

***Weinmannia magnifica* and *W. aggregata* (Cunoniaceae): two distinctive new species from Madagascar**

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ABSTRACT

Two new species, *Weinmannia magnifica* J.C. Bradford & Z.S. Rogers and *W. aggregata* Z.S. Rogers & J.C. Bradford from Madagascar, are described and illustrated. Based mainly on inflorescence characters, *W. magnifica* is allied with four other species in *Weinmannia* sect. *Spicatae* Bernardi ex J.C. Bradford, but uniquely possesses large, pubescent, trifoliolate or rarely 5-foliolate leaves that easily distinguish it from putative relatives. *Weinmannia aggregata* is clearly related to *W. venusta* Bernardi (sect. *Inspersae*), but differs markedly in the aggregation of floral fascicles into globose clusters (i.e. pseudo-umbels) along the flower-bearing axes, by the tendency towards obovate rather than ovate leaflets, and by having proportionally wider fruit capsules. Keys to the five species in species-group F and to the two members of species-group D are provided, followed by descriptions and illustrations of the new species. Based on IUCN (2001) criteria, *W. magnifica* qualifies as an endangered species (EN), and *W. aggregata* should be considered a species vulnerable to extinction (VU).

KEY WORDS

Cunoniaceae,
Weinmannia,
Madagascar,
endangered species,
conservation.

RÉSUMÉ

Weinmannia magnifica et *W. aggregata* (Cunoniaceae) : deux remarquables nouvelles espèces de Madagascar.

Deux nouvelles espèces, *Weinmannia magnifica* J.C. Bradford & Z.S. Rogers et *W. aggregata* Z.S. Rogers & J.C. Bradford, de Madagascar sont décrites et illustrées. D'après les caractères de l'inflorescence, *W. magnifica* est proche de quatre autres espèces de *Weinmannia* sect. *Spicatae* Bernardi ex J.C. Bradford, mais est la seule à posséder des feuilles grandes, pubescentes, trifoliolées ou rarement 5-foliolées qui la distinguent facilement de ses parents probables. *Weinmannia aggregata* est clairement apparentée à *W. venusta* Bernardi (sect. *Inspersae*), mais en diffère principalement par l'agrégation des fascicules floraux en amas globuleux (i.e. pseudo-ombelles) le long des axes florifères, par des folioles qui sont plutôt obovales qu'ovales, et par les capsules des fruits proportionnellement plus larges. Des clés pour la détermination des cinq espèces du groupe F et des deux membres du groupe D sont présentées, suivies des descriptions et illustrations des nouvelles espèces. D'après les critères de l'UICN (2001), *W. magnifica* est qualifiée d'espèce en danger (EN), et *W. aggregata* devrait être considérée comme vulnérable (VU).

MOTS CLÉS

Cunoniaceae,
Weinmannia,
Madagascar,
espèces menacées,
conservation.

INTRODUCTION

About 28 species of *Weinmannia* are currently described and recognized from Madagascar and the Comoros, and it is likely that several more undescribed taxa await treatment (BRADFORD 2001; BRADFORD & MILLER 2001). Species diagnosis and classification have recently been improved by the publication of a key to, and list of species within, seven species-groups (referred to as A-G) in Madagascar (BRADFORD 2001) following a survey of qualitative morphological variation for cladistic analyses (BRADFORD 1998). Molecular systematic studies confirm that the Malagasy lineage is monophyletic and consists of two main clades, representing *Weinmannia* sect. *Inspersae* Bernardi ex J.C. Bradford and sect. *Spicatae* Bernardi ex J.C. Bradford respectively, but relationships within the species-groups remain unresolved (BRADFORD 2002).

Diagnoses and classification of *Weinmannia* into species-groups in Madagascar emphasize qualitative characters of the inflorescence that can be observed in bud, flower or fruit (BRADFORD 2001).

The two specimens described below as *W. magnifica* both show the inflorescence pattern typical of species-group F in sect. *Spicatae*, i.e. sessile flowers initiated in groups of usually 3 or 4 that dissociate from their bract. Only four species of *Weinmannia* were previously known with this character, *W. hildebrandtii* Baill., *W. icacifolia* Bernardi, *W. marojejyensis* J.S. Mill. & J.C. Bradford, and *W. rakotomalazana* J.C. Bradford. *Weinmannia aggregata*, the second species described here, is clearly related to *W. venusta* Bernardi of species-group D in sect. *Inspersae*. Both species have very unusual inflorescences for *Weinmannia* in that their axis may branch multiple times and bears a number of racemes (BRADFORD 2001). The flowers of species in sect. *Inspersae* are arranged in clusters subtended by a bract.

The species-group keys are designed to work with fertile material or sterile samples from near the crown of the canopy. Understory branches of *Weinmannia* tend to possess larger leaves than fertile branches and those found in the canopy. The descriptions are based on fertile material representing distal nodes and probably from higher light

intensity positions in the crown. Terminology on indumentum follows HEWSON (1988), with short trichomes (which define the puberulous state) being no more than *c.* 0.5 mm long.

Older collections lacking coordinates were post-facto georeferenced using the Gazetteer to Mala-

gasy Botanical Collecting Localities (<http://www.mobot.org/MOBOT/Research/madagascar/gazetteer/>) and are enclosed in square brackets. Images of cited specimens are available on the MBG w³TROPICOS website (<http://mobot.mobot.org/W3T/Search/vast.html>).

Key to the species of *Weinmannia* sect. *Spicatae*, species-group F (*sensu* BRADFORD 2001)

- | | |
|---|--------------------------|
| 1. Leaves simple | <i>W. icacifolia</i> |
| 1'. Leaves compound | 2 |
| 2. Leaves composed of 7-13 leaflets (rarely less); each leaflet <i>c.</i> 6-20 × 4-8 mm | <i>W. marojejensis</i> |
| 2'. Leaves composed of 3-5 leaflets (rarely more); each leaflet > 20 × 8 mm | 3 |
| 3. Leaves 3- or 5-foliolate, leaflets with acute apices, 2.5-3.5 × 0.9-1.3 cm | <i>W. rakotomalazana</i> |
| 3'. Leaves 3-foliolate, rarely 5-foliolate, leaflets with blunt apices, <i>c.</i> 6-25 × 3-8 cm | 4 |
| 4. Leaves glabrous, 6-8 cm long | <i>W. hildebrandtii</i> |
| 4'. Leaves pubescent, 10-25 cm long | <i>W. magnifica</i> |

Weinmannia magnifica J.C. Bradford & Z.S. Rogers, *sp. nov.*

Arbor c. 16 m alta. Folia 3- vel 5-foliolata, foliolis terminus petiolulus vel sessilibus, oblongis, 8-19 cm longis, 4-13 cm lata, apiceum obtusis, basium acutis, foliolis lateribus sessilibus, oblongis ad ellipticis, 7-15 cm longis, 3-9 cm lata, apiceum obtusis, basium obliquis, margine serrata. Inflorescentia spicata, (4- ad) 11-13 cm longa, bracteis 2 mm longis, c. 1 mm lata, subtensens (1- ad) 2-4 flores sessilia. Ovarium puberulum. Semina non visi.

TYPUS. — Ratovoson, Andrianjafy, Rakotomandrasana, Rakotondrajaona, Randrianjanaka, Manajara & Randrianjafison 569, Madagascar, Prov. Toamasina, Zahamena, Vavatenina, Ambodimangavalo, Manakambahiny, Ambinanin Ambatodrama, forêt dense humide de basse altitude, 600 m, 17°37'38"S, 48°56'48"E, 10 Oct. 2001, fl. (holo-, MO!; iso-, DAV!, G!, P!, TEF!).

Trees *c.* 16 m tall, internodes (1.1-)-2-4.5(-6) cm long, stems golden-brown, quadrangular to cylindrical, densely pubescent, trichomes 0.7-1 mm long, straight to slightly wavy, upright or adpressed, golden. Stipules caducous, puberulous, orbicular to obovate, *c.* 1.5 × 1 cm. Leaves decussate, 3-foliolate, rarely 5-foliolate, lamina mostly glabrous above (trichomes restricted to midvein and lateral veins), golden pubescent

below, densely so along veins, to 25 cm long (including petiole), coriaceous, terminal leaflet larger than laterals, 8-19 × 4-9(-13) cm, obovate, base decurrent, apex obtuse, lateral leaflets 7-15 × 3-9 cm, elliptic to slightly obovate, sessile or short petiolate, base obtuse to acute, margin serrate, teeth blunt, sinus shallow, apex obtuse, midrib slightly raised above, prominently raised below, lateral veins 13-15 pairs (in terminal leaflets), prominently raised, semicraspedodromous, with veins terminating at the sinus, angle of divergence 50-70°, fine venation reticulate. Flower-bearing axes spicate, spikes (4-)11-13 cm long, borne in pairs, peduncles axillary, 1.5-3 cm long, with a vegetative bud between each spike (i.e. forming dyads), and borne from leaf axils at the distal node along the main stem, densely puberulous, floral bracts *c.* 2 × 1 mm, elliptic, sparsely puberulous, subtending fascicles of (1-) 2-4 flowers, spreading apically in a line away from the bract, fewer flowers per bract apically, flowers inserted 1-10 mm from their bract. Flowers bisexual, pentamerous, sessile, creamy yellow when fresh; calyx cup-shaped with triangular lobes, about half the length of the flower lobes, *c.* 1.5 × 1 mm, puberulous; petals oblong to slightly obovate, *c.* 2 × 1 mm, membranous, margins entire, glabrous; stamens 10, filaments

4-5 mm long, curled in bud, exceeding the perianth when fully elongated, glabrous, anthers *c.* 0.5 mm long, suborbicular; floral nectary composed of *c.* 5 thick membranous segments, *c.* 0.7 mm tall, each segment opposite the taller, anti-sepalous whorl of stamens, with nectary whorl gaps filled by the anti-petalous stamens; gynoecium ovoid at base, *c.* 3 mm long (including styles), densely puberulous up to base of styles; ovary bilocular, each locule containing *c.* 20 ovules; styles 2, bifid, *c.* 1 mm long, glabrous; stigma capitate. Fruits unknown. — Fig. 1.

The specific epithet refers to the large leaves and dense golden pubescence on leaves and stems, making the species visually distinct and quite attractive. According to label notes on *Ratovoson et al.* 569, the wood of the species is used for construction, and the local name is recorded as “Lalona be ravina”, which translates as “big-leaved *Weinmannia*”. Based on the height of the trees collected (16 m), and what is a typical spatial ecology for *Weinmannia* species, *W. magnifica* is probably found on steep slopes or ridges, rather than in sheltered ravines.

CONSERVATION STATUS. — The two known collections of *Weinmannia magnifica* were made at similar elevations (600 and 780 m) and about 5 km from each other, at what could be considered a “single” geographic locality (Fig. 3). The known

population occurs in wet forest along the eastern escarpment in Zahamena National Park, which encompasses over 70000 hectares and ranges between 500 m and 1500 m elevation (WCMC Protected Areas Database, http://www.wcmc.org.uk/protected_areas/data/nat2.htm). Because the species is only known from such a limited area, it potentially has a very restricted geographic range and a narrow ecological tolerance. Furthermore, habitat loss is rapid in Madagascar, including conversion of forests to farming land in the region of occurrence of *W. magnifica*, so it is likely that at least some additional populations in the area may already be extirpated.

Using IUCN Red List criteria (IUCN 2001), *Weinmannia magnifica* is provisionally classified as Endangered because it has an extent of occurrence and area of occupancy on the order of 10 km², only occurs at one location, and the quality of its habitat is probably declining or has an uncertain future due to edge effects, fires, cyclones, and climate change (EN B1ab i, ii, iii, v).

PARATYPES. — Madagascar, *Prov. Toamasina: Rakotonandrasana, Ratovoson, Rakotondrajaona, Randrianjanaka, Rapaolonanoara & Randrianjafison* 578, Zahamena, Vavatenina, Ambodimangavalo, Manakambahiny, forêt dense humide de basse altitude, le long de la piste Besakay-Namantonina, 780 m, 17°39'20"S, 48°54'22"E, 7 Oct. 2001, fl. (DAV!, MO!, P!, TEF!).

Key to the species of *Weinmannia* sect. *Inspersae*, species-group D (*sensu* BRADFORD 2001)

1. Groups of flowers more or less evenly distributed along the raceme-like inflorescence axes; leaves 5-foliolate, rarely 3-foliolate, terminal leaflets ovate to elliptic, usually plicate *W. venusta*
- 1'. Groups of flowers clustered into pseudo-umbels with extensive areas of intervening inflorescence axis barren; leaves 3-foliolate, rarely 5-foliolate, terminal leaflets obovate to elliptic, usually planar *W. aggregata*

Weinmannia aggregata Z.S. Rogers & J.C. Bradford, *sp. nov.*

Arbor 20 m alta. Folia 3- vel 5-foliolata; foliolis omnibus sessilibus etiam margine crenatis ad subserrata, terminali oblongo usque elliptico, 7-15 cm longo, 2.5-8 cm lato, ad apicem obtuso usque acuto, ad basim cuneato usque decurrente, lateralibus ellipticis usque ovatis, 5.4-12 cm longis, 2-6 cm latis, ad apicem obtusis usque acutis, ad basim decurrentibus usque truncatis.

Inflorescentia ramosa ex floribus pedicellatis in fasciculis (6- ad) 8- ad 15- (ad -20) floros, bracteis c. 2 mm longis, 1.5-2 mm lato, subtentis aggregatis constans. Flos ovario hirsuto. Fructus seminibus dense comosis.

TYPUS. — *Réserves Naturelles (Rakotoniana) 111*, Madagascar, *Prov. Toamasina, Canton Ambodiriana, Alohaniranomandry, Betampona (Réserves Naturelles #1)*, [17°55'S, 49°13'E], 13 Feb. 1954, fl. (holo-, P!; iso-, K, MO!, P!, TEF!, WAG).

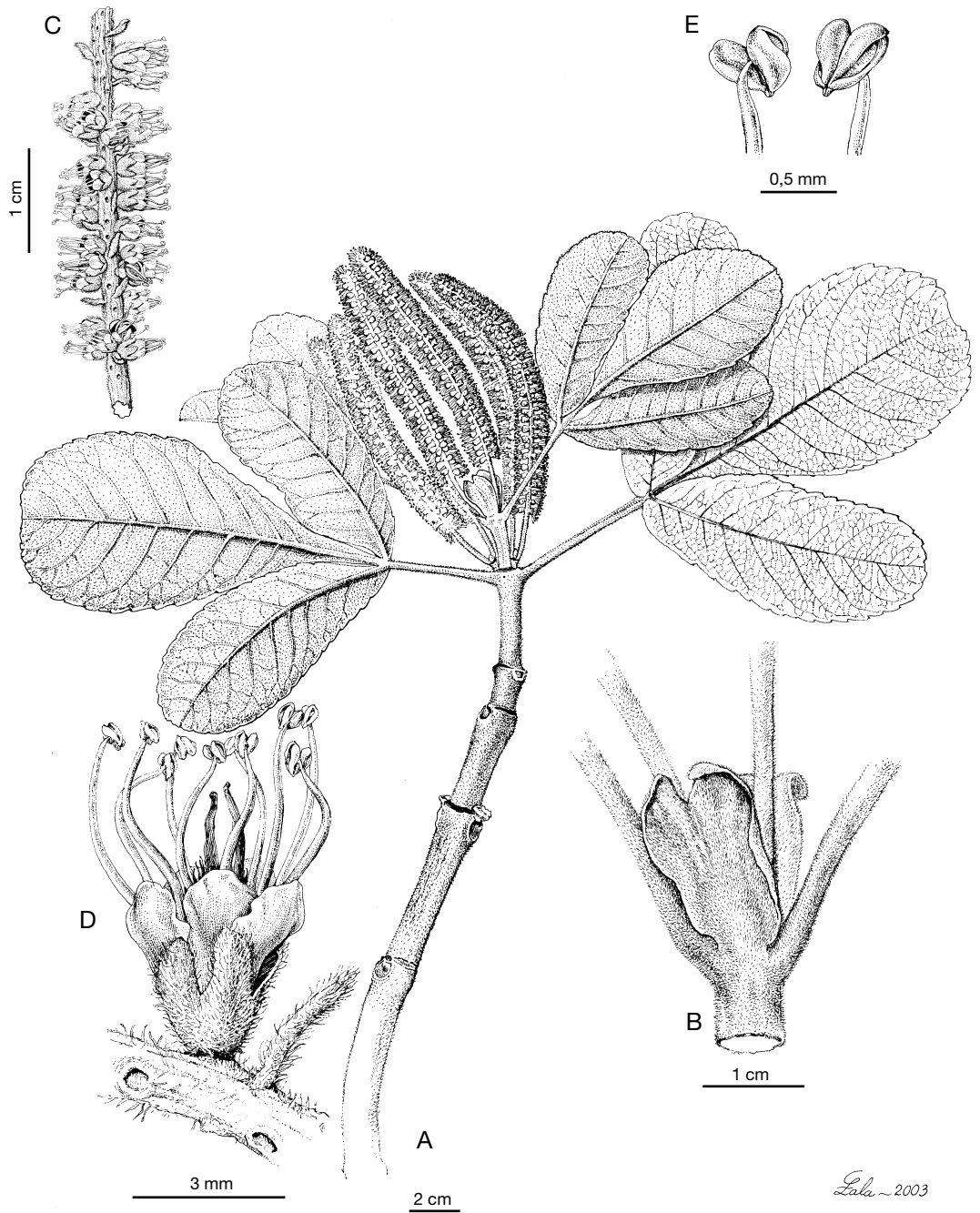


FIG. 1. — *Weinmannia magnifica* J.C. Bradford & Z.S. Rogers: **A**, branch with flowering inflorescences; **B**, stipule; **C**, inflorescence; **D**, flower and associated bract and scars; **E**, stamen. A, *Ratovoson et al.* 569; B-E, *Rakotonandrasana et al.* 578.

Trees to 20 m tall, internodes (1-)2-4(-5.5) cm long, stems grayish brown, cylindrical, glabrous. Stipules caducous, puberulous, orbicular to ovate, *c.* 1 × 0.6 cm. Leaves decussate, 3-foliolate, rarely 5-foliolate, lamina glabrous above and below, to 21 cm long (including petiole), coriaceous, terminal leaflet larger than laterals, 7-15 × 2.5-8 cm, obovate to elliptic-ovate, base decurrent to cuneate, apex obtuse to acute, lateral leaflets 5.4-12 × 2-6 cm, elliptic to ovate, sessile or subsessile, base decurrent to truncate, margin crenate to subserrate, teeth blunt, sinus shallow, apex obtuse, midrib slightly raised above, prominently raised below, darker than blade, lateral veins 9-15 pairs (in terminal leaflets), slightly raised on both surfaces, lighter in color than midrib and surrounding blade, curving slightly toward the apex and terminating at the sinus, angle of divergence 60-75°, fine venation reticulate. Flower-bearing axes decussately branched with globose floral clusters (pseudo-umbels), 3.5-11 cm long, floral clusters tightly congested, distance between floral clusters (1.5-)2-3.5 cm, peduncles axillary, (0.8-)1.2-3.5(-4.1) cm long, flowering more prolific at subdistal nodes (i.e. inflorescence basitonic), puberulous, floral bracts *c.* 2 × 1.5-2 mm, elliptic to suborbicular, puberulous, subtending fascicles of (6-)8-15(-20) flowers. Flowers bisexual, pentamerous, pedicellate, drying reddish-brown, pedicels 2-5 mm long; calyx cup-shaped with triangular lobes, lobes about one-half to two-thirds the length of the flower, *c.* 1 mm long, puberulous; petals obovate to oblong, *c.* 2 × 1 mm, membranous, margins entire, glabrous; stamens 10, filaments to 2 mm long, curled in bud, exceeding the perianth when fully elongated, glabrous, anthers *c.* 0.3 mm long, suborbicular; floral nectary composed of 5 thick segments, *c.* 0.3 mm tall, each segment opposite the taller, anti-sepalous whorl of stamens, with nectary whorl gaps filled by the anti-petalous stamens; gynoecium ovoid at base, *c.* 3 mm long (including styles), densely puberulous up to base of styles; ovary bilocular; styles 2, bifid, *c.* 2 mm long, glabrous; stigma capitate. Fruits capsular, septicial, 2-valved, 1.3-1.6 × 0.5-0.7 cm (length includes styles), obovate to orbicular, puberulous, reddish-brown, outer surface covered with numerous longitudinal ridges; persistent styles

2-4 mm long. Seeds 1-1.5 × 0.5-1 mm, oblong, crescent-shaped, densely comose, trichomes *c.* 2 mm long, matted, reddish-brown. — Fig. 2.

BERNARDI (1965) did not recognize *Weinmannia aggregata* as a distinct species, treating the material he saw instead as part of *W. venusta* Bernardi. Only three collections were available to him at the time of original publication (*Boivin s.n.*, Apr. 1851; *Réserves Naturelles 2853*; *Service Forestier 5464*); the Boivin collection is sterile and the latter two are fruiting. Apparently, BERNARDI noticed that the larger and broader fruit capsules of *W. aggregata* differed from the “normal” capsules of *W. venusta*, which he considered to be caused by insect damage (see BERNARDI 1965: 54, fig. X: 2 & 5b). BERNARDI did not recognize the significant differences in vegetative characters and inflorescence morphology that clearly separate the two species.

Specimens representing *Weinmannia aggregata* and *W. venusta* are summarized in Table 1; the determinations and localities presented in the table illustrate the determination history of specimens examined by BERNARDI and ROGERS & BRADFORD, and are intended to stress the geographic range differences of the two species. *Weinmannia venusta* has narrower leaves, which are usually 5- or rarely 3-foliolate. The leaflets of *W. aggregata* are broader, more ovate, and 3- or less often 5-foliolate. Leaflets are also usually adaxially plicate in *W. venusta* and planar in *W. aggregata*.

While it is possible to distinguish between the two species relying solely on vegetative characters, the most striking difference between *W. aggregata* and *W. venusta* is the highly-clustered arrangement of flowers of the former (Fig. 2B, C), which gives the appearance of small globose pseudo-umbels spaced along the inflorescence axis (see also BRADFORD & MILLER 2001: 235). The sterile portions between pseudo-umbels in *W. aggregata* are (1.5-)2-3.5 cm long. In *W. venusta*, however, the inflorescences are densely congested with numerous fascicles of several to many flowers.

In addition to their significant morphological differences, *Weinmannia aggregata* and *W. venusta* have allopatric distributions (Fig. 3). The range

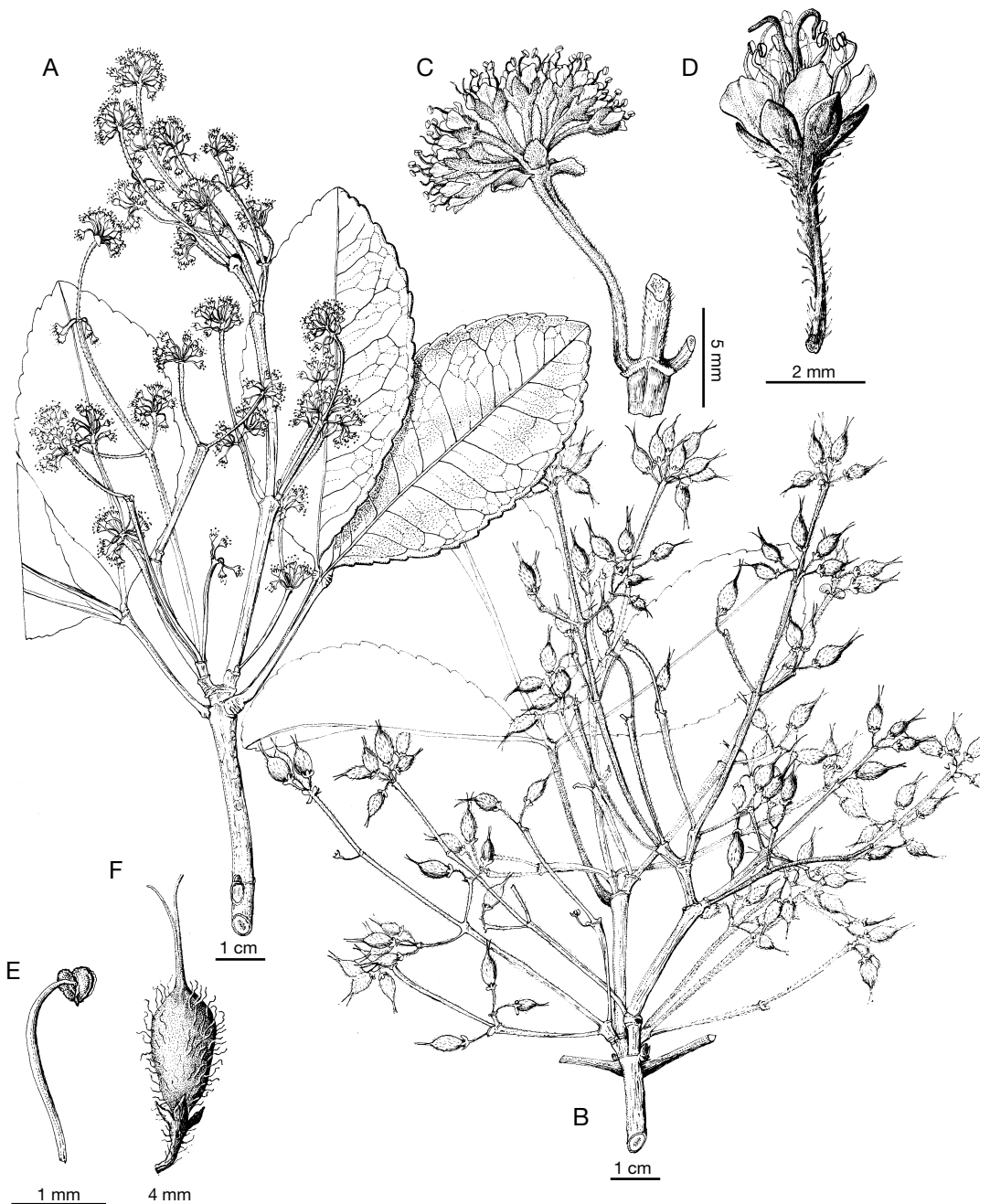
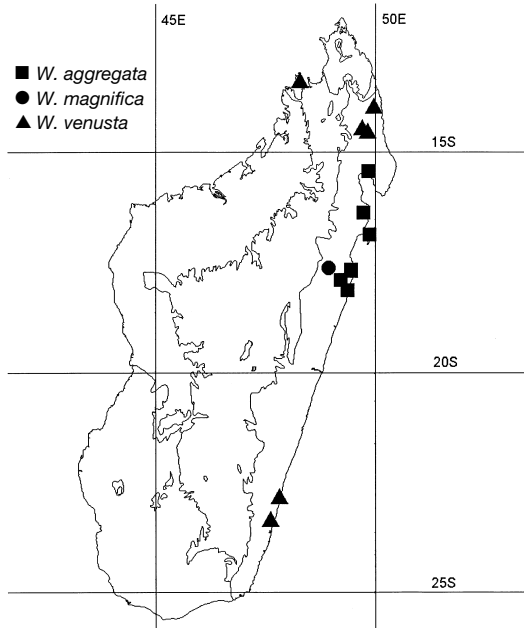


FIG. 2. — *Weinmannia aggregata* Z.S. Rogers & J.C. Bradford: **A**, branch with flowering inflorescences; **B**, inflorescence axis showing pseudo-umbels and immature fruit capsules; **C**, pseudo-umbel; **D**, flower; **E**, stamen; **F**, immature fruit. A, C-E, *Réserves Naturelles 111*; B, F, *Service Forestier 24061*.

TABLE 1. — Collections of *Weinmannia aggregata* and *W. venusta*. Specimens recognized as *W. venusta* by BERNARDI (■); type specimens (▲); specimen not seen (●). RN, Réserves Naturelles.

<i>W. aggregata</i>	Locality	Coordinates
Boivin s.n. (Apr. 1851) ■	Île Sainte-Marie	16°53'S, 49°53'E
Bradford et al. 654B	Analalava	17°42'34"S, 49°26'50"E
Bradford et al. 655	Analalava	17°42'34"S, 49°26'50"E
Raharimalala 295	Mananara Nord	16°23'S, 49°44'E
Réserves Naturelles 111 ▲	Betampona	17°55'S, 49°13'E
Réserves Naturelles 2853 ■	Betampona	17°55'S, 49°13'E
Service Forestier 25-R-202	Antanimenabaka	18°09'S, 49°23'E
Service Forestier 5464 ■	Farankaraina (Maroantsetra)	15°26'S, 49°51'E
Service Forestier 24061	Analalava	17°41'S, 49°27'E
<i>W. venusta</i>		
Humbert & Capuron 21944 ▲ ■	Andapa (Lokoho bassin)	14°31'45"S, 49°49'30"E
Pervillé 749 ■ ●	Nosy-Komba	13°24'S, 48°17'E
Service Forestier 17231 = RN 8206	Marojejy	14°27'30"S, 49°42'30"E
Service Forestier 17610 = RN 7990	Marojejy	14°27'30"S, 49°42'30"E
Service Forestier 5126 ■	Vangaindrano (Anakatrika)	23°20'36"S, 47°36'46"E
Service Forestier 7296 ■	Manombo (Farafangana)	22°49'S, 47°49'E
Service Forestier 27632	Tsihomanaomby	13°58'S, 49°58'E

FIG. 3. — Distribution map of *Weinmannia aggregata*, *W. magnifica* and *W. venusta*, mapped on the simplified bioclimatic zones of Madagascar (SCHATZ 2000, after CORNET 1974).

of *W. aggregata* extends from the Masoala peninsula south to the forest near the coastal city of Toamasina (c. 25-280 m elevation). *Weinmannia*

venusta occurs further inland at higher elevations in most northern populations, whereas southern populations grow in forests near sea-level around Farafangana, Madagascar.

Based on available label data, *Weinmannia aggregata* has been collected in flower in February and fruit from December to March. The epithet of the species refers to the dense globose fascicles aggregated along the inflorescence axes. Local names recorded for the species are “lalona”, “lalombary” and “lalona mena”. Lalombary is a combination of the words “lalona” and “vary” the Malagasy word for rice. Lalona mena literally translates as “red *Weinmannia*”, aptly given to the species for its bright red juvenile leaves (J.C. BRADFORD pers. obs.).

CONSERVATION STATUS. — *Weinmannia aggregata* is known from six localities, at least one of which, the small patch of forest at Analalava (c. 8 km W of Foulpointe), has since been burnt and cleared (G. SCHATZ pers. comm.). Three other sites are either within or near existing protected areas (Betampona R.N. #1, Ibanda Biosphere Reserve [= Mananara Nord P.N.], Masoala P.N.). Outside of these protected areas and even along their margins, habitat of *W. aggregata* is rapidly being degraded by logging and conversion into agricultural land. The

two remaining sites, Île Sainte-Marie and Antanimenabaka, are not formally protected, so those habitats are probably even more threatened. Therefore, we infer that most of the habitat of *W. aggregata* is no longer suitable for its existence and that much of this change has occurred within recent decades. The extent of occurrence for the species is c. 8200 km², and the area of occupancy is c. 600 km². According to IUCN (2001) guidelines, *Weinmannia aggregata* should be considered Vulnerable (VU B1ab i, ii, iii, v).

PARATYPES. — Madagascar, *Prov. Toamasina: Boivin s.n.*, Sainte Marie de Madagascar, forêt de Ravine tsara, [16°53'S, 49°53'E], Apr. 1851, st. (P(2)!); *Bradford, Miller, Rakotonasolo & A. Randrianasolo 654B*, Forest of Analalava, 8 km W of Foulpointe, disturbed forest surrounded by agricultural field and small human settlements, 10 m, 17°42'34"S, 49°26'50"E, 26 Oct. 1996, fr. (DAV!, MO!, TAN!); *Bradford, Miller, Rakotonasolo & A. Randrianasolo 655*, same locality, fr. (DAV!, MO!, TAN!); *Raharimalala 295*, Ibanda, NW Antanambe, récoltes dans la Réserve de Biosphère Mananara-Nord, 280 m, 16°23'S, 49°44'E, 12 Feb. 1990, fr. (P!); *Réserves Naturelles (Rakotoniana) 2853*, Betampona (Réserves Naturelles #1), [17°55'S, 49°13'E], 20 Mar. 1951, fr. (K, MO(2)!, P(2)!, TAN!); *Service Forestier 25-R-202*, Tamatave, Antanimenabaka, [18°09'S, 49°23'E], 2 Dec. 1953, fr. (P!, TEF!); *Service Forestier 5464*, Maroantsetra, Farankaraina, [15°26'S, 49°51'E], 16 Feb. 1952, fr. (P!); *Service Forestier (Capuron) 24061*, Est: Forêt orientale d'Analalava, à l'ouest de Foulpointe, [17°41'S, 49°27'E], 10 Mar. 1965, fr. (K, MO!, P(2)!, TEF!).

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