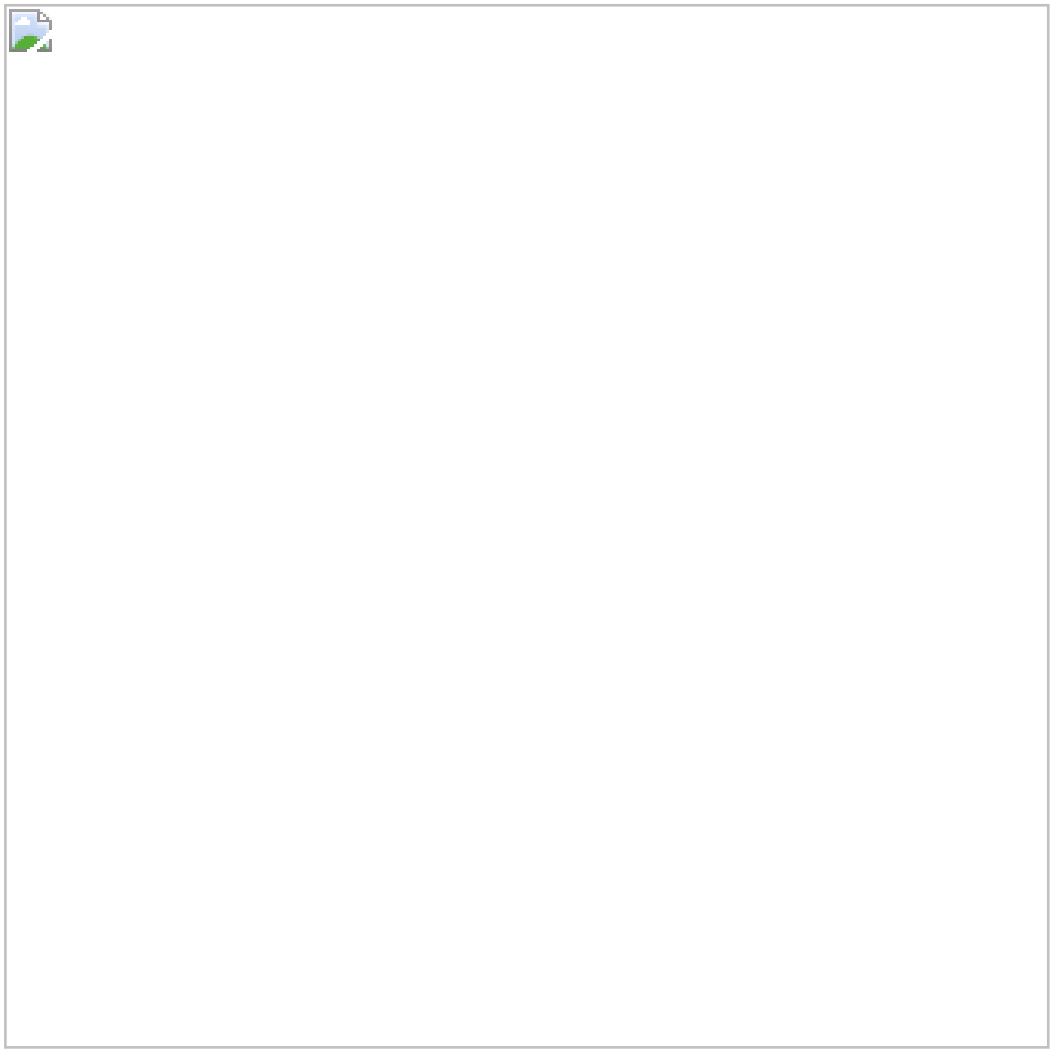

Transfer of the endemic Malagasy species of Kosteletzkya to Hibiscus and Perrierophytum (Malvaceae)

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Transfer of the endemic Malagasy species of Kosteletzkya to Hibiscus and Perrierophytum (Malvaceae)

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Abstract

HANES, M.M., B. MASHBURN & M.W. CALLMANDER (2022). Transfer of the endemic Malagasy species of Kosteletzkya to Hibiscus and Perrierophytum (Malvaceae). *Candollea* 77: 161–171. In English, English and French abstracts. DOI: http://dx.doi.org/10.15553/c2022v772a4

Madagascar is home to eight species that are currently assigned to the pantropical genus *Kosteletzkya* C. Presl. (*Malvaceae*). Phylogenetic studies have revealed that these species are not monophyletic and, instead, fall into three distinct clades that are each currently recognized at generic rank. The widespread African species *K. adoensis* (Hochst. ex A. Rich.) Mast. is the only species of the genus *Kosteletzkya* still recognized on Madagascar while the seven endemic Malagasy *Kosteletzkya* species are transferred to either *Hibiscus* L. or *Perrierophytum* Hochr., in accordance with their morphology, phylogenetic understanding, and generic delimitation. In so doing, we propose seven new combinations: *Hibiscus retrobracteatus* (Hochr.) M.M. Hanes & Callm., *Perrierophytum macranthum* (Hochr.) M.M. Hanes & Callm., *P. madagascariense* (Baker) M.M. Hanes & Callm., *P. malvocoeruleum* (Hochr.) M.M. Hanes & Callm., *P. reflexiflorum* (Hochr.) M.M. Hanes & Callm., *P. thouarsianum* (Baill.) M.M. Hanes & Callm., and *P. velutinum* (Garcke) M.M. Hanes & Callm. Four new synonyms are also proposed and five lectotypes are designated. Risk of extinction assessments of these seven species indicate that two species should be classified as "Least Concern", one as "Endangered", and four as "Critically Endangered".

Résumé

HANES, M.M., B. MASHBURN & M.W. CALLMANDER (2022). Transfert des espèces endémiques malgaches du genre Kosteletzkya à Hibiscus et Perrierophytum (Malvaceae). *Candollea* 77: 161–171. En anglais, résumés anglais et français. DOI: http://dx.doi.org/10.15553/c2022772a4

Madagascar abrite huit espèces qui sont actuellement assignées au genre pantropical *Kosteletzkya* C. Presl. (*Malvaceae*). Des études phylogénétiques ont révélé que ces espèces ne sont pas monophylétiques et, au contraire, se répartissent en trois clades distinctes, de rang générique. L'espèce africaine répandue *K. adoensis* (Hochst. ex A. Rich.) Mast. est la seule espèce du genre *Kosteletzkya* reconnue à Madagascar, tandis que les sept espèces endémiques malgaches de *Kosteletzkya* sont transférées à *Hibiscus* L. et *Perrierophytum* Hochr. conformément à la morphologie, à la compréhension phylogénétique et à la délimitation générique. Nous proposons donc sept nouvelles combinaisons : *Hibiscus retrobracteatus* (Hochr.) M.M. Hanes & Callm., *Perrierophytum macranthum* (Hochr.) M.M. Hanes & Callm., *P. madagascariense* (Baker) M. Hanes & Callm., *P. malvocoeruleum* (Hochr.) M. Hanes & Callm., *P. reflexiflorum* (Hochr.) M.M. Hanes & Callm., *P. thouarsianum* (Baill.) M.M. Hanes & Callm. et *P. velutinum* (Garcke) M.M. Hanes & Callm. Quatre nouveaux synonymes sont également proposés et cinq lectotypes sont désignés. Les évaluations du risque d'extinction de ces sept espèces indiquent que deux taxons doivent être classés dans la catégorie «Préoccupation mineure», une «En danger» et quatre «En danger critique d'extinction».

Keywords

MALVACEAE – *Hibiscus* – *Kosteletzkya* – *Perrierophytum* – Madagascar – New combinations – New synonyms – Nomenclature

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Introduction

The genus *Kosteletzkya* C. Presl. (*Malvaceae*, *Hibisceae*), as recently circumscribed, is not monophyletic (Pfeil & Crisp, 2005; Koopman & Baum, 2008; Neubig et al., 2015). A well delineated clade of true *Kosteletzkya* comprises 17 species with a mostly African and northern Neotropical distribution (with one species in the Philippines) and belongs in the /Trionum clade of tribe *Hibisceae* in the family *Malvaceae* (Pfeil & Crisp, 2005; Blanchard, 2009, 2012, 2013; Neubig et al., 2015). The widespread African species *K. adoensis* (Hochst. ex A. Rich.) Mast., which has also been collected in Madagascar, but only rarely, belongs to the *Kosteletzkya* s.s. clade (Blanchard 2012, 2013; Neubig et al., 2015). The seven remaining species from Madagascar that are currently referred to as *Kosteletzkya* are endemic to the island (Madagascar Catalogue, 2022), but none are closely related phylogenetically to species included in *Kosteletzkya* s.s. These Malagasy *Kosteletzkya* instead belong to the /Megistohibiscus clade (Koopman & Baum, 2008) together with *Humbertiella* Hochr., *Megistostegium* Hochr., *Perrierophytum* Hochr., and some misplaced *Hibiscus* L. awaiting taxonomic transfer (Koopman & Baum, 2008). The exclusion of all endemic species formerly placed in *Kosteletzkya* occurring in Madagascar from true *Kosteletzkya* is further supported by their morphology (Blanchard, 2012, 2013): all species in *Kosteletzkya* s.s. have capsules that disarticulate completely from the fruiting axis at maturity, a trait that is absent from these endemic taxa.

The seven endemic Malagasy species of *Kosteletzkya* do not form a single monophyletic group (Koopman & Baum, 2008; Blanchard et al., unpubl. data). For Madagascar, Hochreutiner (1949, 1955) divided the genus into two sections: sect. *Azanzoides* Hochr. (3 spp.) and sect. *Eukosteletzkya* Hochr. (6 spp., including *K. adoensis*). *Kosteletzkya* species placed in sect. *Azanzoides* are closely related to some Malagasy-endemic *Hibiscus* species (as discussed by Hochreutiner, 1955; suggested by Schatz, 2001; Koopman & Baum, 2008). They were placed in this section based solely for their uni-ovulate carpels (vs. multi-ovulate in *Hibiscus*), but the overall morphology of this section is highly reminiscent of *Hibiscus*, especially the habit (Hochreutiner, 1955). The only remaining species of section *Azanzoides* (sensu Hochreutiner, 1955), that do not have a basionym in *Hibiscus* are *Kosteletzkya retrobracteata* Hochr. and *K. thouarsiana* Baill. We propose the new combination *Hibiscus retrobracteatus* (Hochr.) M.M. Hanes & Callm. for the former, while we refer the latter to *Perrierophytum* (see below).

The remaining six *Kosteletzkya* species endemic to Madagascar correspond to *K.* sect. *Eukosteletzkya* and are embedded within the genus *Perrierophytum* (Koopman & Baum, 2008). The inclusion of these six *Kosteletzkya* species in *Perrierophytum* is further supported by morphology (Hochreutiner, 1915, 1929). The necessary new combinations are provided below: *Perrierophytum macranthum* (Hochr.) M.M. Hanes & Callm., *P. madagascariense* (Baker) M.M. Hanes & Callm., *P. malvocoeruleum* (Hochr.) M. Hanes & Callm., *P. reflexiflorum* (Hochr.) M. Hanes & Callm., *P. thouarsianum* (Baill.) M.M. Hanes & Callm., and *P. velutinum* (Garcke) M.M. Hanes & Callm. None of the varieties in *Kosteletzkya* described by Hochreutiner are currently recognized in *Perrierophytum* pending an ongoing revision of the latter genus by MMH and MWC. Four new synonyms are therefore proposed and five new lectotypes are designated.

The most recent treatment of *Perrierophytum* (Hochreutiner, 1955) in the *Flore de Madagascar et des Comores* recognized nine species known from throughout western Madagascar and Juan de Nova Island (*P. glomeratum* Hochr.). The genus was traditionally united by having leaves with pellucid dots, inflorescences in paniculate cymes, an epicalyx that equals or surpasses the globular to tubular calyx, and a reduced corolla with bilobed petals. Expanding *Perrierophytum* to include the six endemic species of *Kosteletzkya* broadens the distribution of the genus to the Central Plateau, Andringitra National Park, and southeastern Madagascar. The new delimitation of the genus encompasses 15 species united by habit (leggy shrubs to large, perennial herbs), leaves that are often grouped at branch summit with flowers, and a tomentose to glandular leaf surface; it comprises a wide variety of floral morphologies (often but not always with bilobed petals), corolla sizes and colors (white, pink, purple, green, and red).

Hochreutiner received early duplicates from Perrier de la Bâthie's *Malvaceae* collections, which he renumbered. The specimens nevertheless clearly belong to the same gatherings of those in Perrier de la Bâthie's own herbarium, now at P (Fig. 1). Hochreutiner only studied the collections he received from Perrier de la Bâthie as the correspondence between the two botanists attests (Perrier de la Bâthie, 1918–1948). He was later able to study Perrier de la Bâthie's personal herbarium after it was donated to P in 1932 (Humbert, 1958).

Each of the species treated below are provided with notes on their morphological affinities, a distribution map, and risk of extinction assessments following the IUCN Red List Categories and Criteria (IUCN, 2012, 2019). Calculations of Extent of Occurrence (EOO) and Area of Occupancy (AOO) have been conducted with GeoCat (Bachman & Moat, 2012).

Taxonomy and nomenclature

Hibiscus retrobracteatus (Hochr.) M.M. Hanes & Callm., **comb. nov.** (Fig. 2).

≡ *Kosteletzkya retrobracteata* Hochr. in Mém. Soc. Hist. Nat. Afrique N., Hors Sér. 2: 157. 1949. **Lectotypus** (designated here): **Madagascar. Reg. DIANA [Prov. Antsiranana]:** forêt d'Analamera [Analamerana], 17.X.1927, *Ursch 148* (P [P034489]!; isolecto-: G [G00014373]!, P [P034463]!).

Fig. 1. – Label of the isotype of *Kosteletzkya macrantha* var. *herbacea* Hochr. at P with Perrier de la Bâthie's handwriting. [*Perrier de la Bâthie 5465*, P] [P00037088; © Muséum national d'Histoire naturelle, Paris]

Vernacular name. – "Mainaty" (*Service Forestier 9422*).

Distribution and ecology. – *Hibiscus retrobracteatus* is restricted to the dry deciduous forest (sensu Gautier et al., 2018) of northern Madagascar. It grows in the regions of Ankarana, Analamerana, Sahafary plateau, and Loky-Manambato (Daraina) (Fig. 3).

Conservation status. – *Hibiscus retrobracteatus* (under *Kosteletzkya retrobracteata*) is listed as "Endangered" [EN B1ab (i,ii,iii,iv)+2ab(i,ii,iii,iv)] in the IUCN Red List (IUCN, 2022) and *The Red List of Trees of Madagascar* (Beech et al., 2021).

Notes – Hochreutiner's handwriting on G00014373 and P034489 attests that he was unsure whether to describe this species in *Hibiscus* or in *Kosteletzkya.* Gross morphology clearly shows that this species belongs to *Hibiscus.*

Hibiscus retrobracteatus is distinctive among Malagasy *Hibiscus* species due to the unique combination of six small (2–5 mm), free, triangular, glabrous, epicalyx bracts that are reflexed tightly against the peduncle (Fig. 2B).

Hochreutiner (1949: 157) cited the type as "Hb. Mus. Paris et G". The best-preserved material of *Ursch 148* is at P [P034489] and designated here as the lectotype.

Additional specimens examined. – **Madagascar. Reg. DIANA [Prov. Antsiranana]:** massif de l'Ankarana, 12°54'S 49°08'E, 10.XI.1990 & 20.III.1991, fr., *Bardot-Vaucoulon 140* (P [P00574032]); ibid. loco, 19.I.1991, ster., *Bardot-Vaucoulon 394* (P [P00569734]); ibid. loco, 1.III.1991, fl., *Bardot-Vaucoulon 414* (P [P00553055]); ibid. loco, bordure de la rivière Ampandrabe, chem. vers le canyon forestier, 12°57'08"S 49°07'43"E, 24.III.2007, fl., *Bardot-Vaucoulon 1555* (P [P00643074]); Diégo, s.d., fr., *Louvel s.n.* (P [P00574801]); forêt d'Analafondro, au pied SE du plateau de Sahafary (bassin inférieur du Rodo), [12°37'S 49°29'E], 7.II.1966, fr., *Service Forestier 24525* (CANB, K, MO, P [P00574959]). **Reg. SAVA [Prov. Antsiranana]:** Daraina, forêt d'Antsaharaingy, 12°54'52"S 49°39'25"E, 3.III.2005, bud, *Nusbaumer 2113* (G); ibid. loco, 12°54'29"S 49°40'27"E, 45 m, 16.IV.2004, fr., *Ranirison 663* (G [G00028385], P [P00653158]).

Perrierophytum macranthum (Hochr.) M.M. Hanes & Callm., **comb. nov.** (Fig. 4A).

≡ *Kosteletzkya macrantha* Hochr. in Annuaire Conserv. Jard. Bot. Genève 20: 98. 1917. ≡ *Kosteletzkya macrantha* var. *lignosa* Hochr. in Annuaire Conserv. Jard. Bot. Genève 20: 99. 1917 [nom. inval.]. ≡ *Kosteletzkya macrantha* f. *lignosa* (Hochr.) Hochr. in Humbert, Fl. Madagascar Comores 129: 107. 1955 [nom. inval.].

Holotypus: Madagascar. Reg. Haute Matsiatra [Prov. Fianarantsoa]: rocailles du massif d'Andringitra, 2200 m, s.d., fl., *Perrier de la Bâthie 5473* [as "*70*" at G] (G [G00014378]!; iso-: P [P00037090]!).

= *Kosteletzkya macrantha* var. *herbacea* Hochr. in Annuaire Conserv. Jard. Bot. Genève 20: 99. 1917. ≡ *Kosteletzkya macrantha* f. *herbacea* (Hochr.) Hochr. in Humbert, Fl. Madagascar Comores 129: 107. 1955, **syn. nov. Holotypus: Madagascar. Reg. Haute Matsiatra [Prov. Fianarantsoa]:** pentes W du massif d'Andringitra, IX.1911, fl., *Perrier de la Bâthie 5465* [as "*75*" at G] (G [G00014377]!; iso-: P [P00037088, P00037089]!).

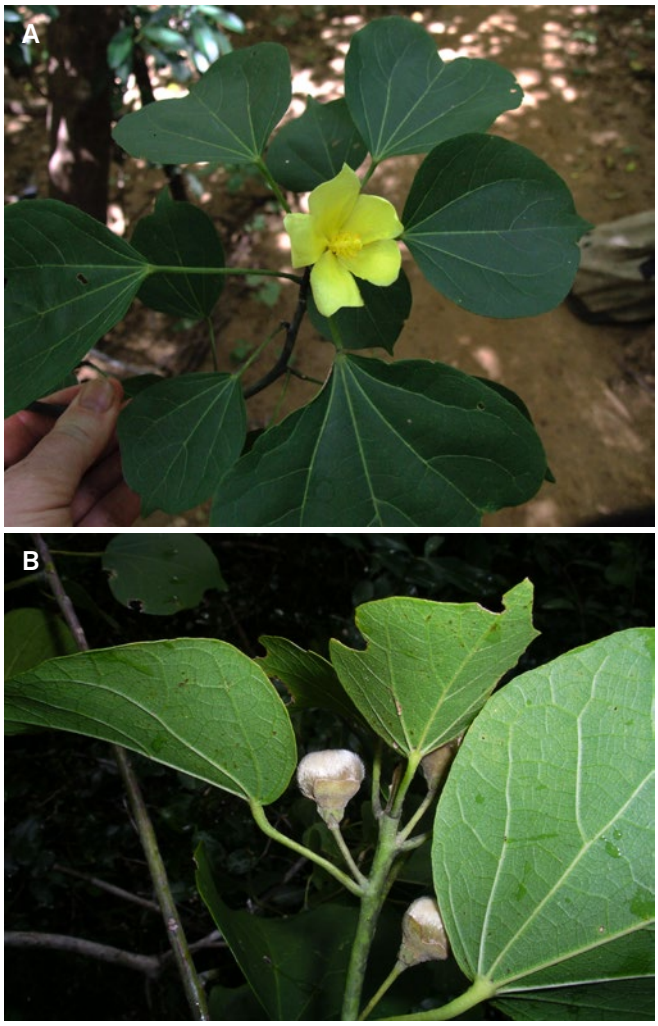

Fig. 2. – *Hibiscus retrobracteatus* (Hochr.) M.M. Hanes & Callm.: **A.** Flower; **B.** Fruits.
[**A:** *Bardot-Vaucoulon 1555*; **B:** *Ranirison 663*]
[Photos: **A:** M. Bardot-Vaucoulon; **B:** P. Ranirison]

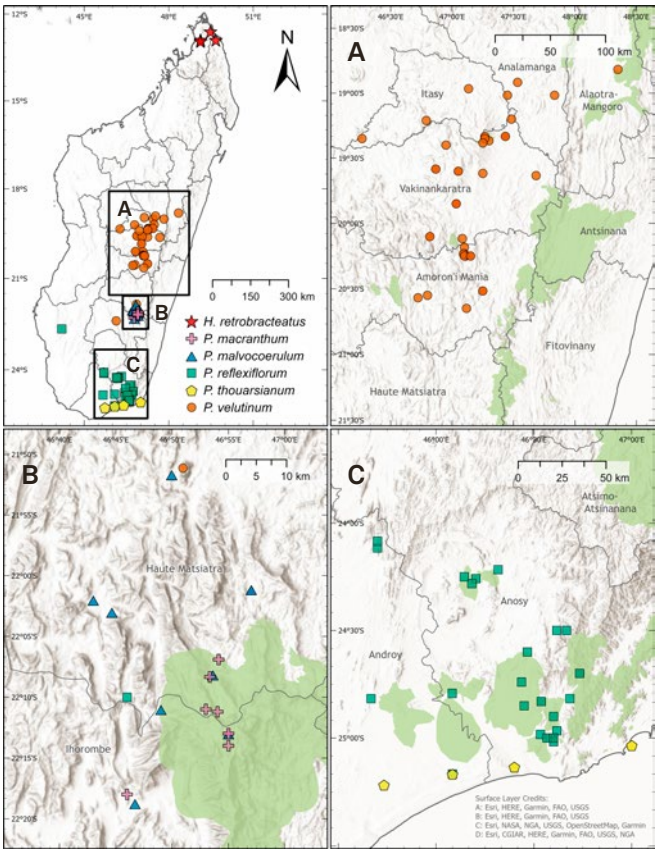

Fig. 3. – Known distribution of the *Hibiscus* L. and five *Perrierophytum* Hochr. species treated in this paper.

Distribution and ecology. – This species is restricted to granite outcrops in montane ericoid thicket on the Andringitra massif, and in the nearby "haute vallée de la Menarahaka", from 1700–2200 m (Fig. 3). Though not commonly collected, it is possibly abundant in locations where it is found: "très abondant à la cascade du roi et de la reine, près d'Antanifotsy" (specimen label on *Cours 5155* in P [P00574213]).

Conservation status. – *Perrierophytum macranthum* is known from a handful of collections that are tightly clustered in south-central Madagascar, in and near Andringitra National Park. The collections made outside the national park (e.g. *Boiteau 2078*, *RNM 111189*) are now over 50 years old. Given the ongoing habitat loss in areas surrounding the national park since these collections were made, a reduction in the number of subpopulations can be inferred, both historically and projecting into the future. Even within the national park, a majority of specimens were collected before 1970, though there is one more recent collection (2006, *Skema 202*), suggesting that at least one subpopulation is extant. If the subpopulations outside the national park have been lost, a highly likely scenario, *P. macranthum* has an EOO of c. 6 km^2 and an AOO of 16 km^2. The tight clustering of collections in the park suggests that the number of locations is limited to one or two, which are threatened by fire, deforestation, and animal grazing. Thus, *P. macranthum* is assessed as "Critically Endangered" [CR B1ab(i,ii,iii,iv,v)].

Notes. – *Perrierophytum macranthum* can be distinguished by its long, filiform, densely pubescent, caducous stipules, and serrate leaf margins with teeth coming to a sharp point. The species has large flowers comprised of 15 epicalyx lobes that are filiform, reddish in color, and densely pubescent with long, cream to gold-colored hairs; large sepals (1.5 cm long), similarly pubescent; and large mauve petals (2.5–3.2 cm long) with dark purple veins.

Hochreutiner described two varieties under *P. macranthum*. The first one, var. *lignosa*, that he referred to as "Varietas typica", while the second one was named var. *herbacea*. He wrote:

Fig. 4. – A. *Perrierophytum macranthum* (Hochr.) M.M. Hanes & Callm.; **B.** *Perrierophytum malvocoeruleum* (Hochr.) M.M. Hanes & Callm. Ambalavao, 4 April 2019; **C.** *Perrierophytum reflexiflorum* (Hochr.) M.M. Hanes & Callm.; **D.** *Perrierophytum velutinum* (Garcke) M.M. Hanes & Callm. [**A:** *Skema et al. 202*; **C:** *Lowry 6987*; **D:** *Koopman 215*] [Photos: **A:** C. Skema; **B:** T. Cordenos; **C:** P. Lowry; **D:** M.M. Hanes]

"Ces deux variétés ne sont peut-être que des formes altitudinaires, néanmoins, à cause de leur différence de port [These two varieties are perhaps only altitudinal forms, that nevertheless results in their different growth-forms]." (Hochreutiner, 1917: 99–100). Later, Hochreutiner considered these varieties as forms in the *Flore de Madagascar* treatment. We do not retain these formally described infraspecific taxa.

Hochreutiner did not explicitly cite a type for *Kosteletzkya macrantha* but his citation of Perrier de la Bathie's collection, under his "typical variety", can be interpreted as a nomenclaturally valid typification. A specimen at G [G00014378] that he cited under his typical variety can be considered as a valid act of typification, and we consider the specimen deposited at G as the holotype.

Additional specimens examined. – Madagascar. **Reg. Haute Matsiatra [Prov. Fianarantsoa]:** sentier du pic Boby, Andringitra, IV.1964, fl., *Bosser 19469* (P [P00569773, P00574212], MO-3332244, MO-6071571); massif de l'Andringitra, 2050 m, s.d., fl., *Cours 5155* (P [P00574213, P00574863]); ibid. loco, IX.1942, fl., *Jard. Bot. Tana. 5149* (P [P00574214]); ibid. loco, VI.1956, fl. & fr., *Morat 1291* (P [P00569772]); ibid. loco, 2000 m, IV.1921, fl., *Perrier de la Bâthie 13751* (P [P00553053, P00553054]); ibid. loco, 6.V.1955, fl., *Réserves Naturelles 7509* (P [P00574215]); Distr. Ambalavao, 30.V.1958, fl., *Réserves Naturelles 9873* (P [P00574216]); ibid. loco, 23.III.1960, fl., *Réserves Naturelles 11189* (G, P [P00574217]); Andringitra NP, Fokotany Namoly, on tourist trail in Ivangomeina Forest, 22°11'12"S 46°54'03"E, 2115 m, 26.IX.2006, bud & fl., *Skema et al.* 202 (BH). **Reg. Ihorombe [Prov. Fianarantsoa]:** Haute vallée de la Menarahaka, près de la Réserve de l'Andringitra, 10.IV.1970, fl., *Boiteau* 2078 (MO-6071570, P [P00574210, P00574211]).

Perrierophytum madagascariense (Baker) M.M. Hanes & Callm., **comb. nov.**

≡ *Kosteletzkya madagascariensis* Baker in J. Bot. 20: 46. 1882.

Holotypus: Madagascar: "in a wooded valley in West Betsileo", VII.1880, fl. & fr., *Baron 121* (2-part specimen: K000240497, K000240498]!; iso-: G [G00014376]!, P [P00037096]!).

Distribution and ecology. – *Perrierophytum madagascariense* is known from a single collection in "Betsileo-land". This locality refers to the Malagasy tribe that inhabits the collection area and can be understood as somewhere in either the Amoron'i Mania or Haute Matsiatra regions, that the Betsileo people traditionally inhabited.

Conservation status. – *Perrierophytum madagascariense* is known only from a single location, where it was collected in 1880. Relatively few fragments of native vegetation remain on the highlands in the Betsileo region of Madagascar, and the absence of more recent collections indicates that this species is not common. It is reasonable to infer that the habitat in which the species was originally collected has largely disappeared, likely through deforestation, overgrazing, or fire, and would suggest that *P. madagascariense* could be extinct. Yet, in the absence of exhaustive surveys of the region, including a targeted search for the species, such an assessment is premature. Even if the species was found in a remaining habitat fragment or in a protected area in the Betsileo region, the EOO would likely still be under 100 km², with a single location likely to still be threatened by the factors mentioned above. In addition, continued decline in extent and quality of habitat would be inferred. Therefore we recommend that *P. madagascariense* be assessed as "Critically Endangered" [CR B1ab(iii)].

Notes. – *Perrierophytum madagascariense* can be differentiated from other species by its sparsely pubescent leaves (vs. densely pubescent), and relatively small flowers (Table 1).

Perrierophytum malvocoeruleum (Hochr.) M.M. Hanes & Callm., **comb. nov.** (Fig. 4B).

≡ *Kosteletzkya malvocoerulea* Hochr. in Annuaire Conserv. Jard. Bot. Genève 20: 100. 1917.

Holotypus: Madagascar. **Reg. Haute Matsiatra [Prov. Fianarantsoa]:** W du massif d'Andringitra, [22°13'S 46°55'E], 1000 m, IX.1911, fl., *Perrier de la Bâthie 5467* [as "*69*" at G] (G [G00014375]!; iso-: P [P00037094, P00037095]!).

Vernacular names. – "Tsietilahy" (*Rakotovao 801*); "Hafotra" (*Réserves Naturelles 2266*).

Distribution and ecology. – Known from rocky summits in montane ericoid thicket from 1000–2650 m; Andringitra, valleys of Riambava and Antsifotra (Fig. 3).

Conservation status. – *Perrierophytum malvocoeruleum* has been collected from six subpopulations in south-central Madagascar, three of which are within Andringitra National Park. No collections are known to have been made outside of the park in the past 54 years, and the most recent of these is *Haine 200* from SW of Ambalavao. With all collections included, the EOO of *P. malvocoeruleum* is estimated to be 739 km², and the AOO is estimated to be 32 km². However, given recent habitat loss in this region outside of the park, and the lack of recent collections, we infer a decline in the number of subpopulations. Thus, if we do not include these subpopulations in our assessment, *P. malvocoeruleum* has an AOO of, at most, 8 km². In addition, collection details for specimens thought to occur within the national park are vague, and so we infer a single location within the park. Even though this one location is within a protected area, loss due to fire or illegal incursions of forest clearing and/or grazing animals is still possible. Given these measures and the inferred recent decline in number of subpopulations from three to one, *P. malvocoeruleum* can be assessed as "Critically Endangered" [CR B2ab(i, ii, iii, iv, v)].

Table 1. – Comparison of morphological characters between the six species of *Perrierophytum* Hochr. treated herein. Characters diagnostic for a species are in bold type.

	P. macranthum	*P. madagascariense*	*P. malvocoeruleum*	*P. reflexiflorum*	*P. thouarsianum*	*P. velutinum*
Habit	shrub; leaves grouped with flowers at branch apex	**perennial herb; flowers axilary, solitary**	shrub; flowers grouped at summit	shrub; flowers axilary	shrub; leaves grouped with flowers at branch apex	shrub; flowers grouped at summit
Leaf width x length [mm]	65 x 20–80, tomentose, **sharp discolored points on leaf teeth**	**35 x 20, nearly glabrous**	30 x 15, tomentose	27 x 19, tomentose	80 x 73, tomentose	20, tomentose
Stipule length [mm]	**8**, filiform, densely pubescent, deciduous	unknown	4, filiform, deciduous	10, deciduous	15, deciduous	4, deciduous
Petiole length [mm]	10–15	15–20	5–**37**	7–16	5–45	5–20
Peduncle length [mm]	30	20–30	20	**15–20, articulated towards apex**	**3–9, articulated half way**	15–20
Epicalyx bract shape	filiform	linear, almost filiform	filiform, free	**ovate, cordate, with long acuminate tips, free**	triangular, fused at base	filiform
Number of epicalyx bracts	**15**	5 to 6	10	5 to 6	4 to 6	10 to 12
Calyx lobe length [mm]	**15**	**6**	8	9	9	7–9
Calyx shape	free	infondiuliforme', fused halfway	cupuliform, fused at base	free	cupuliform, fused halfway	cupuliform, fused halfway
Corolla color	pale violet, **dark purple veins**	unknown	mauve	**red**	rose, mauve	rose, blue violet
Flower shape	cupuliform	cupuliform	**flat**	**reflexed**	cupuliform	cupuliform
Petal shape	ovate	obovate	ovate, to **gently bilobed** at apex	**deeply bilobed at apex**	ovate	ovate
Staminal column length [mm]	25–32	2–3	2–3.5	**10**	6	4–5

Notes – *Perrierophytum malvocoeruleum* has solitary, axillary flowers on long, delicate peduncles that are clustered at branch tips. Flowers of this species have a unique combination of a cupuliform calyx and filiform epicalyx with an open, flat floral architecture with gently notched petals. *Perrierophytum malvocoeruleum* is noted as a medicinal plant. The leaves and branches are used to treat maladies of the skin ("la gale") (*Rakotovao 801*).

We consider the specimen deposited at G to be the holotype.

Additional specimens examined. – **Madagascar. Reg. Haute Matsiatra [Prov. Fianarantsoa]:** rocailles SO de l'Ivangomena (Pic Humbert), massif d'Andringitra, 16.X.1934, fl., *Heim s.n.* (P [P00569770, P00569771]); massif d'Andringitra, vallée de la Riambava, 1924, fl., *Humbert 3802* (G, P [P00569768]); massif d'Andringitra, IV.1911, fl., *Perrier de la Bâthie 13750* (P [P00569766, P00569767]); ibid. loco, 22°10'S 46°56'E, 1650 m, 8.IV.1997, fl., *Rakotovao 801* (MO-5340237, P [P00569764]); ibid. loco, 22.VI.1948, fl., *Réserves Naturelles 1409* (G, P [P00569764]); ibid. loco, 18.VII.1952, fl., *Réserves Naturelles 4781* (P [P00569761, P00569762]). **Reg. Ihorombe [Prov. Fianarantsoa]:** 12 km SO Ambalavao, 67 km S of Fianarantsoa, 29.XII.1968, *Haine 200* (K); Distr. Ambalavao, Vohitsaoka, 23.II.1960, fl., *Rabevazaha 189RN* (P); Antaranomby, 26.VIII.1950, fl., *Réserves Naturelles 2266* (G, P [P00569763, P00553056]); Distr. Ivohibe, Antambohobe, 22.X.1953, fl., *Réserves Naturelles 5865* (P [P00569760]); Distr. Ambalavao, Vohitsaoka, 8.II.1961, fl., *Réserves Naturelles 11673* (P [P00574879]).

Perrierophytum reflexiflorum (Hochr.) M.M. Hanes & Callm., **comb. nov.** (Fig. 4C).

≡ *Kosteletzkya reflexiflora* Hochr. in Candollea 2: 138. 1929. ≡ *Kosteletzkya reflexiflora* var. *genuina* Hochr. in Candollea 5: 13. 1932 [nom. inval].

Holotypus: Madagascar. Reg. Haute Matsiatra [Prov. Fianarantsoa]: contreforts W de l'Andringitra, [22°13'S 46°55'E], 900 m, IV.1921, fl., *Perrier de la Bâthie 13589* (G [G00014374]!; iso-: P [P00037084, P00037085]!).

= *Kosteletzkya reflexiflora* var. *meridionalis* Hochr. in Candollea 5: 13. 1932, **syn. nov. Holotypus: Madagascar. Reg. Androy [Prov. Toliara]:** bassin supérieur du Mandrare, du col de Vavara à la vallée de la Manambolo, 700–1200 m, 20.XI.1928, fl., *Humbert 6745* (G [G00014470]!; iso-: G [G00014471]!, K [K000240511] image!, P [P00037087, P00037086]!, US [US00101868]!).

Vernacular name. – "Sarondroy" (*Humbert 12941*).

Distribution and ecology. – *Perrierophytum reflexiflorum* grows on granite, gneiss or calcareous soils at altitudes from 0–900 m, primarily in deciduous dry forest of southeastern Madagascar. In the far south-east of the island, collections have been made within the last 30 years from roadsides (e.g. *Koopman 258*, *Phillipson 3993*) and from protected areas such as Andohahela National Park (e.g. *Lowry 6987*). Though a majority of specimens are found in this southeastern region, the holotype (*Perrier de la Bâthie 13589*) was collected over 200 km to the north, in the vicinity of Andringitra National Park. Already in 1921, *Perrier de la Bâthie* noted the significant loss of individuals from the region near Andringitra: "Cette espèce […] est sans doute en voie d'extinction; je n'en ai vu qu'un seul pied, et dans une région que j'ai souvent parcourue [This species […] is probably on the way to extinction; I have only seen one individual in an area I have often visited]." Another distant collection (*Andriamihajarivo 1641*) comes from the "Forêt d'Analavelona", 135 km to the northwest of the nearest collection. Altogether, these collections indicate the *P. reflexiflorum* may have once occurred widely throughout the dry southern third of Madagascar (Fig. 3).

Conservation status. – More than 100 years ago, Perrier de la Bâthie noted the significant deforestation and threat of fire affecting populations of *Perrierophytum reflexiflorum* (*Perrier de la Bâthie 13589*). Given this assessment and the fact that no other specimens have been collected near Andringitra since his collection in 1921, we do not include this location in our current conservation assessment. The majority of the collections of *P. reflexiflorum* listed below were made in or nearby areas in south-east Madagascar that are now in the Protected Area Network: Réserve de Vohidava-Betsimalaho, Complexe Anjozorobe-Angavo, Nord Ifotaka (Ifotaky), Complexe Behara-Tranomaro and Andohahela National Park, and at Analavelona (Monument Naturel de la Forêt Sacrée Alandraza Analavelo) in the south-west, where a collection was made in 2010, c. 135 km to the NW of the nearest other collection of the species. *Perrierophytum reflexiflorum* has an estimated EOO of 19,539 km², and an AOO of 100 km². The number of locations is inferred to be greater than 10. *Perrierophytum reflexiflorum* can therefore be assessed as "Least Concern" [LC].

Notes – *Perrierophytum reflexiflorum* can be easily distinguished in flower from all other *Perrierophytum* species, as it is the only species with red, deeply notched petals and free epicalyx lobes with cordate bases and long acuminate tips. The leaves of *P. reflexiflorum* have a rounded base and are discolorous (dark green above, light, yellowish green below) and the petioles are articulated towards the apex.

Kosteletzkya reflexiflora var. *meridionalis* Hochr. was described in 1932 based on its larger flowers and leaves. In light of the rather continuous variation in these characters displayed by the specimens that have accumulated since then, we prefer to maintain a species with broad distribution and encompassing some morphological variation pending a full revision of the genus *Perrierophytum*.

Hochreutiner received G00014470 from Henri Humbert in 1931. The second sheet at G [G00014471] arrived only in

1949 and was not studied by Hochreutiner when *Kosteletzkya reflexiflora* var. *meridionalis* Hochr. was published in 1932. We therefore consider G00014470 as the holotype.

Selected specimens examined. – **Madagascar. Reg. Androy [Prov. Toliara]:** Distr. Ambovombe, 18.IV.1924., fl., *Decary 2573* (P [P00569759]); moyenne Mananara, à la limite orientale de l'Androy, 27.XI.1931, fl., *Decary 9448* (P [P00569755]); vallée de la Manambolo, rive droite (bassin du Mandrare) aux env. d'Isomonono (confluent de la Sakamalio), XII.1933, fl., *Humbert 12941* (G [2 sheets], MO-6200327, P [P00569737, P00569738, P00569739, P00569740]); just NE of Ankoba village, Andohahela NP, 24°47'34"S 46°41'55"E, 200 m, 24.I.2008, fl., *Lowry 6987* (MO-6443243); 7.5 km N of Beraketa, on road to Bevitiky, 24°06'55"S 45°42'00"E, 590 m, 27.III.1992, fl., *Phillipson 3993* (MO-4287798); Ambararata, 1 km du pic de Vohimainty, III.1949, fl., *Réserves Naturelles 4803* (P [P00569750, P00569751, P00569752]); Ampandrandava, crête E, XI.1942, fl., *Seyrig 276* (P [P00569747, P00569748]). **Reg. Anosy [Prov. Toliara]:** Ranobe, Behalomboro, Betsingilo, Besely, 24°16'53"S 46°10'56"E, 15.XI.2008, fl., *Andriamihajarivo 1611* (MO-6563348, P [P01044580]); RNI d'Andohahela, Parcelle nº 2, 24°49'49"S 46°32'15"E, 16.III.1994, *Andrianarisata 83* (P [P00554893]); de Ranipiso à Amboasary, 100–150 m, 17.XI.1967, *Bernardi 11553* (G); Tranomaro, au NE d'Ambovombe, 18.VI.1931, fl., fr., *Decary 9002* (P [P00569754]); Bevilany, confins de l'Anosy et de l'Androy, 8.VIII.1932, fl., *Decary 10259* (G, P [P00569746]); basse vallée de la Mananara, affluent du Mandrare, III.1955, fl., *Humbert 29192* (P [P00574219]); près du poste forestier d'Imonty au N d'Ambatohabo, haute Mananara, II.1962, bud, *Keraudren 1524* (P [P00574221]); 44 km N of Amboasary on the road to Tranomaro, 24°44'25"S 46°26'13"E, 167 m, 7.II.2005, fl., *Koopman 258* (MO-6438159, P [P00980543], TAN, WIS); Amboasary Sud, Marotsiraka, Besavoa, forêt d'Anadabolava-Betsimalaho, 24°15'00"S 46°08'36"E, 282 m, 8.II.2013, fl., *Randriatsivery 329* (MO-6730804); galerie de la Mangatsiaka, à Ranomainty (entre le Mandrare et Ranopiso), III.1955, fl., *Service Forestier 11849* (P [P00874224, P00574224]). **Reg. Atsimo-Andrefana [Prov. Toliara]:** Sakaraka, Mahaboboka, Marotsiraka, forêt d'Analavelona, 22°39'52"S 44°12'05"E, 869 m, 18.II.2009, fl., *Andriamihajarivo 1641* (MO-6485227, P [P01044602], TAN).

Perrierophytum thouarsianum (Baill.) M.M. Hanes & Callm., **comb. nov.**

≡ *Kosteletzkya thouarsiana* Baill. in Bull. Mens. Soc. Linn. Paris 1: 541. 1883.

Lectotypus (designated here): **Madagascar:** sine loco, s.d., fl., *Du Petit-Thouars s.n.* (P [P00037076]!).

≡ *Kosteletzkya humbertiana* Hochr. in Mém. Soc. Hist. Nat. Afrique N., Hors Sér. 2: 157. 1949. ≡ *Kosteletzkya thouarsiana* var. *humbertiana* (Hochr.) Hochr. in Humbert, Fl. Madagascar Comores 129: 104. 1955, **syn. nov. Lectotypus** (designated here): **Madagascar. Reg. Anosy [Prov. Toliara]:** Andrahomana, 21.IX.1932, fl. & fr., *Decary 10659* (P [P00037077]!; isolecto-: G [G00014372]!, K [K000580217] image!, MO-6089630!, P [P00037078, P00389394]!).

Distribution and ecology. – Known only from the extreme south-east of Madagascar on fixed dunes, from Fort Dauphin to the west of Ambovombe (Fig. 3).

Conservation status. – *Perrierophytum thouarsianum* is known from only a few collections in south-east Madagascar. No collections are known to have been made since 1931, and GPS coordinates have been estimated from the descriptions on the specimens. With these estimates, it is unlikely that collections have been made inside any current protected area. The species has an estimated EOO of 83 km² and an AOO of 16 km². Given the limited EOO, the known habitat degradation in this region in the last 100 years, and the time since the last collection, *P. thouarsianum* can be assessed as "Critically Endangered" [CR B1ab(iii)].

Notes – *Kosteletzkya thouarsiana* was placed in sect. *Azanzoides* by Hochreutiner (1955). Nevertheless, he wrote: "espèce ± intermédiaire entre les deux sections du genre, par son port presque herbacé et son ovaire déprimé ainsi que sa capsule [species ± intermediate between the two sections of the genus, by its almost herbaceous habit and its depressed ovary as well as its capsule]." (Hochreutiner, 1955: 103). These characters nevertheless place this species in sect. *Eukosteletzkya* and *K. thouarsiana* is therefore now transferred to *Perrierophytum*.

Perrierophytum thouarsianum is distinctive in having its epicalyx and calyx similar in size and form (both fused at base, and with triangular lobes). Leaves range from almost triangular to distinctly trilobed.

Hochreutiner described *Kosteletzkya humbertiana* in 1949 but reduced it to a variety of *K. thouarsiana* in his *Malvaceae* flora treatment in 1955. We do not maintain this variety here as we do not see any convincing morphological character to distinguish it as distinct from the typical variety.

Baillon (1883: 342) cited the type of *Kosteletzkya thouarsiana* in "hb. Juss" but no specimen has been located in P-JU. The specimen deposited in P with Baillon's handwriting is therefore designated here as the lectotype. Hochreutiner (1949: 158) cited the type of *K. humbertiana* as "Hb. Mus. Paris et G". The best-preserved material of *Decary 10659* is at P [P00037077] and designated here as the lectotype.

Additional specimens examined. – **Madagascar. Reg. Androy [Prov. Toliara]:** Ampasimpolaka, 6.X.1924, fl., *Decary 2832* (G, P [P00574034]); ibid. loco, 5.IX.1924, fl., *Decary 3127* (P [P00574035]); Ambovombe, 24.II.1931, fl., *Decary 8557* (P [P00574036]); env. d'Ambondro, à l'O d'Ambovombe, 7.VIII.1931, fl., *Decary 9119* (P [P00553051]); Ampasimpolaka à l'E d'Ambovombe, 29.VI.1931, fr., *Decary 9047* (MO-1492389, MO-5594153, P [P00574037]). **Reg. Anosy [Prov. Toliara]:** Lac Anony, X.1956, *Bosser 10439* (MO-3332245); Fort-Dauphin, s.d., fl., *Cloisel 4* (P [P00574033]); ibid. loco, 16.VI.1926, fl., *Decary 4111* (G, P [P00553052]).

Perrierophytum velutinum (Garcke) M.M. Hanes & Callm., **comb. nov.** (Fig. 4D).

≡ *Kosteletzkya velutina* Garcke in Abh. Naturwiss. Vereins Bremen 7: 198. 1881. ≡ *Kosteletzkya velutina* var. *genuina* Hochr. in Annuaire Conserv. Jard. Bot. Genève 6: 53. 1902 [nom. inval.].

Holotypus: Madagascar. Reg. Analamanga [Prov. Antananarivo]: "in der Nahe von Antananarivo", XII.1877, *Rutenberg s.n.* (BRNU-347802 image!)

= *Hibiscus ciliatus* Bojer ex Baill. in Bull. Mens. Soc. Linn. Paris 1: 541. 1883 [nom. nud.].

= *Pavonia macrotis* Baker in J. Linn. Soc., Bot. 20: 98. 1883. **Lectotypus** (designated here): **Madagascar:** "Central Madagascar", s.d., fl., *Baron 1869* (K [K000240501] image!; isolecto-: P [P00574040]!). **Syntypi: Madagascar:** "Prov Emirna", 1857, fl., *Bouton s.n.* (K [K000240503] image!); ibid. loco, s.d., fl., *Lyall 189* (K [K000240504] image!); "Tannanarnivon", s.d., fl., *Blackburn s.n* (K [K000240507] image!); "Central Madagascar", s.d., fl., *Baron 615* (K [K000240506] image!); ibid. loco, s.d., fl., *Baron 933* (K [K000240505] image!); ibid. loco, XI.1885, fl., *Baron 3506* (BM, K [K000240499], P [P00574041]). **Reg. Haute Matsiatra [Prov. Fianarantsoa]:** N & E of Ankaratra Mts., s.d., fl., *Kitching s.n.* (K [K000240500] image!).

= *Kosteletzkya velutina* var. *goudotiana* Hochr. in Annuaire Conserv. Jard. Bot. Genève 6: 53. 1902, **syn. nov. Lectotypus** (designated here): **Madagascar. Reg. Analamanga [Prov. Antananarivo]:** env. de Tananarive, 15.I.1838, *Goudot s.n.* (G [G00014369]!; isolecto-: G [G00014370, G00014371]!).

Distribution and ecology. – *Perrierophytum velutinum* is restricted to degraded sclerophyllous woodland and secondary montane grassland on the Central Plateau between Antananarivo and Fianarantsoa from 1000–1700 m (Fig. 3).

Conservation status. – *Perrierophytum velutinum* is relatively widespread across the Central Plateau though only four collections were clearly made within a protected area (Réserve de Manjakatompo Ankaratra). The species has an estimated EOO of 46,498 km² and an AOO of 128 km². The existence of collections made within the last 20 years along roadsides and in degraded habitat suggests *P. velutinum* is resistant to threats such as habitat loss, grazing, and fires. *Perrierophytum velutinum* can therefore be assessed as "Least Concern" [LC].

Notes – Diedrich Christian Rutenberg (1851–1878) was a German explorer and botanical collector. He travelled and collected in Madagascar in 1878 where he was murdered by his porters. His collections were eventually shipped to Bremen thanks to Johann Maria Hildebrandt (1847–1881) (Dorr, 1997). Rutenberg's collections were subsequently evacuated in 1943 to Mährisch-Schönberg (today Sunperk), in Czech Republic (Metzing, 1999). They are now deposited at BRNU with some still at BREM. The original material of *Kosteletzkya velutina* Garcke is represented by a single collection in BRNU considered here to be the holotype.

Three Goudot specimens collected on January 15, 1938 are deposited at G. The best-preserved specimen with Hochreutiner's handwriting is designated here as the lectotype of *Kosteletzkya velutina* var. *goudotiana* Hochr. The variety *goudotiana* was described on the basis of a slightly larger calyx and the absence of long trichomes. We consider these slight variations within the circumscription of the species and do not retain this taxon here as a separate entity.

Perrierophytum velutinum is distinct in its densely tomentose leaves with strongly cordate leaf bases and rounded leaf apices. It differs from *P. malvocoeruleum* in having a wider calyx, densely tomentose branches, and peduncles and petals without two lobes. Hochreutiner (1917: 98) quoted Perrier de la Bâthie label information discussing the potential role of fire in resprouting in *Kosteletzkya velutina*.

Selected specimens examined. – **Madagascar. Reg. Amoron'i Mania [Prov. Fianarantsoa]:** 48 km N of Ambositra, 1300 m, 24.I.1975, *Croat 29340* (MO 2591499); col de tapia, entre Antsirabe et Ambositra, 20°15'S 47°06'E, 1500 m, 6.III.1985, fl., *Dorr 3836* (MO-3280577, P [P00574185]); env. d'Ambatofinandrahana (Betsileo), 6.I.1955, fl., *Humbert 28044* (MO-6071577, P [P00574179]); km 49.5 on RN 7 just after Ambohimanjaka between Ansirabe and Ambositra, 20°14'00"S 47°05'31"E, 1414 m, 8.I.2005, fl., *Koopman 215* (MO-6438153, P [P00980551], TAN, WIS); 14 km on road to Itremo from Ambatofinandrahana, 20°34'07"S 46°43'23"E, 1039 m, 9.I.2005, fl., *Koopman 217* (MO, P, TAN, WIS); col des Tapia, près d'Ilaka, 26.X.1960, fl., *Leandri 3326* (P [P00574186]); entre Ambositra et Ambohimahasoa, 20.X.1922, fl., *Poisson 626* (P [P00574196]). **Reg. Analamanga [Prov. Antananarivo]:** Antsahadita, [19°01'S 47°27'E], 25.XII.1905, fl. & fr., *Alleizette 762* (P [P00574038]); près des marais de la Sisaony, 13.VIII.1950, fl., *Benoist 69* (G, P [P00574159]); env. de Tananarive, 10.II.1939, fl., *Decary 13880* (P [P00574205]). **Reg. Haute Matsiatra [Prov. Fianarantsoa]:** Ankafana, 1880, *Cowan s.n.* (BM); Anja parc à 12 km au S d'Ambalavao, inselberg Ambohilady, 21°51'08"S 46°50'58"E, 1194 m, 10.XII.2010, fl., *A. Ramahefaharivelo 259* (MO-6440406, P [P04642005], TAN). **Reg. Ihorombe [Prov. Antananarivo]:** Ihosy, 10.IX.1939, fl., *Decary 15067* (P [P00574169]). **Reg. Itasy [Prov. Antananarivo]:** ruisseau entre Soavinandriana et Faratsiho au niveau du village Manakambahiny, 19°12'36"S 46°47'21"E, 1413 m, fl., 12.VI.2015, *Andriambololonera 434* (MO-6715120, TAN); Mahobo (interior), I.1931, fl., *Scott Elliot 1905* (K [K000240502]); massif de l'Ankaratra (versant E), 27.IV.1955, fl., *Humbert 30319* (P [P00574180]); entre Arivonimamo et Soamananety, I.1931, fl., *Peltier 1664* (P [P00574188]). **Reg. Vakinankaratra [Prov. Antananarivo]:** Betafo, Alakamisy Marososona, Ranomainty, à 312 m à l'E du Mt Trafo, 20°06'01"S 46°49'11"E, 1743 m, 17.IX.2004, fl., *Andriamihajarivo 365* (G, MO-6260834, P [P01072348], TAN, TEF); Manjakatompo, 5.I.1951, fl., *Benoist 926* (P [P00574161]); Ankaratra, entre Antsampandrahana et Nanokely, II.1957, *Bosser 10948* (MO-3332246); massif des Vavavako, 5.IX.1940, fl., *Decary 14410* (G); massif des Vavavato, 9.V.1940, fr., *Decary 15410* (P [P00574171]); rocher d'Iaranandriana, PK 38, route d'Antsirabe, avant Behenjy, 19°12'S 47°29'E, 1400 m, 25.XI.1984, fl., *Dorr*

3278 (MO-3322225, P [P00574173]); Lac d'Andraikiba, 2.IX.1895, *Forsyth-Major s.n.* (G [4 sheets]); Nord-Betsileo: Sirabé, VIII.1880, fl., *Hildebrant 3532* (G [2 sheets], P [P00574174]); col de Mahafompeno, 20.X.1963, fl., *Peltier 4250* (P [P00574190]); env. de Tsinjoarivo, bassin de l'Onive (Mangoro), II.1925, fl., *Perrier de la Bâthie 5466* [as "*77*" at G] (G, P [P00574194]); env. de Faratsiho (Ankaratra), IX.1921, fl., *Perrier de la Bâthie 13945* (P [P00574195]).

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Unpublished source

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