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Impatiens alboarenicola, a new species of Balsaminaceae from north-western Madagascar

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Abstract

A new species of *Impatiens*, *I. alboarenicola* (Balsaminaceae), is described and illustrated from Ankarafantsika National Park, north-western Madagascar. This species is similar to *I. barthlottii* and *I. tsingycola* in leaf and flower shape, but clearly distinguished from the former by its shorter stature, absence of a tuber at the stem base, solitary (rarely 2) flowers in the axils of leaves, and smaller flowers, and from the latter by its smaller leaf blades with fewer pairs of teeth on the dentate leaf margin, solitary (rarely 2) flowers in the axils of leaves, and saccate spur-like projection located at ca. 5 mm below the apex of the lower petal lobe of the lateral united petals (vs. at the apex of the lower petal lobe).

Key words: African flora, Ericales, plant taxonomy, seasonally dry tropical forest

Introduction

Impatiens Linnaeus (1753: 937) (Balsaminaceae) is a large genus comprising more than 1,100 species distributed in the Old World and North and Central America (POWO 2023). It has been known to have five hotspots in species richness, namely Southeast Asia and southwestern China, eastern to central Himalaya, southern India, tropical Africa, and Madagascar (Grey-Wilson 1980, 1989, Chen *et al.* 2007, Ruchisansakun *et al.* 2018).

In Madagascar, 186 species of *Impatiens* are accepted to date (POWO 2023). Among them, as many as 78 species have been discovered by recent intensive fieldwork and subsequent taxonomic studies since 2000 (Fischer & Rahelivololona 2002, Fischer *et al.* 2003, Fischer & Rahelivololona 2004, 2007a, b, Abrahamczyk & Fischer 2015, Fischer & Rahelivololona 2015a, b, c, 2016, Fischer 2016, Fischer *et al.* 2017, 2020), suggesting that the inventories are not enough and more species remain to be discovered in the region.

Ankarafantsika National Park, with an area of 136,513 ha, established in 1927, is one of the oldest national parks in Madagascar. It is located in Boeny Region, north-western Madagascar (Fig. 1), and the area is known as one of the largest remnants of the severely reduced dry forest (IUCN/UNEP/WWF 1987, Pons & Wendenburg 2005). Annual precipitation in the recent five years (2018–2022) is 1,154–1,957 mm, and the dry season (monthly precipitation < 10 mm) typically occurs from May to October (rainfall data provided by the Durrel Wildlife Conservation Trust in

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Ampijoroa, https://www.durrell.org). Monthly mean temperature generally ranges from ca. 23°C in July to ca. 28°C in October, with the annual mean being 25.4–26.1°C. A botanical survey was conducted in Jardin Botanique A, ca. 30-ha area dedicated to scientific research, on a gentle hill at an elevation from 140 to 200 m. Topsoil is coarse white sand, which is quick to drain and infertile (Lourenço & Goodman 2006). The canopy layer normally appears at 10–15 m high, consisting of both deciduous and evergreen species (Ramangason 1988, Fujimoto *et al.* 2024).

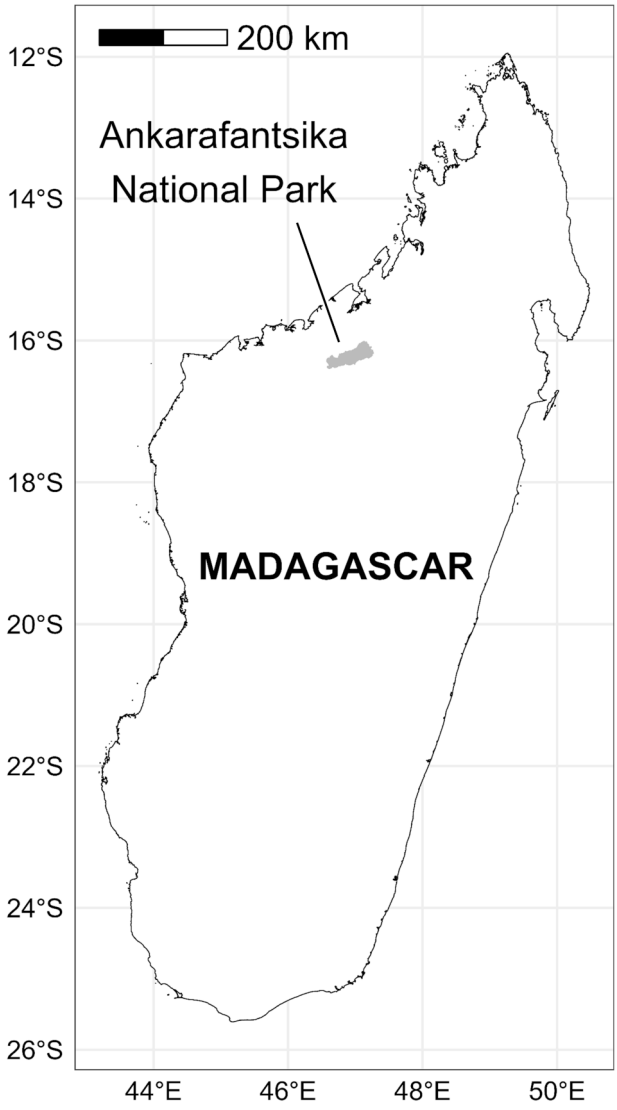

FIGURE 1. Location of Ankarafantsika National Park.

During our botanical inventories in the above area in 2023, an unknown species of *Impatiens* was collected. After careful examination with reference to herbarium specimens at Herbs. DBEV, KAG, and TAN (herbarium codes follow Thiers 2024), digital specimen images available online (e.g., JSTOR Global Plants, https://plants.jstor.org), and relevant literature (Perrier de la Bâthie 1934, 1948, Fischer & Rahelivololona 2002, Fischer *et al.* 2003, Fischer & Rahelivololona 2004, 2007a, b, Abrahamczyk & Fischer 2015, Fischer & Rahelivololona 2015a, b, c, 2016, Fischer 2016, Fischer *et al.* 2017, 2020), it was clear that the species was as yet undescribed. It is formally described below.

Taxonomy

Impatiens alboarenicola Y.Fujimoto, Rabarison & Tagane, *sp. nov*. (Figs 2 & 3)

TYPE:—MADAGASCAR. Boeny Region: Marovoay District, Ankarafantsika National Park, 16.31722°S, 46.81053°E, 152 m elev., 20 February 2023, *S. Tagane & H. Rabarison A261* (holotype DBEV!; isotypes KAG [KAG184161!], TAN!).

Diagnosis:—*Impatiens alboarenicola* is similar to *I. barthlottii* Fischer & Rahelivololona (2007a: 272) of Madagascar in leaf and flower shape, but clearly distinguished from it by its shorter stature of 5.3–18.5 cm tall (vs. 20–70 cm tall in *I. barthlottii*), absence of a tuber at the stem base (vs. presence, with elongate tuber), solitary (rarely 2) flowers in the axils of leaves (vs. with 2 flowers), and smaller light purple to pale purple flowers of 1.3–1.8 cm long (vs. white, 2.3–2.5 cm long). It is also similar to *I. tsingycola* Fischer & Rahelivololona (2007a: 274) of Madagascar in its short stature, leaf shape, and petal colour, but different in having smaller leaf blades (7–)16–41(–64) mm long (vs. 55–81 mm long in *I. tsingycola*), (1–)7–9(–11) pairs of teeth on the dentate leaf margin (vs. 15–21 pairs), solitary (rarely 2) flowers in the axils of leaves (vs. 2–3 flowers), and saccate spur-like projection located at ca. 5 mm below the apex of the lower petal lobe of the lateral united petals (vs. at the apex of the lower petal lobe).

Annual herb, 5.3–18.5 cm tall, glabrous except adaxial surface of lamina. **Stems** erect, succulent, pale brown to reddish-brown *in vivo*, often dark blue to dark purple *in sicco*, not branched or rarely branched, without tuber at base. **Leaves** alternate, petiolate; petiole pale brown to reddish-brown, (7.5–)12–20(–46) mm long, with extrafloral nectaries; lamina ovate-triangular, ovate, elliptic-ovate, (7–)16–41(–64) × (4–)10–27(–43) mm, adaxial surface covered with short white hairs, abaxial surface glabrous, apex acute, base cuneate to acute, slightly decurrent, margin dentate, teeth (1–)7–9(–11) on each side, with gland-tipped appendages, secondary veins (3–)4–6(–8) pairs, tertiary veins indistinct on both surfaces. **Flowers** light purple to pale purple with yellow spots on lateral united petals and with spur, 1.3–1.8 cm long. **Pedicels** 18–25 mm long. **Bracts** narrowly triangular, 0.9 × 0.5 mm, apex acute. **Lateral sepals** 2, lanceolate, 2.5–3.0 × 0.5–1.0 mm, apiculate, shallowly cucullate. **Lower sepal** navicular, 8 × 3 mm, apex acuminate, spur obtuse, 4.0–4.5 mm long, strongly curved. **Dorsal petal** cucullate, 5.0–6.5 × 2.5–4.5 mm, apex rounded to emarginate, often with apicule 0.5 mm long. **Lateral united petals** 10–13 mm long, upper petal lobe rounded, 4.5–6.5 × 2.0–3.5 mm, lower petal lobe suborbicular, 10–13 × 3.5–5.0 mm, with yellow, 1 mm long, saccate spur-like projection at ca. 5 mm below apex. **Anthers** ca. 2 mm long. **Ovary** 1.5 mm long, light greenish-yellow *in vivo*, style cone-shaped, 0.2 mm long, stigma acute. **Fruits** fusiform, 3.0–7.5 × 1.0–2.5 mm, slightly recurved, green *in vivo*. **Seeds** 12 per capsule, ellipsoid, 1–2 mm long, brown to yellowish-brown, apex acute.

Other specimens examined:—MADAGASCAR. Boeny Region: Marovoay District, Ankarafantsika National Park, 16.32035°S, 46.81037°E, 175 m elev., 18 February 2023, with flowers, *S. Tagane et al. A190* (DBEV, KAG [KAG184090], TAN); ibid., 16.32048°S, 46.81055°E, 22 March 2023, with flowers, *Y. Fujimoto A339* (DBEV); ibid., 16.32048°S, 46.81055°E, 27 March 2023, with flowers in a spirit collection and fruits, *Y. Fujimoto A340* (DBEV).

Distribution:—Madagascar (thus far known only from Ankarafantsika National Park) (Fig. 1).

Habitat:—In the semi-shaded understory of seasonally dry tropical forest on white sand, 140–200 m elev. The forests are dominated by *Baudouinia fluggeiformis* Baillon (1868: 201), *Bussea perrieri* Viguier (1949: 355), *Dalbergia greveana* Baillon (1884: 436) (Fabaceae), *Drypetes perrieri* Leandri (1939: 194) (Putranjivaceae), *Noronhia alleizettei* Dubard (1907: 551) (Oleaceae), *Cassipourea lanceolata* Tulasne (1856: 121) (Rhizophoraceae), *Rhopalocarpus similis* Hemsley (1903: t. 2774) (Sphaerosepalaceae), and *Pyrostria ampijoroensis* (Arènes 1960: 24) Razafimandimbison *et al.* (2007: 519) (Rubiaceae) (Fujimoto *et al.* 2024).

Phenology:—Flowering at the end of February to March, fruiting in March.

Etymology:—The epithet *alboarenicola* refers to the white sand habitat of the new species.

Vernacular name:—*Kivolanala kely* or *rangy kely*, suggested here. *Kivolanala* and *rangy* in Madagascar refer to *Impatiens* species. *Kely* means small, referring to the plant size of *I. alboarenicola*.

Preliminary conservation assessment:—Critically Endangered (CR). *Impatiens alboarenicola* is known from a single location, Jardin Botanique A of the Ankarafantsika National Park. The number of mature individuals is estimated fewer than 50. It is likely to have more subpopulations in the region, but a large area of seasonally dry tropical forests around Ankarafantsika has disappeared (Schüßler *et al.* 2023). The present habitat is within the protected area of the national park. However, forest fires have often occurred, which might gradually reduce the habitat of *I. alboarenicola*. Given this situation, it is assessed as CR, according to the IUCN criterion D (IUCN 2012).

Note:—*Impatiens alboarenicola* is morphologically classified into the *Impatiens* subgen. *Impatiens sensu* Fischer and Rahelivololona (2002) because of the lower sepal with a spur and the petiole with extrafloral nectaries (Fischer & Rahelivololona 2007a, b). Within the *I.* subgen. *Impatiens*, *I. alboarenicola* belongs to the section *Uniflorae* Hooker & Thomson (1859: 113), based on its short-fusiform capsules, conspicuously turgid at the middle, and fascicled inflorescence with 1 to 2 flowers (Yu *et al.* 2016). However, recent molecular phylogenetic analyses based on nuclear and plastid markers demonstrated that the species of Malagasy *I.* subgen. *Impatiens* was not a monophyletic group (Rahelivololona *et al.* 2018). Further analysis including *I. alboarenicola* is necessary to clarify its phylogenetic and taxonomic position.

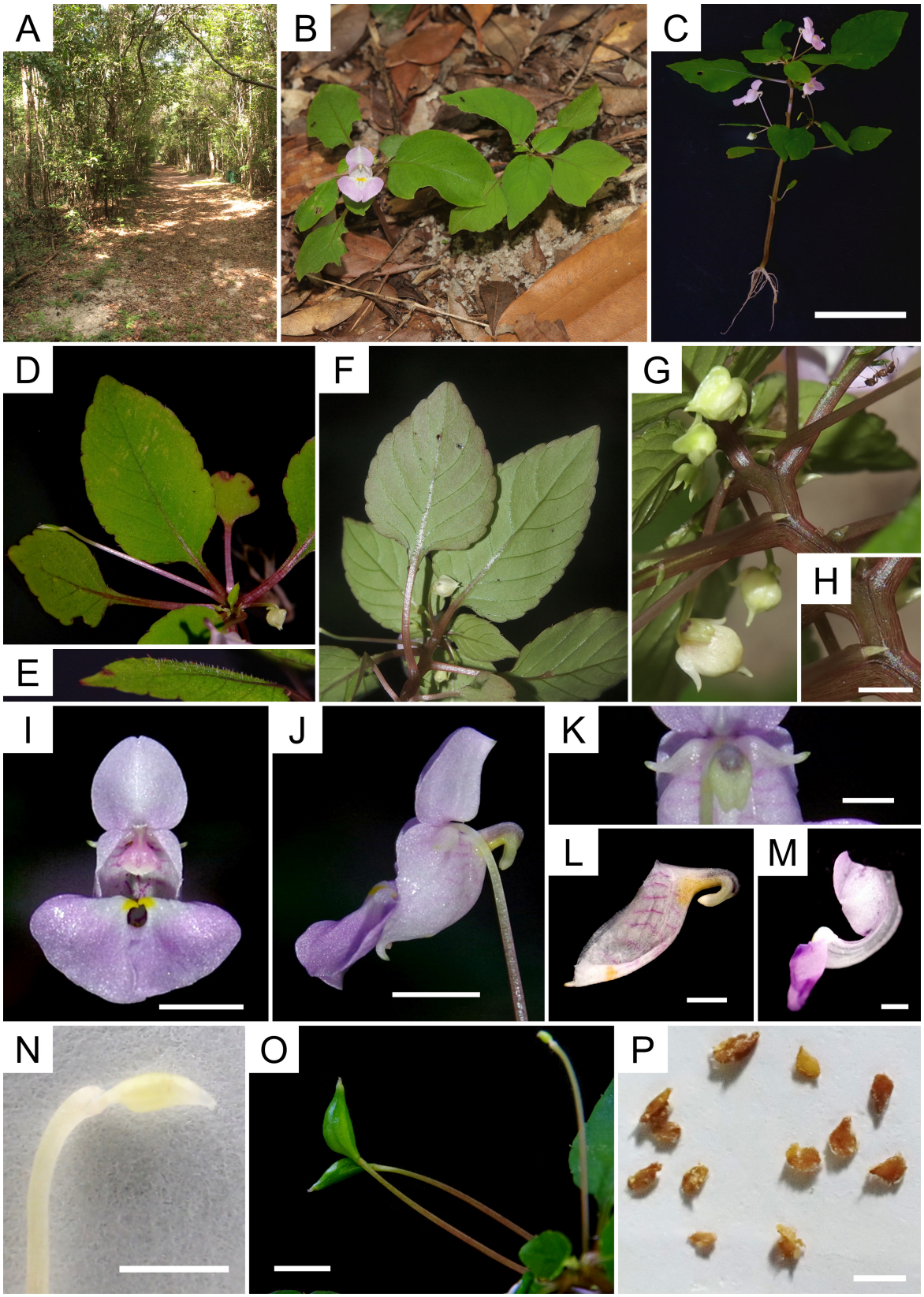

FIGURE 2. *Impatiens alboarenicola* Y.Fujimoto, Rabarison & Tagane. A. Habitat. B. Habit. C. Entire plant body. D. Adaxial leaf surface. E. Hairs on an adaxial leaf surface. F. Abaxial leaf surface. G. Flower buds. H. Bract. I. Flower (front view, male stage). J. Flower (lateral view). K. Lateral sepals. L. Lower sepal with spur (lateral view). M. Lateral united petal (lateral view). N. Ovary. O. Fruits. P. Seeds. Photos: A and F–H from *S. Tagane et al. A261*; B from *S. Tagane et al. A190*; D from *Y. Fujimoto A339*; C, E, and I–P from *Y. Fujimoto A340*. Scale bars: C = 5 cm; I, J, and O = 5 mm; H, K–N, and P = 2 mm. Photographed by S. Tagane (A, B, and F–H), Y. Fujimoto (C–E and I–O), and W. Noyori (P).

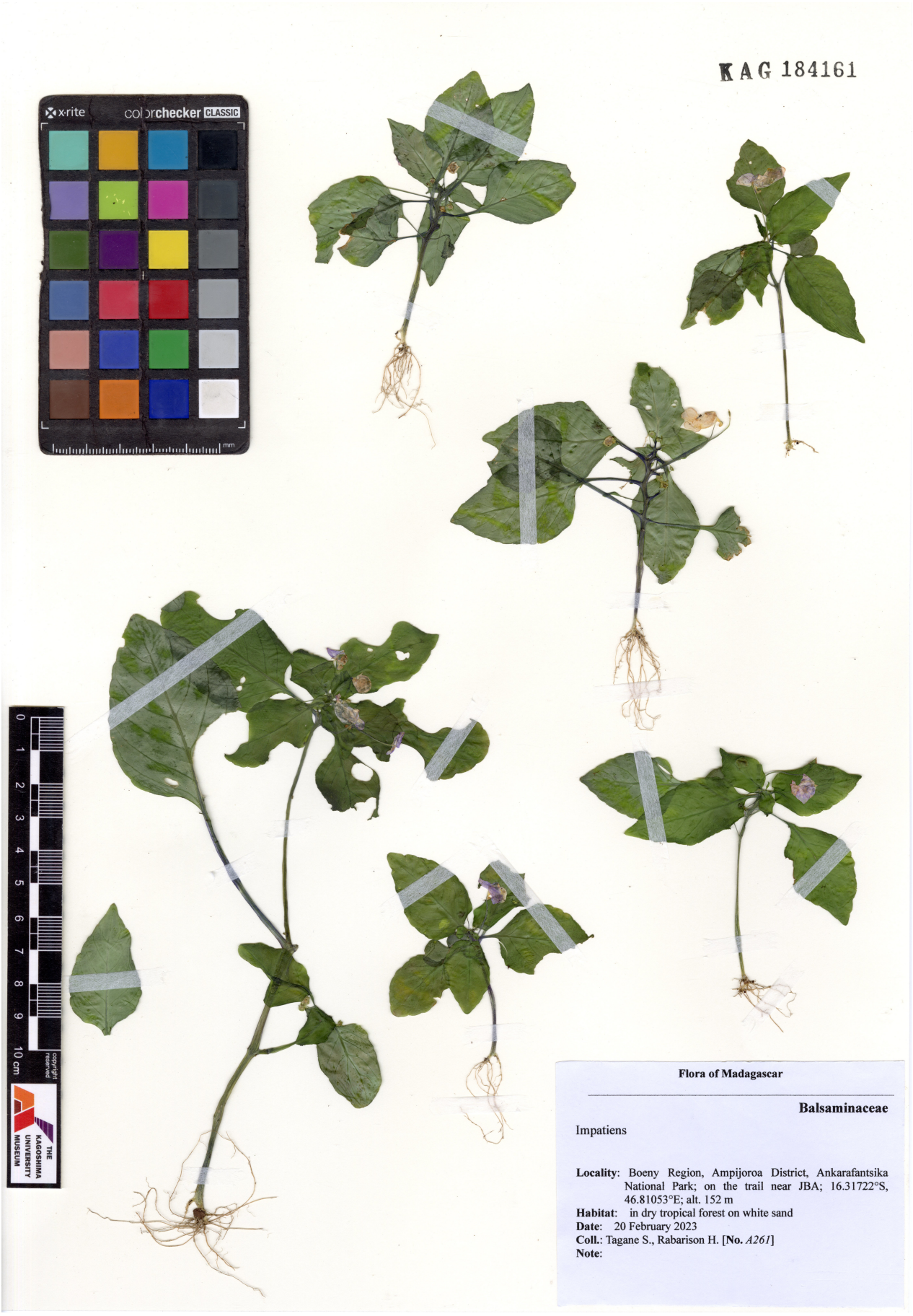

FIGURE 3. Isotype of *Impatiens alboarenicola* Y.Fujimoto, Rabarison & Tagane (KAG184161).

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References

Abrahamczyk, S. & Fischer, E. (2015) *Impatiens elianae* (Balsaminaceae), a new species from central Madagascar, with notes on the taxonomic relationship of *I. lyallii* and *I. trichoceras*. *Phytotaxa* 226: 83–91. https://doi.org/10.11646/phytotaxa.226.1.8

Arènes, J. (1960) A propos de quelques genres Malgaches de Rubiacées (Vanguériées et Gardenieés). *Notulae Systematicae, Herbier du Muséum de Paris Phanérogamie* 16: 6–41. Available from: https://www.biodiversitylibrary.org/page/12869550#page/12/mode/1up (accessed 28 May 2024)

Baillon, H.E. (1868) Stirpes exoticae novae. *Adansonia* 8: 198–203. Available from: https://www.biodiversitylibrary.org/page/6166394#page/201/mode/1up (accessed 28 May 2024)

Baillon, H.E. (1884) Liste des plantes de Madagascar (suite de la p. 416): Leguminosae. *Bulletin Mensuel de la Société Linnéenne de Paris* 1 (55): 436–440. Available from: https://www.biodiversitylibrary.org/page/11016974#page/31/mode/1up (accessed 28 May 2024)

Chen, Y., Akiyama, S. & Ohba, H. (2007) Balsaminaceae. *In*: Wu, Z.Y., Raven, P.H. & Hong, D.Y. (Eds.) *Flora of China*, vol. 12. Science Press, Beijing and Missouri Botanical Garden Press, St. Louis, pp. 43–114.

Dubard, M.M. (1907) Sur quelques espéces nouvelles du genre *Noronhia*. *Bulletin du Muséum National d'Histoire Naturelle* 13: 549–551. Available from: https://www.biodiversitylibrary.org/item/27212#page/599/mode/1up (accessed 28 May 2024)

Fischer, E. (2016) *Impatiens hedbergiae* (Balsaminaceae), a new species from the Tsaratanana Massif, Madagascar. *Symbolae Botanicae Upsalienses* 38: 133–138.

Fischer, E., Rahelivololona, E.M. & Killmann, D. (2020) *Impatiens serusiauxii* (Balsaminaceae), a new species from Marojejy National Park, Madagascar. *Plant and Fungal Systematics* 65: 134–138. https://doi.org/10.35535/pfsyst-2020-0008

Fischer, E. & Rahelivololona, M.E. (2002) New taxa of *Impatiens* (Balsaminaceae) from Madagascar. I. *Adansonia* 24: 271–294.

Fischer, E. & Rahelivololona, M.E. (2004) New taxa of *Impatiens* (Balsaminaceae) from Madagascar. III. *Adansonia* 26: 37–52.

Fischer, E. & Rahelivololona, M.E. (2007a) New taxa of *Impatiens* (Balsaminaceae) from Madagascar. IV. *Adansonia* 29: 269–315.

Fischer, E. & Rahelivololona, M.E. (2007b) New taxa of *Impatiens* (Balsaminaceae) from Madagascar. V. New species of *Impatiens* from Masoala Peninsula. *Adansonia* 29: 317–332.

Fischer, E. & Rahelivololona, M.E. (2015a) New taxa of *Impatiens* (Balsaminaceae) from Madagascar VI. *Impatiens otto-eleonorae*, a new species from Masoala Peninsula, and notes on the taxonomic relationships of *Impatiens firmula* and *I. hildebrandtii*. *Phytotaxa* 217 (2): 155–163. https://doi.org/10.11646/phytotaxa.217.2.5

Fischer, E. & Rahelivololona, M.E. (2015b) New taxa of *Impatiens* (Balsaminaceae) from Madagascar VII. Two new species of *Impatiens* from Mt. Marojejy, Madagascar. *Phytotaxa* 239 (3): 213–222. https://doi.org/10.11646/phytotaxa.239.3.2

Fischer, E. & Rahelivololona, M.E. (2015c) New taxa of *Impatiens* (Balsaminaceae) from Madagascar IX. *Impatiens lutzii*, a new species from Montagne d'Ambre National Park. *Phytotaxa* 239 (2): 183–189. https://doi.org/10.11646/phytotaxa.239.2.7

Fischer, E. & Rahelivololona, M.E. (2016) New taxa of *Impatiens* (Balsaminaceae) from Madagascar VIII. *Impatiens max-huberi*, a new species from Marojejy and Anjanaharibe-Sud. *Phytotaxa* 244 (2): 191–195. https://doi.org/10.11646/phytotaxa.244.2.7

Fischer, E., Rahelivololona, M.E. & Abrahamczyk, S. (2017) *Impatiens galactica* (Balsaminaceae), a new spurless species of section *Trimorphopetalum* from Madagascar. *Phytotaxa* 298 (3): 269–276. https://doi.org/10.11646/phytotaxa.298.3.6

Fischer, E., Wohlhauser, S. & Rahelivololona, M.E. (2003) New taxa of *Impatiens* (Balsaminaceae) from Madagascar. II. A collection from Masoala Peninsula. *Adansonia* 25: 17–31.

Fujimoto, Y., Kaneko, T., Sato, H., Rakotomamonjy, A.H., Razafiarison, Z.L. & Kitajima, K. (2024) Topographical gradient of the structure and diversity of a woody plant community in a seasonally dry tropical forest in northwestern Madagascar. *Ecological Research*. https://doi.org/10.1111/1440-1703.12475

Grey-Wilson, C. (1980) *Impatiens of Africa: Morphology, pollination and pollinators, ecology, phytogeography, hybridisation, keys and a systematic treatment of all African species with a note on collecting and cultivation*. A.A. Balkema, Rotterdam, 235 pp.

Grey-Wilson, C. (1989) A revision of Sumatran *Impatiens*: Studies in Balsaminaceae: VIII. *Kew Bulletin* 44 (1): 67–106. https://doi.org/10.2307/4114646

Hemsley, W.B. (1903) *Hooker's Icones Plantarum; or figures, with brief descriptive characters and remarks of new or rare plants.* Series 4, vol. 8: t. 2774. Available from: https://www.biodiversitylibrary.org/page/16049230#page/178/mode/1up (accessed 28 May 2024)

Hooker, J.D. & Thomson, T. (1859) Praecursores ad Floram Indicam.—Balsamineae. *Journal of the Proceedings of the Linnean Society. Botany* 4: 106–157. Available from: https://www.biodiversitylibrary.org/item/8353#page/327/mode/1up (accessed 28 May 2024)

IUCN. (2012) *IUCN Red List categories and criteria, version 3.1, second edition*. IUCN Species Survival Commission (SSC), Gland and Cambridge, 32 pp.

IUCN/UNEP/WWF. (1987) *Madagascar, an environmental profile*. IUCN, Gland and Cambridge, 374 pp.

Leandri, J. (1939) Contribution a l'étude des Euphorbiacées de Madagascar. I. Phyllanthées (suite). *Notulae Systematicae, Herbier du Muséum de Paris Phanérogamie* 7 (4): 168–197. Available from: https://www.biodiversitylibrary.org/item/7374#page/406/mode/1up (accessed 28 May 2024)

Linnaeus, C. (1753) *Species Plantarum: exhibentes plantas rite cognitas, ad genera relatas, cum differentiis specificis, nominibus trivialibus, synonymis selectis, locis natalibus, secundum systema sexuale digestas (1st. ed.)*. Laurentius Salvius, Stockholm, 1200 pp.
https://doi.org/10.5962/bhl.title.37656

Lourenço, W.R. & Goodman, S.M. (2006) Notes on the postembryonic development and ecology of *Grosphus hirtus* Kraepelin, 1901 (Scorpiones, Buthidae) from the Parc National d'Ankarafantsika, northwest Madagascar. *Zoologischer Anzeiger* 244: 181–185. https://doi.org/10.1016/j.jcz.2005.09.001

Perrier de la Bâthie, H. (1934) Les Impatiens de Madagascar. *Archives de Botanique. Mémoires* 7 (1): 1–124.

Perrier de la Bâthie, H. (1948) Révision des Impatiens de Madagascar et des Comores. *Memoires de l'Academie des Sciences (Paris)*, Sér. 2, 67: 1–16.

Pons, P. & Wendenburg, C. (2005) The impact of fire and forest conversion into savanna on the bird communities of West Madagascan dry forests. *Animal Conservation* 8 (2): 183–193. https://doi.org/10.1017/S1367943005001940

POWO. (2023) *Plants of the World Online*. Royal Botanic Gardens, Kew. Available from: http://www.plantsoftheworldonline.org/ (accessed 7 July 2023)

Rahelivololona, E.M., Fischer, E., Janssens, S.B. & Razafimandimbison, S.G. (2018) Phylogeny, infrageneric classification and species delimitation in the Malagasy *Impatiens* (Balsaminaceae). *PhytoKeys* 110: 51–67. https://doi.org/10.3897/phytokeys.110.28216

Ramangason, G.S. (1988) Flore et végétation de la Forêt d'Ampijoroa. *In*: Rakotovao, L., Barre, V. & Sayer, J. (Eds.) *L'équilibre des écosystèmes forestiers à Madagascar*. IUCN, Gland and Cambridge, pp. 130–137.

Razafimandimbison, S., Lantz, H. & Bremer, B. (2007) New combinations and names in *Peponidium* and *Pyrostria* (Rubiaceae, Vanguerieae). *Novon* 17 (4): 516–521. https://doi.org/10.3417/1055-3177(2007)17[516:NCANIP]2.0.CO;2

Ruchisansakun, S., Suksathan, P., Van der Niet, T., Smets, E.F., Saw-Lwin & Janssens, S.B. (2018) Balsaminaceae of Myanmar. *Blumea* 63 (3): 199–267. https://doi.org/10.3767/blumea.2018.63.03.01

Schüßler, D., Andriamalala, Y.R., Van der Bach, R., Katzur, C., Kolbe, C., Maheritafika, M.H.R., Rasolozaka, M., Razafitsalama, M., Renz, M., Steffens, T.S., Radespiel, U. & Brenner, J. (2023) Thirty years of deforestation within the entire ranges of nine endangered lemur species (3 CR, 4 EN, 2 VU) in northwestern Madagascar. *Ecotropica* 25 (1/2): a202304 [10 pp.]. https://doi.org/10.30427/ecotrop202304

Thiers, B. (2024) *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. Available from: https://sweetgum.nybg.org/science/ih/ (accessed 24 April 2024)

Tulasne, L.R. (1856) Florae Madagascariensis. *Annales des Sciences Naturelles, Botanique*, sér. 4, 6: 75–138.

Viguier, R. (1949) Leguminosae Madagascariensis Novae. *Notulae Systematicae, Herbier du Muséum de Paris Phanérogamie* 13: 333–369. Available from: https://www.biodiversitylibrary.org/page/7774954#page/623/mode/1up (accessed 28 May 2024)

Yu, S.-X., Janssens, S.B., Zhu, X.-Y., Lidén, M., Gao, T.-G. & Wang, W. (2016) Phylogeny of *Impatiens* (Balsaminaceae): integrating molecular and morphological evidence into a new classification. *Cladistics* 32 (2): 179–197. https://doi.org/10.1111/cla.12119