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Novelties from the Northern Mountains Complex of Madagascar VI: *Kalanchoe apiifolia* (Crassulaceae), a particular new species

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Abstract

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A new species of medium-sized and upright-flowered *Kalanchoe* Adans. (Crassulaceae) from medium altitude moist evergreen forests in northern Madagascar is described and illustrated: *K. apiifolia* D.-P. Klein, Shtein & Callm. By its herbaceous habit, forming erect flowers with a short and indistinct calyx tube, ligulate nectary scales, and not possessing bulbils of any kind, it represents a member of *Kalanchoe* subg. *Kalanchoe*. Morphologically, *K. apiifolia* is most similar to *K. briquetii* Raym.-Hamet but differs from it by being glabrous throughout, by having bi- to tripinnate leaves that are particularly long petiolate, and by the seed-bearing part of the carpels being about as long as the stylar part. The new species is preliminary assessed as “Endangered” [EN] using the IUCN Red List Categories and Criteria.

Résumé

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Une nouvelle espèce du genre *Kalanchoe* Adans. (Crassulaceae), caractérisée par sa taille moyenne et ses fleurs dressées, des forêts denses humides sempervirentes de moyenne altitude du nord de Madagascar est décrite et illustrée: *K. apiifolia* D.-P. Klein, Shtein & Callm. Par son habitus herbacé, ses fleurs érigées, son tube du calice court et indistinct, ses écailles ligulées sur les nectaires et en ne produisant pas de bulbilles de quelque forme que ce soit, cette espèce fait partie de *Kalanchoe* subg. *Kalanchoe*. Morphologiquement, *K. apiifolia* est très similaire à *K. briquetii* Raym.-Hamet mais s'en différencie par son aspect glabre, par la présence de feuilles bi- à tripennées possédant un pétiole particulièrement long, et par la partie des carpelles portant les graines qui est à peu près aussi longue que la partie stylisée. La nouvelle espèce est provisoirement évaluée comme “En danger” [EN] en se basant sur les catégories et les critères de l’UICN.

Keywords

CRASSULACEAE – *Kalanchoe* – Madagascar – Ambohimiravavy – New species

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Introduction

Madagascar is one of the centres of diversity of the genus *Kalanchoe* Adans. (Crassulaceae, Kalanchooideae) with more than 80 taxa and four out of six subgenera being endemic to the island (MADAGASCAR CATALOGUE, 2022). In the past two decades, a total of 18 species and nothospecies have been newly described from the island.

Kalanchoe subg. *Kalanchoe* is the only subgenus within the genus to be present in Madagascar as well as in continental Africa, the Arabian Peninsula, and Asia. Several species of this subgenus in Madagascar are particularly similar to species indigenous to continental Africa and do not have much morphological affinities with other Malagasy species. They are characterised by the absence of bulbils of any kind (whether on leaf margins, inflorescences, or from leaf parts), a small to medium-sized and herbaceous habit, erect flowers with unfused sepals, and filiform nectary scales. These species, which occur predominantly in the northern and western part of the island, include *K. antennifera* Desc., *K. blossfeldiana* Poelln., *K. boisii* Raym.-Hamet & H. Perrier, *K. briquetii* Raym.-Hamet, *K. chapototii* Raym.-Hamet, *K. darainensis* D.-P. Klein & Callm., *K. globulifera* H. Perrier, and *K. pareikiana* Desc. & Lavranos (see also KLEIN et al., 2021). Out of these, *K. blossfeldiana* is the only species to be sampled and included in a phylogenetic analysis to date, which recovered it in a clade with continental African and Asian species, while other Malagasy species occupied more basal positions (GEHRIG et al., 2001).

Between 2005 and 2008, a team of botanists conducted a series of field expeditions to explore the flora and vegetation in a long-neglected region of low to high elevation humid forests in northern Madagascar, which is referred to as the Northern Mountains (NM) Complex. This collection effort has revealed several new species in various families, e.g. *Burseraceae* (DALY et al., 2015), *Meliaceae* (CALLMANDER et al., 2009, 2012), *Oleaceae* (CALLMANDER et al., 2009a; HONG-WA, 2016), *Pandanaceae* (CALLMANDER et al., 2008, 2021), *Rubiaceae* (DE BLOCK, 2014; DAVIS & RAKOTNASOLO, 2021), or *Violaceae* (WAHLERT, 2016). Since these inventories, a forest corridor between the previously protected areas of Marojejy, Anjanaharibe-Sud, and Tsaratanana has been officially protected. This corridor named COMATSA Nord is important in maintaining endemic and threatened Malagasy taxa (RABEARIVONY et al., 2015). A field expedition to the western portion of the NM Complex, aiming to reach the summits of the Ambohimirahavavy (2301 m) and Biempoko (2219 m) massifs, revealed another new and particular species of *Kalanchoe* that is formally described here.

Taxonomy

Kalanchoe apiifolia D.-P. Klein, Shtein & Callm., sp. nov. (Fig. 1, 2).

Holotypus: MADAGASCAR. Reg. Sofia [Prov. Mahajanga]: Bealanana, Ambohimiravavy, Befamo, forêt d'altitude 13 km au NE de la commune rurale de Mangindrano, 14°13'29"S 49°03'40"E, 1730 m, 20.X.2005, fl., Rakotovoao et al. 2321 (G [G00427109]!; iso-: MO-5933515 image!, P [P00853199]!, TAN).

Kalanchoe apiifolia D.-P. Klein, Shtein & Callm. differs from *K. briquetii* Raym.-Hamet by being glabrous throughout, by having more strongly dissected leaves that are bi- to tripinnate, particularly long petiolate and have ovate to obovate leaflets, filaments that are not papillose, and the seed-bearing part of the carpels being about as long as the stylar part. It differs from all other known members of *Kalanchoe* subg. *Kalanchoe* by a combination of characters including the above and additionally: compound thyrsoid inflorescences, bearing up to 180 erect, whitish green flowers, tinged with bright purplish red spots, indistinct calyx tube, widely spreading sepals, and mucronate petals.

Plants medium-sized herbs, succulent, 23–29 cm high, upright, unbranched, glabrous throughout. Stems creeping at base and rooting, later erect, terete, 5–6 mm in diam. near base, narrowing down to c. 2.5 mm at insertion of uppermost pair of leaves, bearing ± 6 pairs of leaves, internodes 1.8–3 cm long, leaf scars croissant-shaped. Leaves compound, decussate, fleshy (very thin when dried), green to dark green; lowermost leaves bi- to tripinnate, long petiolate, petiole 3.2–8.7 × 0.2–0.3 cm, lamina 5–9 × 5.5–13.5 cm, when bipinnate, in its proximal half up to 2 pairs of opposite imparipinnate pinnae, with a stalk of 0.2–1.8 cm long and 3–5 leaflets, in its distal half up to 2 pairs of leaflets and 1 terminal leaflet, when tripinnate, in its proximal half 1 pair of at least partially bipinnate pinnae, with a stalk of 1.7–1.9 cm long and 6–12 leaflets, followed by up to 2 pairs of opposite imparipinnate pinnae, with a stalk of 0.1–0.5 cm long and 3–5 leaflets, in its distal half up to two pairs of leaflets and 1 terminal leaflet; leaflets 0.8–1.8 × 0.6–1.6 cm, (sub-)opposite, ovate, with a truncate to cuneate and more or less asymmetric base, broadly and irregularly crenate, sessile to shortly petiolulate, flat, slightly decurrent, terminal leaflet similar, but 1.9–2.8 × 1.3–2.1 cm, ovate to irregularly lobed; subsequent leaves imparipinnate, petiole 1.2–4.0 × 0.2–0.3 cm, lamina 4.4–6 × 4–8 cm, with 3–5 leaflets, 1.7–2 cm × 0.7–1 cm, simple, rarely trilobate, ovate to oblanceolate, widely sinuate, base cuneate to attenuate, shortly petiolulate to sessile. Inflorescences a terminal determinate thyrses or double thyrses, supplemented by up to 2 pairs of opposite auxiliary inflorescences of same type, together bearing up to 180 flowers; thyrses composed of dichasial cymes, frequently grading into monochasia from



Fig. 1. – Close-up of flowers of *Kalanchoe apiifolia* D.-P. Klein, Shtein & Callm. [Rakotovao et al. 2327] [Photo: C. Rakotovao]

their second order branches onwards; terminal inflorescence with a peduncle of 3–3.6 cm long and a rachis of 5–6.4 cm long. Bracts oblanceolate, widely sinuate to entire, lowermost bracts 2.5–2.7 × 1.2–1.5 cm, petioles 0.6–1 × 0.05–0.1 cm, uppermost bracts 0.7–1.3 × 0.2–0.4 cm, petioles 0.2–0.3 × 0.03–0.1 cm; auxiliary inflorescences similar, but peduncles 5.6–7.5 cm long, rachides 3–7 cm long, lowermost bracts 1–2 × 0.4–1 cm, petioles 0.2–0.7 × 0.03–0.08 cm, uppermost bracts 0.4–1 cm × 0.1–0.3 cm, petioles 0.1–0.3 × 0.02–0.05 cm. Bracteoles 1.5–3.8 × 0.3–0.7 mm, oblanceolate, entire, apically acute, sessile. Pedicels 0.2–0.4 × 0.02–0.05 cm, slightly widening towards flower. Flowers 0.7–0.9 × 0.3–0.4 cm, erect. Sepals 3.5–4.3 × 0.3–1 mm, widely spreading, lanceolate to narrowly oblong, apically acute, bright green, fused only at base and forming an indistinct calyx tube of 0.1–0.2 mm long. Corolla tube 6.1–7.7 mm long, ± quadrangular, 3.3–4.5 mm in diam. at widest part, gradually constricted above ovary to a short subconical tube, whitish green, tinged with a bright purplish red, especially in its lower half and before anthesis. Petal lobes 1.5–2.0 × 1–1.3 mm, ovate, apex mucronate (0.3–0.5 mm long). Stamens 8, arranged in two rows of 4, anthers of lower row included, anthers of upper row included to very slightly exerted; filaments non-papillose, lower filaments alternipetalous, inserted at c. 5.5 mm above base of corolla tube, free for 1.5 mm; upper filaments oppositipetalous, inserted at c. 6 mm, free for 2.5 mm. Anthers creamy white to yellowish, each theca 0.6 × 0.2 mm, elliptic, base emarginate, apex rounded. Pistil composed of 4 carpels, seed-bearing part 3.5–4.5 mm long, fused in its lower 3/4, forming an ovoid to ellipsoid ovary of 2–3 mm diam.; styles free, filamentous, 3.5–4.5 mm long, stigmas capitate. Scales ligulate, 3.5–4.3 × c. 0.2 mm, thin, transparent, adpressed to carpel. Seeds 14–18 per follicle, 0.5–0.6 × 0.2–0.3 mm, brown, striate, with a 0.1 mm broad wing.

Etymology. – The species epithet refers to the leaves of this new species, which strongly resemble the foliage of some members of *Apiaceae*, such as *Apium graveolens* L.

Distribution, ecology and phenology. – *Kalanchoe apiifolia* is known only from a single collection in medium altitude moist evergreen forest (GAUTIER et al., 2018) east of Mangindrano in the upper watershed of the Befamo river at the base of the Ambohimiravavy massif (Fig. 3). The type locality is underlain by Paleoproterozoic rocks including amphibolite, calcic silicate, and quartzite belonging to the Sambirano-Sahantaha group (CROWLEY & SAPRKS, 2018). The vegetation structure in the watershed is composed of three layers: a canopy with *Dombeya spectabilis* Bojer (*Malvaceae*) and *Elaeocarpus subserratus* Baker (*Elaeocarpaceae*), a shrub layer with *Eugenia diospyroides* H. Perrier (*Myrtaceae*), *Macphersonia gracilis* O. Hoffm. (*Sapindaceae*), *Oncostemum hildebrandtii* Mez (*Primulaceae*), *Turraea andriamiarisoana* Callm. et al. (*Meliaceae*) or *Volkameria* sp. (*Lamiaceae*), and a continuous understory with *Adiantum flabellum* C. Chr. (*Pteridaceae*) and *Asplenium lastii* C. Chr. (*Aspleniaceae*) mixed with *Elatostema goudotianum* Wedd. (*Urticaceae*) and *Impatiens lyallii* Baker (*Balsaminaceae*).

Kalanchoe apiifolia was collected in flower in October.

Conservation status. – *Kalanchoe apiifolia* is known only from a single collection in the Befamo river watershed situated within the COMATSA Nord protected area. The upper part of the watershed is still forested but an extensive trace of former deforestation exists along the southern part where the river flows into the Androranga river (GAUTIER & CALLMANDER, 2018). Fires are known to occasionally enter pristine forests and are also known along pastures and summit zones (GOODMAN et al., 2018). Due to its very restricted range and the plausible threats to its habitat caused by slash-and-burn agriculture, *K. apiifolia* is assigned to a preliminary risk of extinction status of “Endangered” [EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)] using the IUCN Red List Categories and Criteria (IUCN, 2012).

Notes. – The new species belongs to *Kalanchoe* subg. *Kalanchoe* based on the following characters: herbaceous habit, leaves and inflorescences never bulbiferous, flowers erect, short to indistinct calyx tube, sepals largely free, filaments inserted ± above the middle of the corolla tube, carpels fused for most of their length of their seed-bearing part, scales elongated to linear, > 3 × longer than wide, and anthers included in corolla-tube or very slightly exerted (DESCOINGS, 2003; BOITEAU & ALLORGE-BOITEAU, 1995; SMITH & FIGUEIREDO, 2018). While in most species belonging to *Kalanchoe* subg. *Kalanchoe* the ovaries are much longer than the styles (DESCOINGS, 2003), *K. apiifolia* possesses such of almost equal length.

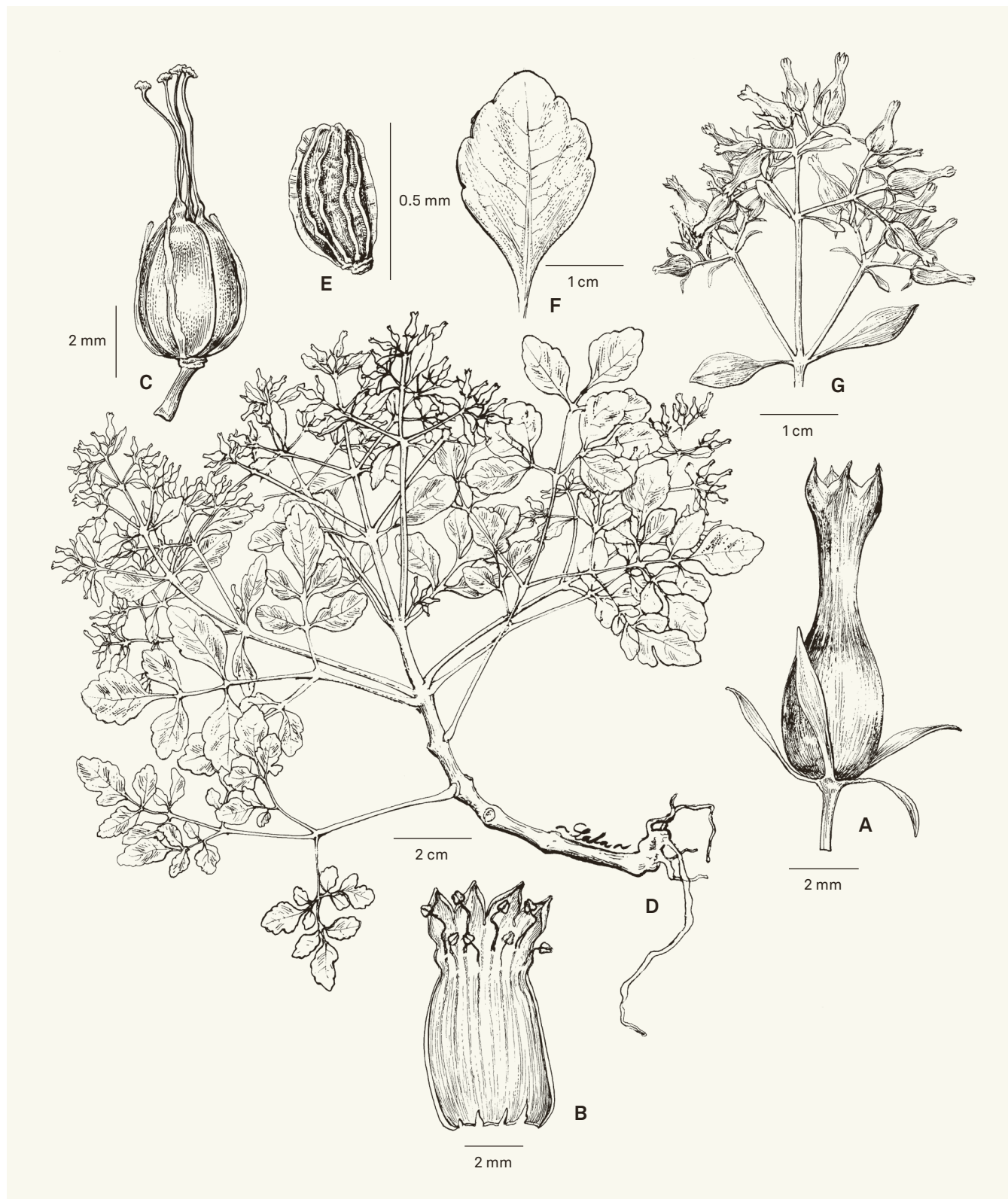


Fig. 2. – *Kalanchoe apiifolia* D.-P. Klein, Shtein & Callm. A. Flower; B. Dissection of corolla, showing androecium; C. Gynoecium; D. Habit; E. Seed; F. Leaflet of lowermost leaves; G. Detail of an inflorescence.
[Rakotavao et al. 2321, G] [Drawings: R.L. Andriamiarisoa]

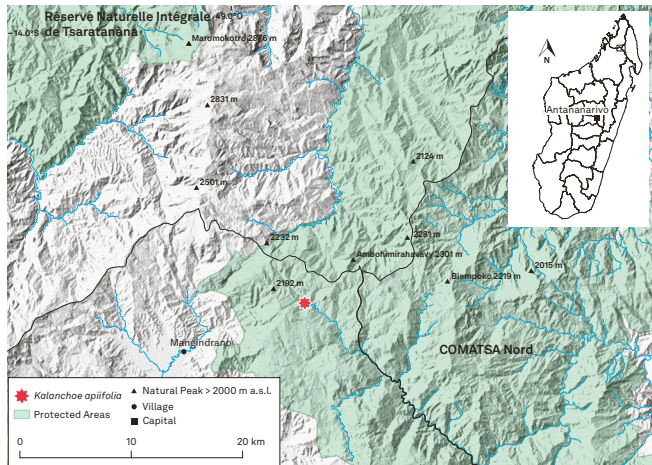


Fig. 3. – Distribution map of *Kalanchoe apiifolia* D.-P. Klein, Shtein & Callm. [Map derived from open data sources: <https://earthdata.nasa.gov>, OpenStreetMap®, MOAT & SMITH (2007) and UNEP-WCMC & IUCN (2022)]

Kalanchoe apiifolia can be easily distinguished from other representatives of *Kalanchoe* subg. *Kalanchoe* which occur in northern and western Madagascar by the characters indicated in Table 1. It morphologically most resembles *K. briquetii* by the comparatively rich-flowered inflorescences comprising a terminal part that is supplemented by auxiliary inflorescences, sepals that are much longer than wide and strongly spreading, a short isodiametric corolla portion, relatively short filaments, and by the lack of connective glands on the anthers. Nevertheless, *K. apiifolia* can be easily distinguished from *K. briquetii* by the absence of an indumentum (vs. entirely covered by glandular trichomes), by its bi- to tripinnate leaves (vs. 3-partite), the presence of long stalked pinnae with distinct leaflets (vs. sessile

lobes), ovate to oblanceolate leaflet blades (vs. lanceolate to linear leaf lobes), a wider than long inflorescence (vs. longer than wide), ovate and mucronate petals (vs. suboblong and retuse), longer than wide anthers that are partially to fully included (vs. wider than long and fully exerted), and the seed-bearing part of the carpels being about as long as the stylar part (vs. 1.3–1.5 times longer), containing more seeds.

Kalanchoe briquetii is known only from the type collection made by Jules Goudot in northern Madagascar during his second expedition to the Island in 1833 (DORR, 1997). The holotype in G [G00023459] has the locality “Baie de Diégo Soarès [Suarez]” and was probably collected in dry, wooded grassland-bushland mosaics whereas *K. apiifolia* is known from medium altitude moist evergreen forest, suggesting different ecological niches.

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Table 1. – Selected diagnostic characters distinguishing *Kalanchoe apiifolia* D.-P. Klein, Shtein & Callm. from other *Kalanchoe* subg. *Kalanchoe* from northern and western Madagascar. Characters diagnostic for a species are in bold type.

	<i>K. apiifolia</i>	<i>K. briquetii</i>	<i>K. antennifera</i> , <i>K. boisii</i> , <i>K. chapototii</i>	<i>K. globulifera</i>	<i>K. blossfeldiana</i>	<i>K. darainensis</i>	<i>K. pareikiana</i>
Leaves	bi- to tripinnate	bi-lobed, tripartite	entire to bi-pinnate	entire	entire	entire	entire
Indumentum	absent	dense, glandular	dense, glandular	sparse, glandular	absent	dense, glandular	sparse, glandular
Flowers	erect, actinomorphic, white-greenish	erect, actinomorphic, colour unknown	erect, actinomorphic, yellow	erect, actinomorphic, yellow	erect, actinomorphic, red	erect, actinomorphic, red	erect, actinomorphic, yellowish
Sepals	spreading, lanceolate, acute	spreading, lanceolate, acute	adpressed, deltoid, acuminate	spreading, lanceolate, acute	spreading, lanceolate, acute	spreading, lanceolate, acute	adpressed, ovate, obtuse
Petals	ovate, mucronate	sub-oblong, retuse	ovate, acuminate	ovate, mucronate	(ob)ovate, mucronate	(ob)ovate, mucronate	ovate, obtuse
Anther glands	absent	absent	present	present	absent	present	absent

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