

Taxonomic novelties in *Manihot* (Euphorbiaceae) from Bolivia and adjacent areas

Novedades taxonómicas en *Manihot* (Euphorbiaceae) de Bolivia y áreas adyacentes

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Abstract: *Manihot coimbrana* is described and illustrated as a new species from dry forests in the Chiquitana region of Bolivia. Studies of collections in Brazilian herbaria show that the range of this species extends into Brazil. It is also discussed the taxonomic filiation of *Manihot boliviana* showing that it is distinct from *M. guaranitica* in which it has been included as a synonym. Morphological characteristics for each species are presented, also differences between both species and other related are provided together with ecological and distributional notes.

Key Words: Bolivia, Brazil, dry forest, endemic, lectotype, taxonomy.

Resumen: *Manihot coimbrana* es descrita e ilustrada como especie nueva de los bosques secos en la región de la Chiquitania de Bolivia. Estudios de colecciones, en herbarios de Brasil, muestran que la distribución de esta especie se extiende hasta Brasil. También se discute la filiación taxonómica de *Manihot boliviana* demostrando que es distinta e independiente de *M. guaranitica* bajo el que fue incluido como sinónimo. Características morfológicas de cada especie son presentadas; también diferencias entre ambas especies con otras, estrechamente relacionadas, son proporcionadas junto con notas ecológicas y de distribución.

Palabras clave: Bolivia, Brasil, bosque seco, endémico, lectotipo, taxonomía.

INTRODUCTION

The Bolivian lowlands comprise a varied landscape covered by a mosaic of different vegetation types, particularly in the Department of Santa Cruz, and constitute an important centre of plant diversity and endemism (Mamani *et al.* 2010, Beck 2014). Studies emphasize the importance of habitat heterogeneity as the principal factor behind the high levels of species diversity that characterize the region of the Parque Nacional Noel Kempff Mercado (Killeen & Shulenberg 1998). Likewise, the Inter-Andean dry valleys contain a specialised flora with high levels of diversity and endemism varying according to ecological conditions (Beck 2014) and characterised particularly by the abundance, diversity, and endemism of Cactaceae (Navarro 1996, Kiesling 1999 in Beck 2014). As part of this high diversity of ecosystems and habitats, grows naturally the species of *Manihot*.

Taxonomic knowledge of *Manihot* in Bolivia has increased considerably over the last ten years. Only three species: *Manihot anomala* Pohl, *M. condensata* Rogers & Appan and *M. guaranítica* Chodat & Hassl., were recognized from Bolivia by Rogers & Appan (1973), in the last treatment of the genus for the Neotropics. Recent studies by Mendoza (2007, 2010) have recognised 19 taxa, of which only ten have been formally described. Three of these nine taxa (morpho-species) were described as new species by Mendoza (2014) and of the remainder two are validated here as part of on-going studies in the genus, leaving four which are still not recognized formally.

MATERIALS AND METHODS

The description of species in this paper is based on the examination of herbarium specimens complemented by field observations made principally in Bolivian lowlands between 2007 and 2015. Herbarium specimens were examined from Bolivia (BOLV, HSB, LPB, USZ), from Brazil (CEN, COR, CGMS, MBM, R, RB, UB, UFG), also historical collections from United States of America (NY,

US), and high resolution digital images of type material at CORD, G, L and S available on JStor database were also examined. The figures in this paper, which illustrate the salient characteristics of each species, were made up from photographs of living plants.

TAXONOMIC TREATMENT

Manihot coimbrana M. Mend. *sp. nov.*

TYPO: BOLIVIA. Santa Cruz: Prov. Velasco, km 114 de Santa Rosa de la Roca camino a Piso Firme. 14°58'19"S, 61°29'39"W, 326 m, 5 Dic. 2010 (fl, fr), *J.R.I. Wood, D Villarroel & M. Mendoza 27079* (holotipo: USZ!; isotipos: K!, LPB!, UB!); Fig. 1.

Species nova affinis Manihot anomalae Pohl (1874: 448), sed ab ea indumento glaberrimo (non pubescenti vel tomentoso), stipulis foliaceis magnis, plus quam 15–25 mm longis, persistentibus (non setaceis, <5 mm longis nec caducis), foliis anguste peltatis (non epeltata), inflorescentia paniculata (non racemosa), floribus masculis solitariis pedicello florum feminarum medium versus vel infrauno flore masculino instructo (non flor masculinus deest), fructu costato (non laeve).

Erect to decumbent shrub, 2–4 m high; stems 2–3 erect, arising from a woody base, branching abundant, especially upwards; branches 2–5, normally decumbent and 3- to 4-chotomous. Leaves narrowly peltate, petiolate, alternate, spirally arranged, glabrous on both surfaces, adaxially lustrous dark green, abaxially intense green-glaucous; stipules foliaceous, persistent, entire or very rarely bifid, elliptic-lanceolate, 15–25 mm long, margin finely and sparsely dentate, glabrous; petioles cylindrical, (5-)8–15(-20) cm long; laminas membranous, 3–5-lobed, rarely an unlobed leaf present at inflorescence base; central lobes obovate to elliptic-obovate, (5-)8–11(-16) × (3-)4–5(-7) cm, margin entire, apex acuminate or sometimes rotund and mucronate, glabrous; venation brochidodromous, primary veins somewhat prominent abaxially; lateral lobes gradually reduced and asymmetric

at the base. Inflorescences many-flowered, generally apical, large, 10–15(-20) cm long, consisting of one central panicle and 3–4 lateral racemes, all arising from the same point; bracts and bracteoles caducous; bracts ovate-lanceolate to lanceolate, 2–3 × 0.5–1 mm, margin entire or sparsely ciliate, glabrous, apex attenuate; bracteoles reduced. Flowers pedicellate, glabrous on both surfaces, yellowish to greenish-cream, usually with reddish tinge internally; pedicels 8–12 mm long on staminate flowers, 25–35 mm long on pistillate flowers with one solitary staminate flower present in the middle part; staminate flowers short-campanulate, 8–9 × 6–7 mm, tube 4–5 mm long, tepal lobes slightly opened, 4–5 mm long, apex acute; pistillate flowers dialitepalous, opened, 10–12 × 9–10 mm, tepals erect, apex acute; stigma formed of 3 spatulate styles with the fused area at the base very small and not visible, apex papillose, white. Capsule globose, 15–16 mm, bright, glaucous-green; ribs somewhat prominent, apically purplish. Seeds (immature) narrowly elliptic, 7–8 × 4–4.5 mm; caruncle somewhat prominent, reniform from ventral side.

Additional specimens examined: BOLIVIA.

Santa Cruz: Prov. Ñuflo de Chávez, 1 km E of San Javier, 16°16'30"S, 62°30'00"W, 525 m, 30 Nov. 1990, *M. Nee & G. Coimbra 40080* (NY); entrando 67 km del cruce carretera central y, ca. 7–8 km antes de la comunidad Tacucito, camino hacia aserradero Monte Verde, 15°41'26"S, 62°06'39"W, 385 m, 4 May 2007, *M. Mendoza & C. Rivadeneira 2421* (USZ). Prov. Velasco, 17–18 km from Florida along road to Cerro Pelao, 14°35'42"S, 61°20'16"W, 203 m, 16 May 2010, *J.R.I. Wood, M. Mendoza & H. Huaylla 26828* (USZ, K, LPB, UB). **BRASIL. Mato Grosso:** Mun. Guaranta, 10 km a NE da cidade ao longo da rodovia BR-163 rumo a Cachimbo, 09°52'S, 55°03'W, 280 m, 6 Nov. 1998, *A.C. Allem 4759* (CEN); *ibid. 4760* (CEN), *ibid. 4761* (CEN), *ibid. 4762* (CEN). Mun. Jauru, Rod. MT-248, 16 km a O, 7 June 1995, *G. Hatschbach 62425* (CEN, MBM). Mun. Pontes e Lacerda, 104 km a NW de Lacerda, ao longo da rodovia BR-174

rumo a Vilhena, sítio do Sr. Gentil Rodrigues, distrito de Lacerdinha, 14°18'S, 59°39'W, 340 m, 8 June 1992, *A.C. Allem 4033* (CEN); Rod. BR-174, próximo do Córrego Bugres, 16 Ago. 1997, *G.G. Hatschbach 66943* (CEN, MBM). Mun. Porto Espiadão, Rodovia entre Destacamento Militar de Santa Rita e Fortuna, 11 Nov. 1996, *G.G. Hatschbach 65519* (CEN, MBM). **Rondônia:** Mun. Pimenta Bueno, BR-364, km 543 Vilhena – Porto Velho, Fazenda São João; Km 163 Vilhena – Porto Velho, 200 m, 15 Oct. 1985, *A.R. Miranda & W.L. Werneck 965* (CEN); *ibid. 966* (CEN), *ibid. 967* (CEN).

Distribution and ecology: Tropical forest species with reduced distribution in Bolivia and Brazil. In Bolivia, it is restricted to a small area between the provinces of Ñuflo de Chávez and Velasco in Department of Santa Cruz. In Brazil, it extends to the states of Mato Grosso and Rondônia. It grows in flat to slightly undulating areas, on heavy hard soils poor in organic matter, from 200 to 500 m and which are covered by well-preserved tropical humid forest in areas of transition with dry and semi-deciduous chiquitano forest, with presence of *Attalea phalerata* Mart. ex Spreng. (motacú), *Attalea speciosa* Mart. (cusi), and *Anadenanthera colubrina* (Vell.) Brenan. (curupaú) as indicator species.

Phenology: It was collected in flower from November to March and in fruit from January to June.

Etymology: The specific epithet is in honors to German Coimbra Sanz, one of the first to study the botany of the Bolivian lowlands, especially wild fruits and their uses.

Discussion: *Manihot coimbrana* is distinguished by the presence of persistent, foliaceous stipules, 15–25 mm long; by leaves narrowly peltate, lustrous dark green leaves which are adaxially an intense green-glaucous; by the paniculate inflorescence, pedicel of the pistillate flowers with one solitary staminate flower in the middle part; by globose fruits with moderately prominent ribs. Morphologically it is similar to *Manihot anomala* with which it

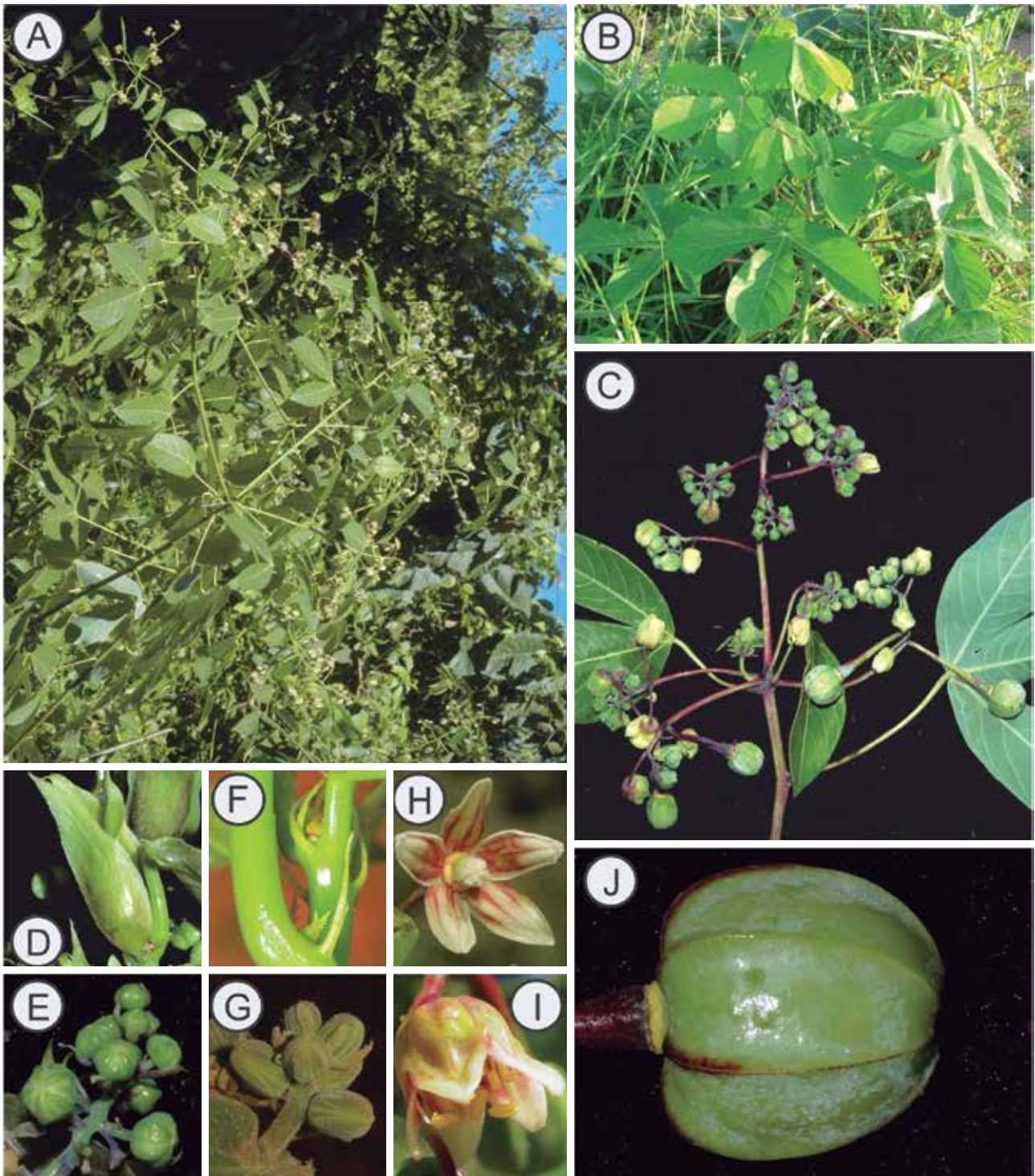


Fig. 1: *Manihot coimbrana*. A) Habit. B) Sterile branch. C) Inflorescence. D) Stipule. E) Immature inflorescence, with detail of bracts and floral buds. H) Pistillate flower. I) Staminate flower. J) Capsule. *Manihot anomala*. F) Stipule. G) Immature inflorescence, with detail of bracts and floral buds. [A-E, H, I: from type - Wood 27079. F: from Mendoza 5156. G: from Mendoza 5048].

shared growing habit with branches erect to decumbent and 3- to 4-chotomous, similar leave blades (when, they are 3-lobate), and gamotepalous pisitillate flowers. *Manihot anomala* differs from *Manihot coimbrana* by having a pubescent to tomentose indumentum, early caduceus, setaceous stipules, <5 mm long; leaves not peltate, the lobes usually pandurate; inflorescence of usually 3–4 racemes or sometime of one central short, reduced panicle and 2–3 lateral racemes, pedicel of pistillate flowers without any staminate flower, pedicels of staminate flowers 0–3 mm long; fruits globose without ribs.

Mendoza (2010) recognized this taxon under the provisional name of *Manihot* sp9 – chiquitania (Santa Cruz).

Manihot boliviana Pax. Journal of Botany, British and Foreign 12: 230. 1874.

TYPE: BOLIVIA. Santa Cruz: Charagua, Dec. 1910, *T. Herzog 1233* (lecto-: L!, designated here; isolecto-: S!); Fig. 2.

Erect shrub, 1–2 m high, usually with a single, robust central stem arising from the base, branching moderate from the middle of the stem, increasing upwards; branches 2–4, erect to spreading, normally dichotomous. Leaves very narrowly peltate (rarely not peltate), petiolate, alternate, spirally arranged; stipules setaceous, caducous, entire or dentate, or sometimes bifid with margin entire (on the same branch), 4–6 mm long, glabrous; petioles cylindrical, (3.5-)5–9(-12) cm long; laminas membranous, 3–5-lobed; central lobes obovate to elliptic-obovate, 5–8 (-10) × 3–5 cm, margin entire, very rarely slightly pandurate, apex acuminate to acuminate-attenuate, glabrous on both surfaces, adaxially green to glaucous-greenish, abaxially intense glaucous to glaucous-silver; venation broquidodromous, primary veins somewhat prominent abaxially; lateral lobes gradually reduced and slightly asymmetric in the base. Inflorescences many-flowered, reduced to medium, 3–5(-8) cm long, formed of one long

central raceme (rarely with a small branch near the base) and 2–3 reduced lateral racemes, all arising from the same point; bracts and bracteoles caducous; bracts setaceous, linear-lanceolate, 4–5 × 0.4–0.5 mm, margin entire, apex long attenuate, glabrous; bracteoles reduced. Flowers pedicellate, glabrous on both surfaces, greenish to white with a green tinge; pedicels jointed at the base of the flowers 8–10(-12) mm long on staminate flowers, 10–12 mm long on pistillate flowers; staminate flowers globose-campanulate, 9–10 × 7–8 mm, tube 4–5 mm long, tepal lobes slightly opening, 4–5 mm long, apex acute; pistillate flowers dialitepalous, opened, 9–10 × 10–13 mm, tepals erect to slightly reflexed, apex acute; stigma formed of 3 separate styles, the fused area at the base very evident, apex moderately papillose, white to cream. Capsule globose-conical, 20–22 × 15–18 mm, strongly glaucous to silvery-glaucous with blackish tinge (especially at base); ribs very prominent with tinge blackish upwards. Seeds (immature) elliptic, 11–12 × 8–9 mm; caruncle prominent, subreniform (from ventral side), base entire.

Additional specimens examined: BOLIVIA.

Sucre: Prov. Luis Calvo, ca. 25 km SO de Cuevo, pasando la Estancia Morocuapira por el camino a Igëmbé, 20°31'10"S, 63°36'16"W, 1186 m, 09 Feb 2008, *M. Mendoza et al. 2749* (K, LPB, NY, USZ). **Santa Cruz:** Prov. Cordillera, Abapó, ca. 2.5 km pasando el Río Grande, carretera Abapo–Camiri, 18°55'53"S, 63°23'40"W, 461 m, 08 Feb 2008, *M. Mendoza et al. 2706* (K, LPB, NY, USZ); carretera Abapó – Camiri, ca. 2 km pasando puente de Río Grande, 18°55'52"S, 63°23'42"W, 465 m, 30 Dic. 2015, *M. Mendoza 5146* (CEN, CGMS, HSB, HUEFS, K, LPB, MG, MO, NY, SP, USZ); Cuevo, adentro de la sierra, cerca de la planchada de Chevron, 29 Dic 1994, *A. Jardim 1563* (USZ); Camiri, ca. 9.5 km de Cuevo camino a la Planchada, 20°26'43"S, 63°35'17"W, 1123 m, 09 feb 2008, *M. Mendoza et al. 2757* (K, LPB, USZ); ca. 16.3 km de la plaza central de Cuevo, camino a Mandiuti, 20°27'31"S, 63°37'51"W, 1406 m, 15 Ene 2016,

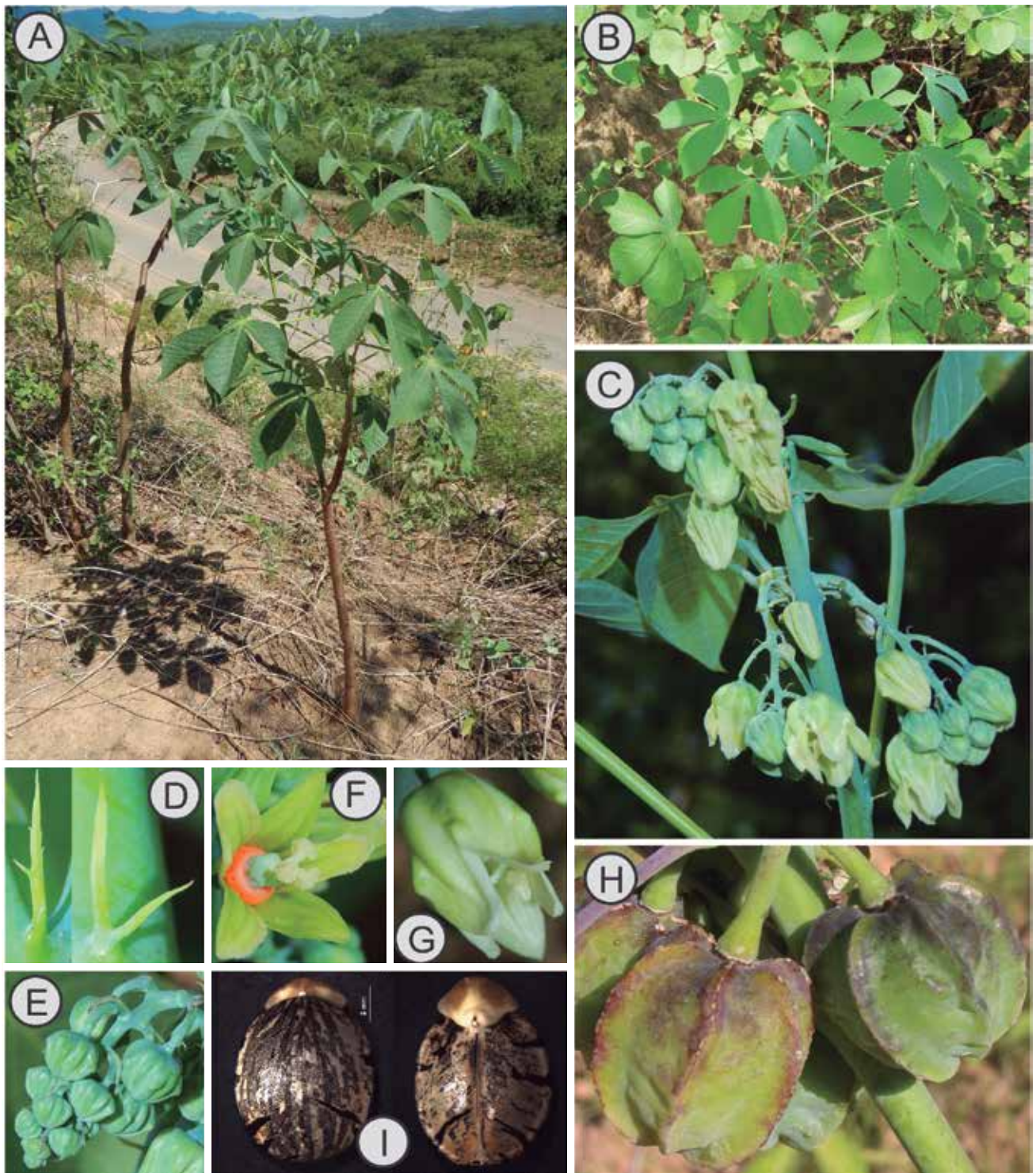


Fig. 2: *Manihot boliviana*. A) Habit. B) Sterile branch. C) Inflorescence. D) Stipules and their variation. E) Immature inflorescence, with detail of bracts and floral buds. F) Pistillate flower. G) Staminate flower. H) Capsule. I) Seeds. [A-G, from Mendoza 5146. H from Mendoza 2706. I from Villarroel 4136].

M. Mendoza et al. 5160 (K, HSB, LPB, MO, NY, USZ). Prov. Vallegrande, Masicurí, Jardín Botánico, a 12 km de la ciudad, del mirador al bosque húmedo, 18°52'41"S, 63°44'35"W, 13 Nov 2009, A. Parada 2513 (MO, USZ).

Distribution and ecology: Endemic to the Inter-Andean dry valleys, restricted to a reduced strip between the Departments of Santa Cruz and Chuquisaca in Bolivia. This species is so far known from dispersed populations in the Provinces of Cordillera and Vallegrande in Santa Cruz, and one adjacent small population in Luis Calvo Province of Chuquisaca, but based on geographical proximity and the presence of a similar habitat, this taxon might be expected in Tarija Department. It grows on loose rocky (sometime red sandstone) slopes with steep to moderate inclination, at elevations of 460 to 980 m in Serrano Chaqueño forest and dry valleys vegetation with pronounced chaco influence, where indicator species include: *Anadenanthera colubrina* (Vell.) Brenan. (curupaú), *Schinopsis haenkeana* Engl. (soto), and *Capparis retusa* Griseb. (porotillo).

Phenology: Collected in flower and fruit from November to February.

Discussion: *Manihot boliviana* is distinguished from others species by having leaves very narrowly peltate, glaucous to glaucous-silver in colour (more visible on live plants), leaf lobes entire (very rarely pandurate) and fruits 20–22 mm long, conical and with strongly prominent ribs. Morphologically it is similar to *Manihot anisophylla* Müll. Arg. (1874: 230), with which it shares 3–5-lobate leaf blades, leaves coloured glaucous to glaucous-silver, flowers pedicellate; the pistillate flowers dialitepalous and the staminate flowers globose-campanulate. *Manihot anisophylla* (Fig. 3) differs from *Manihot boliviana* by the leaves not peltate, lobes normally pandurate (rarely entire) and the fruits 12–14 mm long, elliptic to subelliptic, the ribs scarcely prominent; the seeds are small, 7–8 mm long and the caruncle reniform with the base bilobed.

The principal morphological differences that distinguish these two taxa are also presented in Table 1. In *Manihot anisophylla* other distinctive character that are also observable in herbaria include: inflorescence in racemes, with pedicels of the basal flowers reaching the level of the buds, acquiring an appearance of corymbiform inflorescence; in contrast, in *M. boliviana* the inflorescence is formed of a normal raceme, without appearance of corymb, the pedicel much reduced in relation to the apical floral buds. Two other interesting morphological characters not observable on herbaria specimens are found in the stem. In *M. anisophylla* the stem is pentagonal in cross-section and the internal structure is formed of five distinctive and lignified areas (Fig 3D), whereas in the other species including *M. boliviana* the stem is cylindrical and cross-section shows concentric rings.

This taxon was originally described as *Manihot boliviana* by Pax (1914: 402), who made a complete description based on the type material (*T. Herzog 1233*). He compared it with *Manihot recognita* Pax (1910: 91), highlighting the diagnostic morphological characters of *Manihot boliviana*: leaves, rarely not peltate “*rarius epeltatus*”, ovary winged “*ovarium alatum*” characteristics evidently observable on the specimens reviewed here, under *M. boliviana*. In more recent times Rogers & Appan (1973) considered this taxon to be a synonym of *Manihot guaranitica* Chodat & Hassler (1905: 671), but subsequently recognized it as *Manihot guaranitica* subsp. *boliviana* (Pax) Rogers & Appan (1973: 112). More recently, Mendoza (2010) treated this taxon as different from other known species in Bolivia and described it as “*Manihot* sp4 – chaco (Santa Cruz)”. It is here recognized as *Manihot boliviana*.

In reality, *Manihot boliviana* is more closely related morphologically to *M. anisophylla* than to *M. guaranitica*, the differences between these two species being very evident from the colour of both living plants and herbarium specimens. Thus, *Manihot guaranitica* differs from *M. boliviana* by the foliaceous entire

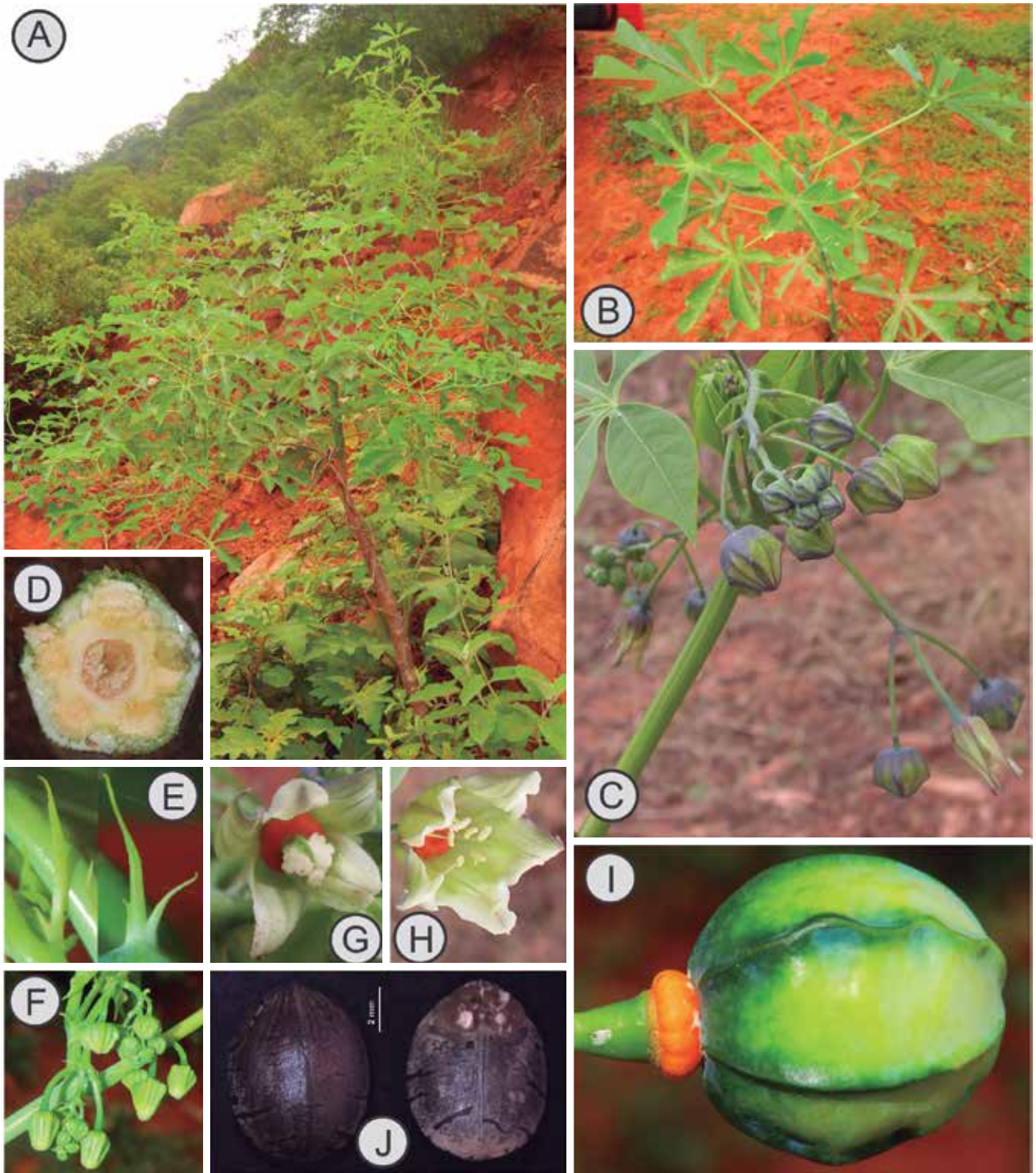


Fig. 3: *Manihot anisophylla*. A) Habit. B) Sterile branch. C) Inflorescence. D) Cross-section of stem, showing pentagonal form and internal details. E) Stipules and their variation. F) Immature inflorescence, with detail of bracts and floral buds. G) Pistillate flower. H) Staminate flower. I) Capsule. J) Seeds. [A-B, E-F, I-J: from Mendoza 5146. C-D, G-H from Mendoza 2658].

Table 1. – Morphological differences among *M. boliviana*, *M. anisophylla*, *M. coimbrana*, and *M. anomala*

	<i>M. boliviana</i>	<i>M. anisophylla</i>	<i>M. coimbrana</i>	<i>M. anomala</i>
Indumentum	Glabrous.	Glabrous.	Glabrous.	Usually pubescent to tomentose
Leaves	Very narrowly peltate 3–5-lobate, lobes entire (never pandurate).	Not peltate, 3–5-lobate, lobes entire (never pandurate).	Narrowly peltate, 3–5-lobate, rarely an unlobed leaf present at inflorescence base, lobes entire (never pandurate)	Not peltate, 3–5-lobate, unlobed leaves at inflorescence branches, lobes frequently pandurate.
Stipules	Setaceous, caducous, 4–6 mm long, entire or bifid, margin entire or dentate.	Setaceous, caducous, 4–6 mm long, entire or bifid, margin finely dentate	Foliaceous, persistent, entire, 15–25 mm long, margin dentate.	Setaceous, early caducous, entire, <5 mm long, margin entire.
florescence	One long central raceme (rarely with one small side branch) and 2–3 lateral racemes	One long central raceme (without small side branches) and 2–3 lateral racemes	One long central panicle and 3–4 lateral racemes.	One long central raceme and 2–3 lateral racemes or one reduced panicle and 2–3 lateral racemes.
Pedicels of pistillate flowers	Without any staminate flowers.	Without any staminate flowers	With a solitary staminate flower in the middle part	Without any staminate flowers.
Fruits	Sub-globose-conical, 20–22 mm long, ribs very prominent	Elliptic, 12–14 mm long, ribs slightly prominent	Globose, ribs slightly prominent.	Globose, ribs absent
Seeds	Broadly elliptic, 11–12 mm long, caruncle subreniform, base entire	Shortly elliptic, 7–8 mm long, caruncle reniform, base bilobed	Not seen	Oblong-elliptic, 9–10 mm long, caruncle broadly triangular, base entire

dentate-margined stipules, narrowly peltate, greenish to yellowish-green leaves with lobes deeply pandurate; foliaceous, oblong-lanceolate, dentate-laciniate bracts, tubular-campanulate staminate flowers, usually with a purplish tinge and longitudinal lines externally and internally. Additionally the fruits are globose, 15 mm in diam., smooth and without ribs.

Based on the information here presented, it concluded that *Manihot boliviana* is sufficiently different morphologically from *Manihot guaranitica*, to justify its acceptance as a separate species.

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