BEGONIA FLORA ALONG THE MARAI PARAI TO WEST GURKHA HUT TRAIL, MOUNT KINABALU

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ABSTRACT

A study was conducted on the begonia flora along the Marai Parai to West Gurkha Hut trail from October 6th to 12th, 2023. Twelve transects were established, ranging from 938 to 3986 meters above sea level, encompassing the lowland forest to alpine scrub and dwarf in the alpine rock desert area. The findings indicated that Transect 4 at an altitude of 1656-1929 m in the lower montane to upper montane forest, exhibited the highest begonia count (222 individuals, 6 species), followed by Transect 1 at 1043-1110 m in Lowland Hill Forest (180 individuals, 4 species), Transect 3 1444-1529 m in the lower montane forest (104 individuals, 1 species). In our study, one begonia species was identified and recognized as a novel species named *Begonia maraiparaiense* Rossiti & Rimi sp. nov. This new species, *Begonia maraiparaiense*, is exclusive to Mount Kinabalu and has been found solely in the upper montane forest, thriving on both ultramafic and non-ultramafic substrates at Marai-Parai. This study is the first of its kind in the area. The study has identified 11 species of begonias from Marai Parai to West Gurkha Trail Hut.

Keywords: *Marai Parai, West Gurkha Hut, begonia, new species.*

INTRODUCTION

The Marai Parai plateau, situated in the northwest region of Mount Kinabalu, holds historical significance in mountaineering. It garnered attention as early as 1858 during the inaugural visit by Sir Hugh Low and Sir Spenser St. John. Named after the abundant *Tetraria pilisepala* (Cyperaceae), which resembles hill rice (Beaman & Beaman, 1998), Marai Parai stands as a distinguished site for botanists on Mount Kinabalu. Several local institutions have undertaken botanical research in the Marai Parai area, shedding light on species composition and vegetation ecology by Van der Ent et al. (2015) conducted investigations to document the diversity of unique, endemic, and scarce ultramafic soils in Marai Parai. Despite its ecological significance, no specific research has been undertaken to document the begonia species along the Marai Parai to West Gurkha Hut trail.

Located atop the Penibukan ridge on the mountain's western flank above Kiau village. Marai Parai features pioneer vegetation in various stages of succession on landslides. Despite being situated in an area with dense lower montane rainforests at 1,600 m above sea level (a.s.l), Marai Parai has a characteristic of stunted appearance that resembles certain facies of kerangas vegetation found on leached acid sandstone plateaux elsewhere in Borneo, rather than the surrounding forest. The Marai Parai area is a region of stunning natural beauty that boasts a rich diversity of plant life, including 11 different species of *Begonia*, a large and diverse genus of flowering plants that belong to the family Begoniaceae. This genus is estimated to contain over 1,500 species, making it one of the world's largest genera of flowering plants. These plants are known for their colourful and showy flowers, which come in various shapes and sizes. There are currently 216 species and one subspecies of Begonia in Borneo that have been identified (Julia et al., 2022). Sabah is home to 82 species of Begonia (Kiew et al., 2015).

The objective of this study is to compile a comprehensive checklist of begonia species occurring along the Marai Parai to West Gurkha Hut Trail and gather scientific data on *begonia* to support the enhancement of the Marai Parai route leading to the summit of Mount Kinabalu. The findings of the research on begonias along the Marai Parai to West Gurkha Hut Trail will be instrumental in the conservation efforts for Sabah's begonias.

MATERIALS AND METHODS

Study Site

The study was conducted across 12 transects (see Figure 1) along the Marai Parai to West Gurkha Hut Trail. The transects were chosen based on elevations ranging from 938 to 3,986 meters above sea level (a.s.l). Each transect extended 1km long, showcasing vegetation from lowland hill forest to alpine scrub and dwarf in the alpine rock desert. The botanical survey conducted during the Marai Parai – West Gurkha Hut Expedition from October 6th to 12th, 2023, encompassed diverse ecosystems ranging from lowland hill forest (938 m asl) to alpine scrub and dwarf in alpine rock desert (3986 m asl).

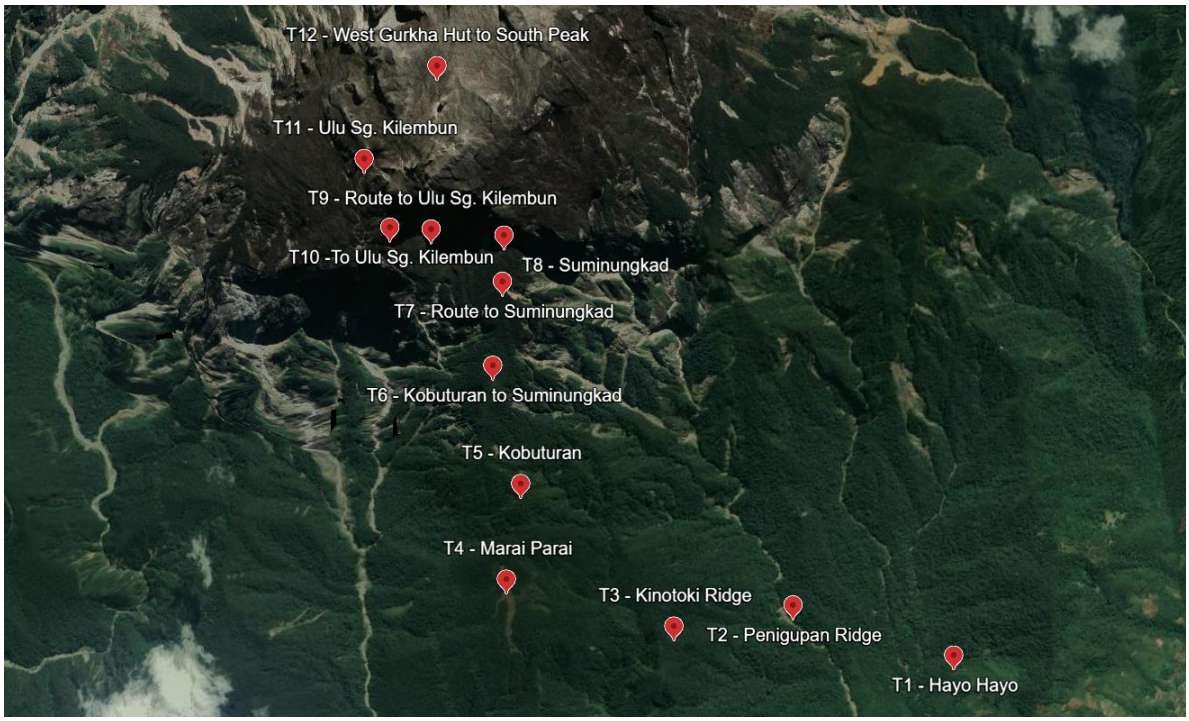

Figure 1. Map showing the location of transects from Kiau Nuluh – Marai Parai – West Gurkha Hut (T1 to T12).

Transect Establishment

For this study, 12 transects each spanning a length of 1 kilometre were specifically designated to conduct plant counts of *Begonia* species within a 5-meter range on both sides of the trail (Table 1). Its elevation ranges from 938 to 3,986 meters (a.s.l), covering a wide range of forest habitats such as lowland hill forest, lower montane forest, upper montane forest, subalpine forest, and alpine scrub and dwarf in alpine rock desert. The central objective of the study revolved around the comprehensive documentation of begonias along these transects, involving the enumeration of begonia individuals, evaluation of total species diversity, and detailed recording of distribution, elevation, and habitat characteristics.

Data analysis

Species richness was measured descriptively using a simple method by counting the number of species in each transect. Voucher specimens were gathered from unidentified plant species within the transect area and subsequently identified at the Sabah Park Herbarium (SNP). Floral samples of begonia were collected and preserved following the established herbarium technique outlined by Bridson & Forman (2000).

Sample Identification

The validation of Begonia distribution and taxonomy involved referencing the monographs by Beaman (2001), Kiew et al. (2015) and Sandakania (SFD-2015). Nomenclature legitimacy was ensured through cross-referencing with the Global Biodiversity Information Facility (GBIF), The World Flora Online (WFO), and the KEW World Checklist of Selected Plant Families (WCSP). Specimens, both live and oven-dried, were meticulously sorted and identified to the species level using the herbarium protocol. Flower parts were preserved in ethanol. Some

specimens were labelled as Begonia sp. due to uncertain species identification. All materials are deposited in the SNP Herbarium following the standard protocol.

Grouping of *Begonia* spp. in Marai Parai Trail to West Gurkha Hut

A total of 11 Begonia species were documented in the Marai Parai area, as outlined in Table 2. Seven of these species are classified under Section *Petermannia* (Klotzsch.) A. DC., characterized by an erect (occasionally rhizomatous) stem, asymmetrical leaves, palmate to pinnate venation, protogynous inflorescence and a two-branched placenta. The pendulous capsule is typically three-loculate with three wings of equal or unequal length. Two species belonging to Section *Bracteibegonia* A.DC., with leaves that may be symmetric or asymmetric and a two-branched placenta. *Begonia chlorocarpa* Irmsch. *ex* Sands (2001) is the sole species in Section *Sphenanthera* (Hassk.) Warb, it is distinguished by its erect or rhizomatous stem, asymmetrical leaves, protandrous inflorescence and a two-branched placenta. Notably, this species bears fleshy green berry-like fruit, nearly spherical, a unique trait among Bornean begonias. The remaining species, identified as Begonia sp., is in its juvenile stage, prompting the collection of herbarium specimens. The specimens were gathered for cultivation in the nursery of the Botanical Garden at Kinabalu Park and will be designated as the holotype (if new to science) upon reaching the flowering and fruiting stages.

RESULTS AND DISCUSSION

The survey results indicated that Transect 4 had the greatest number of begonias, with a staggering number of 222 individuals belonging to six distinct species. The second-highest count was found in Transect 1, with 180 individuals belonging to four species. Transect 3 had 104 individuals of a single species, while Transect 2 had 37 individuals belonging to one species. On the other hand, transect 7 had 29 individuals of one species, and transect 6 had 16 individuals of one species (Figure 2). It was observed that there were no begonias in Transect 5 and transect 8 to 12 (Figure 3).

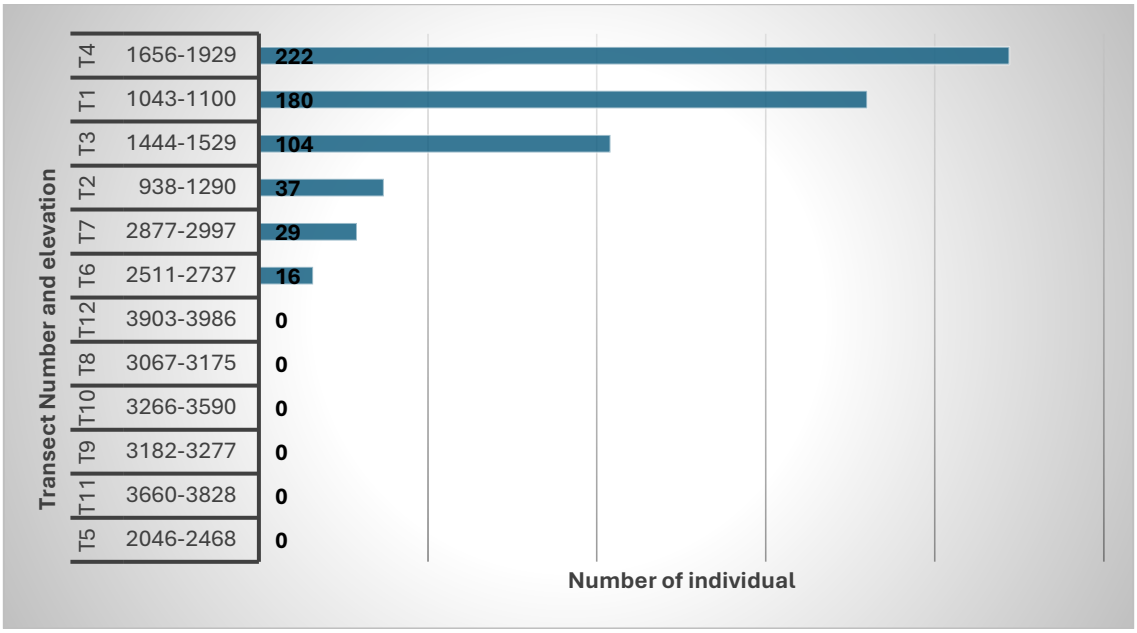

Figure 2. Number of individuals Begonias in descending order and Transect number with elevation (m) Marai Parai – West Gurkha Hut trails.

Based on observations in the field in the lowland area of lower montane forest to upper montane forest and the lowland hill forest during the study, it was found that there are creeks and moist areas around the transect. In Kinabalu Park, the combination of altitude, temperature, rainy seasons, wind, and cloud saturation, together with the topography of the mountain, in combination with the underlying soils, has produced a great diversity of local microclimatic and site variation. This is one of the factors in which a high number of individuals and many species are recorded in the area (Argent et al. 2007). No begonias were found in the lower subalpine forest, upper subalpine forest, or alpine scrub within the alpine rock desert. The canopy in these areas consists of open granite rock slopes and boulder rock vegetation, which are not conducive to *Begonia* habitats. The highest elevation recorded of begonia in the Kinabalu Park area (*Begonia vaccinioides* Sands (2001) is in theA area of Mount Tambuyukon in upper montane or subalpine forest at 1400-2700 m (Kiew et al. 2015). Begonias typically flourish in moist environments, such as riverbanks, creeks and humid areas. Begonia is so sensitive to humidity and temperature that they are adversely affected when the tree canopy is disturbed or removed, and very few persist in secondary forests (Kiew et al. 2015). The begonia species documented along the transect can be found in Table 2. This compilation provides crucial botanical information for the planning of the Marai Parai route, offering valuable insights into the indigenous flora. By utilizing this checklist, developers can ensure the route's design is environmentally sensitive. Additionally, this information is pertinent to researchers, conservationists, and individuals interested in the area's diverse biodiversity.

The research findings from Transect 4 have brought to light the discovery of a new begonia species, named *Begonia maraiparaiense* (Figure 4). This species is unique to Mount Kinabalu and is specifically distributed in the upper montane forest, where it flourishes on both ultramafic and non-ultramafic substrates at Marai-Parai. *Begonia maraiparaiense* displays two colour morphs: red, featuring deep magenta undersides, and green, exhibiting paler green undersides. The red variation stands out as more visually appealing than the lighter green leaves. Species Descriptions: *Begonia maraiparaiense* Rossiti & Rimi sp. nov. § *Petermannia* (Figure 3).

Like *Begonia nothobaramensis* Joffre 2015 in its habit and peltate leave, it is different in its four greenish white tepals of male flower, stamens 16–17, and conical cluster. Broadly oval fruit, crimson-tinged green with subequal wings, 0.6–0.8 cm wide. The male flower in *B. nothobaramensis* consists of two rosy, pink tepals, ca. 36 stamens, globose cluster. The fruit is reddish to pale green with two narrow wings 2.5–4 mm wide. Type: —MALAYSIA. Borneo, Sabah, Kota Belud, Kinabalu Park, Marai-Parai, 18th July 2019, Martin et al. SNP 41417 (holotype SNP! isotype SAN! KEP!)

Cane-like begonia, up to 1.5 m tall. Stem reddish, glabrous, woody, 0.3–0.6 cm thick, hollow when dry, much-branched; internodes 3–10 cm long, nodes are swollen. Stipules pale green, lanceolate, keeled, 0.8–3 × 0.8–2 cm, margin entire, apex acute, caducous. Leaves alternate, oblique, distant, pointing downwards; petiole magenta, peltate, glabrous, 2.5–11 cm long, grooved above, lamina glabrous, thick, dark green above, deep magenta beneath or light green on both surfaces, plain, fleshy when fresh, papery when dried, glossy, broadly ovate, asymmetric, 7.5–14 × 7–11 cm, broad side 5–9 cm wide, basal lobes 3.5–6.5 cm wide, base broadly rounded, 0.8–1.3 cm from stalk to the base, margin entire, apex acuminate, acumen to 1–1.5 cm long, venation palmate-pinnate, glabrous on both sides, reddish at the base on the upper surface, magenta or green beneath, 5–6 veins radiating from the petiole, 2–3 veins in basal lobe, impressed at the base, prominent beneath; Inflorescence protogynous, axillary on the upper leaf axils, erect, racemose, glabrous, 4–9 cm long, shorter than petiole, peduncle

green tinged red, glabrous, 2–4.5 cm long, 2 female flowers at the base, male flowers in cymose, 2–3 flowers. Bracts on male flower overlapped, greenish tinged of magenta, broadly lanceolate, keeled, 0.8–1 × 1–1.2 cm, margin entire, apex slightly rounded, persistent. Bracteoles greenish tinged of magenta, broadly lanceolate, 0.4–0.6 × 0.6–0.8 cm, margin entire, apex slightly acute. Bracts on female flower magenta, 3 pairs, broadly oval, 1–1.5×1–2 cm, margin entire, apex emarginate. Male flower: greenish-white, pedicel 0.5–1.5 cm long; tepals 4, white, outer 2 tepals oval, 1–1.5 × 0.8–1.5 cm, margin entire, apex rounded, inner 2 tepals lanceolate 0.6–1 × 0.2–0.5 cm, margin entire, apex slightly acute; stamens 16–21, conical cluster, sessile, filament yellow, 0.8–1 mm long, anthers yellow, obovate, 1–1.5 × 0.8–1 mm long, apex emarginate. The female flower is not available. Ovary green-tinged magenta, oval, 1–1.2 × 0.8–1 cm, wings 3. Fruits 1–2 pairs, crimson-tinged green, glabrous, broadly oval, 1–1.5 × 1.2–1.6 cm, reflexed when matured on 1.5–2.5 cm long pedicel, locules 3, wings 3, equal, broadly acute proximally, rounded distally, 0.6–0.8 cm wide, tip acute, thinly fibrous, dehiscing between locules and wing; Seeds are barrel-shaped, c. 0.25×0.2mm. Columnar cells are slightly more than half the length of seeds.

Distribution: —MALAYSIA. Borneo. Endemic to Sabah (Marai-Parai, Mount Kinabalu).
Ecology: —Lower montane to the upper montane forest at 1,877-2,754 m elevation on ultramafic and non-ultramafic substrates.
Etymology: —Named after the Marai-Parai plateau of Mount Kinabalu, where it was first collected.

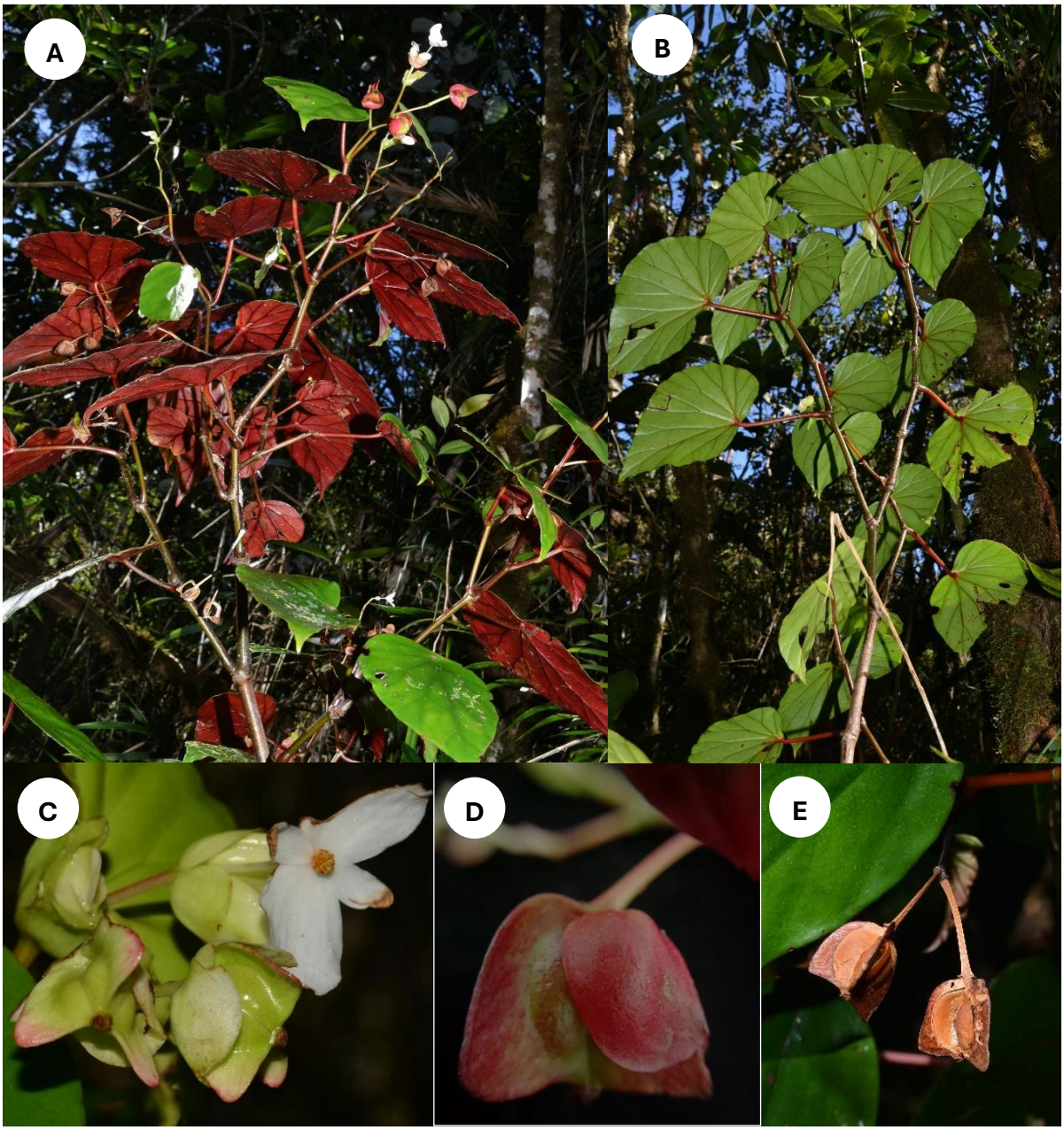

Figure 3. ***Begonia maraiparaiense.*** **A. Habit of red form; B. Green form; C. Male flower; D. Fruit; E. Dried capsule showing dehiscent between locule and the wing; Photos A-C & E by Yabainus Juhalin; Photo D by Rossiti Karim.**

The study results indicate that there are significant variations in the number of begonia species across the different vegetation types, with Transect 4 demonstrating the highest levels of both richness and abundance. Transect 4 had the most diverse species of begonias (6 species). Based on the records of the Herbarium SNP collection and field observations at a similar elevation along the Timpohon Gate to the Kandis Shelter trail area, only one species was documented: *Begonia beryllae* Ridl. (1915). There is a potential discovery of a new species of begonia in the unexplored area in the Kilembun Basin area. This area is located near the Marai Parai region, which is situated at the bottom of Kilembun Water Head. The discovery of a new species of begonia in this unexplored region is particularly exciting as it could potentially lead to new insights into the biodiversity of these plants. However, further research and examination will

be necessary to confirm the discovery and to learn more about this potentially new species of begonia.

CONCLUSION

A study conducted along the Marai Parai to West Gurkha Hut Trail has determined a notable presence of begonias, renowned globally for their aesthetic qualities. The abundance of these flowers along the trail enhances its allure and is expected to be a key draw for tourists. These findings hold significant implications for the future planning and development of the area before its public accessibility. Moreover, the begonia species along this trail harbour a diverse genetic reservoir that could substantially contribute to the enhancement of cultivated begonia varieties. The presence of begonias along the Marai Parai to West Gurkha Hut Trail underscores their role within the broader ecosystem, underscoring the necessity of conserving and safeguarding them to uphold the ecological well-being and biodiversity of the area.

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APPENDIX

Table 1. Elevation and Forest Type of Transect Marai Parai – West Gurkha Hut Trail

Transect number	Elevation (m)	Habitat
T1	1,043-1,100	Lowland hill forest
T2	938-1,290	Lowland hill forest-lower montane forest
T3	1,444-1,529	Lower montane forest
T4	1,656-1,929	Lower montane forest to upper montane forest (ultramafic area)
T5	2,046-2,468	Upper montane forest
T6	2,511-2,737	Upper montane forest
T7	2,877-2,997	Subalpine forest
T8	3,067-3,175	Subalpine forest
T9	3,182-3,277	Subalpine forest
T10	3,266-3,590	Upper subalpine forest
T11	3,660-3,828	Upper subalpine forest – Alpine scrub and dwarf in alpine rock desert
T12	3903-3986	Alpine scrub and dwarf in alpine rock desert

Table 2. Comparisons of the species richness and abundance of begonias across twelve study sites ranging from lowland hill forest to alpine scrub and dwarf in alpine rock desert in Transect 1-12.

Transect Number	Species	Number of individuals	Elevation (m)	Habitat	Section
Transect 1	1. *Begonia chlorocarpa*	1	1043-1100	Lowland hill forest	*Sphenanthera*
	2. *Begonia oblongifolia*	148			*Petermannia*
	3. *Begonia adliniana*	19			*Petermannia*
	4. *Begonia chongii*	12			*Petermannia*
Transect 2	1. *Begonia oblongifolia*	37	938-1290	Lowland hill forest-lower montane forest	*Petermannia*
Transect 3	2. *Begonia adenostegia*	104	1444-1529	Lower montane forest	*Petermannia*
Transect 4	1. *Begonia adliniana*	12	1656-1929	Lower montane forest to upper montane forest	*Petermannia*
	2. *Begonia maraiparaiense* sp. nov	159			*Petermannia*
	3. *Begonia burbidgei*	8		(Ultramafic area)	*Petermannia*
	4. *Begonia beryllae x kinabaluensis*	10			*Bracteibegonia*
	5. *Begonia beryllae*	12			*Bracteibegonia*
	6. *Begonia inostegia*	21			*Petermannia*
Transect 5		0	2046-2468	Upper montane forest	
Transect 6	1. Begonia sp	16	2511-2737	Upper montane forest	*Indet.*
Transect 7	1. Begonia sp	29	2877-2997	Subalpine forest	*Indet.*
Transect 8		0	3067-3175	Subalpine forest	
Transect 9		0	3182-3277	Subalpine forest	
Transect 10		0	3266-3590	Upper subalpine forest	
Transect 11		0	3660-3828	Upper subalpine forest – Alpine scrub and dwarf in alpine rock desert	
Transect 12		0	3903-3986	Alpine scrub and dwarf in alpine rock desert	