

NEMATODES ASSOCIATED WITH THE INVASIVE WEED *MYRICA FAYA* IN HAWAII

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RESUMEN

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Los nematodos fueron recogidos de la zona de la raíz de árboles invasivos (*Myrica faya*) sanos y con síntomas de declinación. *Helicotylenchus*, *Hoplolaimus*, *Longidorus*, *Pratylenchus*, *Tylenchus*, *Xiphinema*, y un undeterminado criconematoid fueron observado sobre la faya sana y con síntomas de declinación. *Meloidogyne* fue aislado solamente sobre la faya sana y en solamente un lugar. Mientras *Trichodorus* fue identificado solamente en lugares con árboles afectados. En la mayoría de los casos los nematodos recuperados no eran abundantes; y probablemente no son incitantes primarios de la declinación. Mientras, *Trichodorus* fue encontrada en numero elevado (100 por 200 centímetros cúbicos de suelo) sobre árboles afectados. Otro estudios son necesarios para descubrir el rol de *Trichodorus* en el fenomeno de declinación.

Palabras claves: control biologica, ecosistemas naturales, Macaronesia.

Invasion by faya (syn. firetree, *Myrica faya* Ait.) is a major threat to natural ecosystems in Hawaii where this actinorrhizal tree aggressively colonizes nitrogen-limited habitats and displaces native vegetation (Vitousek and Walker, 1989). Control efforts (biological, chemical, and physical removal) have failed to check the rapid spread of this noxious weed which now covers over 32 000 ha statewide; most of that area is in or around Hawaii Volcanoes National Park (HAVO) on the island of Hawaii (Whitaker and Gardner, 1985). In 1987, we first observed dead and declining trees in a remote area of HAVO. This decline is by far the most effective natural control ever observed (Gardner and Hodges, 1990; Lutzow-Felling *et al.*, 1995). We are attempting to elucidate the etiology of decline with the aim of possibly increasing and distributing the damage throughout faya's range in Hawaii.

Preliminary studies indicated that fungal pathogens, insect pests, and various abiotic factors are not primary causal factors (Duffy and Gardner, 1995). Nema-

todes have been associated with decline of orchard trees (Nyczepir *et al.*, 1998), but their role in decline of an invasive weed has never been investigated. The specific goal of this study was to identify major groups of nematodes associated with faya in Hawaii and to assess the likelihood that they are responsible for faya decline.

Soil was collected from around the roots (2 to 25 cm below the soil surface) of 30 to 70 declining trees at each of three sites (AH, HP, VD) and from the same number of healthy trees at each of five sites (GC, KR, LB, PC, PH) representative of the range of faya on the island of Hawaii (see Fig. 1 for site descriptions). Trees were considered to be in decline when having over 40% chlorotic foliage and over 40% defoliation. Each site was sampled from three to ten times over a six month period. Care was taken to sample only around faya roots. Nematodes were extracted from subsamples of 200 cm³ soil by standard flotation and centrifugation procedures (Jenkins, 1964). All plant-parasitic nematodes were identified to genus.

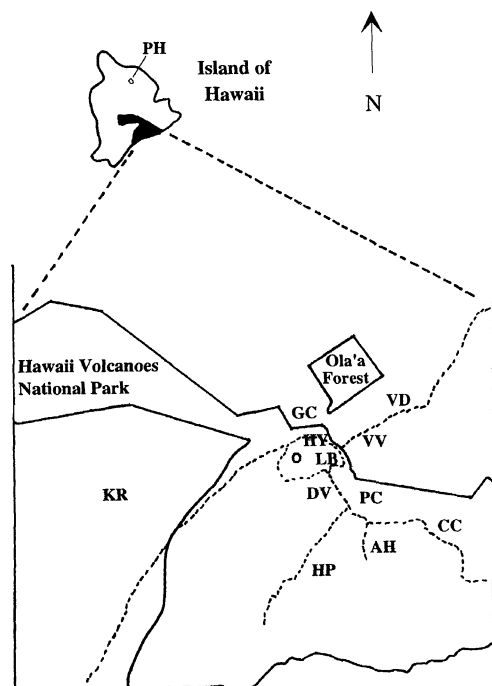


Fig. 1. Nematode collection sites within Hawaii Volcanoes National Park (HAVO; darkened area): Ainahou Ranch (AH), Devastation Trail (DV), Chain of Craters Highway mile marker 8 (CC), along Highway 11 behind Kilauea Military Camp (HY), Lower Byron Ledge (LB), Puhimau Crater (PC), and Hilina Pali (HP). Four additional sites boarder HAVO: Volcano Golf Course Subdivision (GC), Volcano Dump (VD), Volcano Village (VV), Kapapala Ranch (KR). One site at Pauillo-Hamakua (PH) is in the center of an isolated faya population on the island of Hawaii. Not shown is the Palikea site, on the island of Oahu. Dashed lines designate paved roads. The range of faya (shaded area) was based on surveys in 1985 by Whiteaker and Gardner (1985) and in 1992 by R. Camrath (unpublished report).

Nine genera were isolated and identified as *Helicotylenchus*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Pratylenchus*, *Trichodorus*, *Tylenchus*, *Xiphinema*, and an undetermined criconematoid (Table 1). Some of the *Trichodorus* may actually belong to *Paratrachodorus* because many of the common stubby root species have been transferred to this genus. Generally, nematodes were recovered in low numbers (1-10 per

Table 1. Nematodes associated with *Myrica faya* in Hawaii.

Nematode	Site ^z
<i>Helicotylenchus</i>	HP, KR, LB, PC
<i>Hoplolaimus</i>	HP, PC
<i>Longidorus</i>	HP, KR, LB, PC
<i>Meloidogyne</i>	PH
<i>Pratylenchus</i>	AH, GC, HP, KR, LB, PC, VD
<i>Trichodorus</i>	HP, VD
<i>Tylenchus</i>	LB, VD
<i>Xiphinema</i>	HP, LB, PC
Undetermined criconematoid	AH, GC, HP, PC, PH, VD

^zNematode collection sites within Hawaii Volcanoes National Park (HAVO): Ainahou Ranch (AH), Devastation Trail (DV), Chain of Craters Highway mile marker 8 (CC), along Highway 11 behind Kilauea Military Camp (HY), Lower Byron Ledge (LB), Puhimau Crater (PC), and Hilina Pali (HP). Four additional sites boarder HAVO: Volcano Golf Course Subdivision (GC), Volcano Dump (VD), Volcano Village (VV), Kapapala Ranch (KR). One site at Pauillo-Hamakua (PH) is in the center of an isolated faya population on the island of Hawaii.

200 cm³ moist soil). However, samples from declining faya at Volcano Dump had as many as 70 criconematoid and 100 *Trichodorus* per 200 cm³ moist soil. Except for *Trichodorus*, recovered only from decline samples, and *Meloidogyne*, recovered only from a healthy sample from Pauillo-Hamakua, nematodes numbers were comparable in samples from declining and healthy trees. Whereas low numbers and lack of restriction to dying trees suggests that nematodes were not a primary factor in faya decline, all genera but *Meloidogyne* and *Tylenchus* occurred at Hilina Pali, the decline epicenter, suggesting that nematode damage should be considered a possible contributing factor in further decline studies. Interestingly, no nematodes have

been reported on faya in its native habitat of Macaronesia (the Azores, the Canary Islands, and Madeira), despite considerable study (Lutzow-Felling *et al.*, 1995).

Using methods similar to ours, Hennon *et al.* (1986) determined that whereas nematodes were not primary incitants of Alaska yellow-cedar decline, they may be associative factors at certain sites. In the case of faya, nematode damage may compound other plant stress factors such as drought or insect damage (Duffy and Gardner, 1995). Further studies of faya decline should take an interdisciplinary approach and consider nematodes as possible secondary or contributing factors.

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