



Taxonomic revision of the Malagasy endemic and enigmatic *Euphorbia* section *Pachysanthes* (Euphorbiaceae)

XAVIER AUBRIOT^{1,2}, PORTER P. LOWRY II^{1,3} & THOMAS HAEVERMANS¹

¹ISYEB, Institut de Systématique, Évolution, Biodiversité (UMR 7205 CNRS, MNHN, EPHE, UPMC), Muséum national d'histoire naturelle, National Herbarium, CP 39, 57 rue Cuvier, 75231 Paris CEDEX 05, France.

E-mail: aubriot@mnhn.fr; lowry@mnhn.fr; haever@mnhn.fr

²Department of Life Sciences, Natural History Museum, Cromwell Road, London SW7 5BD, England, UK.

E-mail: x.aubriot@nhm.ac.uk (corresponding author)

³Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166-0299, USA. E-mail: pete.lowry@mobot.org

Abstract

Among the more than 170 species of *Euphorbia* (Euphorbiaceae, Malpighiales) that occur in Madagascar, some remain poorly known and dramatically under-collected, and are based on vague and incomplete descriptions. As part of an ongoing study of the genus in Madagascar, a revision is presented of *E.* section *Pachysanthes*, which comprises six species endemic to this island that show clear morphological affinities to one another. Expanded descriptions are provided for the four species already named, and the two others are described as new (*Euphorbia haevermansii* and *Euphorbia nusbaumeri*), both from the Daraina region in north-eastern Madagascar. An identification key is provided to the species, which are characterized by having developed leaves, unarmed twigs (unlike most of Malagasy *Euphorbia*), leafy deciduous cyathophylls, and ecarunculate seeds. Members of the section differ from one another in their geographical distribution, habit, and the shape and the size of their leaves, glands, cyathia and cyathophylls, as well as the size, surface and number of locules of the fruits. The morphological affinities of these six species are discussed and preliminary conservation assessments are provided.

Introduction

The genus *Euphorbia* Linnaeus (1753: 450) (Euphorbiaceae, Malpighiales) is a giant among flowering plants: it has a worldwide distribution and comprises about 2000 species and infraspecific taxa (Haevermans 2003, Mabberley 2008). The island of Madagascar, with at least 170 taxa of *Euphorbia*, almost all endemic (Haevermans 2003), stands out as one of the main hotspots of the genus. Despite this remarkable diversity, the most recent global revision of the genus dates from the 19th century (Boissier 1862). Results from recent molecular phylogenetic analyses, based on both nuclear and plastid markers, have revealed many monophyletic groups and shown that traditional infrageneric systems of classification in large part fail to reflect evolutionary relationships (Steinmann & Porter 2002, Haevermans 2003, Bruyns *et al.* 2006, Zimmermann *et al.* 2010, Dorsey *et al.* 2013). These phylogenetic studies, however, provide a framework for an ongoing series of taxonomic revisions of well supported, monophyletic groups. The present paper focuses on a distinctive clade endemic to Madagascar, *E.* section *Pachysanthes* X.Aubriot & Haev. in Dorsey *et al.* (2013: 309). Although poorly sampled in the above-mentioned phylogenetic studies, this clade nevertheless forms a coherent group, both morphologically and geographically. It comprises four described species of trees [viz. *E. elastica* Jumelle (1905a: 1047), *E. mananarensis* Leandri (1945: 69), *E. mandravioky* Leandri (1957: 499) and *E. pachysantha* Baillon (1886: 624)] that share several features, including more or less pachycaul trunks, developed leaves, unarmed twigs, leafy deciduous cyathophylls and ecarunculate seeds.

When Baillon described *Euphorbia pachysantha* in 1886, he placed it in the highly heterogeneous group *E.* section *Goniostema* Baill. ex Boissier (1862: 10). This section, lectotypified *a posteriori* with *E. lophogona*

Conservation status:—*Euphorbia pachysantha* has an Extent of Occurrence (EOO) of ca. 16,100 km², an Area of Occupancy (AOO) of 54 km², and is known from six fragmented subpopulations (none of which occurs within the protected area network). This species has not been collected in 50 years. Consequently, we have assigned a preliminary status of “Endangered” [(EN B2ab(i,ii,iii))] based on the IUCN Red List Categories and Criteria (IUCN 2012).

Notes:—Considering that Rauh (1996) recently published detailed photos of a living specimen of *Euphorbia pachysantha*, we have refrained from including a line drawing as it would not have provided any new information.

Acknowledgments

The authors wish to thank the CNRE (Centre National de Recherche sur l’Environnement, Antananarivo, Madagascar), MNP (Madagascar National Parks) and the local office of the Missouri Botanical Garden (MO) in Antananarivo for assistance during fieldwork and for help with obtaining permits. We are much indebted to Louis Nusbaumer (G) and Laurent Gautier (G) for their advice and assistance in preparing fieldwork in northern Madagascar. We also wish to thank Agathe Haevermans (P) for the fine drawings and Zachary Rogers (MO) for performing some fruit dissections. Paul Berry is acknowledged for his invaluable advice and recommendations. We are grateful to the curators of the following herbaria for access to their collection: G, K, MICH, MO, P, TAN. Financial support for fieldwork was provided by the PPF MNHN “Taxonomie moléculaire: DNA Barcode & gestion durable des collections”, Sud-Expert-Plantes Programme # 382, and an ANR EVORANGE 6^{ème} extinction grant (ANR-09-PEXT-011). Finally, we are grateful to the two anonymous reviewers and to Hans-Joachim Esser for their valuable comments and suggestions, which helped improve our manuscript.

References

- Altamirano, F. & Rose, J.N. (1905) El Palo Amarillo. *Anales del Instituto Médico-Nacional México* 7: 323–329.
- Aubriot, X. (2012) *Radiations évolutives, “innovations clés” et notions d’espèces dans le genre Euphorbia L. à Madagascar*. Ph.D. dissertation. Muséum national d’histoire naturelle, Paris, 251 pp.
- Baillon, H.E. (1886) Liste de plantes de Madagascar. *Bulletin Mensuel de la Société Linnéenne de Paris* 1: 614–616, 623–624.
- Bentham, G. & Hooker, J.D. (1880) *Genera Plantarum* 3(1). L. Reeve & Co., London, 459 pp.
<http://dx.doi.org/10.5962/bhl.title.747>
- Boissier, P.E. (1862) Euphorbiaceae subordo I. Euphorbieae. In: Candolle, A.P. de (ed.) *Prodromus Systematis Naturalis Regni Vegetabilis* 15(2). Sumptibus Sociorum Treuttel et Würtz, Paris, pp. 3–188.
- Boissier, P.E. (1866) Euphorbiaceae subordo I. Euphorbieae. (Addenda et Corrigenda). In: Candolle, A.P. de (ed.) *Prodromus Systematis Naturalis Regni Vegetabilis* 15(2). Sumptibus Sociorum Treuttel et Würtz, Paris, pp. 1261–1269.
<http://dx.doi.org/10.5962/bhl.title.286>
- Bruyns, P.V., Mapaya, R.J. & Hedderson, T. (2006) A new subgeneric classification for *Euphorbia* (Euphorbiaceae) in southern Africa based on ITS and *psbA-trnH* sequence data. *Taxon* 55: 397–420.
<http://dx.doi.org/10.2307/25065587>
- Callmander, M.W., Schatz, G.E., Lowry II, P.P., Laivao, M.O., Raharimampionona, J., Andriambololona, S., Raminosoa, T. & Consiglio, T.K. (2007) Identification of priority areas for plant conservation in Madagascar using Red List criteria: rare and threatened Pandanaceae indicate sites in need of protection. *Oryx* 41(2): 168–176.
<http://dx.doi.org/10.1017/s0030605307001731>
- CHG (2013) *Catalogue des herbiers de Genève*. Conservatoire & Jardin botaniques de la Ville de Genève, Genève. Available from: <http://www.ville-ge.ch/musinfo/bd/cjb/chg/> (accessed: 04 December 2013).
- Croizat, L. (1972) An introduction to the subgeneric classification of “*Euphorbia*” L., with stress on the South African and Malagasy species. III. *Webbia: Journal of Plant Taxonomy and Geography* 27(1): 1–221.
<http://dx.doi.org/10.1080/00837792.1972.10669972>
- Denis, M. (1921) *Les Euphorbiées des îles australes d’Afrique*. Imprimerie Nemourienne A. Lescot, Nemours, 149 pp.
<http://dx.doi.org/10.5962/bhl.title.36553>
- Dorsey, B.L., Haevermans, T., Aubriot, X., Morawetz, J.J., Riina, R., Steinmann, V.W. & Berry, P.E. (2013) Phylogenetics, morphological evolution, and classification of *Euphorbia* subgenus *Euphorbia*. *Taxon* 62: 291–315.
<http://dx.doi.org/10.12705/622.1>
- Haevermans, T. (2003) *Le genre Euphorbia à Madagascar: phylogénie moléculaire et systématique*. Ph.D. dissertation. Muséum national d’histoire naturelle, Paris, 162 pp.
- Horn, J.W., Van Ee, B.W., Morawetz, J.J., Riina, R., Steinmann, V.W., Berry, P.E. & Wurdack, K.J. (2012) Phylogenetics and

- the evolution of major structural characters in the giant genus *Euphorbia* L. (Euphorbiaceae). *Molecular Phylogenetics and Evolution* 63: 305–326.
<http://dx.doi.org/10.1016/j.ympev.2011.12.022>
- IUCN (2012) *IUCN Red List Categories and Criteria: Version 3.1. Second edition*. IUCN, Gland & Cambridge, iv + 32 pp.
- Jumelle, H.L. (1905a) Une nouvelle euphorbe à caoutchouc. *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences* 140: 1047–1049.
- Jumelle, H.L. (1905b) Deux nouvelles plantes à caoutchouc de Madagascar. *Le Caoutchouc & la Gutta-Percha* 3: 207–210.
- Lamarck, J.B.P.A.M. de (1788) *Encyclopédie méthodique, Botanique* 2. C.J. Panckoucke, Liège, 774 pp.
<http://dx.doi.org/10.5962/bhl.title.824>
- Leandri, J.D. (1945) Contribution à l'étude des euphorbiacées de Madagascar. IX. Groupe de l'*Euphorbia pyrifolia* et observations sur la section *Goniostema. Notulae Systematicae* 12: 64–79.
- Leandri, J.D. (1956) Euphorbiacées malgaches nouvelles récoltées par M. R. Capuron. *Bulletin de la Société Botanique de France* 103(9–10): 604–608.
- Leandri, J.D. (1957) *Euphorbia mandravioky*, nom. nov., et un nom nouveau pour une sous-section du genre euphorbe. *Bulletin de la Société Botanique de France* 104: 499–501.
- Linnaeus, C. (1753) *Species Plantarum*. Laurentius Salvius, Stockholm, 1200 pp.
<http://dx.doi.org/10.5962/bhl.title.669>
- Mabberley, D.J. (2008) *Mabberley's Plant-Book, edition 3*. Cambridge University Press, Cambridge, 1021 pp.
- Marloth, H.W.R. (1910) Some new South African Succulents. Part III. *Transactions of the Royal Society of South Africa* 2: 33–39.
<http://dx.doi.org/10.1080/00359191009519359>
- Pax, F.A. (1894) Euphorbiaceae africanae. II. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 19: 76–127.
- Poisson, H.L. & Pax, F.A. (1902) Sur trois espèces cactiformes d'Euphorbes de la côte occidentale d'Afrique. *Bulletin du Muséum national d'histoire naturelle* 8: 60–62.
- Rauh, W. (1996) *Euphorbia pachysantha* Baillon, a remarkable and little-known arborescent *Euphorbia* from Madagascar. *Cactus and Succulent Journal* 68: 35–39.
- Schatz, G.E. & Lescot, M. (2005) *Gazetteer to Malagasy Botanical Collecting Localities*. Available from: <http://www.mobot.org/mobot/research/madagascar/gazetteer/> (accessed: 04 December 2013).
- Sonnerat/BryoMyco (2013) *Herbarium specimens*. Muséum national d'histoire naturelle, Paris. Available from: <http://science.mnhn.fr/institution/mnhn/search> (accessed: 04 December 2013).
- Steinmann, V.W. & Porter, M. (2002) Phylogenetic relationships in Euphorbieae (Euphorbiaceae) based on ITS and *ndhF* sequence data. *Annals of the Missouri Botanical Garden* 89: 453–490.
<http://dx.doi.org/10.2307/3298591>
- Ursch, E. & Leandri, J.D. (1954) Les euphorbes malgaches épineuses et charnues du Jardin botanique de Tsimbazaza. *Mémoires de l'Institut scientifique de Madagascar, série B, Biologie végétale* 5: 109–186.
- Wheeler, L.C. (1943) The genera of the living Euphorbieae. *American Midland Naturalist* 30: 456–503.
<http://dx.doi.org/10.2307/2421292>
- Zimmermann, N.F.A., Ritz, C.M. & Hellwig, F.H. (2010) Further support for the phylogenetic relationships within *Euphorbia* L. (Euphorbiaceae) from nrITS and *trnL-trnF* IGS sequence data. *Plant Systematics and Evolution* 286: 39–58.
<http://dx.doi.org/10.1007/s00606-010-0272-7>