THE WORLD'S SMALLEST BAMBOO: *RADDIELLA VANESSIAE* (POACEAE: BAMBUSOIDEAE: OLYREAE), A NEW SPECIES FROM FRENCH GUIANA

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ABSTRACT

Raddiella vanessiae (Poaceae: Bambusoideae: Olyreae), a new species of herbaceous bamboo, is described and illustrated. It is probably the smallest bamboo in the world. Known only from savannas in French Guiana, it appears to be related to **R. esenbecki***i* and **R. minima,** differing from both in its much smaller size and leaf blades.

KEY WORDS: Bamboo, Bambusoideae, French Guiana, Olyreae, Poaceae, **Raddiella**

RESUMEN

Raddiella vanessiae (Poaceae: Bambusoideae: Olyreae), una nueva especie de bambú herbáceo probablemente el más pequeño del mundo, es descrita e ilustrada. Es conocido solamente de las sabanas de la Guyana Francesa y está relacionado con *R. esenbeckii* y *R. minima*, pero difiere de ambas especies por su menor tamaño y hojas también mucho más pequeñas.

While some of the approximately 1,000 members of the Bambusoideae may be over 30 m tall, those of the herbaceous tribe Olyreae can be only a few tens of centimeters tall (Judziewicz et al. 1999). I herein describe a new species of *Raddiella* Swallen from French Guiana that, at maturity, is only 2 cm tall and is thus world's smallest bamboo:

Raddiella vanessiae Judz., sp. nov. (**Figs. 1–2**). TYPE: FRENCH GUIANA: Savane Lambert 1 (near Montsinery), 4°53'N, 52°31'W, elev. 10 m, savanes herbacées, 15 May 2001, flowering, Vanessa Hequet 1281 (HOLOTYPE: US!; ISOTYPES: CAY, K, P).

A *Raddiella minima* differt statura minore (10–20 mm), lamina minore (2.7–3.3 × 1.8–2.1 mm), flosculis femina minoribus (0.7–0.9 mm), et caryopsides hilo brevi-lineare.

Mat-forming annual grass with freely-branching culms 10–20 mm tall; culm terete, glabrous, purplish, shining, the nodes retrorsely ciliolate. Leaves in loose complements of 3–5, with sheaths 1.8–3.2 mm long, inflated, striate, 7-nerved, retrorsely pubescent with hairs ca. 0.2 mm long; outer ligule absent; inner ligule a line of erect cilia 0.2–0.3 mm long; pseudopetioles 0.2–0.3 mm long, puberulent; blades 2.7–3.3 mm long, 1.8–2.1 mm wide (area ca. 3.8–5.5 sq. mm), ovate, acute to slightly apiculate at apex, truncate and slightly asymmetrical at base, apparently folding upwards (involute) under drought stress or at night, with a central midvein and 6–7 pairs of lateral veins, the upper (adaxial) surface with veins with scattered appressed macrohairs 0.05–0.15 mm long, especially near the blade base and margins, the abaxial (lower) surface purple, glabrous, the blade margins antrorsely scaberulous. Female inflorescences barely protruding from middle and upper leaf sheaths, a reduced, contracted panicle bearing 2–5 spikelets, the branches and pedicels 0.3–1 mm long, filiform, glabrous, slightly cupulate at the apex; female spikelets 1–1.4 mm long, ultimately deciduous but the floret falling first; rachilla internode between glumes somewhat swollen and adherent to the base of the lower glume; glumes as long as spikelet, subequal, ovate-lanceolate, acute, green, membranous, somewhat laterally compressed, gaping 20–30° at maturity, 1–3-nerved, retrorsely pubescent with macrohairs ca. 0.2 mm long, the margins cartilaginous; floret 0.7–0.9 mm long, 0.35–0.45 mm wide, lanceolate-ellipsoid to ovoid, 3-nerved, white, shining, cartilaginous at maturity, deciduous, glabrous, the apex of the lemma acute and slightly cucullate; lemma much-enfolding the rounded, bicarinate palea, the palea of the same texture as

Fig. 1. Photograph of plant of *Raddiella vanessiae* showing leaf blades that fold involutely to expose their purple undersurfaces. Based on *Hequet 1281* (US).

the lemma; female flower with two subplumose stigmas. Caryopsis 0.65–0.95 mm long, 0.35–0.4 mm wide, ovoid-ellipsoid, tan to brown, glabrous, slightly dorsally compressed, the embryo basal, 0.1 mm long and 0.2 mm wide, the hilum short-linear, 0.15 mm long, dark brown, located about 0.1 mm above the base of the caryopsis. Male inflorescence a reduced panicle included in or barely protruding from terminal leaf sheath, consisting of just one or two spikelets on filiform, glabrous, slightly cupulate pedicels; male spikelets 1.1–1.2 mm long, narrowly lanceolate, hyaline, glabrous, soon deciduous; glumes absent, the lemma 3-nerved, the palea ca. 1 mm long, bicarinate; stamens 3, the mature anthers brown, 0.4–0.5 mm long.

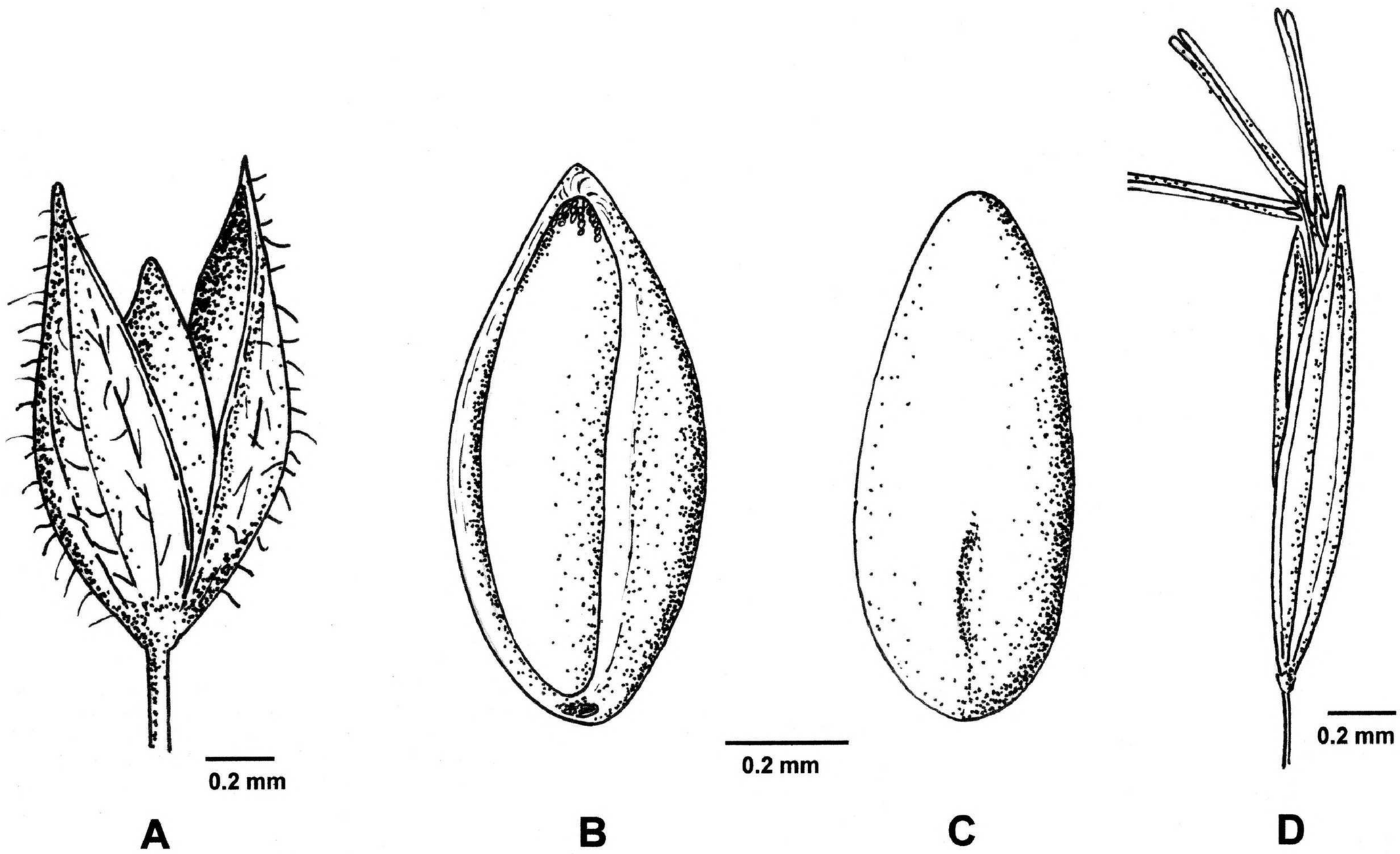

FIG. 2. *Raddiella vanessiae*. **A.** Female spikelet, lateral view showing gaping glumes and exposed apex of floret. **B.** Female floret, slightly oblique ventral view. **C.** Caryopsis, ventral view showing short-linear hilum. **D.** Male spikelet, lateral view. Based on *Hequet 1281* (US). Illustration by E.J. Judziewicz.

Additional collection examined (paratype): **FRENCH GUIANA:** Roura, savane marécageuse incluse dans la forêt á 8 km ESE du degrad de Roura [approximately 4°40'N, 52°20'W], bord de mare, trés petite herbs en touffes, sur la berge nue, au ras de l'eau; feuilles rougeâtres dessous; epillets axillaries, sessiles, vert clair, en partie caches dans les gaines foliares, 21 Apr 1979, A. *Raynal-Roques & J. Jérémie 21288* (CAY).

LEAF AND SPIKELET ANATOMY

A Hitachi S3400 scanning electron microscope was used in the environmental mode to record features of the leaves and spikelets of *Raddiella vanessiae*; uncoated, air-dried material was used. Hand cross-sections of the leaf blades were also made after softening in Pohlstoffe wetting agent. The descriptions below follow the format of Watson and Dallwitz (1992 onwards):

Abaxial leaf blade epidermis (Fig. 3). *Papillae* present and abundant in both costal and intercostal zones, simple, 4–5 μm in diameter, the *papillae* on intercostals long cells generally in two rows. *Intercostal long cells* with very sinuous walls. *Bicellular microhairs* present, elongated, clearly two-celled, ca. 40 μm long, the distal cell ca. 23 μm long, ca. 8 μm in diameter and remaining inflated in the SEM, the apical cell ca. 17 μm long and deflated by the SEM. *Stomata* common, 18–23 μm long, the subsidiary cells papillate (two on each but fairly inconspicuous). *Intercostal silica bodies* vertically elongated, ca. 20 μm tall, nodular.

Leaf blade transverse section. *Blade* ca. 40 μm thick at midnerve. *Mesophyll* consisting or a single abaxial palisade of arm cells. *Fusoid cells* absent. *Bulliform cells* in discrete, regular, intercostals, adaxial, fan-shaped groups of 3–6 cells, the largest cells 22–25 μm tall and 18–22 μm wide. *Marginal scabrae* 15–20 μm long. *Vascular bundles* all accompanied by sclerenchyma.

Female floret (Fig. 4). Floret smooth except for a few short vertical files of 6–12 μm long circular excavations or pits near the summit of the palea, or occasionally one or two ca. 40 μm long bicellular microhairs present on the uppermost margins of the lemma.

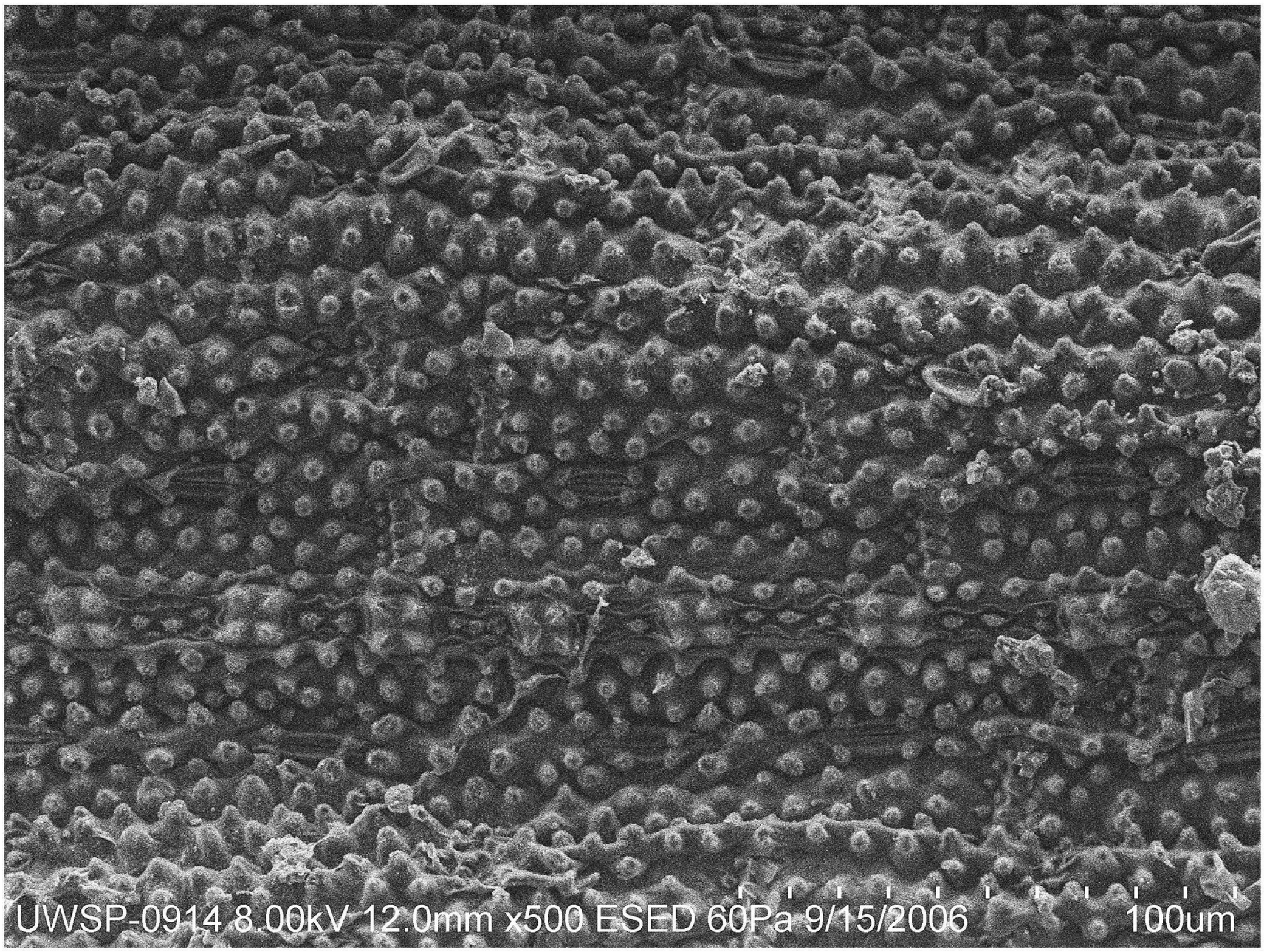

Fig. 3. Scanning electron micrograph of lower (abaxial) leaf blade surface of *Raddiella vanessiae* showing papillate long cells, stomates, bicellular microhairs with collapsed apical cells, and vertically oriented olyroid silica bodies. Based on *Hequet 1281* (US).

DISCUSSION

Raddiella vanessiae is the smallest bambusoid grass yet known, even smaller than *Raddiella minima* Judz. & Zuloaga (Zuloaga & Judziewicz 1991; Zuloaga et al. 1993; Judziewicz et al. 1999). Table 1 shows that both *R. minima* and *R. vanessiae* have smaller leaves than the endemic Cuban olyroid *Mniochloa pulchella* (Griseb.) Chase (Zuloaga et al. 1993). The new species appears to be related to both *R. minima* (known only from the Brazilian type collection made about 1600 km to the south of French Guiana) and the widespread Neotropical species *R. esenbeckii* (Steud.) C.E. Calderón & Soderstr. but is much smaller than either one. The new species is also distinguished from these related species by its smaller female florets and female lemmas that are slightly cucullate at the apex. The follow key distinguishes the three taxa in the *Raddiella esenbeckii* species complex:

1. Plants 8–40 cm tall, perennial; leaf blades 9–22 mm long, 4–11 mm wide, with fusoid cells present; female spikelets 1.9–2.7 mm long, the glumes firmly membranous, the floret 1.6–2 mm long; anthers 1.3–3 mm long; widespread in tropical South America, Trinidad, and Panama _____ **Raddiella esenbeckii**
1. Plants 1–6 cm tall, annual; leaf blades 2.7–6 mm long, 1.8–3.3 mm wide, with fusoid cells absent, at least in R. vanessiae; female spikelets 1–1.4 mm long, the glumes just membranous, the floret 0.7–1.2 mm long; anthers 0.4–0.6 mm long; rare endemics of tropical South America (French Guiana and Pará, Brazil)
   2. Plants 3–6 cm tall; leaf blades 4–6 mm long, 2.7–3.3 mm wide (area ca. 8.5–15.5 sq. mm); female glumes 3–nerved; female floret 0.9–1.2 mm long; hilum punctiform; southern Pará, Brazil _____ **Raddiella minima**
   2. Plants 1–2 cm tall; leaf blades 2.7–3.3 mm long, 1.8–2.1 wide (area ca. 3.8–5.5 sq. mm); female glumes 1–3-nerved; female floret 0.7–0.9 mm long; hilum short-linear; French Guiana _____ **Raddiella vanessiae**

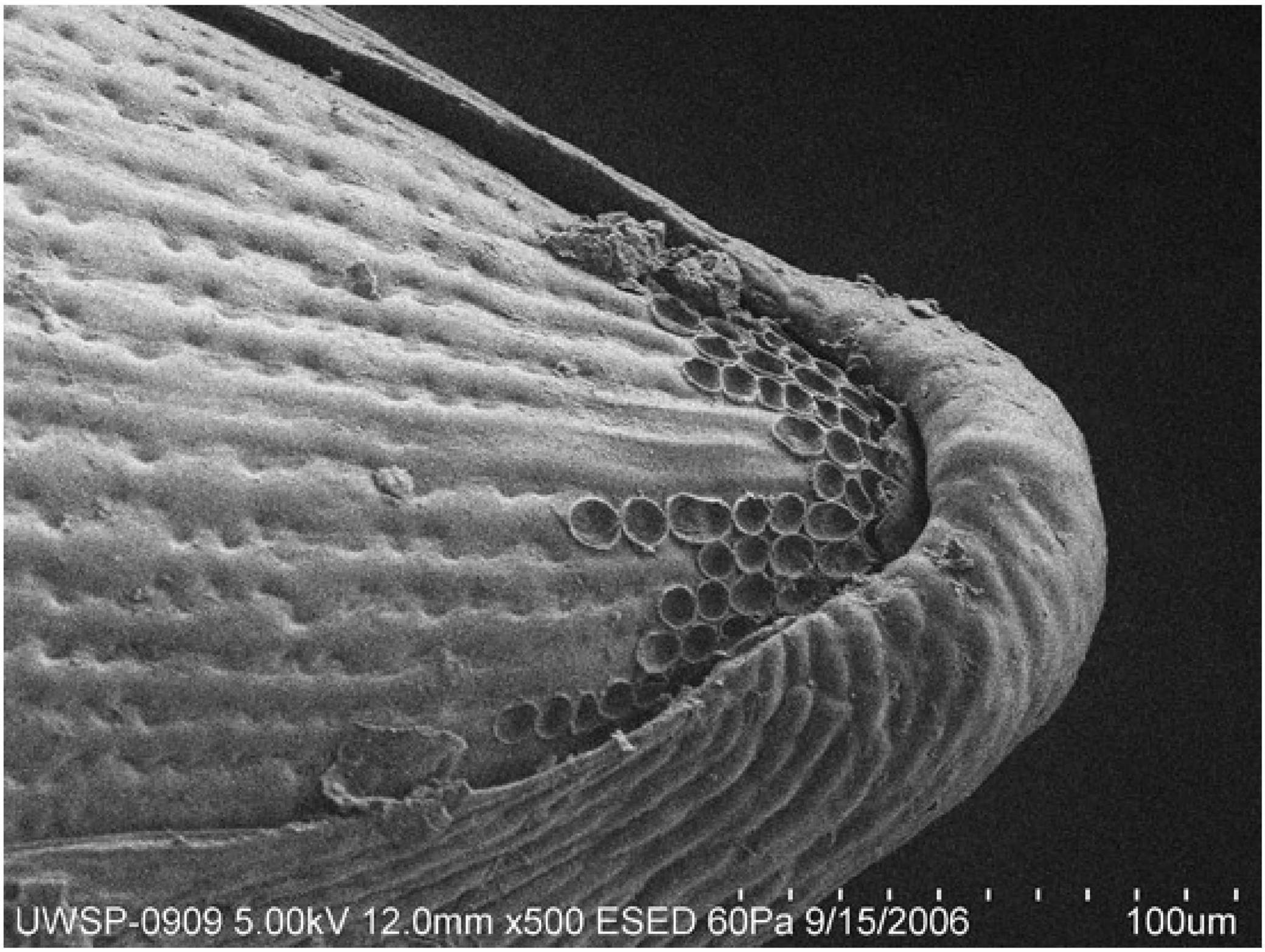

Fig. 4. Scanning electron micrograph of summit of ventral side of female floret of *Raddiella vanessiae* showing circular excavations or pits at summit of palea (note also the slightly cucullate apex of the enfolding lemma). Based on *Hequet 1281* (US).

All three species in the putative *Raddiella esenbeckii* complex share 1) asymmetrically-based leaf blades that are often anthocyanic (purple) beneath; 2) leaves that exhibit sleep movements (the blades folding upwards); 3) female spikelets with essentially glabrous, smooth, shining florets that fall before the tardily deciduous glumes; and 4) an open savanna rather than waterfall-base habitat. The remaining species of *Raddiella* generally have elliptical leaf blades lacking anthocyanic pigment and apparently not exhibiting sleep movements; female florets that are variously papillate throughout; and a waterfall-base (phreatophyte) habitat.

Raddiella vanessiae may be one of the few, or perhaps the only, member of the Bambusoideae with a truly annual habit. The Cuban herbaceous bamboos, although small, are all cormose perennials (Zuloaga et al. 1993); congeneric *Raddiella* species are apparently all perennial except possibly for *R. minima*; and the only other putative annual is *Olyra filiformis* Trin. from Bahia, Brazil, which is reported (Soderstrom & Zuloaga 1989) to be either a cespitose perennial or perhaps an annual. In any case it is a much larger plant 40–125 cm tall.

HABITAT

The type locality of *Raddiella vanessiae* is a lightly-vegetated savanna dominated by grasses (Poaceae), especially *Andropogon bicornis* L. and *Panicum cyanescens* Nees, and sedges (Cyperaceae) including *Rhynchospora holoschoenoides* (Rich.) Herter and *Scleria cyperina* Kunth. The soil is sandy and the lower parts of the savanna seasonally flood, but *Raddiella vanessiae* grows in the driest (highest) part, where it is uncommon (Chaix et al. 2002). See http://www.cayenne.ird.fr/aublet2/Selection_Collecteur.php3 for a complete list of Vanessa

TABLE 1. Comparison of *Raddiella vanessiae* with related species and *Mniochloa pulchella*. Approximate leaf blade area was calculated from the formula a = πlw/4 (the formula for the area of an ellipse), where l is leaf blade length and w is the blade width.

Character	*Raddiella esenbeckii*	*Raddiella minima*	*Raddiella vanessiae*	*Mniochloa pulchella*
Habit	Cespitose perennial	Annual?	Mat-forming annual	Cormose perennial
Plant height (cm)	8–40	3–6	1–2	3–12
Leaf blade length (mm)	9–22	4–6	2.7–3.3	7–15
Leaf blade width (mm)	4–11	2.7–3.3	1.8–2.1	2–4
Leaf blade area (square mm)	28–104	8.5–15.5	3.8–5.5	11–47
Fusoid cells	present or absent	?	absent	absent
Leaf blade sleep movements?	yes	yes	yes	no?
Female spikelet length (mm)	1.9–2.7	1–1.4	1–1.4	2.2–2.8
Female spikelet glume texture	firmly membranous; becoming blackish at maturity	membranous; remaining green at maturity	membranous; remaining green at maturity	delicately membranous, green at maturity
Female spikelet glume nerve number	3	3	1-3	3
Female floret length (mm)	1.6–2	0.9–1.2	0.7–0.9	2.2–2.8
Male spikelets/inflorescence	(1–)2–4	1	1 or 2	(3–)7–12
Male spikelet length (mm)	3–5	ca. 1.3	1.2	1.3–1.7
Anther length (mm)	1.3–3	0.6	0.4–0.5	0.8–1
Caryopsis length × width (mm)	1–1.2 × 0.7–0.8	0.7 × 0.6	0.65–0.95 × 0.35–0.4	1.5–2 × 0.5–0.6
Hilum morphology	short-linear	punctiform	short-linear	linear
Distribution	Panama, tropical South America, Trinidad	Southern Pará, Brazil	French Guiana	Cuba

Hequet's specimens (1238–1245, 1250–1263, 1268–1284) collected on 15 May 2001 in the Savane Lambert. Google Earth (http://earth.google.com/) shows "Savane Lambert" to be several square kilometers in area and situated about 20 km WSW of the city of Cayenne. The Raynal-Roques & J. Jérémie specimen of *Raddiella vanessiae* is from a swamp savanna on the Roura-Kaw road, about 27 km by air from the type locality.

Although widespread in South America, there are only two records of the related species *Raddiella esenbeckii* from French Guiana, from Passoura and the Savane des Singes (Judziewicz 1991), about 25 km NW of the type locality of *R. vanessiae*.

LEAF AND SPIKELET ANATOMY

The leaf anatomy of *Raddiella vanessiae* is more or less consistent with descriptions of the anatomy of *R. esenbeckii* (Watson & Dallwitz 1992 onwards) with one possible exception. Fusoid cells are absent in *Raddiella vanessiae*, but apparently can be either absent (Calderón & Soderstrom 1967; Renvoize 1985; this study, based on hand sections of *R. potaroensis* Soderstr. (*Redden et al. 1465,* Guyana, UWSP)), or present (Watson & Dallwitz 1992 onwards, based on *R. esenbeckii*; this study, based on hand sections of *R. esenbeckii* (*Schwab 491,* Aripo Savanna, Trinidad, UWSP) in species of *Raddiella*. While fusoid cells are a characteristic feature of the leaf blades of most species of the Bambusoideae, they are absent in several distantly related taxa in the herbaceous Olyreae (Judziewicz et al. 1999: 33), and this absence is probably a derived condition: the small Cuban genera *Ekmanochloa* Hitchc. and *Mniochloa* Chase (Zuloaga et al. 1993) and the Brazilian *Parodiolyra ramosissima* (Trin.) Soderstr. & Zuloaga (Renvoize 1985; Soderstrom & Ellis 1987) all lack fusoid cells.

In leaf blade transverse section, Watson and Dallwitz (1992 onwards) could not discern arm cells in *Raddiella esenbeckii*; however, these were easily visible in hand-cut sections of *R. vanessiae* blades and in blades of *R. esenbeckii* (based on *Schwab 491*). The micromorphology of the female floret of *Raddiella vanessiae* is similar to that of *R. esenbeckii* (Zuloaga & Judziewicz 1991): its surface is essentially smooth except for small longitudinal files of curious tiny "excavations" or "pits" at the summit of the palea that may represent

deflated cells. Seemingly identical "pits" are present on the female paleas of other olyroid bamboos such as *Parodiolyra lateralis* (Nees) Soderstr. & Zuloaga and various species of *Olyra* such as the widespread common species *O. latifolia* L. (Soderstrom & Zuloaga 1989).

ETYMOLOGY

At the suggestion of my colleague Isabelle Girard, we had considered naming this new species for the mythical country of Lilliput (from Jonathan Swift's novel *Gulliver's Travels*) where it would be an appropriately-sized bamboo for the use of the Lilliputians. Instead, we have chosen to recognize Vanessa Hequet, whose type collection and careful and detailed characterization of the species' savanna community habitat was so useful in preparing this paper. The epithet seems doubly appropriate: Vanessa was Swift's nickname for his close friend Esther Van Homrigh.

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