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Seringia (*Byttneriaceae* / *Malvaceae-Byttnerioideae*) new to Southeast Asia and *S. botak* endangered in Indonesian New Guinea grassland and savannah

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Key words

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Gunung Botak
nickeliferous
seedbank
Tangguh LNG Project

Abstract *Seringia botak* Cheek sp. nov., based on a collection made by the authors in 2017, is described from metalliferous grassland and savannah habitats in Indonesian New Guinea. Initially this appeared to be the first verified record of *Seringia* from SE Asia and to extend the range of the genus c. 1 500 km further north than the previously recorded northern limit in Northern Territory, Australia. Further research, however, showed two previous specimens of the taxon from New Guinea, which had been overlooked. The extinction risk of *Seringia botak* is assessed as Endangered using the IUCN 2016 standard.

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INTRODUCTION

At the end of a mission to research *Nepenthes* L. in Indonesian New Guinea in June 2017 (Cheek et al. 2018) an excursion was made to Gunung Botak. Gunung Botak, two hours southeast of Manokwari by road, is a popular destination for local touristic daytrips. It comprises four ridges that descend gradually into the sea from the north coast of New Guinea. The ridges of Gunung Botak are remarkable, in a country blanketed with evergreen forest, for being treeless, presumably owing to the reputedly nickeliferous, phytotoxic substrate.

During the mission, seeds were collected for the Indonesian Seed Bank (Cheek 2017a). Among the species of which seed was collected at Gunung Botak was a thicket-forming roadside shrub. The herbarium voucher specimen, *Cheek 18779*, is identified in this paper as a new species of *Seringia* J.Gay (*Byttneriaceae* or *Malvaceae-Byttnerioideae*). Searching the Naturalis specimen website resulted in what appeared to be a second specimen of the same taxon collected a few years earlier, also in Indonesian New Guinea, c. 135 km from the first, in savannah: *Takeuchi et al. 15719* (misidentified as *Keraudrenia corollata* (Steetz) Druce. This identification was confirmed when the specimen arrived on loan from L to K.

Seringia consists of one species in Madagascar and 20 in Australia (Wilkins & Whitlock 2016). This investigation initially appeared to be the first evidenced, published record of the genus from SE Asia. Previous records of the genus from New Guinea have been unsubstantiated by specimens (Wilkins & Whitlock 2016). However, a reviewer pointed to an earlier record, overlooked by Wilkins & Whitlock (2016) and all other authors, of what is almost certainly the same species, also at Gunung Botak, that of *Kanehira & Hatusima 12963, 13205* (Merrill & Perry 1949, discussed below).

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Traditionally, *Seringia* was regarded as monotypic and close to the genus *Keraudrenia* J.Gay. Wilkins & Whitlock (2016) united the latter with the former on morphological grounds after a careful and detailed monographic revision. Both genera had been included within tribe *Lasiopetaleae* of *Sterculiaceae* in *Malvales*. Phylogenetic analysis of the four families of core *Malvales* (*Malvaceae*, *Bombacaceae*, *Tiliaceae* and *Sterculiaceae*) by Baum et al. (1998) and by Bayer et al. (1999) showed that while the monophyly of traditional *Malvaceae* and *Bombacaceae* (excluding *Durionaceae*) was unchallenged, *Grewioideae* of former *Tiliaceae* are more closely related to *Byttnerieae* of former *Sterculiaceae* than to the rest of the former *Tiliaceae*.

The solution is to recognise either nine subfamilies in a super-*Malvaceae* as proposed by Bayer et al. (1999) and maintained in Bayer & Kubitzki (2003), or to recognise nine, not four families in the core *Malvales* (Baum et al. 1998, Cheek 2007b, 2017b, Cheek & Dorr 2007, Cheek et al. in press). Under the second option, preferred here, *Seringia* is placed in the *Byttneriaceae*, sister to *Sparrmanniaceae* (Cheek 2007c). *Byttneriaceae* is a pantropical family of c. 650 species in c. 24 genera best known for the genus *Theobroma* L. from which chocolate is produced (Cheek 2007a).

The *Byttneriaceae* have been divided into three tribes since the 19th century: *Hermannieae*, *Byttnerieae* and *Lasiopetaleae* (Cheek 2007a). The first two are both centred in tropical Africa and America, the last in Australia. Wilkins & Whitlock (2016) give a key to the nine genera of *Lasiopetaleae*. All are restricted to Australia, apart from *Maxwellia* Baill. (New Caledonia) and both *Commersonia* J.R.Forst. & G.Forst., and *Seringia* which have outliers in Madagascar and (*Commersonia*) SE Asia and the Pacific. *Cheek 18779* clearly falls in *Seringia* since it lacks a distinct epicalyx, has styles free, inconspicuous highly reduced petals, staminal filaments prominent and yellow with short simple hairs on the abaxial surface, and anthers with vertical slit dehiscence.

With the key to species of *Seringia* in Wilkins & Whitlock (2016), *Cheek 18779* keys out to *S. corollata* Steetz since the inner surface of the calyx lacks glandular hairs and instead has dense stellate hairs which are appressed and fan-shaped, and

because glandular hairs are concealed below the stellates on the abaxial surface of the calyx, on the stems and on the upper leaf surface. Indeed, *Takeuchi et al. 15719* had been previously identified as *Keraudrenia corollata* (Steetz) Druce (≡ *S. corollata*). Because *Cheek 18779* and *Takeuchi et al. 15719* do have conspicuous long glandular hairs along the margins of the calyx and leaf-blade, they do have resemblances to *S. adenolasia.* Yet, *Cheek 18779* and *Takeuchi et al. 15719* do not match reference material of *S. corollata* or *S. adenolasia*, differing from that species (and all others of the genus) in having uniformly 1-flowered inflorescences, not 2–5 or more-flowered. The new taxon also differs from *S. corollata* in having a dense band of long-stalked glandular hairs on the margin of both calyx and leaf-blade, and in the densely orange-brown tomentose indumentum of the young stems, clothed in massive (2 mm diam) robust stellate hairs exceeding in size those recorded by Wilkins & Whitlock (2016) in other species of the genus. Accordingly, it is here described as new to science as *S. botak.*

New plant species are still steadily being described from Indonesian New Guinea. Recent examples are Schuiteman & De Vogel (2011), Schuiteman (2013, 2015), Juswara et al. (2016), Hambali et al. (2017), Schuiteman & Wanma (2017), Cheek et al. (2018).

The number of flowering plant species known to science is disputed, [with published figures varying widely depending on the method of estimation (Nic Lughadha et al. 2017),] but a reasonable estimate is 369 000 (Nic Lughadha et al. 2016), while the number of species described as new to science each year has been fairly constant in the 21st century, regularly exceeding 2 000 (RBG Kew, 2016).

Approximately 5 % of known plant species have been assessed for their global extinction risk following the IUCN (2012) 'gold standard' categories and criteria, with the results being published on the IUCN Red List. This number rises to 21–26 % when evidence-based assessments beyond those on IUCNs global list are considered, and 30–44 % of these assessments consider the species assessed to be threatened (Bachman et al. 2018). Newly discovered species such as that reported in this paper, are increasingly likely to be threatened, since widespread species tend to be discovered sooner. [Although there are notable exceptions to this rule (e.g., De Oliveira et al. 2013).] Generally speaking, it is the more localised, rarer species that remain undiscovered. This makes it all the more urgent to discover, document and protect such species before they become extinct.

MATERIALS AND METHODS

Nomenclatural changes were made according to the Code (McNeill et al. 2012). Names of species and authors follow IPNI (continuously updated). Herbarium material was examined with a Leica Wild M8 dissecting binocular microscope fitted with an eyepiece graticule measuring in units of 0.025 mm at maximum magnification. The drawing was made with the same equipment with a Leica 308700 camera lucida attachment. Specimens were inspected from the following herbaria: BM, BO, K, L, MAN and P. Those for L were first accessed via the Naturalis bioportal website: http://bioportal.naturalis.nl. The format of the description largely follows those in Wilkins & Whitlock (2016) modified to Blumea format. Specimens cited have been seen unless indicated 'not seen'. The conservation assessment follows the IUCN (2012) standard. Herbarium codes follow Index Herbariorum (Thiers, continuously updated).

RESULTS

Seringia botak Cheek, *sp. nov.* — Fig. 1, 2

Differs from all other known species of *Seringia* J.Gay in having uniformly 1-flowered inflorescences (not 2–many-flowered). Differing from those species with appressed, fan-shaped stellate hairs on the adaxial surface of the calyx (*S. adenolasia* F.Muell., *S. corollata* Steetz and *S. hookeriana* (Walp.) F.Muell.) in the dense long-stalked glandular hairs at margins of calyx and leaf-blade, and in the large (2 mm diam) brown, dense stellate hairs on the stems. — Type: *Cheek 18779* (holo MAN; iso BO, K, L), New Guinea, Indonesia, West Papua Province, SE of Manokwari, Manokwari Regency, Ransiki District, Gunung Botak, S1°38'44.69" E134°05'27.54", fl., fr. 25 June 2017.

Etymology. Named as a noun in apposition for the type locality, Gunung Botak (meaning Bald Mountain) where the authors discovered this species and which is a possible future Important Plant Area (Darbyshire et al. 2017).

Thicket-forming shrub, probably spreading by rhizomatous growth, 1.5–2 m tall. *Stems* stiff, branching only sparingly, and only at 1 m or more above the ground. Stems erect, terete 1–1.5 cm wide at base, with side-branches ascending at c. 45° from the vertical, arising at intervals of 10–30 cm from the principal axis, internodes 1.2–1.8(–2) cm long, 0.15–0.2 mm wide; stem apices held horizontally or nodding, indumentum dense bright sessile stellate orange-brown tomentose, hairs 10–40-armed, 2 mm long, arms stiff, erect, copper-coloured, concealing sparse stalked translucent capitate glandular hairs 0.25–0.3 mm long, mixed with white erect armed stellate hairs 0.3–0.5 mm long. *Stipules* early caducous, very narrowly triangular at base, apex filiform, 4–5 by 0.5 mm wide at base, 0.25 mm wide at apex membranous, pink-brown, indumentum as stem, but shorter and sparser. *Leaves* alternate, distinctly distichous, in two ranks on each side of the horizontal or ascending stems, declinate, held 30–80° from the horizontal. *Petiole* terete c. 4 mm long, indumentum as stem. *Blade* discolorous, the upper surface dark green, rugose, lower surface bright white tomentose, narrowly oblong-lanceolate, 5–9 by 0.9–1.8 cm, base rounded, abruptly and slightly cordate, sinus 1 by 1 mm; margin flat, entire; apex acute, without apiculus. *Adaxial surface* with primary to tertiary nerves deeply impressed, 20–30 % covered in white stellate hairs of 2 size classes: 1) sparse 8-armed hairs 0.5 mm diam; 2) minute 3–5-armed erect hairs 0.1 mm diam, glandular hairs absent; margins densely glandular hairy, hairs multicellular, 0.25 mm long, translucent, head black. *Abaxial surface* with secondary nerves 8 or 9 on each side of the midrib, barely detectable, nerves with sparsely scattered large stellate hairs, white with tan centres, 12–14 stiff arms, spreading c. 1.5 mm diam, mixed with black-headed glandular hairs, the rest of the surface between the nerves completely covered in bright white arachnoid stellate hairs 0.25–0.3 mm diam, 10–15-armed, the arms fine, sinuous, entangling with each other; glandular hairs absent or extremely inconspicuous. *Inflorescence* 1-flowered, pendulous, held beneath the horizontal young stems, leaf-opposed, often two inflorescences per stem at successive nodes, opening in succession; 22–25 mm long, indumentum a mixture of four hair types: 1) large stellate hairs, c. 10-armed, arms robust erect 1.5 mm long, moderately dense; 2) glandular hairs about as long as previous, heads pale brown or black, stem translucent, with 6–10 red transverse walls; 3) small, stellate, white hairs, arms fine, sinuous, 0.25 mm tall; 4) short glandular hairs 0.1–0.25 mm long, heads white. *Bracts* (2 or) 3, caducous, pink-brown or red, inserted close to each other, in an uneven whorl, narrowly lanceolate-oblong, membranous 6–7(–8) by 1–1.5(–2) mm, apex acute, base rounded, indumentum as inflorescence axis; bracts inserted: 1) 6–8 mm from base; 2) c. 15–17 mm from base; 3) 17.5–19 mm from base. *Calyx* spreading, purple, 7–8 mm long; tube 1/8–1/9 of total calyx length; lobes ovate, longer than wide c. 7.5 by 3.5–4 mm, margin entire, apex acute. *Abaxial surface* with moderately dense, clavate, white-headed

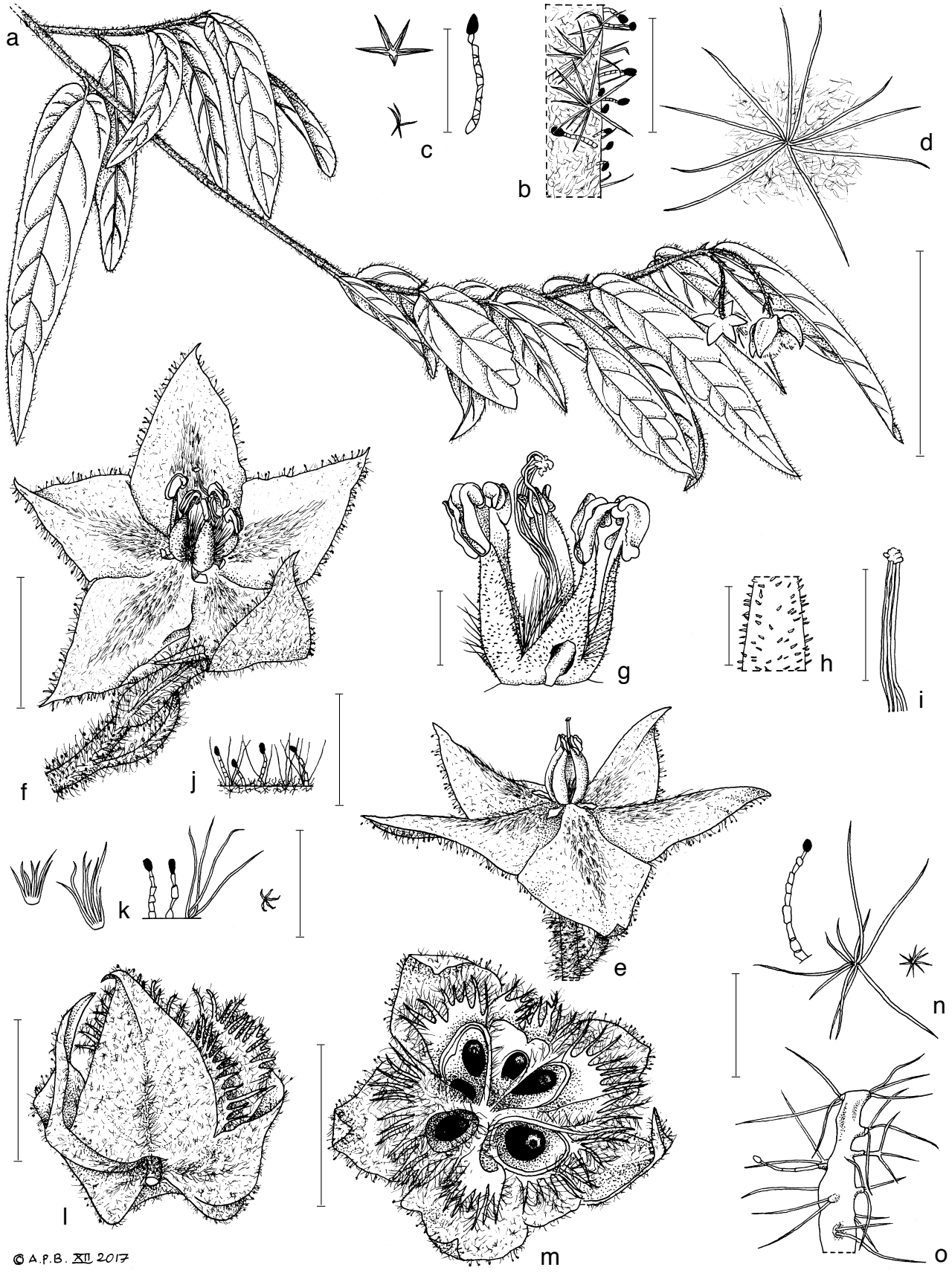

Fig.1 *Seringia botak* Cheek. a. Habit, flowering and fruiting stem; b. leaf margin detail, from abaxial surface; c. trichomes, adaxial leaf surface; d. large stellate hair, in ground of dense small stellate hairs, leaf abaxial surface; e. flower at anthesis, side view (from photo); f. flower, from above (dried specimen); g. androecium and gynoecium, petal in foreground; h. detail of staminal filament; i. detail of styles and stigmas; j. indumentum of sepal margin; k. trichome types, sepal adaxial surface; l. fruit (hydrated) inclined, from below; m. fruit, dried, from above (field photo); n. trichomes, fruiting calyx abaxial surface; o. seta from fruit wing. — Scale bars: a = 5 cm; b, d, g, i–j = 1 mm; c, h, k, n–o = 0.5 mm; e–f = 5 mm; l–m = 1 cm. — Drawn by Andrew Brown from photos and specimens of *Cheek 18779* (K).

Fig. 2 *Seringia botak* Cheek. a. Habit, flowering and fruiting stems with M Jebb and J Wanma for scale; b. flowering stem showing leaves in 2-ranks; c. close-up of flower; d. close-up of the erect dry fruit showing glossy black seeds (*Cheek 18779*, K). — Photos by M. Cheek.

glandular stalked hairs, 0.1–0.25 mm long, over-topped and concealed by 80 % cover of white stellate hairs with c. 12 fine erect arms. *Adaxial surface* with midrib raised in distal quarter, surface entirely lacking glandular hairs (or if present highly inconspicuous), midline of lobes with appressed silvery fan-like stellate hair 0.5–0.75 by 0.1 mm, 6- or 7-armed, the arms all robust, parallel and touching, directed towards lobe apex, covering 60 % of the surface; marginal thirds of calyx lobes with stellate hairs with fine, sinuous, entangled arms c. 0.1 mm long, covering c. 50 % of the surface, calyx tube proximal to androecium glabrous in a ring 0.75–1 mm wide; margin of a calyx entire, densely glandular hairy, hairs 0.3–0.5 mm long, translucent, multicellular, heads black, elliptic, c. 0.1 mm long. *Petals* 5, patent, canaliculate trullate, 0.75–1 by 0.3 mm, the apex triangular, yellow, the two lateral triangles dark red, slightly inflexed. *Androecium* and *gynoecium* erect (in the pendulous flower). Staminal tube absent or 0.2 mm long. Staminodes absent, rarely present, then ligulate, 1.25 by 0.2 mm. *Filaments* yellow, red at apex, ligulate, 1.75–2 by 0.75 mm, outer surface convex, minutely densely puberulent with simple hairs 0.05 mm long. *Anthers* yellow, glabrous, 2-celled, oblong, 1–1.1 by 0.5 mm touching (cohering?) laterally, pollen yellow. *Gynoecium* ovary 5 free carpels, outer surface densely covered in translucent, erect to stellate hairs c. 1 mm long, the arms exserted beyond the staminal filaments by 0.75–1 mm; ovules 6 per carpel; styles as many as carpels, 2–2.5 mm long, glabrous, appressed together and appearing as one when live, not twisted, stigmas truncate, coherent. *Fruit* pendulous during development, the inflorescence axis slightly accrescent, 27–29 mm long. At maturity infructescence erect, fruit and calyx held erect, above the stems, dull brown, matt; sepals becoming concave in fruit, dull dark purple accrescent, doubling in dimensions, 14–15 by 8.5–9 mm, glossy with a raised reticulum of nerves, papery, enfolding the developing green fruit. *Fruit* subglobose, 11 by 15 mm; outer surface with numerous sessile white, stellate hairs with 10–14 erect arms 1 mm long, glandular hairs absent. Carpel wings developed along lines of dehiscence, 3–4 mm wide. Carpels free from each other apart from the basal 1/4–1/3, carpel wall 0.25–3 mm thick, woody, each 2- or 3-seeded. *Setae* numerous, densest along the wing apices, 1.75 by 0.25 mm, also on the sides of the wings and, more sparsely, between the wings. *Seeds* glossy black, straight, ellipsoid, 3.75 by 2 by 1.75 mm, aril bright white, dome-like over micropyle, 1 by 1 mm; chalaza horseshoe-shaped, epidermal cells longitudinal, seed-coat cartilaginous. Embryo green, c. 2 mm long, cotyledons equal, orbicular, flat, 0.9–1 mm diam, radicle cylindric, c. 1.1 mm long, 0.25 mm diam. Seedlings, juvenile leaves and chromosome number unknown.

Phenology — Flowering: June, and probably some months previously and subsequently (fruits seen at all stages of development, and flower buds seen).

Distribution & Ecology — Broken mineral substrate in naturally open, areas (presumed nickeliferous) in an otherwise lowland evergreen forest area (Botak) or “lowland savannah … growing under *Melaleuca* … substrate unconsolidated quaternary alluvial and littoral deposits … rainfall 3000 mm p.a.” (Bomberai: Anon 2005). Endemic to Indonesian New Guinea, near sea-level, at coast.

Additional specimens. Indonesia, New Guinea, *Takeuchi, Sambas, Maturbongs 15719* (BO not seen, CANB not seen, K not seen, L4152226, MAN not seen),Bomberai Peninsula, Tangguh Survey area E of BP Saengga base camp, near S02°27'26" E133°06'38", fl.13 Feb. 2002; *Kanehira & Hatusima 12963, 13205* (FU not seen: see note below), Waren, 60 km S of Manokwari, Mar. 1940.

Conservation — *Seringia botak* has so far only been recorded at two locations. The Bomberai site is part of the licence area of the Tangguh Liquified Natural Gas (LNG) industrial complex owned by BP. Here the species was discovered during a two week botanical survey that was part of an Environmental

Impact Assessment (Anon 2005). In this study the species was (as *Keraudrenia corollata*) one of 18 'Noteworthy Flora Species' listed (Anon 2005: 64, table A5.1) which included five to eight species identified as new to science, among which two of the species later described were: *Glochidion daviesii* W.N.Takeuchi (*Euphorbiaceae*) and *Scaevola burnettii* W.N.Takeuchi (*Goodeniaceae*) (Takeuchi 2003). The last species was indicated as occurring in savannah, as was the *Seringia.* 123 ha of this habitat were due to be cleared as part of a total of 642 ha lost to the industrial installation (Anon 2005). However, Anon (2005: 31) concludes that "All habitats and vegetation types are widespread in the region, and no species of flora or fauna are confined to the project property. Accordingly, the Project will not have significant impacts on the biodiversity of the region". Concerning the savannah, areas are stated to occur to the west, outside the project area (confirmed by viewing on Google Earth 7 March 2018), while the predominant vegetation is lowland rainforest. While the savannah in this area was described as species-poor, and not flagged up as a conservation priority, Takeuchi (2006) later stated that the presence of endemic species such as the *Scaevola* suggested that the *Melaleuca* savannah in this area was not anthropogenic but natural. *Seringia botak* appears to be an additional endemic element of this savannah formation, the extent, composition and conservation value of which are unknown.

Clearly, at the Bomberai site the species may already have been lost subsequent to the Impact study due to the clearance of savannah for the construction of the industrial area or for the accommodation area nearby. The label data suggests that only a single plant or patch may have been seen by Takeuchi. It is not known whether the substrate at this site is nickeliferous or not.

At the type location, Gunung Botak, *Seringia botak* was observed by the authors at a single site, where it occupied an area of 6–8 m^2. It very likely occupies a second site close by also (Merrill & Perry 1949, see below). Owing to the distinctive dense growth and showy purple flowers this is a conspicuous species that is not easy to overlook. Yet, Indonesian New Guinea remains incompletely surveyed for plants and this species may well have other sites in naturally open savannah or grassland areas.

However, using the precautionary principle and the evidence available, as recommended by IUCN (2012), we here assess *Seringia botak* as Endangered B1+2ab(iii) since two locations are known, with a total of three sites being probable. Therefore, the area of occupancy is 12 km^2 (using the preferred IUCN cell-size of 4 km^2), while the extent of occurrence is below the criterion B threshold. Threats are evident at both locations: the Tangguh-Bomberai location is in the licence area of an expanding industrial complex (see above) while the Gunung Botak location is threatened by road-widening work that was in progress during our visit. The plants seen there were all close to the road, and at the foot of a steep cliff. Part of Gunung Botak is also threatened by quarrying for materials for cement manufacture (Makuba 2015). There is also a risk that the area might be open-cast mined since the rock is considered to contain nickel (Utteridge pers. comm. to Cheek 2017). Currently, Gunung Botak is unprotected, but it may be worth recognising it as an Important Plant Area if it fulfils the revised criteria of Darbyshire et al. (2017). *Ex situ* conservation measures are in place for *S. botak* since several hundred seeds are now stored in the Indonesian Seed Bank.

Ecology

The ecology of the New Guinean *Seringia botak* is similar to that of the Australian species in that all favour open habitats, avoiding forest. However, the New Guinean species grows in higher rainfall areas (3000 mm p.a.) than those in Australia (where most species grow in areas with rainfall of 100–1200 mm p.a.). The nickeliferous substrate at Gunung Botak (detailed substrate is unknown for the Tangguh-Bomberai site) does not match those of Australian species which predominantly grow on sandstone or ferralitic substrates (Wilkins & Whitlock 2016). However, the Malagasy species, *S. macrantha* (Baill.) C.F.Wilkins & Whitlock, grows in ultramafic (metalliferous) substrates (Wilkins & Whitlock 2016). Within SE Asia, metalliferous-ultramafic substrates often host narrowly endemic species unique to those outcrops, e.g., in the genus *Nepenthes* (Cheek 2015, Cheek & Jebb 2000, 2001, 2013a, b, c, Jebb & Cheek 1997). Similarly, specificity to nickeliferous substrate may restrict the range of *S. botak.*

Affinities

Seringia botak has affinities with the majority of eastern and northern (rather than western) Australian species of *Seringia* having spreading calyces at anthesis (not reflexed), and with (1–)5 petals present (not none, or rarely, 1), leaf apices acute (not truncate or retuse) and red depressed-capitate glands absent (vs present). Among those eastern and northern Australian species *S. botak* is closest morphologically to three species in particular, sharing two synapomorphies: 1) the distal part of the otherwise yellow staminal filament are red; 2) the adaxial surface of the calyx has peculiar appressed, fan-shaped stellate hairs. These species are: *S. adenolasia*, *S. hookeriana* and *S. corollata*. Of these it seems closest to the last, while having similarities with *S. adenolasia*. *Seringia botak* and *S. corollata* both differ from the other two species in lacking the prominent, long-stalked, glandular trichomes that extend beyond the stellate hairs on stems, upper surface of the leaves and the outer surface of the calyx. However, *S. botak* does have long-stalked glandular hairs on the margins of both calyx and leaf-blade, and on the lower leaf-blade midrib, and so has more resemblance to *S. adenolasia* in respect of long-stalked glandular indumentum than does *S. corollata.* The distichous leaf arrangement of *S. botak* also resembles *S. adenolasia*. *Seringia corollata* and *S. botak* also differ from *S. adenolasia* and *S. hookeriana* in having calyx lobes and leaves with an acute or obtuse, not an acuminate apex.

Seringia in New Guinea

Wilkins & Whitlock (2016) state that the first report of *Keraudrenia* (= *Seringia*) in New Guinea appears to be that of Willis (1919: 605), followed by Green (1935: 488), Van Steenis (1987: 23) and Harden (1990: 308). "However, no specimens of these genera have been located in international herbaria" (Wilkins & Whitlock 2016).

Currently, the main generic checklist for New Guinea is that of Höft (1992: 34, which includes *Keraudrenia*). This checklist was mainly based on a card index at the LAE herbarium (LAE, Papua New Guinea) (Frodin pers. comm. to Cheek, Oct. 2017). Checks at LAE by Tiberius Jimbo (pers. comm. to Cheek. Oct. 2017) showed that the only specimens at LAE of *Seringia* (including *Keraudrenia*) derive from Australia, not New Guinea, indicating that this was the likely source of this error. The present paper was thus thought to be the first verified, evidence-based published record of *Seringia* (including *Keraudrenia*) in New Guinea, and in SE Asia. However, an anonymous reviewer of this paper brought to attention an earlier record based on *Kanehira & Hatusima 12963, 13205* (FU) (Merrill & Perry 1949). Collected within 4 km of the type locality, and, as with *Takeuchi 15719*, identified as *Keraudrenia corollata,* this is almost certainly the first record of *Seringia* from New Guinea that we now know of. However, since the herbarium of Kanehira & Hatusima is at Kyushu University, Japan (FU) (Thiers et al. continuously updated), which does not loan specimens and

does not have a digital herbarium, it is not possible to confirm absolutely the identification without visiting Japan. Enquiries have been made to herbaria in the USA where it is conceivable that a duplicate may have been deposited, but so far, without a successful result.

A proto-epicalyx in Seringia?

An epicalyx is a calyx-like structure of bracts ('epicalycular bracts') that subtends the true calyx of a flower. Within the related *Malvaceae* s.str. it is known in many genera, such as *Pavonia* Cav. and *Urena* L. The origin of the epicalyx appears to be linked with the reduction of the number of flowers in a dichasial cymose inflorescence from several to one, followed (in *Malvaceae* s.str.) by a doubling of the number of bracts. *Seringia botak* is unique in *Seringia* in having a constantly 1-flowered inflorescence which otherwise only occurs as an atypical state in *S. corollata*, or in *S. macrantha* of Madagascar, the sole non-Australian species of the genus previous to this paper.

In *Seringia botak* a loose imperfect whorl of three ± equal bracts (insertion separated from each other by several mm) occurs which partly covers and protects the flower bud, but which, unlike the epicalyx usual in most genera of *Malvaceae* s.str., is not a verticil and is caducous, falling soon, but sometimes persisting in the developing fruit. Clearly this structure does not qualify as an epicalyx but it may be conjectured to be a proto-epicalyx.

Dispersal and biogeography

Nothing is recorded on the dispersal of *Seringia* (Wilkins & Whitlock 2016). We conjecture that birds or more probably ants might disperse the seeds of *S. botak,* in view of the fleshy aril and hard smooth seed-coat. The mature, dehisced, fruits are held close above the horizontal stem apices, presenting the glossy black part of the small seeds (c. 1 mm), but not the aril, to view from above. The seeds are held securely in the fruits so that they are not shed and do not fall easily.

There can be little doubt that *Seringia botak* shares a common ancestor with *S. corollata*, *S. adenolasia* and *S. hookeriana* in view of the synapomorphies noted under 'affinities' and since the two first mentioned species are otherwise the most northerly of the genus, both occurring in northern Northern Territory of Australia. The great geographical disjunction between the *S. botak* and its nearest neighbours is likely to be due to scarcity of suitable available habitat between. Most of the intervening distance is either sea, or in New Guinea dense, high mountain or dense closed forest, none of which provide habitat for the species of *Seringia*. Gunung Botak with its substrate-induced naturally open vegetation and the Tangguh-Bomberai savannah area (despite rainfall of over 3 m p.a.), may be among the few locations in New Guinea that *Seringia* might be capable of colonising.

Key to species of Seringia with fan-shaped stellate hairs on adaxial calyx and red-apexed staminal filaments

Modified from Wilkins & Whitlock (2016)

1. Upper and lower surfaces of calyx, stem and both surfaces of the leaves (except the midrib) without long, conspicuous glandular hairs (if present, then only on the margins of the calyx and leaf-blade, or short and completely concealed below the stellate hairs) 2
1. Outer surfaces of calyx, stem and both surfaces of the leaves with conspicuous glandular hairs extending well beyond the stellate hairs 3
2. Glandular hairs absent, or if present few and all concealed below the stellate hairs on the stem and leaf-blade; inflorescence (1- or) 2- or 3-flowered, bracts green. — Australia . . . . . *S. corollata*
2. Glandular hairs dense, conspicuous and extending beyond the stellate hairs on margins of calyx and margins of leaf blades and on the abaxial midrib; inflorescence 1-flowered, bracts red. — New Guinea . . . . . *S. botak*
3. Mature leaf-blade flat, minor veins conspicuous below. Leaf and calyx lobes with apex acute, apiculus absent . . . . . *S. adenolasia*
3. Mature leaf-blade recurved, minor veins inconspicuous below. Leaf and calyx lobes with apex acuminate (rarely acute), mainly with apiculus . . . . . *S. hookeriana*

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