Description of 11 new Astiella (Spermacoceae, Rubiaceae) species endemic to Madagascar

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Abstract. Astiella is an herbaceous genus endemic to Madagascar, originally described with a single species A. delicatula Jovet. Molecular and morphological evidence place it in the tribe Spermacoceae s. lat. of Rubiaceae. During herbarium studies and fieldwork in Madagascar, 11 new Astiella species were identified and these are described here: A. antongilensis Groeninckx sp. nov., A. antsalovansis Groeninckx sp. nov., A. confusa Groeninckx sp. nov., A. deblockiae Groeninckx sp. nov., A. desseini Groeninckx sp. nov., A. homollea Groeninckx sp. nov., A. latifolia Groeninckx sp. nov., A. longifimbria Groeninckx sp. nov., A. perrieri Groeninckx sp. nov., A. pulla Groeninckx sp. nov., and A. tsaratanensis Groeninckx sp. nov. The genus Astiella now holds 12 species in total that are all endemic to Madagascar.

Keywords. Astiella, endemism, Madagascar, Rubiaceae, Spermacoceae s. lat.


Introduction

Madagascar has a unique and spectacularly rich flora with a high percentage of endemism. The island is home to more than 10,000 plant species, 90% of which occur nowhere else in the world, which makes it one of the most important biodiversity hotspots (Moat & Smith 2007). In Madagascar, Rubiaceae Juss. is the second largest family of flowering plants after Orchidaceae Juss., with currently 751 species in 89 genera (Govaerts et al. 2016). In recent years, several taxonomic works have been completed and in combination with the description of numerous new species, this has resulted in a steadily increase of the total number of Rubiaceae species known from Madagascar (Groeninckx et al. 2010a). Although woody shrubs and trees are most common in Rubiaceae, herbs are present as well and the largest herbaceous
lineage is the tribe Spermacoceae Cham. & Schltdl. ex DC. s. lat. (as described in Groeninckx et al. 2010b). According to current estimations, Spermacoceae s. lat. is represented on Madagascar by at least 28 species in 13 genera, of which 9 species and 7 genera are endemic (Govaerts et al. 2016). *Astiella* Jovet is one of those herbaceous genera endemic to Madagascar (Jovet 1941). The taxonomic position of *Astiella* remained controversial for a long time but it was eventually placed in Spermacoceae s. lat. close to *Phialiphora* Groeninckx, *Amphistemon* Groeninckx, and *Thamnoldenlandia* Groeninckx, three other herbaceous genera endemic to Madagascar (Janssens et al. 2016). The sole species in the genus, *Astiella delicatula* Jovet, is characterized by having two calyx lobes, uni-ovulate ovary locules, conspicuous boat-shaped capsules with a well-developed beak, ruminate seeds with a ventral groove, and pluri-aperturate pollen (Jovet 1941). During herbarium studies and fieldwork in Madagascar, 11 new *Astiella* species were identified and these are described here along with an update of the genus description.

**Material and methods**

This study of *Astiella* is based on the examination of herbarium specimens consulted at BR, K, MO, P, and TAN (acronyms following Thiers continuously updated). Additional plant material was obtained during fieldwork in Madagascar. Measurements, colours and other details given in the descriptions are based on pickled and herbarium specimens and data derived from field notes. Each species is illustrated in detail by a line drawing. It should be noted that pubescence is not shown on the habit. Terminology of simple symmetrical plane shapes follows Anonymous (1962). Indumentum terminology follows Beentje (2012). Distribution data is based on specimens from the above-mentioned herbaria. Maps for the Madagascan endemics were made with the software programme iMap (Schols et al. 2001). Habitat delineation is based on Moat & Smith (2007). Georeferenced specimen data were imported into GeoCAT to calculate area of occupancy (AOO) and extent of occurrence (EOO) for each species (Bachman et al. 2011). The IUCN Red List guidelines recommend a cell width of 2 km (giving a cell area of 4 km$^2$). AOO and EOO results were combined with field observations to produce conservation assessments based on the 2001 IUCN Red List Categories and Criteria (IUCN 2001).

Micromorphological observations were made of pollen and seeds. Pollen grains from herbarium material were acetolysed according to the ‘wetting agent’ method (Reitsma 1969). Using a scanning electron microscope (SEM), external features were observed on grains that had been suspended in 70% ethanol and left to dry. Glycerin jelly slides were observed under a light microscope. Polar axis length (P) and equatorial diameter (E) were measured using the software programme Carnoy (Schols et al. 2002). Pollen terminology follows Punt et al. (2007). Seeds from herbarium specimens were directly mounted on aluminium stubs, coated with gold, and observed under the SEM.

**Results**

**Order Gentianales Juss. ex Bercht. & J.Presl**  
**Family Rubiaceae Juss. nom. cons.**  
**Subfamily Rubioideae Verdc.**  
**Tribe Spermacoceae Bercht. & J.Presl**

*Astiella* Jovet (Jovet 1941)

**Etymology**

Jovet, the author of the genus *Astiella*, dedicated the genus name to his wife Suzanne Jovet-Ast.

**Type species**

*Astiella delicatula* Jovet.
Description
Annual or perennial herb, prostrate or erect, 4–60 cm tall, sometimes rooting at the nodes; stems quadrangular, glabrous or variously covered with trichomes. Stipules glabrous or pubescent; fimbriae 0–9, 0.1–6.5 mm long, often collet-tipped. Leaves sessile or petiolate, sometimes anisophyllous, sometimes succulent; petioles 0.4–17 mm long; blades mostly narrowly elliptic to broadly ovate, rarely linear, 2.2–92 × 0.5–30.5 mm, glabrous or covered with trichomes, often darker green above, paler green below; base attenuate; apex acuminate, acute or obtuse; margin sometimes revolute when dry, scabrate or ciliolate, rarely glabrous; midvein prominent particularly below; secondary veins prominent or invisible; intersecondarys mostly invisible, sometimes prominent. Inflorescences terminal or pseudo-axillary, single or compound dichasia, 1- to multi-flowered; peduncle 0–56 mm long, glabrous to pubescent. Pedicels absent or 0.2–16 mm long, glabrous or pubescent. Flowers predominantly heterostylos, rarely isostylos. Calyx green; tube reduced; lobes 2 or 4, narrowly ovate to broadly ovate or narrowly triangular to triangular, glabrous to densely pubescent, sometimes colleters in between. Corolla mostly white, sometimes pale pink, pale purple or pale blue; tube cylindrical or funnel-shaped, glabrous or pubescent; lobes 4, mostly narrowly ovate to broadly ovate, sometimes elliptic, ligulate or spatulate, glabrous to pubescent. Stamens inserted near the base of the corolla lobes or in the lower half of the corolla tube, included or exserted. Anthers ellipsoid, rarely broadly obovoid, 0.4–1.8 mm long; filaments dorsifixed, 0.2–3.3 mm long. Pollen tri- or pluricolporate, tectum predominantly bireticulate or rarely aperforate. Ovary 2-locular, mostly broadly obovoid to broadly depressed obovoid, sometimes depressed obovoid, broadly obpyramidal or ovoid, glabrous to pubescent; placenta attached near the middle of the septum, predominantly stalked, globose or elongated, bearing 1 to numerous ovules per locule. Style 0.4–6.5 mm long, included or exserted, mostly glabrous, sometimes hirtellous or papillate; stigma bilobed, lobes 0.1–2.3 mm long, papillate or hirtellous; nectary disc bipartite. Capsules mostly broadly depressed obovoid, sometimes ovoid, rarely broadly obovoid or subglobose, crowned with the persistent calyx lobes, dehiscence loculicidal. Seeds 1 to numerous per locule, mostly elliptic, rarely ovate or triangular in outline, sometimes dorsiventrally flattened, ventral groove present or absent, black or brown; seed coat surface reticulate or rarely alveolate, testa cells with undulating or straight radial walls, microsculpturing favulariate, granulate, rugulose or verruculate; endosperm sometimes ruminate.

Distribution
Distributed throughout Madagascar.

Habitat
Dry forest, humid and sub-humid forest, dunes, savannas, degraded vegetation; calcareous, rocky, laterite, granite or white sand substrate.

Key to the Astiella species
1. Leaf blades 2.2–4.5 × 1.1–2.4 mm .........................................................A. deblockiae Groeninckx sp. nov.
   – Leaf blades larger ................................................................................. 2
2. Leaf blades linear or narrowly elliptic; secondary veins obscure or invisible ......................................................... 3
   – Leaf blades different; if narrowly elliptic then secondary veins clearly visible, at least below .......... 4
3. Leaf blades linear, 0.7–1.5 mm wide; flowers sessile ...............A. desseinii Groeninckx sp. nov.
   – Narrowly elliptic, 0.5–4.2 mm wide; flowers pedicellate .......... A. confusa Groeninckx sp. nov.
4. Calyx lobes 2 .............................................................................................. A. delicatula Jovet
   – Calyx lobes 4 ........................................................................................... 5
5. Herbs creeping or prostrate, rarely scrambling, rooting at the nodes ............................................. 6
   – Herbs more or less erect, not or only rooting at the basal nodes ............................................. 8

6. Anisophyllous; flowers sessile .......................................................... \textit{A. latifolia} Groeninckx sp. nov.
   – Isophyllous; flowers pedicellate (pedicel sometimes short) .......................................................... 7

7. Corolla tube usually shorter than the corolla lobes; seeds without ventral groove .................................
   .............................................................................................................................................. \textit{A. perrieri} Groeninckx sp. nov.
   – Corolla tube longer than the corolla lobes; seeds with ventral groove .................................................. \textit{A. tsaratanensis} Groeninckx sp. nov.

8. Corolla tube reduced, clearly shorter than corolla lobes ...................................................................... 9
   – Corolla tube as long or longer than corolla lobes ......................................................................... 10

9. Stems pubescent; leaves covered with trichomes below ................................................ \textit{A. antongilensis} Groeninckx sp. nov.
   – Stems glabrous or rarely with a few scattered trichomes; leaves glabrous ........................................ \textit{A. homolleae} Groeninckx sp. nov.

10. Stems glabrous or scabrate at the nodes; stipular fimbriae less than 1 mm long ................................. 11
    – Stems covered with long reddish brown multicellular trichomes; stipular fimbriae 4–6.5 mm
        long ................................................................................................................................. \textit{A. longifimbria} Groeninckx sp. nov.

11. Inflorescence axes slender; 3 ovules per locule; fruits 1–2 × 1.5–3 mm ..........................................
    – Inflorescence axes more robust; 4–5 ovules per locule; fruits 1.5–3.4 × 2.6–4 mm ........................
    .............................................................................................................................................. \textit{A. pulla} Groeninckx sp. nov.

\textit{Astiella antongilensis} Groeninckx sp. nov.

\url{http://www.ipni.org/urn:lsid:ipni.org:names:77161710-1}
Figs 1, 2A

\textbf{Diagnosis}

\textit{Astiella antongilensis} sp. nov. resembles \textit{A. homolleae} sp. nov. and \textit{A. perrieri} sp. nov. in having a
reduced corolla tube and numerous ovules per locule, but differs in having a pubescent stem, large
leaves that are covered with trichomes below, and pubescent flowers.

\textbf{Etymology}

The epithet refers to Antongil Bay, the largest bay in Madagascar and the area where the species is found.

\textbf{Type}

MADAGASCAR: Toamasina province, Analanjirofo region, Maroantsetra district. Côte est, environs
de la baie d’Antongil, bois, 200 m, Oct. 1912, \textit{Perrier de la Bâthie} 3749
(holo-: P, P00219825; iso-: P, P00516317).

\textbf{Description}

Annual herb, ca 10 cm tall; stems quadrangular in cross section, pubescent. Stipule base 1–2 mm
long, pubescent; fimbriae 3–6, 1–2 mm long, colletter-tipped. Leaves petiolate; petiole 5–15 mm long,
pubescent; blades elliptic, slightly ovate or obovate, (12–)45–72 × (6–)10–26 mm, very sparsely
covered with trichomes particularly on the veins above, more densely covered with trichomes below; base
attenuate; apex acute or obtuse; margin ciliolate; midvein prominent particularly below; secondary veins
Fig. 1. *Astiella antongilensis* Groeninckx sp. nov. A. Habit. B. Brevistylic flower. C. Open brevistylic flower. D. Ovary dissected to show placentation. Drawn by Marijke Meersman. All from *Perrier de la Bâthie 3749* (P).
Fig. 2. Distribution maps. A. Astiella antongilensis Groeninckx sp. nov. B. A. antsalovansis Groeninckx sp. nov. C. A. confusa Groeninckx sp. nov. D. A. deblockiae Groeninckx sp. nov. E. A. delicatula Jivet. F. A. desseinii Groeninckx sp. nov. G. A. homolleae Groeninckx sp. nov. H. A. latifolia Groeninckx sp. nov. I. A. longifimbria Groeninckx sp. nov. J. A. perrieri Groeninckx sp. nov. K. A. pulla Groeninckx sp. nov. L. A. tsaratanensis Groeninckx sp. nov.
4–7 on each side of the midvein; intersecondaries invisible. Inflorescences terminal, multi-flowered; peduncle 0–40 mm long, pubescent. Pedicels 1–7 mm long, pubescent. Flowers heterostylyous (but both style and anthers exerted). Calyx green; tube reduced; lobes 4, narrowly triangular or triangular, 1–1.3 × 0.4–0.5 mm, pubescent. Corolla white or pale purple; tube reduced, 0.2–0.5 mm long; lobes 4, somewhat spatulate, 2.1–2.8 mm long, 0.5–0.6 mm wide at the base, 1–1.2 mm wide at the top, pubescent outside, papillate inside. Stamens inserted near the base of the corolla lobes and exerted for 2.2–3.2 mm beyond the corolla throat. Anthers ellipsoid, 1.2–1.4 mm long, filaments dorsifixed, ca 3.3 mm long in brevistylyous flowers, ca 1.2 mm long in longistylyous flowers. Pollen unknown. Ovary 2-locular, broadly obovoid, 1–1.2 × 1–1.3 mm, densely pubescent; placenta attached above the middle of the septum, stalked, elongated, bearing numerous ovules per locule. Style ca 3.3 mm long in longistylyous flowers (exserted for ca 3 mm beyond the corolla throat), ca 2.5 mm long in brevistylyous flowers (exserted for ca 2.2 mm beyond the corolla throat), glabrous; stigma bilobed, lobes 0.6–1 mm long, papillate. Capsules broadly obovoid or broadly depressed obovoid, 2.5–3 × 2.5–3 mm, crowned with the persistent calyx lobes, pubescent, dehiscence loculicidal. Seeds unknown.

**Distribution**

E Madagascar: Toamasina province, Analanjirofo region, Maroantsetra district.

**Habitat**

Humid forest; at 200 m elevation.

**Conservation status**

The species is only known from its type collected in 1912. There is no detailed information about the locality where the specimen was collected. Given its apparent rarity and following the recommendation of Callmander *et al.* (2005) to avoid the Data Deficient category, we consider the species as vulnerable (VU D2) based on its restricted area of occupancy (D2) and the high human pressure present in the entire area resulting in a general decline of suitable habitats (humid forest) for the species.

_Astiella antsalovansis_ Groeninckx sp. nov.


Figs 2B, 3, 4A, 5A–B

**Diagnosis**

_Astiella antsalovansis_ sp. nov. resembles _A. pulla_ sp. nov. in having black seeds with a reticulate seed coat surface consisting of 5- to 6-angular testa cells and in having a ring of trichomes inside the corolla tube, but differs in the slender inflorescence axes (vs more robust), 3 ovules per locule (vs 4 to 5 ovules per locule), and a shorter style that is included in brevistylyous flowers (vs exerted), and fruits 1–2 × 1.5–3 mm (vs 1.5–3.4 × 2.6–4 mm).

**Etymology**

The specific epithet refers to the Antsalova district where representative specimens were collected.

**Type**


**Additional material examined**

MADAGASCAR: Mahajanga province, Melaky region, Antsalova district. Antsingy d’Antsalova, RN 9, en sous bois de forêt tropophile sur calcaire, Jan. 1975, Morat 4805 (P, TAN); 14 km ouest de
Fig. 3. Astiella antsalovansiis Groeninckx sp. nov. A. Habit. B. Longistyloous flower. C. Open brevistyloous flower. D. Open longistyloous flower. E. Ovary dissected to show placentation. F. Capsule. Drawn by Marijke Meersman. A–E from Morat 4805 (P); F from Villiers, Klackenberg & Badre 4788 (P).

Description
Annual herb, erect, up to 30 cm tall; stems quadrangular in cross section, only sparsely branching, glabrous or scabrate particularly at the nodes. Stipule base 0.5–1 mm long, puberulent; fimbriae 4–6, 0.1–0.4 mm long, collet-tipped. Leaves petiolar; petioles 1–15 mm long, glabrous or scabrate; blades narrowly ovate to ovate, 10–60 × 3.5–30.5 mm, glabrous or sparsely to densely scabrate particularly on the veins and towards the margin; base attenuate; apex acute; midvein prominent particularly below; secondary veins 3–6 on each side of the midvein, prominent below; intersecondarys visible. Inflorescences terminal or pseudo-axillary, lax compound dichasia, multi-flowered, resembling a scorioid cyme, rarely axillary and then few-flowered and compact; peduncle 0–56 mm long, glabrous or scabrate; inflorescence axes slender. Pedicels absent or 0.5–2 mm long, glabrous or scabrate. Flowers heterostylous. Calyx green; tube reduced; lobes 4, triangular, 1–2 × 0.2–0.5 mm, sparsely to densely scabrate or covered with long trichomes, particularly on the margin. Corolla white, pale pink in the throat; tube funnel-shaped, 0.9–1.5 mm long, 0.4–0.6 mm wide at the base and 0.5–0.8 mm wide at

Fig. 4. Scanning electron microscopy micrographs of pollen in polar view (PV), the apocolpium (AC), pollen in equatorial view (EV) and the mesocolpium (ME). A. Astiella antsalovansis Groeninckx sp. nov. B. A. deblockiae Groeninckx sp. nov. C. A. delicatula Groeninckx sp. nov. D. A. desseinii Groeninckx sp. nov. Scale bars for A and C: PV, EV = 5 µm, AC = 1 µm, ME = 2 µm; for B and D: PV, EV = 5 µm, AC, ME = 1 µm.
the throat, with a few trichomes outside, with a ring of trichomes inside; lobes 4, ligulate, 1.3–1.6 × 0.5–0.6 mm in brevistylous flowers, 0.8–1.2 × 0.4–0.5 mm in longistylous flowers, glabrous outside, covered with trichomes inside. Stamens inserted near the base of the corolla lobes and exserted for ca 1 mm beyond the corolla throat in brevistylous flowers, inserted in the lower half of the corolla tube and included or only the apices exserted in longistylous flowers. Anthers ellipsoid, 0.7–1 mm long; filaments dorsifixed, ca 0.5 mm long in brevistylous flowers, 0.3–0.4 mm long in longistylous flowers. Pollen 7-colporate, suboblate; E 32–33 μm; P 28–31 μm; ectocolpi short; endocolpi short; tectum aperforate, granulate. Ovary 2-locular, broadly obpyramidal, 0.4–0.7 × 0.4–0.5 mm, glabrous or with a few trichomes; placenta attached near the middle of the septum, stalked, globose, bearing 3 ovules per locule. Style 1–1.2 mm long and included in brevistylous flowers, 1.8–2 mm long and exserted for 0.7–0.8 mm beyond the corolla throat in longistylous flowers, glabrous; stigma bilobed, lobes 0.2–0.3 mm long, papillate, pale blue. Capsules broadly depressed obovoid, 1–2 × 1.5–3 mm, crowned with the persistent calyx lobes, glabrous, dehiscence loculicidal. Seeds 1 per locule, elliptic in outline, ventral groove absent, 0.7–1 × 0.5–0.6 mm, black; seed coat surface reticulate, 5- to 6-angular testa cells, microsculpturing verruculate, central pit in tangential wall.

**Distribution**

W Madagascar: Mahajanga province, Melaky region, Antsalova district.

**Habitat**

Western humid and sub-humid forest; calcareous or rocky substrate.

**Vernacular name**

Masonkary.

**Conservation status**

The species is known from four localities from the Antsalova district. It is probable that the species grows within the Tsingy de Bemaraha National Park. The extent of occurrence is estimated between 100 and 5,000 km². The area of occupancy is estimated between 10 and 500 km². The number of locations is two: i.e. populations within the protected area and populations outside the protected area. The human pressure on the environment within the region is very high. A decline in the extent of occurrence, area of occupancy, and area, extent, and/or quality of habitat is therefore very likely. The species is therefore considered endangered: EN B1ab(i,ii,iii)+2ab(i,ii,iii).

**Astiella confusa** Groeninckx sp. nov.

Figs 2C, 6

**Diagnosis**

*Astiella confusa* sp. nov. resembles *A. tsaratanensis* sp. nov. in having few ovules per locule, broadly depressed obovoid capsules crowned with the persistent calyx lobes, and black seeds that are elliptic in outline and have a ventral groove, but differs in its erect habit (vs scrambling or prostrate), the much shorter corolla tube (1.5–1.7 mm vs 4.8–9.5 mm long), the tricolporate pollen (vs 7- to 8-colporate), and the reticulate seed coat surface with favulariate microsculpturing (vs an alveolate seed surface with rugulose microsculpturing).

**Etymology**

The specific epithet is the feminine participle of the Latin verb ‘*confundo*’, meaning ‘to confuse’, and refers to the fact that this species has been confused with *A. delicatula*. 
Fig. 6. *Astiella confusa* Groeninkx sp. nov. A. Habit. B. Brevistylos flower. C. Open brevistylos flower. D. Ovary dissected to show placentation. E. Capsule. Drawn by Marijke Meersman. All from Humbert 20713 (BR).
Type
MADAGASCAR: Toliara province, Anosy region, Taolanaro district. Bassin de la Manampanihy (sud est), mont Vohimavo au nord d’Ampasimena, rochers du sommet, forêt ombréphile sur argiles latéritiques et granite, 830 m, 27–28 Mar. 1947, Humbert 20713 (holo-: BR; iso-: MO).

Description
Herb, up to 60 cm tall; stems quadrangular in cross section, glabrous. Stipule base 0.5–1.5 mm long, pubescent; fimbriae usually bifid, 0.4–1.2 mm long, colleret-tipped. Leaves sessile; blades narrowly elliptic, 2.5–20 × 0.5–4.2 mm, glabrous or scabrate, darker green above, paler green below; base attenuate; apex acute; margin revolute when dry; midvein prominent or invisible above, always prominent below; secondary veins invisible or 1–2 on each side of the midvein; intersecondary invisible. Inflorescences terminal, compound dichasia, several-flowered; peduncle 0–12 mm long, glabrous. Pedicels (0.7–)3–9.5 mm long, scabrate. Flowers probably heterostylous (only flowers with anthers exserted and style included were observed). Calyx green; tube reduced; lobes 4, triangular, 0.7–1 × 0.4–0.6 mm, glabrous to scabrate. Corolla white; tube funnel-shaped, 1.5–1.7 mm long, glabrous outside and pubescent inside; lobes 4, ovate, 1.5–1.6 × 0.8–1 mm, glabrous. Stamens inserted near the base of the corolla lobes and exserted for ca 2 mm beyond the corolla throat. Anthers ellipsoid, 0.8–1 mm long; filaments dorsifixed, 1.4–1.7 mm long. Pollen tricolporate. Ovary 2-locular, broadly obovoid to broadly depressed obovoid, 0.5–0.7 × 0.7–1 mm, glabrous; placenta attached near the middle of the septum, stalked, globose, bearing few (3–4) ovules per locule. Style 1.2–1.3 mm long, included, glabrous; stigma bilobed, lobes 0.3–0.4 mm long, papillate to hirtellous. Capsules broadly depressed obovoid, well-developed beak, 1.2–1.4 × 2.3–2.7 mm, crowned with the persistent calyx lobes, glabrous, dehiscence loculicidal. Seeds few (2–3), elliptic in outline, ventral groove present, 0.8–1 × 0.6–0.8 mm, black; seed coat surface reticulate, microsculpturing favulate.

Distribution
SE Madagascar: Toliara province, Anosy region, Taolanaro district.

Habitat
Humid forest; laterite and granite substrate; at 830 m elevation.

Conservation status
Known from only one locality. Given its apparent rarity and following the recommendation of Callmander et al. (2005) to avoid the Data Deficient category, we consider the species as vulnerable (VU D2) based on its restricted area of occupancy (D2) and the high human pressure present in the entire area resulting in a general decline of suitable habitats (humid forest) for the species.

*Astiella deblockiae* Groeninckx sp. nov.
Figs 2D, 4B, 5C–D, 7

Diagnosis
*Astiella deblockiae* sp. nov. resembles *A. desseinii* sp. nov. and *A. latifolia* sp. nov. in having tricolporate pollen and numerous ovules per locule, but differs in having a small habit (5 cm vs 10–25 cm tall), very small leaves (2.2–4.5 mm vs 3.2–20(–30) mm long), small corolla tubes (1.5–2.2 mm vs 3.5–11 mm long), small capsules (1.4–2 mm vs 3–4.5 mm long), and dorsiventrally flattened seeds (vs not flattened).
Fig. 7. *Astiella deblockiae* Groeninckx sp. nov. A. Habit. B. Brevistyloous flower. C. Open longistyloous flower. D. Open brevistyloous flower. E. Ovary dissected to show placentation. F. Capsule. Drawn by Marijke Meersman. All from *De Block, Rakotonasolo & Randriamboavonjy 1303 (BR).*
Etymology
The species is named in honour of Dr. Petra De Block, who collected it at the Baies de Sakalaves and who played an important role in making the inventory of Madagascan Rubiaceae.

Type

Additional material examined

Description
Perennial herb, prostrate, ca 5 cm tall, somewhat succulent; stems quadrangular in cross section, somewhat lignified at the base, glabrous or scabrate, brown. Stipule base 0.4–0.8 mm long, beset with a few trichomes; fimbriae 2–4, 0.1–0.7 mm long. Leaves petiolate, succulent; petioles 0.4–1 mm long, ciliate; blades ovate, broadly ovate or elliptic, 2.2–4.5 × 1.1–2.4 mm, glabrous except for ciliate margin at the base of the leaf; base attenuate; apex shortly acuminate or acute; margin revolute when dry; midvein prominent below; secondary veins invisible; intersecondarys invisible. Inflorescences pseudo-axillary, mostly 1- to 3-flowered; peduncle absent. Pedicels 1–11 mm long, glabrous. Flowers heterostylos. Calyx green; tube reduced; lobes 4, ovate to broadly ovate, 0.6–1 × 0.5–1 mm, glabrous, colleters and a few trichomes in between the lobes. Corolla pale pink; tube cylindrical, 1.5–2.2 × 0.6–1.4 mm in brevistylos flowers, 0.8–1 × 1.2 mm in longistylos flowers, glabrous outside, with a ring of trichomes (ca 0.3 mm long) at the lower half inside; lobes 4, narrowly ovate or ovate, 1.4–2.5 × 0.7–1 mm, glabrous outside, papilllose inside, with a ring of spreading trichomes (ca 0.5 mm long) at the base inside in longistylos flowers. Stamens inserted near the base of the corolla lobes, exserted for 1–1.8 mm beyond the corolla throat in brevistylos flowers, exserted for 0.4–0.6 mm beyond the corolla throat in longistylos flowers. Anthers ellipsoid, 0.7–0.8 mm long; filaments dorsifix, ca 1 mm long in brevistylos flowers, ca 0.2 mm long in longistylos flowers. Pollen tricolporate, oblate spheroidal to prolate spheroidal; E 24–26 μm; P 23–25 μm; ectocolpi long; endocolpi unknown; tectum bireciculate; suprareticulum microreticulate to reticulate; infrareticulum present as granules in the lumina of the suprareticulum. Ovary 2-locular, broadly obovoid to broadly depressed obovoid, 0.7–1.2 × 0.8–1.5 mm, glabrous to sparsely pubescent; placenta attached near the middle of the septum, stalked, globose, bearing numerous ovules per locule. Style ca 1.5 mm long and included or only with the stigma tips exserted beyond the corolla throat in brevistylos flowers, 2–3.5 mm long and exserted for 1.3–1.7 mm beyond the corolla throat in longistylos flowers, hirtellous; stigma bilobed, lobes ca 0.5 mm long in brevistylos flowers, 0.3–0.5 mm long in longistylos flowers, papillate. Capsules subglobose, 1.4–2 × 1.8–2 mm, crowned with persistent calyx lobes, glabrous, dehiscence loculicidal. Seeds numerous per locule, ovate in outline, dorsiventrally flattened, ventral groove absent, 0.4–0.5 × 0.2–0.4 mm, brown; seed coat surface reticulate, microsculpturing rugulate.

Distribution
N Madagascar: Antsiranana province, Diana region, Antsiranana I district.

Habitat
Dunes close to the sea; white sand substrate.
**Conservation status**

The species is known from three collections at two localities representing two different locations. The extent of occurrence could not be calculated because there are only two sets of lat/long coordinates. The area of occupancy is estimated smaller than 10 km². The main threat for the species is the high human pressure in some areas where the species occurs. A decline in the extent of occurrence, area of occupancy, and area, extent, and/or quality of habitat is therefore very likely. Therefore the species is considered endangered: EN B1ab(i,ii,iii)+2ab(i,ii,iii).

**Astiella delicatula** Jovet  
Figs 2E, 4C, 5G–I, 8

**Etymology**

The specific epithet is based on the Latin adjective ‘delicatus’, meaning ‘delicate’, referring to the slender habit of the species.

**Type**


**Additional material examined**


**Description**

Annual herb, up to 23 cm tall; stems quadrangular in cross section, only sparsely branching, puberulous, green tinged reddish. Stipule base 0.7–1 mm long, puberulous, slightly tinged red; fimbriae 3–4, 0.5–1.5 mm long, beset with a few trichomes, with colleters in between. Leaves petiolate; petioles 1.5–4 mm long, puberulous; blades ovate at the basal portion of the stem, 9.5–14.5 × 4.5–8.5 mm, narrowly ovate at the distal portion of the stem, 24–50 × 9–15.2 mm, with a few trichomes particularly on the veins, darker green above, paler green below; base obtuse, attenuate or unequal; apex acuminate; margin scabrate; midvein prominent; secondary veins 3–6 on each side of the midvein, prominent; intersecondarys prominent. Inflorescences terminal or pseudo-axillary, single or compound dichasia, 3- to several-flowered, somewhat resembling a scorpionoid cyme; peduncle 6.5–21.5 mm long, sparsely puberulous. Pedicels 0.2–4.5 mm long, glabrous or puberulous. Flowers isostylous. Calyx green; tube reduced; lobes 2, narrowly ovate, 1.1–4 × 0.2–0.3 mm, scabrate. Corolla white; tube cylindrical, 1.6–1.8 × 0.5–0.7 mm, glabrous; lobes 4, ovate, 0.7–1 × 0.4–0.6 mm, glabrous. Stamens inserted in the lower half of the corolla tube and included. Anthers ellipsoid, 0.4–0.5 mm long; filaments dorsifixed, ca 0.2 mm long. Pollen 5- or 6-colporate, suboblate; E 27–28 μm; P 23–28 μm; ectocolpi short; endocolpi short; tectum bireticulate; suprareticulum microreticulate to reticulate, smooth; infrareticulum perforate with granules. Ovary 2-locular, depressed obovoid, 0.3–0.5 × 0.6–0.8 mm, glabrous; placenta attached near the middle of the septum, stalked, globose, bearing 1 ovule per locule. Style 0.4–0.5 mm long, included, glabrous; stigma bilobed, lobes 0.1–0.2 mm long, papillate; nectary disc bipartite. Capsules broadly depressed obovoid, 2–3 × 3.8–5 mm, well-developed beak, crowned with the persistent calyx lobes, glabrous, dehiscence loculicidal. Seeds 1 per locule, ovate in outline, ventral groove present, 1.8–2 × 1.3–1.5 mm, black; seed coat surface reticulate; endosperm ruminate.
Fig. 8. Astiella delicatula Jovet. A. Habit. B. Isostylos flower. C. Open isostylous flower. D. Ovary dissected to show placentation. E. Capsule. Drawn by Marijke Meersman. All from De Block et al. 2173 (BR).
Distribution

W Madagascar: Mahajanga province, Boeny region, Ambato Boeni district; Toliara province, Atsimo-Andrefana region, Sakaraha district; Toliara province, Menabe region, Morondava district.

Habitat

Western dry forest; white sand or calcareous substrate; at 950–1000 m elevation.

Conservation status

The species is known from three localities, representing three different locations. The extent of occurrence equals 20,589.658 km²; the area of occupancy equals 12 km². Two collections were made within the boundaries of a protected area. The main threat for the species is the deterioration of its habitat caused by the high human pressure in the area, which has also been observed within the protected areas. A decline in the extent of occurrence, area of occupancy, and area, extent, and/or quality of habitat is projected. The species is therefore considered endangered: EN B2ab(i,ii,iii).

Astiella desseinii Groeninckx sp. nov.


Figs 2F, 4D, 5E–F, 9

Diagnosis

Astiella desseinii sp. nov. resembles A. latifolia sp. nov. in having sessile flowers, elongated placentas, ovoid capsules, identical seed and pollen morphology, but differs in the erect habit (vs creeping), the linear leaves with secondary veins invisible (vs ovate to broadly ovate leaves with prominent secondary veins), and the cylindrical corolla tubes with the stamens exerted beyond the corolla throat in brevistylous flowers (vs funnel-shaped corolla tubes with the stamens always included).

Etymology

The species is named in honour of Dr. Steven Dessein, who was the first to observe and collect Astiella desseinii.

Type

MADAGASCAR: Toliara province, Menabe region, Morondava district, RN 35, at Antsehase bridge/river, on elevated sandy bank near river, without herb or shrub vegetation, 197 m, 23 Jan. 2007, De Block et al. 2247 (holo-: BR; iso-: MO, P, TAN).

Description

Herb, up to 25 cm tall; stems quadrangular in cross section, glabrous or beset with minute trichomes with characteristic rounded apex towards the nodes, reddish green. Stipple base 0.4–0.8 mm long, covered with short trichomes with characteristic rounded apex; fimbriae often absent, sometimes 2 clearly visible and then 0.5–0.7 mm long, colletter-tipped. Leaves sessile, anisophyllous; blades linear, large leaves 6–22 × 0.7–1.5 mm, small leaves 3.2–12 × 0.6–1.2 mm, beset with short trichomes with characteristic rounded apex above, glabrous below, yellow-green; base attenuate; apex acute; margin revolute when dry, beset with short trichomes with characteristic rounded apex; midvein prominent, purplish or reddish brown below; secondary veins invisible; intersecondarys invisible. Inflorescences pseudo-axillary, 1–2-flowered; peduncle absent. Flowers sessile, heterostylous. Calyx green; tube reduced; lobes 4, narrowly ovate to ovate with acute apex, 0.9–1.2 × 0.3–0.5 mm, glabrous or with a few trichomes, margin beset with short trichomes with characteristic rounded apex. Corolla yellow-green before anthesis, creamy white after; tube cylindrical, widened at the apex, 4–11 mm long, 0.7–1.2 mm wide at the throat, 0.4–0.6 mm wide at the base, glabrous; lobes 4, broadly ovate, 1.2–1.7 × 0.9–1.2 mm, papillose outside, densely...
Fig. 9. *Astiella desseinii* Groeninckx sp. nov. **A**. Habit. **B**. Longistylos flower. **C**. Open longistylos flower. **D**. Open brevistylos flower. **E**. Capsule. **F**. Capsule dissected to show placentation. Drawn by Marijke Meersman. All from De Block et al. 2247 (BR).
pubescent inside. Stamens inserted near the base of the corolla lobes and exserted for 0.8–1.2 mm beyond the corolla throat in brevistylous flowers, inserted in the lower half of the corolla tube and included in longistyloous flowers. Anthers ellipsoid, 1–1.2 mm long; filaments dorsifixed, ca 0.5 mm long. Pollen tricolporate, prolate spheroidal to subprolate spheroidal; E 26.5 μm in brevistylous flowers, 19–24 μm in longistyloous flowers; P 27 μm in brevistylous flowers, 24–26 μm in longistyloous flowers; ectocolpi long; endocolpi long; tectum bireticulate; suprareticulum microreticulate to reticulate, mostly ornate, smooth or with granules; infrareticulum microreticulate with granules. Ovary 2-locular, ovoid, 1.2–1.5 × 0.8–1 mm, glabrous for the most part, covered with short trichomes with characteristic rounded apex towards the base; placenta fused with the septum, elongated, bearing 6–7 ovules per locule embedded in the placental tissue. Style 5 mm long and exserted for 0.2–1.3 mm beyond the corolla throat in brevistylous flowers, 4.8–6.5 mm long and exserted for 1.3–1.8 mm beyond the corolla throat in longistyloous flowers, glabrous; stigma bilobed, lobes 0.5 mm long in longistyloous flowers, 1–1.2 mm long in brevistylous flowers, papillate, white. Capsules ovoid, 3.4–3.8 × 1.8–2.3 mm, crowned with the persistent calyx lobes, glabrous for the most part, covered with short trichomes with characteristic rounded apex towards the base, green becoming reddish brown, dehiscence loculicidal. Seeds 6–7 per locule, elliptic in outline, ventral groove absent, 5 × 0.7–0.8 × 5 mm, black; seed coat surface reticulate, testa cells with undulating radial walls, microsculpturing granulate.

Distribution
W Madagascar: Toliara province, Menabe region, Morondava district.

Habitat
Plateau grassland-wooded grassland mosaic; elevated sandy bank near river; laterite; at 197 m elevation.

Conservation status
The species is only known from its type locality. The species was collected from an elevated sandy bank. No threat could be identified, but as very little is known about the ecology of the species, we categorise the species as data deficient (DD).

Astiella homolleae Groeninckx sp. nov.

Figs 2G, 5J–K, 10, 11A

Diagnosis
Astiella homolleae sp. nov. resembles A. perrieri sp. nov. in having reduced corolla tubes with the stamens always exserted beyond the corolla throat, but differs in having a perennial, erect habit (vs annual and creeping), stipules with many, long fimbriae (4–8 vs 2–4 fimbriae and 1–4 mm vs 0.8–2.7 mm long), a corolla tube papillate on the inside with trichomes towards the base (vs glabrous), and seeds triangular in outline with a verruculate microsculpturing (vs seeds elliptic in outline with granulate microsculpturing).

Etymology
The species is named in honour of the French botanist Anne-Marie Homolle, who annotated many of the Madagascan Spermacoceae specimens in the herbarium of Paris.

Type
MADAGASCAR: Antsiranana province, Sava region, Antalaha district, Partie occidentale du massif de Marojejy (nord-est) de la vallée de l’Ambatoharanana au bassin supérieur de l’Antsahaberoka, forêt ombrophile sur argile latéritique de gneiss et granite, 1300 m, 9 Nov.–2 Dec. 1959, Humbert & Saboureaux 31739 (holo-: P; iso-: BR).
Fig. 10. Astiella homolleae Groeninckx sp. nov. A. Habit. B. Brevistylos flower. C. Open longistylos flower. D. Open brevistylos flower. E. Ovary dissected to show placentation. F. Capsule. Drawn by Marijke Meersman. A from Perrier de la Bâthie 17438 (P); B–E from Humbert & Sabourea 31739 (BR); F from Cheek & Dominic 1325 (K).
Additional material examined

MADAGASCAR: Antsiranana province, Sava region, Andapa district, Pentes occidentales du massif de Marojejy (north-east), Bassin de la Lokoho, à l’est d’Ambalamanasy II, forêt ombrophile sur latérite de gneiss, 450–800 m, 28 Nov.–6 Dec. 1948, Humbert & Capuron 22130 (BR, P). Masoala Peninsula, S of Ambanizana, Andranobe, Piste A, primary wet evergreen forest, 200 m, 18 Feb. 1999, Hoffman et al. 61 (K); Masoala Peninsula, trail leading south from Ambanizana along coast 1–2 km S of Ambanizana, 0–20 m, 26 Sep. 1989, Schatz 2746 (MO, P, TAN). Sambava district, Antsiranana, sous-préfecture d’Andapa, commune rurale de Doany, fokontany de Betsomanga, versant nord-ouest du Marojejy, camp I, 0.5 km à l’ENE du camp I, relevé LG 18, forêt dense humide sempervivente, versant, 860 m, 19 Oct. 2001, Gautier, Ravelonarivo & Andriampanarin 3873 (K); Vallée inférieure de l’Androranga, affluent de la Bemarivo (north-east) aux environs d’Antongodria [Antongondriha], massif du Betsomanga, 1200 m, 17–20 Nov. 1950, Humbert & Capuron 24314 (P); Vallée inférieure de l’Androranga, affluent de la Bemarivo (north-east) aux environs d’Antongodria [Antongondriha], massif du Betsomanga, 1300–1350 m, 17–20 Nov. 1950, Humbert & Capuron 24369 (P). Toamasina province, Analanjirofo region, Mananara district, Rivière Anove, bois, côte est, 200 m, Sep. 1912, Perrier de la Bâthie 3743 (P). Maroantsetra district, Maroantsetra, Antalavia, ca 50 m inland from the sea, lowland evergreen forest.

Fig. 11. Scanning electron microscopy micrographs of pollen in polar view (PV), the apocolpium (AC), pollen in equatorial view (EV) and the mesocolpium (ME). A. Astiella homolleae Groeninckx sp. nov. B. A. latifolia Groeninckx sp. nov. C. A. perrieri Groeninckx sp. nov. D. A. tsaratanensis Groeninckx sp. nov. Scale bars for A: PV = 2 µm, AC = 1 µm, EV = 5 µm; for B and C: PV, EV = 5 µm, AC, ME = 1 µm; for D: PV, EV = 5 µm, AC = 2 µm, ME = 1 µm.
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Description
Perennial herb, up to 60 cm tall, rooting at the basal nodes; stems quadrangular in cross section, glabrous or rarely with a few scattered trichomes. Stipule base 1–2 mm long, with a few scattered trichomes; fimbriae 4–8, 1–4 mm long, colletter-tipped. Leaves petiolate; petioles 2–5.5 mm long, glabrous; blades elliptic or ovate, rarely narrowly elliptic or narrowly ovate, 7–32.5(–92) × 4.5–14.5(–30) mm, glabrous, darker green above, very pale green below; base attenuate; apex acuminate or acute, rarely obtuse; margin glabrous; mid vein prominent; secondary veins 3–6 on each side of the mid vein, prominent or invisible; inter secondaries invisible. Inflorescences terminal, compound dichasia, multi-flowered; peduncle 0–40 mm long, glabrous or rarely scabrate. Pedicels 0.5–5 mm long, glabrous or rarely scabrate. Flowers heterostylous. Calyx green; tube reduced; lobes 4, triangular or narrowly triangular, 0.9–1.2 × 0.3–0.4 mm, glabrous, colleters in between. Corolla white; tube reduced, 0.2–0.6 mm long, glabrous; lobes 4, narrowly elliptic to elliptic, 2–3 × 0.6–1.2 mm, glabrous or with a few trichomes outside, papillate with trichomes towards the base inside. Stamens inserted near the base of the corolla lobes, exserted for 2.5–3 mm beyond the corolla throat in brevistylous flowers, exserted 0.7–1 mm beyond the corolla throat in longistylos flowers. Anthers ellipsoid, 0.4–0.6 mm long in brevistylos flowers, 0.7–0.8 mm long in longistylos flowers; filaments dorsifixed, 2.3–3 mm long in brevistylos flowers, 0.5–0.6 mm long in longistylos flowers. Pollen tricolporate, oblate spheroidal to prolate spheroidal; E 20–16 μm; P 15–22 μm; ectocolpi long; endocolpi long; tectum bireticulate; suprareticulum microreticulate to reticulate; infrareticulum present as granules in the lumina of the suprareticulum. Ovary 2-locular, broadly depressed obovoid, 0.6–0.7 × 0.8–1 mm, glabrous; placenta attached near the middle of the septum, stalked, globose, bearing numerous ovules per locule. Style ca 1.2 mm long and included in brevistylos flowers, 3.5–4.5 mm long and exserted for 2.6–4 mm beyond the corolla throat in longistylos flowers, papillate or hirtellous; stigma bilobed, lobes ca 0.4 mm long in brevistylos flowers, 0.8–1.3 mm long in longistylos flowers, papillate or hirtellous. Capsules broadly depressed obovoid, 1–2 × 1.8–2.5 mm, crowned with the persistent calyx lobes, glabrous, dehiscence loculical. Seeds numerous per locule, triangular in outline, ventral groove absent, 0.4–0.5 × 0.2–0.4 mm, black; seed coat surface reticulate, microsculpturing verruculate.

Distribution
NE to E Madagascar: Antsiranana province, Sava region, Andapa, Antalaha, and Sambava districts; Toamasina province, Analanjirofo region, Mananara, Maroantsetra, and Sainte Marie districts; Toamasina province, Atsinanana region, Toamasina II district; Fianarantsoa province, Vatovavy-Fitovinany region, Mananjary district.

Habitat
Humid forest; laterite and granite substrate; at 0–1300 m elevation.

Conservation status
The species is known from 15 collections, of which two without locality. The number of locations is eight. The extent of occurrence is more than 20,000 km²; the area of occupancy equals 48 km². Throughout its distribution range there is a high human pressure on the habitat of this species, even
Fig. 12. *Aстиella latifolia* Groeninckx sp. nov. **A.** Habit. **B.** Longistylos flower. **C.** Open longistylos flower. **D.** Open brevistylos flower. **E.** Ovary dissected to show placentation; some ovules removed from the right locule to show the shape of the placenta. **F.** Capsule. Drawn by Marijke Meersman. A, D–F from *De Block et al. 2255* (BR); B–C from *Baron 5214* (P).
Astiella latifolia Groeninckx sp. nov.

**Diagnosis**

*Astiella latifolia* sp. nov. resembles *A. desseinii* sp. nov. in having sessile flowers, elongated placentas, ovoid capsules, identical seed and pollen morphology, but differs in the creeping habit (vs erect), the ovate to broadly ovate leaves with prominent secondary veins (vs linear leaves with secondary veins invisible), and the funnel-shaped corolla tubes with the stamens always included (vs cylindrical corolla tubes with the stamens exerted beyond the corolla throat in brevistylous flowers).

**Etymology**

The species name is derived from the Latin adjective ‘*latus*’ (= broad, wide) and noun ‘*folium*’ (= leaf), referring to the ovate or broadly ovate leaves. It also refers to the illegitimate name *Oldenlandia latifolia* Baker.

**Type**

MADAGASCAR: Fianarantsoa, PK 365 on RN 2 from Antananarivo to Fianarantsoa, dense low grassy vegetation alongside road and *Eucalyptus* forest, 1213 m, 29 Jan. 2007, *De Block et al.* 2255 (holo-: BR; iso-: BR, MO, P, TAN).

**Additional material examined**

Description

Annual herb, creeping, less than 10 cm tall, rooting at the nodes; stems quadrangular in cross section, only sparsely branching, with short (ca 0.2 mm) and longer (ca 0.7 mm) white trichomes on the adaxial side, glabrous or with short white trichomes on the abaxial side, light brown, purplish brown or reddish brown. Stipule base 1–1.5 mm long, beset with a few trichomes (up to 1 mm long); fimbriae 2–4, 0.8–2.7 mm long, beset with trichomes (up to 1 mm long), colletor-tipped. Leaves petiolate, rarely sessile, anisophyllous; petioles 0.5–6 mm long; blades elliptic, ovate or broadly ovate, large leaves 5–20(–30) × 4–12 mm, small leaves 4–9.5 × 3–8.8 mm, glabrous or sparsely covered with short (ca 0.6 mm) appressed trichomes above particularly at the base (especially on younger leaves), glabrous below except for midvein and secondary veins that are covered with very short (ca 0.2 mm) erect trichomes, darker green above, paler green below; base attenuate; apex acute; margin scabrate towards the apex, ciliate at the base; midvein prominent below; secondary veins 3–4 on each side of the midvein, somewhat prominent below; intersecondarys invisible. Inflorescences terminal 3- to several-flowered and pseudo-axillary 1- or 2-flowered; peduncle absent. Flowers sessile, heterostylous. Calyx green to purplish; tube reduced; lobes 4, narrowly triangular, 1.5–2.5 × 0.2–0.5 mm, margin ciliate with trichomes up to 1 mm long. Corolla white, pale pink or pale purple; tube funnel-shaped, 3.5–5.4 mm long, 2–2.8 mm wide at the throat and 0.5–1.1 mm wide at the base in brevistylos flowers, 6.8–8.5 mm long, 3.5–4.8 mm wide at the throat and 0.8–1.2 mm wide at the base in longistylos flowers, glabrous or with a few trichomes outside, covered with long spreading trichomes (up to 1 mm long) inside at the base and sometimes at the throat; lobes 4, ovate to broadly ovate, 1.7–2.5 × 1.5–2 mm in brevistylos flowers, 3.2–3.8 × 2.8–3.5 mm in longistylos flowers, glabrous or covered with a few trichomes outside, sparsely covered with long spreading trichomes (up to 1 mm long) inside. Stamens inserted at 3.5–4 mm height in the corolla tube in brevistylos flowers, inserted at 1.5–3 mm height in the corolla tube in longistylos flowers, always included. Anthers broadly obovoid, 0.4–0.6 mm long, white; filaments dorsifixed, 0.3–0.7 mm long. Pollen tricolporate, prolate spheroidal, sometimes oblate spheroidal or subprolate in brevistylos flowers, subprolate in longistylos flowers; E 22–26 μm in brevistylos flowers, 22–25 μm in longistylos flowers; P 24–26 μm in brevistylos flowers, 26–28.5 μm in longistylos flowers; ecolopli long; endocolpi long; tectum bireticulate; suprareticulum microreticulate to reticulate; infrareticulum perforate to microreticulate with granules. Ovary 2-locular, ovoid, 1.3–1.4 × 1.2–1.3 mm, sparsely covered with trichomes; placenta attached near the middle of the septum, stalked, elongated, bearing 5–10 ovules per locule. Style 3.3–4.8 mm long in brevistylos flowers, 6–8 mm long in longistylos flowers, always included, glabrous, white; stigma bilobed, lobes 0.5–0.8 mm long in brevistylos flowers, 1.5–2 mm long in longistylos flowers, hirtellous. Capsules ovoid, 3–4.5 × 2–3.5 mm, with beak 0.8–1.7 mm long, crowned with the persistent calyx lobes, glabrous or covered with a few trichomes, green with brown beak, dehiscence loculicidal. Seeds 5–10 per locule, elliptic in outline, ventral groove absent, 0.6–0.8 × 0.5–0.6 × 0.4–0.6 mm, black; seed coat surface reticulate, testa cells with undulating radial walls, microsculpturing granulate.

Distribution

NW to SE Madagascar: Antananarivo province, Vakinankaratra region, Antsirabe I and Betofo districts; Antsiranana province, Diana region, Ambanja district; Fianarantsoa province, Amoron’i Mania region, Ambatofinandrahana district; Fianarantsoa province, Haute Matsiatra region, Ambalavao, Ambohimahasoa, and Fianarantsoa districts; Fianarantsoa province, Horombe region, Ivohibe district;
Mahajanga province, Boeny region, Ambato Boeni, Mahajanga I, and Marovoay districts; Mahajanga province, Sofia region, Boriziny district; Toliara province, Androy region, Ambovombe district; Toliara province, Anosy region, Taolanaro district.

**Habitat**
Western dry forest and humid forest; often disturbed vegetations (i.e. degraded dry forest, grass along roads, sandy paths in forests, manioc fields and walls); sand; at 88–1800 m elevation.

**Vernacular name**
Masiramboalavo.

**Conservation status**
The species is known from 23 collections, of which four without locality. The extent of occurrence equals 195,897.347 km$^2$ and the area of occupancy equals 72 km$^2$. *Astiella latifolia* sp. nov. has frequently been collected from disturbed areas. No real threats could be identified and the species does therefore not qualify for an IUCN red list threatened category (LC).

*Astiella longifimbria* Groeninckx sp. nov.


Figs 2I, 13

**Diagnosis**
*Astiella longifimbria* sp. nov. resembles *A. homolleae* sp. nov. in having long fimbriate stipules, but differs in having corolla lobes moderately covered with appressed trichomes (vs glabrous), and a well-developed corolla tube (vs reduced).

**Etymology**
The specific epithet refers to the long fringes of the stipules.

**Type**
MADAGASCAR: Mahajanga province, Sofia region, Bealanana district, Montagnes au nord de Mangindrano (haute Maevanaro) jusqu’aux sommets d’Ambohimirahavavy (partage des eaux Mahavavy-Androranga: centre-nord), clairières naturelles en forêt ombrophile sur latérite de gneiss (berges) de la Bemafo affluent de l’Androranga, 1900 m, 19 Jan.–12 Feb. 1951, Humbert & Capuron 25168 (holo-: P; iso-: BR, P).

**Description**
Herb, up to 15 cm tall, rooting at the basal nodes; young stems quadrangular in cross section, lanate, with reddish brown multicellular trichomes up to 1 mm long, older stems glabrous. Stipule base 0.8–1.5 mm long, moderately covered with reddish brown appressed trichomes; fimbriae 2–4, 4–6.5 mm long, beset with reddish brown trichomes. Leaves petiolate; petioles 3–11.5 mm long, lanate; blades ovate to elliptic, 12–50 × 5.5–23 mm, sparsely covered with appressed trichomes up to 0.5 mm long particularly on the midvein and in between the secondary veins above, sparsely covered with appressed trichomes up to 0.5 mm long particularly on the midvein and on the secondary veins below; base attenuate; apex acute or obtuse; margin revolute when dry, densely ciliolate; midvein prominent below; secondary veins 3–7 on each side of the midvein, prominent below; intersecondary invisible. Inflorescences terminal, compound dichasia, several-flowered; peduncle 5–22.5 mm long, with indumentum similar to the stems. Pedicels 0.5–11 mm long, with indumentum similar to the stems. Flowers probably heterostylous (only flowers with anthers exerted and style included have been observed). Calyx green;
**Fig. 13. Astiella longifimbria** Groeninckx sp. nov. **A. Habit. B. Flower. C. Open flower. D. Ovary dissected to show placentation.** Drawn by Marijke Meersman. All from Humbert & Capuron 25168 (P).
tube reduced; lobes 4, narrowly ovate, 3.5–4.2 × 0.3–0.4 mm, densely pubescent. Corolla white or pale blue; tube funnel-shaped, 2.5–4.5 mm long, 0.6–0.9 mm wide at the base, 1.7–2 mm wide at the apex, moderately covered with appressed trichomes outside, densely covered with spreading trichomes inside; lobes 4, ovate, 2–4.5 × 1.2–1.3 mm, moderately covered with appressed trichomes outside, glabrous inside except for a ring of trichomes at the base. Stamens inserted near the base of the corolla lobes in presumed brevistylous flowers and exserted for 2.5–3 mm beyond the corolla throat. Anthers ellipsoid, 1.3–1.8 mm long; filaments dorsifixed, 1.5–2.3 mm long. Pollen unknown. Ovary 2-locular, broadly obpyramidal, 1–1.2 × 1 mm, densely covered with spreading trichomes up to 0.6 mm long; placenta attached above the middle of the septum, stalked, elongated, bearing numerous ovules per locule. Style ca 4 mm long and included in presumed brevistylous flowers; stigma bilobed, lobes ca 1.2 mm long, papillate. Capsules and seeds unknown.

**Distribution**

NW Madagascar: Mahajanga province, Sofia region, Bealanana district.

**Habitat**

Humid forest; laterite substrate; at 1900 m elevation.

**Conservation status**

Known from only one locality. Given its apparent rarity and following the recommendation of Callmander *et al.* (2005) to avoid the Data Deficient category, we consider the species as vulnerable (VU D2) based on its restricted area of occupancy (D2) and the high human pressure present in the entire area resulting in a general decline of suitable habitats (humid forest) for the species.

*Astiella perrieri* Groeninckx sp. nov.


Figs 2J, 5N–O, 11C, 14

**Diagnosis**

*Astiella perrieri* sp. nov. resembles *A. homolleae* sp. nov. in having a reduced corolla tube with the stamens always exserted beyond the corolla throat, but differs in having an annual habit (vs perennial), stipules with less and shorter fimbriae (2–4 fimbriae vs 4–8 and 0.8–2.7 mm vs 1–4 mm long), a glabrous corolla tube on the inside (vs papillate with trichomes towards the base), and seeds elliptic in outline with granulate microsculpturing (vs seeds triangular in outline with a verruculate microsculpturing).

**Etymology**

The specific epithet is dedicated to the French botanist H. Perrier de la Bâthie who specialized in the plants of Madagascar.

**Type**

MADAGASCAR: Fianarantsoa province, Horombe region, Ivoihibe district, Angrititra, area around campement 1, humid forest, along forest trails and in open places, 28 Jan. 2006, *De Block, Tosh & Rakotonasolo* 1927 (holo-: BR; iso-: BR, MO, P, TAN).

**Additional material examined**

MADAGASCAR: Antananarivo province, Analamanga region, Anjozorobe district, Ampilanonana, Ambohitakatra, 1300 m, 3 Apr. 1999, *Rakotonasolo & Ramaroson* 89a (BR, K); Ampilanonana, Ambohitakatra, on rock, 1300 m, 3 Apr. 1999, *Rakotonasolo & Ramaroson* 90 (K, TAN). Antsiranana province, Melaky region, Besalampy district, Mares de dissolution latéritique, plateau de Marangaka
Fig. 14. *Aстиella perrieri* Groeninckx sp. nov. **A.** Habit. **B.** Brevistylos flower. **C.** Open brevistylos flower. **D.** Open longistylos flower. **E.** Ovary dissected to show placentation; all ovules removed from the right locule to show the placenta. **F.** Capsule. Drawn by Marijke Meersman. **A–C,** **E** from De Block, Tosh & Rakotonasolo 1927 (BR); **D** from Perrier de la Bâthie 3958 (P); **F** from Perrier de la Bâthie 14472 (P).
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[Mrangaka], 1600 m, Dec. 1912, Perrier de la Bâthie 15163 (P). Fianarantsoa province, Atsimo-Atsinanana region, Befotaka district, Pce. de Farafangana, bord des routes en forêt humide, 16 Aug. 1926, Decary 4431 (P). Horombe region, Ivohibe district, Massif d’Andringitra, forêt à sous bois herbacé, 1600 m, Feb. 1922, Perrier de la Bâthie 14472 (P). Rahalina province, Sofia region, Bealanana district, Montagnes au nord de Mangindrano (haute Maevavana) jusqu’aux sommets d’Ambohimahavavy (partage des eaux Mahavavy Andororanga; centre nord), clairière maricagète dans la forêt ombrophile sur latérite de gneiss, par petites plaques à la lisière, en prairie secondaire, 1900 m, 19 Jan.–12 Feb. 1951, Humbert & Capuron 24953 (BR, MO, P, TAN). Toamasina province, Alaotra-Mangoro region, Moramanga district, Beforona [Bé-fouram], s.d., Bojer s.n. (K, P). Anosibe An’Ala district, Terrain humide près d’un forêt, village d’Analamazava [Alamazaze], 1000 m, 13 May 1881, Lantz s.n. (P). Analajirofo region, Maroantsetra district, Island of Nosy Mangabe, 5 km S of Maroantsetra in the Bay of Antongil, along north trail, in full shade, 10 m, 26 Apr. 1990, Carlson 179 (MO, TAN); Nosy Mangabe coastal path from W landing towards N end, bank above path, lowland evergreen rainforest, near Cyperus and Diospyros, on laterite, 10 m, 29 Feb. 1988, Cheek & Schatz 1380 (K); Nosy Mangabe, a 520 ha island in the Bay of Antongil, 5 km from Maroantsetra, 0–330 m, 9 Jan. 1989, Schatz & Miller 2514 (MO, P, TAN); Nosy Mangabe, a 520 ha island in the Bay of Antongil, 5 km from Maroantsetra, 0–330 m, 4 Dec. 1987, Schatz & Villiers 1833 (K, MO, P, TAN). Locality unknown, Bois humides, rivière Simianona [Simiana], 200 m, Sep. 1912, Perrier de la Bâthie 3958 (P); Bois, rivière Mananara, 200 m, Oct. 1912, Perrier de la Bâthie 7941 (P).

Description

Annual herb, creeping, fertile stems 4–20 cm tall, with fine rooting system, rooting at the nodes; stems quadrangular in cross section, only sparsely branching, glabrous or puberulent, green to reddish green. Stipule base 0.5–1.5 mm long, glabrous or pubescent; fimbriae 2–4, 0.8–2.7 mm long, colletter-tipped. Leaves petiolate or sessile; petioles 0.5–3.5 mm long, glabrous; blades broadly elliptic or broadly ovate, 2.2–26.5 × 1.8–14.5 mm, sparsely to densely strigose above particularly towards the edges (but see remarks), glabrous to sparsely puberulent particularly on the veins, darker green above, paler green below; base attenuate; apex acute; margin ciliolate; midvein prominent particularly below; secondary veins 2–5 at each side of the midvein, prominent below; intersecondarys prominent. Inflorescences terminal or pseudo-axillary, single or compound dichasia, 3- to several-flowered, subtended by one leaf pair; peduncle absent or 5–40 mm long, glabrous; lower bracts leaf-like, upper bracts fimbriate. Pedicels 0.5–16 mm long, glabrous to sparsely puberulent. Flowers heterostylous. Calyx green; tube reduced; lobes 4, triangular to narrowly triangular, 1–1.5 × 0.4–0.6 mm, glabrous or beset with trichomes particularly at the sinuses, colleters in between. Corolla white, pale pink, pale blue or pale purple; tube reduced or cylindrical, 0.6–1.5 mm long (but see remarks), glabrous; lobes 4, elliptic, 1.2–2.7 × 1.1–1.7 mm, glabrous outside, papillate and sparsely beset with trichomes inside. Stamens inserted near the base of the corolla lobes, exserted for 1.5–2.2 mm beyond the corolla throat in brevistyloous flowers, exserted for 0.5–1.5 mm beyond the corolla throat in longistyloous flowers. Anthers ellipsoid, 0.5–1 mm long, purple or white; filaments dorsifixed, 1.3–2 mm long in brevistyloous flowers, 0.4–0.5 mm long in longistyloous flowers. Pollen tricolporate, oblate spheroidal, prolate spheroidal or subprolate in brevistyloous flowers, prolate spheroidal to subprolate in longistyloous flowers; E 16–22 μm in brevistyloous flowers, 17–20 μm in longistyloous flowers; P 18–26 μm in brevistyloous flowers, 21–22 μm in longistyloous flowers; ectocolpi long; endocolpi long; tectum bireticulate; suprareticulum microreticulate to reticulate, smooth; infrareticulum perforate to microreticulate with granules and/or spines on the muri in brevistyloous flowers, reduced in longistyloous flowers to granules and/or spines in the lumina around the edges of the muri. Ovary 2-locular, broadly obovoid to broadly depressed obovoid, 0.5–0.7 × 0.6–1.1 mm, glabrous; placenta attached near the middle of the septum, stalked, subglobose, bearing few ovules per locule (but more than 3). Style 1–1.5 mm long and included in brevistyloous flowers, 3–6 mm long and exserted for 2.4–5 mm beyond the corolla throat in longistyloous flowers, papillate; stigma bilobed, lobes 0.7–0.9 mm long in brevistyloous flowers,
Fig. 15. *Astiella pulla* Groeninckx sp. nov. A. Habit. B. Brevistyrous flower. C. Open brevistyrous flower. D. Open longistyrous flower. E. Ovary dissected to show placentation; all ovules removed from the right locule to show the placenta. F. Capsule. Drawn by Marijke Meersman. A, E–F from *Perrier de la Bâthie* 17633 (P); B–D from Groeninckx, De Block & Rakotonasolo 271 (BR).
0.7–2.3 mm long in longistyloous flowers, hirtellous. Capsules broadly obovoid, 1.3–2.7 mm long, 2–2.8 mm wide, crowned with the persistent calyx lobes, glabrous, green, dehiscence loculicidal. Seeds few per locule, elliptic in outline, ventral groove absent, 0.6–0.7 × ca 0.5 × ca 0.5 mm, black or dark brown; seed coat surface reticulate, testa cells with undulating radial walls, microsculpturing granulate.

Distribution
E Madagascar: Antananarivo province, Analamanga region, Anjozorobe district; Antsiranana province, Melaky region, Besalampy district; Fianarantsoa province, Befotaka district; Fianarantsoa province, Horombe region, Ivohibe district; Mahajanga province, Sofia region, Bealanana district; Toamasina province, Alaotra-Mangoro region, Moramanga district; Toamasina province, Analanjirofo region, Maroantsetra district.

Habitat
Humid forest; along forest trails; secondary savannas; laterite substrate; at 0–1900 m elevation.

Conservation status
The species is known from 15 collections, of which two without locality. The number of locations is eight. The extent of occurrence is more than 20,000 km²; the area of occupancy equals 36 km². Throughout the species’ distribution range, there is a high human pressure on the natural habitats. The species is therefore classified as vulnerable: VU B2ab(i,ii,iii).

Remarks
The specimen Lantz s.n. could be included in A. perrieri sp. nov. although it has flowers with well-developed corolla tubes (2.3–2.6 mm long). Several other specimens collected on the Island of Nosy Mangabe (Carlson 179, Cheek 1380, Schatz & Miller 2514, Schatz & Villiers 1833) could be included as well, but these can be distinguished from the other A. perrieri specimens by their glabrous leaves. Because of these discrepancies, these specimens were not included in the species description.

Astiella pulla Groeninckx sp. nov.
Figs 2K, 15

Diagnosis
Astiella pulla sp. nov. resembles A. antsalovansis sp. nov. in having black seeds with a reticulate seed coat surface consisting of 5- to 6-angular testa cells and in having a ring of trichomes inside the corolla tube, but differs in having more robust inflorescence axes (vs slender), 4 to 5 ovules per locule (vs 3), a longer style that is always exerted in brevistylous flowers (vs a shorter style that is included), and fruits 1.5–3.4 × 2.6–4 mm (vs 1–2 × 1.5–3 mm).

Etymology
The specific epithet is the feminine form of the Latin adjective ‘pullus’ that means ‘dark-coloured’ and refers to the black seeds.

Type
MADAGASCAR: Mahajanga province, Boeny region, Mahajanga I district: ca 20 km before Mahajanga, Marohogo, RN 4, just next to road, 47 m, 19 Mar. 2010, Groeninckx, De Block & Rakotonasolo 271 (holo-: BR; iso-: BR, G, K, MO, P, TAN, WAG).
Additional material examined
MADAGASCAR: Mahajanga province, Boeny region, Mahajanga I district, sur le calc rocin à Marohogo près Majunga, s.d., Perrier de la Bâthie 17633 (P).

Description
Annual herb, erect, up to 20 cm tall; stems quadrangular in cross section, glabrous or sometimes scabrate on the ribs. Stipule base 0.2–1 mm long, beset with a few short trichomes; fimbriae 4–9, 0.2–0.8 mm long, sometimes inconspicuous, colletter-tipped. Leaves sessile; blades ovate, elliptic, narrowly ovate or narrowly elliptic, 8–32 × 3–8.5 mm, glabrous, darker green above, paler green below; base attenuate; apex acute; margin revolute when dry, scabrate; midvein prominent below, glabrous or scabrate; secondary veins invisible or 3–4 on each side of the midvein; intersecondaries invisible. Inflorescences terminal or pseudo-axillary, very lax compound and reduced dichasia, 3- to several-flowered; bracts at main branchings leaf-like; peduncle absent; inflorescence branches up to 6 cm long, glabrous or scabrate. Pedicels absent or 0.5–1.5 mm long, glabrous or scabrate. Flowers heterostylous. Calyx green; tube reduced; lobes 4, ovate with acuminate tip, 1–1.7 × 0.7–1 mm, glabrous, margin ciliolate. Corolla white; tube cylindrical 2.2–2.8 × 1–1.5 mm in brevistylous flowers, 1.5–2.2 × 0.8–1.2 mm in longistylous flowers, glabrous outside, with a ring of trichomes in the lower half inside; lobes 4, ovate, 0.6–1.4 × 0.5–1.3 mm, glabrous inside except for trichomes towards the margin. Stamens inserted near the base of the corolla lobes and exserted for 0.6–0.9 mm beyond the corolla throat in brevistylous flowers, inserted in the middle of the corolla tube and included in longistylous flowers. Anthers ellipsoid, 0.5–0.7 mm long; filaments dorsifixed, 0.4–0.5 mm long. Pollen 7-aperturate. Ovary 2-locular, depressed obovoid, 0.5–1 × 0.7–1.3 mm, glabrous to sparsely pubescent; placenta attached near the middle of the septum, stalked, subglobose, bearing 4 to 5 ovules per locule. Style 2.3–3 mm long and exserted for 0.2–0.3 mm beyond the corolla throat in brevistylous flowers, 2.5–2.8 mm long and exserted for 0.6–0.7 mm beyond the corolla throat in longistylous flowers, glabrous; stigma bilobed, lobes 0.5–0.8 mm long, hirtellous. Capsules broadly depressed obovoid, 1.5–3.4 × 2.6–4 mm, crowned with the persistent calyx lobes, glabrous or with a few scabrate trichomes, dehiscence loculicidal. Seeds 1, 3 or 4 per locule, elliptic in outline, ventral groove absent, 0.8–1 × 0.6–0.8 × 0.4–0.5 mm, hilum in the middle, black; seed coat surface reticulate, 5- to 6-angular testa cells, microsculpturing favulariate.

Distribution
NW Madagascar: Mahajanga province, Boeny region, Mahajanga I district.

Habitat
Western (degraded) dry forest; dark clay on calcareous underground; at 47 m elevation.

Conservation status
Known from only one locality. Given its apparent rarity and following the recommendation of Callmander et al. (2005) to avoid the Data Deficient category, we consider the species as vulnerable (VU D2) based on its restricted area of occupancy (D2) and the high human pressure present in the entire area resulting in a general decline of suitable habitats (dry forest) for the species.

Astiella tsaratanensis Groeninckx sp. nov.
Figs 2L, 5P–R, 11D, 16

Diagnosis
Astiella tsaratanensis sp. nov. resembles A. delicatula Jovet in having a reduced number of ovules per locule, pluricolporate pollen, and seeds with a ventral groove, but differs in having 3 ovules per locule (vs 1), and 4 calyx lobes (vs 2).
Etymology
The species epithet refers to the Madagascan town Tsaratanana.

Type

Additional material examined
MADAGASCAR: Antsiranana province, Diana region, Antsiranana I district, Centre nord, Montagne d’Ambre, bords du bois, basalte, 1000 m, Nov. 1909, Perrier de la Bâthie 3730 (P). Antsiranana province, Diana region, Ambanja district, Montagne Tsaratanana, sousbois, 1000 m, Dec. 1912, Perrier de la Bâthie 9403 (P); Montagne au nord de Tsaratanana, Forêt d’Ambre, 800 m, 5 Nov. 1938, Humbert 32085 (BR, P). Additional material examined:

Description
Herb, scrambling or prostrate, up to 30 cm tall, with fine rooting system, rooting at the nodes; stems round in cross section, only sparsely branching, glabrous to sparsely pubescent, pale green to reddish green, tinged red near the nodes. Stipule base 1.3–1.5 mm long, sparsely to densely beset with trichomes (ca 0.6 mm long); fimbriae 1–6, variable in length up to 2.5 mm long, collerette-tipped. Leaves petiolate; petioles 1.5–17 mm long, glabrous; blades ovate or elliptic, rarely broadly elliptic, 5.5–39 × 3.5–20.3 mm, sparsely to moderately covered with appressed trichomes 0.1–1.5 mm long, mostly concentrated on midvein and secondary veins, darker green above, paler green below; base attenuate; apex acute; margin scabrate or ciliate; midvein prominent below; secondary veins 3–5 on each side of the midvein, prominent particularly below; intersecondary invisible. Inflorescences pseudo-axillary, 1- or few-flowered dichasia; peduncle 11–27 mm long, glabrous. Pedicels 1–7.7 mm long, glabrous, green tinged reddish. Flowers heterostylous. Calyx green; tube reduced; lobes 4, narrowly triangular to linear, 1–2 × 0.2–0.5 mm, glabrous or sparsely beset with trichomes, margin usually scabrate rarely beset with long trichomes, collerettes in between. Corolla white or pale blue; tube funnel-shaped, 4.8–9.5 mm long, 0.5–1 mm wide at the base, 2–4.2 mm wide at the throat, glabrous outside, sparsely to moderately beset with trichomes inside; lobes 4, ovate, 3.4–5 × 1.1–2.5 mm, glabrous outside, moderately beset with trichomes inside. Stamens inserted in the corolla throat and exerted for ca 1 mm beyond the
Fig. 16. Astiella tsaratanensis Groeninckx sp. nov. A. Habit. B. Brevistyloous flower. C. Open longistyloous flower. D. Open brevistyloous flower. E. Ovary dissected to show placentation. F. Capsule. Drawn by Marijke Meersman. A–C, E–F from De Block, Rakotonasolo & Randriamboavonjy 1319 (BR); D from Humbert & Capuron 24975 (BR).
corolla throat or included in brevistylous flowers, inserted in the lower half of the corolla tube and included in longistylos flowers. Anthers ellipsoid, 0.8–1 mm long; filaments dorsifixed, 0.3–0.8 mm long. Pollen 7- to 8-cordporate, suboblate; E 34–37 μm; P 26–29.5 μm; ectocolpi short; endocolpi short; tectum bireticulate; suprareticulum microreticulate to reticulate, smooth; infrareticulum perforate to microreticulate with granules. Ovary 2-locular, broadly obovoid to broadly depressed obovoid, 0.4–1 × 0.6–0.9 mm, glabrous; placenta attached near the middle of the septum, stalked, globose, bearing 3 ovules per locule. Style 3.6–4 mm long and included in brevistylous flowers, 9–11 mm long and exserted for 1.2–2 mm beyond the corolla throat or included in longistylos flowers, glabrous; stigma bilobed, lobes 0.6–1.2 mm long in longistylos flowers, 0.5–0.9 mm in brevistylous flowers, papillate, pale blue. Capsules broadly depressed obovoid, 2.5–4.6 × 3.2–5 mm, crowned with the persistent calyx lobes, glabrous, green, dehiscence loculicidal. Seeds 1 per locule, elliptic in outline, ventral groove present, 1.9–2.3 × 1.4–1.5 mm, black; seed coat surface alveolate, microsculpturing rugulose.

**Distribution**

NW to E Madagascar: Antananarivo province, Analamanga region, Ankazobe district; Antananarivo province, Vakinankaratra region, Ambatolampy district; Antsiranana, province, Diana region, Ambanja, and Antsiranana I districts; Fianarantsoa province, Atsimo-Atsinanana region, Farafangana district; Mahajanga province, Sofia region, Bealanana district; Toamasina province, Alaotra-Mangoro region, Ambatondrazaka district.

**Habitat**

Humid forest; along forest stream, forest border; basalt-laterite; at 800–1900 m elevation.

**Conservation status**

The species is known from 14 collections, of which two without locality. The number of locations is nine. The extent of occurrence is more than 20,000 km²; the area of occupancy equals 40 km². The main threat for the species is the deterioration of its habitat caused by the high human pressure throughout its distribution range, which has also been observed within the protected areas. A decline in the extent of occurrence, area of occupancy, and area, extent, and/or quality of habitat is projected. The species is therefore classified as vulnerable: VU B2ab(i,ii,iii).

**Discussion**

The expanded genus *Astiella*

*Astiella* is no longer monospecific but includes, besides *A. delicatula*, also *A. antongilensis* sp. nov., *A. antsalovansis* sp. nov., *A. confusa* sp. nov., *A. deblockiae* sp. nov., *A. desseinii* sp. nov., *A. homolleae* sp. nov., *A. latifolia* sp. nov., *A. longifimbria* sp. nov., *A. perrieri* sp. nov., *A. pulla* sp. nov., and *A. tsaratanensis* sp. nov. The genus now holds 12 species that are all endemic to Madagascar. Most species have a limited distribution range but a few occur throughout the island (Fig. 2). Several *Astiella* species were included in a recent molecular phylogenetic analysis and they were shown to be monophyletic and part of the Spermacoecae s. lat. tribe in Rubiaceae (Janssens et al. 2016). Morphologically, the newly described species also fit the Spermacoecae s. lat. tribe: they are rather small annual or perennial herbs with raphides, fimbriate stipules, tetramerous heterostylos white flowers, two-lobed styles, bilocular ovaries, and multi-ovulate placentas attached to the middle of the septum. The phylogenetic study furthermore demonstrated that the newly described species are part of the TAPA clade, a clade consisting of the Madagascan genera *Thamnoldenlandia*, *Amphistemon*, *Phialiphora*, and *Astiella* (Janssens et al. 2016). Although a single morphological synapomorphy could not be identified for the different *Astiella* species, there is little doubt that the 11 newly described species are part of the genus *Astiella*. Firstly, *A. delicatula* was also included in the phylogenetic analysis and the newly described species clearly form...
a monophyletic group around the type species, significantly separated from the other closely related genera (Janssens et al. 2016). Secondly, all newly described species are morphologically quite different from the three closest related genera: the two Phialiphora species have basal leaves that form ± a rosette, typical involucrate head-like inflorescences, isostylosous flowers with exserted stamens, and heart-shaped placentas distally attached to the septum (Groeninckx et al. 2010a); the two Amphistemon species are perennial herbs or much-branched subshrubs with well-developed taproots and their stamens are inserted at two levels in the corolla tube (Groeninckx et al. 2010b); and Thamnoldenlandia ambovombensis Groeninckx is a 1.5 m tall woody shrub with linear leaves and winged seeds (Groeninckx et al. 2010b). None of the newly described species possess any of these characters. The combination of molecular and morphological evidence clearly places the species together in an expanded genus Astiella.

Species groups within Astiella

Although the genus seems to be morphologically variable (e.g. the variation in the number of ovules), several distinct groups can be recognized within Astiella based on character combinations that define two or more species and by combining the morphological data with the molecular evidence from Janssens et al. (2016).

A first group includes A. delicatula, A. tsaratanensis sp. nov., and A. confusa sp. nov. The first two species are similar in having ovaries with a reduced number of ovules per locule (respectively one and three ovules per locule of which only one develops into a seed; Figs 8D, 16E), pluricolporate pollen (Figs 4C, 11D), and seeds with a ventral groove (Fig. 5H, Q). This character combination is very rare within the Hedyotis-Oldenlandia complex in which species generally have multi-ovulate locules, tricorate pollen and seeds without a ventral groove (Groeninckx et al. 2009). Moreover, the two species have relatively large leaves, terminal inflorescences, flowers with a well-developed corolla tube, and broadly depressed obovoid capsules (Figs 8, 16). Their close relationship has also been confirmed by a molecular phylogenetic study (Janssens et al. 2016). Astiella confusa sp. nov. resembles A. delicatula and A. tsaratanensis sp. nov. in having a reduced number of ovules per locule (viz. three ovules per locule; Fig. 6D) and in having seeds with a ventral groove, a character that is lacking in other Astiella species.

A second group includes A. antsalovansis sp. nov. and A. pulla sp. nov. The two species resemble the first group in having a reduced number of ovules per locule (Figs 3E, 15E) and pluri-aperturate pollen (Fig. 4A). However, they differ from the first group by having seeds without a ventral groove (Fig. 5A). Their seeds also have a reticulate seed coat surface consisting of 5- to 6-angular testa cells with verruculate or favulariate microsculpturing (Fig. 5B). As seed and pollen characters have proven to be useful to delimit species and genera within Spermacoceae s. lat. (e.g. Dessein et al. 2003; Groeninckx et al. 2010b), it is appropriate to consider A. antsalovansis sp. nov. and A. pulla sp. nov. as sister species and most probably closely related to group one.

A third group includes A. antongilensis sp. nov., A. deblockiae sp. nov., A. desseinii sp. nov., A. homolleae sp. nov., A. latifolia sp. nov., and A. perrieri sp. nov. The species of this group are characterized by several ovules per locule (Figs 1D, 7E, 9F, 10E, 12E, 14E), tricorate pollen (Figs 4B, D, 11A–C), and seeds without a ventral groove (Fig. 5C, E, J, L, N). Except for A. antongilensis sp. nov., all species of this third group are also characterized by having pollen with a bireticulate tectum (Figs 4B, D, 11A–C). The molecular phylogenetic study supports the close relationship of these species and they form a monophyletic group (Janssens et al. 2016). Astiella desseinii sp. nov. and A. latifolia sp. nov. are morphologically more similar, as both have sessile flowers (Figs 9A, 12A), elongated placentas (Figs 9F, 12E), and ovoid capsules (Figs 9E, 12F). The latter two characters are exceptional in Astiella, where globose placentas and broadly depressed obovoid capsules are more common. Their pollen and seed morphology are also very similar: pollen is tricolporate with a microreticulate to reticulate suprareticulum
and a well-developed perforate to microreticulate infrareticulum with granules on the muri (Figs 4D, 11B), and the seeds are elliptic in outline, have a reticulate seed coat surface, testa cells with undulating radial walls and granulate microsculpturing (Fig. 5E–F, L–M). The other four species in the group, *A. antongilensis* sp. nov., *A. deblockiae* sp. nov., *A. homolleae* sp. nov., and *A. perrieri* sp. nov., are characterized by a reduced corolla tube with the stamens always exerted beyond the corolla throat (Figs 1B, 7B, 10B, 14B). The largest reduction is found in *A. antongilensis* sp. nov. and *A. homolleae* sp. nov.: their corolla tube is maximum 0.6 mm long. In *A. deblockiae* sp. nov., longistylous flowers have more reduced corolla tubes than brevistylous flowers (0.8–1 mm vs 1.5–2.2 mm). In *A. perrieri* sp. nov., corolla tubes can be up to 1.5 mm long.

The last species included in *Astiella* is *A. longifimbria* sp. nov.. It is morphologically similar to the species of group three because of the numerous ovules per locule (Fig. 13D). Also, it is characterized by long fimbriate stipules (Fig. 13A), a character observed in *A. homolleae* sp. nov. as well (Fig. 10A). *Astiella longifimbria* sp. nov., however, differs in having a well-developed corolla tube (Fig. 13B).

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