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Tessmannia princeps (Fabaceae), a new rainforest tree from the Udzungwa Mountains, Tanzania

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Abstract

Tessmannia princeps, a new canopy emergent rainforest tree species from the Udzungwa Mountains, Tanzania, is described and illustrated. It is a montane, unarmed tree distinguished by its large stature, extensively buttressed bole, and high number of leaflets. *Tessmannia princeps* shows morphological affinities with another Tanzanian species, *T. densiflora*, nevertheless the two species can be distinguished by morphological characters as well as by ecology and geography. A diagnostic key to the East African species of *Tessmannia* is provided. Due to its restricted range and small number of recorded mature individuals, the conservation status of *T. princeps* is assessed as Vulnerable under the IUCN criteria.

Key words: Eastern Arc, Fabaceae, Detarioideae, new species, taxonomy

Introduction

Tessmannia Harms (1910: 295) is a genus of the family Fabaceae subfam. Detarioideae (De la Estrella *et al.* 2018), distributed in tropical Africa (Govaerts *et al.* 2021). The first described species of the genus *Tessmannia* was *T. africana* Harms (1910: 295). Eleven more species were described between 1915 and 1967. To date, the genus includes 13 species (Andrella *et al.* 2024); the most recently described is *T. korupensis* Van der Burgt (2016: 55). A complete revision of this genus has never been published. However, many of the *Tessmannia* species appear at least in one African regional flora, such as *Flora of Tropical East Africa* (Brenan 1967) and *Flora of West Tropical Africa* (Hutchinson & Dalziel 1963).

Tessmannia has simple pinnate leaves that are paripinnate or imparipinnate. Leaflets are alternate, rarely opposite, with leaf surfaces marked by numerous pellucid glandular spots that are always visible in young, thin leaves, and more difficult to visualise in mature or dried specimens (Brenan 1967). The lateral leaflet venules converge into a submarginal vein. Petiolules are short, intrapetiolar stipules often precociously deciduous (Brummit *et al.* 2007). The number of leaflets varies from two in the bifoliate *T. copallifera* Léonard (1957: 68), to 14–30 in *T. anomala* (Micheli 1897: 72) Harms (1915: 457) (Van der Burgt 2016) and to 36–48 in *T. princeps* A.Bianchi, Tomasi, Mwakisoma, Barbieri & Q.Luke described herein.

During field surveys in the Udzungwa Mountains, a population of *Tessmannia* with affinities to *T. densiflora* was observed and collected. This distinctive taxon, which cannot be keyed to any known species, is here described as new to science.

Materials and methods

Field surveys were carried out in the Udzungwa Mountains (at the type locality) throughout 2019 (by A. Bianchi and A. Mwakisoma). The description of *Tessmannia princeps* is based on direct measurements in the field, as well as on herbarium specimens [collected under permit 2019-82-NA-2019-15 issued by the Tanzania commission for science and technology (COSTECH)] reserved at NHT, EA, and K, and on cultivated plants grown in the nurseries of a reforestation project, Udzungwa Corridor LTD, working in the area around the type locality.

Measurements and observation of minute structures such as glands, hairs, petioles, petiolules and flowers were made using a stereomicroscope with camera (*LEICA M60* and *LEICA IC80HD*) and side LED illumination. Photographs were taken using a DSLR camera (*Canon EOS 6D*) with a macro lens (*Canon EF 100mm f/2.8L Macro IS USM*). Drone pictures were taken with DJI Mavic Pro. Measurements of leaves, twigs, seeds, pods and flowers were taken using a digital calliper [*RS PRO, Digital Calliper 6" (150mm) +/-0.001" (0.03mm) Accuracy LCD Stainless Steel RoHS*]. Measurements of tree heights were made both by climbing trees, using dynamic climbing ropes and harnesses, and using a rangefinder (*Nikon Forestry III*). Terminology of plant parts follows *The Kew Plant Glossary*, an illustrated dictionary of plant terms, second edition (Beentje 2016) and the species name was assigned following the rules of the *International Code of Nomenclature for algae, fungi, and plants* (Turland *et al.* 2018).

Results and discussion

Taxonomic treatment

Tessmannia princeps A.Bianchi, Tomasi, Mwakisoma, Barbieri & Q.Luke, *sp. nov.* (Figs. 1–5)

Type:—TANZANIA. Boma la Mzinga Village Land Forest Reserve, Udzungwa Mountains, Afromontane rainforest (*sensu* Lovett *et al.* 1988), 1416 m a.s.l., -8.19900°S 36.08371°E, 6 December 2019. *Bianchi & Mwakisoma 153* (holotype NHT!; isotypes EA!, K!).

Diagnosis:—Superficially comparable to *Tessmannia densiflora*, but *Tessmannia princeps* is a taller tree, growing up to 40 m in height; leaves bear 18–24 pairs of leaflets on a rachis 68–94 mm long; leaflets are opposite to alternate, sub-rectangular or oblong in shape; flowers are white, with sepals and tepals up to 5 mm in length. *Tessmannia densiflora* is a smaller tree, reaching 20–25 m in height; leaves bear 8–13 pairs of leaflets on a rachis 30–60 mm long; leaflets are sub-opposite to alternate and may be oblong, lanceolate, ovate-oblong, or ovate-lanceolate in shape; flowers are red, with sepals and tepals measuring 10–20 mm in length.

Description:—Large, unarmed tree 35(–40) m tall, usually canopy emergent. *Bole* straight, cylindrical, unbranched for 15–20 m, up to 2.7 m in diam. Buttresses up to 15 m tall, radiating for up to 1.5 m from bole, sometimes extending along first branches. Bark greyish-light brown, with lenticels (1–)2–4(–6) mm wide, projecting ca. 1 mm from bark surface. Older twigs sparsely hairy, young twigs (less than 1 year old) pubescent, with short <0.1 mm long, brown hair, curved. Stipules not seen on adult trees, but whitish, linear, 8 × 1 mm, early caducous on young, coppery-coloured leaves. *Leaves* 7.5–10.0 cm long, 2.0–2.5 cm wide, rachis densely pubescent, with short brown hairs, <0.1 mm, curved towards leaf tip. Leaf rachis 68–94 mm long, caniculate on upper surface. Petiole slightly wider in diam. than leaf rachis, 1–3 mm long, 1 mm in diam. *Leaflets* sessile, 18–24 pairs, opposite (in young plants and proximally) to alternate (distally), often with single odd leaflet at leaf tip; sub-rectangular/oblong, 11–13 mm long, 3–4 mm wide, margin slightly revolute; mid-vein asymmetrical, with smaller part of leaf being proximal; base trapezoidal, with angle closer to leaf attachment being acute, while distal one is obtuse; margin sometimes with 1–3 hairs, similar in shape and dimensions to ones found on leaf rachis, but transparent/very light green; tip obtuse, midvein almost symmetrical; surface shiny adaxially, dotted with pellucid translucent dots, and 2–7 raised glands. *Inflorescences* axillary, raceme and panicles arising from same bud, racemes with up to 2 branches, each 5–10-flowered; up to 4 raceme/panicles arising from bud, pubescent; inflorescences carried on regular branchlets and sparsely distributed; or also carried on short, 10–15 cm branchlets, densely covered in flowers with leaves then reflexed. *Flowers:* bracts and bracteoles not noticeable; sweetly scented. Sepals 4, outside very light green, inside white, unequal, one, elliptic, 5 × 4 mm, other three lanceolate, 5 × 2 mm; glabrous on both surfaces, but having an extremely thin ‘skirt’ on margin, projecting inwards, <1 mm wide. Petals 5, alternate to sepals, pure white, 5 × 1.0–1.5 mm, lanceolate; with noticeable midvein; sparsely pubescent in inside, with very thin 0.5–1.0 mm long hairs. Stamens 10, in two whorls, one whorl alternate

to petals and one whorl opposite; filaments white, 10 mm long in outer whorl and 5 mm long in inner, all filaments glabrous; anthers, of same size in both whorls, yellow, 0.5 × 0.8 mm. *Pistil*: ovary pure white, 2 × 1 mm, but only × 0.5 mm at base, glabrous. Style white, 3 mm long, glabrous. Stigma not differentiated. *Fruits* obovate, dark beige/tan, smooth, glabrous, woody, 45–49 mm long, 30 mm wide; valves 1–2 mm thick, being thicker in dorsal suture part; beak 1–2 mm long, sharp and woody; 1–2(–3)-seeded, explosively dehiscent. *Seeds* flat, hard, with small basil aril, shape variable, elliptic to sub-rectangular, 16–19 mm long, 9–12 mm wide, 2.1–3.0 mm thick, dark glossy brown, tending towards olive, pure brown close to aril; aril triangular, dull yellow-brown, 2–4 mm wide, 1–3 mm long. *Seedlings* with permanent cotyledons, first two true leaves opposite. *Wood* of fallen trees dark red/brown with very compact fibres and visible vessels, very heavy and durable, 1040 kg/m³ at 12% moisture content.

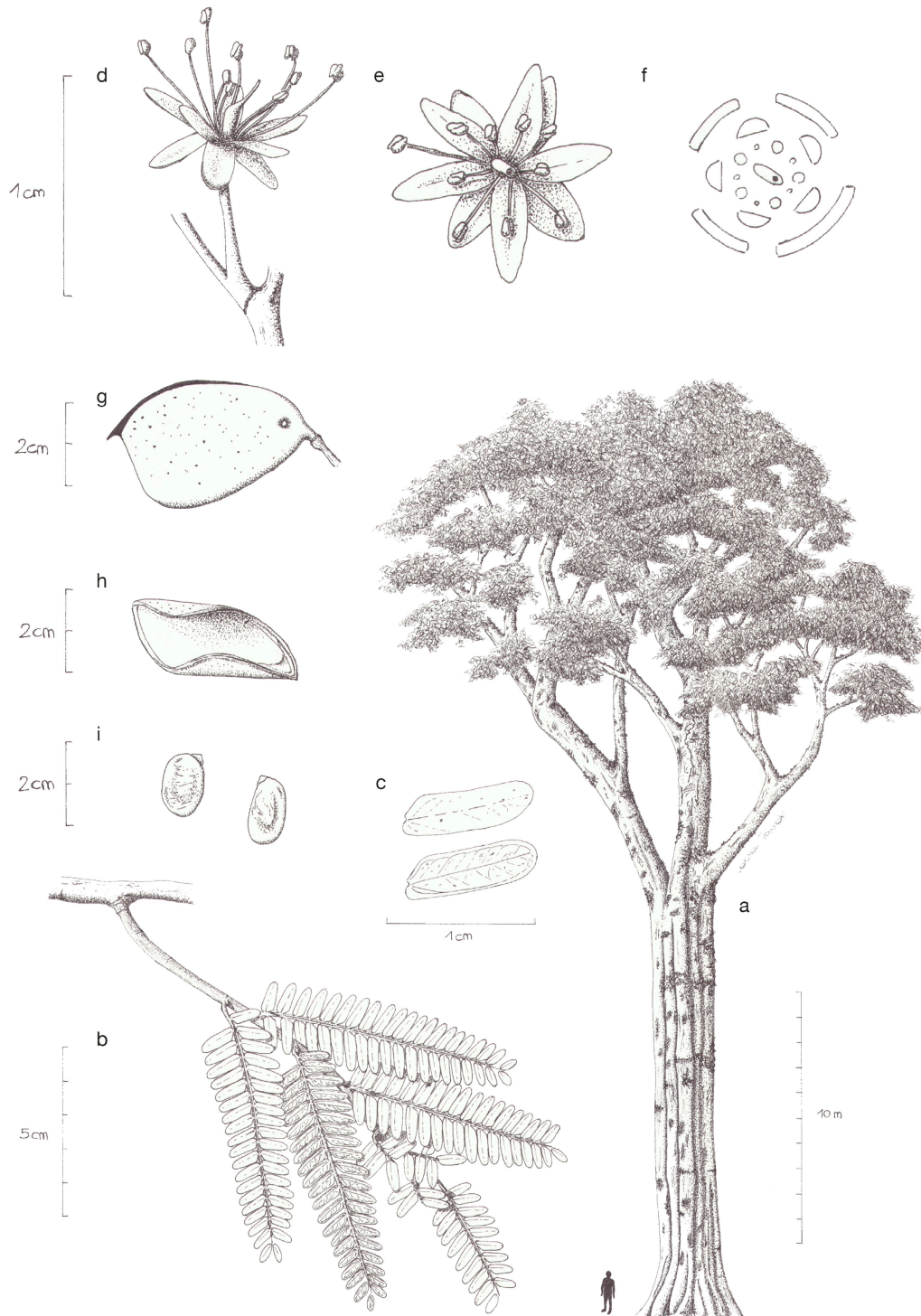


FIGURE 1. *Tessmannia princeps*. **A.** Mature tree. **B.** Branchlet and leaves. **C.** Leaflet adaxial lamina (top) and abaxial lamina (bottom) showing glands. **D, E.** Flower. **F.** Diagram of flower. **G.** Mature pod. **H.** Valve of pod after seed dispersal. **I.** Seeds. Illustration by: Laura Tomasi.



FIGURE 2. Bole of a very large individual of *Tessmannia princeps*, showing the numerous buttresses. Photo by: Andrea Bianchi.

Etymology:—The specific epithet derivation is from the Latin ‘*princeps*’ for ‘the first, the foremost, the most eminent’, in relation to the canopy emergent habit of *Tessmannia princeps*.

Phenology:—Found in flower in December, seeds dispersed in October–November.

Distribution and ecology:—Found in Afromontane rainforest (sensu Lovett *et al.* 1988) associated with *Allanblackia stuhlmannii* Engler (1897: 249), *A. ulugurensis* Engler (1900: 435), *Anthocleista grandiflora* Gilg (1893:

582), *Cassipourea malosana* (Baker 1897: 267) Alston (1925: 258), *Cryptocarya liebertiana* Engler (1899: 390), *Entandrophragma excelsum* (Dave & Sprague 1906: 511) Sprague (1910: 80), *Kuloa usambarensis* (Engler 1894: 51) Trofimov & Rohwer (2020: 528), *Newtonia buchananii* (Baker 1894: 354) Gilbert & Boutique (1952: 213), and *Parinari excelsa* Sabine (1824: 451). *Tessmannia princeps* seems to be restricted to montane rainforest in Mhanga and Mngeta valleys, Tanzania, between 1300 and 1500 m a.s.l. It is found in two (sub)populations, a larger one in Boma La Mzinga Village Land Forest Reserve and a smaller in Uluti Village Land Forest Reserve. A single individual has been recorded in a small patch of riverine forest (100 m × 20 m) close to Boma La Mzinga. Extensive and systematic research (transects and permanent plots) in the neighbouring Uzungwa Scarp Nature Forest Reserve and Mwanihana Forest (a forest ca. 150 km to the north with strong floristic affinities to the research area) have failed to locate it. Local knowledge (Aloyce & Ruben Mwakisoma, pers. com.) also strongly suggests that this species may be a narrow endemic restricted to the two adjacent valleys.

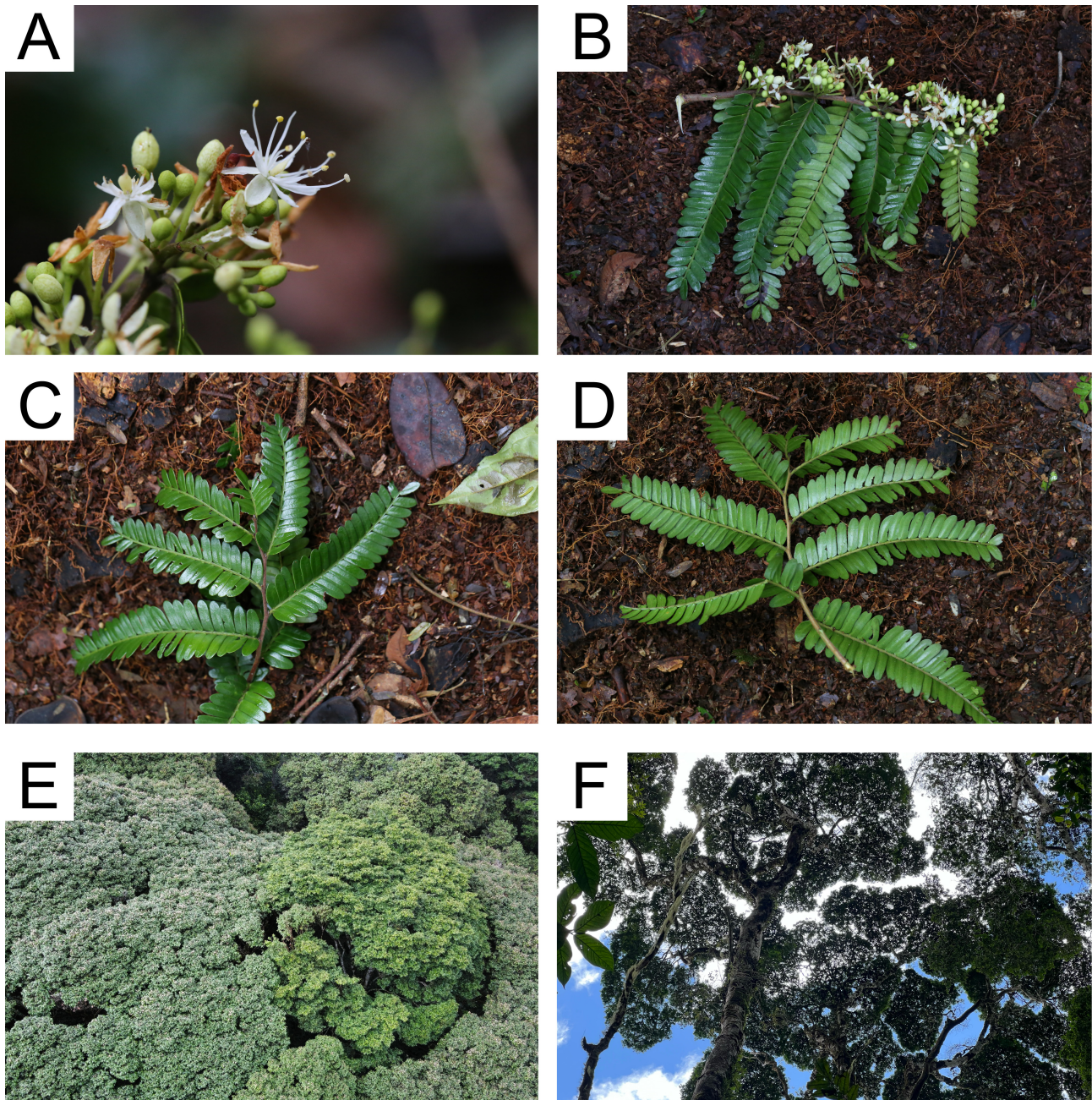


FIGURE 3. Morphological details and general habit of *Tessmannia princeps*. **A.** Close-up of a flower, note the dense inflorescence and a spent, presumably pollinated flower on the left with a young, beaked pod starting its long maturation process. **B.** Flowering branchlet, with leaves naturally reflexed. **C.** Adaxial lamina, note a mature pod in the upper right corner. **D.** Abaxial lamina. **E.** A mature individual of *T. princeps* emerges in a closed, dense canopy of *Parinari excelsa*. **F.** Canopy of *T. princeps* as seen from the forest floor. Not all individuals show canopy shyness as this specimen. Photos by: Andrea Bianchi.

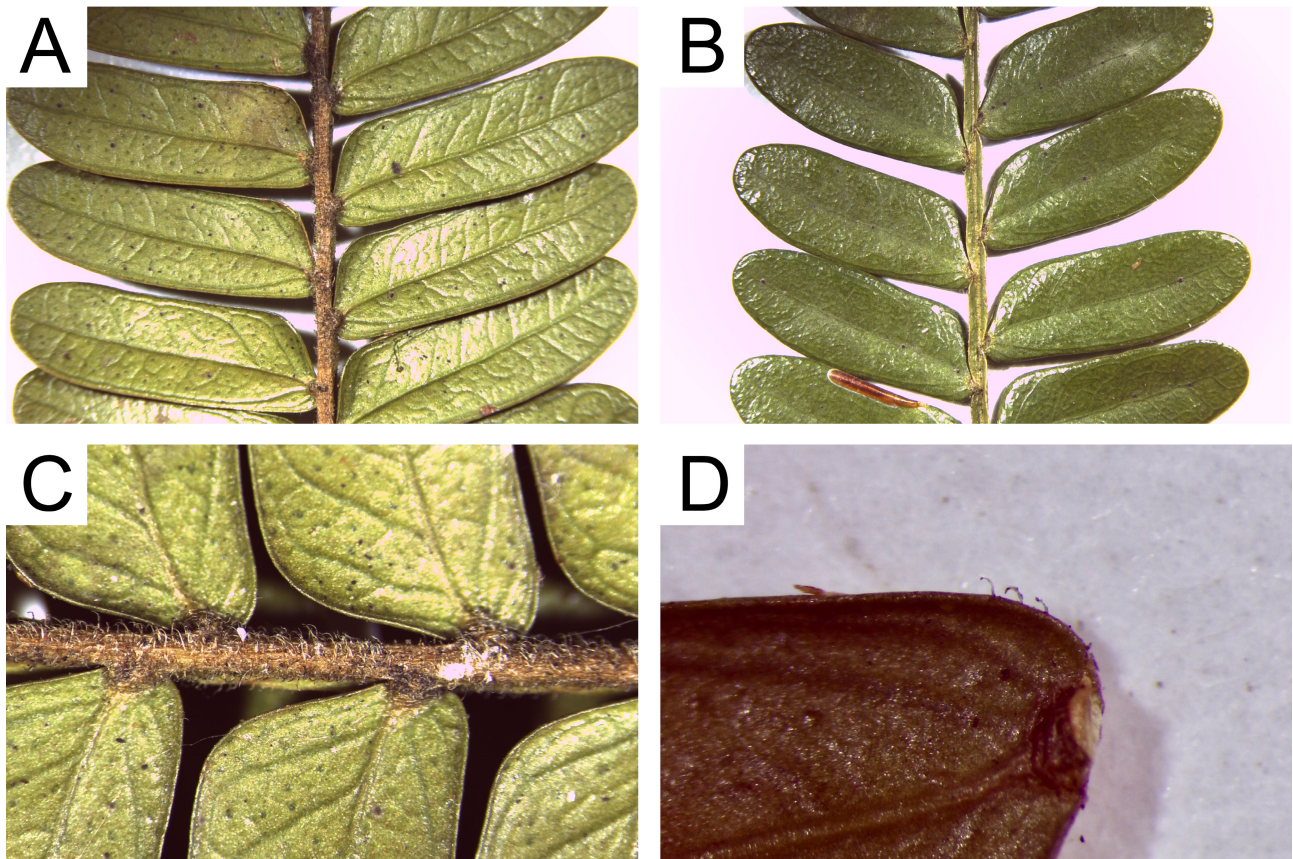


FIGURE 4. Stereomicroscope pictures of *Tessmannia princeps*. A. Abaxial lamina. B. Adaxial lamina. C. Hairy rachis. D. Short hairs on leaflet margin. Photos by: Andrea Bianchi.

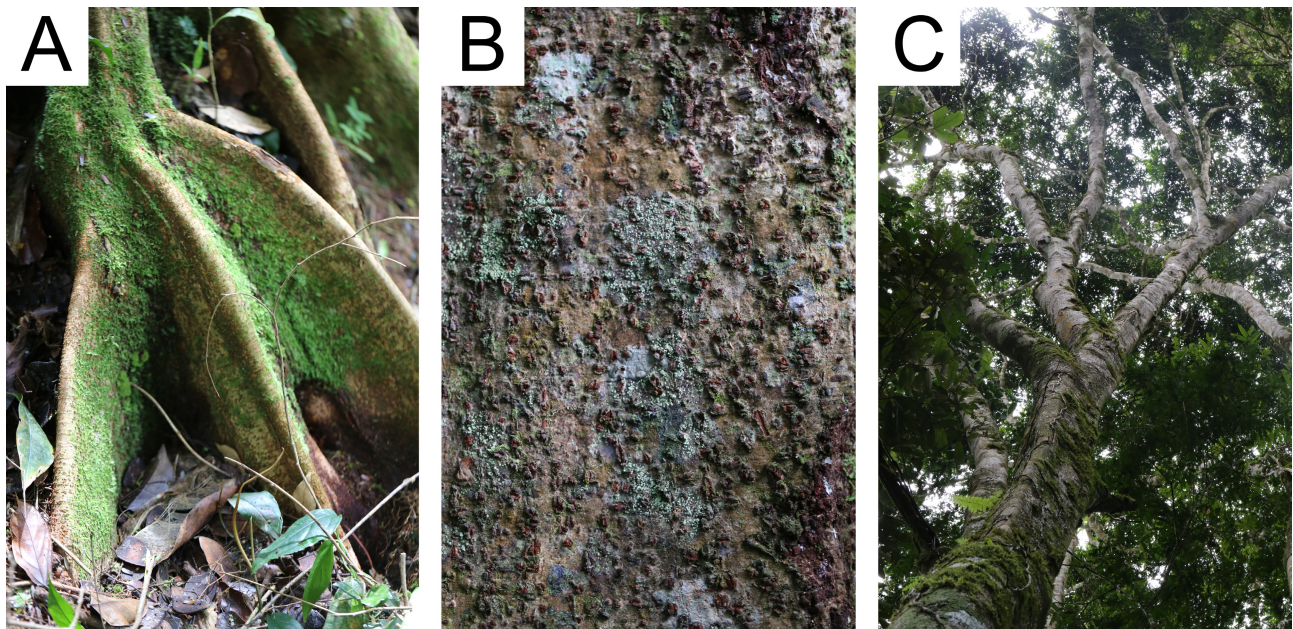


FIGURE 5. Morphological details of *Tessmannia princeps*. A. Buttresses. B. Bark with numerous lenticels. C. Branching pattern. Photos by: Andrea Bianchi.

Taxonomy:—Although *Tessmannia princeps* has a very narrow distribution and ecology, making the possibility of misidentification of this species in the field virtually nil, it is deemed relevant to update the key of East African *Tessmannia* species to be able to distinguish this species from herbarium samples alone. *Tessmannia princeps* is readily distinguishable from other species even from sterile specimens due to the numerous leaflets that separate it from any other species known from East Africa.

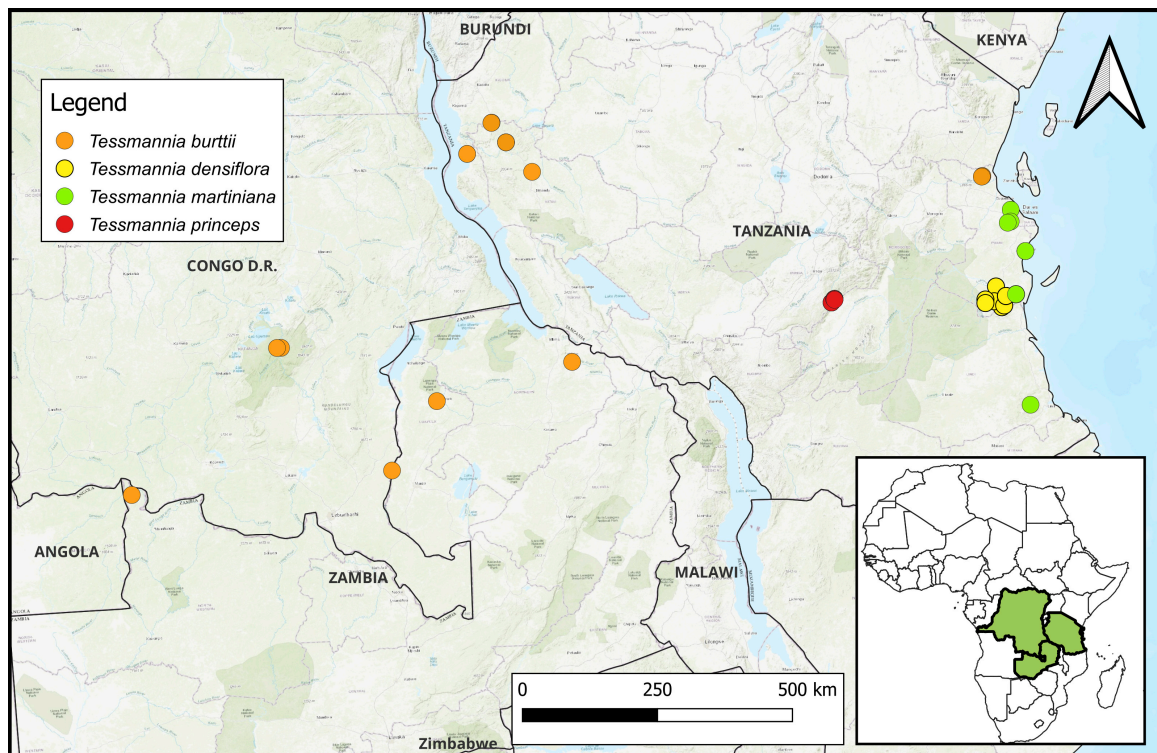


FIGURE 6. Distribution of East African species of *Tessmannia*.

Tessmannia princeps also exhibits morphological affinities with *T. anomala*. However, there are distinct morphological differences that readily separate the two species. Unlike *T. princeps*, *T. anomala* has an emarginate leaflet apex, fewer leaflets (up to 30, compared to a maximum of 48 in *T. princeps*), somewhat elliptic pods, and flowers with large, spatulate, pink petals.

It is noteworthy that, in contrast with other species in the genus *Tessmannia*, which have cardboard-like pods that do not curl up when dry and thus not constructed for ballistic dispersal, *T. princeps* has, as recently described for *T. korupensis*, hard pods that are explosively dehiscent.

Tessmannia densiflora, the most closely related species to *T. princeps* is a tree found on sandy ground between 200–600 m in elevation, whilst *T. princeps* is restricted to a narrow altitudinal range between 1300–1500 m in elevation.

Biogeography:—The present distribution of *Tessmannia princeps*, which is very limited, is interesting and most likely caused by a series of factors. The historical past of the area in which the tree is found, has likely had a major impact in the decline of the habitat of this species. The vast majority of montane forests in the immediate vicinity have been deforested in the last 120 years. It is important to note, however, that the species is totally absent from forest patches, even quite large ones, in the vicinity of the known two subpopulations.

At the same time, the Uluti subpopulation is located in a small Village Land Forest Reserve bordering the larger Uzungwa Scarp Nature Forest Reserve (USNFR), which covers more than 200 km² of closed canopy forest. Nevertheless, permanent plots, transects, and casual observations failed to locate this species in USNFR. Uzungwa Scarp is a nature forest reserve, from which the majority of valuable timbers, such as *Kuloo usambarensis*, *Khaya anthotheca* Candolle (1878: 721), and *Entandophragma excelsum*, had been selectively extracted in the past on a systematic, large scale, and, to this day, on a much smaller one. Is it possible that *Tessmania princeps* has been completely eradicated from Uzungwa Scarp and was left only in two less accessible village land forest reserves? The observed total lack of regeneration in Uzungwa Scarp and the curious fact that this species is not felled in village land forest reserves (where other trees such as *Newtonia buchananii* and *Kuloo usambarensis* are still being logged) would seem to make this hypothesis invalid. As a matter of fact, the other species extracted in Uzungwa scarp in the past show a timid regeneration (vegetatively in *Kuloo* and sexually for the other three species).

Although *Tessmannia* is primarily a genus of plants adapted to perhumid environments, the three species described so far for East Africa grow in more or less arid environments. Further research is needed to investigate whether *T. princeps* is indeed, genetically, more closely related to the species already known for East Africa or more to the species of West and Central Africa instead, an interesting feature that would prove, once again, the link that the humid forests

of the Eastern Arc have with those of West Africa, as demonstrated, for example, with the genera *Octoknema* Pierre (1897: 1290), *Schefflerodendron* Harms (1901: 87), and *Ternstroemia* Mutis ex Linnaeus (1782: 264).

Lastly, it is interesting how the seeds of a canopy-emergent species are small, orthodox, and dispersed abiotically. Most of the other canopy-dominant or emergent species (excluding the pioneer species) growing alongside *T. princeps* have large, recalcitrant seeds, found in fruits or drupes palatable by a wide variety of animals that disperse the seeds. Exceptions are *Newtonia buchananii* and *Entandophragma excelsum*, which possess long, thin, flattened seeds dispersed by the wind. These seeds, however, are highly recalcitrant, cannot tolerate dehydration, and their germination rate decreases exponentially as early as two weeks after dispersal.

Conservation status:—*Tessmannia princeps* is provisionally assessed as Vulnerable (VU) based on the IUCN 3.1 criteria (IUCN 2012), specifically meeting criteria D1, population size estimated to number fewer than 1000 mature individuals (a thorough survey of the forest patches indicates 101 mature individuals). Both *T. princeps* (sub)populations occur within the Udzungwa Corridor, a 75 km² forest restoration project, which has a payment for ecosystem services scheme and protects remaining patches of forest. If the project were to cease, *T. princeps* would be immediately threatened with habitat loss and would then need to be assessed as Critically Endangered (CR) based on criteria B1a (severely fragmented or known to exist at only a single location) and B1b(v) (continued decline of mature individuals). In fact, the species is known from only two (sub)populations, that are very close, and fall within the same location.

Additional specimens examined:—*Tessmannia densiflora*: TANZANIA. Kichi Hill Forest Reserve, NW of Nawanje village, Miselu/Mkinga Peak, Tree 13 m tall × 18 cm dbh, Bark grey, smooth, dry fruit brown, Kindengereko name: “Muundeī”, 27th April 2001, *Y.S. Abeid* 899 (NHT!); Matumbi Hills, Kiwengoma F./R., NE of WWF—camping site, Tree 7 m tall, sterile, 29th April 2001, *Y.S. Abeid* 924 (NHT!).—*Tessmannia* sp.: TANZANIA. Kanga Mtn, Mvomero district, Submontane forest, Tree 4 meters, leaflets alternate, emarginate w ‘windows’—sterile, 10th May 2007, *Festo* 2854 (NHT!); Udzungwa Mountains NP, Pt 228, 7.7500°S, 36.83333°E, Alt 1400 m, Sub-montane forest, Tree 7 m, 29th September 2001, *Luke WRQ* 7982 (NHT!).

TABLE 1. Comparison of floral characteristics of *Tessmannia princeps* with other species occurring in tropical East Africa.

	<i>T. burttii</i>	<i>T. martiniana</i>	<i>T. densiflora</i>	<i>T. princeps</i>
sepals length	13–15 mm	10 mm	10–20 mm	5 mm
petals length	15–30 mm	20 mm	20 mm	5 mm
petal shape	oblanceolate, elliptic	oblanceolate or oblong-oblanceolate	?	lanceolate
petal colour	pink	?	red	white

Updated key to the East African species of *Tessmannia*, adapted from *Flora of Tropical East Africa* (Brenan 1967)

1. Leaflets 30–90 mm long, mostly 14–30 mm wide, gradually acuminate at apex, 5–8 per leaf.....*T. burttii*
- 1'. Leaflets 8–30 mm long, 4–20 mm wide, rounded or obtuse at apex, 6–48 per leaf2
2. Leaflets 6–12 per leaf, 7–20 mm wide; ovary and stipe tomentose; branchlets, petioles and leaf rachis hairy or glabrous*T. martiniana*
- 2'. Leaflets 16–48 per leaf, 3–6 mm wide; ovary glabrous or pubescent, on a villous stipe; branchlets, petioles and leaf rachis shortly pubescent3
3. Leaflets 16–26 per leaf, 4–6 mm wide; ovary glabrous, on a villous stipe; branchlets, petioles and leaf rachis shortly pubescent later glabrescent.....*T. densiflora*
- 3'. Leaflets 36–48 per leaf, 3–4 mm wide, ovary and stipe glabrous; branchlets pubescent, later sparsely so, petioles and leaf rachis densely pubescent.....*T. princeps*

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exceptionally unique biodiversity of the Udzungwa Mountains, at a landscape level over the long term. The species is dedicated to Carter Coleman ‘il principe della foresta’, founder of Udzungwa Corridor Limited, a company with the aim of reforesting 75 km² of abandoned farmland, eventually linking two forest reserves and raising 5500 villagers from poverty.

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