Endemic families of Madagascar. VIII. A synoptic revision of *Xyloolaena* Baill. (Sarcolaenaceae)

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ABSTRACT
As part of an assessment of the vascular plant families endemic to Madagascar and the Comoro Islands, a synoptic revision is presented of *Xyloolaena* Baill. (Sarcolaenaceae). Molecular sequence data place the family sister to Dipterocarpaceae in a broadly defined Malvales. Fossil pollen tetrads of Sarcolaenaceae from the Miocene of South Africa most closely resemble those of *Xyloolaena*, indicating that Sarcolaenaceae were once more widely distributed. *Xyloolaena* appears most closely related to *Rhodolaena*, *Sarcolaena* and *Leptolaena* sensu lato, with which it shares several features; *Xyloolaena* can be distinguished by its involucre that forms a cup at anthesis instead of completely enclosing the flowers, and its numerous multiseriate ovules. Five species are recognized, two of which are newly described (*X. sambiranensis* and *X. speciosa*). *Xyloolaena linearifolia* Cavaco is excluded from the genus. Preliminary assessments of the conservation status of each species are provided, along with a key to the species in English and French.

KEY WORDS
Sarcolaenaceae,
Xyloolaena,
Madagascar,
conservation.

RÉSUMÉ
Familles endémiques de Madagascar. VIII. Une révision synoptique du genre Xyloolaena Baill. (Sarcolaenaceae).
Dans le cadre de l'évaluation des familles de plantes vasculaires endémiques de Madagascar et des Comores, la révision synoptique du genre *Xyloolaena*

Baill. (Sarcolaenaceae) est présentée. Des données moléculaires suggèrent que cette famille est le groupe frère des Dipterocarpaceae, au sein des Malvales élargies. Des tétrades de pollen fossile du Miocène appartenant aux Sarcolaenaceae, provenant d'Afrique du Sud, semblent les plus proches de celles de *Xyloolaena*, indiquant que la famille était autrefois plus largement distribuée. Le genre apparaît proche des *Rhodolaena*, *Sarcolaena* et *Leptolaena sensu lato*, avec lesquels il partage plusieurs caractéristiques ; *Xyloolaena* peut être différencié par son involucre, en forme de coupe à l'anthèse au lieu d'enfermer complètement la fleur, et par ses nombreux ovules multisériés. Cinq espèces sont reconnues, dont deux nouvelles décrites ici (*X. sambiranensis* et *X. speciosa*). *Xyloolaena linearifolia* Cavaco est exclu du genre. Une évaluation préliminaire pour la conservation du statut de chaque espèce est présentée, ainsi qu'une clé à l'espèce, en anglais et en français.

MOTS CLÉS
Sarcolaenaceae, *Xyloolaena*, Madagascar, conservation.

INTRODUCTION

This is the eighth in our series of synoptic revisions of genera in Madagascar's seven endemic plant families (cf. LOWRY et al. 1999, 2000; SCHATZ et al. 1998, 1999a,b, 2000b, 2001; see also RANDRIANASOLO & MILLER 1999), which we are publishing to provide an updated taxonomic framework for assessing the c. 100 species concerned using the IUCN Red List threat categories (SCHATZ et al. 2000a), with the ultimate goal of compiling a Red Data Book detailing the conservation status of each species. For this paper, we have studied all of the available material of *Xyloolaena* Baill. at the major herbaria with important holdings of Malagasy plants (K, MO, P, TAN and TEF), and have reviewed the circumscription of the species as recognized by CAVACO (1950, 1952a,b).

BAILLON (1872a) originally described the genus *Scleroolaena* based solely on several detached fruits collected in Madagascar by RICHARD, correctly assigning it to Sarcolaenaceae. Later that year BAILLON (1872b) published the species name *S. richardii*. Subsequently (BAILLON 1879) he proposed the name *Xyloolaena* to replace *Scleroolaena*, which he regarded as a later homonym of *Sclerolaena* R. Br. (Chenopodiaceae). The combination *X. richardii* (Baill.) Baill. was not made until five years later (BAILLON 1884).

In the treatment of Chlaenaceae (= Sarcolaenaceae) for the Flore de Madagascar, CAVACO (1952b; see also CAVACO 1950, 1952a) recognized three species of *Xyloolaena* based on the limited amount of material available to him. During the next 20 years René CAPURON and his contemporaries added many new collections and had numerous opportunities to observe *Xyloolaena* in the field. Based on CAPURON's annotations and overview of the family (CAPURON 1970), it would appear that he accepted CAVACO's species concepts.

Recent phylogenetic studies utilizing molecular sequence data indicate that Sarcolaenaceae and Dipterocarpaceae are sister taxa within an expanded Malvales (ALVERSON et al. 1998; BAYER et al. 1999). Fossil pollen of Sarcolaenaceae from the Miocene of South Africa most closely resembles the tetrads of *Xyloolaena*, and indicates that the family was more widespread in the past and has become endemic to Madagascar through extinction elsewhere (COETZEE & MULLER 1984; NILSSON et al. 1996).

Within Sarcolaenaceae, *Xyloolaena* appears to be most closely related to *Sarcolaena* and *Leptolaena* sensu lato [including the segregate genera *Xeroclamys* (Cavaco) Hutch. and *Mediusella* Baill.; see SCHATZ et al. 2001]. These genera were included by CAPURON (1970) in one of four informal groups he recognized within the family based on characters of the pollen tetrads (STRAKA 1963, 1964; see also CARLQUIST 1964) as well as other morphological features he considered important. Members of this group have an

involucre that is well developed at anthesis, which CARLQUIST (1964) regarded as a specialization, and in all species (except *Xyloolaena perrieri*) there is a single flower per involucre. Within this group of genera *Xyloolaena* differs by having an involucre that forms a cup at anthesis rather than completely enclosing the lower portion of the flower. CAPURON (1970) also pointed out that the ovary of *Xyloolaena* has numerous multiseriate ovules, whereas the other genera have only (1-)2(-5) ovules in two series. According to STRAKA's (1963, 1964) analyses, the members of this group share a number of distinctive pollen features, which are also found in *Rhodolaena* Thouars; CARLQUIST (1964) independently arrived at similar conclusions. CAPURON (1970) nevertheless placed *Rhodolaena* in a separate group on its own because its involucre is reduced at anthesis, expanding only very late in development just as the fruits reach full maturity (see SCHATZ et al., 2000b). NILSSON & RANDRIANASOLO (1999) reassessed possible relations within Sarcolaenaceae based on pollen morphology, and placed *Xyloolaena* in a slightly expanded group that also include *Rhodolaena*. They regarded *Leptolaena* and *Rhodolaena* as most closely related to one another, with *Xyloolaena* and *Sarcolaena* occupying more "remote" positions. Although pollen characters of Sarcolaenaceae are clearly of great interest (CARLQUIST, 1964, considered the tetrads to be among the most intricately constructed within the angiosperms), a more thorough understanding of phylogenetic relationships within the family must await forthcoming analyses using molecular sequence data from a broad sample of taxa.

As in our previous revisions of genera in Madagascar's endemic families, we have re-evaluated species circumscriptions by examining morphological features in combination with eco-geographic parameters, including bioclimate (CORNET 1974; SCHATZ 2000; see also LOWRY et al. 1997, 1998) and geological substrate (DU PUY & MOAT 1996).

Comparative analysis of the available material of *Xyloolaena* has enabled us to propose the following revised taxonomy, in which five species are recognized, two of which are described as new. For the "Material examined" cited below under each species, abbreviations are as follows: FC = Forêt Classée, PN = Parc National, RNI = Réserve Naturelle Intégrale, and RS = Réserve Spéciale. A full listing of exsiccatae for each species, with complete localities and latitude/longitude coordinates, has been compiled for the Madagascar Conspectus Project (SCHATZ et al. 1996), and is available through W3 TROPICOS (*http://mobot.mobot.org/W3T/Search/vast.html*). Images of selected taxa are also available on the Web at (*http://www.mobot.org/MOBOT/Madagasc/sarcolae.html*). Specimen data can also be accessed through the SONNERAT database at (*http://www.mnhn.fr/base/sonnerat.html*). Geographic coordinates indicated in square brackets were assigned *post facto* using available information on Malagasy place names and topographic maps, compiled as a gazetteer of botanical collecting localities in Madagascar (*http://www.mobot.org/MOBOT/research/madagascar/gazetteer/*).

XYLOOLAENA Baill.

Dict. Bot. 2: 2 (1879).
Scleroolaena Baill., Adansonia 10: 236 (1872), *non Sclerolaena* R. Br., Prodr.: 410 (1810).

TYPE. — *Scleroolaena richardii* Baill. [=*Xyloolaena richardii* (Baill.) Baill.].

Key to the species of *Xyloolaena*

1. Leaves with secondary veins strongly impressed above, blades bullate, strongly concave abaxially; flowers erect, borne in pairs within the involucre, corolla forming a cup at anthesis, petals red, the apical portion recurved ..... 2. **X. perrieri**
1'. Leaves with secondary veins slightly raised above, blades flat to slightly folded upwards along the midvein; flowers pendant, borne singly within the involucre, petals white, yellow or salmon pink, tightly imbricate at anthesis, forming a pyramidal cone with a small apical opening 2

2. Leaves ovate, apex rounded to emarginate, base subcordate to cordate ..... 1. **X. humbertii**
2'. Leaves oblong, elliptic or ovate, sometimes narrowly so, apex acute to acuminate, occasionally rounded to emarginate, base acute to truncate 3
3. Leaves elliptic to ovate, up to 2 times as long as broad (rarely to 2.5 times as long), the apex lacking a mucro; petals yellow; woody involucre in fruit 3-4 cm tall, 2.6-3.8 cm diam. ..... 3. **X. richardii**
3'. Leaves narrowly ovate to oblong, greater than 2 times as long as broad, the apex with a distinct mucro; petals white or salmon pink; woody involucre in fruit 2-3.2(-3.5) cm tall, 2-2.5 cm diam. 4
4. Leaves with (11-)13-16 pairs of secondary veins, largest blade 11-13.5(-15.5) × 3.3-5(-5.5) cm, almost always greater than 2.5 times as long as wide; petals white, extrastaminal disc of 5 rounded to elongate appendages each bearing c. 25 staminodes, inflorescence bracts usually caducous, rarely persistent until anthesis ..... 4. **X. sambiranensis**
4'. Leaves with 9-10(-12) pairs of secondary veins, largest blade (12.5-)13-14.5 × (5-)5.5-7.5 cm, usually less than 2.3 times as long as wide; petals salmon pink, extrastaminal disc a low rim bearing c. 200-250 staminodes, inflorescence bracts persistent at least until anthesis and usually some remaining in fruit ..... 5. **X. speciosa**

Clé des espèces de *Xyloolaena*

1. Feuilles à nervures secondaires fortement imprimées dessus, limbe bullé, face abaxiale fortement concave ; fleurs dressées, par paires à l'intérieur de l'involucre, corolle en coupe à l'anthèse, pétales rouges, la partie apicale recourbée ..... 2. **X. perrieri**
1'. Feuilles à nervures secondaires légèrement proéminentes au-dessus, limbe plan ou un peu replié vers le haut le long de la nervure médiane ; fleurs pendantes, une seule à l'intérieur de l'involucre, pétales blancs, jaunes ou rose saumoné, étroitement imbriqués à l'anthèse et formant un cône pyramidal à petite ouverture apicale 2
2. Feuilles ovales, apex arrondi à émarginé, base subcordée à cordée ..... 1. **X. humbertii**
2'. Feuilles oblongues, elliptiques ou ovales (parfois étroitement), apex aigu à acuminé, quelquefois arrondi à émarginé, base aiguë à tronquée 3
3. Feuilles elliptiques à ovales, jusqu'à deux fois plus longues que larges (rarement deux fois et demi), apex dépourvu de mucron ; pétales jaunes; involucre fructifère ligneux 3-4 cm de haut, 2,6-3,8 cm de diam. ..... 3. **X. richardii**
3'. Feuilles étroitement ovales à oblongues, plus de deux fois plus longues que larges, apex à mucron distinct ; pétales blancs ou rose saumoné ; involucre fructifère ligneux 2-3,2(-3,5) cm de haut, 2-2,5 cm de diam. 4
4. Feuilles à (11-)13-16 paires de nervures secondaires, les limbes les plus grands 11-13,5(-15,5) × 3,3-5(-5,5) cm, presque toujours plus de deux fois et demi plus longs que larges ; pétales blancs, disque extra-staminal formé de 5 appendices arrondis ou allongés, chacun portant c. 25 staminodes, bractées de l'inflorescence habituellement caduques, rarement persistant à l'anthèse ..... 4. **X. sambiranensis**
4'. Feuilles à 9-10(-12) paires de nervures secondaires, les limbes les plus grands (12,5-)13-14,5 × (5-)5,5-7,5 cm, habituellement moins de 2,3 fois plus longs que larges ; pétales rose saumoné, disque extra-staminal en forme de petit rebord portant environ 200-250 staminodes, bractées de l'inflorescence persistant au moins jusqu'à l'anthèse, souvent quelques unes demeurant à la fructification ..... 5. **X. speciosa**

1. Xyloolaena humbertii Cavaco

Bull. Soc. Bot. France 97: 224 (1950). — Type: *Humbert 13837*, Madagascar, Prov. Toliara, bassin de réception de la Mananara, affluent du Mandrare, pentes occidentales des montagnes entre l'Andohahela et l'Elakelaka, Mont Apiky au-dessus de Mahamavo, transition du bush xérophile à la forêt basse sclérophylle, [24°45'30"S, 46°43'30"E], 800-900 m, Jan.-Feb. 1934, fl. (holo-, P!; iso-, MO!, P!).

Xyloolaena humbertii is known from only a single collection made nearly 70 years ago in transitional vegetation between sclerophyllous forest and dry bush (Fig. 1), possibly from within Andohahela PN. Label data on the type material indicate that *X. humbertii* is a small tree 6-8 m tall whose flowers have pale sulfur yellow petals. It can be distinguished from other members of the genus by its ovate leaves with a subcordate to cordate base.

CONSERVATION STATUS. — Because *Xyloolaena humbertii* is known only from a single old collection and has not been recollected since, the avai-

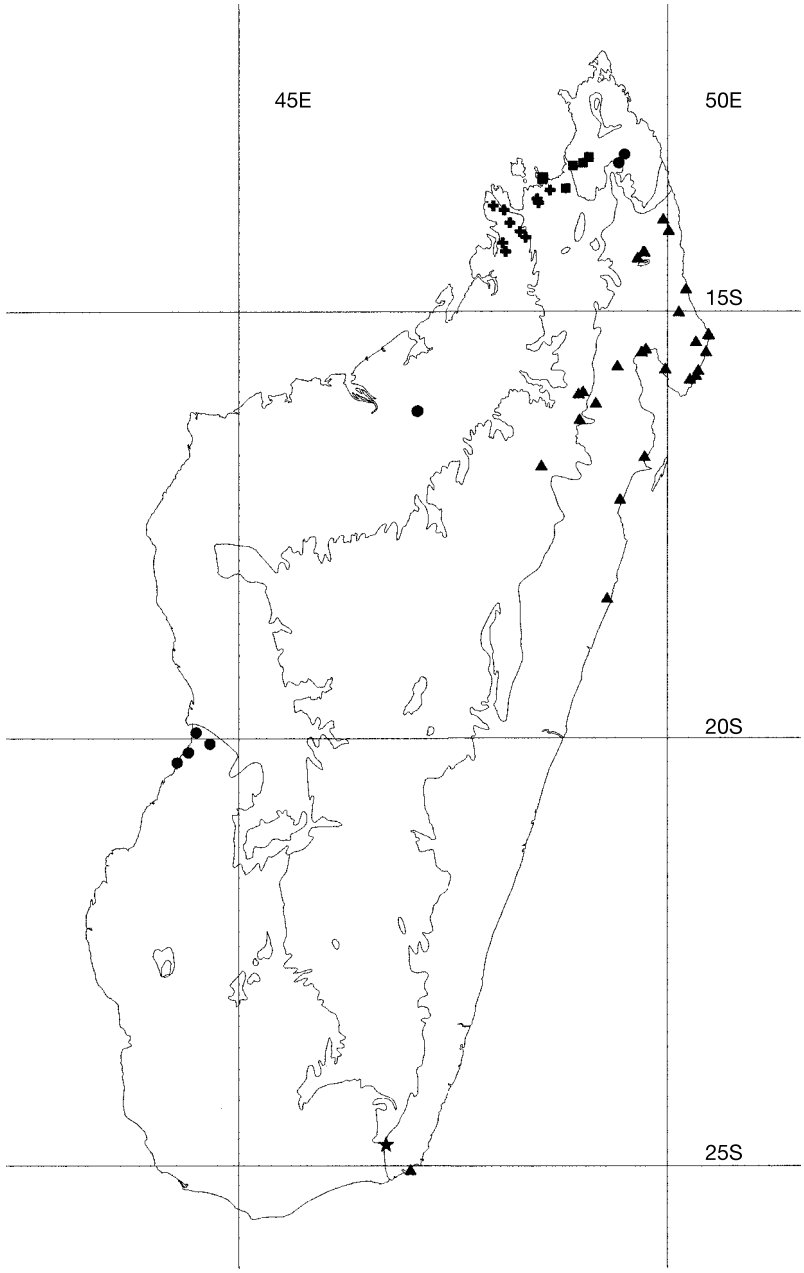

Fig. 1. — Distributions of ***Xyloolaena***, mapped on the bioclimatic zones of Madagascar (after CORNET 1974; see SCHATZ 2000). ***X. humbertii*** (★), ***X. perrieri*** (●), ***X. richardii*** (▲), ***X. sambiranensis*** (✚), ***X. speciosa*** (■).

lable data are insufficient to assess its conservation status, and it must therefore be regarded as Data Deficient (DD). If the original gathering was indeed made within Andohahela PN, then *X. humbertii* could be assigned a preliminary status of Vulnerable (VU).

2. Xyloolaena perrieri F. Gérard

Ann. Inst. Bot.-Géol. Colon. Marseille, sér. 3, 7: 90 (1919). — Type: *Perrier de la Bâthie 3018*, Madagascar, Prov. Antsiranana, bois secs, bassin de la Loky [=Lokia], granite, [13°16'S, 49°26'E], Nov. 1909, fl. (holo-, P!; iso-, K!, MO!, P (2 sheets)!).

Xyloolaena perrieri is a tree c. 4-10 m tall that has been recorded at scattered localities from near Morondava, Ankarafantsika PN and the Lokia [=Loky] river basin E of Ambilobe (Fig. 1) within Madagascar's dry bioclimatic region. Although the known populations are widely disjunct, it may be that this species is more continuously distributed (but bridging the humid Sambirano region) and has simply not yet been recorded from the intervening areas, large parts of which remain under-explored. *Xyloolaena perrieri* differs from other members of the genus by having erect, cup-shaped red flowers borne in pairs within the involucre, and leaves with bullate blades in which the secondary veins are strongly impressed on the upper surface.

VERNACULAR NAME. — Zahana.

CONSERVATION STATUS. — With an area of occupancy < 2,000 km^2 containing fewer than 5 sub-populations, only one of which is within the current protected areas network, *Xyloolaena perrieri* is assigned a preliminary status of Vulnerable (VU).

MATERIAL EXAMINED. — *Du Puy & Du Puy MB249*, Andranomena RS; *Noyes et al. 1025*, Kirindy; *Perrier de la Bâthie 3018*, bassin de la Loky; *Rahantamalala 151*, Morondava; *Randriamarosoa 402*, Kirindy; *Réserves Naturelles 4183, 4683*, Ankarafantsika RNI; *Service Forestier 5487*, Ankarafantsika RNI; *Service Forestier 15838*, Manirena.

3. Xyloolaena richardii (Baill.) Baill.

Bull. Mens. Soc. Linn. Paris 1: 412 (1884). — *Scleroolaena richardii* Baill., Hist. Pl. 4: 224 (1872), "richardi". — Type: *Richard s.n.*, Madagascar, Prov. Antsiranana, Angonsti, [15°16'S, 50°29'E], fr. (holo-, P!).

Xyloolaena richardii, as circumscribed here, is a tree c. 4-20 m tall, ranging from sea level to over 1,500 m elevation in areas with a humid bioclimate in NE Madagascar, with one population recorded in the far SE (Fig. 1). This species occurs in littoral forest on sand from Lac Nosive S of Toamasina to Ampahana N of Antalaha, but is also found at many inland sites, where it likely occurs on quartzite sands, a pattern also seen in *Asteropeia multiflora* Thouars (Asteropeiaceae) (see SCHATZ et al. 1999b). Previous authors (e.g., CAVACO 1952a,b; CAPURON 1970) have defined *X. richardii* broadly to include material placed here in *X. sambiranensis* and *X. speciosa*. It can, however, be distinguished by its elliptic to ovate leaves that are usually less than two times as long as broad and whose apex lacks a mucro, and by its yellow flowers and large woody involucre in fruit that measures 3-4 cm tall and 2.6-3.8 cm in diameter.

The type material of *Scleroolaena richardii* consists only of detached fruits, but their large size makes it abundantly clear that they are conspecific with other collections from humid and subhumid areas in eastern Madagascar.

VERNACULAR NAMES. — Fakody, Fombaotoafo, Pesoala, Takodibe, Tamboro, Tsikody zahana, Vahitoambody, Voakoropetaka, Voantiambody, Voantsatroka.

CONSERVATION STATUS. — With six subpopulations recorded from the current network of protected areas and an area of occupancy > 2,000 km^2, *Xyloolaena richardii* is regarded as a species of Least Concern (LC).

MATERIAL EXAMINED. — *Baron 5799, 6593*, without precise locality; *Bernard 201*, Masoala PN; *Humbert 18052*, Analavory; *Humbert & Capuron 24206* (= *Service Forestier 804*), vallée de l'Andalangy; *Humblot 199*, Lac Nossi-Ve [= Nosive]; *Lowry 5194*, Tanambao; *Morat 4482*, Antsiasiaka; *Perrier de la Bâthie 2162*, Maroantsetra; *Rabe 146*, Masoala PN; *Rahajasoa 245*, Cap Est; *Rahajasoa 628*, Masoala PN; *A. Rakotozafy 815*, Maroantsetra; *A. Rakotozafy 2055*, Ft. Dauphin; *Rasoavimbahoaka 190*, Marojejy PN; *Réserves Naturelles 2129*, Marotandrano RS; *Réserves Naturelles 8806*, Masoala RNI; *Richard s.n.*, Angonsti; *Schatz et al. 3812*, Cap Est; *Schatz & Villiers 1817*, Maroantsetra; *Service Forestier 804* (= *Humbert & Capuron 24206*), vallée de l'Andalangy; *Service Forestier 1372*, Andatsakala; *Service Forestier 3445*, Ampanavoana; *Service Forestier 7492*, Anjanazana; *Service Forestier 9084*, Beanana to Sahajinja; *Service*

Forestier 10606, Angijombarika, Mandritsara; *Service Forestier 10612*, Bemanarana; *Service Forestier 10720*, Ampahana; *Service Forestier 15066*, Besinkara to Maromandia; *Service Forestier 18195*, Manompana; *Service Forestier 25845*, Ambalafarihy.

4. Xyloolaena sambiranensis Lowry & G.E. Schatz, **sp. nov.**

Frutex vel arbor 3-12 m alta. Folia lamina anguste ovata usque oblonga, (5-)7-13.5(-15.5) × 2.7-5 (-5.5) cm, longitudine latitudinem fere semper plus quam 2.5-plo excedente, apice acuta acuminatave plerumque manifeste mucronata, nervis secundariis alternis subopostisve (11- ad) 13- ad 16-jugatis. Inflorescentia plerumque triflora; bracteis longe ante anthesin caducis; involucro florem solitarium subtendente. Flos petalis albis; disco extrastaminali ex appendicibus 5 ligulatis rotundatis usque elongatis 5-6 mm altis unaquaque staminodia c. 25 gerente constante. Fructus involucro 2.1-3.2(-3.5) cm alto, 2.2-2.5 cm diam. subtentus.

TYPUS. — *Schatz 3222*, Madagascar, Prov. Antsiranana, Manongarivo RS, 30 km SE of Ankaramy, W slopes of Antsatrotro, 14°08'S, 48°21'E, 200 m, 23-25 Mar. 1991, fl. (holo-, MO!; iso-, G!, K!, P!, TEF!).

Large shrubs to trees 3-12 m tall. Young twigs glabrous to densely short stellate, consistently glabrous with age. Leaves narrowly ovate to oblong, khaki green to tan or chocolate brown and often shiny above (in dry material), usually greener and dull below, chartaceous to subcoriaceous, (5-)7-13.5(-15.5) × 2.7-5(-5.5) cm, almost always greater than 2.5 times as long as wide, glabrous, apex acute to acuminate, usually with a distinct mucro, margin entire, minutely thickened and occasionally slightly revolute, base acute, sometimes nearly obtuse, venation brochidodromous, with (11-)13-16 pairs of alternate to subopposite secondary veins, midrib flat to weakly channeled above, raised below; petiole 8-13 mm long, glabrous; stipules 2, lateral, free, hyaline, lanceolate, 13-15 × 3-4 mm, glabrous, apex acuminate, margin entire, flat to involute throughout or only toward the apex. Inflorescences terminal on principal and lateral branches, primary axis more or less condensed, with c. 5-8 pairs of bract scars and sometimes 1-2 scars of reduced caducous leaves, axes chocolate brown to nearly black, glabrous to densely white strigulose, especially just below the bract scars, with a single terminal peduncle, and usually 2 alternate lateral axes each with a smaller and later-maturing flower, bracts caducous well before anthesis, broadly ovate or rarely bilobed, c. 7-12 × 8-10 mm, concave adaxially, apex broadly acute, sometimes with 2-3 small triangular lobes, light chocolate brown, weakly coriaceous, outer surface obscured by densely whitish wooly tomentose indument, terminal peduncle (ultimate axis below the involucre) stout, 1.5-3 mm long, 2-3 mm diam., densely white to brownish strigose, peduncle of the lateral axes somewhat more slender, involucre in flower broadly cupulate, tawny to light brown or rusty orange short wooly tomentose, containing a single sessile flower, topped by a prominent ring or flange of spirally arranged rounded-triangular to lanceolate bract-like processes, the smallest ones borne in the lower cycle, gradually larger above, to c. 1.5 mm long, very densely light tawny to rusty brown strigose; sepals 5, imbricate, connate at the base, the outer 2 smaller, narrowly triangular or elliptic to nearly rhombic, c. (11-)15-20 × 5-11 mm, somewhat asymmetrical, the inner 3 very widely ovate to oblate, distinctly asymmetrical, with one lobe broadly expanded laterally (but usually hidden by the adjacent sepal), c. 12-22 × 15-26 mm, glabrous and dark chocolate brown on adaxial surface (in dry material), densely light tawny strigose on abaxial surface, apex acute; petals 5, imbricate, white, membranaceous when dry, ovate to widely ovate, glabrous, apex broadly acute to rounded; extrastaminal disc of 5 basally fused rounded to elongate, ligulate appendages c. 5-6 mm high, each bearing c. 25 filiform staminodes c. 3-12 mm in length, c. 20 borne along the apical margin and 5-7 about midway on the inner surface; stamens c. 100, filaments slender, free, 10-25 mm long, glabrous, anthers ellipsoid to ovoid, 1-1.5 mm long, basifixed, reflexed; ovary cylindrical, densely whitish to light brownish woolly tomentose, style c. 15 mm long, densely whitish to light brownish woolly tomentose at the base, glabrous above, stigma terminal, hemispherical, glabrous. Involucre in fruit woody, dark brown, smooth or slightly wrinkled on outer surface (in dry material), smooth

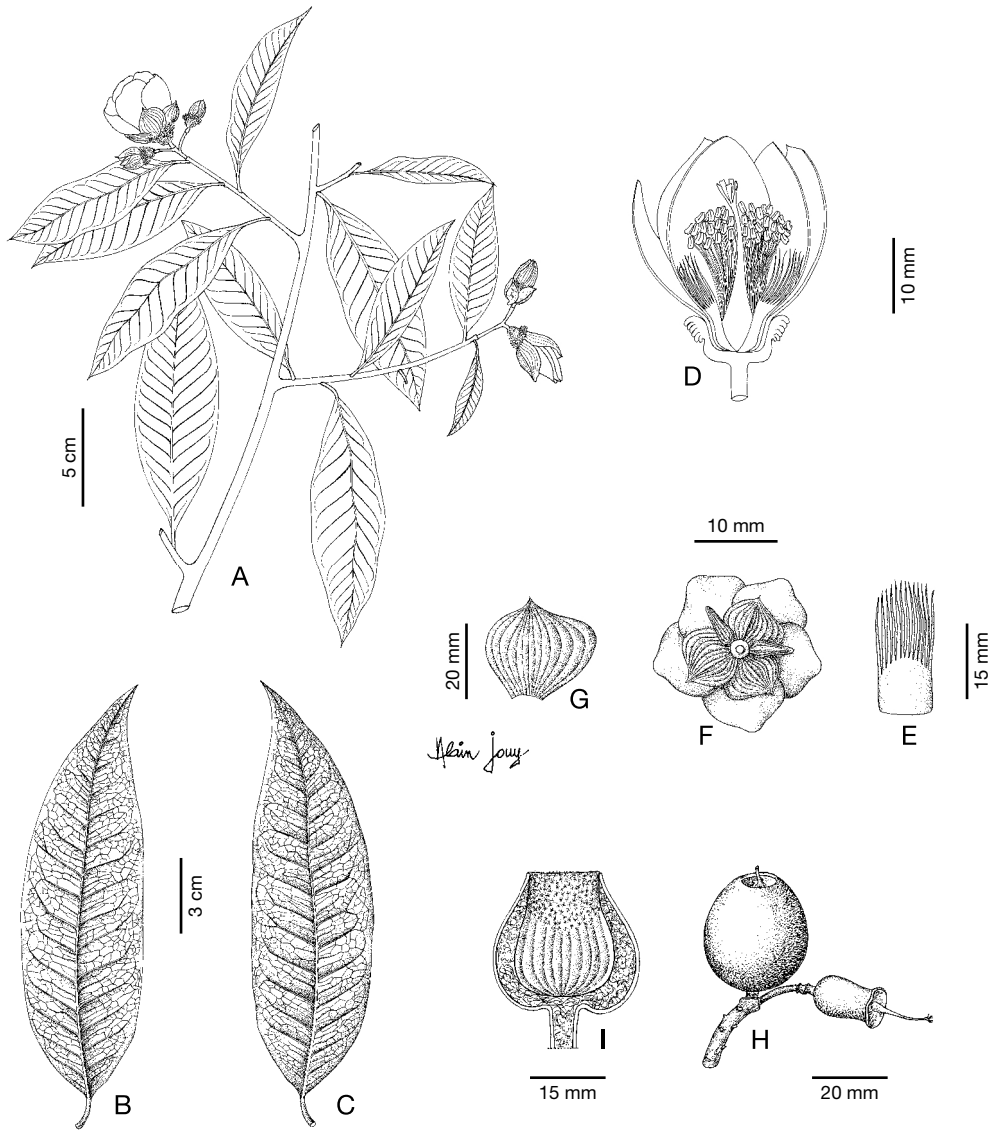

Fig. 2. — ***Xyloolaena sambiranensis*: A**, flowering branch; **B**, leaf (adaxial surface); **C**, leaf (abaxial surface); **D**, flower (cross sectional view); **E**, portion of extrastaminal disc; **F**, flower from below; **G**, inner sepal; **H**, fruiting involucre (mature and immature), **I**, cross section of fruiting involucre. (A, D, E, G, *Schatz 3222*; B-C, H, *Gautier 2984*; F, *Perrier de la Bâthie 15052*).

with vertical striations on inner surface, globose to ellipsoid or ovoid, 2.1-3.2(-3.5) cm tall, 2.2-2.5 cm diam., the wall c. 3-4 mm thick, with an apical opening c. 7-10 mm diam., the collar lined inside with the persistent bract-like processes; fruit globose, entirely contained within the involucre, c. 10-12 mm diam., with 3 weakly defined lobes, densely brown to orangish hirsute, with a persistent, thickened lower portion of the style (sterile upper portion of the fruit?) c. 10 mm long, c. 2-3 mm diam. at the base, densely brown to orange hirsute, tapering to the glabrous upper portion. — Fig. 2.

Xyloolaena sambiranensis is a shrub to tree 3-12 m tall. It can be recognized by its white flowers and narrowly ovate leaves with (11-)13-16 pairs of secondary veins. This species appears to be most closely related to *X. speciosa*, but can be distinguished by its more numerous secondary veins and caducous inflorescence bracts, its extrastaminal disc comprising 5 well-defined lobes each with c. 25 staminodes, and its more southerly distribution in the Sambirano region (subhumid bioclimate) from S of Maromandia N to the Ambanja area (Fig. 1).

VERNACULAR NAMES. — Sofiakomba, Sofiankomba, Sofikomba, Sofinakomba, Sofinkomba.

CONSERVATION STATUS. — *Xyloolaena sambiranensis* has an area of occupancy < 2,000 km^2 and only two of the five recorded sub-populations occur within the network of protected areas, and is therefore assigned a preliminary status of Vulnerable (VU).

PARATYPES. — MADAGASCAR, ***Prov. Antsiranana***: *Derleth 160*, Manongarivo RS, Besinkara, chemin d'Ambodisakoana à Ambalafary, sur le plateau, 14°04'S, 48°17'E, 300 m, 3 Nov. 1994, fr. (G, MO, P, TAN, TEF); *Gautier 2984*, Manongarivo RS, Besinkara, chemin d'Ambodisakoana à Ambalafary, à mi-montée de la corniche, 14°04'S, 48°17'E, 200 m, 4 Apr. 1996, fl., fr. (G, MO, P, TAN, TEF); *Malcomber et al. 1708*, S of Ankaramy, RN 6, beside road, 13°58'S, 48°10'E, 100 m, 15 Nov. 1992, fr. (MO, P); *Perrier de la Bâthie 15052*, bassin de l'Ambazona [=Ambazoana], [13°35'S, 48°38'E], bud, fr. (P); *Perrier de la Bâthie 15424*, same locality, grès liasiques, Feb. 1923, bud, fl. [K, P (2 sheets)]; *Saboureau 60*, chaîne de Bekaka, Ambanja, [13°44'S, 48°30'E], 150 m, fl. (P); *Service Forestier 2956*, Antentezanambo, [13°49'S, 48°06'E], 16-30 Mar. 1951, fl., y.fr. (P, TAN, TEF); *Service Forestier 3161*, Bekaka, Ambanja, [13°44'S, 48°30'E], 20 Mar. 1950, ster. (P); *Service Forestier 7734*, Bandrakorony, Ambanja, [13°49'S, 47°52'E], 6 Oct. 1953, fr. (P, TEF); *Service Forestier 9286*, Benavony, Ambanja, [13°41'30"S, 48°29'E], 22 Mar. 1954, bud, fr. (P, TEF); *Service Forestier 10411*, route de Maromandia à Ambanja, 10 Aug. 1954, fr. (P); *Service Forestier 10451*, rivière Antsahakolana, dist. d'Ambanja, Manongarivo RS, [14°04'30"S, 48°16'E], 360 m, 19 July 1954, fr. (P, TEF); *Totozafy Be 555*, Manongarivo RS, Besinkara, bord de chemin, 14°04'S, 48°17'E, 4 June 1996, fr. (G, MO, P). ***Prov. Mahajunga***: *Decary 2130*, Maromandia, terrain gréseux, [14°12'S, 48°05'E], 15 May 1923, fl. [P (2 sheets)]; *Perrier de la Bâthie 3025*, collines gréseuses des environs de Maromandia, [14°12'S, 48°05'E], Mar. 1909, fl. [P (2 sheets)]; *Service Forestier 19396*, Amparihibe, canton Maromandia, colline sur sol gréseux, [14°18'30"S, 48°07'E], 9 Jan. 1959, bud (P, TEF).

5. Xyloolaena speciosa Lowry & G.E. Schatz, sp. nov.

Frutex vel arbor usque ad 20 m alta. Folia lamina elliptica usque ovata, (6-)8-14.5 × (4-)4.5-7.5 cm, longitudine latitudinem plerumque minus quam 2.3-plo excedente, apice rotundata acutave plerumque manifeste mucronata, nervis secundariis alternis subopositisve 9- vel 10- (ad 12-)jugatis. Inflorescentia (2- vel) 3- ad 5-flora; bracteis omnibus plerumque ad anthesin nonnullis saepe sub fructum persistentibus; involucro florem solitarium subtendente. Flos petalis salmoneis; disco extrastaminali ex annulo humili 3-5 mm alto staminodia 200 ad 250 gerente constante. Fructus involucro 2.0-2.7 cm alto, 2.0-2.5 cm diam. subtentus.

TYPUS. — *Service Forestier (Capuron) 3051*, Madagascar, Prov. Antsiranana, base des collines gréseuses du Levika [=Leviky], aux environs de Matsoborilava, [13°16'S, 49°01'E], 12 Mar. 1951, fl., fr. (holo-, P!; iso-, K!, MO!, P!, TEF).

Large shrubs or trees to 20 m tall. Twigs glabrous. Leaves elliptic to ovate, chocolate brown or occasionally brownish green and often shiny above (in dry material), brownish to khaki green and dull below, subcoriaceous, (6-)8-14.5 × (4-)4.5-7.5 cm, usually less than 2.3 times as long as wide, glabrous, apex rounded to acute, usually with a distinct mucro, margin entire, minutely thickened and usually slightly revolute, base rounded to obtuse, occasionally almost truncate, venation brochidodromous, with 9-10(-12) pairs of alternate to subopposite secondary veins, midrib flat to weakly channeled above, raised below; petiole (6-)10-15 mm long, glabrous; stipules 2, lateral, free, crustaceous to subcoriaceous, ovate, c. 6-8 × 3.5-4.5 mm, glabrous, apex acute to acuminate, margin entire. Inflorescences terminal on main branches and short lateral shoots, a compact cyme with (2-)3-5 flowers, primary axis c. 2-20 mm long, with 2-10 pairs of bract scars, brown (orangish tan on bract scars),

glabrous at base, upper internodes densely light tawny wooly tomentose, secondary axes 2-12 mm long, whitish to light tawny wooly tomentose throughout, bracts prominent, usually persistent at least until anthesis and often at least some in fruit, broadly ovate, c. 10-18 × 8-16 mm, strongly concave adaxially, apex broadly acute or with 2-3 irregular lobes, light chocolate brown (in dry material), crustaceous to coriaceous, outer surface often obscured by dense whitish wooly tomentose indument, terminal peduncle (ultimate axis below the involucre) stout, 1-2 mm long, 2-3 mm diam., densely brown to rusty orange wooly tomentose, those of the lateral, later-flowering axes somewhat more slender, involucre in flower densely rusty orange wooly, whitish on the flared rim, containing a single flower, topped by a more or less prominent ring of spirally arranged narrowly triangular bract-like processes, the smallest ones borne in the lower cycle, gradually larger above, to c. 1 mm long, very densely rusty brown wooly, tawny on the tips of the processes; sepals 5, imbricate, connate at the base, the outer 2 smaller, narrowly triangular, c. 16-22 × 9-13 mm, nearly symmetrical, the inner 3 widely ovate, weakly asymmetrical, with one lobe slightly expanded laterally (but often hidden by the adjacent sepal), c. 16-22 × 22-25 mm, glabrous and dark chocolate brown on the adaxial surface (in dry material), densely whitish to light tawny short tomentose on the abaxial surface, apex rounded to broadly acute; petals 5, imbricate, salmon pink, membranaceous when dry, broadly ovate to nearly circular, glabrous, apex rounded; extrastaminal disc a low, weakly 5-lobed rim c. 3-5 mm high bearing c. 200-250 spreading to recurved, filiform staminodes c. 8-12 mm in length; stamens c. 100, filaments slender, erect at anthesis, free, 20-22 mm long, glabrous, anthers ellipsoid, basifixed, reflexed; ovary narrowly ovoid, densely rusty brown tomentose, style c. 15 mm long, densely rusty brown tomentose at the base, glabrous above, stigma terminal, flat-topped, glabrous. Involucre in fruit woody, dark brown, smooth on outer surface (in dry material), smooth and light brown on inner surface, globose to ellipsoid or ovoid, 2-2.7 cm tall, 2-2.5 cm diam., the wall c. 4-5 mm thick, with an apical opening c. 6-8 mm diam., the collar lined inside with the persistent bract-like processes; fruit globose to depressed globose, entirely contained within the involucre, c. 12-14 mm diam., 3-lobed, densely brownish orange wooly tomentose, also with scattered erect, white strigose trichomes, apex forming a distinct conical rostrum. — Fig. 3.

Xyloolaena speciosa is a large shrub or tree whose flowers are reported to be salmon pink. Along with *X. sambiranensis*, which appears to be its closest relative, this species has narrowly ovate to oblong leaves, although their length rarely exceeds 2.3 times the width (in *X. sambiranensis* they are almost always at least 2.5 times as long as wide). *Xyloolaena speciosa* can be further distinguished by having only 9-10(-12) pairs of secondary leaf veins, persistent inflorescence bracts, and an extrastaminal disc that forms a low rim with c. 200-250 staminodes. It is narrowly distributed in an area with a dry to subhumid bioclimate extending from the Ambato Peninsula and the lower Ifasy river valley N to near Ambilobe (Fig. 1).

Humbert & Capuron 25590 was collected at the same locality and on the same day as the type, and is virtually identical in all aspects, suggesting that the specimens of both numbers were taken from the same individual.

VERNACULAR NAME. — Marabanty.

CONSERVATION STATUS. — With no sub-populations recorded from within the current protected areas network, and thus a predicted population decline of > 80% in the next three generations, *Xyloolaena speciosa* is assigned a preliminary status of Critically Endangered (CR).

PARATYPES. — MADAGASCAR, ***Prov. Antsiranana***: *Antilahimena et al. 321*, Ambato FC, 13°26'42"S, 48°33'18"E, 21 Nov. 1996, fr. (MO, P, TEF); *Bosser 20243*, route Ambilobe-Ambanja, PK 20, [13°18'S, 48°54'E], forêt sempervirente, 18 Apr. 1970, fl., y.fr. (P); *Humbert & Capuron 25590*, collines gréseuses au SW d'Ambilobe dans les vallonnements et près de ruisseaux temporaires, [13°16'S, 49°01'E], 10 m, 12 Mar. 1951, fl., fr. (MO, P); *Humbert & Capuron 25873*, vallée de l'Ifasy en aval d'Anaborano, vers Irary (Dist. d'Ambilobe), grès du Karroo et alluvions, [13°34'S, 48°49'E], 50-200 m, 31 Mar. 1951, fl. (P); *Perrier de la Bâthie 3020*, schistes liasiques de la presqu'île d'Ambato, [13°26'S, 48°33'E], Jan. 1909, ster. (P);

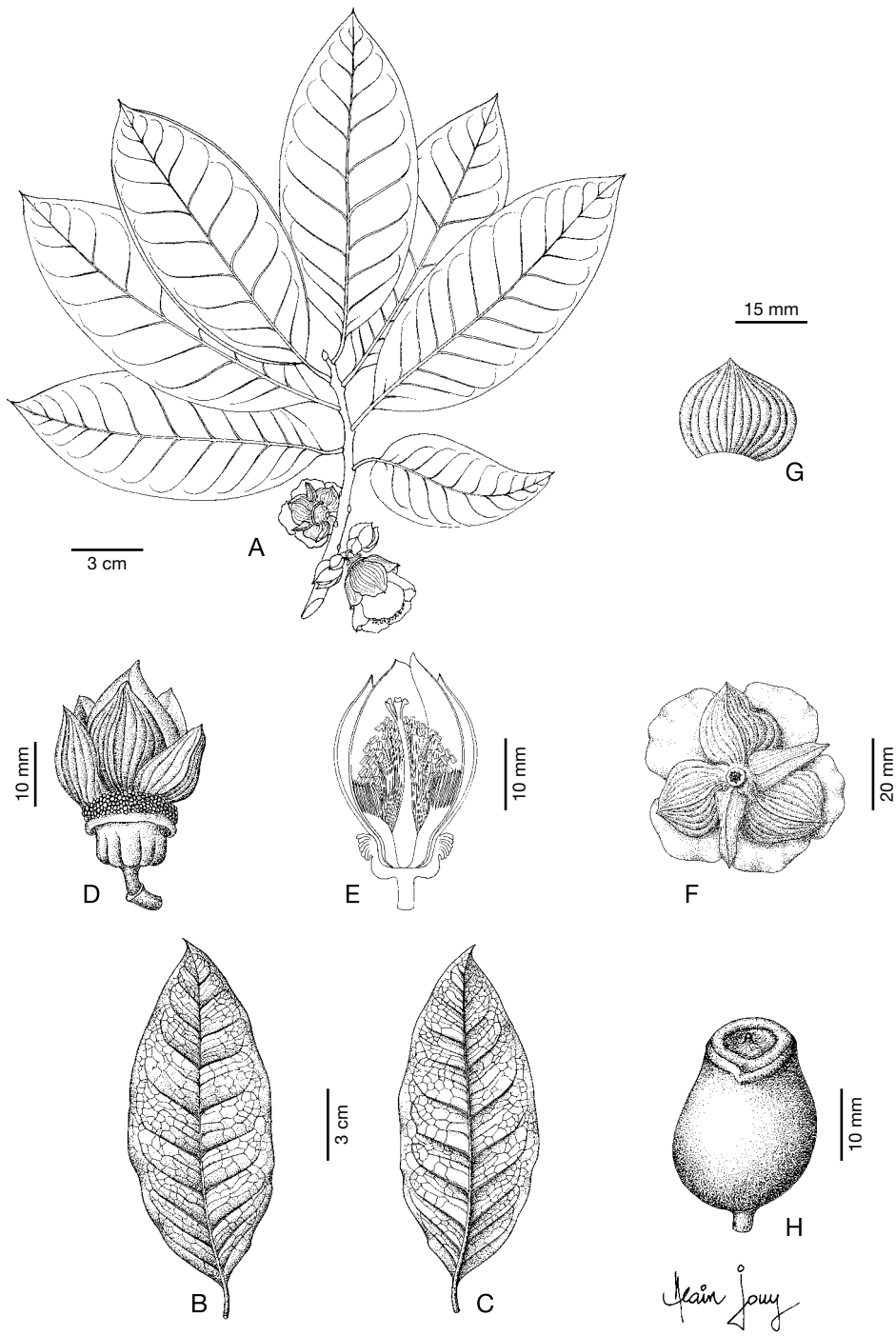

Fig. 3. — ***Xyloolaena speciosa*: A**, flowering branch; **B**, leaf (adaxial surface); **C**, leaf (abaxial surface); **D**, flower near anthesis; **E**, flower (cross sectional view); **F**, flower from below; **G**, inner sepal; **H**, fruiting involucre. (A-C, F-G, *Service Forestier 3051*; D-E, *Service Forestier 23426*; H, *Antilahimena et al. 321*).

Randrianaivo et al. 236, Bevoay, Ambato FC, 40 km N d'Ambanja, 13°27'43"S, 48°32'33'E, 50-60 m, 16 May 1998, fr. (K, G, MO, TEF, P); *Service Forestier 23426*, presqu'île d'Ambato, [13°26'S, 48°33'E], 16 Mar. 1964, fl. [MO, P(2 sheets)]; *Ursch 279*, forêt à l'est d'Ambilobe, [13°12'S, 49°05'E], 30-200 m, Jan. 1927, fr. (P).

EXCLUDED SPECIES

Xyloolaena linearifolia Cavaco

Bull. Soc. Bot. France 97: 225 (1950). — Type: *Humbert 13853*, Madagascar, Prov. Toliara, Mont Apiky au-dessus de Mahamavo, transition du bush xérophile à la forêt basse sclérophylle, [24°45'30"S, 46°43'30"E], 800-900 m, Jan.-Feb. 1934 (holo-, P, not seen).

The material on which this species was based is not among the collections of *Xyloolaena* in the Paris herbarium. Shortly after the name was published CAVACO probably realized that HUMBERT's collection does not belong to *Xyloolaena*, as suggested by the fact that he did not cite it in his treatment of Sarcolaenaceae for the Flore de Madagascar (CAVACO 1952b). The illustration accompanying the protologue shows an exserted fruit, which would appear to exclude it from *Xyloolaena*, whose fruits are completely enclosed within the involucre. The illustration suggests that HUMBERT's material may belong to *Diospyros* (Ebenaceae), but this can not be confirmed until the collection is re-located.

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REFERENCES

ALVERSON W.S., KAROL K.G., BAUM D.A, CHASE M.W., SWENSEN S.M., MCCOURT R. & SYTSMA K.J. 1998. — Circumscription of the Malvales and relationships to other Rosidae: evidence from *rbc*L sequence data. *Amer. J. Bot.* 85: 876-887.

BAILLON H. 1872a. — Sur le fruit d'une nouvelle Chlaenacée. *Adansonia* 10: 234-239.

BAILLON H. 1872b. — Histoire des Plantes. Vol. 4. Hachette & Co., Paris.

BAILLON H. 1879. — Dictionnaire de Botanique. Vol. 2. Paris.

BAILLON H. 1884. — Les *Xylolaena* et la valeur de la famille des Chlénacées. *Bull. Mens. Soc. Linn. Paris* 1: 410-414.

BAYER C., FAY M.F., DE BRUIJN A.Y., SAVOLAINEN V., MORTON C.M., KUBITZKI K., ALVERSON W.S. & CHASE M.W. 1999. — Support for an expanded family concept of Malvaceae within a recircumscribed order Malvales: a combined analysis of plastid *atp*B and *rbc*L DNA sequences. *J. Linn. Soc. Bot.* 129: 267-303.

CAPURON R. 1970. — Observations sur les Sarcolaenacées. *Adansonia*, sér. 2, 10: 247-265.

CARLQUIST S. 1964. — Pollen morphology and evolution of Sarcolaenaceae (Chlaenaceae). *Brittonia* 16: 231-254.

CAVACO A. 1950. — Deux *Xiloolaena* (Chlaenaceae) nouvelles. *Bull. Soc. Bot. France* 97: 224-225.

CAVACO A. 1952a. — Recherches sur les Chlénacées, famille endémique de Madagascar. *Mém. Inst. Sci. Madagascar*, sér. B, Biol. Vég. 4: 59-92.

CAVACO A. 1952b. — Chlénacées. *Fl. Madagascar* 126: 1-37.

COETZEE J.A. & MULLER J. 1984. — The phytogeographic significance of some extinct Gondwanan pollen types from the Tertiary of the southwestern Cape (South Africa). *Ann. Missouri Bot. Gard.* 71: 1088-1099.

CORNET A. 1974. — Essai de cartographie bioclimatique à Madagascar. *Notic. Explic. ORSTOM* No. 55.

DU PUY D.J. & MOAT J. 1996. — A refined classification of the vegetation types of Madagascar, and

their current distribution: 205-218, in LOURENÇO W.R. (ed.), *Biogéographie de Madagascar*. Éditions de l'ORSTOM, Paris.

LOWRY II P.P., SCHATZ G.E. & PHILLIPSON P.B. 1997. — The classification of natural and anthropogenic vegetation in Madagascar: 93-123, in GOODMAN S.M. & PATTERSON B.D. (eds.), *Natural change and human impact in Madagascar*. Smithsonian Inst. Press, Washington & London.

LOWRY II P.P., SCHATZ G.E. & PHILLIPSON P.B. 1998. — Classification de la végétation naturelle et anthropique de Madagascar. *Bull. Acad. Natl. Madagascar*, n.s., 73: 219-233.

LOWRY II P.P., SCHATZ G.E., LEROY J.-F. & WOLF A.-E. 1999. — Endemic families of Madagascar. III. A synoptic revision of *Schizolaena* (Sarcolaenaceae). *Adansonia*, sér. 3, 21: 183-212.

LOWRY II P.P., HAEVERMANS T., LABAT J.-N., SCHATZ G.E., LEROY J.-F. & WOLF A.-E. 2000. — Endemic families of Madagascar. V. A synoptic revision of *Eremolaena*, *Pentachlaena*, and *Perrierodendron* (Sarcolaenaceae). *Adansonia*, sér. 3, 22: 11-31.

NILSSON S., COETZEE J. & GRAFSTRÖM E. 1996. — On the origin of the Sarcolaenaceae with reference to pollen morphological evidence. *Grana* 35: 321-334.

NILSSON S. & RANDRIANASOLO A. 1999. — Morphology and functional aspects of the pollen in the Sarcolaenaceae. *Palaeoecology of Africa* 26: 191-200.

RANDRIANASOLO A. & MILLER J.S. 1999. — Taxonomic revision of the genus *Sarcolaena* (Sarcolaenaceae). *Ann. Missouri Bot. Gard.* 86: 702-722.

SCHATZ G.E. 2000. — Endemism in the Malagasy tree flora: 1-9, in LOURENÇO W.R. & GOODMAN S. M. (eds.), *Diversity and Endemism in Madagascar*. *Mém. Soc. Biogéogr.*, Paris.

SCHATZ G.E., BIRKINSHAW, C.R., LOWRY II P.P., RANDRIANTAFIKA F. & RATOVOSON F. 2000a. — The endemic plant families of Madagascar project: integrating taxonomy and conservation: 11-24, in LOURENÇO W.R. & GOODMAN S.M. (eds.), *Diversity and Endemism in Madagascar*. *Mém. Soc. Biogéogr.*, Paris.

SCHATZ G.E., LOWRY II P.P., LESCOT M., WOLF A.-E., ANDRIAMBOLOLONERA S., RAHARIMALALA V. & RAHARIMAMPIONONA J. 1996. — Conspectus of the vascular plants of Madagascar: a taxonomic and conservation electronic database: 10-17, in VAN DER MAESEN L.J.G., VAN DER BURGT X.M. & VAN MEDENBACH DE ROOY J.M. (eds.), *The Biodiversity of African Plants*. Proc. XIV AETFAT Congress. Klower Academic Publishers, Wageningen, The Netherlands.

SCHATZ G.E., LOWRY II P.P. & WOLF A.-E. 1998. — Endemic families of Madagascar. I. A synoptic revision of *Melanophylla* Baker (Melanophyllaceae). *Adansonia*, sér. 3, 20: 233-242.

SCHATZ G.E., LOWRY II P.P. & WOLF A.-E. 1999a. — Endemic families of Madagascar. II. A synoptic revision of Sphaerosepalaceae. *Adansonia*, sér. 3, 21: 107-123.

SCHATZ G.E., LOWRY II P.P. & WOLF A.-E. 1999b. — Endemic families of Madagascar. IV. A synoptic revision of *Asteropeia* (Asteropeiaceae). *Adansonia*, sér. 3, 21: 255-268.

SCHATZ G.E., LOWRY II P.P. & WOLF A.-E. 2000b. — Endemic families of Madagascar. VI. A synoptic revision of *Rhodolaena* (Sarcolaenaceae). *Adansonia*, sér. 3, 22: 239-252.

SCHATZ G.E., LOWRY II P.P. & WOLF A.-E. 2001. — Endemic families of Madagascar. VII. A synoptic revision of *Leptolaena* Thouars sensu stricto (Sarcolaenaceae). *Adansonia*, sér. 3, 23: 171-189.

STRAKA H. 1963. — Betrachtungen zur Phylogenie der Sarcolaenaceae (Chlaenaceae). *Ber. Deutsch. Bot. Ges.* 76: 55-62.

STRAKA H. 1964. — Palynologia Madagassica et Mascarenica. Fam. 126, Sarcolaenaceae (Chlaenaceae). *Pollen & Spores* 6: 289-301.

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