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Notes on the plant endemics of the quartzitic slopes of Mt Chimanimani (Mozambique & Zimbabwe), and a new, Critically Endangered species, *Empogona jenniferae* (*Rubiaceae-Coffeeae*)

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Key words

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Abstract *Empogona jenniferae* is described from the upper quartzitic slopes of Mt Chimanimani on both sides of the Zimbabwe-Mozambique border, a prospective Tropical Important Plant Area. Its conservation status is assessed as Critically Endangered under the 2012 IUCN criteria. A figure and notes on the endemic plant species of Chimanimani are provided. Two additional names in *Empogona, E. congesta* and *E. congesta* subsp. *chasei* are published.

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INTRODUCTION

Robbrecht monographed the *Tricalysia* A.Rich. ex DC. species of Africa in a series of publications. The first covered *Tricalysia* subg. *Empogona* (Robbrecht 1979). Subsequent to the Flora Zambesiaca account of *Tricalysia* by Bridson (2003), Tosh et al. (2009) performed a molecular phylogenetic analysis of *Tricalysia*. *Tricalysia* subg. *Empogona* was shown to arise in a separate clade from subg. *Tricalysia,* with the Asian *Diplospora* Dalzell in a sister relationship. Accordingly, *Empogona* Hook.f. was resurrected, and the necessary combinations were made to accommodate in that genus the species formerly placed in *Tricalysia* subg. *Empogona* (Tosh et al. 2009).

Empogona is separated morphologically from *Tricalysia* s.str. by the characters that distinguished subg. *Empogona* from subg. *Tricalysia:* Calyx with very short limb-tube and well developed lobes. Corolla throat mostly bearded. Anthers with a conspicuous apical appendage. Style mostly entirely glabrous. Drupes first white, then turning purple and at maturity almost black (Bridson 2003).

The genus is one of 12 genera currently recognised in the coffee tribe, *Coffeeae*. It is restricted to continental Africa, with about 30 species, mainly tropical (Cheek et al. 2018).

Among the specimens collected in a series of recent botanical surveys of Chimanimani, one, a *Rubiaceae* resembling a *Tricalysia, Wursten 1070*, was identified using the Flora Zambesiaca *Tricalysia* key, (Bridson 2003) as *Tricalysia congesta* (Oliv.) Hiern, then to subsp. *chasei* Bridson. *Tricalysia congesta* and the geographically and morphologically close *T. cacondensis* Hiern are both accepted in subg. *Empogona* sect. *Kraussiopsis* by Bridson (2003) so must now be considered as *Empogona*. Yet, *Wursten 1070* did not match most of the material of this species held at Kew. Checking the account of Bridson (2003) further, the notes to that subspecies state: "Two specimens from the Chimanimani area (The Corner, Martin Forest Reserve, fl. bud 15.xii. 1967, *Müller* 728 (K; SRGH) and Chimanimani Mts., fr. 23.v.1923, *Cronwright* in *Swynnerton* 4026 (BR; K) stand apart. The leaf blades are somewhat thicker, somewhat broader and the margins recurved. The calyx lobes touch or can be slightly spaced. The fruit is larger (c. 8 mm in diameter), appears leathery (? normal) and the disk is exposed. More material is needed."

Wursten 1070 matched the two specimens from Chimanimani highlighted by Bridson (2003) closely. It is the first material of this taxon with open flowers. These flowers show additional points of separation of this taxon from *Tricalysia congesta* subsp. *chasei*. Table 1 gives the more significant diagnostic features that separate *T. congesta* subsp. *chasei* and the taxon represented by *Wursten 1070*.

This appears to be yet another endemic taxon of the quartzite uplands of Mt Chimanimani.

This paper is completed as part of a series of studies to document the highest priority plant species for conservation in Mozambique, so that they might be protected as part of Tropical Important Plant Area (TIPA) project for that country, one of seven in a global programme (https://www.kew.org/science/who-we-are-and-what-we-do/strategic-outputs-2020/tropical-important-plant-areas).

MATERIALS & METHODS

Nomenclatural changes and lectotypifications were made according to the Code (McNeil et al. 2012). Names of species and authors follow IPNI (continuously updated). Herbarium material was examined with a Leica Wild M8 dissecting binocular microscope fitted with an eyepiece graticule measuring in units of 0.025 mm at maximum magnification. The drawing was made with the same equipment with a Leica 308700 camera lucida attachment. Specimens were inspected from the following herbaria: BM, FHO, K and WAG. BR and COI specimens were not accessible since they were being digitized during the period of study. The format of the description follows those in other papers describing new species in the *Coffeeae*, e.g., Stoffelen et al. (1997) and Cheek et al. (2002).

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Table 1 Characters separating *Empogona congesta* subsp. *chasei* from *Empogona jenniferae*

	Empogona congesta subsp. *chasei*	*Empogona jenniferae*
Leaf margin	flat	recurved
No. secondary nerves on each side of midrib	(5–)7–10(–12)	4–6(–7)
Calyx lobes at anthesis	overlapping	distant
Corolla tube length (mm)	2–4(–5)	5–6(–7)
Corolla lobes (mm)	(2.75–)4.5–5 by 1–2	5–6(–7) by 3(–3.5)
Anther length (mm)	2–2.5	4.5–5.5
Fruit shape, dimensions (mm)	globose, 5	ellipsoid, 7 by 6–8
Disc in fruit	not exserted, concealed by calyx lobes	exserted, conspicuous

All specimens cited have been seen unless indicated 'n.v.'. The conservation assessment follows the IUCN (2012) standard. Herbarium codes follow Index Herbariorum (Thiers, continuously updated).

Tricalysia congesta

Tosh et al. (2009) did not transfer *T. congesta* to *Empogona.* This may have been because they followed only Robbrecht's (1979) revision. Here Robbrecht considered that the type of *T. congesta* (*Cameron s.n.,* K) was insufficient to assign reliably to species. Therefore he resurrected the later *T. ruandensis* Bremek. to accommodate the specimens that up to that point had been named *T. congesta.* Robbrecht (1988) restated this position. However, Bridson (2003) was confident in maintaining *T. congesta* with this type and reinstated *T. congesta.* Further, she recognised two subspecies: *T. congesta* subsp. c*ongesta* (DRC, Rwanda, Burundi, Uganda, Tanzania and Zambia) and *T. congesta* subsp. c*hasei* Bridson (Zimbabwe and Mozambique). Bridson's treatments have been followed throughout most of these countries, and are supported here.

To address Robbrecht's concern we propose an epitype to buttress Bridson's application of the name *T. congesta*. We select an epitype from the region of the stated type location of *T. congesta* i.e., Lake Tanganyika, and one which is both consistent with the type specimen itself and the material identified by Bridson (2003) and other previous workers, as *T. congesta.* Further, we transfer the species to *Empogona*:

Empogona congesta (Oliv.) Cheek, *comb. nov*.

Kraussia congesta Oliv., J. Linn. Soc., Bot. 15 (1876) 95. — *Tricalysia congesta* (Oliv.) Hiern (1877) 120). — Type: 'Lake Tanganyika, Lt. Cameron s.n. Recd. 2/75' (K). Epitype selected here: *R.M. Lawton 2017* (K), Tanzania, c. 30 miles S. of Tabora, along Sikonge Rd., E32°50' S5°45', fl. 7 Nov. 1978.

Tricalysia ruandensis Bremek. (1956) 253

Tricalysia ruandensis was described by Bremekamp (1956) in reference to *T. cacondensis* Hiern, but without mention of the closely related *T. congesta*, suggesting that he may have overlooked that species in naming it.

Empogona congesta (Oliv.) Cheek subsp. *chasei* (Bridson) Cheek, *comb. nov.*

Basionym. *Tricalysia congesta* (Oliv.) Hiern subsp. *chasei* Bridson, Fl. Zambes. 5, 3 (2003) 478. — Type: *Chase 3229* (holo K; iso BM n.v., SRGH n.v.), Zimbabwe, Mutare Distr., Marange C.L. (Maranki Reserve), fl. 26 Oct. 1950.

KEY TO THE SPECIES OF EMPOGONA SECT. KRAUSSIOPSIS (ROBBR.) TOSH & ROBBR. INCLUDING EMPOGONA JENNIFERAE

(revised from Flora Zambesiaca, Bridson 2003: 466)

Section *Kraussiopsis* is characterised by flowers sessile or subsessile, with bractlets mostly absent; bract and bracteoles stiff, remaining entire, with leaf and stipule-derived lobes clearly dissimilar; calyx lobes touching or overlapping; throat hairs of corolla not forming a domed mat; leaf blades coriaceous, drying yellow green (Bridson 2003: 465)

9. Leaves subcoriaceous with 10–13 main pairs of lateral nerves; peduncles 2–3 mm long; filaments c. 4 mm long; cultivated . . . . . *lanceolata*
9. Leaves coriaceous with 4–10 main pairs of lateral nerves; peduncles 0.1–2 mm long; filaments to 3 mm long; indigenous 10
10. Shrub or small tree of rocky, loamy or lateritic substrates, 1.25–5 m tall (infrequently a subshrub 30–50 cm tall); leaf blades mostly elliptic acute, subacuminate or acuminate; petiole 2–8 mm long, grooved, glabrous above . . . 10a
10. Rhizomatous pyrophytic undershrub of Kalahari sands, 7.5–30(–40) cm high; leaf blades mostly obovate rounded, obtuse or infrequently acute; petiole 1.5–3 mm long, ± flat, hairy above. . . . . 9. *cacondensis*
10a. Secondary nerves 4–6(–7) on each side of midrib; corolla tube length 5–6(–7), lobes 5–6(–7) mm long; fruit ellipsoid, 6–8 mm diam, disc exserted, conspicuous . . . . . 8a. *jenniferae*
10a. Secondary nerves (5–)7–10(–12) on each side of midrib; corolla tube length 2–4(–5) mm, lobes (2.75–)4.5–5 mm long; fruit globose 5 mm diam, disc concealed by calyx lobes 10b
10b. Calyx lobes 0.5–0.75(–1) mm long, ovate, overlapping at base when flowering*;* anther apiculum 0.25–0.5 mm long. — Zimbabwe, Mozambique . . . . . *congesta* subsp. *chasei*
10b. Calyx lobes (0.75–)1–1.25 mm long, broadly ovate, overlapping for most of their length; anther apiculum 0.5–1 mm long. — Democratic Republic of Congo (Katanga), Rwanda, Burundi, Uganda, Tanzania, Zambia . . . . . *congesta* subsp. *congesta*

Empogona jenniferae Cheek, *sp. nov.* — Fig. 1

Differing from *E. congesta* (Oliv.) Cheek in the number of secondary nerves on each side of the midrib 4–6(–7) (not (5–)7–10(–12)); corolla tube and lobes both 5–6(–7) mm long (not 2–4(–5) mm and 4.5–5 mm, respectively); fruit ellipsoid, 7 by 6–8 mm, disc exserted, conspicuous (not globose, 5 mm diam, disc concealed). — Type: *Wursten 1070* (holo K; iso BR n.v., LMA n.v.), Mozambique, Manica, slopes of 'Mt Chimanimani', western side Mevumodzi Valley, Eastern Chimanimani Mts, S19°47'51" E33°07'21", fl. 30 Oct. 2014.

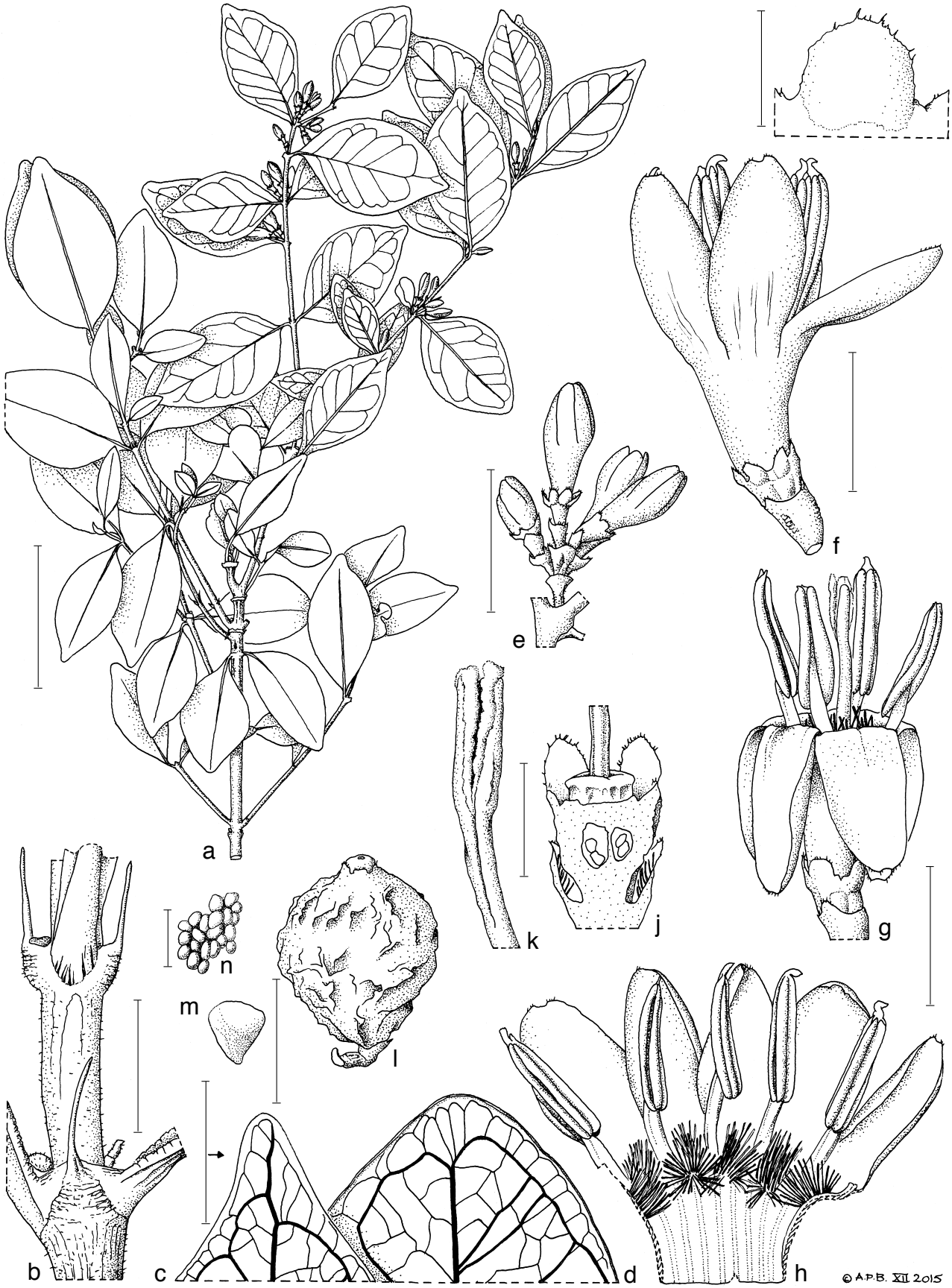

Fig. 1 *Empogona jenniferae* Cheek. a. Habit, flowering branch; b. stem, showing stipules; c. subacuminate leaf apex; d. rounded leaf apex; e. axillary inflorescence; f. flower, side view, near anthesis; g. flower at anthesis; h. corolla opened showing inner surface; i. calyx lobe, abaxial surface; j. subsagittal section of flower (corolla removed) showing ovary, upper cupulus and disc; k. style head and stigmas; l. fruit (dried); m. seed, side view; n. epidermal cells, seed surface (a–e: *Müller 728*; f–k: *Wursten 1070*; l–n: *Cronwright 4026*). — Scale bars: a = 5 cm; b, f–h, m, l = 5 mm; c–e = 1 cm; i = 1 mm; j–k = 2 mm; n = 0.5 mm. Drawn by Andrew Brown.

Etymology. Named in memory of Jennifer Ward Oppenheimer who was a philanthropist, committed conservationist and supporter of Kew's Tropical Important Plant Areas work in Mozambique.

Erect tree 3 m tall, bark finely fissured, slash lime (*Müller 728*). Internodes terete, (0.5–)2–3 cm long, (1–)1.8–2.5(–3) mm diam, pale brown, minutely and sparsely puberulent, hairs simple, patent, 0.1 mm long. *Leaves* opposite and equal at each node, glossy and leathery, green yellow, elliptic, rarely rhombic-ovate, (3.2–)3.6–5.6(–6.3) by (1.4–)1.9–2.5(–3.5) cm, apex with a short, broad, round-apexed acumen 2–4(–6) mm long, rarely the apex not acuminate but rounded, base asymmetric, acute to obtuse, often decurrent as narrower wings of the petiole; secondary nerves 4–6(–7) on each side of the midrib, arising at c. 50° from the midrib, strongly brochidodromous, uniting to form a looping marginal nerve 1–2 mm from the margin, distalmost secondary nerves reflexing towards the more proximal nerves; tertiary nerves conspicuous on both surfaces, forming a coarse reticulum, also forming an intramarginal nerve < 0.1 mm from the margin, connected with the thicker secondary marginal nerve by numerous radiating tertiary veins. Domatia absent. Margin reflexed. *Petiole* canaliculate, (1–)2–4(–5) mm long, margin narrowly winged, glabrous. *Stipules* free, not sheathing but margins united with petiole bases, forming a pocket c. 2 by 2.5 mm, apex aristate, aristae 3–4 mm long, inner surface with simple hairs 0.3–0.8 mm long, abaxial surface with fine transverse lines, sparsely puberulent as stem. *Inflorescences* axillary, opposite, in up to 4 successive nodes below the stem apex, 1–4-flowered, c. 1.5 cm long, peduncle 1–1.5 mm long; cymose, calyculate, minutely, sparsely and inconspicuously patent-puberulent, at stem; calyculi cupular, or with minute and obscure stipular and foliar lobes, subtending each flower pair, flowers sessile, subtended by a cup-shaped calyculus, 1.1–1.8 by 2 mm, inner surface with simple hairs 0.3–0.5 mm long, outer surface glabrous or with a few patent hairs as stem. *Calyx-hypanthium*, subcylindric, 1.3–1.7 by 2 mm, base concealed by calyculus; calyx limb-tube short c. 0.1–0.2 mm; calyx lobes (4 or) 5, quadrate or hemi-orbicular 0.6–0.8 by 0.8–0.9 mm, not touching at anthesis, glabrous on both surfaces or with 1–3 hairs near the margin on the inner surface, the margin with 7–9 patent fimbriae 0.05–0.13 mm long. *Corolla* in pre-anthetic bud narrowly ovoid c. 8 by 4 mm, lobes overlapping to left; at anthesis white, tube dilating, 5 mm long, 2 mm wide at base, 4 mm at apex, lobes (4 or) 5 reflexed, about as long as tube, ovate-oblong 5–6(–7) by 3(–3.5) mm, apex shallowly retuse, with 5–10 patent minute hairs 0.1 mm long, otherwise glabrous. Inner surface glabrous, except for five densely hairy patches alternating with and inserted 0.5 mm below the attachment of the staminal filaments, patches 1–1.5 mm diam at base, hairs 1–1.5 mm long, radiating from patch, rigid. *Stamens* (4 or) 5, exserted, introrse, inserted 0.5–1 mm below the mouth of the corolla tube; filaments 2.5–3 by 0.6 mm, anthers narrowly oblong 4.5–5.5 by 0.6–1 mm, apex with connective extended apically beyond the thecae, triangular, 0.5–0.7 by 0.4 mm, filament insertion between basi- and medi-fixed. *Disc* glabrous, shortly cylindric, 0.4–0.5 by 1.2 mm, the upper surface flat, sunken around style base, the sides vertical, with shallow flanges (Fig. 1j). *Style* glabrous, cylindric, 0.3–0.5 mm diam, apex dilated, 0.75 mm wide, bifurcate, the two arms with stigmatic surface appressed together, exserted with stamens, c. 2.5 mm long. Ovary 2-celled, ovules numerous. *Fruit* ripening black, ellipsoid, c. 7 by 6 mm, apex with disc accrescent, slight exserted beyond the persistent calyx lobes. *Seeds* numerous, triangular in side view, with adaxial excavation, c. 2–2.5 by 2–2.5 mm, outer surface with epidermal cells, hardened, black, convex.

Distribution & Ecology — Zimbabwe and Mozambique; known only from submontane forest and cliff, quartzitic sandstone substrate, Chimanimani Mt, 1200–1580 m altitude.

Additional material. Zimbabwe, *Müller 728* (K, SRGH), The Corner, Martin Forest Reserve, Melsetter [Chimanimani] District, fl. buds, 15 Nov. 1967; *Cronwright 4026* (BR n.v., K), Chimanimani Mts, fr., 23 May 1923.

Conservation — Since the Cronwright specimen only gives 'Mt Chimanimani', the location cannot be pinpointed. We are left with the Müller specimen and that of Wursten giving us two precise sites one on each side of the border. Nothing in the data labels suggests that more than one individual was seen by each collector. Wursten specifies 'One specimen seen only'. Therefore the evidence points to *E. jenniferae* as occurring as widely scattered single individuals. It is not common even within its small range.

A mission to gather populational data and an understanding of threats on the endemic plant species of Chimanimani in 2015 did not refind this species (Timberlake et al. 2016). In contrast, another narrowly endemic coffeoid woody plant, *Sericanthe* sp. B of Flora Zambesiaca, was found in more than ten sites on that survey. Ongoing artisanal mining for gold in the upland quartzitic areas was and may continue to be a threat for tree species such as *E. jenniferae* since the miners used the sparse locally available trees and shrubs for fuel and shelter construction (Timberlake et al. 2016).

Under Criterion B we assess *E. jenniferae* as EN B1+B2ab(iii) in view of the stated threat, and since two management based locations are known (one in Zimbabwe, the other in Mozambique) equating to an area of occupancy of 8 km^2 using IUCN-prefixed 4 km^2 cell size. The extent of occurrence is estimated as equal to the area of occupancy.

Under Criterion D we assess *E. jenniferae* as Critically Endangered, since despite numerous missions surveying the plant of the upper quartzitic slopes of Chimanimani by numerous botanists, including all three of the authors of this paper, only three individuals have been recorded. We estimate that the total number of mature individuals is greater than this, but that it is less than 50.

Cultivation. This species has potential for ornamental horticulture if it can be cultivated in view of its attractive glossy leaves and abundant, relatively large, likely sweet-smelling flowers.

Müller 728 had been initially determined as *Tricalysia congesta*, and *Cronwright 4026* as *T. cacondensis*. Both had been redetermined as *T. ruandensis* Bremek. by Robbrecht in 1978 in the course of his revision of *Tricalysia*.

THE CHIMANIMANI MOUNTAINS

The Chimanimani Mountains, which are situated towards the north-eastern limit of the Great Escarpment of southern Africa (Clark et al. 2011), have long been known for their botanical importance, in particular for their high number of endemic species (see, for example, Goodier & Phipps 1961, Wild 1964). Van Wyk & Smith (2001) designated this area as the Chimanimani subcentre of endemism within the wider Chimanimani-Nyanga Centre. Until very recently, however, only the Zimbabwean side of the massif was well known botanically, and the much larger Mozambican portion of the massif remained under-explored. Following a series of botanical surveys on the Mozambican Chimanimani in 2014–2016 supported by a 'Critical Ecosystem Partnership Fund (CEPF)' grant (Timberlake et al. 2016), a comprehensive checklist of species occurring above 1200 m on the massif is now available. A total of 977 taxa is recorded

including 74 strict endemic and 19 near-endemic taxa (Wursten et al. 2017). For these reasons alone, Chimanimani will merit rating as two Tropical Important Plant Areas (TIPAs), one on each side of the border, using the criteria of Darbyshire et al. (2017). The endemism rate on Chimanimani (7.7 %) is markedly higher than that of other comparable mountain ranges of southern tropical Africa – for example, the Nyanga massif in Zimbabwe (1.4 %) and Mt Mulanje in Malawi (5.4 %) (Strugnell 2002, Clark et al. 2017, Wursten et al. 2017). This high endemism is concentrated on the extensive outcrops of quartzite which result in thin, nutrient-poor and phosphorus-deficient soils that encourage local speciation through specialisation to these harsh growing conditions (Phipps & Goodier 1962, Wild 1964, Wursten et al. 2017). Indeed, many of the endemics are from plant groups typical of nutrient-poor soils, including four species of *Thesium*, one endemic and two near-endemic *Erica* species, and one of the few tropical African restio species, *Platycaulos quartziticola* (H.P.Linder) H.P.Linder & C.R.Hardy. Others are typical of rocky environments including four endemic species of *Aloe* and several species in the African *Asclepias* complex (Chuba et al. 2017, Goyder 1998, 2001, 2009), or of associated seasonal wet flushes over thin soils, such as *Xyris asterotricha* Lock, *Mesanthemum africanum* Hassk. and *Centella obtriangularis* Cannon. Whilst most of the endemic species are herbs or ericaceous shrubs, the new *Empogona* described here is one of a small number of woody endemics which include *Olea chimanimani* Kupicha, *Sericanthe* sp. B of Flora Zambesiaca and a new species of *Olinia* currently under description (T. Shah & I. Darbyshire, in prep.). A number of other potentially new endemic species were discovered during the 2014–2016 surveys, including a species of *Streptocarpus* and a species of *Indigofera* (Wursten et al. 2017).

Following a long period of relative neglect in terms of biodiversity research, driven in part by the protracted period of unrest associated with the war of independence (1964–1975) and subsequent civil war (1977–1992), Mozambique has seen a recent upsurge in botanical exploration over the past decade and a half. Although the total flora is currently unknown due to under-exploration of many areas, the species richness is likely to be the highest of the Flora Zambesiaca region. New surveys at botanically interesting sites in Mozambique are routinely producing new country records and new species. For example, botanical expeditions to Mt Namuli in Zambezia Province in 2007 resulted in the discovery of four entirely new species to science – *Coleus namuliensis* E.Downes & I.Darbysh., *Crotalaria namuliensis* Polhill & T.Harris, *Isoglossa namuliensis* I.Darbysh. and *Crepidorhopalon* sp. nov. ined. – as well as 28 new taxon records for Mozambique (Harris et al. 2011, Downes & Darbyshire 2017). Of even greater note, during surveys of the coastal dry forests of northeastern-most Mozambique in Cabo Delgado Province between 2003 and 2009, of the 738 plant taxa recorded from over 3 000 botanical collections, 68 new species records for Mozambique were listed and an additional 36 taxa were either entirely new to science or previously known only from fragmentary material and so undescribed (Timberlake et al. 2011). Several of these species have subsequently been described, including *Didymosalpinx callianthus* J.E.Burrows & S.M.Burrows and *Oxyanthus biflorus* J.E.Burrows & S.M.Burrows in *Rubiaceae* (Burrows & Burrows 2010), *Stylochaeton tortispathum* Bogner & Haigh in *Araceae* (in Haigh & Boyce 2012), *Warneckea cordiformis* R.D.Stone (Stone 2013), *Ochna dolicharthros* F.M.Crawford & I.Darbysh. in *Ochnaceae* (Crawford & Darbyshire 2015), *Xylopia lukei* D.M.Johnson & Goyder and *X. tenuipetala* D.M.Johnson & Goyder in *Annonaceae* (Johnson et al. 2017) and *Crossopetalum mossambicense* I.Darbysh. in *Celastraceae* (Darbyshire et al. 2016). The lattermost discovery led to the recognition of the genus *Crossopetalum* P.Browne in Africa for the first time, it previously having been considered a New World genus (Darbyshire et al. 2016).

The continued botanical exploration of Mozambique over forthcoming years will no doubt lead to many more species discoveries and will provide us with a much clearer understanding of the total species richness of this fascinating and diverse country.

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