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FIELD NOTE

A checklist of showy mistletoe (Santalales, Loranthaceae) of Lambir Hills National Park in Sarawak, Malaysian Borneo

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ABSTRACT Tropical rainforests in Southeast Asia are globally recognized as biodiversity hotspots. However, floristic inventories are limited, particularly for hemiparasites growing in forest canopies. This study presents a checklist of showy mistletoe (Loranthaceae) from the Lambir Hills National Park located in the Miri district, Sarawak, northern Borneo, Malaysia. The data were obtained from our intensive field surveys in the national park from 2016 to 2022, and analysis of the herbaria of The Sarawak Herbarium, The Kyoto University Museum, and the Botanical Research Centre in the Semenggoh Wildlife Centre in Sarawak, Malaysia.

A total of 21 species belonging to 10 genera of Loranthaceae were enumerated, along with ecological information for each species. Of these, 15 species were identified at the species level and 6 were identified at the genus level. The occurrence of *Macrosolen brunsing* Y. W. Low & Ariffin, formerly known only from Brunei Darussalam, was confirmed and represents the first record of the flora in Malaysia. In addition, *Lepidaria vaginata* Tiegh., formerly known only from its type locality, Mt. Matang, was confirmed. We show that Lambir Hills National Park is the second locality for this species.

Key words: Forest canopy, Hemiparasite, Mistletoe, Santalales, Tropical rainforest

INTRODUCTION

The tropical rainforests of Southeast Asian tropics are considered one of the top hotspots for biodiversity worldwide (Bruyn et al. 2014). Among these, forests on the lowland hills in northern Borneo stand out as the most species-rich areas in terms of plant diversity (Ashton 2005). Many diversity studies based on plant inventory surveys have been conducted to reveal the full picture of plant diversity in this area (Lee et al. 2002; Ashton 2005; Davies et al. 2005). However, knowledge of the floristic components at a fine scale remains limited in this area. Furthermore, studies focusing on plants growing in the canopy, including hemiparasites and epiphytes, have been hindered by the accessibility of the crowns of trees on which they inhabit (Nagamasu and Sakai 1996; Yumoto et al. 1997; Komada et al. 2022a).

Primary lowland tropical rainforests in the Lambir Hills National Park (hereafter, Lambir Hills NP) in Sarawak, Malaysian Borneo, are characterized as one of the most plant-diverse forests worldwide (Ashton 2005; Davies et al. 2005). Since 1992, a program specializing in canopy biology has been ongoing in this national park, involving plant surveys of the canopy using ladders, towers, and cranes (Inoue et al. 1995; Yumoto and Nakashizuka 2005). These investigations have revealed the importance of canopy-inhabiting vascular plants as essential components of ecosystems that provide food and habitat sources for numerous organisms (Yumoto et al. 1997; Inui et al. 2009; Kurita et al. 2019). Among plants, epiphytes exhibit high

diversity and unique taxonomic composition in this region (Nagamasu and Sakai 1996; Komada et al. 2020, 2022b). However, little is known regarding these hemiparasites.

Loranthaceae (also known as showy mistletoe), a family of hemiparasitic vascular plants with high diversity in tropical regions, comprises approximately 200 species in the Southeast Asian tropics (Barlow 1997). To establish a baseline for a better understanding of hemiparasites in the Lambir Hills NP, the present study aimed to elucidate the species diversity and ecological characteristics of Loranthaceae in the area by referencing herbarium specimens and field observations.

MATERIALS AND METHODS

Study site

Lambir Hills NP is located in Miri district, Sarawak, Malaysia, which is the northwestern part of Borneo Island (4° 12′ N, 114° 02′ E). It covers 6,949 ha with an altitudinal range of 20–465 m (Putz and Chai 1987; Yumoto and Nakashizuka 2005; Sarawak Forestry 2023). Its climate is classified as equatorial rain forest (Af) (Kottek et al. 2006). The mean annual temperature is 25.8 ℃; the mean annual precipitation from 2001 to 2016 was 2,620 mm (Nakagawa et al. 2019). Most of the area is covered with a primary lowland mixed dipterocarp forest (Lee et al. 2002; Ashton 2005), where the canopy height of the forest ranges from 25 to 40 m above the ground, with some emergent trees reaching 70 m in height (Lee et al. 2002; Ashton 2005). In addition to the predominant lowland mixed dipterocarp forest, the park has patches of heath (kerangas) forests on its ridge tops (Ashton 2005).

Field surveys

Field surveys were conducted from 2016 to 2019 and in 2022. Observations and collections were conducted along the trails of the Lambir Hills NP, crowns of 98 canopy-reached trees. Tree crowns were accessed using facilities such as towers with walkways and cranes installed in the national park (see Inoue et al. (1995) for details). Single- and double-ropework techniques (Perry 1978; Lowman and Schowalter 2012) were used, and trees were climbed for observation. To collect ecological information, host plant species of the Loranthaceae individuals were recorded in the field, and the aboveground height of the growing site on trees was measured using a razor rangefinder (TruPulse 360; Laser Technology, CO, USA) or a surveying pole for trees.

Studied materials

All Loranthaceae species recorded from Lambir Hills NP, which are stored in the herbaria of The Sarawak Herbarium (SAR), The Kyoto University Museum (KYO) (the herbarium acronyms are followed by Thiers (2016)), and the Botanical Research Centre (HBRC) in Semenggoh Wildlife Centre, Sarawak, were targeted. The measurements described in the checklist below were performed based on the examined specimens. Information on ecological characteristics, including flower color, was assembled based on the examination of the labels of herbarium specimens and field surveys by the authors.

Species identification

To verify the species identification, morphological comparison was conducted on closely related species based on the dry specimens of the above mentioned herbaria and specimen images on the web (GBIF: https://www.gbif.org/, JSTOR Global Plants: http://plants.jstor.org/, Muséum National d'Histoire Naturelle: http://www.mnhn.fr/, and Naturalis Biopotal (L): https://bioportal.naturalis.nl/) and by referring to the relevant literature (Lecomte 1915; Danser 1938; Barlow 1995, 1997, 2002; Yumoto et al. 1997; Hô 2003; Pelser and Barcelona 2013; Singh and Murugan 2013; Han 2014; Singh 2015; Barkman et al. 2016; Pelser et al. 2016, 2018; Low et al. 2017; Tagane et al. 2017; Singh et al. 2020; Sivaramakrishna et al. 2021; Mazo et al. 2022). The distribution of each species was obtained from the literature and POWO (2023).

RESULTS AND DISCUSSION

Based on field observations and examination of 41 sheets of herbarium specimens collected between 1962 and 2022, 21 species in 10 genera of Loranthaceae were confirmed to occur in Lambir Hills NP. Fifteen species were identified at the species level and six at the genus level. The specimens that were stored in the SAR were digitized using a scanner (DS-50000; EPSON, Nagano, Japan), and the images and specimen information are in the process of being databased and will be available in Komada et al. (in submission).

Records of two species, *Macrosolen brunsing* Y. W. Low & Ariffin and *Lepidaria vaginata* Tiegh., are notable from the viewpoint of their distribution. *M. brunsing* has only been found in Brunei Darussalam (Low et al. 2017); however, this species was identified and collected in Bukit Pantu, Lambir Hills NP, which represents the first record of its occurrence in Malaysia. *Lepidaria vaginata* is a rare species that has only been known from its type locality, Mt. Matang, since Tieghem (1895) described it. The collection in the Lambir Hills NP is the second locality, c. 450 km NE of the type locality. Additionally, the habitats of *L. vaginata* are not fully understood. However, our observations show for the first time that this species grows in canopy habitats on large *Dryobalanops lanceolata* Burck.

Generally, owing to limited observations in the canopy of tropical rainforests, where tree heights average between 25 and 40 m and some emergent trees reach 70 m, it is difficult to describe host plants and habitat environments for all listed species in detail. In the field survey, 10 of 21 species were listed below parasitized branches or trunks more than 20 m above ground height. Of these, six species were recorded in the canopy habitats. These results suggest that surveys based on intensive canopy access are essential to better understand the ecology of Loranthaceae species.

In this study, we were unable to identify six taxa at the species level. Further accumulation of taxonomic information based on field observations, examination of herbarium specimens, and phylogenetic analyses is required. These studies will contribute to elucidating among-site variations in the floristic composition of this family, which will help unveil the mechanisms underlying the high plant species diversity found in northern Borneo.

The list below contains species names, materials examined in this study, brief morphological descriptions, recorded host plants, ecology, distribution, and notes on the ecology and/or taxonomy of each species.

A checklist of Loranthaceae in Lambir Hills National Park

Amyema sp. 1 [aff. *beccarii* (Tiegh.) Danser, Bull. Jard. Bot. Buitenzorg, sér. 3, 10: 294 (1929).]

Materials examined in this study. *B.L. Burtt B.11645* (SAR).

Description. Young twigs grayish-brown, old twigs dark grayish-brown. Leaves opposite; petioles 0−3 mm long; blades narrowly obovate, elliptic, or oblong-elliptic, 5.5−11 × 3.4−5.3 cm, apex rounded, base cuneate. Corolla 6-merous, 3.6−3.8 cm long; tube red, 2.3−2.4 cm long; lobes green tinged with yellow-green at apex, 1.3−1.4 cm long.

Host plants. Unrecorded.

Ecology. Bukit Lambir, alt. 370−460 m.

Distribution. Borneo (Lambir Hills NP).

Notes. Barlow (1997) documented 58 *Amyema* species in Malaysia. Among them, this specimen is morphologically most similar to *Amyema beccarii* in having narrowly obovate to elliptic leaves with rounded apex and indistinct lateral veins, 6-merous corolla tinged with red at lower to middle and green at apex, and corolla lobes longer than the tube, but differs in its longer corolla 3.6−3.8 cm long (vs. 1.3−2.2 cm long in *A. beccarii*). This could be an undescribed species. However, only one collection with flower bud is currently available. To conclude and describe this species as a new one, further field surveys are required to obtain its flowers and fruits.

Amyema sp. 2 [aff. *seemeniana* (K. Schum.) Danser subsp. *melastomatifolia* (K. Krause) Barlow, Austral. J. Bot, 22(3): 591 (1974).]

Materials examined in this study. *S. Sakai 100* (SAR) & *206* (SAR).

Description. Young twigs reddish-brown, old twigs dark-brown, strigosely lenticellate. Leaves opposite; petioles 5−7 mm long; blades oblong to oblong-ovate, 5.3−9.5 cm × 3.5−6 cm, apex rounded, base cuneate, venation curvinerved with 3 veins. Corolla 5-merous, reddish, c. 7.5 cm long, curved; tube 5.8 cm long; lobes 1.7 cm long, reflexed. Anthers 7 mm long.

Host plants. Unrecorded.

Ecology. In mixed dipterocarp forest, alt. 150−220 m.

Distribution. Borneo (Lambir Hills NP).

Notes. This species is morphologically similar to *A. seemeniana* subsp. *melastomatifolia* in having opposite leaves with curvinerved venation, 5-merous curved corolla with more than 6 cm long, and anthers up to 7 mm long, but differs in its longer corolla (c. 7.5 cm in *Amyema* sp. 2 vs. 4−6.5 cm in *A. seemeniana* subsp. *melastomatifolia*) and shape of leaf apex (mostly rounded vs. acuminate).

Amylotheca duthieana (King) Danser, Bull. Jard. Bot. Buitenzorg, sér. 3, 10: 301 (1929). Fig. 1a−c.

Materials examined in this study. Photographs in Fig. 1.

Description. Shrub with epicortical runners bearing secondary haustoria (tissues that absorb nutrients and water from hosts). Branches up to 4 m long. Young twigs reddish-brown, old twigs grayish-pale brown.

Leaves opposite or subopposite, rarely alternate; petioles reddish-brown, c. 2 cm long; blades rather glaucous on both surfaces, ovate-orbicular to orbicular, c. 10 × 5 cm, apex rounded, base rounded, truncate, to cuneate. Inflorescences racemose, with decussately arranged triads. Corolla red, 4.5−6 cm long. Fruits globose.

Host plants. Shorea acuta P.S. Ashton (Dipterocarpaceae).

Ecology. Occasional in mixed dipterocarp forest; on branches in outer crown of canopy and emergent trees; on branch in outer crown, 37−53 m above ground height.

Distribution. Borneo, Peninsular Malaysia, Sumatra, and Thailand.

Notes. Although voucher specimens were not available, we listed the species based on our field observations and previous observation at Lambir (see Yumoto et al. 1997). This species was identified as having predominantly opposite leaves, a lamina with a rounded apex, and racemose inflorescences with decussately arranged triads.

Dendrophthoe constricta (Korth.) Danser, Bull. Jard. Bot. Buitenzorg, sér. 3, 10: 307 (1929). Fig. 1d−f.

Materials examined in this study. *N. Komada LCV335* (SAR).

Description. Shrub with epicortical runners bearing secondary haustoria. Young shoots, inflorescences, and flowers are densely covered with ochre to reddish-brown short hairs. Branches up to 50 cm long. Young twigs dark-brown or reddish-brown, old twigs whitish-gray. Leaves subopposite to alternate; petioles 5−9 mm long; blades ovate to elliptic-ovate, (7.5−)10−16 × (3−)6−9 cm, apex obtuse, rounded, or acute, base rounded to cuneate. Inflorescences racemose, 18 mm long, c. 11-flowered; peduncle 1−1.5 mm long; rachis 8 mm long. Pedicels 1−1.2 mm long. Corolla pale yellowish-green, less than 2.5 cm long. Ovary cylindrical, 1.1 mm long. Fruits obovoid.

Host plants. *Citrus* sp. (Rutaceae) (*N. Komada LCV335*).

Ecology. Occasional in edge of lowland mixed dipterocarp forest; on branch, 2−4 m above ground height.

Distribution. Borneo and Sulawesi.

Notes. Inflorescence measurements were obtained at the young stage. This species is characterized by ochre to reddish-brown short hairs on young shoots, inflorescences, and flowers, not opposite or subopposite leaves with ovate to elliptic blades 7−25 cm long, racemose 10−20-flowered inflorescences 1−4 cm long, and corolla 1.8−3 cm long.

Dendrophthoe sp. [aff. *clementis* (Merr.) Danser, Bull. Jard. Bot. Buitenzorg sér. 3, 10: 307 (1929).] Fig. 2a−d.

Materials examined in this study. *N. Komada LCV 51* (SAR) & *LCV289.1* (SAR); *S. Okuno* et al. *LCV20220905.2* (HBRC).

Description. Shrub up to c. 60 cm wide and tall, young parts densely covered with reddish-brown hairs. Young twigs dark reddish-brown, old twigs pale-brown to grayish-brown. Leaves subopposite to alternate; petioles 2−5 mm long; blades lanceolate to falcate, or ovate, (2.2−)5−11 × (1.2−)2−3.5 cm, apex rounded or obtuse, base cuneate. Inflorescences racemose, up to c. 3 cm long; peduncle 3−4 mm long; rachis 5−11 mm long. Pedicels 1.5 mm long. Corolla 5-merous, 23−25 mm long with one keel-like protuberance at 5−6 mm from the apex of the corolla; tube yellowish-green, c. 18 mm long, deeply splitted at one side; lobes yellowish-green in lower half part and brownish-red in upper half part, 5−7 mm long. Ovary cylindrical, 1.2 mm long. Fruits ellipsoid c. 4 mm long.

Host plants. *Shorea acuta* P.S. Ashton and *S. foxworthyii* Symington (Dipterocarpaceae) (*N. Komada LCV 51* & *LCV289.1*).

Ecology. Occasional in mixed dipterocarp forest, alt. 100 m; on branch in outer crown, 27−40 m above ground height.

Distribution. Borneo (Lambir Hills NP).

Notes. Two *Dendrophthoe* species were observed in the Lambir Hills NP. This species is distinguished from *D. constricta* by its relatively smaller and narrower leaves and a corolla with one keel-like protuberance. It resembles *Dendrophthoe clementis* but differs in its corolla (with one keel-like protuberance and tube deeply splitted at one side in *D*. sp. [aff. *clementis*] vs. protuberance absent and tube not splitted in *D. clementis*). Although this species could be an undescribed one, to conclude and describe, examination of further specimens is required.

Helixanthera cylindrica (Jack ex Roxb.) Danser, Bull. Jard. Bot. Buitenzorg, sér. 3, 11: 377 (1931).

Materials examined in this study. *H.P. Fuchs 21315* (L.1643499, SAR).

Description. Young twigs dark-grayish or yellowish-brown. Leaves subopposite or opposite; petioles 10−15 mm long; blades narrowly ovate, ovate, or elliptic-ovate, (5.5−)7.5−10 × (1.7−)2.5−4 cm, margin undulate, apex acute or obtuse, base attenuate or cuneate. Inflorescences racemose, up to 17-flowered, 11−14 cm long; peduncle 1.2−1.5 cm long; rachis 8−9 cm long, angular.

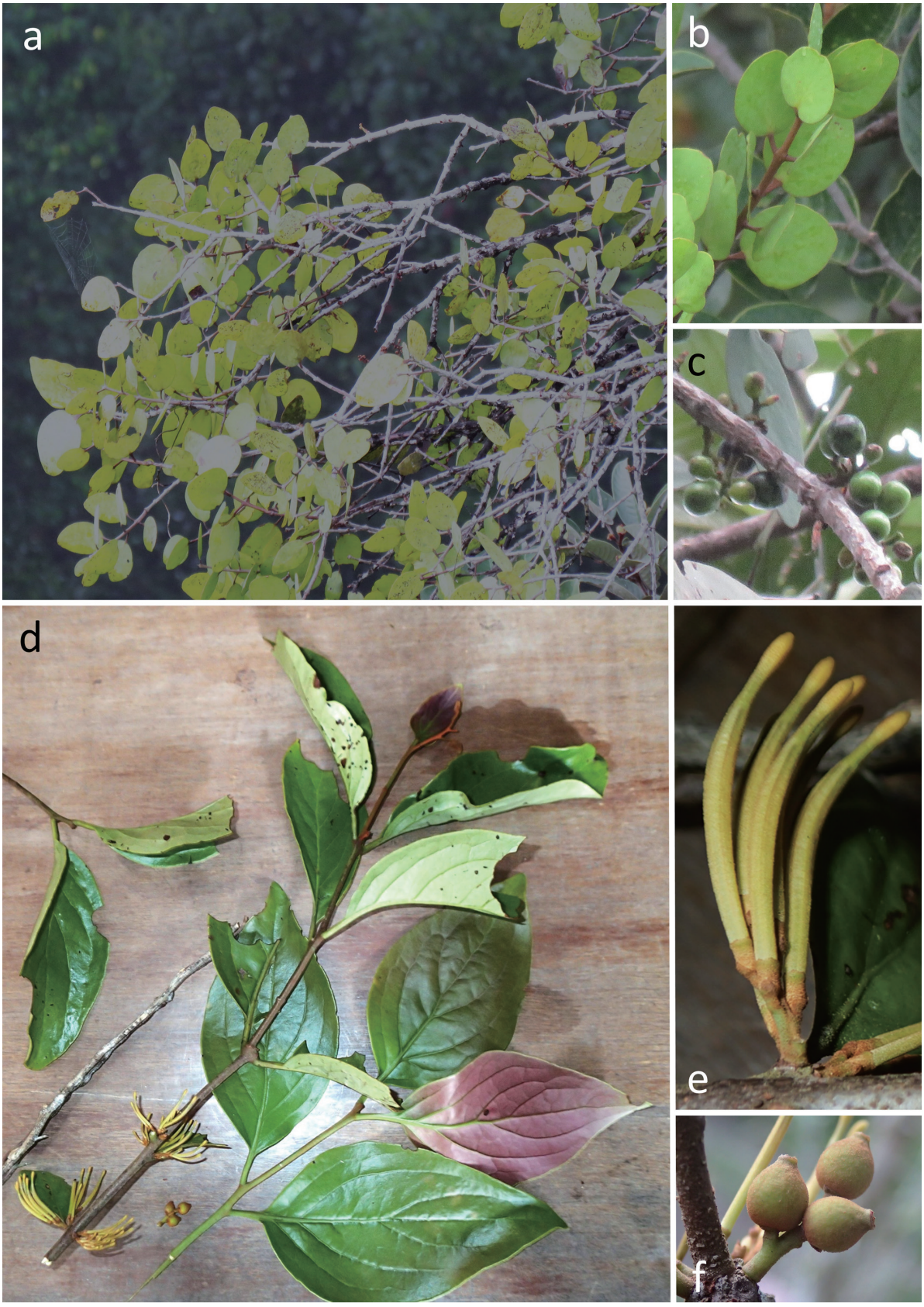

Fig. 1. *Amylotheca duthieana* (King) Danser: a. Habit; b. leafy twig; c. young fruits. *Dendrophthoe constricta* (Korth.) Danser: d. Branches with inflorescences; e. flower buds; f. young fruits.

Fig. 2. *Dendrophthoe* sp. [aff. *clementis* (Merr.) Danser]: a. Habit; b. haustorium; c. flowers; d. fruits. *Helixanthera parasitica* Lour.: e. Branches with inflorescences; f. leaf, abaxial surface; g. young inflorescence; h. inflorescence after anthesis.

Pedicels 3−4 mm long. Corolla orange-yellow, 2−2.5 cm long. Style uniformly slender, 19−22 mm long. Ovary cylindrical 4−4.5 mm long.

Host plants. Unrecorded.

Ecology. In mixed dipterocarp forest, alt. 280 m.

Distribution. Bangladesh, Borneo, Cambodia, Jawa, Laos, Lesser Sunda Is., Peninsular Malaysia, Myanmar, Sulawesi, Sumatra, Thailand, and Vietnam.

Notes. Helixanthera cylindrica is distinguished from other *Helixanthera* species by its opposite, subopposite to subverticillate leaves with elliptic to ovate blades, inflorescence up to 30 cm long with angular rachis, and 5-merous orange-red to bright-red corolla (sometimes yellow or yellow-green) with 2.2−3.2 cm long. The pedicel of *H. cylindrica* is generally longer than the ovary; however, the pedicel of the above-cited specimens is equal to or shorter than the ovary. We consider this to be within the infraspecific variation of this polymorphic species.

Helixanthera parasitica Lour., Fl. Cochinch, 1: 142 (1790). Fig. 2e−h.

Materials examined in this study. *R. George S.40275* (L.1652474, SAR); *N. Komada LCV288.1* (SAR); *I. Paie & Y.E. Teck S.38374* (L.1652475, SAR).

Description. Shrub up to 1 m wide and tall. Twigs yellowish-brown to dark blackish-brown. Leaves opposite to subopposite; petioles 7−12 mm long; blades ovate, elliptic-ovate, or oblong-ovate, (4.5−)7−10 × (2.3−)3.5−4.5 cm, apex acute rarely obtuse, base rounded to truncate, sometimes cordate. Inflorescences racemose, 3.5−5.5 cm long; peduncle 2−6 mm long; rachis 2−4.5 cm long. Pedicels 1−2 mm long. Corolla bright-red, c. 3 mm long. Fruits ellipsoid, c. 5 mm long.

Host plants. *Gymnacranthera bancana* (Miq.) J. Sinclair ssp. *borneensis* (Warb.) Sinclair (Myristicaceae) (*N. Komada LCV288.1*).

Ecology. Occasional in mixed dipterocarp forest, alt. 50−150 m; on branch in outer crown, 9−50 m above ground height.

Distribution. Assam, Bangladesh, Borneo, Cambodia, China South-Central, China Southeast, East Himalaya, Hainan, Jawa, Laos, Peninsular Malaysia, Myanmar, Nepal, Philippines, Sumatera, Thailand, Tibet, Vietnam.

Notes. Two *Helixanthera* species were recorded in Lambir Hills NP. This species is distinguished from *H. cylindrica* by its shorter pedicel length (1−2 mm in *H. parasitica* vs. 3−4 mm in *H. cylindrica*) and bright-red corolla, c. 3 mm long (vs. orange-yellow, 20−25 mm long).

Lepeostegeres bahajensis Miq., Fl. Ned. Ind, 1(2): 833 (1856).

Materials examined in this study. *B.L. Burtt B.11644* (SAR); *O. Haron S.21386* (SAR) & *S.21393* (SAR).

Description. All part glabrous. Young twigs terete and dark-brown, old twigs grayish-brown. Leaves opposite; petioles 5−13 mm long; blades lanceolate, broadly lanceolate, narrowly ovate, or ovate, (4−)6−12 × 1.8−3.8(−4) cm, apex acute or acuminate, base rounded to attenuate, rarely truncate. Inflorescences involucrate head, c. 5.5 cm long; involucral bracts reddish, spathulate, up to 2 cm long, apex rounded. Corolla pale-green, 4.6−4.8 cm long. Fruits ellipsoid, c. 6 mm long, maturing red.

Host plants. Unrecorded.

Ecology. In mixed dipterocarp forest, alt. 50−460 m.

Distribution. Borneo.

Notes. This species is distinguished from other *Lepeostegeres* species recorded in Lambir Hills NP by its terete young twigs, acute and acuminate apex of leaf blades, and involucral bracts rounded at the apex.

Lepeostegeres beccarii Gamble, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3): 381 (1914). Fig. 3a−e.

Materials examined in this study. *Ilias & E.T. Yeo S.38453* (L.1652554, SAR); *N. Komada LCV320* (SAR) & *LCV321* (SAR); *T. Yahara* et al. *SWK3116* (SAR) & *SWK3438* (SAR).

Description. Shrub with epicortical runners bearing secondary haustoria. Young twigs dark-brown, 4-angular, ferruginous short-hairy along the ridges, old twigs brownish-gray, glabrous. Leaves opposite to subopposite; petioles 7−20 mm long, ferruginous hairy; blades broadly ovate, elliptic-ovate, or obovate, 3.8−8.8 × 1.8−6.3 cm, apex acute, obtuse, or rounded, base rounded or cuneate, ferruginous hairy along midrib abaxially. Inflorescences involucrate head, 12 × 5 cm; involucral bracts reddish, oblong-spathulate, up to 8 cm long, apex recurved. Corolla 6-merous, 7.8−10.4 cm long, red.

Host plants. *Koompassia malaccensis* Maingay (Fabaceae).

Ecology. Occasional in mixed dipterocarp forest or secondary forest, alt. 150−311 m; on branch in outer crown, c. 35 m above ground height.

Distribution. Borneo, Peninsular Malaysia, Sumatra.

Notes. Among the three *Lepeostegeres* species recorded in Lambir Hills NP, this species is easily distinguished by its 4-angular twigs with short-ferruginous hairs along the ridges.

Lepeostegeres sp. 1 [cf. *alveolatus* Danser, Bull. Jard. Bot. Buitenzorg, sér. 3, 10: 320 (1929).]

Materials examined in this study. *Ilias & E.T. Yeo S.38447* (L.1652607, SAR).

Description. Young twigs terete and dark-brown. Leaves opposite; petioles 11−20 mm long; blades broadly ovate, ovate-elliptic, oblong-ovate, (2.3−)5−10(−12) × (3.4−)4.2−7 cm, apex obtuse to rounded, sometimes retuse, base rounded, cuneate, or attenuate. Inflorescences involucrate head, 2.5 cm long; involucral bracts bright-red, oblong-spathulate, c. 2 cm long.

Host plants. Unrecorded.

Ecology. In secondary forest on hill slope.

Distribution. Borneo (Lambir Hills NP).

Notes. Inflorescence measurements were obtained at a young stage. Additional specimens with mature flowers are required to verify its taxonomic identity.

Lepidaria pulchella Danser, Bull. Jard. Bot. Buitenzorg, sér. 3, 11: 315 (1931). Fig. 3f−i.

Materials examined in this study. *N. Komada LCV351* (SAR); *U. Shimizu-kaya & H. Kawagoe PIP800* (SAR).

Description. Leaves opposite; petiole 8−12 mm long; blades ovate-oblong, elliptic-ovate, (6−)7.2−9(−11.8) × 3.6−5.1 cm, apex obtuse or rounded, or slightly retuse, base attenuate or cuneate, sometimes oblique. Inflorescences 4−8-flowered involucrate capitate spike; involucral bracts elliptic to oblong-spathulate, up to 2 cm long, apex acute, yellowish to bright-red, longer ones keeled and recurved along the upper margin. Corolla 6-merous, red with whitish striation, c. 4.8 cm long, curved, 6-keeled on upper part; tube 3.4 cm long; lobes 1.4 cm long, reflexed and twisted. Anthers c. 4 mm long. Stigma red.

Host plants. Unrecorded.

Ecology. Occasional in mixed dipterocarp forest, alt. c. 150 m.

Distribution. Borneo.

Notes. This species is distinguished from all other known *Lepidaria* species by its leaf blade, which is more than 9 cm long, inflorescences of 1−4 pairs of flowers, involucral bracts keeled and recurved along the upper margin (Barlow 1997).

Lepidaria vaginata Tiegh., Bull. Soc. Bot. France 42: 440 (1895). Fig. 3j−l.

Materials examined in this study. *N. Komada LCV251* (SAR).

Description. Leaves opposite or subopposite; petioles 18−20 mm long; blades broadly ovate, 5 × 3.8 cm, apex rounded, base truncate or slightly cuneate. Inflorescences 4-flowered involucrate capitate spike, c. 5 cm long, involucre 2 cm long; involucral bracts brownish, elliptic, 0.9−3.2 cm long, apex obtuse, weekly keeled. Corolla red streaked with yellow on upper part, 4.2−4.5 cm long. Anthers 3.5−4 mm long. Stigma yellow.

Host species. *Dryobalanops lanceolata* Burck (Dipterocarpaceae) (*N. Komada LCV251*).

Ecology. In lowland mixed dipterocarp forest, alt. c. 150 m; on branch in outer crown of emergent trees, 40−55 m above ground height.

Distribution. Borneo (Mt. Matang and Lambir Hills NP).

Notes. *Lepidaria vaginata* was described by Tieghem (1895) from Mt. Matang, c. 450 km southeast of the Lambir Hills NP and has been known only from the type locality (Barlow 1997). Although the collection in Lambir Hills NP comprises a few fallen leaves and flowers, we identified it as *L. vaginata* because this species is easily distinguished from all other congeneric species by its elliptic to ovate shaped leaf blades less than 9 cm long with rounded or obtuse apex, inflorescences with up to 4 flowers, involucre with 2−2.5 cm long, not recurved involucral bracts, and red corolla 3.2−6 cm long streaked with yellow (Barlow 1997). Thus, Lambir Hills NP was the second locality for this species. To date, detailed information on the habitat and host plants for *L. vaginata* (Tieghem 1895; Barlow 1997) has not been known; however, we observed that it predominantly grew in the upper canopy of large *Dryobalanops lanceolata* trees.

Loxanthera speciosa Blume, Syst. Veg, ed. 15[bis] [Roemer & Schultes] 7(2): 1730 (1830). Fig. 4a−d.

Materials examined in this study. *I. Asano PIP437* (SAR); *S. Sakai 22* (SAR).

Description. Corolla 6-merous, deep-pink to reddish, 14.5 cm long, robust and curved; tube c. 10 cm long, basally inflated; lobes c. 4.5 cm long, reflexed and twisted. Anthers 5 mm long, dorsifixed and immobile.

Host plants. *Ficus* (Moraceae).

Ecology. Rare in mixed dipterocarp forest; on branch of hemiepiphytic *Ficus*, c. 30 m above ground height.

Distribution. Borneo, Jawa, Peninsular Malaysia, and Sumatra.

Notes. These two samples were obtained from flowers fallen on the ground. Our identification was based on the characteristic dorsifixed and immobile anthers of this monotypic genus. As suggested by Barlow (1997), it may have a high host specificity for *Ficus* species.

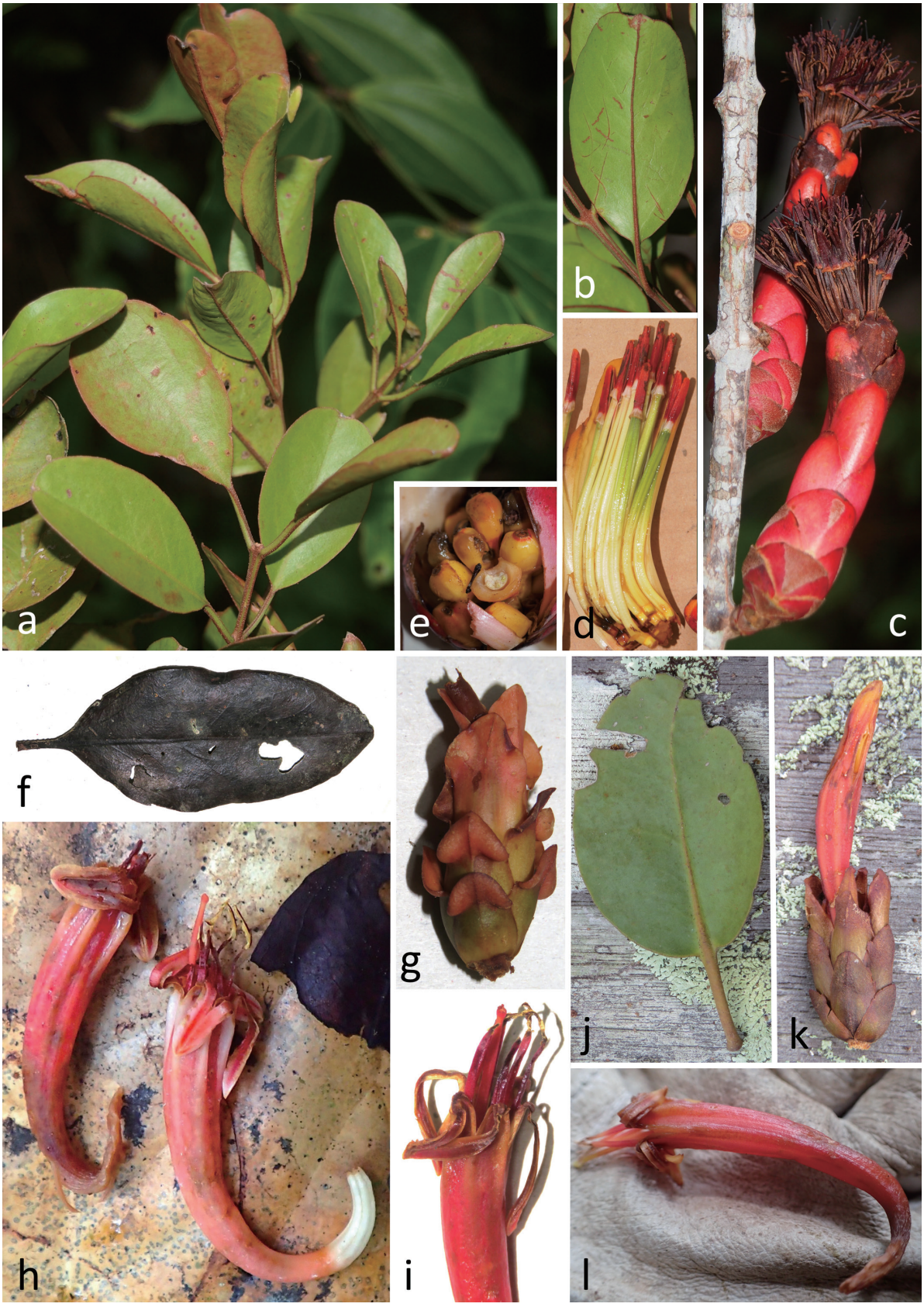

Fig. 3. *Lepeostegeres beccarii* Gamble: a. Leafy twigs; b. abaxial leaf surface; c. inflorescences; d. young flowers; e. fruits. *Lepidaria pulchella* Danser: f. Leaf, adaxial surface; g. involucre; h & i. fallen flowers. *L. vaginata* Tiegh.: j. Leaf, abaxial surface; k. inflorescence; l. fallen flower.

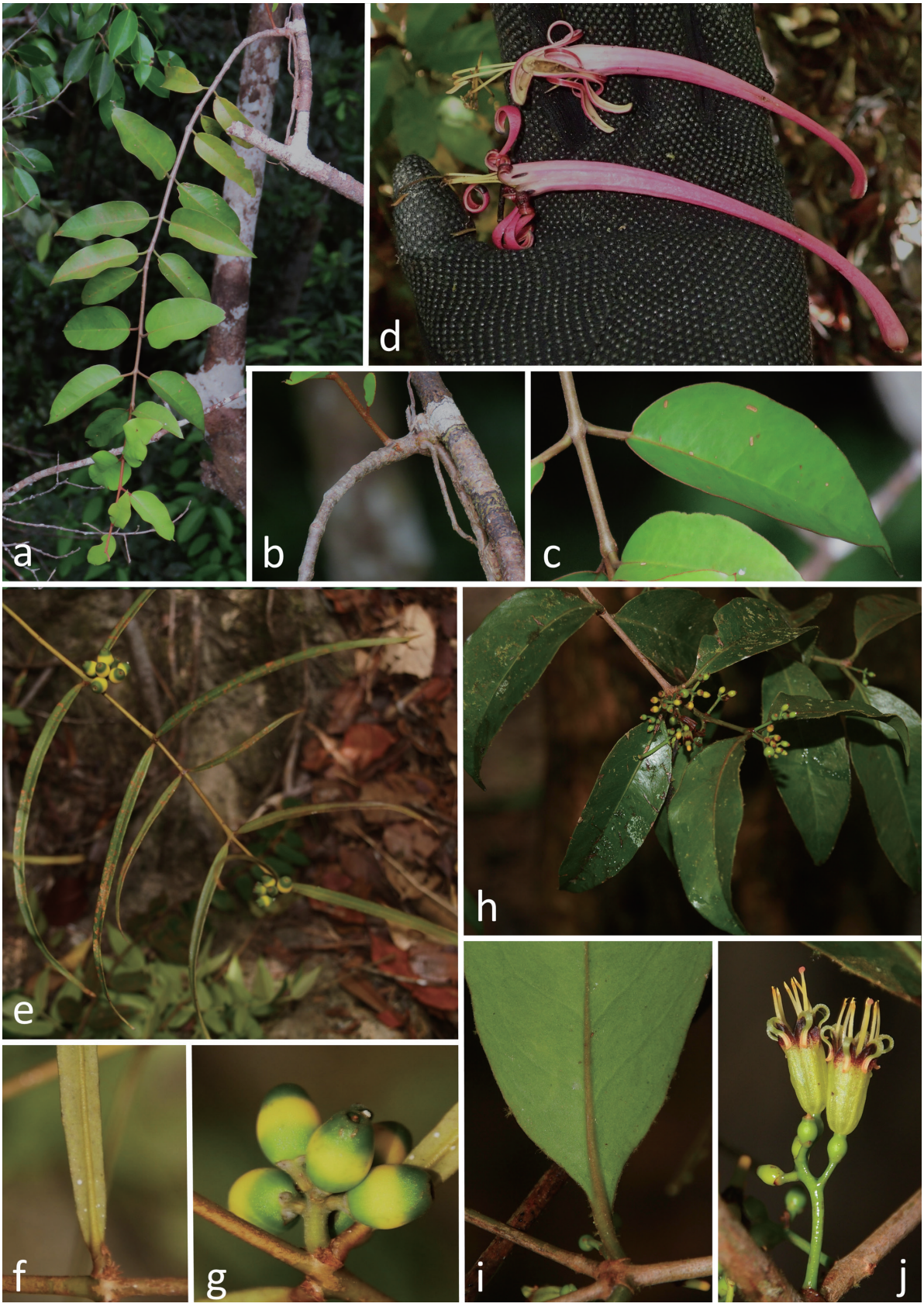

Fig. 4. *Loxanthera speciosa* Blume: a. Habit of young plants; b. basal part of stem with epicortical runners; c. leaf blade, adaxial surface; d. flowers. *Macrosolen brunsing* Y. W. Low & Ariffin: e. Fruiting branch; f. Portion of abaxial leaf surface; g. infructescence. *M. cochinchinensis* (Lour.) Tiegh.: h. flowering branches; i. portion of abaxial leaf surface; j. inflorescence.

Macrosolen brunsing Y. W. Low & Ariffin, Gard. Bull. Singapore 69(1): 68 (2017). Fig. 4e−g.

Materials examined in this study. *J. Au & P.S. Ashton S.16758* (L.1648085, SAR); *S. Tagane SWK3512* (SAR).

Description. Shrub with epicortical runners bearing secondary haustoria. Young twigs grayish-green or dark brownish-green, old twigs and epicortical runners whitish-brown. Leaves opposite or subopposite, rarely alternate; petioles 1−2 mm long; blades narrowly linear, (2.5−)7−9(−13) × 0.3−0.5(−0.8) cm, apex narrowly acute, base cuneate or rounded. Inflorescences racemose, 4−6-flowered, decussately arranged, c. 25 mm long; peduncle 3−4 mm long; rachis 4−5 mm long. Pedicels c. 1.5 mm long. Corolla 16−20 mm long, 6-keeled, bright-red tinged with black at the middle. Ovary cylindrical, 3 mm long. Fruits ovoid c. 5 mm long.

Host plants. *Strombosia rotundifolia* King (Olacaceae) (*J. Au & P.S. Ashton S.16758*).

Ecology. Steep slope, near the summit of Bukit Pantu, alt. 342 m; on branch, 4.6 m above ground height.

Distribution. Borneo.

Notes. *Macrosolen brunsing* was described by Low et al. (2017) from the Ladan Hills Forest Reserve in Brunei Darussalam, c. 100 km northeast of Lambir Hills NP. The leaf blades of above-cited collections are broader than the variation in Brunei Darussalam (0.1−0.2 (−0.25) cm wide, Low et al. 2017); we considered it is within an infraspecific variation of this species. This is the first report of this species in Malaysia.

Macrosolen cochinchinensis (Lour.) Tiegh., Bull. Soc. Bot. France 41: 122 (1894). Fig. 4h−j.

Materials examined in this study. *N. Komada LCV304* (SAR); *B. Lee S.46555* (L.1675544, SAR); *K. Momose 7400* (SAR); *U. Shimizu-kaya & H. Kawagoe PIP781* (SAR); *S. Tagane* et al. *PIP600* (SAR); *T. Yahara* et al. *SWK2482* (SAR); *M. Yamauchi 549* (SAR).

Description. Glabrous shrub. Young twigs terete whitish-yellowish-brown, old twigs whitish-brown to grayish-brown. Leaves opposite to sub-opposite; petioles 2−5 mm long; blades ovate, elliptic-ovate, or narrowly ovate, 7−11.5 × (3−)4−5.5 cm, apex acuminate or acute sometimes obtuse, base cuneate or attenuate. Inflorescences subumbellate racemose, 1−6-flowered, usually arranged subopposite, up to 4 cm long; peduncle (4−)7−8(−13) mm long; rachis (8−)10−18 mm long. Pedicels 1−2 mm long. Corolla 6-merous, yellowish-green tinged with bright-red at the apex, 14−16 mm long, weakly keeled medially; tube c. 7 mm long.

Host plants. *Calophyllum* (Calophyllaceae) (*B. Lee S.46555*), *Memecylon* (Melastomataceae) (*K. Momose 7400*), *Syzygium* (Myrtaceae) (*N. Komada LCV304*).

Ecology. Common in mixed dipterocarp forest, alt. 100−200 m; on branch in outer crown of tree growing on riverbank and ridge, 5−35 m above ground height.

Distribution. Andaman Is., Assam, Bangladesh, Borneo, Cambodia, China South-Central, China Southeast, East Himalaya, Hainan, Jawa, Laos, Lesser Sunda Is., Peninsular Malaysia, Maluku, Myanmar, Nepal, New Guinea, Nicobar Is., Philippines, Sulawesi, Sumatera, Thailand, Tibet, and Vietnam.

Notes. This species is easily distinguished from other *Macrosolen* species in Lambir Hills NP by its ovate, elliptic-ovate, or narrowly ovate leaf blades with a cuneate or attenuate base.

Macrosolen sp. 1 [cf. *acunae* (Merr.) Danser, Bull. Jard. Bot. Buitenzorg, sér. 3, 11: 343 (1931)].

Materials examined in this study. *Yii* et al. *S.43136* (L.1648370, SAR).

Description. Young twigs yellowish-green. Leaves opposite; petioles 1−3 mm long; blades elliptic, ovate-elliptic, or slightly obovate, 14.5−19 × 5.5−9.5 cm, apex acute or acuminate, base rounded. Flowers Unrecorded. Fruits yellow to red.

Host plants. Unrecorded.

Ecology. In mixed dipterocarp forest, alt. c. 400 m; on branch, 15 m above ground height.

Distribution. Borneo (Lambir Hills NP).

Notes. Only one collection lacked flowers. Additional flower collections are required to verify the taxonomic identity of this species. This species was included in the genus *Macrosolen* based on its vegetative similarity to *Macrosolen acunae.* This species is distinguished from other *Macrosolen* species in Lambir Hills NP by its leaves with petioles 1−3 mm long and rounded base of blades.

Macrosolen sp. 2 [aff. *melintangensis* Miq., Fl. Ned. Ind. 1 (1): 830 (1856)]

Materials examined in this study. *J. Au & P.S. Ashton S.16444* (L.1648400, SAR).

Description. Young twigs grayish-brown, old twigs dark to blackish-brown. Leaves opposite; petioles 8−14 mm long; blades ovate, oblong-ovate, 9.4−14 × 6.1−9.5 cm, apex acute or slightly acuminate, base rounded or truncate. Inflorescences racemose, up to 4-flowered; peduncle 0.5 mm long, rachis 4−6.5 mm long. Pedicels

1−1.5 mm long. Corolla bright-red basally, black medially, and green near apex, 18−20 mm long; tube angular, 6.5−8 mm, lobes 11.5−12 mm. Style and anthers pale-yellow. Ovary cylindrical, 3 mm long.

Host plants. Anisophyllea ferruginea Ding Hou (Anisophylleaceae) (*J. Au & P.S. Ashton S.16444*).

Ecology. On a branch, c. 4 m above ground height.

Distribution. Borneo (Lambir Hills NP).

Notes. This species is similar to *Macrosolen melintangensis* but differs in the shorter length of its corolla tube (6.5−8 mm in *Macrosolen* sp. 2 vs. 12−18 mm in *M. melintangensis*). This could be an undescribed species.

Macrosolen sp. 3 [“large ovate leaf”]

Materials examined in this study. *J. Au & P.S. Ashton S.16760* (L.1648398, SAR).

Description. Young and old twigs pale grayish-brown, with minute spots of lenticels. Leaves opposite; petioles 6−14 mm long; blades broadly ovate, (9−)14.5−25 × (6−)10−17 cm, apex acute or obtuse, base rounded or truncate. Corolla red basally, black medially, green near apex. Anthers and style rich golden-yellow.

Host plants. Mallotus (Euphorbiaceae) (*J. Au & P.S. Ashton S.16760*).

Ecology. On branch, c. 5 m above ground height.

Distribution. Borneo (Lambir Hills NP).

Notes. This species is distinct from all the above-listed *Macrosolen* species in having young branches with minute spots of lenticels and broadly ovate blades with rounded to truncate bases; however, its identity could not be well examined, as the specimen lacked flowers and fruits. Flowers were unavailable on the specimen at SAR; however, the color information documented above was cited from the specimen label.

Scurrula ferruginea (Roxb. ex Jack) Danser, Bull. Jard. Bot. Buitenzorg, sér. 3, 10: 320 (1929). Fig. 5a−d.

Materials examined in this study. *N. Komada LCV290.1* (SAR).

Description. Shrub with epicortical runners bearing secondary haustoria. Young parts densely covered with ochre to ferruginous hairs. Young twigs grayish-brown. Leaves opposite or subopposite; petioles (2−)5−6 mm long; blades elliptic, elliptic-oblong, or ovate, (3.2−)5−7 × 2.2−3.5 cm, apex acute to obtuse, base rounded, cuneate, or slightly cordate. Inflorescences 2-flowered raceme; peduncle 2 mm long. Pedicels 3.8−4 mm long. Corolla yellowish-brown, c. 8 mm long, faintly curved. Fruits stipitate, 8−9 mm long.

Host plants. Citrus (Rutaceae) (*N. Komada LCV290.1*).

Ecology. Common in edge of mixed dipterocarp forest, alt. below 100 m; on branch 3−25 m above ground height.

Distribution. Borneo, Cambodia, China South-Central, Jawa, Laos, Lesser Sunda Is., Peninsular Malaysia, Myanmar, Philippines, Sulawesi, Sumatera, Thailand, Vietnam.

Notes. The corolla measurements were obtained at a young stage. This species is easily distinguished from other Loranthaceae species in Lambir Hills NP by its young parts, which are densely covered with ochre to ferruginous hairs, opposite or subopposite leaves, petioles 2−10 mm long, elliptic to ovate blades 3−10 cm long, 2−5-flowered racemose inflorescences, faintly curved corolla 8−14 mm long, and stipitate fruits 8−9 mm long (Barlow 1997).

Trithecanthera sparsa Barlow, Blumea 40(1): 29 (1995). Fig. 5e−h.

Materials examined in this study. *N. Komada LCV2022092702* (HBRC)

Description. Shrub with epicortical runners bearing secondary haustoria. Branches up to 2 m long. Leaves alternate; petioles 1−1.5 cm long; blades ovate to elliptic-ovate, 18−20 × 7 cm, apex obtuse, base attenuate. Corolla yellow, c. 7.7 cm long.

Host plants. Dipterocarpus globosus Vesque, *Shorea beccariana* Burck (Dipterocarpaceae) (Yumoto et al. 1997).

Ecology. Occasional in mixed dipterocarp forest; on upper part of trunk or basal part of large branch, 25−30 m above ground height.

Distribution. Borneo.

Notes. This species is distinguished from all other *Trithecanthera* species by its mostly alternate and petiolate leaves, and yellow corolla with 6.5−7.7 cm long (Barlow 1997, Yumoto et al. 1997).

Trithecanthera xiphostachya Tiegh., Bull. Soc. Bot. France 41: 599 (1894).

Materials examined in this study. *T. Nagamitsu 522* (SAR); *R. Rahman 103* (SAR); *M. Yamauchi 547* (SAR) .

Description. Leaves verticillate; petioles 2−3 cm long; blades broadly lanceolate, c. 30 × 7 cm, apex obtuse, base attenuate. Corolla 5-merous, pink, 14.8−16 cm long, curved; tube 11.5−12.5 cm long, lobes 3.3−4 cm long. Anthers 17 mm long.

Host plants. Shorea smithiana Symington (Diptero-

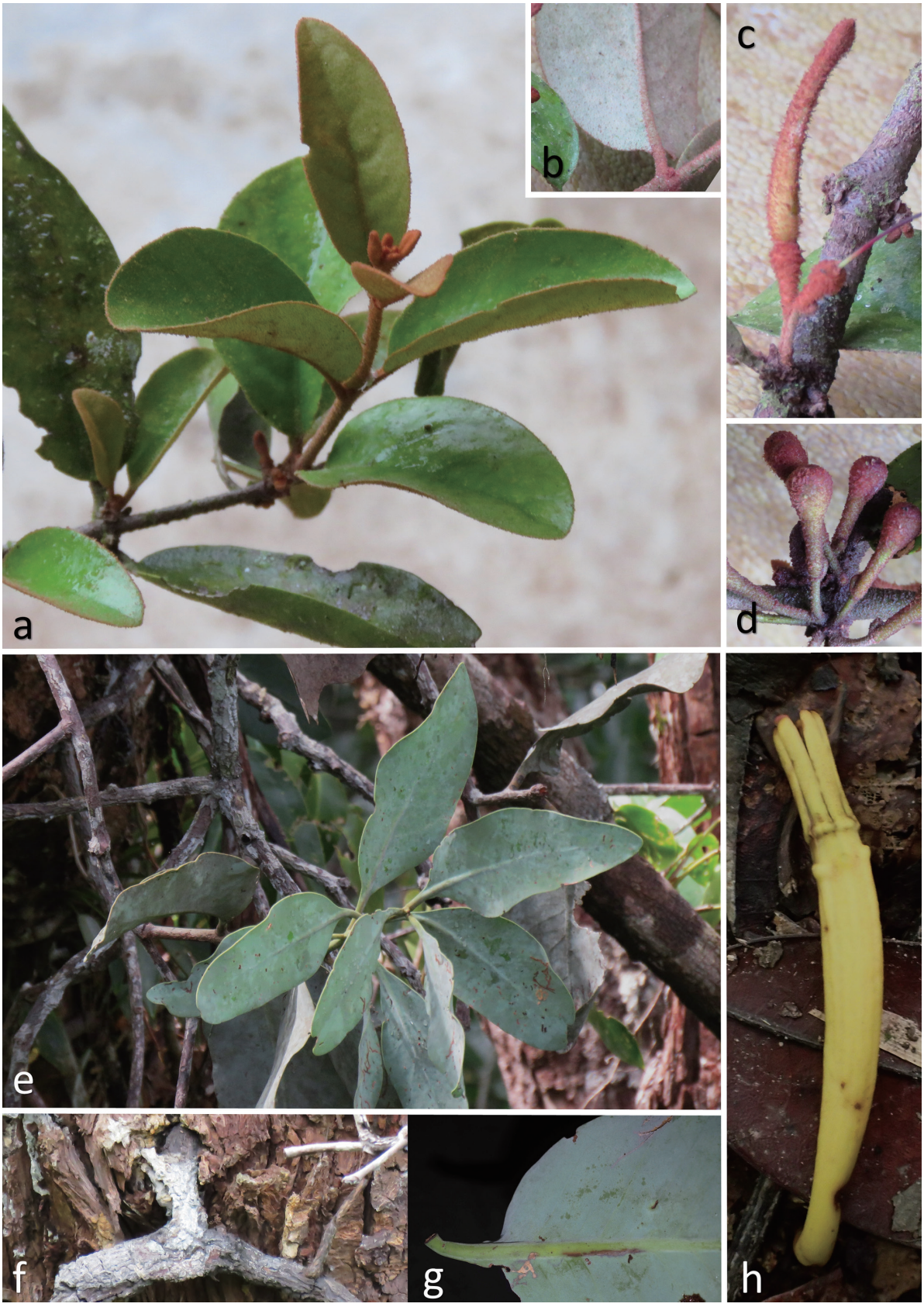

Fig. 5. *Scurrula ferruginea* (Roxb. ex Jack) Danser: a. Leafy twig; b. portion of abaxial leaf surface; c. inflorescence with flower bud; d. young fruits. *Trithecanthera sparsa* Barlow: e. Habit; f. epicortical runner; g. portion of abaxial leaf surface; h. flower.

carpaceae) (Yumoto et al. 1997)

Ecology. Rare in mixed dipterocarp forest, alt. 150 m.

Distribution. Borneo.

Notes. Two *Trithecanthera* species were recorded in Lambir Hills NP. This species is distinguished from *T. sparsa* by its leaf arrangement (verticillate in *T. xiphostachya* vs. alternate in *T. sparsa*) and corolla color and size (pink, 14.8−16 cm long in *T. xiphostachya* vs. yellow, 6.5−7.5 cm long in *T. sparsa*).

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