Journal of Nematology 19(4):420–423. 1987.

Criconemella spp. in Pennsylvania Peach Orchards with Morphological Observations of *C. curvata* and *C. ornata*[1]

B. A. Jaffee,[2] A. P. Nyczepir,[3] and A. M. Golden[4]

Abstract: *Criconemella xenoplax* and *C. curvata*, previously associated with decline of peach trees in other parts of the United States, were found in 20 of 25 Pennsylvania peach orchards. Population densities were high in some samples. Morphometrics of juveniles and adult females of *Criconemella curvata* and *C. ornata* are provided. Cuticular crenations were observed on J2 and J3 stages of *C. curvata* and J2–J4 stages of *C. ornata*.

Key words: *Criconemella curvata, C. ornata, C. xenoplax, Hirsutella rhossiliensis,* morphometrics, peach decline, ring nematode.

Peach trees (*Prunus persica* (L.) Batsh) in Pennsylvania often decline by the tenth year after planting due to stem-pitting (incited by tomato ringspot virus), a winter injury-canker complex, and (or) unknown factors (6). *Criconemella xenoplax* (Raski) Luc & Raski predisposes stone fruits to bacterial canker in California (11) and cold injury in the southeastern United States (13). In a recent survey of Georgia and South Carolina peach tree short-life orchards (14), *C. xenoplax* and *C. ornata* (Raski) Luc & Raski were detected in all the orchards sampled. The purpose of the present study was to determine the *Criconemella* spp. present in Pennsylvania peach orchards and to compare *C. curvata* (Raski) Luc & Raski and *C. ornata* morphologically, with particular reference to cuticular crenations on juveniles.

Materials and Methods

In October 1983, five 200-cm^3 subsamples of soil (one 200-cm^3 subsample from within the drip line from each of five trees) were collected and composited from each of 25 orchards in Adams, Berks, Franklin, York, and Lehigh counties in Pennsylvania. The selected orchards had histories of decline problems. Nematodes were extracted from soil by a combination of elutriation (1) and centrifugal flotation (9). Extracted nematodes were counted, and approximately 20 adult females per orchard were examined with a compound microscope (bright field and interference contrast optics) and identified to species with appropriate keys and descriptions (5,10,15,16). Soil textural classifications included loams (12 orchards), sandy loams (11 orchards), and silt loams (2 orchards).

For morphological comparisons, all *C. curvata* (except 10 gravid females) present in two orchard samples were heat killed and stored in 3% formalin.Ten gravid females were incubated (22 C) in BPI dishes (one female per dish) containing 1 ml distilled water; eggs subsequently deposited hatched in ca. 2 weeks. Newly hatched juveniles and their parent females then were heat killed and placed in vials containing 3% formalin. Vials were labeled so that individual females and their respective progeny could be identified. A similar procedure was followed with *C. ornata* originally from a peach orchard in Georgia but grown on common bermuda grass (*Cynodan dactylon* (L.) Pers.) in the greenhouse in Byron, Georgia. Morphometrics and observations were obtained with nematodes fixed in 3% formalin and examined with bright field and interference contrast microscopy. Voucher specimens were deposited in the USDA Nematode Collection, Beltsville, Maryland. Paratypes of *C. curvata* from the University of California Davis Nematode Collection were examined.

Criconemella xenoplax specimens that appeared to be colonized by a nematopha-

Received for publication 5 January 1987.

[1] Paper number 7550 in the journal series of the Pennsylvania Agricultural Experiment Station. Supported in part by the Northeast Regional Project NE-133.

[2] Department of Plant Pathology, Pennsylvania State University, University Park, PA 16801. Present address: Division of Nematology, University of California, Davis, CA 95616.

[3] USDA ARS, Southeastern Fruit and Tree Nut Research Laboratory, Byron, GA 31008.

[4] Systematic, Botany, Mycology, and Nematology Laboratory, USDA ARS, ARC-W, Beltsville, MD 20705.

TABLE 1. Prevalence and population densities of *Criconemella* spp. in 25 peach orchards in Pennsylvania, October 1983.

Species	No. orchards infested	Nematodes (no./100 cm³ soil) Mean	Range	No. orchards with > 50/100 cm³ soil
C. xenoplax	7	259	1–819	6
C. curvata	11	45	1–317	3
C. rusticum	2	124	4–240	2
Mixed†	2	30	7–54	1

† Two orchards contained mixed populations of *C. xenoplax* and *C. curvata*.

gous fungus were incubated on water agar for 7–14 days to permit identification of the fungus (8).

RESULTS

Criconemella spp. were found in 22 of 25 orchards (Table 1). *Criconemella xenoplax, C. curvata,* and *C. rusticum* (Micoletzky) Luc & Raski were the only ring nematode species detected in the survey. Population densities, particularly of *C. xenoplax,* were high (up to 819/100 cm³ soil) in some samples. Eleven of the orchards contained >50 *Criconemella* spp./100 cm³ soil, which is the threshold level for recommending chemical control of *C. xenoplax* in South Carolina. In three of the seven orchards containing *C. xenoplax,* the nematophagous fungus *Hirsutella rhossiliensis* Minter and Brady was recovered from *C. xenoplax* incubated on water agar.

On the basis of stylet length, *C. curvata* specimens were assigned to the J2, J3, J4, or adult female stage (Table 2). Ranges in body and stylet length of J3 and J4 overlapped; however, the variances were very low. Males were not observed. The annulations of J2 were indistinctly crenate, whereas those of the J3 were clearly crenate. Neither the J4 nor adult female had crenate annulations. Paratype adult females and J4 from the University of California Davis Nematode Collection had no crenations, but J2 and J3 were not present on these slides. Annulations and morphometrics of J2 obtained from female *C. curvata* (oviposited and hatched in vitro) were similar to those of J2 from field samples.

Based on body and stylet length, *C. ornata* specimens were assigned to the J2, J3, J4, or adult female stage (Table 3). Ranges in body and stylet length of the different life stages did not overlap. Males were not observed. Crenations were clearly visible on the annulations of J2, J3, and J4 but were not present on the adult female. Annulations and morphometrics of J2 obtained from females identified as *C. ornata* (oviposited and hatched in vitro) were similar to those of J2 from greenhouse soil samples. The number of body annulations decreased from J2 to adult female for both *C. curvata* and *C. ornata* (Tables 2, 3).

DISCUSSION

Criconemella xenoplax contributes to the decline of stone fruit in California and in the Southeast (11,13,14). In Maryland (3) and New Jersey (7), *C. simile* and *C. curvata,*

TABLE 2. Morphometrics of *Criconemella curvata* from a Pennsylvania peach orchard.

Stage	No.	Body length (μm)	Stylet length (μm)	Body annulations	Annulations crenate
J2	20	150 ± 14 (116–172)	27.6 ± 1.0 (25.0–29.5)	91 ± 3 (84–96)	+ (indistinctly)
J3	56	205 ± 18 (172–245)	37.5 ± 1.8 (33.0–40.5)	88 ± 3 (81–95)	+
J4	77	273 ± 25 (202–330)	46.1 ± 1.8 (40.0–50.0)	87 ± 3 (80–94)	–
♀	20	387 ± 28 (335–435)	57.6 ± 1.8 (53.0–60.0)	83 ± 2 (79–87)	–

Values are means ± standard deviations; ranges are in parentheses.

TABLE 3. Morphometrics of *Criconemella ornata* from common bermuda grass grown in the greenhouse.

Stage	No.	Body length (μm)	Stylet length (μm)	Body annulations	Annulations crenate
J2	20	159 ± 8 (148–180)	26.2 ± 0.7 (25.0–27.5)	103 ± 3 (97–108)	+
J3	20	258 ± 39 (210–312)	35.2 ± 2.0 (32.5–39.0)	100 ± 3 (95–107)	+
J4	34	348 ± 24 (320–402)	42.4 ± 0.9 (40.0–44.0)	98 ± 3 (92–103)	+
♀	15	533 ± 31 (488–590)	51.3 ± 1.0 (50.0–53.0)	92 ± 3 (89–97)	–

Values are means ± standard deviations; ranges are in parentheses.

respectively, were associated with decline of peach trees. In the present study, *C. xenoplax* and (or) *C. curvata* were present in 20 of the 25 Pennsylvania orchards sampled, and population densities in 10 samples exceeded 50 specimens/100 cm^3 soil. These results suggest that further research on the role of *Criconemella* spp. in peach decline in Pennsylvania is warranted.

Hirsutella rhossiliensis has been isolated frequently from *C. xenoplax* in South Carolina (8) and California (Jaffee, unpubl.) and was present in three of seven samples in Pennsylvania. *Criconemella xenoplax* and *H. rhossiliensis* appear to occur together frequently.

Initially, we had difficulty identifying a *Criconemella* sp. from certain orchards. All adult females from these orchards conformed to descriptions of *C. curvata*; however, the cuticular annulations of juveniles were smooth in some specimens and crenate in others. Raski (15) indicated that the cuticle of juvenile *C. curvata* was without crenations. Loof (10) noted that annulations of juvenile females were smooth or had slightly irregular posterior margins. In his key to species of *Criconemella,* Luc (12) separated *C. xenoplax* and *C. curvata* on the basis of cuticular crenations of the juveniles; *C. xenoplax* had crenations but *C. curvata* did not. However, de Grisse (4) stated that *C. curvata* juveniles have "crenated posterior edges of the annules but only in the younger stages," and Chaves (2) indicated that the annulations of *C. curvata* juveniles were finely crenate. Our observations support those of de Grisse and Chaves; i.e., crenations occur on J2 and J3, but not on J4 or adult females. All juvenile stages of *C. ornata* displayed crenations as originally reported (15).

Criconemella curvata and *C. ornata* are morphologically close and are difficult to separate (4). Our data indicate that adult females can be distinguished by body and stylet lengths, but other reports (2,10,15) show considerable overlap in these measurements. Apparently, morphometrics on the designated individual juvenile stages of *C. curvata* and *C. ornata* were not published previously. However, Streu et al. (17) previously stated that stylet lengths of *C. curvata* fell into four groups—27.2, 37.9, 46.6, and 58.3 μm for J2, J3, J4, and adult female, respectively. These measurements are similar to those reported in this study.

LITERATURE CITED

1. Byrd, D. W. Jr., K. R. Barker, H. Ferris, C. J. Nusbaum, W. E. Griffin, R. H. Small, and C. A. Stone. 1976. Two semi-automatic elutriators for extracting nematodes and certain fungi from soil. Journal of Nematology 8:206–212.

2. Chaves, E. 1983. Criconematoidea (Nematoda) from Argentina. Nematologica 29:404–424.

3. Chitwood, B. G. 1949. Ring nematodes (Criconematinae). A possible factor in decline and replanting problems of peach orchards. Proceedings of the Helminthological Society of Washington 16:6–7.

4. DeGrisse, A. 1967. Description of fourteen new species of Criconematidae with remarks on different species of this family. Biologisch Jaarboek 35:66–125.

5. Ebsary, B. A. 1982. *Bakernema yukonense* n. sp. (Nematoda: Criconematidae) with keys to the species of *Criconemella* and *Discocriconemella.* Canadian Journal of Zoology 60:3033–3047.

6. Hickey, K. D. 1984. Peach integrated crop management survey: 1. Overview and summary. Pennsylvania Fruit News 63:36–40.

7. Hung, Chia-Ling Pi, and W. R. Jenkins. 1969. *Criconemoides curvatum* and the peach decline problem. Journal of Nematology 1:12 (Abstr.).

8. Jaffee, B. A., and E. I. Zehr. 1982. Parasitism of the nematode *Criconemella xenoplax* by the fungus *Hirsutella rhossiliensis.* Phytopathology 72:1378–1381.

9. Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Disease Reporter 48:692.

10. Loof, P. A. A. 1974. *Macroposthonia curvata.* C.I.H. descriptions of plant-parasitic nematodes. Set 4, No 58. Herts.: Commonwealth Institute of Helminthology.

11. Lownsbery, B. F., H. English, E. H. Moody, and F. J. Schick. 1973. *Criconemoides xenoplax* experimentally associated with a disease of peach. Phytopathology 63:994–998.

12. Luc, M. 1970. Contribution a l'étude du genre *Criconemoides* Taylor, 1936 (Nematoda: Criconematidae). Cahiers ORSTOM, Série Biologie 11:69–131.

13. Nyczepir, A. P., E. I. Zehr, S. A. Lewis, and D. C. Harshman. 1983. Short life of peach trees induced by *Criconemella xenoplax.* Plant Disease 67:507–508.

14. Nyczepir, A. P., P. F. Bertrand, R. W. Miller, and R. E. Motsinger. 1985. Incidence of *Criconemella* spp. and peach orchard histories in short-life and non-short-life sites in Georgia and South Carolina. Plant Disease 69:874–877.

15. Raski, D. J. 1952. On the morphology of *Criconemoides* Taylor, 1936, with descriptions of six new species (Nematoda: Criconematidae). Proceedings of the Helminthological Society of Washington 19:85–99.

16. Raski, D. J., and A. M. Golden. 1965. Studies on the genus *Criconemoides* Taylor, 1936 with descriptions of eleven new species and *Bakernema variable* n. sp. (Criconematidae: Nematoda). Nematologica 11: 501–565.

17. Streu, H. T., W. R. Jenkins, and M. T. Hutchinson. 1961. Nematodes associated with carnations. Bulletin 800, New Jersey Agricultural Experiment Station, Rutgers.