

TWO NEW BOLIVIAN SPECIES OF *AULONEMIA*
(POACEAE: BAMBUSOIDEAE: BAMBUSEAE)

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ABSTRACT

Two new Bolivian bamboo species, *Aulonemia bromoides* and *A. scripta* (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae), are described and illustrated. Both species are known from just one collection each in montane forests (elevations between 1800–2000 m) in Parque Nacional Madidi in the Department of La Paz. For both species, the abaxial leaf blade surface was examined using a scanning electron microscope (SEM). *Aulonemia bromoides* is characterized by its large, efinbrate leaf blades with elongate 20–25 mm long foliaceous inner ligules, and robust spikelets with prominently nerved florets. *Aulonemia scripta* is distinguishable from its congeners by the following combination of characters: the culms are both viscid and hollow; the leaves are also viscid; and the spikelets are awned. The only other members of the Bambusoideae known to have viscid foliage are two congeners from Costa Rica, *Aulonemia patriae* and *A. viscosa*; they have pulpy, succulent, easily crushable solid culms and awnless spikelets. Since only a single collection of each species is known to exist, we recommend to the International Union for the Conservation of Nature (IUCN) that they both be assessed as Critically Endangered.

RESUMEN

Dos especies nuevas de bambúes bolivianos, *Aulonemia bromoides* y *A. scripta* (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae), son descritas e ilustradas. Ambas especies son conocidas solamente a partir de un espécimen colectado en los bosques montanos (a elevaciones entre 1800–2000 m) en el Parque Nacional Madidi, Departamento de La Paz. En ambas especies, se examinó la lámina abaxial con microscopio electrónico de barrido. *Aulonemia bromoides* se caracteriza por sus hojas grandes sin fimbrias, con ligulas internas foliáceas y elongadas (20–25 mm), y por sus espiguillas robustas con nervios prominentes. *Aulonemia scripta* se diferencia de sus congéneres por la combinación de los siguientes caracteres: Culmos viscosos y huecos, hojas también viscosas, y espiguillas aristadas. Las únicas especies del Bambusoideae que poseen follaje viscoso son dos congéneres costarricenses, *Aulonemia patriae* y *A. viscosa*; estos tienen culmos sólidos, pulposos, succulentos y débiles, y espiguillas sin aristas. Debido a que existe únicamente una colección de cada especie, recomendamos a la International Union for the Conservation of Nature (IUCN) que éstas sean denominados "Críticamente Amenazadas."

INTRODUCTION

Aulonemia Goudot (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae) is a genus of about 34 species of woody bamboos (McClure 1973; Calderón and Soderstrom 1980; Clayton and Renvoize 1986; Judziewicz et al. 1999; Judziewicz et al. 2000). Of the 34 species that we currently recognize within the genus, 20 have been described since 1990 (Clark 2004; Clark et al. 2007; Clark and Londoño 1990; Clark et al. 1997; Judziewicz 2005; Judziewicz et al. 1991; Judziewicz and Riina 2005; Judziewicz and Tyrrell 2007; Renvoize 1998). The Andean countries of Venezuela, Colombia, Peru, and Bolivia appear to have many new species of *Aulonemia* awaiting description (Judziewicz, pers. obs.).

Recent collections from the Parque Nacional Madidi (<http://www.mobot.org/MOBOT/Research/madidi/>) on the northern slope of the Andes in the Department of La Paz, in western Bolivia have revealed a number of distinctive new species of *Aulonemia*, two of which are described below. Specimens were examined from

several herbaria (F, ISC, K, MO, P, US, UWSP and WIS), but only MO had representatives of the new taxa. Plant parts were measured using a mm ruler, and the abaxial leaf blade epidermis of both species was examined using dried material in a Hitachi S3400 scanning electron microscope. Neither taxon is included in the most recent treatment of Bolivian grasses (Renvoize 1998: 38–41). The following key differentiates the (six) described species now known to occur in Bolivia:

1. Culms with alternating long and very short internodes; culm leaves well-developed, with fimbriate auricles at least 10 mm long _____ **A. herzogiana** (Henrard) McClure
1. Culms with internodes all the same length; culm leaves absent or poorly-developed, if present then lacking fimbriate auricles
 2. Plants with culms and leaves viscid (sticky) _____ **A. scripta** Judz., Shea & Wayda
 2. Plants not at all viscid (sticky).
 3. Foliage leaves with prominent papery, foliose inner ligules 20–25 mm long; leaf blades 5.3–6.7 cm wide; lemmas with prominent green veins _____ **A. bromoides** Judz., Wayda & Shea
 3. Foliage leaves with membranous small inner ligules less than 4 mm long; leaf blades cm wide; lemmas not with prominent green veins.
 4. Foliage leaves with prominent sheath auricles ca. 3 mm long _____ **A. boliviana** Renvoize
 4. Foliage leaves lacking sheath auricles.
 5. Branches of inflorescence glabrous or scabrous, not pubescent; leaf blades 2.0–3.8 cm wide _____ **A. longipedicellata** Renvoize
 5. Branches of inflorescence covered with spreading hairs 2–4 mm long; leaf blades 1–2 cm wide _____ **A. tremula** Renvoize

Aulonemia bromoides Judz. & Shea, sp. nov. (**Figs. 1, 2, 3D–F**). TYPE: BOLIVIA. LA PAZ: Prov. Franz Tamayo: Senda Apolo-San José de Uchupiamonas, a media hora de 3 de Mayo, hacia Turnia, 14°33.654'S [=39.2"], 68°20.076'W [=04.6"], 1824 m [1740 m on Google Earth], hierba graminoide 2 m, tallo hueco, espigas verde plomizo, 22 Apr 2003, Leslie Cayola Pérez, Tatiana Miranda & Freddy Canqui 289 (HOLOTYPE: LPB!; ISOTYPES: MO 4793775! 4793776!).

Culmi usque ad 12 mm diam., 2 m alti. Vagina foliorum quasi glabra, nonauriculata, efimbriata; ligula 20–25 mm, chartacea; lamina foliorum 18–25 cm longa, 5.3–6.7 cm reflexa. Inflorescentia paniculata, 25–35 cm longa. Spiculae 27–37 mm longae, glabra, straminea, cum nervatas virides prominentes, 4–5 flosculos fertiles continentes; glumae 2, lanceolatae, acutae; gluma I 4.0–5.2 mm longa, gluma II 5–6 mm longa; lemmata fertilia 12.5–14.5 mm longa, lanceolata, acuta.

Apparently cespitose from sympodial rhizomes; culms to 2 m tall, up to 1.2 cm in diameter, hollow, the lumen occupying 40–70% of the diameter of the culm; culms apparently dimorphic, some with well-developed foliage leaves and terminal inflorescences, others with poorly-developed culm leaves, no foliage leaves, and terminating in inflorescences, the culms thus apparently dimorphic. Culm leaves with sheaths 3–18 cm long, 0.8–1.2 cm wide (folded width), glabrous, with a minute inner ligule and no outer ligule or auricles, efimbriate, bladeless or with tiny erect blades ca. 2.5 mm long and 1.5 mm wide. Culms with lower internodes glabrous, slightly purplish and verrucose, the upper internodes slightly striate, glabrous or with scattered glassy appressed hairs 0.7–1.5 mm long. Branching pattern not seen. Foliage leaves in complements of at least 3, efimbriate; sheaths slightly striate, glabrous or with scattered glassy appressed hairs 0.7–1.5 mm long, stramineous with tiny gray or purple maculae, lacking an auricle at the summit; outer ligules abaxially 1 mm long, laterally 1.5–2 mm long; inner ligules 20–25 mm long, foliaceous, linear-lanceolate, pale stramineous (at least when mature); pseudopetioles 4–6 mm long; blades 18–25 cm long, 5.3–6.7 cm wide, lanceolate-ovate, obtuse to slightly cuneate at the base, acuminate at the apex, reflexed, glabrous, the margins cartilaginous and somewhat antrorsely hispid. Inflorescence an ovoid panicle 25–35 cm tall and 17–22 cm wide with the base included in the uppermost leaf sheath; rachis and primary branches smooth, glabrous, and slightly maculate, the primary branches ascending at a 45° angle, the secondary branches and pedicels capillary and antrorsely scabrous, the pedicels up to 6 cm long. Spikelets 40–43 mm long, 3.0–4.1 mm wide, robust, stramineous with prominent grayish-green nerves, glabrous, the bracts all acute and awnless with pubescent margins; lower glume 2.7–4.4 mm long, 0.8–1.3 mm wide (folded), lanceolate to lance-ovate, 3–5-nerved, some of the lateral nerves not extending to the apex; upper glume 4.8–6.7 mm long, 1.0–1.6 mm wide (folded), lanceolate, 5–7-nerved, some of the lateral nerves not extending to the apex; lowermost floret sterile, lacking a palea, 6.1–10.1 mm long, 1.1–2.0 mm wide (folded), lanceolate, 7–9-nerved; second

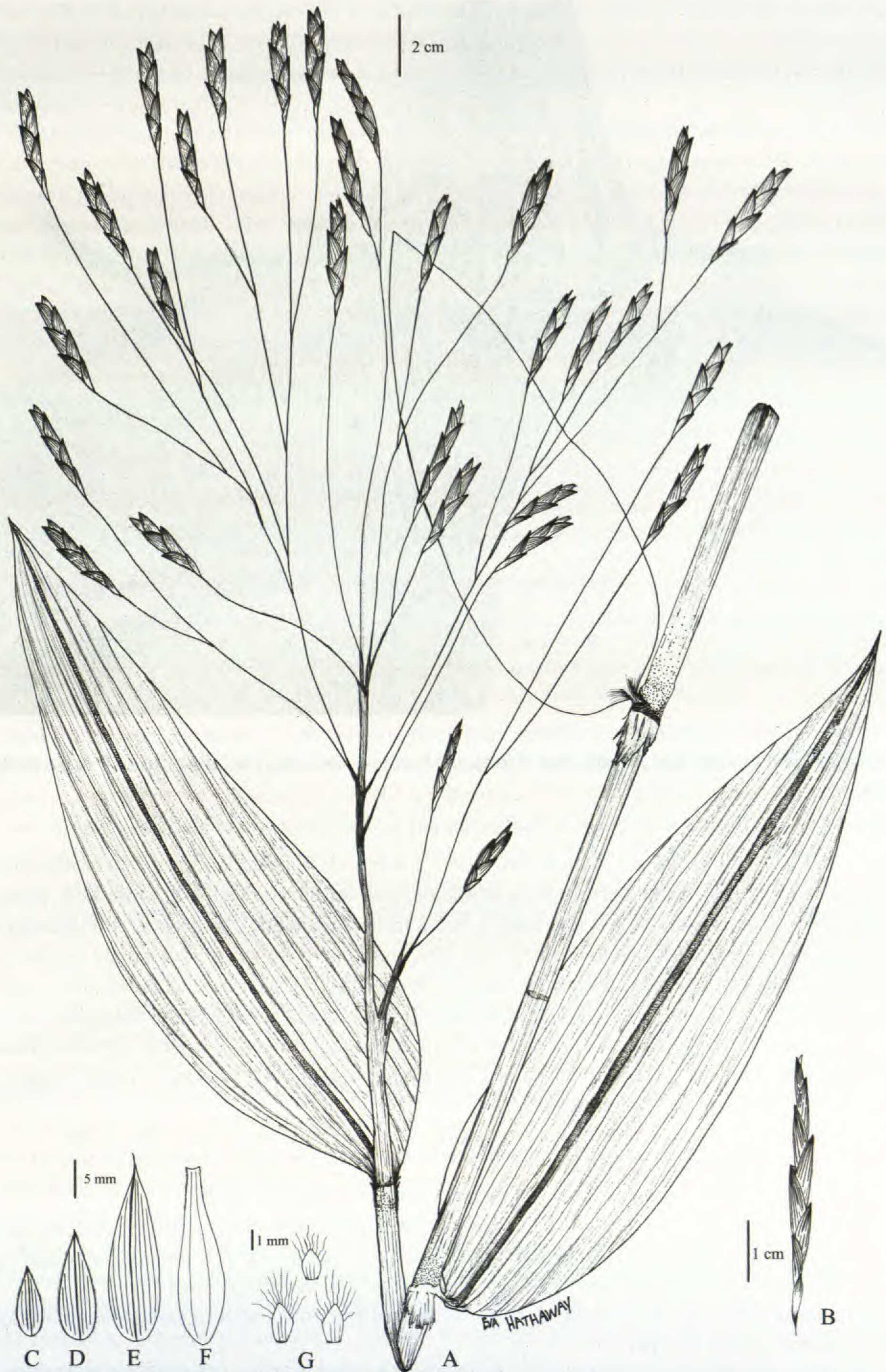


FIG. 1. *Aulonemia bromoides* (Cayola et al. 289, MO). A. General habit of flowering culm. B. Spikelet, lateral view. C. Lower glume. D. Upper glume. E. Lemma. F. Palea. G. Lodicules. Illustration by Eva Hathaway.

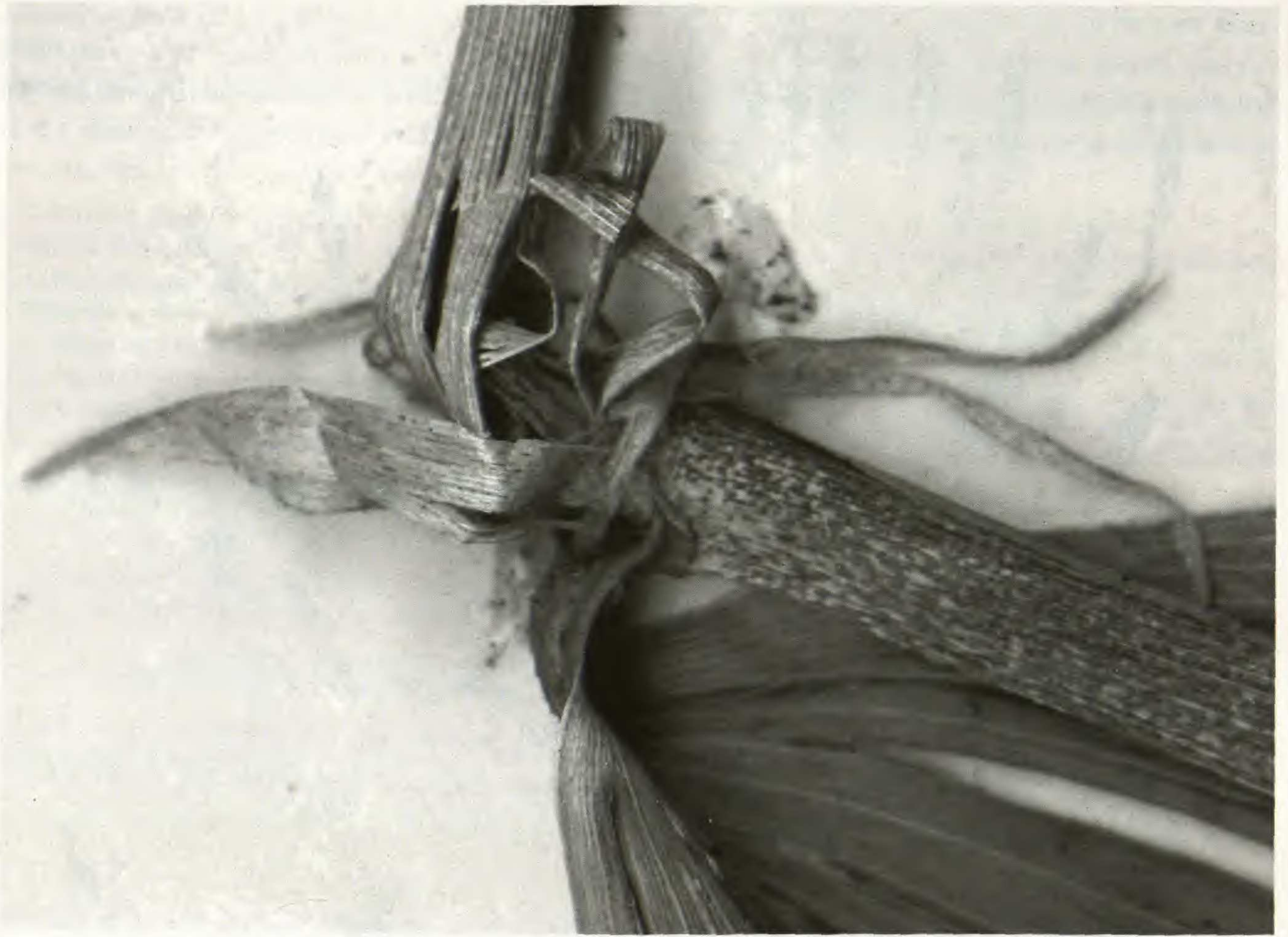


FIG. 2. *Aulonemia bromoides* (Cayola et al. 289, MO). Detail of foliage leaf showing elongate papery inner ligule (here split longitudinally during pressing).

floret also sterile, lacking a palea, 9–11 mm long, 1.9–2.5 mm wide (folded), lanceolate, 9–11-nerved; rachis internodes between uppermost sterile lemma and lowermost fertile lemma 1.9–2.2 mm long, pubescent; fertile florets 4–5; lemmas 11.7–14.9 mm long, 2.5–2.8 mm wide (folded), lanceolate, 9–11-nerved, some of the lateral nerves not extending to the apex, the apex and uppermost margins minutely ciliolate; paleas 8.4–12.5 mm long (as long as the lemmas and not protruding), 1.5–2.9 mm wide, elliptical, greenish-stramineous, bicarinate, the keels ciliolate; lodicules 3, prominent, 1.5 mm long, lanceolate-rhomboid, acute, transparent, with 2–3 fine short nerves near base, the margins densely fringed with erect clear cilia 1.2–1.7 mm long; stamens 3, the anthers 3.6–6.2 mm long, 0.4–0.8 mm wide, linear, rusty orange-brown; pistil with 2 hispid stigmas. Fruit not seen.

Leaf anatomy of abaxial leaf blade epidermis (Fig. 3D–F; terminology follows Ellis 1979).

Costal zones.—Spaced 200 μm apart.

Papillae.—In general common, globose to slightly oblique; simple; variable.

Stomates.—Common; shape triangular to dome-shaped, partly obscured by overarching papillae; each stomate overarched by 4 irregularly compound papillae, each papillae ca. 5–8 μm long; stomatal rows 2, distinct, flanking each costal zone and slightly extending into the intercostal zone.

Interstomatal cells.—ca. 30 μm long, narrow, width variable; ends indeterminable due to overarching papillae; papillae sparse, 3–5 per cell.

Long cells.—Rectangular, 30–80 μm long, 8–10 μm wide, outline of cells sinuous; papillae sparse, 3–12 per cell, 3–5 μm long, apparently minutely concave at summit.

Prickles.—None seen.

Short cells.—Abundant, ca. 25 μm tall, 17–25 μm wide, abundant, slightly raised, in ca. 5 rows (60–70/mm) in intercostal zones, ca. 3 rows (30–45/mm) in costal zones.

Microhairs.—Few; two-celled; basal cell 15–33 μm long, 7–8 μm wide; apical cell (only one seen) 25 μm .

Macrohairs.—None seen.

Aulonemia bromoides, known only from the type locality in the Parque Nacional Madidi, La Paz, Bolivia, is distinctive in its combination of large efinbriate leaves with elongate papery inner ligules (Fig. 2), and robust spikelets with prominently nerved florets somewhat resembling those of a species of the grass genus *Bromus* L. (hence the specific epithet). It has been suggested that these elongate inner ligules may represent, at least in part, fused fimbriae such as are prominently manifested in the Brazilian species *Aulonemia fimbriatifolia* L.G. Clark (pers. comm.). The only other described species of *Aulonemia* with elongate, papery inner ligules is the Peruvian endemic *A. parviflora* (J. Presl) McClure. It differs from *A. bromoides* in its generally narrower ((3–) 3.7–5.8 cm wide), linear-lanceolate to lanceolate, abaxially tessellate leaf blades and smaller (7.5–9.5 mm long), more weakly-nerved, mucronate lemmas (Tovar 1993; also examination of McClure 21453, US).

Aulonemia bromoides is assessed as Critically Endangered because its EOO (extent of occupancy) is (as far as is known) less than 100 km^2 , and it is only known to occur at a single location; thus, criterion CR B1a of the IUCN (2001) applies.

Aulonemia scripta Judz. & Wayda, sp. nov. (Figs. 3A-C, 4, 5, 6). TYPE: BOLIVIA. LA PAZ: Prov. Franz Tamayo: Senda Apolo-San José de Uchupiamonas, quebrada antes de cruzar Arroyo Huacataya, 14°31.478'S [=28.7"], 68°17.914'W [=54.8"], 1960 m [1980 m on Google Earth], hierba graminoide 50 cm, espigas verde amarillentas, 10 Jul 2002, Carla Maldonado G., Tatiana Miranda, Freddy Canqui & R. Alvarez 3100 (HOLOTYPE: LPB!; ISOTYPES: MO 4793771! 4793772!).

Culmi 7 mm diam., 0.5 m alti. Vagina foliorum glabra, viscida, auriculata (3 \times 1 mm), tantum ad apicem fimbriata; fimbriae 4–8 mm longae, sparsa, delicata; lamina foliorum 16–18 cm longa, 2.0–2.7 cm lata, reflexa, viscida. Inflorescentia paniculata, 20–23 cm longa. Spiculae 22–26 mm longae, puberulentes, 3–5 flosculos fertiles continentes; glumae 2, lanceolatae, acutae; gluma I 2.0–2.5 mm longa, gluma II 5.5–7 mm longa; lemmata fertilia 10–12 mm longa, lanceolata, aristata, arista 4–5.5(–7) mm longa.

Habit uncertain, perhaps cespitose; culms reportedly only 0.5 m tall, in available material 7 mm in diameter near base, hollow, the lumen about 30% of the diameter of the culm; internodes glabrous, brownish, shiny and apparently viscid in life. Culm leaves with lower sheaths stramineous and maculate with scattered tiny black dots, striate, shiny (appearing varnished), apparently viscid in life as evidenced by newsprint lettering impressed on culm (Fig. 4), bladeless or with tiny reflexed blades up to 2 cm long, gradually transitioning to typical foliage leaves. Promontory absent; branch one per node. Foliage leaves in complements of up to at least 12; sheaths striate, apparently viscid, glabrous or finely puberulent near the apex, lacking marginal fimbriae; sheath auricles rare, only one delicate arcuate auricle ca. 3 \times 1 mm seen on just one leaf; terminal fimbriae sparse, 0–2 per leaf, each 4–8 mm long, delicate, curling; outer ligules 1–2 mm long; inner ligules 1.5–2.5 mm long, membranous; pseudopetioles 5–6 mm long; blades 16–18 cm long, 2–2.7 cm wide, somewhat coriaceous, strongly reflexed, narrowly lanceolate, obtuse at base, long-acuminate at apex, glabrous and apparently viscid above, finely and densely antrorsely scaberulous and apparently at least sparingly viscid beneath, the margins cartilaginous, smooth below and somewhat scabrous above. Peduncle 6–8 cm long, smooth and glabrous. Inflorescence an ovoid panicle 20–23 cm tall and 12–20 cm wide, with few primary branches laxly ascending at a 45° angle, the rachis and primary branches smooth and glabrous, the secondary branches and pedicels capillary and antrorsely scaberulous. Spikelets 18.3–23.1 mm long, 2.9–5.5 mm wide (folded), stramineous to yellowish, 6–8 flowered, perhaps viscid; glumes lanceolate, pubescent, acute, the lower glume 2.1–3.0 mm long, 0.8–1.2 mm wide (folded), 3–7-nerved, awnless, the upper glume 6.0–7.8 mm long, 1.0–1.3 mm wide (folded), 9–11-nerved, awns 0.4–0.5 mm long; florets largest below, the uppermost floret sterile and reduced in size; lemmas with bodies 9.1–11.6 mm long, 1.5–2.1 mm wide (folded), lanceolate, puberulent throughout, finely 9–15-nerved, the apex acute but terminated by an abrupt, erect, antrorsely scabrous awn 1.0–4.7 mm long; paleas 8.0–11.0 mm long (as long as lemmas, flush with or slightly protruding from their margins and apex), 1.1–1.9 mm wide, elliptical, stramineous, bicarinate, the keels ciliolate; lodicules 3, 1–1.3 mm long, flabellate, obtuse, transparent, with 2–3 fine short nerves

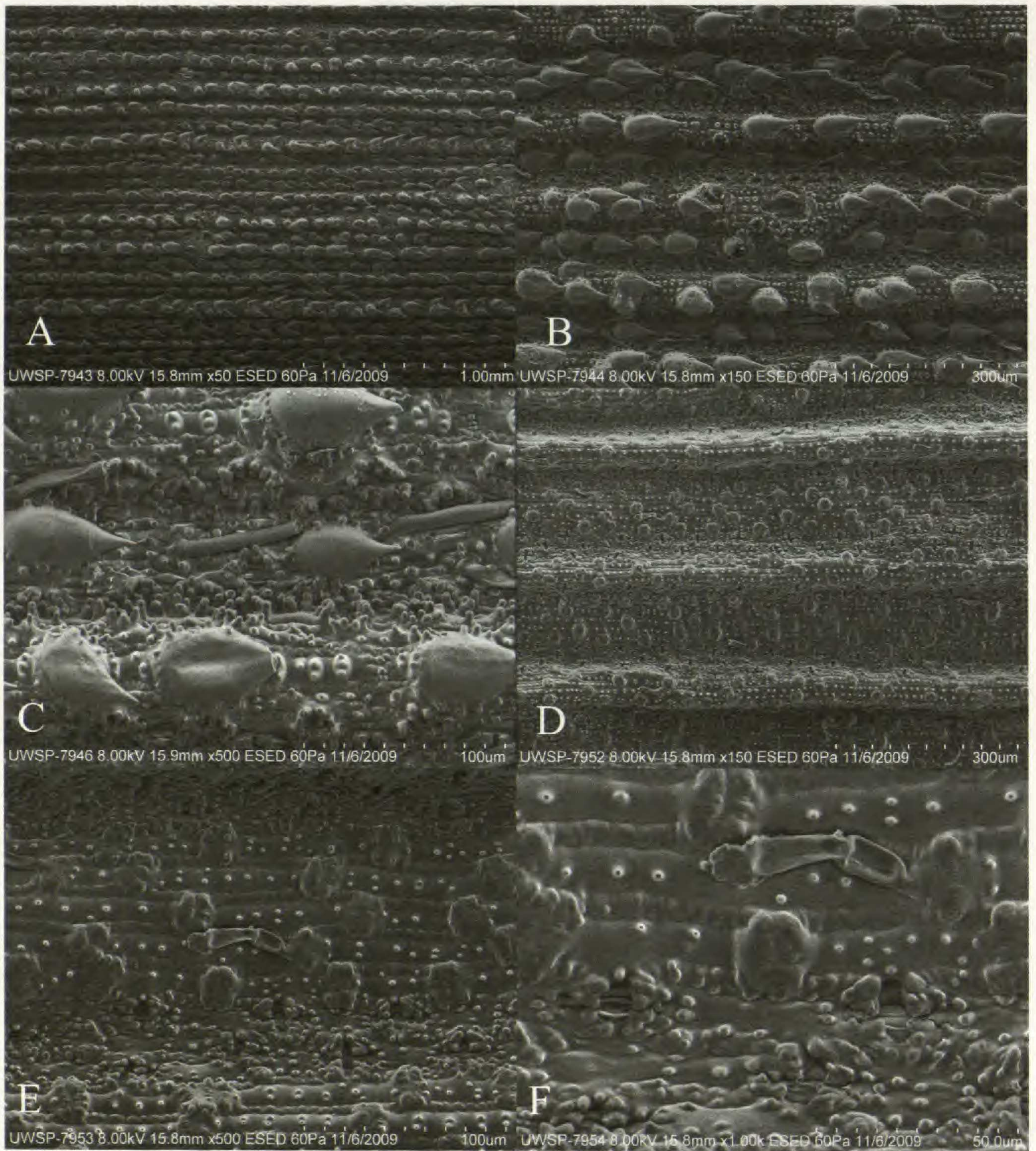


FIG. 3. Scanning electron micrographs of abaxial (lower) leaf blade epidermis of *Aulonemia scripta* (A–C, at increasing magnification, showing abundant prickles and papillae; Maldonado et al. 3100, MO) and *A. bromoides* (D–F, at increasing magnification, showing prominent intercostal short cells, bicellular microhairs, lack of prickles, and relatively sparse papillae; Cayola et al. 289, MO).

near base, the margins densely fringed with erect clear cilia ca. 0.5 mm long; stamens 3, the filaments apparently dilated, the anthers 4.5 mm long, 0.8 mm wide, linear, stramineous to brown. Fruit 4.3–5.9 mm long, 0.7–1.0 mm wide, narrowly oblong, rusty brown; embryo 2.9 mm long, 0.8 mm wide; hilum 4.1–5.4 mm long; all fruits observed were immature.

Leaf anatomy of abaxial leaf blade surface (Fig. 3A–C; terminology follows Ellis 1979).

Costal zones.—Spaced ca. 150 μm apart.



FIG. 4. *Aulonemia scripta* (Maldonado et al. 3100, MO). Detail of specimen showing newsprint adhering to and imprinted upon culm and leaves.

Papillae.—In general very abundant; up to 12 μm long and 6 μm wide, variable, occasionally slightly branched at the apex.

Stomates.—Common; shape unknown, possibly triangular, nearly obscured by overarching papillae; each stomate overarched by 9–15 papillae, each papillae 4–12 μm long; stomates in 2 rows flanking each costal zone and slightly extending into the intercostal zone.

Interstomatal cells.—Shape apparently rectangular, often nearly obscured by papillae; papillae absent or solitary, globose to slightly oblique.

Long cells.—Rectangular, 40–60 μm long, 4–6 times as long as wide; outline of cells sinuous; papillae simple, in one or two rows, globose.

Prickles.—Abundant, 10–20 prickles/mm in 1–2 rows in both costal and intercostal zones, individual prickles 40–110 μm long, base at least twice as long as the stomates, the barb shorter than the base.

Short cells.—Not evident, perhaps obscured by over-arching papillae.

Microhairs.—Common; two-celled, the basal cell 60–80 μm long, 10–12 μm wide, the apical not seen, apparently detached in SEM preparation.

Macrohairs.—None seen.

Known only from the type locality in Parque Nacional Madidi, La Paz, Bolivia, *Aulonemia scripta* is distinctive in its apparently viscid hollow culms, viscid leaves, and awned spikelets. The specific epithet of the new species alludes to the newsprint that is imprinted upon and adhering in fragments to the culm and leaves of the type collection. The culms, branches, leaf sheaths, and lower leaf blade surfaces also have a shiny “varnished” appearance suggestive of viscosity. The collectors did not note any stickiness on their label notes, but this is not surprising: In another new species of *Aulonemia* from Brazil (Pedro Viana, pers. comm. from field observations) with viscid foliage (and spikelets), the collector, the late Thomas R. Soderstrom, who took copious field notes on the bamboos he collected, does not note any viscosity, and viscosity is not apparent in his dried specimens (Judziewicz, pers. obs.). Besides *Aulonemia scripta* and the unpublished

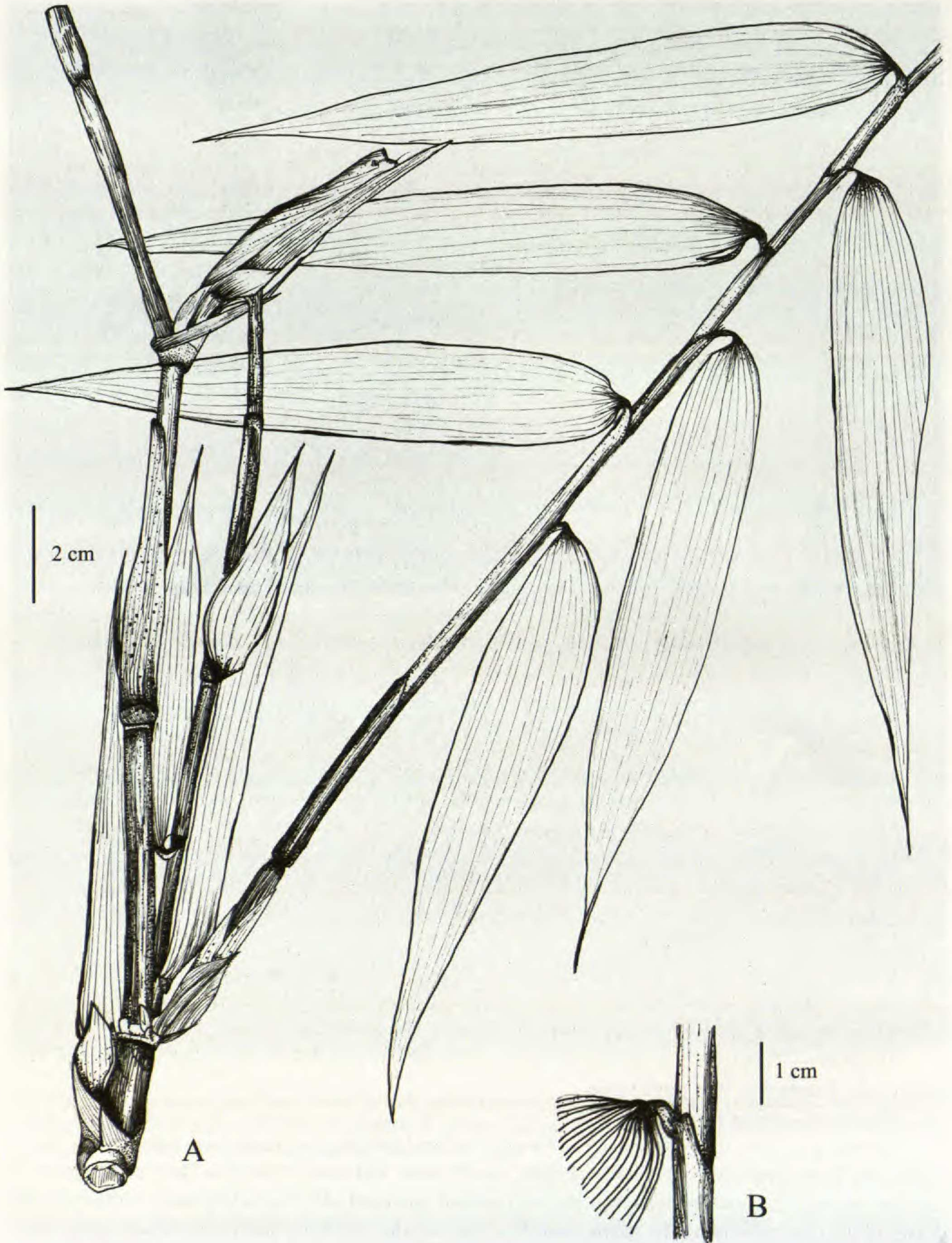


FIG. 5. *Aulonemia scripta* (Maldonado et al. 3100, MO). A. Vegetative habit showing branching pattern. B. Summit of leaf sheath and base of blade. Illustration by Eva Hathaway.

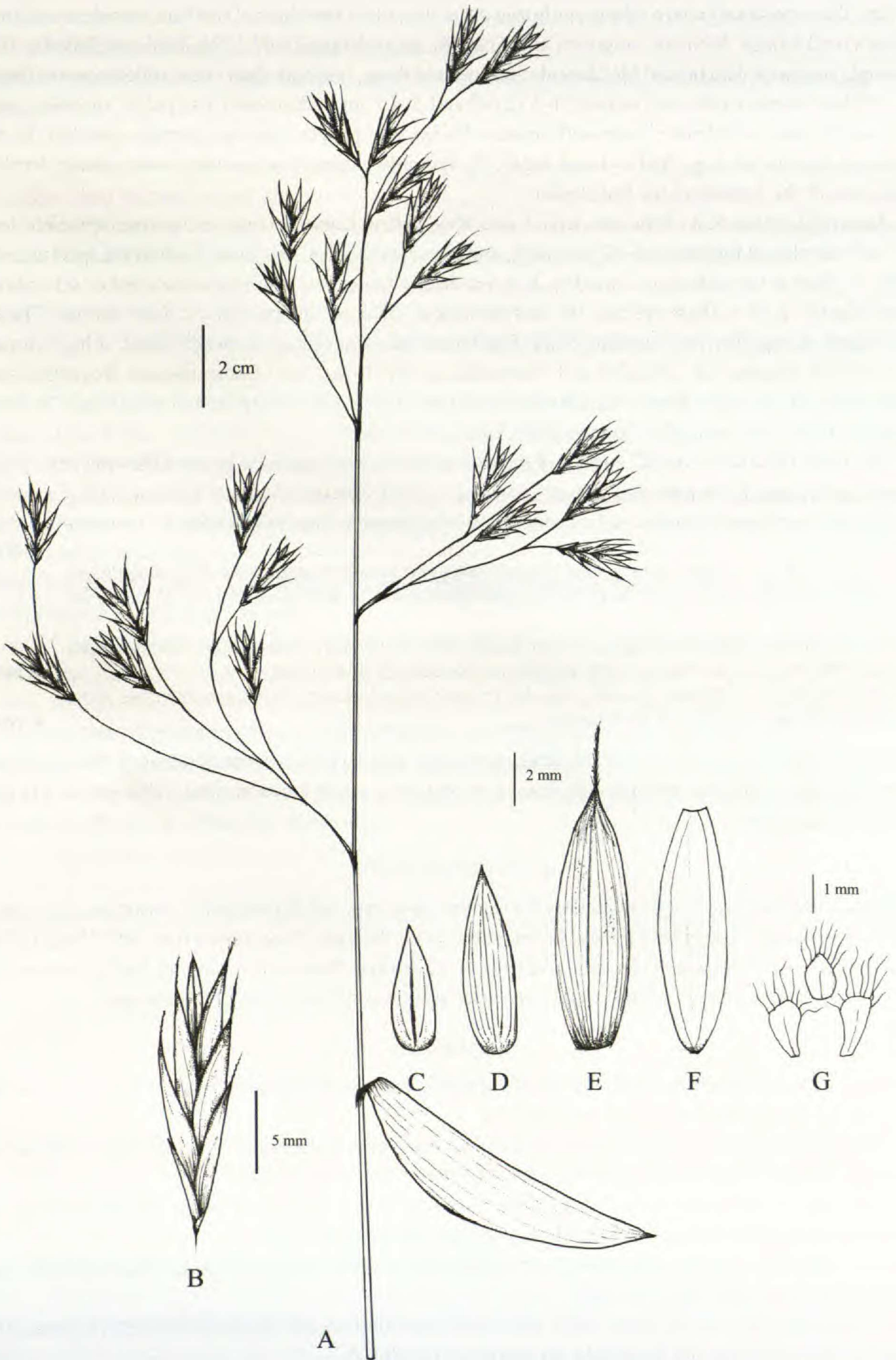


FIG. 6. *Aulonemia scripta* (Maldonado et al. 3100, MO). A. Summit of flowering culm. B. Spikelet, lateral view. C. Lower glume. D. Upper glume. E. Lemma. F. Palea. G. Lodicules. Illustration by Eva Hathaway.

new Brazilian species alluded to above, only two other described members of the Bambusoideae are known to have viscid foliage. Both are congeners and Costa Rican endemics (Pohl 1980; Pohl and Davidse 1994). *Aulonemia viscosa* (A. Hitchcock) McClure also has viscid foliage, but it also has viscid inflorescences (including spikelets), is more robust in stature (4–5 m tall and 5–15 cm in diameter), has pulpy, succulent, easily compressed culms, efimbriate leaves with broader blades, and purple-maculate awnless spikelets. In dried herbarium specimens (e.g., Pohl & Lucas 13113, F), the only evidence of viscosity is the shiny, varnished appearance of the summit of the leaf sheath.

Aulonemia patriae R.W. Pohl, also from Costa Rica, differs from *A. scripta* in its larger spikelets, leaves with well-developed fimbriae 15–30 mm long, and ovate leaf blades; in a dried herbarium specimen (Pohl 12798, F), there is no evidence of viscosity. It is not clear whether viscid foliage arose once or several times independently in all of these species; the morphological variation among them is quite diverse. The only other report of viscosity in a member of the Bambusoideae is in *Chusquea spencei* Ernst, a high elevation species of the páramos of Colombia and Venezuela, in which the culm internodes are frequently sticky (Clark 1989: 58). In other plants, viscosity has been postulated to be an attribute of what might be termed “protocarnivory” (Darwin 1875; Spomer 1999; Chase et al. 2009).

The three described “viscid” species of *Aulonemia* can be distinguished by the following key:

1. Culms ca. 0.5 m tall, 2–7 mm in diameter, rigid and hollow; spikelets with lemma awns 4–5.5(–7) mm long; foliage leaves narrowly lanceolate, 2–2.7 cm wide; leaf fimbriae sparse (0–2 per leaf), delicate, 4–8 mm long; Bolivia _____ **A. scripta**
1. Culms 4–5 m tall, 5–15 mm in diameter, easily crushed, pulpy and succulent; spikelets awnless; foliage leaves narrowly to broadly ovate, 4–8 cm wide; leaf fimbriae either absent or well-developed (15–30 mm long); Costa Rica
 2. Leaves with fimbriae well-developed, 15–30 mm long, the blades broadly ovate, 4–8 cm wide; peduncles and inflorescence branches not viscid; spikelets not maculate, 25–40 mm long _____ **A. patriae**
 2. Leaves efimbriate, the blades narrowly ovate, 4–5 cm wide; peduncles and inflorescence branches viscid; spikelets purple-maculate, 15–25 mm long _____ **A. viscosa**

Aulonemia scripta is assessed as Critically Endangered because its EOO (extent of occupancy) is (as far as is known) less than 100 km², and it is only known to occur at a single location; thus, criterion CR B1a of the IUCN (2001) applies.

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