

TWO NEW SPECIES OF *DIOSPYROS* (EBENACEAE) FROM NEW GUINEA

C. Puglisi ¹, T. Jimbo ² & A. Hagwood³

The genus *Diospyros* (Ebenaceae) is highly diverse throughout Malesia, and New Guinea is thought to host c.46 species. Here we present a taxonomic treatment of a group of vegetatively similar species from the region, characterised by the large, chartaceous leaves that develop a peculiarly dark colour when dried. As a result of examination of herbarium collections, we describe two species new to science, *Diospyros multimaculata* and *D. tehno*; we exclude the presence of *D. rostrata* from New Guinea; and we provide a key to these and the three other species with a similar habit, namely, *D. janowskyi*, *D. fusicarpa* and *D. pulchra*.

Keywords. *Diospyros multimaculata*, *Diospyros tehno*, ebony, Indonesia, Malesia, Papua New Guinea, taxonomy.

Received 5 October 2021 Accepted 5 April 2022 Published 11 July 2022

Introduction

Diospyros L. is a genus of more than 700 species found throughout the tropics and reaching into the temperate zones (Wallnöfer, 2001; POWO, 2021). It is most diverse in Madagascar and the Malesian region. Several species of *Diospyros* have been harvested for their timber (ebony) and fruits (persimmons) for millennia (Deblauwe, 2021), and yet the taxonomic knowledge of the genus in particular regions of its distribution is limited. This is due partly to dioecy, which complicates the task of compiling comprehensive descriptions and identification keys, and partly to the convoluted nomenclatural history, which leads to inconsistencies in the application of names.

The study of *Diospyros*, and indeed of most plant groups, in New Guinea, is accompanied by two other significant challenges: the relative paucity of collections, and the extraordinary endemic diversity of the island's flora (Cámara-Leret *et al.*, 2020). Relevant taxonomic research in the region was conducted by Bakhuisen van den Brink (1933, 1936–1955), who produced a monograph and illustrations of many Malesian species of *Diospyros*, and later by Kostermans (1977), who went on to describe some of the unnamed material at the Leiden herbarium. In terms of species number, the current estimate for the diversity of *Diospyros* in New Guinea (also including neighbouring islands and the insular parts of Papua New Guinea) is 46 (Cámara-Leret *et al.*, 2020).

There is great variation among the local species of *Diospyros*, much of which can be observed in their vegetative morphology. The reproductive features that best aid

¹ Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AE, England, UK. E-mail: c.puglisi@kew.org.

² Papua New Guinea National Herbarium, Papua New Guinea Forest Research Institute, PO Box 314, Lae, Papua New Guinea.

³ College of Humanities and Sciences, University of Montana, Missoula, MT 59812, USA.

identification are the fruit and the accrescent fruiting calyx. Flowers of either sex, being seldom present in specimens and overall incompletely known, are not used here to characterise species.

As part of the preparation of an account of the species of *Diospyros* in New Guinea, we separated the specimens with the unique combination of dark, large (mature leaves > 10 cm long) and chartaceous leaves with scalariform tertiary venation from the rest of the material. They were mainly ascribed to two species, *Diospyros rostrata* (Merr.) Bakh. and *D. pulchra* Bakh., based on the fruiting calyx, which is tetramerous, large and leafy in *D. pulchra*, and trimerous, small and tough in *D. rostrata*. Two other known species sharing similar vegetative features are *Diospyros janowskyi* Bakh. and *D. fusicarpa* Bakh., both scantily represented in herbaria and better known from Bakhuizen van den Brink's plates (1936–1955).

The present study was prompted by the need to better characterise these four species, and by the recent collection of a specimen with a large, red, oblong fruit resembling that of the New Guinea endemics *Diospyros janowskyi* and *D. fusicarpa*. The six taxa examined, although somewhat similar, are not inferred to be evolutionarily close relatives. Phylogenomic studies exploring the evolution of New Guinean *Diospyros* are under way.

Materials and methods

We examined herbarium specimens held at the Royal Botanic Gardens, Kew (K), Naturalis (L), the Royal Botanic Garden Edinburgh (E) and the Papua New Guinea Forest Research Institute (LAE) (herbarium codes according to *Index Herbariorum*; Thiers, [continuously updated](#)), and photographs of type specimens at Herbarium Bogoriense (BO). Additionally, we used the illustrations made by Bakhuizen van den Brink (1936–1955) to score otherwise indiscernible characters.

All measurements were taken from herbarium specimens, except for the fruit of *Diospyros tehno*, which was preserved in spirit.

Taxonomic treatment

As a result of our observations, the specimens from New Guinea previously ascribed to *Diospyros rostrata* are removed to a new species, *D. multimaculata* C.Puglisi, thus restricting the distribution of *D. rostrata* to the Moluccas. A recently collected plant with a turbinate red fruit is also described as a species new to science: *Diospyros tehno* C.Puglisi, Jimbo & Hagwood. Both species are diagnosed and described below.

In the [Table](#) we present a summary of the key characters used to differentiate the six species examined. Full conservation assessments are being prepared as part of a larger project and will be published in due course.

Table. Key characters of the six species of *Diospyros* from New Guinea and the Moluccas with large, chartaceous leaves

Character	<i>D. fusicarpa</i>	<i>D. janowskyi</i>	<i>D. multimaculata</i>	<i>D. pulchra</i>	<i>D. rostrata</i>	<i>D. tehno</i>
Petiole length	3–8 mm	1.3–4 mm	6–8 mm	5–8 mm	3–6 mm	7–10 mm
Leaf base (mature leaves)	Acute, obtuse, subrounded	Narrow, obtuse to rounded	Subcordate	Subcordate or truncate, rarely obtuse	Subcordate to obtuse	Broadly acute
Leaf shape	Oblanceolate, obovate	Oblanceolate, obovate	Ovate, elliptic, slightly obovate	Obovate to elliptic	Ovate to elliptic	Elliptic to obovate
Leaf apex	Acute, acuminate	Acuminate	Acuminate	Acuminate to shortly acuminate	Acute to broadly acuminate	Acuminate
Midrib on upper side of leaf	Flat to slightly prominent	Prominent at base, then sulcate	Prominent at base, then sulcate	Flat to slightly prominent at base, flat to slightly sulcate near apex	Sulcate	Prominent
Basal black glands	Often present	Inconspicuous	Many	Inconspicuous	2–5 pairs, small	Absent
Fruiting calyx	Tube broadly campanulate, lobes oblong and acute	Tube reduced, lobes small and obtuse	Tube reduced, lobes small and broadly acute	Tube reduced, lobes very large and leafy	Tube campanulate, lobes broadly acute	Tube conical, lobes acute
Calyx lobes	4	3	3	4	3	4
Fruit	Fusiform	Prolate	Prolate to fusiform	Globose to oblate. Young fruit slightly ovoid	Subglobose, slightly oblong	Turbinate
Fruit apex	Caudate	Obtuse	Acute	Rounded base with a short acumen	Rostrate	Acute
Fruit surface	Sparsely verrucose	Not applicable	Smooth	Densely and minutely punctate (dry specimens)	Densely colliculate	Smooth, hairy
Seeds	2–4(–8)	6	Usually 5 or 6	4–6	6	2

Species descriptions

***Diospyros multimaculata* C.Puglisi, sp. nov.**

Diospyros multimaculata is vegetatively most similar to *Diospyros rostrata* (Merr.) Bakh. and *D. pulchra* Bakh. It differs from the former in the fruit with a nearly smooth epicarp (markedly colliculate in *Diospyros rostrata*) and in lacking the pronounced

apical projection, and from the latter in the trimerous calyx and the prolate to fusiform fruit (calyx tetramerous and fruit globose to oblate in *D. pulchra*). It also resembles *D. janowskyi* Bakh. in the overall habit and fruit shape but differs in the conspicuously glandular and subcordate base of mature leaves (leaf base inconspicuously to not glandular and obtuse in *D. janowskyi*). *Diospyros multimaculata* is characterised by the large, mature leaves with subcordate base and acuminate apex; numerous dark glands at the leaf base and alongside the midrib; the hairy leaves; and the prolate to fusiform fruit subtended by a small, trimerous calyx. – Type: Papua New Guinea, Sandaun (West Sepik) Province, Vanimo District, Ossima, 30 m a.s.l., 30 i 1969, *Streimann & Kairo* NGF 39283 (holotype K [K00618534]; isotypes E [E01014580], L [L.2667453]). **Figure 1.**

Small tree 6–8 m tall; bark black, stems hairy. *Leaves* simple, alternate; petiole 6–8 mm long, hairy, terete; lamina dark green above, paler beneath, ovate, elliptic or slightly obovate, 11–20 × 3.5–8.5 cm, base subcordate (obtuse to rounded in younger leaves), apex acuminate; indumentum simple on both sides, adaxially denser (although brittle and caducous) and more abundant along the midrib, abaxially also including T-shaped hairs on the lamina, young leaves with ciliate margin; black (at least in herbarium specimens) pitted glands along the midrib throughout its length, densely clustered at the leaf base and peculiarly visible on the adaxial side; on the adaxial side midrib raised at the base and then becoming sulcate, secondary veins flat or slightly raised, tertiary veins almost inconspicuous, on the abaxial side midrib raised throughout, secondary veins raised and visibly anastomosing near the margin in loops, tertiary veins raised and scalariform. Male inflorescences and flowers not seen. Remnants of female inflorescences axillary, to 2.5 cm long, 4- to 10-flowered. *Flowers* not seen, reported as yellow for both sexes. *Fruiting calyx* very small, tube reduced, lobes 3, divided almost to base, broadly acute, 1–2 mm long, spreading or slightly reflexed, hairy outside, glabrous inside. *Fruit* fleshy, prolate to fusiform, light green when immature, orange to red when ripe, sparsely hairy to nearly glabrous, 3.5–5.6 × 2–2.5 cm, acute at the base and acute at the apex, epicarp smooth to slightly irregular. *Seeds* up to 6, usually 5 or 6, dark brown, smooth.

Distribution. New Guinea (**Figure 2**).

Habitat and ecology. Lowland swampy or seasonally inundated primary forest, on clay soil.

Etymology. This species is named after the numerous glands at the leaf base and throughout the lamina alongside the midrib.

Vernacular name. *Usrapai* (Kemtuk [Kamtuk] language).

Other specimens examined. INDONESIA. **Papua Province:** Jayapura, Sekoli, South of Lake Sentani, 110 m a.s.l., 7 viii 1957, *Kalkman* BW 3767 (K, L).

PAPUA NEW GUINEA. **Sandaun (West Sepik) Province:** Vanimo District, near Poar River, 30 m a.s.l., 22 vi 1975, *Katik* LAE 62262 (E, K, L); **Madang Province:** Wanang Village, 115 m a.s.l., 29 x 2008, *Ctvrtecka* 2971 (K); Josephstaal FMA area, 160 m a.s.l., 5 viii 1999, *Takeuchi* et al. 13764 (K, L).

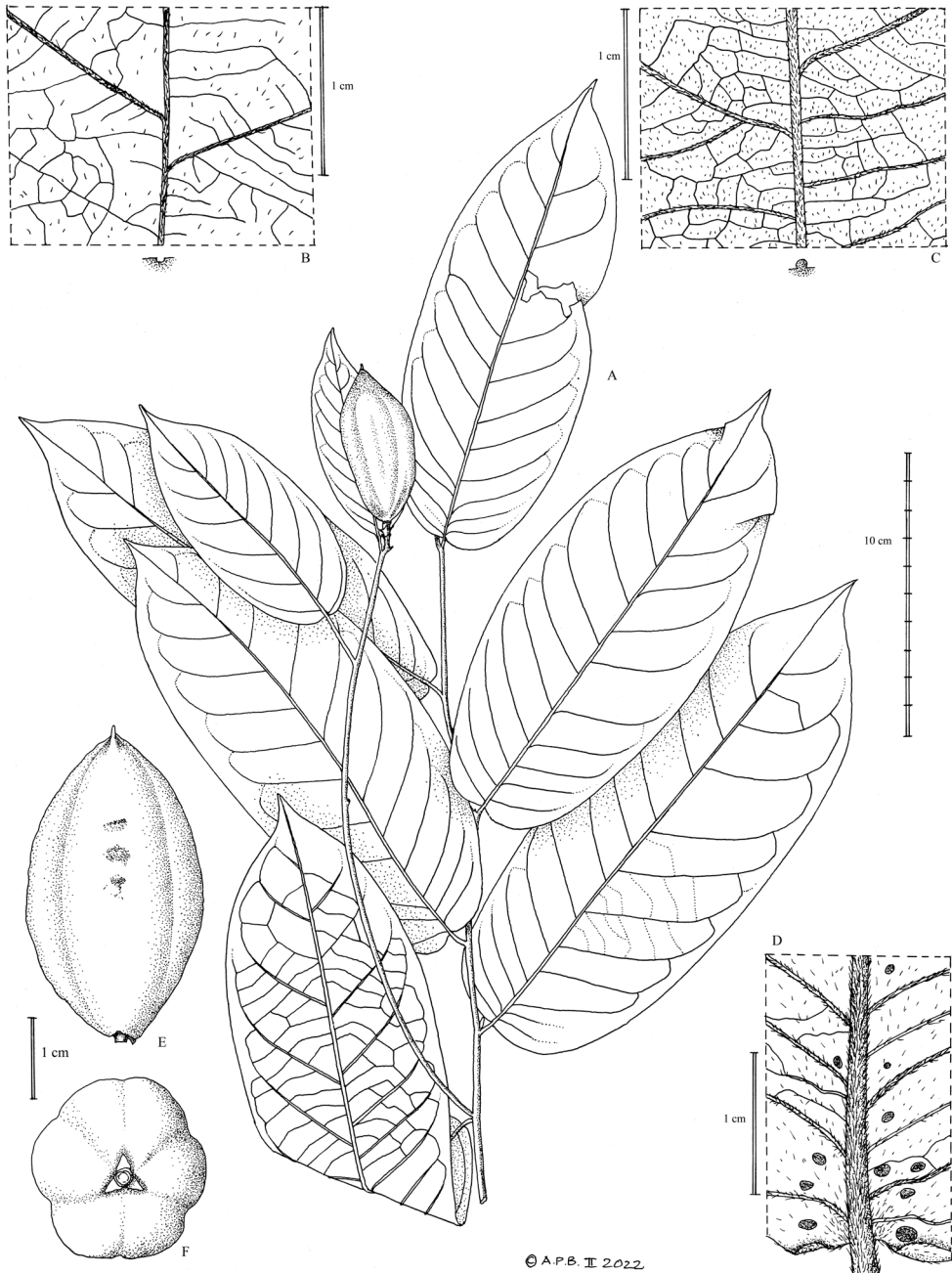


Figure 1. *Diospyros multimaculata* C.Puglisi, sp. nov. A, Habit; B, upper leaf surface and profile of midrib; C, lower leaf surface and profile of midrib; D, detail of the glands at the base of the leaf on the lower surface; E, side view of the fruit; F, basal view of the fruit, showing the persistent calyx. Drawn by Andrew P. Brown from the type collection, *Streimann & Kairo* NGF 39283 (K) (A–C) and *Takeuchi et al.* 13764 (K) (D–F).

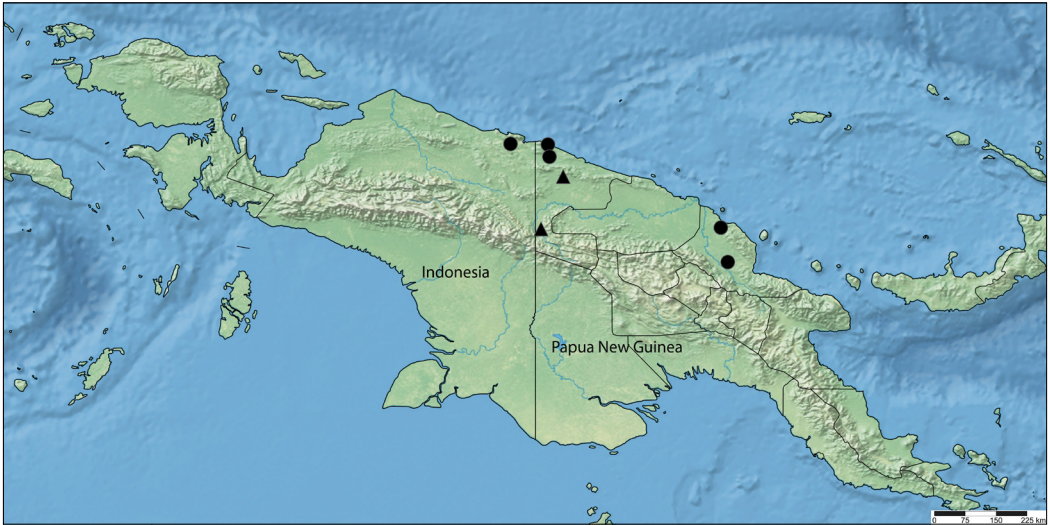


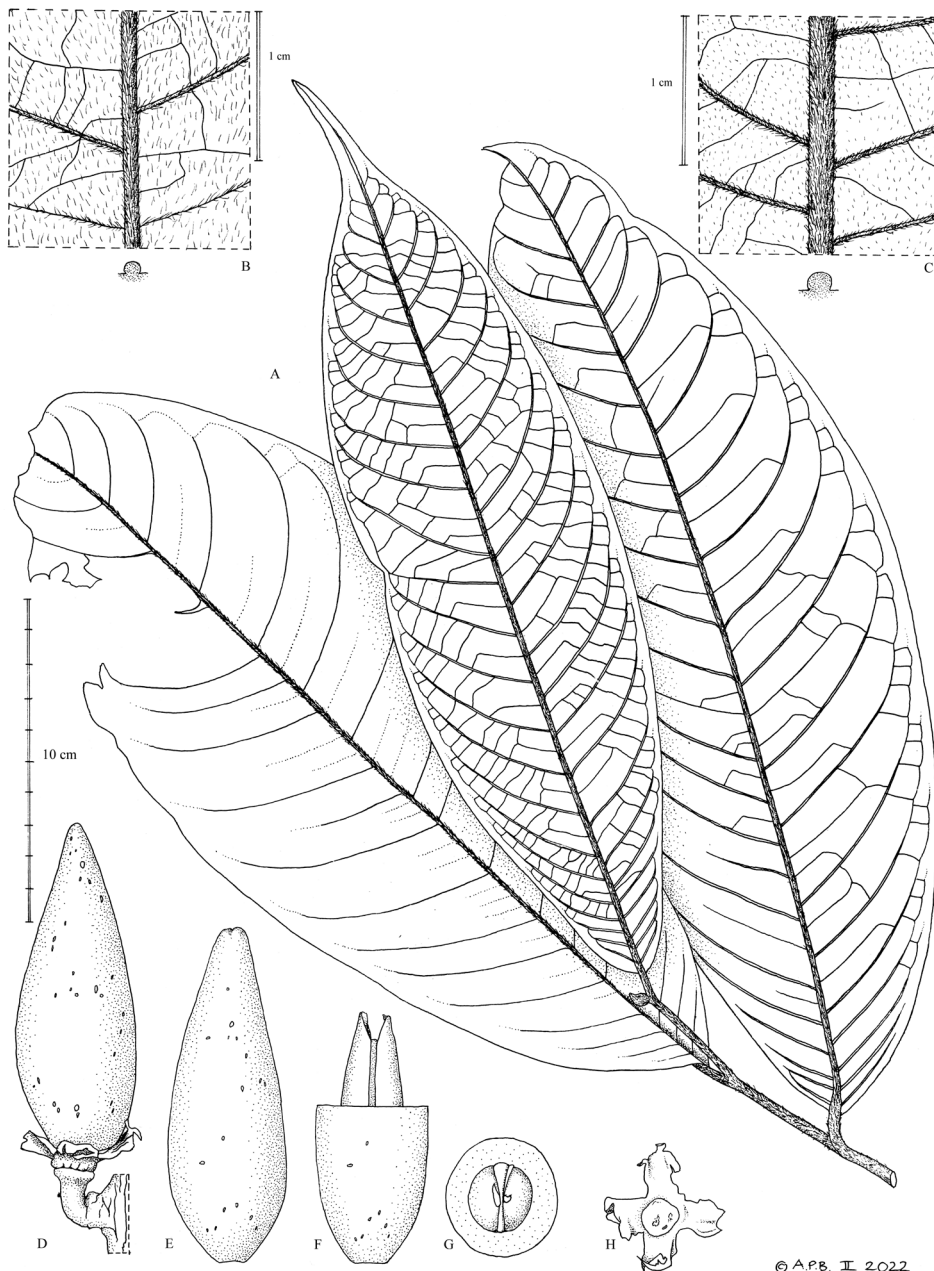
Figure 2. Map showing the distribution of *Diospyros multimaculata* (●) and *D. tehno* (▲) in New Guinea.

***Diospyros tehno* C.Puglisi, Jimbo & Hagwood, sp.nov.**

Diospyros tehno is similar to *Diospyros fusicarpa* Bakh. in the shape of the fruit, the cauliflory and the overall leaf texture. It differs in the leaf being hairy on both sides (vs glabrous above and hairy only along the midrib below in *Diospyros fusicarpa*), the pronounced midrib on the upper side (vs very slightly so or flat in *D. fusicarpa*), and the pigmentation which is light green (fresh) or mid-brown (dry) on the lower side (vs reddish when fresh and amaranth brown when dry in *D. fusicarpa*). – Type: Papua New Guinea, Sandaun (West Sepik) Province, Kwima – Wara John, 125 m a.s.l., 17 v 2018, Jimbo, Hagwood, Sule, Aika, Maharape, Cook LAE 91326 (holotype LAE, isotype K).

Figures 3, 4.

Small tree to 3 m high, bark black, younger stems densely tomentose; terminal bud c.0.5 cm long, broadly conical. Leaves simple, alternate; petiole 7–10 mm long, 3–3.5 mm thick, densely tomentose, slightly flat above; lamina dark green above (silver brown when dry), light green beneath (mid-brown when dry), elliptic to obovate, 30–35 × 8–11.5 cm (only three mature leaves seen), base broadly acute, apex acuminate; indumentum simple on both sides, denser along the venation, and including small, widespread, superficial, pale glands which are more noticeable on the lower surface; black pitted glands absent; midrib raised on both sides, secondary veins weakly raised above, more pronounced beneath, visibly anastomosing through serial scalariform tertiary veins, these inconspicuous above and weakly raised beneath. Inflorescences and flowers not seen. Female trees cauliflorous, inflorescences probably multiflorous. Fruiting calyx tetramerous, tube c.0.6 cm long, conical,



© A.P.B. II 2022

Figure 3. *Diospyros tehno* C.Puglisi, Jimbo & Hagwood, sp. nov. A, Habit; B, upper leaf surface and profile of midrib; C, lower leaf surface and profile of midrib; D, fruit, showing attachment to the tree trunk; E, fruit, side view with calyx removed; F, dissected fruit, showing the seeds; G, apical view of the fruit dissection; H, apical view of the calyx, showing the fruit attachment. Drawn by Andrew P. Brown from the type collection, *Jimbo, Hagwood, Sule, Aika, Maharape, Cook LAE 91326* (K).



Figure 4. *Diospyros tehno* C. Puglisi, Jimbo & Hagwood. A, Fruit; B, cauliflorous stem; C, leaves. All photographs of the type collection, Jimbo, Hagwood, Sule, Aika, Maharape, Cook LAE 91326 (LAE), taken by T. Jimbo and A. Hagwood.

lobes spreading, oblong-ovate, apex acute, rigid, c.1 cm wide at base, at least 1.7 cm long (no entire calyx lobes seen); tube and basal part of the lobes hairy outside and inside, the distal portion glabrescent outside, sparsely hairy inside. *Fruit* fleshy, turbinate, red, pilose with a fine upright indumentum, c.10.7 × 3.8 cm, narrower at the base and acute at the apex, epicarp smooth, held upright from the trunk. *Seeds* 2, c.6.5 cm long, turbinate, dark brown, surface minutely punctate.

Distribution. New Guinea (see [Figure 2](#)).

Etymology. The epithet is the local name of this tree in the Abau language.

Other specimen examined. PAPUA NEW GUINEA. Sandaun (West Sepik) Province: Utai Station, Nuya Forest Area, 206 m a.s.l., 19 iii 2018, *Jimbo & Magun* LAE 91714 (LAE).

Key to Diospyros species from New Guinea and the Moluccas with large, chartaceous leaves

- 1a. Leaf glabrous above and reddish purple beneath, fruit fusiform with caudate apex *D. fusicarpa*
- 1b. Character combination not as above _____ 2
- 2a. Mature fruit globose to oblate, lobes of fruiting calyx very large and leafy, young leaves conspicuously hairy _____ *D. pulchra*
- 2b. Character combination not as above _____ 3
- 3a. Leaf base subcordate, black pitted glands at leaf base conspicuous _____ 4
- 3b. Leaf base acute to narrowly obtuse, black pitted glands inconspicuous to absent ____ 5
- 4a. Fruit densely colliculate, leaf apex broadly acuminate or acute, black pitted glands at leaf base small and not densely clustered, [Moluccas] _____ *D. rostrata*
- 4b. Fruit smooth, leaf apex narrowly acuminate, black pitted glands at leaf base densely clustered, [New Guinea] _____ **D. multimaculata**
- 5a. Petioles < 5 mm long, fruiting calyx 3-merous, fruit apex obtuse _____ *D. janowskyi*
- 5b. Petioles >6 mm long, fruiting calyx 4-merous, fruit apex acute _____ **D. tehno**

Acknowledgements

We would like to thank the curators and staff of Naturalis and the Royal Botanic Garden Edinburgh for their support during research visits and in loaning specimens, and Dr Himmah Rustiami (Herbarium Bogoriense) for providing specimen images. T.J. and A.H.'s expedition was kindly sponsored by a National Geographic Early Career Grant and a US Fulbright Study/Research Award. The findings presented in this paper do not reflect the views of the National Geographic Society nor those of the US Department of State. The authors are

grateful to the people of Yapsiei Station and Kwima for their hospitality and for sharing their time and knowledge with us. Inock Aika, Benson Wairom and Andy Mai provided extraordinary help as field assistants throughout our expedition. We wish to thank staff at the Papua New Guinea National Herbarium and Forest Research Institute in Lae, particularly Robert Kiapranis, Kipiro Damas, Peter Homot, Penniel Lamei, Bernard Sule and Thomas Magun, for their support.

ORCID iDs

Carmen Puglisi  <https://orcid.org/0000-0003-0304-1812>

Tiberius Jimbo  <https://orcid.org/0000-0003-0651-5307>

References

- Bakhuizen van den Brink RC. 1933. Enumeration of Malayan Ebenaceae. *Gardens' Bulletin, Straits Settlements, Singapore*. 7:161–189, pl. 48–50.
- Bakhuizen van den Brink RC. 1936–1955. *Revisio Ebenacearum Malayensium*. *Bulletin du Jardin Botanique de Buitenzorg, Série 3*. 15:1–515. Published in parts. Vol. 1:1–49 (1936). Vol. 2:49–178 (1937). Vol. 3:179–368 (1938). Vol. 4:369–515 (1941). Vol. 5:i–xx, pl. 1–92 (1955).
- Cámara-Leret R, Frodin DG, Adema F, Anderson C, Appelhans MS, Argent G, Guerrero SA, Ashton P, Baker WJ, Barfod AS, *et al.* 2020. New Guinea has the world's richest island flora. *Nature*. 584:579–583. <https://doi.org/10.1038/s41586-020-2549-5>
- Deblauwe V. 2021. Life history, uses, trade and management of *Diospyros crassiflora* Hiern, the ebony tree of the Central African forests: a state of knowledge. *Forest Ecology and Management*. 481:118655. <https://doi.org/10.1016/j.foreco.2020.118655>.
- Kostermans AJGH. 1977. Notes on Asiatic, Pacific, and Australian *Diospyros*. *Blumea*. 23:449–474.
- POWO. 2021. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet. <http://www.plantsoftheworldonline.org/> [Retrieved 27 July 2021.]
- Thiers B. Continuously updated. Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/science/ih/> [Accessed 5 August 2021.]
- Wallnöfer B. 2001. The biology and systematics of Ebenaceae: a review. *Annalen des Naturhistorischen Museums in Wien. Serie B, Botanik und Zoologie*. 103:485–512.