

Taxonomic notes on *Didymoplexiella siamensis* and *Gastrodia peichatieniana*, two fully mycoheterotrophic orchids new to the flora of Hong Kong

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The ephemeral, leafless orchids *Didymoplexiella siamensis* and *Gastrodia peichatieniana* are newly recorded from Hong Kong. A lectotype is selected for the former, and the recently described *D. denticulata* from southern Vietnam is reduced to its synonymy. Full descriptions and global conservation assessments are presented for these hitherto poorly known species.

Introduction

Fully mycoheterotrophic plants rely entirely upon endophytic fungi for their nutrient supply, allowing them to colonise deeply shaded forest habitats of low photosynthetic potential (Bidartondo 2005). It is a mode of life that has evolved independently across many diverse lineages of the orchid family (Merckz & Freudenstein 2010, Merckz *et al.* 2013). The above-ground parts of mycoheterotrophic orchids are typically slender and dull coloured, and their lack of leaves renders obsolete the need to persist for longer than it takes to flower and set fruit. This inconspicuous and ephemeral growth habit makes them difficult to detect as compared to autotrophic species, and could delay their discovery in a manner analogous to the detection biases described for 'less apparent' members of certain other plant (Rob-

erts & Marshall 2009) and animal (Collen *et al.* 2004) groups.

The orchid flora of Hong Kong is relatively well studied, with an almost unbroken history of sighting effort dating back to 1831 (Barretto *et al.* 2011). This record reveals an average taxon accumulation rate of 0.72 per year, giving rise to a total known orchid flora of 127 taxa as of 2012 (Barretto *et al.* 2011, Gale *et al.* 2013a, 2013b). Interestingly, survey work over the last year has led to the discovery of an additional three fully mycoheterotrophic orchids not previously recorded from Hong Kong, doubling the number discovered throughout the entire preceding 181-year period. Two of these are described here, and notes on their taxonomy, ecology and global conservation status are presented; the third, *Lecanorchis nigricans*, will be treated elsewhere.

Material and methods

Fresh material of *Gastrodia peichatieniana* and *Didymoplexiella siamensis* was collected from the new localities in Hong Kong in 2012 and 2013, respectively, and critically compared with herbarium collections at BKF, HK, HSNU, K, KFBG, QBG and TAIF, and with digital images available online of herbarium material held at HN, NTUF and PE. Relevant literature was consulted (Seidenfaden 1972, 1978, Ying 1987, 1990, Leou 2000, Chen *et al.* 2009a, 2009b, Averyanov 2010).

The global conservation status of *D. siamensis* and *G. peichatieniana* was assessed against IUCN (2012) criteria B (geographical range) and D (very small or restricted population). Sightings of the species within the last 50 years (i.e. post-1963) based on herbarium collections were georeferenced and the Extent of Occurrence (EOO) and Area of Occupancy (AOO) of the populations were estimated using the conservation assessment tool extension developed by the Royal Botanic Gardens, Kew (Moat 2007) in ArcView software. For AOO, a 2 × 2 km grid cell size was used. The preliminary assessments generated for EOO and AOO in this way were then subject to a subsequent round of verification based on an understanding of the species' ecological attributes (estimated population size, inferred habitat requirements and reproductive success).

Taxonomy

***Didymoplexiella siamensis* (Rolfe ex Downie) Seidenf. (Figs. 1 and 2).**

Bot. Tidsskrift 67: 99. 1972. — *Leucolena siamensis* Rolfe ex Downie, Bull. Misc. Inform. (Royal Gardens, Kew) 1925: 416. 1925. — TYPE: Thailand. Chiang Mai Province, Doi Suthep, 700 m, 8 May 1910, *A.F.G. Kerr 245* (lectotype, selected here, K!).

Didymoplexiella denticulata Aver., *Taiwania* 55: 92. 2010, *syn. nov.* — TYPE: Vietnam. Quang Binh Province, Le Thuy District, 150–200 m, 9 April 2008, *L. Averyanov, P.K. Loc, N.T. Vinh et al.*, HAL 11443 (holotype HN, photo!; isotype LE, photo!).

Description of Hong Kong material: Leafless, terrestrial holomycotrophic herb, 18.0–23.5 cm tall. Rhizome horizontal, brown, tuber-

ous, fleshy, many-noded, irregularly fusiform, 3.6–5.0 cm long, up to ca. 10 mm in diameter, bearing 3 or 4 roots at the apex. Roots slender, 4.2–5.5 cm long. Peduncle brown, erect, slender, glabrous, 14.5–17.4 cm long, 1.1–1.5 mm in diameter, 3- or 4-noded, with a tubular, sheathing membranous sterile bract at each node. Sterile bracts 2.0–4.5 mm long. Floral rachis 2.4–4.5 cm long, elongating during anthesis, subdensely 6–15-flowered; floral bracts brown, ovate-deltoid, 1.0–2.0 mm long, apex acute. Flowers opening one at a time, short-lived, erect, opening widely, ivory white, the outer surface of the sepals tinged beige at the tip, the inner surface of the dorsal sepal and petals tinged rose-pink, the centre of the lateral sepals flushed rust red-brown, the lip tinged mauve towards the base; pedicel and ovary brown, glabrous, erect, 7.5–8.8 mm long; dorsal sepal and petals connate for 2/3 of their length and forming a hood over the column; dorsal sepal elliptic-obovate, 7.0–8.5 mm long, 2.5–3.0 mm wide, free apical portion ovate, apex obtuse, 3-veined, slightly verrucose at the tip on the outer surface; lateral sepals connate for 1/2 of their length, longitudinally deflexed along their common margin, broadly elliptic-obovate, 6.5–8.2 mm long, ca. 2.5 mm wide, free apical portions oblique, broadly rounded, 3-veined, slightly verrucose at the tip on the outer surface; petals broadly oblong-ovate, slightly oblique, 6.5–7.6 mm long, ca. 2.4 mm wide, free apical portions semi-circular, 2-veined; labellum projecting forwards, narrowly oblong-flabellate, 6.0–6.5 mm long, ca. 2.9 mm wide, obscurely 3-lobed above the middle, disc bearing a pair of small gland-like domes near the base and a prominent, fleshy, slightly bilobed callus rising above the middle of the lip and terminating just below the apex of the mid-lobe; mid-lobe broadly quadrate or trapezoid, the apex shallowly notched and finely denticulate; side lobes short, broad, deflexed, margins finely and irregularly denticulate. Column erect, cylindrical, elongate, ca. 5 mm long, with a pair of prominent, filiform, decurved stelidia ca. 2 mm long at the apex; anther spherical, ca. 0.8 mm across; stigma ventral. Capsule not seen.

PHENOLOGY: In Hong Kong, plants emerge in late March or early April, flower from mid-April to early May, and fade rapidly thereafter. Across



Fig. 1. *Didymoplexiella siamensis* and *Gastrodia peichatieniana* growing in the wild in Hong Kong. — **A** and **B**: Habit of *D. siamensis*. — **C** and **D**: Close-up of flowers of *D. siamensis*. — **E**: Excavated plant of *G. peichatieniana* showing underground parts. — **F** and **G**: Close-up of inflorescence and flowers of *G. peichatieniana*.

the species' range, flowering has been observed from late March until May, with fruits developing a month later if pollinated.

HABITAT AND ECOLOGY: Only a single population comprising about ten emergent plants has been found in Hong Kong. It occurs in deep

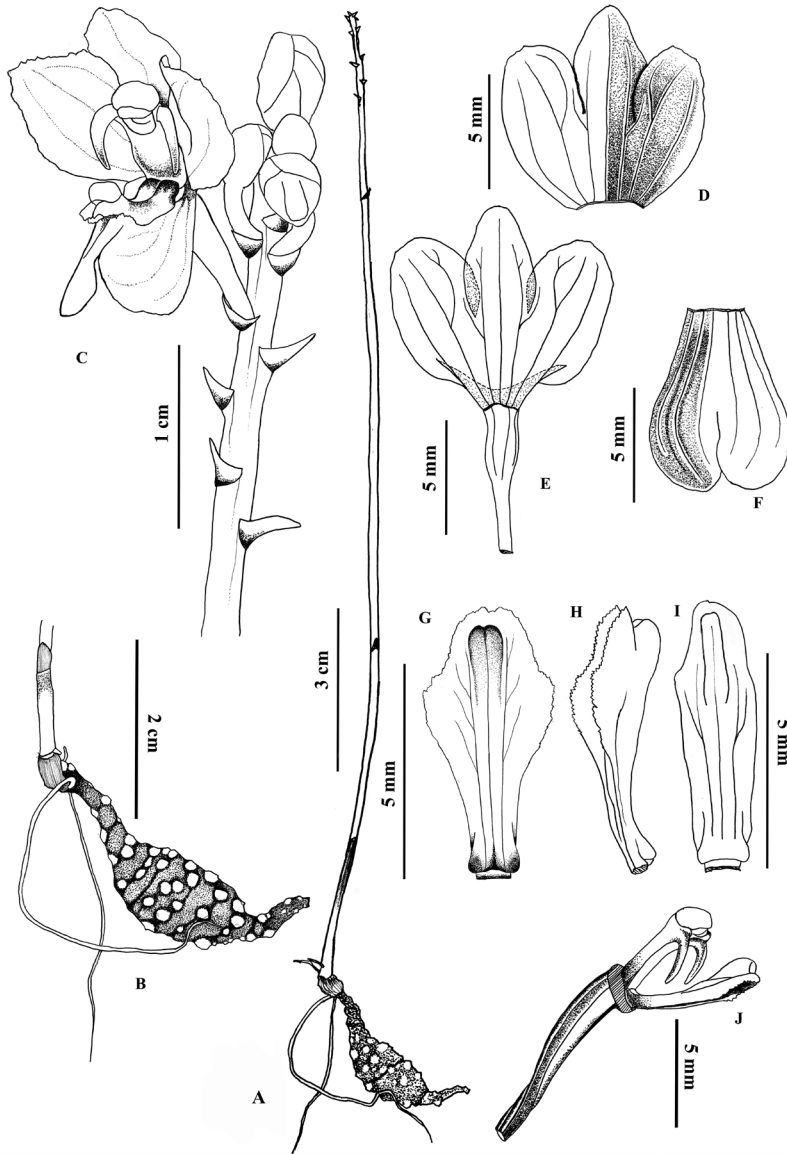


Fig. 2. *Didymoplexiella siamensis* (drawn by P. Kumar; **A** and **B** from A.-Q. Hu 575; **C**–**J** from P. Kumar 12024). — **A**: Plant. — **B**: Close-up of tuber. — **C**: Close-up of inflorescence. — **D**: Fused dorsal sepal and petals. — **E**: Dorsal sepal and petals attached to the ovary and pedicel. — **F**: Fused lateral sepals. — **G**: Labellum, flattened, top view. — **H**: Labellum, in nature, side view. — **I**: Labellum, in nature, top view. — **J**: Column, label, and ovary.

shade and in thick leaf litter under broadleaved evergreen hill forest dominated by *Lithocarpus* and *Castanopsis* species. Each flower lasts for only one day before dropping; no fruit set was observed in the present study. Averyanov (2010) reported a strong floral fragrance for the plants in Vietnam. Together with the vibrant colouration of the flowers, these attributes are possibly indicative of an outcrossing pollination syndrome. Throughout its range, *D. siamensis* occurs at elevations under 1000 m a.s.l.

DISTRIBUTION: Southeast China, Taiwan, northern Thailand and Vietnam.

CONSERVATION: Only five sightings at five localities were confirmed for the species since 1963. Based on the distribution of these sightings, *D. siamensis* was found to have an EOO of > 20 000 km² (Least Concern) and an AOO of < 500 km² (Endangered). The species is widespread, with isolated populations scattered across northern Thailand, Vietnam, Hong Kong and Taiwan. Its highly inconspicuous growth habit may mean that it is under-recorded throughout its range, and it seems likely that it occurs also in Laos and parts of south China. It has a relatively wide elevational range, from ca. 200–1000 m

a.s.l., and has been found in a range of habitats, including moist evergreen forest (*Kerr 245*), mixed deciduous forest (*J.F. Maxwell 97-385*) and secondary hill forest (*A.-Q. Hu 575*). However, some of these habitat types are threatened with clearance and conversion to agriculture and plantation forestry throughout the Indo-Burma region, and its populations typically consist of only a few plants. Moreover, its apparent dependency upon pollinators for fruit set may limit its reproductive potential. We have no data to indicate that the species has undergone decline at either a regional or local scale. Given these attributes, we infer a conservation status of VU (B2abiii; D1+2).

NOTES: In the protologue for this species, Downie (1925: 416) cited two specimens (*Kerr 245* collected on 8 May 1910, and *Kerr 305* collected on 19 May 1912), both from Doi Suthep in northern Thailand, and both held at K. Collection number 245 comprises two sheets, one bearing six plants in flower, and a second comprising a further three plants mounted on the same sheet as collection number 305, which comprises a single flowering plant. At K, there are a further two sheets labeled as 305, both also from Doi Suthep, but with the collection date marked as 7 June 1914; these plants are in fruit. Given this disparity in collection dates, we infer either that plants collected in 1914 have been mislabeled, or that collection 305 is mixed, incorporating two distinct collecting events. In light of this ambiguity, we select collection *Kerr 245* as the lectotype for this name.

Chen (1999) and Chen *et al.* (2009a) recorded this species from Hainan Island, south-east China, based on a collection deposited at PE (Hainan Province, Yazhou (Sanya), Luopeng Village, 5 July 1933, *K.Z. Hou 75954* (PE, photo!)). The specimen consists of four inflorescences but lacks flowers (*X.H. Jin pers. comm.*), making it difficult to verify its identity. However, it was collected in July, significantly later than the flowering period for *D. siamensis* elsewhere in its range, and the peduncle of all four plants is flexuous, not erect, as would be typical for the species. Moreover, *D. siamensis* has not been collected in Hainan since. For these reasons, we consider this record doubtful, and exclude it from the exsiccatae.

Averyanov (2010) recently described *D. denticulata* based on material collected in Vietnam. It was distinguished from *D. siamensis* on account of the finely denticulate margins of the lip's lateral and mid-lobes. However, our examination of material of *D. siamensis* across the species' range, including those from the type locality in Thailand, indicates that plants often have a more or less divided lip margin. Notably, material collected at a single site in Taiwan comprised both plants with a distinctly denticulate lip margin and others that had only an obscurely divided lip margin (*T.C. Hsu pers. comm.*). In fact, the lateral and mid-lobes of the lip are deflexed in nature (Fig. 2I), giving the appearance of an entire margin, especially in pressed specimens. We find no other characters to distinguish *D. denticulata*, leading us to conclude that it is conspecific and here reduce it to the synonymy of *D. siamensis*.

SPECIMENS EXAMINED: **China.** Hong Kong, Tai Tam, 278 m, *A.-Q. Hu 575* (HK0043854 & HK0043855) (HK); Hong Kong, Tai Tam, 278 m, *P. Kumar 12024* (KFBG). **Taiwan.** Taipei County, Chachiao, 100–200 m, *T.C. Hsu 734* (TAIF). **Thailand.** Chiang Mai Province, Doi Suthep, 700 m, *A.F.G. Kerr 245* (K); Chiang Mai Province, Doi Suthep, 910 m, *A.F.G. Kerr 305* (K); Chiang Mai Province, Doi Suthep, 900 m, *A.F.G. Kerr "305"* (K); Chiang Mai Province, Doi Suthep, 650 m, *A.F.G. Kerr s.n.* (K); Chiang Mai Province, Mueang District, Doi Suthep, 1000 m, *P. Suksathan 4292* (QBG); Lampang Province, Wang Nuea District, Doi Luang National Park, 825 m, *J.F. Maxwell 97-385* (BKF). **Vietnam.** Quang Binh Province, Le Thuy District, 150–200 m, *L. Averyanov, P.K. Loc, N.T. Vinh et al., HAL 11443* (HN, photo, LE, photo).

Gastrodia peichatieniana S.S. Ying (Figs. 1 and 3).

Coloured Illustrated Flora of Taiwan, vol. 2: 690, pl. 404. 1987. — TYPE: Taiwan. Nantou County, Peichiatianshan, 1100 m, 10 October 1985, *S.S. Ying s.n.* (holotype NTUF!).

Gastrodia autumnalis T.P. Lin, Native Orchids of Taiwan, vol. 3. 122. 1987. — TYPE: Taiwan. Taipei County, Mt. Tatung, 916 m, 10 October 1976, *Lin 392* (holotype TAIF, photo!).

Description of Hong Kong material: Leafless, terrestrial, holomycotrophic herb, 12.2–50.2 cm tall. Rhizome horizontal, tuberous, beige, fleshy, shortly pilose, irregularly cylindrical, ca. 2.5 cm long, ca. 4 mm in diameter, bearing 3 or 4 roots.

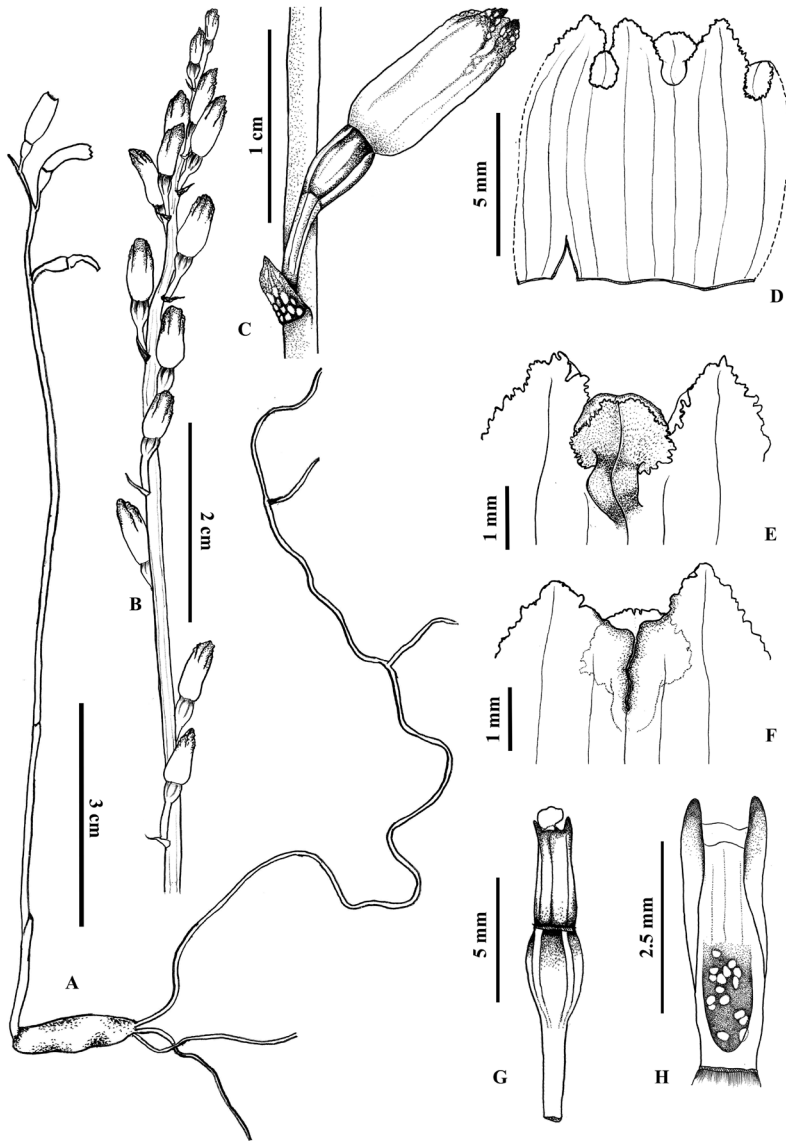


Fig. 3. *Gastrodia pechatieniana* (drawn by P. Kumar; **A** from K.S. Pang s.n., HK43267; **B** and **C** from living plants in habitat; **D–H** from K.S. Pang s.n., HK43268). — **A**: Plant. — **B**: Inflorescence. — **C**: Close-up of flower. — **D**: Perianth tube, opened and flattened. — **E**: Labellum, viewed from inside perianth tube. — **F**: Labellum, viewed from outside perianth tube. — **G**: Column and ovary. — **H**: Column, ventral view, showing pollen grains on the stigma at base.

Roots slender, up to 14.9 cm long, ca. 0.8 mm in diameter, with primary and secondary branching. Peduncle erect, slender, glabrous, pale beige-brown, 9.9–41.5 cm long, 1.1–1.3 mm in diameter, distantly 3- or 4-noded, with a tubular, sheathing membranous sterile bract at each node. Sterile bracts 3.5–6.3 mm long. Floral rachis 1.5–7.4 cm long, laxly to subdensely 3–15-flowered; floral bracts brown, deltoid-ovate, 2.2–4.0 mm long, 1.2–1.5 mm wide, apex acute. Flowers erect, barely opening, probably self-pollinating, pale beige or whitish tinged brown at apex; pedi-

cel 2.5–5.7 mm long; ovary conical, 2.5–3.4 mm long, 1.4–2.1 mm in diameter; sepals, petals and labellum united and forming a 6-lobed, cylindrical perianth tube, 4.8–7.5 mm long, outer surface of tubular part smooth, apical lobes verrucose and with crisped margins; sepals subsimilar, the dorsal sepal slightly wider than the lateral sepals, 4.8–7.5 mm long, connate with the petals for ca. 4/5 of their length, free apical portions ovate-triangular, slightly incurved, margins undulate, dorsal sepal 3-veined, lateral sepals 2-veined; petals slightly shorter and narrower than the

sepals, subsimilar, margins of free apical portions undulate, 1-veined; labellum connate with the lateral sepals for ca. 3/4 of its length, the free apical portion composed of a narrow, concave, hooked claw ca. 0.6 mm wide adjoining the sinus between the lateral sepals at base and along its sides, and an ovate-orbicular limb ca. 1 mm long and 1.5 mm wide with erose, retrorse margins. Column erect, semi-cylindrical, 4–4.8 mm long, ca. 1.6 mm wide, narrowly winged; column wings extending from near the base to the apex of the column, widest at the apex, terminating in narrowly triangular, acute projections either side of the anther cap; rostellum not apparent; stigma ventral, located at the base of the column, elliptic, slightly concave and contained within the column wings; anther cap hemispheric, hinged at apex of column; pollinia 2, loosely contained within the anther, mealy and degenerating into individual massulae, massulae deposited on the stigma in some specimens; column foot inconspicuous. Capsule ellipsoid.

PHENOLOGY: In Hong Kong, plants emerge in September or October and flower rapidly before fructifying, dehiscing and withering by mid-November. This matches the phenology observed for the species in other parts of its range.

HABITAT AND ECOLOGY: In Hong Kong, *G. peichatieniana* grows in thick leaf litter and soil humus, in the shade of broadleaved evergreen montane forest. Other orchids found in the immediate vicinity include *Aphyllorchis montana*, *Goodyera foliosa*, *G. viridiflora* and *Liparis nervosa*. Two populations are known in Hong Kong, both comprising over 50 emergent plants. Although the flowers barely open, pollen massulae were observed on the stigma in flowers dissected in the present study, and fruit set per plant was consistently high, probably indicative of autogamy. This species occurs at high elevation throughout its range, from 650–1500 m a.s.l.

DISTRIBUTION: Taiwan and coastal southeastern China only.

CONSERVATION: A total of 12 sightings at ten localities were confirmed for the species since 1963. Based on the distribution of these sightings, *G. peichatieniana* was found to have an EOO of > 20 000 km² (Least Concern) and an AOO of < 500 km² (Endangered). Our data indicate that the distribution of this species has two iso-

lated geographic centres, in northern Taiwan and coastal southeast China. Throughout its range, populations are highly localised and habitat specific, occurring exclusively at high elevation in broadleaved evergreen forest, a habitat type that is threatened by degradation and climate change in South China. However, populations may comprise 50 or more individuals, suggesting a strong capacity for regeneration at the site level. The species is probably self-pollinating and mean fruit set per individual is high. Given its ephemeral growth habit, the species may be under-recorded. There is no indication that the species has undergone decline in EOO or AOO, or in the number of populations or mature individuals. Based on these attributes, we infer a conservation status of NT.

NOTES: The discovery of *G. peichatieniana* in Hong Kong represents only the second time the species has been recorded outside Taiwan, the previous case being in northern Guangdong Province (Tian *et al.* 2010).

SPECIMENS EXAMINED: **China.** Guangdong Province, Ruyuan, Nanling National Nature Reserve, 1100 m, *H.Z. Tian & H.Q. Li 1007* (HSNU); Hong Kong, New Territories, Tai Mo Shan, 680 m, *K.S. Pang s.n.* (HK43267 & HK43268) (HK). **Taiwan.** Hsinchu County, Mt. Neiniaotsuei, 1500 m, *T.C. Hsu 591* (TAIF); Hsinchu County, Shangshuitien Logging Road, 1500 m, *T.C. Hsu 592* (TAIF); Nantou County, Peichiatienshan, 1100 m, *S.S. Ying s.n.* (NTUF, photo); Taichung County, Mt. Tahsueh logging trail, 1000 m, *T.C. Hsu 964 & 965* (TAIF); Taipei County, Mt. Pataoerh, 1000 m, *T.C. Hsu 674* (TAIF); Taipei County, Mt. Shihtsaitou, 850 m, *T.C. Hsu 633* (TAIF); Taipei County, Mt. Shihtsaitou, 850 m, *T.C. Hsu 676 & 677* (TAIF); Taipei County, Mt. Tatung, 916 m, *Lin 392* (TAIF, photo); Taipei County, Mt. Tatung, 920 m, *T.C. Hsu 634* (TAIF); Taoyuan County, Mt. Peichatien, 1400–1500 m, *T.C. Hsu 581* (TAIF); Taoyuan County, Mt. Nanchatien, 1300–1500 m, *T.C. Hsu 4599* (TAIF).

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