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Six new and one known species of *Geomonhystera* (Nematoda, Monhysteridae) from moss, an epiphytic plant and soil in México and Ecuador

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Abstract

Six new species of *Geomonhystera* (Nematoda, Monhysterida: Monhysteridae) Andrássy, 1981, are described and illustrated, five from México and one from Ecuador. The new species have many features in common and in common with at least several other species of the genus. Consequently, those features individually are not very useful for species-level diagnosis. They include the cuticular striation which, under light microscopy, ranges from fine to apparently smooth; however, scanning electron micrographs reveal very fine cuticular striation on all the new species. All the new species have a few body setae scattered along the length of the body and the vulval lips of females are slightly protruding. As for other species of the genus, there is considerable overlap in the ranges of standard morphometric characters so a combination of standard and additional morphometrics, as well as qualitative characters, is necessary for species separation. *Geomonhystera mexiquense* **sp. n.**, collected from moss on a rock and on the trunk of *Quercus crassipes* in Juchitepec, México State, México, has outer labial setae that are unsegmented and 44–67% of the head width, the cephalic setae are thin, unsegmented and 31–50% of the head width; the vulval lips protrude slightly. *Geomonhystera michoacana* **sp. n.**, collected from moss on a rock in Tzararacua National Park, Uruapan, Michoacan State, México, has a very finely-striated cuticle which appears almost smooth and bears rare cervical and caudal setae; the tail is long, 15–17% of the body length, and the rectum also is long, 23–32 (27±2.0) µm. *Geomonhystera longispiculata* **sp. n.**, collected from an epiphytic plant in the botanical garden of the Ecology Institute in Jalapa, Veracruz State, México, is distinguished from all the species of the genus by the long, slender spicules, 55–85 (75±3.0) µm. The cuticle has conspicuous fine striation and there are somatic setae scattered along the body. *Geomonhystera ecuatoriana* **sp. n.**, collected from moss on the trunk of *Scalesia pedunculata* growing on the twin volcanoes of Isla Santa Cruz, Galapagos, Ecuador, has fine cuticular striation and a few small body setae; the unsegmented outer labial setae are 42–54% of the head width and the cephalic setae are thin, unsegmented and 33–45% of the head width; the vulval lips protrude slightly and the vulva-anus distance is 37–48 µm or 2.1–2.5 times anal body diameter. Males of *G. ecuatoriana* have slightly arcuate spicules, 35 µm long. *Geomonhystera galindoi* **sp. n.**, collected from moss on the trunk of *Quercus peduncularis* in San Pablo Ixzayo, Texcoco, México State, México, has fine cuticlar striation and a few fine body setae, the vulval lips are slightly protruding; the vulva-anus distance is 35–50 (41±0.9) µm, 1.5–2.2 (1.9±0.2) times anal body diameter. Males of *G. galindoi* are slightly ventrally curved with the posterior end strongly curved, giving the body a hook-shaped appearance. *Geomonhystera chiautzingoensis* **sp. n.**, collected from moss on the trunk of *Crataegus mexicana* in Chiautzingo, Puebla State, México, has exceedingly fine striation of the cuticle and outer labial and cephalic setae that are less than 50% of the head width. Additionally, *G. dubia* Siddiqi & Shahina, 2004 was sollected in soil samples around a plum tree (*Prunus* sp.) in the garden of Montecillo Campus, Colegio de Postgraduados, Texcoco, México State, México This species has a small body with fine cuticular striation and a few sparsely-distributed body setae; the outer labial and cephalic setae are unsegmented, 5–8 and 3–5 µm long, 56–80% and 33–50% of the head width, respectively; the vulval lips protrude slightly but are sometimes flush with the body contour.

Key words: New species, *Geomonhystera*, moss, epiphyte, tree trunks, rocks, Monhysteridae

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Introduction

Species of the genus *Geomonhystera* are terrestrial nematodes with smooth to finely-striated cuticles which may bear somatic setae either along the body or in the cervical and tail regions. The six lips surrounding the stoma are not fused. The anterior sensillae are in three whorls, six circum–oral inner labial papillae, which are located at the bases of the lips and may be surrounded by cuticular protrusions, six outer labial setae which may be articulated or segmented by a joint near the base, and four cephalic setae which may be similarly segmented. The jointed condition of the base of the setae, where present, was referred to as articulated by Andrássy (1981) but some authors have described it as segmented (Brzeski, 1993); in this paper we use the terms segmented and unsegmented. The amphid fovea are circular and obvious, usually near the level of the base of the stoma. The tapered tail has three caudal glands that are ducted into a common ampulla and then through the conspicuous, terminal, spinneret.

The buccal cavity is small and funnel-shaped; buccal teeth are not reported for most species of *Geomonhystera*. The pharynx is an elongated muscular tube which opens into the intestine through a pharyngeal valve in the form of a cardia comprised of several conspicuous cells. The intestine opens to the anus or cloaca through an elongate rectum. In the female, the gonad is outstretched; the vulva may have protruding lips and is close to the anus, usually within 1.5–2.5 times the anal body diameter. In the male, there is a single testis, paired spicules and a gubernaculum but no bursa (Andrássy, 2005).

Brzeski (1993) noted that many morphometric characteristics of *Geomonhystera* species have high variability and that there are overlaps in the standard De Man ratios (a, b, c, c', V) among the species. He suggested that additional quantitative ratios (including vulva-anus distance as a proportion of anal body diameter, anterior end of amphid to head, and lengths of anterior sensillae as percentages of head width) and qualitative characteristics (including the shape and location of somatic setae, segmentation of outer labial and cephalic setae, cuticular striation and the presence or absence of a spermatheca) are useful and important diagnostic features. Striation of the cuticle is usually very fine, sometimes so fine that the cuticle has been described as smooth, and males are not known in many species. Consequently, separation of species on the basis of morphological, morphometric and anatomical features is not a trivial undertaking; DNA sequences will likely become progressively important in characterizing and separating the already-described and new species.

The genus *Geomonhystera* was erected by Andrássy (1981) to accommodate terrestrial species of the family Monhysteridae de Man, 1876 that have general characters of the Monhysteridae but, among other features, the vulva is located at around 80% of the body length and very close to the anus, there are well-developed cephalic setae and a long, thick, muscular rectum. In his most recent description of the genus, Andrássy (2005) listed some characteristics that were not included in the 1981 description. They included statements that the body cavity is devoid of crystalloids and that the lips are completely amalgamated. Based on our SEM micrographs, the lips are clearly separate and not amalgamated. While the definition of crystalloids is uncertain, Andrássy (1981) indicated that in the genus *Monhystera,* the "body cavity is packed with fine bio-crystals". Since we observed refractive inclusions in the intestinal cells of one species, we prefer to omit the reference to lack of crystalloids in the genus definition.

Drawing heavily on Andrássy (1981, 1984, 2005) and our own observations, we emend the genus description of *Geomonhystera* as follows:

Monhysteridae. Body 0.5 to 1.2 mm long. Cuticle apparently smooth or finely striated, provided with scattered setae. Stoma simple, funnel-shaped, without denticles. Labial region as wide as or somewhat wider than adjacent body, six triangular-shaped lips, not amalgamated. Labial papillae setose. Outer labial setae either segmented or not, 50–75% as long as lip width; cephalic setae shorter than outer labial setae. Amphids large, usually one to two head widths from anterior of body. Ocelli absent. Pharynx cylindrical without terminal swelling. Rectum unusually strong and muscular, more than one anal body diameter long. Vulva at 75–85 % of body length, within 1–3 body widths of anus. Gonad never reaching to pharynx. Oviparous. Males unknown in many species. Spicula ventrally arcuate, usually less than 1.5 times anal body diameter but exceptionally longer. Gubernaculum small, simple, without dorsal apophysis. Cuticle on ventral precloacal region of male wrinkled. Tail rather stout, never filiform, ventrally curved in female 2–3 times as long as vulva-anus distance. Spinneret short, conoid. Amphimictic or parthenogenetic depending on the existence of males. The genus exclusively contains terrestrial species. Some are in soil but many occur in mosses and on or under the bark of trees.

TABLE 1. List of species of *Geomonhystera*, including those described herein.

Geomonhystera villosa (Bűtschli, 1873) Andrássy, 1981 (type species) syn. *Monhystera villosa* Bütschli, 1873, *M. insignis* Cobb, 1893, *M. impetuosa* Cobb, 1904, *M. mali* Fuchs, 1938, *M. paravillosa* Meyl, |1954	
G. aenariensis (Meyl, 1953) Andrássy, 1981 syn. *M. aenariensis* Meyl, 1953	
G. pervaga (Argo & Heyns, 1973) Andrássy, 1981 syn. *M. pervaga* Argo & Heyns, 1973	
G. steineri (Micoletzky, 1922) Andrássy, 1981 syn. *M. villosa steineri* Micolezky, 1922	
G. tripyloides (Andrássy, 1969) Andrássy, 1981 syn. *M. tripyloides* Andrássy, 1969	
G. altaica Gagarin, 2002	*G. japonica* Khan & Araki, 2001
G. antarcticola Andrássy, 1998	*G. karuni* Siddiqi & Shahina, 2004
G. auvillis Saha, Lal & Singh, 2002	*G. longicaudata* Gagarin, 2002
G. breviseta Brzeski, 1993	*G. longispiculata* **sp. n.**
G. chiautzingoensis **sp. n.**	*G. media* Gagarin, 2002
G. dubia Siddiqi & Shahina, 2004	*G. mexicana* Brzeski, 1993
G. ecuatoriana **sp. n.**	*G. mexiquense* **sp. n.**
G. galindoi **sp. n.**	*G. michoacana* **sp.n.**
G. glandulata Khan & Tahseen, 2006	

The genus *Geomonhystera*, after various revisions and transfers, currently consists of 16 described species (Table 1). In this paper we add six new species to the genus. The new species were collected from moss on rocks or on trunks of trees. Also, we provide a new locality record and additional diagnostic characteristics for *G. dubia* Siddiqi & Shahina, 2004. We provide consolidated morphometric and qualitative data for all known species of *Geomonhystera* as Appendices A and B.

Material and methods

Most of the species studied were collected from moss growing on rocks or on the bark of trees; one species was associated with an epiphytic plant. The substrate material, usually moss, was placed in a jar and submerged in water. After 12, 24 and 48 hours, the water was passed through 60 and 325 mesh sieves and nematodes collected by back-washing the 325 mesh sieve. Nematodes, selected by their characteristic very rapid, sinusoidal movement and the location of the vulva close to the anus, were hand-picked under a dissecting microscope and placed in a vial with 5–7 ml water. About 10 nematodes from each sample were hand-picked and placed in 95% ethanol for DNA analysis. The nematodes in the vial containing water were killed by heating in a microwave for 6 seconds. Seven ml of formalin (8%) were added to the vial to achieve a final fixative concentration of 4%. The vial was stored at room temperature for 10 days and 7 ml of the supernatant formalin was removed carefully with a pipette without disturbing the nematodes. The remainder of the formalin, with the nematodes, was transferred to a 5–cm diameter. Petri dish which was placed in a small desiccator containing 95% ethanol and incubated at 40°C. After 3 days, the excess alcohol was removed under a microscope with a pipette. The nematodes were processed to glycerin using a modification of the Seinhorst (1959) method as described by Cid del Prado-Vera *et al*. (2010) and mounted on glass slides using the paraffin wax ring method (De Maeseneer & d'Herde, 1963). Measurements and drawings were made using a drawing tube mounted on an American Optical compound microscope. The morphometric parameters of the De Man formulae (L, a, b, b', c, c' and V), herein referred to as index values per Fortuner (1990), were calculated for each new species for comparison with already-described species. Measurements are provided as ranges, means and standard deviations.

For scanning electron microscopy, specimens were placed in phosphate buffer for 15 min and dehydrated in an alcohol series (10 to 100%) for 15 minutes at each concentration (Cid del Prado-Vera & Subbotin, 2012). The specimens were critical-point dried and coated with gold-palladium before observation under a scanning electron microscope (Jeol JSM-6390) at 10 kv.

DNA extraction was performed on nematodes stored in ethanol. Detailed protocols for DNA extraction, PCR and sequencing used in the molecular analysis are described by Tanha Maafi *et al.* (2003). The D2–D3 expansion segments of the 28S rRNA gene were amplified with the forward D2A (5'- ACA AGT ACC GT GAG GGA AAG

TTG - 3') and the reverse D3B (5'- TCG GAA GGA ACC AGC TAC TA - 3') primers (Subbotin *et al.* 2006). The PCR products were directly sequenced or cloned into the pGEM-T vector and transformed into JM109 High Efficiency Competent Cells (Promega). PCR products from clones were sequenced. Sequencing was conducted at Quintara Biosciences (CA, USA). New sequences were submitted to the GenBank database under the accession numbers MG077077–MG077081. The new sequences of the D2–D3 of 28S rRNA gene were aligned using ClustalX 1.83 (Thompson *et al.* 1997) with published sequences of other Monhysteridae and outgroup taxa (Litvaitis *et al.* 2000; Fonseca *et al.* 2008; Van Gaever *et al.* 2009; Vogt *et al.* 2014; Schenk *et al.* 2017). Outgroup taxa were selected based on the phylogenetic tree published by Van Megen *et al. (*2009). The alignment was analyzed with Bayesian Inference (BI) using MrBayes 3.1.2 (Huelsenbeck & Ronquist, 2001) under the GTR + I + G model. BI analysis was run with four chains for 1.0×10^6 generations. Two runs were performed for each analysis. After discarding burn-in samples, other trees were used to generate a 50% majority rule consensus tree. Sequence analyses of alignments were performed with PAUP 4b10 (Swofford, 2003). Pairwise divergences between taxa were computed as absolute distance values and as percentage mean distance values based on whole alignment, with adjustment for missing data.

Species descriptions

Geomonhystera mexiquense sp. n.

(Fig. 1 A–G; Fig. 2 A–D)

Measurements. Tables 2 and 3.

Female (n=17). Body almost straight to slightly arcuate ventrad after fixation; cuticle 1 µm thick, with very fine striations; 0–15 (7±4.4) somatic setae concentrated in the cervical region; lips not fused; head convex continuous with body contour, width 13–16 (15.2 ±0.7) µm and height 3–5 µm; inner labial papillae very small, coniform, 2.0 µm long; outer labial setae unsegmented, 7–10 (9.0±0.8) µm long or 44–67% of head width; cephalic setae thin, 5–8 (6.1±0.9) µm long and 31–50% of head width; amphid apertures circular, 3.0–5.0 (4.0±0.4) µm diameter and 15–22 (19.1±1.9) µm from the anterior margin to the head; both amphids at the same level; no denticles observed in the lumen of the stoma; pharynx muscular, 147–174 µm (160±8.4) long or 16–24 (18.4±2.1) % of the body length, 325–697 (543±86.2) µm from the vulva and 353–726 (572±85.4) µm from the anus; nerve ring at 69–98 (76±7.4) µm from the anterior end; cardia 6–12 (9.5±1.7) µm long and 8–15 (9.5±1.6) µm wide, composed of three conspicuous cells; outer zone of intestinal walls with many granular refractive inclusions; rectum thick and muscular, 27–36 (31±2.5) µm long and 0.9–1.75 (1.5±0.2) times the anal body diameter; anterior anus lip slightly protruding; distance between vulva and anus 31–42 µm (36±3.1) or 1.5–2.0 (1.7±0.2) times anal body diameter; gonad (n=10) 198–358 (249±48) µm long, ovary short with one row of oocytes, 24–33 (28±2.9) % of body length. Vagina short, with slightly thickened walls 4–10 (6.6±1.7) µm long, vulval lips slightly protruding, post-vulval uterine sac absent; tail tapering evenly,112–135 µm (123±6.6) µm long and 19–23 (21±1.1) µm wide or 11–19.5 (14.3±1.9) % of the body length, with a few caudal setae; three caudal glands, posterior to the anus and in line, with ducts opening into an ampulla 5–11 (7.4 ±1.6) µm long and then ducted through the conspicuous, terminal, spinneret, 2–3 µm long.

Male. Unknown.

Diagnosis and relationships. *Geomonhystera mexiquense* **sp. n.** has fine cuticlar striation and few body setae; the outer labial setae, 44–67% of the head width, are not segmented, the cephalic setae are thin, not segmented and 31–50% of the head width; vulval lips protrude slightly; the vulva-anus distance is 31–42 (36±3.1) µm and the rectum length 27–36 (31±2.5) µm; caudal glands are ducted into a common ampulla, 5–11 (7.4±1.6) µm long; the spinneret is conspicuous, 2–3 µm long.

Geomonhystera mexiquense **sp. n.** is close to *G. breviseta* Brzeski, 1993 in the length of the body, the thin cuticle, the position of the vulva, the length of the rectum and in having setae scattered along body. It differs in having longer cephalic setae, 5.0–8.0 (6.1) vs. 3.0–5.0 (4) µm, the greater range of the outer labial setae in relation to head width, 43.8–67 (59) vs. 25–45 (34) %, and in having a smaller amphid diameter, 3.0–4.0 (3.9) vs. 4.0–5.0 (4.3) µm. It is also close to *G. karuni* Siddiqi & Shahina, 2004 in the vulva-anus distance, in the length of the outer labial setae, in the length of the pharynx and in the scattered body and tail setae. It differs in the finely-striated vs. smooth cuticle, in the index a, 22–39 (32±4.6) vs. 39–48 (42), in the index c', 5.3–6.4 (6.0) vs.6.5–9.0, and in having a wider body, 24–30 (26.9) vs. 20–26 µm.

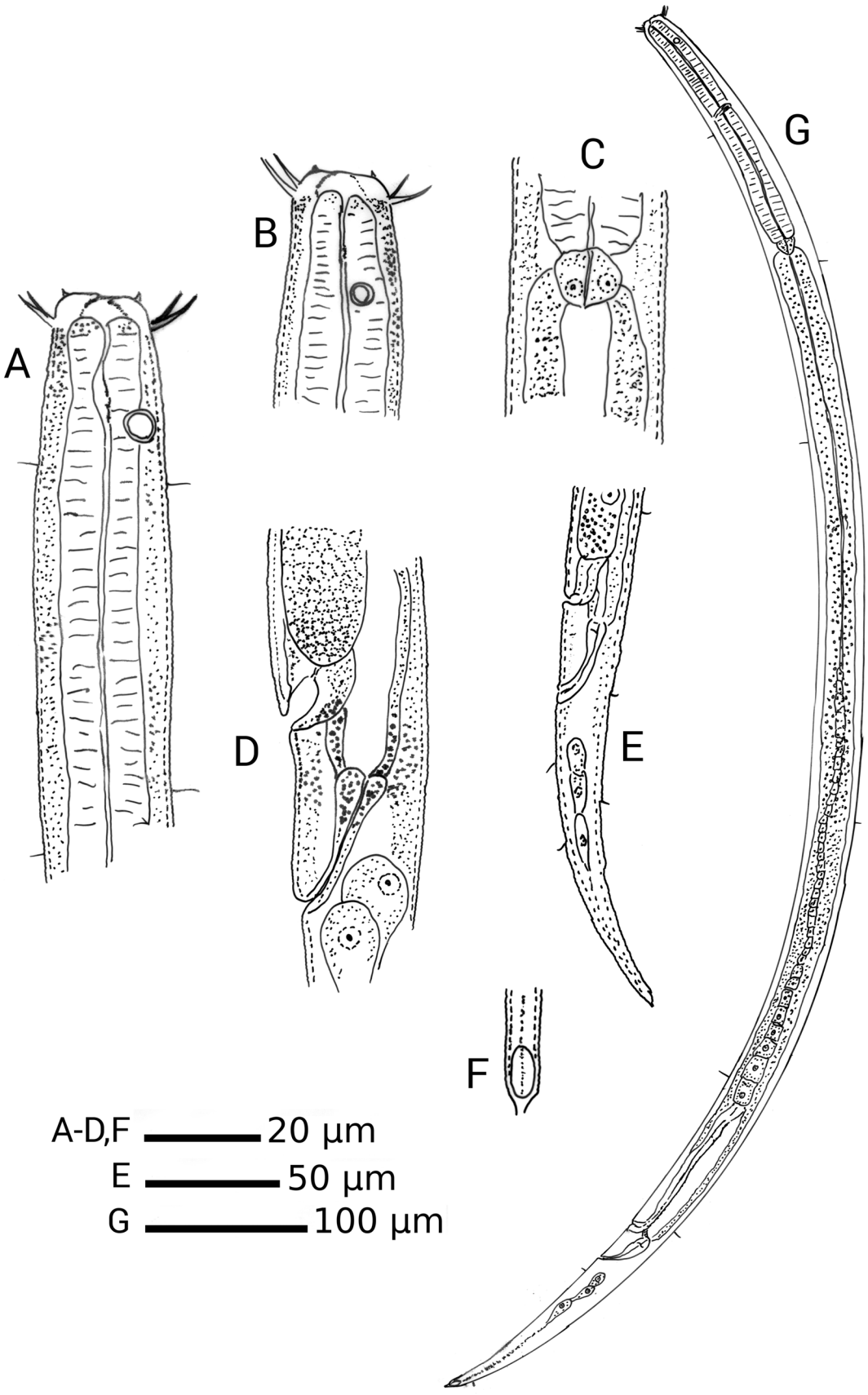

FIGURE 1. *Geomonhystera mexiquense* **sp. n.**; Female (A–G). A, B: Anterior end body; C: Pharyngeo-intestinal junction; D: Vulva-anus region; E: Posterior end body; F: Spinneret; G: Entire body.

Geomonhystera mexiquense **sp. n.** is similar to G. *galindoi* **sp. n.** in the body length, the fine transverse striae and sparsely-distributed body setae, the position of the vulva and the indexes a and b. The species differ in that there are males present in *G. galindoi* **sp. n.** but not in *G. mexiquense* **sp. n.** Two D2–D3 of 28S rRNA gene sequences obtained from two samples of *G. mexiquense* **sp. n.** were different by 0.9% (7 bp) from each other and in 17 % (119–120 bp) from those of *G. galindoi* **sp. n.** and by 8.4–8.5% (60–61 bp) from that of *G. longispiculata* **sp. n.**

The *G. mexiquense* **sp. n.** population from the type locality in Juchitepec is similar to a *Geomonhystera* population from San Diego Huehuecalco, Municipio de Amecameca in the following characters: body length, head width, length of the outer labial and cephalic setae, length of the pharynx and index b, length of the rectum, position of the vulva and vulva-anus distance. We consider the population from San Diego Huehuecalco, Municipio de Amecameca to be *G. mexiquense* **sp. n.**

Type locality and habitat. Juchitepec, México State, 19° 03' 45.2" N, 98° 49' 39.1" W, 2544 m asl, collected on January 23, 2009 and January 24, 2012 from moss on a rock and on the trunk of *Quercus crassipes* Humb. & Bonpl., respectively. A second locality and habitat is from moss growing on a Tepozan tree (*Buddleia cordata* Kunth.) near San Diego Huehuecalco, Municipio de Amecameca 19° 05' 46.3" N 98° 44' 44.6" W, elevation 2529 m asl.

Type specimens. Holotype female on slide 10384; five paratype females on slide 10385 in the Colección Nacional de Helmintos Instituto de Biología, Laboratorio de Helmintología, Universidad Nacional Autónoma de México (CNHE). Other type material is deposited in the University of California, Riverside, Nematode Collection (UCRNC) on slide 28539, Wageningen University Nematode Collection (WaNeCo) on slide WT3716, and the Colegio de Postgraduados Nematode Collection (CPNC) on slide number A-097.

Etymology. The species name recognizes that the type locality, Juchitepec, is in the State of México.

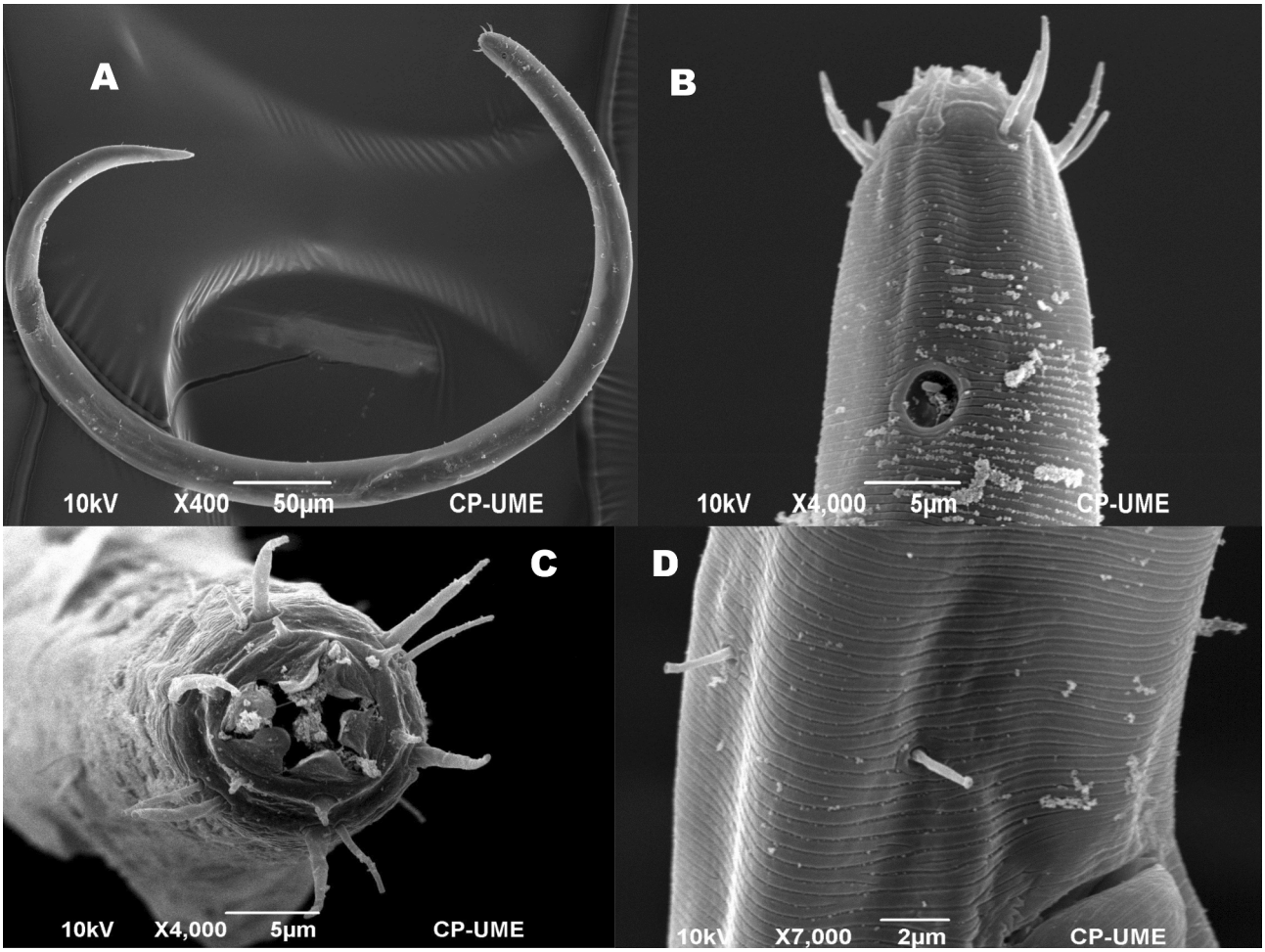

FIGURE 2. *Geomonhystera mexiquense* **sp. n.** scanning electron micrographs; Female (A–D). A: Entire body, lateral view; B: Anterior end, lateral view; C: Face view; D: Somatic setae.

***Geomonhystera michoacana* sp. n.**
(Fig. 3 A–G)

Measurements. Tables 2 and 3.

TABLE 2. Morphometric data for holotypes of new species of *Geomonhystera*. (Females; all measurements in µm, to except for body length, L (mm)).

	G. mexiquense **sp. n.**	*G. michoacana* **sp. n.**	*G. longispiculata* **sp. n.**	*G. ecuatoriana* **sp. n.**	*G. galindoi* **sp. n.**	*G. chiautzingoensis* **sp. n.**
Body length	0.905	0.782	0.952	0.820	0.952	0.782
a	33.5	31.3	39.7	30.4	35.3	34
b	5.9	5.4	5.6	5.4	5.3	5.1
c	7.9	6.5	8.4	7.8	6.2	8.5
c’	5.2	6.0	5.7	5.5	6.6	5.4
Head width	13	14	13	11	16	11
Body width	27	25	24	27	27	23
Outer labial setae length	9.0	8	6	6	9	5
Cephalic setae length	5	5	5	5	5	4
amphid to head	18	16	25	17	19	19
Pharynx length	152	146	170	152	179	154
Pharynx in % of body length	16.8	18.7	17.9	18.5	18.8	19.7
Rectum length	30	29	35	25	34	31
Rectum/anal body diameter	0.94	1.5	0.74	1.3	1.5	1.8
V%	83	79.5	82.2	81.6	79.2	80.8
Vulva to anus distance	32	28	47	39	39	42
Vulva to anus distance / anal body diameter	1.5	1.4	2.4	2.1	1.7	2.5
Tail length	115	120	113	105	153	92
Tail length in % of body length	12.7	15.3	11.9	12.8	16.1	11.8
Tail length/vulva-anus distance	3.6	4.2	2.4	2.7	3.9	2.2

Female (n=5). Body strongly curved ventrally after fixation; cuticle 1 µm thick, with very fine striations; body setae rare, occasionally on tail and cervical region; head convex continuous with body contour, head width 13–14 (13.8±0.5) µm; lips triangular, fused at the base and clearly separated distally; inner labial papillae very small, coniform, 2.0 µm long; outer labial setae not segmented, 7–8 (7.5±0.6) µm long or 36–57 (48±9.0) % of head width; cephalic setae thin, 5–6 µm long or 36–43 (38±4.2) % of head width; amphid apertures rounded, 4.0–5.0 (4.2±0.5) µm diameter, 15–21 (17±2.4) µm from the anterior margin to the head, both amphids at the same level; pharynx muscular, 123–178 (147±21.8) µm long or 18–21 (19±1.3) % of the body length, and 368–537 (441±68.1) µm from vulva and 395–673 (495±108.6) µm from anus; nerve ring 63–80 (69±7.8) µm from the anterior end; cardia 6–10 (8.0±2.0) µm long and 7–12 (9.4±2.3) µm wide, composed of three small cells. Rectum 23–32 (27±4.0) µm long and 1.3–1.7 (1.5±0.2) times anal body diameter, thick, anterior end almost at level of vulva. Anterior anus lip slightly protruding. Gonad difficult to see in all specimens. Vulva lips slightly protruding; vagina short, post-vulval uterine sac absent; vulva-anus distance 24–37 (29±4.9) µm or 1.4–1.9 (1.6±0.2) times anal body diameter. Tail tapering evenly, 110–135 (118±10.4) µm long or 15–17 (16±1.1) % of the body length, with a few setae; three caudal glands ducted into an ampulla 5–10 (7.5±2.4) µm long and then into the conspicuous spinneret, 2–3 µm long.

TABLE 3. Morphometric data for all specimens (holotype and paratypes) of new species of *Geomonhystera*. (Females; range and mean ± standard deviation; all measurements in µm, to except for body length L (mm)).

	G. mexiquense **sp. n.** (n=17)	*G. michoacana* **sp. n.** (n= 5)	*G. longispiculata* **sp. n.** (n=7)	*G. ecuatoriana* **sp. n.** (n=2)	*G. galindoi* **sp. n.** (n=25)	*G. chiautzingoensis* **sp. n.** (n=9)
Body length	0.6–1.1 (0.9±0.1)	0.63–0.91 (0.8±0.1)	0.73–1.1 (1.0±0.1)	0.75–0.96 (0.84±0.1)	0.75–1.1 (0.95±0.1)	0.71–1.1 (0.86±0.1)
a	22–39 (32±4.6)	25–31 (28±2.5)	29.39.7 (37±3.7)	30–37 (34±3.3)	29–39 (35±2.7)	31–37 (34±2.2)
b	4.1–7.1 (5.5±0.6)	4.7–5.9 (5.2±0.4)	4.5–6.2 (5.7±0.6)	5.4–6.6 (6.1±0.6)	4.8–6 (5.3±0.3)	4.9–6.1 (5.4±0.4)
c	5.1–9.0 (7.1±0.9)	5.7–6.8 (6.4±0.4)	7.4–10.8 (8.8±1.1)	7.2–8.6 (7.9±0.7)	4.5–7.5 (6.5±0.6)	7.5–10 (8.4±1.0)
c´	5.2.6.4 (5.9±0.4)	5.8–7.1 (6.3±0.5)	4.8–7.2 (5.8±0.8)	5.5–5.9 (5.7±0.2)	4.3–9.2 (6.7±0.9)	4.4–8 (5.9±1.0)
Head width	13–16 (15.2±0.7)	13–14.0 13.8±0.5)	11–15 (14±1.5)	11–12 (11.3±0.6)	12–19 (16±1.4)	9–12 (10±0.9)
Body width	25–30 (26.9±1.5)	22–27 (25±1.8)	24–30 (27±1.9)	22–27 (24±2.8)	23–31 (25±2.1)	21–28 (25.5±2.2)
Pharynx length	147–174 (160±8.4)	123–178 (147±21.8)	160–182 (172±8.4)	113–152 (139±22.5)	156–198 (179±10.9)	133–185 (159±16.4)
Outer labial setae	7.0–10 (8.9±0.9)	7.0–8.0 (7.5±0.6)	5–7 (5.8±0.7)	5–6 (5.3±0.6)	7–10 (9±1.0)	4–7 (4.8±1.0)
Cephalic setae	5–8 (6.1±0.9)	5–6 (5.3±0.6)	3–5 (4.4±0.8)	4–5 (4.3±0.6)	5–7 (5.8±0.8)	3–5 (3.6±0.7)
Amphid to head	15–22 (19.2±1.9)	15–21 (17±2.4)	17–26 (23±3.1)	13–18 (16±2.7)	15–25 (21±2.4)	16–25 (21±2.9)
Pharynx % of body length	14–24 (18±2.1)	18–21 (19±1.3)	16–22 (17.7±2.0)	15–18.5 (16.5±1.8)	16.6–21 (18.9±1.1)	17–20 (18.5±1.4)
Rectum length	27–36 (31.6±2.5)	23–32 (27±4.0)	29–35 (33±2.4)	25–30 (27±2.7)	25–45 (33±4.9)	25–44 (31±5.9)
Rectum/anal body diameter	0.9–1.8 (1.5±0.2)	1.3–1.7 (1.5±0.2)	0.64–1.8 (1.3±0.5)	1.3–1.6 (1.4±0.2)	1.0–2.2 (1.6±0.3)	0.6–2.2 (1.4±0.7)
V%	74–84 (80±2.7)	78–80 (79±0.9)	79–86 (83±2.4)	80–82 (81±1.0)	77–86 (80±1.8)	80–86 (82±1.8)
Vulva to anus	31–42 (36±3.1)	24–37 (29±4.9)	34–5 (44±6.0)	37–48 (41±5.9)	35–50 (41±4.5)	37–50 (42±4.4)
Vulva to anus/anal body diameter	1.5–2.0 (1.7±0.2)	1.4–1.9 (1.6±0.2)	1.8–2.4 (2.2±0.2)	2.1–2.5 (2.2±0.3)	1.5–2.2 (1.9±0.2)	2–3.4 (2.5±0.4)
Tail length	112–135 (123±6.2)	110–135 (118±10.4)	94–136 (113±13.5)	103–112 (107±4.7)	126–184 (149±12.6)	79–131 (104±19.4)
Tail in % of body length	11–19.5 (14±1.9)	15–17 (16±1.2)	9.2–14 (11.5±1.4)	12–14 (12.8±1.1)	13–21 (15.8±1.8)	10–13 (12±1.3)
Tail/vulva-anus	3.2–3.8 (3.5±0.2)	3.6–4.6 (4.1±0.4)	2–4 (2.6±0.7)	2.3–2.8 (2.6±0.3)	3.1–4.4 (3.7±0.3)	1.9–2.9 (2.5±0.3)

Male. Unknown.

Diagnosis and relationships. *Geomonhystera michoacana* **sp. n.** has a body that is strongly ventrally curved after fixation; the cuticle appears smooth but actually is finely striated; relatively few setae, primarily located in cervical and tail regions; the tail is 15–17 (16±1.1) % of body length and the rectum is 23–32 (27±4.0) µm long.

Geomonhystera michoacana **sp. n.** is close to *G. pervaga* (Argo and Heyns, 1973) Andrássy, 1981, in the short body, in the fine striation of the cuticle; in the index b, in the distance from the anterior border of the amphid fovea to the head, in the position of the vulva and in the vulva-anus distance, and in having unsegmented outer labial

setae. It differs in having a slightly longer tail. 110–135 (118±10.4) µm vs. 101 µm, a somewhat smaller range of index c, 5.7–6.8 (6.4) vs.6.4–7.4 (7.1), a larger amphid to head/head width, 1.1–1.6 (1.3) vs. <1.0 and in having fewer setae on the body. The new species is close to *G. auvillis* Saha, Lal & Singh, 2002 and *G. aenariensis* (Meyl, 1953) Andrássy, 1981, in the length of the body. It differs from *G. auvillis* in the finely-striated vs. smooth cuticle, in the presence vs. absence of body setae and in the index c, 5.7–6.8 (6.4±0.4) vs. 8.1–8.8, the length of the pharynx, 123–178 (147) vs. 100–112 µm and position of the vulva, 78–79.5 (78.6) vs. 80.6–86.2. It differs from *G. aenariensis* in the somewhat smaller c value, 5.7–6.8 (6.4) vs. 6.6–8.7, the shorter outer labial setae, 7.0–8.0 (7.5) vs 9.5 µm, and in the position of the vulva, 78–79.5 (78.6) vs. 80.3–84%.

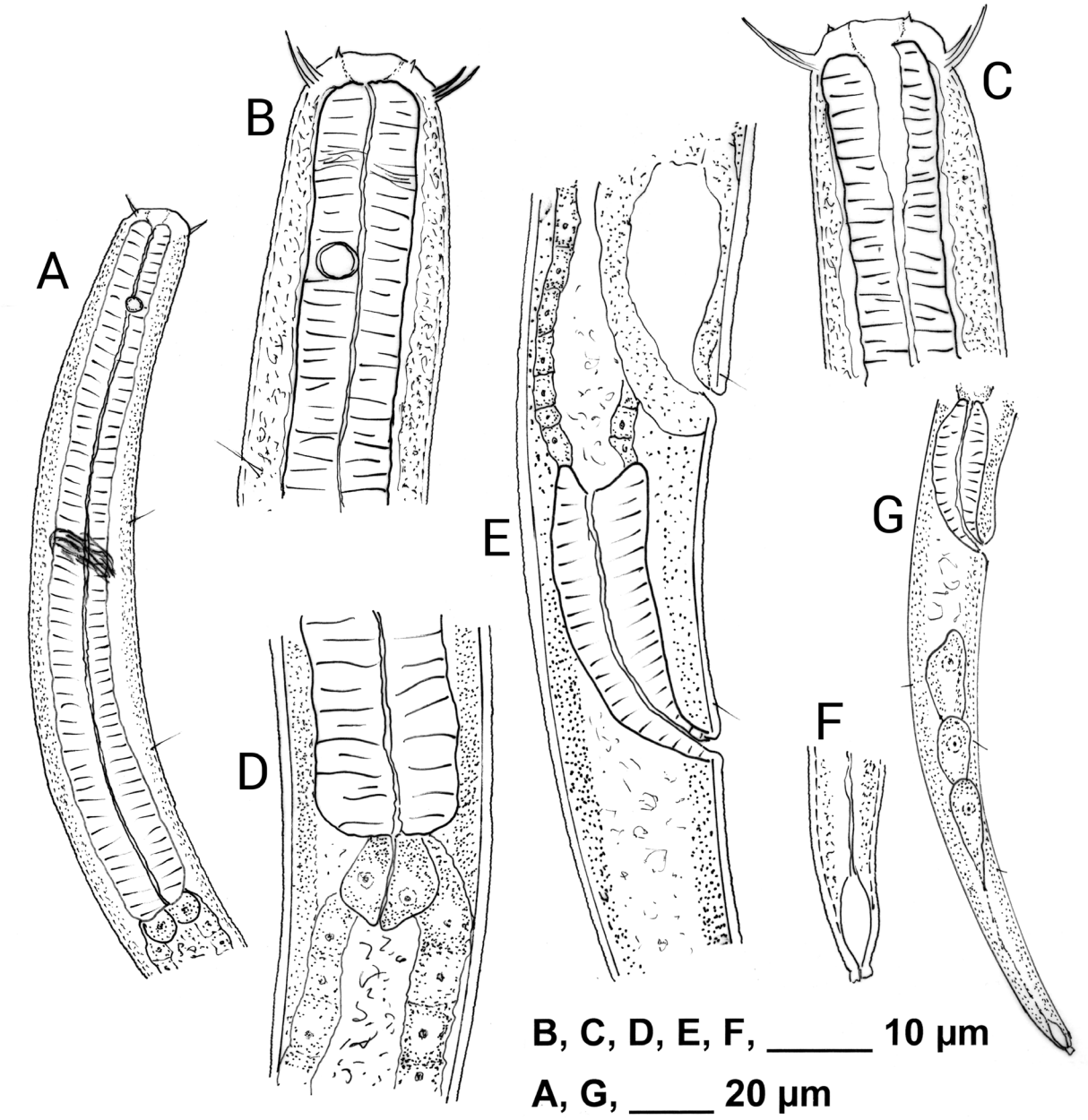

FIGURE 3. *Geomonhystera michoacana* **sp. n.**; Female (A–G). A, B, C: Anterior end body; D: Pharyngeo-intestinal junction; E: Vulva-anus region; F: Spinneret; G: Posterior end body.

Type locality and habitat. The Tzararacua National Park, Uruapan, Michoacan State, México 19° 25′ 29.4″ N, 102° 04′ 21.6″ W, elevation 1620 m asl, collected from moss on rock on June 21, 2009.

Type specimens. Holotype female on slide 10386; five paratype females on slide 10387 deposited in CNHE. One paratype is deposited in each following institutions UCRNC on slide number 28540, WaNeCo on slide number WT3717 and CPNC on slide number A-098.

Etymology. The species name recognizes that the type locality is in Michoacan State.

***Geomonhystera longispiculata* sp. n.**
(Fig. 4 A–I; Fig. 5 A–D; Fig. 6 A–D)

Measurements. Tables 2, 3 and 4.

Female (n=7). Body slightly curved, tail curved ventrally after fixation. Cuticle 1 µm thick with conspicuous fine striation. Somatic setae scattered along the body. Cephalic region slightly convex, rounded in some specimens, 11–15 (14±1.5) µm wide. Lips triangular, fused at the base and clearly separated distally. Inner labial papillae conical, 2.0 µm long, outer labial setae unsegmented, 5–7 (5.9±0.7) µm long and 13–18 (14±1.8) % and 33–55 (42±7.3) % of head width respectively. Cephalic setae thinner, 3–5 (4.4±0.8) µm long and 21–39 (32±5.9) % of head width. Stoma funnel shaped. Amphidial fovea circular, 5.0 µm diameter, 17–26 (23±3.1) µm from anterior border to anterior of body. Pharynx a muscular tube, slightly expanded near posterior end, 160–182 (172±8.4) µm long. Nerve ring in the anterior part of the pharynx at 60–89 (76±11.4) µm from the anterior end. Cardia cone-shaped, 5–13 (9±2.9) µm long and 8–14 (10±1.9) µm wide. Rectum 29–35 (33±2.4) µm long and 0.6–1.8 (1.3±0.5) times anal body diameter. Gonad (n=2) 424–726 (575±213) µm long, ovary short, 42–68 (55±18) % of body length, with one or two rows of oocytes. Vagina short, 8–15 (11.6±2.8) µm long, bent anteriorly. Vulval lips protruding; vulva-anus distance 34–51 (44±6.0) µm or 1.8–2.4 (2.2±0.2) times anal body diameter. Tail ventrally arcuate, 94–136 (112±13.5) µm long or 9.2–14 (11.5±1.4) % of the body length, with a few caudal setae. Three caudal glands arranged in tandem, with ducts terminating in a common ampulla, 9–11 (10.4±0.8) µm long, opening through a blunt-ended, terminal, spinneret, 2–3 (2.1±0.4) µm long.

Male (n=9). Body slightly curved, tail strongly curved ventrally after fixation. Cuticle very thin, 1 µm, with conspicuous fine striation and scattered setae. The somatic setae are thin and in latero-ventral and latero-dorsal positions. Cephalic region low, slightly convex and rounded in some specimens, 12–16 (14.6±1.2) µm wide. Inner labial papillae conical, 2.0 µm long. Outer labial setae unsegmented, 5–8 (6.3±0.9) µm long and 36–58 (44±6.7) % of head width. Four cephalic setae, thinner, 4–5 (4.8±0.4) µm long and 27–42 (33±4.4) % of head width. Amphidial fovea circular, 5.0 µm diameter, anterior border 22–27 (24±1.5) µm from anterior of body. Pharynx a muscular tube slightly expanded near posterior end, 152–191 (171±11.1) µm long. Nerve ring in the anterior part of the pharynx, 70–87 (80±6.7) µm from the anterior end. Cardia cone-shaped, 5–13 (8.6±2.2) µm long and 7–11 (9.2±1.2) µm wide. Testis outstretched, 600–655 (625±22.7) µm long and 52–61 (59±4.6) % of total body length. Spermatozoa oval shape, 8–9 µm long. Spicules slender, 55–85 (75±9.0) µm long; gubernaculum 8–11 (9.8±0.8) µm long, slightly ventrally curved, with rounded distal tip. In the ventral precloacal region is a series of 39–57 papilloid cuticular folds. Tail ventrally arcuate, 114–142 (128±10.1) µm long or 11–13 (12±0.6) % of body length, with three large caudal glands ducted into an ampulla, 10–12 (11.2±1.0) µm long, and then through a 3 µm long, blunt-ended spinneret.

Diagnosis and relationships. *Geomonhystera longispiculata* **sp. n.** is distinguished from all the species of the genus with males by the long, 55–85 (75±9.0) µm, slender spicules. The new species is also characterized by the conspicuous fine cuticular striation and somatic setae scattered along the body.

Geomonhystera longispiculata **sp. n.** resembles *G. antarcticola* Andrássy, 1998, in the fine striation of the cuticle, in the body length of males, in the rounded distal tip of the gubernaculum and in the presence of scattered body setae. It differs in the length of the spicules, 55–85 (75±8.9) vs. 35 µm, in the index a, 29–40 (37±3.7) vs. 38–46, in the shorter body length of females, 0.7–1.1 (0.98) vs. 1.1–1.3 mm, in the rectum length/anal body diameter, 0.6–1.8 (1.3) vs. 3 in *G. antarcticola*. It is also close to *G. villosa* (Bütschli, 1873) Andrássy, 1981, in the body length of both females and males, in the index a, in the distance from the amphid to anterior of the body. It differs from *G. villosa* in the length of the spicules, 55–85 (75±8.9) vs. 30–33 µm, in the smaller value of c', 4.8–7.2 (5.8) vs. 7–9, in the shorter outer labial setae, 5.0–7.0 (5.9) vs. 12 µm, in the shorter cephalic setae, 3.0–5.0 (4.4) vs. 6 µm, in the smaller value or rectum/anal body diameter, 0.6–1.8 (1.3) vs. 2.0–2.5, in the finely-striated vs. smooth cuticle, in the presence of a few vs. several body setae, and in the rounded distal tip vs. forked end of the gubernaculum. The D2–D3 of 28S rRNA gene sequence of *G. longispiculata* **sp. n.** differed by 8.4–8.5% (60–61 bp) from those of G. *mexiquense* **sp. n.**

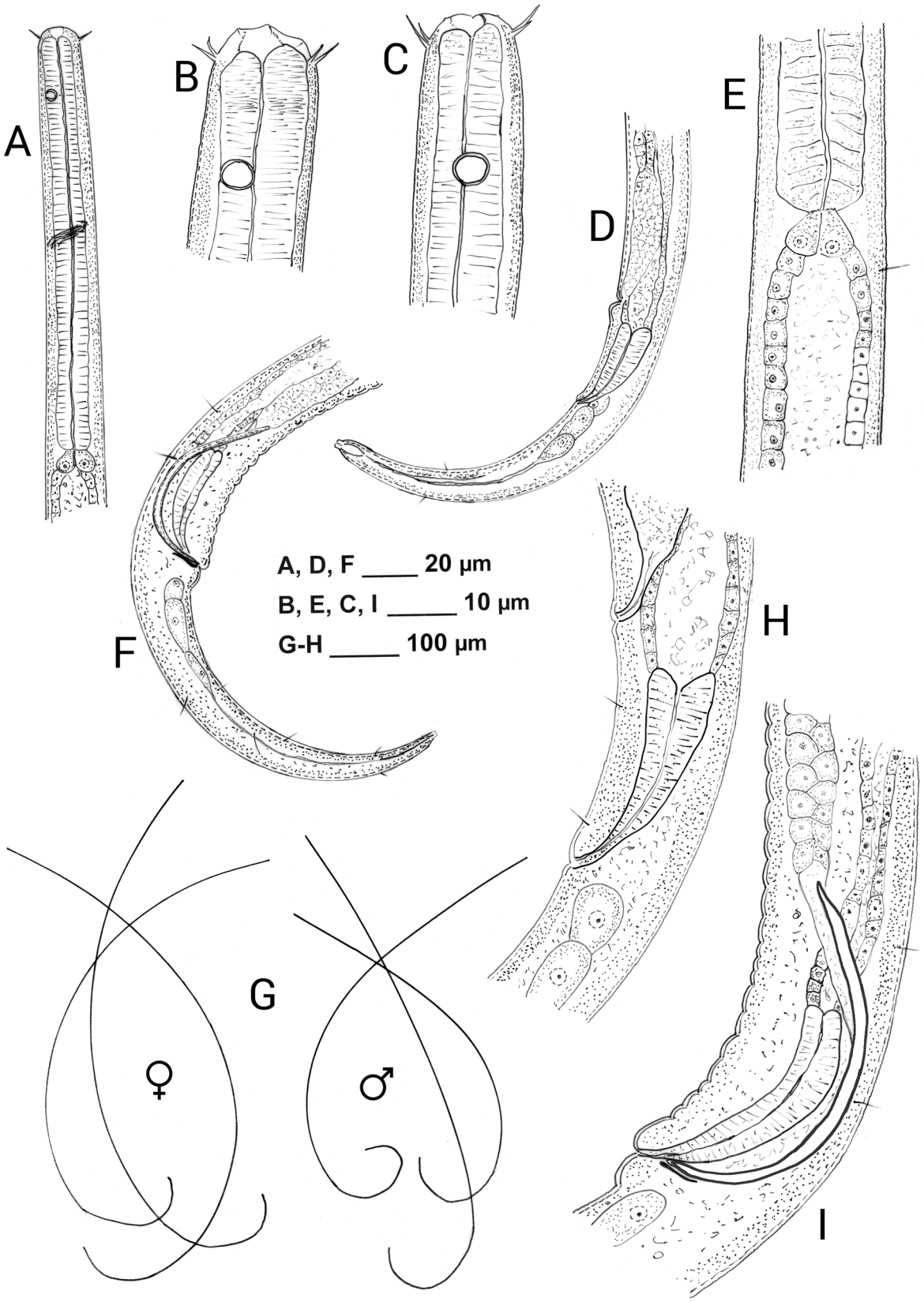

FIGURE 4. *Geomonhystera longispiculata* **sp. n.**; Female (A, B, D, E, H). A, B: Anterior end body; D: Posterior end body; E: Pharyngeo-intestinal junction; H: Vulva-anus region. Male (C, F, I). C: Anterior end body; F: Posterior end body; I: Cloacal region. G: Body shape, females and males.

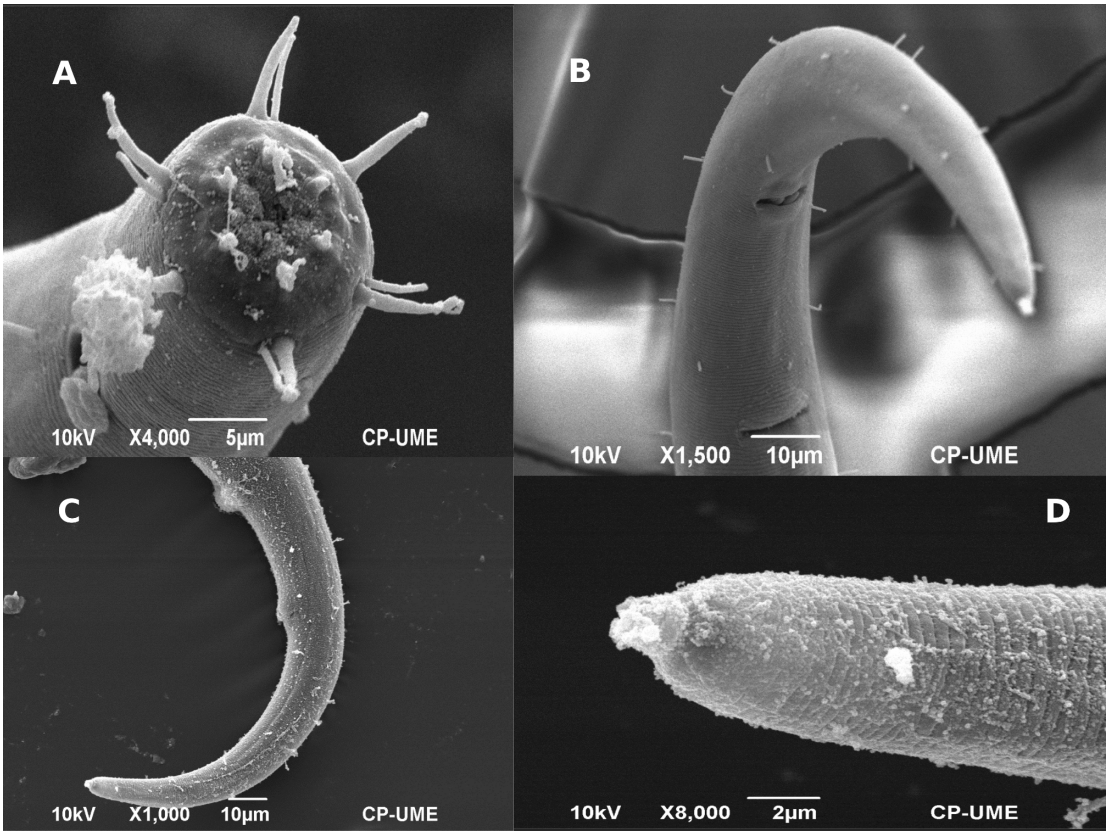

FIGURE 5. *Geomonhystera longispiculata* **sp. n.** scanning electron micrographs; Female (A–D). A: Face view; B: Posterior end, vulva and anus, ventral view; C: Tail lateral view; D: Spinneret.

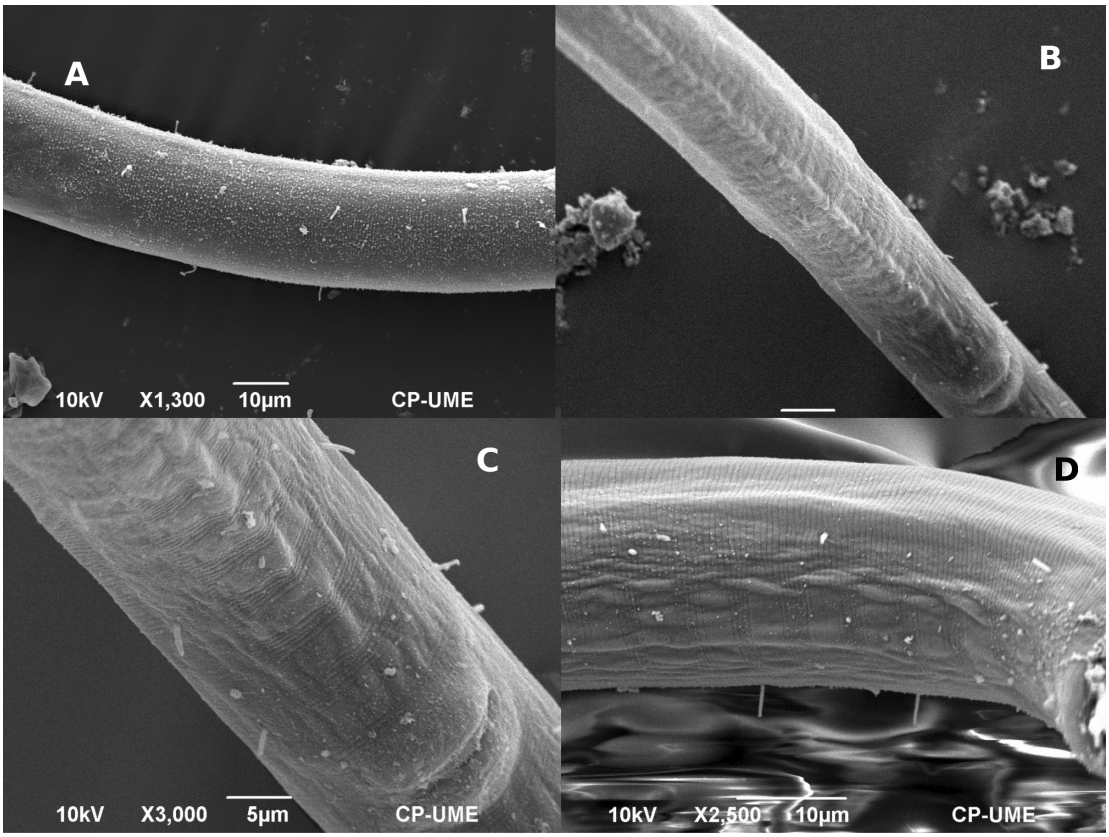

FIGURE 6. *Geomonhystera longispiculata* **sp. n.** scanning electron micrographs; Male (A–D). A: Somatic setae, lateral view; B: Precloacal region, papilloid cuticular folds; C: Close up papilloid cuticular folds, lateral view; D: Cloaca and precloacal papilloid cuticular folds, latero-ventral view.

Type locality and habitat. Collected on March 6, 2015, from a filamentous epicphyte, *Misodendrum* **sp.** (Misodendraceae) growing on a tree in the Botanical Garden of the Ecology Institute of Jalapa, Veracruz, México, 19°30'47.4" N 96°56'32.9" W, elevation 1400 m asl.

Type specimens. Holotype female on slide 10388; allotype male on slide 10389, five paratype females on slide 10390 in CNHE. Other type material is deposited in the UCRNC on slide number 28541, WaNeCo slide number WT3718, and CPNC on slide number A-099.

Etymology. The species name is based on the length of the spicules.

***Geomonhystera ecuatoriana* sp. n.**
(Fig. 7 A–H; Fig. 8 A–D)

Measurements. Tables 2, 3 and 4.

Female (n=3): Body sigmoid or curved ventrally after fixation; cuticle I–2 µm thick, with very fine striation; body with a few thin setae, 3–4 µm long, mainly in cervical region and in vulva-anus area; no setae observed on tail; head 11–12 (11.3 ±0.6) µm wide and 3 µm high; lips triangular, fused at the base and clearly separated distally; inner labial papillae very small, coniform, 2 µm long; outer labial setae unsegmented, 5–6 (5.3±0.6) µm long or 42–55 (47±6.6) % of head width; cephalic setae thin, 4–5 (4.3±0.6) µm long and 33–46 (38±6.3) % of head width; amphid foveae rounded, 4 µm diameter and 13–18 (16±2.7) µm from anterior margin to anterior of head, both amphids at the same level; pharynx muscular,113–152 (139±23) µm long; nerve ring at 55–77 (68±11.7) µm from the anterior end; cardia valve 5–10 (7.5±3.5) µm long and 7–10 (8.5±2.1) µm wide; rectum muscular, 25–30 (27±2.7) µm long and 1.3–1.6 (1.4±0.2) times the anal body diameter; anterior anus lip slightly protruding. Gonad (n=1) 330 µm long, ovary short with one row of oocytes, 34% of body length, vulva to anus distance 37–48 (41±5.9) µm or 2.1–2.5 (2.2±0.3) times the anal body diameter; vulval lips slightly protruding; vagina with slightly thickened walls, 7.0–10 (8.7±1.5) µm long, post-vulval uterine sac absent; tail tapering evenly, straight or slightly curved ventrally,103–112 (106.7±4.7) µm long or 12–14 (12.8±1.1) % of the body length, with a few setae; three caudal glands, posterior to the anus and in line, ducted to a common ampulla, 6–10 (8.0±2.0) µm long and then to a conspicuous, terminal spinneret, 2–3 µm long.

Male (n=1): Body of relaxed specimen slightly wave-shaped after fixation; cuticle 2 µm thick, with very fine transverse striation; body with few setae; head 11 µm wide and 3 µm high; lips fused; inner labial papillae very small, coniform; outer labial setae unsegmented, 5 µm in length or 45.5% of head width; cephalic setae thin, 4 µm in length and 36% of head width; amphid foveae rounded, 4 µm diameter, anterior edge 18 µm from the head end, both amphids at the same level; pharynx muscular, 137 µm long; nerve ring at 69 µm from the anterior end; cardia 5 µm long and 10 µm wide, composed of conspicuous cells. In the ventral precloacal region is a series of 38 papilloid cuticular folds. Copulatory spicules equal in length, slightly arcuate, 35 µm long or about 1.5 times cloacal body diameter and non-cephalate with acute tips; gubernaculum 8 µm long; tail with a few thin setae, 110 µm long or 12.2% of body length and 24 µm wide, ending in a terminal spinneret 2 µm long. Caudal glands not seen.

Diagnosis and relationships. *Geomonhystera ecuatoriana* **sp. n.** has fine cuticular striation and a few thin body setae; the outer labial setae, which are unsegmented, are 42–54% of the head width and the cephalic setae are thin, unsegmented, 33–45% of the head width; vulval lips slightly protruding; vulva-anus distance 37–48 µm or 2.1–2.5 times the anal body diameter; spinneret conspicuous, 2–3 µm long, with ampulla 6–10 µm long. Males with copulatory spicules of equal size, slightly arcuate, 35 µm long or about 1.5 times the cloacal body diameter.

Geomonhystera ecuatoriana **sp. n.** has cuticular striations that are finer than most of the other species of the genus in which the cuticle is striated; it is distinguished also by the length of the outer labial and cephalic setae which, in length, are <50% of head width. It is distinguished from those species in which males are present (*G. steineri* (Micoletzky, 1922) Andrássy, 1981 and *G. villosa* (Bütschli, 1873) Andrássy, 1981) by the fine cuticle striation. It is close to *G. steineri* in the body length, very short body setae, and shape and length of the spicules but differs in the index c′, 5.5–5.9 (5.8) and 4.6 vs. 6–8 and 5.5–6.5 in females and males, respectively, in the relationship of outer labial setae to head width, 42–46 (44) vs. 50–56, the amphid diameter, 4 vs 1.0–1.5, in the somewhat greater the vulva-anus distance, 37–48 vs. 28–40, the tail length times the vulva-anus distance, 2.3–2.8 (2.6) vs. 3–4. *Geomonhystera ecuatoriana* **sp. n.** differs from *G. villosa* in the index c′, 5.5–5.9 vs. 7–9, in the few,

small vs. abundant, longer body setae, and the length of the rectum relative to the anal body diameter, 1.3–1.6 vs. 2.0–2.5.

Geomonhystera ecuatoriana **sp. n.** resembles *G. dubia* Siddiqi & Shahina, 2004 and *G. pervaga* (Argo and Heyns, 1973) Andrássy, 1981 in the fine striation of the cuticle and in the position of the vulva. It differs from *G. dubia* in the body length, 0.49–0.55 vs. 0.7-1.0 mm, the length of the rectum, 26-30 vs. 20-24 µm, the length of the tail, 103–112 (107±4.7) vs. 57–77 (69) µm, in the length of the pharynx, 113–152 (139) vs. 102–120 (115) µm. The new species differs from *G. pervaga* in the index b, 6.3-6.6 (6.5) vs. 4.5-5.5 (4.9), c', 5.7-5.9 (5.8) vs. 6.4-7.4 (7.1), the length of the outer labial setae, 5 vs. 6-11 µm, in the amphid to head/head width, 1.2-1.5 (1.3) vs. <1, and the vulva to anus distance vs. anal body diameter, 2.1-2.5 (2.2) vs. 1.9.

Type locality and habitat. Moss on trunk of native trees, *Scalesia pedunculata* Hook., f., on the twin volcanoes in the Parque Nacional Galapagos, of Isla Santa Cruz, Galapagos, Ecuador, 0° 37′ 33″ S 90° 23′ 04.7″ W, elevation 800 m asl., collected September 28, 2010.

Type specimens. Holotype female on slide 10391, allotype male on slide 10392 and one paratype female on slide 10393 deposited in CNHE. One paratype is deposited in CPNC on slide number A-103.

Etymology. The name of the species comes recognizes the country in which the specimens were collected.

***Geomonhystera galindoi* sp. n.**
(Fig. 9 A–E; Fig. 10 A–D)

Measurements. Tables 2, 3 and 4.

Female: (n=25). Body shape of fixed specimens almost straight to slightly arcuate ventrad; cuticle thin, 1 µm thick, with very fine and visible transverse striae, Very small setae sparsely scattered over whole body; head 12–19 (15.5±1.4) µm wide and 3–6 µm high; lips not fused; inner labial papillae very small, conical, 2–3 (2.1±0.4) µm long; outer labial setae not segmented, 7–10 (9.4±0.9) µm long or 47–67 (61±6.0) % of head width; cephalic setae thin, 5–7 (5.8±0.8) µm diameter, 28–47 (36±5.7) % of head width; amphid openings rounded 3–5 (4.7±0.6) µm diameter with the anterior edge 15–25 (21±2.4) µm from the head, both amphids at the same level; pharynx muscular, 156–198 (179±10.7) µm long or 16.6– 21 (18.9±1.1) % of the body length, 438–688 (587±62.2) µm from the vulva and 476–735 (632±61.9) µm from the anus; nerve ring at 40–104 (81±15.2) µm from the anterior end; cardia at base of pharynx 5–17 (11±3.4) µm long and 6–15 (9.4±2.7) µm wide, composed of two conspicuous cells. Outer zone of intestinal walls with many granular refractive inclusions; rectum muscular, 25–45 (33±4.8) µm long and 1.0–2.2 (1.6±0.3) times anal body diameter; anterior anal lip slightly protruding. Distance between vulva and anus 35–50 (41±4.5) µm or 1.5–2.2 times anal body diameter. Gonad (n=7) 132–322 (228±69.6) µm long, ovary short with one row of oocytes, 13–35 (23±7.3) % of body length. Vulval lips slightly protruding; vagina with slightly thickened walls, post-vulval uterine sac absent. Tail tapers evenly, 126–184 (149±12.4) µm long or 13–21 (15.8±1.8) % of the body length, with a few setae; three caudal glands, posterior to the anus and in line, ducted into a common ampulla 5–10 (8.1±2.3) µm long and then through a conspicuous, terminal spinneret which is 2–5 (3.1±0.8) µm long.

Male (n=3): After fixation, body slightly curved with the posterior end strongly curved ventrally, giving a hook-shaped appearance; cuticle 1 µm thick, with exceedingly fine striations; somatic setae rare to few; head 12 µm wide; six lips not fused; inner labial papillae very small, coniform 2 µm long; outer labial setae unsegmented, 6 µm long or 50% of head width; cephalic setae thin, 4–5 (4.3±0.6) µm long or 33– 42 (36±4.8) of head width; amphid apertures rounded, 4 µm diameter and 21–23 (21.7±1.2) µm, or 1.7–1.9 times the head width from the anterior edge of the amphid to the anterior end, respectively; both amphids at the same level; pharynx muscular 160–166 (163±3.0) µm long; nerve ring at 80–85 (82±2.7) µm from the anterior end; cardia 6–10 (8.7±2.3) µm long and 7–11 (9.0±2.0) µm wide, composed of conspicuous cells. Copulatory spicules equal in length, slightly arcuate, 30–34 (32.5±2.1) µm long, with acute tips and non-cephalate; gubernaculum 9–11 (10.3±1.1) µm long. In the ventral precloacal region is a series of 30–37 papilloid cuticular folds. Tail 109–145 (129±18.4) µm long with a few thin setae (4–8 observed), ending in conspicuous, terminal, spinneret 4–6 µm long.

Diagnosis and relationships. *Geomonhystera galindoi* **sp. n.** has fine cuticlar striation and sparsely–scattered body setae; the outer labial setae are unsegmented; vulval lips are slightly protruding; vulva-anus distance 35–50 (41±4.4) µm and 1.5–2.2 times anal body diameter; the outer labial setae are 47–67% of head width and the

cephalic setae thin, unsegmented and 28–47 (36±5.7) % of the body width; caudal gland ampulla 5–10 µm long and spinneret conspicuous, 2–5 µm long.

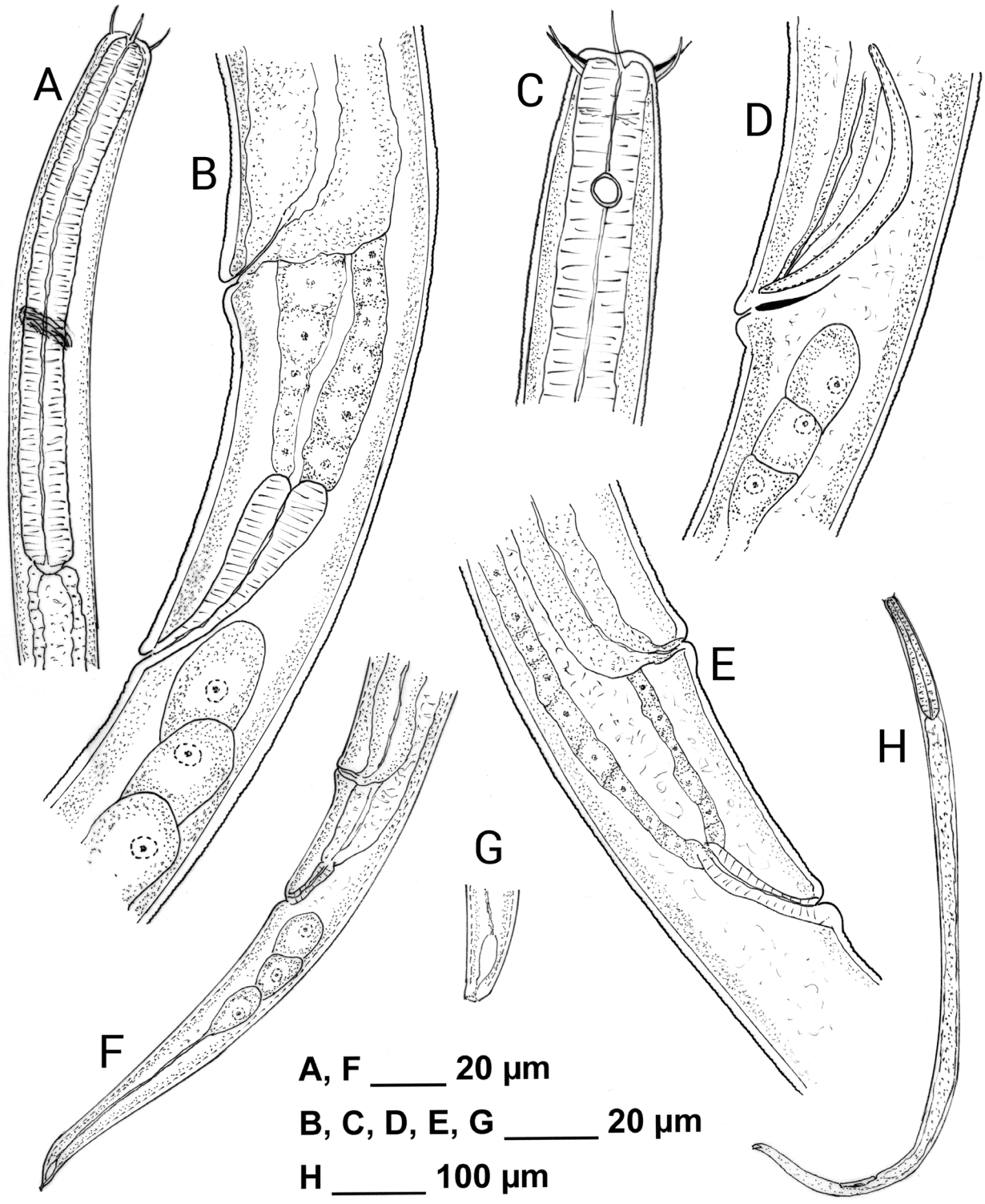

FIGURE 7. *Geomonhystera ecuatoriana* **sp. n.** Female (A, B, E, F, G, H). A: Anterior end body. B, E: Vulva-anus region; F: Posterior end body; G: Spinneret; H: Entire body. Male (C, D). C: Anterior end; D: Cloacal region.

Geomonhystera galindoi **sp. n.** is close to *G. dubia* Siddiqi & Shahina, 2004, mainly in the fine striation of the cuticle, in the position of the amphids, the shape of the body when relaxed and in the position of the vulva. It differs in the small and scattered vs. abundant and conspicuous body setae, in the larger body width, 23–31 (25) vs.16–20

µm, in having longer outer labial and cephalic setae, 7.0–10.0 (9.4) and 5.0–7.0 (5.8) vs. 5.0–6.5 (5.8) and 3.5–4.5 µm, respectively, in the vulva-anus distance, 35–50 (41) vs. 22–29 (27) µm; in the length of the tail, 126–184 (149±12.4) vs. 57–77 (69) µm, in the length of the rectum, 25–45 (33±4.8) vs. 20–24 µm. It is also close to *G. pervaga* (Argo and Heyns, 1973) Andrássy, 1981 in the finely-striated cuticle, the position of the vulva and in the indexes a and b. It differs in the sparse, small body setae vs. abundant, conspicuous setae, in the shorter tail length, 126–184 (149) vs. 101, and in the vulva-anus distance, 35–50 (41±4.4) vs. 27–39 µm. Males of *G. galindoi* **sp. n.** are close to those of *G. ecuatoriana* **sp. n.**, *G. antarcticola* Andrássy, 1998, *G. steineri* (Micoletsky, 1922) Andrássy, 1981 and *G. villosa* (Bűtschli, 1973) Andrássy, 1981 in the size of the spicules, but differ from *G. ecuatoriana* **sp. n.** in the length of the pharynx (160–166 (163) vs. 137 µm and the distance of the anterior border of the amphid to the head 21–23 (21.7) vs. 18 µm; from *G. antarcticola* in the length of the body, 0.83–0.93 (0.89) vs. 1.04–1.41 mm, and lengths of the outer labial and cephalic setae, 6 and 4.0–5.0 (4.3) vs. 14.6 and 9.2 µm, respectively; from *G. steineri* by the index c, 6.2–7.6 (6.9) vs.7.5–9.0, and from *G. villosa* in the number and size of the body setae and the number of cuticular folds and the indexes a and c', 37.7–40.6 (39) and 5.2–6.0 (5.7) vs. 45–40 and 6.0–7.0, respectively.

Geomonhystera galindoi **sp. n.** is similar to *G. mexiquense* **sp. n.** in the body length, the fine transverse striae and sparsely-distributed body setae, the position of the vulva and the indexes a and b. It differs in that there are males present in *G. galindoi* **sp. n.** but not in *G. mexiquense* **sp. n.** Two D2–D3 of 28S rRNA gene sequences obtained from two clones of a sample of *G. galindoi* **sp. n.** were different by 0.6% (4 bp) from each other and 17 % (119–120 bp) from two sequences of *G. mexiquense* **sp. n.** and by 17% (119–120 bp) from those of *G. longispiculata* **sp. n.**

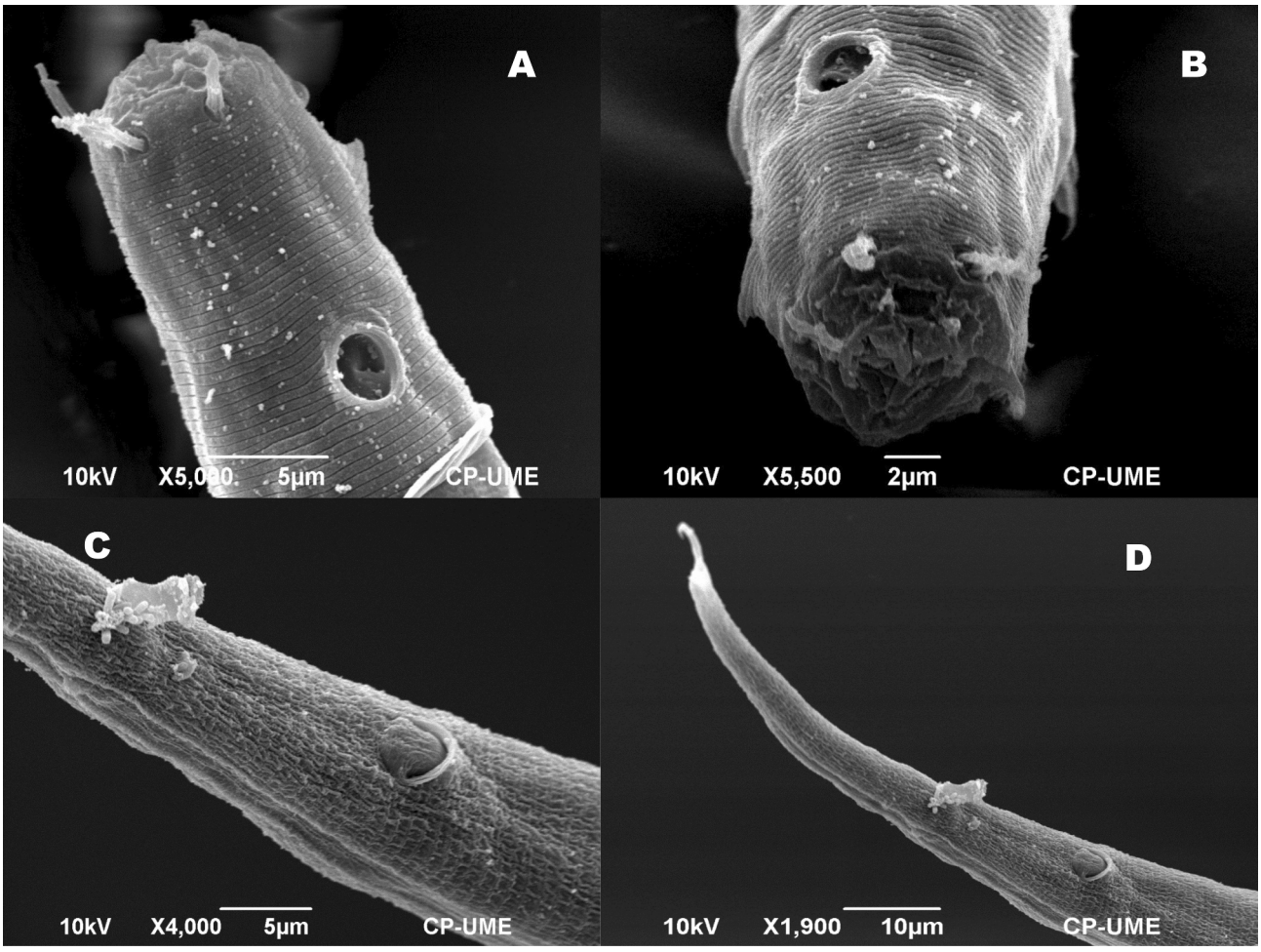

FIGURE 8. *Geomonhystera ecuatoriana* **sp. n.** scanning electron micrographs; Female (A–D). A: Anterior end, lateral view. B: Head region, antero-lateral view. C: Anal region, ventral view; D: Tail, ventral view.

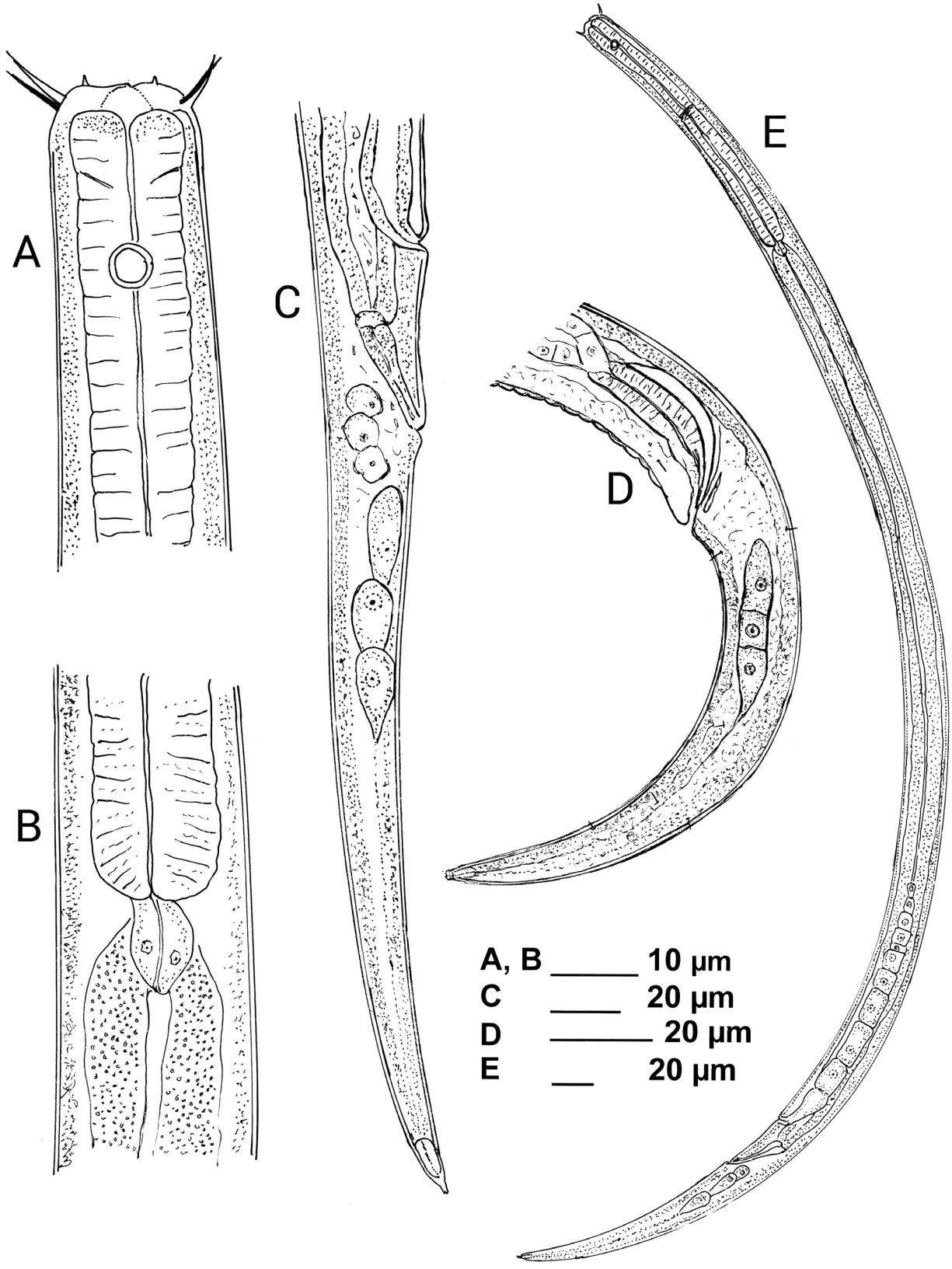

FIGURE 9. *Geomonhystera galindoi* **sp. n.** Female (A, B, C, E). A: Anterior end body; B: Pharyngeo-intestinal junction; C: Posterior end body; E: Entire body. Male (D). D: Posterior end body.

Type locality and habitat. Moss and lichen on trunk of *Quercus peduncularis* Née in a woodland at San Pablo Izayoc, Texcoco, México State, 19° 28' 06.7" N 98° 47' 15.4" W, elevation 2572 m asl. The second locality is

Juchitepec, México State, 19° 03' 45.2" N 98° 49' 39.1" W. Collections were made from the type locality on October 10, 2008 and from the second locality on January 23, 2009.

Type specimens. Holotype female on slide 10394, 15 paratype females on slide 10395 in CNHE. Other type material is deposited in UCRNC on slide number28542, WaNeCo on slide number WT3719, and CPNC on slide number A-100.

Etymology. The species is dedicated to the memory of Dr. Jorge Galindo Alonso, eminent Mexican plant pathologist and outstanding professor and artist.

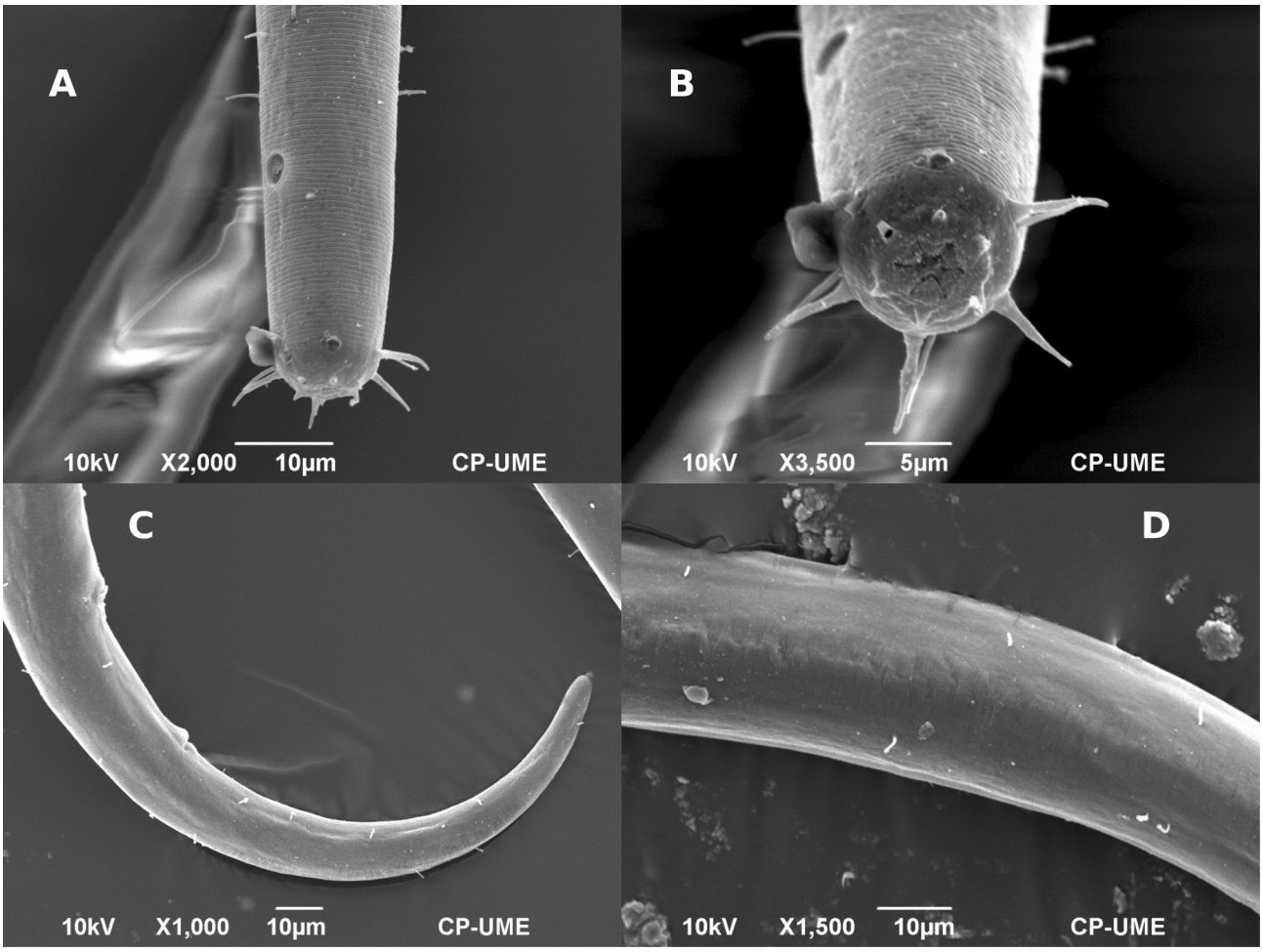

FIGURE 10. *Geomonhystera galindoi* **sp. n.** scanning electron micrographs; Female (A–D). A: Anterior end body, lateral view; B: Face view; C: Posterior end body, lateral view; D: Somatic setae, lateral view.

***Geomonhystera chiautzingoensis* sp. n.**
(Fig. 11 A–I; Fig. 12 A–D; Fig. 13 A–D)

Measurements. Tables 2, 3 and 4.

Female (n=9): Body of fixed specimens curved ventrally with the posterior end hook-shaped; cuticle 1 µm thick, with exceedingly fine striations; body with a few thin setae, 3 µm long, in cervical, mid-body and vulva-anus areas; we observed 0–8 setae on the tails of specimens; head 9–12 (10±0.9) µm wide; lips triangular, fused at the base and clearly separated distally; inner labial papillae very small, coniform, 1 µm long; outer labial setae unsegmented, 4–7 (5.0±0.9) µm long or 36–58 (45±6.9) % of head width; cephalic setae very thin, 3–5 (3.6±0.7) µm long and 27–42 (33±5.9) % of the head width; amphid apertures rounded, 4–5 (4.3±0.5) µm diameter and 16–25 (20.7±2.9) µm from the anterior end or 1.6–2.3 (2.0±0.2) times the head width; pharynx muscular, 133–185 (159±16.4) µm long; nerve ring at 66–87 (79±7.1) µm from the anterior end; cardia 6–11 (8.7±1.9) µm long and 6–14 (9.3±2.2) µm wide; rectum muscular 25–44 (31±5.9) µm long and 0.6–2.2 (1.4±0.7) times anal body diameter; anterior anal lip slightly protruding; vulva-anus distance 37–50 (42±4.4) µm or 2.0–3.4 (2.5±0.4) times anal body

diameter.. Gonad (n=3) 292–509 (380±114.2) µm long, ovary short with one row of oocytes, 37–49 (41±6.5) % of body length; vulval lips slightly protruding; vagina with slightly thickened walls, 5–10 (7.0±1.7) µm long, post-vulval uterine sac absent. Tail tapering evenly, curved ventrally, 79–131 (104±19.4) µm long or 10–13 (12.1±1.3) % of the body length; three caudal glands, posterior to the anus and in line, ducted into a common ampulla, 8–10 (8.7±1.1) µm long, and opening through a conspicuous, terminal spinneret, 2 µm long.

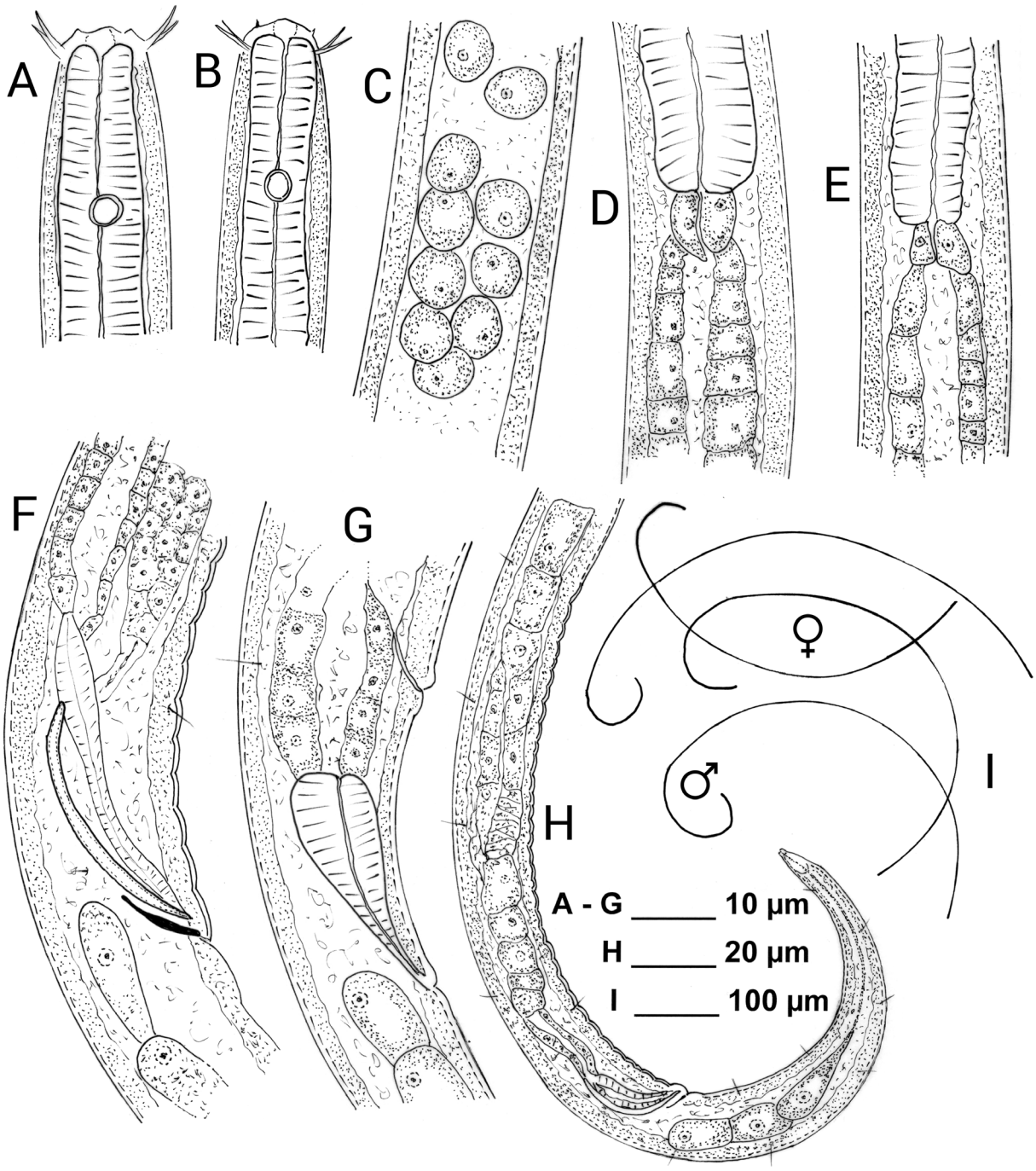

FIGURE 11. *Geomonhystera chiautzingoensis* **sp. n.** Female (A, D, G). A: Anterior end body; D: Pharyngeo-intestinal junction; G: Vulva-anus region. Male (B, C, E, F, H). B: Anterior end body; C. Sperm; E: Pharyngeo-intestinal junction; F: Cloacal region; H: Posterior end body; I: Body shape, females and males.

Male (n=13): After fixation, body curved ventrally after fixation with the posterior end hook-shaped; cuticle 1 µm thick, with exceedingly fine striations; somatic setae rare to few; head 9–12 (10.4±0.9) µm wide; lips fused; inner labial papillae very small, coniform 1 µm long; outer labial setae unsegmented, 3–7 (4.5±1.3) µm long or 27–

64 (43±11.1) % of head width; cephalic setae thin, 2–5 (3.5±1.0) µm long or 18–50% of head width; amphid apertures rounded, 4–5 µm diameter and 17–26 (21±3.0) µm, or 1.7–2.4 times the head width from the anterior edge of the amphid to the head end; both amphids at the same level; pharynx muscular 132–188 (159.7±17.9) µm long; nerve ring at 52–92 (74±17.3) µm from the anterior end; cardia 4–10 (6.1±1.6) µm long and 6–9 µm wide, composed of conspicuous cells. Copulatory spicules equal in length, slightly arcuate, 27–50 (33.5±6.2) µm long, with acute tips and non-cephalate; gubernaculum 9–11 (10.2±0–8) µm long; tail 70–144 (111±18.5) µm long with a few thin setae (4–11 observed), ending in conspicuous, terminal, spinneret 2–3 µm long.

Diagnosis and relationships. *Geomonhystera chiautzingoensis* **sp. n.** has fine cuticular striation and a few tiny body setae; the outer labial setae are unsegmented, 4.0–7.0 (5.0±0.9) µm long; the amphids are 16–25 µm or 1.6–2.3 times the head width from the anterior end, the vulva-anus distance is 37–50 (42±4.4) µm and 2.0–3.4 times anal body diameter.. Body length of males 0.7–1.0 (0.85±0.1) µm, the spicules 27–50 µm long and the tail 70–144 µm long.

Geomonhystera chiautzingoensis **sp. n.** has extremely fine striations of the cuticle; the outer labial and cephalic setae are <50% of head width. It is close to *G. steineri* in the length of the body, the very few and short body setae, and the shape and size of the spicules. It differs from *G. steineri* in the somewhat smaller head width, 9.0–12.0 (10.4) vs. 11.0–15 µm .in the amphid diameter, 4.0–5.0 (4.3) vs. 1.0–1.5 µm the amphid to head/head width, 1.6–2.3 (2.0) vs. 1.2–1.3, and the tail length/vulva-anus distance, 1.9–2.9 (2.5) vs. 3–4. It differs from *G. villosa* in having a few thin somatic setae vs abundant setae, shorter outer labial and cephalic setae, 4.0–7.0 (4.75) and 3.0–5.0 (3.5) vs.12 and 6 µm, respectively, the length of the outer labial setae as a percentage of head width, 35.4–58.3 (45) vs. 66–75 %, and the amphid diameter, 4.0–5.0 (4.3) vs. 6.

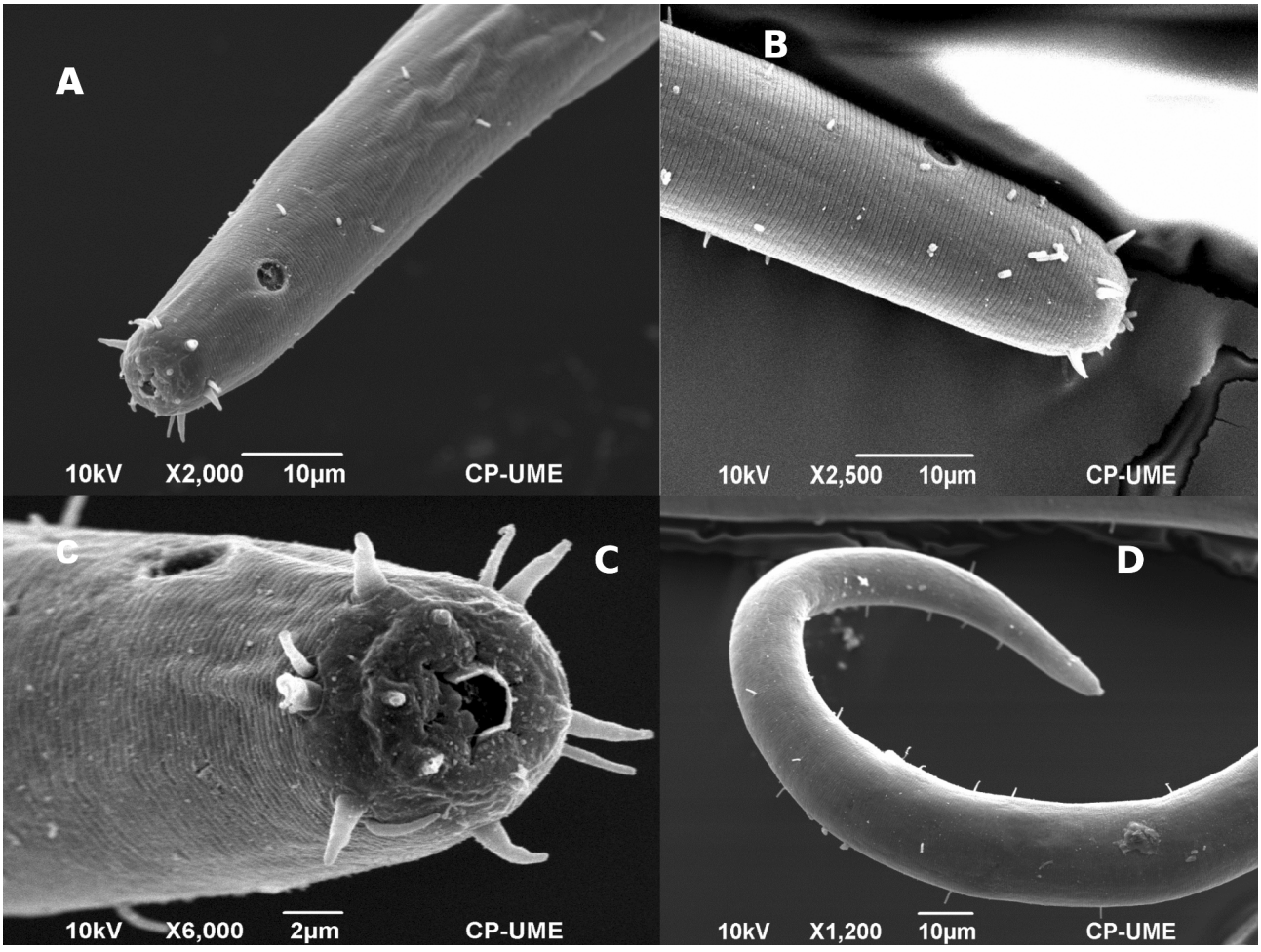

FIGURE 12. *Geomonhystera chiautzingoensis* **sp. n.** scanning electron micrographs; Female (A–D). A: Anterior end, lateral view; B: Amphid and head, lateral view; C: Close up anterior end, antero-latero-ventral view; D: Posterior end body, dorso-lateral view.

TABLE 4. Morphometric data for paratypes of new species of *Geomonhystera*. (Males; range and mean ± standard deviation; all ±measurements in µm, except for L (mm)).

	G. longispiculata **sp. n.** (n=9)	*G. ecuatoriana* **sp. n.** (n=1)	*G. chiautzingoensis* **sp. n.** (n=13)	*G. galindoi* **sp. n.** (n=3)
Body length	0.98–1.2 (1.1±0.1)	0.905	0.7–1.0 (0.85±0.1)	0.8–0.9 (0.9±0.05)
a	39.2–45 (41.6±2.0)	34.8	30–40 (34.9±3.3)	37.7–40.6
b	5.8–6.8 (6.2±0.3)	6.6	4.6–6 (5.4±0.5)	5.5–5.7 (5.6±0.14)
c	7.7–8.9 (8.3±0.4)	8.2	7–10 (7.8±0.9)	6.2–7.6 (6.9±0.7)
c'	4.8–5.5 (5.1±0.2)	4.6	3.2–6 (5.1±0.8)	5.2–6.0 (5.7±0.5)
Head width	12–16 (14.6±1.2)	11	9.0–12 (10.4±0.9)	12.0
Body width	24–28 (25.6±1.2)	26	22–27 (24.6±0.9)	22–23
Outer labial setae	5–8 (6.3±0.9)	5	4–7 (4.8±1.0)	6.0
Cephalic setae	4–5 (4.8±0.4)	4	2–5 (3.5±1.0)	4.0–5.0 (4.3±0.6)
Outer setae % head width	36–58 (43.7±6.7)	45.5	27–64 (42.8±11.1)	50
Amphid to head	22–27 (24±1.5)	18	17–26 (21±3.0)	21–23 (21.7±1.2)
Amphid to head / head width	1.5–1.9 (1.7±0.1)	1.6	1.7–2.4 (2.0 ±0.2)	1.8–1.9 (1.8±0.1)
Pharynx length	152–191 (171±11.1)	137	132–188 (160±17.9)	160–166 (163±3.0)
Pharynx % of body length	14.7–17 (16.1±0.9)	15.1	16.6–22 (18.8±1.6)	17.5–19.3 (18.4±0.9)
Tail length	114–142 (128±10.1)	110	70–144 (111±18.5)	109–145 (129±18.5)
Tail width at anus level	22–27 (25±1.5)	24	20–24 (21.9±1.2)	21–22 (21.3±0.6)
Tail in % of body length	11:3–13 (12.1±0.6)	12.2	9.6–14 (13±1.3)	13–16 (14.5±1.5)
Spicule length	55–85 (75±9.0)	35	27–50 (33.5±6.2)	30–34 (31–7±2.1)
Gubernaculum length	8–11 (9.8±0.8)	8.0	9–11 (10.3±0.8)	9.0–11.0 (10.3±1.2)

Geomonhystera chiautzingoensis **sp. n.** is distinguished from *G. antarcticola* Andrássy, 1998 by having a few thin somatic setae, by the somewhat shorter body length 0.69–1.1 vs. 1.1–1.3 mm, index a, 31.3–37.4 (34) vs. 38–46, the head width, 9.0–12.0 (10.4) vs. 15. The length of the outer labial setae, 4.0–7.0 (4.75) vs. 9.0–10.0 µm, and the pharynx length, 133–185 (159) vs. 220 µm. It differs from *G. ecuatoriana* **sp. n.** in the index b, 4.9–6.0 (5.4) vs. 6.3–6.6 (6.5), the amphid to head distance/head width. 1.6–2.3 (2.0) vs. 1.2–1.5 (1.3), and the pharynx length as % of body length, 16.7–20.4 (18.4) vs. 15.0–15.8 (15.5). It differs from *G. longispiculata* **sp. n.** in the length of the spicules, 27–50 (34) vs. 55–85 (75) µm.

Type locality and habitat. Moss on trunk of *Crataegus mexicana* Moc & Sesse trees, Chiautzingo, Puebla State, México, 19° 47′ N, 98° 47′ W, elevation 2386 m asl.

Type specimens. Holotype female on slide 10396; allotype male on slide 10397 and one paratype female on slide 10398 deposited in CNHE. Paratypes are deposited in UCRNC on slide number 28543, WaNeCo on slide number WT3720, and CPNC on slide number A-101.

Etymology. The name of the species refers to the town where the specimens were collected.

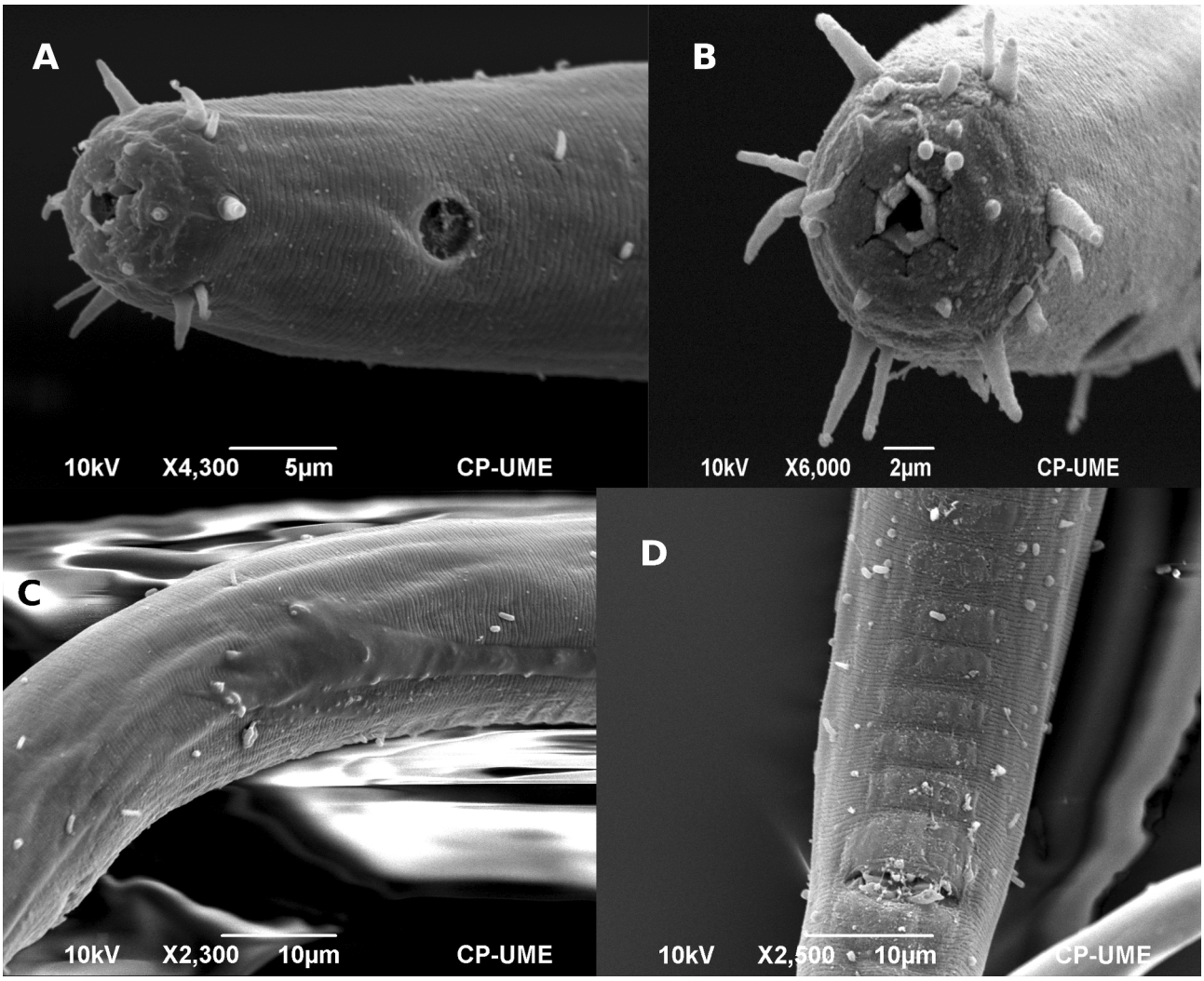

FIGURE 13. *Geomonhystera chiautzingoensis* **sp. n.** scanning electron micrographs; Male (A–D). A: Anterior end body, lateral view; B: Face view, latero-dorsal view; C: Precloacal cuticular folds region, lateral view; D: Precloacal cuticular folds and cloaca, ventral view.

Geomonhystera dubia Siddiqi & Shahina, 2004

Measurements. Appendix A.

Female (n=9). Body of fixed specimens ranging from almost straight to slightly arcuate ventrad; cuticle thin, 1 µm thick, with very fine transverse striae, whole body with few scattered setae; head 9–12 (9.9±0.9) µm wide; lips triangular, not fused at distal end; inner labial papillae very small, conical, 2 µm long; outer labial setae unsegmented, 5–8 (6.3±1.1) µm long or 56–80 (64±9.0) % of head width; cephalic setae thin, 3–5 (4.2±0.8) µm long, 33–50 (43±7.1) % of head width; amphid openings rounded, 3 µm diameter and 9–14 (12±1.5) µm from the anterior edge to head, both amphids at the same level; pharynx muscular, 91–122 (109±10.8) µm long or 15–22 (19±2.2) % of body length, 311–415 (355±41.2) µm from the vulva and 335–434 (395±43.9) µm from the anus; nerve ring at 44–60 (51±6.6) µm from the anterior end; cardia 3–6 (5.0±1.1) µm long and 5–10 (7.6±1.5) µm wide, composed of two small cells. Outer zone of intestinal walls with many granular refractive inclusions; rectum muscular 10–17 (15±2.3) µm long and 0.68–1.2 (0.96±0.24) times anal body diameter; anterior anal lip slightly

protruding. Distance between vulva and anus 15–29 (22±4.9) µm or 1.1–2.2 (1.5±0.5) times anal body diameter. Vulval lips protrude slightly but sometimes flush with body contour; vagina with slightly thickened walls, post-vulval uterine sac absent. Tail tapers evenly, 61–76 (70±4.4) µm long or 11–13 (12.4±0.7) % of body length, without caudal setae; three caudal glands, posterior to the anus and in line, ducted into a common ampulla, 5–7 (6.0±1.2) µm long and then through a conspicuous, terminal, spinneret, 2–3 (2.1±0.4) µm long.

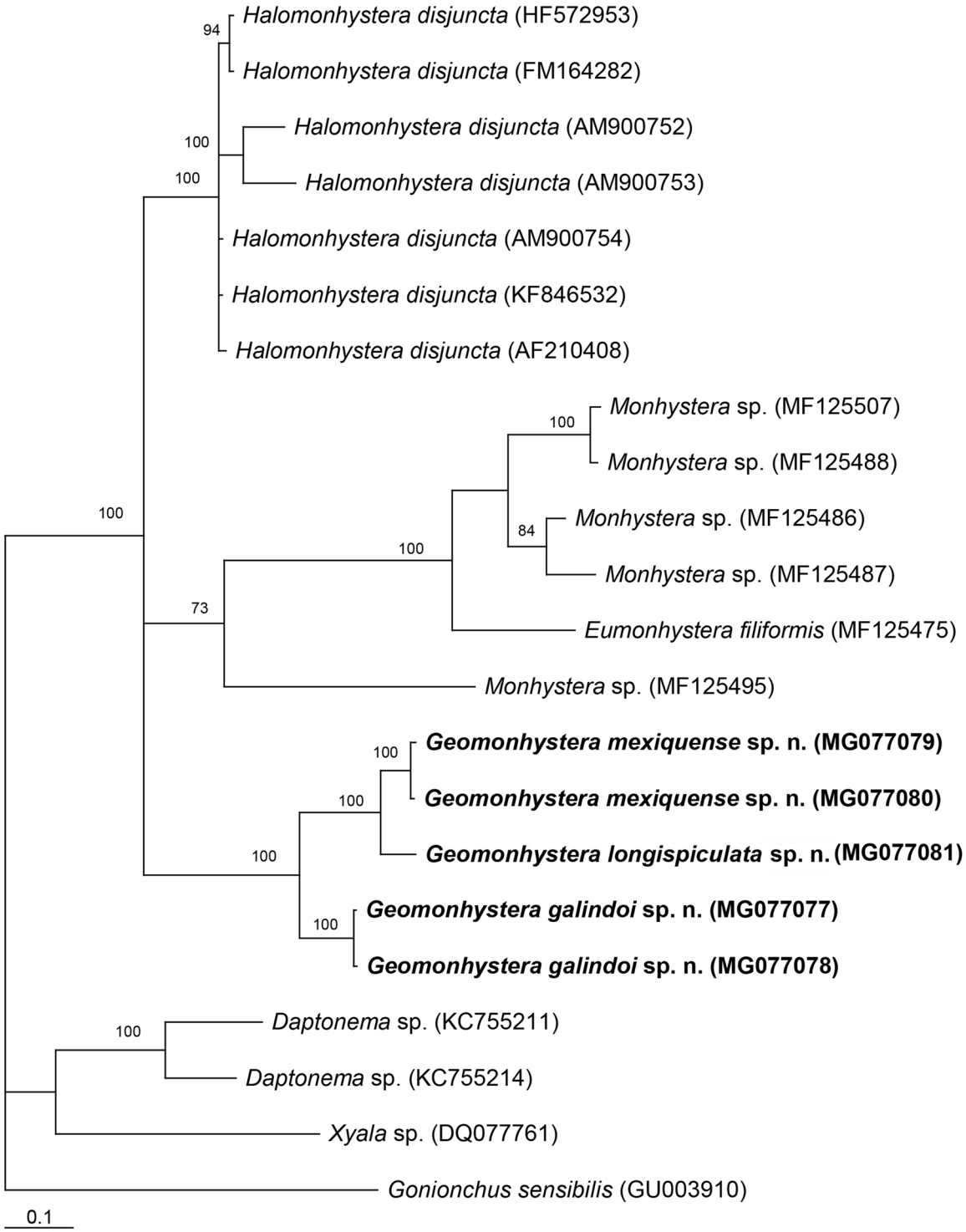

FIGURE 14. Phylogenetic relationships within Monhysteridae as inferred from Bayesian analysis using the D2–D3 of the 28S rRNA gene sequence data set under the GTR+G+I model. Posterior probabilities of over 70% are given for appropriate clades. New sequences are indicated in bold.

Male. Unknown.

Diagnosis and relationships. This population of *Geomonhystera* is characterized by the small body size, sparse, scattered somatic setae, and fine cuticular striation; the outer labial setae are unsegmented; vulval lips protrude slightly but sometimes are flush with the body contour; vulva-anus distance anus 15–29 µm and 1.0–2.2 times anal body diameter; the outer labial setae are 56–80% of head width and the cephalic setae thin, unsegmented and 33–50% of the head width; the anterior border of the amphid to the anterior end is 9–14 µm.

We identify this population as *G. dubia* Siddiqi & Shahina, 2004, by the fine striation of cuticle, the size of the amphid aperture, the shape of the body when relaxed, the position of the vulva, length of the tail, shape of the spinneret and the soil habitat. It differs from the original description in having sparse setae along the body, in the amphid being closer to the anterior end, 9.0–14 vs. 14–21 µm, and a greater range in the vulva-anus distance, 15–29 (22) vs. 22–29 (27) µm. We consider that this Mexican population corresponds to the description of the species *G. dubia* which was described from soil around roots of ornamental plants by Siddiqi & Shahina (2004) and that this represents a new locality for the species.

New locality and habitat. Soil around a plum tree (*Prunus* sp.) at the Colegio de Postgraduados, Campus Montecillo, Texcoco, México State, 19° 27' 47.9" N 98° 54' 15.1" W, elevation 2243 m asl.

Specimens. Four females on slide 10399 deposited in CNHE. One female deposited in each of the nematode collections of UCRNC on slide number 28544, WaNeCo on slide number WT3721, and the CPNC on slide number A-102.

Phylogenetic relationships. Five new sequences of the D2–D3 of 28S rRNA gene of the genus *Geomonhystera* were obtained in this study: two sequences for two samples of *G. mexiquense* **sp. n.**, one sequence for *G. longispiculata* **sp. n.** and two sequences from clones of one sample of *G. galindoi* **sp. n.** Alignment included 18 sequences of Monhysteridae and four outgroup taxa and was 750 bp in length. Phylogenetic relationships within Monhysteridae are given in Fig. 14. Representatives of the genus *Geomonhystera* formed a highly supported clade. Relationships among monhysterid genera were not well resolved.

Discussion

The family Monhysteridae consists of many genera and species. They have been described from terrestrial, freshwater and marine environments. The genus *Geomonhystera* was erected by Andrássy (1981) for terrestrial species that have general characters of the Monhysteridae but, among other features, the vulva is located at around 80% of the body length and very close to the anus, there are well-developed cephalic setae and a long, thick, muscular rectum. In some species, the outer labial and cephalic setae have a joint near the base and are then described as segmented or articulated. Andrássy (1981) transferred *Monhystera villosa* Bütschli, 1873 and four other species of *Monhystera* to *Geomonhystera*. He made *G. villosa* the type species of the genus. More species were added to the genus by Brzeski (1993), Khan & Araki (2001), Gagarin (2002), Saha *et al.* (2002) and Siddiqi & Shahina (2004).

Several marine monhysterid species with the vulva in a very posterior position, previously designated as *Monhystera disjuncta* (Bastian, 1865), *M. ambiguoides* (Bütschli, 1874), *M. antarctica*, Cobb, 1914, *M. chitwoodi* Steiner, 1958 , *M. paradisjuncta* De Coninck, 1943, *M. socialis* Bütschli, 1874 and *M. uniformis* Cobb, 1914, were transferred by Jacobs (1987) to the genus *Geomonhystera*. Andrássy (2005) strongly rejected those assignments on the basis that the genus was established for terrestrial species. He (Andrássy, 2006) established the genus *Halomonhystera* Andrássy, 2006 for the marine and brackish water species with habitat distinctly different from the terrestrial geomonhysterids, with *H. disjuncta* (=*Monhystera disjuncta* Bastian, 1865) as the type species. The marine species were subsequently distributed among other genera (*Cryonema* Tchesunov & Riemann, 1995, *Halomonhystera* Andrássy, 2006, *Hieminema* Tchesunov & Portnova, 2005, *Diplolaimella* Allgén, *1929, Diplolaimelloides Meyl, 1954, Thalassomonhystera* Jacobs, 1987 and *Monhystrella* Cobb, 1918) (Fonseca & Decraemer, 2008; Tchesunov *et al.* 2015). Thus, morphological and ecological unity of the genus *Geomonhystera* was restored, as supported in the revision of Monhysteridae by Fonseca & Decraemer (2008).

In a useful attempt to create a diagnostic structure for the family Monhysteridae, Jacobs (1987), assembled an extensive compilation of the marine species and established two subfamilies based on the shape of the buccal cavity. As summarized by Fonseca & Decraemer (2008), the Monhysterinae included those genera in which the

species have a single V-shaped buccal cavity while the Diplolaimellinae consisted of genera in which the species have two buccal cavities arranged in series. In contrast to the subfamily designations of Jacobs (1987), the lips of most *Geomonhystera* species are described as either fused or not fused and usually there is no indication of either single or double buccal chambers (e.g., *G. breviseta* and *G. mexicana* (Brzeski, 1993), *G. japonica* (Khan & Araki, 2001)). Although buccal teeth have sometimes been described in the stoma wall, e.g., in *G. australis* (Brzeski, 1993), teeth are not reported for most species of *Geomonhystera*. Incidentally, *G. australis* was considered *species inquirenda* by Andrássy (2005) due to the incomplete description provided by Cobb (1893) and he proposed that the name *G. steineri* was a more appropriate designation for the former *G. australis*.

Interestingly, in a study of the positions and outlets of pharyngeal glands of *H. disjuncta* and other species of *Halomonhystera*, Coomans *et al*. (1996) reported five pharyngeal glands with the dorsal gland outlet at the base of a buccal tooth. The outlets of the first pair of ventrosublateral glands were determined to be at mid-pharynx and those of the second pair close to the base of the pharynx. The positions and outlets of pharyngeal glands have not been described for *Geomonhystera s*pecies.

Other than observational reports, we are not aware of detailed studies on the biology, ecology or life history strategies of nematodes of the genus *Geomonhsytera.* Based on stomal and pharyngeal morphologies, including the apparent lack of teeth, they are assumed to be bacterivores. However, we report herein, consistent with Yeates *et al*. (1993), the occasional observation of detrital particles and a fungus spore in the intestines of some specimens, suggesting that non-specific ingestion of detritus may occur during the feeding process (personal observation of first author). In concordance with the aboveground habitats of many *Geomonhystera species*, we have observed their very rapid sinusoidal movement in water films. Further, as expected for habitats subject to drying, including mosses, bark and leaf-litter, they are reported to survive in an anhydrobiotic state in the absence of moisture (Andrássy, 1981). In contrast to the dry habitats of many of the species of this genus, *G. aenariensis* was described from thermal waters of fumaroles ranging in temperature from 28 to 40˚C (Meyl, 1953) and presumably has physiological adaptations to those environments. Meyl (1953) classified *G. aenariensis*, among other species from the fumaroles, as "probable thermophiles". In laboratory experiments he determined that they became coiled and rigid in water heated to above 37˚C. Reproduction in the genus is assumed to be either by parthenogenesis or amphimixis, depending on the presence of males in the species. Of the 22 species that include those described herein, seven are known to have males, including four of the six new species.

In contast to the dearth of biological information for *Geomonhystera* spp., detailed studies of the characteristics of some marine *Halomonhystera* species have been undertaken, including the effects of temperature, sulfide and salinity concentrations on differences in fatty acid compositions of inter-tidal and deep-sea inhabitants (Van Campenhout & Vanreusel, 2016).

We agree with the suggestions of Brzeski (1993) that most standard morphometric indexes (a, b, c, c', V) are quite similar across species of *Geomonhystera* and that additional quantitative ratios (including ratios of vulva-anus distance, amphid locations and lengths of setae in relation to body width measurements) are useful. However, the ranges of these characters among individuals of a species are quite large so consideration of both quantitative and qualitative characters (including shape, location and segmentation of cephalic setae, cuticular striation and the presence or absence of a spermatheca) is necessary. Also, as noted by Brzeski (1993), in characters such as gonad length and gonad length as a percent of body length, there may be continued growth of the organ after the animal reaches adulthood which renders the metric less useful. We have included both the extended quantitative ratios and qualitative characteristics in our descriptions and diagnostics. Striation of the cuticle is usually very fine, sometimes so fine that the cuticle has been described as smooth. However, in our experience, fine striations may be revealed by SEM when the cuticle appears smooth under light microscopy. Consequently, separation of species on the basis of morphological, morphometric and anatomical features is not a trivial undertaking. Our attempts to produce a dichotomous key for the species have been unsuccessful. Rather than binary choices between quantitative character sets, separation of species will be aided by synoptic consideration of suites of characters as envisioned in expert systems approaches (Diederich *et al.* 2000). Molecular sequences will likely become progressively important in characterizing and separating the already-described and new species of Monhysteridae.

We have assembled spreadsheets which include extensive lists of quantitative and some qualitative characteristics of the current species of *Geomonhystera* (Appendix A—Females, Appendix B—Males). In some cases, mainly for those species described after the Brzeski (1993) paper, the non-standard morphometric characteristics were reported by the original authors, in other cases, and in earlier descriptions, they were not and

we have tried to estimate them from the drawings accompanying the species descriptions. For narrowing down the possible identity of an unknown specimen, we have found it useful to prepare a spreadsheet with separate columns for the minimum and maximum value of the range of each quantitative character. A problem arises when the ranges of characters are not provided in the description of a species. In that case, rather than omit the character, we arbitrarily create a range that is plus or minus 10% of the reported value. In a third column for each character we indicate by Yes or No whether the unknown fits into that range. By sorting the spreadsheet based on the number of Yes annotations, those species that are candidates for the identity of the unknown may be selected. Fine-tuning of the identification then requires consideration of the qualitative characteristics. Clearly molecular libraries that include all the described species will be an enormous benefit in the identification of species of *Geomonhystera*.

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APPENDIX A. Characteristics of females of *Geomonhystera* species (all measurements in micrometers except for Body lengths, which are in millimeters).

***Geomonhystera* females**	***aenariensis***	***altaica***	***antarcticola***	***auvillis***	***breviseta***	***chiautzingoensis* sp. n.**	***dubia***	***ecuatoriana* sp. n.**
Body length (millimeters)	0.6-0.76	0.65-0.84	1.1-1.3	0.58-0.73	0.68-1.0(0.88)	0.69-1.1(0.87)	0.49-0.55(0.52)	0.75-0.96(0.85)
a	23-39.4	29-40	38-46	27-34	29-37(33)	31.3-37.4(34)	27-33(29)	34-40(35)
b	4.1-5.6	4.3-5.1	4.3-5.1	5.8-6.7	4.2-5.1(4.8)	4.9-6.0(5.4)	4.2-4.9(4.5)	6.3-6.6(6.5)
c	6.6-8.7	6.0-7.2	7.2-11.4	8.1-8.8	6.8-8.2(7.5)	7.5-10.0(8.4)	6.7-8.5(7.6)	7.2-8.6(7.9)
ć		6.0-7.3			4.8-6.4(5.7)	4.4-8.0(6.0)	7.6	5.7-5.9(5.8)
Head width		13-14	15	12	11.0-22(18.6)	9.0-12.0(10.4)	10.0-12.0	11-12(11.5)
Body width						21-28(25.5)	16-20	22-26(24)
Inner labial papillae		1.5				1		2
Outer labial setae length	9.5	8.5-10	9.0-10.0	5	4.0-9.0(6)	4.0-7.0(4.75)	5.0-6.5(5.8)	5
Cephalic setae length		6.0-8.8			3.0-5.0(4)	3.0-5.0(3.5)	3.5-4.5	4
Setae segmentation						no		no
Inner papillae % head width						8.3-10.0(9.6)		0
Outer setae % head width		65-70			25-45(34)	36.4-58.3(45)	50-60	42-46(44)
Cephalic setae % head width						27.3-41.7(33)		33-36(35)
Somatic setae % body diameter						15.4-25(19)		19-23(21)
Amphid edge to head		15-21	14-16		15-28(23)	16-25(20.8)	14-21	13-18(15.5)
Amphid diameter		4.5-5.0	5		4.0-5.0(4.3)	4.0-5.0(4.3)	3	4
Amphid to head/head width		1.2-1.5	1		0.6-1.8(1.2)	1.6-2.3(2.0)	1.3-1.6(1.4)	1.2-1.5(1.3)
Pharynx length		150-179	220	100-112	139-208(185)	133-185(159)	102-120(115)	113-152(133)
Pharynx % body length						16.7-20.4(18.4)		15-15.8(15.5)
Pharynx to anus distance						471-726(596)		509-679(594)
pharynx to vulva distance						434-679(558)		471-631(551)
Cardia length						6.0-11.0(8.9)		5.0-10(7.5)
Cardia width			9			6.0-14(9.8)		7-10(8.5)
Tail length		108-129			97-144(117)	79-131(106)	57-77(69)	103-112(107)
Anal body diameter						11.0-21(17.9)		18-19(18.5)
Tail % body length						10.0-13.4(12)	11.6-14.0	11.7-13.8(12.8)
Tail/vulva-anus		3.1-4.0	3		2.8-3.8(3.2)	1.9-2.9(2.5)	2.3-2.9(2.6)	2.3-2.8(2.6)

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APPENDIX A. (Continued)

***Geomonhystera* females**	***aenariensis***	***altaica***	***antarcticola***	***auvillis***	***breviseta***	***chiautzingoensis* sp. n.**	***dubia***	***ecuatoriana* sp. n.**
Rectum length		25-31	63	16	27-42(34)	25-44(31)	20-24	26-30(28)
Rectum/anal body diameter		1.5-1.7	3	2	1.4-1.9	0.6-2.2(1.4)	1.3-1.8	1.4-1.6(1.5)
V%	80.3-84	79-82	80.6-8	80.6-86.2	81-84	80.2-85.6(83)	80-83.5(81)	79.7-81(80.6)
Vulva to anus		28-38			29-43(37)	37-50(42.4)	22-29(27)	37-48(42.5)
Vulva-anus/anal body diameter	1.4	2.2		1.9	1.5-2.2(1.8)	2.0-3.4(2.5)	2.2	2.1-2.5(2.2)
Gonad length						339-509(424)		330
Gonad % body length						37.4-48.7(43)		34.3
Cuticle thickness		1				1		1.0-2.0
Nerve ring to head						66-87(80)		55-73(64)
Spinneret length		2.0-3.0			2.0-3.0	2		2.0-3.0(2.5)
Spinneret ampullae						8.0-10(8.7)		6.0-10(8.0)
Cervical setae anterior body						a few		a few
Cervical setae posterior body						a few		a few
Somatic setae	none	yes	present	absent	not numerous	few	along body	absent
Postuterine sac	present	absent	absent	absent	absent	absent	absent	absent
Striation	smooth	smooth	annulated	smooth	smooth	fine	fine	fine
Head		convex				rounded	rounded	rounded
Habitat	thermal water			cowdung	moss	moss	soil	moss
Males present/unknown	unknown	unknown	present	unknown	unknown	present	unknown	present

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APPENDIX A. (Continued)

***Geomonhystera* females**	***galindoi* sp. n.**	***glandulata***	***japonica***	***karuni***	***longicaudata***	***longispiculata* sp. n.**	***media***
Body length (mm)	0.75-1.08(0.95)	630-938(774)	0.60-0.81	0.9-1.2	0.55-0.74	0.7-1.1(0.98)	0.5-0.63(0.59)
a	29-39(35)	32-47(38)	36-44	39-48	35-37	29-40(37)	28-34(32)
b	4.8-6.0(5.3)	5.1-6.4(5.1)	4.4-5.2	5.5-6.8	4.2-4.8	4.5-6.2(5.7)	4.1-4.7(4.4)
c	4.5-7.5(6.5)	6.9-8.1(7.7)	5.1-7.7	6.9-8.4	5.6-6.0	7.4-10.8(8.8)	6.5-7.6(7.1)
ć	4.3-9.2(6.7)	4.9-6.5(5.9)	6.2-8.4	6.5-9.0	7.0-8.0	4.8-7.2(5.8)	5.1-7.0(5.8)
Head width	12.0-19(15.5)	11.0-15(12)	9.0-11.0	13-19(15)	12.0-14.0	11-15(14)	11.0-12.5(11.4)
Body width	23-31(25)	15-23(20)	13-16	20-26		24-30(27)	
Inner labial papillae	2.0-3.0(2.1)			1.0-2.0	1.5	2	
Outer labial setae length	7.0-10.0(9.4)	8.0-10.0(6.9)	robust	8.0-11.0(9.0)	9.0-13	5.0-7.0(5.9)	8.0-10.0(8.9)
Cephalic setae length	5.0-7.0(5.8)		`	6.0-7.0	6.0-10.0	3.0-5.0(4.4)	6.0-8.0
Setae segmentation	no					no	
Inner papillae % head width	10.5-17.6(13.5)					13-18(14)	
Outer setae % head width	47-67(61)		60-82		65-90	33-55(42)	68-90(78)
Cephalic setae % head width	28-47(37)					21-39(32)	
Somatic setae % body diameter	32-40(35)		1.5-2.0			17-26(22)	
Amphid edge to head	15-25(21)	15-20(17)	16-20	15-21	15.5-20	17-26(23)	12.5-17.0(14.8)
Amphid diameter	3.0-5.0(4.7)	2.0-4.0(3.6)		3.0-4.0	4.5-5.0	5	3.0-4.0
Amphid to head/head width	1.2-5.0(3.2)		1.5-2.0	1.0-1.3(1.2)		1.6-1.9(1.7)	1.0-1.5
Pharynx length	156-198(180)	124-160(136)	128-169	144-180(164)		160-182(172)	126-150
Pharynx % body length	17-21(19)					16-22(17.6)	
Pharynx to anus distance	476-735(632)					452-792(694)	
pharynx to vulva distance	438-688(588)					415-735(645)	
Cardia length	5.0-17(11.5)	4.0-8.0				5.0-13(9.0)	
Cardia width	6.0-15(9.4)		2.6-3.8			8.0-14(10)	
Tail length	126-184(149)	88-134(105)	88-119	109-155(133)	98-123(110)	94-136(113)	77-98(84)
Anal body diameter	18-25(21.8)	13-20	13-16			18-21(19.6)	
Tail % body length	13-21(16)					9.2-13.5(11.5)	
Tail/vulva-anus	3.1-4.4(3.7)		2.6-3.8		3.5-4.0	2-4(2.6)	2.8-3.5

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APPENDIX A. (Continued)

***Geomonhystera* females**	***galindoi* sp. n.**	***glandulata***	***japonica***	***karuni***	***longicaudata***	***longispiculata* sp. n.**	***media***
Rectum length	25-45(33)		27-32		19-22	29-35(33)	19-21(20)
Rectum/anal body diameter	1.0-2.2(1.6)	1.3-2.0		1.2-1.5	1.4-1.5	0.6-1.8(1.3)	1.3-1.5(1.4)
V%	77-86(80)	80-84(82)	78-85	80-85(83)	77-79	79-86(82.6)	80-82(81)
Vulva to anus	35-50(41)	29-39	31	31-46(40)	28-31	34-51(44.1)	25-28(27)
Vulva-anus/anal body diameter	1.5-2.2(1.9)	2	1.8	1.8	2.7	1.8-2.4(2.2)	1.9
Gonad length	132-322(228)		160-202			424-726(575)	
Gonad % body length	13-34.5(23)					42-68(55)	
Cuticle thickness	1			1		1	
Nerve ring to head	40-104(81)	49-89(58)	72-90			60-89(76)	
Spinneret length	2.0-5.0(3.1)	2.0-3.0			2.0-3.0	2.0-3.0(2.1)	
Spinneret ampullae	5.0-10(8.1)					9.0-11(10.4)	
Cervical setae anterior body	a few					a few	
Cervical setae posterior body	a few					a few	
Somatic setae	fine	very fine	smooth	smooth	smooth	evident	smooth
Postuterine sac	few	sparse	a few	a few disperse	along body	few	scattered
Striation	moss	soil		soil	soil	epiphyte	soil
Head	absent	absent	absent	absent	absent	absent	absent
Habitat	rounded	rounded		rounded		slight convex	rounded
Males present/unknown	present	unknown	unknown	unknown	unknown	present	unknown

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APPENDIX A. (Continued)

***Geomonhystera* females**	***mexicana***	***mexiquense* sp.n.**	***michoacana* sp. n.**	***pervaga***	***steineri***	***tripyloides***	***villosa***
Body length (millimeters)	0.49-0.60(0-55)	0.64-1.1(0.9)	0.63-0.9(0.76)	0.65-0.8(0.72)	0.7-1.1	0.9-1.0	0.7-1.0
a	26-31(29)	22-39(32)	25-29(27)	25-45(32)	30-40	32-38	30-40
b	4.4-5.1(4.7)	4.1-7.1(5.5)	4.7-5.9(5.2)	4.5-5.5(4.9)	4.5-6.0	5.4-5.6	4.8-5.6
c	6.6-7.7(7.0)	5.1-9.0(7.1)	5.7-6.8(6.4)	6.4-7.4(7.1)	6.0-9.0	8.2-8.5	6.0-8.0
ć	5.6-6.5(6.0)	5.3-6.4(6.0)	5.8-7.1(6.4)	6.4-7.4(7.1)	6.0-8.0		7.0-9.0
Head width	10-11.5(11)	14-16(15.2)	13-14.0(13.8)	11.4-21.4	11.0-15		11.0-12.0
Body width		25-30(26.9)	22-27(25)				
Inner labial papillae		2	2				
Outer labial setae length	5.0-6.0(5.6)	7.0-10.0(8.9)	7.0-8.0(7.5)	6-11			12
Cephalic setae length	3.5-5(4.1)	5.0-8.0(6.1)	5-0-6.0(5.3)				6
Setae segmentation	yes	no	no				
Inner papillae % head width		12.5-14.3(13.2)	36-57				
Outer setae % head width	25-45(51)	43.8-67(59)	50-57(54)		50-66		66-75
Cephalic setae % head width		31-50(41)	36-43(38)				
Somatic setae % body diameter		24.3-38.5(33)	25.9-32(30)				
Amphid edge to head	13-16(15)	15-22(19)	15-21(17)	13.8-22.9		22-30	21-28
Amphid diameter	3.0-4.0(3.2)	3.0-4.0(3.9)	4	3.6-4.8	1.0-1.5	5-6	6
Amphid to head/head width	1.2-1.8(1.4)	1.1-1.4(1.3)	1.1-1.6(1.3)	1.0 or less	1.2-1.3		30-43
Pharynx length	110-123(118)	147-174(160)	123-178(147)				
Pharynx % body length		14-24(18.5)	18-21(19.6)				
Pharynx to anus distance		353-726(568)	396-673(490)				
pharynx to vulva distance		325-697(540)	368-537(431)				
Cardia length		6.0-12(9.6)	6.0-10(7.5)				
Cardia width		8.0-15(9.4)	7.0-12(9.0)				
Tail length	71-87(79)	112-135(123)	110-135(118)	101	100-140		
Anal body diameter		19-23(20.9)	17-20(18.5)				
Tail % body length		11.1-19.5(14.3)	14.8-17.4(15.7)				
Tail/vulva-anus	2.5-3.9(3.1)	3.2-3.8(3.5)	3.6-4.6(4.1)		3-4.0		
Rectum length	19-23(21)	27-36(31.7)	23-32(26.7)	13.3-29.2			

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APPENDIX A. (Continued)

***Geomonhystera* females**	***mexicana***	***mexiquense* sp.n.**	***michoacana* sp. n.**	***pervaga***	***steineri***	***tripyloides***	***villosa***
Rectum/anal body diameter	1.2-1.8(1.5)	0.9-1.8(1.5)	1.3-1.7(1.5)		1.0-1.5		2.0-2.5
V%	80-82	73.5-83.8(80.2)	78-79.5(78.6)	79-84(82)	79-84(82)	84-85	76-82
Vulva to anus	20-31(26)	31-42(36.1)	24-37(29.5)	27-39	28-40		
Vulva-anus/anal body diameter	1.5-2.4(2.0)	1.5-2.0(2.7)	1.4-1.9(1.6)	1.9		1.3	2.0-2.5
Gonad length		198-358(249)					
Gonad%body length		24-32.5(27.5)					
Cuticle thickness		1	1	0.6-1.2			
Nerve ring to head		69-98(77)	63-80(69)				
Spinneret length		2.0-3.0(2.9)	2				
Spinneret ampullae		5.0-11.0(7.3)	5.0-10.0(7.0)				
Cervical setae anterior body		a few	a few				
Cervical setae posterior body		a few	rare				
Somatic setae	yes	few	few	moderate long	very short	a few disperse	long
Postuterine sac	absent	absent	absent	absent	absent	absent	present
Striation	smooth	fine	fine	fine	smooth		smooth
Head		convex	convex				
Habitat		moss	moss	soil	terrestrial		
Males present/unknown	unknown	unknown	unknown	unknown	present	unknown	present

APPENDIX B. Characteristics of males of *Geomonhystera* species (all measurements in micrometers except for Body lengths, which are in millimeters).

***Geomonhystera* Males**	***antarcticola***	***chiautzingoensis* sp. n.**	***ecuatoriana* sp. n.**	***galindoi* sp. n.**	***longispiculata* sp. n.**	***steineri***	***villosa***
Body length (millimeters)	1.04-1.41	0.7-1.0(0.85	0.905	0.83-0.93(0.89)	0.98-1.2(1.1)	0.9-1.2	0.7-0.9
a	43-71	30-40(30.9)	34.8	37.7-40.6(39)	39-45(42)	45-68	45-50
b	4.5-5.7	4.6-6(5.4)	6.6	5.2-5.7(5.5)	5.8-6.8(6.2)	4.5-5.8	4.6-5.4
c	7.4-9.8	7-10(7.8)	8.2	6.2-7.6(6.9)	7.7-8.9(8.3)	7.5-9.0	7.0-8.0
c'	6.7	3.2-6(5.1)	4.6	5.2-6.0(5.7)	4.8-5.5(5.1)	5.5-6.5	6.0-7.0
Head width	13.1	9.0-12(10.4)	11	12	12.0-16(14.6)		11.0-12.0
Body width	20	22-27(24.6)	26	22-23(22.7)	24-28		
Inner labial papillae	1.5		1	2	2		
Outer labial setae length	14.6	4-7(4.8)	5	6	5.0-8.0(6.3)		
Cephalic setae length	9.2	2-5(3.5)	4	4.0-5.0(4.3)	4.0-5.0(4.7)		
Inner papillae % head width	10		9.1	16.7	12.5-16.7		
Outer setae % head width	97.3	27-64(42.8)	45.5	50	35.7-58.3		
Cephalic setae % head width	61.3		36.4	33.3-41.7(36.1)	26.7-41.7		
Somatic setae % body diameter			19.2	26	20.8-30.8		
Amphid edge to head	18	17-26(21)	18	21-23(21.7)	22-27(24)		
Amphid diameter	10	4-5(4.25)	4	4	5		7
Amphid to head/head width	1.2	1.7-2.4(2.0)	1.6	1.8-1.9(1.81)	1.5-1.9(1.7)		1.5-2.0
Pharynx length		137-188(160)	137	160-166(163)	152-191(171)		
Pharynx % body length		16.6-22(18.8)	15.1	17.5-19.3(18.4)	14.7-17.316)		
Pharynx to anus distance			646	556-650(603)	679-877(753)		
Cardia length	7.7		5	6.0-10.0(8.7)	5.0-13		
Cardia width	6.9		10	7.0-11.0(9.0)	7.0-11.0		
Tail length	158	70-144(1110	110	109-145(129)	114-142		
Cloacal body diameter	18.5	20-24(21.9)	24	21-22(21.3)	22-27		
Tail % body length	14	9.6-14(13)	12.2	13.1-16(14.5)	11.3-12.9		
Rectum length	53		42	36-52(44.3)	37-59(48)		
Rectum/cloacal body diameter	2.9		1.8	1.7-2.5(2.1)	1.4-2.3(1.9)		
Spicule length	33-37	27-50(33.5)	35	30-34(31.7)	55-85(75)	33-35	30-33
Gubernaculum length	10	9-11(10.3)	8	9.0-11.0(10.3)	8.0-11	10-11	10.0-13
Gonad length				424-603(515)			
Gonad % body length				46.8-64.6(60)			
Precloacal cuticular folds	50-100		38	30-37(32.7)	39-57		11-13
Nerve ring to head			86	80-85(82)	70-87(80)		
Spinneret length	1.1		3	2.0-3.0(2.3)	3		
Spinneret ampullae	?		69	4.0-6.0(5.0)	10.0-12.0(11.2)		
Cervical setae anterior body	?		2	rare	3		
Cervical setae posterior body	abundant		a few	rare	10-12		
Somatic setae	very thin		a few	rare	several		several
Striation	very fine		very fine	very fine	fine		smooth
Habitat	moss		moss	moss	epiphyte		moss