

Tetrameranthus (Annonaceae) revisited including a new species

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Abstract

The taxonomic revision of the infrequently collected genus *Tetrameranthus* by Westra (1985) is updated. A new species is described from French Guiana and Amapá, Brazil, increasing the number of species in this genus to seven.

Keywords

Annonaceae, taxonomy, Neotropics, *Tetrameranthus*

Introduction

An as-yet unknown species of the rare genus *Tetrameranthus* has been collected a few times in French Guiana and also once in neighboring Amapá, Brazil. The material was too incomplete to justify publication. Recently a new collection from French Guiana came in bearing ripe fruits and also reported to have a white flower. This made us decide now to formally publish this new species. We then also decided to update the revision of the genus *Tetrameranthus* (Westra, 1985), with the inclusion of *T. globuliferus* published later (Westra, 1988), adding the present new species as well. Some, mostly color, photographs of this seldom collected genus serve as an illustration.

Taxonomic history

The Annonaceae form a large pantropical family, the largest family in the order Magnoliales, currently with (about) 129 genera and >2000 species (Stevens 2001 onwards). In the Neotropics the family is represented by 40 genera and c. 900 species (Chatrou et al. 2004). Annonaceae are woody plants, mostly trees and shrubs; lianas are mainly found in the Old World, only few lianas occur in the New World. The family is very distinctive and generally easy to recognize by, among others, simple leaves placed in two rows and without stipules, flowers with perianth members in 3-merous whorls, many tightly packed stamens, and a varying number of free carpels that remain free or become fused in fruit.

The Neotropical genus *Tetrameranthus* was described by Fries (1939) with the only species *T. duckei* R.E.Fr. It is aberrant by, among others, the unusual leaf disposition in a spiral instead of in two rows, the presence of four bracts placed in a whorl under the articulation of the flower stalk, and, above all, the perianth consisting of 4 sepals and 2 whorls of 4 petals each. The position of this peculiar genus is discussed by Fries in that paper, placing *Tetrameranthus* in an isolated position within the Annonaceae.

Over fifteen years later Fries added a second species, *T. macrocarpus* R.E.Fr., from Southeastern Colombia (Fries 1957). In his large survey of the whole family Fries even more emphasized the isolated position in placing it as the only member in a tribe Tetramerantheae in subfamily Annonoideae (that also included Uvarieae and Unoneae) (Fries, 1959).

Four more species were added in later years, viz. *T. laomae* D.R.Simpson from Eastern Peru (Simpson 1975), *T. pachycarpus* Westra from the environs of Iquitos, Peru, *T. umbellatus* Westra from northern Amazonian Peru, and *T. globuliferus* Westra from Yasuní National Park, Ecuador (Westra 1985, 1988). Gradually more material was collected, particularly around Manaus (*T. duckei*), and near Iquitos (*T. pachycarpus*). Outside these areas of concentration mainly collections from scattered localities have come in spanning a range from Andean Amazonia and the Pacific coast of Colombia (Chocó: one collection) in the West to French Guiana and adjacent Amapá, Brazil, in the East – including now the newly described *Tetrameranthus guianensis* in this paper. With the notable exception of the locally common *T. duckei*, *Tetrameranthus* as a whole still must be regarded as a rather rare genus.

Based on recent molecular data it was shown that *Tetrameranthus* belongs to an early branching lineage within Annonaceae (Richardson et al., 2004; Couvreur et al., 2011; Chatrou et al. in press). It is classified in the subfamily Ambavioideae Chatrou, Pirie, Erkens and Couvreur (Chatrou et al. in press). Within this subfamily the South American genus *Tetrameranthus* is part of a highly supported clade together with the Southeast Asian genus *Mezzettia* and the African genera *Ambavia* and *Cleistopholis*. Recent analyses show *Tetrameranthus* in a fully resolved clade as sister to the other three above mentioned genera (Surveswaran et al. 2010; Chatrou et al. in press).

The generic name is composed of the Ancient Greek word elements “tetra” (four), “meros” (part), and “anthos” (flower), referring to the four-parted flowers.

Morphology

Vegetative part

Tetrameranthus is a genus of shrubs to (large) trees. As for all Annonaceae, the leaves are simple, entire, pinnately veined, symmetrical, and lack stipules, generally of moderate to fairly large size (greatest length ± 30 cm). In contrast to the rest of Annonaceae, where the leaves are in two alternate rows almost without exception (Fries 1959: p. 8), in all species of *Tetrameranthus* the leaves are spirally arranged. Another uncharacteristic feature of this genus is the apical disposition of the leaves, generally found 10 cm from the apex of the branches, the ones below that are shed.

This rosette-like appearance of leaf disposition is suggestive of a number of other plant families such as Sapotaceae, but not of Annonaceae. This could explain in part why *Tetrameranthus* might seem rare, i.e., simply because many botanists do not identify it as Annonaceae.

Inflorescences

Inflorescences in *Tetrameranthus* are truly axillary. As for the structure of the inflorescence in Annonaceae in general, the reader is referred to publications by Fries (1919, 1959). *Tetrameranthus* conforms to Fries's type 1 (1959: p. 13) in that it has a primary flower stalk which carries bracts below the articulation, but no bracts above it. Seen more closely, the inflorescence structure is somewhat unusual within Annonaceae. Single-flowered inflorescences, as most commonly seen in *Tetrameranthus*, appear as an articulate stalk bearing the flower. The articulation in all but one species is at some distance above the base (the leaf axil; see e.g. Figures 3A, 3E). The only exception is in *T. laomae* where the articulation is found at the base (see Figure 2E). Immediately below the articulation there are (mostly) 4 bracts in a whorl. The bracts are shed before or (shortly) after flowering. In *T. duckei* a flower is sometimes seen originating from the axil of one the bracts, thus creating a 2-flowered inflorescence (Figure 2A). The pedicel of that lateral, or second-order, flower has an articulation at the base and lacks bracts. In *T. umbellatus* all four bracts have the potential to develop a similar axillary flower, thus resulting in an umbel-like inflorescence (Figure 2G). Pedicels of lateral flowers being bractless, inflorescences of *Tetrameranthus* are static: they cannot expand by reiterative growth processes as is characteristic for the rhpidium in most Annonaceae. The inflorescence of *Tetrameranthus* is best circumscribed as a botryoid (Weberling and Hoppe 1996: p. 32–33), albeit mostly reduced to a single flower.

For these reasons the basal part of the first-order flower stalk up to the articulation and including the whorl of bracts is referred to as peduncle, while the part above the articulation is termed pedicel. The stalks of second-order flowers, then, are termed pedicels in their entirety.

Flowers

As in most Annonaceae, the perianth consists of one whorl of sepals and two whorls of petals (Figure 1A). The whorls are 4-merous in at least five of the seven species, although incidentally a single deviating flower might occur, e.g. a 3-merous flower on one specimen of *T. laomae*, and a 5-merous flower on the type collection of *T. pachycarpus*. Such phenomena are not unusual throughout flowering plants in general, and have been observed in other Annonaceae genera (Couvreur 2009). *T. globuliferus* appears exceptional by having 6-merous whorls as far as seen, but this may need confirmation from more collections yet to be made. No good flower has been collected in *T. guianensis* so far, but see under the notes with that species. It should be stressed that in all other genera where deviations from trimery occur, this is an autapomorphy for individual species. In *Tetrameranthus*, however, this is synapomorphic for the genus (see also Saunders 2010).

The sepals are small in relation to the petals. They are free or connate just at the base. The aestivation is imbricate, only observable in very young buds as the sepals soon spread. The sepals drop after flowering.

The petals vary from rather fleshy (e.g. *T. duckei*, Figure 2C) to rather thin (*T. laomae*, *T. umbellatus*, Figure 2F), those of the outer whorl being somewhat larger or broader than those of the inner whorl. The photographs also show curved petals in *T. duckei* in the living condition, while in *T. umbellatus* (and possibly also in *T. laomae*) the petals appear rather flat at least before anthesis. The petals are adorned with a callus or callus-like tissue at the base on the inner side: this is an area of varying size, depending upon the species, which is devoid of indument. In *T. duckei* the callus appears as a protruding hump (Figure 2C), particularly on the inner petals where it is even larger than on the outer petals. In the other species the callus is smaller in relation to the size of the whole petal than in *T. duckei*.

The convex torus bears mostly numerous stamens and a mostly rather small number of free carpels in the center. The stamens have a short filamental part, a thick connective capped by a massive, more or less conical or flat shield, and an extrorse to latrorse anther. The carpels contain two (exceptionally three), lateral, superposed ovules, and have on top a sessile stigma which varies from trilobed to an irregularly lobed disc.

Curculionidae beetles have been observed as pollinators in *T. duckei* (Webber 1981; Gottsberger 1999). There are no reports known to us so far for other *Tetrameranthus* species.

Fruit

Depending on the species, the number of free monocarps varies from 1–15. The ellipsoid to oblongoid monocarps are fleshy, indehiscent, and two-seeded or, due to abortion of one ovule, one-seeded (rarely three seeds develop) (Figure 1C–G). The seeds are laterally attached, with the lowest one near the base, and are ascending, thus resulting in the characteristic oblique constriction seen in monocarps with >1 seed on herbarium specimens. In fresh fruits the constriction is less obvious, and in very thick-walled monocarps of some of the species (e.g. *T. guianensis*, *T. pachycarpus*) it becomes practically indistin-

guishable. In herbarium material the fruit wall is smooth in most species, but becomes shriveled in *T. globuliferus* (Westra 1988: pp 269, 278, Fig. 21) and *T. guianensis*.

The seeds are quite large in relation to the fruit body; they are slightly compressed dorsiventrally, and possess ruminations in the shape of fairly numerous lamellae protruding from the seed coat into the interior almost to the middle.

Indument

The indument of *Tetrameranthus* consists of stellate hairs with 2–10 rays, varying with the species. In addition to stellate hairs, simple hairs are present in varying densities, also depending upon the species. Most genera of Neotropical Annonaceae have simple hairs, or have stellate hairs beside simple hairs in a small percentage of the species only (e.g. *Annona* including *Rollinia*). The notable exception (apart from *Tetrameranthus*) is *Duguetia*: in this genus most species even have scales, rather than stellate hairs (Maas et al. 2003).

Indument in *Tetrameranthus* is found especially on young vegetative parts and inflorescences. Some of it persists on the primary vein of the leaves, and to a lesser extent on the secondary veins, mainly on the lower side; it is also seen on petioles and branchlets in the leafy zone. In *T. umbellatus* stellate hairs are also found diffusely spread over the leaf surface, especially on the abaxial side. In *T. laomae*, too, scattered stellate hairs may be spotted on the lower leaf surface.

Floral parts, with the exception of stamens and the callus area on petals mentioned earlier, are usually covered with a dense indument of stellate hairs. Carpels, when enlarging into monocarps, quickly become glabrous.

The trichome length on vegetative parts (except in a very young stage, and persisting near axils) does not exceed 0.1–0.2 mm in *T. laomae* and *T. umbellatus*: these two species thereby are easily distinguished from the other ones, where considerably longer (to 0.5 mm, or even more) and stiffer trichomes are found, next to simple hairs of the same size. Trichomes on inflorescences and flower parts may reach a somewhat larger average size than those on vegetative parts (this we did not investigate in detail).

Taxonomic treatment

Genus *Tetrameranthus* R.E.Fr.

<http://species-id.net/wiki/Tetrameranthus>

Acta Horti Bergiani 12(3): 554. fig. 41. 1939; Westra, Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, ser. C.88: 449–482. 1985.

Type. *Tetrameranthus duckei* R.E.Fr.

Description. *Trees* or *shrubs*. Leafy twigs and most floral parts sparsely to densely covered with stellate to simple hairs to glabrous. *Leaves* spirally arranged, often concen-

trated towards the end of the branches, primary vein impressed to slightly raised on the upper side. *Inflorescences* axillary, 1-flowered to several-flowered and umbel-like, bracts up to 4 below the articulation. *Flowers* bisexual, 4-merous or less often 5–6-merous, white to yellow or cream; sepals 4(–6), imbricate, free or basally connate; petals 8(–12), free, subequal, imbricate, much longer than the sepals, often with a callus at the inner base; stamens numerous, connective shield discoid, either flat, cushion-shaped, or with a conical prolongation; carpels c. 5–30, ovules 1–2(–3), lateral, stigma sessile, more or less lobed. *Fruit* apocarpous; monocarps 1–15, free, sessile or sometimes narrowed into a short and thick stipe-like base, indehiscent, sometimes constricted, wall rather thick (1–7 mm) and fleshy. *Seeds* 1–2(–3) per monocarp, lower one near the base, upper one(s) lateral.

Distribution. Seven species in the Amazon regions of Venezuela, Colombia, Brazil, Peru, and Ecuador, but also in the Colombian state of Chocó and in French Guiana and neighboring Amapá, Brazil.

Key to the species of *Tetrameranthus*

- 1a Young plant parts covered with stellate hairs ≤ 0.2 mm long; primary vein mostly flat (or slightly raised or slightly impressed) above **2**
- 1b Young plant parts covered with stellate and simple hairs ≥ 0.5 mm long; primary vein impressed (exceptionally almost flat) above..... **3**
- 2a Inflorescences with up to 5 umbellately arranged flowers; peduncle manifest, ≥ 5 mm long (Amazonian Peru and Brazil) *T. umbellatus*
- 2b Inflorescences 1-flowered; peduncle inconspicuous, < 1 mm long. (Amazonian Peru and Brazil and the Colombian states of Amazonas and Chocó).....
..... *T. laomae*
- 3a Monocarps globose or almost; perianth (as far as known) of 6-merous whorls (Amazonian Ecuador) *T. globuliferus*
- 3b Monocarps ellipsoid, oblongoid or fusiform; perianth of 4-merous or less often 5-merous whorls **4**
- 4a Monocarps, both 1- and more-seeded ones, ellipsoid or fusiform, without constriction or with a weak constriction..... **5**
- 4b 2-Seeded monocarps oblongoid, with a manifest oblique constriction about the middle **6**
- 5a Monocarps 7–15, 35–60 by 20–30 mm, wall shriveled in sicco; petioles ≤ 10 mm long (French Guiana and the Brazilian state of Amapá) *T. guianensis*
- 5b Monocarps 1–3, to c. 70 by 40 mm, wall not shriveled in sicco; petioles ≥ 20 mm long (Amazonian Peru, vicinity of Iquitos) *T. pachycarpus*
- 6a Monocarps ≥ 35 mm in diam.; tall tree (Amazonian Colombia)
..... *T. macrocarpus*
- 6b Monocarps ≤ 25 mm in diam.; shrub or small tree ≤ 12 m (Amazonian Colombia, Venezuela, and Brazil) *T. duckei*

***Tetrameranthus duckei* R.E.Fr.**

http://species-id.net/wiki/Tetrameranthus_duckei

Figs 1C, D, 2A–D; Map 1

Acta Horti Bergiani 12(3): 557. 1939.

Type. *Ducke RB 23919* (holotype S; isotypes RB, S), Brazil, Amazonas: Manaus, Estrada do Aleixo, km 7, 14 June 1933.

Description. *Shrub* or *tree*, 3–12 m tall, 4–8 cm diam., young twigs and petioles densely to rather densely covered with brown, stellate hairs >0.5 mm long, becoming glabrous. *Leaves:* petioles 10–40 mm long, 1.5–4 mm diam.; lamina narrowly elliptic to narrowly obovate, 10–25 by 3–10 cm (index 2.7–4), chartaceous to coriaceous, dull or slightly shiny brown or greenish brown above, dull brown or greenish brown below in sicco, rather densely covered with stellate hairs on primary vein, otherwise glabrous above, rather densely to sparsely covered with stellate hairs on primary vein and secondary veins, otherwise mostly glabrous below, the stellate hairs similar to those on branchlets, base acute, apex acuminate (acumen 5–25 mm long), primary vein impressed above, secondary veins 8–12 on either side of primary vein, impressed above, loop-forming, shortest distance between loops and margin 1.5–5 mm, or not loop-forming in basal part, tertiary veins slightly raised, flat, or indistinct above, percurrent to reticulate. *Inflorescences* 1(–2)-flowered, peduncles 5–15 mm long, c. 1.5 mm diam., fruiting peduncles to c. 3 mm diam., bracts 4, narrowly triangular, 3–6 mm long, soon falling after flowering, pedicels 10–25 mm long, c. 1.5 mm diam., fruiting pedicels to c. 40 mm long, 3 mm diam., peduncles and pedicels densely covered with stellate hairs, becoming glabrous. Flowers green, turning yellow in vivo; sepals elliptic to obovate, free, 5–7 mm long, outer side densely covered with stellate hairs; outer petals ovate, 20–25 by 9–12 mm, inner base with fleshy and longitudinally grooved callus 5–6 mm long and extending across the whole width, inner petals narrowly ovate to ovate, 15–22 by 6–9 mm, with similar callus to c. 8 mm long, outer side of petals densely covered with stellate hairs, the callus on the inner side glabrous; stamens 2–2.5 mm long, connective shield conical or acuminate, 1–1.5 mm long, more or less curved toward the center. *Monocarps* 1–6, green or shiny green, turning green-yellow in vivo, brown to dark brown in sicco, ellipsoid or oblongoid to narrowly so, 25–65 by c. 20(–25) mm, with (2-seeded forms) or without oblique constriction, apex a thick obtuse beak 2.5–10 mm long. *Seeds* 1–2 per monocarp, to c. 35 by c. 20 mm.

Distribution. Amazonian regions of Venezuela (Amazonas), Colombia (Guainía), and Brazil (Amazonas, most common in Manaus and vicinity).

Habitat and ecology. Mostly in low forest or shrub vegetation (campina, campinarana, Amazonian caatinga, and bana) on white sand. At low elevations up to c. 200 m. Flowering and fruiting: throughout the year.

Additional specimens examined. **Colombia.** Guainía: Puerto Colombia (opposite Venezuelan town of Maroa) and vicinity, alt. 800–850 ft, Schultes et al. 18157 (US). **Venezuela.** Amazonas: Mun. Guainía, along road from Maroa to Yavita, Aceve-

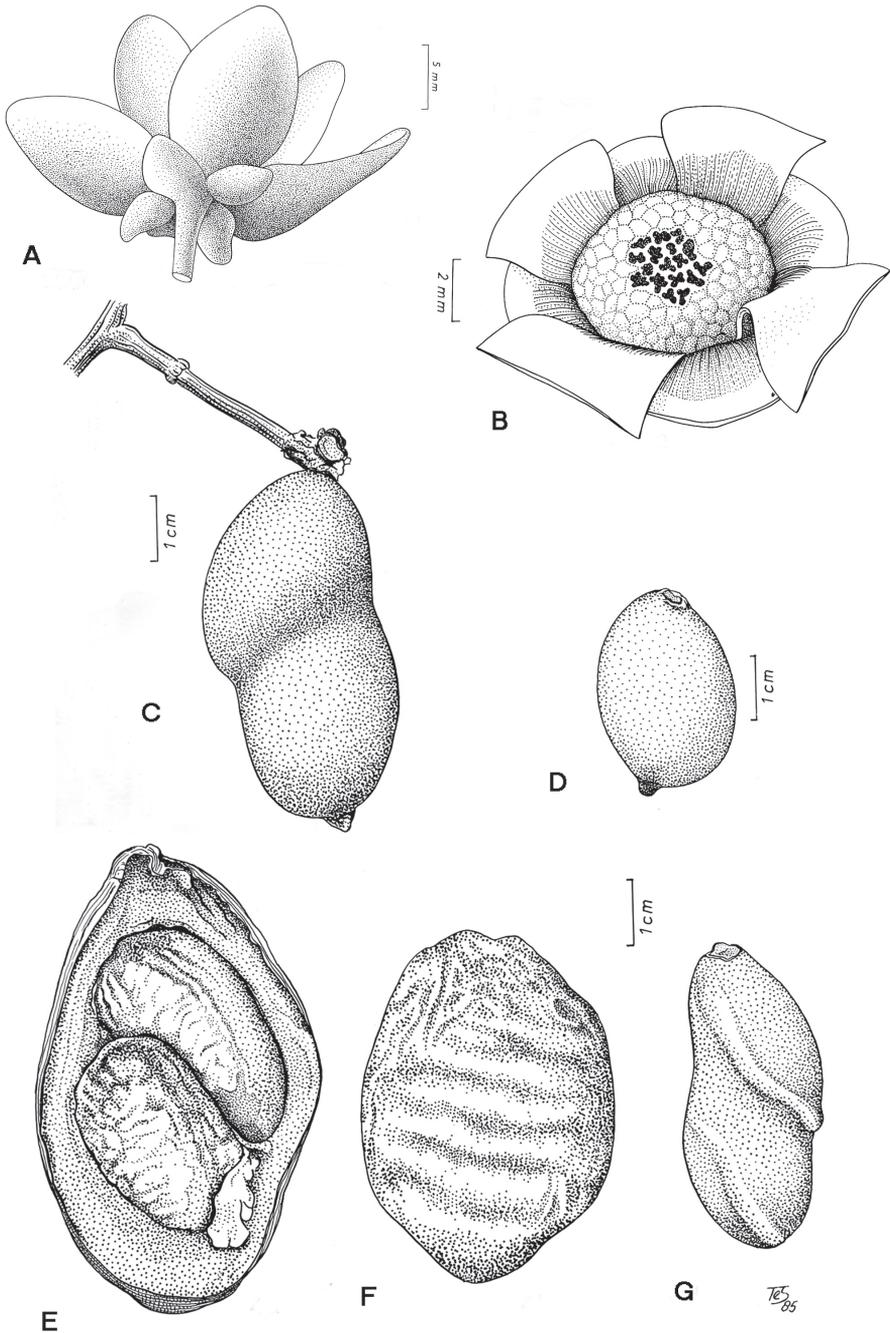


Figure 1. *Tetrameranthus umbellatus* Westra **A** Young flower (*Tunqui* 62, U) **B** Androecium and gynoecium of same. *Tetrameranthus duckeri* R. E. Fr. **C** Two-seeded monocarp (*Rodrigues & Coêlho* 3835, U) **D** One-seeded monocarp (*Morawetz et al.* 21-9883, U). *Tetrameranthus pachycarpus* Westra **E, F** Two-seeded monocarp cut open and seen from outside (*Foster* 4271, NY). *Tetrameranthus umbellatus* Westra **G** Two-seeded monocarp (*Huashikat* 613, U).

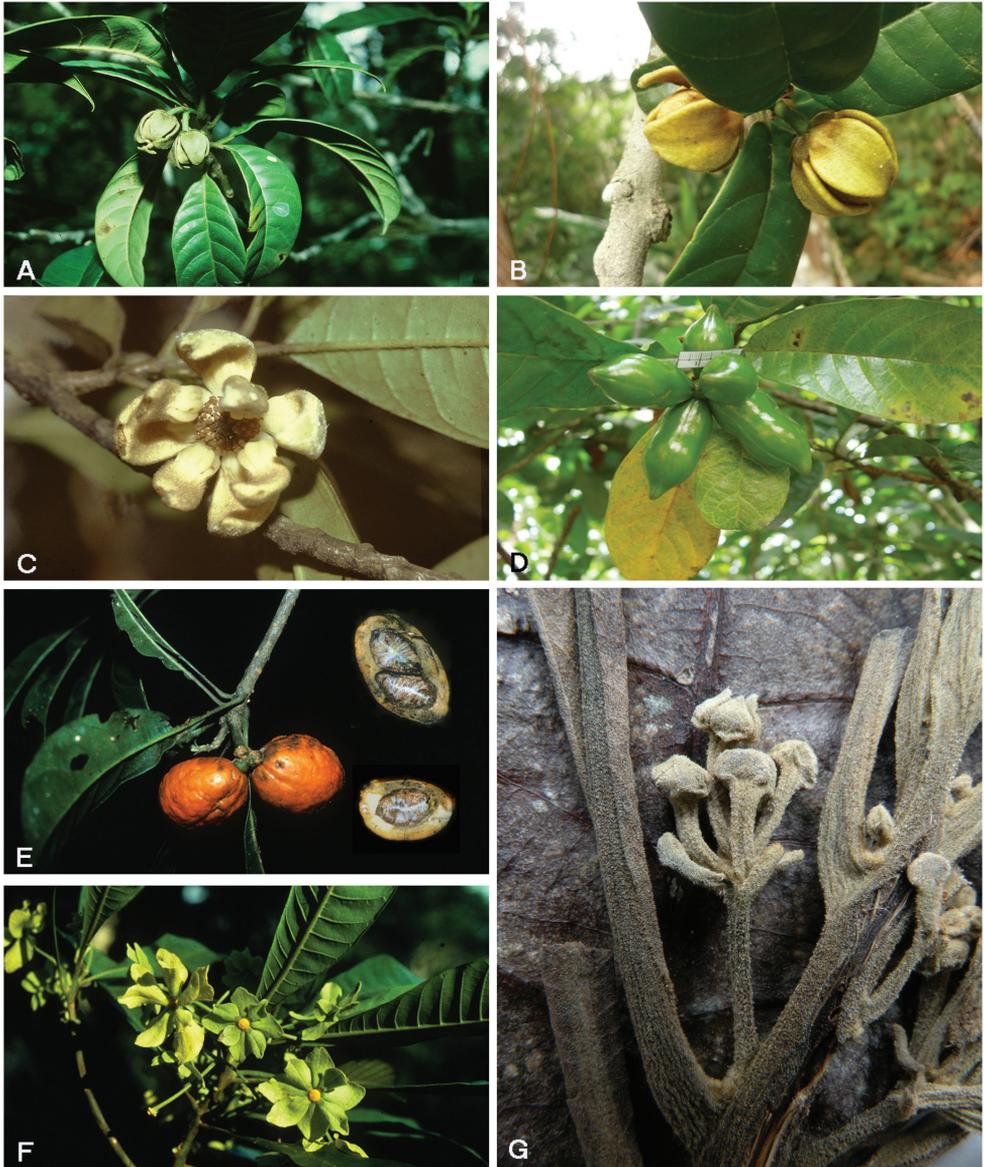
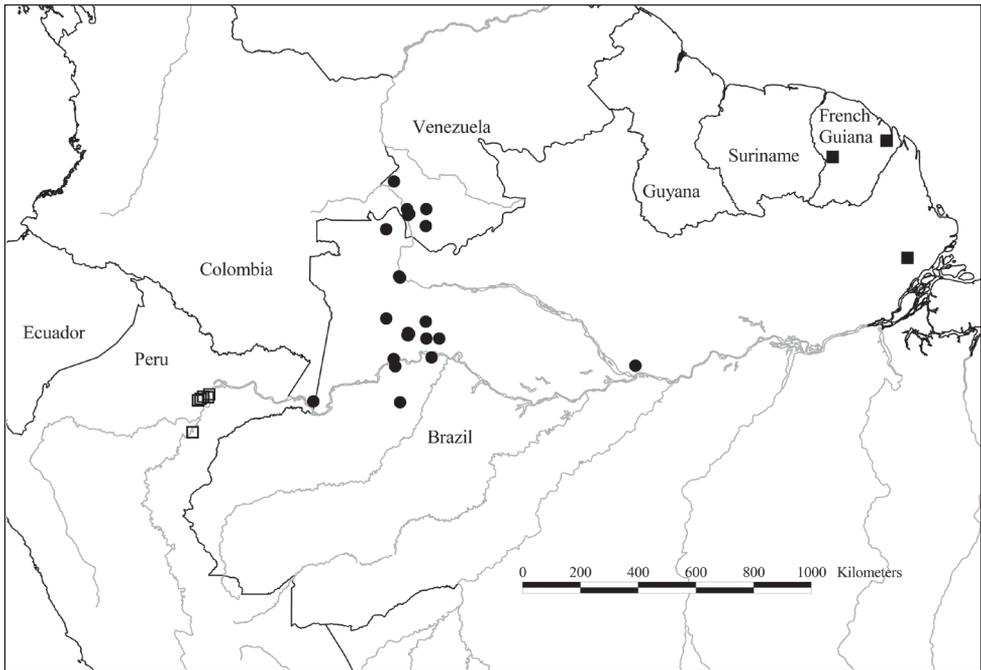


Figure 2. *Tetrameranthus duckei* R. E. Fr. **A** Two-flowered inflorescence **B** Flowers at early anthesis **C** Flower at late anthesis, liberation of pollen (Webber, 1981) **D** Fruit. *Tetrameranthus laomae* D.R.Simpson **E** Ripe fruit, also sectioned to show seeds. Note articulation at base of fruiting stalk. *Tetrameranthus umbellatus* Westra **F** Flowers **G** Young inflorescence, detail of herbarium specimen (Morawetz & Wallnöfer 14-81085, U). **A, E–F** Photos by W. Morawetz, **B–D** Photos by A. C. Webber.

do-R. et al. 10250 (U); Lower Río Guainía, Raudal Lombriz, 2 km from mouth of Río Casiquiare, 140 m, Aymard et al. 9751 (MO, U); Río Casiquiare, below Capibara (“Capihuara”), Colella et al. 1879 (U); Río Casiquiare, El Porvenir, Colella et



Map I. Distribution of *Tetrameranthus duckei* R. E. Fr. (●), *T. guianensis* Westra & Maas (■), and *T. pachycarpus* Westra (□).

al. 2170 (U); San Carlos de Río Negro, Christenson 1386 (US), Liesner 6744 (MO, U), 7590 (MO, U), 8598 (MO, U), 8838 (MO, U), Steyermark & Bunting 102721 (NY, US); Río Negro, base of Piedra de Cucuy, 100–200 m, Maas et al. 6879 (INPA, NY, U); Río Pasimoni, 80 m, Velazco 1954 (MO, U). **Brazil.** Amazonas: Manaus and vicinity, Almeida INPA 3580 (INPA), L. Coêlho INPA 3673 (INPA, S), Ducke 1908 (F, NY), Ducke RB 35313 (RB, S), Ferreira 79/57 (S), Miralha et al. 230 (INPA, U), Morawetz et al. 21-9883 (WU), 21-23883 (WU), 22-19883 (WU), 24-12983 (WU), Personnel of Centro de Pesquisas Florestais INPA 6232 (INPA, S), Plowman et al. 12647 (U), Prance et al. 2721 (INPA, NY, US), 3816 (NY, US), 4679 (NY, US), Rodrigues & L. Coêlho 2937 (U), Rodrigues & Almeida 3068-A (U), Rodrigues & Lima 3454 (U), Rodrigues & D. Coêlho 3839 (INPA, U), Rodrigues 8742 (INPA), Webber 162 (U), 163 (U); Reserva Florestal Ducke, Igarapé Acará, Ribeiro et al. 1501 (INPA), 1749 (INPA, U), Sothers et al. 757 (INPA, U); Rio Negro, at its confluence with Rio Vaupés, Serra Canaleão, 150 m, Stevenson et al. 1002 (NY, U); Rio Javari, behind Estirão de Equador, Lleras et al. P17302 (NY, U); mouth of Rio Vaupés, Pires et al. 7473 (S).

Vernacular names. Venezuela: Banayo (*Liesner* 7590), Cuchara (*Liesner* 6744), Majagua (*Velazco* 1954), Palo de cuchara (*Liesner* 7590). Brazil: Envira (*Ferreira* 79/57).

Note. In a previous paper (Westra, 1985) there was some doubt about the identity of the collection *Lleras et al.* P17302. It should be regarded as no more than an extreme form of *T. duckei*, with pedicels to c. 40 mm long and outer petals to c. 15 mm wide.

***Tetrameranthus globuliferus* Westra in Maas et al.**

http://species-id.net/wiki/Tetrameranthus_globuliferus

Fig. 3D–G; Map 2

Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, ser. C. 91: 262, figs 20–22. 1988.

Type. *Lawesson et al. SEF 8779* (holotype AAU; isotypes AAU, QCA, QCNE, U), Ecuador, Orellana: Añangu, Parque Nacional Yasuní, 260–350 m, May–June 1986.

Description. *Medium-sized tree*, >10 cm diam., young twigs and petioles densely covered with pale brown, stellate hairs >0.5 mm long. *Leaves:* petioles 4–8 mm long, 4–6 mm diam., lamina narrowly obovate, 27–37 by 9–15 cm (index 2.8–2.9), chartaceous, shiny green above in vivo, greenish brown above, pale greenish brown to brown below in sicco, rather densely covered with stellate hairs >0.5 mm long on primary vein, to rather sparsely so on smaller veins on both sides, base acute to attenuate, to obtuse or rounded at the extreme base, apex acute to acuminate (acumen to c. 10 mm long), primary vein flat to slightly raised above, secondary veins 20–25 on either side of primary vein, flat to impressed above, loop-forming, shortest distance between loops and margin 1.5–3 mm, or not loop-forming, tertiary veins flat to raised above, percurrent to more or less reticulate. *Inflorescences* 1-flowered; peduncles 3–5 mm long, 3–4 mm diam., fruiting peduncle c. 5 mm diam., bracts [4?] narrowly oblong or narrowly triangular, 4–5 mm long, falling after flowering, pedicels {18–30} mm long, {4–6} mm diam., densely covered with brownish, stellate hairs; flowers with perianth in 6-merous whorls, cream with the inner petals yellow at the inner base in vivo; sepals broadly ovate-triangular, connate at the very base, {6–11} by {5–10} mm; outer petals elliptic to ovate, {30–45} mm long, {10–25} mm wide, with small callus at the inner base; inner petals {30–40} mm long, {5–10} mm wide, more or less narrowed toward the base, with larger callus, outer side of petals densely covered with stellate hairs, the callus on the inner side glabrous; stamens {2–2.5} mm long, connective shield flat, cushion-shaped. *Monocarps* 2–7, globose or almost, green in vivo, brown in sicco, c. 40 mm diam., wall strongly shriveled in sicco. *Seeds* 1–2 per monocarp, 25–30 by 15–20 mm.

Distribution. Ecuador (Orellana). Only known so far from Parque Nacional Yasuní.

Habitat and ecology. In rain forest on terra firme. At elevations of 200–400 m. Flowering recorded in November; fruiting recorded in May, June, August.

Additional specimens examined. **Ecuador.** Orellana: NW corner of Parque Nacional Yasuní, 355–365 m, Korning & Thomsen 47626 (AAU, U); Parque Nacional Yasuní, E of Juan Tapuy's finca, 250 m, Pitman & Delinks 1440 (MO, QCA, U).

Note. The description of the flower was largely made from a very recent photograph of a freshly collected twig of *Pérez & Santillán 4404* (QCA). Measurements between { } were made on two flowers preserved in alcohol kept in QCA and were kindly supplied to us by Álvaro J. Pérez C.

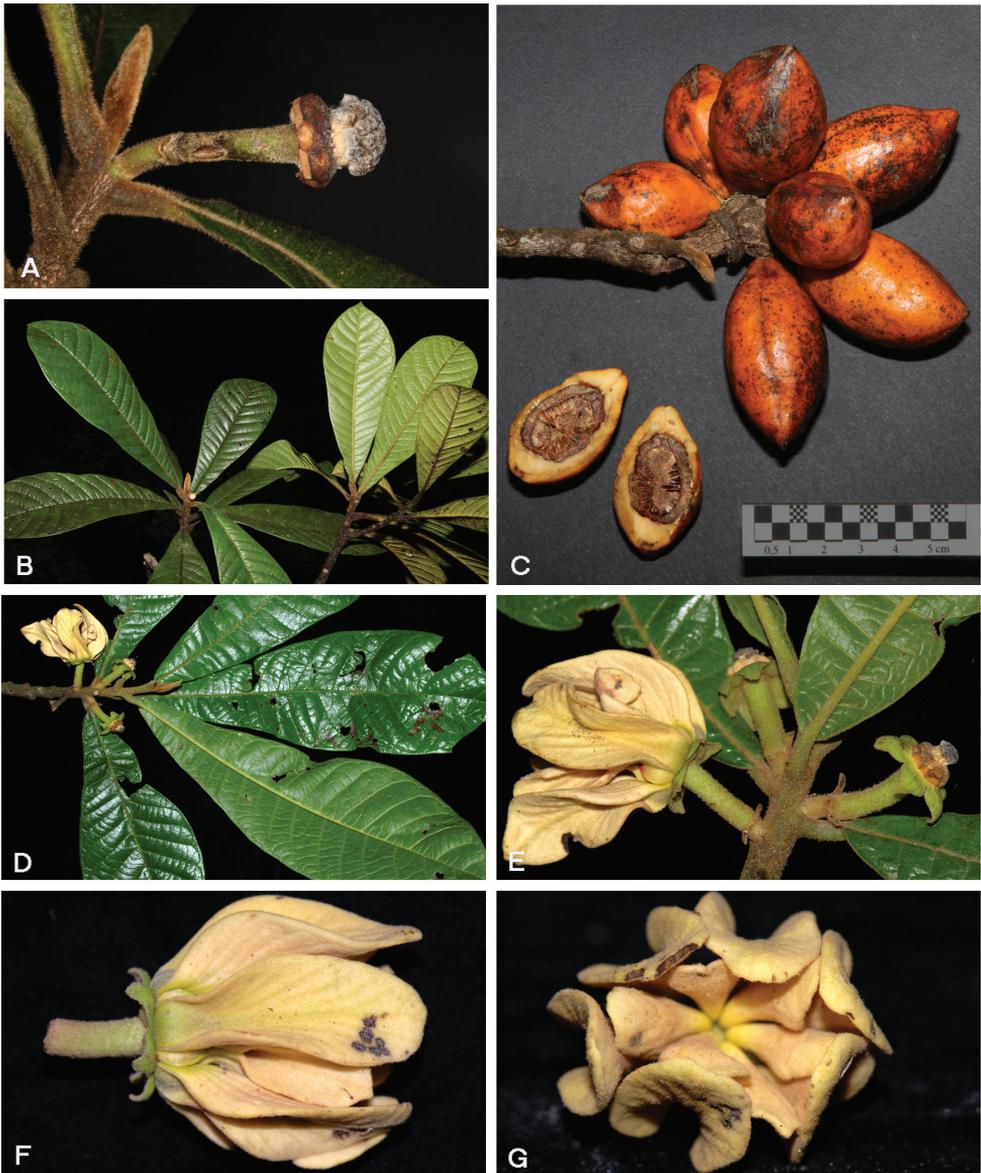
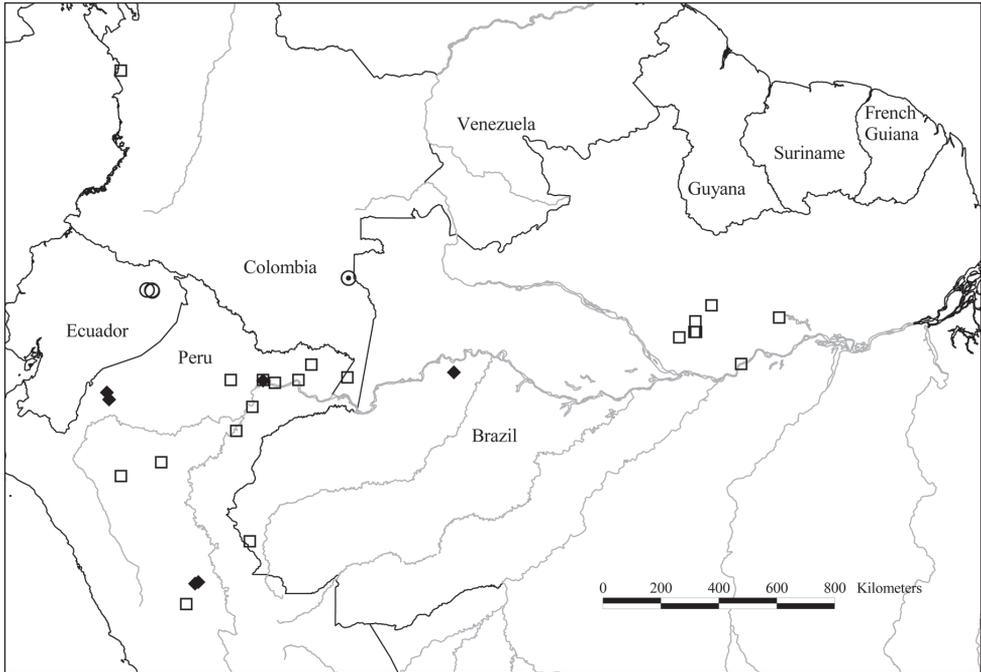


Figure 3. *Tetrameranthus guianensis* Westra & Maas **A** Single-flowered inflorescence after shedding of perianth and stamens **B** A twig **C** Ripe fruit, also sectioned to show seed. *Tetrameranthus globuliferus* Westra **D**, **E** Twig with inflorescences (Pérez C. & Santillán 4404, QCA) **F**, **G** Flower seen from the side and from above (same). **A–C** Photos by D. Sabatier, **D–G** Photos by A. J. Pérez C.

Á. J. Pérez also reports to us a clustered occurrence of *T. globuliferus*: he found few individuals all close to the one that he collected, but did not spot any more around the trails of the Yasuní Scientific Station.



Map 2. Distribution of *Tetrameranthus globuliferus* Westra (○), *T. laomae* D. R. Simpson (□), *T. macrocarpus* R. E. Fr. (⊙), and *T. umbellatus* Westra (◆).

The species has been listed as near-threatened on the IUCN red list (Muriel and Pitman 2003). In an important paper on global conservation significance of Yasuni National Park *T. globuliferus* is documented as one of five species (and one of only two woody species) not found anywhere else in the world (Bass et al. 2010).

***Tetrameranthus guianensis* Westra & Maas, sp. nov.**

urn:lsid:ipni.org:names:77118748-1

http://species-id.net/wiki/Tetrameranthus_guianensis

Fig. 3A–C; Map 1

A speciebus ceteris hujus generis pilis stellatis vel simplicibus validis et monocarpis rugosis in statu sicco distinctus.

Type. *Sabatier & Gonzalez 5387* (holotype CAY; isotype L), French Guiana, Savane-roche Virginie, Parcelle SRV2, 4°11'N, 52°9'W, 18 March 2008.

Description. *Tree*, 8–25 m tall, 10–25 cm diam., slash yellow-orange (*Mori et al. 23521*); young twigs and petioles densely covered with brownish, stellate and simple hairs >0.5 mm long. *Leaves:* petioles 5–10 mm long, 3–4 mm diam., more or less thickened toward the base; lamina narrowly obovate to obovate-elliptic, 14–26 by 5–10 cm (index 2.4–2.9), chartaceous, shiny green above in vivo, dark brown above

and pale brown below in sicco, rather densely covered mainly on large veins to rather sparsely covered with stellate hairs >0.5 mm long or glabrous elsewhere above, densely covered with stellate hairs on large veins, rather densely to sparsely so or almost glabrous elsewhere below, base acute to attenuate, apex abruptly acuminate (acumen 2–12 mm long), primary vein impressed above, secondary veins 14–19 on either side of primary vein, impressed above, loop-forming, shortest distance between loops and margin 1–3 mm, or not loop-forming, tertiary veins impressed above, percurrent to reticulate. *Inflorescences* 1-flowered, only seen in postfloral and fruiting stages, peduncles c. 10 mm long, c. 3 mm diam., fruiting peduncles to c. 5 mm diam., pedicels c. 20 mm long, c. 3 mm diam., fruiting pedicels to c. 5 mm diam., peduncles and pedicels densely covered with brownish, stellate and simple hairs; sepals not seen; petals whitish (fide collectore) in vivo, estimated to be c. 35 by 40 mm; stamens not seen. *Monocarps* 7–15, ellipsoid to fusiform, yellowish green to yellowish orange in vivo, pale brown in sicco, 35–60 by 20–30 mm, apex obtuse, rounded, or bluntly pointed, with or without weak oblique constriction, wall shriveled in sicco. *Seeds* 1–3 per monocarp, 25–30 by 15–20 by 15 mm.

Distribution. French Guiana and the adjacent Brazilian state of Amapá.

Habitat and ecology. In forests. At an elevation of c. 100 m. Flowering recorded in December; fruiting recorded in March, July, and December.

Notes. *Tetrameranthus guianensis* is the first species of the genus reported from the Guianas. It is distinct from other species of *Tetrameranthus* by a dense cover of coarse stellate and simple hairs on all vegetative parts. Like the Ecuadorian *T. globuliferus*, it has shriveled fruit walls in dry condition.

As no complete flowers were available in herbarium material, description of floral characters is based in part on field observations of a single living flower at distance. The collector, D. Sabatier, has informed us that an attempt to collect that flower which was high up in a large tree and out of reach had failed. Sabatier (pers. comm.) notices 5 scars per whorl on the receptacle (compare Figure 3A) implying that we have a 5-merous flower here! This definitely requires confirmation from further collections, though.

Two sterile collections, namely Mori et al. 23521, 23674, also from French Guiana, seem to come quite near this species, differing mainly in the leaf shape (obovate-elliptic, rather than narrowly obovate), and the less dense and more coarse indument of stellate hairs of comparable size. It concerns trees of 8 m, 10 cm diam., and 15 m, 12 cm diam., respectively, from non-flooded moist forest. More material, and more complete in particular, is needed here.

Additional specimens examined. French Guiana. Sinnamary River, above Petit Saut, between Crique Plomb and Crique Tigre, 500 m above Saut Tigre in area to be inundated by waters of Petit Saut Dam, Mori et al. 23521 (CAY, NY, U), Mori et al. 23674 (CAY, NY, U); Rivière Grand Inini, Basin of Maroni River, Arbre II-59, 3°40'N, 53°50'W, Sabatier & Prévost 3084 (CAY, P, U); Savane-roche Virginie, Parcelle SRV2, 4°11'N, 52°9'W, Sabatier 5784 (CAY, WAG). **Brazil.** Amapá: Rio Araguari, upland plant, Pires et al. 51490 (MG).

***Tetrameranthus laomae* D.R.Simpson**

http://species-id.net/wiki/Tetrameranthus_laomae

Fig. 2D, E; Map 2

Phytologia 30(5): 309. 1975.

Type. *Soria S. 64* (holotype F), Peru, Loreto: Alto Amazonas, Distr. Yurimaguas, road from Yurimaguas to Tarapoto, km 19 from Yurimaguas, 115 m, 11 March 1969.

Description. *Tree*, 7–35 m tall, 11–45 cm diam., young twigs and petioles densely covered with whitish, stellate hairs <0.2 mm long, becoming glabrous. *Leaves*: petioles 10–20 mm long, 1–1.5 mm diam.; lamina obovate to narrowly obovate or narrowly elliptic-obovate, 6–24 by 2–7 cm (index 2.4–3.7), chartaceous to thinly coriaceous, shiny to dull greenish brown above, dull greenish brown below in sicco, rather densely to sparsely covered with stellate hairs <0.2 mm long on primary vein, otherwise sparsely so to glabrous on both sides, base attenuate, decurrent along petiole, apex acute or acuminate (acumen (0)–7–20 mm long), primary vein raised to almost flat above, secondary veins 7–10 on either side of primary vein, more or less raised above, loop-forming, shortest distance between loops and margin 2–4 mm, or not loop-forming in basal part, tertiary veins raised above, reticulate and often tending to form intersecondaries. *Inflorescences* 1-flowered, peduncles 0–1 mm long, bracts 3, narrowly triangular or narrowly oblong, 1–2.5 mm long, soon falling after flowering, pedicels 7–15 mm long, 1–1.5 mm diam., fruiting pedicels to c. 20 mm long, 2.5–4 mm diam., densely to rather densely covered with stellate hairs, becoming glabrous. *Flowers* green to yellowish, green with yellow center, or yellow in vivo; sepals broadly elliptic to broadly ovate, 2.5–3 by 2–2.5 mm, outer side densely covered with stellate hairs; outer petals ovate-elliptic, 10–16 by 5–8 mm, inner petals narrowly elliptic, 8–11 by 3–4 mm, outer side of petals rather densely covered with stellate hairs, the inner base glabrous; stamens c. 1 mm long, connective shield cushion-shaped, flat. *Monocarps* 4–13, green, maturing orange or red in vivo, black in sicco, ellipsoid to oblongoid, 2-seeded forms 30–45 by 15–<20 mm and with oblique constriction, 1-seeded forms smaller and without constriction, apex mostly rounded. *Seeds* 1–2 per monocarp, to c. 25 by 20 mm.

Distribution. Amazonian Peru (Loreto, Pasco) and Brazil (Acre, Amazonas, Pará), and the Colombian states of Amazonas and Chocó.

Habitat and ecology. In forest on terra firme, on clay or sandy soil. At low elevations to c. 350 m. Flowering and fruiting: throughout most of the year.

Additional specimens examined. **Colombia.** Amazonas: Mun. Leticia, Corregimiento de Tarapacá, Parque Nacional Natural Amacayacu, Cabaña Pamaté, 100 m, Rudas et al. 2611 (MO, U). Chocó: Parque Nacional de Utría, 0–100 m, García C. & Agualimpia 398 (MO, U). **Brazil.** Acre: vicinity of Serra da Moa, Prance et al. 12236 (MO, NY, U). Amazonas: Mun. Itapiranga, Rio Uatumã, above confluence of Rio Uatumã with Rio Pitinga, Cid et al. 824 (MO, NY, U); Mun. Presidente Figueiredo, near Represa de Balbina, Cid et al. 6657 (NY, U), 8084 (NY, U), Thomas et al.

5271 (NY, U), 5358 (NY, U). Pará: Mun. Oriximiná, Rio Trombetas, Lago Maincoé, 8 km NE of Mineração Santo Patricia, 80 m, Martinelli 7338 (NY, U). **Peru.** Loreto: Guarnición Pijuayal, near Pebas, 130 m, Díaz S. et al. 571 (MO); Distr. Las Amazonas, “Roca Eterna”, 120–130 m, Grández & Jaramillo 2850 (MO, U); Distr. Las Amazonas, Explornapo Camp, near Sucusari, 100–140 m, Pipoly et al. 13386 (MO, U), 13407 (MO, U), 13496 (MO,U), 14575 (MO, U); Prov. Mariscal Ramón Castilla, Upper Río Yaguas, tributary of Río Putumayo, 80 km NE of Pebas, 140 m, Ríos et al. 464 (U); Prov. Ucayali, Sapuena, Jenaro Herrera, 130 m, Vásquez et al. 12012 (MO, U); Prov. Maynas, Sargento Lores, Esperanza, 120 m, Vásquez & Jaramillo 13249 (MO, U). Pasco: Prov. Oxapampa, Cabeza de Mono, Río Iscozacín, Palacazu Valley, 320 m, Gentry et al. 41743 (MO, U); Prov. Oxapampa, Distr. Iscozacín, Pariona & Ruíz C. 1038 (MO).

Vernacular names. Peru: Sacha anona (*Pariona* & *Ruíz C. 1038*).

Uses. Peru: used for construction work on the countryside (*Soria S. 64*).

***Tetrameranthus macrocarpus* R.E.Fr.**

http://species-id.net/wiki/Tetrameranthus_macrocarpus

Map 2

Arkiv för Botanik Ser. 2, 3(18): 603, plate 4. 1957.

Type. *Schultes & Cabrera 17091* (holotype S; isotypes COL, GH, U), Colombia, Vaupés: Río Piraparaná, Raudal Coro (“Koro”), 30 August 1952.

Description. Tall *tree*, young twigs and petioles densely to rather densely covered with stellate hairs >0.5 mm long. *Leaves:* petioles 20–30 mm long, 3–4 mm diam., slightly thickened toward the base; lamina elliptic to obovate to narrowly so, 14–20 by 5–8 cm (index 2–2.9), coriaceous, glabrous above, rather densely to sparsely covered with stellate hairs on large veins, otherwise glabrous below, base acute to attenuate, apex acuminate (acumen 5–20 mm long), primary vein impressed above, secondary veins 9–11 on either side of primary vein, impressed above, loop-forming, shortest distance between loops and margin 1–2 mm, or not loop-forming, tertiary veins flat and inconspicuous above, percurrent to reticulate. *Inflorescences* 1-flowered; peduncles c. 5 mm long, 2–2.5 mm diam., fruiting peduncles to c. 5 mm diam.; bracts 4, triangular to narrowly triangular, 2–3 mm long, outer side densely covered with stellate hairs, falling after flowering; pedicels 25–30 mm long, c. 2 mm diam., fruiting pedicels to c. 35 mm long, peduncles and pedicels densely covered with stellate hairs, becoming glabrous. *Flowers:* color not mentioned; sepals broadly triangular-ovate, connate just at the base, 3–4 mm long, outer side densely covered with stellate hairs; outer petals elliptic, 25–30 mm long, 12–15 mm wide, base attenuate into a more or less distinct claw, apex acute to obtuse, callus area at inner base to c. 5 mm long, inner petals similar to outer petals, 20–25 mm long, outer side of petals densely covered with stellate hairs; stamens c. 3 mm long, connective shield with conical prolongation (fide Fries 1957). *Monocarps*

1–2, green, probably maturing yellow in vivo, brown in sicco, ellipsoid or oblongoid, with (2-seeded forms) or without oblique constriction, apex rounded, to c. 60 (1-seeded) or c. 80 by 35 mm (2-seeded). *Seeds* 1–2 per monocarp, to c. 35 by 28 mm.

Distribution. Colombia (Vaupés). Only known from the type collection.

Habitat and ecology. Not recorded.

Note. This single collection of *Tetrameranthus macrocarpus* seems to come quite near some forms of the variable *T. duckei*. It is distinct from the latter primarily by the larger fruit. Moreover, it is reported to be a tall tree (without more precise indication of size), whereas reports for *T. duckei* indicate a medium-sized tree to about 12 m tall so far. Nevertheless one might wonder if *T. macrocarpus* is merely an extreme form of *T. duckei*, but more extensive collecting in the western Amazon region is needed before this question could be answered.

Tetrameranthus pachycarpus Westra

http://species-id.net/wiki/Tetrameranthus_pachycarpus

Fig. 1E, F; Map 1

Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, ser. C. 88: 477, plate 2, fig. 1, plates 12 & 13. 1985.

Type. *Klug 1216* (holotype NY; isotypes F, U), Peru, Loreto: Mishuyacu, near Iquitos, 100 m, April 1930.

Description. *Tree*, 4–26 m tall, young twigs and petioles densely to rather densely covered with brown, stellate hairs >0.5 mm long, becoming glabrous. *Leaves:* petioles 20–30 mm long, 2–4 mm diam., slightly thickened toward the base, lamina elliptic, narrowly elliptic or narrowly obovate, 17–22 by 5–10 cm (index 2.1–3.4), coriaceous, brown in sicco, glabrous except for primary vein above, rather densely to sparsely covered with stellate hairs on large veins and otherwise sparsely covered with stellate hairs to glabrous below, base acute to attenuate, apex obtuse, acute, or acuminate (acumen 1–5 (rarely more) mm long), primary vein impressed to almost flat above, secondary veins 10–15 on either side of primary vein, not loop-forming, or less often loop-forming, shortest distance between loops and margin 2–3 mm, tertiary veins flat and inconspicuous above, percurrent to more or less reticulate. *Inflorescences* 1-flowered; peduncles 4–5 mm long, 1–2 mm diam., fruiting peduncles to c. 5 mm diam., bracts 2(–more?), narrowly triangular to linear-triangular, 3–5 mm long, outer side densely covered with stellate hairs, falling at or after flowering, pedicels 10–15 mm long, 1.5–2 mm diam., fruiting pedicels to c. 25 mm long, 3–4 mm diam., peduncles and pedicels densely to rather densely covered with stellate hairs, becoming glabrous; flowers yellow in vivo; sepals broadly elliptic, 3–4 mm long, connate at the very base, outer side densely covered with stellate hairs; outer petals narrowly elliptic to oblong, to c. 35 by 16 mm, outer side densely to rather densely covered with stellate hairs, the inner base glabrous, to c. 3 mm long, inner petals narrowly elliptic to oblong, somewhat smaller

than outer petals and with slightly larger glabrous inner base; stamens c. 2 mm long, connective shield more or less conical and curved toward the center. *Monocarps* 1–3, yellow in vivo, brown in sicco, ellipsoid, 2-seeded forms to c. 70 by 40 mm, without or with inconspicuous, oblique constriction, apex rounded. *Seeds* 1–2 per monocarp, 30–40 by 20–28 mm.

Distribution. Peru (Loreto), fairly common in the region around Iquitos, not known elsewhere so far.

Habitat and ecology. In forest on white sand. At elevations of 100–200 m. Flowering and fruiting: probably throughout most of the year.

Additional specimens examined. Peru. Loreto: Mishana, 100–140 m, Ayala 1564 (AMAZ), Díaz S. et al. 404 (MO), Foster 4271 (F, MO, U), Gentry et al. 39313 (U), Vásquez et al. 5285 (MO, U), Vásquez & Jaramillo 9651 (MO, U); Puerto Almendras, 100–120 m, Díaz & Arévalo 81 (MO, U), Grández & Jaramillo 4983 (MO, U), Vásquez & Jaramillo 4619 (MO, U), 11031 (MO, U), Vásquez et al. 8067 (MO, U); Carretera de Peña Negra, at 2 km from Quista Cocha, 180 m, Rimachi Y. 4537 (MO, US), 7735 (MO, NA); Ninarumi (“Nina Rummy”), 123 m, Ruiz M. 808 (MO); Prov. Maynas, Allpahuayo, Vásquez et al. 17984 (MO).

Tetrameranthus umbellatus Westra

http://species-id.net/wiki/Tetrameranthus_umbellatus

Figs 1A, B, G, 2F, G; Map 2

Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, ser. C. 88: 479, plates 1, 14, 15. 1985.

Type. *Tunquí* 62 (holotype U; isotype MO), Peru, Amazonas: Río Santiago, Huambisa, other side of La Poza 1 km, 180 m, 14 November 1979.

Description. *Tree*, 8–25 m tall, 15–25 cm diam., young twigs and petioles densely to rather densely covered with stellate hairs <0.2 mm long, becoming glabrous. *Leaves*: petioles 5–25 mm long, 1.5–3 mm diam., lamina narrowly obovate or narrowly elliptic-obovate, 15–30 by 4–9 cm (index 2.4–4.7), chartaceous, greenish brown to brown above, pale greenish brown to brown below in sicco, sparsely covered with stellate hairs to glabrous above, rather densely to sparsely covered with stellate hairs on primary vein and sparsely covered to glabrous otherwise below, base acute to attenuate, decurrent along the petiole, apex acute to (abruptly) acuminate (acumen 5–10 mm long), primary vein flat to slightly impressed above, secondary veins 13–20 on either side of primary vein, slightly impressed to raised above, loop-forming, shortest distance between loops and margin 0.5–2 mm, tertiary veins flat to raised above, percurrent to more or less reticulate. *Inflorescences* up to 5-flowered, umbel-like; peduncles 5–25 mm long, c. 1.5 mm diam., densely to rather densely covered with stellate hairs, becoming glabrous in age, fruiting peduncles to c. 3 mm diam., bracts 4, oblong, 4–5 mm long, outer side densely covered with stellate hairs, falling before flowering, pedicels 25–70

mm long, ≥ 1 mm diam., densely to rather densely covered with stellate hairs, becoming glabrous in age, fruiting pedicels to c. 3 mm diam. *Flowers* green, maturing yellow in vivo; sepals broadly triangular-ovate to ovate, connate just at the base, to c. 4 by 3–5 mm, outer side densely covered with stellate hairs; outer petals ovate-elliptic, 16–20 by 9–12 mm, densely to rather densely covered with stellate hairs, the inner base with small glabrous area, inner petals elliptic, 13–17 by 6–7 mm, indument as in outer petals, the glabrous inner base slightly larger; stamens ≤ 1 mm long, connective shield cushion-shaped, flat. *Monocarps* 2–7, orange or red in vivo, brownish black in sicco, ellipsoid to oblongoid, 2-seeded forms to c. 45 by 20 mm and with oblique constriction, 1-seeded forms smaller and without constriction, mostly rounded at the apex. *Seeds* 1–2 per monocarp, to c. 25 by 18 mm.

Distribution. Amazonian Peru (Amazonas, Huánuco, Loreto) and Brazil (Amazonas, Pará).

Habitat and ecology. In non-inundated (terra firme) forest or rarely periodically inundated forest. At elevations of 100–600 m. Flowering and fruiting: probably throughout the year.

Additional specimens examined. Brazil. Amazonas: Mun. Jutaí, Cid et al. 7269 (K, NY, US); km 1225 of Cuiabá-Santarém Highway (BR 163), Prance et al. 25602 (NY, U). **Peru.** Amazonas: Río Santiago, 2 km below Caterpiza, trail to Mitayar, E side of Quebrada Caterpiza, Huashikat 613 (MO, U); Quebrada Sasa, Monte Numi, 600 m, Kayap 2015 (MO, U). Huánuco: Distr. Llullapichis, Prov. Puerto Inca, Dantas, 280 m, Kröll Saldaña 712 (U); S of Pucallpa, next to the junction of the Río Pachitea and Río Llullapichis, 260 m, Morawetz & Wallnöfer 14-81085 (U); Prov. Pachitea, region of Pucallpa, Sira Mts., 26 km S of Puerto Inca, next to the junction of the Río Pachitea and Río Llullapichis, field station “Panguana”, 260 m, Morawetz & Wallnöfer 18-14188 (U, WU). Loreto: Prov. Maynas, Paucarillo Reserve, Río Amazonas, 110 m, Choo 347 (MO); Prov. Maynas, Distr. Las Amazonas, Explornapo Camp, near Susucari, 100–140 m, Pipoly et al. 14565 (MO, U); Prov. Maynas, Llachapa, Río Napo, 130 m, Vásquez & Jaramillo 3732 (MO, U).

Vernacular names. Peru: Washi yais (*Tunquí* 62), Wáshi yéis (*Huashikat* 613), Yaú (*Kayap* 2015).

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Synopsis of *Trichosanthes* (Cucurbitaceae) based on recent molecular phylogenetic data

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Abstract

The snake gourd genus, *Trichosanthes*, is the largest genus in the Cucurbitaceae family, with over 90 species. Recent molecular phylogenetic data have indicated that the genus *Gymnopetalum* is to be merged with *Trichosanthes* to maintain monophyly. A revised infrageneric classification of *Trichosanthes* including *Gymnopetalum* is proposed with two subgenera, (I) subg. *Scotanthus* comb. nov. and (II) subg. *Trichosanthes*, eleven sections, (i) sect. *Asterospermae*, (ii) sect. *Cucumeroides*, (iii) sect. *Edulis*, (iv) sect. *Foliobracteola*, (v) sect. *Gymnopetalum*, (vi) sect. *Involucraria*, (vii) sect. *Pseudovariifera* sect. nov., (viii) sect. *Villosae* stat. nov., (ix) sect. *Trichosanthes*, (x) sect. *Tripodanthera*, and (xi) sect. *Truncata*. A synopsis of *Trichosanthes* with the 91 species recognized here is presented, including four new combinations, *Trichosanthes orientalis*, *Trichosanthes tubiflora*, *Trichosanthes scabra* var. *pectinata*, *Trichosanthes scabra* var. *penicaudii*, and a clarified nomenclature of *Trichosanthes costata* and *Trichosanthes scabra*.

Keywords

Cucurbitaceae, *Trichosanthes*, *Gymnopetalum*, infrageneric classification, new combinations

Introduction

Background

Trichosanthes L. is the largest genus in the Cucurbitaceae family, with over 90 species. The genus has its center of diversity in Southeast Asia, but ranges from India throughout Asia east to Taiwan, the Philippines and Japan, and southeast to New Guinea, Australia, Fiji and Vanuatu (de Wilde and Duyfjes 2010). The snake gourd (*Trichosanthes cucumerina* L.) is a popular vegetable in South and Southeast Asian cuisine and

cultivated in tropical and subtropical regions around the globe. *Gymnopetalum* Arn. includes four species (de Wilde and Duyfjes 2006) and ranges from India through China and Southeast Asia into the Malay archipelago, but does not occur in New Guinea and Australia (de Wilde and Duyfjes 2010).

Morphology and classification

Trichosanthes are mostly stout perennial climbers, 3–30 m long, dioecious, less frequently monoecious, with branched tendrils, distinctly fringed petals, and often egg-sized brightly colored fruits. Dioecy, variation in vegetative morphology (esp. in juvenile plants), and incomplete herbarium collections, complicate taxonomical studies and have contributed to the description of nearly 300 taxa (de Wilde and Duyfjes 2010; IPNI 2011).

No full taxonomic treatment of the genus exists, but in recent years regional revisions have been published for most of its distribution: India (Chakravarty 1959; Jeffrey 1980a; Jeffrey 1982), China (Lu et al. 2011; Yueh and Cheng 1974; Yueh and Cheng 1980), Thailand (Duyfjes and Pruesapan 2004), Cambodia, Laos and Vietnam (Keraudren-Aymonin 1975), Malaysia, Indonesia, the Philippines and Papua New Guinea (Rugayah and de Wilde 1997; Rugayah and de Wilde 1999; de Wilde and Duyfjes 2004; de Wilde and Duyfjes 2010), Australia (Telford 1982; Cooper and de Boer 2011) and Japan (Ohba 1984).

Infrageneric classifications of the genus *Trichosanthes* have been proposed by various authors (Yueh and Cheng 1974; Jeffrey 1980b; Chen 1985; Huang et al. 1997; Rugayah and de Wilde 1999; de Wilde and Duyfjes 2004). The most recent classifications of the genus (Rugayah and de Wilde 1999; de Wilde and Duyfjes 2004) propose six sections: (i) sect. *Trichosanthes*, (ii) sect. *Cucumeroides* (Gaertn.) Kitam. including subsect. *Cucumeroides* (Gaertn.) Kitam. and subsect. *Tetragonosperma* (C.Y.Cheng & Yueh) Rugayah, (iii) sect. *Edulis* Rugayah, (iv) sect. *Foliobracteola* C.Y.Cheng & Yueh, (v) sect. *Involucraria* (Ser.) Wight including subsect. *Bracteatae* C.Jeffrey ex S.K.Chen and subsect. *Pedatae* (C.Y.Cheng & Yueh) C.Jeffrey ex S.K.Chen, and (vi) sect. *Astrosperma* W.J.de Wilde & Duyfjes. However, both Rugayah and de Wilde (1999) and de Wilde and Duyfjes (2004; 2010) are reserved in their infrageneric classifications, and mention a need for further investigation.

Pollen morphology has also been used for infrageneric classification in the genus (Khunwasi 1998; Pruesapan and Van Der Ham 2005; Huang et al. 1997), but as a character is very variable in Cucurbitaceae, and its taxonomic value is not clear (Schaefer and Renner 2011). Palynological studies (Pruesapan and Van Der Ham 2005) have indicated that a variety of pollen types exist in *Trichosanthes* including 3(-4)-porate and 3(-4)-colporate pollen with psilate, perforate, verrucate, reticulate, and regulate ornamentation. Their study of pollen from 37 species distinguishes five pollen types, two of which are further divided into subtypes, and categorized these using exine ornamentation patterns for the major types and ectoaperture characters for the subtypes.

Gymnopetalum strongly resembles certain *Trichosanthes* species, but lack thread-like fringes on the petals, and the overall shape of the folded petals in the mature bud is elongate (short and rounded in *Trichosanthes*) (de Wilde and Duyfjes 2006). A revision of the genus was published by de Wilde and Duyfjes (2006), with minor nomenclatural changes published later (de Wilde and Duyfjes 2008). Cogniaux (1881) divided *Gymnopetalum* into two sections, (i) sect. *Gymnopetalum* containing the type *G. tubiflorum* (Wight & Arn.) Cogn. from southern India and Sri Lanka, and (ii) sect. *Tripodanthera* (M.Roem.) Cogn. containing the Southeast Asian and Malesian species. Later authors did not follow this classification (Jeffrey 1980a; Philcox 1997; de Wilde and Duyfjes 2006).

Recent molecular phylogenetic studies

The molecular phylogenetic study of *Trichosanthes* by de Boer et al. (Submitted) shows that *Trichosanthes* and *Gymnopetalum* are both non-monophyletic, but together form a clade with high support in the Bayesian tree and weak support in the ML tree (0.99/62). This indicates that *Gymnopetalum* should be merged with *Trichosanthes*, and that a revised infrageneric classification is necessary. Some previously recognized sections in *Trichosanthes* and *Gymnopetalum* are well supported, but others need to be described or redefined.

Results and discussion

Molecular phylogeny

The molecular phylogeny of *Trichosanthes* and *Gymnopetalum* by de Boer et al. (Submitted) has nomenclatural implications for the species in *Gymnopetalum* and the infrageneric classification of *Trichosanthes*. The species of *Gymnopetalum* are placed in different clades within *Trichosanthes*, with the sect. *Gymnopetalum*, including the type *G. tubiflorum*, grouping in a well-supported clade (1.00/84) together with species of sect. *Trichosanthes* and sect. *Cucumeroides*. The sect. *Tripodanthera*, consisting of the three other species in the genus, *G. orientale* W.J.de Wilde & Duyfjes, *G. chinense* (Lour.) Merr., and *G. scabrum* (Lour.) W.J.de Wilde & Duyfjes, forms a well-supported clade (1.00/86) together with the taxa in *Trichosanthes* sect. *Edulis*.

Within *Trichosanthes* the support for the two clades here defined as subgenera *Trichosanthes* (1.00/94) and *Scotanthus* (1.00/97) is high. However, splitting the genus into two genera corresponding to subg. *Scotanthus* and subg. *Trichosanthes* would not improve clarity, as both would consist of species with fringed and fringeless corollas. Maintaining a large *Trichosanthes* is in accordance with the recent taxonomic revisions of the genus (de Wilde and Duyfjes 2010; Chakravarty 1959; Lu et al. 2011; Duyfjes and Pruesapan 2004; Keraudren-Aymonin 1975; Cooper and de Boer 2011; Ohba 1984), and is the alternative that best provides taxonomic stability.

Some proposed sections in *Trichosanthes* and *Gymnopetalum* are well supported: (i) sect. *Cucumeroides* (1.00/93), including subsect. *Cucumeroides* (0.99/-) and subsect. *Tetragonosperma* (0.99/69), (ii) sect. *Edulis* (1.00/75), and (iii) sect. *Asterosperma* (1.00/100). The subsections of sect. *Cucumeroides* are statistically supported, but subsect. *Cucumeroides* consists solely of accessions of *Trichosanthes pilosa* Lour. and species that have been reduced to its synonymy (Cooper and de Boer 2011). Sect. *Involucraria* is only weakly supported (0.83/65), primarily due to the low support for inclusion of its type, *T. wallichiana* (Ser.) Wight. The subsections of *Involucraria* are not supported, and taxa belonging to subsect. *Pedatae* are nested in different locations within subsect. *Bracteatae*. Sect. *Tripodanthera* is not supported by the analysis, and could possibly form a grade at the base of sect. *Edulis*. However, morphological support for this section is strong as all taxa share characters of flower morphology, i.e. fringeless corollas. Sect. *Foliobracteola* Cheng & Yueh, which in its original sense included the species related to *T. kirilowii* Maxim. and *T. villosa* Blume (Yueh and Cheng 1974; Rugayah and de Wilde 1999; de Wilde and Duyfjes 2004), is not supported. However, a clade consisting of *T. kirilowii* Maxim., *T. miyagii* Hayata, *T. homophylla* Hayata, *T. hylonoma* Hand.-Mazz., *T. rosthornii* Harms, and *T. multiloba* Miq. is strongly supported (1.00/99). Section *Truncata*, in its original sense including *Trichosanthes truncata* C.B. Clarke, *T. kerrii* Craib, *T. homophylla* Hayata (Yueh and Cheng 1980), and *T. smilacifolia* C.Y. Wu (Jeffrey 1980b), is not supported, as the three latter species all end up elsewhere in the phylogenetic tree.

Trichosanthes villosa was placed in sect. *Involucraria* by Yueh and Cheng (1974), and later in subsect. *Involucraria* by Jeffrey (1980b), but subsequently moved to sect. *Foliobracteola* by Rugayah and de Wilde (1999). In the protologue of *T. phonsenae* Duyfjes and Pruesapan (2004), the authors stated that the three species *T. kerrii*, *T. phonsenae* and *T. villosa* form a coherent, distinct group based on presence of white fruit pulp, male flowers with the stamens inserted low in the receptacle tube, and a pseudo-ovary. The molecular evidence shows that all accessions of these species in this study form a well-supported monophyletic group, confirming the observations by Duyfjes and Pruesapan (2004) and warranting placement of these taxa in a new section, sect. *Pseudovariifera* H.J. de Boer.

Cooper and Ford (2010) and Cooper and de Boer (2011) placed *Trichosanthes subvelutina* F. Muell. ex Cogn. in section *Foliobracteola* as it has obovate seeds with an entire broad marginal band similar to those found in Malesian species of section *Foliobracteola*. However, Huang et al (1997) proposed to place it in section *Foliobracteola* subsect. *Villosae* based on its pollen morphology. The current phylogenetic data place the accessions of *T. subvelutina* as sister (1.00/91) to a well-supported clade (1.00/84) consisting of sections *Gymnopetalum*, *Trichosanthes*, and *Cucumeroides*, and the species is here placed in a separate section, sect. *Villosae* (Yueh & L.Q. Huang) H.J. de Boer.

Pollen

Species with colpporate ectoaperturate pollen form two monophyletic groups in *Trichosanthes* subg. *Trichosanthes*, one including sections *Asterosperma*, *Pseudovariifera*, *Foliobracteola*, and *Truncata*, and the other including sect. *Villosae*, with *T. subvelutina* (data from R. van der Ham 2011, pers. comm.). The latter clade is sister to the clade consisting of sections *Trichosanthes*, *Gymnopetalum* and *Cucumeroides* (1.00/84). The remaining sections in subg. *Trichosanthes* have porate ectoapertures, and varying exine ornamentation including psilate, (micro-)reticulate, perforate, verrucate, and rugulate pollen (Huang et al. 1997; Pruesapan and Van Der Ham 2005). *G. scabrum* in sect. *Tripodanthera* has 3-colporate, rugulate-reticulate pollen (Khunwasi 1998; van der Ham et al. 2010), whereas in *G. tubiflorum* in sect. *Gymnopetalum* the pollen is 3-porate and microreticulate (R. van der Ham 2010, pers. comm.).

The other genera in the tribe Sicyoeae have colpate-colporate pollen, similar to that in many other distantly related groups in Cucurbitaceae (Schaefer and Renner 2011). In the light of the molecular data and the phylogenetic analysis (de Boer et al. Submitted), a transition from colpporate to porate apertures has taken place three times in the evolutionary history of *Trichosanthes*, in the common ancestors of: 1) sect. *Involucraria*; 2) sect. *Edulis*; and 3) sections *Trichosanthes*, *Gymnopetalum* and *Cucumeroides*.

Taxonomy and classification

A revision of the infrageneric classifications suggested by previous authors on the basis of morphological studies (Yueh and Cheng 1974; Jeffrey 1980b; Huang et al. 1997; Rugayah and de Wilde 1999; de Wilde and Duyfjes 2004) is here proposed on the basis of the molecular phylogenetic data (de Boer et al. Submitted). A synopsis is presented in which we attempt to assign all 91 species recognized here to sections using the clades recovered in the phylogenetic analysis as a framework, along with a plentitude of data from macromorphological studies of herbarium vouchers (Chakravarty 1959; Jeffrey 1980a; Jeffrey 1980b; Jeffrey 1982; Telford 1982; Ohba 1984; Rugayah and de Wilde 1997; Rugayah and de Wilde 1999; Duyfjes and Pruesapan 2004; de Wilde and Duyfjes 2004; de Wilde and Duyfjes 2006; Cooper and Ford 2010; de Wilde and Duyfjes 2010; Lu et al. 2011; Cooper and de Boer 2011) and palynological work (Huang et al. 1997; Pruesapan and Van Der Ham 2005; van der Ham et al. 2010). Synonyms are only included if these are new or relevant for this paper. Names that have been placed in synonymy by previous authors can be found in the above-cited morphological studies.

Trichosanthes L. (1753) Sp. Pl. 2: 1008 – Type: *Trichosanthes anguina* L. [= *T. cucumerina* L.]

T. subg. Scotanthus (Kurz) H.J.de Boer, comb. nov. – *Gymnopetalum* subg. *Scotanthus* Kurz (1877) J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 46: 99. – Lectotype, designated here: *Bryonia cochinchinensis* Lour. [= *Trichosanthes costata* Blume]

Scotanthus Naud., nom. illeg. (1862) Ann. Sci. Nat., Bot. sér. 4, 16: 172. – Type: *Momordica tubiflora* Roxb. [= *Trichosanthes costata* Blume]

T. sect. Edulis Rugayah (1999) Reinwardtia 11: 232. – Type: *Trichosanthes edulis* Rugayah.

T. densiflora Rugayah (1999) Reinwardtia 11: 252

T. dentifera Rugayah (1999) Reinwardtia 11: 253

T. dieniensis Merr. & L.M.Perry (1949) J. Arnold Arbor. 30: 59

T. edulis Rugayah (1999) Reinwardtia 11: 254

T. hastata Harms (1925) Bot. Jahrb. Syst. 60: 160

T. laeoica C.Y.Cheng & Lu Q.Huang (1996) Bull. Bot. Res., Harbin 16: 503

T. odontosperma W.E.Cooper & A.J.Ford (2010) Austrobaileya 8: 126

T. pulleana Harms (1925) Bot. Jahrb. Syst. 60: 160

T. schlechteri Harms (1925) Bot. Jahrb. Syst. 60: 159

T. sect. Involucraria (Ser.) Wight (1840) Madras J. Lit. Sci. 12: 52. – *Involucraria* Ser. (1825) Mém. Soc. Phys. Genève 3: 27, t. 5. – Type: *Involucraria wallichiana* Ser. [= *Trichosanthes wallichiana* (Ser.) Wight]

T. anamalaiensis Bedd. (1864) Madras J. Lit. Sci. III, 1: 47

T. borneensis Cogn. (1881) Monogr. Phan. [A.DC. & C.DC.] 3: 369

T. bracteata (Lam.) Voigt (1845) Hort. Suburb. Calcutt. 58

T. celebica Cogn. (1881) Monogr. Phan. [A.DC. & C.DC.] 3: 385

T. cordata Roxb. (1832) Fl. Ind. 3: 703

T. coriacea Blume (1826) Bijdr. Fl. Ned. Ind. 15: 935

T. dolichosperma Duyfjes & Pruesapan (2004) Thai Forest Bull., Bot. 32: 84

T. dunniana H. Lév. (1911) Repert. Spec. Nov. Regni Veg. 10: 148

T. ellipsoidea Merr. (1918) Philipp. J. Sci., C 13: 332

T. elmeri Merr. (1929) Univ. Calif. Publ. Bot. 15: 299

T. emarginata Rugayah (1999) Reinwardtia 11: 258

T. erosa Duyfjes & Pruesapan (2004) Thai Forest Bull., Bot. 32: 85

T. fissibracteata C.Y.Wu ex C.Y.Cheng & C.H.Yueh (1974) Acta Phytotax. Sin. 12: 438

T. floresana Rugayah (1999) Reinwardtia 11: 260

T. globosa Blume (1826) Bijdr. Fl. Ned. Ind. 15: 936

T. intermedia W.J.de Wilde & Duyfjes (2004) Sandakania 14: 19

T. inthanonensis Duyfjes & Pruesapan (2004) Thai Forest Bull., Bot. 32: 86

T. khasiana Kundu (1939) J. Bot. 77: 11

T. kinabaluensis Rugayah (2000) Reinwardtia 11: 419

T. kostermansii Duyfjes & Pruesapan (2004) Thai Forest Bull., Bot. 32: 89

- T. laceribractea* Hayata (1911) J. Coll. Sci. Imp. Univ. Tokyo 30. Art. 1: 117
T. lepiniana (Naud.) Cogn. (1881) Monogr. Phan. [A.DC. & C.DC.] 3: 377
T. leuserensis Rugayah (1999) Reinwardtia 11: 265
T. longispicata Rugayah (1999) Reinwardtia 11: 266
T. montana Rugayah (1998) Reinwardtia 11: 218
T. morrisii W.E.Cooper (2011) Austrobaileya 8: 381
T. obscura Rugayah (1999) Reinwardtia 11: 269
T. pallida Duyfjes & Pruesapan (2004) Thai Forest Bull., Bot. 32: 90
T. papuana F.M.Bailey (1900) Queensland Agric. J. 7: 349
T. pedata Merr. & Chun (1934) Sunyatsenia 2: 20
T. pentaphylla F.Muell. in Benth. (1867) Fl. Austral. 3: 314
T. philippinensis Rugayah (1999) Reinwardtia 11: 271
T. planiglans Rugayah (1999) Reinwardtia 11: 273
T. pubera Blume (1826) Bijdr. Fl. Ned. Ind. 15: 936
T. quinquangulata A. Gray (1854) U.S. Expl. Exped., Phan. 15: 645
T. quinquefolia C.Y.Wu ex C.Y.Cheng & C.H.Yueh (1980) Acta Phytotax. Sin. 18: 351
T. refracta C.H.Yueh (1996) Bull. Bot. Res., Harbin 10: 500
T. rugatisemina C.Y.Cheng & C.H.Yueh (1974) Acta Phytotax. Sin. 12: 440
T. sepilokensis Rugayah (1999) Reinwardtia 11: 275
T. subrosea C.Y.Cheng & C.H.Yueh (1980) Acta Phytotax. Sin. 18: 349
T. tricuspadata Lour. (1790) Fl. Cochinch. 2: 589
T. valida Rugayah (1999) Reinwardtia 11: 277
T. wallichiana (Ser.) Wight (1840) Madras J. Lit. Sci. 12: 52
T. wawrae Cogn. (1881) Monogr. Phan. [A.DC. & C.DC.] 3: 384

T. sect. Tripodanthera (M.Roem.) H.J.de Boer, *comb. nov.* – *Tripodanthera* M.Roem. (1846) Fam. Nat. Syn. Monogr. 2: 48. – *Gymnopetalum* sect. *Tripodanthera* (M.Roem.) Cogn. (1881) Monogr. Phan. [A.DC. & C.DC.] 3: 390. – Type: *Bryonia cochinchinensis* Lour. [= *Trichosanthes costata* Blume]

T. costata Blume (1826) Bijdr. Fl. Ned. Ind. 15: 933. — Type: *Blume s.n.* barcode L0589632, (lectotype L, designated by de Wilde and Duyfjes (2006); 2 isotypes L), Java, Indonesia. Heterotypic synonyms: *Evonymus chinensis* Lour. (1790) Fl. Cochinch. 1: 156. – *Gymnopetalum chinense* (Lour.) Merr. (1919) Philipp. J. Sci. 15: 256 – Type: *Loureiro* †. *Bryonia cochinchinensis* Lour. (1790) Fl. Cochinch. 1: 595. – *Gymnopetalum cochinchinense* (Lour.) Kurz (1871) J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 40: 57 – Type: *Loureiro s.n.* (BM), Vietnam. *Momordica tubiflora* Roxb. (1832) Fl. Ind. 3: 711 – Type: *Wallich Cat.* 6749 (holotype? K-W), Dacca, Bangladesh. Note: The existence of *Trichosanthes chinensis* Ser. (1828) Prodr. [A.P. de Candolle] 3: 315 blocks the transfer of *Gymnopetalum chinense*, based on the basionym *Evonymus chinensis*, to *Trichosanthes*. The second name in line of priority would be *Gymnopetalum cochinchinensis*, based on the basionym *Bryonia cochinchinensis*. However, the combination *Trichosanthes cochinchinensis* M.Roem. (1846) Fam. Nat. Syn. Monogr. 2: 96, based on *Trichosanthes cucumerina* Lour.

(1790) 722 (non L.), blocks the transfer. The third name in line of priority is *Trichosanthes costata* Blume (1826) *Bijdr. Fl. Ned. Ind.* 15: 933, and this name is available for *Gymnopetalum chinense*.

T. scabra Lour. (1790) *Fl. Cochinch.* 2: 589. – *Gymnopetalum scabrum* (Lour.) W.J.de Wilde & Duyfjes (2008) *Reinwardtia* 12: 268. – Type: *Poilane 11322* (neotype P; isoneotype L, designated by de Wilde and Duyfjes (2008)), Annam. Heterotypic synonym: *Cucumis integrifolius* ('*integrifolia*') Roxb. (1832) *Fl. Ind.* 3: 724. – *Gymnopetalum integrifolium* (Roxb.) Kurz (1871) *J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist.* 40: 58. – Type: *Wallich Cat. 6730* (holotype? K-W), Burma.

var. *scabra*

var. **pectinata** (W.J.de Wilde & Duyfjes) H.J.de Boer, *comb. nov.* – *Gymnopetalum scabrum* (Lour.) W.J.de Wilde & Duyfjes var. *pectinatum* (W.J. de Wilde & Duyfjes) W.J.de Wilde & Duyfjes (2008) *Reinwardtia* 12: 268 – *Gymnopetalum integrifolium* (Roxb.) Kurz var. *pectinatum* W.J.de Wilde & Duyfjes (2006), *Blumea* 51: 287. – Type: *W.J. de Wilde and Duyfjes 21692* (holotype L), Java, Indonesia.

var. **penicaudii** (Gagnep.) H.J.de Boer, *comb. nov.* – *Gymnopetalum penicaudii* Gagnep. (1918) *Bull. Mus. Natl. Hist. Nat.* 24: 374. – *Gymnopetalum scabrum* (Lour.) W.J.de Wilde & Duyfjes var. *penicaudii* (Gagnep.) W.J.de Wilde & Duyfjes (2008) *Reinwardtia* 12: 268 – Type: *Pénicaud 43* (lectotype P), Hainan, China.

T. orientalis (W.J.de Wilde & Duyfjes) H.J.de Boer, *comb. nov.* – *Gymnopetalum orientale* W.J.de Wilde & Duyfjes (2006) *Blumea* 51: 290. – Type: *De Wilde and Duyfjes 21937* (holotype L), Lombok, Indonesia.

T. subg. *Trichosanthes*

Unresolved placement within this subgenus:

T. reticulineris C.Y.Wu ex S.K.Chen (1985) *Bull. Bot. Res., Harbin* 5(2): 114

T. smilacifolia C.Y.Wu ex C.H.Yueh & C.Y.Cheng (1980) *Acta Phytotax. Sin.* 18: 347

T. sect. *Asterosperma* W.J.de Wilde & Duyfjes (2004) *Sandakania* 14: 6. – Type: *Trichosanthes postarii* W.J.de Wilde & Duyfjes.

T. auriculata Rugayah (1998) *Reinwardtia* 11: 216

T. fusca W.J.de Wilde & Duyfjes (2004) *Sandakania* 14: 17

T. postarii W.J.de Wilde & Duyfjes (2004) *Sandakania* 14: 26

T. rotundifolia Rugayah (1998) *Reinwardtia* 11: 223

T. sect. *Cucumeroides* (Gaertn.) Kitam. (1943) *J. Jap. Bot.* 19: 35. – *Cucumeroides* Gaertn. (1791) *Fruct. Sem. Pl.* 2: 485, t. 180, t. 4. – Type: *Trichosanthes cucumeroides* (Ser.) Maxim. [= *Trichosanthes pilosa* Lour.].

T. adhaerens W.J.de Wilde & Duyfjes (2004) *Sandakania* 14: 11

T. beccariana Cogn. (1881) *Monogr. Phan. [A.DC. & C.DC.]* 3: 380

T. mucronata Rugayah (1999) *Reinwardtia* 11: 268

- T. pendula* Rugayah (1998) Reinwardtia 11 (3): 219
- T. pilosa* Lour. (1790) Fl. Cochinch. 2: 588. Heterotypic synonyms according to Cooper and de Boer (2011): *T. baviensis* Gagnep. (1918) Bull. Mus. Natl. Hist. Nat. 24: 379; *T. trichocarpa* C.Y.Wu ex C.Y.Cheng & C.H.Yueh (1980) Acta Phytotax. Sin. 18: 340; *T. holtzei* F.Muell. (1886) Australas. Journ. Pharm. 1: 447.
- T. siamensis* Duyfjes & Pruesapan (2004) Thai Forest Bull., Bot. 32: 97
- T. tetragonosperma* C.Y.Cheng & C.H.Yueh (1974) Acta Phytotax. Sin. 12: 425
- T. sect. Foliobracteola*** C.Y.Cheng & C.H.Yueh (1974) Acta Phytotax. Sin. 12: 427.
– Type: *Trichosanthes kirilowii* Maxim.
- T. homophylla* Hayata (1921) Icon. Pl. Formosan. 10: 8
- T. hylonoma* Hand.-Mazz. (1936) Symb. Sin. Pt. 7: 1066
- T. ishigakiensis* E.Walker (1971) J. Jap. Bot. 46: 71
- T. jinggangshanica* C.H.Yueh (1980) Acta Phytotax. Sin. 18: 342
- T. kirilowii* Maxim. (1859) Prim. Fl. Amur. 482
- T. mianyangensis* C.H.Yueh & R.G.Liao (1992) Bull. Bot. Res., Harbin 2: 115
- T. miyagii* Hayata (1921) Icon. Pl. Formosan. 10: 11
- T. multiloba* Miq. (1865) Ann. Mus. Bot. Lugd.-Bat. 2: 82
- T. rosthornii* Harms (1901) Bot. Jahrb. Syst. 29: 603
- T. sect. Gymnometalum*** (Arn.) H.J.de Boer, *comb. et stat. nov.* – *Gymnometalum* Arn. (1840) Madras J. Lit. Sci. 12: 52. – Type: *Bryonia tubiflora* Wight & Arn. [= *Trichosanthes tubiflora* (Wight & Arn.) H.J.de Boer].
- T. tubiflora*** (Wight & Arn.) H.J.de Boer, *comb. nov.* – *Bryonia tubiflora* Wight & Arn. (1834) Prodr. Fl. Ind. Orient. 1: 347. – *Gymnometalum tubiflorum* (Wight & Arn.) Cogn. (1881) Monogr. Phan. [A.DC. & C.DC.] 3: 388 – Type: *Rottler s.n.* ex Herb. Klein in Herb. Wight Cat. 1118, February 1796 (holotype K; isotypes E, several duplicates), Trincomalee, Ceylon.
- T. sect. Pseudovariifera*** H.J.de Boer, *sect. nov.* Diagnosis: Similar to sect. *Foliobracteola*, but male flowers with stamens inserted low in receptacle tube, with pseudo-ovary (a thick-walled basal part of the receptacle tube, without staminodes), and fruit with white pulp. Type: *Trichosanthes villosa* Blume.
- T. kerrii* Craib (1914) Bull. Misc. Inform. Kew: 7
- T. phonsenae* Duyfjes & Pruesapan (2004) Thai Forest Bull., Bot. 32: 9
- T. sericeifolia* C.Y.Cheng & C.H.Yueh (1980) Acta Phytotax. Sin. 18: 346
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A new species of *Miconia* (Melastomataceae, Miconieae) from the Ecuador-Peru border

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Abstract

Miconia machinazana C.Ulloa & D.A. Neill, **sp. nov.**, a new species of Melastomataceae from the Ecuador-Peru border is described and illustrated. It is characterized by the narrow, decussate leaves, dense reddish brown indument, small flowers in short panicles, pale yellow petals, and anthers opening by two large terminal pores.

Resumen

Se describe e ilustra *Miconia machinazana* C. Ulloa & D.A. Neill, **sp. nov.**, una nueva especie de Melastomataceae de la frontera ecuatoriano-peruana, caracterizada por las hojas angostas, decusadas, el denso indumento café-rojizo, las flores pequeñas en panículas cortas, los pétalos de un amarillo pálido y las anteras abriéndose por dos poros anchos terminales.

Keywords

Cordillera del Cóndor, Ecuador, endemism, IUCN, Melastomataceae, *Miconia*, Peru

Introduction

Miconia Ruiz & Pav., is a megadiverse genus, the largest in the family Melastomataceae, and comprises some 1050 Neotropical species (Goldenberg et al. 2008). Some 250 species have been recorded for Ecuador (Wurdack 1980, Renner 1999, Cotton 2000, Ulloa Ulloa and Homeier 2008), occurring from sea level to ca. 4000 m. Within the

Melastomataceae, *Miconia* belongs to the Neotropical tribe Miconieae DC. *Miconia* is paraphyletic, and its current circumscription is rather arbitrary. *Miconia* is distinguished only by plesiomorphic characters found elsewhere in the tribe, and by eliminating other genera (Goldenberg et al. 2008, Michelangeli et al. 2004). As currently understood, the genus is characterized by its woody habit, terminal inflorescences, hypanthium not apically constricted, calyx of small lobes not forming a circumscissile cap, anthers without a bifurcation at the base, and a fleshy fruit (Cogniaux 1891, Judd and Skee 1991, Goldenberg et al. 2008).

Explorations in the remote Cordillera del Cóndor in southern Ecuador yielded a shrub erroneously identified in the field as the genus *Myrteola* O. Berg (Myrtales) due to the decussate, coriaceous, small, linear leaves reminiscent of *Myrteola phylloides* (Benth.) Landrum. The leaf arrangement and the non-apparent classic checkerboard venation, of many species in the Melastomataceae led to that mistake. However, the habit of this plant is characteristic of a few high Andean species of *Miconia*, including the widespread *M. salicifolia* (Naudin) Naudin, to which this plant shows a similar habit. Further study has revealed unique features that lead us to propose it as a new species of *Miconia*.

Methods

Herbarium and laboratory work involved taking measurements of the vegetative parts from the dry herbarium specimens; the flowers were rehydrated before taking measurements under a dissecting scope. Seeds were sputter coated with gold/palladium and photographed with a scanning electron microscope (JEOL JCM-5000). Herbarium specimens were consulted and compared at HA, K, LOJA, MA, MO, QCA, and QCNE; necessary herbarium specimens were requested on loan, and additional material was consulted over the internet in various virtual herbaria (COL, NY, US, JStor Plant Science types).

Taxonomic treatment

Miconia machinazana C.Ulloa & D.A.Neill, sp. nov.

urn:lsid:ipni.org:names:77118901-1

http://species-id.net/wiki/Miconia_machinazana

Figs 1–4

Note. Haec species ad *Miconiam* sect. *Cremanium* (D.Don) Hook.f. pertinens, a congeneris sect. *Chaenopleurae* (DC.) Hook.f. floribus pentameris differt; intra sect. *Cremanium* a *Miconia rigente* Naudin foliis minoribus (usque ad 35.1 mm vs. 60 mm longis) petalis luteolis (vs. albis et roseis) atque foliis 1- (vs. 3-)nerviis, a *M. ledifolia* (DC.) Naudin foliis latioribus (usque ad 10.5 mm vs. 4 mm latis) atque

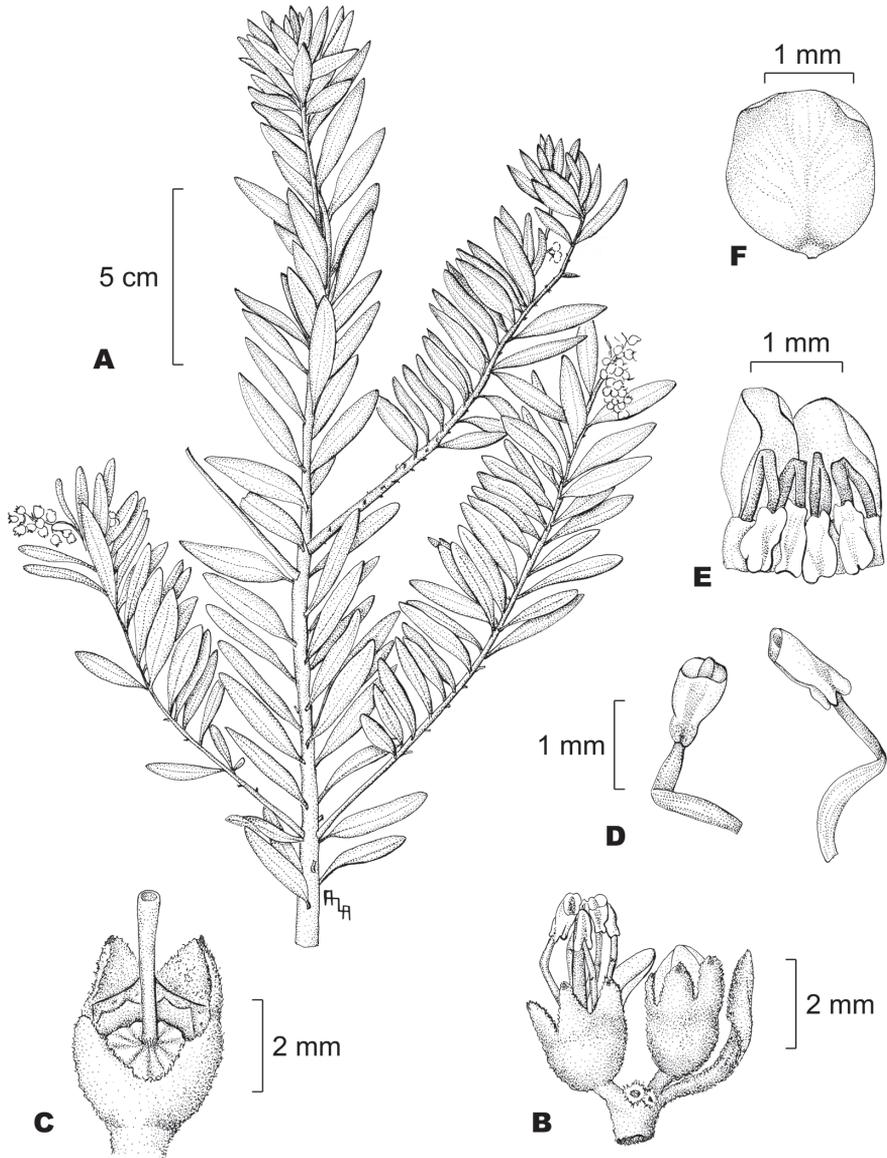


Figure 1. *Miconia machinazana* C. Ulloa & D.A. Neill, **A** fertile branch **B** partial inflorescence and flower bract **C** young fruit crowned by calyx lobes and style **D** stamens, ventral (left) and lateral views **E** young stamens folded inside a partial flower bud **F** petal, ventral view. Line drawing by A.L.Arbeláez; voucher Neill & Kajekai 16909.

fructu majore (2.4–3.9 × 2.8–3.8 mm in *M. ledifolia*) seminibus pluribus (usque ad 9 in *M. ledifolia*) differt.

Type. Ecuador. Zamora-Chinchipe: Paquisha, Cordillera del Cóndor. The Machinaza plateau. About 500 m W of the Ecuador-Peru international border, near end of

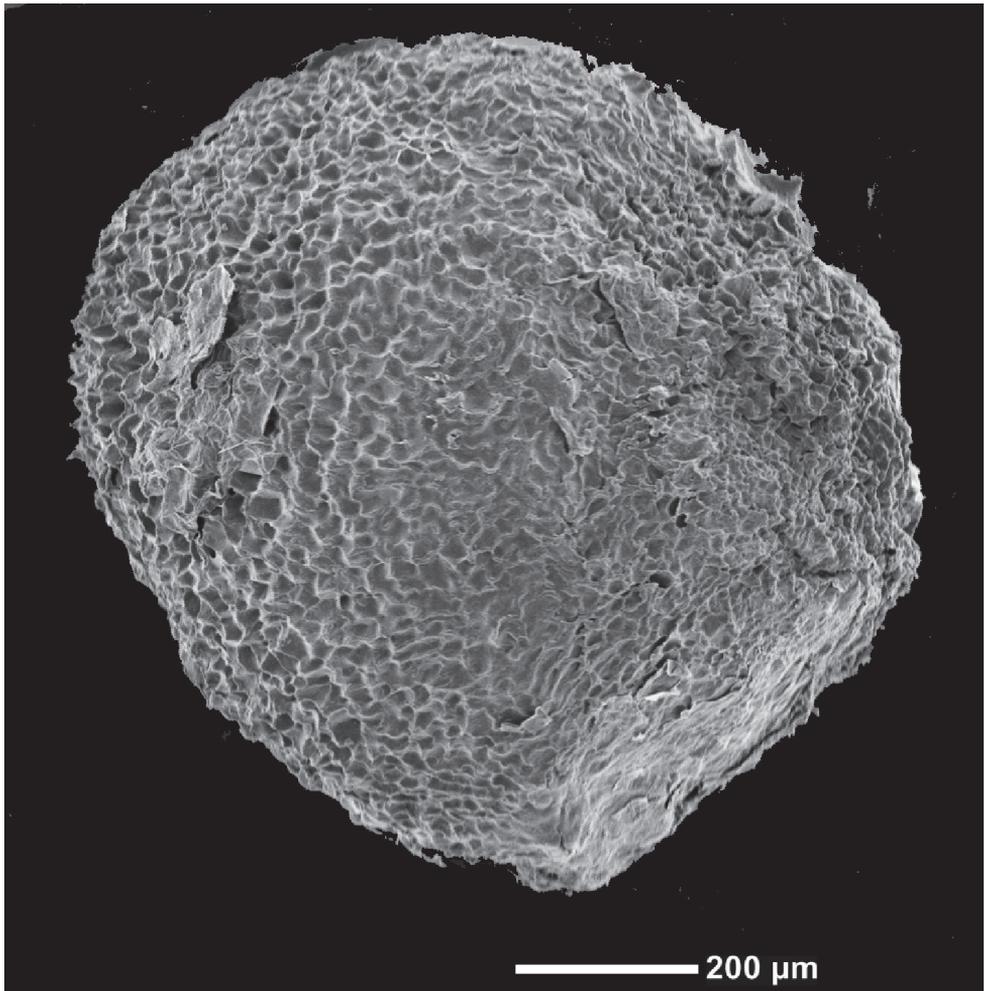


Figure 2. Scanning electron micrograph of a seed of *Miconia machinazana* (photograph O.A. Dudek).

trail from Paquisha Alto military post. 03°54'06"S, 78°28'57"W, 2315 m, 23 June 2009 (fl, fr), D.A. Neill & C. Kajekai 16909 (holotype MO!; isotypes AAU!, CAS!, LOJA!, M!, NY!, QCNE!).

Description. Small, profusely branched shrub 0.5–1.2 m tall; internodes 1.5–7.0 × 1.2–2.4 mm. A thick indument of pinoid trichomes densely covering and totally concealing the surface of branches, petioles, both surfaces of young leaves, bracts, pedicels, hypanthium, calyx lobes outside surface, and fruits, the indument reddish-brown (cinnamon) colored on young parts and becoming darker, maroon-brown, and caducous on older organs, leaving the base of older branches and the adaxial surface of leaves with scattered trichomes. Leaves decussate, the petiole erect and nearly parallel to the stem, and the blade ascending at an angle of 90–120° with the petiole, 11.8–35.1 × 2.2–10.5 mm, narrowly elliptic to nar-



Figure 3. *Miconia machinazana*, flowering branch, Neill 16909 (photograph D.A. Neill).

rowly lanceolate, coriaceous, with 15–22 pairs of faintly visible nerves adaxially, the base acute, the margins revolute and remotely crenate, the minute teeth dark, the adaxial surface dark green with scattered pinoid whitish trichomes on the surface and covering the midrib, the abaxial surface concealed by the indument, the apex bluntly acute and mucronate; petiole 1.6–4.5 mm. Inflorescences 10–20 mm, panicles, terminal at the tip of the branches or on short lateral branches, 1–3 flowers open at a time; bracts 3–9 mm, spatulate, persistent. Hypanthium 1.0–2.4 mm, campanulate, maroon red, glabrous inside. Flowers 5-merous; calyx lobes ca. 1.2 × 1.2 mm, maroon red and glabrous adaxially, the external teeth thick, ca. 0.35 mm, projecting, concealed by the indument. Corolla pale yellow, the petals 1.3–2 × 1.5–1.7 mm, concave, the apex oblique, the margin minutely erose, the outer surface granulose. Stamens 10, slightly dimorphic in size, the filaments 2.0–2.3 mm, geniculate above the middle, twice as wide below the folding point towards the base, cream colored, tinged with pink in older flowers, the anthers 0.9–1.2 mm, 2-celled, obovate, retuse at apex, initially uniformly cream colored and later tinged with pink, opening by two broad, apical, ventrally inclined pores, the connective at the base ventrally with a blunt, bilobed appendage and dorsally with a blunt,



Figure 4. *Miconia machinazana*, fruiting branch, Neill 16167 (photograph D.A. Neill).

minutely notched tooth, slightly longer than the ventral lobes; ovary 3-celled, 3/4 inferior, ridged, with a ring of pinoid trichomes at the apex, the style ca. 3.5 mm, straight, pale yellow, glabrous, the stigma clavate but not conspicuously so, pale yellow. Inflorescences with up to 22 mature fruits. Berries 5–7 × 5.5–7.5 mm, nearly globose, fleshy, the surface concealed by the indument, maroon red apically, ridged and with a few trichomes at the base of the attachment of the style; seeds 15–25, globose, ca. 0.99 × 0.93 mm.

Distribution. *Miconia machinazana* has only been found on the Machinaza plateau, one of the highest-elevation Hollín Sandstone plateaus in the Cónдор region between 2315 and 2420 m (Fig. 5). The area is precisely on the Ecuador-Peru international border, near the end of the trail from the Paquisha Alto military post. Since the population actually straddles the border it is recorded as occurring in the province of Zamora-Chinchi in Ecuador and in the department of Amazonas, Peru.

Ecology. The specimens collected in June have just a few open flowers and several fruits, while the specimens collected in March have abundant fruits. The Cónдор is an eastern outlier of the main Andes chain and has revealed a fascinating and unexpected biogeographical connection between the sub-Andean cordilleras and the Guayana Shield in northeastern South America (Ulloa Ulloa and Neill 2006). The soils are very nutrient-poor, and consist of a bare sandstone substrate or coarse-



Figure 5. Vegetation at the summit of the Machinaza plateau, Cordillera del C6ndor, Ecuador, 2450 m (photograph D.A. Neill).

medium-grained quartzite sand derived there from. The vegetation is mostly dwarf scrub, dominated by shrubs to about 0.5 m tall, with occasional small trees to four meters tall (Fig. 5). The vegetation seems to be recovering slowly from an extensive fire that occurred between 1990 and 1995, with charred woody stems in abundance on the ground.

Etymology. The species name *machinazana* commemorates the name of the Machinaza plateau and river in the Cordillera del C6ndor area where this species was collected.

Conservation status. *Miconia machinazana* has a restricted distribution, only known from scattered populations within a single mountain range. The Area of Occupancy (AOO) of the species is 3 km² and it falls completely outside any protected area under Ecuador's System of Protected Areas. In terms of our current knowledge, the species is assigned a provisional IUCN (2001) conservation status of Critically Endangered (IUCN SPWG 2010).

Paratypes. Ecuador. Zamora-Chinchipec: Centinela del C6ndor, Cordillera del C6ndor, Machinaza plateau summit area, adjacent to obelisk-shaped border marker, at end of trail from upper Paquisha military post, precisely at Ecuador-Peru border. 03°53'50"S, 78°28'49"W, 2420 m, 15 Mar 2008 (fr), D.A.Neill & W.Quizhpe 16167 (COL, HA, K, LOJA, MO, QCA, QCNE, USM).

Discussion

Miconia machinazana differs from other species of *Miconia* by the combination of the strictly decussate arrangement of very narrow, coriaceous leaves, thick reddish brown (cinnamon) indument of pinoid trichomes, pale yellow petals, the anthers opening by two large pores, and the berries with large seeds. Following Wurdack's (1980) Flora of Ecuador key to Artificial Species Groups, this species will key out within group D, the group of species with the lower leaf surface completely concealed by the dense pubescence, and next to *Miconia ledifolia* (DC.) Naudin. In Cogniaux's (1891) classification and following Goldenberg et al. (2008) this species belongs in *Miconia* sect. *Cremanium* (D. Don) Hook. f., that is characterized by the very short anthers with two or four, wide apical pores.

Miconia machinazana has pale yellow petals, yellow being a color uncommon in the tribe Miconieae (Almeda 2000, Morales-Puentes et al. 2008). This new species resembles in its habit the widespread *M. salicifolia*, however, a closer examination immediately differentiates the species belonging not only to different sections (the latter belongs to sect. *Chaenopleura* (DC.) Hook. f.), but showing differences in flower merosity, stigma shape, fruit size, and number of seeds per fruit (see Table 1). *Miconia rigens* Naudin, *M. ledifolia*, *M. stenophylla* Wurdack, and *M. tephrodes* Wurdack are all high-Andean shrubs with short inflorescences, crowded leaves with the lower surface totally concealed by a dense indument, and the stamens opening by two apical pores, as in *M. machinazana*, but the combination of characters separates each of these taxa and with the new species (see Table 1). The species here compared from sect. *Chaenopleura* have 4-merous flowers, but the flowers are 5-merous in the ones from sect. *Cremanium*. *Miconia rigens*, from Colombia's Cordillera Oriental, is distinct by its much wider 3-nerved leaves (up to 3 cm) and longer internodes.

The species compared in Table 1, apart from for *Miconia salicifolia*, are all narrow endemics. *Miconia rigens* is a seemingly rare species, restricted to the páramo of a small area of Colombia's Boyacá Department (Fernández Alonso pers. comm.), and the rest occur in southern Ecuador, where *M. tephrodes* is only known from four collections from the Eastern Andean Cordillera, and *M. machinazana* farther east from the remote Cóndor sandstone plateau (Fig. 6).

Table 1. Comparison of *Miconia machinazana* and other Andean species of *Miconia* with leaf lower surface completely concealed by indument.

Characters	<i>Miconia machinazana</i>	<i>Miconia ledifolia</i>	<i>Miconia rigens</i>	<i>Miconia salicifolia</i>	<i>Miconia stenophylla</i>	<i>Miconia tephrodes</i>
Internode length (mm)	1.5–7	1.8–6.4	8–14	2–7.1	2–4.3	2.6–3.4
Leaf blade length (mm)	11.8–35.1	10–15(–22)	40–60	20–50	8–14	8–15
Leaf blade width (mm)	(2.2)3–10.5	1.5–2.5(–4)	20–30	3–7	1–2	4–7
Leaf blade main nerves	1-nerved	1-nerved	3-nerved	3-nerved	1-nerved	1-nerved
Petiole length (mm)	1.6–4.5	1–3	2–4	2–5	1–2	1.5–3
Flower merosity	five	five	five	four	four	four
calyx lobes length (mm)	ca. 1.2	4–5	ca. 3	4–5	ca. 2	3–4
Calyx external teeth	thick	thick	inconspicuous	not projecting	appressed	inconspicuous
Petals color	pale yellow	pale yellow	white and pink	cream-white	pink	unknown
Petals length (mm)	1.3–2	1.5–1.7	ca. 2	1.7–1.8	ca. 1.4	ca. 1.1
Filaments indument	glabrous	glabrous	glabrous	moderately puberulous abaxially	apically sparsely glandular-setulose	apically sparsely glandular
Stigma shape	clavate not expanded	barely clavate-expanded	subpeltate	elongate capitate	capitate	capitate
Ovary cells and position	3-celled and 3/4 inferior	3-celled and 1/3 inferior	3-celled and 3/4 inferior	3–4 celled and 2/3 inferior	3-celled and 1/2 inferior	3-celled and 1/2 inferior
Ovary apical cone indument	ring of pinoid hairs	glabrous or sparsely furfuraceous	glabrous	stylar collar	densely glandular-puberulous	stellulate furfuraceous and glandular
Fruit length × width (mm)	5–7 × 5.5–7.5	2.4–3.9 × 2.8–3.8	4–6 × 4–6	2.5–4 × 2.5–5.4	2–3 × 2.8–3.5	1.4–2 × 1.4–2.1
Seed number per fruit	15–25	6–9	15–23	55–95	ca. 50	9–15
Country (Division)	Ecuador (Zamora-Chinchepe); Peru (Amazonas, not collected)	Ecuador (Azuay, Loja)	Colombia (Boyaca)	N Colombia to C Peru (divisions below†)	Ecuador (Azuay, Loja)	Ecuador (Azuay, Cañar, Morona-Santiago)
Elevation (m)	2315–2420	2200–3800	3105–3450	2600–4400	2500–3500	3200–3500
Section within <i>Miconia</i>	<i>Cremanium</i>	<i>Cremanium</i>	<i>Cremanium</i>	<i>Chaenopleura</i>	<i>Chaenopleura</i>	<i>Chaenopleura</i>
Representative specimen	Neill 16167, 16909 (MO)	Ulloa 1508 (HA, MO)	Cuatreucas 9787 (COL, US)	Ulloa 2117 (HA, MO, QCA)	Prieto P-312 (MO)	Camp E-4872 (US)

†Colombia: Antioquia, Boyacá, Caldas, Cauca, Cundinamarca, Santander, Tolima. Ecuador: Azuay, Cañar, Carchi, Chimborazo, Cotopaxi, Imbabura, Loja, Morona-Santiago, Napo, Pichincha, Tungurahua. Peru: Ancash, Cusco, La Libertad, Lambayeque, Pasco.

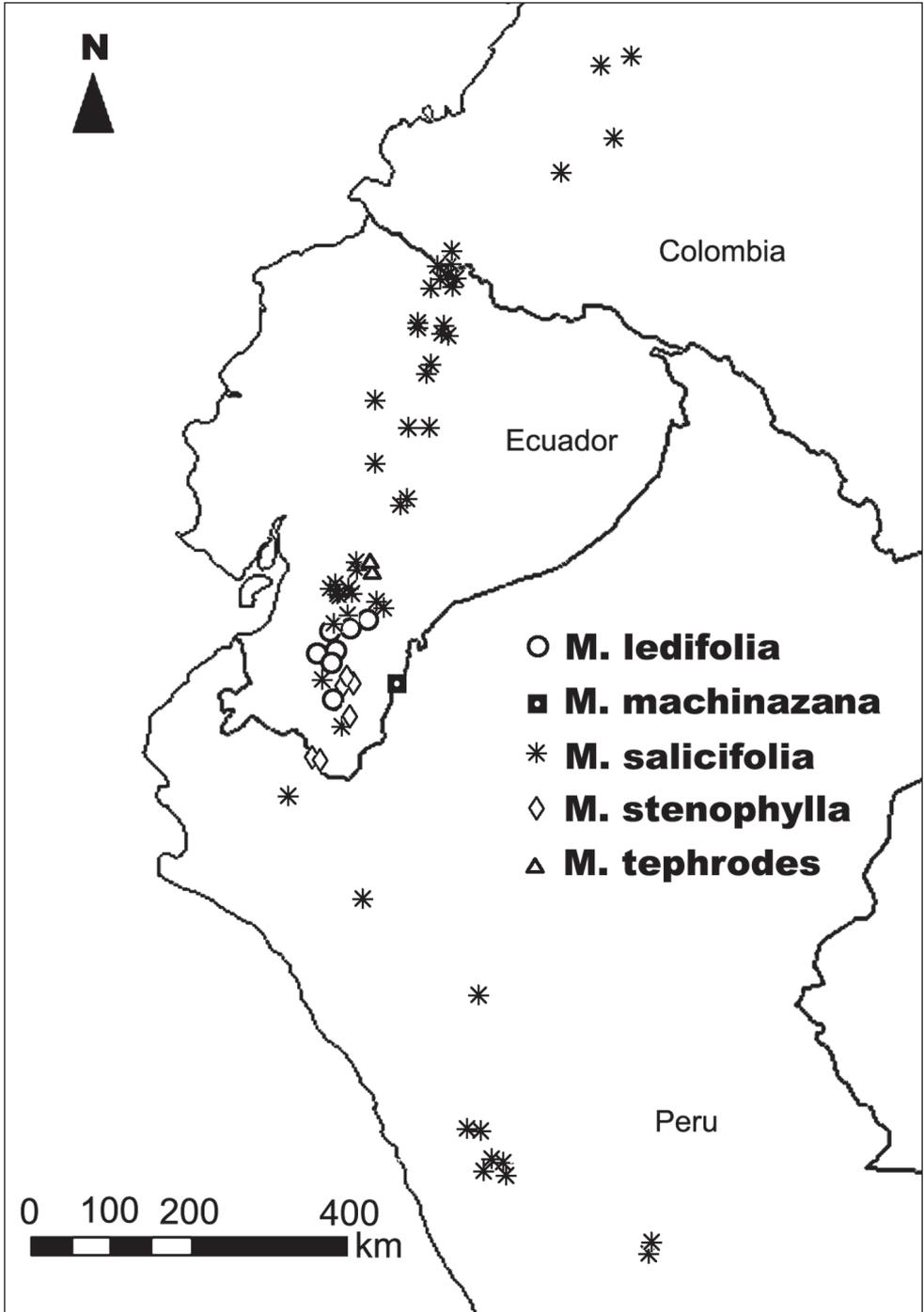


Figure 6. Distribution map of *Miconia ledifolia*, *M. machinazana*, *M. salicifolia* (partial), *M. stenophylla*, and *M. tephrodes* (See Table 1; for complete species distribution see www.tropicos.org).

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A new species of *Dorstenia* (Moraceae) from southeastern Brazil

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Abstract

Dorstenia stellaris is a new species from southeastern Brazil. This species is endemic to the region and differs from the others by its star shaped coenanthium and cordiform leaves. A description and illustration of this species is presented here. *Dorstenia stellaris* is found in moist and shady places, in small populations within the type locality, thus we recommend its inclusion in the endangered (EN) status of conservation.

Resumo

Dorstenia stellaris é uma espécie nova do sudeste do Brasil. A espécie é endêmica da região e difere-se das demais, pelo cenanto estrelado e folha com base cordada. Neste trabalho foi apresentada descrição e ilustração da espécie. *Dorstenia stellaris* é encontrada em locais úmidos e sombreados, em pequenas populações, somente na localidade típica, desta forma, recomendamos sua categorização como em perigo.

Keywords

Atlantic forest, Mantiqueira, Pindamonhangaba

Introduction

Dorstenia was described by Carl Linnaeus (1753), and differs from the other Moraceae genera by the presence of rhizomes, herbaceous and sometimes succulent habit and patelliform inflorescences, the coenanthium. It is the second largest genus in the Moraceae, ca. 105 species distributed through Africa and neotropics, with one species

extending into Asia. Brazil holds about 37 species, with the majority of these species Brazilian endemics (Romaniuc Neto et al. 2010).

The great number of species and morphological variation in this genus is reflected by numerous infrageneric groups established by Berg and Hijman (1999). The authors proposed the subdivision of the genus into 9 sections, three of which (*Lecanium*, *Dorstenia* and *Emygdioa*) occur within the neotropical region. *Dorstenia stellaris* is placed in *Lecanium* section, being characterized mostly by showing camephytes and nanophanerophytes species with simple leaves, subulate or foliaceous stipules, and an entire coenanthium.

Dorstenia is the only genus in the family that shows an herbaceous habit and its populations often tend to occupy restricted areas with favorable ecological niches. *D. stellaris* is endemic to Mantiqueira Ridge area and has a restricted distribution, being found only on its type locality, in the municipality of Pindamonhangaba. This species occurs in small populations along moist and shady areas.

Taxonomic treatment

Dorstenia stellaris A. Sant. & Romaniuc, sp. nov.

urn:lsid:ipni.org:names:77119223-1

http://species-id.net/wiki/Dorstenia_stellaris

Fig. 1 A–D; Fig. 2

Diagnosis. Coenanthium ellipticum, irregulariter stellatum et lamina basis cordiformis differt.

Type. BRASIL. São Paulo, Pindamonhangaba, distrito de Ribeirão Grande, near Fazenda São Sebastião do Ribeirão Grande, 26 Nov. 2011, A. Santos et al. 142 (Holotype: SP!); Brasil. São Paulo, Pindamonhangaba, distrito de Ribeirão Grande, Fazenda São Sebastião do Ribeirão Grande, 30 Mar. 1994, I. Cordeiro et al. 1323 (Paratype: SP!); São Paulo, Pindamonhangaba, distrito de Ribeirão Grande, near Fazenda São Sebastião do Ribeirão Grande, 26 Nov. 2011, A. Santos et al. 143, 144, 145, 146 (Paratype: SP!).

Description. Camephytes 30–70 cm tall; stems aerial, erect, hirsute to tomentose; internodes 1–2.5 cm long.; latex white and abundant. Stipules 1–2 mm long., subulate, narrowly triangular, ciliate, persistent to deciduous, hairs white. Leaves distichous to whorled; blade 8–12 × 3.5–5 cm, membranaceous, apex long acuminate, base cordate, adaxial side scabrous, hairs sparse, white, abaxial side puberulous to hirsute, hairs gathered on the veins; margins entire to denticulate; petiole 2.5–5 cm long., hirsute; brochidodromous venation; 5–6 pairs of secondary veins; tertiary veins scalariform. Coenanthium elliptic, 1–2 cm diam., pateliform, stellate, 3–5 angulate, puberulous; margin with sessile bracts, 0.5–1 mm long., mostly on the angle apex, puberulous, fringes 0.5–0.7 mm alt., greenish to vinaceous; peduncle 1.5–2.5 cm long., puberulous. Staminate flowers distributed through the whole coenanthium; stamens 2; perianth 2 lobed.

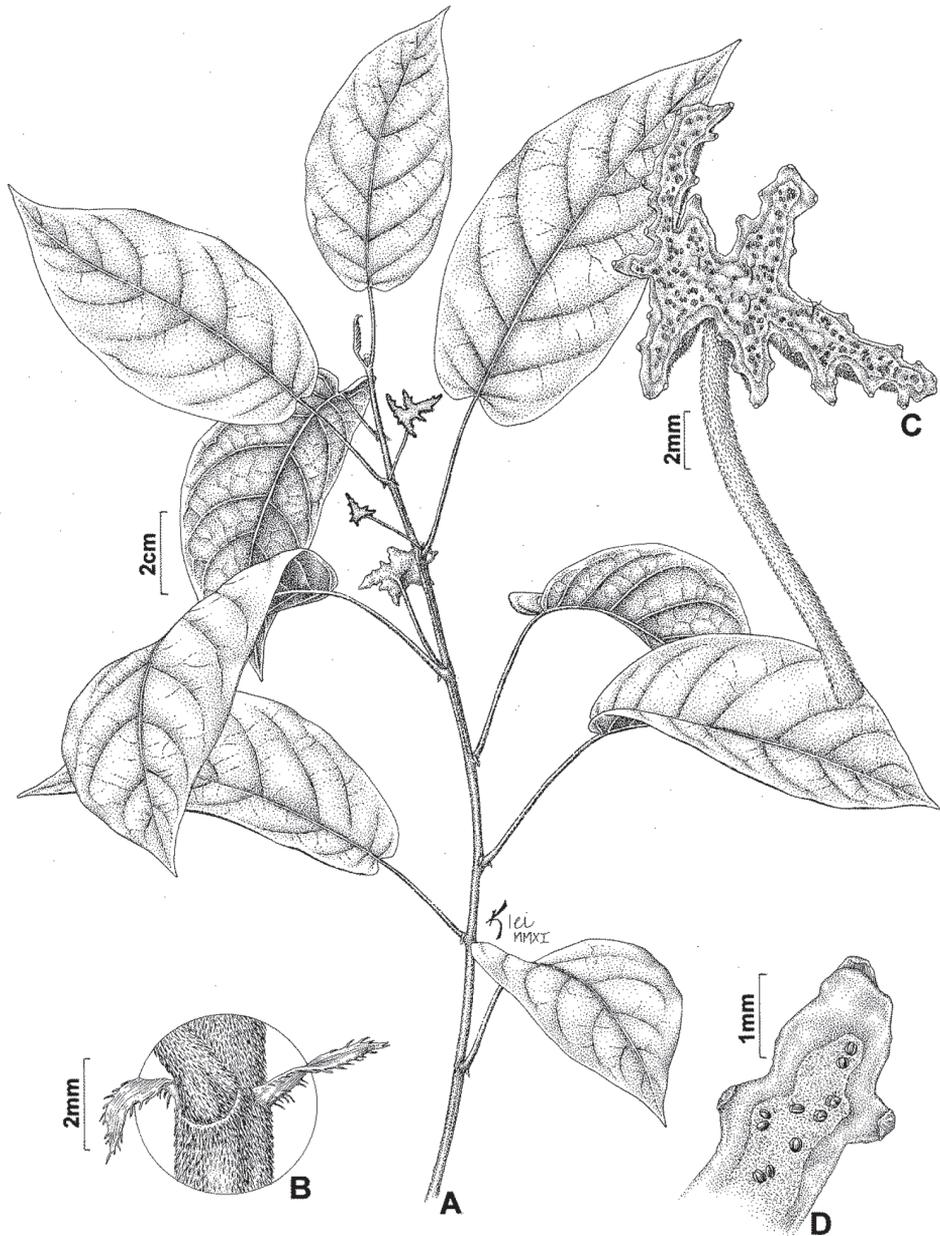


Figure 1. *Dorstenia stellaris* A.Sant. & Romaniuc **A** habit **B** ciliate stipule **C** stellate coenanthium **D** inflorescence, detail of coenanthium fringes and bracts on the angles of the coenanthium margin. (A. Santos et al. 142).

Pistillate flowers distributed through the whole coenanthium: perianth short lobed, whit apex minutely 2–3 lobed, puberulous; stigma 0.5–1 mm long., slender, white. Drupes elliptical, endocarp smooth to verrucosus; stigmas persistent. Seeds with a flat testa.



Figure 2. *Dorstenia stellaris* inflorescence, detail of coenanthium (photo: A. Santos 2011).

Table 1. Morphological comparison between *Dorstenia* species related to *D. stellaris*.

Taxa	stellate coenanthium	angulate coenanthium	rounded coenanthium	subulate stipule	base cordate leaves	base acute leaves
<i>D. stellaris</i>	x			x	x	
<i>D. bowmaniana</i>		x		x		x
<i>D. carautae</i>		x		x		x
<i>D. milaneziana</i>			x	x	x	
<i>D. setosa</i>			x	x	x	

Phenology. Collected with flowers in march and november, and fruits in march.

Ecology. *Dorstenia stellaris* is a camephyte from shady and moist areas within the Atlantic forest, which occur in litter soils, near waterfalls inside forests of the type locality.

Similar species. The angulate shape of *D. bowmaniana*, and *D. carautae* coenanthium is similar to that *D. stellaris*, however, the differs on the strongly irregularly-stellate coenanthium and on the cordate leaves. *D. milaneziana* and *D. setosa* are also similar to *D. stellaris* by the cordate leaves, however, they differ from *D. stellaris* by the rounded coenanthium. The other species of the *Lecanium* section are mostly orbicular to elliptic coenanthium.

Distribution and conservation status. As *D. stellaris* is a newly described and very restricted taxon occurring in a non-conserved area, it warrants special attention with regard to its conservation status. This species has only been found within its type locality in small populations. We believe, indeed, that this species is endangered and following IUCN (2011) criteria we recommend its classification within the endangered status of conservation (EN).

Etymology. *stellaris* epithet refers to the irregularly-stellate shape of the coenanthium.

Acknowledgments

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A new species of *Camchaya* (Asteraceae, Vernonieae) from Thailand

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Abstract

Camchaya thailandica Bunwong, Chantar. & S.C.Keeley, **sp. nov.** from Phu Phrabat Historical Park, Udon Thani, Thailand is described as a new species. Plant of this new species are similar to *C. gracilis* (Gagnep.) Bunwong & H.Rob. but differ in having ovate phyllaries without margin spines, 10-ribbed achenes, and broadly ovate leaves. This species is a rare endemic known only from the type collection and probably confined to open areas of sandstone hills in Udon Thani province.

Keywords

Asteraceae, Compositae, Vernonieae, *Camchaya*, Thailand, new species

Introduction

Koyama (1984) described six species of *Camchaya* in Thailand, recognizing the genus based on the presence of 5–10 ribbed achenes and a bristle-like pappus on some florets, thus broadening earlier concepts of the genus by Kerr (1935) and Kitamura (1968). Bunwong et al. (2009) reviewed the status of *C. eberhardtii* (Gagnep.) Kitam., *Iodocephalus glandulosus* Kerr and *I. eberhardtii* Gagnep. and recognized these taxa as *Iodocephalopsis eberhardtii* (Gagnep.) Bunwong & H.Rob. while *I. gracilis* Thorel ex Gagnep. was recognized as *C. gracilis* (Gagnep.) Bunwong & H.Rob. Continuing with these studies Bunwong (2010) found seven species of *Camchaya* including a new

taxon, *C. thailandica*, described here. *Camchaya thailandica* is one of the five endemic Thai species: including *C. pentagona*, *C. spinulifera*, *C. tenuiflora*, and *C. gracilis*. The two remaining species, *C. kampotensis* and *C. loloana* extend beyond Thailand into Laos, Cambodia and adjacent Yunnan, China.

Methodology

Camchaya specimens examined were obtained from the following herbaria: AAU, BK, BKF, BM, CMU, E, K, KKU, L, P, QBG, and US. All measurements given herein were taken from field notes, dried herbarium specimens, and spirit collections. Pollen and achenes were obtained from field collections around Thailand by the first author. Pollen samples for the SEM work were acetolyzed (Erdtman 1960). Acetolyzed pollen was freeze-dried using the critical point drying method. Acetolyzed pollen, unacetolyzed achenes and leaf surfaces were then placed on specimen stubs with double sided silver tape and sputter coated with gold. Photomicrographs were taken with SEM (LEO, 1450VP; Applied Taxonomic Research Center, Department of Biology, Faculty of Science, Khon Kaen University).

Taxonomy

Camchaya thailandica Bunwong, Chantar. & S.C.Keeley, sp. nov.

urn:lsid:ipni.org:names:77119225-1

http://species-id.net/wiki/Camchaya_thailandica

Type. Thailand. Prov. Udon Thani, rare on rocky areas in Phu Phrabat Historical Park. alt. 300 m, 17°43.84'N; 102°29.65'E, 29 September 2007 (flower) S. Bunwong 328 (holotype KKU, isotype US) (Figures 1–3). Known only from the type collection.

Annual. Inflorescences axillary or terminal, pedunculate. Phyllaries imbricate in 5–6 series, arachnoid-glandular, apices purple. Differs from *C. gracilis* (Gagnep.) Bunwong & H. Rob. in having ovate acuminate rather than broadly ovate acute phyllaries without margin spines, 10-ribbed rather than 4–5-ribbed achenes, and broadly ovate leaves.

Annual herbs, 50–100 cm tall. *Stems* erect, rounded, inconspicuously ribbed, scabrous, hairs uniseriate, T-shaped, and glandular. *Leaves* alternate; petioles to 2 cm long; blades elliptic to oblong, 3–8 by 2–3 cm, chartaceous; bases attenuate, margins serrate, apices acute; both surfaces pubescent, hairs cylindric, T-shaped, and glandular, lateral veins 5–10 pairs. *Capitulescences* terminal and axillary, corymbose. *Capitula* pedunculate, involucre broadly campanulate, 5–6 mm diam. *Receptacles* convex, 2.5–3 mm diam., glabrous. *Phyllaries* 5–6-seriate, imbricate, light green with purple apices, 7–8 mm long, margins pale, without margin spines, outer surfaces arachnoid-glandular; the outer and the middle ones ovate, apices acuminate; the inner ones lanceolate to oblong, apices acuminate. *Florets* 50–70; corollas infundibular, purple, pubescent,

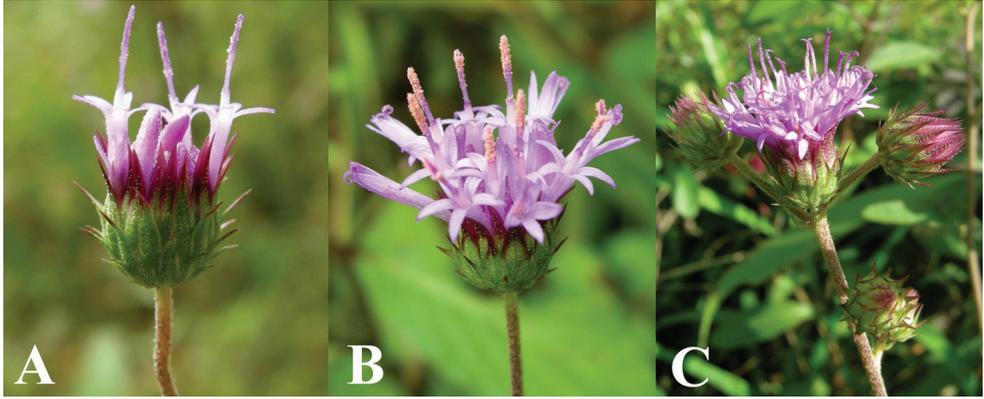


Figure 1. Capitulescences, **A–B** terminal **C** axillary. Note that phyllaries are in 5–6 series and without margin spines.

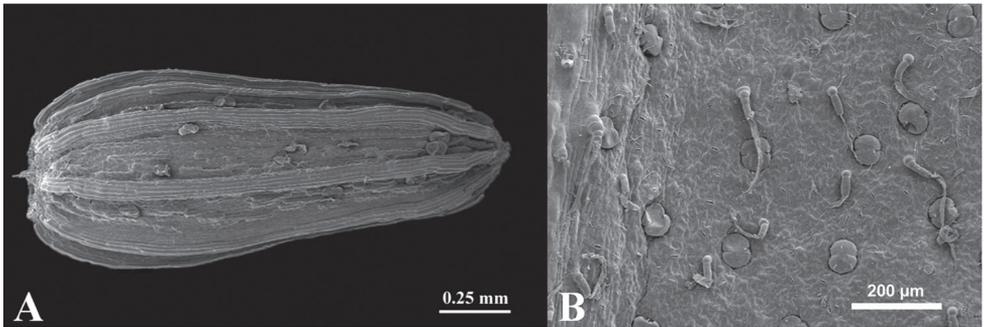


Figure 2. SEM micrographs, **A** Achene with glands and 10 ribs, **B** Abaxial leaf surface with cylindrical hairs and capitate glands.

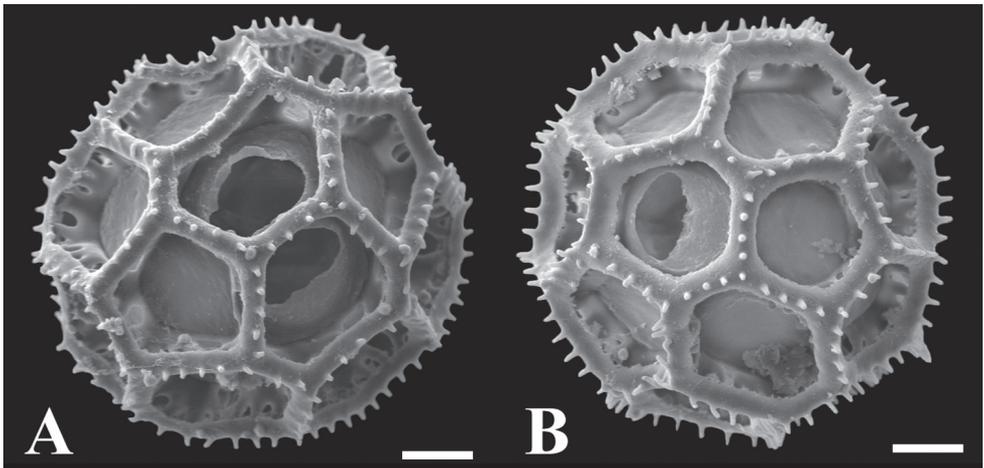


Figure 3. **A–B** SEM micrographs of acetolysed pollen show 6-porate echinolophate pollen. (scale bars = 6 μ m).

glands capitate; tubes 6–7 mm long; lobes 2.5–3 mm long. *Anthers* ca. 2 mm long, bases rounded, apical appendages acute. *Styles* purple, 6–7 mm long; branches 2–2.5 mm long; sweeping hairs on the outer surfaces reaching below style bifurcation. *Achenes* obovate, ca. 1.5 mm long, glandular, 10-ribbed, carpopodium absent. *Pappus* bristles, uniseriate, 1–2 mm long, sometimes absent, deciduous. *Pollen* echinolophate, 6-porate, without micropuncta.

Distribution. Endemic to Thailand. Only found in Phu Phrabat Historical Park, Udon Thani province.

Ecology. Rocky areas of sandstone hills, scattering in dipterocarp forest, flowering from November and December.

Discussion. *Camchaya thailandica* is similar to *C. gracilis* in having ovate phyllaries without spines on the margin, but differs in having 10-ribbed achenes and a broadly ovate leaf shape. Its 6-porate echinolophate pollen is unique to *Camchaya* (Bunwong and Chantaranonthai 2008) and places it firmly in this genus. Additionally, this species has an inconspicuous carpopodium which is common in *Camchaya*.

Key to the genus *Camchaya*

- 1 Phyllaries broadly ovate without margin spines 2
- Phyllaries broadly ovate with margin spines 3
- 2 Achenes 4–5-ribbed *C. gracilis*
- Achenes 10-ribbed *C. thailandica*
- 3 Achenes 5 (6–9)-ribbed *C. pentagona*
- Achenes 10-ribbed 4
- 4 Phyllaries eglandular, margin spines to 10 mm long *C. spinulifera*
- Phyllaries glandular, margin spines to 5 mm long 5
- 5 Phyllaries acuminate; achenes 2.5–3 mm long *C. kampfotensis*
- Phyllaries aristate or apiculate; achenes 1.5–2 mm long 6
- 6 Leaves with T-shaped hairs; phyllaries spinose \leq 1 mm long *C. loloana*
- Leaves without T-shaped hairs; phyllaries spinose \geq 1 mm long... *C. tenuiflora*

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Florabank1: a grid-based database on vascular plant distribution in the northern part of Belgium (Flanders and the Brussels Capital region)

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Abstract

Florabank1 is a database that contains distributional data on the wild flora (indigenous species, archaeophytes and naturalised aliens) of Flanders and the Brussels Capital Region. It holds about 3 million records of vascular plants, dating from 1800 till present. Furthermore, it includes ecological data on vascular plant species, redlist category information, Ellenberg values, legal status, global distribution, seed bank etc. The database is an initiative of “Flo.Wer” (www.plantenwerkgroep.be), the Research Institute for Nature and Forest (INBO: www.inbo.be) and the National Botanic Garden of Belgium (www.br.fgov.be). Florabank aims at centralizing botanical distribution data gathered by both professional and amateur botanists and to make these data available to the benefit of nature conservation, policy and scientific research.

The occurrence data contained in Florabank1 are extracted from checklists, literature and herbarium specimen information. Of survey lists, the locality name (verbatimLocality), species name, observation date and IFBL square code, the grid system used for plant mapping in Belgium (Van Rompaey 1943), is recorded. For records dating from the period 1972–2004 all pertinent botanical journals dealing with Belgian flora were systematically screened. Analysis of herbarium specimens in the collection of the National Botanic Garden of Belgium, the University of Ghent and the University of Liège provided interesting distribution knowledge concerning rare species, this information is also included in Florabank1. The data recorded before 1972 is available through the Belgian GBIF node (<http://data.gbif.org/datasets/resource/10969/>), not through FLORABANK1, to avoid duplication of information. A dedicated portal providing access to all published Belgian IFBL records at this moment is available at: <http://projects.biodiversity.be/ifbl>

All data in Florabank1 is georeferenced. Every record holds the decimal centroid coordinates of the IFBL square containing the observation. The uncertainty radius is the smallest circle possible covering the

whole IFBL square, which can measure 1 Km² or 4 Km². Florabank is a work in progress and new occurrences are added as they become available; the dataset will be updated through GBIF on a regularly base.

Keywords

Tracheophyta, grid mapping, flora, indigenous species, archeophytes, naturalised aliens

Data published through

GBIF: <http://ipt.inbo.be/resource.do?r=florabank1>

Taxonomic coverage

Note: The taxonomic reference for the florabank1 database is the 1998 edition of the Belgian Flora by Lambinon et al. 1998.

General taxonomic coverage description

The coverage (figure 1) of this database spans the Phylum Tracheophyta or vascular plants. The highest number of records are from the Magnoliopsida (76.48%) followed by Monocotyledones (20.92%), Filicopsida (1.44%), Sphenopsida (0.97%) Coniferopsida (0.13%) and Lycopsidea (0.03%). Ginkgopsids are within the scope of Florabank, but do not occur within the geographical scope of the database.

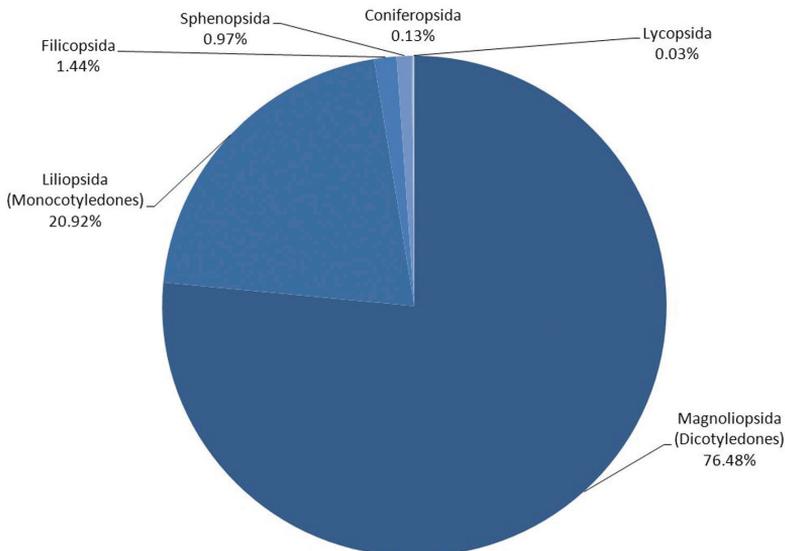


Figure 1. Taxonomic coverage of Florabank1

Taxonomic ranks

Phylum: Tracheophyta

Class: Coniferopsida, Filicopsida, Ginkgopsida, Liliopsida (Monocotyledones), Lycopopsida, Magnoliopsida (Dicotyledones), Sphenopsida

Order: Pinales, Taxales, Filicales, Marsileales, Ophioglossales, Osmundales, Salviniaceae, Ginkgoales, Alismatales, Arales, Commelinales, Cyperales, Hydrocharitales, Juncales, Liliales, Najadales, Orchidales, Poales, Pontederiales, Typhales, Typhales, Zingiberales, Isoetales, Lycopodiales, Selaginellales, Apiales, Apiales, Aristolochiales, Asterales, Callitrichales, Campanulales, Capparales, Caryophyllales, Celastrales, Cornales, Cucurbitales, Dipsacales, Elaeagnales, Ericales, Euphorbiales, Fabales, Gentianales, Geraniales, Haloragales, Haloragales, Hamamelidales, Juglandales, Lamiales, Linales, Loganiales, Magnoliales, Malvales, Myricales, Myrtales, Nymphaeales, Oleales, Paeoniales, Papaverales, Piperales, Plantaginales, Plumbaginales, Polemoniales, Polygalales, Polygonales, Primulales, Ranunculales, Rhamnales, Rosales, Rubiales, Rutales, Salicales, Santalales, Sapindales, Sarraceniales, Saxifragales, Scrophulariales, Theales, Thymelaeales, Urticales, Violales, Violales, Gymnospermae, Equisetales

Family: Araucariaceae, Cupressaceae, Pinaceae, Taxodiaceae, Taxaceae, Adiantaceae, Aspleniaceae, Blechnaceae, Dennstaedtiaceae, Dryopteridaceae, Hymenophyllaceae, Polypodiaceae, Thelypteridaceae, Woodsiaceae, Marsileaceae, Ophioglossaceae, Osmundaceae, Azollaceae, Salviniaceae, Ginkgoaceae, Alismataceae, Butomaceae, Araceae, Lemnaceae, Commelinaceae, Cyperaceae, Hydrocharitaceae, Juncaceae, Agavaceae, Alliaceae, Amaryllidaceae, Dioscoreaceae, Iridaceae, Liliaceae, Aponogetonaceae, Juncaginaceae, Najadaceae, Potamogetonaceae, Ruppiaceae, Scheuchzeriaceae, Zannichelliaceae, Zosteraceae, Orchidaceae, Poaceae, Pontederiaceae, Sparganiaceae, Typhaceae, Cannaceae, Isoetaceae, Lycopodiaceae, Selaginellaceae, Apiaceae, Araliaceae, Aristolochiaceae, Asteraceae, Callitrichaceae, Campanulaceae, Lobeliaceae, Brassicaceae, Capparaceae, Resedaceae, Aizoaceae, Amaranthaceae, Caryophyllaceae, Chenopodiaceae, Molluginaceae, Nyctaginaceae, Phytolaccaceae, Portulacaceae, Aquifoliaceae, Celastraceae, Cornaceae, Cucurbitaceae, Adoxaceae, Caprifoliaceae, Dipsacaceae, Valerianaceae, Elaeagnaceae, Actinidiaceae, Clethraceae, Empetraceae, Ericaceae, Monotropaceae, Pyrolaceae, Buxaceae, Euphorbiaceae, Caesalpiniaceae, Fabaceae, Betulaceae, Fagaceae, Apocynaceae, Asclepiadaceae, Gentianaceae, Balsaminaceae, Geraniaceae, Limnanthaceae, Oxalidaceae, Tropaeolaceae, Gunneraceae, Haloragaceae, Hippuridaceae, Hamamelidaceae, Platanaceae, Juglandaceae, Boraginaceae, Lamiaceae, Verbenaceae, Linaceae, Buddlejaceae, Calycanthaceae, Magnoliaceae, Malvaceae, Tiliaceae, Myricaceae, Lythraceae, Onagraceae, Trapaceae, Cabombaceae, Ceratophyllaceae, Nymphaeaceae, Oleaceae, Paeoniaceae, Fumariaceae, Papaveraceae, Saururaceae, Plantaginaceae, Plumbaginaceae, Convolvulaceae, Cuscutaceae, Hydrophyllaceae, Menyanthaceae, Polemoniaceae, Solanaceae, Polygalaceae, Polygonaceae, Primulaceae, Berberidaceae, Menispermaceae, Ranunculaceae, Rhamnaceae, Vitaceae,

Amygdalaceae, Malaceae, Rosaceae, Rubiaceae, Anacardiaceae, Rutaceae, Simaroubaceae, Zygophyllaceae, Salicaceae, Loranthaceae, Santalaceae, Aceraceae, Hippocastanaceae, Sapindaceae, Staphyleaceae, Droseraceae, Crassulaceae, Grossulariaceae, Hydrangeaceae, Saxifragaceae, Bignoniaceae, Globulariaceae, Lentibulariaceae, Martyniaceae, Orobanchaceae, Pedaliaceae, Scrophulariaceae, Elatinaceae, Hypericaceae, Thymelaeaceae, Cannabaceae, Moraceae, Ulmaceae, Urticaceae, Begoniaceae, Cistaceae, Frankeniaceae, Loasaceae, Passifloraceae, Tamaricaceae, Violaceae, Ephedraceae, Equisetaceae

Common names: conifers, ferns, ginkgos, monocots, lycopods, dicots, horsetails

Spatial coverage

General spatial coverage: Florabank deals with distribution data of the wild flora of Flanders and the Brussels Capital Region (Federal states of the Kingdom of Belgium). Florabank covers an area of 13.682 km². Flanders has a temperate maritime climate influenced by the North Sea and the Atlantic Ocean, with relatively moderate summers and mild winters. Flanders is the northern part of Belgium. The two main geographical regions of Flanders are the Yser basin, in the North-West and the central plain. Flanders is divided in 6 ecoregions (Dunes district; Kempens district; Loam district; River Maas; Polder district, Sand and Loam district). The Brussels Capital region is a small region (162 km²) surrounded Flanders and is entirely situated in the Loam district. The majority of this region is highly urbanized and only the southern part is occupied by a large beech forest.

Coordinates: 50°37'12"N and 51°29'24"N Latitude; 2°31'12"E and 6°12'0"E Longitude

Temporal coverage

1800–2011.

Sampling Methods

The spatial coverage of the territory has evolved through time. The data from the period before 1939 pertains mostly to herbarium specimens and reflects only part of the vascular plant composition of the region. From 1939 onwards most observations are collected using a standardized protocol based on the methodology used for the Atlas of the flora of Belgium and Luxemburg (Van Rompaey and Delvosalle 1972). The atlas area is covered by a grid of 4 × 4 Km squares, which is further subdivided into 1 × 1 Km squares. All species observed during a visit to a grid cell of 1 km² were recorded without distinguishing between common or rare species. In each 4 × 4 km square,

more than one 1 km² squares were surveyed. The inventories dating from the period 1939–1971 fed the Atlas of the flora of Belgium and Luxemburg (Van Rompaey and Delvosalle 1972) (figure 2), while those from 1972–2004 served to produce that by Van Landuyt et al. (2006) (figure 3). During the first period (figure 2) only one survey of 1km² in each grid of 4 × 4km was required, during the second period we attempted to obtain data from at least four 1 km² grids in each grid of 4×4 km. From 2005 onwards we continued to gather data using the same protocol.

Quality Control

All records are validated before they are added to Florabank. The basic reference for quality control is the Belgian atlas (Van Rompaey and Delvosalle 1972). New data to be entered into the database are first submitted to a preliminary, automatic control. Observations pertaining to common species which were previously validated to occur in the neighbouring grid cells of 4 × 4 km squares over the last 35 years are automatically validated. Observations of species that are considered rare, or common species that have not been recorded in the neighbouring grid cells since 35 years are subjected to a manual control by experts. If the record concerns a location validated by other sources (e.g. recent herbarium specimens, peer reviewed papers) it is validated by the managers of the database, if not the observers can be asked to provide extra proof of their observation (e.g. herbarium specimens or photographs). Once an observation is validated (automatically or by the database manager) it can be considered for the validation of new observations.

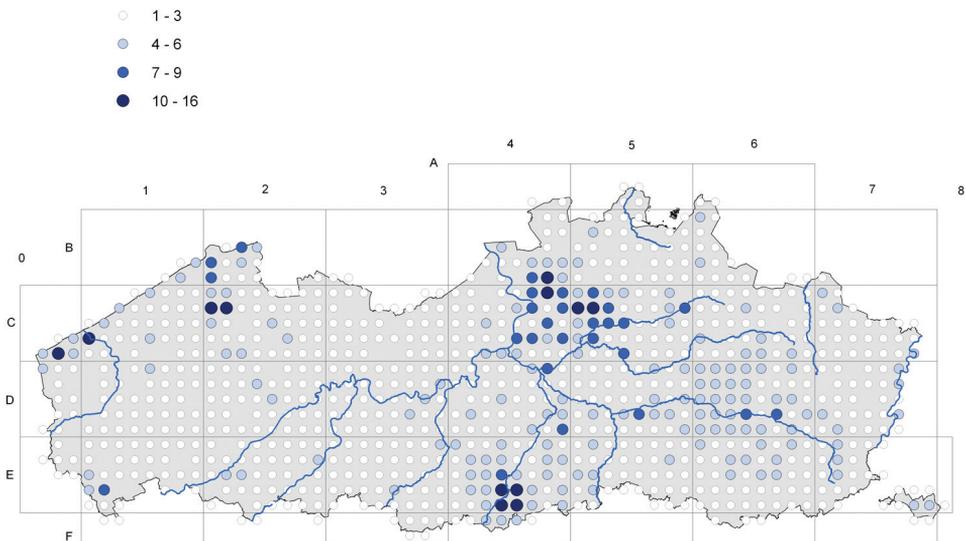


Figure 2. Number of prospected 1 km² grids in each grid of 4×4 km for the period 1939–1971. A 1 km² grid cell is considered as prospected if at least 90 species have been recorded.

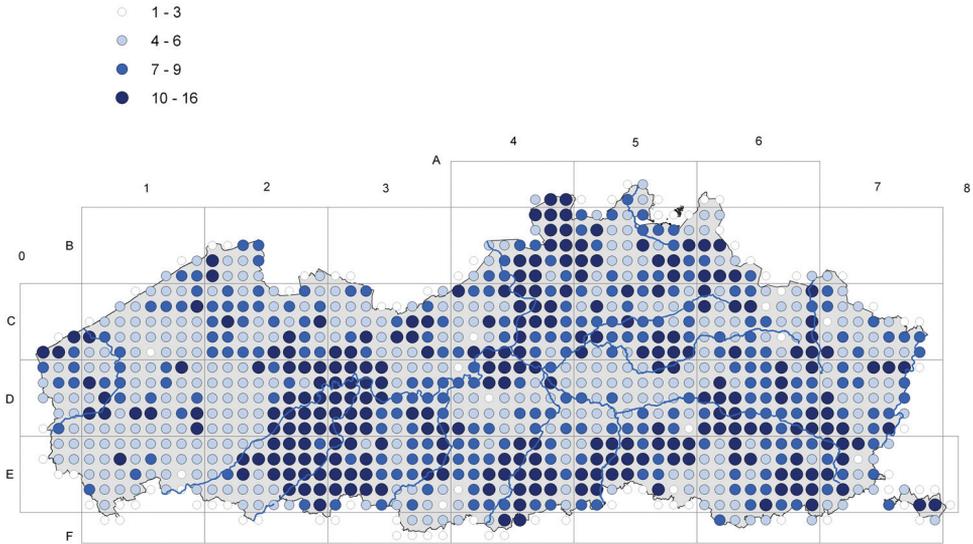


Figure 3. Number of prospected 1 km² grids in each grid of 4×4 km for the period 1972-2004. A 1 km² grid cell is considered as prospected if at least 90 species have been recorded.

Datasets

Dataset description

The Florabank1 dataset is a custom made SQL view of the Florabank database hosted in the Research Institute for Nature and Forest. The view shows only those data that are accepted for publication in the Darwin Core standard. Fields given are: occurrenceID, modified, language, institutionCode, collectionCode, basisOfRecord, catalogNumber, recordedBy, occurrenceDetails, eventDate, country, verbatimLocality, verbatimCoordinates, verbatimCoordinatesystem, decimalLatitude, decimalLongitude, geodeticDatum, coordinateUncertaintyInMeters, scientificName, originalNameUsage, taxonRank, verbatimTaxonrank and nomenclaturalCode.

Object name: Darwin Core Archive Florabank1: a grid-based database on vascular plant distribution in the northern part of Belgium

Character encoding: UTF-8

Format name: Darwin Core Archive format

Format version: 1.0

Distribution: <http://ipt.inbo.be/archive.do?r=florabank1>

Publication date of data: 2011-03-25

Language: Dutch

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Metadata language: English

Date of metadata creation: 2011-03-25

Hierarchy level: Dataset

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2) References to literature used to build the dataset

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