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Three new endemic species of *Manihot* (Euphorbiaceae) from the Chapada dos Veadeiros, Brazil

Três novas espécies endêmicas de *Manihot* (Euphorbiaceae) da Chapada dos Veadeiros, Brasil

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Resumo

Durante trabalho de campo e herbário focado na taxonomia e filogenia do gênero *Manihot* do bioma Cerrado, foram encontradas três novas espécies endêmicas das terras altas da Chapada dos Veadeiros do Brasil central. *Manihot debilis, Manihot minima* e *Manihot robusta* são descritas e ilustradas. Características morfológicas que diferenciam estas espécies dos táxons mais relacionados, como também comentários sobre aspectos ecológicos e distribuição natural para cada táxon, são adicionados.

Palavras Chave: Parque Nacional Chapada dos Veadeiros, Brasil, Cerrado, Endémico, Euphorbiaceae, *Manihot*, Taxonomia.

Abstract

During field and herbarium work focused on the taxonomy and phylogeny of the genus *Manihot* from the Cerrado biome, we found three new species endemic to the Chapada dos Veadeiros highlands of central Brazil. *Manihot debilis, Manihot minima* and *Manihot robusta* are described and illustrated. Morphological characteristics that differentiate these species from closely related taxa as well as comments on ecological aspects and natural distribution are provided.

Keywords: Chapada dos Veadeiros National Park, Brazil, Cerrado, Endemic, Euphorbiaceae, *Manihot*, Taxonomy.

Introduction

The Chapada dos Veadeiros in central Brazil (Goiás state) is a highland area formed by a heterogeneous landscape with different vegetations types within the Cerrado biome and is notable for its rich and highly endemic flora, especially in families such as Asteraceae, Eriocaulaceae, Leguminosae, Lythraceae, Melastomataceae, Poaceae and Velloziaceae (Munhoz & Proença 1998; Simon & Proença 2000). Floristic inventories in the region included the project "Planalto Expedition Program" a collaboration between the NYBG and the University of Brasilia carried out between 1965 and 1975, that included a number of expeditions to the Chapada dos Veadeiros. After that, more sporadic surveys by Brazilian botanists have been conducted (Simon & Amaral 2003; Munhoz & Felfili 2006; Chaves & Soares-Silva 2012). A compilation of the Chapada dos Veadeiros flora recorded 1,310 species (Munhoz & Proença 1998), but this number is certainly underestimated since a number of new species have been described in the last 15 years, and also because large areas remain botanically unexplored due to difficult access. The region harbours the Chapada dos Veadeiros National Park (65,514 ha), but the flora of this reserve is largely unknown. Recent field and herbaria studies in different botanic families have showed a significant increment of species for the region, including the description of new species of Diplusodon (Lythraceae; Cavalcanti 2007; 2011; Polygala (Polygalaceae; Pastore & Mervyn 2009), Syagrus (Palmae; Noblick & Lorenzi 2010), *Utricularia* (Lentibulariaceae; Souza & Petean 2011), *Chamaecrista* (Leguminosae-Caesalpinioideae; Silva & Souza 2014). The number of new species described in the area suggests that the floristic inventory of the Chapada dos Veadeiros is far from complete, and therefore botanists are urged to explore in detail the flora of this important centre of endemism.

The most recent taxonomic treatment

for the genus *Manihot* Mill. (Euphorbiaceae) is the work of Rogers & Appan (1973). These authors recognized 98 species in the Neotropical region, of which 80 were found in Brazil, 37 species are registered for the Cerrado, including 20 endemics (Rogers & Appan 1973). In recent years, the taxonomic studies on *Manihot* have had an important advance, including the description of a number of new species for the Chapada dos Veadeiros (Silva & Sodré 2014; Silva 2014b, 2015; Silva *et al*., 2013). This region has been shown to be an important centre of diversity and endemism for the genus, since Silva (2014a) reported 28 species of *Manihot*, 17 endemic to Goiás state, and 8 restricted to the Chapada dos Veadeiros. As another contribution to the flora of the Chapada dos Veadeiros, here we describe three new endemic species.

Material and methods

Exsiccates deposited in herbaria: CEN, HB, HRCB, HUEFS MG, K, LPB, MO, NY, R, RB, SP, SPF, UFG, UB, USZ were reviewed. Complemented by several in-situ observations for each species, which were made between February 2013 and April 2015. Line illustrations based in type specimens and illustrative sheets organized from photographic images of live plants, that highlight salient features of each species is provided

Results

Taxonomic treatment

1. *Manihot debilis* M. Mend. & T. B. Cavalc. sp. nov. (Fig. 1- 2)

TYPE: BRAZIL. Goiás: Alto Paraíso de Goiás. São Jorge, GO-239, ca. 3 km de São Jorge, sentido Colinas do Sul, 14°11′35″S, 47°50′07″W, 890 m, 13-XI-2014, *M. Mendoza, T. Reis & A.A. Santos 4404* (holotype: CEN!; isotypes: K!, LPB!, MO!, NY!, UB!, USZ!).

Diagnosis

Species nova valde distincta; inflorescentia longiracemosa, multiflora; foliis laminis semper 3-lobatis, basi valde cordata instructis; floribus staminatis longipedicillatis, pedicellis 6–10 mm longis; floribus pistillatis gamotepalis.

Erect perennial herbaceous, 15–26 cm high. Central stem arising from a woody base; moderately to abundant branching; branches 1–3, erect and dichotomy, usually after inflorescence or rare from near to base. Leaves not peltate, petiolate, spirally alternate, glabrous on both surfaces; stipules caducous, setaceous filiform, 1.5–3 mm long, margin entire, glabrous; petioles cylindrical (2-)4–8(-17) cm long; laminas membranaceous, base cordate, strictly 3-lobed, rarely a non-lobate cordate leave at inflorescence base; central lobe symmetric, oblong to oblong-lanceolate, (1.7-)4.5–8 (-10.5) × 0.5–0.12(-2) cm; margin entire, apex acuminate and apiculate; venation brochidodromus, primary veins slightly prominent in adaxial surface; lateral lobes reduced, asymmetric and prominent at base. Inflorescences multiflora, 3–5(-8.5) cm long, formed of one long central raceme, and 2–3 short lateral racemes, arising the same point; bracts and bracteoles caducous; bracts setaceous, linear-lanceolate, 2–3 × 0.3–0.5 mm, margin entire, apex attenuate, glabrous; bracteoles reduced. Flowers pedicelate, glabrous in outer surface and few simples hairs on inner surface, greenish or green-glaucous; pedicels 6–10 mm long on staminal flowers, 4–5 mm long on pistillate flowers; staminal flowers tubular-campanulate slightlopening 11–13 × 5–7 mm, tube 7–8 mm long, tepal lobe reflexed, 4–5 mm long, apex acute and mucronate; pistillate flowers gamotepalous, tubular-

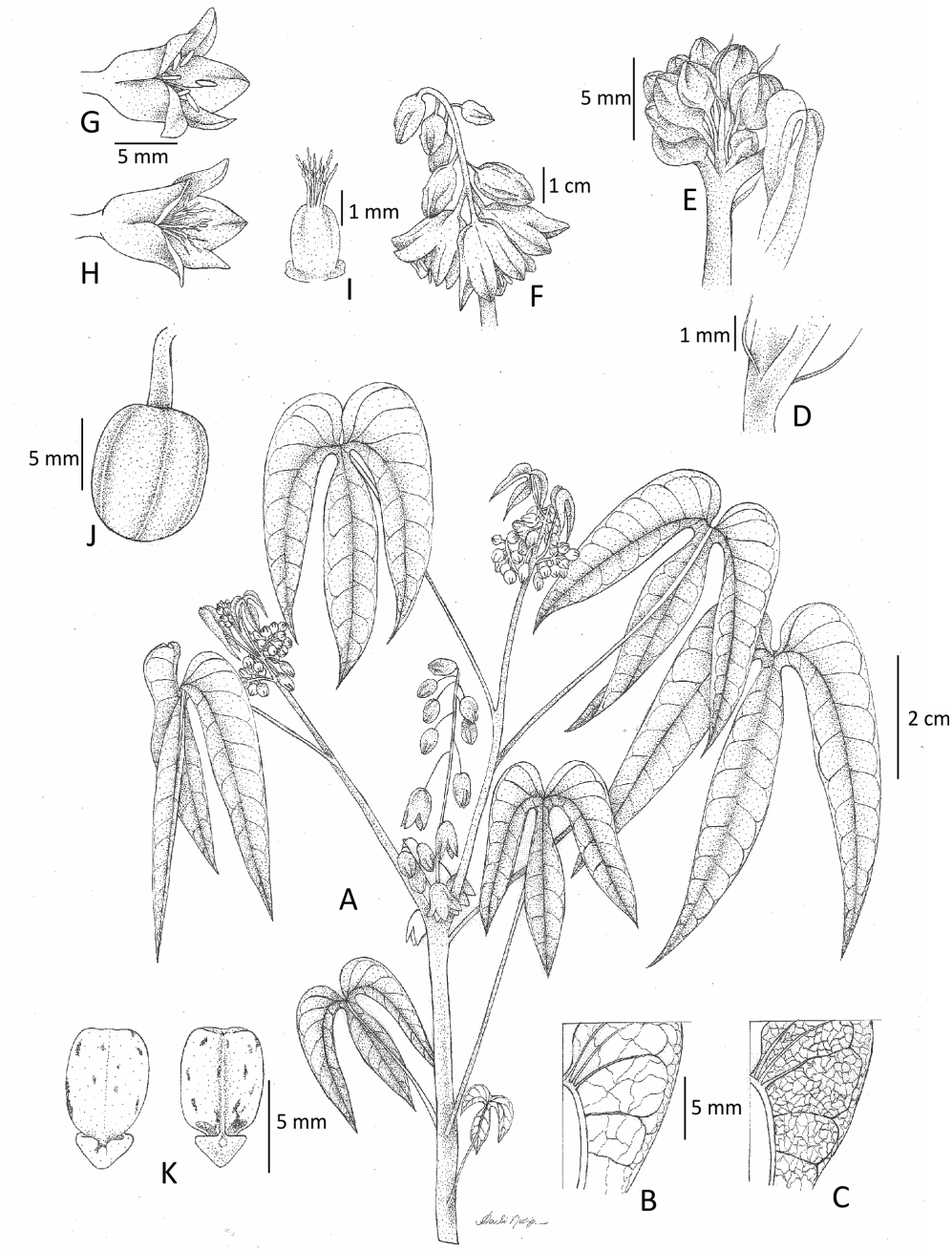

Fig. 1. ***Manihot debilis***. A. Fertile branch; B. Detail of leaf venation, abaxial surface; C. Detail of leaf venation, adaxial surface; D. Stipules; E. Immature inflorescence with detail of bracts; F. Inflorescence; G. Staminal flower; H. Pistillate flower; I. Ovary and stigma; J. Capsule; K. Seeds. [A-H, from type - *Mendoza 4404*; J-K, from *Mendoza 4820*].

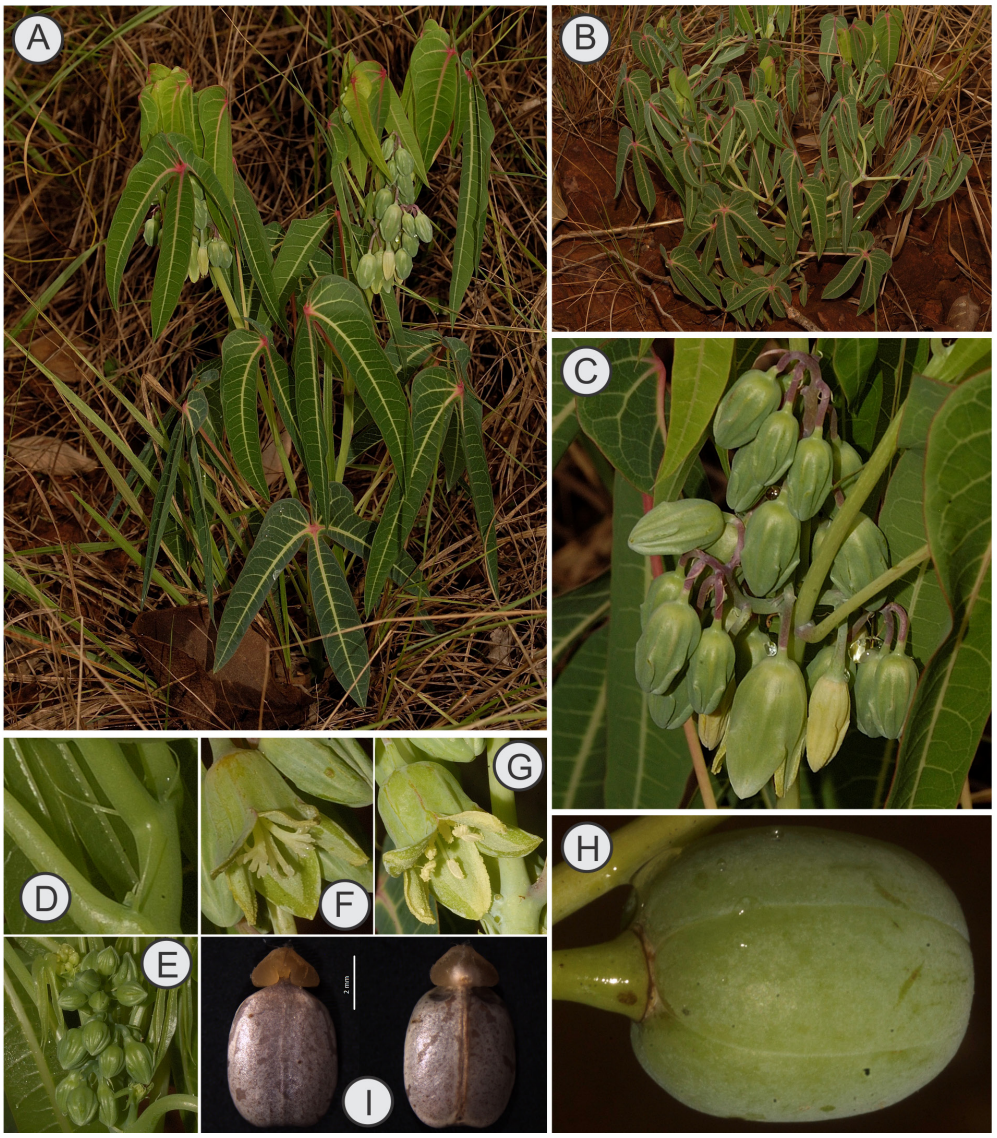

Fig. 2. ***Manihot debilis***. A. Habit, fertile plant; B. Habit old sterile plant; C. Inflorescence; D. Stipule; E. Immature inflorescence, with detail of bracts; F. Pistillate flower; G. Staminal flower; H. Capsule; I. Seeds. [A-H, from type - *Mendoza 4404*; J-K, from *Mendoza 4820*].

Table 1. – Morphological differences between *M. debilis* and *M. minima* in relation to closely related species *M. kalungae* and *M. pusilla*

	M. debilis	*M. kalungae*	*M. minima*	*M. pusilla*
Plant size	15–26 cm tall.	11–40 cm tall.	5–15 cm high.	15–40 cm tall.
Stipules	Setaceous or filiform, entire 1.5–3 mm long, caducous.	Setaceous, entire, 5–13 mm, persistent.	Setaceous, bifid from base, 9–12 mm long, caducous.	Foliaceous, entire to pinnately sectate, 30–80 mm long, caducous.
Lamina	Strictly 3-lobate, rare not lobed and cordate at inflorescence base, flat.	Always non-lobed, and cordate or narrowly cordate, flat.	5–7 lobed, flat.	7–11 lobed, falcate.
Infloresc.	3–5 cm long, one long central raceme, and 2–3 short lateral racemes.	2.5–3 cm long, one central solitary raceme.	4–5 cm long, one central panicle and 3–6 reduced lateral racemes.	7–15 cm long, 1–2 central racemes and 2–3 short lateral racemes.
Pedicels in male flowers	6–10 mm long.	1–2 mm long.	4–5 mm long.	7–11 mm long.
Pistillate flowers	Gamotepalous.	Dialitepalous.	Gamotepalous.	Gamotepalous.
Stamen	Glabrous.	Pubescent.	Glabrous.	Glabrous.
Bracts, bracteoles	5–7 mm long, entire.	6–7 mm long, entire.	Less than 7 mm long, entire.	8–14 mm long, lacinate.
Caruncle	Moderately prominent, broadly triangular in both side.	Prominent, narrowly triangular in dorsal side.	Strongly prominent, reniform.	Prominent, subreniform,

campanulate, slightly opening, 8–10 × 5–6 mm, tube 7–8 mm long, tepal lobe reflexed, 3–5 mm long, apex acute and mucronate; stigmas cream or yellow-green. Capsule sub-cylindrical, 8–10 × 7–8 mm, smooth, glaucous-green; ribs absent but fine whitish lines replacing ribs. Seeds semi-elliptic, 6–7(-8) × 4–5 mm, caruncle moderately prominent, broadly triangular in both side, apex rotund.

Additional specimens examined

BRAZIL. Goiás: Alto Paraíso de Goiás. ca. 3.6 km de São Jorge, sentido Colinas do Sul, 14°11′39″S, 47°50′25″W, 893 m, 13-XI-2014, *M. Mendoza, T. Reis & A. A. Santos 4396* (CEN); Estrada de São Jorge para Colinas do Sul, ao lado da entrada do Raizama, 1-II-2004, *J. F. B. Pastore et al. 782* (CEN); GO-239.- ca. 3 km de São Jorge, sentido Colinas do Sul, 14°11′35″S, 47°50′07″W, 890 m, 4-III-2015, *M. Mendoza, T. Reis, J. B. A. Bringel & A. A. Santos 4820* (CEN, K, LPB, NY, UB, USZ,).- São Jorge após mata seca, à esquerda, 20-I-2012, *M. J. E. C. Júnior 156* (UFG).

Distribution and Ecology: Endemic to the state of Goiás. According to the information of specimens collected, this species is restricted to the area around the São Jorge village, in the municipality of Alto Paraíso de Goiás, where it grows in well-preserved grassland slopes and also in moderately disturbed areas, always in fragments of campo limpo, surrounded by

cerrado stricto-sensu vegetation, in rocky soils of mountainous areas, at elevations up to 900 m altitude.

Phenology: It was collected in flower from November to December and fruits from February to March.

Etymology: The specific epithet alludes to delicate appearance of the species, which was observed in all individuals studied.

Discussion

Manihot debilis can be recognized by its large inflorescence in relation to plant size, leaves 3-lobate with blades totally flat and pistillate gamotepalous flowers. In some sense, this species in vegetative state can be confused with *M. kalungae* M. J. Silva & R. C. Sodré, which morphologically shares the delicate habit, stipule filiform, green-glaucous colour (more evident in herbarium specimens) and cordate leaves (when *M. debilis* present not lobed leaves at inflorescence base). In contrast to *Manihot debilis, M. kalungae* has a reduced inflorescence (2.5–3 cm long), leaves always non-lobed with cordate lamina, pistillate flowers dialitepalous, staminal flowers short-pedicelate, 1–2 mm long (Table 1).

2. *Manihot minima* M. Mend. & T. B. Cavalc. sp. nov. (Fig. 3- 4)

TYPE: BRAZIL. Goiás: Alto Paraíso de Goiás. GO-239, ca. 12,7 km de Alto Paraíso de Goiás, e entrando, ca. 4,6 km sentido Mulungú, 14°07′46″S, 47°38′19″W, 1211 m, 13-XI-2014, M. *Mendoza, T. Reis & A. A. Santos 4405* (holotype: CEN!; isotypes: K!, LPB!, NY!, RB!, UB!, USZ!).

Diagnosis

Species nova Manihot pusillae Pohl affinis, sed distincta habitu minore, ca. 5–15 cm alta (non 20–40 cm alta); stipulis bifidis, filiformibus et minoribus, 9–12 mm longis (non grandibus 30–80 mm, foliaceis, intregris vel pinnnatisectis); foliis, laminis 5–7-lobatis, rectis (non 7–11-lobatis nec falcatis); inflorescentia paniculata, 5 cm longa (non racemosa, 7–15 cm); bracteis et bracteolis integris (non lacinatis); et floribus flavis vel virido-flavis (non violáceo-pruinosis).

Erect perennial herbaceous, 5–15 cm high, a central erect stem arising from a woody base, rarely 2 stems; branches absent or reduced when present and strictly after inflorescence. Leaves not peltate, spirally alternate giving the appearance of a basal rosette, glabrous on both surfaces; stipules persistent, bifid from base, linear-lanceolate and laciniate each part, 9–12 mm long, apex filiform; petioles cylindrical, (2-)4–8(-10) cm long; laminas membranaceous, palmate-lobate, base cordate, 5–7-lobate, rarely 3-lobate at inflorescence base; central lobe symmetric oblong to oblong-lanceolate, 3.5–5(-7) × 0.4–0.6(-0.8) cm; margin entire, apex attenuate-apiculate; venation broquidodromous, primary veins slightly prominent in abaxial surface; lateral lobes gradually reduced with the last lobe asymmetric and prominent at base. Inflorescences multiflora, 4–5 cm long, formed by one reduced central panicle and 3–6 reduced lateral racemes, all arising from the same point; bracts and bracteoles persistent, bracts linear-lanceolate, 5–7 × 0.4–0.5 mm, margin entire, apex attenuate, glabrous, bracteoles reduced. Flowers, pedicelate, glabrous in both sides, yellow-greenish, sometimes with reddish tinge on the external side; pedicels ca. 4–5 mm long on staminal flowers, 5–6 mm long on pistillate flowers; staminal flowers subglobose-campanulate, 7–8 × 5–6 mm, tube 4–5 mm long, tepal lobe slightly opened, 3–4 mm long, apex acute; pistillate flowers gamotepalous, strongly opened, 6–8 × 4–5 mm, tube 2–3 mm long, tepal lobe

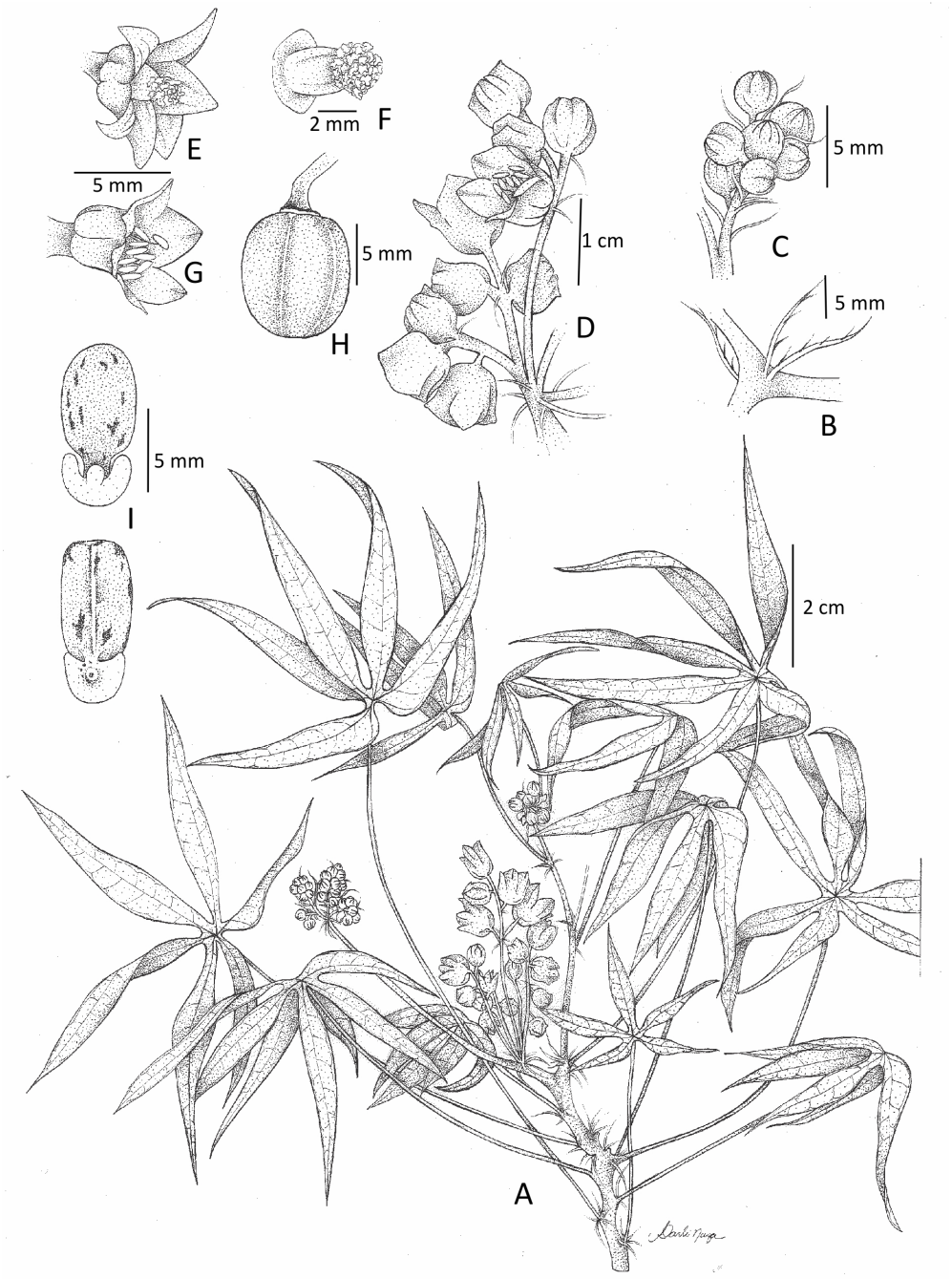

Fig. 3. ***Manihot minima***. A. Fertile branch; B. Stipules; C. Immature inflorescence, with detail of bracts; D. Inflorescence; E. Pistillate flowers; F. Ovary and stigma; G. Staminal flower; H; Capsule; I. Seeds. [A-H, from type - *Mendoza 4405*; J-K, from *Mendoza 4848*].

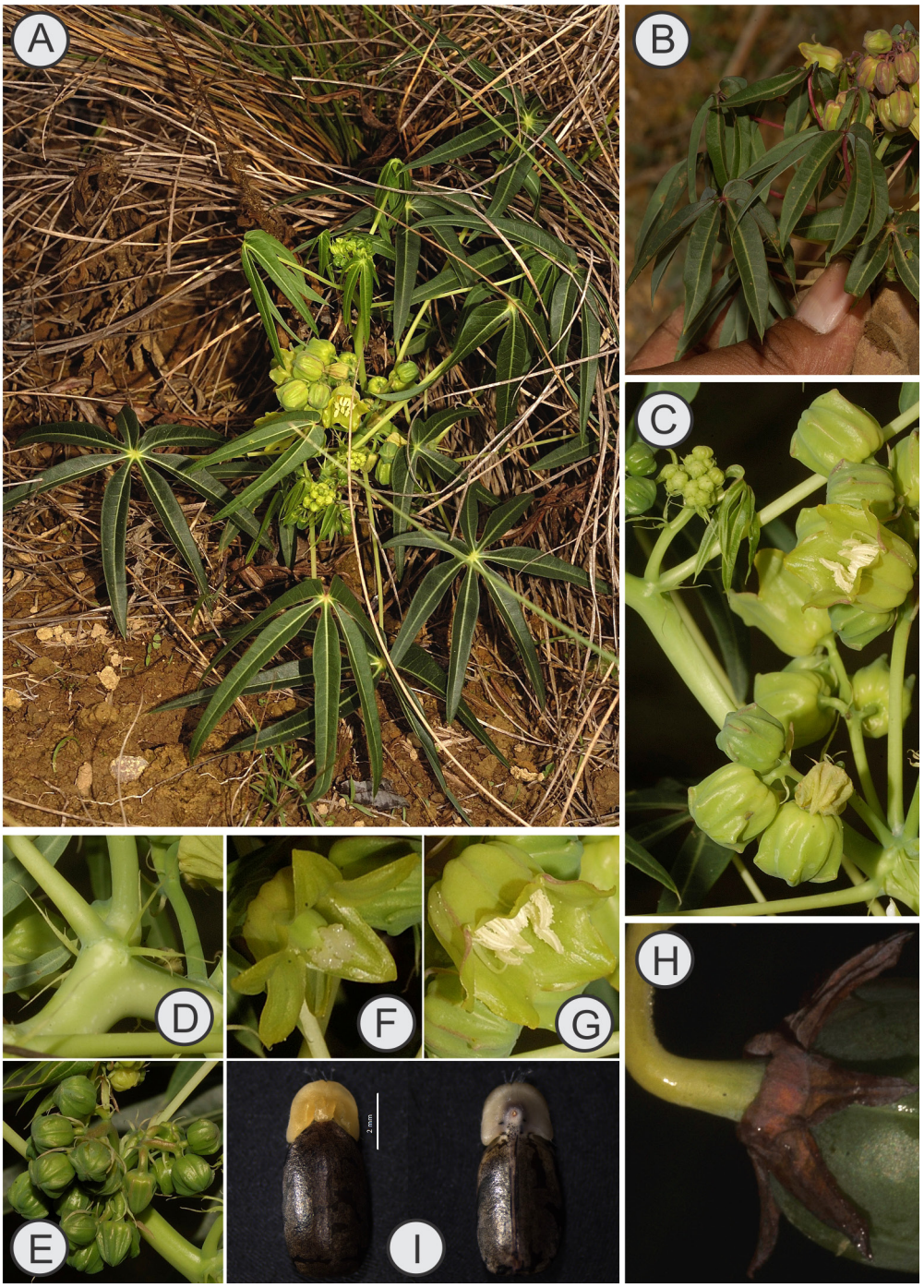

Fig. 4. ***Manihot minima***. A. Habit, B. Fertile plant showing its small size; C. Inflorescence; D. Stipules; E. Immature inflorescence, with detail of bracts; F. Pistillate flower; G. Staminal flower; H. Capsule; I. Seeds. [A-H, from type - *Mendoza 4405;* J-K, from *Mendoza 4848*].

reflexed, 4–5 mm long, apex acute; stigma white-yellowish. Capsule subglobose, 8–10 mm, glaucous green; fine whitish lines replacing ribs. Seeds long elliptic, 7–8 × 3.53–4 mm, dark grayish; caruncle strongly prominent, reniform, apex rotund.

Additional specimens examined

BRAZIL. Goiás: Alto Paraíso de Goiás. ca. 12,7 km de Alto Paraíso de Goiás na GO-239, e entrando, ca. 4,6 km sentido Mulungú, 14°07'46"S, 47°38'19"W, 1211 m, 06-III-2015, *M. Mendoza, T. Reis, A. A. Santos & J. B. A. Bringel, 4848* (CEN, K, NY, RB, UB, USZ); entrando, ca. 6.2 km da GO-239 sentido Mulungú, 14°06'57"S, 47°38'36"W, 1261 m, 06-III-2015, *M. Mendoza, T. Reis, J. B. A. Bringel & A. A. Santos 4849* (CEN, USZ).

Distribution and Ecology

Endemic to the Chapada dos Veadeiros in Goiás state. Based on the information of specimens collected, this species is restricted to São Jorge village area, in the municipality of Alto Paraíso de Goiás, growing in well preserved and also moderately disturbed areas, at 1200-1260 m altitude. The species grows in cerrado, campo sujo, with sporadic small trees, on sandy-clay soil.

Phenology: It was collected with flower from November to December and fruits in February to March.

Etymology: The specific epithet alludes to the very small size of the plant, since this species could be smallest in the genus.

Discussion: *Manihot minima* it characterized by very small size of 5–15 cm high, stipules setaceous, small, 9–12 mm long, bifid from base, linear-lanceolate and laciniate each part; leaves 5–7 lobed and not falcate, inflorescence in panicle, 5 cm long, bracts and bracteoles entire, and flowers yellow-greenish. *Manihot pusilla* is morphologically similar to *M. minima* because shares in general, plant habit with leaf like rosete disposition, stipules persistent, pistillate flowers gamotepalous and staminal flowers subglobose-campanulate. *M. pusilla* differs by stipules foliaceous to laminar, large, 30–80 mm long, entire to pinnately sectate, haphazardly lacinate; leaves 7–11 lobed and falcate; inflorescence in raceme 7–15 cm long, bracts and bracteoles lacinate, flowers reddish to red-salmon (Table 1).

3. *Manihot robusta* M. Mend. & T. B. Cavalc. sp. nov. (Fig. 5- 6).

TYPE: BRAZIL. Goiás: Alto Paraiso de Goiás. Parque Nacional Chapada dos Veadeiros, ca. 0.3 km da GO-239, sentido Sede – alojamento do ICMBio (lado direito), 14°09'55,92"S, 47°47'25,62"W, 1046 m, 31-X-2014, *M. Mendoza, J.B.A. Bringel, A.A. Santos & T. Reis 4343* (holotype: CEN!; isotypes: HRCB!, HUEFS!, K!, LPB!, MG!, MO!, NY!, RB!, SP!, UB!, USZ!).

Diagnosis

Species nova affine M. attenuatae Müll. Arg., sed ab ea habitu erecta, robusta, ca. 40–70 cm alta (non 15–30 cm alta nec rosetta flácida instructa), foliis, ca 30 venis secundaris patentibus, sub angulo 40–50° (non, 50–65 fere rectangularibus sub angulo 80–90°), inflorescentia supra, 3–4-racemis (non basale nec uni-racema); floribus flavis vel virido-flavis (non violaceo-pruinosis) differt.

Robust shrub, erect, 40–70 cm high, a central stem arising from a woody base; branching moderate to abundant from near base to top; branches 2–3, erect to decumbent, usually dichotomy but sometimes 3-cothomy. Leaves not peltate, sessile to subsessile, spirally alternate and regularly distributed on the stem, glabrous on both surfaces, purple-reddish the adaxial

surface and dark reddish to greenish at abaxial surface in young, and strong green-glaucous on both surfaces when mature; stipules not early caducous, setaceous, linear to linear-lanceolate, 5–9 mm long, entire or rarely lacinate at apex, glabrous; petioles canaliculated in adaxial face, reduced, ≤0.5 mm long; laminas membranaceus, not lobate, oblong to oblong-lanceolate, (14-)19–23(27) × 2.5–5(-6.5) cm; base acute, margin entire, apex acute to apiculate, glabrous; venation camptodromous, primary veins strongly prominent in abaxial surface; secondary 30 pairs, forming a 40–50° angle in relation to primaries. Inflorescence multiflora, small, 3.5–8(-12) cm long, formed by one long central raceme and 2–3 reduced lateral raceme, all arising the same point; bracts and bracteoles not early caducous; bracts oval-lanceolate, 7–9 × 2–4 mm, margin entire, apex acuminate-attenuate, glabrous; bracteoles, linear to linear-lanceolate, reduced, 4–5 mm long, entire. Flowers pedicelate, glabrous in both surface, yellow to green-yellow; pedicels 1.5–2 mm long on staminal flowers, 4–5(-8) mm long on pistillate flowers; staminal flowers short-campanulate, 9–12 × 6–7 mm, tube 7–8 mm long, tepal lobes reflexed, 3–4 mm long, apex rotund; pistillate flowers gamotepalous, short-campanulate, 7–9 × 5–6 mm, tube 4–5 mm long, tepal lobe reflexed, 3–4 mm long, apex acute; stigma white. Capsule globose, 10–11 mm; fine red lines replacing ribs. Seeds elliptic, 8–9 × 4–5 mm, caruncle moderately prominent, flattened cordate and apex rotund.

Additional specimens examined

BRAZIL. Goiás: Alto Paraíso de Goiás. São Jorge, ca. 34,8 km da GO-118 para São Jorge, e caminhando 10-30 m lado direito, 14°10′17″S, 47°47′46″W, 1050 m, 12-II-2014, *M. Mendoza, A.A. Santos & T. Reis 4136* (CEN, NY, UB, USZ); ca. 35,5 km da GO-118, para São Jorge, caminhando 10-30 m lado esquerdo, 14°10′35″S, 47°48′06″W, 1017 m, 12-II-2014, *M. Mendoza, A. A. Santos & T. Reis 4138* (CEN, HRCB, HUEFS MG, MO, NY, RB, SP, UB, USZ); Estrada Alto Paraíso – Colinas do Sul, ca. 35 km de Alto Paraíso, 14-III-1995, *T. B. Cavalcanti et al. 1361* (CEN, SPF); Estrada do Parque Nacional da Chapada dos Veadeiros (a esquerda), Estrada Alto Paraíso – Colinas do Sul, 34 km da GO-118, 14°09′49″S, 47°47′08″W, 1250 m, 27 -I- 1997, *B. M. T. Walter et al. 3644* (CEN); Parque Nacional Chapada dos Veadeiros, ca. 1,0 km da sede do Parque, 7-II-1987, *R. M. Pirani et al. 1724* (SP); Parque Nacional do Tocantins, arredores da sede do Parque, 46 km W de Veadeiros, 25-IX-1967, *De Haas Sr., J. H. De Haas & R. P. Belen 310* (HB); Rod. GO-239, ca. 1.3 km São Jorge para Alto Paraíso de Goiás, e entrando, ca. 100-200 m (lado direito), 14°10′35″S, 49°48′06″W, 1012 m, 31-X-2014, *M. Mendoza, A. A. Santos, J. B. A. Bringel & T. Reis 4354* (CEN, K, MO, NY, UB, USZ).

Distribution and Ecology: Endemic to the Chapada dos Veadeiros. This species so far is known only from two small populations in São Jorge village area, in the municipality of Alto Paraíso de Goiás, growing in well-preserved vegetation, in slopes and flat areas of valleys in mountain areas from 1000 to 1050 m altitude. This species grows in relatively open habitats with some trees of Cerrado and campo rupestre vegetation on sandy soil.

Phenology: It was collected with flowers in October to November and fruits from December to April.

Etymology: The specific epithet is derived from the robust habit of the plant, in relation of all species known of this species group with uni-lobate leaves and herbaceous habit in the genus.

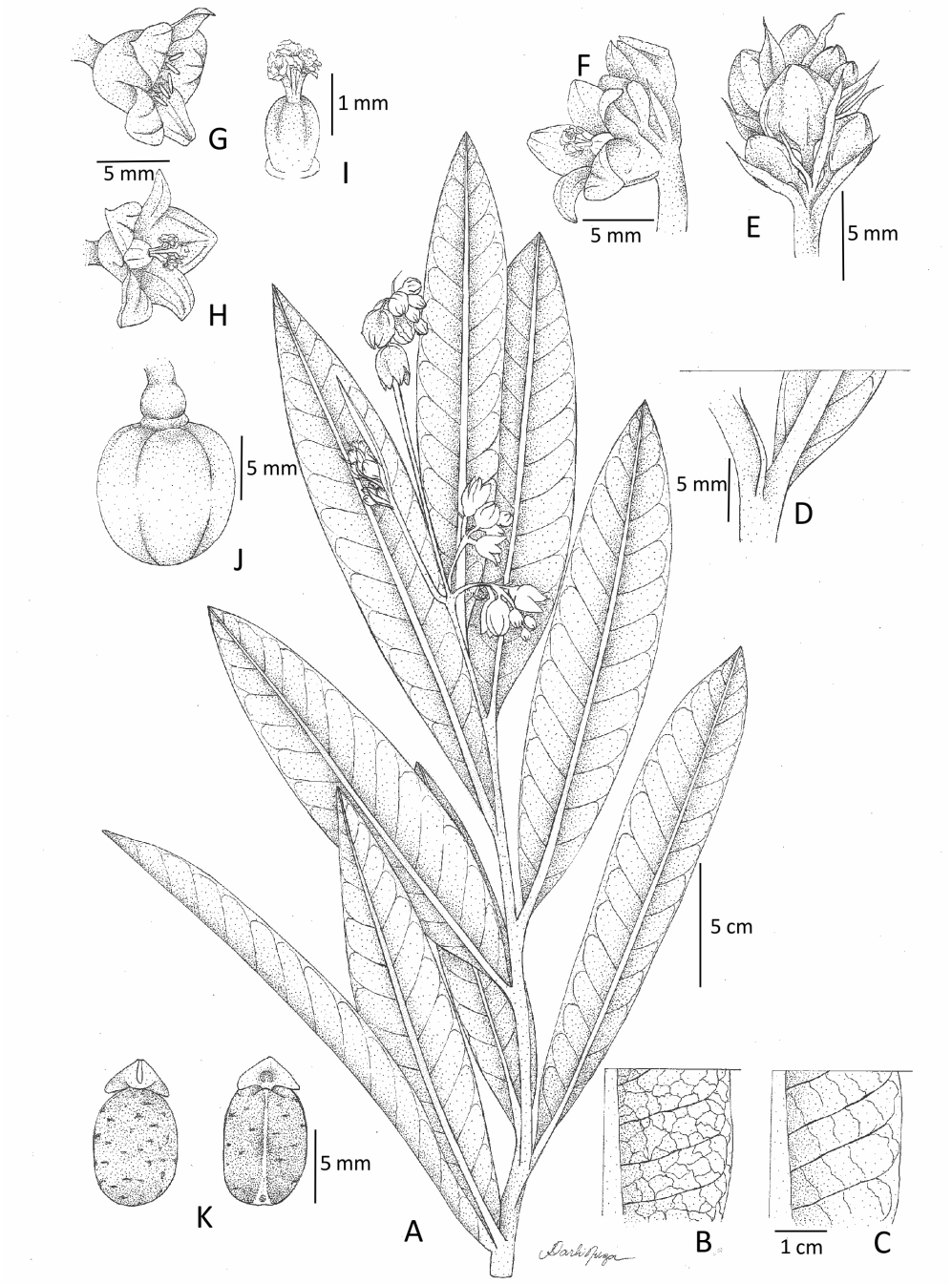

Fig. 5. ***Manihot robusta***. A. Fertile branch; B. Detail of leaf venation, abaxial surface; C. Detail of leaf venation, adaxial surface; D. Stipule, E. Immature inflorescence, with detail of bracts; F. Inflorescence; G. Staminal flower; H. Pistillate flower; I. Ovary and stigma; J. Capsule; K. Seeds. [A-G, from type - *Mendoza 4343*; H-I, from *Mendoza 4138*].

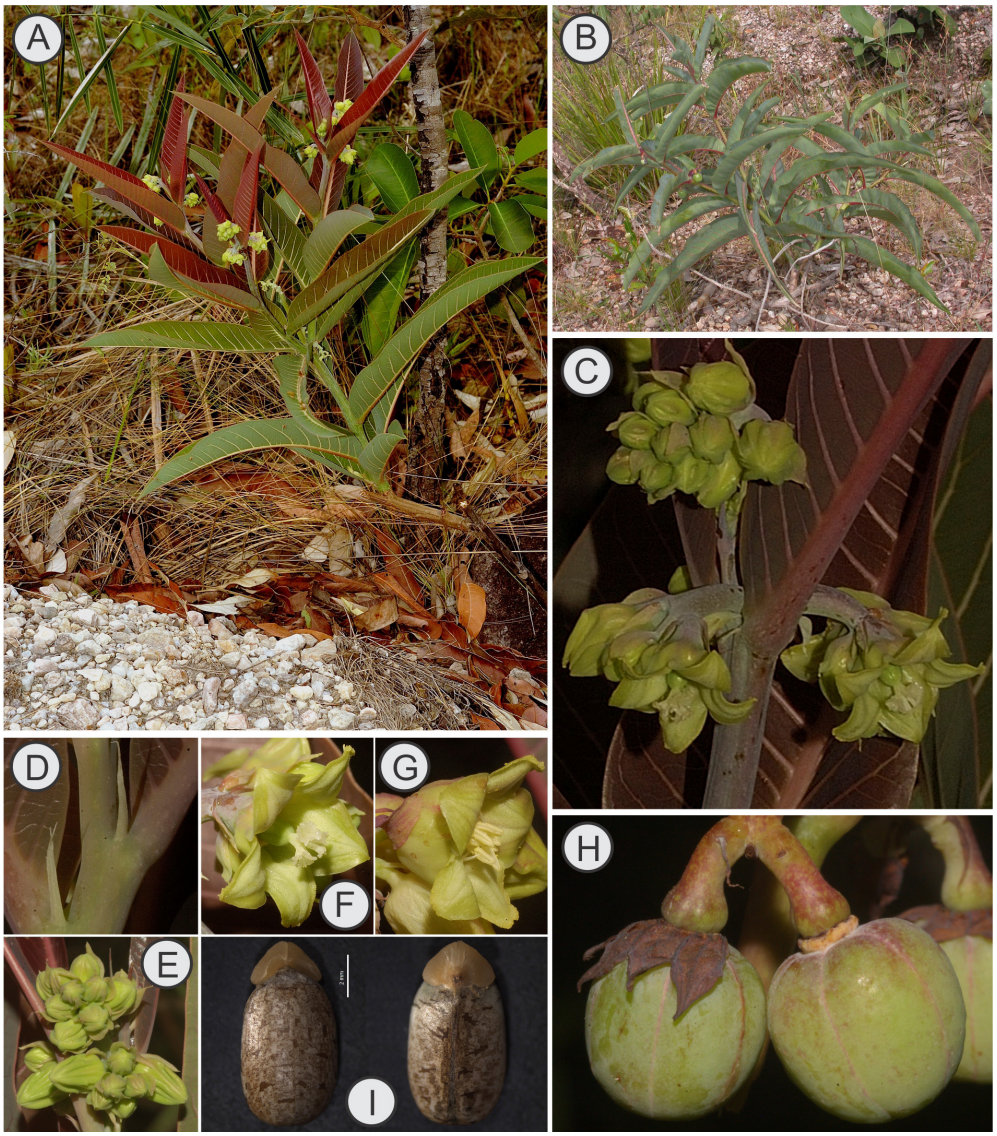

Fig. 6. ***Manihot robusta***. A. Habit, young plant; B. Habit, mature plant; C. Inflorescence; D. Stipules; E. Immature inflorescence, with detail of bracts; F. Pistillate flower; G. Staminal flower; H. Capsule; I. Seeds. [A-G, from type - *Mendoza 4343*; H-I, from *Mendoza 4138*].

Table 2. – Morphological differences between *M. robusta* and *M. attenuata*.

	M. robusta	*M. attenuata*
Habit	Erect and robust, 40–70 cm high.	Basal dense rosette, 15–30 cm high.
Leaves, secondary venation	Moderately numerous (less 30) forming a 40–50° angle in relation to primary veins.	Numerous (50–60) veins forming a 80–90° angle in relation to primary ones.
Inflorescence	Upper part, formed by 3–4 racemes	Basal, in solitary raceme
Bracts	Oval-lanceolate, 7–9 mm long, apex acuminate-attenuate	Linear to linear-lanceolate, 4–5 mm long, apex attenuate
Pistillate flowers	Gamotepalous, yellow to greenish - yellow	Dialitepalous, reddish to violet-pruinose

Discussion: *Manihot robusta* is distinguished by the erect and robust habit, ca 40–70 cm high, by leaves with 30 secondary veins forming 40–50° angle in relation to primaries; inflorescence upper part formed by 3–4 racemes; bracts oval-lanceolate, 7–9 mm long; yellow to green-yellowish flowers. *Manihot robusta* is morphologically similar to *M. attenuata*, which shares unilobate leaves, lamina attenuate >15 cm long and >3 cm wide, bracts and bracteoles entire. *Manihot attenuata* differs from *M. robusta* by rosete habit, ca 15–30 cm; by leaf venation with 50-60 secondary veins forming a 80–90° angle in relation to primary venation, inflorescence basal in solitary raceme; flowers reddish to violet-pruinose (Table 2).

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