Ternstroemia guineensis (Ternstroemiaceae), a new endangered cloudforest shrub with neotropical affinities from Kounounkan, Guinea, W Africa

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Ternstroemia guineensis (Ternstroemiaceae), a new endangered cloudforest shrub with neotropical affinities from Kounounkan, Guinea, W Africa

Abstract: Ternstroemia guineensis is described from a sandstone table mountain at Kounounkan, possibly the last in the Fouta Djallon (Guinea Highlands) to remain largely unimpacted by humans and to have mainly intact natural habitats. It occurs about 2400 km westward of the nearest existing record (Nigeria) of the genus in Africa. It is confined to cloud (submontane) forest in galleries along watercourses. Its conservation status is assessed as Endangered using the IUCN 2012 criteria. The species differs from the other two African highland species, T. cameroonensis and T. polypetala, in having hermaphrodite flowers with a long subcylindric style and punctiform stigmas, and petals connate at the base into a tube (not dioecious, with a short style and cone-like stigmas, and free petals) resembling in these features the neotropical Ternstroemia species, as does also the lowland wetland T. africana of Nigeria, Gabon and Angola.

Key words: Amphi-atlantic, conservation, Guinea, Guinea Highlands, Kounounkan, medicinal, new species, Pentaphylacaceae, relic, Ternstroemia, Ternstroemiaceae, Theaceae, West Africa

Introduction

In November 2017, the last three authors were on a botanical survey team seeking to discover the most important surviving areas for plant conservation in Guinea following the criteria of Darbyshire & al. (2017) and Darbyshire (2019+). The object is to evidence Important Plant Areas and to prioritize them for protection. The November 2017 survey was at Kounounkan Forest Reserve, the largest surviving remnant of forest in Fouta Djallon. Among the herbarium specimens collected was one, Pepe Haba 1060, which was identified as a Ternstroemia Mutis ex L. f. This specimen was collected about 2400 km westward of the nearest existing record of the genus in Africa. It is superficially similar to the recently described T. cameroonensis Cheek (Cheek & al. 2017) of Cameroon to the east. Close inspection showed it to be different from all other species of the genus known in Africa by the absence of any visible secondary nerves and from the other African highland species in the leaves arranged in pseudo-verticils and lacking Terminalia-branching. Rehydration and dissection of the flowers showed further points of difference (see Table 1). Attempts were made to key out the specimen in the three regional treatments of Ternstroemia for the Neotropics (Kobuski 1942a, 1942b, 1943) and it was compared with material of neotropical species at Kew, but no match was found. Accordingly, it is described in this paper as T. guineensis Cheek, sp. nov. Additional specimens with fruit developed were collected on a follow-up visit by the three last authors in February 2019, and ripe fruit were observed and seed collected (Konomou 691) in May 2019.
Ternstroemia

The genus *Ternstroemia* is pantropical, extending into subtropical and temperate areas (Stevens 2001+; Weitzman & al. 2004). Estimates of species numbers range from c. 100 (Stevens 2001+) to 152 (Plants of the World Online 2018+). Of these 152 species, 101 are Neotropical, just three African, with 31 in Malesia (SE Asia), one (*T. cherryi* (F. M. Bailey) Merr. ex J. F. Bailey & C. T. White) extending to N Australia, with 15 species in China, Indo-China, Japan and Tibet, and one species, *T. gymnanthera* (Wight & Arn.) Bedd., extending to India. The genus is absent from Madagascar, the Indian Ocean, all but W Oceania, and from N temperate areas apart from China and Japan. Most of the species are montane and submontane and are absent from lowland habitats apart from some species in swamp forest. The genus is incompletely known, especially in the neotropics: in local Floras, species remain formally unnamed, for example in the Venezuelan Guayana (Berry & Weitzman 2005) and in Guaramacal (Venezuelan Andes) (Dorr & al. 2000: 144).

Several species are used in traditional medicine, for example, in Mexico, *Ternstroemia oocarpa* Melch., *T. pringlei* Standl., *T. sylvatica* Schltdl. & Cham., are all used for treating “nervios”, depression and anxiety (Guzmán-Gutiérrez & al. 2014). Phytochemical studies of *Ternstroemia* species have reported the isolation of oleanane- and ursane-type triterpenoids, triterpenoid glycosides, triterpenoid saponins, carotenoids, monoterpenoids, tannins (Balderas-López & al. 2013). Triterpenoid saponins have been reported from the fruits of *T. gymnanthera* (as *T. japonica*) in Asia (Shin & al. 2003). *Ternstroemia cherryi* is used as a fish poison in N. Australia (Williams 2012). In Africa, *T. cameroonensis* has numerous medicinal uses (Cheek & al. 2017).

The genus was formerly included in *Theaceae* together with *Ficalhoa* Hiern (now usually placed in *Sladeniaceae*) e.g. in Verdcourt (1962). *Ternstroemia* is now placed in *Ternstroemiaceae* (*Ericales*) together with *Balthasaria* Verdc. (also Tropical Africa) and in Macaronesia *Visnea* L. f. (Weitzman & al. 2004). The remaining nine genera of *Ternstroemiaceae* occur mainly in Tropical Asia, but with two genera restricted to the Neotropics (Weitzman & al. 2004). By some, *Ternstroemiaceae* is merged with *Pentaphylacaceae* where the latter unfortunately takes preference (*nom. cons.*) (Culham 2007; Stevens 2001+). However, the sister relationship of *Ternstroemiaceae* and *Pentaphylacaceae* is uncertain (Stevens pers. comm. 2017).

The number of species described as new to science each year regularly exceeds 2000, adding to the estimated 369,000 already known (Nic Lughadha & al. 2016), although the number of flowering plant species known to science is disputed (Nic Lughadha & al. 2017). Only about 7% of plant species have been assessed and included on the Red List using the IUCN (2012) standard (Bachman & al. 2019), but this number rises to 21–26% when additional evidence-based assessments are considered, and 30–44% of these assess the species as threatened (Bachman & al. 2018). Newly discovered species such as that reported in this paper are likely to be threatened, since widespread species tend to have been already discovered. There are notable exceptions to this rule (e.g. *Vepris occidentalis* Cheek (Cheek & al. 2019) a species widespread in W Africa from Guinea to Ghana. Generally, it is the more localized, rarer species that remain undiscovered. This makes it all the more urgent to discover, document and protect such species before they become extinct or possibly extinct e.g. as is *Inversodicraea pygmaea* G. Taylor in Guinea (Cheek 2018; Couch & al. 2019), or in the case of another cloud forest tree *Vepris bali* Cheek (Cheek & al. 2018a).
Table 1. Characters separating *Ternstroemia guineensis* from *T. polypetala*, *T. cameroonensis* and *T. africana*. Data on *T. polypetala* from Verdcourt (1962), on *T. cameroonensis* from Cheek & al. (2017) and on *T. africana* from Kobuski (1961).

<table>
<thead>
<tr>
<th>Character</th>
<th><em>T. guineensis</em></th>
<th><em>T. polypetala</em></th>
<th><em>T. cameroonensis</em></th>
<th><em>T. africana</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitudinal range</td>
<td>900–1100 m</td>
<td>1800–2300 m</td>
<td>1900–2300 m</td>
<td>0–50 m</td>
</tr>
<tr>
<td>Geography</td>
<td>Guinea</td>
<td>Tanzania–Malawi</td>
<td>Cameroon</td>
<td>Nigeria–Angola</td>
</tr>
<tr>
<td>Breeding system</td>
<td>hermaphrodite</td>
<td>dioecious</td>
<td>monoeocious</td>
<td>hermaphrodite</td>
</tr>
<tr>
<td>Leaf dimensions</td>
<td>(2.5–)3.7–6.1(–6.7) × (1.3–)1.6–2.5(–3) cm</td>
<td>4.5–9 × 1.5–2.5 cm</td>
<td>(2.3–)5–7.2(–9) × (0.7–)1.7–2.8 cm</td>
<td>(4–)8–10 × (2–)4–5 cm</td>
</tr>
<tr>
<td>Secondary nerves</td>
<td>not visible</td>
<td>conspicuous</td>
<td>conspicuous</td>
<td>visible</td>
</tr>
<tr>
<td>Quaternary nerves</td>
<td>not visible</td>
<td>conspicuous, reticulate</td>
<td>not visible</td>
<td>not visible</td>
</tr>
<tr>
<td>Petals</td>
<td>5, proximal quarter strongly connate</td>
<td>7–10, free</td>
<td>7 or 8, free</td>
<td>5, lightly connate at base</td>
</tr>
<tr>
<td>Stamens</td>
<td>20–25, uniseriate</td>
<td>c. 60, multiseriate</td>
<td>35–40, uniseriate</td>
<td>15–20, uniseriate</td>
</tr>
<tr>
<td>Connective appendage</td>
<td>present</td>
<td>present</td>
<td>absent</td>
<td>present</td>
</tr>
<tr>
<td>Locule number, placation</td>
<td>bilocular, axial placentation</td>
<td>bilocular, axial placentation</td>
<td>unilocular apical placentation</td>
<td>bilocular, axial placentation</td>
</tr>
<tr>
<td>Style-stigma</td>
<td>stigma punctiform, inconspicuously and minutely bilobed at end of a long style</td>
<td>stigma subsessile, forming a 2(or 3)-lobed dome over ovary</td>
<td>stigma subsessile forming a 2(or 3)-lobed dome over ovary</td>
<td>stigma punctiform at end of a long style</td>
</tr>
</tbody>
</table>

- Trees of Cameroon; peduncle 8–12 mm long at anthesis; bracts opposite, transversely elliptic, broader than long.............................. *T. cameroonensis*

*Ternstroemia guineensis* Cheek, sp. nov. – Fig. 1, 2. Holotype: Guinea, Forécariah Préfecture, S part of Kounouankan Plateau, 09°32′55.5″N, 12°51′35.6″W, 910 m, fl., 26 Nov 2017, P. M. Haba with X. M. van der Burgt, L. Jennings & G. Komoumou 1060 (K K001286639; isotypes: HNG, MO, P, US, WAG).

**Diagnosis** — Similar to *Ternstroemia africana* Melch., differing in the smaller leaves (2.5–)3.7–6.1(–6.7) × (1.3–)1.6–2.5(–3) cm, secondary nerves not visible, (not (4–)8 × 2–)4–5 cm, secondary nerves visible, c. 7 pairs; petiole margins entire or with 1–2 setae (not densely glandular dentilicate); peduncles 1.4–2.4 cm long (not 3–4.5 cm long).

**Description** — Hermaphrodite multi-stemmed shrub to 5 m tall (Fig. 2E), rarely a tree to 9 m high and then trunk c. 18 cm in diam. at 1.3 m above ground, glabrous. Trunk and large branches with thick, tessellated, grey bark, tessellations more or less isodiametric, each 2–3 cm in diam., separated by deep fissures (Fig. 2F). **Branches** all erect, leafy branchlets pseudo-verticillate (loose verticils of (2 or)3 or 4 leaves separated by 1.25–3.1 cm of leafless stems (Fig 2G)). Stems grey, subterete, 2–2.5 mm in diam. at lowest leafy node, wrinkled. Apical bud curved, cornute c. 2 × 1 mm, subtended by two unequal scale leaves in dry season (Feb), with a black conical gland, margins reflexed, each with c. 14 smaller, regularly spaced glands. New shoots probably arising in early wet season (June–July), from dormant apical bud. First, 2 or 3(or 4) internodes very short (<1 mm long), followed by 2–3 longer internodes (each 5–7 mm long), probably with caducous scale-leaves (not seen), distal part of shoots with 3–4 fully-formed leaves at nodes <1 mm apart (pseudo-verticils). **Leaves** with spiral phyllotaxy, persisting for three season’s growth: blade coriaceous, surface wrinkled and verrucate, drying green, obovate to obovate-elliptic, length: breadth ratio c. 2:1, (2.5–)3.7–6.1(–6.7) × (1.3–)1.6–2.5(–3) cm, apex rounded or obtuse, base gradually decurrent into slightly winged petiole, margin revolute, with 12–15 inconspicuous dark spots 5–7 mm apart on each side (Fig. 1B, C), remains of marginal glandular setae visible only in young, expanding leaf (Fig. 1D), setae red, patent, c. 0.6 mm in diam. at base to c. 1 mm in diam. at apex, sometimes not extending to apex; secondary, tertiary and quaternary nerves not visible. **Petiole** winged, broadly triangular in transverse section, with a shallow adaxial groove, (0.4–)0.5–0.8(–1) × 0.1–0.18 mm, margin with 2 caducous setae on each side (as in blade); petioles of previous season developing basal articulation. **Stipules** absent. **Pedicels** single, in axes of presumed caducous scale-leaves of first produced (proximal) successive three nodes of current season’s growth, each 1.4–2.4 cm long, widening gradually from c. 0.6 mm in diam. at base to c. 1 mm in diam. at apex, patent or slightly nodding. **Bracts** inserted as a pair immediately below calyx; opposite, subequal, ovate or ovate-triangular (2–)2.2–2.8 × 1.5–2.1 mm, midrib raised as a keel, extending beyond obtuse apex as a swollen mucro of c. 0.2 mm long, margin with 2 or 3 caducous red setae, as those of leaf. **Flowers** hermaphrodite, 7–9 mm in diam., pendulous. **Sepals** 5, patent, white, quincuncially, slightly

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Fig. 1. *Ternstroemia guineensis* – A: habit, flowering leafy stems; B: detail of revolute margin of mature leaf, abaxial view, showing circular scars of fallen marginal setae; C: detail of one seta scar from B; D: detail of margin of immature leaf showing patent setae; E: flower, hydrated, side view; F: connate corolla with staminal ring, as self-detaching after anthesis; G: flower, with pistil exposed by removal of two sepals, two petals and several stamens; H: transverse section of ovary showing intruding placentas in both of two locules; I: side view of stamen, showing inward arching; J: adaxial view of stamen; K: inner view of two adherent petals, with adherent staminal ring; L: petal (flattened), adaxial surface showing slightly lacerate distal margins and longitudinal nerves; M: outer sepal (flattened); N: inner sepal (flattened). – Scale bars: A = 5 cm; B–G, K–N = 5 mm; I, J = 2 mm; H = 1 mm. – All drawn from Pepe Haba 1060 (K) by Andrew Brown.
concave, thick, leathery, outer surface wrinkled when dry, unequal, outer pair suborbicular, c. 4.5 × 5.2 mm, leathery, margin scarious, 0.5–1 mm wide, erose, apex rounded or retuse, sometimes with mucro 0.3–0.4 mm long, inserted adaxially below margin; inner sepals ovate, c. 6.5 × 6 mm, mucro absent, margin as outer sepals. Petals 5(or 6), yellow or yellowish white, together forming a short cylinder enclosing stamens, petals imbricate, connate in basal ¼ (for 1.7–2 mm, Fig. 1F, 2C), each narrowly ovate, apex obtuse, sides distally folded in from midrib, base truncate, c. 2.2 mm wide, margin irregularly and minutely lacerate mainly in distal half, longitudinal nerves c. 9 from base, parallel, equally spread, rarely branched, slightly visible in rehydrated material (Fig. 1L). Stamens 20–25, uniseriate, adnate to corolla, all falling together as one unit (Fig. 1F), each stamen (4.5–)5.5(–6) mm long, arching inward toward ovary (Fig. 1I), white anther theca inserted along lateral mar-
pink sepals, inner sepals 8–9 × 1.1–1.5 cm, subtended by appressed, persistent, accrescent, green flushed pink sepals, inner sepals 8–9 × c. 7 mm; style persistent, accrescent 6–8 mm long, with a central groove, (0.5–)0.7–0.9 × c. 0.6 cm, laterally flattened, 0.2–0.3 cm wide.

Phenology — flowering in the dry season from November onward, a few flowers still present in February, when fruits are nearly fully-formed. Fruits ripe in May, as wet season begins. Shoot extension and new leaves are inferred to develop in the wet season (May–October).

Distribution — Ternstroemia guineensis is currently only known from the southernmost plateau of the Kounounkan Massif in Forécariah Prefecture, an uninhabited sandstone table mountain, where it is known from gallery forests along four streams.

Ecology — The species was found in species-rich submontane gallery (cloud) forest, on rocky soils, at 900–1100 m altitude.

Conservation status — Ternstroemia guineensis is a very rare species, collected only by the last three authors, on a single uninhabited table mountain despite targeted searches on other mountains over three years by our team. We assess T. guineensis as Endangered (EN B1+B2ab(ii,iii,v); D) according to the categories and criteria of IUCN (2012) since the species has only been found at the one location, where 169 mature individuals have been observed. The grasslands on parts of the nearby main southern plateau of the Kounounkan Massif are frequently burned in the dry season. These frequent dry-season fires may damage gallery forest edges; the habitat of T. guineensis. Continuous decline was observed there in quality of habitat, in the form of burned and fire-killed trees of other species, and continuous decline in number of mature individuals of T. guineensis is therefore likely should these frequent fires reach the location of that species.

The species is known from a total of nine sites (four collections and five observations) at one location. The area of occupancy is 16 km², calculated using IUCN-preferred 2 × 2 km cells, and the extent of occurrence slightly larger, estimated at 17 km² to satisfy IUCN preferences, although a minimum convex polygon around the nine sites gives an area of only 4.3 km². Despite searches elsewhere in Guinea, especially in the Kounounkan Massif, the species has not yet been found outside the nine known sites. It has been conjectured that Ternstroemia guineensis and other point endemics that occur at the same location (e.g. Gladiolus mariae Burgt, Burgt & al. 2019), several of which are also in the process of being described, may be relics, and may once have been much more widespread over the sandstone table mountains of the Fouta Djallon, since these appear so similar in terms of ecology to the Ternstroemia location, excepting the presence of humans and the consequent high fire-frequency (Burgt & Haba cited in Couch & al. 2019).

Although the location is unprotected, the immediate threat of farmers or cattle rangers moving in is currently low, due to its inaccessibility. However, this could change rapidly. Currently, there are no paths up to and on the southern plateau. Should a path to the site be constructed, there is a risk that, as with other sandstone table mountains known to us in Guinea, livestock will be introduced for seasonal grazing and as a consequence dry-season fires will be introduced, and as a result submontane gallery forest will be degraded and will decrease in extent. In this event, the assessment should be reviewed and it is likely to become Critically Endangered.

The authors intend to raise public awareness through a poster programme on the importance of protecting this rare species and its habitat, and efforts are being made to obtain seed for seed banking as a safeguard, and to continue to attempt to discover additional locations for Ternstroemia guineensis. Given the comparatively large number of rare plant species recorded at the site for this species, and the presence of priority threatened habitats (sandstone cliffs, high altitude bolar, submontane and lowland evergreen forest) the location for T. guineensis has been included in the proposed Kounounkan Important Plant Area, for which National Park status is being sought (Couch & al. 2019).

Etymology — The specific epithet guineensis signifies from Guinea (Guinea-Conakry or the Republic of Guinea), which holds the only known global location for this species.

Specimens examined — GUINEA: Forécariah Prefecture, southern plateau of Kounounkan Massif, 09°32′58.6″N, 12°51′35.6″W, 920 m, fr., 3 Feb 2019, X. M. van der Burgt 2250 (B, BM, BO, BR, E, FHO, G, HNG, K, LISC, MO, NY, P, PRE, R, SERG, SING, SL, US, WAG); same locality, 09°32′42.5″N, 12°50′36.4″W, 970 m, fl., 4 Feb 2019, X. M. van der Burgt 2258 (BR,
New species from the Guinea Highlands

Ternstroemia guineensis is the most recent of numerous new species to science discovered in the Guinea Highlands in recent years. These are, in alphabetical order:


Eriocaulon cryptocephalum S. M. Phillips & Mesterházy (Eriocaulaceae) (Phillips & Mesterházy 2015),

Eriosema triforium Burgt (Leguminosae) (Burgt & al. 2012),

Gymnosiphon samoritoureanus Cheek (Burmanniaceae) (Cheek & Burgt 2010),

Inversodicraea pepehabae Cheek (Podostemaceae) (Cheek & Haba 2016),

Isoglossa dispersa Darbysh. & L. J. Pearce (Acanthaceae) Darbyshire & al. (2011),

Napoleonaea alata Jongkind (Lecythidaceae) (Prance & Jongkind 2015),

Psychotria samoritoureai Cheek (Rubiaceae) (Cheek & Williams 2016),

Striga magnibracteata Eb. Fisch. & I. Darbysh. (Orobanchaceae) (Fischer & al. 2011),

Xysmalobium samoritoureai Goyder (Apocynaceae) (Goyder 2009) and the new genus Karima Cheek & Riina (Euphorbiaceae) (Cheek & al. 2016).

Those recently discovered taxa specific to sandstone substrate in the S part of the Fouta Djalon are Gladiolus mariae Burgt (Burgt & al. 2019), Keetia susu Cheek (Cheek & al. 2018c), Kindia gangan Cheek (Cheek & al. 2018b), Talbotiella cheekii Burgt (Burgt & al. 2018) and the resurrected Mespanthemum tuberosum Lecomte (Phillips & al. 2018).

Morphological affinities and amphi-Atlantic distributions

The morphological affinities of Ternstroemia guineensis are not with the other highland African Ternstroemia species, T. polypetala Melch. and T. cameroonensis. The last two species both have 7 or more free petals and minute styles bearing large, foliose stigmas that form a cone over the top of the ovary. In contrast, T. guineensis and the lowland swamp-dwelling T. africana Melchior both have hermaphrodite flowers with 5 petals united at the base, and a cylindric style that exceeds or equals the ovary in length, bearing two minute, punctiform stigmas. The features of T. guineensis and T. africana are seen in the Neotropical Ternstroemia treated by Kobuski (1942b, 1943), while the affinities of T. polypetala (and T. cameroonensis) are with the Asian species (e.g. Kobuski 1961). It can be postulated that the ancestors or ancestor of T. guineensis and T. africana arrived in W Africa as a result of long-distance dispersal from the Neotropics as did Pitcairnia felicina (A. Chev.) Harms & Mildbr. (Bromeliaceae) and Maschalochephalus dinklagei Gilg & K. Schum. (Rapataceae) shown e.g. by Givnish & al. (2004). In the case of the Pitcairnia and Maschalochephalus, the direction of travel was unambiguously from west to east, since all other members of their families are Neotropical. However, this is not the case with pantropical Ternstroemia. Although the species diversity of the genus in the Neotropics, with 101 species, far exceeds that of Africa, now with four species, it cannot be ruled out that the Neotropical Ternstroemia may have arisen by dispersal from Africa. In fact, although Africa has by far the lowest species diversity of Ternstroemia of all the three major tropical areas, it has the highest level of infra-generic diversity for Ternstroemia, containing species with both Asiatic (T. polypetala and T. cameroonensis) and American (T. africana and T. guineensis) morphology. It is even possible that Africa was the crucible in which Ternstroemia arose. This hypothesis is supported by the proximity of potential sister genera Visnea (Manson-ronesia) and Balthasaria (Albertine Rift and Eastern Arc mountains).

Another group recently discovered to be amphi-atlantic is Peridiscaceae, regarded as American until research showing that Cameroonian Medusandra Brenet together with WC African Soyauxia Oli., is confamilial (Soltis & al. 2007; Breteler & al. 2015). In this case also, travel from east to west is credible. Morphological and species diversity in Peridiscaceae is far higher in Africa than in the Americas.

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