



## ***Criscianthus*, a new genus of Eupatorieae (Asteraceae) with a key to members of the tribe in Africa**

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### **Abstract**

*Stomatanthes zambiensis* is segregated from the African genus *Stomatanthes* and raised as the only species of the new genus *Criscianthus* (Eupatorieae, Asteraceae). *Criscianthus zambiensis* is characterized by its verticillate phyllotaxy with three leaves per node, phyllaries with caudate apex, and an exclusive type of hair in its cypsela. A full description of the genus and its species, a morphological analysis, photographs, illustrations, and a distribution map are provided. A key to native and alien species of the tribe Eupatorieae in Africa is included.

### **Resumen**

Se segrega a *Stomatanthes zambiensis* del género africano *Stomatanthes* y se eleva como la única especie del nuevo género *Criscianthus* (Eupatorieae, Asteraceae). *Criscianthus zambiensis* se caracteriza por su filotaxis verticilada con tres hojas por nudo, filarias con el ápice caudado y un tipo exclusivo de pelo en su cipsela. Se incluye una descripción completa del género y de su especie, un análisis morfológico, fotografías, ilustraciones y un mapa de distribución. También se incluye una clave de las especies nativas y adventicias de Eupatorieae en África.

**Key words:** African Eupatorieae, Eupatoriinae, morphology, *Stomatanthes*

### **Introduction**

Generic circumscription and the number of accepted genera within the tribe Eupatorieae (Asteraceae) has changed significantly over the last 45 years. Most of the species of the tribe were once classified as *Eupatorium* Linnaeus (1753: 836). Between 1967 and 1986 in a series of papers of Robert M. King and Harold Robinson (King & Robinson 1987) the genus was split into ca. 100 new genera, mainly on the basis of micromorphological (i.e., microscopically observed) characters. Currently the tribe consists of 17 subtribes, 182 genera, and ca. 2200 species concentrated in the Americas with few representatives in the Old World (Hind & Robinson 2007).

The subtribe Eupatoriinae, as defined by King & Robinson (1987) and Hind & Robinson (2007), would comprise four genera: *Austroeupatorium* King & Robinson (1970a: 433; 13 species), *Eupatorium* (ca. 45 species), *Hatschbachiella* King & Robinson (1972: 393; two species), and *Stomatanthes* King & Robinson (1970a: 430; 17 species). Some authors (Schmidt & Schilling 2000 sub *Eupatoriadelphus*, Lamont 2004, Siripun & Schilling 2006) consider also the genus *Eutrochium* Rafinesque (1836: 78; five species) as a member of the subtribe whereas other authors (e.g., Hind & Robinson, 2007) do not recognize it.

King & Robinson (1970a) included 15 species in *Stomatanthes*, and two more species were added later (Lisowski 1991; Grossi & Nakajima 2009). The genus was divided into the subgenera *Stomatanthes* and *Verticifolium* King & Robinson (1975: 463). The subgenus *Verticifolium*, with its only African species *Stomatanthes zambiensis* King & Robinson (1975: 465), was distinguished by the more corymbose inflorescence, the lack of a prominent close reticulation of the veins on the lower leaf surface, and the cypselae with few or no setulae (= twin hairs). As indicated by the name of the subgenus, the leaves are verticillate, ternate.

In a recent revision of *Stomatanthes* (Grossi 2011a; Grossi & Katinas 2013) the phylogeny of the genus was assessed based on morphological characters combined with a cluster analysis and a non-metric multidimensional scaling. As it also occurs with the molecular phylogenies performed in Eupatorieae, a moderate to low branches support was obtained, which is explained by the rapid radiation of lineages within the tribe (Ito *et al.* 2000, Schmidt & Schilling 2000, Schilling 2011). However, the combined phylogenetic and phenetic analyses helped to resolve several polytomies that exist in the group. The results of Grossi & Katinas (2013) indicated that some groups of the 17 species traditionally included in *Stomatanthes* have distinctive morphological differences, and that the genus was not monophyletic (Fig. 1). *Stomatanthes* was restricted to three African species (Grossi & Katinas 2013), with the other African member *S. zambiensis* (the only species of the subgenus *Verticifolium*) constituting an independent branch, sister to American and European members of the Eupatoriinae. *Stomatanthes zambiensis* is characterized by its verticillate phyllotaxy with three leaves per node, phyllaries with caudate apex (Fig. 2A), and an exclusive type of hair in its cypselae (Fig. 2D), different from those hairs in other members of the subtribe. Therefore, *Stomatanthes zambiensis* is transferred to the new genus *Criscianthus* here.

## Material and methods

This study was conducted using herbarium collections, digital images, and photographs of herbaria BRLU, K, M, and US (acronyms as in Holmgren *et al.* 1990). For microscopic studies, vegetative and reproductive parts were rehydrated, treated with a clearing process, stained with 2% safranin in ethanol, and mounted on microscope slides. Plant organs were isolated and free hand cut transversely were made. Observations and drawings of morphological and anatomical features were carried out on a Nikon Eclipse E200 light microscope equipped with a camera lucida. Light microscope photographs were taken with a Nikon Coolpix S10.

For the diafanization process the marginal area of median part of leaves were boiled in 96 % ethanol and transferred into a 5 % sodium hydroxide (NaOH) solution for 5–10 seconds. The samples were washed with distilled water before bleaching in 50 % sodium hypochlorite (NaOCl) for 5–10 minutes. After several washes in distilled water, leaves were transferred into chloral hydrate for 24–48 hours, washed, coloured with safranin, and mounted in glycerine.

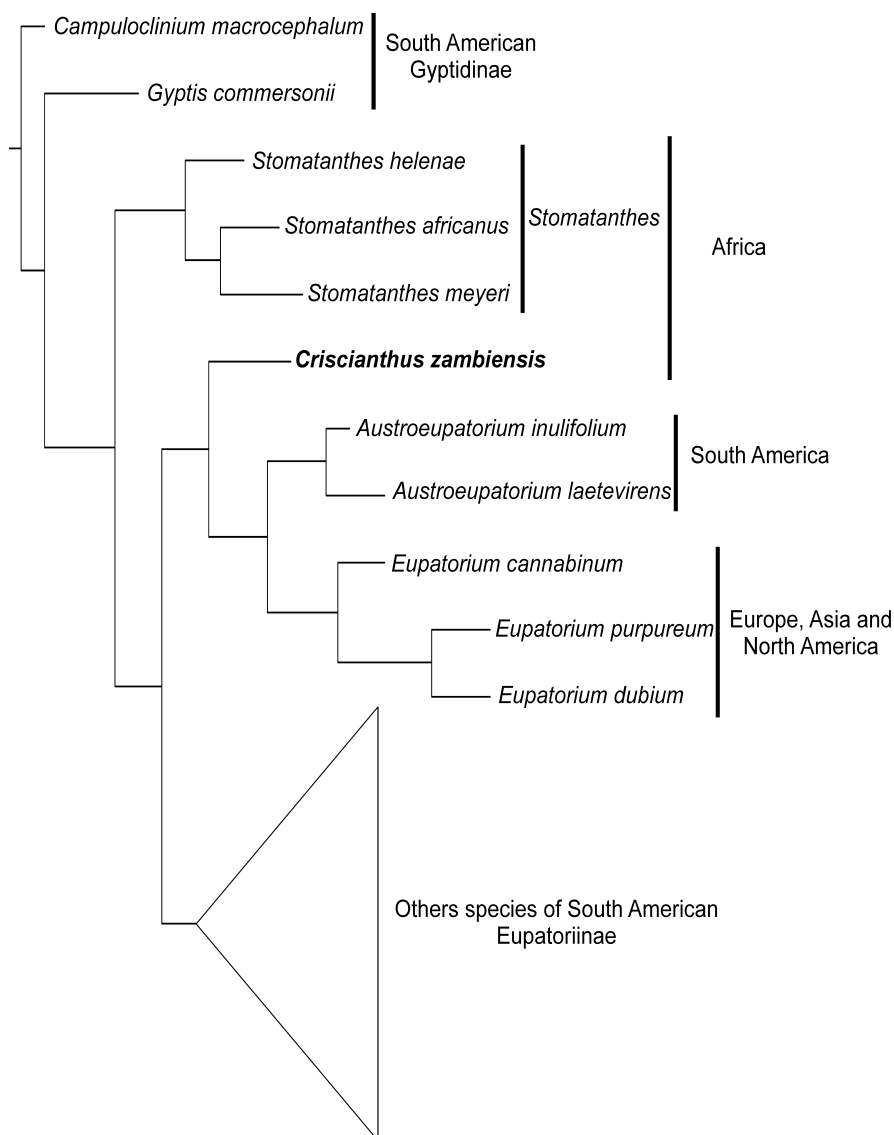
Leaf terminology follows Harris & Woolf Harris (1994) and Leaf Architecture Working Group (1999); some venation terms are defined here as follows.

Primary veins: Leaves of *Criscianthus* are trinerved, therefore primary veins comprise the midvein and the two basal lateral veins.

Secondary veins: They are the next set in width after the primary veins.

Tertiary veins: They are usually considerably narrower than the secondary set and have courses that connect primary and secondary veins to one another.

Areoles: They are the smallest areas of the leaf tissue surrounded by veins. Any order of venation can form one or more sides of an areole.



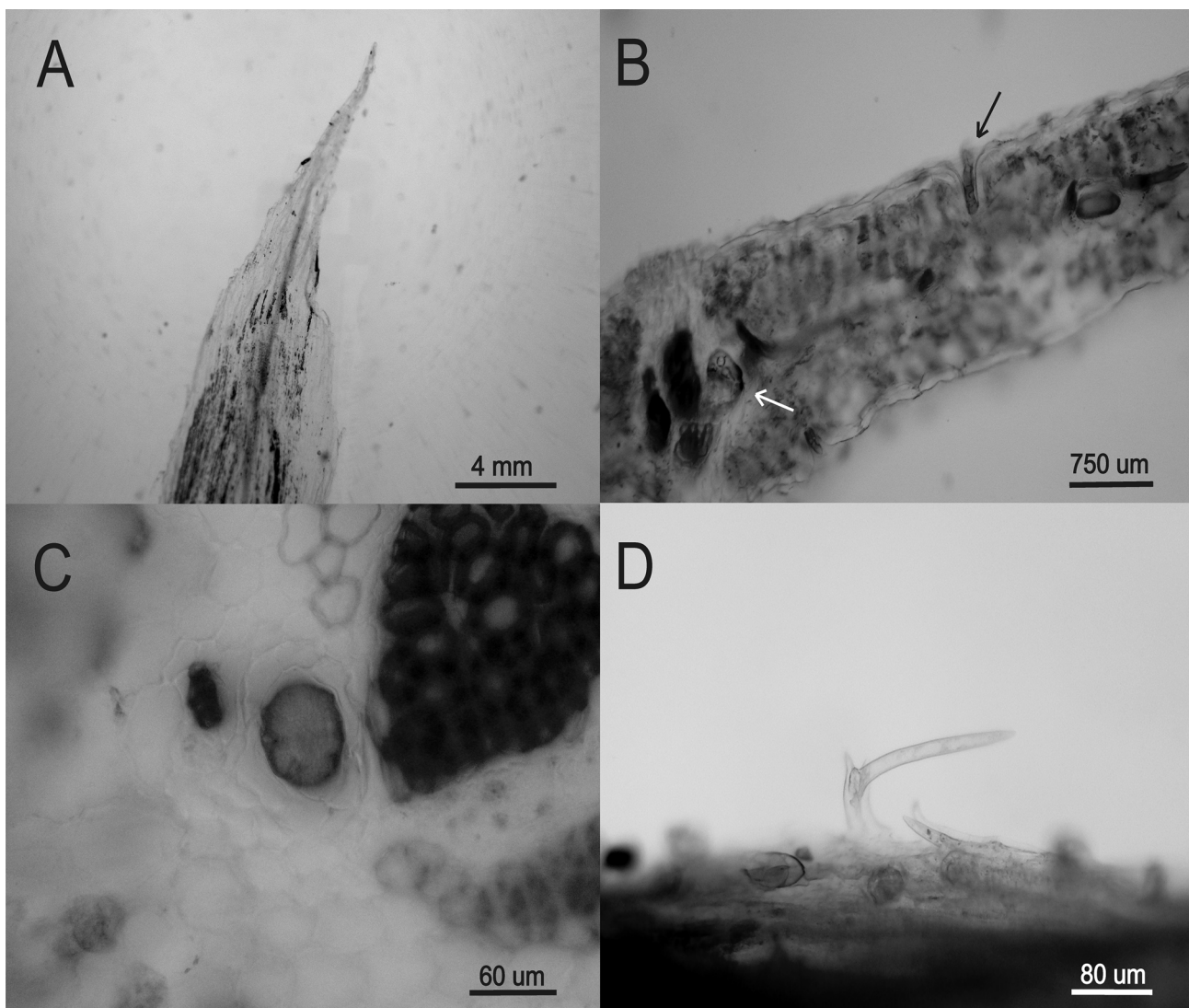
**FIGURE 1.** Modified phylogenetic tree obtained by cladistic analysis of morphological characters from maximum parsimony of members of the subtribe Eupatoriinae published by Grossi & Katinas (2013). Note the independent position of *Criscianthus zambiensis* regarding the species of *Stomatanthes*.

## Results and Discussion

### Morphology

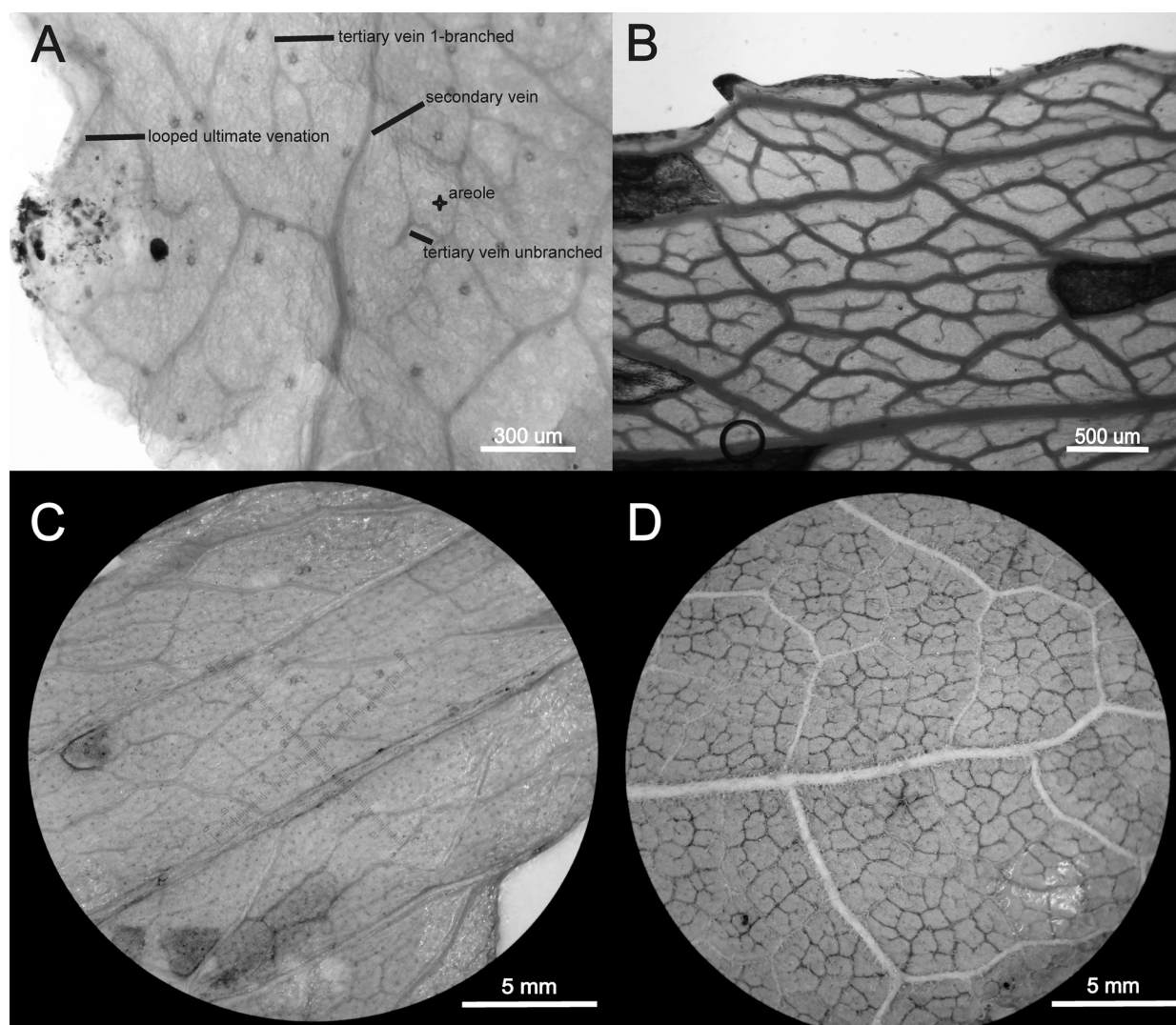
**Leaves.** The leaves of *Criscianthus* are verticillate, with three leaves per node. This is a distinctive feature of the new genus, since species of *Stomatanthes* have alternate or subopposite leaves. At stereoscope observation the leaves appear glabrous, but with microscope examination a few hairs are seen. These hairs were called simple filiform by Ramayya (1962) and described for example in the genus *Ageratum* Linnaeus (1753: 839) (Eupatorieae). In *Criscianthus*, the hairs have a 1-celled foot, a body uniseriate, 5-more-celled, with an opaque content at the stereomicroscope observation, and a cylindrical or tapering apical cell. The opaqueness is attributed to the presence of pectic substances by Ramayya (1962). However, it cannot be discarded that they are also involved with a secretion process due to the extensive secretory system in the vegetative organs of *Criscianthus*. Hairs are sunken in the epidermis (Fig. 2B), and sometimes they shed off. The epidermal cells surrounding the hairs are thickened giving a punctate or dotted appearance to the leaves, mainly in the lower face.

In transection (Fig. 2B), the leaves of *Criscianthus zambiensis* show that the midrib is generally protruding. The leaf symmetry is bifacial, with adaxial palisade clorenchyma and abaxial spongy clorenchyma. Bifacial structure in the leaves is found also in one species of *Stomatanthes* [*S. meyeri* King & Robinson (1975: 463)], the genus from which *Criscianthus* was split, whereas the other two species of *Stomatanthes* have an isobilateral structure. The 1-layered, rectangular adaxial and abaxial epidermal cells have thickened walls and a thick cuticle layer, stomata have commonly small stomatal chambers, and are at the same level with the epidermis or slightly elevated. The chlorenchyma is constituted by adaxial palisade cells in three to five layers, and abaxial spongy mesophyll cells in up to seven layers, with relatively small intercellular spaces. The primary collateral vein is sheathed by sclerenchyma tissue, and separated from adaxial and abaxial epidermis by collenchyma layers. Secondary vascular bundles are arranged in one row, approximately equidistant from the abaxial and adaxial epidermal layers. Schizogenous secretory structures are conspicuous and located close to the veins (Figs. 2B, C). Leaves are amphistomatic and stomata are of the anomocytic type.

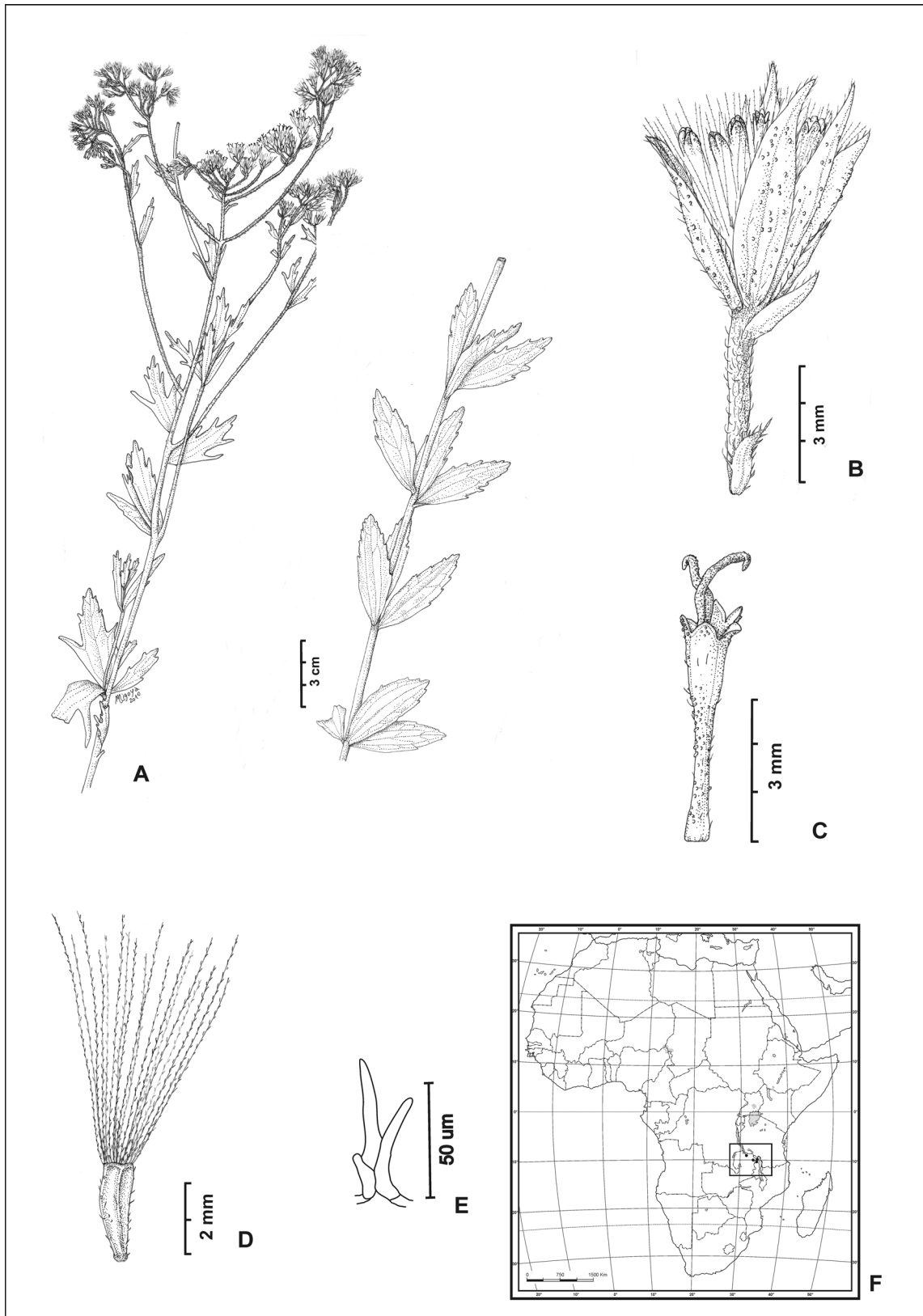


**FIGURE 2.** Phyllary, leaf, and fruit morphology and anatomy of *Criscianthus zambiensis*. **A.** Upper part of a phyllary of the involucre showing the caudate apex. **B.** Leaf transection showing the bifacial symmetry, with one hair sunken in the epidermis and the position of secretory ducts close to the vein (arrows). **C.** Detail of secretory duct in transection, note its schizogenous nature evidenced by the two rows of epithelium surrounding the space with dark content. **D.** Modified twin hair in cypsel exclusive of *Criscianthus*, with two basal hair cells diverging at the apex and a third, long cell placed in a right angle at the point of divergence of the two basal cells. A–D from Richards 18908 (US).

King & Robinson (1975) distinguished *Criscianthus zambiensis* (as *Stomatanthes zambiensis*) by three features, one of them the leaf venation. They observed that *S. zambiensis* differs from typical *Stomatanthes* by the lack of closely anastomosing veins such as are seen in all other species of the genus. Therefore, cleared leaves of *Criscianthus zambiensis* were here analyzed and compared with leaves of *Stomatanthes africanus* (Oliv. & Hieron. in Oliver 1877: 301) King & Robinson (1970a: 430) and *S. helenae* (Buscalioni & Muschler 1913: 505) Lisowski (1991: 456) to check if there are differences in venation patterns. On the basis of the number of strands entering the base of the leaf, *C. zambiensis* is triveined, i.e., there are three primary veins. Tertiary veins reticulate randomly, i.e., tertiaries anastomose with other tertiary or secondary veins at random angles (Figs. 3A, C). Areolation is poorly to moderately developed, with areoles of irregular shape, more or less variable in size. The freely ending ultimate veins (tertiary) are unbranched or 1-branched. The veinlets adjacent to the leaf margins do not end freely but these veins are recurved forming loops. The venation branching system is almost similar in the species of *Stomatanthes*, but the veins are wider and conspicuous (Fig. 3B). Another difference is that the areolation in *Stomatanthes* is well developed, i.e., areoles are relatively consistent in size and shape. This feature can be clearly seen at stereomicroscope observation (Fig. 3D). Probably, the less developed areolation in *Criscianthus* is what King & Robinson (1975) defined as a lack of closely anastomosing veins.



**FIGURE 3.** Venation of *Criscianthus* and *Stomatanthes*. **A, B.** At light microscope observation. **A.** *Criscianthus zambiensis*, the dark staining area in the marginal tooth probably corresponds to the ending of a secretory duct. **B.** *Stomatanthes helenae*, note the conspicuous areolation. **C, D.** At stereomicroscope observation. **C.** *Criscianthus zambiensis*. **D.** *Stomatanthes meyeri*. A, from Richards 18908 (US); B, from Duvigneaud 4446 (BRLU); C, from Chapama et al. 705 (K); D, from Friis et al. 1518 (K). Photos: A and B by Mariana A. Grossi, C and D by Jimi Nakajima.



**FIGURE 4.** *Criscianthus zambiensis*. A. Apex of flowering branch. B. Capitulum. C. Floret. D. Cypselae and pappus. E. Fruit hair. F. Geographical distribution. A, from Richards 12084 (K); B–E, from Richards 18908 (US).

*Cypselae*. Cypselae have a distinctive carpopodium at the base, which is constituted by oblong cells. The distribution and the type of hairs are other features that separate *Criscianthus* from *Stomatanthes*. Glandular hairs in *Criscianthus* are spread in the whole surface of the cypselae, whereas they are scarce and mostly surrounding

the carpodium in *Stomatanthes*. These hairs are biseriate vesicular, with a foot 1–many-celled, have a biseriate body, 2–10-celled in each row, and a cuticular vesicle at the apex. Non-glandular hairs in *Criscianthus* are scarce and with a morphology exclusive of this genus regarding other members of Eupatoriinae. They are atypical twin hairs (Freire & Katinas 1995), i.e., a modification of the typical 4-celled twin hairs (*Zwillinghaare*; Hess 1938) (Figs. 2D, 4E). They are mostly 3-celled with all cells cylindrical and tapering above; two basal cells, one shorter, are united with each other at the base and diverge at the apex, subtending the third, longer cell. Different hair ontogenetic stages may be found in the cypselae represented by younger two-celled hairs diverging near the apex, and mature hairs with transversal septa, forming up to six cells.

### ***Subtribal and generic relationships***

According to the key to subtribes proposed by King & Robinson (1987) and Hind & Robinson (2007), *Criscianthus* belongs to the subtribe Eupatoriinae mainly because of its heads with less than 20 florets, involucre subimbricate with few (up to seven) phyllaries, corolla lobes smooth on the inner surface, and style base with hairs. Thus, Eupatoriinae is constituted by six genera: *Austroeupatorium*, *Criscianthus*, *Eupatorium*, *Eutrochium*, *Hatschbachiella*, and *Stomatanthes*.

Within Eupatoriinae, *Criscianthus* is morphologically most similar to the North American genus *Eutrochium* and to the species of *Eupatorium* with verticillate phyllotaxy (e.g., *E. cannabinum*) from Eurasia and North America (Hind & Robinson 2007). They have in common the leaves verticillate and the cypselae covered mostly by glandular hairs. *Criscianthus* differs by its subshrubby habit (vs. annual or perennial herbs in the other taxa), 7–10 phyllaries (vs. 10–22), and the presence of particular non-glandular hairs mixed with the glandular hairs on the cypselae (vs. cypselae completely glandulose, occasionally with few twin hairs).

### ***The Eupatorieae in Africa***

The Eupatorieae in Africa are represented by 10 genera and about 27 species, including the newly described monotypic genus (Table 1). Regarding other regions of the world, the tribe Eupatorieae has few representatives in this continent. The African Eupatorieae are *Adenostemma* Forster & Forster (1776: 89), *Ageratina* Spach (1841: 286), *Ageratum*, *Campuloclinium* Candolle (1836: 136), *Chromolaena* Candolle (1836: 133), *Criscianthus* M.A.Grossi & J.N.Nakaj., *Eupatorium*, *Fleischmannia* Schultz Bipontinus (1850: 417), *Mikania* Schmidt (1795: 272), and *Stomatanthes*. Overall, these genera belong to eight different subtribes of Eupatorieae, with five genera represented by only one species. The subtribe Eupatoriinae contains the major number of genera: *Criscianthus*, *Eupatorium*, and *Stomatanthes*, two of them native to Africa. Considering all the genera, there are 16 native species on the continent and 11 are alien. Species of *Ageratina*, *Ageratum*, *Campuloclinium*, and *Chromolaena* are alien invaders and weeds in the region (Table 1). One of these, *Chromolaena odorata* (Linnaeus 1759: 1205) R.M.King & Robinson (1970c: 204), has become a very aggressive, invasive weed, first recorded as naturalized in South Africa in the late 1940s, and then spread all over the continent (Zachariades & Goodall 2002, Paterson & Zachariades 2013). On the other hand, *Mikania*, *Adenostemma* and *Stomatanthes* have species considered of importance in host-specificity trials of potential biological control agents (Retief 2002). In this sense *Criscianthus zambiensis* could be considered as another candidate to explore the control of the threat that *Chromolaena odorata* represents not only in Africa but internationally, to agriculture and biodiversity.

It is important to remark that apparently there is nomenclatural confusion and misidentifications in some African Eupatorieae. For example, in the past authors tended to recognize a single, variable, pantropical species *Adenostemma viscosum* Forster & Forster (1775: 90), but then a broad view of the species gradually occurred with the recognition of more species although with some morphologic overlapping. The names *Adenostemma lavenia* (Linnaeus 1753: 902) Kuntze (1891: 304), *A. lavenia* var. *lavenia*, and *A. viscosum* have been variously applied to this widespread taxon in some floras of Asia and the Pacific regions. Here we apply the name *Adenostemma viscosum* according to King & Robinson (1987) who restricted the distribution

of *A. lavenia* to Sri Lanka. A more extended discussion on this topic is developed by Orchard (2011). On the other hand, *Mikania scandens* (Linnaeus 1753: 836) Willdenow (1803: 1743) and *M. cordata* (Burmah 1768: 176) Robinson (1934: 65), of the "*Mikania scandens*" complex, have been reported for Africa (Table 1), but the presence of both species on the continent is dubious (Holmes 1982; Walter Holmes, pers. comm.). *Mikania scandens* is generally limited to the United States and sparsely found in the Bahama Islands and northeastern Mexico. It seems that the reports of the species throughout much of the Americas are better treated under other names, and those reports of *M. scandens* in the Old World are misidentifications. According to Holmes (pers. comm.) at one time the name *Mikania scandens* was used to refer to all of the *Mikania* species of Asia and the Pacific region, Africa, and many South and Central American species. Regarding *Mikania cordata*, the species might be limited to southeastern Asia (Burma to Hainan), Indonesia, the Philippines, and eastward to New Guinea and the Solomon Islands. Despite the probable absence of both species in Africa but due to the complexity of this group of species, we decided to include *Mikania cordata* and *M. scandens* in the key below to facilitate future specimen's identification.

### Key to the species of Eupatorieae in Africa

1. Pappus capillary ..... 2.
- Pappus not capillary ..... 22.
2. Mostly scandent vines or leaning on vegetation ..... 3.
- Herbs or shrubs erect, not scandent ..... 13.
3. Phyllaries and florets in number of four ..... 4.
- Phyllaries and florets more than four ..... *Chromolaena odorata*
4. Leaves palmately cleft into 3–7 irregularly toothed to entire lobes. Pappus bristles ca. 1 mm long .... *Mikania carteri*
- Leaves with entire, serrate, or dentate margins. Pappus bristles 3 mm long or more ..... 5.
5. Stems hexagonal, the angles with narrow wings. Corolla teeth ca. three times the length of the throat ..... *Mikania microptera*
- Stems terete or nearly so, after drying multi-striate to costulate, not winged. Corolla teeth shorter than or of the same length as the throat ..... 6.
6. Synflorescence a lax cymose panicle; pedicels 5–15 mm long. Corolla tube two times the length of the throat or longer ..... *Mikania chevalieri*
- Synflorescence an open to dense corymb or a corymbose panicle; pedicels up to 5 mm long; corolla tube approx. of the same length as the throat ..... 7.
7. Leaves cordate, lanceolate, or triangular ..... 8.
- Leaves ovate ..... 12.
8. Leaves cordate ..... 9.
- Leaves lanceolate or triangular ..... 11.
9. Heads 4–7 mm long ..... 10.
- Heads 7–7.5 mm long ..... *Mikania cordata*
10. Phyllaries linear-oblong ..... *Mikania scandens*
- Phyllaries ovate-oblong or elliptic ..... *Mikania micrantha*
11. Leaves lanceolate, 2 times or more longer than wide ..... *Mikania sagittifera*
- Leaves triangular, ca. one and one-half times longer than wide ..... *Mikania natalensis*
12. Heads 9–12 mm long; capitulescence a dense corymb ..... *Mikania capensis*
- Heads 4–7.5 mm long; capitulescence a rather open corymb or a corymbose panicle ..... *Mikania chenopodiifolia*
13. Leaves at the median part of the stem alternate or opposite, never verticillate ..... 14.
- Leaves at the median part of the stem verticillate ..... *Criscianthus zambiensis*
14. Receptacle rounded to conical, with scars ..... *Campuloclinium macrocephalum*
- Receptacle flat, completely naked ..... 15.
15. Florets 10–60 ..... 16.
- Florets 4–8 ..... 19.
16. Phyllaries equal in length; inner phyllaries acute at the apex. Cypselae with inconspicuous basal callus or carpopodium ..... 17.
- Phyllaries unequal, the outer shorter; inner phyllaries aristate at the apex. Cypselae with a well delimited and conspicuous basal callus or carpopodium ..... *Fleischmannia microstemon*
17. Leaves ovate-deltoid, cordate or cordate-ovate ..... 18.



- Leaves elliptic..... *Ageratina riparia*
- 18. Capitula peduncles densely stipitate-glandular..... *Ageratina adenophora*
- Capitula peduncles puberulent (not glandular) or glabrous..... *Ageratina altissima*
- 19. Stems hollow and fistulose. Leaves pinnately veined. Cypselae with a papillose aspect, mostly with glandular hairs and few or absent non-glandular (twin) hairs..... *Eupatorium cannabinum*
- Stems not fistulose. Leaves triveined. Cypselae with a hispid aspect, mostly with non-glandular (twin) hairs and few glandular hairs..... 20.
- 20. Leaves 3.5–7 cm wide, cordate at the base. Anthers with apical appendage truncate and emarginate at the apex..... *Stomatanthes meyeri*
- Leaves 0.2–2.2 cm wide, cuneate or rounded at the base. Anthers with apical appendage rounded at the apex..... 21.
- 21. Leaves ovate, pubescent below. Phyllaries pubescent..... *Stomatanthes africanus*
- Leaves oblong-lanceolate to linear, glabrous below. Phyllaries glabrous..... *Stomatanthes helenae*
- 22. Pappus of 3–5 elongate, viscid-tipped knobs..... 23.
- Pappus coroniform, of 5–6 short (up to 3 mm) free scales, rarely with setae or absent..... 26.
- 23. Stems decumbent. Cypselae surface not spiny..... *Adenostemma mauritianum*
- Stems erect. Cypselae muricate, covered with many short spines..... 24.
- 24. Aquatic plants; stems fleshy..... *Adenostemma caffrum*
- Terrestrial plants; stems not fleshy..... 25.
- 25. Leaves oblong-elliptic, base attenuate. Corolla white..... *Adenostemma schimperi*
- Leaves ovate, base rounded-cuneate. Corolla white or violet..... *Adenostemma viscosum*
- 26. Phyllaries glabrous or sparsely pilose, margins often ciliate..... *Ageratum conyzoides*
- Phyllaries with numerous sticky hairs, margins not ciliate or inconspicuously ciliate..... *Ageratum houstonianum*

## Taxonomic treatment

***Criscianthus*** M.A.Grossi & J.N.Nakaj., *gen. nov.* Type species:—*Criscianthus zambiensis* (R.M.King & H.Rob.) M.A.Grossi & J.N.Nakaj.

*Planta suffrutescens, radice tuberosa, caule terete, glabro vel puberulo. Folia ternata, superne alternata raro opposita, margine serrata vel laciniato-lobata, trinervata. Synflorescentiae laxe corymbosae. Capitula homogama, discoidea; receptaculum epaleatum, glabratum. Involucri squamae 2–3-seriatae, apice caudatae. Flosculi 4–5, hermaphroditi; corollae infundibulares, quinquelobatae. Cypselae obconicae, glanduliferae et setiferae, setis polycellulis immixtis; carpodium obsoletum. Pappi setiformes, setis valde scabris, cellulis apicalibus rotundatis. Genus characteribus stylorum antherarumque familiae Compositarum, tribui Eupatoriearum congruens.*

Subshrub with xylopodium. Stem erect, moderately branched, terete, striate, glabrous to pubescent. Leaves verticillate, the upper ones sometimes alternate or opposite, sessile, blade membranaceous to subcoriaceous, lanceolate to elliptic, base cuneate, apex acute, margins serrate to laciniate-lobate, glabrous or subglabrous; venation triveined, veins more or less marked, reticulate. Heads homogamous, grouped into a lax corymbose inflorescence, pedunculate. Involucre cylindrical-campanulate, 2(–3)-seriate; phyllaries ovate-lanceolate to lanceolate, glabrous or pubescent, caudate at the apex. Receptacle planate, glabrous, naked. Florets 4–5, bisexual, corollas white to white-greenish, tubular-funnelform, with a narrow tube and a widened limb, limb 5-lobed, pubescent, with glandular hairs, lobes papillose, without stomata. Anthers with the base rounded, anther collar oblong, anther appendages well developed, deltoid, acute at the apex. Style base not enlarged, covered with long papillae, branches linear, with papillose, sterile apical appendages, stigmatic areas in two widely separated marginal lines at the base of each style branch. Cypselas prismatic, 5-ribbed, rarely 8-ribbed, pubescent, with many glandular hairs and few atypical twin hairs, carpodium distinct. Pappus white or pale yellow, uniseriate, of scabrous, capillary, persistent bristles, with slender tips, apical cells rounded. Pollen grains spheroidal, tricolporate, echinate.

**Etymology:**—The generic name honors Jorge Víctor Crisci (born 1945), recognized botanist from Argentina who made important contributions to the systematics and biogeography of the plant family Asteraceae; and its second part comes from the Greek *anthos* = flower.

*Criscianthus zambiensis* (R.M.King & H.Rob.) M.A.Grossi & J.N.Nakaj., *comb. nov.*

Basionym: *Stomatantes zambiensis* King & Robinson (1975: 465). Type:—ZAMBIA. Northern Province: Mporokoso District, Mporokoso-Kawimbe, close to Mporokoso, 7 January 1960, *Richards 12084* (holotype K!, isotypes M!). (Fig. 4).

Subshrubs 0.30–1 m tall, with xylopodium. Stems pale yellow. Upper leaves close to the inflorescence alternate or opposite, rarely verticillate, lower leaves verticillate, in whorls of three, blade 3–7 × 0.5–2.1 cm, margins entire at the base and serrate to lacinate-lobate at the median and upper parts, glabrous or scarcely pubescent, with simple filiform hairs, upper face with sparse hairs, lower face more pubescent, surface punctate. Heads pedunculate, peduncles 5–25 mm, pubescent, with glandular and non-glandular hairs. Involucre 4.5–10 × 8–10 mm; phyllaries 7–10, subimbricate, trinerved, scarious at the margins, glabrous or pubescent, with scarce non-glandular, marginal hairs, rarely with glandular hairs, outer phyllaries 1.5–3 × 0.5–0.7 mm, intermediate 4–6 × 1–1.5 mm, inner phyllaries 4–8 × 1–1.5 mm. Florets with corollas 4.5–6 mm long, tube 2.5–4 × 0.3–0.5 mm, limb 1.5–2 × 0.6–1.5 mm, lobes 0.5–0.7 × 0.4–0.6 mm, thickened at the margins. Anthers 0.8–0.9 mm long, anther collar 0.4–0.5 × 0.1–0.2 mm, cells with transversely banded thickenings, anther appendages 0.2–0.54 × 0.2 mm. Style base surrounded by a nectariferous disc, shaft 7–8 mm long, style branches 2–2.5 mm long. Cypselae 2–3.5 × 0.7–1 mm, with abundant glandular hairs, and few 3-(6)-celled twin hairs, carpodium 0.25 mm × 0.3 mm, with oblong cells. Pappus 5–6 mm long, of ca. 40 scabrous bristles unequal in length. Pollen grains  $P \times E = (18 \times 20) \mu\text{m}$ .

**Etymology:**—The specific epithet “*zambiensis*” refers to Zambia, which is part of the geographical distribution of the species, and to the African country where the type specimen was found.

**Phenology:**—Flowering from January to April. Fruiting capitula are found from May to August.

**Distribution and ecology:**—*Criscianthus zambiensis* grows in northern Zambia, adjacent areas of Malawi (Fig. 4F) and probably in Tanzania because of the close proximity of this country, at altitudes of 1200–2200 m. These areas correspond to the biogeographic province of Miombo woodland/savanna (Udvardy 1975) and to the central Zambebian miombo woodlands ecoregion (White 1983), characterized by the Miombo trees (*Brachystegia*, *Julbernardia*, *Isoberlinia*, of the Fabaceae family). *Criscianthus zambiensis* grows in the wet miombo woodlands that receive more than 1000 mm of rainfall per year. Canopy height is usually greater than 15 m reflecting deeper and moister soils, which create favorable conditions for very rich vegetation (Abdallah & Monela 2007). This species may be found in mixed woodlands and among grasses on loam soils, rock slabs, amongst boulders of rocky outcrops, and top of escarpments, sometimes associated with species of *Helichrysum*, *Osteospermum* (Asteraceae), *Eragrostis* (Poaceae), and *Xerophyta* (Velloziaceae). The xylopodium of *Criscianthus zambiensis*, as in many typical pyrophytic savanna herbs and shrubs, prevents a complete damage of the plant during the dry season wildfires by remaining low to the ground.

**Conservation:**—Proposed here as endangered (EN) according to the IUCN (2010) criteria and subcriteria B2 ab (iii), i.e. the area of occupancy is estimated to be less than 500 km, severely fragmented, and there is a continuing decline in the extent and/or quality of the habitat.

**Additional specimens examined:**—ZAMBIA. Northern Province: Mbala (previously Abercorn) District, Kambole, near Kambole falls, 30 January 1964, *H. Richards 18908* (K, US); Kambole escarpment, 19 February 1957, *H. Richards 8251* (K); path to Katenga Falls, Kambole, 21 February 1957, *H. Richards 8303* (K); Nyika National Park, 0.5 km SE of Zambian Govt. Rest House, 15 April 1986, *D. Philcox et al. 9962* (K). MALAWI. Northern Province: Rumphi District, Nyika, 30 March 1970, *J. Pawek 3437* (K); Nyika National Park, Vitinthiza peak, 29 July 2009, *S. Mphamba 950* (K); Mafinga Hill Top, Chitipa, 5 August 2007, *H. Chapama et al. 705* (K).

**TABLE 1.** Native and alien genera and species of Eupatorieae that occur in Africa, their subtribal placement according to Hind & Robinson (2007), general distribution, status in Africa, and reference literature. Generic names are in boldface.

Taxa	Subtribe	Distribution	Native or alien	Literature
<b>1. <i>Adenostemma caffrum</i></b> DC.	Adenostemmatinae	Widespread throughout Africa	Native	Burrows & Willis (2005)
<b>2. <i>A. mauritanum</i></b> DC.		Mauritius, Zimbabwe, Ceylon, Indian Ocean	Native	Candolle (1836), King & Robinson (1987), Hyde <i>et al.</i> (2013)
<b>3. <i>A. schimperii</i></b> Sch.Bip. ex A.Rich.		E Africa	Native	King & Robinson (1987)
<b>4. <i>A. viscosum</i></b> J.R.Forst. & G.Forst.		S Africa, Zimbabwe, Madagascar, Ceylon, Indonesia, Pacific	Native	Humbert (1960), King & Robinson (1987), Retief (2002), Hyde <i>et al.</i> (2013)
<b>5. <i>Ageratina adenophora</i></b> (Spreng.) R.M.King & H.Rob.	Oxylobinae	S Africa, Nigeria, Zimbabwe, Mexico, alien in California, West Indies, S America, Portugal, Pacific Islands, Australia	Alien and aggressive weed	King & Robinson (1987), Muniappan <i>et al.</i> (2009)
<b>6. <i>A. altissima</i></b> (L.) R.M.King & H.Rob.		S Africa, E United States, E Canada	Alien	King & Robinson (1987), Retief (2002)
<b>7. <i>A. riparia</i></b> (Regel) R.M.King & H.Rob.		S Africa, Mexico, alien in W Indies, Peru, Ceylon, Pacific Islands, Australia	Alien and aggressive weed	King & Robinson (1987), Retief (2002)
<b>8. <i>Ageratum conyzoides</i></b> L.	Ageratinae	Throughout tropical Africa, Madagascar, Mexico, Central and S America, W Indies	Widely alien	Humbert (1960), King & Robinson (1987), Burrows & Willis (2005)
<b>9. <i>A. houstonianum</i></b> Mill.		S Africa, Zimbabwe, Mexico, Central and S America, W Indies	Widely cultivated and alien	King & Robinson (1987), Retief (2002), Hyde <i>et al.</i> (2013)
<b>10. <i>Campuloclinium macrocephalum</i></b> (Less.) DC.	Gyptidinae	S Africa, Mexico, Guatemala, Honduras, Colombia, Bolivia, Brazil, Paraguay, Argentina	Alien and aggressive invader	King & Robinson (1987), Retief (2002)
<b>11. <i>Criscianthus zambiensis</i></b> (R.M.King & H.Rob.) M.A. Grossi & J.N. Nakaj.	Eupatoriinae	Malawi, Zambia	Native	This paper
<b>12. <i>Chromolaena odorata</i></b> (L.) R.M.King	Praxelinae	S Africa, SE United States, W Indies, Mexico, Central America	Alien and aggressive weed	King & Robinson (1987), Retief (2002)
<b>13. <i>Eupatorium cannabinum</i></b> L.	Eupatoriinae	N Africa, Europe, Asia Minor, India	Native	King & Robinson (1970b, 1987)

.....continued on the next page

TABLE 1. (Continued)

Taxa	Subtribe	Distribution	Native or alien	Literature
14. <i>Fleischmannia microstemon</i> (Cass.) R.M.King & H.Rob.	Fleischmanniinae	Africa, Mexico, C and S America, W Indies	Alien	King & Robinson (1987)
15. <i>Mikania capensis</i>	Mikaniinae	E and S Africa, Madagascar	Native	King & Robinson (1987)
16. <i>M. carteri</i> Baker		Cameroon, Nigeria, Zimbabwe	Native	King & Robinson (1987), Hyde <i>et al.</i> (2013)
17. <i>M. chenopodiifolia</i> Willd.		Tropical W Africa to S Sudan, Ethiopia, S to Angola, Mozambique, Madagascar and other offshore islands, Bioko	Native	King & Robinson (1987)
18. <i>M. chevalieri</i> (C.D.Adams) W.C.Holmes & McDaniel		Sierra Leone to Nigeria, Cameroon, Zaire, Angola, Zambia, Central African Republic	Native	King & Robinson (1987)
19. <i>M. cordata</i> (Burm.f.) B.L.Rob.		Zambia (dubious, see section 3.3). SE Asia, Borneo, New Guinea, Philippines, Taiwan, Hainan	Native	King & Robinson (1987), Phiri (2005)
20. <i>M. micrantha</i> Kunth		W Africa, Mauritius, Mexico, C and S America, W Indies. Widely introduced in Asia, Indonesia, Pacific Islands, Australia	Alien and aggressive weed	King & Robinson (1987), DEEDI (2011), Macanawai (2011)
21. <i>M. microptera</i> DC.		Tropical W Africa to Zaire, Angola, Central African Republic, Uganda, Tanzania, Brazil, Bolivia, Peru, Venezuela, Guyana, Suriname	Alien	King & Robinson (1987)
22. <i>M. natalensis</i> DC.		S Africa	Native	King & Robinson (1987)
23. <i>M. sagittifera</i> B.L.Rob.		Zaire, Ruanda, Burundi, Tanzania, Zambia, Zimbabwe, Angola, Botswana, Namibia, Uganda	Native	King & Robinson (1987)
24. <i>M. scandens</i> (L.) Willd.		Madagascar (dubious) E North America, NE Mexico, Bahamas	Alien	Humbert (1960), King & Robinson (1987)
25. <i>Stomatanthus africanus</i> (Oliv. & Hieron.) R.M.King & H.Rob.	Eupatoriinae	Widespread in central, E, W, and S Africa	Native	Grossi & Katinas (2013)
26. <i>S. helenae</i> (Buscal. & Muschl.) Lisowski		S Democratic Republic of Congo and N Zambia	Native	Grossi & Katinas (2013)
27. <i>S. meyeri</i> R.M.King & H.Rob.		SW Ethiopia	Native	Grossi (2011b), Grossi & Katinas (2013)

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