Notes on Economic Plants

Plukenetia carolis-vegae (Euphorbiaceae) – A New Useful Species from Northern Peru

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Introduction

Plukenetia L. (Euphorbiaceae) is a Pantropical genus of lianas and scrambling vines. Of the 20 known species (Bussmann et al. 2009; Gillespie 1994), 12 occur in the Neotropics, seven in Africa and Madagascar, and one in Asia. It is most noteworthy for four-carpellate ovaries, fused styles that are often massive, scandent habit, adaxial, basilaminar glands, numerous stamens and, often large, pistillate flowers with four sepals. *Plukenetia* belongs to the tribe *Plukenetieae* (Webster 1975, 1994), characteristically lacking latex. The *Plukenetieae* were monographed by Pax (1890) and Pax & Hoffmann (1919, 1931). Gillespie (1994) reviewed the pollen morphology. The genus *Plukenetia* is amongst the most well recognized of the tribe (Baillon 1858; Bentham 1880; Mueller 1866; Pax 1890). After MacBride (1951), Gillespie (1993) provided a thorough revision of the Neotropical species.

All Neotropical species of the genus are lianas or vines, and the majority occurs in humid tropical forest at altitudes up to around 1000m. *Plukenetia lehmanniana* (Pax & K. Hoffm.) Huft & L.J. Gillespie is only known from Colombia and Ecuador, reaching montane forest locations up to 2100m. The only other two species known from mountain forests are *Plukenetia multiglandulosa* Jabl., known from a single locality in Venezuela, and *Plukenetia huayllabambana* Bussmann, Tellez & Glenn. *Plukenetia volubilis* L., the most widely used and grown species, is mostly found from sea level to less than 1000m. *Plukenetia polyadenia* Müll.-Arg.is found only in humid tropical rainforest locations. Gillespie (1993) notes that collections from Peru labeled *P. volubilis* occur at altitudes from 1600 – 2100m, and "may represent a distinct species." During fieldwork in northern Peru a specimen was collected that was shown to be different from species already described for *Plukenetia*, and as such we submit that this is a new species to science.

Materials and Methods

Since 2007 we have been conducting general collection expeditions to the Departments Amazonas, San Martin and La Libertad in Northern Peru. Currently we estimate that so far 1500–2000 plant species were encountered. Special emphasis was also given to species that were growing in local home-gardens, or that were indicated by field-guides, mule drivers and local population as especially useful. In such cases semi-structured interviews were conducted in order to elucidate more details on plant usage. For all interviews we received prior informed consent. One set of all plant specimens collected was deposited in the herbaria HAO (Universidad Anteno Orrego) and HUT (Universidad Nacional de Trujillo), as well as with INRENA (Instituto Nacional de Recursos Naturales). Duplicates were deposited in MO, NY and shared with taxonomic specialists.

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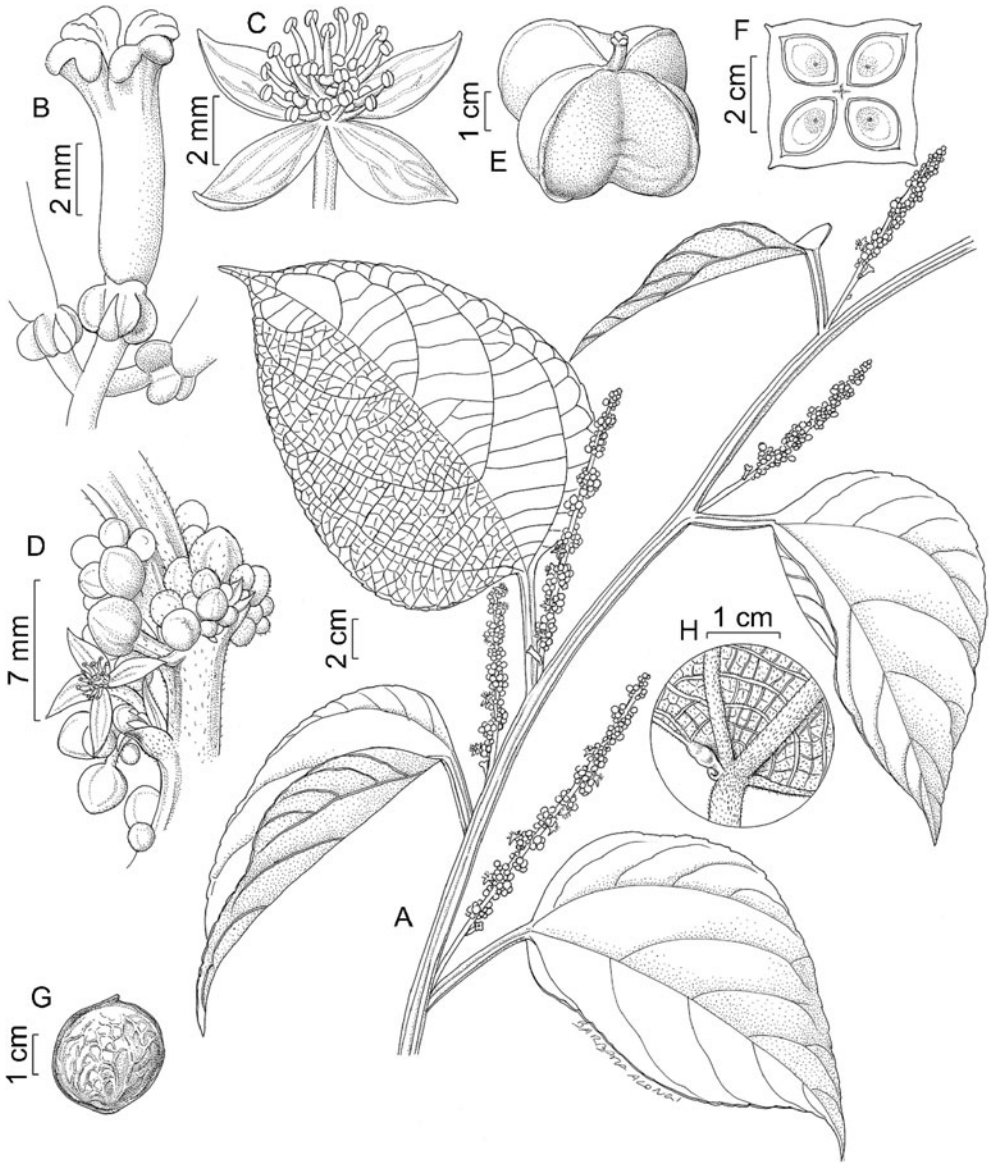

Fig. 1. *Plukenetia carolis-vegae*. A. Habit. B. Pistillate flower. C/D. Staminate flowes. E/F. Capsule. G. Seed.

Results

Plukenetia carolis-vegae, a new species from Northern Peru

Plukenetia carolis-vegae R.W. Bussmann, N. Paniagua Zambrana & C. Téllez, sp. nov. - TYPE: PERÚ. Región Amazonas, Provincia de Rodríguez de Mendoza, Districto Limabamba, finca of Sr. Rodriguez in Monte Allegre. 1,854m, 19. August 2012, 06 ° 35 ' 08 "S, 77 ° 31' 56" W, *Bussmann et al. 17132* (holotype: HAO!; isotypes: MO!, INBIAPERU (Instituto para el Desarrollo Local Sostenible y la Conservación Biológica y Cultural Andino-Amazónica**,** Trujillo)!).

Haec species *P. huayllabambana* Bussmann, Tellez & Glenn. similis, sed a hac sepalis florum

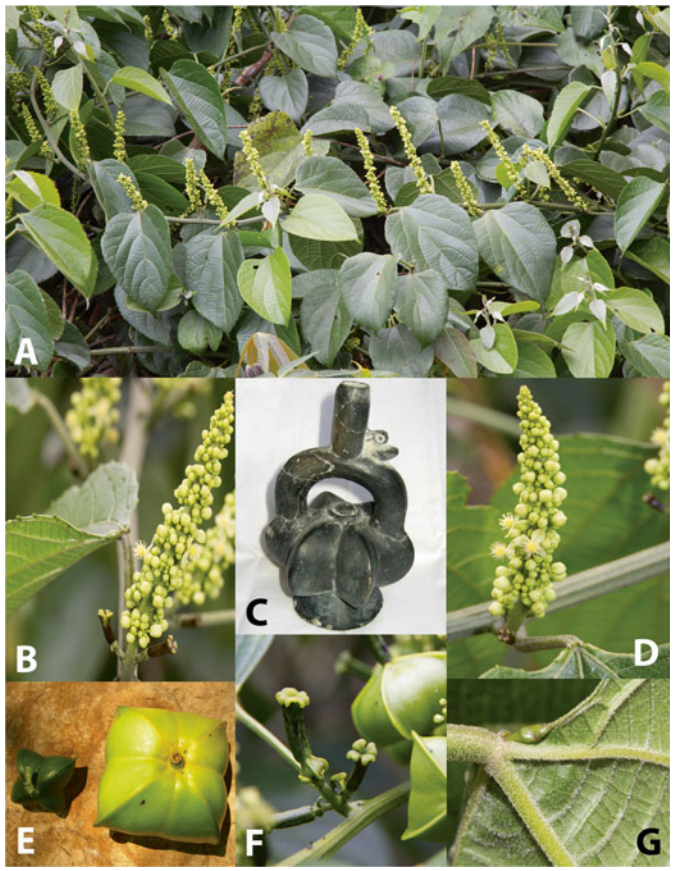

Fig. 2. *Plukenetia carolis-vegae*: A. Habit. B. Inflorescence w/pistillate flower at base. C. Moche vessel depicting *Plukenetia*: D. Open staminate inflorescence. E. Mature fruit (right) in comparison to *Plukenetia volubilis* (left). F. Pistillate flower with young fruits G. Leaf base w/ laminar glands H. Lower leaf surface with basilaminar gland.

staminatorum 4, ab illa petiolo apice convexo, con bullae glandulatae, stylis brevioribus (4–7 mm) atque filamentis latioribus, fructa majore (4–8 x 5–10 cm) atque seminibus majoribus differt.

Large monoecious liana or twining vine; branches slender, puberulous. Leaves alternate, simple, stipules small, persistent; petiole (2-) x 5 x (7) cm long, puberulous; blade large, 7–12 x 9–17 cm, cordate,

Table 1. Fatty acid profiles of *Plukenetia huayllabambana* and *P. volubilis.*

	Plukenetia huayllabambana	*Plukenetia volubilis*
Fatty Acids	%	%
Saturated	5.6	7.3
Monounsaturated	9	9
Polyunsaturated	86.4	76.8
Linoleic Acid (Omega 6)	25.11	32.1
a-Linolenic Acid (Omega 3)	61.29	44.7
Oleic Acid (Omega 9)	9	9
Palmitic Acid	4.21	4.3
Stearic Acid	1.39	3

Table 2. Trade volume of *P. volubilis*.

	2004	2005	2006	2007	2008	2009	2010	2011
Trade value $	6250	28000	124000	437000	592000	797000	1133000	951000
Kg exported	2500	3000	14000	42500	49000	69500	111400	89500
median $/kg	2.5	9.3	8.9	10.3	12.1	11.5	10.2	10.6

slender acuminate at apex with acumen 6–25 mm long x 2–6 mm wide, cuneate to slightly cordate at base, serrulate, almost glabrescent adaxially with only a few unbranched hairs, with densely, white puberulous abaxially; primary veins 3, secondary veins 3–4 on each side of central primary vein and 4–6 on lower side of lateral primary veins; tertiary veins percurrent; quarternary veins reticulate; basilaminar glands 2, narrowly transverse 3–6 mm long x 0.8-1.5 mm wide, marginal, adaxial, laminar glands absent; small pair of stipels at petiole apex between basilaminar glands, conical, 0.5-2 mm long, rounded at apex; glandular knob globular, 0.5-1 mm in diameter. Inflorescense slender, racemose, (4) 6–13 cm long, bisexual, axillary; axes puberulous, pistillate flowers 2–3 at basalmost node; staminate flowers numerous, cyme axes 2–5 mm long, bracts obovate, 2.5-4 mm long; staminate pedicel 1–2.5 mm long, puberulous; bud rounded, 1.8-3 mm wide; sepals 4 (rarely 5), ovate, 2.5-3.5 mm long, 1.5-2.5 mm wide, corolla and disc absent; stamina (filament and anthers) 25–35 x 0.1 – 0.3 mm in diameter; filaments flattened, broad, 0.5 – 1 mm long; pistillate pedicel 2–4 mm long, puberulous, sepals 4, oval-elongate with black tip, 1.5-2 mm long, 0.7-1 mm wide; ovary 4 locular, 2–3 mm wide, 1–2 mm long, puberulous, 4-winged; styles puberulous in cylindrical column, 4–7 mm long x 1.5-2 mm wide; 4 free style arms 4-5mm long, forming a cross shape when mature; fruiting pedicel 2–4 cm long, capsule 4 lobed, 4–8 – 6–10 cm; glabrous, each lobe with a small, winged horn. Seeds large, lenticular, laterally compressed, 3–5 cm long, 3–4 cm wide x 2.5 – 3.5 cm thick, slightly verrucose (Figs. 1 and 2).

Plukenetia carolis-vegae displays characteristics similar to *P. huayllabambana* Bussmann, Tellez & Glenn but differs by having a smaller number of sepals (4 instead of 5) in the staminate flowers, a glandular knob, much shorter styles (4–7 mm instead of 10-12mm), much broader filaments, larger (7–12 x 9–17 cm vs. 4–10 – 7–14 cm) and cordate (instead of elliptic to ovate elliptic) leaves, and larger fruits (4–8 – 5–10 cm instead of 3–4 – 4–6 cm). TYPE: PERÚ. Región Amazonas, Provincia de Rodríguez de Mendoza, Districto Limabamba, finca of Sr. Rodriguez in Monte Allegre. 1,854m, 19. August 2012, 06 ° 35 ’ 08 "S, 77 ° 31’ 56" W, *Bussmann et al. 17132* (holotype: HAO!; isotypes: MO!, INBIAPERU (Instituto para el Desarrollo Local Sostenible y la Conservación Biológica y Cultural Andino-Amazónica, Trujillo)!).

Distribution and conservation status

Known only cultivated from the Peruvian region Amazonas, province Rodríguez de Mendoza, on the eastern slopes of the Northern

Table 3. Nutrient comparison Sacha Inchi and other oilseeds.

Nutrient content in comparison (%) of seed oil content								
	Sacha Inchi	Olive Oil	Soy	Corn	Peanut	Sunflower	Cotton	Palmoil
Protein	**33.3**	1.6	28	0	23	24	32	0
Fatty Acids	**55**	22	19	0	45	48	16	0
Palmitic Acid	**4.21**	13	10.7	11	12	7.5	18	45
Stearic Acid	**1.39**	3	3.3	2	2.2	5.3	3	4
Total saturated	**5.6**	16	14	13	14	13	21	49
Oleic Acid (Omega 9)	**9**	71	22.3	28	43.3	29.3	18.7	40
Linoleic Acid (Omega 6)	**25.11**	10	54.5	58	36.8	57.9	57.5	10
Linolenic Acid (Omega 3)	**61.29**	1	8.3	1	0	0	0.5	0
Total unsaturated	**94.4**	83	85.1	87	80.1	87.72	76.7	50

Peruvian Andes, where it was found in one farm at an altitude of 1854m. Although only known from the type collection the species is, according to the farm owner, grown in other farms and can also be found in natural forest between 1800-2200m, and is thus regarded as not endangered.

Etymologie

The new species is named *Plukenetia carolis-vegae* in honor of our friend and collaborator Carlos Vega, for his untiring efforts to investigate and preserve the flora of Northern Peru.

Uses

Plukenetia spp. are well known in Peru as sacha inchi, sacha inchic, maní del monte, yuchi, which all translate to "forest peanut" or "Inka Peanut (Brack 1999, Tellez-Alvarado 2008, Vega 2008). *Plukenetia volubilis*, and in particular *Plukenetia huayllabambana* have proven to contain extraordinarily large amounts of Omega fatty acids (Bussmann et al. 2009; Tellez-Alvarado 2008). The seeds and oil of both species, as well as the roasted seeds are widely consumed by the local population in the study region, and the archaeological record shows that this use goes back at least 1500 years (Brack 1999, Tellez-Alvarado 2008, Vega 2008). Moche ceramics, dating back to about 650 CE (Fig. 2) clearly show fruit capsules of *Plukenetia* spp. The seeds of *Plukenetia volubilis* contain about 55% fatty acids, of which between 85-96% are unsaturated, with the highest amount of linioleic acid (25-32%, omega 6) and linolenic acid (45-61%, omega 3) and 33% proteins, in particular containing cysteine, tyrosine, threonine and tryptophan (Fanali et al. 2011, Maurer et al. 2012). They are also rich in Vitamins A and E (Guillén et al. 2003, Tellez Alvarado 2008, Vega 2008, Bussmann et al. 2009, (Table 1). The high content of essential polyunsaturated fatty acids offers interesting nutritional benefits.

During the last decade, the trade in Sacha Inchi products, especially oil for the cosmetic industry, but also roasted seeds as snacks and oil for human consumption, mostly derived from *Plukenetia volubilis,* have risen tremendously (Tables 2 and 3, Tellez Alvarado 2008, Vega 2008), and are now a multi million-dollar business. Both, *P. huayllabambana* and *P. carolis-vegae* have shown a higher content of Omega fatty acids, and are thus especially interesting for the development of future nutraceuticals. In contrast to *Plukenetia volubilis*, these two species require shade to grow, and are producing mostly in natural or semi-natural forest conditions, and could as such be an excellent alternative for sustainable income generation and replacement of illicit crops such as Cannabis sativa and Erythroxylum coca, both of which have been found in increasing quantities in the region.

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