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SHORT COMMUNICATION

Eriobotrya balgooyi (Rosaceae), a new obligate ultramafic endemic from Kinabalu Park, Borneo

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Background – The still highly incomplete floristic knowledge of ultramafic outcrops in Borneo has been emphasised. Specialised investigation often turns in novel discoveries and in Kinabalu Park, Malaysian Borneo, the recent completion of a floristic inventory has facilitated such research.
Methods – Normal practices of herbarium taxonomy have been applied (using material from K, L, MSC, SING and the Kinabalu Park Herbarium).
Results – *Eriobotrya balgooyi* (Rosaceae) is a new species described from Sabah, Malaysian Borneo. It is an obligate endemic to ultramafic soils on a hill near the eastern ridge of Mount Kinabalu and on nearby Mount Tambuyukon, both localities within Kinabalu Park, a World Heritage Site. The new species illustrates a growing list of rarities from the little-documented flora of ultramafic soils that form significant outcrops in northern Borneo, and for which urgent study is needed.

Key words – Extreme environments, loquat, Mount Kinabalu, Mount Tambuyukon, narrow endemics, peridotite, rare species, Sabah, Southeast Asia, taxonomy, World Heritage Site.

INTRODUCTION

Insular Southeast Asia is a region that includes New Guinea, Borneo and Sumatra, three of the world's four largest tropical islands, amid some 25,000 islands making up the world's largest archipelago straddling two continental shelves and the equator. Its western continental shelf, Sunda, is one of the acknowledged biodiversity hotspots within this region (Myers et al. 2000). On Sunda, Borneo is the largest island with probably the richest plant life. Kier et al. (2005) regard the Borneo lowlands ecoregion as the number one hotspot in the world as it is the only ecoregion to surpass 10,000 plant species, while Barthlott et al. (2007) consider North Borneo as one of the top five biodiversity centres in the world. Recent reviews of the biogeographical significance of this region include those by Lohman et al. (2011) and Wong (2011).

The northern part of Borneo mainly comprises the Malaysian state of Sabah, across which, from the north stretching southwards and then following an arc to the east of the state, are major ultramafic outcrops (Van der Ent 2011). In its northwestern portion, this ultramafic belt outcrops in the iconic Kinabalu Park, a World Heritage Site that includes the high mountains Kinabalu (4095 m) and Tambuyukon (2579 m) (fig. 1). There is no completely documented flora of Borneo, although the regional Flora Malesiana and local flora and checklist projects are in progress (Wong 1995). Here the towering Mount Kinabalu (itself granite), a geologically young mountain pushed up over 7 million years by crustal deformation processes in northwest Borneo (Hall et al. 2008), together with its sister peak, have fired the interest of naturalists and scientists interested in its vegetation, natural history and intense species richness since the late 19th century (Stapf 1894, Wong & Phillipps 1996, Van der Ent 2013). One of the most acclaimed botanical documentations of any one tropical site was that led by Professor John Beaman, culminating in the fifth and final volume (Beaman & Anderson 2004) of a work that records over 5000 species of vascular plants. In effect, the physiographically complex Kinabalu Park protects one of the richest floras known worldwide (Barthlott et al. 2007, Beaman 2005).

The still highly incomplete floristic knowledge of ultramafic outcrops has been emphasised (Van der Ent 2011), and recent taxonomic revisions of various plant families or floristic inventories such as for Kinabalu have helped reveal the existence of distinct taxa restricted to this substrate type (Beaman & Beaman 1990, Wong 1998). However, the flora of ultramafic substrates in Sabah is still poorly known and, often, each specialised investigation turns in novel discoveries. Ultramafic rocks have a mantle origin and are rich in mafic minerals (magnesium and iron, and enriched in nickel, cobalt and chromium) producing shallow and stony soils at high elevations, which can be phytotoxic and that many

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plant species find inhospitable, but some others specially adapt to. The kind of ultramafic rock common in Sabah and Kinabalu Park is peridotite, and this rock-type is invariably serpentinised (a metamorphic reaction during emplacement that alters its chemical and mineralogical properties). On high mountains the occurrence of ultramafics in upper montane or even near-alpine environments produce an extreme environment where substrate phytotoxicity, concomitantly with the effects of high elevation, may partly explain the stunting of vegetation at such sites. In such environments, reproductive isolation of plant populations leads to the selection of some distinct, even bizarre forms, eventually stimulating the evolution of so-called 'edaphic endemics'.

Here we describe a highly distinctive but rare species of *Eriobotrya* Lindl., which is known only from an ultramafic hill on the south-eastern side of Mount Kinabalu and from the upper montane slopes of Mount Tambuyukon, an entirely ultramafic mountain composed of peridotite. It might be emphasised that the Mount Kinabalu site, Bukit Babi, is an ultramafic outcrop not part of the granitic Eastern Ridge, but wedged in by the tilloid deposit of the Pinosuk Plateau.

Eriobotrya is the genus of the *loquat*, a long-cultivated fruit tree of the orient. The new species was first collected by Professor John Beaman of Michigan State University in May 1984 (fig. 2). Subsequently it was recollected in 2011–2012 during fieldwork led by the second author (A. van der Ent), investigating the ecology of vegetation communities on ultramafic areas in Kinabalu Park. The new species is named for Dr M.M.J. (Max) van Balgooy of the Naturalis Biodiversity Centre in Leiden, The Netherlands, a renowned student of Pacific plant geography and a foremost specialist in Malesian plant identification, who first diagnosed the correct genus of this taxon for Professor Beaman in 2002.

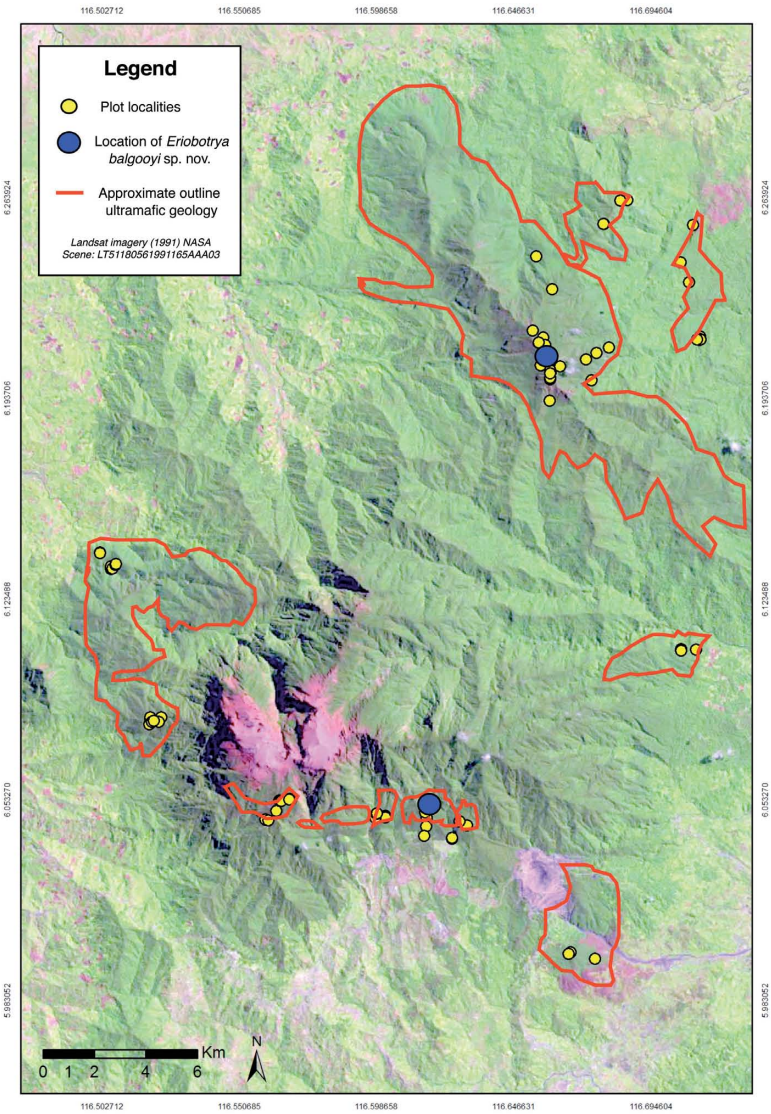

Figure 1 – General terrain in the Kinabalu Park area, showing Mount Kinabalu to the south-west, and the Tambuyukon Range to the north-east; approximate extents of ultramafic geology; plot localities for tree enumeration studies; and the locations of *Eriobotrya balgooyi*. Using infrared false colour composite, pink indicates bare rock or soil. (Base map from Landsat imagery (1991) NASA, United States).

THE NEW SPECIES DIAGNOSED AND DESCRIBED

Eriobotrya balgooyi K.M.Wong & Ent, **sp. nov.**

This new species has some resemblance to *E. bengalensis* (Roxb.) Hook.f. but differs in its much smaller thick-coriaceous leaves that are 2–6.2 cm long and 1.5–4.7 cm wide; much reduced panicle in which the rachis is only 1–2 cm long with short primary branches hardly 1 cm long; generally subglabrous inflorescences; and much smaller fruits just 9–15 mm long and 8–12 mm wide. (*E. bengalensis* has larger, thinner leaves; longer panicles with longer branches of at least several cm long, distinctly hairy inflorescences, and larger fruits of 2–3 cm across.). – Type: Malaysia. Sabah, Ranau District, Bukit Babi [Pig Hill] on south-east side of Mount Kinabalu, 6°03'N 116°36'E, 2000–2300 m elevation, *Beaman* 9871 (holo-: K; iso-: MSC).

The following description is based on field notes and measurements using herbarium (dried) material:

Small multi-branched tree or shrub to 0.5–2 m high, stems to 3–4 cm thick at their base; branching proleptic, with each new branch axis bearing reduced bract-like leaves before the normal foliage leaves, branch segments 2.5–10 cm long, with 4–5 closely spaced branches per episode. Leaves spirally inserted on branches and often crowded along the distal portions 20–30 cm long; petioles very short to inconspicuous, only 1.5–2.5(–3) mm long; leaf blades broad-elliptic to obovate, base rounded to subcordate, apex acute to obtuse, 2–6.2 × 1.5–4.7 cm, thick-coriaceous, slightly bullate between secondary veins, margin sparsely but conspicuously serrate; dark green with reddish purple veins, drying straw-yellow; secondary veins 5–8 pairs, arching slightly and often reaching the margin, with some forming angular vein loops just before the margin; fine venation conspicuously reticulate-areolate. Stipules 2 per leaf, narrowly triangular, to 3.5–4 mm long, coriaceous, inserted beside the petiole base and fused slightly at their bases in the axillary position; semi-persistent even after leaf-fall. Inflorescence terminal, a reduced panicle with rachis 1–2 cm long and 2–2.5 mm thick, with 1–10 short primary branches 1–8 mm long with inconspicuous rebranching; subglabrous. Flowers bisexual, actinomorphic; pedicels 1–2 mm long; hypanthium obconical, 2–2.5 mm long, with sparse appressed pale brown hairs; sepals 5, triangular, 1.5–2 mm long, glabrous; petals 5, free, obovate, clawed, 3.5–4.5 mm long, 2.5–3 mm wide, each with 6–7 conspicuous longitudinal veins; glabrous; stamens 20, free, filaments fine, 2–3 mm long, glabrous; anthers rounded, c. 0.5 mm across; style 1, 2.5–3.5 mm long. Infructescence with rachis 1.3–2.5 cm long and 2.5–3.5 mm thick, primary branches 3–12(–18) mm long, sometimes with 1–5 secondary branches 2–4 mm long. Fruits ovoid-globose, 9–15 mm long, 8–12 mm wide, crowned by 5 thick triangular erect persistent sepals to 2 mm long forming an apical beak.

Figure 3 shows the habitat, habit and flowering and fruiting features of *E. balgooyi*.

Other specimens examined – **Borneo**: Sabah, Kinabalu Park, Mount Tambuyukon, main summit ridge, 2487 m elevation, 14 Apr. 2011, *Van der Ent et al. SNP* 24531 (Kinabalu Park Herbarium, SING), ibid., 2499 m elevation, 4 May 2011, *Van der Ent et al. SNP* 25940 (Kinabalu Park Herbarium, SING); near top of 2nd summit, 2535 m elevation, 6 May 2011, *Van der Ent et al. SNP* 26155 (Kinabalu Park Herbarium, L, SING).

Habitat and ecology – *Eriobotrya balgooyi* is found exclusively in vegetation on shallow ultramafic soils, known from an ultramafic hill (Bukit Babi) at the foot of the granitic east ridge of Mount Kinabalu, as well as in the ligneous scrub on the ultramafic summit ridge of Mount Tambuyukon. On Tambuyukon, it occurs in dense species-rich scrub (1–2 m tall), on exposed ridges at 2420–2560 m a.s.l. Co-occurring species (ligneous dwarf scrubs) include: *Styphelia malayana* J.J.Sm., *Weinmannia clemensiae* Steenis, *Leptospermum javanicum* Blume, *Wikstroemia indica* (L.) C.A.Mey, *Lithocarpus rigidus* Soepadmo, *Podocarpus brevifolius* Foxw. and *Scaevola verticillata* Leenh.

Across the Kinabalu-Tambuyukon massifs, the high elevations, deeply dissected, precipitous topography with frequent landslides, coupled with the effects of past disturbance brought by Pleistocene climate change and drought episodes, could have contributed to high selective pressure that partitioned species populations and promoted adaptive speciation (Beaman & Beaman 1990, Beaman 2001). Closely related species occupying different elevation ranges, such as species pairs or sets in *Dacrycarpus*, *Dacrydium* (Podocarpaceae), *Leptospermum* (Myrtaceae), and *Machaerina* (Cyperaceae), suggest either ecological vicariance or competitive displacement of less successful alleles with similar resource-use profiles (Lee & Lowry 1980, Kitayama 1996).

This new *Eriobotrya* is but one of a growing list of species restricted ('obligate') to ultramafic sites, the occurrence of which is patchy and surrounded by sedimentary geology where different communities grow, and in which populations are subjected to edaphic pressures, and the isolation associated with a habitat island effect. Its nearest known congener, *E. bengalensis*, has also been recorded for Borneo, in Sarawak and East Kalimantan (Kalkman 1973), and is a more widespread species across the region, distributed from Northeast India (Lalfakawma et al. 2009) across to Northeast Thailand (Lamotte et al. 1998), South China and Indochina (Gu & Spongberg 2003, Liu et al. 2003), and the Malay Peninsula (on limestone) (Chin 1973). It seems therefore of interest to subsequently be able to test the hypothesis that *E. balgooyi* is a derivative of the more common *E. bengalensis*. Relicts from other lineages have likewise persisted and radiated on high mountains in western Malesia (Bramley et al. 2004). Here we have employed the Biological Species Concept, where discontinuous gaps in morphological variation have been taken to result from underlying reproductive isolation, because a lack of gene flow would prevent different lineages from homogenising (Coyne & Orr 2004, Mallet 2008). Thus, based on morphological evidence, differences between the new taxon here and *E. bengalensis*, in both vegetative as well as reproductive characters, would imply that these are distinct, although perhaps related, species.

Rarity and conservation status – On Mount Tambuyukon, the new *Eriobotrya* has only been found on the main summit ridge, an area of just few hundred square-meters, and only 50–100 individuals have ever been seen. It is therefore an obligate ultramafic endemic species. There is no further information of the population on Bukit Babi apart from the specimen collecting details, but this locality is several hours'

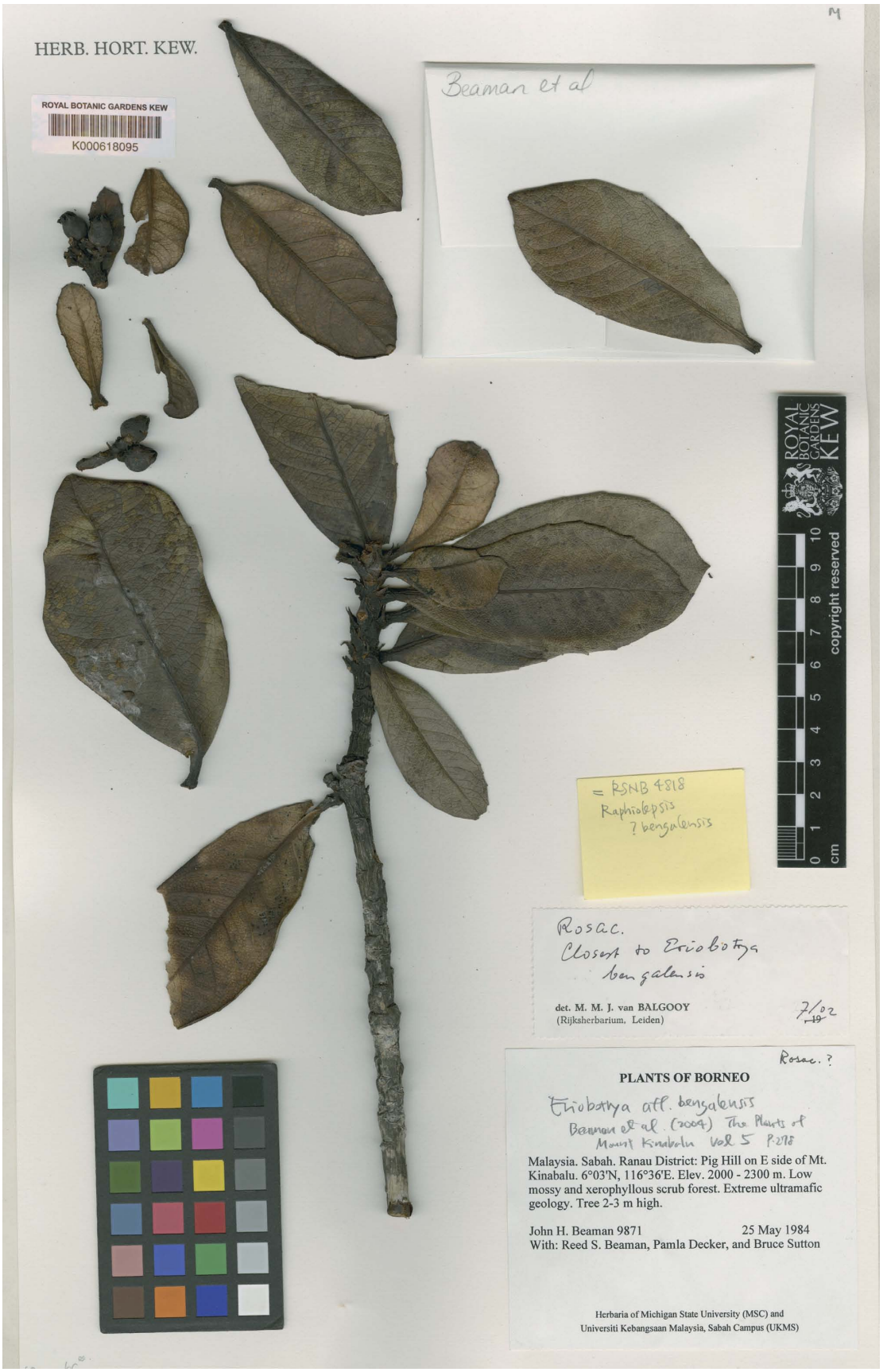

Figure 2 – The type collection of *Eriobotrya balgooyi* at Kew (Courtesy Royal Botanic Gardens, Kew).

walk from the Mesilau Nature Resort and so seems to be well protected. Overall, at this time, the IUCN category of 'Least Concern' (IUCN 2001) appears to be applicable, because the known populations are protected within the Kinabalu Park system and no imminent threats present themselves. However, the extreme localisation of its occurrence means that potential catastrophic events, such as major forest fires, known to occur periodically and associated with intense El-Niño induced droughts and climate change, could threaten the only known populations.

Relationships – *Eriobotrya* was classified in subtribe Pyrinae Dumort. in subfamily Spiraeoideae C.Agardh, one of three subfamilies recognised for the Rosaceae by Potter et al. (2007). However, revisions to Article 19 of the International Code for Algae, Fungi, and Plants (McNeill et al. 2012) dictate that these taxa should be designated as Malinae Reveal and Maleae Small, in subfamily Amygdaloideae Arn. The subtribe is distinguished by having a hypanthium that is adnate to more than half of the ovary, 20 stamens in the flower, a pome as the typical fruit type, and prismatic crystals in the axial parenchyma (Potter et al. 2007). It is phylogenetically close to *Rhaphiolepis* Lindl. (Potter et al. 2007, Yang et al. 2012) and intergeneric hybridisation has been documented (Coombes & Robertson 2008); the two genera are nevetheless separable by the more persistent stipules and persistent apical fruit sepals found in *Eriobotrya* (figs 2 & 3F), compared to early caducous stipules and fruit sepals in *Rhaphiolepis*. Both these genera overlap in their distribution through parts of temperate and subtropical East Asia to mainland Southeast Asia, where they seem to be most diverse, and peter out into the Malesian region (Kalkman 1973, 1992). Relationships within *Eriobotrya*, currently with some thirty species, are not yet clearly resolved and it is not possible to say which species seem most closely related to the Kinabalu Park taxon, although species distributions (above) suggest *E. balgooyi* and *E. bengalensis* could be closely related.

Figure 3 – Habitat and features of *Eriobotrya balgooyi*: A, high-altitude vegetation along the summit ridge of Mount Tambuyukon, with the main summit (2579 m a.s.l.) in the background; B, extreme species-rich ligneous scrub on Mount Tambuyukon, the primary habitat of *E. balgooyi*, with blocks of peridotite bedrock clearly visible; C, side view of a flowering branch of *E. balgooyi*, note that the leaves are borne in rosette-like clusters at the distal branch portions; D, top view of the compact inflorescence of *E. balgooyi*; E, close up of *Eriobotrya balgooyi* flowers; F, infructescence of *E. balgooyi.* (Photographs by A. van der Ent, except C & E by Rogier van Vugt).

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