Operculicarya (Anacardiaceae) revisited: an updated taxonomic treatment for Madagascar and the Comoro Islands, with descriptions of two new species

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ABSTRACT
A taxonomic revision of *Operculicarya* H.Perrier (Anacardiaceae) in Madagascar and the Comoro Islands is presented. Eight species are recognized, seven endemic to Madagascar, two of which (*O. capuronii* and *O. multijuga*) are described as new and illustrated. The two new species are distinguished by the size of their leaves and leaflets, and the structure of their inflorescences. A slightly expanded circumscription of the genus is adopted to include *O. gummifera*, most recently placed in *Poupartia* by Eggli. Eco-geographic features of each species are discussed, and preliminary conservation assessments are calculated using IUCN Red List criteria. A key to the species is provided in English and French.

KEY WORDS
Anacardiaceae,
Operculicarya,
Madagascar,
Comoro Islands,
conservation,
new species.

RÉSUMÉ
Reconsidération du genre Operculicarya *(Anacardiaceae) : mise à jour taxonomique pour Madagascar et les Comores et description de deux nouvelles espèces.*
Une révision taxonomique d'*Operculicarya* H.Perrier (Anacardiaceae) à Madagascar et aux Comores est présentée. Huit espèces sont reconnues (dont sept endémiques de Madagascar) parmi lesquelles deux (*O. capuronii* et *O. multijuga*) sont nouvellement décrites et illustrées. Les deux nouvelles espèces se distinguent par la taille de leurs feuilles et folioles et la structure de leurs inflorescences. La délimitation du genre est un peu élargie pour ré-inclure *O. gummifera*, récemment placé dans le genre *Poupartia* par Eggli. Les caractéristiques éco-géographiques sont discutées pour chaque espèce et conduisent à une analyse préliminaire de leur statut de conservation effectuée selon les critères des Listes Rouges de l'UICN. Une clé des espèces est fournie, en anglais et français.

MOTS CLÉS
Anacardiaceae,
Operculicarya,
Madagascar,
Comoro Islands,
conservation,
espèces nouvelles.

INTRODUCTION

Perrier de la Bâthie (1944) described *Operculicarya* in his revision of Anacardiaceae of Madagascar and the Comoro Islands to accommodate a small group of xerophytic species from western Madagascar that he felt could not be placed in any of the other genera occurring on the island. In the protologue, he indicated that *Operculicarya* most closely resembled *Poupartia* Comm. ex Juss. (which he circumscribed to include *Sclerocarya* Hochst.), sharing several important features, in particular the presence of one or more opercula in the bony endocarp. *Operculicarya* was distinguished primarily on the basis of a distinctive horseshoe-shaped embryo (vs. slightly curved in *Poupartia*), coupled with an isostemonous androecium, i.e. one in which the stamens are equal in number to the petals (vs. two or more times as many in *Poupartia*). A nearly identical treatment was published two years later in the *Flore de Madagascar et des Comores* (Perrier de la Bâthie 1946).

Based on the limited and incomplete material available at the time, Perrier de la Bâthie (1944) recognized three species of *Operculicarya*, all described as new. One of these, *O. monstruosa*, originally known only from material with male flowers, was subsequently shown by Capuron (1962) to be a species of *Commiphora* (Burseraceae), a fact that became evident once additional collections with female flowers and especially fruits were available. Several years later, Capuron (1975) transferred *Poupartia gummifera* Sprague into *Operculicarya*, noting that it possessed fruits with a single operculum in the mesocarp (*Poupartia* was characterized by fruits with 2-5 opercula) as well as a horseshoe-shaped embryo, features shared with the two remaining species of *Operculicarya* originally described by Perrier de la Bâthie (1944).

The most recent treatment of *Operculicarya* is that of Eggli (1995), who briefly reviewed the relationships of the genus and described three additional, well-delimited species. He restricted *Operculicarya* to include only taxa with small leaves borne on short shoots and with a distinctly winged rachis, along with a 1-flowered pistillate inflorescence, preferring (at least provisionally) to exclude *P. gummifera*, which lacks short shoots and has leaves with an unwinged rachis as well as a multi-flowered, spicate female inflorescence. Eggli (1995) indicated that the androecium of *Operculicarya* is not isostemonous, as erroneously reported by Perrier de la Bâthie (1944), an error probably due to the fact that the collections available at that time were so fragmentary. Eggli also questioned whether the presence of a single operculum was a reliable generic feature, pointing out that Teichman & Hardy (1992) had observed a small percentage of fruits with a pair of opercula in *O. decaryi* H.Perrier.

For the present revision, we have examined all of the available material at the major herbaria with important holdings from Madagascar (K, MO, P, TAN, TEF), including a number of older collections that apparently were not seen by Eggli as well as more recent gatherings. A careful re-evaluation of this material confirms that the five species recognized in his 1995 treatment all represent well-delimited entities. Our study has also revealed two additional species, which we describe here as new, both of which have fruits with a single operculum and a horseshoe-shaped embryo, conforming to the original definition of the genus proposed by Perrier de la Bâthie (1944, 1946) and retained by Capuron (1975). We have decided not to follow Eggli's (1995) narrower circumscription of *Operculicarya* (adopted by Schatz 2001), because it would be very difficult to apply unambiguously to the new species described here, which present one or more features that he ascribed to *Poupartia*, significantly blurring the distinction between the two genera. One option would be to merge *Operculicarya* into *Poupartia* (the latter having nomenclatural priority). This approach would, however, result in a morphologically rather heterogeneous assemblage and would unnecessarily obscure differences that appear to be of taxonomic value. Instead, we prefer to use a more conservative approach, reinstating Perrier de la Bâthie's original (1944, 1946) concept, at least until additional information (e.g., from molecular phylogenetic studies) becomes available that might clarify relationships within this complex group.

In his revision of *Operculicarya*, Eggli (1995) cited two collections that he ascribed to the genus but could not place with confidence, referring them to his "Species A". The first of these, *Phillipson 2890*,

from N of Ejeda on the road to Betioky, Toliara Prov., in SW Madagascar, closely resembles material of *Operculicarya* in having small leaves borne on short shoots, a winged rachis, and a single fruit per inflorescence. However, the leaves are nearly all paripinnate (vs. uniformly imparipinnate in *Operculicarya*) and the embryo lacks an operculum and does not have the distinctive horseshoe-shape so characteristic of that genus. Careful analysis has shown that *Phillipson 2890* is in fact referable to *Doratoxylon chouxii* Capuron (Sapindaceae), a small tree known from several localities in western and southern Madagascar. The remarkable resemblance between *D. chouxii* to members of *Operculicarya* provides a striking example of morphological convergence, a pattern that appears to be common in Madagascar's drier vegetation types.

Eggli's (1995) second unplaced collection (*Service Forestier 23400*) is a sterile gathering from W of Mont Ambohipiraka near Ambilobe in NW Madagascar. While superficially resembling *Phillipson 2890* in having distinctly emarginate leaflets, its leaves are uniformly imparipinnate and lack any indication of wings on the rachis, strongly suggesting that the two collections are not conspecific. *Service Forestier 23400* may well belong to *Operculicarya*, but without fertile material, especially mature fruit, like Eggli (1995) we are not able to determine its identity.

For the material cited below under each species, FC indicates "Forêt classée", RF refers to "Réserve forestière", and PA designates Protected Areas, which include the following categories: Parc national, Réserve naturelle intégrale, and Réserve spéciale. A full listing of exsiccatae for each species, with complete localities, dates, and latitude/longitude coordinates, is available through W3 TROPICOS (http://mobot.mobot.org/W3T/Search/vast.html). Geographic coordinates indicated in square brackets were assigned *post facto* using available information on Malagasy place names and topographic maps, compiled as a gazetteer of botanical collecting localities in Madagascar (http://www.mobot.org/MOBOT/research/madagascar/gazetteer/).

SYSTEMATICS

Genus *Operculicarya* H.Perrier

Mémoires du Muséum national d'Histoire naturelle 18: 248 (1944). — Type: *Operculicarya decaryi* H.Perrier (lecto-, designated by Capuron, *Adansonia*, sér. 2, 2: 271, 1962).

Key to the species of *Operculicarya* H.Perrier

1. Leaf rachis winged; leaflets sessile 2
— Leaf rachis not winged; leaflets subsessile or with a distinct petiolule 7

2. Largest leaflet at least 20 mm long; fruits 2-3 per infructescence, sometimes solitary (flowers unknown) ..... 2. *O. capuronii*
— Largest leaflet < 10(-15) mm long; flowers and fruits always solitary 3

3. Leaves moderately to densely villous to lanate on rachis and usually on margin and midvein on lower surface of leaflets 4
— Leaves mostly glabrous, sometimes leaflets with sparse indument on base and along midrib and margins (especially on young leaves) 6

4. Venation slightly impressed on lower surface of leaflets ..... 5. *O. hirsutissima*
— Venation prominent and raised on lower surface of leaflets 5

5. Leaflets narrowly oblong, apex truncate, lacking a mucro, margin strongly revolute, venation prominently raised on lower surface forming deep cavities between the veins; fruit 9-10 × 8-9 mm ..... 6. *O. hyphaenoides*
— Leaflets elliptic to slightly obovate, apex rounded to broadly acute, mucronate, margin not revolute, venation moderately raised on lower surface, but not forming deep cavities between veins; fruit 7 × 7 mm ..... 1. *O. borealis*

6. Shrub 1(-2) m tall; small branches with a distinct zig-zag orientation; leaves 1.5-3.6 cm long, leaflets 7-8 × 4 mm ..... 8. *O. pachypus*
— Small to medium-sized tree (2-)3-6 m tall, sometimes up to 15 m; small branches straight; leaves 2.5-3.6 cm long, leaflets 4-7 × 3-4 mm ..... 3. *O. decaryi*

7. Fruits solitary (flowers unknown); leaflets 9-21, subsessile (petiolule < 0.5 mm long) .... 7. *O. multijuga*
— Flowers and fruits 2-15 or more per infructescence; leaflets 7-17, petiolule 1-4 mm long ..... 4. *O. gummifera*

CLÉ DES ESPÈCES D'*OPERCULICARYA* H.PERRIER

1. Feuilles à rachis ailé ; folioles sessiles 2
— Feuilles à rachis non ailé ; folioles subsessiles ou à pétiolule distinct 7

2. Foliole la plus grande ≥ 20 mm de long ; 2-3 fruits par infrutescence, quelquefois un seul (fleurs inconnues) ..... 2. *O. capuronii*
— Foliole la plus grande < 10(-15) mm de long ; fleurs et fruits toujours uniques 3

3. Feuilles densément velues à laineuses sur le rachis et souvent sur la marge ainsi que la nervure centrale sur la face inférieure des folioles 4
— Feuilles glabres en général, avec parfois quelques poils épars sur la nervure médiane des folioles (surtout sur les feuilles jeunes) 6

4. Nervation légèrement marquée sur la face inférieure des folioles ..... 6. *O. hirsutissima*
— Nervation sur la face inférieure des folioles, marquée, en relief 5

5. Folioles étroitement oblongues, apex tronqué, sans mucron, marges fortement révolutées, nervation fortement saillante sur la face inférieure formant de profondes cavités entre les nervures ; fruit 9-10 × 8-9 mm ..... 7. *O. hyphaenoides*
— Folioles elliptiques à légèrement obovales, apex arrondi à largement aigu, mucroné, à marges non révolutées, nervation modérément saillante sur la face inférieure, ne formant pas de profondes cavités entre les nervures ; fruit 7 × 7 mm ..... 1. *O. borealis*

6. Arbuste 1(-2) m de haut ; rameaux distinctement divariqués en zig-zag ; feuilles 1,5-3,6 cm de long, folioles 7-8 × 4 mm ..... 9. *O. pachypus*
— Arbre petit à moyen (2-)3-6 m de haut, parfois jusqu'à 15 m ; rameaux droits ; feuilles 2,5-3,6 cm de long, folioles 4-7 × 3-4 mm ..... 4. *O. decaryi*

7. Fruits solitaires (fleurs inconnues) ; folioles 9-21, subsessiles (pétiolule < 0,5mm de long) ..... 8. *O. multijuga*
— Fleurs et fruits 2-15 ou plus par infrutescence ; folioles 7-17, pétiolule 1-4 mm de long ..... 5. *O. gummifera*

1. ***Operculicarya borealis*** Eggli

Bulletin du Muséum national d'Histoire naturelle, Paris, 4e sér., sect. B, *Adansonia* 17: 152 (1995). — Type: Madagascar, Prov. Antsiranana, forêt d'Analafondro, sur sables, au pied SE du plateau de Sahafary (bassin inférieur du Rodo), [12°37'S, 49°32'E], 27.XII.1963, fr., *Service Forestier (Capuron) 23097* (holo-, P!; iso-, P!, TEF!).

ADDITIONAL MATERIAL EXAMINED. — **Madagascar.** Prov. Antsiranana, Andavakoera, *Razafitsalama et al. 632*. — Orangea, *Service Forestier (Capuron) 22726, 22954 bis, 22967*. — Forêt d'Analafondro, *Service Forestier (Capuron) 23097*. — Route Diégo-Orangea, *Service Forestier (Capuron) 29225*.

REMARKS

Operculicarya borealis is a shrub or small tree only known from the Orangea and Sahafary forests

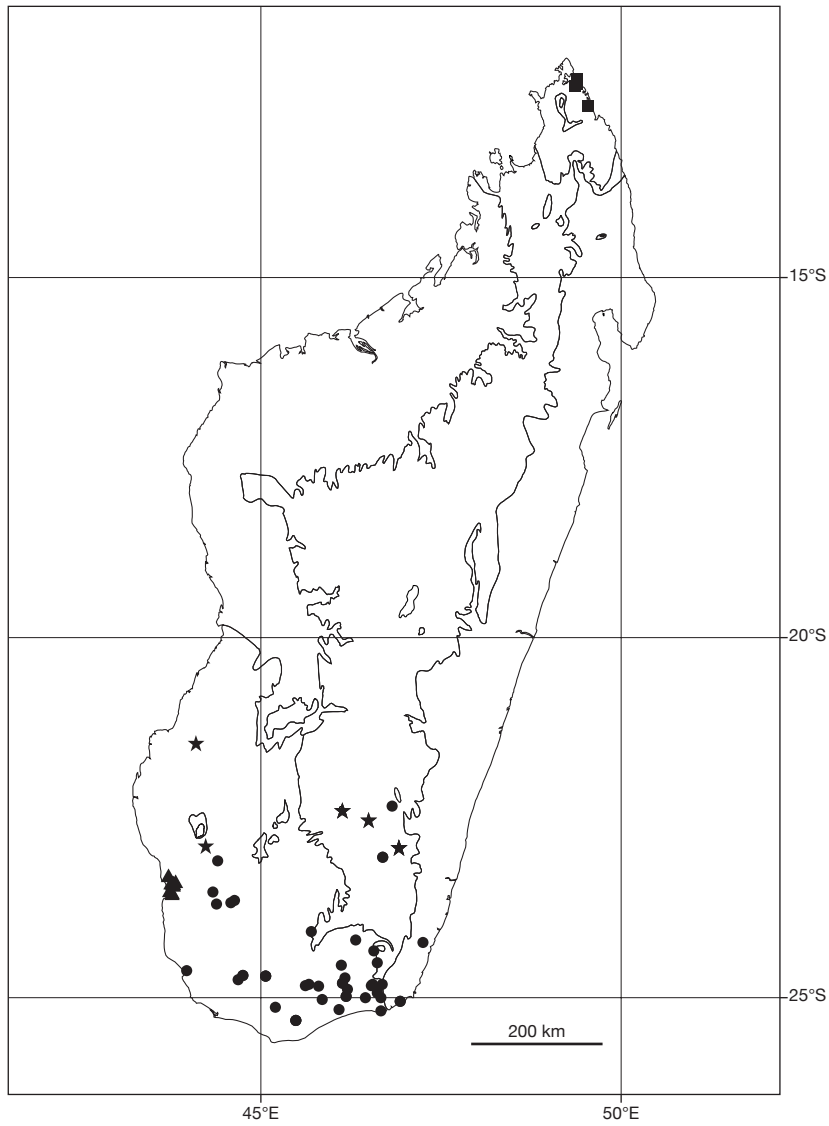

FIG. 1. — Distributions of *Operculicarya*, mapped on the bioclimatic zones of Madagascar (after Cornet 1974; see Schatz 2000): *O. borealis* (■), *O. decaryi* (●), *O. hirsutissima* (★), *O. pachypus* (▲).

in far northeastern Madagascar (Fig. 1), where it grows on unconsolidated sand (Orangea) and sandstone (Sahafary). It can be distinguished from other members of the genus by its small elliptic to slightly obovate leaves with a rounded, mucronate apex, villous to lanate indument, and secondary venation on the lower surface that is moderately raised but does not form distinct cavities between the individual veins.

CONSERVATION STATUS

With an Extent of Occurrence (EOO) less than 100 km², an Area of Occupancy (AOO) of 200 km², and only three subpopulations, none of which are

currently included within Madagascar's protected areas network, *Operculicarya borealis* is assigned a preliminary status of Endangered (EN B1ab(ii,iii) +2ab(ii,iii)) using the IUCN Red List threat criteria (IUCN 2001).

2. ***Operculicarya capuronii*** Randrian. & Lowry, sp. nov. (Fig. 2)

Haec species quoad rhachim foliarem alatam Operculicaryae boreali, O. hirtusissimae, O. decaryi, O. pachypodi *et* O. hyphaenoidi *similis, sed ab eis foliis foliolisque majoribus atque fructibus plerumque duobus vel tribus (nec solitario) in quaque infructescentia portatis distinguitur.*

TYPUS. — **Madagascar.** Prov. Toliara, versant S du plateau sommital du massif granitique du Vohitsiandriana (au S de Ranopiso), [25°10'S, 46°39'E], 8.XII.1968, fr., *Service Forestier (Capuron) 28571* (holo-, P!; iso-, MO!, P!, TEF).

PARATYPES. — **Madagascar.** Prov. Toliara, pentes inférieures du massif du Vohitsiandriana, au SW de Fort-Dauphin, [25°10'S, 46°39'E], 100-330 m, 11.I.1963, fr., *Service Forestier (Capuron) 22376* (G, K, MO, P [2 sheets], TEF); Vohitsiandriana, without additional label data, ster., *Service Forestier (Capuron) s.n.* (P).

DESCRIPTION

Small to medium-sized tree 2-8 m tall, trunk more or less swollen; branches waxy, grayish to brown, short shoots 1-3 cm long, puberulous toward the apex, glabrous toward the base. Leaves imparipinnate, regularly alternate on long branches and clustered at the apex of short shoots, 2.5-9 cm long; leaflets 7-9, opposite to subopposite, sessile, subcoriaceous, obovate, 1-3 × 0.5-1.8 cm, lower ones progressively smaller, chocolate brown, glabrous but sparsely puberulous when young, venation impressed, craspedodromous, more visible on lower surface, apex rounded or sometimes slightly emarginate, margin entire, base attenuate; rachis winged, glabrous; petiole 1-2 cm long, glabrous, canaliculate above. Flowers unknown. Fruits 2-3 per infructescence, sometimes solitary, 0.7-1 × 0.5-0.7 cm; pedicel short, 1-2 mm long, glabrous, subtended by triangular bracts; endocarp stony, operculum 1, oval.

REMARKS

Operculicarya capuronii is known from only three collections, all made on granitic substrate on the slopes of Mt. Vohitsiandriana to the SW of Fort Dauphin in extreme SE Madagascar (Fig. 3). Among the species with a winged rachis, *O. capuronii* differs by having larger leaves and leaflets, and fruits that are usually borne 2-3 per infructescence (rather than solitary).

ETYMOLOGY

The species epithet honours René Capuron, who personally collected all eight species of *Operculicarya*, and who made a unique and lasting contribution to our knowledge of Madagascar's remarkable woody flora.

CONSERVATION STATUS

With both an EOO and AOO of no more than 100 km^2 and a single unprotected subpopulation, *Operculicarya capuronii* is assigned a preliminary status of Critically Endangered (CR B1ab(ii,iii)) by application of the IUCN Red List threat criteria (IUCN 2001).

3. ***Operculicarya decaryi*** H.Perrier

Mémoires du Muséum national d'Histoire naturelle 18: 249 (1944). — Type: Madagascar, Prov. Toliara, Ambatomainty, au N d'Ambovombe, sur sables, [24°33'S, 46°07'E], 26.X.1931, fr., *Decary 9305* (holo-, P!; iso-, P!).

ADDITIONAL MATERIAL EXAMINED. — **Madagascar.** Prov. Fianarantsoa, Ihosy à Sakalalina, *Service Forestier 23540*. Prov. Toliara, no precise locality, *Alluaud 89*; *Aubréville 26*. — Ifotaka, *Bosser 3735*. — Tsihombe, *Bosser 10185*. — Environs d'Ambovombe, *Bosser 10528*. — Forêt de Rapily, *Bourgeois 59, 65*. — SW of Ampanihy, *Croat 31412*. — Ifotaka, *Decary 3294*. — Antanimora, *Decary 4383*. — Ambatomainty, *Decary 9305*. — Vinanibe, *Dumetz 1299, 1326*. — Andohahela PA, *Dumetz 1417*; *Eboroke 858*. — 5 km south of Tranoroa junction, *Fosberg 52472*. — Environs de Tongobory, *Humbert 2720*. — Vallée moyenne du Mandrare près d'Anadabolava, *Humbert 12456*. — NW de Maroaomby (Betsioky), *Humbert 12798 bis*. — Col d'Ambato et pentes orientales du Vohipaly, *Humbert 14158 bis*. — Imonty, Andohahela PA, *Keraudren 1502*. — Entre Tranoroa et Beloha, Andohahela PA, *Laha 205*; *Leandri & Saboureau 4171*; *Leandri 4468*. — Behevoa, near Betioky, *Morat 696*. — Berenty, *Phillipson 2315*. — Beza Mahafaly PA, *Phillipson 2525*. — Beza Mahafaly PA,

FIG. 2. — *Operculicarya capuronii*: **A**, fruiting branch; **B**, detail of fruit. *Service Forestier (Capuron) 28571*. Scale bars: A, 1 cm; B, 6 mm.

Ampanihy, *Rakotomalaza & Messmer 1764*. — Andohahela PA, *Randriamanantena & Durbin 48*; *Randrianasolo et al. 627*. — Entre Antanimora et Ambovombe, *Service Forestier (Capuron) 344*. — Antanimora à Ambovombe, *Service Forestier 354*. — Morafeno Ifotaka, *Service Forestier 1635*. — Entre Tsihombe et Beloha, *Service Forestier (Capuron) 8470, 8470 bis*. — Tsimela, *Service Forestier 8519*. — Entre Ambatoabo et Imonty, *Service Forestier (Capuron) 8523*. — Entre Beraketa et Betroka, *Service Forestier (Capuron) 8549*. — Entre Ampanihy et Itrobiky, *Service Forestier (Capuron) 18678*. — Entre Amboasary et Ranomainty, *Service Forestier (Capuron) 20460*. — Est d'Ampanihy, *Service Forestier (Capuron) 27955*. — Est d'Antanimora, *Service Forestier (Capuron) 28303*. — Angavo, Antanimora, *Service Forestier 31-R-316*. — Ambondro-Ampasy, *Service Forestier (de Neef) 100-R-78*. — Amboasary to Fort-Dauphin, *McWhirter & Capuron 163, 164*. — NE of Betioky, *Sussman 170*. — Environs d'Ampandrandava (entre Bekily et Tsivory), *Seyrig 865*.

Remarks

Operculicarya decaryi is a small, branched tree with a bole-like or conical trunk. It is more widespread than other members of the genus (except *O. gummifera*), extending throughout much of southern Madagascar, from Toliara E to Ambovombe (Fig. 1). In addition to its distinctive habit, several additional features separate *O. decaryi* from other members of the genus whose leaves have a winged rachis, including leaflets that are totally glabrous below, and branches that are straight (rather than zig-zag in orientation, as in *O. pachypus*).

Vernacular names

Zabia, Zabihy daro, Zaby.

Conservation status

Operculicarya decaryi has an EOO of *c.* 71 600 km², an AOO of 3 000 km², and *c.* 30 subpopulations, two of which are encompassed within protected areas (Andohahela PA, Beza Mahafaly PA). It is thus assigned a preliminary status of Least Concern (LC) based on the IUCN Red List threat criteria (IUCN 2001).

4. ***Operculicarya gummifera*** (Sprague) Capuron

Adansonia, sér. 2, 14: 571 (1975). — *Poupartia gummifera* Sprague, *Bulletin de l'Herbier Boissier*, sér. 2, 5: 408 (1905). — Type: Madagascar, Boina, III.1905, *Jumelle s.n.* (holo-, K; photo seen).

Operculicarya gummifera (Sprague) Capuron var. *seyrigii* Capuron, *Adansonia*, sér. 2, 14: 572 (1975). — Type: Madagascar, Prov. Toliara, Ampandrandava, crête E, *c.* 1100 m, *Seyrig 192* (holo-, P; not found).

Additional material examined. — **Madagascar.** Prov. Antsiranana, Ankarana PA, *Andrianantoanina & Bezara 904*. — Ankarana PA, *Bardot-Vaucoulon 116, 117, 118, 217, 244, 793*. — Montagne des Français, *Homolle 311*. — Ankarana PA, *Humbert 18839*. — Montagne des Français, *Service Forestier 12799*. — Ankarana PA, *Service Forestier (Capuron) 18991*. — Îlot du Pain de Sucre, *Service Forestier 14878*.
Prov. Fianarantsoa, Ihosy, *Keraudren 329*. — Itremo, *Keraudren-Aymonin & Aymonin 25855*. — Zombitsy PA, *Service Forestier 7755*. — Massif de Vohipary, *Service Forestier (Capuron) 22498 bis*. — Bassin de la Sahambana, *Service Forestier (Capuron) 22606 bis*. — Massif de Lalanandro, *Service Forestier (Capuron) 23511*. — Ihosy à Sakalalina, *Service Forestier 23543*. — Anjiamavo, *Service Forestier (G. Rakotovao) R-8-174*.
Prov. Mahajanga, forêt de Marosalaza, *Abraham 39*. — Andranomavo, *Decary 8139*. — Bemaraha PA, *Jongkind et al. 3223, 3228*. — Environs d'Antsalova, *Labat et al. 2254*. — Antsingy, *Leandri 318*. — Bois de Beritsoka, *Perrier de la Bâthie 356 bis*. — Environs de Firingalava, *Perrier de la Bâthie 765*. — Ankirihitra près du Mt. Tsitondroina, *Perrier de la Bâthie 765 bis*. — Environs de Maevatanana, *Perrier de la Bâthie 765 ter*. — Bongalava, *Razakamalala 1694*. — Andranomavo, *Réserves Naturelles (Randriamiera) 6685*. — Ankarafantsika PA, *Service Forestier 47*. — Antsely, *Service Forestier 5402*. — Près de Majunga, *Service Forestier (Capuron) 18438*. — Analalava, forêt d'Ambondro-Ampasy, *Service Forestier (Capuron) 18837*. — Molavava, forêt d'Antsarolo, *Service Forestier 19613*. — Forêt de Tsiombikibo, *Service Forestier (Capuron) 24198*. — Anjiamangirana FC, *Service Forestier (Capuron) 24830*. — Mitsinjo, *Service Forestier 57-R-66*. — Andalirano, *Service Forestier 162-R-130*.
Prov. Toliara, forêt de Marosalaza, *Hladik 3, 23*. — Bassin de la Malio, près d'Ambalabe, *Humbert 19393*. — Zombitsy PA, *Leandri et al. 3970, 3978, 3981*. — 30 km NE of Sakaraha, *Lorence 2088*. — Bemaraha PA, *Morat 3698*. — Mangalakandoha-Sakaraha, *Service Forestier 4117*. — Zombitsy PA, *Service Forestier 7755*. — Forêt de Tanambao, *Service Forestier 12265*. — N d'Andranohinaly, *Service Forestier (Capuron & Chauvet) 20765*. — Andranomena, *Service Forestier 21070*. — Près d'Analaivo, E de Morondava, *Service Forestier (Capuron) 22136*. — Massif du Vohidava, *Service Forestier 22584 bis*.
Comoro Islands. Moheli, Djando, Chissiwa Madahani, *Labat 3196*.
Mayotte, Kani kaly, Choungi, *Barthelat 496*. — Mliha, Mtsumbatsu, *Barthelat 622*. — Saziley, *M'Changama*

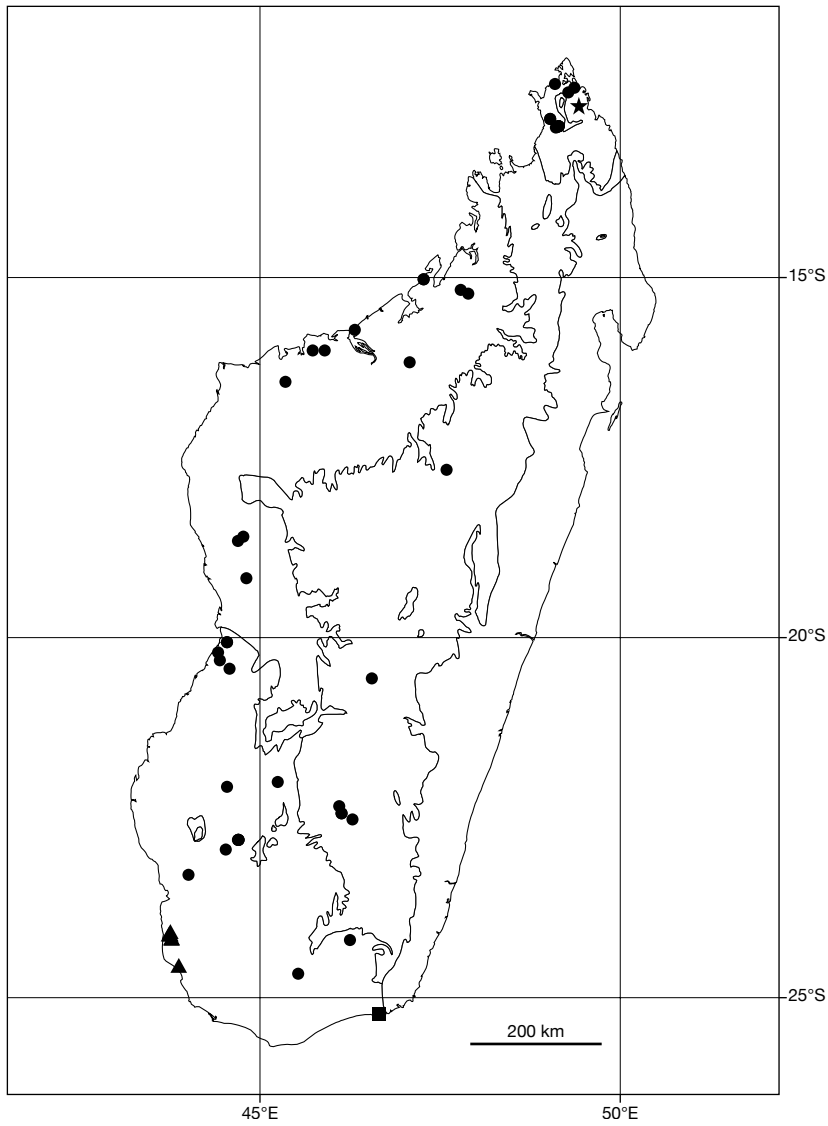

FIG. 3. — Distributions of *Operculicarya*, mapped on the bioclimatic zones of Madagascar (after Cornet 1974; see Schatz 2000): *O. capuronii* (■), *O. gummifera* (●), *O. hyphaenoides* (▲), *O. multijuga* (★).

& Sifary 257. — Saziley, *Hladik 6562*. — Combani, *Humblot 1272*. — Mlhia, *Pignal 1892*. — Choungui Keli, *Pignal 1898*.

REMARKS

Operculicarya gummifera is a tree that can reach 15 m in height, growing in dry and semi-deciduous forest. It ranges from far northern Madagascar throughout the W and into the SW, reaching its southern limit at Vohipary SSE of Bekily (Fig. 3). *Operculicarya gummifera* also occurs in the Comoro Islands, where it has been recorded numerous times on Mayotte and once on Moheli. Although the leaves of *O. gummifera* are quite variable and populations

have been recorded from a diversity of habitats, this species can be distinguished easily from the other members of the genus by its large leaves with an unwinged rachis, distinctly petiolulate leaflets mostly with an acuminate apex, and a long spicate pistillate inflorescence and infructescence (4-15 cm in length) bearing up to 15 fruits.

Within *Operculicarya gummifera*, variation in several characters, including the height of the plants, the size and shape of its leaves and leaflets, the length of its inflorescence and infructescence, and the number of fruits per infructescence, exhibits clear geographic structuring. Plants occurring in S and SW Madagascar tend to be smaller with respect to each of these features, engendering a noticeably more gracile appearance. We initially considered recognizing these populations as a distinct species, but careful examination of the available material revealed that several sympatric collections have larger leaves and longer infructescences characteristic of more northern populations. Additional material, perhaps coupled with field observations, may show that these entities can indeed be distinguished and are worthy of recognition, whether at the specific or infraspecific level. For the time being, however, we prefer to regard them as comprising a single, albeit variable, taxon.

Operculicarya gummifera is the only member of the genus not endemic to Madagascar. In addition to being present on two of the Comoro Islands (Mayotte and Moheli), it has also been collected on Aldabra (South Island, 24.II.1968, fr., *Renvoize 1113* [P]).

Vernacular names

Behoditra, Heringerinombilahy, Sakoala, Sakoambanditse (Madagascar); Maruditi, Sari sakwa, Toukoun'soungou (Mayotte); Dziamantra (Moheli).

Conservation status

Within Madagascar, *Operculicarya gummifera* has an EOO of *c.* 236 000 km², an AOO of 3 400 km², and *c.* 30 subpopulations, three of which are encompassed within protected areas (Ankarana PA, Zombitsy PA, Anjiamangirana FC). Using the IUCN Red List threat criteria (IUCN 2001), it is thus assigned a preliminary status of Least Concern (LC).

5. ***Operculicarya hirsutissima*** Eggli

Bulletin du Muséum national d'Histoire naturelle, Paris, 4e sér., sect. B, *Adansonia* 17: 154 (1995). — Type: Madagascar, Prov. Toliara, restes de forêts de la vallée de la Menarahaka entre Ihosy et Ivohibe, Antanifotsy, forêt à feuilles caduques et transition vers le bush à xérophytes, [22°24-29'S, 46°08-29'E], 600-800 m, 29.X.1960, fr., *Leandri 3447* (holo-, P!; iso-, P!).

Additional material examined. — **Madagascar.** Prov. Toliara, vallée de la Menarahaka, *Leandri 3447*. — Beroroha-Sakaraha, *Service Forestier 4121*.
Prov. Fianarantsoa, Sakalalina-Ihosy, *Service Forestier 4755*. — Environs NE d'Ihosy, *Service Forestier 8553*. — Menarahaka, E d'Ihosy, Ihosy à Sakalalina, *Service Forestier (Capuron) 23543*; *Service Forestier (Capuron) 27842*. — Ankiranja, W de Manja, *Service Forestier (Capuron) 28943*. — Menarahaka, E d'Ihosy, *Service Forestier 48-R-239, 49-R-222, 69-R-47, 89-R-10, 119-R- 239*.

Remarks

Operculicarya hirsutissima is a small tree known only from the area around Ihosy and Sakaraha in South-Central Madagascar (Fig. 1). It can be distinguished from the other species whose leaves have a winged rachis by its small, densely villous leaflets bearing secondary venation that is slightly impressed (vs. prominently raised) on the lower surface.

Vernacular names

Beoditra (= Behoditra), Botiboty, Sakoakomba.

Conservation status

Operculicarya hirsutissima has an EOO of *c.* 24 600 km², an AOO of 500 km², and five subpopulations, none of which are encompassed within protected areas. It is therefore assigned a preliminary status of Vulnerable (VU B2ab(ii,iii)) based on the IUCN Red List threat criteria (IUCN 2001).

6. ***Operculicarya hyphaenoides*** H.Perrier

Mémoires du Muséum national d'Histoire naturelle 18: 249 (1944). — Type: Madagascar, Prov. Toliara, Manampetsa (= Tsimanampetsotsa PA), calcaire, [24°07'S, 43°47'E], IV.1933, fr., *Perrier de la Bâthie 19169* (holo-, P!; iso-, P!).

Additional material examined. — **Madagascar.** Prov. Toliara, Tsimanampetsotsa PA, *Phillipson 2730,*

3722. — Tsimanampetsotsa PA, *Perrier de la Bâthie 19169*. — Gouffre de Mihoto, Tsimanampetsotsa PA, *Service Forestier (Capuron) 18649 bis*. — Tsimanampetsotsa PA, *Service Forestier (Capuron) 20614*. — Efoatse à Itampolo, *Service Forestier 20632 bis*.

REMARKS

Operculicarya hyphaenoides is a well-branched shrub or small tree about 1.5 m tall. It is restricted to SW Madagascar (Fig. 3), where it occurs in xerophytic scrub vegetation on limestone in and around Tsimanampetsotsa National Park. This species can be recognized by its numerous small leaflets with strongly revolute margins and prominently raised venation on lower surface that forms deep cavities between veins.

CONSERVATION STATUS

With an EOO well below 500 km², an AOO of 300 km² and only two subpopulations, one from a protected area (Tsimanampetsotsa PA), *Operculicarya hyphaenoides* is assigned a preliminary status of Endangered (EN B1ab(ii,iii)+2ab(ii,iii)) based on application of the IUCN Red List threat criteria (IUCN 2001).

7. ***Operculicarya multijuga*** Randrian. & Lowry, sp. nov. (Fig. 4)

Haec species ad Operculicaryam gummiferam *maxime accedit, sed ab ambabus foliolis multioribus crebris subsessilibusque atque fructu solitario differt.*

TYPUS. — **Madagascar.** Prov. Antsiranana, lisière supérieure de la forêt d'Andranomadiro (rebord S du plateau de Sahafary, entre les bassins de la Saharenana et de Rodo), [12°37'S, 49°25'E], *c*. 300 m, 27.X.1963, fr., *Service Forestier (Capuron) 23059* (holo-, P!; iso-, K!, MO!, P!, TEF).

DESCRIPTION

Tree, twigs waxy, short shoots apparently absent. Leaves imparipinnate, clustered at the apex of branches, 5-12 cm long; leaflets 9-21, opposite to subopposite, subsessile (petiolule, 0.5 mm long), chartaceous, ovate, asymmetric especially at the base (except the terminal one), 0.5-2.5 × 0.3-0.8 cm, lower ones progressively smaller, villous on the margins midrib and base, venation impressed, cladodromous, visible on both surfaces, apex acute, margin entire, base attenuate; rachis villous, not winged; petiole 1-2 cm long, very slightly flattened above, villous. Flowers unknown. Fruits solitary, 0.7 × 0.7(-0.8) cm, globose, subsessile; endocarp stony, compressed, lenticular, operculum 1, oval.

REMARKS

This new species, like *O. gummifera*, has leaves with an unwinged rachis and lacks short shoots, but can readily be distinguished by its smaller leaves, more numerous and subsessile leaflets, and solitary fruits. *Operculicarya multijuga* is known from a single collection made along the southern edge of the Sahafary Plateau, SSE of Antsiranana (Fig. 3), in the same general area as the type locality for *O. borealis*.

CONSERVATION STATUS

Operculicarya multijuga has an EOO and AOO of less than 100 km², and is known from a single unprotected subpopulation, where it was collected only once more than 40 years ago. Application of the IUCN Red List threat criteria (IUCN 2001) therefore results in it being assigned a preliminary status of Critically Endangered (CR B1ab(ii,iii)).

8. ***Operculicarya pachypus*** Eggli

Bulletin du Muséum national d'Histoire naturelle, Paris, 4e sér., sect. B, *Adansonia* 17: 156 (1995). — Type: Madagascar, Prov. Toliara, vallée de l'Onilahy, vers l'embouchure, coteaux et plateaux calcaires, [23°33'S, 43°46'E], 10-250 m, 27-30.IX.1924, ♂ fl., *Humbert 2614* (holo-, P!).

ADDITIONAL MATERIAL EXAMINED. — **Madagascar.** Prov. Toliara, La Table, Tulear, *Bosser 10158*; *Chauvet 167*. — Route St. Augustin, *Chauvet 203*. — PK 19.5, route de Tananarive, *Chauvet 224*. — Miary, *Dequaire 27442*. — La Table, *Du Puy, Labat & Comtet 686*. — Vallée de l'Onilahy, *Humbert 2614*. — La Table, *Keraudren 581*. — Près de La Table, *Rakotozafy 759*. — La Table, *Randrianasolo 622, 623*. — La Table, St. Augustin, *Service Forestier (Capuron) 20807*.

REMARKS

Operculicarya pachypus is a very short, branched shrub with tiny compound leaves. It is restricted

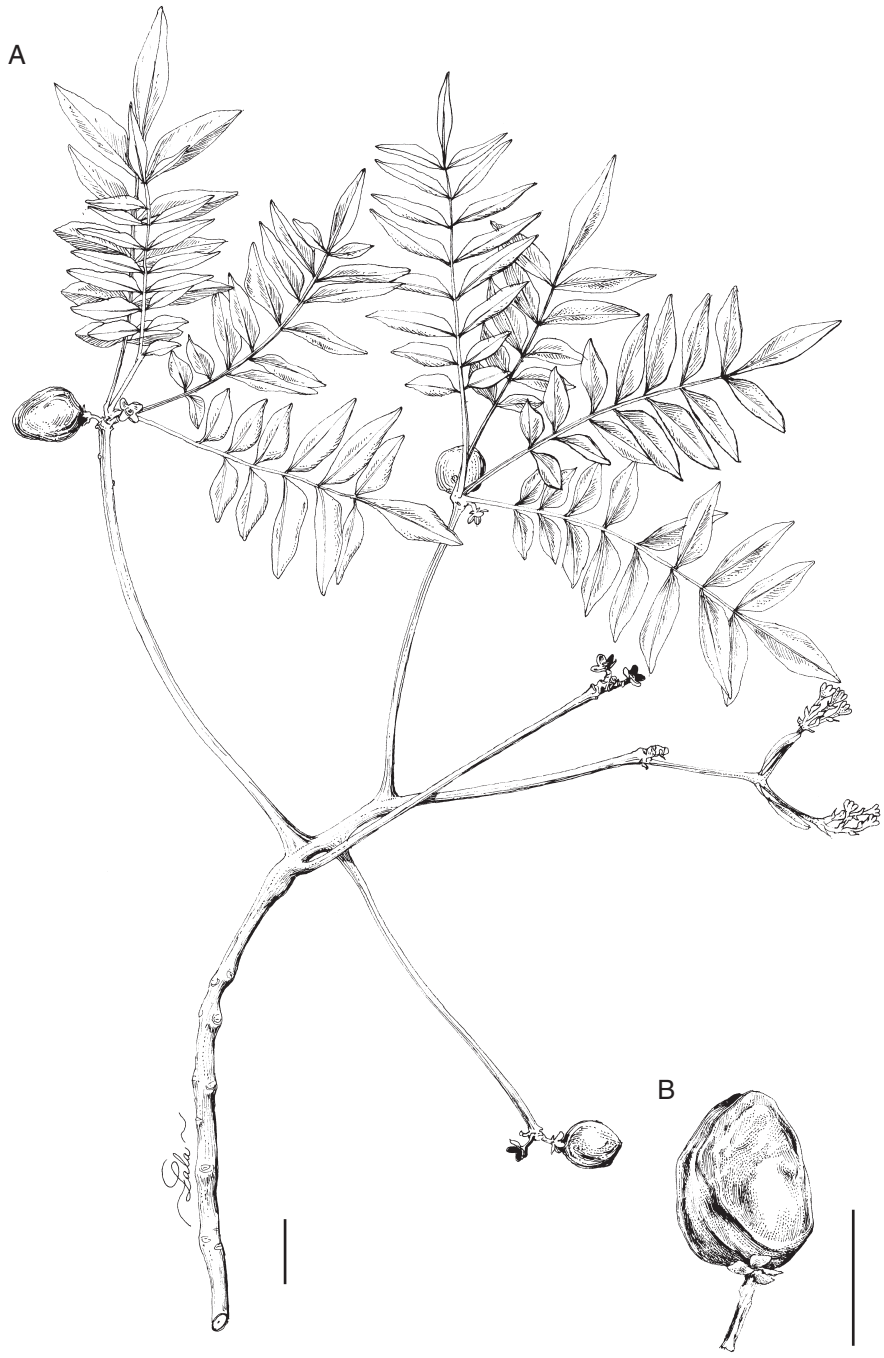

FIG. 4. — *Operculicarya multijuga*: **A**, fruiting branch; **B**, detail of fruit. *Service Forestier (Capuron) 23059*. Scale bars: A, 1 cm; B, 7 mm.

to xerophytic forest in the vicinity of Toliara in SW Madagascar (Fig. 1). This species most closely resembles (and is often confused with) *O. decaryi*, but can readily be distinguished by the distinctive zig-zag pattern of its branches.

Conservation status

With an EOO of less than 200 km², an AOO of 400 km², and four subpopulations, none occurring in a protected area, *Operculicarya pachypus* is assigned a preliminary status of Endangered (EN B1ab(ii,iii+2ab(ii,iii)) based on the IUCN Red List threat criteria (IUCN 2001).

EXCLUDED SPECIES

Operculicarya monstruosa H.Perrier

Mémoires du Muséum national d'Histoire naturelle, Paris, n.s., 18: 249 (1944) ≡ ***Commiphora monstruosa*** (H.Perrier) Capuron [Burseraceae], *Adansonia*, sér. 2, 2: 270 (1962). — Type: Madagascar, Prov. Toliara, rocailles calcaires non loin de la mer, entre la Linta et l'Onilahy, sur la côte Mahafaly, VIII.1919, fl., *Perrier de la Bâthie 12783* (holo-, P!; iso-, P!).

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