Criconematinae Habitats and *Lobocriconema thornei* n. sp. (Criconematidae:Nematoda)[1]

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Abstract: A 16.4-ha area at the Michigan State University Water Quality Research Site was surveyed to obtain information on the habitats and prominence of taxa of the Criconematinae. Fifteen species representing six genera *(Macroposthonia, Lobocriconema, Criconema, Crossonema, Nothocriconema,* and *Xenocriconemella)* of this subfamily were recovered from the experimental site. Species occurrence and population densities were evaluated by using prominence and importance values. The Criconematinae was one of the most prominent and important nematode subfamilies recovered from this area. The species successfully inhabited a broad range of woodlot and field vegetations, and soil management groups. Taxa of the Criconematinae were generally more prominent in woodlot than in field vegetations, although with several important exceptions, especially within the genus *Macroposthonia.* The second-most prominent and important species recovered was an undescribed species of *Lobocriconema.* It is described as *Lobocriconema thornei* n. sp., including scanning electron micrographs of females, and descriptions of several of the juvenile stages. *Key Words:* Ecology, *Macroposthonia, Lobocriconema, Criconema, Crossonema, Nothocriconema, Xenocriconemella.*

Little is known about the biology of the Criconematinae. The literature was recently reviewed by Hoffman (8). Some species are cosmopolitan, whereas others are less widely distributed and appear to be associated with specific habitats. All species of the Criconematinae are assumed to be parasites of higher plants, and some have been shown to be pathogens. *Macroposthonia xenoplax* can be a predisposition agent (13). A limited number of observations have been made about relationships of species of the Criconematinae with soil moisture, temperature, pH, and texture (1, 7, 8, 11, 12, 14, 15, 16, 18). This project was done to evaluate species of the Criconematinae in relation to their habitats and other stylet-bearing nematodes in a 16.4-ha area in central Michigan. A new species of *Lobocriconema* was recovered from the experimental site and is described herein.

MATERIALS AND METHODS

A 16.4-ha (671 x 244 m) area at the Michigan State University Water Quality Research Site was selected for a survey of nematode species and determination of their population densities. The site was divided into 110 experimental units (Fig. 1). Sixty-six of the plots were 0.186 ha (61.0 x 30.5 m) in size, and 44 were 0.093 ha (30.5 x 30.5 m). Forty-eight percent of the area consisted of forests (Fig. 1 A-C), 40% old fields (Fig. 1 D-E), and 9% second-growth shrubland (Fig. 1-F). The following is a general vegetation description of the area:

Forest

A: Sugar maple, beech, elm, red maple, and basswood (75, 10.7, 4.5, 3.9, and 2.2% dominance, respectively, in ≥ 10-cm size class (trunk diameter), with 422.9 trees/ha and a mean basal area of 41.6 m^2/ha), and sugar maple, elm, *Ostrya* sp., red maple, and black maple (30.7, 24, 14, 7.9, and 7.9% dominance,

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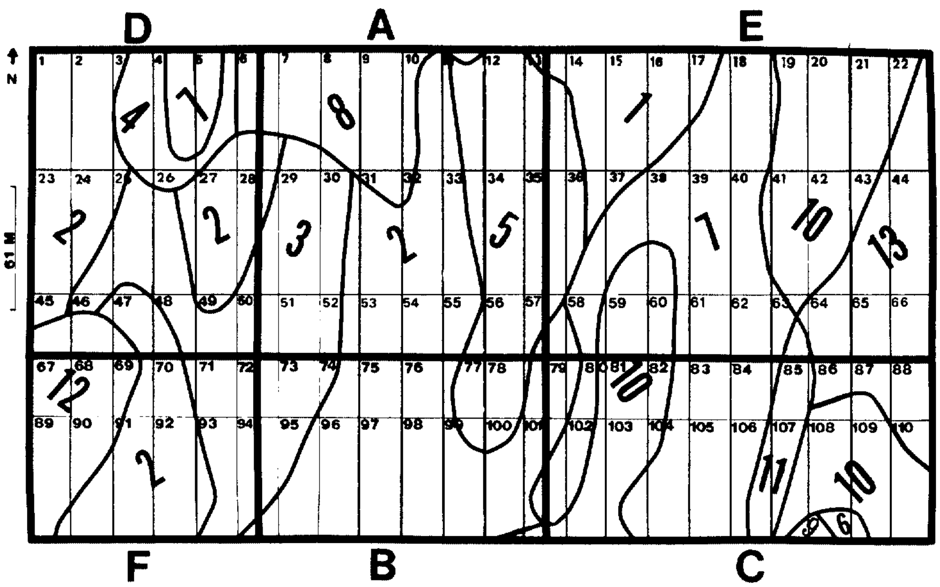

FIG. 1. Illustration of the 16.4-ha experimental area at the Michigan State University Water Quality Research Project [110 experimental units, 13 soil types and 6 (A-F) vegetation categories].

respectively, in ≤ 10-cm size class, with 2352 trees/ha and a mean basal area of 2.82 m^2/ha.

B: Sugar maple, beech, white ash, elm, and hickory (34.2, 33.8, 8.4, 6.4, and 3.9% dominance, respectively, in ≥ 10-cm size class, with 372.5 trees/ha and a mean basal area of 17.7 m^2/ha, and *Ostrya* sp., sugar maple, white ash, beech, and *Prunus serotina* (26, 18.3, 13.2, 12.3, and 1.5% dominance, respectively, in ≤ 10-cm size class, with 3592.3 stems/ha and a mean basal area of 2.77 m^2/ha.

C: Sugar maple, beech, red maple, red oak, and black maple (35.9, 17.6, 7.9, 6.8, and 6.1% dominance, respectively, in ≥ 10-cm size class, with 450.8 trees/ha and a mean basal area of 18.7 m^2/ha).

Field

D: Fourteen-to-sixteen-year postcultivation field with mixed cool-season grasses with *Phleum* sp., *Agropyron* sp., *Poa* sp., and *Agrostis* sp. most common. *Solidago* sp. and *Aster* sp. are the most common dicots, with a wide variety of additional dicot herbs. Some woody encroachment, mainly by *Ulmus* sp., *Rubus* sp., and *Acer* sp., is present over most of the field, and there is extensive invasion by *Quercus rubra*. This field is heterogeneous because of differences in topography and drainage, and possibly variable cultural practices. Slopes indicate low nutrient status of the soil by open vegetation and extensive moss cover on the ground.

E: Nine-year post corn field, dominated by *Agropyron repens*, *Solidago* sp., and *Aster* sp. Some areas planted with *Lolium* sp.

F: Pasture area with considerable slope and depression. Woody species mostly *Rhus* sp., *Ulmus* sp., *Prunus* sp., and *Acer* sp. Herb cover highly variable in both species composition and density.

The experimental area contained 13 different soil-management groups (Fig. 1:1-13). They were combined into three general soil types (sandy loam, loamy sand, and loam and silt loam) and three general soil drainage patterns (good, fair, and poor). The area was sampled for nematodes on December 4-5, 1973, using a cone-shaped nematode-sampling tube attached to a wooden handle. Three hundred and eighty samples were taken, as illustrated in Figure 2. Each sample consisted of 25 cores of soil and roots, taken to a depth of 15 to 20 cm. The samples were placed in plastic bags and stored for 30 to 60 days at 15 C. Then they were mixed well by filling the plastic bags with air and shaking them for 30 sec.

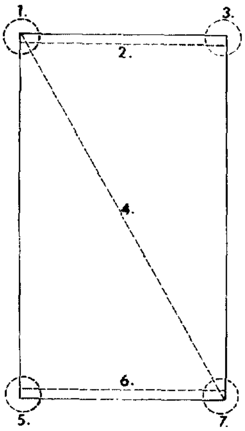

FIG. 2. Nematode sampling scheme: the rectangle outlined by solid lines represents one of the 110 experimental units at the Michigan State University Water Quality Research Sites. Seven samples were taken from this area, represented by the broken lines (1-7). Each sample consisted of 25 cores of soil and roots taken to a depth of 15-20 cm.

Nematodes were extracted from subsamples (100 cm^3) by a modified centrifugation-flotation technique (10). All nematodes recovered belonging to the Tylenchida, Diphtherophoroidea, and Longidorinae were identified to species, and quantitative population estimates were made. None of the other soil-inhabiting nematodes were identified.

Each nematode taxon was evaluated in relation to the other taxa and ecological parameters through calculation and comparison of their prominence and importance values (3, 11). Prominence value = $p\sqrt{n}/1{,}000$, where p = total number of individuals recovered and n = total number of recoveries. Importance value = relative density + relative dominance + relative frequency, where relative density = (taxon density per 100 cm^3 soil/total Nematode (Table 1) or Criconematinae (Table 2) density/100 cm^3 soil)100; relative dominance = (taxon dominance (area present/area sampled)/Nematoda or Criconematinae dominance)100; and relative frequency = [taxon frequency of occurrence (number of plots in which taxon occurs per number of plots sampled)/frequency of occurrence of Nematode or Criconematinae) 100]. Nematode recoveries and densities from the experimental units, vegetation categories, soil types, and soil drainage groups were standardized (areas made equivalent) so that appropriate data could be compared.

TABLE 1. Prominence and importance of sixteen subfamilies of the Nematoda recovered from woods and fields at the Michigan State University Water Quality Research Project Site.

Nematode taxa	Prominence value[a]	Importance value[a]
Dorylaimida		
Dorylaimina		
Dorylaimoidea		
Longidorinae	1030.0	207
Diphtherophoroidea		
Diphtherophorinae	5.1	78
Trichodorinae	14.9	44
Tylenchida		
Tylenchina		
Criconematoidea		
Criconematinae	1141.9	204
Paratylenchinae	368.7	146
Hemicycliophorinae	237.3	122
Tylenchoidea		
Rotylenchinae	875.5	178
Tylenchinae	398.0	144
Pratylenchinae	74.9	106
Tylenchorhynchinae	133.4	75
Psilenchinae	4.7	35
Ditylenchinae	0.1	8
Neotylenchoidea		
Neotylenchinae	31.5	82
Heteroderoidea		
Meloidogyninae	17.7	48
Heteroderinae	0.4	27
Aphelenchina		
Aphelenchoidea		
Aphelenchoidinae	3.0	37

[a]See text.

One undescribed species of *Lobocriconema* was found, and the specimens were heat-relaxed, fixed in 4% formalin, processed in glycerine according to the method of Seinhorst (17), and described in this paper. Measurements and illustrations were made with a Wild micrometer and camera lucida tracings through a Wild drawing tube. The specimens used for the scanning electron micrographs (SEM) were prepared by Seinhorst's rapid glycerine method (17) and mounted on double-sided clear tape on SEM stubs, and the excess glycerine was removed with slightly wet filter paper. The species were coated with 200 to 300 Å of gold in a sputter coater (Flein-Vac, Englewood, N.J.). They were examined under an ISI Super III SEM at a beam-accelerating voltage of 15KV.

TABLE 2. Prominence and importance of six genera and 15 species of Criconematinae recovered from woods and fields at the Michigan State University Water Quality Research Project Site.

Nematode taxon	Total site		Prominence values							
			Vegetation		Soil type			Soil drainage		
	Prominence[a] value	Importance value	Woods	Field	Sandy loam	Loamy sand	Loam and silt loam	Good	Fair	Poor
Criconematinae	1,141.9	204	587.6	236.6	347.8	10.3	173.4	198.9	527.2	75.2
Macroposthonia spp.	270.2	119	27.7	191.0	60.5	3.6	65.3	10.4	61.8	49.3
Lobocriconema spp.	128.7	97	109.8	3.5	43.1	0.3	18.5	17.1	2.2	2.2
Criconema spp.	76.0	88	69.0	1.9	28.6	1.2	8.8	9.4	0.2	1.3
Crossonema spp.	33.3	61	31.6	0.1	14.3	0.2	3.5	5.3	100.3	0.1
Nothocriconema spp.	26.6	53	24.3	0.1	10.3	0.1	0.7	0.3	0.0	0.7
Xenocriconemella spp.	0.8	44	0.8	0.0	0.2	0.0	0.1	0.0	0.5	0.0
Macroposthonia rustica	146.1	83	3.8	126.0	10.0	1.9	21.5	4.4	3.4	12.4
Lobocriconema thornei	128.7	97	109.8	3.5	43.1	0.3	18.5	17.1	2.2	2.2
Criconema octangulare	76.0	88	69.0	1.9	28.6	1.2	8.8	9.4	0.2	1.3
Macroposthonia curvata	37.8	66	5.5	30.3	9.6	0.2	8.6	1.3	2.2	4.1
Crossonema menzeli	28.6	56	27.0	0.1	12.1	0.1	3.0	3.9	100.3	0.0
Nothocriconema permistum	18.6	49	19.1	0.1	8.4	0.1	0.1	0.3	0.0	0.2
Macroposthonia xenoplax	11.0	42	9.5	0.1	6.3	0.0	1.7	0.3	12.9	0.3
Macroposthonia sp.	8.1	23	4.9	0.1	1.1	0.2	1.3	0.1	0.1	0.0
Macroposthonia ornata	1.4	24	0.0	1.4	1.1	0.0	0.2	0.0	0.0	1.4
Nothocriconema princeps	1.3	20	1.0	0.1	0.2	0.0	0.2	0.0	0.6	0.0
Crossonema cobbi	1.0	16	1.0	0.1	0.5	0.1	0.1	0.3	0.0	0.1
Xenocriconemella macrodora	0.8	44	0.8	0.0	0.2	0.0	0.1	0.0	0.8	0.0
Macroposthonia denoudeni	0.3	10	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.3
Nothocriconema petasum	0.2	9	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.2
Nothocriconema mutabile	0.1	5	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0

[a]See text.

RESULTS AND DISCUSSION

Criconematinae habitats: Species of sixteen subfamilies within the Tylenchida, Diphtherophoroidea, and Longidoridae were recovered from the experimental site. The Criconematinae had the greatest prominence value and the second-largest importance value, while the Longidorinae (mainly *Xiphinema americanum*) had the largest importance value and the second-greatest prominence value (Table 1). The third-ranking taxon according to both values was the Rotylenchinae (mainly *Helicotylenchus* spp.). Comparison of the prominence and importance values indicated that these parameters were similar for indication of the relative significance of the taxa.

Six genera and fifteen species of the Criconematinae were recovered from the experimental site (Table 2). The genus *Macroposthonia* was both the most prominent and most important taxon of the Criconematinae recovered from this location. *Lobocriconema* was the genus with the second-highest importance and prominence values. Six species of *Macroposthonia* were present, whereas only one species of *Lobocriconema* was recovered. *M. rustica* and *L. thornei* n. sp. were by far the most prominent species of the Criconematinae recovered from the experimental site.

There were no differences in the nematode prominence values among the three categories of forest vegetation or among the three categories of field vegetation. There were distinct relationships between the general vegetation type and taxa within the Criconematinae. Representatives of the subfamily were most prominent in woodland habitats (Table 2). Five of the six genera, *Lobocriconema, Criconema, Crossonema, Nothocriconema,* and *Xenocriconemella,* were recovered mainly from woodlot habitats. The genus *Macroposthonia,* however, was most prominent in field habitats. *M. rustica* and *M. curvata* were the most prominent species in the fields, and *Lobocriconema thornei* n. sp. the most prominent species in the woods.

Representatives of the Criconematinae were most prominent in sandy loam soils, and more prominent in loam and silt loam soils than in loamy sands (Table 2). Prominence values for the genus *Macroposthonia* were similar in sandy loam soils and loam and silt loam soils; however, the other five genera were more prominent on sandy loams.

The subfamily Criconematinae was most prominent in soils with fair drainage and least prominent in soils with poor drainage (Table 2). The genus *Macroposthonia* was most prominent in soils with fair drainage and had a relatively high prominence value in poorly drained soils. The single species of *Lobocriconema,* however, was more prominent in soils with good drainage than in fairly or poorly drained soils.

All the recorded hosts for each of the 13 previously described species and their habitats in the Michigan experimental site were very similar in general nature. Taxa of the Criconematinae were generally more prominent and important in woodlot than in field vegetations. There were, however, several notable exceptions, especially within the genus *Macroposthonia.* This relationship is not particularly evident in the scientific literature, since most studies have been with agricultural, not natural, environments (12). The results of this investigation support the theory that the ecological importance of taxa of the Criconematinae is greater than generally believed (8). Both the nature of the habitats colonized by many species of the Criconematinae, and the fact that recovery of these nematodes is poor with several commonly used nematode extraction procedures, has hindered the development of a more adequate understanding of the role of the taxa of this subfamily (8, 12).

Lobocriconema thornei n. sp.: The undescribed species of the genus *Lobocriconema,* recovered commonly and in high population densities from the original sampling of the experimental site, was named *Lobocriconema thornei* in honor of Professor Gerald Thorne. His guidance, encouragement, and friendship will never be forgotten. The morphometrics and morphological descriptions of the types are:

Holotype female: L 0.50 mm; a 9.4; b 3.6, V ^{56}90%; stylet 87 μm; R (number of body annules) 46.

Paratype females (20): L 0.55 (0.48-0.64) mm; a 9 (8-11); b 3.8 (3.2-4.5); c (from ventral view of two paratype females) 37-38;

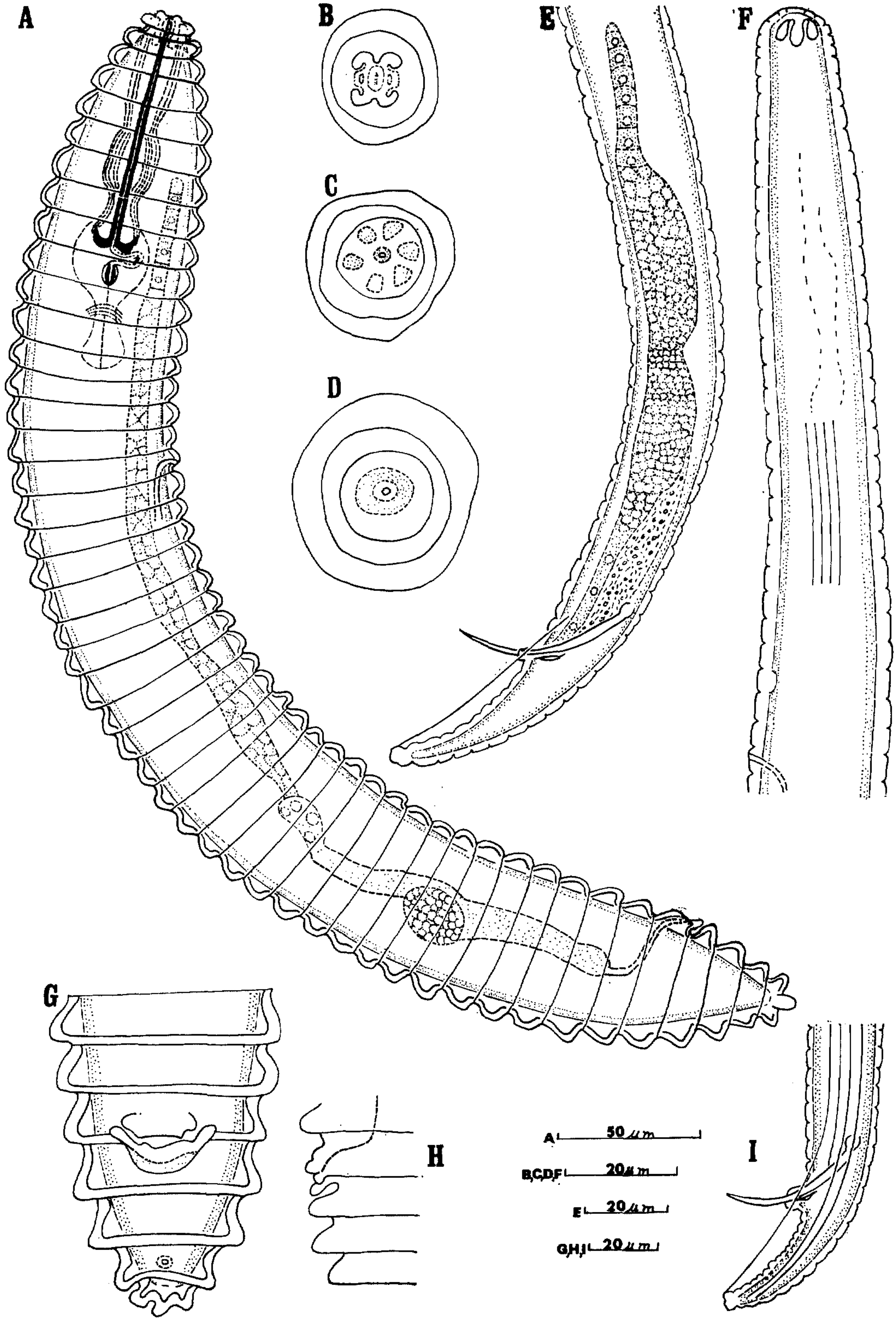

FIG. 3 (A-I). *Lobocriconema thornei* n. sp. *A)* Female. *B-D)* Female serial *en face* views (anterior to posterior); sublateral lobes and amphids, cephalic framework, and stoma, respectively. *E)* Tail region and testis of male. *F)* Anterior end of male. *G)* Ventral view of female tail showing vulva and anus. *H)* Vulva and vagina shape. *I)* Male tail region with pattern of lateral field.

V 92% (90-92%); stylet 89 (85-97) μm R 49 (46-51).

Body thick, cylindroid, tapering toward both blunt extremities (Fig. 3-A, 3-G, 4-A, and 4-E). Body straight or very slightly ventrally arcuate when killed by gentle heat. Annules retrorse except two most-anterior; posterior edges smooth (Fig. 4-A, D). In a few paratype females, posterior edges rough on ventral side near posterior end. Very faint ornamentation of small lines, dots, or punctations on subcuticle underneath each annule (Fig. 4-E). Width of annules at midbody about 10 μm, no anastomoses (Fig. 3-A; 4-D). Stylet well developed; basal part 22 μm long; anterior part 67 μm long (Fig. 3-A; 4-A-B). Basal knobs about 12 μm wide with pointed outer edges directed anteriad. Submedian lobes and cephalic framework prominent (Fig. 3-B, C; 4-B, C). Excretory pore opening on fifteenth annule from anterior end. Vulva on fifth annule from terminal knob (Fig. 3-A, G; 4-E, F). Vagina sigmoid, narrow, leading to a wide uterus; round spermatheca prominent, filled with sperm. Ovary prodelphic, outstretched. In a few specimens, ovary is reflexed; in some specimens, ovary extends to middle of stylet. Anus not observed in holotype; in ventral views of paratype females, anus on first or second annule from terminus. Tail conoid, bluntly rounded at end, with knob at terminus (Fig. 3-A, G; 4-F).

Allotype male: L 0.56 mm; a 20; c 11; spicules 47 μm; gubernaculum 8 μm; T 33.

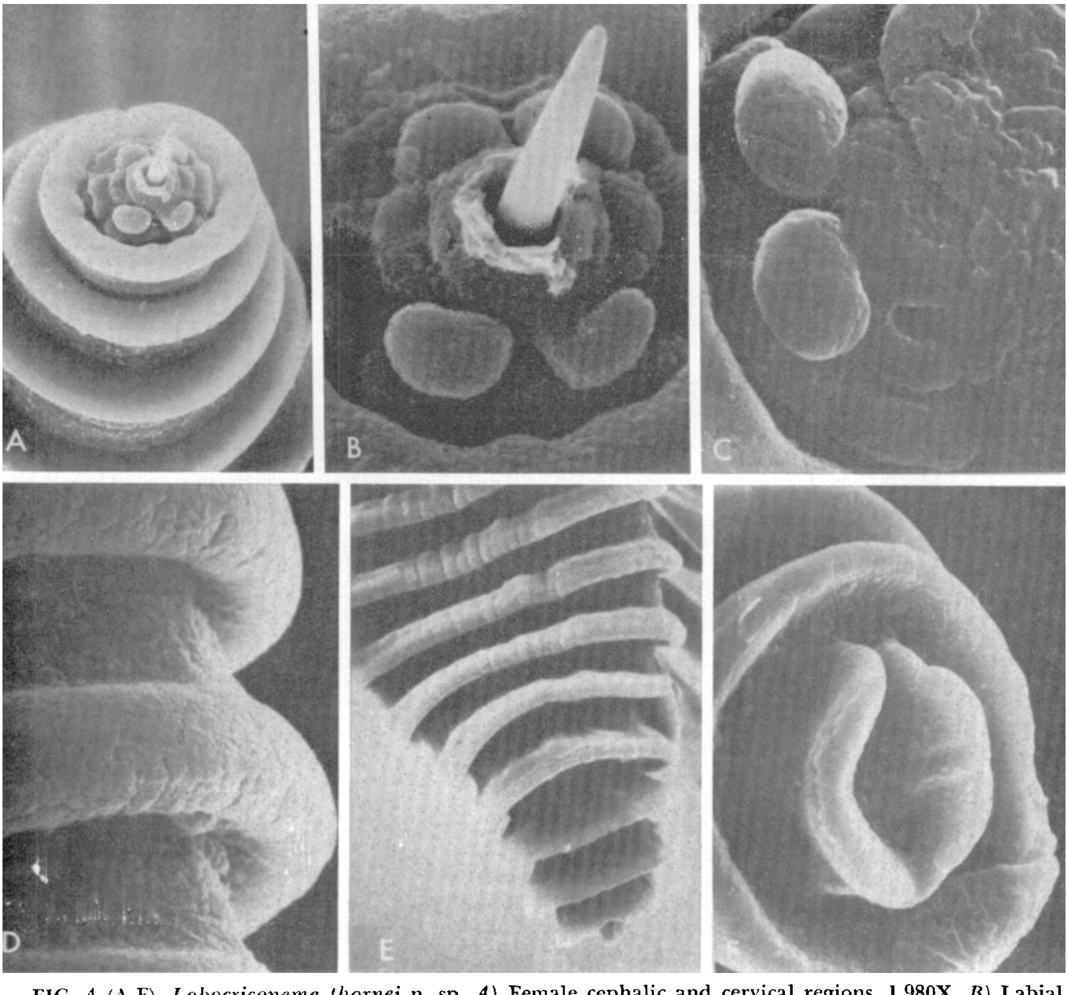

FIG. 4 (A-F). *Lobocriconema thornei* n. sp. *A)* Female cephalic and cervical regions, 1,980X. *B)* Labial region of female with partially extruded stomatostyle, 6,600X. *C)* Female (recently molted), sublateral lobes and amphid aperture, 6,600X. *D)* Female annulation in the midbody region, 6,600X. *E)* Female lateral view of posterior region, 1,980X. *F)* Female (recently molted), tail terminus, 6,600X.

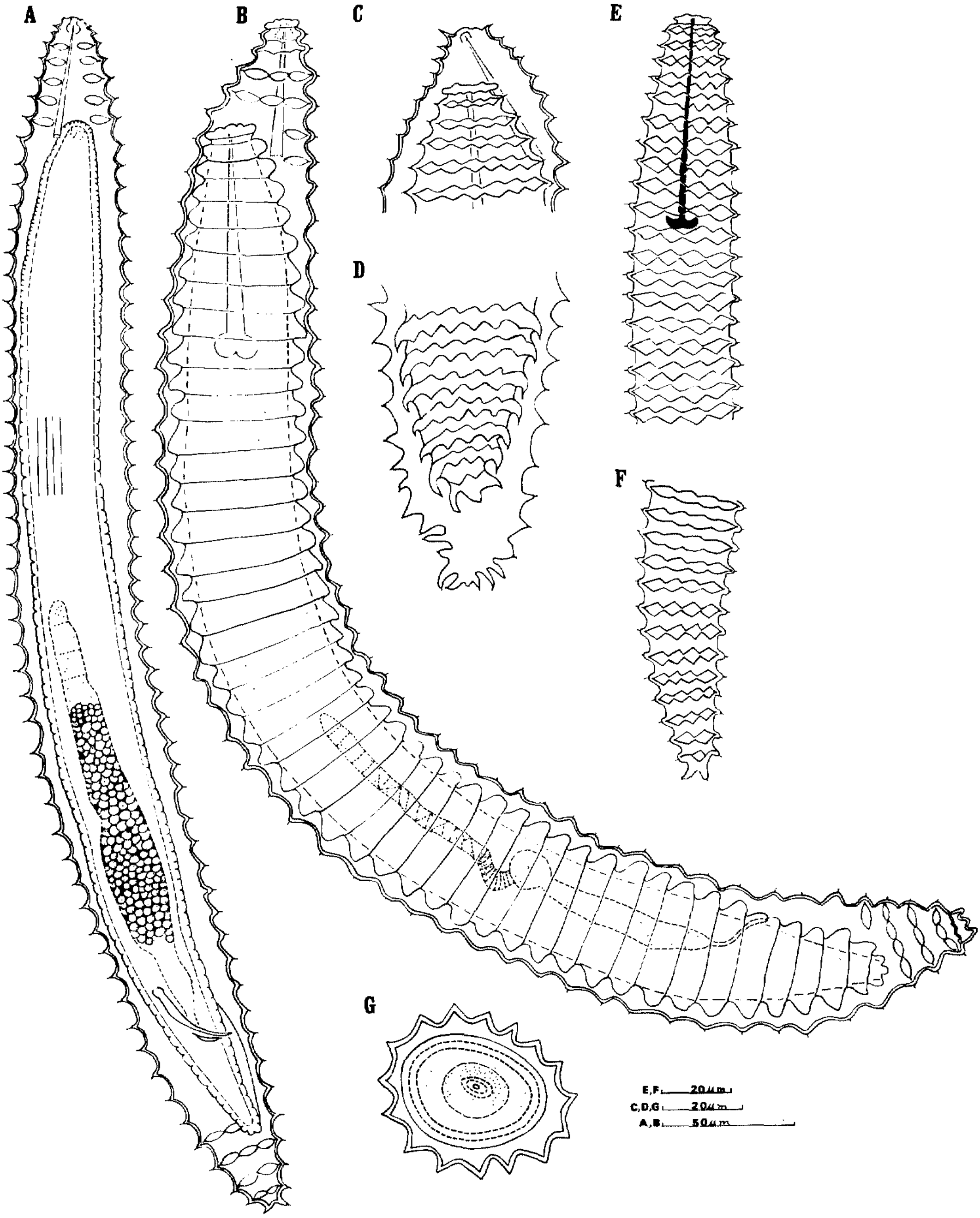

FIG. 5-(A-G). *Lobocriconema thornei* n. sp. moults and juveniles. *A)* Male adult within fourth-stage cuticle. *B)* Female adult within fourth-stage cuticle. *C-D)* Fourth-stage juvenile anterior and posterior region within third-stage cuticle. *E)* Anterior region of third-stage juvenile. *F)* Posterior region of third-stage juvenile. *G)* Cross-section of esophageal region of adult female within fourth-stage cuticle.

Paratype males (2): L 0.49 (0.48-0.50) mm; a 20 (19-21); c 10 (10-11); spicules 45 (44-46) μm; gubernaculum 7.5 (7-8) μm; T 39 (38-41).

Body almost straight in anterior part; at middle of body, shape becomes ventrally arcuate (Fig. 3-E, F). Head flatly rounded. Annulation coarse. Lateral field with four incisures (Fig. 3-I). Excretory pore opening on 30th body annule from anterior end. Hemizonid located at third annule anterior to excretory pore. Testis single, occupying most of body width. Spicules 47 μm long, slender, curved, cephalate proximally, pointed distally. Anal sheath present. Gubernaculum slightly curved, 8 μm long. Tail curved ventrally, rounded at terminus. Bursa as illustrated (Fig. 3-E, I).

Juvenile: 3rd-stage: L 0.32 mm; a 11; b 3.3, stylet 54 μm; R 53.

No juveniles of *L. thornei* were found for several years. On April 26, 1976, several fourth-stage moults with the adult female and male were collected at the original site (Fig. 5-A, B). Later a third moult was found and a third-stage nonmoulting juvenile (Fig. 5-C-F). The fourth-stage juvenile is 0.29 mm long, with 51-52 body annules and stylet 65 μm long. Cuticular patterns are as shown.

Diagnosis: Lobocriconema thornei n. sp. is most similar to *L. neoaxestum* (Jairajpuri & A. H. Siddiqi, 1963) de Grisse, 1967 (4, 9), *L. crassianulatum* (de Guiran, 1963) de Grisse & Loof, 1965 (5, 6), and *L. rara* Boonduang, A. & R. Ratanaprapa, D., 1974 (2). *L. thornei* differs from *L. neoaxestum* in shape of head region, length of stylet, smooth body annules, position of vulva. *L. neoaxestum* has a poorly differentiated neck annule, stylet 65-75 μm long, body annules marked with longitudinal striations and rough posterior margins, vulva on seventh or eighth annule, and juveniles present. From *L. crassianulatum, L. thornei* differs in its larger size, number of body annules, stylet length, shape of head, and tail terminus. *L. crassianulatum* has a body length of 236-362 μm, 33-41 body annules, stylet length 51-70 μm; and although the neck annule is well differentiated, all the body annules except the first are retrorse and the tail terminus is ventrally contracted. From *L. rara,* it differs in body length, vulval position, stylet length, and number of body annules. *L. rara* has a body length of 0.375 (0.350-0.400) mm; V = 95.9 (94.3-97.5)%; stylet 54 (51-57) μm; and body annules 61 (56-65).

Holotype female: Collected July, 1974. Slide T-256t deposited with the USDA Nematology Collection at Beltsville, Maryland, USA.

Allotype male: Slide T-257t. Same data as holotype.

Paratypes: Four females on slide T-2015p deposited with USDA Nematology Collection at Beltsville, Maryland, USA. Eighteen paratype females and two paratype males on four slides deposited with the Canadian National Collection of Nematodes, Nematology Section, Entomology Research Institute, Ottawa, Ontario. All other paratype slides deposited in Nematology Collection in Entomology Department, Michigan State University, East Lansing, Michigan, U.S.A.

Type habitat and locality: Soil around roots of maple trees, *Acer saccharum,* and numerous other habitats in woods of the Michigan State University Water Quality Management Project site in East Lansing, Michigan, USA.

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