

Notes on the endemic plant species of the Ebo Forest, Cameroon, and the new, Critically Endangered, *Palisota ebo* (Commelinaceae)

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Background and aims – This paper reports a further discovery in the context of a long-term botanical survey in the Cross River-Sanaga interval of west-central Africa, focussing on species discovery and conservation.

Methods – Normal practices of herbarium taxonomy have been applied to study the material collected. The relevant collecting data are stored in the Herbarium of the Royal Botanic Gardens, Kew, London.

Key results – The growing number of endemic species being discovered from the Ebo forest of Cameroon points to the importance of its conservation. *Palisota ebo* Cheek (Comelinaceae) is described as an additional new species to science and is compared with *P. flagelliflora* Faden. Restricted so far to the Ebo Forest its conservation status is assessed as Critically Endangered (CR B1+2ab(iii)) according to the 2012 criteria of IUCN.

Key words – Conservation, geocarpy, conservatory plant, Tropical Important Plant Areas, variegated leaves.

INTRODUCTION

During a visit to the Ebo forest of Littoral Region, Cameroon in April 2005, an unusually small, variegated species of *Palisota* was seen dominating the forest understorey over a 2 km section of footpath. Although many hundreds of plants were seen, all appeared sterile, lacking the conspicuous erect central flowering axis usual in the genus. Passing along this path the following year, a determined effort was made to investigate this species further. Uprooted plants revealed dull, yellow–brown berries that had been concealed in the soil under the leaves. Other plants yielded axillary flowering shoots/inflorescences, with flowers in bud, unopened, at 7–8 a.m. About 10 fertile live plants were taken and placed in plastic bags for later investigation where, after several days, some produced open flowers, which, with the fruits were preserved in alcohol. This material provides the basis for the description of *Palisota ebo* Cheek below. Dimensions of floral, fruit and seed features are taken from the fluid preserved specimens, while other elements are described from the herbarium material and photographs taken in the field.

The genus *Palisota* P.Beauv.

Placement of this species in *Palisota* in a West African context is confirmed by the fleshy, berried fruit, the absence of a ‘spatheaceous bract’, the lack of perforated leaf sheaths and the presence of silky-hairy leaf margins (Brenan 1963). On a global basis, the floral morphology of petaloid sepals, 3 stamens attached in front of the petals and (2–)3 staminodes lacking anthers, attached in front of the sepals, place this species in *Palisota* (Faden 1998). *Palisota* is a genus of about 20 species restricted to the evergreen forests of subsaharan tropical Africa from Senegal in the west to Tanzania in the east (Faden 2007). The genus is most species-diverse in the forests of Cameroon and Gabon. *Palisota* includes the most massive species of Comelinaceae in Africa, including those with rosettes of leaves exceeding 110 cm long and 20 cm broad, shrub-like herbs 6 m tall, and fleshy lianas reaching 15 m high, mainly with large terminal inflorescences. Only three other species of the genus have axillary inflorescences, these being *P. bogneri* Brenan, *P. satabiei* Brenan, and *P. flagelliflora* Faden (Brenan 1984, Faden 1995). All three also occur in the species-rich coastal forests of Cameroon and Gabon (Faden 1995).

The botanical importance of the Ebo forest

Ebo is a proposed National Park that is co-managed by the Ebo Forest Research Project (EFRP) and the Ministry of Environment and Forest (MINEF). It covers about 2000 km² of evergreen lowland and submontane forest with *Podocarpus latifolius* (Thunb.) R.Br. ex Mirb. (B. Tchiengué pers. obs.) along numerous low, parallel ridges that run SSW-NNE, parallel to the line of the Cameroon Highlands which lie c. 100 km to the northwest. Ebo extends c. 50 km both north to south, and west to east, around the point of c. 4°22'N, 10°25'E (see map in Abwe & Morgan 2008). The geology is ancient, highly weathered basement complex, with some ferrallitic areas in the south. Altitude ranges from c. 130 to 1115 m. In the region, rainfall is comprised between 2 and 3 m p.a. Annual mean rainfall was measured in 2010–2016 at two points within Ebo Forest: Bekob (2336 mm p.a.), and Njuma (3135 mm p.a.). The wet season (successive months with cumulative rainfall > 100 mm) was between March and November at both sites (Abwe & Morgan 2008, Abwe, Ebo Forest Research Program, Yaoundé, Cameroon, pers. comm. 2018).

Many small villages surround the Ebo forest, which until the late 1950s and early 1960s was inhabited mostly by the people of the Banen and Bassa tribes. The forest harbours eleven diurnal primate species including the Nigeria-Cameroon chimpanzee and a small population of gorillas of uncertain taxonomic affinity (Abwe & Morgan 2008). The high diversity and global conservation importance of the primates has driven the push to conserve Ebo against competing pressures of logging, oil palm plantations and mining. To date, the population of gorillas has attracted most attention, especially given the threats which they face (Gawaorecki 2016, Mowbray 2017). However, sampling of the plant life, while far from complete, indicates that the diversity and endemism levels of plant species is likely to be of similar or even greater global importance for conservation than that of the primates, perhaps exceeding that even of the Kupe-Bakossi area 100 km to the northwest. Surveys conducted in Kupe-Bakossi mainly in 1993–2002 resulted in 14 000 specimens, from which over 2412 plant species have been documented, of which 82 are endemic and 212 threatened with extinction using the IUCN standard (Cheek et al. 2004).

The Ebo forest was unsurveyed for plants until the dawn of the 21st century, although several collections were made in the general Yabassi-Yingui area by the botanists Letouzey and Leeuwenberg in the late 20th century. This may be due to the comparative inaccessibility of Ebo by road, the lack of dramatic relief, and the greater attraction of the high peaks of the nearby mountains of the Cameroon line.

Our survey was conducted as part of the long-term survey of plants in Cameroon led by botanists from RBG, Kew and the National Herbarium of Cameroon (Cheek et al. 2006). This survey has focussed on the Cross River-Sanaga interval (Cheek et al. 2001) which contains the area with the highest species diversity per degree square in tropical Africa (Barthlott et al. 1996). The methodology for the surveys is detailed in Cheek & Cable (1997). To date 2875 herbarium specimens have been collected from Ebo with the intention that they will form the nucleus of data for a 'Conservation Checklist

of the Plants of Ebo Forest', in the series that began with Mt Cameroon (Cable & Cheek 1998) and continued with Mt Oku and the Ijim Ridge (Cheek et al. 2000), Bali-Ngamba (Harvey et al. 2004), and Lebialelem (Harvey et al. 2010).

New species to science discovered at Ebo as a result of the recent surveys to date are: *Ardisia ebo* Cheek (Cheek & Xanthos 2012), *Costus kupensis* Maas & H. Maas (Maas-van de Kamer et al. 2016), *Crateranthus cameroonensis* Cheek & Prance (Prance & Jongkind 2015), *Gilbertiodendron ebo* Burgt & Mackinder (van der Burgt et al. 2015), *Inversodicraea ebo* Cheek (Cheek et al. 2017), *Microcos magnifica* Cheek (Cheek 2017), *Myrianthus fosi* Cheek (Cheek & Osborne 2010), *Salacia nigra* Cheek (Gosline & Cheek 2014), *Talbotiella ebo* Mackinder & Wieringa (Mackinder et al. 2010) and *Uvariopsis submontana* Kenfack, Gosline & Gereau (Kenfack et al. 2003).

Most of these species are so far endemic to Ebo or its immediate neighbourhood, but a number of the submontane species are found to the West at Mt Kupe and the Bakossi Mts which are much more intensively surveyed (Cheek et al. 2004). These species are *Costus kupensis*, *Microcos magnifica*, *Salacia nigra*, *Uvariopsis submontana*, and extending to the Lebialelem Highlands (Harvey et al. 2010), *Myrianthus fosi*. Additional species first thought to be endemic to Kupe-Bakossi (Cheek et al. 2004) that have subsequently been found at Ebo include *Coffea montekupensis* Stoff. (Stoffelen et al. 1997).

It is possible that with further surveys at Ebo, more of the numerous apparently endemic and threatened species of Kupe-Bakossi will be found at Ebo, such as *Kupea martinuigei* Cheek & S.A. Williams (Cheek et al. 2003), *Ledermanniella onanae* Cheek (2003), and *Impatiens frithii* Cheek (Cheek & Csiba 2002).

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 2000 (Kew R.B.G. 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 IUCN's global list are taken into account, 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. Cheek & Etuge 2009), 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 as is *Oxygyne triandra* Schltr. (Cheek & Onana 2011). Most of the Cameroonian species are threatened with extinction due to habitat clearance, mainly for small holder and plantation agriculture following logging (Onana & Cheek 2011, Cheek et al. 2018).

Key to the species of *Palisota* with axillary, prostrate inflorescences

1. Habit procumbent, stems prostrate, 15–40 cm long, rooting along their length, internodes 1–2 cm long or more *P. satabiei*
- 1'. Habit an acaulous rosette, stems (sub-)erect, internodes < 0.5 cm long 2
2. Leaves glabrous or appressed glabrescent, lateral nerves 12–15 on each side of the midrib, flowers borne on prostrate axes (1.5–)25–100(–175) cm long *P. flagelliflora*
- 2'. Leaves pilose, lateral nerves 3–5 on each side of the midrib, flowers borne on prostrate axes (0–)1.5–7(–10) cm long 3
3. Petioles (4–)6.5–10(–14) cm long, width even from base to apex, not conspicuously sheathing, hairs patent-pilose; inflorescences composed of a single cincinnus *P. ebo*
- 3'. Petioles 2–5 cm long, proximal half dilated, about 3 × width of upper half, sheathing, hairs appressed-lanate; inflorescences composed of several cincinni *P. bogneri*

Table 1 – Characters separating *Palisota ebo* and *P. flagelliflora*.

	<i>Palisota flagelliflora</i>	<i>Palisota ebo</i>
Leaf blade: number of lateral nerves each side of midrib	12–15	3–4
Leaf blade angle of tertiary nerves from midrib	45°	90°
Indumentum of upper leaf blade	glabrous or appressed glabrescent	patent-pilose hairy, persistent
Indumentum of petiole and lower leaf blade	appressed white hairs 0.5–1.5 mm long	patent-pilose hairs 3–4 mm long
Leaf shape	elliptic or elliptic-oblong to oblanceolate or ovate	ovate-lanceolate, rarely oblong- elliptic
Leaf length	14–50 cm	(10–)12–15(–17.8) cm
Length of scale-leaves on flowering shoots	1.5–4 cm	0.5 cm
Length of flowering shoots	(1.5–)25–100(–175) cm	(0–)1.5–7(–10) cm
Inflorescence vivipary	sometimes viviparous	never viviparous
Paired stamen bearding	not bearded	bearded
Flower opening & closing times	0900–1200	1200–1400
Seed outline	ovate-triangular	elliptic
Ripe fruit colour	scarlet or reddish brown	dull yellow-brown

Efforts are now being made to delimit the highest priority areas in Cameroon for plant conservation as Tropical Important Plant Areas (TIPAs) using the revised IPA criteria set out in Darbyshire et al. (2017). This is intended to help avoid the global extinction of more narrowly endemic species such as *Palisota ebo*.

MATERIAL AND METHODS

This study is based mainly on herbarium specimens and field observations made in Cameroon during a series of botanical surveys beginning in 1991 mainly led by the first author, which so far have resulted in 52450 specimens being studied at K and YA, of which 37850 were newly collected, the data stored on the Kew Cameroon specimen Access database (Cheek et al. 2004: 11). The top set of specimens was ini-

tially deposited at SCA, and later YA, duplicates being sent to K. All specimens cited have been seen by the authors. Herbarium citations follow Index Herbariorum (Thiers continuously updated), nomenclature McNeill et al. (2012) and binomial authorities IPNI (continuously updated). Material of the suspected new species was compared morphologically with material of all other African *Palisota*, principally at K, but also using material from BM, P and US. The online search address used for retrieving specimen data from labels at P was https://science.mnhn.fr/institution/mnhn/collection/p/item/list?full_text=Palisota&higherTaxonomy_dynamic=genus&administrativeRegion_dynamic=stateProvince. The conservation assessment was made using the categories and criteria of IUCN (2012). 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 using Leica 308700 camera lucida attachment.

RESULTS

The new species, *Palisota ebo*, appears to be most closely related to *P. flagelliflora*, sharing several features rare within the genus or unique to that species (Faden 1995):

- 1) inflorescence-bearing axillary shoots that lie on the forest floor and continue to produce additional inflorescences;
- 2) inflorescences composed of a single cincinnus;
- 3) long pedicels;
- 4) vertical flowers;
- 5) bearded filament in the unpaired stamen.

It is likely that the two taxa share a recent common ancestor. The two taxa can be separated using the characters shown in table 1.

Palisota ebo Cheek, sp. nov.

A P. flagelliflora Faden foliis paria nervium lateralium 3–4 (non 12–15) gerentibus, pagina foliorum supera persistenter patenterque pilosa (non glabra vel pilis adpressis obsita atque glabrescenti), surculis floriferis longitudine (0–)1.5–7(–10) cm (non (1.5–)25–100(–175) cm), bracteis 0.5 cm longis (non 1.5–4 cm) differt. – Type: Cameroon, Littoral Region, E. of Yingui, Ebo Forest, Bekob to Logndeng along the footpath, c. 4°22'35"N, 10°25'15"E, alt. 800 m, fl., fr., 19 Feb. 2006, Cheek 13073 (holo-: K; iso-: BR, MO, P, US, WAG, YA).

Perennial rosulate herb, lacking an aerial stem, leaves 4–5(–8) per rosette, rhizome ascending, short and stout, (1.5–) 2–3(–3.5) cm sometimes dividing to form an offset, densely clothed in petiole bases and hairs. Roots wiry, mainly in the range 7–16 cm long, 1 mm wide, with frequent short lateral branches. Leaves alternate in a basal rosette c. 30 cm wide. Blades held ± horizontally, ovate, rarely elliptic or oblong, (10–)12–15(–17.8) × (4.9–)5.5–7.5(–8.8) cm, acumen 0.8–1.5 cm long with an acute apex, base rounded, rarely obtuse or subtruncate, major lateral nerves 3–4 on each side of the midrib, sunken in life, giving the blade longitudinal, curved corrugations; tertiary nerves all parallel, at 90° from midrib, upper surface bicolored, a stripe 1–1.5 cm wide along the midrib yellow-green the rest of the blade dark green, very rarely plants lacking the stripe; hairs on upper surface persistent, bristle-like, 2.5–3.25 mm long, patent, white, c. 200 hairs per cm² evenly spread; hairs on lower surface finer, 1–1.75 mm long, c. 300 hairs per cm², often mixed with shorter appressed hairs 0.5 mm long, hairs densest and longest on midrib; margin with dense, long, appressed hairs. Petioles ascending, canaliculate, fleshy, (4–) 6.5–10(–14) cm long, 2.5 mm wide (dried), densely clothed with patent (pilose) pale brown hairs 3–5 mm long. Flowering shoots 1–2 per plant, axillary, horizontal (0–)1.5–7(–10) cm long, concealed under the leaves and amongst leaf litter, rarely branched, not rooting, 0–4-noded; internodes 1.3–3(–4) cm long, indumentum sparse, glabrescent, nodes with scale-leaves c. 0.5 cm long, indumentum as lower leaf surface, each shoot bearing 1–2 inflorescences. Inflorescences

terminal, scale-leaf-opposed, pedunculate, with a single c. 6-flowered cincinnus subtended by a terminal pair of bracts; peduncle 0.8–1.8 cm long, mostly sheathed with spirally inserted bracts; bracts 4–6 per peduncle oblong-triangular, amplexicaul 6–9 × 4 mm; terminal bracts pair 1–1.5 cm long, forming a cup c. 0.4 cm wide, indumentum as scale-leaves. Flowers bisexual – and male – (but only male flowers seen and described here) predominantly vertical, c. 12 mm wide, odourless. Pedicel erect in flower, becoming spirally contorted shortly after anthesis and in fruit, c. 2.5 cm long, white, pilose (fig. 2C). Sepals petaloid, subequal, boat-shaped, ovate-oblong to oblong-elliptic, 5–6 mm long, c. 2 mm wide, reddish purple outside at the tips, the colour shining through, pilose similar to pedicel, hairs forming an apical tuft, usually intermixed with finer, shorter, hairs. Petals subequal, outer slightly broader than the others, elliptic 5–6 mm long, c. 3 mm wide, white, inner petals oblong to spatulate-oblong, 5 mm long, c. 2 mm wide, white, curved back at anthesis. Stamens with unpaired staminode with a filament c. 2 mm long and bearded subapically with apparently moniliform (individual cells are dumbbell-shaped), white-based yellow hairs (fig. 2D); paired staminodes with filaments c. 3 mm long, white, bearded in the distal half with hairs like those of the outer staminode; paired stamens with filaments c. 3–3.5 mm long, glabrous, white, anthers broadly elliptic to oblong-elliptic, c. 1.5 mm long, 1 mm wide, dehiscence extrorse, connective yellow, bearded with moniliform hairs, pollen yellow; unpaired stamen longer than the paired stamens, filament c. 5 mm long, white, usually densely bearded with minute yellow hairs just below the anther. Anther broadly ovoid, c. 1.8 mm long and wide, yellow, pollen sacs C-shaped, dehiscent, connective usually densely bearded with minute yellow hairs; pollen concolorous with that of the paired stamens. Mature gynoecium not seen, that of the male flowers: ovary ovoid, 3-lobed, c. 2 mm long, densely pubescent with forward-directed, white or reddish hairs, locules 1-ovulate, style not exceeding the stamens, 1.5 mm long, straight, yellow, glabrous, stigma 3-lobed, yellow with a central brownish area. Fruits ovoid berries, dull, yellow-brown, pilose, 2.5 × 1.5 cm, apex slightly rostrate, base rounded to truncate, 3-seeded (1 per locule), mesocarp white, juicy, several mm thick. Pedicel dilated in fruit and 3–4 coiled. Seeds ellipsoid 5.5 × 4 × 2.5 mm ventrally flattened, with hilum elliptic, c. 2 mm long, containing short slit; dorsally concave, when live grey, hard, glossy, with a central dorsal circular brown embryotegea c. 1 mm diam live. Figs 1 & 2.

Habitat and distribution – Cameroon, so far only known from Ebo Forest, Littoral Region.

Locally dominant understorey herb of undisturbed lowland-submontane evergreen forest on sand, terrain flat; 800 m alt.

Additional specimen studied – **Cameroon**: Littoral Region, E. of Yingui, Ebo Forest, Bekob to Logndeng along the footpath, c. 4°22'35"N, 10°25'15"E, 800 m alt., fl. fr., 19 Feb. 2006, Prenner 56 (inflorescences and fruit in spirit K, YA).

Etymology – Named (noun in apposition) for the forest of Ebo.

Conservation – *Palisota ebo* was assessed in Onana & Cheek (2011: 361) as Endangered: EN B1ab(iii) since it was interpreted as known from two locations with an estimated

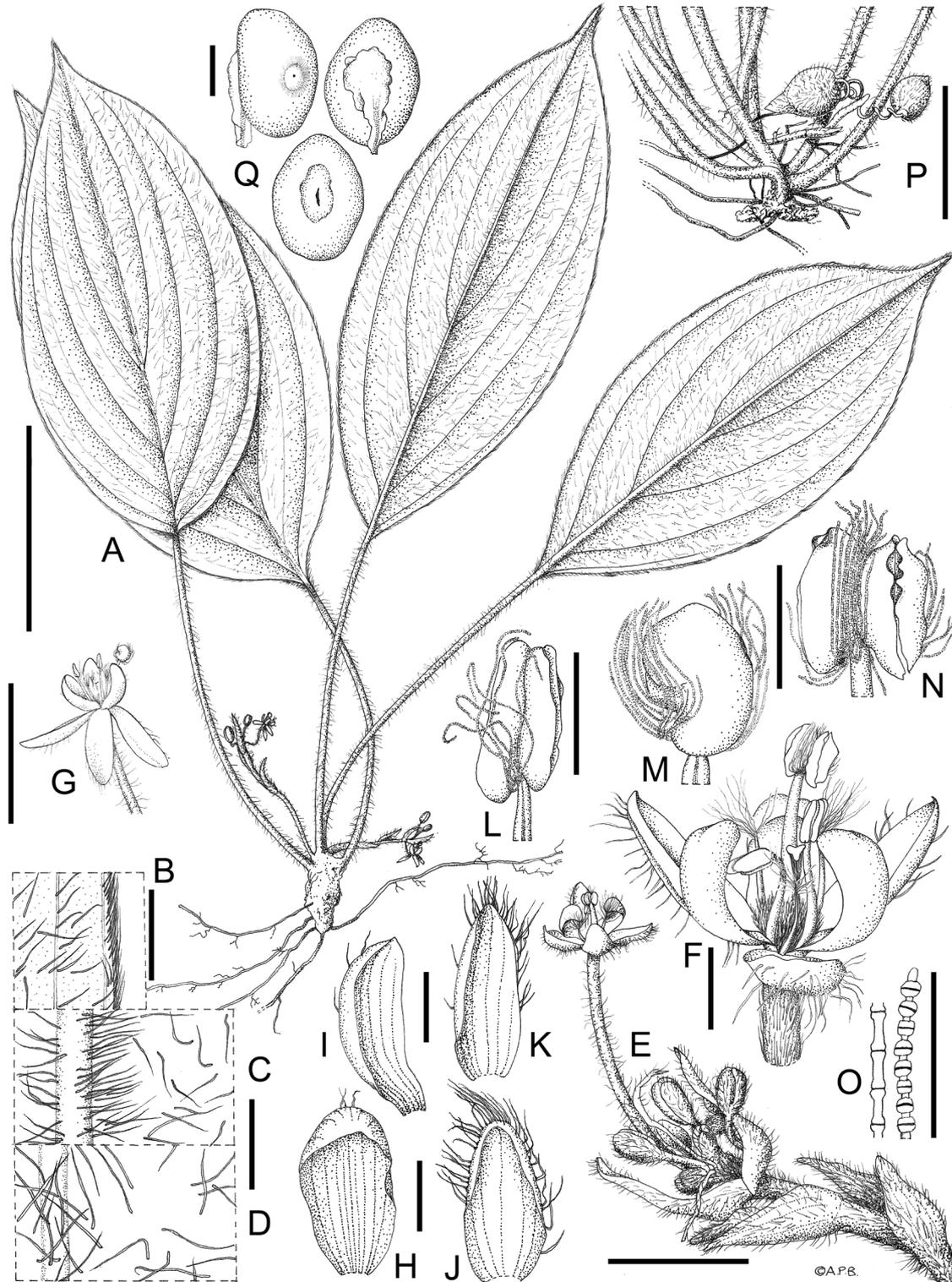


Figure 1 – *Palisota ebo*: A habit; B leaf margin and abaxial surface; C, abaxial surface showing midrib; D, adaxial surface showing midrib; E, inflorescence; F, male flower, lateral view; G, male flower drawn from photograph showing reflexed sepals (earlier stage than F); H, median petal, inner surface; I, lateral petal, inner surface; J, median sepal, inner surface; K, lateral sepal, inner surface; L, paired anther; M, unpaired anther, lateral view; N, unpaired anther, inner face; O, stamen hair (from micrograph); P, fruit *in situ* from photograph by G. Prenner; Q, seed, dorsal (left) and ventral (right) views with part of placenta attached, below ventral view with placenta removed showing hilum. Scale bars: A, P = 5 cm; B–D, F, H–K, Q = 2 mm; E, G = 1 cm; L–N = 1 mm; O = 250 μ m. A–D from Cheek 13073 (K); E–Q from Prenner 56 (K), all drawn by Andrew Brown.

area of occupancy of 8 km² and a projected decline of extent, area and quality of habitat due to the threat of logging followed by slash and burn agriculture. Subsequently these threats have been augmented by clearance for oil palm plantations and open cast mining (Mowbray 2017). The previous assessment is modified here to Critically Endangered since we now interpret the species as having a single, threat-based location following the guidance of (IUCN 2012). At the type location, thousands of plants are present since it is the dominant forest floor species along a 2 km length of trail, where individuals occur at intervals of 0.3–0.9 m (Cheek 13073).

Notes – Although common at the type locality within Ebo, *Palisota ebo* is absent from the rest of the forest.

We did not observe visitors to the flowers, nor did we see dispersal of the seeds. We can only speculate that day-flying insects are likely to effect pollination of the flowers, and that rodents consume the fruits (hidden as they are in the leaf-litter) and might sometimes distribute the seeds.

Palisota ebo has potential as an ornamental indoor plant for conservatories in temperate climates, and as a shade-plant in the tropics. Its colourful variegated leaves make it eye-catching and attractive all year round.

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Figure 2 – *Palisota ebo*: A, habit, fruiting plant; B, fruits, note the spirally coiled pedicels and the indumentum; C, flower, note the recurved sepals and petals and the indumentum on the pedicel and other floral organs; D, detail of staminodial hair with dumbbell-shaped cells. Scale bar: D = 50 µm. From *Prenner* 56 (K). Photographs by G. Prenner.

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