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A new species of *Chusquea* subg. *Swallenochloa* (Poaceae: Bambusoideae) from the Peruvian upper montane forest

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Abstract

A new woody bamboo from Peru, *Chusquea robinfosteri*, is described here based on a combination of morphological and anatomical characters. Within *Chusquea* subg. *Swallenochloa, C. robinfosteri* and *C. depauperata* are similar in having awnless falcate spikelets, foliage leaf blades with the abaxial epidermis exhibiting abundant single and branched papillae, a simple midrib, and mesophyll comprising rosette cells and lacking fusoid cavities. The two species are distinguished mainly by the presence or absence of glumes and the shape of the leaf sheath summit extension. While *C. robinfosteri* usually has both glumes I and II developed and a long acuminate foliage leaf sheath summit extension, *C. depauperata* usually lacks glumes I and II and has a truncate foliage leaf sheath summit extension. The description of the new species is accompanied by detailed photographs captured under a stereomicroscope, images of the foliage leaf blade anatomy and micromorphology, a morphologically comparative table, diagnostic key, and map indicating the type locality. Likewise, detailed images of *C. depauperata* are provided.

Key words: Bamboo, Chusqueinae, Peru, tropical Andes

Introduction

Chusquea Kunth (1822: 151), a morphologically very diverse woody bamboo genus, is native to the New World and found from Mexico to Argentina. Its species richness is highest along the tropical Andes and in eastern and southeastern Brazil (Ruiz-Sanchez *et al.* 2021). Based on morphology, the ca. 204 named species of the genus are classified into five subgenera: *Chusquea* subg. *Chusquea*, *C.* subg. *Magnifoliae* L.G. Clark & Fisher in Fisher *et al.* (2014: 841), *C.* subg. *Platonia* Nees (1835: 486), *C.* subg. *Rettbergia* (Raddi 1823: 17) Clark (1997: 41), and *C.* subg. *Swallenochloa* (McClure 1973: 106) Clark (1997: 42), which consists of one section, sect. *Swallenochloa* (McClure) Clark (1997: 42), and a few informal groups (Fisher *et al.* 2014, Ruiz-Sanchez *et al.* 2022).

Chusquea sect. *Swallenochloa*, with about 38 species, is usually found in open habitats of tropical high elevation grasslands (Clark 1997, Fisher *et al.* 2009, 2014, Fadrique *et al.* 2019). It is recognized principally by having an erect habit, relatively stiff and erect foliage leaf blades, a triangular central bud, intravaginal branching, the central branch usually developing simultaneously with the subsidiary branches, and the foliage leaf blade abaxial surface with abundant papillae (Clark 1986, Fisher *et al.* 2014, Fadrique *et al.* 2019). Peru is home to approximately 33 species of *Chusquea* (representing four of the five subgenera, with the exception of subg. *Rettbergia*) mainly restricted to the montane forests of the eastern slopes of the Peruvian Andes (Tovar 1993, Ruiz-Sanchez *et al.* 2021). These include humid and perhumid forests, many of which are true cloud forests because they are often immersed in fog. The Peruvian eastern montane forests occupy areas between 1500 and 3500 m elevation and constitute part of a long but narrow corridor that runs from south-western Venezuela to northern Argentina (Young & León 2000).

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A preliminary revision of *Chusquea* sect. *Swallenochloa* in Peru was carried out by Fadrique *et al.* (2019). They recognized eight species for the country, seven of which are considered endemic, and listed 11 different sets of specimens as *Incertae Sedis*. After morphological examinations of the specimens listed in their first *Incertae Sedis* set, we concluded that the *Boyle et al. 4221* specimen represents a new species, here named *C. robinfosteri*. The description of the new species is accompanied by photos of the most important macro- and micromorphological and anatomical features, a morphologically comparative table, diagnostic key, and map indicating the type locality. Likewise, detailed images of the poorly known *C. depauperata* Pilger (1905: 149), the species most similar to *C. robinfosteri* within the subg. *Swallenochloa*, are provided.

Materials and methods

All morphological and anatomical data of the new species were obtained from the *Boyle et al. 4221* specimen. For *Chusquea depauperata,* morphological and anatomical data were obtained from the available parts of the type material, *Weberbauer 3709*, housed at the US herbarium. The identification key to the species of *C.* sect. *Swallenochloa* in Peru was prepared based on vegetative and reproductive features. The map showing the type locality of the new species within Otishi National Park, Peru, was prepared using QGIS Desktop 3.30.1 (QGIS Development Team, Open Source Geospatial Foundation Project). Herbaria acronyms follow Thiers (2025, continuously updated).

Macromorphological data:—Vegetative and reproductive characters of herbarium specimens were examined and measured using a Leica S6D dissecting scope. Photographs were obtained using a Nikon SMZ745T digital stereo microscope fitted with a Nikon Digital Sight DS-Vi1 camera connected to a Nikon Digital Sight DS-L2 camera control system. The descriptive terminology follows Clark (1989).

Micromorphological data [Scanning Electron Microscopy (SEM)]:—While foliage leaf blades of *Weberbauer 3709* were prepared and imaged using the procedure of Clark (1990), the foliage leaf blades of *Boyle et al. 4221* were prepared using the procedures described by McMurchie *et al.* (2022) and imaged using a Hitachi SU4800 FE_SEM field emission scanning electron microscope at the Iowa State University Roy J. Carver High Resolution Microscopy Facility. Additionally, epidermal peels were obtained using the pectinase method described in Klahs *et al.* (2023) to complement SEM images of *Boyle et al. 4221*. The epidermal peels were stained with 1% alcoholic safranin and semipermanent slides were prepared using an aqueous mounting solution, analyzed, and photographed using a Nikon Eclipse 55i compound microscope. Descriptions of micromorphological features were primarily based on Ellis (1979), with the description of unicellular microhairs based on Leandro *et al.* (2017).

Anatomy:—Segments of the middle portion of a fully expanded foliage leaf blade were excised from the *Boyle et al. 4221* specimen, immersed in polyethylene glycol 1.500 and ethanol (1:1) solution, and kept in an incubator at 60°C for ten days (Rupp 1964), then placed in disposable base molds with embedding rings until they became dry and ready for sectioning. Cross-sections were made using a Spencer 820 or Leica RM2235 rotary microtome, cleared in 50% sodium hypochlorite, rinsed in distilled water, and stained in Safrablau solution (0.1% Astra blue and 1% Safranin) (Kraus & Arduin 1997). Semi-permanent slides were mounted in 50% glycerin and analyzed and documented with a Leica DM4000B microscope using the Leica Application Suite LASV4.0. Hand cross sections from the foliage leaf blade of *Weberbauer 3709* were made due to the limited material available. Anatomical descriptions and terminology followed Ellis (1976) and Leandro *et al*. (2020).

Results

Taxonomic treatment

Chusquea robinfosteri Refulio, Klahs & L.G. Clark, ***sp. nov.*** (Figs. 1–5; 8A–D; 9A–C).

Type:—PERU. Junín: Satipo Province/Cusco: La Convención Province. Cordillera Vilcabamba, Otishi National Park, Rio Ene slope, near summit of divide. 11°39'36" S, 73°40'02" W, 3350–3400 m, 8 June 1997, *B. Boyle*, *M. Arakaki & H. Beltrán 4221* (holotype: USM!; isotypes: F!, ISC!).

FIGURE 1. Type locality of *Chusquea robinfosteri* Refulio, Klahs & L.G. Clark in Otishi National Park, Peru.

Diagnosis:—Within *Chusquea* section *Swallenochloa*, *Chusquea robinfosteri* is most similar to *C. depauperata* in having awnless falcate spikelets, foliage leaf blades with the abaxial epidermis exhibiting abundant single and branched papillae, a simple midrib, and mesophyll comprising rosette cells and lacking fusoid cavities. However, it differs by usually having both glumes I and II developed (rarely lacking glume I) and by possessing a long acuminate extension at the summit of the foliage leaf sheath.

FIGURE 2. The holotype specimen of *Chusquea robinfosteri* Refulio, Klahs & L.G. Clark.

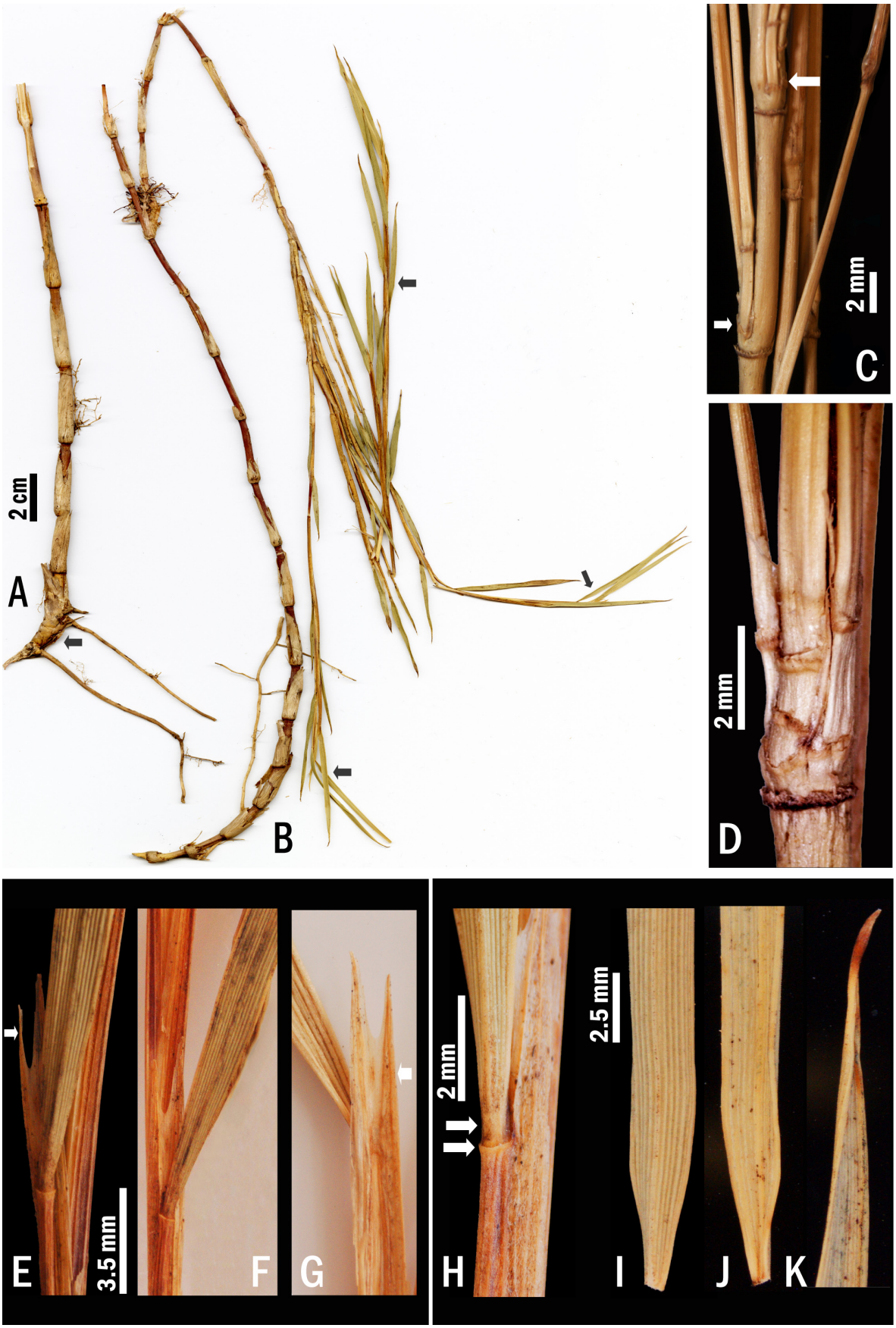

FIGURE 3. *Chusquea robinfosteri* Refulio, Klahs & L.G. Clark. **A.** Pachymorph rhizome. **B.** Foliage leaves per complement. **C–D**. Branch complement. **E–F.** Foliage leaf sheath summit extension. **G.** Detail on the inner ligule fused to the foliage leaf sheath summit extension. **H.** Foliage leaf outer ligule and pseudopetiole. **I.** Abaxial foliage leaf blade. **J.** Adaxial foliage leaf blade. **K.** Foliage leaf blade apex. Scale bars: 2 cm (A,B); 3.5 mm (E–G); 2.5 mm (I–K). Photographs from the isotype, *Boyle et al. 4221* (ISC).

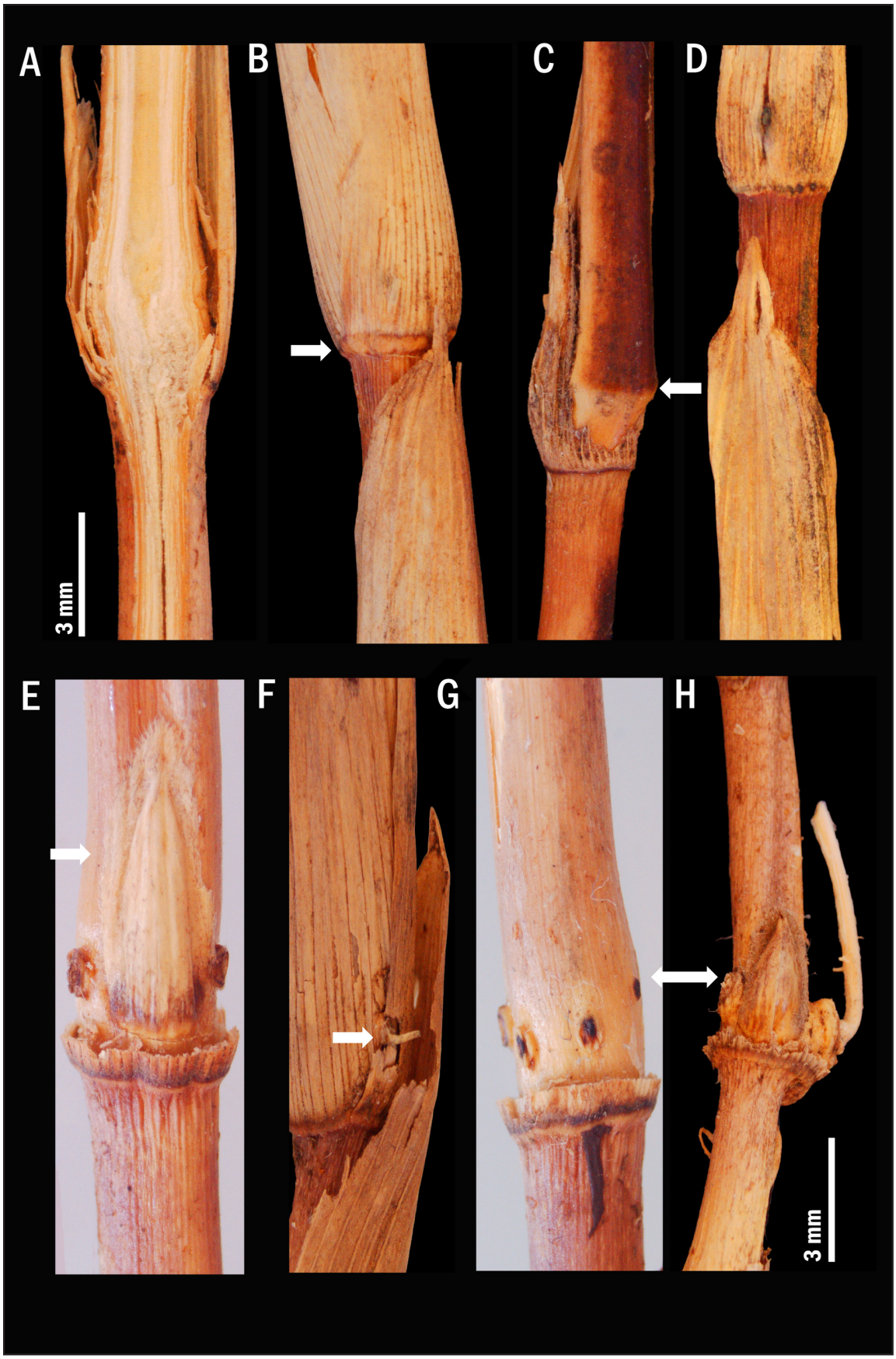

FIGURE 4. *Chusquea robinfosteri* Refulio, Klahs & L.G. Clark. **A**. Fistulose culm. **B**. Culm leaf girdle. **C**. Supranodal ridge. **D**. Culm leaf sheath and blade. **E**. Central triangular bud. **F**. Adventitious root. **G–H**. Adventitious root buds. Scale bar: 3 mm (A–H). Photographs from the isotype, *Boyle et al. 4221* (ISC).

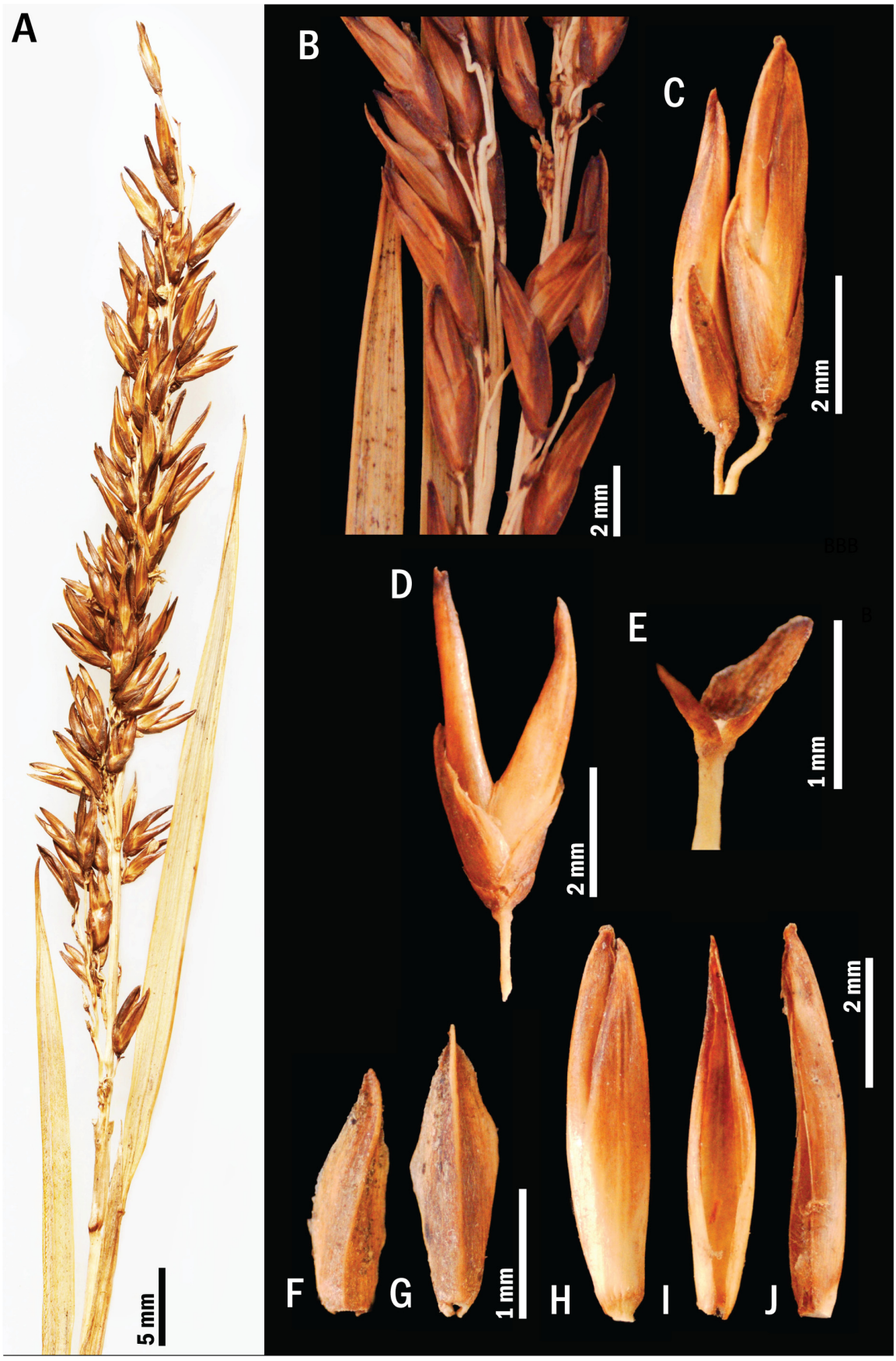

FIGURE 5. *Chusquea robinfosteri* Refulio, Klahs & L.G. Clark. **A–B**. Synflorescence. **C–D**. Spikelets. **E**. Glume I and Glume II. **F**. Glume III. **G**. Glume IV. **H**. Floret. **I**. Lemma. **J**. Palea. Scale bars: 1 mm (F,G); 2 mm (H–J). Photographs from the isotype, *Boyle et al. 4221* (ISC).

FIGURE 6. The lectotype specimen of *Chusquea depauperata* Pilg. Image courtesy of the Smithsonian National Museum of Natural History (http://n2t.net/ark:/65665/365e368bb-4624-47a7-a7e9-1f81a0fa76b9).

Description:—Rhizomes pachymorph. Culms scandent. Internodes 2.2–3.8 cm long, 2.4–3 mm in diameter, terete but slightly flattened for much of the length above the central bud, fistulose, glabrous, maroon to golden-yellow, waxy. Culm leaves 1.9–3.5 cm long, juncture of the sheath and blade abaxially horizontal, more or less visible; sheaths 1.8–3.3 cm long, 18–22 times as long as the blade, persistent and disintegrating on the culm, more or less triangular with rounded shoulders, glabrous adaxially and abaxially pubescent, with no marginal fusion, margins glabrous, sheath summit extension absent; girdle glabrous, slightly developed, 0.8–1 mm; outer ligule absent; inner ligule ca. 0.1 mm long, a faint line; blades 1–1.5 mm long, triangular, minute, erect, deciduous. Nodes with a triangular central bud and several adventitious roots; nodal line horizontal; supranodal ridge conspicuous. Branching intravaginal, at mid-culm

with 3 branches per node, the central one thicker than the other two. Foliage leaves 4–7 per complement on vegetative branches, 5–7 per complement on flowering branches; sheaths pubescent, keeled, margins glabrous; sheath summit extension present on both sides, acuminate, confluent with the inner ligule, glabrous, 4–9 mm long; outer ligules erect, glabrous, ca. 0.1 mm long; inner ligules fused with sheath summit extension, 2–4 mm long; pseudopetioles 0.1–0.2 mm long, glabrous; blades 2.7–5.7 cm long, 1–2.5 mm wide, linear, stiff, erect to ascending, flat in cross-section, slightly yellow-green, adaxially pubescent and abaxially mostly glabrous, not tessellate, margins ca. 0.2 mm wide, yellow, scabrid, cartilaginous, midrib centric and abaxially barely distinguishable, attenuate at base, subulate at apex. Synflorescences 4–10 cm long, 0.4–1 cm wide, paniculate, narrow, congested and appearing spicate, not or only slightly interrupted, branches appressed; subtending bract absent; rachis angular, flattened, glabrous; basal primary branches 1.5–2.5 cm long, becoming progressively shorter towards the apex until ending in pedicels, pulvinus absent; pedicels 1–5 mm long, rounded, glabrous. Spikelets 5.8–6 mm long, 1.5–1.8 mm wide, laterally compressed, slightly falcate; glume I developed (sometimes absent), 0.4–0.8 mm long, scalelike, glabrous, nerves absent; glume II developed, 0.8–1.2 mm long, scalelike, glabrous, nerves absent; glumes III and IV subequal, ca. ½ the spikelet length, 3-nerved; glume III 2.8–3 mm long, pubescent on the base and on middle nerve, acute; glume IV 3.3–3.5 mm long, pubescent on the base and on middle nerve, mucronate; lemma 5–5.2 mm long, glabrous, acuminate, 7-nerved; palea 5.2–5.4 mm long, emarginate, glabrous, 2-nerved. Stamens 3; anthers 2.5–3 mm long, yellow. Gynoecium 1.8–2.6 mm long, styles 2, stigmas plumose. Caryopsis not seen.

Distribution and habitat:—*Chusquea robinfosteri* is currently known only from a very remote and difficult to access area located on the border between Junín Department (Province Satipo) and Cusco Department (Province La Convención) which forms part of the Otishi National Park and the Cordillera Vilcabamba (Fig. 1). It was found on the Rio Ene slope, near the summit of divide at 3350–3400 m elevation in mossy upper montane forest dominated by *Weinmannia* Linnaeus (1759: 997, 1005, 1367), *Clethra* Linnaeus (1753: 396), *Symplocos* Jacquin (1760: 5), and *Myrsine* Linnaeus (1753: 196). It is patchily distributed, but often locally dominant in restricted areas of pajonal (herbaceous meadows with scattered low shrubs).

Phenology:—Flowering collections are only known from 8 June 1997. There are no observations on extent of flowering in the label data.

Recognition:—*Chusquea robinfosteri* is distinguished from the other small (shrubby) species in sect. *Swallenochloa* by the combination of its vegetative and reproductive attributes (see identification key below). *Chusquea robinfosteri* and *C. depauperata* are similar in having awnless falcate spikelets (Figs. 5C–D, 7D). Morphological key differences that help to differentiate these two species are the shape of the leaf sheath summit extension and the presence or absence of glumes (Table 1). While *C. robinfosteri* has a long acuminate foliage leaf sheath summit extension and usually both glumes I and II developed (rarely lacks glume I) (Figs. 3E–F, 5E), *C. depauperata* has a truncate foliage leaf sheath summit extension and usually lacks both glumes I and II (rarely glume II is present) (Fig. 7B,D).

Etymology:—This species is named in honor of Robin B. Foster (Field Museum, Chicago and ForestGEO) in recognition of his immense contributions to tropical botany, in particular to the poorly known areas with complex topography and limited access of the Peruvian tropical Andes and Amazon.

TABLE 1. Comparison of *Chusquea robinfosteri* and *C. depauperata*. Diagnostic states or states that in combination with others are diagnostic are in boldface.

Characters	***C. robinfosteri***	***C. depauperata***
Foliage leaf sheath summit extension length (mm), shape	**4–7, acuminate**	0.5–1, truncate
Synflorescence length (cm)	4–10	3–9
Spikelet length (mm)	5.8–6	3.5–5.5
Glume I	**developed** (sometimes absent)	absent
Glume II	**developed**	usually absent
Glume III length (mm)	2.8–3	1.5–2.5
Glume IV length (mm)	3.3–3.5	2–3
Lemma length (mm)	5–5.2	3.5–5.5
Lemma apex	**acuminate**	acute to mucronulate
Palea length (mm)	5.2–5.4	3–5
Palea apex	emarginate without sulcus	acute with sulcus well developed
Habitat	mossy upper montane forest	high elevation peat bogs (bofedales)

Key to the species of *Chusquea* sect. *Swallenochloa* in Peru based on vegetative and reproductive features

1. Foliage leaf blades tessellate on both surfaces, mostly reflexed, the pseudopetioles flat with ciliate-pubescent margins ..... *C. intipaqariy* Fadrique & Clark in Fadrique *et al.* (2019: 183)
- Foliage leaf blades not tessellate, ascending to erect, the pseudopetioles adaxially concave to keeled with glabrous margins.....2
2. Spikelets with glume IV nearly equaling the spikelet length ..... *C. smithii* Clark (1986: 107)
- Spikelets with glume IV no more than ¾ the spikelet length.....3
3. Spikelets falcate or slightly falcate.....4
- Spikelets straight 6
4. Spikelets with glumes III and IV and lemma awned; foliage leaf blades (1.5–) 1.8–3.9 (–4.2) cm wide ..... *C. gamarrae*
- Spikelets with glumes III and IV and lemma acute to mucronulate; foliage leaf blades 0.1–0.25 cm wide.....5
5. Spikelets with glumes I always absent and II usually absent; foliage leaf sheath summit extension truncate .....*C. depauperata*
- Spikelets with glumes I sometimes absent and II always present; foliage leaf sheath summit extension acuminate..... *C. robinfosteri*
6. Spikelets with glumes III and IV and lemma mucronulate but blunt; foliage leaf blades V-shaped in cross section..... *C. neurophylla* Clark (1986: 105)
- Spikelets with glumes III and IV and lemma short-awned to awned; foliage leaf blades flat in cross section 7
7. Foliage leaf sheath summit with an extension; paleas with an apical tuft of short cilia ..... *C. weberbaueri* Pilger (1905: 146)
- Foliage leaf sheath summit without an extension; paleas without a conspicuous apical tuft of short cilia 8
8. Foliage leaf blades 11.9–20 cm long, base rounded-attenuate; lemmas awned.....*C. simplicissima* Pilger (1905: 145)
- Foliage leaf blades (3.6–) 5–9 cm long, base truncate-cordate; lemmas short-awned.....*C. spicata* Munro (1868: 60)

Macromorphology

Foliage leaf sheath summit extension:—*Chusquea robinfosteri* and *C. depauperata* have foliage leaf sheath summit extensions. A long acuminate foliage leaf sheath summit extension was found in the former (Fig. 3E–F), whereas the latter has a shorter, truncate foliage leaf sheath summit extension (Fig. 7B).

Spikelets:—The spikelets of *Chusquea robinfosteri* and *C. depauperata* are slightly falcate and lack awns. In *C. robinfosteri* (Fig. 5A–D), the spikelets usually have both glumes I and II developed (rarely lack glume I). In *C. depauperata* (Fig. 7C–D), the spikelets usually lack both glumes I and II (rarely glume II is present as a diminutive scale-like structure).

Foliage leaf blade micromorphology

Chusquea robinfosteri adaxial surface (Fig. 8A,C):—Long cells elongated horizontally in the costal zone and equidimensional in the intercostal zone, with slightly undulating horizontal anticlinal walls. Silica cells elliptical in shape, mostly with smooth outline but sometimes with irregular outline, vertically elongated in the costal zone. Cork cells present in the costal zone. Silica and cork cells occur as silico-suberose pairs, alternating with long cells in the costal zone. Bicellular microhairs rare in costal zone. Macrohairs and papillae absent. Prickles and stomata not observed.

Chusquea robinfosteri abaxial surface (Fig. 8B,D):—Long cells elongated horizontally in the costal and intercostal zones, with abundant papillae obscuring their cell walls. Silica cells elliptical in shape, mostly with smooth outline but sometimes with irregular outline, vertically and horizontally elongated in the costal zone. Cork cells present in the costal zone. Silica and cork cells occur as silico-suberose pairs in the costal zone. Papillae elongated, simple or with two branches, rarely three to seven branches; smaller in the costal zone; larger and crowded on the interstomatal long cells obscuring the stomata. Prickles common in the costal zone and interstomatal bands but absent in the stomatal bands, with barbs shorter than the base and mainly all pointing one direction; the base of the prickles with abundant papillae. Microhairs of two types, one unicellular, rare, slightly enlarged at the base and broadly rounded at the apex found in the costal zone; the other bicellular, rare, found in the interstomatal bands of the intercostal zone. Macrohairs absent. Stomatal bands with up to four rows of stomata on both sides of a costal zone; subsidiary cells not observed due to abundant papillae encircling the stomata and obscuring the subsidiary cells.

Chusquea depauperata adaxial surface (Fig. 8E):—Long cells elongated horizontally in the costal and intercostal zones. Silica cells elliptical in shape, vertically elongated in the costal zone, arrangement not observed. Prickles rare in the intercostal zone. Macrohairs absent. Microhairs and stomatal apparatus not observed.

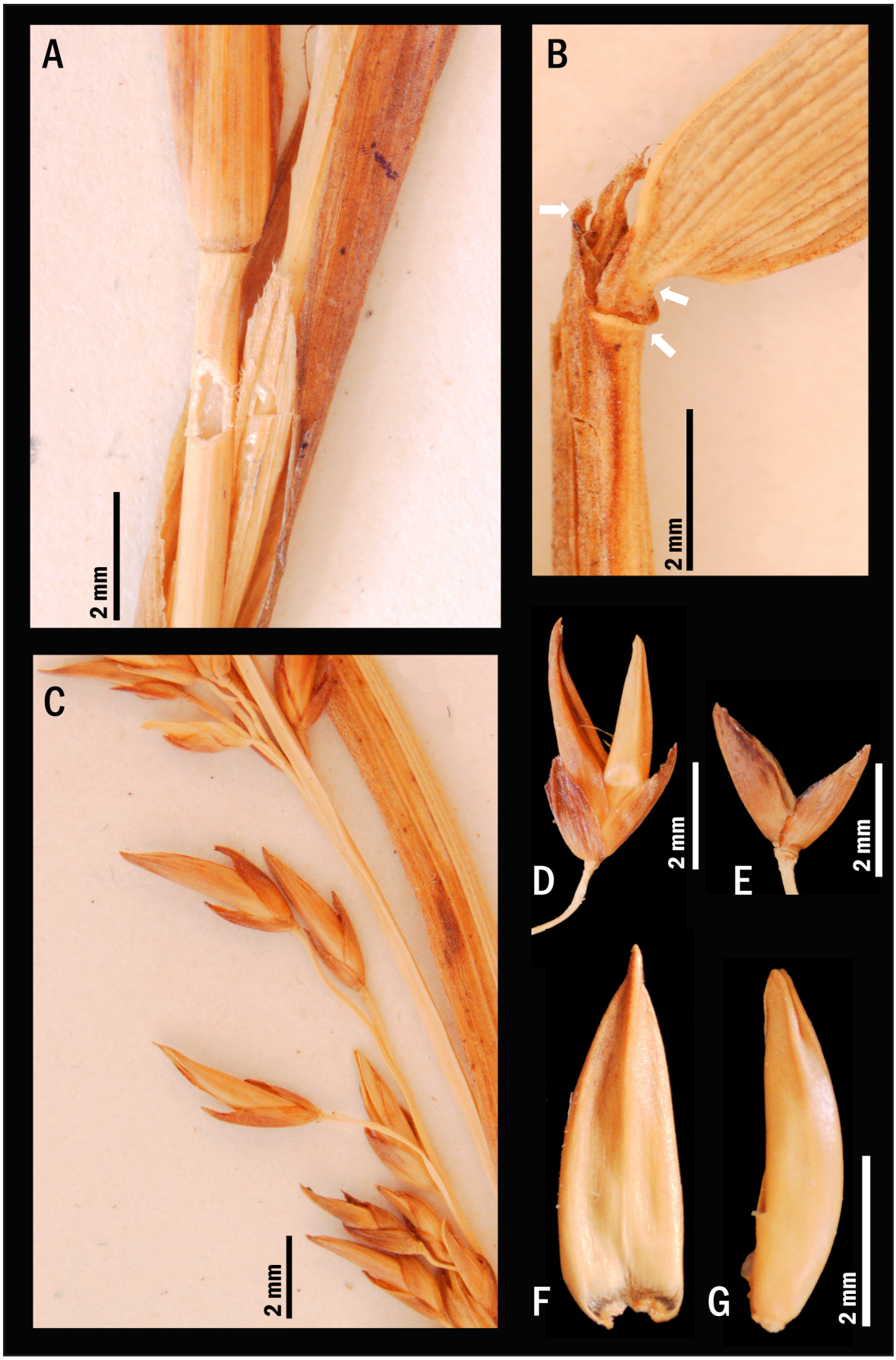

FIGURE 7. *Chusquea depauperata* Pilg. **A.** Fistulose culm. **B.** Foliage leaf outer ligule, pseudopetiole, and sheath summit extension. **C.** Synflorescence. **D.** Spikelet. **E.** Glume III and IV. **F.** Lemma. **G.** Palea. Scale bar: 2 mm (F,G). Photographs from *Weberbauer 3709* (US-2874618): **A–C** and (US-1127078): **D–G**.

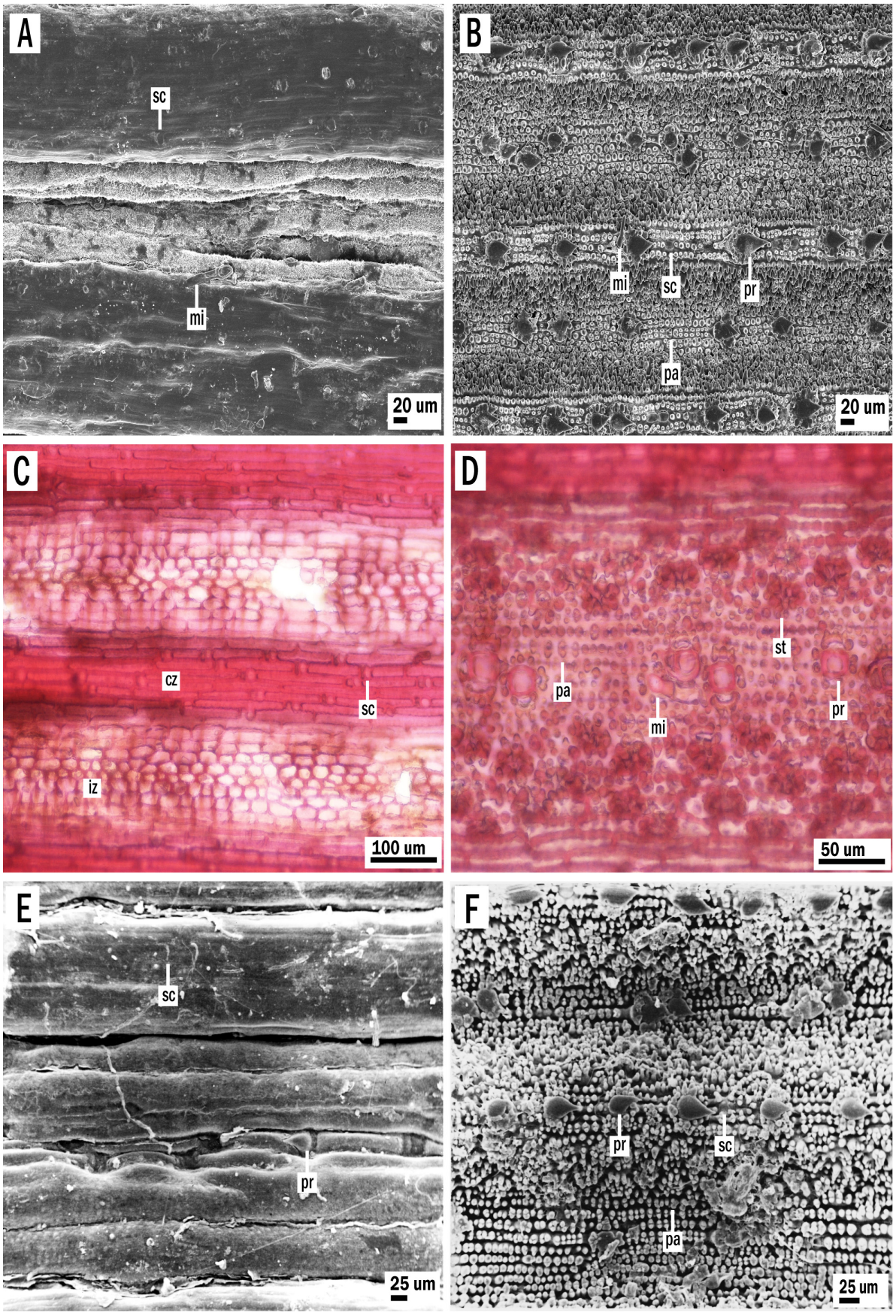

FIGURE 8. Micromorphology of the foliage leaf blades of *Chusquea robinfosteri* [*Boyle et al. 4221* (ISC)]: **A–D** and *C. depauperata* [*Weberbauer 3709* (US)]: **E–F**. **A,E.** SEM adaxial surface. **B,F.** SEM abaxial surface. **C.** Adaxial surface after pectinase treatment for epidermal peel. **D.** Abaxial surface after pectinase treatment for epidermal peel. cz = costal zone; iz = intercostal zone; mi = microhair; pa = papilla; pr = prickle; sc = silica cell; st = stoma.

Chusquea depauperata abaxial surface (Fig. 8F):—Long cells elongated horizontally in the costal and intercostal zones with abundant papillae. Silica cells elliptical in shape, obscured by papillae, vertically elongated in the costal zone. Papillae simple or with two branches, rarely three; shorter in the costal zone; enlarged and crowded on the interstomatal long cells obscuring the stomata. Prickles common in the costal zone and interstomatal bands but absent in the stomatal band, with barbs shorter than the base and mainly all pointing one direction; the base of the prickles with abundant papillae. Microhairs not observed. Macrohairs absent. Subsidiary cells not observed due to abundant papillae encircling the stomata and obscuring the subsidiary cells.

Note:—The foliage leaf blade micromorphology of *C. robinfosteri* (Fig. 8A–D) and *C. depauperata* (Fig. 8E–F) is very similar making it difficult to differentiate them based on epidermal micromorphological features. The abaxial surface in both species is covered with abundant simple or branched papillae. The stomata are encircled by abundant papillae obscuring the subsidiary cells.

Foliage leaf blade anatomy

Chusquea robinfosteri cross-section (Fig. 9A–C):—Foliage leaf blade expanded-corrugated with dimorphic margins (acute and obtuse). Ribs on adaxial surface present. Epidermis single-layered with thick tangential cell walls on both surfaces. Epidermal cells about the same size on both surfaces, except for the fan-shaped arrays of 8–12 bulliform cells that slightly project above the adaxial epidermal surface. Papillae simple and branched, readily distinguishable on the abaxial surface. Stomatal apparatus with a small substomatal chamber on the abaxial surface. Mesophyll non-radiate, consisting of weakly-lobed rosette cells, these mostly horizontally elongated, in particular below the bulliform cells, where 5–6 layers of elongated rosette cells are found; round-shaped rosette cells often surround the vascular bundles; fusoid cavities absent. Vascular system with first- and second-order collateral vascular bundles, surrounded by an outer incomplete parenchyma sheath and inner thickened mestome sheath. First-order vascular bundles with distinguishable metaxylem and phloem and protoxylem lacunae absent. Second-order vascular bundles with few lignified tracheary elements and a small patch of phloem. Girders interrupting the parenchyma sheath on both surfaces; adaxially V-shaped in both first- and second-order vascular bundles. Midrib simple, slightly projecting abaxially, with one first-order vascular bundle and girders interrupting the parenchyma sheath on both surfaces.

Chusquea depauperata cross-section (Fig. 9D–F):—Foliage leaf blade expanded-corrugated with acute margins. Ribs on adaxial surface present. Epidermis single-layered with thick tangential cell walls on both surfaces. Epidermal cells about the same size on both surfaces, except for the fan-shaped arrays of 6–10 bulliform cells that project above the adaxial epidermal surface. Papillae simple and branched, easily distinguishable on the abaxial surface. Stomatal apparatus with a small substomatal chamber on abaxial surface. Mesophyll non-radiate, consisting of weakly-lobed rosette cells, these mostly horizontally elongated in particular below the bulliform cells, where 4–5 layers of elongated rosette cells are found; round-shaped rosette cells often surround the vascular bundles; fusoid cavities absent. Vascular system with first- and second-order collateral vascular bundles, surrounded by an outer incomplete parenchyma sheath and inner thickened mestome sheath. First-order vascular bundles with distinguishable metaxylem and phloem and protoxylem lacunae absent. Second-order vascular bundles with few lignified tracheary elements and a small patch of phloem. Girders interrupting the parenchyma sheath on both surfaces; adaxially slightly V-shaped to nearly equidimensional in all vascular bundles. Midrib simple, with one first-order vascular bundle and girders interrupting the parenchyma sheath in both surfaces.

Note:—The cross-section of the foliage leaf blade of *Chusquea robinfosteri* (Fig. 9A–C) shares many anatomical similarities with *C. depauperata* (Fig. 9D–F), but it has more bulliform cells that slightly project above the epidermal surface and a mesophyll with more layers of elongated rosette cells.

Discussion

Material of *Chusquea depauperata* deposited at S (isolectotype) and US (lectotype and isolectotype) herbaria consists only of flowering fragments (synflorescences) from the original holotype specimen. The holotype of *C. depauperata* housed at the herbarium of the Botanic Garden and Botanical Museum Berlin-Dahlem (B) was destroyed during World War II (Velarde Núñez 1968), and the plant material of its isotype stored at the herbarium of the Universidad Nacional Agraria La Molina (MOL) is currently missing, with just the specimen sheet with the label remaining (Refulio-Rodriguez, pers. obs.). Before World War II, R. Pilger of the B Herbarium, sent to US and S herbaria flowering

fragments of the type specimens of almost all the species he described based on the collections of Weberbauer in Peru (Hitchcock 1927), including synflorescences of *C. depauperata*.

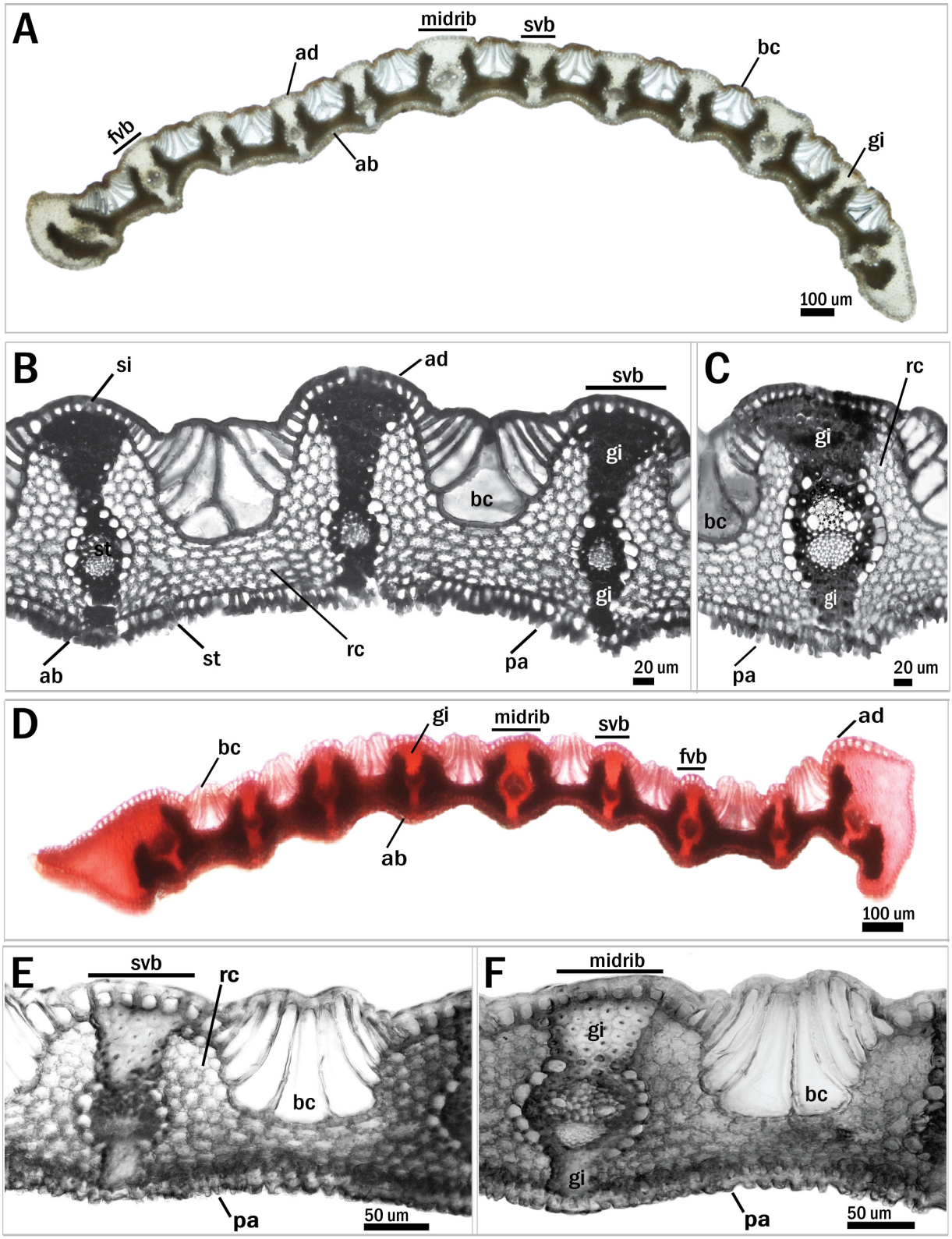

FIGURE 9. Cross-sections of the foliage leaf blades of *Chusquea robinfosteri* [*Boyle et al. 4221* (ISC)]: **A–C** and *C. depauperata* [*Weberbauer 3709* (US)]: **D–F**. **A,D.** General view showing midrib, first- and second-order vascular bundles associated with girders. **B,E.** General view showing the mesophyll comprising rosette cells and second-order vascular bundles associated with girders. **C,F.** Simple midrib consisting of a first-order vascular bundle with girders and surrounded by rosette cells. ab = abaxial epidermis; ad = adaxial epidermis; bc = bulliform cell; fvb = first-order vascular bundle; gi = girder; pa = branched papilla; rc = rosette cell; si = silica cell; st = stoma; svb = second-order vascular bundle.

Clark (1989) and Fadrique *et al.* (2019) assigned the collections *Weberbauer 3709* and *Smith 8106* to *Chusquea depauperata*. Since the *Smith 8106* collection consists solely of vegetative material, in this study we compare only *Boyle et al. 4221* (Fig. 2), which includes both vegetative and reproductive parts, with *Weberbauer 3709* (Fig. 6), the type material of *C. depauperata*, which contains only flowering fragments.

Fadrique *et al.* (2019) listed the collections *Boyle et al. 4221*, *Young 2464*, and *Young 2465* as the first *Incertae Sedis* set based on similarities in their foliage leaf blade features. However, the authors did not examine the foliage leaf sheath summit extensions. Our detailed study of the foliage leaves of these three specimens revealed that all of them bear foliage leaf sheath summit extensions. In *Boyle et al. 4221* (Fig. 3E–F), the foliage leaf sheath summit extension is long and acuminate, whereas in *Young 2464* and *Young 2465* it is truncate. Since the *Young 2464* & *2465* collections consist only of vegetative branches and differ from *Boyle et al. 4221* by having a truncate foliage leaf sheath summit extension, we do not include them in this study.

Foliage leaf blade anatomy and its contribution to taxonomy:—*Chusquea robinfosteri* and *C. depauperata* display anatomical features commonly found in Bambusoideae in that they share: single-layered epidermises bearing papillae at least abaxially; fan-shaped arrays of adaxial bulliform cells; non-radiate mesophyll (C_3 photosynthetic pathway), and first- and second-order collateral vascular bundles with a double sheath and opposing girders (Metcalfe 1960, Ellis 1987, Judziewicz *et al*. 1999, Leandro *et al*. 2020). However, the foliage leaf anatomy of both species and that of *C. pinifolia* (Nees 1829: 525) Nees (1835: 490) (Brandis 1907) reveals an unexpected pattern for bamboos and *Chusquea*. The mesophyll consists only of weakly-lobed rosette cells with no fusoid cavities making the foliage leaf blade anatomy of the three species unusual for bamboos and especially *Chusquea*. In cross-section, the mesophyll of most bamboos and *Chusquea* species often comprises one to three layers of adaxial arm cells, one to two layers of abaxial arm cells, cavities flanking the vascular bundles, and one to several rosette cells between the cavities (Leandro *et al*. 2020). In contrast, the mesophyll structure of *C. robinfosteri*, *C. depauperata*, and *C. pinifolia* resembles that observed in some *Oryza* (Chatterjee *et al*. 2016) in the Oryzoideae, which together with Bambusoideae and Pooideae comprises the BOP clade (Soreng *et al*. 2022). While this feature proves relevant for taxonomic purposes for *Chusquea*, its ecological significance needs further investigation. The simple midrib of *C. robinfosteri* and *C. depauperata* also needs further consideration. With a few exceptions (*C. pinifolia*), *Chusquea* species usually exhibit a complex midrib comprised of two to several vascular bundles (Clark *et al*. 2015, Leandro *et al*. 2020). The midrib structure (i.e., number and arrangement of vascular bundles) has proved to be helpful for taxonomic purposes within *Chusquea* (Mota 2013, Lizarazu 2013, Leandro *et al*. 2016, 2017, McMurchie *et al*. 2022), delimiting even morphologically related species. However, in the present study, the midrib vasculature seems to reflect most likely the taxonomic affinity of *C. robinfosteri* and *C. depauperata* within *Chusquea* and thus is not valid for species delimitation.

Diversity of *Chusquea* in Peru:—The description of this new species represents a step towards a better understanding of the poorly studied Peruvian bamboo diversity. It increases the total number of named species of sect. *Swallenochloa* in Peru to nine (eight of which are endemic) and for *Chusquea* as a whole in Peru to 34. As highlighted in Fadrique *et al.* (2019), field and herbarium studies are crucial to resolve taxonomic uncertainties in *Chusquea* (and other woody bamboos) in Peru. Fieldwork should be carried out with the aim of obtaining additional specimens of species that are known only from their type material and to recollect material of herbarium collections with missing flowering or vegetative parts. For example, we need to recollect *C. depauperata* to obtain its missing vegetative parts as a redescription and full illustration of this species is necessary.

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