed.

With the importation of soil-covered ware potatoes the risk of the nematode becoming associated with a suitable plant host is low. Most UK processors meet the current Code of Practice guidelines for waste disposal, (DEFRA, 2008; Peter Reed, pers. comm.) with waste water being treated by, for example, UV light, heat, and settlement, and peelings being processed or sent for deep burial, to prevent the spread of ring rot (*Clavibacter michiganensis* subsp. *sepedonicus*) and brown rot (*Ralstonia solanacearum*). Waste water from potatoes supplied for domestic use will enter the UK sewer

⁴ A pathway description would typically identify a geographic origin, a host and what the intended use of the host is.

⁵ Pest entry includes an assessment of the likelihood of transfer to a suitable host (ISPM No. 11, FAO, Rome)

system and eventually be discharged into rivers, but, unless river water is used to irrigate agricultural land, the chance of *P. minor* coming into contact with suitable hosts is small. Contaminated soil associated with seed potatoes could pose a higher potential threat, because they would be planted directly into agricultural land, but their import is highly regulated and, with the exception of Switzerland, restricted from outside the EU (Plant Health Directive, 2007). The majority of seed potatoes are imported from the Netherlands and with the current range of *P. minor* in the EU limited to Greece, Italy, Portugal and Spain this limits the potential of this nematode entering the UK on this commodity.

The greatest likelihood of entry is via the import of ornamentals, in growing media designated “necessary to sustain vitality”, and where a host is already available. The most recent interception of this nematode was on soil associated with the root balls of large palm trees from Chile (CSL, unpublished data).

14. How likely is the pest to establish outdoors in the PRA area?

Very unlikely Unlikely Moderately likely Likely Very likely

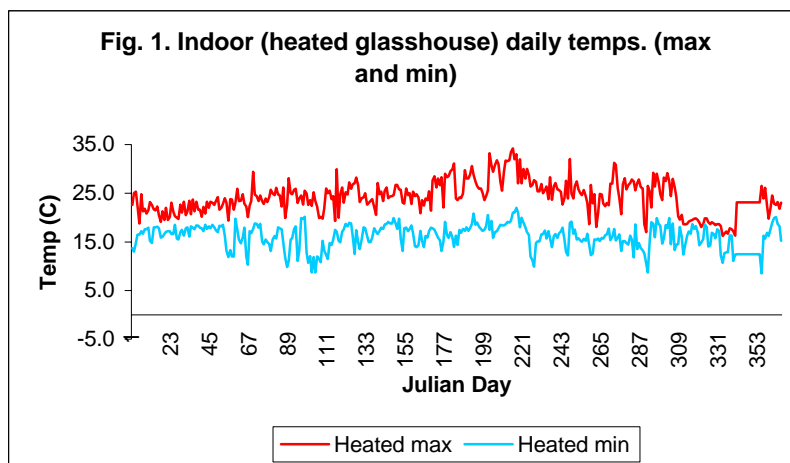
P. minor is a pest largely occurring in warm or subtropical soils, although it has been found as far north as Massachusetts and Montana in the USA (CABI, 2008). Data on the temperature requirements for the development of *P. minor* is varied and other factors may also affect the likelihood of establishment, such as humidity, host and soil type, for example *P. minor* prefers sandy or sandy-loam soils, but has also been found in peat and soils with high organic content (Decraemer, 1995). Rohde & Jenkins (1957a) investigated the length of the lifecycle on tomato seedlings. At 30°C the life cycle was completed in 16-17 days, whilst at 22°C it took 21-22 days. At 20°C the population did not increase and at 35°C no larvae were found. On sweet corn the nematodes were found to reproduce at all constant temperatures tested (12°C to 29°C), with the optimum being somewhere between 16°C and 24°C (Ayala *et al.*, 1970). Brodie (1976) found the highest *P. minor* populations at soil depths of 30cm in sandy soil, where the temperature varied between 11°C and 17°C and the soil moisture was 18-23% by volume. There is no data on the minimum temperature at which these nematodes can survive, but their survival will also depend on the soil depth at which they are living, with those deeper being able to survive more readily than those closer to colder winter surface temperatures. They are also less likely to freeze if they have not been in contact with water or ice and have not been feeding.

When, in 2006, *P. minor* was detected in the UK on palm trees imported from Chile, around half of the consignment had already been planted. The soil was sampled three times over the following year to determine if the nematodes had survived the winter. No *P. minor* were found (CSL, unpublished data). This was in East Yorkshire and their chances of establishment may be greater in the warmer climate of southern UK. However, factors other than the temperature in the area where these palms were planted may have been involved in the nematodes non-establishment.

15. How likely is the pest to establish in protected environments in the PRA area?

Very unlikely Unlikely Moderately likely Likely Very likely

P. minor has been experimentally shown to reproduce on sweet corn at glasshouse ambient temperatures (15 - 35°) (Ayala *et al.*, 1970). Data collected over a year from a heated tomato glasshouse in the UK is shown in Fig. 1 and gives a maximum daily temperature of 34.2°C and a minimum of 8.5°C. Given that *P. minor* has been demonstrated to be capable of reproducing between 12°C and 35°C (Ayala *et al.*, 1970) it seems likely that the pest could establish in heated glasshouses in the UK and none heated protected environments should also provide temperatures more amenable to the development of *P. minor* than the outdoors.



16. How quickly could the pest spread⁶ within the PRA area?

Very slowly Slowly Moderate pace Quickly Very Quickly

The natural spread of any nematode is dependant on the species and the physical and chemical properties of the medium, but is generally very slow, of the magnitude of metres or even centimetres a year (Thomas, 1981). Dispersal through the intervention of humans moving plant material and growing media is the most likely means of this pest spreading.

17. Which part of the PRA area is the endangered area?

P. minor is a pest of some highly important crops grown in the UK, but most of these are unlikely to come into contact with imported plant material associated with growing media. Crops such as cereals and vegetables are grown from seed or modules, large numbers of which are grown in the UK themselves.

⁶ ISPM No 5. defines spread as the expansion of the geographic distribution of a pest within an area. Note that just because an organism can move or be transported quickly, does not mean that it will spread quickly, i.e. it also has to establish.

Seed potatoes may have small amounts of soil associated with them, but very few are imported from countries where *P. minor* is known to occur. At greatest risk is the glasshouse / polytunnel grown ornamental industry, with the importation of ornamentals from all over the world and a higher chance of the nematode surviving winters in protected conditions than if the ornamentals have been planted outside.

18. What is the pest’s economic, environmental or social impact within its existing distribution?

Very small Small Medium Large Very large

Stubby-root nematodes, including *P. minor*, cause direct damage by feeding on a root’s meristematic tissue. This reduces root growth and leads to the characteristic short stunted roots. When large numbers of nematodes are present the roots can become discoloured with necrotic lesions, but this seems rare with *P. minor* (Ferris, 2005). The above ground symptoms of an infected plant may be retarded growth, wilted foliage and sensitivity to drought (CABI, 2008; Decraemer, 1995). The main reason for its pest status, however, is because of its ability to vector viruses (see 20).

Damage by this nematode is widely reported, but rarely quantified. It is reported as limiting to vegetables and injurious to tomatoes and onion in south-eastern USA (Ferris, 2005), damaging to onions in Australia (Stirling, 1976; Stirling *et al.*, 1992) and Venezuela (Jimenez-Perez *et al.*, 2005) as well as tomatoes in Senegal (CABI, 2008), as an economic pest on St Augustine grass in Florida and Georgia, and damaging to sugarcane and cotton (Ferris, 2005), but is considered of little importance in California (Ferris, 2005).

19. What is the pest’s potential to have economic, environmental or social impacts in the PRA area?

Very small Small Medium Large Very large

There is a possibility that the establishment of *Paratrichodorus minor* could bring to the UK strains of *Tobacco rattle virus* (TRV) not already present. However, it is not unknown for potatoes to have TRV and show no symptoms (Evans *et al.*, 2006), suggesting that seed potatoes could carry new strains of TRV into the UK without carrying any non-native nematodes with them. The nematode itself is less likely to come in on seed potatoes (see 13) and is generally unlikely to come into contact with plants or soil heading for outdoor vegetable or cereal growing. Indoor crops are only at risk if there is a chance of contamination from imported ornamental plants, or soil in containers that have carried these plants. The impact in the UK would be limited to the imported plants themselves and the area to which they were planted out, probably as garden or amenity plants, rather than near commercial crops.

20. What is the pest’s potential as a vector of plant pathogens?

P. minor is a vector for the Californian and Wisconsin isolates of *Tobacco rattle virus* (TRV) which causes stem mottle and tuber spraing, or corky

ringspot, in potatoes (Decraemer, 1995; Ferris, 2005) and it may also transmit TRV from the roots of asters. It is not, however, a very efficient vector, large numbers of nematodes being required (Ayala & Allen, 1968). Strains of TRV are present in the UK and of particular note in potato growing areas of Scotland, where prevention of its spread accounts for the majority of nematicide usage. There are already nematodes of the genus *Paratrichodorus* present in the UK which can transmit this virus and many weed species capable of acting as a reservoir (Alphey *et al.*, 1975; Dale *et al.*, 2006; Evans *et al.*, 2006).

In Brazil, *P. minor* has been found to vector Pepper ringspot virus (PepRSV) (Decraemer, 1995) and links have been reported between this nematode and other disease causing pathogens (Decraemer, 1995; Stirling, 1976).

STAGE 3: PEST RISK MANAGEMENT

21. If not already present in the PRA area, how likely is the pest to continue to be excluded from the PRA area?

Outdoors: Very likely Likely Moderately likely Unlikely Very unlikely

The pathways that *P. minor* has for entry into the UK limit the chance of it establishing outdoors as there is minimal risk of the nematode being planted in an area where commercial food crops are grown. It could be planted with imported ornamentals, such as the palms on which it was detected in 2006, but these are probably destined for gardens or amenity areas, albeit sometimes in close proximity to agricultural land. From sampling of the soil where the palms were planted in 2006 there is no evidence that the nematode survived the winter in northern England (Yorkshire). In milder, more southerly, parts of the UK this may not be the case, hence the designation of 'moderately likely' to be excluded, but there is still very little risk of the pest spreading to commercial food crops.

In protection: Very likely Likely Moderately likely Unlikely Very unlikely

Through the importation of ornamentals *P. minor* may enter UK glasshouses / polytunnels. Imported plants grown on there may then harbour the nematode and there is a danger of spread if hygiene measures regarding potting up and cleaning of containers are not adhered to. *P. minor* is not itself highly mobile and is very unlikely to be passed between plants under protection by workers brushing against the plants. The risk to commercial food crops such as lettuce or tomatoes though is low and deterioration in an imported plant may allow this pest to be detected before the plants are sold on.

22. If the pest enters or has entered the PRA area how likely are outbreaks to be eradicated?

Very likely Likely Moderately likely Unlikely Very unlikely

Historically *P. minor* has been killed easily by nematicides, but many of these actives, such as aldicarb, are no longer available. Eradication is more likely to be successful with plants in pots. Here the nematodes are contained and root washing (*P. minor* is an ectoparasite) may be used. Pots should be either disposed of safely or sterilised before reuse. Manual washing of the roots is preferable to powerwashing as there is likely to be less spray contamination (CSL, unpublished data). Eradication is more difficult if the hosts have been planted out, their removal and root washing likely to be destructive.

23. If eradication is not possible, what management options are available for containment and control?

Chemical controls are available for use, but most are recommended for application before or at planting. They could be used if land needed for potato, cereal or vegetable growing was found to have become infested or under protection to treat bays before planting, but the efficacy of control of stubby-root nematodes by nematicides is highly variable. Crop rotation with poor or non-hosts may also reduce *P. minor* populations, although the nematode is highly polyphagous so there may be limited options. Leaving the land fallow and weed free for a period may be another option as is growing susceptible crops away from the nematodes favoured sandy and loam soils (CABI, 2008). Where infested ornamentals have been planted outside soil sampling can establish the extent to which the nematodes have spread from initial planting and whether they are capable of surviving the winter in the UK.

24. Conclusion

Paratrichodorus minor is a highly polyphagous plant pest, with many potential hosts in the UK. This pest causes physical damage to crops in many areas of the world, but there are no reports of major economic damage. The nematode also vectors *Tobacco rattle virus* (TRV), but this virus is already present on potatoes in the UK along with many established vectors. It's pathways into the PRA area are restricted to growing media around plant material and for this reason this nematode is considered a low risk to most field grown crops. There is a small possibility of *P. minor* entering on soil associated with seed potatoes, but these are unlikely to be sourced from areas where this nematode is found. It is most likely to come into the PRA area, as it already has done, on ornamental plants. Eradication may be possible if these remain in pots and the nematodes are contained. Of more difficulty is if infested plants are planted outdoors, but the possibility of spread from such plants is limited, the plants generally remaining in one place and soil around them undisturbed.

Overall this pest is considered of low risk to the UK. The virus it is known to vector is already present and although different strains exist the nematode's potential pathways into the UK limit it's establishment to areas of low risk.

Further work that would reduce uncertainties

Area of PRA	Uncertainties	Further work that would reduce uncertainty
Taxonomy	Distinguishing between <i>P. minor</i> and <i>P. renifer</i> .	
Pathway	Seed potatoes: what numbers are imported to the UK from the Mediterranean?	Check with DEFRA import data
Distribution	The distribution in Europe is unclear.	Clarification that <i>P. minor</i> is present in southern Europe and not northern or central. Monitoring in the UK.
Establishment	It is not clear what would be the most limiting factor for establishment: temperature, soil type, host, humidity?	Greater investigation into the environmental factors affecting the survival and development of <i>P. minor</i> .
Spread	How did the pest enter southern Europe? What is the level of establishment?	Contact with Mediterranean countries where <i>P. minor</i> has been found.
Impact	Data on economic impact of <i>P. minor</i> in other countries sketchy.	Possible contact with countries that have <i>P. minor</i> for information on the scale of damage caused.
Management	Are there any possible drench treatments available?	CSL knowledge is that there are not.

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