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Authors: Veranso-Libalah, Marie Claire, Stone, Robert Douglas, Haba, Pepe M., Magassouba, Sékou, Kadereit, Gudrun, et al.

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MARIE CLAIRE VERANSO-LIBALAH^{1,2*}, ROBERT DOUGLAS STONE³, PEPE M. HABA⁴, SÉKOU MAGASSOUBA⁵, GUDRUN KADEREIT⁶ & XANDER M. VAN DER BURGT⁷

Phylogenetic placement of *Cailliella praerupticola* (*Melastomataceae*), a rare, monospecific lineage from Guinea, West Africa

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Abstract: The genus *Cailliella* includes a single species, *C. praerupticola*, restricted to a sandstone plateau region in Coyah, Dubreka, Forécariah and Kindia Préfectures, Guinea, West Africa. Until its rediscovery in 2016, this species was known only by the type gathering made in 1937. We provide an emended description, photographs of living material, locality and habitat data, and a discussion of its conservation status. We further designate a lectotype for *C. praerupticola*. On the basis of morphology, *Cailliella* had been considered an isolated member of the tribe *Melastomateae*, possibly sister to *Melastomastrum*. We tested the classification of *Cailliella* by means of a phylogenetic analysis of *C. praerupticola* and 40 other samples of African *Melastomateae*, based on molecular sequence data from the external and internal transcribed spacer regions of nuclear ribosomal DNA (nrETS and nrITS) as well as the *ndhF*, *psbK-psbL* and *accD-psaI* regions of chloroplast DNA. Our results corroborate the placement of *Cailliella* in the *Melastomateae*, where it was resolved as sister to a clade consisting of both *Melastomastrum* and *Tristemma*. The hypothesis of *C. praerupticola* being an evolutionary relict or “palaeoendemic” is supported by our findings.

Key words: *Cailliella*, Guinea, *Melastomataceae*, *Melastomateae*, molecular phylogeny, morphology, pachycauly, palaeoendemic, plant conservation, threatened species, West Africa

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Introduction

The sandstone plateau region in Coyah, Dubreka, Forécariah and Kindia Préfectures in Guinea is floristically very interesting. The sandstone table mountains and vertical cliffs have been a factor in promoting speciation, and these species have been preserved by the inaccessibility of some of the table mountains. This region

was one of the main study areas of the Darwin Initiative-funded Tropical Important Plant Areas (TIPA) Guinea project undertaken by the Kew Herbarium (Darbyshire & al. 2017; Couch & al. 2019) and the Garfield Weston-funded African Tree Seed Project by Kew’s Millennium Seed Bank. New species discovered and published during the work on these projects, and endemic to the sandstone plateau, are: *Gladiolus mariae* Burgt (Burgt

1 Institut für Molekulare Physiologie, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany.

2 Institut für Organismische und Molekulare Evolutionsbiologie, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany; *e-mail: mario_clario@yahoo.ca (author for correspondence).

3 School of Life Sciences, University of KwaZulu-Natal, Private Bag X01, Pietermaritzburg 3209, South Africa.

4 Guinée Biodiversité, Conakry, Guinea.

5 Herbar National de Guinée, Dépt. Biologie, Université Gamal Abdel Nasser de Conakry, Conakry BP 1147, Guinea.

6 Systematik, Biodiversität & Evolution der Pflanzen, Ludwig-Maximilians-Universität München, Menzinger Str. 67, 80638 München, Germany.

7 Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, U.K.

& al. 2019), *Inversodicraea koukoutamba* Cheek and *I. tassing* Cheek (Cheek & al. 2019b), *Keetia susu* Cheek (Cheek & al. 2018a), *Kindia gangan* Cheek (Cheek & al. 2018b), *Talbotiella cheekii* Burgt (Burgt & al. 2018), *Ternstroemia guineensis* Cheek (Cheek & al. 2019a) and *Trichantheium tenerium* Xanthos (Xanthos & al. 2020). Numerous plant species are endemic or near-endemic to the sandstone plateau region, such as *Anisotes guineensis* Lindau, *Cincinnobotrys felicis* (A. Chev.) Jacq.-Fél., *Diospyros felicianae* Letouzey & F. White, *Fleurydora felicis* A. Chev., *Mesanthemum bennae* Jacq.-Fél. and the remarkable *Pitcairnia felicianae* (A. Chev.) Harms & Mildbr., the only *Bromeliaceae* occurring naturally outside of the Americas. To protect these and other plant species, parts of the sandstone plateau region, notably the Kounounkan Forest and Plateau, are proposed to be given increased protected status (Couch & al. 2019). Kew Herbarium is currently working with the Guinean government to achieve this.

In this paper, we report an investigation of the monospecific genus *Cailliella* Jacq.-Fél. (Jacques-Félix 1939: 637), another Guinean endemic first collected in December 1937 by the French botanist, agronomist and explorer Henri Jacques-Félix (1907–2008), who went on to make a huge contribution to our knowledge of African *Melastomataceae*. The type gathering of *C. prae-rupticola* Jacq.-Fél. (*Jacques-Félix 2139*) was made on sandstone cliffs of the Benna Plateau (west of Gombokori village, in Forécariah and Kindia Préfectures). For almost 80 years, *C. prae-rupticola* was known only from the type material (including three sheets housed in the Paris herbarium plus one duplicate in Kew) until September 2016 when collecting efforts led by two of the present authors (X.M.v.d.B. & P.M.H.) rediscovered it in a second locality on the southern part of the Kounounkan Plateau (Rokni & Lopez Poveda 2018). In 2017 to 2019, plants from several additional localities were found; the species is now known from seven table mountains.

Morphologically, *Cailliella* is distinguished from other genera of *Melastomataceae* by its solitary flowers and isomorphic stamens, with anthers attenuate toward the apex, recurved, connective with two linear ventral appendages, one acute dorsal appendage and not produced at base into a pedoconnective (Jacques-Félix 1939, 1995; Fig. 1). In the protologue, Jacques-Félix (1939) proposed that *Cailliella* should be placed in the *Osbeckieae* (= *Melastomataceae*) even though its seeds were said to be cuneate, not cochleate as in the other members of this tribe (Whiffin & Tomb 1972; Renner 1993; Clausen & Renner 2001; Michelangeli & al. 2013). Among the genera of *Melastomataceae*, a close relationship with *Melastomastrum* Naudin has also been suggested (Jacques-Félix 1995; Veranso-Libalah & al. 2017).

Although several African *Melastomataceae* taxa have been recently sampled in a phylogenetic context (see Veranso-Libalah & al. 2017), the monospecific

Cailliella had remained unsampled until now. With recent collections of *C. prae-rupticola* now available, we aimed to test for the first time the phylogenetic placement of *Cailliella* using molecular data. We further provide an emended description, photographs of living material, locality and habitat data, and a discussion of conservation status. Because the name *C. prae-rupticola* was originally published without a holotype, we also designate a lectotype selected from the duplicates kept in the Paris museum.

Material and methods

Taxonomic sampling and DNA sequencing — Sequence data from five regions (nrETS, nrITS, *ndhF*, *psbK-psbL* and *accD-psaI*) were used in this study (see Table 1 for accessions data). DNA extraction, PCR amplification and sequencing of a herbarium specimen of *Cailliella prae-rupticola* (*Haba & Burgt 428*, sampled from a duplicate in BR) was accomplished following the protocols described in Veranso-Libalah & al. (2017, 2018). Also included in our analysis were 40 other species representing 12 genera from across the African *Melastomataceae*, with corresponding sequences downloaded from GenBank.

Phylogenetic inference — We conducted phylogenetic analyses using maximum likelihood (ML) and Bayesian inference (BI) methods. We first separately analysed each of the five datasets (nrETS, nrITS, *ndhF*, *psbK-psbL* and *accD-psaI*), then combined the two nuclear (nrETS and nrITS) and three plastid (*ndhF*, *psbK-psbL* and *accD-psaI*) datasets and analysed them with the same settings. With no supported conflict identified between the plastid and nuclear gene trees based on ML methods (see supplementary Fig. S1, S2), all further analyses were based on the combined data including all five regions.

Maximum likelihood analyses were implemented in RAxML (Stamatakis 2014) under the GTRGAMMA model of sequence evolution through the CIPRES Science Gateway (<http://www.phylo.org/>; Miller & al. 2010).

The Bayesian inference was performed using MrBayes v3.2 (Ronquist & al. 2012). The best-fitting model for nucleotide substitutions was determined using Partitionfinder v.2 (Lanfear & al. 2017). The selected substitution models for the plastid and nuclear datasets were GTR + Γ + I and GTR + Γ , respectively. The BI analyses were run for 20 million generations with four chains in two parallel runs sampling every 2000 generations. All analyses were performed via the CIPRES Science Gateway (<http://www.phylo.org/>; Miller & al. 2010). Proper mixing was determined using Tracer v.1.5 (Rambaut & Drummond 2009), and all parameters had an effective sample size (ESS) value greater than 200. The first 2000 trees (10%) were discarded as burn-in, and a maximum clade credibility (MCC) tree was con-

Table 1. GenBank accession numbers for all species included in this study.

Species	nrITS	accD-psal	psbK-psbL	nrETS	ndhF
<i>Anaheterotis pobeguinii</i> (Hutch. & Dalziel) Ver.-Lib. & G. Kadereit	KX889284	KY284710	KY284809	MF398010	MF398108
<i>Antherotoma naudinii</i> Hook. f.	KX889216	KY284655	KY284735	MF397943	MF398037
<i>Antherotoma phaeotricha</i> (Hochst.) Jacq.-Fél. var. <i>phaeotricha</i>	KX889218	KY284657	KY284737	MF397945	MF398039
<i>Argyrella amplexicaulis</i> (Jacq.-Fél.) Ver.-Lib. & G. Kadereit	KX889273	KY284702	KY284798	MF398000	MF398097
<i>Argyrella canescens</i> (E. Mey. ex Graham) Harv.	KX889280	KY284707	KY284805	MF398006	MF398104
<i>Cailliella praeurpticola</i> Jacq.-Fél.	MT583479	–	MT572371	MT572372	MT572370
<i>Derosiphia tubulosa</i> (Sm.) Raf	KX889271	KY284699	KY284795	MF397997	MF398094
<i>Dichaetanthera arborea</i> Baker	KX889223	–	KY284742	MF397948	MF398043
<i>Dichaetanthera articulata</i> Endl.	KX889224	–	KY284743	MF397949	MF398044
<i>Dissotidendron caloneurum</i> (Gilg ex De Wild.) Ver.-Lib. & G. Kadereit	KX889230	KY284662	KY284749	MF397954	MF398050
<i>Dissotidendron melleri</i> (Hook. f.) Ver.-Lib. & G. Kadereit	KX889248	–	KY284769	MF397971	MF398069
<i>Dissotis grandiflora</i> Benth.	KX889243	KY284670	KY284763	MF397964	MF398062
<i>Dissotis longisetosa</i> Gilg & Ledermann ex Engl.	KX889247	KY284675	KY284768	MF397970	MF398068
<i>Dupineta hensii</i> (Cogn.) Ver.-Lib. & G. Kadereit	KX889244	KY284671	KY284764	MF397965	MF398063
<i>Dupineta multiflora</i> (Sm.) Raf.	KX889251	KY284678	KY284772	MF397974	MF398072
<i>Eleotis welwitschii</i> (Cogn.) Ver.-Lib. & R. D. Stone	–	KY284700	KY284796	MF397998	MF398095
<i>Feliciotis cryptantha</i> (Baker) Ver.-Lib. & G. Kadereit	KX889237	KY284668	KY284757	MF397960	MF398057
<i>Feliciotis perkinsiae</i> (Gilg) Ver.-Lib. & G. Kadereit	KX889261	KY284688	KY284783	MF397985	MF398082
<i>Guyonia antennina</i> (Benth.) Ver.-Lib. & R. D. Stone	KX889276	KY284705	KY284801	MF398003	MF398100
<i>Guyonia ciliata</i> Hook. f.	KX889272	KY284701	KY284797	MF397999	MF398096
<i>Heterotis decumbens</i> (P. Beauv.) Jacq.-Fél.	KX889282	KY284709	KY284807	MF398008	MF398106
<i>Heterotis prostrata</i> (Thonn.) Benth.	KX889287	KY284713	KY284812	MF398013	MF398111
<i>Melastomastrum afzelii</i> (Hook. f.) A. Fern. & R. Fern.	KX889290	KY284715	KY284815	MF398015	MF398113
<i>Melastomastrum capitatum</i> (Vahl) A. Fern. & R. Fern.	KX889291	KY284716	KY284816	MF398016	MF398114
<i>Melastomastrum porteresii</i> (Jacq.-Fél.) Ver.-Lib. & G. Kadereit	KX889299	KY284721	KY284825	MF398022	MF398122
<i>Melastomastrum segregatum</i> (Benth.) A. Fern. & R. Fern.	KX889294	KY284717	KY284819	MF398018	MF398116
<i>Melastomastrum theifolium</i> (G. Don) A. Fern. & R. Fern.	KX889296	KY284720	KY284822	MF398021	MF398119
<i>Nerophila congolensis</i> (Cogn.) Ver.-Lib. & R. D. Stone	KX889235	KY284666	KY284755	MF397958	MF398055
<i>Nerophila senegambiensis</i> (Guill. & Perr.) Ver.-Lib. & R. D. Stone	KX889219	KY284658	KY284738	MF397946	MF398040
<i>Nothodissotis alenensis</i> Ver.-Lib. & O. Lachenaud	MK617541	–	MK617552	MK617545	MK677462
<i>Nothodissotis barberi</i> (Hook. f.) Ver.-Lib. & G. Kadereit	MK617542	–	MG518552	MG518528	MG702564
<i>Pseudosbeckia swynnertonii</i> (Baker f.) A. Fern. & A. Fern.	KX889302	KY284722	KY284828	MF398024	MF398125
<i>Pyrotis gilgiana</i> (De Wild.) Ver.-Lib. & R. D. Stone	KX889233	–	KY284752	MF397956	MF398052
<i>Rosettea elliotii</i> (Gilg) Ver.-Lib. & G. Kadereit	KX889265	KY284692	KY284787	MF397990	MF398087
<i>Rosettea riparia</i> (Gilg & Ledermann ex Engl.) Ver.-Lib. & G. Kadereit	KX889257	KY284683	KY284778	MF397980	MF398078
<i>Tristemma akeassii</i> Jacq.-Fél.	KX889303	–	KY284829	MF398025	MF398126
<i>Tristemma albiflorum</i> (G. Don) Benth.	KX889304	KY284723	–	MF398026	MF398127
<i>Tristemma demousei</i> De Wild.	KX889306	KY284724	KY284831	MF398027	MF398129
<i>Tristemma involucreatum</i> Benth.	KX889307	KY284725	KY284832	MF398028	MF398130
<i>Tristemma oreophilum</i> Gilg	KX889308	KY284726	KY284833	MF398029	MF398131
<i>Tristemma vestitum</i> Jacq.-Fél.	KX889309	–	KY284834	–	MF398132

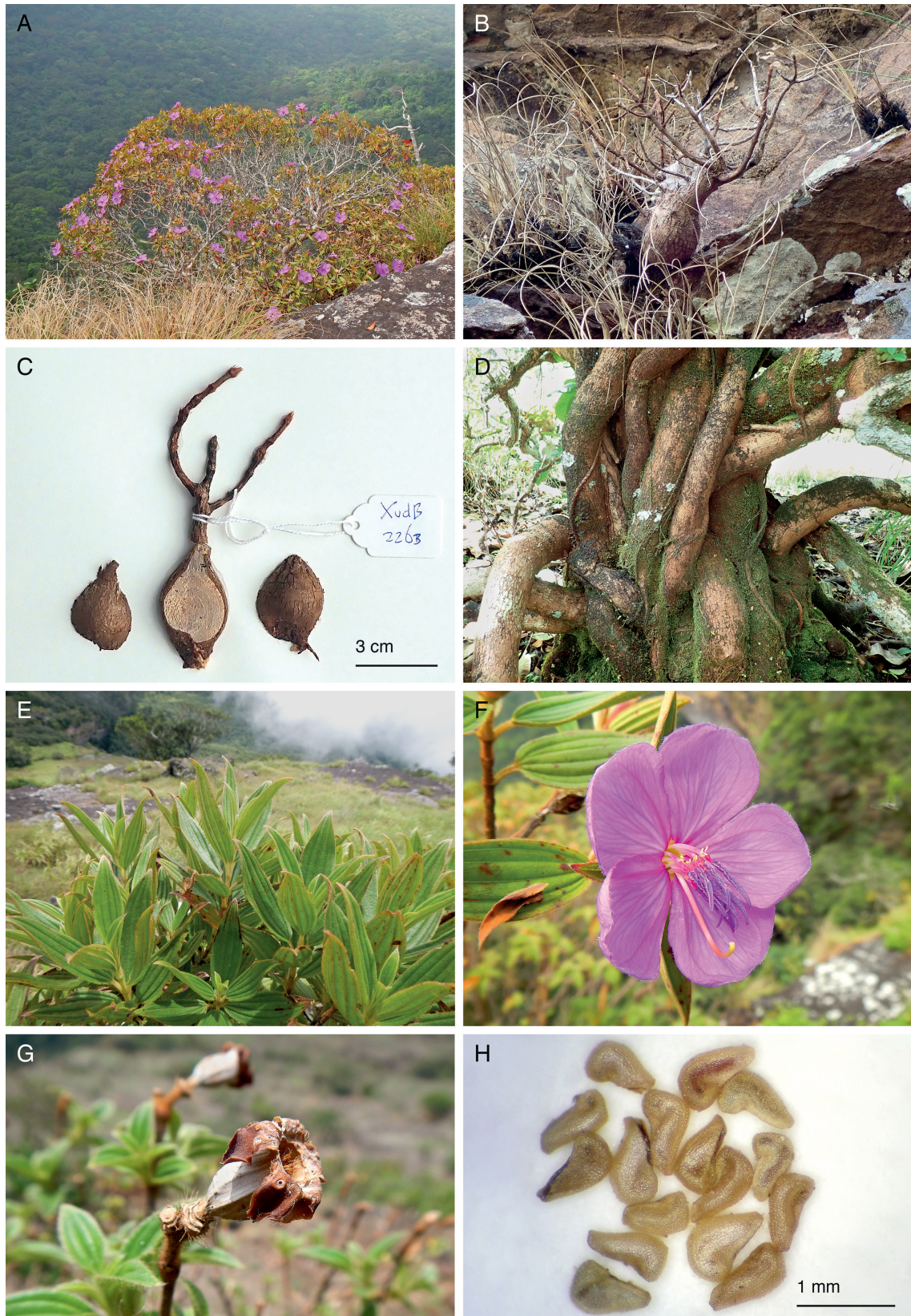


Fig. 1. *Cailliella praerupticola*. – A: flowering plant on top of a vertical cliff, 27 Nov 2017; B: juvenile, c. 23 cm tall plant with pachycaulous base, 5 Feb 2019; C: juvenile, c. 10 cm tall plant with pachycaulous base, 5 Feb 2019; D: stem base of mature plant, with several stems and adventitious roots, 18 Oct 2018; E: mature, sterile plant with leaves, during the wet season, 25 Sep 2016; F: flower, 27 Nov 2017; G: fruit, still with seeds inside, 16 Apr 2017; H: seeds. – Origin: A, F from *Burgt* 2159; B, C from *Burgt* 2263; D from *Burgt* 2204; E from *Haba & Burgt* 428; F from *Burgt* 2159; G, H from *Burgt* 2106. – All photographs by Xander van der Burgt.

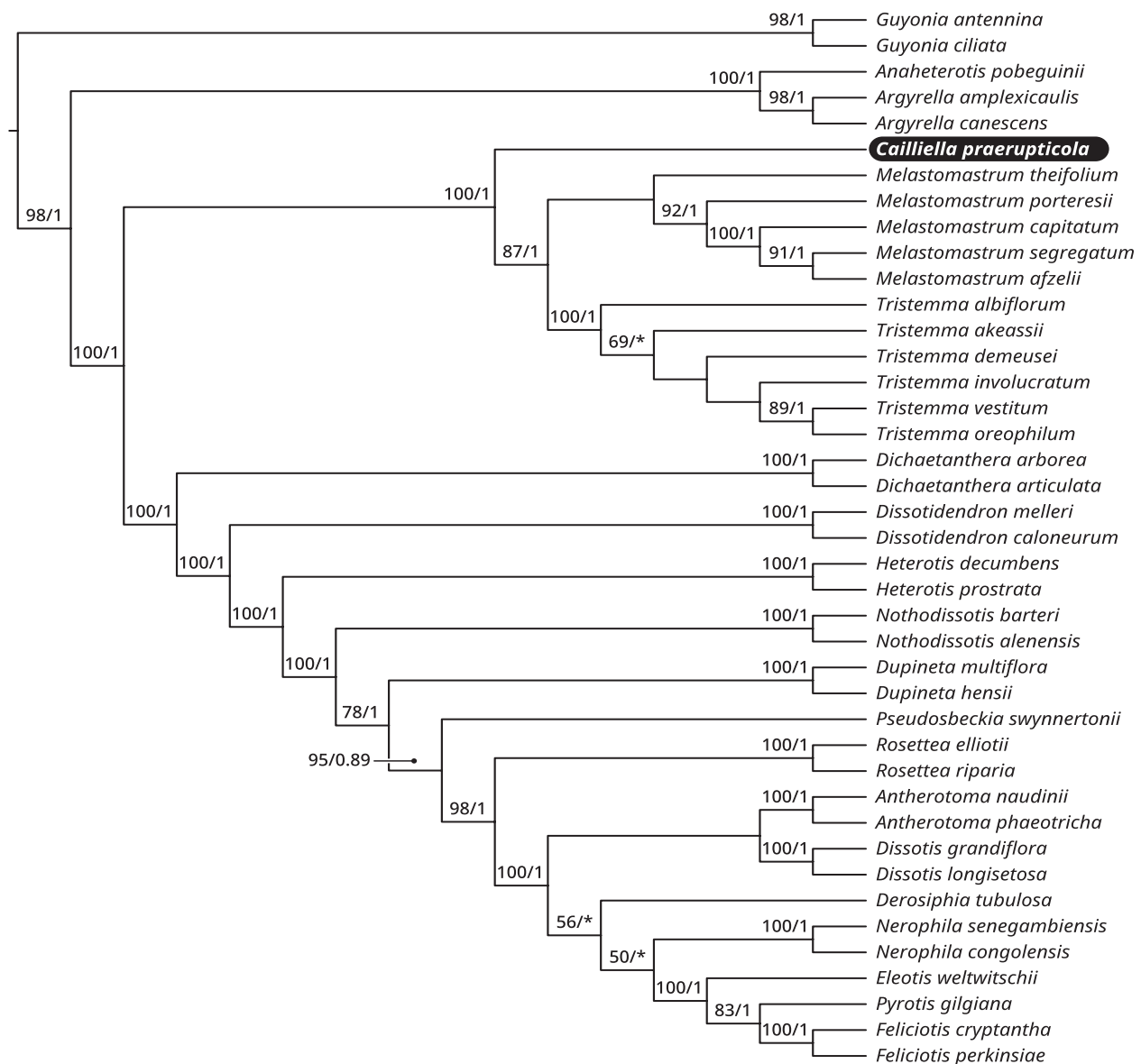


Fig. 2. Maximum likelihood tree of African *Melastomateae* showing the phylogenetic placement of *Cailliella praerupticola* based on nuclear (nrETS and nrITS) and plastid (*ndhF*, *psbK-psbL* and *accD-psaI*) matrices. Values on branches refer to bootstrap values resulting from the ML analysis (only values ≥ 50) and posterior probabilities resulting from Bayesian inference (only values ≥ 0.95).

structured using TreeAnnotator v.1.8.0 (Drummond & al. 2012). We considered the clades as resolved when the bootstrap value in the ML (BSL) analysis was $\geq 70\%$ and the posterior probability (PP) was ≥ 0.95 in the BI analysis.

Morphological studies — Morphological data were obtained from the literature and supplemented by our own observations. Field observations were conducted in Guinea by X.M.v.d.B. & P.M.H., while the study of herbarium material was made through visits to BR (M.C.V.-L.) and K (X.M.v.d.B.). Additionally, type specimens were studied through the online repository in P (<https://science.mnhn.fr/all/search>). Maps were produced using QGIS 2.18 (QGIS Development Team 2016) and Google Earth (2020).

Results

Phylogenetic analysis — The final sequence alignment for the plastid data included 41 sequences 2126 nucleotides in length (*ndhF* 667, *psbK-psbL* 485 and *accD-psaI* 974), while the nuclear data alignment included 41 sequences 1566 nucleotides in length (ETS 649 and ITS 917). All sequence alignments are provided in the Supplemental content online. Summary statistics of genomic regions sequenced for the phylogenetic placement of *Cailliella* are provided in Table 2. A tree showing the position of *C. praerupticola* is presented in Fig. 2. All currently recognized clades of African *Melastomateae* are resolved with *C. praerupticola* recovered as sister to a clade comprising *Melastomastrum* and *Tristemma* Juss.

Table 2. Summary statistics of genomic regions sequenced for the phylogenetic placement of *Cailliella*.

Region	nrETS	nrITS	<i>ndhF</i>	<i>psbK-psbL</i>	<i>accD-psaI</i>	combined
Accessions sampled	40	41	41	39	31	41
Aligned base pairs	649	917	667	485	974	3692
% Missing data	2	0	0	0	24	6
Conserved sites	310	652	506	356	812	2636
Variable sites	331	248	144	94	134	951
% Variable sites	51	27	22	19	14	26
Parsimony-informative sites	273	152	97	59	67	648
% PIS	42	17	15	12	7	18
Best-fit substitution model	GTR+G	GTR+G	GTR+G+I	GTR+G+I	GTR+G+I	GTR+G+I

Discussion

The placement of *Cailliella praeurupticola* in the tribe *Melastomateae*, as previously proposed by Jacques-Félix (1995) based on morphology, is here corroborated with phylogenetic analyses of DNA sequences from both nuclear and plastid genomes. *Cailliella praeurupticola* is well-supported (Fig. 2; BSL 100/ PP 1) as sister to a clade consisting of *Melastomastrum* and *Tristemma*. Even though Veranso-Libalah & al. (2017) suggested *Melastomastrum* as probably sister to *Cailliella*, our current results are unable to confirm this because there is no resolution between *Melastomastrum* and *Tristemma*. In previous analyses, these two clades were each well supported as sister genera (Veranso-Libalah & al. 2017). All three genera (*Cailliella*, *Melastomastrum* and *Tristemma*) have persistent and leafy bracts enveloping the flowers. Nevertheless, the mono-specific *Cailliella* seems more similar morphologically to *Melastomastrum* (see below for a discussion of diagnostic features). Based on the estimated age of *Melastomastrum* and *Tristemma* (Veranso-Libalah & al. 2018), *Cailliella* is therefore considered one of the oldest “palaeoendemic” lineages or an evolutionary relict of *Melastomateae* as earlier suggested by Jacques-Félix (1995).

Taxonomy

Cailliella Jacq.-Fél. in Bull. Mus. Natl. Hist. Nat., ser. 2, 10: 637. 1939. – Type (and only species): *Cailliella praeurupticola* Jacq.-Fél.

Diagnostic features — Flowers terminal, solitary, closely subtended by an involucre of leafy bracts. Stamens isomorphic, connective not produced at base into a pedoconnective, dorsal appendage short, 2 ventral appendages linear. Seeds cochleate.

Differs from *Melastomastrum* by having isomorphic stamens (versus iso- or dimorphic); connective with two ventral appendages and one dorsal appendage (versus two ventral appendages and no dorsal appendage), pedoconnective not developed (versus usually well-developed and distinctly prolonged). Jacques-Félix (1939) had pre-

viously described the seeds of *Cailliella* as cuneate. However, our observations indicate that the seeds of this genus are indeed cochleate (Fig. 1H, similar in this respect to other members of the tribe *Melastomateae*, including *Melastomastrum*).

Cailliella praeurupticola Jacq.-Fél. in Bull. Mus. Natl. Hist. Nat., ser. 2, 10: 637. 1939. – **Lectotype (designated here)**: Guinea, environs de Kindia, falaises du Benna [c. 9.73°N, 12.83°W], sur corniche de falaise à 900–1000 m d’altitude, Dec 1937, *H. Jacques-Félix 2139* (P00412601!; isolectotypes: K000312779!, P00412600!, P00412602!).

Description — Much-branched deciduous shrub, 0.3–2.5 m tall, half-spherical in shape; juvenile plants with a pachycaulous base, mature plants branched near base, old plants with adventitious roots (Fig. 1B–D). *Branches* to 3.5 m long; young branches subterete, dilated at nodes, densely strigose; older branches terete, glabrous (Fig. 1A). *Leaves* opposite, densely strigose; petiole 7–8 mm long; blade oblong-lanceolate, 50–60 mm long × 13–16 mm wide, abruptly cuneate or rounded at base, progressively narrowed then acute at apex; 5-nerved from base with nerves impressed adaxially, prominent abaxially, sometimes also with a pair of faint marginal nerves; transverse veins invisible (Fig. 1E). *Bracts* 3 pairs, closely subtending hypanthium, 15–18 mm long × 7–10 mm wide, with reticulate, non-protruding veins, apex acute or subobtusate; outer bracts strigose, inner bracts pubescent only on adaxial surface (Fig. 1F, 3A2). *Flowers* 5-merous. *Hypanthium* oblong, 12–15 mm long × 6–8 mm wide, glabrous; sepals persistent, oblong, 8–11 mm long × 6–8 mm wide, obtuse at apex, margin ciliate (Fig. 1G, 3B). *Petals* pink-mauve, c. 20 mm long × c. 16 mm wide. *Stamens* 10, equal; filament c. 8 mm long; anther 11 mm long, falcate (Fig. 1F); connective not extended at base into a pedoconnective but provided with a short dorsal appendage and two linear ventral appendages c. 3 mm long. *Ovary* remaining included in hypanthium and adherent to its base by lines, free toward apex, strigose on lines of dehiscence, epigynous crown with 5 ciliate lobes; placentas elongated, stipitate; style c. 13 mm long. *Seeds* c. 0.8 mm long, cochleate, surface finely echinulate (Fig. 1H).

Distribution — *Cailliella praeurupticola* is endemic to Guinea in the Coyah, Dubreka, Forécariah and Kindia Préfectures (Fig. 4).

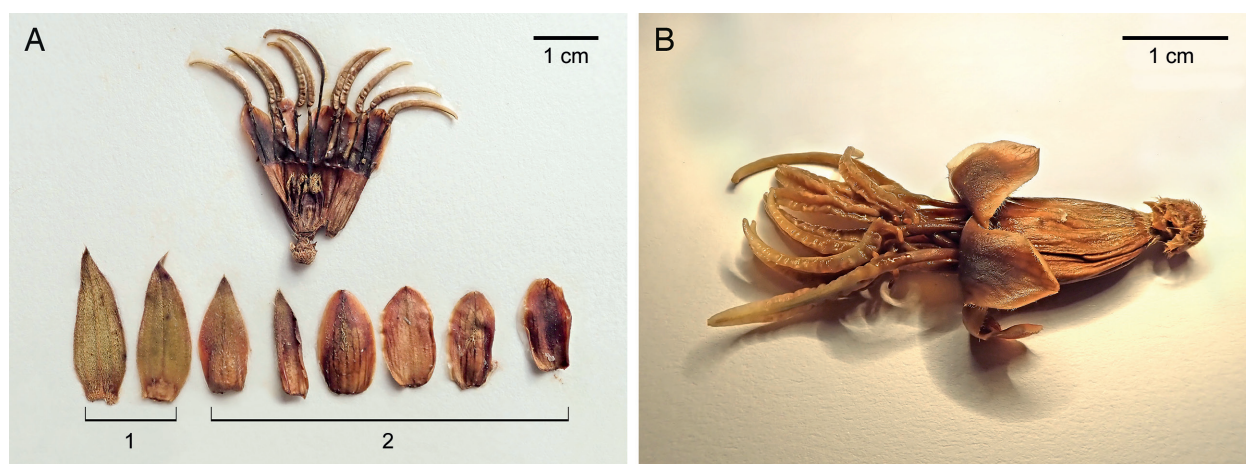


Fig. 3. *Cailliella praerupticola*. – A: dissected flower; 1: pair of leaves subtending flower; 2: three pairs of bracts subtending hypanthium; B: flower with petals removed. – Origin: A, B from *Burgt 2159*.

Habitat and ecology — *Cailliella praerupticola* occurs on hills in a sandstone plateau. The species is found in fire-free open shrubland vegetation and on vertical cliffs, at 430–1170 m elevation. The species is not at all resistant to the annual anthropogenic dry-season grassland fires that affect the vegetation of large areas in rural Guinea. On the southern Kounounkan Plateau and the Banga Guemey table mountain, *C. praerupticola* was found to be abundant and locally dominant in five patches of open shrubland vegetation, each 1–4 hectares, at 650–950 m elevation (Burgt & al. 2019). This shrubland is remarkably poor in grasses. Three soil samples taken under this vegetation contained no charcoal at all, although many wood pieces were present. These patches of shrubland may have been protected from fire because they are remote and surrounded by vertical rock cliffs and sub-montane forest (Burgt & al. 2019). These five patches, with

a few other patches not visited but seen on Google Earth (2020), form the only open vegetation in the sandstone plateau region that is not yet affected by fire. Elsewhere in the sandstone plateau region, annual dry-season fires occur, and *C. praerupticola* shrubs are only found growing on vertical cliffs out of reach of fires. Rows of shrubs can often be seen at the top of these cliffs, where enough water is available for them to grow and where they are just out of reach of the dry-season grassland fires.

Juvenile plants of *Cailliella praerupticola* have a pachycaulous base. The woody, succulent stem base of a young sapling c. 10 cm tall was elliptic in shape and c. 2.5 cm in diam. (Fig. 1G). A larger sapling c. 23 cm tall had a pachycaulous base c. 5 cm in diam. (Fig. 1E). This is thought to be an adaptation to the long dry season and the low water-retention capacity of the sandstone cliffs. The pachycaulous lower stem of juvenile *C. praerupti-*

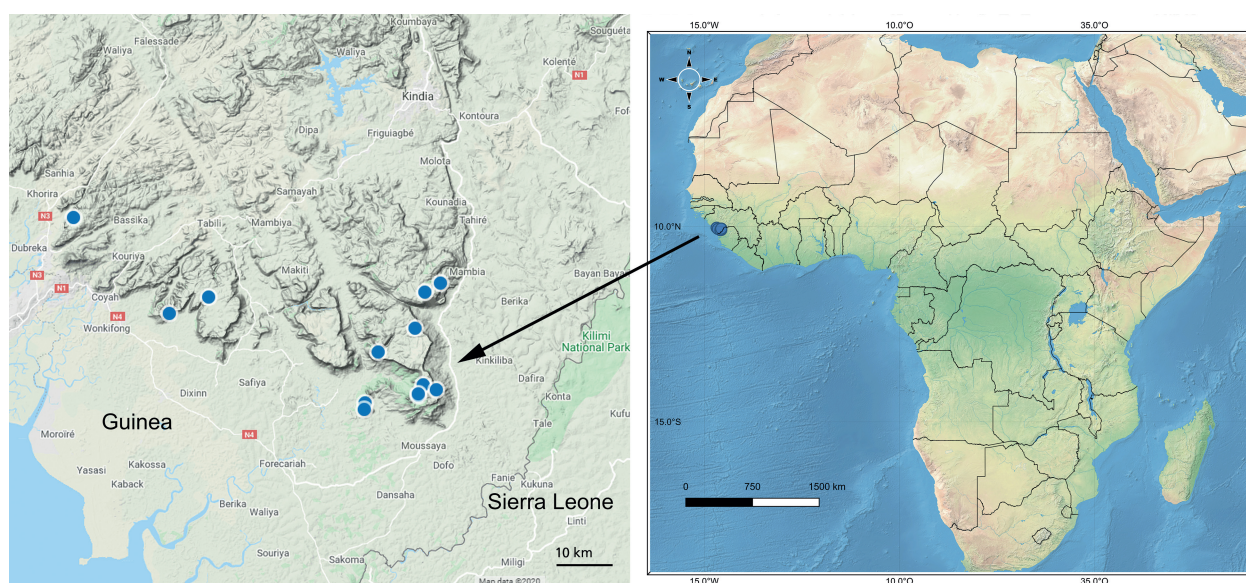


Fig. 4. Distribution of *Cailliella praerupticola*, blue dots. – Left map from Google Earth (2020); right map from QGIS 2.18 (QGIS Development Team 2016).

cola plants is remarkable because this seems to be the first report of this feature among African members of the *Melastomataceae*. In South America, where this family has its highest diversity, pachycauly is also seen in young seedlings of certain species of *Pleroma* D. Don, notably *P. heteromallum* (D. Don) D. Don, inhabiting the seasonally dry Cerrado (tropical savanna) region of Brazil (Dr. Frank Almeda, pers. comm., 17 Apr 2020). Another adaptation to the long dry-season is that the foliage of both juvenile and mature plants is strongly deciduous; during several dry-season months, the plants have no leaves, and only the fruits remain on mature plants.

Conservation status — *Cailliella praerupticola* was assessed in the IUCN category Endangered, EN D (Rokni & Lopez Poveda 2018). This assessment was based on fewer than 250 mature individuals having been seen. Since this assessment was made, many more mature individuals have been found in several new sites. *Cailliella praerupticola* is currently known from 13 collections, one made in 1937 and the others from 2016 to 2019. It is estimated that 1600 mature individuals were seen by two of the present authors (X.M.v.d.B. & P.M.H.) at the type locality, the other collection sites and a few other nearby sites where no collections were made. Google Earth (2020) imagery was used to find most of these other sites, and shows there are some more patches of fire-free shrubland and much more vertical cliff habitat in the sandstone plateau region, which have not yet been assessed for the presence of this species. We therefore believe that the actual number of remaining individuals is higher than the number currently observed.

The Extent of Occurrence of *Cailliella praerupticola* is 1160 km²; the Area of Occupancy is 56 km² (Bachman & al. 2011; GeoCAT 2020). The species occurs in seven locations. Within and near the Extent of Occurrence, on the table mountains of the sandstone plateau, only a few patches of open shrubland vegetation exist. Most of the vegetation is grassland, which is annually burned. The burned grassland is visible on Google Earth (2020) historical imagery by the grey colour of the vegetation. Before the arrival of farmers and cattle rangers in the area, practising annual burning to support their farming, *C. praerupticola* was without doubt much more common in these grassland areas. The population reduction may well be 95–99% since the start of the fires, but these fires probably started to occur longer ago than three generation lengths of *C. praerupticola*. The population reduction over three generations is estimated at 75% over 90 years. There may have been much decline in Area of Occupancy and in extent and quality of habitat, and this is still continuing. The last remaining large populations of *C. praerupticola* on the table mountains of the southern Kounounkan Plateau and Banga Guemey are very much at risk of being destroyed by fire. A single fire lit by a hunter could destroy hundreds of shrubs. The population reduction over the next 90 years may well be over 50%.

Cailliella praerupticola is here assessed in the IUCN (2012) Red List category Endangered EN A2c+3c.

Seeds of *Cailliella praerupticola* have been collected from a population of c. 50 individuals on the southern Kounounkan Plateau (*Burgt 2106*). These seeds are stored in Kew's Millennium Seed Bank and in the seed bank of the HNG Herbarium in Conakry. The estimated seed quantity at Kew's MSB, adjusted using the results of an X-ray test on a sample of 50 seeds, is 950 000 seeds.

Remarks on typification — Of the original material (*Jacques-Félix 2139*), there are three sheets in P, i.e. three specimens, each of which has been labelled as a "TYPE". However, the *Code* of nomenclature says that the type of a species name is a single specimen (Turland & al. 2018: Art. 8.1), and the protologue (*Jacques-Félix 1939*) did not specify which sheet should be considered as the type (in fact he did not even state that this material was kept in Paris, although one has to assume that this was the case). Even in his Fig. 4, which is a photograph of one of the Paris sheets (P00412601), he did not state that this sheet was the type, nor is the "TYPE" label visible in the photograph (presumably having been attached later). The *Code* does allow a type specimen to consist of more than one herbarium sheet, as long the sheets "are clearly labelled as being part of the same specimen, or bear a single, original label in common" (Art. 8.3). However, this is not true of the original material of *Cailliella*. In conclusion, because the name *C. praerupticola* was published without a holotype, our designation of a lectotype is warranted (Art. 9.3, 9.11).

Additional specimens seen — GUINEA: FORECARIAH PRÉFECTURE: Mont Dalonia Ghia, southern Kounounkan Plateau, 9.54964°N, 12.86105°W, elev. 950 m, 25 Sep 2016, *Haba & Burgt 428* (BR, HNG, K, MO, P, WAG); southern Kounounkan Plateau, 9.56442°N, 12.85392°W, elev. 970 m, 16 Apr 2017, *Burgt 2106* (BR, G, HNG, K, MO, P, WAG); 4 km east of village Taban, North Kounounkan Plateau, 9.619°N, 12.9286°W, elev. 810 m, 22 Apr 2017, *Burgt 2125* (B, C, HNG, K, LISC, NY, PRE, WAG); southern Kounounkan Plateau, 9.54619°N, 12.86103°W, elev. 840 m, 27 Nov 2017, *Burgt 2159* (B, BR, G, HNG, K, LISC, MO, P, PRE, SERG, SING, WAG); Kounounkan Massif. Banga Guemey table mountain, 9.53486°N, 12.95094°W, elev. 680 m, 18 Oct 2018, *Burgt 2204* (BR, G, HNG, K, MO, P, PRE, SERG, WAG); Kounounkan Massif, Banga Guemey table mountain, 9.52319°N, 12.95164°W, elev. 620 m, 21 Oct 2018, *Haba 1208* (HNG, K, WAG); southern Kounounkan Plateau, 9.55647°N, 12.83081°W, elev. 1030 m, 5 Feb 2019, *Burgt 2263* (NHG, K, WAG); slopes of Benna Plateau above Gombokori Village, 9.73211°N, 12.82386°W, elev. 920 m, 11 Feb 2019, *Burgt 2271* (BR, HNG, K, MO, P, PRE, WAG); North Kounounkan Plateau, 9.65806°N, 12.86642°W, elev. 960 m, 29 Oct 2019, *Burgt 2329* (HNG, K, WAG). — BORDER BETWEEN

KINDIA AND COYAH PRÉFECTURES: Plateau de Tassing above Fossikouré Village, top of the 270 m high Chute de Kili, 9.70853°N, 13.21375°W, elev. 430 m, 7 Dec 2017, *Burgt 2183* (BR, HNG, K, MO, P, SERG, WAG). — DUBREKA PRÉFECTURE: Dobi-ro, 9.83972°N, 13.43933°W, elev. 470 m, fallen leaves at base of vertical sandstone cliff, 10 Dec 2017, *Burgt 2192* (HNG, K). — COYAH PRÉFECTURE: Tambilo Plateau above Kountaya village, 9.68217°N, 13.27847°W, elev. 600 m, 17 Feb 2019, *Burgt 2281* (HNG, K, WAG).

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References

- Bachman S., Moat J., Hill A. W., de la Torre J. & Scott B. 2011: Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. – *ZooKeys* **150**: 117–126.
- Burgt X. M. van der, Konomou G., Haba P. M. & Magassouba S. 2019: *Gladiolus mariae* (Iridaceae), a new species from fire-free shrubland in the Kounounkan Massif, Guinea. – *Willdenowia* **49**: 117–126.
- Burgt X. M. van der, Molmou D., Diallo A., Konomou G., Haba P. M. & Magassouba S. 2018: *Talbotiella cheekii* (Leguminosae: Detarioideae), a new tree species from Guinea. – *Kew Bull.* **73**: 26.
- Cheek M., Haba P. M., Konomou G. & Burgt X. M. van der 2019a: *Ternstroemia guineensis* (Ternstroemiaceae), a new endangered cloudforest shrub with neotropical affinities from Kounounkan, Guinea, West Africa. – *Willdenowia* **49**: 351–360.
- Cheek M., Magassouba S., Howes M. R., Doré T., Doumbouya S., Molmou D., Grall A., Couch C. & Larridon I. 2018a: *Kindia* (Pavetteae, Rubiaceae), a new cliff-dwelling genus with chemically profiled colleter exudate from Mt Gangan, Republic of Guinea. – *PeerJ* **6**: e4666.
- Cheek M., Magassouba S., Molmou D., Doré T. S., Couch C., Yasuda S., Gore C., Guest A., Grall A., Larridon I., Bousquet I. H., Ganatra B. & Gosline G. 2018b: A key to the species of *Keetia* (Rubiaceae–Vanguerieae) in West Africa, with three new, threatened species from Guinea and Ivory Coast. – *Kew Bull.* **73**: 56.
- Cheek M., Molmou D., Jennings L., Magassouba S. & Burgt X. M. van der 2019b: *Inversodicraea koutoutamba* and *I. tassing* (Podostemaceae), new waterfall species from Guinea, West Africa. – *Blumea* **64**: 216–224.
- Clausing G. & Renner S. S. 2001: Molecular phylogenetics of *Melastomataceae* and *Memecylaceae*: implications for character evolution. – *Amer. J. Bot.* **88**: 486–498.
- Couch C., Cheek M., Haba P., Molmou D., Williams J., Magassouba S., Doumbouya S. & Diallo M. Y. 2019: Threatened habitats & Tropical Important Plant Areas (TIPAs) of Guinea, West Africa. – Kew: Royal Botanic Gardens, Kew.
- Darbyshire I., Anderson S., Asatryan A., Byfield A., Cheek M., Clubbe C., Ghrabi Z., Harris T., Heatubun C. D., Kalema J., Magassouba S., McCarthy B., Milliken W., de Montmollin B., Nic Lughadha E., Onana J.-M., Saïdou D., Sârbu A., Shrestha K. & Radford E. A. 2017: Important Plant Areas: revised selection criteria for a global approach to plant conservation. – *Biodivers. & Conservation* **26**: 1767–1800.
- Drummond A. J., Suchard M. A., Xie D. & Rambaut A. 2012: Bayesian phylogenetics with BEAUti and the BEAST 1.7. – *Molec. Biol. Evol.* **29**: 1969–1973.
- GeoCAT 2020: Geospatial Conservation Assessment Tool. – Published at <http://geocat.kew.org/> [accessed 15 Apr 2020].
- Google Earth 2020: Google Earth. – Published at <http://www.google.com/earth/index.html> [accessed 15 Apr 2020].
- IUCN 2012: IUCN Red List categories and criteria, version 3.1, ed. 2. – Gland & Cambridge: IUCN.
- Jacques-Félix H. 1939: Sur quelques Mélastomacées africaines. – *Bull. Mus. Natl. Hist. Nat., ser. 2*, **10**: 630–642.
- Jacques-Félix H. 1995: Histoire des *Melastomataceae* d’Afrique. – *Bull. Mus. Natl. Hist. Nat., B*, Adansonia **16**: 235–311.
- Lanfear R., Frandsen P. B., Wright A. M., Senfeld T. & Calcott B. 2017: PartitionFinder 2: new methods for selecting partitioned models of evolution for molecular and morphological phylogenetic analyses. – *Molec. Biol. Evol.* **34**: 772–773.

- Michelangeli F. A., Guimarães P. J. F., Penneys D. S., Almeda F. & Kriebel R. 2013: Phylogenetic relationships and distribution of New World *Melastomeae* (*Melastomataceae*). – *Bot. J. Linn. Soc.* **171**: 38–60.
- Miller M. A., Pfeiffer W. & Schwartz T. 2010: Creating the CIPRES Science Gateway for inference of large phylogenetic trees. – Pp. 1–8 in: 2010 Gateway Computing Environments Workshop (GCE 2010). – New Orleans: IEEE.
- QGIS Development Team 2016: QGIS geographic information system. Open-source geospatial foundation project. – Published at <https://qgis.org/>
- Rambaut A. & Drummond A. J. 2009: Tracer version 1.5. – Published at <http://beast.bio.ed.ac.uk/> [accessed 15 Mar 2016].
- Renner S. S. 1993: Phylogeny and classification of the *Melastomataceae* and *Memecylaceae*. – *Nordic J. Bot.* **13**: 519–540.
- Rokni S. & Lopez Poveda L. 2018: *Cailliella praeurpticola*. – The IUCN Red List of threatened species **2018**: e.T85743729A85743732.
- Ronquist F., Teslenko M., van der Mark P., Ayres D. L., Darling A., Höhna S., Larget B., Liu L., Suchard M. A. & Huelsenbeck J. P. 2012: MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. – *Syst. Biol.* **61**: 539–542.
- Stamatakis, A. (2014). RAxML version 8: A tool for phylogenetic analysis and post-analysis of large phylogenies. – *Bioinformatics* **30**: 1312–1313.
- Turland N. J., Wiersema J. H., Barrie F. R., Greuter W., Hawksworth D. L., Herendeen P. S., Knapp S., Kuster W.-H., Li D.-Z., Marhold K., May T. W., McNeill J., Monro A. M., Prado J., Price M. J. & Smith G. F. (ed.) 2018: International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. – Glashütten: Koeltz Botanical Books. – *Regnum Veg.* **159**.
- Veranso-Libalah M. C., Kadereit G., Stone R. D. & Couvreur T. L. P. 2018: Multiple shifts to open habitats in *Melastomeae* (*Melastomataceae*) congruent with the increase of African Neogene climatic aridity. – *J. Biogeogr.* **45**: 1420–1431.
- Veranso-Libalah M. C., Stone R. D., Fongod A. G. N., Couvreur T. L. P. & Kadereit G. 2017: Phylogeny and systematics of African *Melastomeae* (*Melastomataceae*). – *Taxon* **66**: 584–614.
- Whiffin T. & Tomb A. S. 1972: The systematic significance of seed morphology in the neotropical capsular-fruited *Melastomataceae*. – *Amer. J. Bot.* **59**: 411–422.
- Xanthos M., Konomou K., Haba P. M. & Burgt X. M. van der 2020: *Trichantheicum tenerium* (*Poaceae: Panicoideae*), a new species from Guinea-Conakry. – *Kew Bull.* **75**: 11.

Supplemental content online

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Fig. S1. Maximum likelihood tree of African *Melastomeae* showing the phylogenetic placement of *Cailliella praeurpticola* based on nuclear (nrETS and nrITS) matrix. Values on branches refer to bootstrap values resulting from the ML analysis.

Fig. S2. Maximum likelihood tree of African *Melastomeae* showing the phylogenetic placement of *Cailliella praeurpticola* based on plastid (*ndhF*, *psbK-psbL* and *accD-psaI*) matrix. Values on branches refer to bootstrap values resulting from the ML analysis.

Sequence alignments for the five regions (in nex format): nrETS, nrITS, *ndhF*, *psbK-psbL* and *accD-psaI*.

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