Blumea 55, 2010: 105–110
www.ingentaconnect.com/content/nhn/blumea

RESEARCH ARTICLE

doi:10.3767/000651910X525259

A revision of Madagascan *Bertiera* (*Rubiaceae*)

P.M. Wittle[1], A.P. Davis[1]

Key words

Bertiera
Bertiereae
conservation
IUCN Red List Categories
Madagascar
Rubiaceae

Abstract A taxonomic revision of the Madagascan representatives of the genus *Bertiera* is presented, to include three species, *B. brevithyrsa*, *B. crinita* and *B. longithyrsa*. A key to their identification is provided, each species is fully described, and summaries of distribution, habitat and ecology, and phenology are given; conservation assessments are also provided. *Bertiera brevithyrsa* is described as new species; *B. crinita* represents a new combination, and a lectotype is designated for this name.

Published on 5 August 2010

INTRODUCTION

The genus *Bertiera* Aubl. comprises c. 52 species, and occurs from Mexico to tropical America, tropical Africa, Madagascar and the Mascarenes, with the greatest species diversity in Africa (www.rbgkew.org.uk/data/rubiaceae). The tribal placement of *Bertiera* has been the matter of recent systematic debate, with placements in the tribe *Heinsieae* (Verdcourt 1983: 549), *Gardenieae* DC. subtribe *Gardeniinae* (Robbrecht et al. 1994), *Gardenieae* subtribe *Bertierinae* K.Schum. (Bridson 1998: 214), *Coffeeae* DC. (Andreasen & Bremer 2000), *Bertiereae* (K.Schum.) Bridson (Bridson & Verdcourt 2003: 386) and *Coffeeae* subtribe *Bertierinae* (K.Schum.) Robbr. & Manen (Robbrecht & Manen 2006). Recent molecular and morphological data (Davis et al. 2007, Tosh et al. 2009) supports placement within its own tribe, *Bertiereae* (Bridson & Verdcourt 2003).

The only complete revision of *Bertiera* (Wernham 1912) is now very much out of date, although useful works exist for America (Steyermark 1967), Africa (Bridson 1988, Hallé 1960, 1970, Robbrecht et al. 1994, Nguembou et al. 2003) and the Macarenes (Verdcourt 1983, Leroy 1989). For Madagascar there is presently only a single species known, *B. longithyrsa* Baker, which according to Baker (1890) closely resembles the Mauritian species *B. zaluzania* Gaertn. Following this work little has been written about *B. longithyrsa*, or *Bertiera* in Madagascar. Robbrecht et al. (1994) briefly mentions *B. longithyrsa*, and commented that it can be separated from other *Bertiera* species by its conspicuous sub-foliaceous bracts. Schatz (2001) treats Madagascan *Bertiera*, comprising one species (*B. longithyrsa*), but infers that there are other species present in Madagascar ("2 or more? spp."). The original description of *B. longithyrsa* remains the most comprehensive work on Madagascan *Bertiera*. Upon examination of material held at several herbaria (see Materials and Methods) and on the basis of fieldwork, it became apparent that a revision of the Madagascan species was needed. In particular, it is necessary to recognize two other species of *Bertiera* for Madagascar, including: *B. crinita* (A.Rich.) Wittle & A.P.Davis, a new combination based on *Sabicea crinita* A.Rich., and *B. brevithyrsa* A.P.Davis, a new species from NE Madagascar.

[1] Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB, UK; corresponding author e-mail: a.davis@kew.org.

MATERIALS AND METHODS

This study is based on herbarium specimens and associated spirit material, at the herbaria of K, MO, P, TAN and TEF (abbreviations after Holmgren et al. 1990). Each specimen was databased, and where possible georeferenced. Ecological and geographical data were collected from specimen labels. The measurements provided in the descriptions were made from herbarium specimens and spirit material. All material was examined using a Leica MZ95 stereomicroscope. The georeferenced specimen data was imported into ArcView™ geographic information software to produce distribution maps, ecological data and to calculate area occupancy (AOO) and extent of occurrence (EOO) for each species. AOO and EOO figures were used in conjunction with field observations to produce conservation ratings based on the IUCN Red List Categories criteria (IUCN 2001) using the methodology of Willis et al. (2003). Climatic data was extracted from BIOCLIM data (Hijmans et al. 2005), and elevation data from the Digital Elevation Model (DEM).

REMARKS ON THE MORPHOLOGY OF *BERTIERA* IN MADAGASCAR

Bertiera brevithyrsa, *B. crinita* and *B. longithyrsa* sit firmly within the circumscription of *Bertiera* (Wernham 1912, Robbrecht et al. 1994, Bridson & Verdcourt 2003), possessing the salient characters of the genus: stipule pairs shortly connate above each node, inflorescences terminal (although rarely axillary; Leroy 1974, Robbrecht et al. 1994); corolla lobes contorted to the left; stigma (pollen presenter) 10-winged/ridged in the upper part; ovary 2-locular; placentas peltate, with numerous ovules over the entire surface of each placenta; fruits berry-like, containing numerous angular seeds (surface finely reticulate/pitted). *Bertiereae* comprises a single genus, and so the salient characters of *Bertiera* are the same as those of the tribe (Bridson & Verdcourt 2003, Davis et al. 2007). Overall, the Madagascan species are similar to the Mascarene species (*B. bistipulata* Bojer, *B. borbonica* A.Rich. ex DC., *B. rufa* A.Rich. ex DC. and *B. zaluzania* Comm. ex C.F.Gaertn). In the three Madagascan species each flower is subtended (i.e. at the base of the hypanthium) by a pseudo-whorl of two to four (rarely five) bracteoles, which are broader and more conspicuous in *B. crinita* than *B. brevithyrsa* and *B. longithyrsa*. Flower

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subtending bracteoles are present in the Mascarene species but they are fewer and smaller (Verdcourt 1983, Leroy, 1989), or sometimes absent.

TAXONOMIC TREATMENT FOR MADAGASCAN *BERTIERA*

Bertiera Aubl. (1775a) 180; (1775b) t. 69; Wernham (1912) 110; N.Hallé (1960) 280. — Type species: *Bertiera guianensis* Aubl.

Description of Madagascan Bertiera

Shrubs or small trees. Many vegetative parts (shoots, stipules, petioles, leaf margins, leaf midrib and other venation), puberulous to densely pubescent. *Young shoots* terete. *Stipules* pairs shortly connate (united in basal 1/3) above each node or ± free, narrowly triangular to ± lanceolate; apex long acuminate. *Leaves* petiolate; leaf blades narrowly elliptic to elliptic, elliptic-oblong, or elliptic-obovate to elliptic-ovate, or narrowly obovate; base narrowly cuneate to cuneate-rounded; apex attenuate to attenuate-acuminate, or sometimes narrowly acute, chartaceous; margins flat; secondary venation eucamptodromus to weakly brochidodromus, 6–11 pairs; tertiary venation ramified to reticulate, indistinct to invisible; higher order venation reticulate to ramified obscure to ± invisible; domatia present or absent, if present found in the axils of the midrib and secondary vein on the lower surface of the leaf, pit-like, 0.2–0.5 mm diam, usually obscured by the hairs of the midrib and the secondary veins; on the upper surface usually not visible, if present manifest as an obscure pustule-like swelling. *Inflorescence* a terminal thyrse, open (rather lax) or compact (inflorescence branches short), pedunculate, all parts (peduncle, inflorescence branches, bracts and bracteoles) puberulous to pubescent; bracts present or absent, in axils of first order inflorescence branches, single, paired only if inflorescence branches opposite, linear, narrowly triangular, or very narrowly elliptic to very narrowly oblanceolate; bracteoles subtending the flower (at the base of hypanthium), in groups (pseudo-whorls) of 2–4(–5), within groups size unequal, very narrowly triangular to ± lanceolate, or linear to linear-triangular. *Flowers* hermaphroditic, homostylous, secondary pollen presentation present, sessile, 5-merous, flower buds with corolla lobes overlapping to the left; hypanthium ± obconical to urceolate, puberulous to pubescent; calyx tube short, 0.5–1 mm long; calyx lobes triangular to narrowly triangular, or lanceolate, apices narrowly acute; corolla ± tubular-infundibuliform, constricted in the upper 1/3 and expanded above the constriction, white (greenish white, yellowish white, cream-white), slightly fleshy, external surface sparsely puberulous to sparsely pubescent, internal surface densely pubescent in apical 1/3 (hairs white); corolla lobes triangular to narrowly triangular; disc ± cylindrical, flat-topped, glabrous; stamens: anthers included, fixed within the upper 1/4 of the corolla tube, introrse, sessile, ± medifixed, very narrowly ellipsoid-oblong, apex and base acute, with a brownish (when dry) apical connective appendage; ovary ovoid to ovoid-spherical, bilocular, placentation axile, placenta fixed ± at the midpoint, distinctly peltate, with numerous ovules over entire surface of each placenta; style narrowly club-shaped in general outline; stigma (pollen presenter) included, 10-winged/ridged, apex acute. *Fruits* berry-like, ellipsoid to ovoid, green to white (immature) to white and blue (nearly mature), then blue to dark blue (mature), external surface glabrous to pubescent; calyx lobes persistent. *Seeds* flattened-angular, surface minutely reticulate/pitted, brown (when dry).

Distribution — NW and E Madagascar (Map 1).

Habitat & Ecology — Occurring in humid, evergreen forest and seasonally dry evergreen-deciduous forest, mostly in primary forest but also recorded in secondary vegetation; 0–1300(–1500) m.

Phenology — Flowering: (August–) September to March; fruiting: November to May.

KEY TO SPECIES

1. Young shoots pubescent to densely pubescent (hairs 0.7–3 mm long); lower leaf surface (including secondary and tertiary venation) sparsely pubescent (hairs 0.4–1.7 mm long) . . . . . 2. *B. crinita*
1. Young shoots puberulous to pubescent (hairs 0.3–0.8 mm long); lower leaf surface (including secondary and tertiary venation) sparsely puberulous (hairs 0.2–0.3 mm long) . 2
2. Leaf blades 9–22.5 by 2–7 cm; inflorescence an open, rather lax thyrse, 4.5–20 cm long, peduncle 1–4.9 cm long; bracteoles narrowly triangular to narrowly lanceolate, 0.5–1 mm wide. — NW Madagascar . . . . . 3. *B. longithyrsa*
2. Leaf blades 4–10.4 by 1.1–2.9 cm; inflorescence a compact thyrse, 1–2 cm long, peduncle 0.2–0.4 cm long; bracteoles linear to linear-triangular, 0.2–0.4 mm wide. — NE Madagascar . . . . . 1. *B. brevithyrsa*

1. *Bertiera brevithyrsa* A.P.Davis, *spec. nov.* — Map 1

Bertierae longithyrsae Baker affinis sed foliis 4–10.4 longis 1.1–2.9 cm latis (nec 9–22.5 longis neque 2–7 cm latis), inflorescentia 1–2 cm (nec 4.5–20 cm) longo, pedunculo 0.2–0.4 cm (nec 1–4.9 cm) longo, bracteolis linearis vel lineari-triangularis, 0.2–0.4 mm (nec anguste triangularis neque anguste lanceolatis, 0.5–1 mm) latis, differt. — Typus: *Davis & Rakotonasolo APD 4524* (holo K; iso BR, MO, P, TAN, TEF), Madagascar, Province Toamasina, Region Analanjirofo, District Maroantsetra, Makira Protected Area, c. 15 km due west of Ambinanitelo, near Mt Beanivona, 16 May 2007.

Shrub or small narrow tree, 3–5 m high. *Young shoots* puberulous to pubescent (hairs 0.3–0.5 mm long, light brown). *Stipules* 8–12.6 by 2.6–3.8 mm, pubescent (young stipules) to sparsely pubescent or with hairs mainly confined to central portion of stipule (hairs 0.4–0.7 mm long, brown) and the rest of the stipule glabrous to puberulous. *Leaves*: petioles 8–12.4 mm long, pubescent (like the young shoots); leaf blades narrowly obovate to narrowly elliptic, 4–10.4 by 1.1–2.9 cm; base narrowly cuneate, slightly attenuate, rarely slightly asymmetric; margin puberulous to very sparsely pubescent (hairs 0.2–0.5 mm long, light brown); apex attenuate to attenuate-acuminate; lower surface: midrib pubescent (hairs 0.4–0.5 mm long, appressed, light brown to brown); secondary veins (6–)7–8(–9) pairs, pubescent (like the midrib but density and length of hairs less); tertiary venation ramified to reticulate, rather obscure; higher order venation obscure; leaf surface (including secondary and tertiary venation) sparsely puberulous (hairs 0.2–0.3 mm long, brown); upper surface: midrib sparsely pubescent (hairs 0.4–0.6 mm long, light brown), venation and leaf surface glabrous. *Inflorescence* a compact thyrse, 1–2 by 1–1.8 cm, all parts (peduncle, inflorescence branches, bracts and bracteoles) sparsely pubescent to pubescent (hairs appressed, 0.3–0.5 mm long, light brown to brown); peduncle 0.2–0.4 cm long; bracts present or absent, if present narrowly triangular to linear, 5.5–7.4 by 0.3–0.5 mm; bracteoles linear to linear-triangular, 5.1–7.2 by 0.2–0.4 mm. *Flowers*: hypanthium 1.4–1.7 by 1.1–1.4 mm, pubescent (hairs 0.3–0.5 mm long, whitish brown to light brown); calyx lobes very narrowly triangular, 2.8–3.2 by 0.3–0.5 mm; other flower parts unknown. *Fruit* (4.2–)6.1–6.8 by 4.2–6.6 mm, sparsely pubescent (hairs 0.3–0.4 mm long, whitish brown to light brown). *Seeds* 0.6–0.9 by 0.2–0.6 by 0.6–0.7 mm.

Distribution — NE Madagascar. **Province Toamasina**, Region Analanjirofo (District Maroantsetra).

Habitat & Ecology — Based on specimen data: closed canopy, humid evergreen forest, riverine vegetation, with only slight disturbance; recorded on quartz; c. 700 m. Based on GIS data:

humid forest; igneous and metamorphic rocks; 900 m; mean annual precipitation 2 000 mm; mean annual temperature: 21 °C; dry season 0(–2) months.

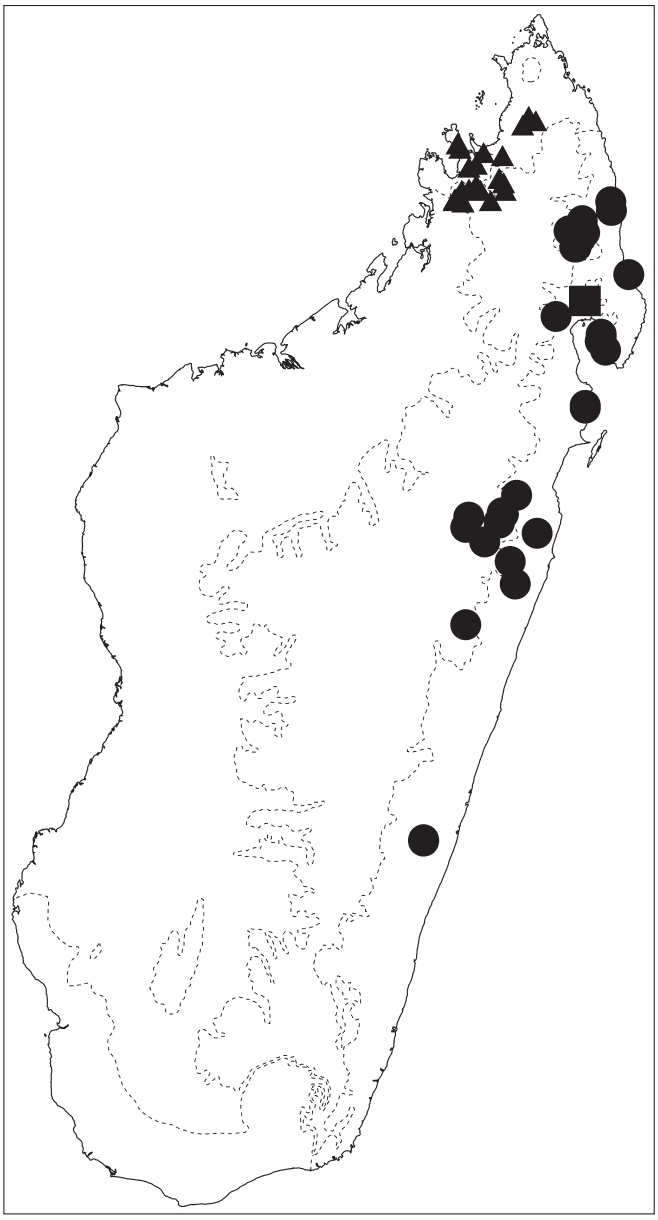
Phenology — Poorly known. Flowering: unknown; fruiting: May.

Vernacular names — None known.

Conservation status — IUCN Red List Category (IUCN 2001): Data Deficient (DD). *Bertiera brevithyrsa* is only known from two collections, from a single locality/population. Further fieldwork in the Makira Protected Area and nearby forested areas in north eastern Madagascar is required before a conservation assessment can be made.

Note — This species was first discovered in 2007, from the Makira Protected Area, near Maroantsetra in NE Madagascar. It is so far known only from a single locality within Makira, despite exploration in several localities in the same protected area. For details of the difference between *B. brevithyrsa* and *B. crinita* see Notes for the latter species (below). See Key to Species for differences between *B. brevithyrsa* and *B. longithyrsa*.

Additional material. Briggs 125 (K, MO, P, TAN, TEF), Madagascar, Province Toamasina, Region Analanjirofo, District Maroantsetra, Makira Protected Area, c. 15 km due west of Ambinanitelo, near Mt Beanivona (Andramenahely camp), 14 May 2007.



Map 1 Distribution of *B. brevithyrsa* A.P.Davis (■), *B. crinita* (A.Rich.)Wittle & A.P.Davis (●) and *B. longithyrsa* Baker (▲).

2. *Bertiera crinita* (A.Rich.) Wittle & A.P.Davis, *comb. nov.* — Fig. 1; Map 1

Basionym: *Sabicea crinita* A.Rich. (1830) 148. — *Mussaenda crinita* (A.Rich.) Homolle (1938) 3. — Type: *Herb. Richard s.n.* [large specimen on sheet, excluding small specimen of a *Mussaenda*] (lectotype P, designated here), Madagascar, without date.

Shrub or small narrow tree, 1–5 m high. *Young shoots* pubescent to densely pubescent (hairs 0.7–3 mm long, ginger-brown). *Stipules* 10.8–23.4 by 2.9–7.4 mm, sparsely to densely pubescent (hairs 1–3.1 mm long, ginger-brown). *Leaves:* petioles (1–)3–10.6 mm long, pubescent (like the young shoots); leaf blades narrowly elliptic to elliptic, elliptic-oblong, or elliptic-ovate, 7.5–16.5 by 2–5.3 cm; base narrowly cuneate to ± rounded, rarely slightly asymmetric; margin sparsely pubescent (hairs 0.6–1.7 mm long, ginger-brown to brown); apex attenuate to attenuate-acuminate; lower surface: midrib pubescent to densely pubescent (hairs 0.4–2.2 mm long, erect to appressed, light brown to ginger-brown); secondary veins 7–11 pairs, intersecondaries sometimes present, pubescent (like the midrib but density and length of hairs less); tertiary venation ramified to reticulate, rather obscure or ± absent; higher order venation obscure to ± invisible; leaf surface (including secondary and tertiary venation) sparsely pubescent (hairs 0.4–1.7 mm long, brown to ginger-brown); upper surface: midrib, venation and leaf surface sparsely pubescent (like the lower surface but density and length of hairs less to much less), venation and leaf surface very rarely glabrous. *Inflorescence* a compact thyrse, rarely rather open and lax but usually becoming open and lax at fruiting, 1.5–12.9(–16.8) by 1.8–6.3 cm, all parts (peduncle, inflorescence branches, bracts and bracteoles) pubescent to densely pubescent (hairs erect to erecto-patent, (0.4–)0.7–1.7 mm long, white-brown to brown, or ginger-brown); peduncle 0.2–3.5(–5.2) cm long; bracts present or absent, if present narrowly triangular, linear, or rarely very narrowly elliptic, 6.7–13.4(–25.8) by 0.4–1.8(–3.2) mm; bracteoles very narrowly triangular to ± lanceolate, 3.9–8.9 by 0.5–1.5 mm. *Flowers*: hypanthium 2.8–3.5 by 1.4–1.6 mm, sparsely pubescent (hairs 0.3–0.7 mm long, brown to ginger-brown); calyx lobes triangular to narrowly triangular or lanceolate, 1–4 by 0.4–0.7 mm; corolla 6.1–12.5 by 1.8–3.7 mm, exterior sparsely pubescent, hairs mainly confined to corolla lobes (hairs c. 0.5 mm long, light brown); corolla tube 2.5–8 by 1.6–2.5 mm; corolla lobes narrowly triangular, 1.9–4.7 by 0.7–1.7 mm, apices acute to acuminate, acumen c. 2 mm long; disc 0.5–2 by 0.5–2 mm; stamens: anthers 2–2.7 by 0.2–0.4 mm long, terminal appendage 0.5–1 mm long; pollen sacs 1.5–2 mm long; style 2.5–4.5 by 0.2–0.3 mm; stigma 2–3.5 by 0.5 mm. *Fruit* 3–6 by 4–7 mm, sparsely pubescent to pubescent (hairs 0.4–1 mm long, light brown to brown, or ginger-brown). *Seeds* 0.7–1 by 0.2–0.5 by 0.7 mm.

Distribution — E Madagascar, **Province Antsiranana**, Region Sava (Districts: Sambava, Andapa and Antalaha). **Province Toamasina**, Region Analanjirofo (Districts Maroantsetra, Mananara and Vavatenina); Region Alaotra-Mangoro (Districts Ambatondrazaka and Moramanga); Region Atsinanana (Districts Toamasina II and Brickaville). **Province Fianarantsoa**, Region Vatovavy-Fotovinany (District Ifanadiana).

Habitat & Ecology —Based on specimen data: closed canopy, humid, evergreen forest; recorded on gneiss and clay; 10–850 m. Based on GIS data: humid forest; basement rocks, lavas and alluvial deposits; 100–1600 m; mean annual precipitation 1100–3000 mm; mean annual temperature 19–25 °C; dry season: usually 0–2 months but 7 months for population in Ambatondrazaka area.

Phenology — Flowering: September to March; fruiting: November to May.

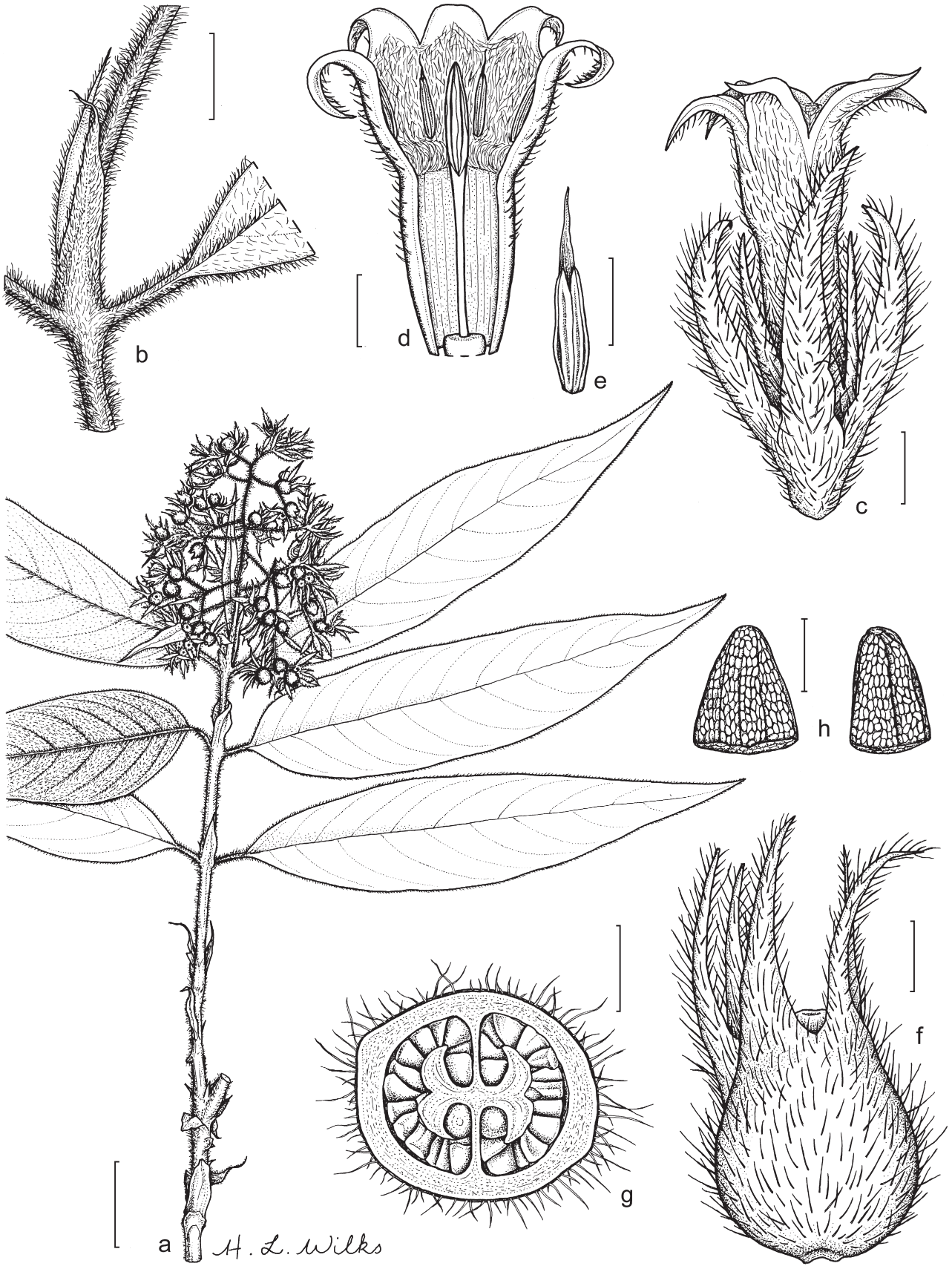


Fig. 1 *Bertiera crinita* (A.Rich.) Wittle & A.P.Davis. a. Habit; b. part of shoot, showing interpetiolar stipule; c. flower subtended by bracteoles; d. cut and opened out corolla to show anthers, disc and style and stigma (pollen presenter); e. anther in adaxial view, showing apical connective appendage; f. immature fruit with persistent calyx lobes; g. transverse section of fruit, showing two locules, peltate placentas, and seeds; h. seed in two views (a, b: *Rakotonasolo RNF 275*; c–h: *Davis et al. APD 1093*; all K). Scale bars: a = 2 cm; b = 6 mm; c, d, f, g = 2 mm; e = 1 mm; h = 0.5 mm.

Vernacular names — Sirontafoka (District Andapa); Tsirintafika (District Vavatenina); Soritafika and Hazovolena (District Ambatondrazaka).

Conservation status — IUCN Red List Category (IUCN, 2001): Near Threatened (NT). This species does not qualify for a threatened status (IUCN 2001) at present but is close to qualifying in the future based on an area of occupancy (2 500 km^2 (based on a 10 × 10 km grid) and by having seven locations (subpopulations). Other information: extent of occurrence 53 844 km^2.

Notes — We originally proposed to describe a new species for the above taxon but during a study of unplaced names in *Rubiaceae* (Ruhsam et al. 2008) we found that the unplaced name *Sabicea crinita* A.Rich. represented our new species of *Bertiera*. We have deduced that the original material used by Richard (1830) is a sheet held in the Paris (P) herbarium. It bears the original label in the lower left-hand corner of the sheet, with "*Sabicea crinita* Nob." written upon it. In another hand, presumably written at a later date is written: "Herbarium Richard. Madagascar. Scripsit A.Richard." On this sheet there are clearly two elements: 1) a *Bertiera* sp., taking up most of the sheet, as detailed above; and 2) a much smaller specimen of a *Mussaenda* sp., circled in pencil and annotated "*M. crinita* A.M. H." [A.-M. Homolle]. In the lower right-hand corner there is another label, which postdates the original. Printed on this label is "HERBIER E. DRAKE", and written below (blue ink) in an unknown hand is "*Mussaenda crinita*". The original diagnosis by Richard (1830) clearly refers only to the *Bertiera* specimen: "rufo-crinita; fol. elliptico-lanceolatis acuminatis praesertium subtus sparsè crinitis; stipulisque connatis acuminatis, acumine longissimo; floribus terminalibus racemoso-congestis", and not the smaller *Mussaenda* fragment. We have therefore lectotypified *Sabicea crinita* based on the main element of the sheet and one that is unambiguously in accord with the diagnosis of Richard (1830). Homolle (1938) made the combination *Mussaenda crinita* (A.Rich.) Homolle, based on *Sabicea crinita* A.Rich., but instead of citing the original material (see above) a Chapelier specimen was cited ("Madagascar, Chapelier"; Madagascar, *Chapelier s.n.* (holo P)). Richard (1830) cited Chapelier specimens when they were used as original material, but in the case of *Sabicea crinita* he did not.

Bertiera crinita is very easily separated from *B. longithyrsa* and *B. brevithyrsa*, on the basis that it is a very much more pubescent plant: the distribution, density and length of hairs is considerably greater in *B. crinita*. *Bertiera crinita* also can be separated from *B. longithyrsa* due to its longer calyx lobes (1–4 mm vs 0.3–1.5 mm long), longer corolla tube (2.5–8 mm vs 2–3 mm long) and generally shorter peduncle (0.2–3.5 cm vs 1–4.9 cm long). *Bertiera crinita* also can be separated from *B. brevithyrsa* on the basis of its generally longer peduncle (0.2–3.5 cm vs 0.2–0.4 cm long), broader bracteoles (0.5–1.5 mm vs 0.2–0.4 mm wide) and generally smaller leaves (7.5–16.5 by 2–5.3 cm vs 4–10.4 by 1.1–2.9 cm). The distribution of *B. crinita* and *B. longithyrsa* does not overlap (see Map 1). Their ecologies are also different, with the former in wetter forest (higher mean annual precipitation, and shorter dry season; see Habitat & Ecology, for each species). *Bertiera crinita* and *B. brevithyrsa* overlap in their distribution but do not appear to be sympatric.

Bertiera crinita has been recorded as a climber (*Herbier Institut Scientifique Madagascar 2489* (P); *Cours 189[1]* (P)) but this is erroneous.

3. *Bertiera longithyrsa* Baker — Map 1

Bertiera longithyrsa Baker (1890) 322. — Type: *Baron 5788* (holo K), Madagascar, Sambirano, Nossi-Bé [Nosy Be], 1887 (received at K).

Shrub to small tree, 1–5(–10) m high. *Young shoots* puberulous to pubescent (hairs 0.3–0.8 mm long, light brown to reddish brown). *Stipules* 6–20 by 3–5 mm, ± glabrous to puberulous or sparsely pubescent, hairs mainly confined to central portion of stipule (hairs 0.5–0.9 mm long, brown to reddish brown). *Leaves:* petioles (1–)3–10 mm long, puberulous or pubescent (like the young shoots); leaf blades elliptic to narrowly elliptic, or elliptic-ovate to elliptic-obovate, 9–22.5 by 2–7 cm; base narrowly cuneate to cuneate, sometimes rounded-cuneate, often slightly asymmetric; margin puberulous to very sparsely pubescent (hairs 0.2–0.3 mm long, light brown); apex attenuate to attenuate-acuminate, rarely narrowly acute; lower surface: midrib pubescent (hairs 0.4–0.6 mm long, appressed, light brown to brown); secondary veins 6–11 pairs, pubescent (like the midrib but density and length of hairs less); tertiary venation reticulate to ramified, obscure; higher order venation obscure; leaf surface (including secondary and tertiary venation) sparsely puberulous (hairs 0.2–0.3 mm long, brown); upper surface: midrib glabrous or very sparsely pubescent (hairs 0.4–0.7 mm long, light brown), venation and leaf surface glabrous. *Inflorescence* an open, rather lax thyrse, 4.5–20 by 1.8–7(–8) cm, all parts (peduncle, inflorescence branches, bracts and bracteoles) puberulous to pubescent (hairs erecto-patent to appressed, 0.1–0.5(–0.7) mm long, light brown to brown, or reddish brown); peduncle 1–4.9 cm long; bracts present or sometimes absent, if present narrowly triangular, linear, very narrowly elliptic, or very narrowly oblanceolate, 7–13(–22) by 1–1.5(–2) mm; bracteoles narrowly triangular to narrowly lanceolate, 3–5.5 by 0.5–1 mm. *Flowers:* hypanthium 2.7–4.1 by 1.5–1.9 mm, puberulous to sparsely puberulous (hairs c. 0.2 mm long, brown); calyx lobes triangular to narrowly triangular, 0.3–1.5 by 0.3–0.5 mm; corolla 2.4–6 by 1.4–4 mm, exterior sparsely puberulous, hairs mainly confined to median ridge of corolla lobes (hairs c. 0.1 mm long, light brown); corolla tube 2–3 by 1–2 mm; corolla lobes triangular, 1.5–2.3 by 1–1.5 mm, apices acute to narrowly acute or very shortly acuminate, acumen 0.2–0.4 mm long; disc 0.5–1 by 0.5–1 mm; stamens: anthers 1–1.5 by 0.3–0.5 mm, terminal appendage 0.3–0.5 mm long; pollen sacs c. 0.8 mm long; style 2–2.5 by 0.2–0.3 mm; stigma c. 1.5 by 1 mm. *Fruit* 4–6 by 4–7 mm, glabrous or rarely very sparsely puberulous to pubescent (hairs 0.2–0.4 mm long, light brown to brown). *Seeds* 0.7–1 by 0.2–0.7 by 0.7–0.8 mm.

Distribution — NW Madagascar, including the islands Nosy Be and Nosy Komba, **Province Antsiranana**, Region Diana (Districts Ambilobe, Ambanja and Nosy Be). **Province Mahajanga**, Region Sofia (District Analalava).

Habitat & Ecology — Based on specimen data: occurring in humid, evergreen forest (including Sambirano forest type) and seasonally dry evergreen-deciduous forest, in primary and secondary forest, frequently found adjacent to rivers and streams; one record on siliceous substrate (*Humbert 18733* (P)); 0–1000(–1300) m. Based on GIS data: subhumid and humid forest, woodlands; sandstones, basement rocks and alluvial deposits; 100–1300 m; mean annual precipitation 1400–2100 mm; mean annual temperature: 19–27 °C; dry season: 6–7 months.

Phenology — Flowering: (August–) September to December; fruiting: (August–) September to May.

Vernacular names — Tsinitafiky (Districts Nosy Be, Analalava); Duigaduigana (District Ambaja); Valomitiry (District Ambanja); Sevabe (District Ambanja).

Conservation status — IUCN Red List Category (IUCN 2001): Vulnerable (VU). VU B1ab (i, ii, iii, iv, v); B1, extent of occurrence less than 20 000 km^2 (*B. longithyrsa*: 6 757 km^2); a, severely fragmented or known to exist at 10 locations (the distribution of *B. longithyrsa* is severely fragmented; known from 7 locations (subpopulations)); b (i–v), continuing decline inferred

due to habitat loss and degradation. Other information: area of occurrence 2 100 km^2 (based on a 10 × 10 km grid). *Bertiera longithyrsa* is confined to the NW region of Madagascar (Map 1). Most of the recent collections (post 1960) for this species have been made in the southern areas of the range; the northern part has been reduced by agricultural development. For example, suitable habitat near Ambilobe is either highly degraded or reduced in extent; the last collection of *B. longithyrsa* from this general locality was made in 1921.

Note — For details of the difference between *B. longithyrsa* and *B. crinita* see Notes for the latter species (above). See Key to Species for differences between *B. longithyrsa* and *B. brevithyrsa*.

Acknowledgements This investigation would not have been possible without the agreement of CAFF (Comité Ad'hoc Faune et Flore, which is the association of the Ministère des Eaux et Forêts, Ministère de l'Enseignement Supérieure, Ministère de l'Environnement and Ministère de la Recherche Scientifique, in Antananarivo, Madagascar). We would like to thank the directors and staff of the herbaria at K, MO, P, TAN and TEF for providing us with access to their collections. We also gratefully acknowledge the following: Hazel Wilks for preparing the illustrations used in this contribution; Franck Rakotonasolo for his assistance with herbarium specimens and fieldwork; Mijoro Rakotoarinivo and Charlotte Cole for producing GIS data for conservation assessments, map and ecological data; Sally Dawson for various support and advice.

REFERENCES

Andreasen K, Bremer B. 2000. Combined phylogenetic analysis in the Rubiaceae-Ixoroideae: morphology, nuclear and chloroplast DNA data. American Journal of Botany 87: 1731–1748.

Aublet JBC. 1775a. Histoire des Plantes de la Guiane François, vol. 1: 1–621. Didot Jeune, Paris.

Aublet JBC. 1775b. Histoire des Plantes de la Guiane François, vol. 3: 1–193. Didot Jeune, Paris.

Baker JG. 1890. Further contributions to the Flora of Madagascar. Journal of the Linnean Society 25: 294–350.

Bridson DM. 1988. Bertiera. In: Bridson DM, Verdcourt B, Rubiaceae, part 2, Flora of Tropical East Africa: 479–483. Balkema, Rotterdam.

Bridson DM. 1998. Rubiaceae. In: Pope GV (ed), Flora Zambesiaca, vol. 5, part 2: 211–377. Royal Botanic Gardens, Kew.

Bridson DM, Verdcourt B. 2003. Rubiaceae. In: Pope GV (ed), Flora Zambesiaca, vol. 5, part 3: 379–720. Royal Botanic Gardens, Kew.

Davis AP, Chester M, Maurin O, Fay MF. 2007. Searching for the relatives of Coffea (Rubiaceae, Ixoroideae): the circumscription and phylogeny of Coffeeae based on plastid sequence data and morphology. American Journal of Botany 94: 313–329.

Hallé N. 1960. Sur les Bertiera (Rubiaceae) d'Afrique. Notulae Systematicae. Phanerogramie (Paris) 16: 280–292.

Hallé N. 1970. Bertiera. Rubiacées, 2e partie. In: Aubréville A, Leroy J-F (eds), Flore du Gabon vol. 17: 32–69. Muséum National d'Histoire Naturelle, Paris.

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A. 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965–1978.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. Part 1: The Herbaria of the World, 8th Edition. Regnum Vegetabile [series]. New York Botanical Garden, New York.

Homolle A-M. 1938. Mussaenda noveaux de Madagascar. Notulae Systematicae. Phanerogramie (Paris) 7: 3–7.

IUCN 2001. IUCN Red List Categories: Version 3.1. IUCN Species Survival Commission, Cambridge.

Leroy J-F. 1974. Recherches sur la phylogenèse du développement. Mise en évidence d'une série de trois états dans le genre Bertiera (Rubiacées). Adansonia, sér. 2, 14, 2: 53–59.

Leroy J-F. 1989. Bertiera. In: Bosser J, Cadet T, Guého J, Marais W (eds), Flore des Mascareignes La Réunion, Maurice, Rodrigues. 107. Caprifoliacées à 108bis. Valérianacées: 71–76. Mauritius Sugar Industry Research Institute, Reduit, Mauritius; L'Office de la Research Scientifique et Technique Outre-Mer, Paris, France; and Royal Botanic Gardens, Kew, UK.

Nguembou CK, Sonké B, Zapfack L, Lejoly J. 2003. Les espèces camerounaises du genre Bertiera (Rubiaceae). Systematics and Geography of Plants 73: 237–280.

Richard A. 1830. Mémoire sur la Famille des Rubiacées. Tastu, Paris.

Robbrecht E, Manen JF. 2006. The major evolutionary lineages of the coffee family (Rubiaceae, angiosperms). Combined analysis (nDNA and cpDNA) to infer the position of Coptosapelta and Luculia, and supertree construction based on rbcL, rps16, trnL-trnF and atpB-rbcL data. A new classification in two subfamilies, Cinchonoideae and Rubioideae. Systematics and Geography of Plants 76: 85–146.

Robbrecht E, Rohrhofer U, Puff C. 1994. A survey of Bertiera (Rubiaceae), including a discussion of its taxonomic position. Opera Botanica Belgica 6: 101–141.

Ruhsam M, Govaerts R, Davis AP. 2008. Nomenclatural changes in preparation for a World Rubiaceae Checklist. Botanical Journal of the Linnean Society 157: 115–124.

Steyermark JA. 1967. Bertiera. The botany of the Guayana Highland, VII. Memoirs of the New York Botanical Garden 17, 1: 316–322.

Schatz GE. 2001. Generic tree flora of Madagascar. Royal Botanic Gardens, Kew & Missouri Botanical Garden.

Tosh J, Davis AP, Dessein S, De Block P, Huysmans S, Fay MF, Smets E, Robbrecht E. 2009. Phylogeny of Tricalysia A.Rich. (Rubiaceae) and its relationships with allied genera based on plastid DNA data: resurrection of the genus Empogona. Annals of the Missouri Botanical Garden 96: 194–213.

Verdcourt B. 1983. Notes on Mascarene Rubiaceae. Kew Bulletin 37: 521–576.

Wernham HF. 1912. A revision of the genus Bertiera. Journal of Botany 50: 110–117, 156–164.

Willis F, Moat J, Paton A. 2003. Defining a role for herbarium data in Red List assessments: a case study of Plectranthus from eastern and southern tropical Africa. Biodiversity and Conservation 12: 1537–1552.

IDENTIFICATION LIST

1 = *Bertiera brevithyrsa*
2 = *Bertiera crinita*
3 = *Bertiera longithyrsa*

Anonymous (herb. Richard) s.n.: 2 — Anonymous 4878-RN: 3 — Antilahimena 46: 3 — Antilahimena et al. 448: 3.

Baron 5788: 3 — Bernardi 11829: 3 — Birkinshaw & Andrews 28: 3 — Boivin 2070: 3 — Bosser 14742: 3 — Briggs et al. MB 125: 1.

Capuron 23705-SF: 2; 23921-SF: 2; 24937-SF: 2 — Capuron & Chauvet 24776-SF: 2 — Cours 189 [1]: 2; 1891: 2; 4266: 2 — Cours & Humbert 5668: 3.

Davis & Rakotonasolo APD 4524: 1 — Davis et al. APD 1093: 2 — Déquaire 27847: 2; 27975: 2 — Derleth 153: 3.

Gautier & Totozafy Be LG 2867: 3 — Gautier et al. LG 3187: 3; LG 3875: 2 — Gentry & Schatz 62214: 2.

Harizo 1264-RN: 3; 6904-RN: 3 — Hildebrandt 3002: 3 — Humbert 4006: 3; 4015: 3; 18733: 3; 18767: 3; 21876 [a]: 2; 25929: 3 — Humbert & Capuron 24295: 2 — Humbert & Cours 32691: 3; 32907: 3.

Institut de Recherche Scientifique de Madagascar 2489: 2.

Jacquemin 453: 3 — Jardin Botanique de Tananarive 2760: 2; 2767: 2.

Keraudren 1584: 3; 1600: 3; 1608: 3.

Laibosaka 7811-RN : 3 — Lowry et al. 4126b: 2.

Malcomber 2791: 2; 2809: 2 — Malcomber et al. 1922: 3; 1969: 3; 2252: 3 — Morat 1408: 3.

Perrier de la Bâthie 3759: 3; 3833: 3; 3947: 2 — Pervillé 359: 3; 463: 3.

Rabenantoandro et al. 457: 2 — Rabevohitra 4848: 2 — Raboarivo 7727-SF: 3 — Raharimalala 170: 2 — Rajokiny 11744-RN: 2 — Rakoto 4898-RN: 3; 4899-RN: 3 — Rakotomalala & Velomaro 54: 3 — Rakotomalaza et al. 742: 2 — Rakotonasolo RNF 275: 2 — Rakotoniaina 2329-RN: 2; 2878-RN: 2 — Rakotovao 10870-RN: 2 — Rakotozafy 275: 3 — Ramarokoto 7768-RN: 2 — Ranarivelo et al. RTI 292: 2 — Rasovimbahoaka 639: 2 — Razafindrazaka et al. 1: 3 — Reboroaka 7811-RN: 3 — Richard (herb. Richard) 173: 3 — Rokoalina [?] 7565-RN: 2.

Saboureau 58: 3 — Schatz 2749: 2 — Service Forestier de Madagascar 3164-SF: 3; 3907-SF: 3; 26131-SF: 2.

Tosh et al. JT 259: 2 — Totozafy Be STB 527: 3 — Tsilizy 6904-RN: 3.

Waterlot 369: 3 — Wohlhauser & Ranjatson SW 60038: 3.