PARASITIZATION OF VASCULAR BUNDLES OF ANTHURIUM RHIZOMES BY *RADOPHOLUS SIMILIS*

N. Vovlas[1], A. Troccoli[1], M. Pestana[2], I. M. de O. Abrantes[3], and M. S. N. de A. Santos[3]

[1]Istituto per la Protezione delle Piante, Sezione di Bari (Nematologia Agraria), C.N.R., via Amendola, 165/A, 70126 Bari, Italy. [2]Laboratório Agrícola da Madeira, Direcão de Serviços de Investigação Agrícola, 9135 Camacha, Madeira, Portugal. [3]Istituto do Ambiente e Vida, Departamento de Zoologia, Universidade de Coimbra, 3004-517 Coimbra, Portugal; E-mail: nemanv10@area.ba.cnr.it

ABSTRACT

Vovlas, N., A. Troccoli, M. Pestana, I. M. de O. Abrantes, and M. S. N. de A. Santos. 2003. Parasitization of vascular bundles of anthurium rhizomes by *Radopholus similis*. Nematropica 33:209-213.

Radopholus similis, the burrowing nematode colonizes and reproduces in roots and rhizomes of *Anthurium andraeanum* Linden ex Andre in Madeira, Portugal. Histological examination of nematode-infected rhizomes shows necrosis and cavities extending from the cortical parenchyma into the vascular bundles. Nematode feeding and migration caused disruption of the vascular bundles. All nematode life stages, coiled juveniles, adults, including gravid females, and eggs, occurred in the phloem. Nematode specimens were also observed in metaxylem elements.

Key words: *Anthurium andraeanum*, burrowing nematode, histopathology, Madeira, *Radopholus similis*, rhizomes.

RESUMEN

Vovlas, N., A. Troccoli, M. Pestana, I. M. de O. Abrantes, y M. S. N. de A. Santos. 2003. Parasitación de receptáculos vasculares de rizomas de anturio por *Radopholus similis*. Nematropica 33:209-213.

Radopholus similis, el nemátodo barrenador, coloniza y se reproduce en las raíces y los rizomas de *Anthurium andraeanum* Linden ex Andre, en Madeira, Portugal. Examinación histológica de rizomas infectados con el nemátodo indica necrosis y cavidades que se extienden del parénquima cortical a los receptáculos vasculares. La alimentación y migración del nemátodo causaron rotura de los receptáculos vasculares. Todos los estados del nemátodo, juveniles espirales, adultos, incluido hembras hinchadas, y huevos, ocurrieron en el floema. Ejemplares del nemátodo también fueron observados en elementos del metaxilema.

Palabras clave: *Anthurium andraeanum*, nemátodo barrenador, histopatología, Madeira, *Radopholus similis*, rizomas.

INTRODUCTION

The burrowing nematode *Radopholus similis* (Cobb) Thorne, is recognized as a serious economic pest of banana and citrus (Du Charme and Price, 1966; Gowen and Quénéhervé, 1990; O'Bannon, 1977). This nematode is also a damaging pest for the ornamental industry in many tropical countries because it infects and reproduces on many plant ornamentals (Esser *et al.*, 1988).

Anthurium, *Anthurium andraeanum* Linden ex Andre, is very susceptible to and damaged by this pest in tropical and subtropical areas such as: Hawaii and Jamaica (Aragaki *et al.*, 1984; Huton *et al.*, 1980; Sipes and Litchy, 1998); Florida (Esser *et *al.*, 1988); and Trinidad and Tobago (Bala and Hosein, 1966). In recent years, the production of this plant ornamental has been hampered by burrowing nematode infection in the island of Madeira, Portugal (Vovlas *et al.*, 1998; Vovlas *et al.*, 2000). Nematode-infected anthurium showed extended decay of roots and rhizomes. The burrowing nematode is commonly a root feeder but it can also infect other plant organs such as leaves and rhizomes (Lehman *et al.*, 2000). The anatomical alterations induced by *R. similis* in root tissues are well known (Blake, 1961; Du Charme, 1959; Vallette *et al.*, 1997). A recent study reports extensive damage of leaf tissues of anubias infected by *R. similis* (Lehman *et al.*, 2000). There is a scarcity of reports on the anatomical alterations caused by *R. similis* in the rhizomes of ornamental plants. Rhizomes are underground stems, which in the case of anthurium are damaged by the nematode. The objective of the present study was to determine the nematode parasitic habits on anthurium rhizomes.

MATERIAL AND METHODS

Roots and rhizomes were collected from infected anthurium plants growing in greenhouse under plastic cover. Rhizomes with nematode lesions were cut into 3-5 mm pieces, placed in petri dishes containing tap water and incubated for 24 h. The emerged nematodes were counted, and population densities estimated. Rhizomes used for histological studies were selected from those that showed high nematode numbers after 24 h. Selected rhizomes were cut into 5 × 5 × 5 mm slices, fixed in FAA (formaldehyde, acetic acid, ethanol), dehydrated in a tertiary butyl alcohol series, and embedded in 58°C melting point paraffin. Embedded material was sectioned 10-12 µm thick, stained in safranin and fast green, and mounted permanently in Dammar xylene. Selected sections were examined and photographed (Johansen, 1940).

RESULTS AND DISCUSSION

Biological and histological observations:

All life stages (eggs, juveniles and adults) of *R. similis* emerged from both roots and rhizomes after incubation in water. The highest numbers recovered were 185 and 288 nematodes per g root and rhizome tissues, respectively, indicating that the nematode invades and colonizes both type of plant organs. Examination of stained plant tissues confirmed these findings. Histological examination of cross and longitudinal sections of infected roots and rhizomes showed that the nematodes were able to invade the cortical parenchyma by moving intracellularly. In the rhizomes, they also reached and penetrate into the vascular bundles colonizing metaxylema elements (Fig. 1B,E-G). Nematode feeding and migration induced large cavities in the phloem. Phloematic tissues constitute the preferred trophic site by the nematode, which, inside the bundles, causes disruption of vascular elements (Fig. 1C,D). Necrosis was also observed in the cavities (Fig. 1C,D). As noted in other studies, necrotic lesions are also a consequence of the subsequent invasions of secondary organisms (Du Charme and Price, 1966, Lehman *et al.*, 2000).

Remarks:

Radopholus similis behaves as a cortical root feeder on the majority of its hosts. Peripheral damage of the central cylinder of citrus roots has been reported by Du Charme (1959), and of the vascular bundles of anubias leaves by Lehman *et al.* (2000). Vallette *et al.* (1997) observed that

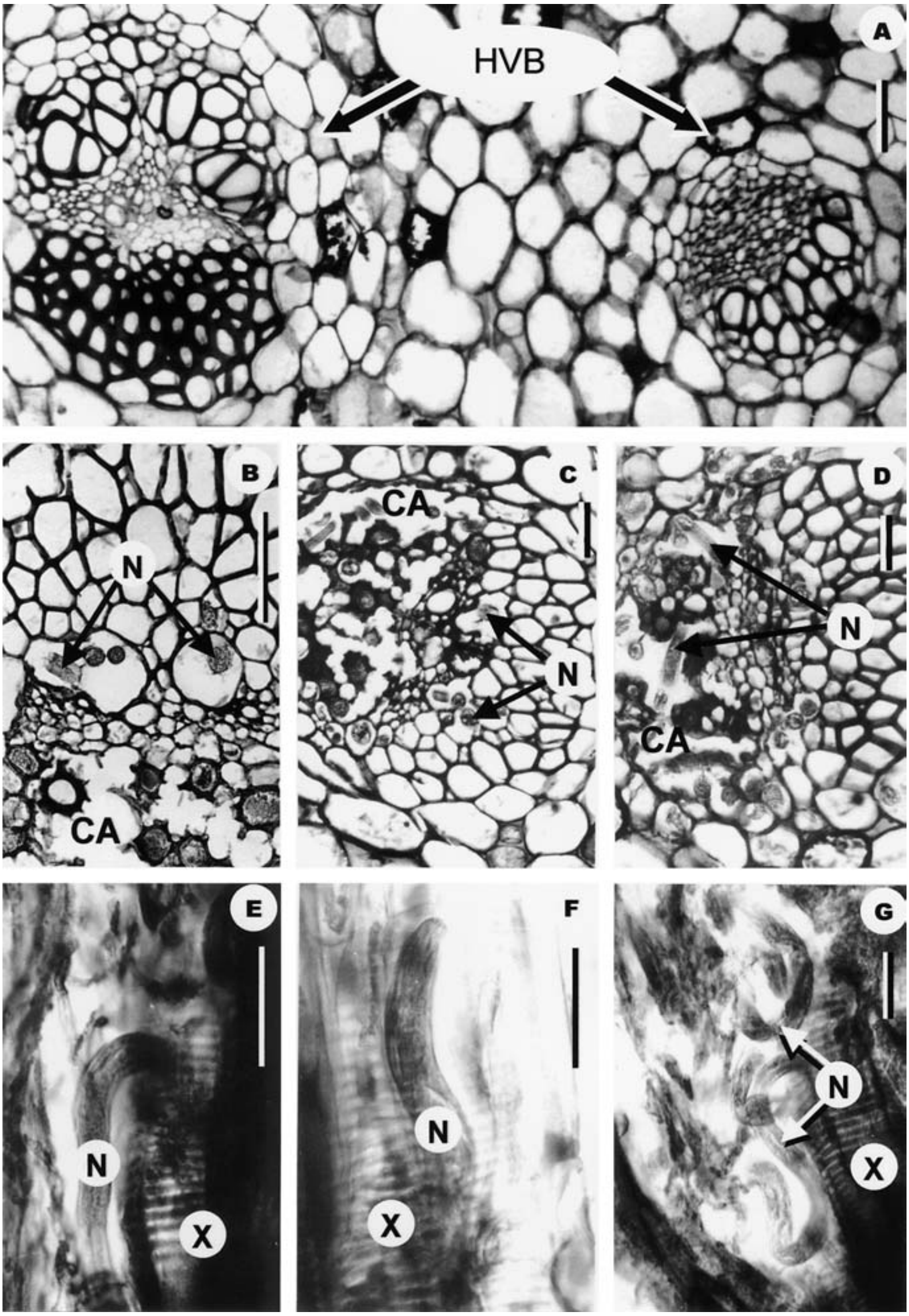

Fig. 1. Histology of uninfected (A) and nematode-infected anthurium rhizomes (B-G). A) Cross section showing two healthy vascular bundles (HVB). B) Cross sections showing nematodes inside two metaxylem elements (arrows). Note a cavity (CA) in the phloem. C, D) Cross sections showing cavities (CA), nematodes (N), and necrosis (dark stained cell walls) in the phloem of the vascular bundles. E-G) Longitudinal sections showing nematodes (N) into and around metaxylem elements. Scale bars: A-D = 100 μm; E-G = 50 μm.

the nematode invasion of vascular elements (metaxylema) occurred in roots of susceptible banana cv. Poyo, but not in resistant banana cv. Yangambi, where the nematode remained confined to the cortical tissues. Vallette *et al.* (1997) concluded that host susceptibility and absence of resistance factors of chemical and anatomical nature such as constitutive β-1,3-glucans and suberization of the endodermal cell walls are essential requirements for the nematode invasion of the vascular tissues and consequent increased plant damage. O'Bannon (personal communication) found invasion of vascular tissues by *R. similis* citrus race in susceptible citrus rootstocks. The burrowing nematode parasitizes many aroids (ornamental plant species in the Araceae family), which have different geographical origin in the world (Bailey and Bailey, 1976). Some of these foliage ornamentals such as *Epipremnum* spp. originated and co-evolved as hosts with the nematode in the Far East, which also is the center of origin of *R. similis* (Ryss and Wouts, 1997; Sher, 1968). However, other aroid species, such as anthuriums, originated in the tropical America and became hosts of the nematode at a later time. It is reasonable to assume that, in spite of the great geographical distance from the center of origin of *R. similis*, the burrowing nematode adapted and became able to parasitize this new plant species when the nematode was introduced to tropical America with infected banana propagative material (Marin *et al.*, 1998). The destructive effect of the nematode on anthuriums extended to the rhizome vascular system, as it does in susceptible banana and citrus cultivars.

ACKNOWLEDGMENT

The authors are grateful to Dr. R. N. Inserra, Division of Plant Industry, Gainesville, FL, U.S.A. for suggestion and critical review of the manuscript.

LITERATURE CITED

ARAGAKI, M., W. J. APT, R. K. KUNIMOTO, W. H. KO, and J. Y. UCHIDA. 1984. Nature and control of anthurium decline. Plant Disease 68:509-511.

BALA, G., and F. HOSEIN. 1996. Plant-parasitic nematodes associated with anthuriums and other tropical ornamentals. Nematropica 26:9-14.

BAILEY, L. H., and E. Z. BAILEY. 1976. Hortus Third. A concise dictionary of plants cultivated in the United States and Canada. MacMillan Publishing Co., New York, U.S.A.

BLAKE, C. D. 1966. The histological changes in banana roots caused by *Radopholus similis* and *Helicotylenchus multicinctus.* Nematologica 12:129-137.

DU CHARME, E. P. 1959. Morphogenesis and histopathology of lesions induced on citrus roots by *Radopholus similis.* Phytopathology 49:388-395.

DU CHARME, E. P., and W. C. PRICE. 1966. Dynamics of multiplication of *Radopholus similis.* Nematologica 12:113-121.

ESSER, R. P., J. H. O'BANNON, and R. A. CLARK. 1988. How to detect burrowing nematode when making annual nursery inspections. Nematology Circular n° 155. Florida Department of Agricultural and Consumer Service. Division of Plant Industry 4 pp.

GOWEN, S., and P. QUÉNÉHERVÉ. 1990. Nematode parasites of bananas, plantains and abaca. Pp. 431-460 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. C.A.B. International Institute of Parasitology, Wallingford, Oxon, U.K.

HUTON, D. G., M. P. TURNER, M. A. MAIS, and B. E. WILLIAMS. 1980. Occurence and control of anthurium decline in Jamaica. W. I. Ministry of Agriculture, Report of 1980 p. 14.

JOHANSEN, D. A. 1940. Plant microtechniques. Mc Graw-Hill. New York and London.

LEHMAN, P. S., N. VOVLAS, R. N. INSERRA, L. W. DUNCAN, and D. T. KAPLAN. 2000. Colonization of foliar tissues of an aquatic plant, *Anubias barteri* Schott, by *Radopholus similis.* Nematropica 30:63-75.

MARIN, D. H., T. B. SUTTON, and K. R. BARKER. 1998. Dissemination of bananas in Latin America and the Caribbean and its relationship to the occurrence of *Radopholus similis.* Plant Disease 82:964-974.

O'BANNON, J. H. 1977. World wide dissemination of *Radopholus similis* and its importance in crop production. Journal of Nematology 9:16-25.

RYSS, A. Y., and W. M. WOUTS. 1997. The genus *Radopholus* (Nematoda: Pratylenchidae) from native vegetation in New Zealand, with description of two new species. International Journal of Nematology 7:1-7.

SHER, S. A. 1968. Revision of the genus *Radopholus* (Nematoda: Tylenchoidea). Proceedings of the Helminthological Society of Washington 35:219-237.

SIPES, B. S., and J. S. LITCHY. 1998. *Radopholus similis* damage to *Anthurium andraeanum*. Nematologica 44:582-583.

VALLETTE, C., M. NICOLE, J. L. SARAH, M. BOISSEAU, B. BOHER, M. FARGETTE, and J. P. GEIGER. 1997. Ultrastructure and cytochemestry of interactions between banana and the nematode *Radopholus similis*. Fundamental and Applied Nematology 20:65-77.

VOVLAS, N., M. PESTANA, A. TROCCOLI, I. M. de O. ABRANTES, and M. S. N. de A. SANTOS. 1998. Rhizome lesion patterns induced by the burrowing nematode (*Radopholus similis*) on anthurium (*Anthurium andraeanum*) in Madeira. Poster presented at the III Symposium Fauna and Flora of the Atlantic Islands, Azores.

VOVLAS, N., I. M. de O. ABRANTES, A. TROCCOLI, M. PESTANA, and M. S. N. de A. SANTOS. 2000. Parasitism of roots and rhizomes of Anthurium (*Anthurium andraeanum*) induced by *Radopholus similis* in Madeira. Poster presented at the E.S.N. International Symposium, Herzliya, Israel.

Received: *16.XII.2002*
Recibido:

Accepted for publication: *17.IV.2003*
Aceptado para publicación:

BLANK PAGE
USED IN PAGE COUNT