

Host-Range, Distribution, and Bibliography of the Reniform Nematode, *Rotylenchulus reniformis*, with Special Reference to Puerto Rico

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INTRODUCTION

The reniform nematode, *Rotylenchulus reniformis* Linford and Oliveira, 1940, described originally from Hawaii, is known to have a wide distribution in the Tropics and warmer parts of the Temperate Zone. For many years this species only was known. Recently four other species have been described: *R. queirozi* (Lordello and Cesnik, 1958) Sher 1961, from Brazil (49)²; *R. parvus* (Williams, 1959) Sher 1961, from Mauritius (88); *R. borealis* Loof and Oostenbrink, 1962 from the Netherlands (48); and *R. leiperei* (Das, 1960) Loof and Oostenbrink, 1962, from India (26).

Besides cowpeas, the type host of *R. reniformis*, 65 host plants were reported from Hawaii, in 1940 (40,46). Also, the reniform nematode was identified as a parasite of cotton in Georgia by G. Steiner, as reported by Smith (75), which constitutes the first record from the United States. In 1942, Steiner (77) reported it attacking coffee weed and tomato in Florida. Subsequent reports have established its distribution in the Southern States from East to West including Florida (77), Georgia (75), Louisiana (76), Texas (4), Alabama (60) and California (2,52,71). It has also been reported from China (36); from meadows in the Netherlands (64); from *Adansonia digitata* L., *Bambos vulgaris* Schrad., and *Zea mays* L. in Rhodesia and Nyasaland; from several hosts in the Gold Coast (65); coconut palms in Togo, Ghana (51), and Jamaica (87); from Guam (69) and Pakistan (82); from tomatoes and papaws in Queensland, Australia (24) and citrus in Montserrat (67). In 1954, Tanaka (80) reported it from Japan; Loof and Oostenbrink, in 1962, from the Netherlands (48); Sasser *et al.*, in 1962, from Perú (70); Das (26), in 1960, from India; Thorne (85), in 1961, from tobacco, clover, and tea from Java, and clover from Sumatra and the Philippines. It was also reported from Venezuela and Central America by Allen in a personal communication.

In Puerto Rico, the first report of the reniform nematode was made by Steiner in 1960 (79) as attacking pigeonpea, *Cajanus indicus* Spreng., and as being one of the most common nematode species in the Island. Several

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² Italic numbers in parentheses refer to Literature Cited pp. 155-61.

other hosts were added in an anonymous publication in 1960 (4). In 1961, Román (68) reported its presence in sugarcane fields and Ayala (6) from pineapple fields, where it was found in large numbers, widely distributed.

During recent years numerous other plant species have been reported as affected by this parasite in Puerto Rico and elsewhere. The interest in the study of this group of parasitic nematodes has increased after several observations, the organism being associated with symptoms, crop damage, and disease complexes. For these reasons it was deemed important to bring together all scattered reports and to give general consideration to, and host range and distribution of the reniform nematode. This paper has been prepared with the purpose of giving an idea of the geographic distribution of the nematode and the plants susceptible to its attack under varied conditions. It is intended to serve as a guide for future investigations. A list of hosts gathered from almost all publications available to the authors, is presented herein, as well as the localities in which observations have been made, and the authority who first reported it. To facilitate checking of publications a general bibliography is also given in Literature Cited, pp. 155-61.

The results of studies conducted in Puerto Rico for determining host range are hereby included. Most of the observations were based on the recovery of preparasitic females, males, and juveniles from soil around plant roots, while in other cases controlled greenhouse experiments were conducted to determine susceptibility of plant species to the parasite. Samples were taken using the conventional sampling methods. The Baermann-funnel and modified screening petri-dish methods were used during most of the study for the separation of nematodes from the soil. In many instances roots were also used and in these cases they were broken up with a blender. Since this method was not at all practical for recovering this nematode, the roots were incubated in petri-dishes and moist chambers, in most cases.

Another phase of the study consisted in the inoculation of roots with certain cultures of the nematode, especially from pigeonpeas, in the greenhouse. Plants were usually taken up after 3 months, when roots were examined directly under a low-power microscope. Viability of eggs was checked by placing opened egg masses in water for a short time, after which the eggs normally hatched. Roots were usually stained using the simplified lacto-phenol-acid fuchsin method to facilitate observations.

The plants were classified as susceptible, carriers, or resistant, according to the degree of susceptibility. Only those in which the nematode was able to produce viable eggs, even in small numbers, were classified as hosts. Plants in which the females were able to develop to maturity but did not produce eggs were classified as resistant or nonhosts.

HOST RANGE, DISTRIBUTION, AND LITERATURE CITED

A list of the plants found to be hosts under Puerto Rican conditions was combined with the observations made by other investigators from different parts of the world.

The locality in which observations were made is given after the host's scientific and common names. The number given in parentheses corresponds with numbers in the Literature Cited and indicates the first report of the host in that locality. When no such number appears this indicates new host records from Puerto Rico and Caja de Muertos, a small Island south of Puerto Rico. Stars after numbers in parentheses indicate whether observations were made: Under field conditions only (*), under greenhouse conditions only (**), or under both field and greenhouse conditions (***).

A list of the publications available, in which the reniform nematode is mentioned, is given. A short comment is also given on most of the publications, which may provide additional information to that given in the titles.

HOST LIST AND DISTRIBUTION

Rotylenchulus spp.

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
<i>Abelmoschus esculentus</i> (L.) Moench.	Okra	P.R.: Lajas*
<i>Acanthus mollis</i> L.	Bear's-breech	U.S.: Florida (86)**
<i>Adansonia digitata</i> L.	Baobabtree	Rhodesia and Nyasa- land (54)*
<i>Ananas sativus</i> Schultes	Pineapple	Puerto Rico (4)*
<i>Arecastrum romanzoffianum</i> Becc.		U.S.: Florida (86)**
<i>Bambos vulgaris</i> Schrad.	Bamboo	Rhodesia and Nyasa- land (54)*
<i>Cajanus indicus</i> Spreng	Pigeonpea	Puerto Rico (79)* P.R.: Río Piedras,* Isabela, Yauco***
<i>Camellia</i> spp.	Camellia	U.S.: Louisiana (4)
<i>Caryota mitis</i> Lour.	Fishtail palm	U.S.: Florida (86)**
<i>C. urens</i> L.	Wine palm	U.S.: Florida (86)**
<i>Chrysanthemum morifolium</i> Ram.	Chrysanthemum	P.R.: Naranjito*
<i>Citrus</i> spp.	Citrus	Montserrat Is. (67) U.S.: Louisiana (30)*
<i>C. mitis</i> Blanco	Calamondin orange	U.S.: Florida (86)**

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
<i>C. sinensis</i> (L.) Osbeck	Sweet orange	Puerto Rico (4)*
<i>Cocos nucifera</i> L.	Coconut	U.S.: Florida (86)** Jamaica (87)**
<i>Coleus blumei</i> Benth.	Coleus	P.R.: Villalba*
<i>Croton</i> spp.		U.S.: Florida (86)**
<i>Dioscorea alata</i> L.	Water yam	P.R.: Naranjito*
<i>Drymaria cordata</i> (L.) Willd.	Drimaria	P.R.: Río Piedras*
<i>Emelista tora</i> (L.) Britton and Rose	Coffeeweed	P.R.: Yabucoa*
<i>Gladiolus</i> spp.	Gladiolus	P.R.: Lajas*
<i>Hemerocallis</i> sp.	Yellow day lily	U.S.: Florida (86)*
<i>Impatiens balsamina</i> L.	Balsam	P.R.: San Juan*
<i>Inga vera</i> Willd.	"Guaba"	P.R.: Jayuya*
<i>Ipomoea batata</i> (L.) Lam.	Sweetpotato	Puerto Rico (4)*
<i>Lespedeza</i> spp.	Lespedeza	U.S.: Louisiana (4)
<i>Lycopersicon esculentum</i> Mill	Tomato	Puerto Rico (4)
<i>Manihot utilissima</i> Pohl	Cassava	P.R.: Añasco*
<i>Musa paradisiaca</i> L.	Plantain	Puerto Rico (4)*
<i>M. sapientum</i> L.	Banana	Puerto Rico (4)*
<i>Opsiandra maya</i> O. F. Cook		U.S.: Florida (86)**
<i>Panicum maximum</i> Jacq.	Guinea grass	P.R.: Juana Díaz*
<i>Paurotis wrightii</i> (Griseb and Wendl.) Britton		U.S.: Florida (86)**
<i>Phaseolus vulgaris</i> L.	Field beans	U.S.: Florida (86)**
<i>Phoenix</i> sp.		U.S.: Florida (86)**
<i>P. reclinata</i> Jacq.	Senegal date palm	U.S.: Florida (86)**
<i>Pinus</i> spp.	Pine	U.S.: Louisiana (4)*
<i>Ptychosperma elegans</i> Blume		U.S.: Florida (86)**
<i>Raphiolepis</i> sp.		U.S.: Florida (86)**
<i>Rosa multiflora</i> Thunb.	Rose	P.R.: Barranquitas*
<i>Roystonea regia</i> O. F. Cook	Cuban royal palm	U.S.: Florida (86)**
<i>Sabal palmetto</i> Lodd.	Cabbage pal- meto	U.S.: Florida (86)**
<i>Saccharum officinarum</i> L.	Sugarcane	Puerto Rico (4)*
<i>Sansevieria thyrsoiflora</i> Thumb.	Sansevieria	P.R.: Arecibo*
<i>Stenotaphrum secundatum</i> (Walt) Kuntze	St. Augustine grass	P.R.: Barceloneta*
<i>Swietenia mahagony</i> Jacq.	Mahogany	Puerto Rico (4)*

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
<i>Trifolium repens</i> L.	Whiteclover	U.S.: Louisiana (4)
<i>Valerianoides jamaicensis</i> (L.) Kuntze	Vervain	P.R.: Río Piedras**
<i>Washingtonia</i> spp.		U.S.: Florida (86)**
<i>Zea mays</i> L.	Corn	Puerto Rico (4)*
<i>Zoysia</i> spp.	Zoysia	U.S.: Florida**
<i>Rotylenchulus borealis</i> Loof and Oostenbrink, 1962		
	Plum	Netherlands (48)*
<i>Malus</i> spp.	Apple	Netherlands (48)*
<i>Fragaria chiloensis</i> Du- chesne	Strawberry	Netherlands (48)*
<i>Solanum tuberosum</i> L.	Potato	Netherlands (48)*
<i>Rotylenchulus leiperi</i> (Das, 1960) Loof and Oostenbrink, 1962		
<i>Lactuca sativa</i> L.	Lettuce	India: Hyderabad (26)
<i>Rotylenchulus parvus</i> (Williams, 1960) Sher, 1961		
<i>Saccharum officinarum</i> L.	Sugarcane	Mauritius (88)**
<i>Rotylenchulus queirozi</i> (Lordello and Cesnick, 1958) Sher, 1961		
<i>Lycopersicon esculentum</i> Mill.	Tomato	Brazil (49)
<i>Rotylenchulus reniformis</i> Linford and Oliveira, 1940		
<i>Abelmoschus esculentus</i> (L.) Moench.	Okra	Hawaii (46)** Africa: Gold Coast (65)**
<i>Acacia farnesiana</i> (L.) Willd.	Casha	Caja de Muertos Is.*
<i>Ageratum conyzoides</i> L.	Ageratum	Hawaii (46)*
<i>Amarantus spinosus</i> L.	"Bledo"	Africa: Gold Coast (65)**
<i>Ananas sativus</i> Schultes vars. Smooth Cayenne Red Spanish Bull Head	Pineapple	P.R.: Manatí, Corozal, Lajas, Vega Alta, Barceloneta, Vega Baja, Arecibo, Las Piedras, Juana Díaz*** Hawaii: (46)***
<i>Argyreia nervosa</i> Burm	Bojer	Hawaii (46)**

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
<i>Bambos vulgaris</i> Schrad.	Bamboo	P.R.: Río Piedras*
<i>Begonia semperflorens</i> Link and Otto	Begonia	Hawaii: (46)**
<i>Beloperone guttata</i>	Brandegae	Hawaii (46)**
<i>Beta vulgaris</i> L.	Beet	Hawaii (46)** U.S.: Louisiana (16)***
<i>B. vulgaris</i> L. var. <i>cicla</i> L.	Swiss chard	Hawaii (46)**
<i>Bixa orellana</i> L.	Annatto	Hawaii (46)**
<i>Brassica oleracea</i> L. var. <i>acephala</i> DC.	Kale	Hawaii (46)**
<i>B. oleracea</i> L. var. <i>botrytis</i> L.	Cauliflower	Hawaii (46)**
<i>B. oleracea</i> L. var. <i>capitata</i>	Cabbage	Hawaii (46)**
<i>B. pekinensis</i> Rupr.	Chinese cabbage	Hawaii (46)**
<i>Buddleia asiatica</i> Lour.		Hawaii (46)**
<i>Cactus intortus</i> Mill.	Turk's-head	Caja de Muertos Is.*
<i>Cajanus indicus</i> Spreng.	Pigeonpea	Caja de Muertos Is.* Hawaii (46)**
<i>Calendula officinalis</i> L.	Pot marigold	Hawaii (46)**
<i>Callistephus chinensis</i> Cass.	China-aster	Hawaii (46)**
<i>Capsicum annum</i> L.	Red pepper	P.R.: Naranjito*
<i>Carica papaya</i> L.	Papaw	P.R.: Isabela, Hatillo* Caja de Muertos Is.* Hawaii (46)** U.S.: Florida (77)** Australia: Queensland (24)*
<i>Centella asiatica</i> (L.) Urban.	Asiatic penny- wort	Hawaii (46)*
<i>Centrosema pubescens</i> Benth.	"Flor de pito"	P.R.: Río Piedras**
<i>Chamaesyce nutans</i> (Lag.) Small	"Lehecilla"	P.R.: Río Piedras**
<i>Chloris inflata</i> Link.	"Paragüita"	Caja de Muertos Is.*
<i>Cicer arietinum</i> L.	Chickpea	Africa: Gold Coast (28)*
<i>Citrullus vulgaris</i> Schrad.	Watermelon	P.R.: Río Piedras* U.S.: Louisiana (18)**
<i>Citrus grandis</i> Osbeck	Pummelo	East Pakistan (83)*

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
<i>C. limonia</i> Osbeck	Lemon	Africa: Gold Coast (65)**
<i>C. maxima</i> (Burm.) Merrill	Grapefruit	P.R.: Río Piedras*
<i>Citrus sinensis</i> (L.) Osbeck	Sweet orange	P.R.: Río Piedras, Bayamón, Trujillo Alto, Isabela*
<i>Coccoloba uvifera</i> (L.) Jacq.	Sea-grape	Hawaii (46)**
<i>Cocos nucifera</i> L.	Coconut	P.R.: Carolina* Africa: Guam (69)*
<i>Coleus blumei</i> Benth.	Coleus	Hawaii (46)**
<i>Commelina difusa</i> Burm.	Dayflower	P.R.: Luquillo*
<i>Crepis japonica</i> (L.) Benth	Asiatic hawks beard	Hawaii (46)*
<i>Crotalaria</i> sp.	Crotalaria	P.R.: Manatí* Africa: Gold Coast (28)*
<i>C. anagyroides</i> H.B.K.	Ornamental crotalaria	P.R.: Río Piedras** Africa: Gold Coast (28)*
<i>C. juncea</i> L.		Africa: Gold Coast (66)**
<i>C. striata</i> DC.	"Matraca"	Africa: Gold Coast (66)*
<i>C. spectabilis</i> Roth.		Hawaii (46)**
<i>Croton humilis</i> L.	Pepper bush	Caja de Muertos Is.*
<i>Cucumis melo</i> L.	Muskmelon	P.R.: Santa Isabel* U.S. Louisiana (18)**
<i>C. sativus</i> L.	Cucumber	P.R.: Corozal, Lajas* Hawaii: (46)** U.S.: Alabama (59)* Louisiana (18)**
<i>Cucurbita maxima</i> Duch.	Gourd	Pakistan: (83)**
<i>Cucurbita pepo</i>	Pumpkin	U.S.: Louisiana (18)**
<i>Cucurbita pepo</i> var. <i>melo pepo</i>	Scallop	U.S.: Louisiana (18)**
<i>Cynara scolymus</i> L.	Artichoke	Hawaii (46)**
<i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass	Hawaii (85)**
<i>Daucus carota</i> L.	Carrot	Hawaii (46)**
var. <i>sativa</i> DC.		Africa: Gold Coast (66)**

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
<i>Desmodium tortuosum</i> (Sw.) DC.	Beggarweed	U.S.: Florida (23)**
<i>Dieffenbachia seguine</i> (Jacq.) Schott	Dumb cane	P.R.: Naguabo*
<i>Digitaria sanguinalis</i> Scop.	Crabgrass	P.R.: Isabela*
<i>Dolichos lablab</i> L.	Hyacinth bean	Pakistan (83)**
<i>Dracaena fragans</i> Ker-gawl	Indian palm	P.R.: Arecibo*
<i>D. deremensis</i> var. <i>warneki</i> Engler.	Dracena	P.R.: Río Piedras, Arecibo*
<i>D. sanderiana</i> Hort.	Sanders dracena	P.R.: Arecibo*
<i>Echeveria</i> sp.		Hawaii (46)**
<i>Elaeodendrum xylocarpum</i> (Vent.) DC.	Marbletree	Caja de Muertos Is.*
<i>Eleusine indica</i> (L.) Gaertn.	Goosegrass	P.R.: Isabela, Río Piedras*** Hawaii (46)*
<i>Emilia sonchifolia</i> (L.) DC.	"Yerba social- ista"	P.R.: Isabela, Río Piedras*** Hawaii (46)*
<i>Emelista tora</i> (L.) Britton and Rose	Coffeeweed	U.S.: Florida (77)*
<i>Erechtites valerianifolia</i> (L.) Raf.	Fireweed	Hawaii (46)*
<i>Erigeron albidus</i> (Willd.) Gray	Horseweed	Hawaii (46)*
<i>Eugenia melaccensis</i> L.	Mountain apple	Hawaii (46)**
<i>Euphorbia hirta</i> L.	Garden spurge	Hawaii (46)*
<i>E. hypericifolia</i> L.	Graceful spurge	Hawaii (46)*
<i>E. pulcherrima</i> Willd.	Poinsettia	Hawaii (46)**
<i>Fleurya aestuans</i> (L.) Gaud.	West Indian nee- dle	P.R.: Río Piedras**
<i>Fragaria chiloensis</i> Du- chesne	Strawberry	P.R.: Corozal
<i>Glycine max</i> Merr.		Africa: Gold Coast (66)**
<i>Gossypium</i> spp.	Cotton	Africa: Gold Coast (65)** U.S.: Georgia (75)** United States (75)*

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
<i>Hedychium coronarium</i> Koenig	White ginger	Hawaii (46)*
<i>Holchus sorghum</i> L.	Sorghum	Africa: Guam (69)**
<i>H. sorghum</i> L. var. <i>caudatus</i> Bailey	Feterita	Hawaii (46)**
<i>Hibiscus rosa-sinensis</i> L.	Chinese hibiscus	P.R.: Río Piedras*
<i>Hyptis capitata</i> Jacq.	Wild hops	P.R.: Río Grande*
<i>Impatiens balsamina</i> L.	Balsam	P.R.: San Juan* Hawaii (46)**
<i>Indigofera suffruticosa</i> Mill.	Wild indigo	Hawaii (46)**
<i>Inga laurina</i> (Sw.) Willd.	Pomsock	P.R.: Jayuya*
<i>Ipomoea batatas</i> (L.) Lam.	Sweetpotato	P.R.: Barranquitas, Corozal, Yauco, Agua- dilla* Africa: Gold Coast (65)** U.S.: Louisiana (55)*** P.R.: Río Piedras*
<i>I. tiliacea</i> (Willd.) Choisy	Wild morning- glory	Hawaii (46)**
<i>I. tuberosa</i> L.	Wooden rose	P.R.: Santurce*
<i>Ixora coccinea</i> L.	Burning love	U.S.: Georgia (77)**
<i>Jacquemontia tamnifolia</i> Griseb.		Hawaii (46)**
<i>Kalanchoe</i> sp.		P.R.: Las Piedras*
<i>Lactuca sativa</i> L.	Lettuce	Hawaii (46)**
<i>Lamairocereus hystrix</i>	Spanish dildo	Caja de Muertos Is.*
<i>Lantana aculeata</i> L.	Pink sage	Caja de Muertos Is.*
<i>Lathurus hirsutus</i>	Singletaru peas	U.S.: Louisiana (18)**
<i>Leonotis nepetaefolis</i> (L.) R. Br.	Lion's ear	P.R.: Isabela*
<i>Lepidium virginicum</i> L.	Peppergrass	P.R.: Barceloneta*
<i>Laucaena glauca</i> Benth.	"Acacia"	U.S.: Florida (77)*
<i>Lycopersicon esculentum</i> Mill.	Tomato	P.R.: Isabela, Corozal, San Germán, Río Pie- dras,*** Hawaii (46),** Pakistan (83),** Africa: Gold Coast (65),** Aus- tralia (24), United States (77),* U.S.:

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
		Louisiana (4),** Florida (77)*
<i>Malpighia infestissima</i> (A. Juss.) Rich.	Cowhage cherry	P.R.: Isabela*
<i>M. puniceifolia</i> L.	West Indian cherry	P.R.: Isabela, Dorado*
<i>Mangifera indica</i> L.	Mango	U.S.: Florida (86)*
<i>Manihot utilissima</i> Pohl	Cassava	Africa: Gold Coast (65)**
<i>Mimosa pudica</i> L.	Sensitive plant	P.R.: Río Piedras, Manatí,*** Río Grande, Naguabo***
<i>Mirabilis jalapa</i> L.	Four-o'clock	P.R.: Río Piedras*
<i>Murraea exotica</i> L.	Orange jessamine	Hawaii (46)**
<i>Musa paradisiaca</i> L.	Plantain	P.R.: Río Grande, Corozal, Luquillo, Río Piedras, Isabela, Naranjito, San Juan, Arecibo*
<i>M. sapientum</i> L.	Banana	P.R.: Lares, Castañer, Río Grande, Río Piedras*
<i>Nicotiana tabacum</i> L.	Tobacco	P.R.: Río Piedras, Orocovi, Manatí, Aguas Buenas, Barceloneta, Gurabo*** Africa: Gold Coast (65)** United States: (78)*
<i>Panicum maximum</i> Jacq.	Guinea grass	P.R.: Juana Díaz*
<i>Parthenium hysterophorus</i> L.	Mugwort	P.R.: Isabela*
<i>Passiflora edulis</i> Sims.	Waterlemon fruit	P.R.: Isabela*
<i>P. seemannii</i> Griseb	Passionflower	Hawaii (46)**
<i>Persea americana</i> Milld.	Avocado	Africa: Gold Coast (65)**
<i>Pepo moschata</i> (Duch.) Britton	Pumpkin	P.R.: Isabela* Hawaii (46)**
<i>Phaseolus lathyroides</i> L.	Wild pea-bean	Hawaii (46)**

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
<i>Phaseolus limensis</i> var. <i>limen- naus</i>	Bush lima bean	U.S.: Louisiana (18)**
<i>Phaseolus vulgaris</i> var. <i>humilis</i>	Bush bean	U.S. Louisiana (19)**
<i>P. limensis</i> Macf.	Bush lima bean	Hawaii: (46)** U.S.: Louisiana (16)***
<i>P. lunatus</i> L.	Civetbean	U.S.: Louisiana (4)* Africa: Gold Coast (28)*
<i>P. vulgaris</i> L.	Field beans	P.R.: Isabela, Barran- quitas* Hawaii (46)** Africa: Gold Coast (65)**
<i>P. vulgaris</i> L. var. <i>humilis</i>	Bean	U.S.: Louisiana (16)***
<i>Philodendron duvium</i> Hort.	Philodendron	P.R.: Vega Alta*
<i>P. oxycordium</i>	do.	P.R.: Vega Alta*
<i>P. pertusum</i> Kunth and Bche.	do.	P.R.: Vega Alta*
<i>Phlox drummondii</i> Hook		Hawaii (46)**
<i>Pisum sativum</i> L.	Garden pea	Hawaii (46)**
<i>Poinciana pulcherrima</i> L.	Barbados flower- fence	Africa: Gold Coast (65)**
<i>Polyscias guilfoylei</i> (Bull.) Bailey	Nothopanax	P.R.: Aguadilla* Hawaii (46)**
<i>Portulaca oleracea</i> L.	Purslane	P.R.: Isabela, Río Pie- dras*** Hawaii (46)***
<i>Pothos aureus</i> Lindl. and André	Yellow tree lover	P.R.: Arecibo, Vega Baja, Vega Alta*
<i>Prosopis chilensis</i> (Molina) Stuntz	"Algarroba"	Hawaii (46)**
<i>Psidium guajava</i> L.	Guava	P.R.: Isabela*
<i>Pueraria thunbergiana</i> Benth.	Tropical kudzu	Africa: Gold Coast (28)*
<i>Quamoclit coccinea</i> Moench.	Star ipomoea	P.R.: Isabela*
<i>Q. pinnata</i> (Desr.) Boj.	Cypress vine	P.R.: Río Piedras*
<i>Raphanus sativus</i> L.	Radish	P.R.: Fajardo*
<i>Richardia scabra</i>	False ipecac	Hawaii (46)*
<i>Saccharum officinarum</i> L.	Sugarcane	P.R. Isabela, Ponce,

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
		Lajas, Loíza, Manatí, Río Piedras, Agua- dilla*
<i>Schinus terebinthifolius</i> Raddi	Christmas-berry tree	Hawaii (46)***
<i>Sida carpinifolia</i> L.	Wireweed	P.R.: Isabela*
<i>Soja max</i> (L.) Piper	Soybean	Africa: Gold Coast (65)*
<i>Solanum melongena</i> L.	Eggplant	P.R.: Corozal, Lajas* Hawaii (46)** Africa: Gold Coast**
<i>S. nigrum</i> L.	Black nightshade	Hawaii (46)*
<i>S. quitoensis</i> Lam.	"Naranjilla"	P.R.: Corozal*
<i>S. tuberosum</i> L.	Potato	Hawaii (46)**
<i>Sonchus oleraceus</i> L.	Annual sowthis- tle	Hawaii (46)*
<i>Stachys arvensis</i> L.	Staggerweed	Hawaii (46)**
<i>Stenotaphrum secundatum</i> (Walt.) Kuntze	St. Augustine grass	Hawaii (85)*
<i>Stizolobium deeringianum</i> Bort.	Velvetbean	Africa: Gold Coast (28)*
<i>Swietenia mahagony</i> Jacq.	Mahogany	P.R.: Yauco, Quebra- dillas*
<i>Synedrella nodiflora</i> Gaertn.		Africa: Gold Coast (65)**
<i>Tagetes erecta</i> L.	African marigold	Hawaii (46)**
<i>T. patula</i> L.	French marigold	Hawaii (46)**
<i>Trifolium</i> spp.	Clover	U.S.: Louisiana (16)***
<i>T. incarnatum</i>	Crimson clover	U.S.: Louisiana (16)***
<i>T. repens</i>	Whiteclover	U.S.: Louisiana (16)***
<i>Taxus</i> spp.	Yew	United States (78)
<i>Urena lobata</i> L.	Bur	P.R.: Manatí*
<i>Vanilla fragans</i> (Salisb.) Ames	Vanilla	P.R.: Río Piedras*
<i>Vernonia cinerea</i> (L.) Less	Ironweed	Hawaii (46)*
<i>Vicia faba</i> L.	Broadbean	Hawaii (44) Pakistan (82)**
<i>Vicia villosa</i> Roth.	Hairyvetch	Africa: Gold Coast (28)* U.S.: Louisiana (18)**
<i>Vigna sinensis</i> Endl.	Cowpea	U.S.: Louisiana (76)***

<i>Scientific name</i>	<i>Common name</i>	<i>Locality</i>
		Hawaii (46)*** Africa: Gold Coast (65)**
<i>Wedelia trilobata</i> (L.) Hitchc.	"Manzanilla"	P.R.: Isabela*
<i>Xanthium</i> sp.	Cocklebur	U.S.: Florida (23)**
<i>Xanthosoma sagittaeifolium</i> (L.) Schott	Tanier	P.R.: Isabela*
<i>Zea mays</i> L.	Corn	P.R.: Lajas, San Ger- mán, Río Piedras, Isa- bela* Hawaii (46)** Africa: Gold Coast (66)* Rhodesia and Nyasa- land (54)*
<i>Zinnia elegans</i> Jacq.	Zinnia	Hawaii (46)**

DISCUSSION

The reniform nematode, *Rotylenchulus* Linford and Oliveira, 1940, of which five species have been described, is widely distributed. It has been reported from 15 countries including 5 States of the southern part of the United States. In Puerto Rico it has been found in 40 localities. The populations are generally higher in loamy soils rich in organic matter. In pineapple fields it is numerous in sandy loams and in clay soils. In the pigeonpea, which has been found to be one of the best hosts, its populations are high, even in very dry sandy and saline soils and in heavy, moist clays. It was also found in coffee, plantain, and coleus at about 3,000 feet above sea level, and in heavy soils rich in organic matter. Temperature, humidity, and pH of the soil do not seem to affect its abundance and distribution in an appreciable way, as shown by the findings of high populations under varied climatic conditions.

Probably more than one species are represented here as evidenced by the observations of morphological differences and host-parasite relationships. As an example, sugarcane, which is normally a host under field conditions, was not attacked in greenhouse inoculation tests by populations obtained from about pigeonpea roots. The same situation is true for other cultures in relation to several other crops.

Different degrees of susceptibility have been observed among the plants included in the previous list, ranging from very susceptible plants like

pigeonpea, *Cajanus indicus*, in the roots of which the nematode reaches great numbers in a few months, to ornamental crotalaria, *Crotalaria anagyroides*, where only a limited number of females can grow and reproduce.

Two hundred and one plant species are recorded as hosts in this paper. Eighty-nine of them are found in Puerto Rico. Sixty-four new host plants are reported here from Puerto Rico and Caja de Muertos Island; 15 for *Rotylenchulus* spp. and 74 for *R. reniformis*. Some of them were found to be nonhosts when studied under controlled conditions, but in most cases the host-parasite relationships have been corroborated in greenhouse trials.

Most of these plants are usually attacked by mixed populations of several other parasitic nematode species, but in some of them like pineapple, *Ananas sativus*; sweetpotato, *Ipomoea batatas*; pigeonpea, *Cajanus indicus*; tomato, *Lycopersicon esculentum*; and tobacco, *Nicotiana tabacum*, the reniform nematode predominates even over common abundant species like the root knot nematode. In these crops the nematode is usually associated with crop damage. In other crops like sugarcane, *Saccharum officinarum*, corn, *Zea mays*, and others, only few specimens are usually encountered.

SUMMARY

The reniform nematode which comprises five described and several undescribed species has been recognized as a dangerous plant parasite. It is undoubtedly one of the most common nematode types in our soils and its populations are usually very high. It has been found associated with most of our agricultural crops including pineapple, coffee, pigeonpea, tobacco, sugarcane, ornamentals, and vegetables.

Increasing interest in the study of this parasite has suggested the existence of several other species which still remain undescribed. In Puerto Rico, it is now evident that several species are present. This statement is based on differences observed in relation to morphological and pathogenic characteristics among different populations.

A list of 201 different host plants from 15 countries, including Puerto Rico and Caja de Muertos, an adjacent Island south of Puerto Rico, is given. Most of them are the result of field observations, but in many cases the susceptibility of the host has been corroborated on greenhouse inoculation trials. Eighty-nine host plants were found in Puerto Rico, 15 of which are new hosts to *Rotylenchulus* spp., and 74 to *R. reniformis*. Differences in degrees of susceptibility have been recognized, pigeonpea being the most susceptible, and ornamental crotalaria only a carrier.

In Puerto Rico, the nematode has been located in 40 localities in some of which several plants have been found to be hosts. Humidity, elevation,

temperature, and soil pH do not seem to be limiting factors in relation to the occurrence and distribution of the nematode. It occurs more in loamic soils but clay or sandy soils with little organic matter harbor large numbers if a suitable host plant is present.

A general list of publications regarding this nematode citing 89 papers is also included.

RESUMEN

El nemátodo reniforme *Rotylenchulus* Linford y Oliveira 1940 comprende cinco especies descritas y otras aún sin describir. Es sin duda uno de los más comunes en nuestros suelos; ocurre en grandes números y se considera como un parásito dañino de muchas plantas. La mayor parte de las cosechas comerciales de Puerto Rico, tales como la piña, el tabaco, la caña, las plantas ornamentales y las hortalizas sufren de sus ataques.

Anteriormente se creía que había una sola especie, *Rotylenchulus reniformis*, pero debido al mayor interés en este estudio, se ha llegado a la conclusión de que existen varias otras especies aún sin describir. En Puerto Rico es evidente que tenemos varias especies de este nemátodo, porque se han observado diferencias morfológicas, al igual que patogénicas, en distintas especies de este organismo.

El presente trabajo incluye 201 plantas hospedadoras en 15 distintos países incluyendo a Puerto Rico y Caja de Muertos, que es una pequeña isla al sur de Puerto Rico.

Las observaciones, en su mayoría, se han hecho en el campo, pero en otras ocasiones ha sido en pruebas en invernaderos donde se ha corroborado la susceptibilidad de las plantas al ataque de este nemátodo.

De las 89 plantas informadas de Puerto Rico, 15 se determinaron por primera vez que son hospedadoras del *Rotylenchulus* spp. y 74 del *R. reniformis*. Las restantes ya habían sido informadas en trabajos anteriores. La susceptibilidad de estas plantas a los efectos del nemátodo varía en grado, desde el gandul que es la más afectada, hasta el pitillo ornamental en cuyas raíces suelen desarrollarse pocas hembras que producen un número muy limitado de huevos.

En Puerto Rico, el nemátodo se encontró en 40 localidades, en algunas de las cuales se observó que un gran número de plantas estaban afectadas por este organismo. Tal parece, que ni la humedad, la temperatura, el pH y la elevación del terreno sean factores que restrinjan en modo alguno la presencia y distribución de este nemátodo.

Se observó, además, que este nemátodo abunda más en los suelos ricos en materia orgánica, pero aun en aquellos suelos deficientes en contenido orgánico son numerosas las poblaciones de este organismo si hay buenas plantas hospedadoras.

También se incluye aquí una lista general que comprende 89 publicaciones relacionadas con el nemátodo reniforme.

LITERATURE CITED

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2. Allen, M. W., and Maggenti, A. R., Plant nematology in California: State's crop losses led to first department for research in plant nematology to be established by Experiment Stations, *Calif. Agr.* **13** (9) 2-3, 1959. (*Rotylenchulus reniformis* is reported along with other parasitic species from ornamentals in California.)
3. Anderson, E. J., Comparison of initial kills and subsequent increase of nematode populations following soil fumigation, (abs.) *Phytopath.* **46** (11) 634, 1956. (Population increases of *Rotylenchulus reniformis* were observed in pineapple roots after fumigation with D-D, EDB, and Nemagon in Hawaii.)
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5. —, Biennial Report 1956-58, Hawaii Agr. Expt. Sta., Univ. Hawaii, pp. 47 and 55-6, 1958. (Growth and yield of papaya increased after application of nematocides for controlling *Rotylenchulus reniformis* in Hawaii.)
6. Ayala, A., An Analysis of the quantitative and qualitative composition of the nematode populations in pineapple fields in Puerto Rico, *J. Agr. Univ. P.R.* **45** (4) 265-99, 1961. (*Rotylenchulus reniformis* was found to be the most common and numerous among 23 genera of known and suspected plant parasitic nematodes in pineapple fields in Puerto Rico.)
7. —, Parasitism of bacterial nodules by the reniform nematode, *J. Agr. Univ. P.R.* **46** (1) 67-9, 1962. (Bacterial nodules attached to pigeonpea roots were found to be attacked by an undescribed species of the reniform nematode.)
8. —, Pathogenicity of the reniform nematode on various hosts, *J. Agr. Univ. P.R.* **46** (2) 73-82, 1962. (The behavior of a population of *Rotylenchulus* spp. was studied on seven hosts. All but sugarcane were attacked by the nematode.)
9. —, Occurrence of the nematode *Meloidogyne javanica* on pigeonpea roots in Puerto Rico, *J. Agr. Univ. P.R.* **46** (2) 154-6, 1962. (*Rotylenchulus reniformis* was mentioned among four parasitic species attacking pigeonpea in Puerto Rico.)
10. —, Greenhouse tests with nematocides for control of nematodes attacking tomato (*Lycopersicon esculentum* var. Rutgers) in Puerto Rico, *J. Agr. Univ. P.R.* **46** (4) 319-27, 1962. (*Rotylenchulus reniformis* was controlled with soil treatments with D.D., EDB, Durlone, Nemagon, Telone, and Fumazone.)
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12. Ayala, A., Román, J., and Gandía, H., Effect of soil fumigation used in the control of pineapple nematodes in Puerto Rico, *J. Agr. Univ. P.R.* **47** (2) 76-90, 1963. (*Rotylenchulus reniformis* was one of the most common species of nematodes found on experimental plots of pineapple.)
13. Baker, A. D., Checklists of the Nematode Superfamilies Dorylaimoidea, Rhab-

- ditoidea, Tylenchoidea, and Aphelenchoidea, E. J. Brill, Leiden, Holland, pp. 157, 1962. (Includes *Rotylenchulus* in the subfamily Pratylenchinae.)
14. Birchfield, W., Host-parasite studies on reniform nematode on cotton, (abs.) *Phytopath.* **52** (1) 4, 1962. (Death of roots is reported caused by necrosis and partial dissolution of cells. The reniform nematode was observed feeding in phloem.)
 15. —, Host-parasite relations of *Rotylenchulus reniformis* on *Gossypium hirsutum*, *Phytopath.* **52** (9) 862-5, 1962. (Parasitism of *Rotylenchulus reniformis* on cotton is demonstrated. Life cycle and host relationships are discussed.)
 16. Birchfield, W., and Brister, L. R., New hosts and nonhosts of reniform nematode, *Plant Dis. Rptr.* **46** (9) 683-5, 1962. (Forty-three agronomic plants were tested for their reaction to *Rotylenchulus reniformis*. Eleven nonhosts were discovered which were adaptive to growing in Louisiana, where this organism is a serious pest. Six new hosts were reported.)
 17. Birchfield, W., and Brister, L. R., New hosts and crop plants resistant to the reniform nematode, (abs.) *Phytopath.* **52** (8) 725, 1962. (Six new hosts and 12 immune plants are reported.)
 18. Birchfield, W., and Jones, J. E., Distribution of the reniform nematodes in relation to crop failure of cotton in Louisiana, *Plant Dis. Rptr.* **45** (9) 671-3, 1961. (*Rotylenchulus reniformis* was found to be widely distributed in cotton in Louisiana causing yield reduction of 40-60 percent.)
 19. Carvalho, J. C., *Rotylenchus elisensis* nova espécie associada com raízes de soja, *Rev. Inst. Adolfo Lutz* **17** (1) 43-6, 1958. (A new species of *Rotylenchus* was described; this was later transferred to *Helicotylenchus* and eventually synonymised with *Rotylenchulus reniformis* by Sher.)
 20. —, *Helicotylenchus elisensis* n. comb. (Nematoda: Tylenchida) *Arch. Inst. Biol.*, São Paulo, **26** 45-8, 1959. (*Rotylenchus elisensis* was relocalized in the genus *Helicotylenchus*.)
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 22. Chitwood, B. G., and Chitwood, M. B., An Introduction to Nematology, Monumental Printing Co., Baltimore, Md., rev. ed., pp. 1-213, 1950. (The genus *Rotylenchulus* was placed with *Nacobbus* in a new subfamily, Nacobbinae.)
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 26. Das, V. M., Studies on the nematode parasites of plants in Hyderabad Andhra Pradesh, India, *Z. Parasitenk* **19** 553-605, 1960. (*Leiperotylenchus leiperi* was described from roots of lettuce from Hyderabad, India. This nematode was placed in *Rotylenchulus* by Loof and Oostenbrink.)

27. Doolittle, S. P., Tomato Diseases, USDA Farmer's B. 1934 52-5, 1948. (*Rotylenchulus* spp. is included among the parasitic nematodes that affect tomatoes.)
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46. Linford, M. B., and Yap, F., Some host plants of the reniform nematode in Hawaii, *Proc. Helminthol. Soc. Wash.* 7 (1) 42-4, 1940. (Sixty-five plants belonging to thirty families are given as hosts of *Rotylenchulus reniformis*.)
47. Loof, P. A. A., and Oostenbrink, M., Synopsis of the Genus *Rotylenchulus* Vith International Nematology Symposium, abs. of the papers, Gand (Belgique), 24-28 juillet, p. 57, 1961. (A discussion of the reniform nematode including the 3 described species is presented and a new undescribed species is suggested to occur in the Netherlands.)
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