Distribution of stylet-bearing nematodes associated with raspberries and strawberries in British Columbia

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In the Fraser Valley of British Columbia stylet-bearing nematodes of 16 genera were isolated from raspberry soils, and of 11 genera from strawberry soils. ***Pratylenchus penetrans*** was the most widely distributed, occurring in nearly 90% of the samples. ***Xiphinema bakerialso*** occurred frequently but only in loam soils. Both species were associated with direct plant damage. ***X. americanum*** was restricted to silty clay loam soils and was associated with tomato ringspot virus in raspberry. ***Longidorus elongatus*** was found in less than 5% of the samples but caused considerable damage to strawberries. The other genera occurred less frequently and caused no plant damage.

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On a prélevé 16 et 11 genres de nématodes de sols à framboisiers et a fraisiers respectivement dans la vallée du Fraser en Colombie-Britannique. ***Pratylenchus penetrans*** Btait le plus répandu, Btant représenté dans 90% environ des Bchantillons. ***Xiphinema bakeri*** Btait Bgalement abondant, mais seulement dans les loams. Ces deux espèces étaient directement responsablesdes dégâts causés aux végétaux. ***X. americanum*** se limitait à des loams argileux limoneux et était associé au virus de la tache annulaire de la tomate chez le framboisier. Moins de 5% des Bchantillons contenaient ***Longidorus elongatus,*** lequel a causé des dégâts considérables aux fraisiers. Les autres genres étaient moins répandus et n'ont causé aucun dégât.

More than 2300 acres of the Fraser Valley of British Columbia are devoted to raspberries, which gave a return of about 4 million dollars in 1975. Under optimum growing conditions, disease-free plantings remain productive 10-15 years and should yield at least 4-5 tons per acre. In recent years, however, plantings have begun to decline. Yields in many fields are down by 40-50% and plantings are becoming unproductive after only 7-8 years.

Strawberry also is an important crop in this area with 1200 acres returning almost 3 million dollars a year. Plants normally remain in the ground for 3-4 years and yield an average of 4 tons per acre. However, many plantings fail to become established while others suffer from patchy areas of poor growth. These plantings often become uneconomical after the second year and are usually plowed out.

Many species of plant parasitic nematodes have been found associated with raspberry and strawberry throughout the world (12). Several of these have been reported from British Columbia (1, 2, 3, 4, 13, 18), some associated with decline, but the extent of their occurrence and the amount of damage they cause were unknown. To assess their importance, a nematode survey was conducted of the berry plantings in the Fraser Valley of British Columbia. The results of this survey are reported here.

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Materials and methods

The nematode survey was conducted during May through September from 1969 to 1971. In this paper the terms 'unhealthy' or 'unthrifty' refer to plants that lack vigor, are stunted, off color, or produce lower yields than other plants in the same field. Where large areas of unhealthy plants were encountered, samples were taken from the margin, where preliminary sampling showed nematode populations were highest.

A total of 636 samples was taken from soil around the roots of red raspberry (***Rubus ideaus*** L.) and strawberry (***Fragaria chiloensis*** L.). For each sample, six soil cores, 2.5 cm in diameter, 15-30 cm deep, were taken from each of the root zones .of both unthrifty and apparently healthy plants and placed in a polyethylene bag. The samples were carried to the laboratory in an insulated box, and either processed immediately or stored at 5°C for not longer than 48 hours.

After thorough mixing of the soil a 200 cc subsample was processed by the Christie-Perry (6) and modified Flegg (9) methods to recover the nematodes. Freshly extracted nematodes were counted and identified to genus under a dissecting microscope. Species identifications were made under a compound research microscope from specimens mounted in glycerine.

Determination of ***Meloidogyne*** species was made from mature females obtained by growing tomato (***Lycopersicum esculentum*** L. cv. Rutgers) for 8 weeks in soil from which ***Meloidogyne*** larvae had been recovered.

Composite nematode samples from each farm were preserved in TAF fixative (8) and stored as a permanent record. All samples were cross-indexed according to location, associated crop and nematode genus. A map

Table 1. Distribution of stylet–bearing nematode genera associated with raspberry in the berry growing municipalities of the Fraser Valley

Nematode genus	Municipality								
	Chilliwack (156)*	Kent (2)	Langley (27)	Matsqui (85)	Mission (10)	Richmond (37)	Sumas (24)	Surrey (8)	Total (349)
Aphelenchoides	2.6†	0	43.6	9.4	0	8.1	4.2	25.0	10.0
Aphelenchus	2.6	0	36.0	14.1	0	2.7	8.3	37.5	10.3
Criconema	0.6	0	0	1.2	0	0	0	0	0.5
Criconemoides	1.9	0	0	3.5	0	0	0	0	1.7
Ditylenchus	7.1	0	34.4	8.2	0	2.7	0	0	9.2
Helicotylenchus	8.3	0	0	12.9	0	0	0	0	6.8
Heterodera	10.9	0	7.7	3.5	0	18.9	0	0	8.5
Longidorus	1.3	0	0	0	0	0	0	0	0.5
Meloidogyne	0	0	2.6	0	0	0	8.3	0	0.8
Paratylenchus	33.3	0	3.3	8.2	40.0	2.7	0	0	18.6
Pratylenchus	88.5	0	92.3	75.3	100	86.4	100	100	89.3
Rotylenchus	0	0	2.7	0	0	0	0	0	0.3
Trichodorus	0	0	0	0	0	0	50.0	0	3.4
Tylenchorhynchus	3.2	0	0	0	0	0	0	0	1.4
Tylenchus	25.6	50.0	41.0	20.0	40.0	45.9	66.6	50.0	32.9
Xiphinema	58.9	50.0	15.4	41.1	10.0	0	12.5	0	10.8

* Total number of samples taken from raspberry fields in the municipality.
† Percentage of samples containing the genus.

Table 2. Distribution of stylet–bearing nematode genera associated with strawberry in the berry growing municipalities of the Fraser Valley

Nematode genus	Municipality						
	Delta (38)*	Kent (30)	Langley (105)	Matsqui (40)	Mission (10)	Richmond (64)	Total (287)
Aphelenchoides	13.2†	0	35.2	5.0	10.0	12.5	18.5
Aphelenchus	21.1	23.3	22.8	22.5	0	20.3	21.2
Ditylenchus	21.1	16.7	8.6	5.0	0	3.1	9.0
Helicotylenchus	0	10.0	0	2.5	0	0	4.5
Heterodera	15.8	0	8.6	15.0	30.0	20.3	12.9
Longidorus	0	40.0	2.5	0	0	0	4.5
Paratylenchus	21.1	3.3	10.5	22.5	0	18.8	14.3
Pratylenchus	84.2	13.3	82.8	95.0	60.0	90.5	88.8
Rotylenchus	0	0	2.9	0	0	0	1.0
Tylenchus	10.6	6.7	31.4	20.0	0	26.6	22.2
Xiphinema	60.0	0	4.8	20.0	10.0	0	11.1

* Total number of samples taken from strawberry fields in the municipality.
† Percentage of samples containing the genus.

was made for each farm showing the source of each sample as a reference for future samplings.

Results and discussion

Stylet-bearing nematodes of 16 genera were isolated from raspberry soils (Table 1) and 11 from strawberry soils (Table 2) in the Fraser Valley. Figures 1, 2, and 3 show the nematode distribution in the Fraser Valley with the associated soil textures. For convenience soil textural classes have been grouped into families as follows: fine (heavy clay, clay, silty clay, sandy clay); medium fine (silty clay loam, loam, clay loam); medium (silt, silty loam, loam); coarse (sandy loam, loamy sand, sand); organic (>30% organic matter).

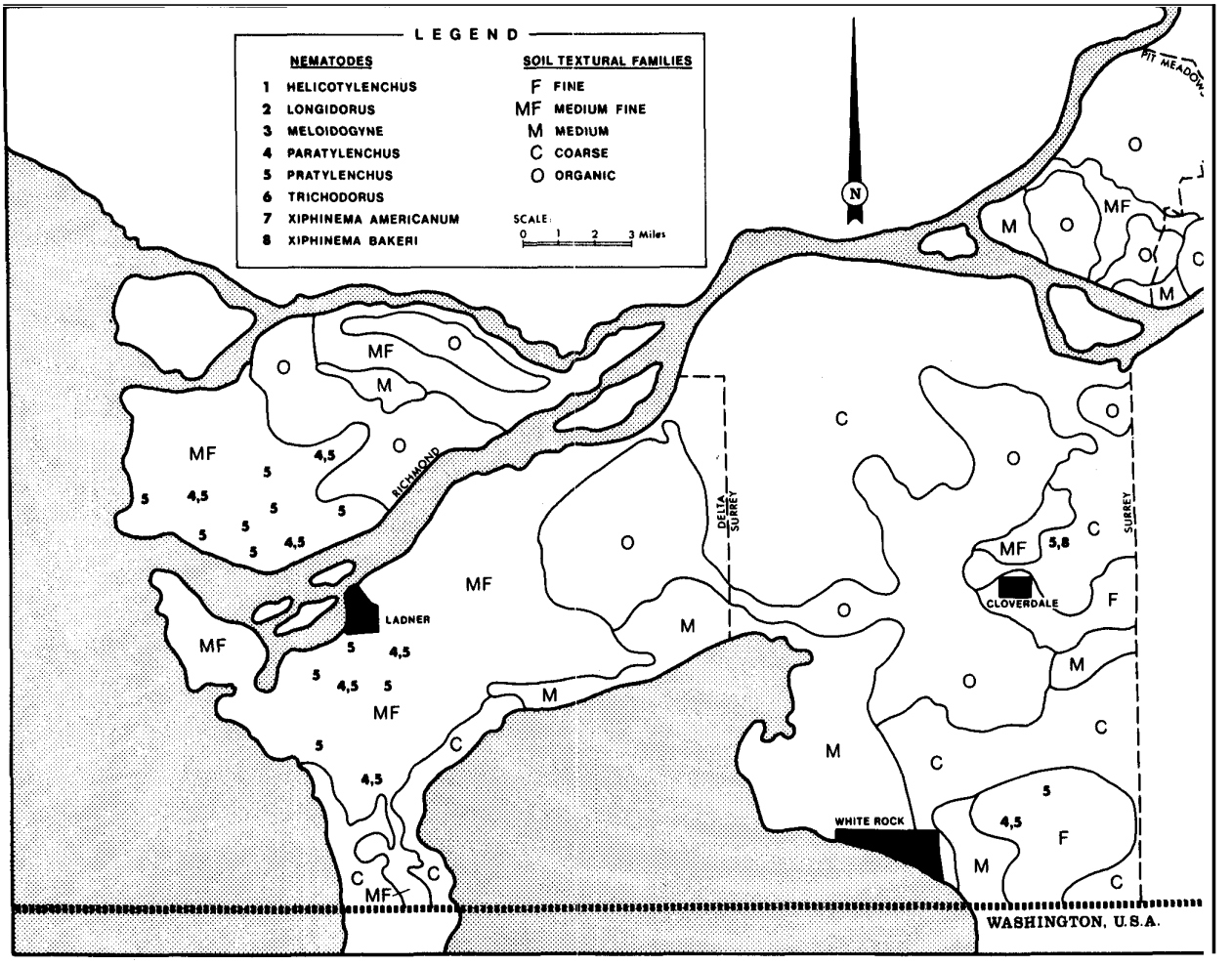

Figure 1. Distribution of stylet-bearing nematode genera and the associated soil textures in the western Fraser Valley.

Pratylenchus penetrans (Cobb) Chitwood and Oteifa was the species most frequently recovered from beneath both of these crops. In several municipalities it was recovered from every sample taken. While this species was usually present in samples from both healthy and unhealthy plants, populations were consistently and significantly greater under the unhealthy plants. Soil type appeared to have little influence on presence or absence of the species (Fig. 1, 2, 3) but populations were usually higher and caused greater damage in the medium textured soils.

Two species of ***Xiphinema*** were recovered, ***X. americanum*** Cobb and ***X. bakeri*** Williams. The first was confined to the raspberry fields in the medium fine textured soils of the municipality of Chilliwack (Fig. 3). This is also the only area in the Fraser Valley where tomato ringspot virus (TmRSV) occurs in raspberry, and it is consistentlly associated with ***X. americanum.*** Populations were usually low (20-50/200 cc of soil) and not associated with direct plant damage.

X. bakeri was more widely distributed in the medium textured soils of all raspberry and strawberry growing areas from the municipalities from Langley to Kent (Fig. 2, 3). It was never recovered from any of the heavier soils (containing more than 25% clay). When it occurred in large numbers plants were unthrifty and swollen, curled root tips indicated root feeding. The pathogenic effect of this species has been reported elsewhere (11). In the field X. ***bakeri*** occurred with ***Pratylenchus*** in ***52%*** of the raspberry samples and 53% of the strawberry samples. The two nematodes together were associated with considerable plant damage.

Longidorus elongatus (deMan) Thorne and Swanger was first reported from British Columbia in 1971 (10). It occurred in only a few of the samples (Table 1, 2; Fig. 2, 3), but it was consistently associated with stunted and dying strawberry plants. ***L. elongatus*** has been shown to be a pathogen of strawberry in other parts of the world (14, 15) and observations here confirm a similar behavior in B.C. It was also recovered from two

serve as hosts for *P. penetrans* and *X. americanum*. *X. bakeri* has been found associated with native trees, especially red cedar (*Thuja plicata* D. Don), red alder (*Alnus rubra* Bong.) and broadleafed maple (*Acer macrophyllum* Pursh.). *L. elongatus* was also found under the native broadleafed maple. These recoveries point to the importance of preplant sampling and fumigation even in newly cleared land.

None of the other genera found were associated with plant damage except in combination with those already mentioned. Most of the *Aphelenchoides* species were *A. subtennis* (Cobb) Steiner and Buhrer. Neither *A. fragariae* (Ritzema Bos) Christie nor *A. ritzema-bosi* (Schwartz) Steiner were found in this survey. *A.* raspberry soil samples in the Chilliwack area (Fig. 3) where it was associated with *X. americanum, X. bakeri* and *P. penetrans*. Because of this association it was difficult to ascertain its involvement in plant damage. Raspberry is not normally a host of this species (16) so it may have had a weed host. A similar situation has been reported from Scotland (17) where *L. elongatus* multiplies on virus infected weed hosts and feeds on raspberry only sufficiently to transmit the virus. No virus was found to be associated with this nematode in British Columbia.

The four genera mentioned above have all been recovered from virgin, forested areas in several locations in the Fraser Valley (Fig. 2, 3). Several native weeds also

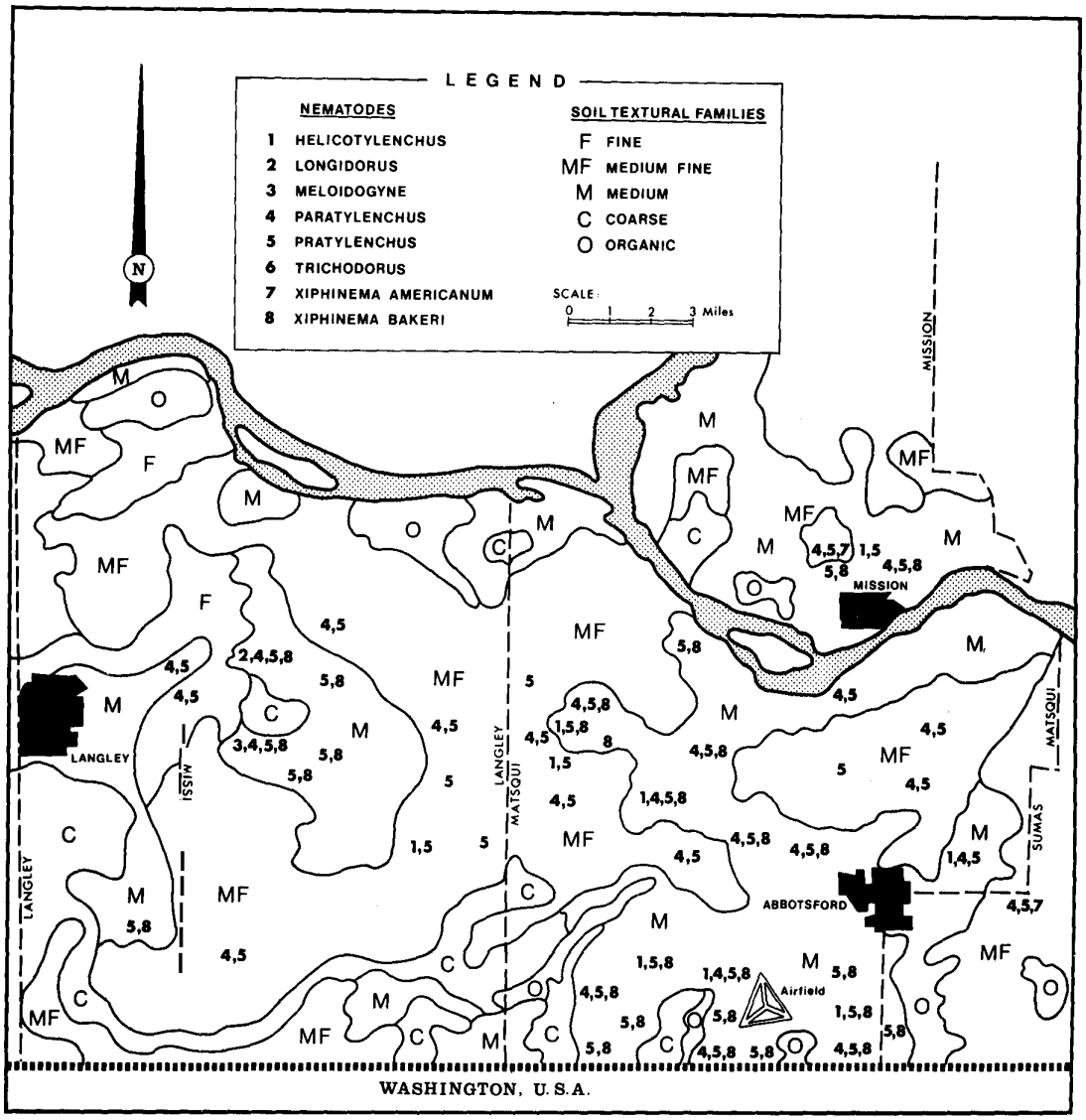

Figure 2. Distribution of stylet-bearing nematode genera and the associated soil textures in the central Fraser Valley.

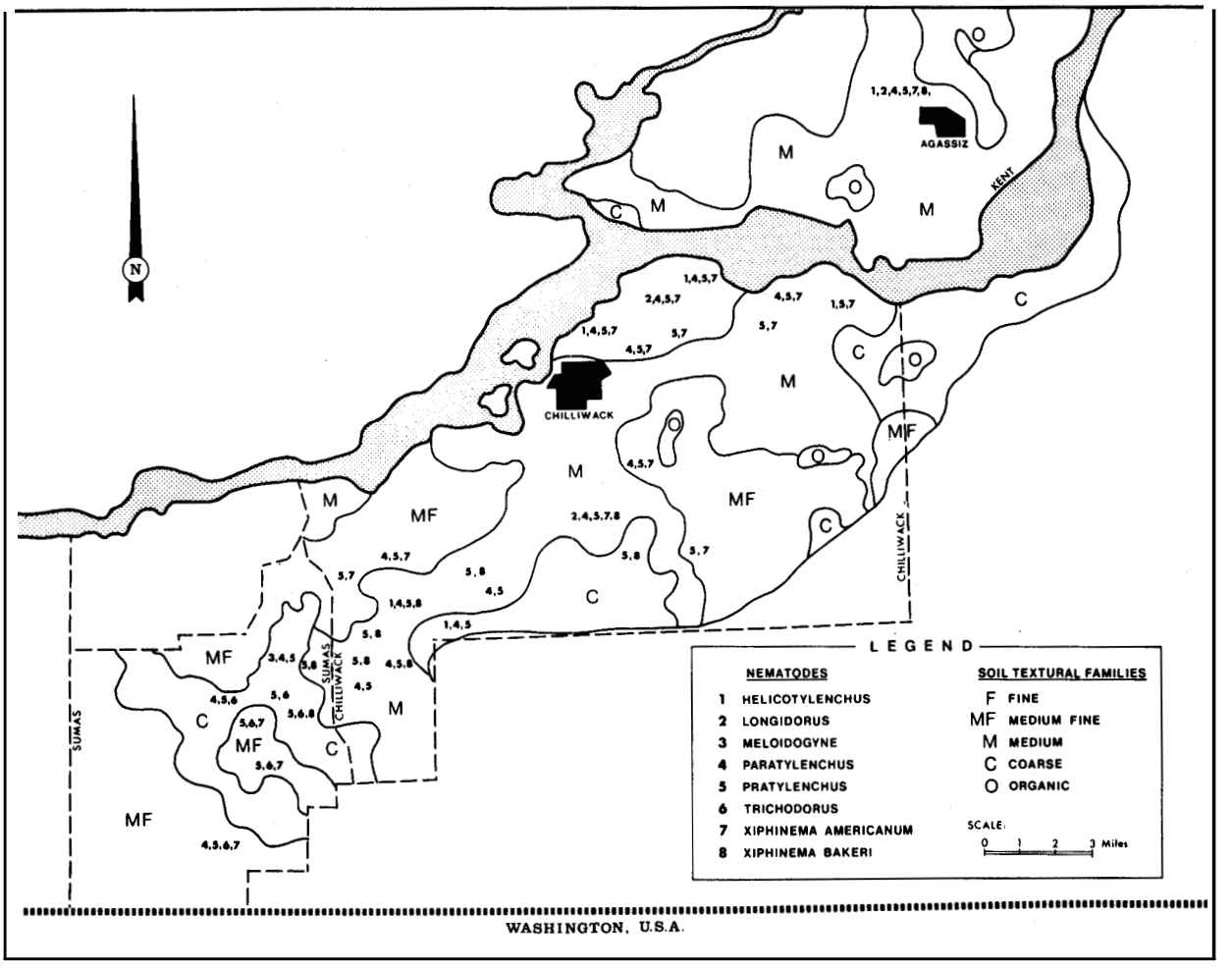

Figure 3. Distribution of stylet-bearing nematode genera and the associated soil textures in the eastern Fraser Valley.

fragariae has been reported in British Columbia (18) but not from strawberry.

Ditylenchus dipsaci (Kuhn) Filipjev, has been reported as a strawberry pest in Washington (5, 7). and is an economically important pest of bulb crops in British Columbia but, while present, it was not associated with damaged strawberry or raspberry.

Meloidogyne hapla Chitwood was the only root knot species found. Root galling was not evident on raspberry. It was not recovered from strawberry in this survey, although it has been reported on this host in the Fraser Valley (13). It does not appear to be a serious pest on either crop in the valley.

Heterodera trifolii Goffart was the only cyst nematodle species recovered from raspberry and strawberry soils. This is a ubiquitous species in British Columbia and has been reported from raspberry here (18). In this survey it was never associated with damaged raspberry or strawberry plants.

The remainder of the genera found occurred less frequently, were less widely distributed, and did not appear to be associated with any plant damage. It appears therefore that P. ***penetrans*** and X. ***bakeri*** are the main nematode pests causing direct damage to raspberries and strawberries in British Columbia. While X. ***americanum*** is important as a vector of TmRSV its restricted distribution and apparent lack of direct pathogenic effect limit its importance in berry production. L. ***elongatus*** can be a serious pathogen on strawberry but it too is of minor importance because of its limited distribution.

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