

The Gardens' Bulletin Singapore

VOL. 66(1) 2014

ISSN 0374-7859

The Gardens' Bulletin Singapore

Vol. 66(1) 2014



Singapore
Botanic Gardens

Singapore Botanic Gardens, 1 Cluny Road, Singapore 259569 Tel: 64719921 Telefax: 64674832

Singapore Botanic Gardens

THE GARDENS' BULLETIN, SINGAPORE

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Homotypic synonyms should be provided in a block, stating the type at the end.

Front cover picture: *Orchidantha lengguanii* (Photo by Jana Leong-Škorničková)

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Date of publication: 10 July 2014

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1 Cluny Road
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Printed by **Oxford Graphic Printers Pte Ltd**

Editorial

After around three years as editor of *Gardens' Bulletin Singapore* Dr Wong Khoon Meng is stepping down and I shall now be attempting to maintain the high standards we have become used to. Singapore Botanic Gardens was fortunate to have such a capable editor to see through the passage of two particularly notable volumes of the *Bulletin* during his tenure. These were volume 63, the *Proceedings of the 8th Flora Malesiana Symposium*, and volume 64, comprising the two issues that marked the 100 years of the *Gardens' Bulletin Singapore* in its various guises. We thank Khoon Meng wholeheartedly for his service to the *Bulletin* in this period.

Apart from a change in editor there have been a few format changes in the journal. Rather than list them here it is perhaps easiest for authors to follow the format of papers in this issue or, if in doubt, to contact the editor for advice. All papers will continue to be peer reviewed and we will ensure that the period from submission to publication is as short as possible for those papers accepted for publication. We will also continue to offer free publication, including for colour figures, and all published papers will appear freely online (i.e. Open Access publication). Authors will no longer receive reprints as these have rapidly fallen out of favour. Instead the lead author will receive a copy of the issue in which the paper is published plus an electronic PDF copy of their paper.

The rest of the editorial team at Singapore Botanic Gardens will remain the same, namely Serena Lee, Jana Leong-Škorničková, Yee Wen Low and Christina Soh.

The core work of the journal has always primarily been to publish high quality botanical papers on the plants of Southeast Asia and the Pacific (with forays into the plants of South and East Asia), focusing on plant taxonomy and phylogeny, floristics, biogeography, nomenclature, morphology, anatomy and conservation. The subject and geographical foci of the journal will continue as before under my editorship and I look forward to receiving your contributions.

David J. Middleton

The conservation of Peninsular Malaysian *Geostachys* (Zingiberaceae)

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ABSTRACT. There are currently 15 species of *Geostachys* in Peninsular Malaysia of which 13 are hyper endemic to their localities. Four taxa are categorised as Endangered, eight as Vulnerable and one each as Near Threatened, Least Concern and Data Deficient. Maps showing the Extent of Occurrence and Area of Occupancy for each species are included. Key issues and recommendations on conservation measures, particularly with respect to ecotourism, are discussed.

Keywords. Area of occupancy, assessment, conservation, extent of occurrence, *Geostachys*, Peninsular Malaysia

Introduction

Geostachys (Baker) Ridl. is a genus of lesser-known gingers distributed in Vietnam, Thailand, Sumatra, Peninsular Malaysia and Borneo. Of the 25 taxa currently known (The Plant List, 2013), 15 occur in higher altitude lush rain forests of Peninsular Malaysia (Lau et al., 2007; Lau & Lim, 2012). This makes Peninsular Malaysia the genus hotspot. Among the 15 taxa, 13 are hyper-endemic to their localities and the other two are quite widespread.

In Malaysia, the main threats to lowland forest are from deforestation and changes in land use. Despite their preference for higher altitudes, *Geostachys* habitats suffer from similar disturbances. While there are several works describing the genus in Peninsular Malaysia (Ridley, 1899, 1920, 1924; Holttum, 1950; Stone, 1980), none address the conservation perspective. This paper discusses threats faced by the species and their conservation status. It also complements an earlier account (Lau & Lim, 2012) by presenting further insights into the current conservation issues involving the genus.

Materials and methods

Dried specimens from Universiti Kebangsaan Malaysia Herbarium (UKMB), Kepong Herbarium (KEP), University Malaya Herbarium (KLU), Singapore Herbarium (SING) and Royal Botanic Gardens Kew Herbarium (K) were scrutinized and recorded into

the Botanical Research and Herbarium Management System (BRAHMS). All species were assessed using the modified Malaysian Red List Categories (Chua, 2012). The modification from the standard IUCN (2001) system involves the addition of a Rare (RA) category. This category has this definition: the taxon is not exposed to any known direct or plausible potential threat and does not qualify under the five IUCN criteria AND occurs in not more than two sites OR has an Extent of Occurrence (EOO) not more than 100 km² OR Area of Occupancy (AOO) not more than 10 km². A taxon data information sheet was completed for each species and the information was uploaded into the Malaysia Clearing House Mechanism website (<http://www.chm.frim.gov.my/>). The EOO and AOO were calculated for each species using ArcView GIS 3.2a software. Forest cover data was obtained from the Third National and State Forest Inventories (1991–1993). Field efforts were made to gather fresh data and analyse current threats.

Results

Table 1 summarises the conservation status of each species of *Geostachys* in Peninsular Malaysia.

Table 1. Conservation status of *Geostachys* following the modified Malaysian Red List Categories.

Species	Category	EOO (km ²)*	AOO (km ²)	Endemicity
<i>G. belumensis</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. decurvata</i>	EN D2	n.a.	8	Hyper-endemic
<i>G. densiflora</i>	NT	3,172	32	Widespread
<i>G. elegans</i>	LC	23,108	24	Widespread
<i>G. erectifrons</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. leucantha</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. megaphylla</i>	VU D2	n.a.	8	Hyper-endemic
<i>G. montana</i>	DD	n.a.	4	Hyper-endemic
<i>G. penangensis</i>	EN B2ab(iii)	n.a.	8	Hyper-endemic
<i>G. primulina</i>	EN D2	n.a.	4	Hyper-endemic
<i>G. rupestris</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. secunda</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. sericea</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. tahanensis</i>	VU D2	n.a.	4	Hyper-endemic
<i>G. taipingensis</i>	EN D2	n.a.	8	Hyper-endemic

*EOO can only be calculated if at least 3 localities are present.

The species calculated to be Endangered (EN) are *Geostachys decurvata* (Baker) Ridl., *G. penangensis* Ridl., *G. primulina* Ridl. and *G. taipingensis* Holttum,

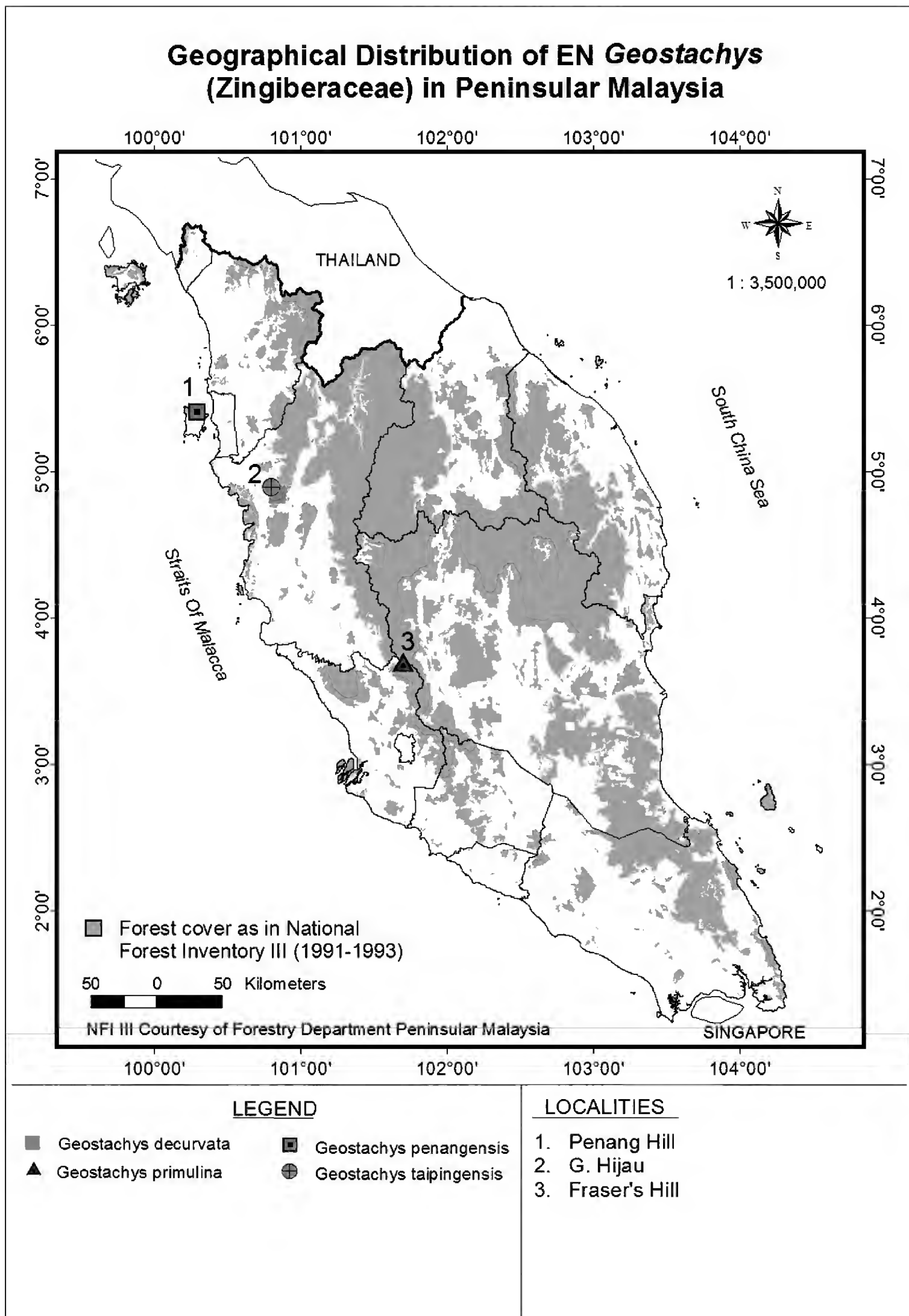


Fig. 1. Distribution of Endangered (EN) *Geostachys* species in Peninsular Malaysia.

all of which are hyper-endemic (Fig. 1). Found growing discreetly within the cool atmosphere of hill forests in Perak, Penang and Pahang, these taxa are endangered mainly due to low numbers of individuals per species. With the exception of *Geostachys penangensis*, several attempts to locate additional populations of these species in these forest reserves proved futile. *Geostachys decurvata* and *G. taipingensis* occur sympatrically on Gunung (G.) Hijau, Maxwell's Hill. These two taxa have both been very infrequently collected and *G. taipingensis* has not been collected for the herbarium since 1949. Lau (2006) reported the rediscovery of *Geostachys primulina* from Fraser's Hill for the first time in more than 80 years. *Geostachys penangensis* can still be found quite abundantly on Penang Hill (Lau, 2004) with populations at several locations on the hill such as Government Hill, Tiger Hill, Western Hill and Moniot Road West. However, road widening activities along the main road (Jalan Tuanku Yahaya Petra) have caused much destruction to the clumps. The increase in human activities on the hill is of concern and long-term monitoring of the impacts on the populations is required. In addition, the sites of these four taxa are also used as eco-forest trails and are exposed to the risk of being trampled.

The Vulnerable (VU) taxa are *Geostachys belumensis* C.K.Lim & K.H.Lau, *G. erectifrons* K.H.Lau, C.K.Lim & K.Mat-Salleh, *G. leucantha* B.C.Stone, *G. megaphylla* Holttum, *G. rupestris* Ridl., *G. secunda* (Baker) Ridl., *G. sericea* (Ridl.) Holttum and *G. tahanensis* Holttum (Fig. 2). In Taman Negara National Park, three taxa are found, namely *Geostachys erectifrons*, *G. sericea* and *G. tahanensis*. Their distributions are, however, very localised. So far, *Geostachys erectifrons* is only known from the area between Permatang and Kubang campsites (Merapoh) at an elevation of 1000–1200 m (Lau et al., 2005). Scattered clumps can be seen on ridges and slopes along both sides of the main trail. The distribution of *Geostachys tahanensis* is also very restricted, occurring on a different side of the mountain near Kuala Tahan Rest Camp, formerly known as Wray's Camp, at about 1100 m above sea level. *Geostachys sericea* has a wider distribution on both the Kuala Tahan and Merapoh sides, but is loosely scattered from the lower montane forest to upper montane forest. Until more populations are discovered beyond these well-used trails and spots, they remain vulnerable as they are at risk of being trampled or collected. For *Geostachys belumensis*, some of the populations in Gerik are now likely protected since 18,866 ha of the Amanjaya Forest Reserve (FR) was gazetted in May 2013. The area has also been identified as an important wildlife corridor under the Central Forest Spine (CFS) Masterplan. This provides protection to many other flora and fauna species along the East-West Highway. Recent discoveries include populations in Piah FR (Perak) and *G. Tebu* (Terengganu) (C.K. Lim pers. obs.). However, the type location of this taxon, which is in Gerik, is showing signs of degradation due to encroachment. In particular the surrounding area has been cleared, probably for the harvesting of non-timber forest products. *Geostachys leucantha* and *G. megaphylla* are found in G. Ulu Kali (Genting Highlands) and G. Brinchang (Cameron Highlands) respectively. Although there are no immediate direct threats to these populations, the environmental impacts arising from non-forest land use will likely affect the viability of the populations. Infrastructure projects, such as for resorts, power lines and slope enhancement structures, as well as

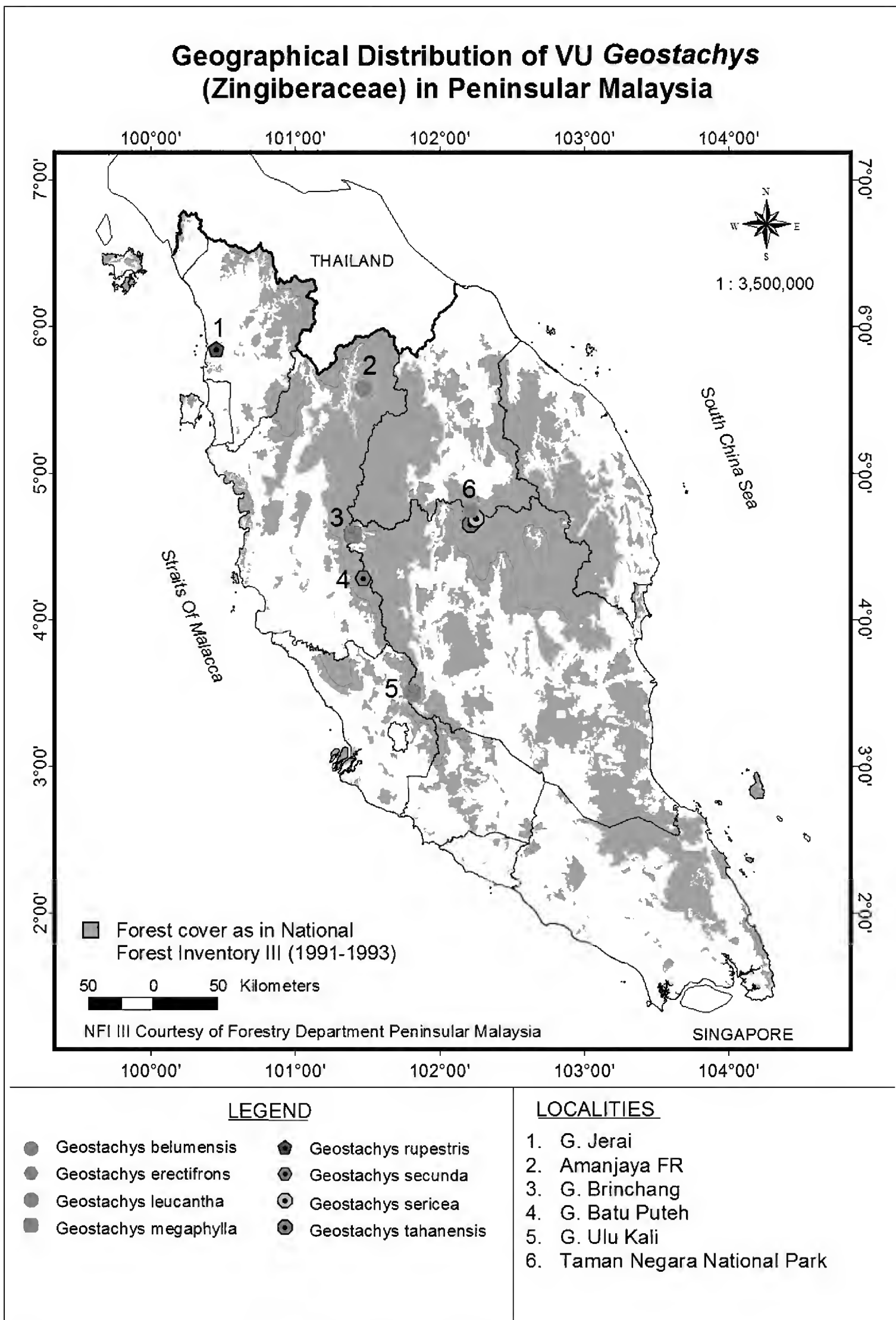


Fig. 2. Distribution of Vulnerable (*VU*) *Geostachys* species in Peninsular Malaysia.

forest clearance for agriculture, especially around Brinchang town and above, have imposed great pressures on the health of the species' populations. For *Geostachys rupestris*, which is found on G. Jerai (Kedah), dumpsites at forest fringes are slowly degrading the quality of the habitat where clumps once grew. Part of the forested area on G. Jerai serves as a tourist attraction. In the pristine forest of G. Batu Puteh (Perak) *Geostachys secunda* is found along trails used by the local communities and are, therefore, at risk of being trampled.

The two more widely distributed species are *Geostachys densiflora* Ridl. and *G. elegans* Ridl. *Geostachys densiflora* is mainly found in the mountainous area along the Titiwangsa Ridge in the Cameron Highlands and on Fraser's Hill (Fig. 3). Until recently this species was only known from Pahang and Perak but a 2010 expedition to G. Chamar and G. Chamar Anak, Kelantan revealed new sites for *Geostachys densiflora*. These new populations occur at an elevation of 1300 m and 1700 m respectively. This has expanded its AOO to close to 32 km². At the type locality in G. Korbu it was last collected in 1913 and it is not known if it still occurs there; further investigation is needed to verify its status.

Most populations of *Geostachys elegans* are restricted to the state of Pahang although the type locality is G. Ledang in northern Johor (Fig. 4). The populations in both Taman Negara National Park and G. Ledang State Park are relatively safe within their Protected Areas (PAs).

Geostachys montana (Ridl.) Holttum is Data Deficient (DD) as it could not be relocated on G. Berembun in the Cameron Highlands (Fig. 5) even after several attempts. There are two possibilities, i.e., either the original locality details were inaccurate or it has gone extinct in the wild. Further research is required to determine its status in the near future.

Discussion

Protected areas remain the best places for material for taxonomic research and the most likely place for the discovery of new species. In Malaysia, the pristine conditions of its National and State Parks and other protected forest areas provide the last refuges for rich biodiversity that tropical forests are famed for. For instance, examples of new species discovered from protected areas in Malaysia include two new *Geostachys* species (Lau et al., 2005) in Taman Negara National Park, another *Geostachys* species in Maliau Basin, Sabah (Lim & Lau, 2006), a *Pennilabium* orchid in Endau Rompin National Park, Johor (O'Byrne et al., 2009), two gingers from the genus *Scaphochlamys* in Krau Wildlife Reserve, Pahang (Sam et al., 2010) and 13 new species of *Begonia* from G. Mulu National Park and G. Buda National Park, Sarawak (Sang et al., 2013). These, and many others, indicate that more inventory attention should be given to areas that are 'botanical black holes'. It is anticipated that more new species will be found in the future as the diversity in the protected areas continues to be studied.

With 60% of the world's *Geostachys* species occurring in Peninsular Malaysia, with more than 85% of these taxa hyper-endemic, this region is regarded as the genus

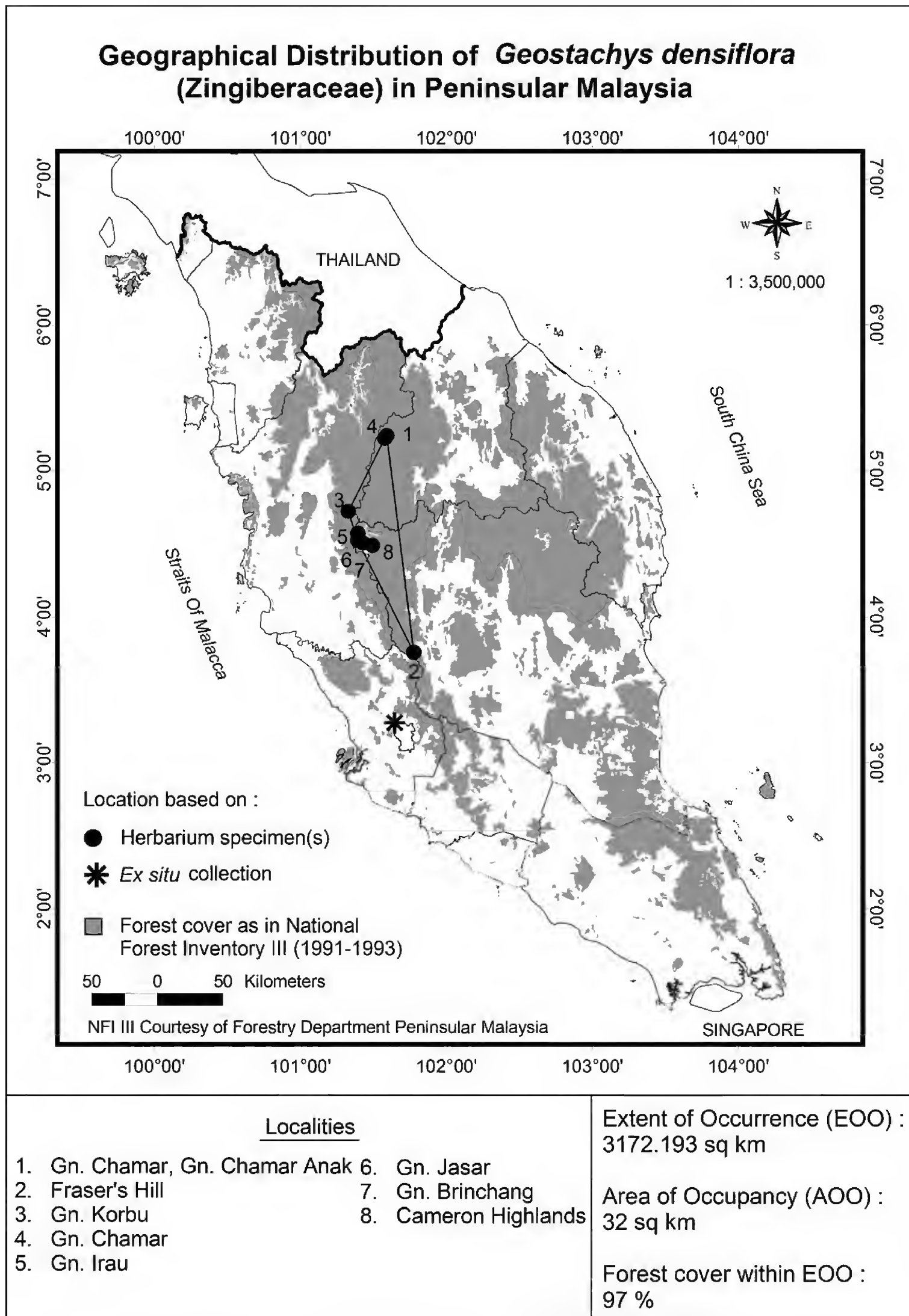


Fig. 3. Distribution of *Geostachys densiflora* Ridl. in Peninsular Malaysia.

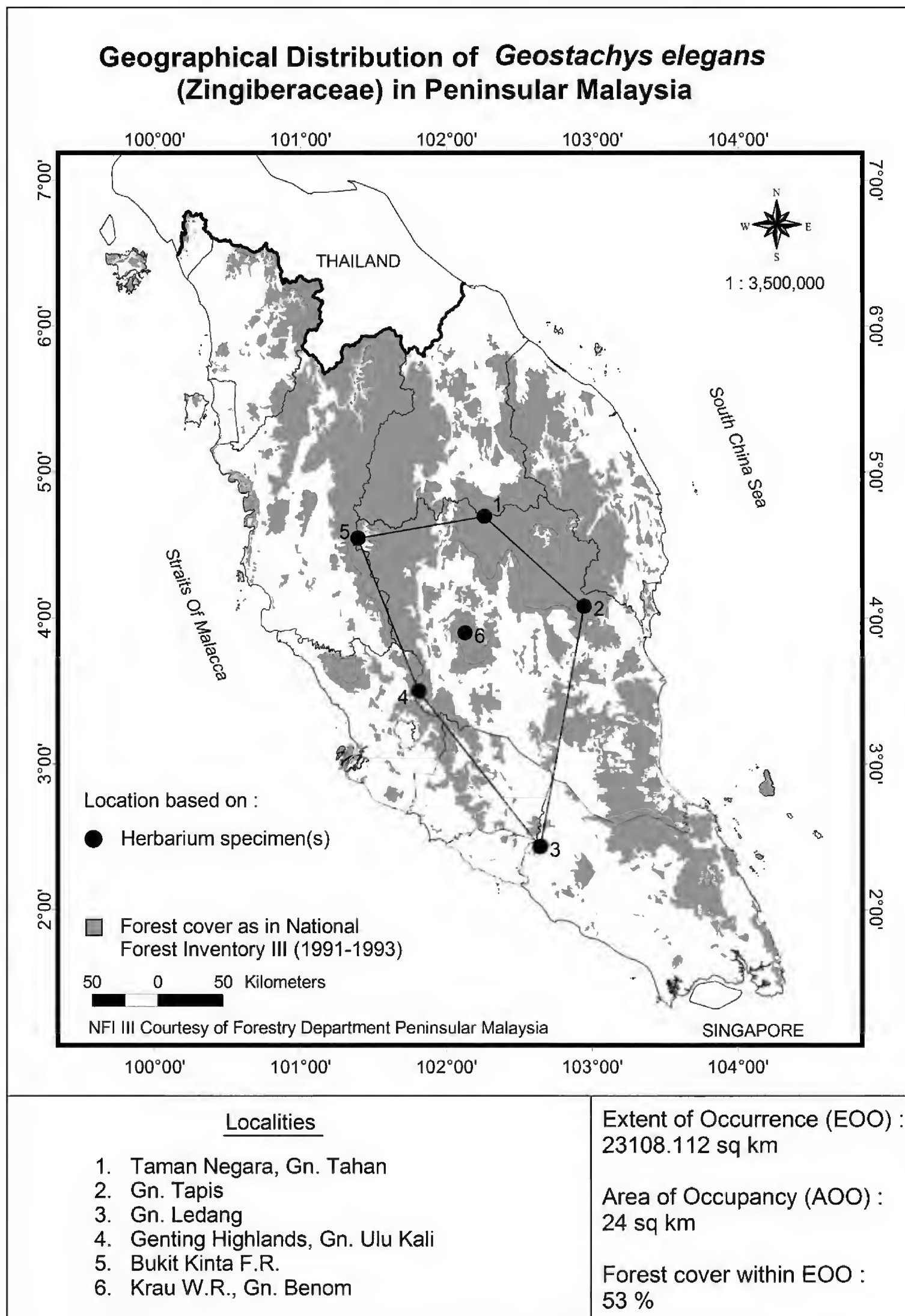


Fig. 4. Distribution of *Geostachys elegans* Ridl. in Peninsular Malaysia.

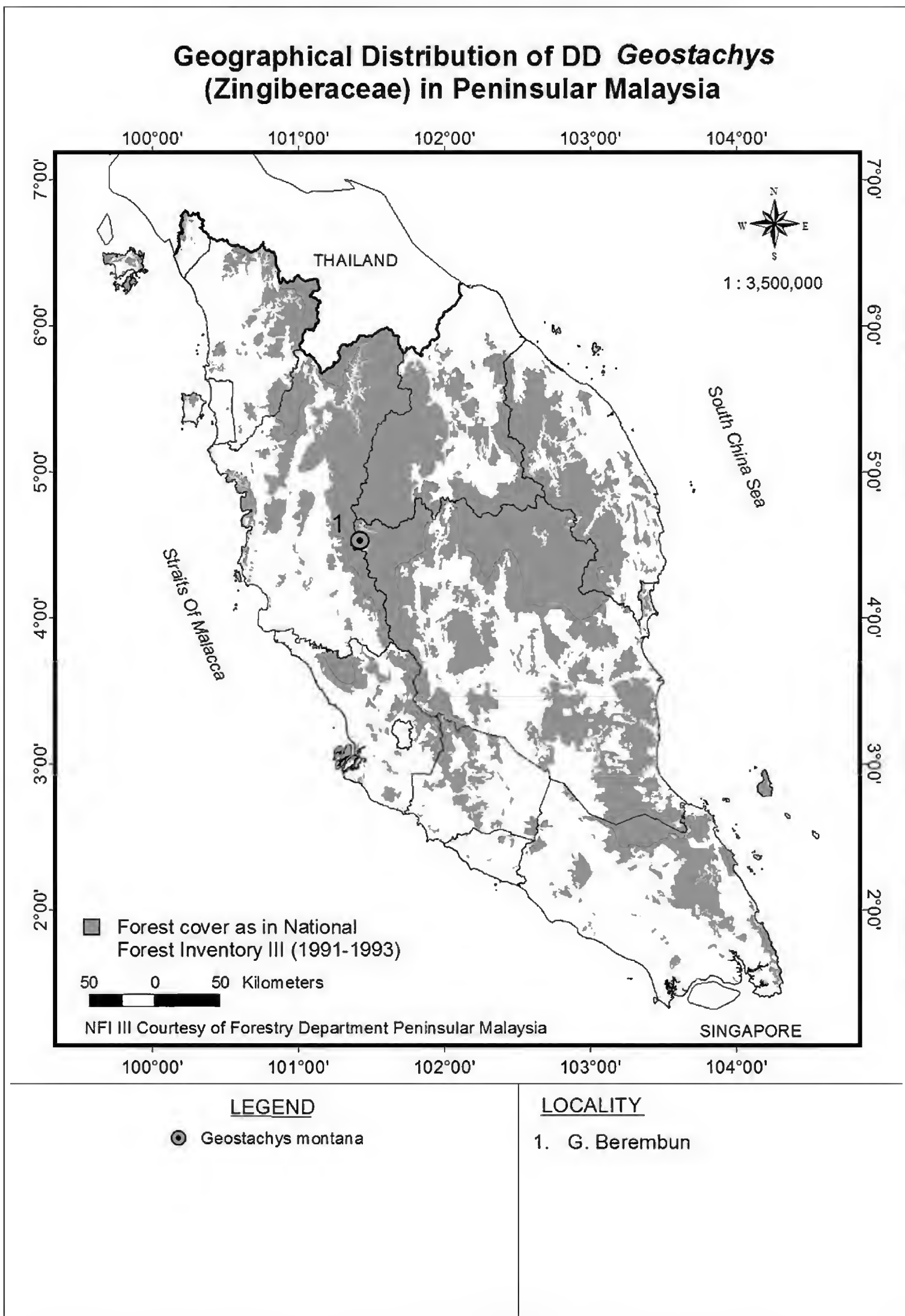


Fig. 5. Distribution of Data Deficient (DD) *Geostachys* species in Peninsular Malaysia.

hotspot. Therefore, conservation of these gingers should be given priority. While some taxa occur in Protected Areas, there are many which do not. These taxa are exposed to threats such as habitat encroachment and land use changes, i.e. in the Cameron Highlands and Genting Highlands. The expansion of forest trail packages by tourist operators in the Cameron Highlands could further disturb the ecosystem due to higher footfall. Currently, there are no specific guidelines and support given to the ecotourism companies to encourage conservation mindfulness. In the Genting Highlands, massive developments over recent decades have altered the forested landscape and environment and consequently affected the viability of all species of flora and fauna. In the development of management plans for such sites, the effects of how changes in land use negatively impact on the environment, and how this can be mitigated, must be researched.

The occurrence of *Geostachys* species in tourist sites also means additional conservation measures to protect the taxa must be adopted. For instance, although the habitat is well-protected in National and State Parks, the populations of *Geostachys* species themselves may not be. Stricter rules and regulations should be imposed on forest trails which are heavily used by tourists. These should include a total ban of removal of any flora and fauna found in the forests, and higher fines if caught doing so. Hikers should not be allowed to clear vegetation for the setting up of camps anywhere in the forest outside designated camping grounds. This is to protect the indiscriminate or unintentional removal of rare plants. Also, unauthorised clearing of new forest paths must be prohibited for the same purpose, to avoid the killing and trampling of plants and disturbance of the ecosystem. Prominent notice boards should be erected at strategic locations to serve as reminders.

There are a few ecotourism models that have set good examples of balanced development, such as can be found on Fraser's Hill and Maxwell's Hill. These places have developed into niche-market tourist attractions. On Fraser's Hill, the annual bird race competition that attracts thousands of people has proven that retaining forested areas is rewarding. The annual event has also directly increased the public's awareness of forest conservation. On Maxwell's Hill, where the state government-owned resort has full administrative authority, including accessibility to the peak, the impact from tourism is very much minimized. For example, only authorised vehicles have access to the hill. Tourists have to be carried in these vehicles from the base of the hill to their destinations and the somewhat antiquated transport style adds allure to the concept of the cool private highland getaway.

The threat assessment process itself has been a daunting task. It has been long believed that taxa which are confined to protected areas are not really at any risk of extinction due to decades-old protection legislation (Chua, 2012). However, each should be reviewed on a case by case basis. It has not been easy to determine the conservation status for some species, especially those from protected habitats where threats are nevertheless believed to exist. The three species in Taman Negara National Park may at first seem to fit into the Rare (RA) category (*sensu* Chua, 2012), but further analyses showed that they deserved a threatened category. Although their AOO qualified the species under both categories, i.e., not more than 10 km², the RA category

is not suitable for species under threat. Therefore, for the reasons discussed above, the Vulnerable category is more appropriate.

It is clear that the survival of *Geostachys* is very much dependent on the management strategies employed by forest managers who in turn have to balance their management practices with their obligations to deliver government policy. What is needed is that Malaysia's biodiversity heritage is given ample attention and protection so that its full potential can be appreciated not only now but also by future generations.

ACKNOWLEDGEMENTS. I am grateful to Datuk Seri Lim Chong Keat for first bringing the genus to my attention, and for his sincere guidance throughout the process. Many of the localities would not have been rediscovered without his keen knowledge. Dr Lillian Chua was very helpful with her critical comments and suggestions during the early stage of the manuscript. Her expertise with conservation assessments is much appreciated. Sincere gratitude also goes to Hamidah Mamat and Wendy Yong S.Y. for their technical input in the preparation of the maps. Further thanks are due to the herbarium curators at K, KEP, KLU, SING and UKMB for access to specimens. The work could not have been completed without the assistance of the staff of the Department of Wildlife and National Parks (PERHILITAN), Johor State Park, Penang Botanic Gardens and Universiti Kebangsaan Malaysia. The State Forestry of Kedah, Penang, Perak and Pahang granted the forest permits.

References

- Chua, L.S.L. (2012). Conservation. In: Kiew, R., Chung, R.C.K., Saw, L.G. & Soepadmo, E. (eds) *Flora of Peninsular Malaysia Series II*. Vol. 3. Kepong: Forest Research Institute Malaysia.
- Holtum, R.E. (1950). The Zingiberaceae of the Malay Peninsula. *Gard. Bull. Singapore* 13(1): 224–236.
- IUCN (2001). *Red List Categories and Criteria Version 3.1*. Switzerland, Gland and UK, Cambridge: IUCN.
- Lau, K.H. (2004). Observations on the endemic *Geostachys* of Penang Hill and its environment. *Folia Malaysiana* 5: 109–114.
- Lau, K.H. (2006). A ginger lost and found. *Conservation Malaysia* 2: 3.
- Lau, K.H. & Lim, C.K. (2012). Revision of the genus *Geostachys* (Zingiberaceae) in Peninsular Malaysia. *Folia Malaysiana* 13: 7–42.
- Lau, K.H., Lim, C.K. & Mat-Salleh, K. (2005). Two new species of *Geostachys* (Zingiberaceae) from Peninsular Malaysia. *Folia Malaysiana* 6: 83–94.
- Lau, K.H., Lim, C.K. & Mat-Salleh, K. (2007). Materials for a taxonomic revision of *Geostachys* (Zingiberaceae) in Peninsular Malaysia. *Gard. Bull. Singapore* 59: 129–138.
- Lim, C.K. & Lau, K.H. (2006). A new *Geostachys* species from Maliau Basin, Sabah. *Folia Malaysiana* 7: 33–40.
- O'Byrne, P., Phoon, S.N. & Ong, P.T. (2009). *Pennilabium armanii*: A new species from Peninsular Malaysia. *Malesian Orchid J.* 3: 113–116.
- Ridley, H.N. (1899). The Scitamineae of the Malay Peninsula. *J. Straits Branch Roy. Asiat. Soc.* 32: 157–160.

- Ridley, H.N. (1920). New and rare species of the Malayan plants. *J. Straits Branch Roy. Asiat. Soc.* 82: 1–201.
- Ridley, H.N. (1924). *The Flora of the Malay Peninsula*. Vol. 4. London: Reeve & Co. Ltd.
- Sam, Y.Y., Ibrahim, H. & Saw, L.G. (2010). *Scaphochlamys krauensis* and *S. pusilla* spp. nov. (Zingiberaceae) from Krau Wildlife Reserve, Pahang, Peninsular Malaysia. *Nord. J. Botany* 28: 673–679.
- Sang, J., Kiew, R. & Geri, C. (2013). Revision of *Begonia* (Begoniaceae) from the Melinau Limestone in Gunung Mulu National Park and Gunung Buda National Park, Sarawak, Borneo, including thirteen new species. *Phytotaxa* 99: 1–34.
- Stone, B.C. (1980). A new *Geostachys* (Zingiberaceae) from Gunung Ulu Kali, Pahang, Malaysia. *Malaysian J. Sci.* 6(A): 75–81.
- The Plant List (2013). Version 1.1. Published on the Internet; <http://www.theplantlist.org/> (accessed 1st January 2014).

Orchidantha lengguanii* (Lowiaceae), a new species from Peninsular Malaysia, and typification of *O. maxillarioides

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ABSTRACT. A new *Orchidantha* species from Endau-Rompin National Park (Johor, Peninsular Malaysia), *O. lengguanii* Škorničk., is described and illustrated. It is compared to its morphologically most similar species *Orchidantha maxillarioides* (Ridl.) K.Schum., which is also illustrated. A lectotype and epitype for *Orchidantha maxillarioides* are also designated here.

Keywords. Epitype, Johor, lectotype, *Lowia*, *Orchidantha maxillarioides*, *Protamomum*, Sungai Selai, typification

Introduction

The Lowiaceae, with a single genus *Orchidantha*, is one of three small families in the Zingiberales. The entire family was last revised by Holttum (1970) who recognised six species. Since then there have been numerous additions, mainly from Borneo (Nagamasu & Sakai, 1999; Pedersen, 2001) but also from Thailand (Jentjittikul & Larsen, 2002) and Vietnam. Currently 20 species are recognised, including two recent additions from Vietnam, *Orchidantha stercorea* (Trần & Leong-Škorničková, 2010) and *O. virosa* (Leong-Škorničková et al., in press). Some of the more recent works include a more detailed introduction to the genus and this information is not repeated here.

Four species are currently known to occur in Peninsular Malaysia: *Orchidantha longiflora* (Scort.) Ridl. (Scortechini, 1886; Ridley, 1924), *O. maxillarioides* (Ridl.) K.Schum. (Ridley, 1893; Schumann, 1900), *O. fimbriata* Holttum (Holttum, 1970), and *O. siamensis* Larsen (Larsen, 1961). *Orchidantha calcarea* Henderson (1933) is currently recognised as a heterotypic synonym of *O. longiflora*.

In August 2002, Dr Saw Leng Guan and his team (FRIM) encountered an interesting *Orchidantha* during the 'Second Scientific Expedition 2002' to the Sungai Selai area of Endau-Rompin National Park. As the new collection seemed to be closely related to *Orchidantha maxillarioides*, and without comparative material of the latter to hand, they did not pursue the description of a new species. Dr Saw, however, brought a living specimen back for cultivation at the Forest Research Institute Malaysia in

Kepong (*FRIM 2002-0665*), and this plant has established well. During my work towards a monograph of Lowiaceae, the novelty has been confirmed and is therefore described and illustrated below.

It is compared to the morphologically similar species *Orchidantha maxillarioides*, and both species are illustrated with detailed colour plates here. The terminology follows Beentje (2012).

***Orchidantha lengguanii* Škorničk., sp. nov.**

Similar to *Orchidantha maxillarioides*, but an overall larger plant with flesh-coloured to rusty-brown labellum with a prominent bulge opposite the stigma (versus cream to pinkish coloured labellum with minute dark purple violet dots, without a prominent bulge opposite the stigma) and stigma with broadly U-shaped viscidium (versus stigma with V-shaped viscidium).

TYPE: Voucher from a cultivated plant at the Forest Research Institute Malaysia, Kepong (*FRIM 2002-0665*), 25 Nov 2013, R. Kiew *FRI 75738* (holotype KEP, including a flower in spirit collection; isotype SAN, SING (incl. spirit)). (Fig. 1, 2)

Clump-forming herb to 1 m high. Juvenile and adult plants with distinctly petiolate leaves, *leaves* of mature plants up to 105 cm long, arching, petiolate; *petiole* up to 85 cm long, green, glabrous; *lamina* narrowly elliptic, slightly unequal, 38–50 × 8.5–11.5 cm, green and glabrous on both sides, base obtuse to attenuate, apex acute to attenuate, mid-vein pale green, impressed (grooved) above, prominent beneath. **Inflorescence** on branched, subterranean stem with prominent bracts and/or their scars; prophyll, second and third bracts cream (subterranean parts) to light green (above ground parts); *prophyll* triangular (roundly triangular), 2-keeled, c. 7 mm long, c. 6 mm wide; *second bract* c. 13 mm long, 8–9 mm wide; *third bract* c. 27 mm long, c. 8 mm wide; *floral bract* appearing above the soil or with the proximal part embedded in the soil and/or leaf litter, light green, tinged slightly maroon, c. 45 mm long. **Flowers** appearing above the ground, emitting a very slight, almost imperceptible, scent of mushrooms; *ovary extension* c. 55 mm long, cream-white with slight reddish tinge towards the sepals; *sepals* semi-translucent deep purple-red (claret) with greenish apices, narrowly elliptic, cuspidate, slightly unequal (dorsal being shorter and narrower); *dorsal sepal* c. 40 mm long, c. 8 mm wide, with slightly reflexed margins, bending backwards; *lateral sepals* c. 43 mm long, 9–10 mm wide; *lateral petals* asymmetric, oblong, c. 7 mm long, c. 3 mm wide, overlapping along inner side covering stamens and style, dark purple-violet with a white thick patch at base, semi-translucent greenish towards the apex, apiculate to cuspidate (c. 1 mm); *labellum* elliptic to mildly obovate with narrow base, 30–35 mm long (incl. base), 18–21 mm at widest point, flesh-coloured to rusty brown, with a raised midrib (midrib c. 5 mm wide) and few (usually 2) raised lines along the midrib, margin entire, irregularly undulate, greenish or dark brown, base c. 7 mm long,



Fig. 1. *Orchidantha lengguanii* Škorničk. **A.** Habit. **B.** Flowers. Photographed at the Forest Research Institute Malaysia, Acc. No. *FRIM 2002-0665*. (Photos: Jana Leong-Škorničková)



Fig. 2. *Orchidantha lengguanii* Škorničk. **A.** Flower (semi-side view). **B.** Flower (front view). **C.** Detail of stigma (dorsal view) with anthers attached and petals removed, stigma (ventral view) and petals (scale in mm). **D.** Detail of petals and a prominent bulge on the basal part of the labellum opposite the stigma. Photographed at Forest Research Institute Malaysia, Acc. No. FRIM 2002-0665. (Photos: Jana Leong-Škorničková)

with prominently inflexed side lobes, 4 mm wide (with side lobes unextended – i.e. in their inflexed position), dark maroon-purple (almost black) but lighter towards the ovary extension. *Stamens* c. 3 mm long; *filament* c. 0.5 mm long, *anther thecae* c. 2.5 mm long, longitudinally dehiscent throughout their length. *Style* 2–3 mm long; *stigma* 2–2.5 mm long, deeply three-lobed, dorsal surface pink with purple patches; stigma lobes pink purple, conduplicate, with margin whitish, semi-translucent, membranous, irregularly and sparsely serrated; *median lobe* 2–2.5 mm long; *lateral lobes* c. 2 mm long; *viscidium* broadly U-shaped. *Fruits* and seeds not seen. Based on living and spirit material of FRI 75738 and spirit material of FRI 48193.

Etymology. The species is named after its discoverer, Dr Saw Leng Guan, an excellent field botanist from the Forest Research Institute of Malaysia. He is not only a well-known palm specialist, but also has a particular interest in the Zingiberales of Peninsular Malaysia (see e.g. Larsen et al., 1999).

Distribution. So far known only from the type locality in Endau-Rompin National Park, Sungai Selai area.

Ecology & phenology. Growing in lowland dipterocarp forest, river side. The phenology is not well understood. The original collection made in August 2002 was flowering only sparsely. In cultivation, profuse flowering has been observed in November–December.

Notes. Based on its morphology, *Orchidantha lengguanii* appears to be closely related to *O. maxillarioides* (Fig. 1–4). Both species have petiolate leaves (both as juveniles and adult plants) making them hardly distinguishable when sterile, except that *O. lengguanii* is somewhat larger, reaching up to 1 m in height (versus up to 0.7 m in height for *O. maxillarioides*). Both species have dark maroon sepals, with a dorsal sepal reflexed, but the labella of both species are markedly different: *Orchidantha lengguanii* has a larger (30–35 × 18–21 mm), flesh-coloured to rusty-brown labellum with irregularly undulate green or dark brown margin compared to *O. maxillarioides* (20–23 × 10–11 mm) which has a recurved cream to pinkish coloured labellum with minute dark purple violet dots and mildly crisp purplish margin. A prominent bulge on the basal part of the labellum opposite the stigma is a typical feature of *O. lengguanii* (Fig. 2D). Other clearly visible differences are in the shapes and sizes of lateral petals, the shape of the stigma (broadly U-shaped viscidium in *O. lengguanii* vs. V-shaped viscidium in *O. maxillarioides*) and the anthers (compare Fig. 2C–D and 4C–D).

Other specimens examined: PENINSULAR MALAYSIA. **Johor.** Endau-Rompin National Park, Sungai Selai, 8 Nov 2005, *Saw, L.G. FRI 48193*, collected from material cultivated at Kepong Botanic Gardens as *FRIM 2002-0665* (KEP, only spirit material).

Orchidantha maxillarioides (Ridl.) K.Schum. in Engler, H.G.A. (ed), *Pflanzenr.* IV, 45: 42 (1900). – *Protamomum maxillarioides* Ridl., *Trans. Linn. Soc. London, Bot.* 3: 383, t. 66 (1893). – *Lowia maxillarioides* (Ridl.) Baker, *Bot. Mag.* 120: t.7351 (1894). TYPE: Peninsular Malaysia, Pahang, Pulau Tawar woods, *H.N. Ridley 2399* (lectotype SING [SING0043128], designated here; isolectotypes K [K000292166, K000292166], SING [SING0043127]). EPITYPE: *Protamomum maxillarioides*, colour painting by James de Alwis, SING, designated here. (Fig. 3–5)

Notes. *Orchidantha maxillarioides* was first described and illustrated by Ridley as *Protamomum maxillarioides* based on material collected from Kota Glanggi limestone rocks in the woods of Pulau Tawar [Pahang, Peninsular Malaysia] (Ridley, 1893). He brought living material to Singapore Botanic Gardens and sent some of it to Kew Gardens, where it flowered in June 1893. The plant was then illustrated for *Botanical Magazine* (t. 7351), where Baker provided it with a short note and description, and



Fig. 3. *Orchidantha maxillarioides* (Ridl.) K.Schum. **A.** Habit. **B.** Flowers. Photographed at Singapore Botanic Gardens, *SBG 20104107*. (Photos: Jana Leong-Škorníčková)

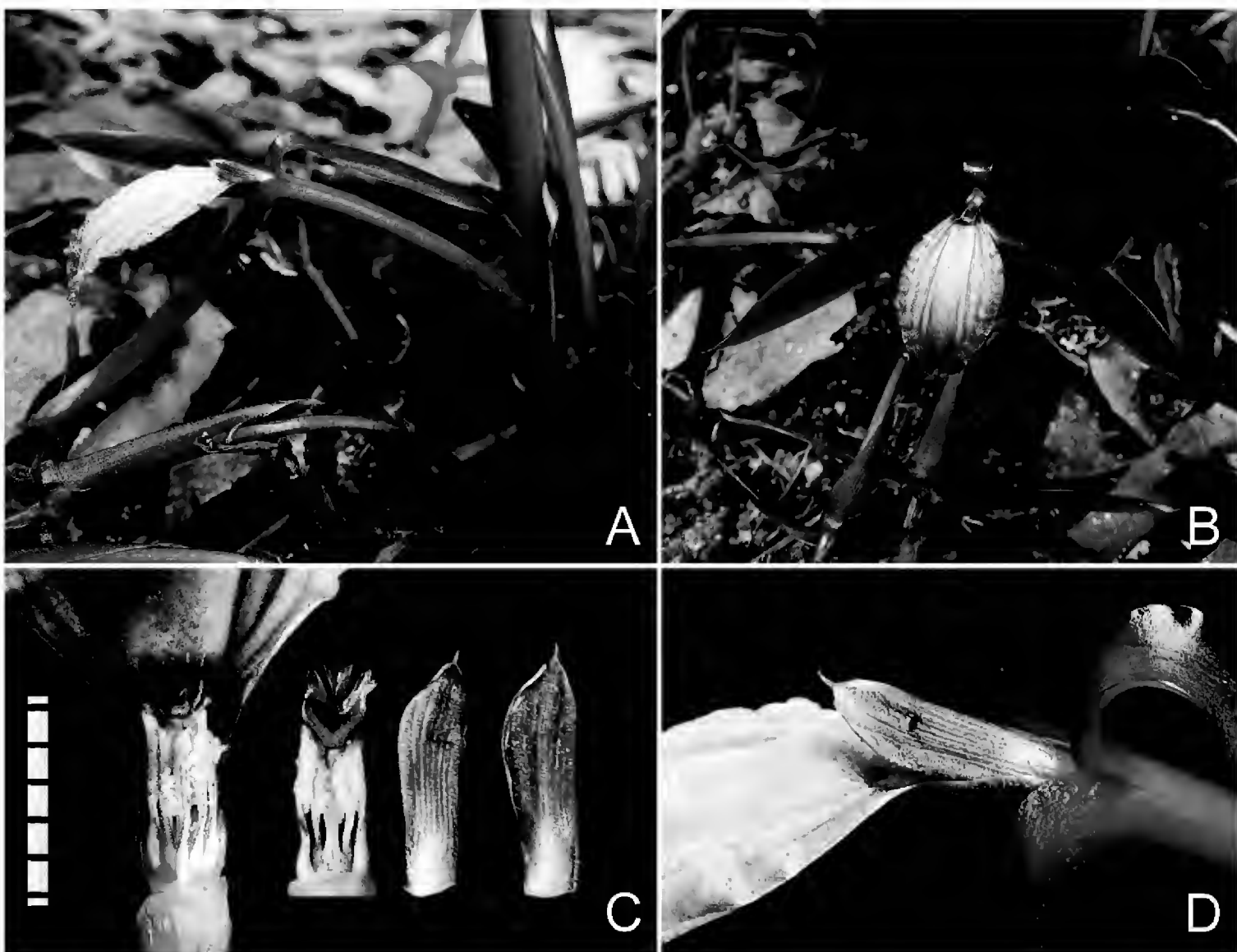


Fig. 4. *Orchidantha maxillarioides* (Ridl.) K.Schum. **A.** Flower (side view). **B.** Flower (front view). **C.** Detail of stigma (dorsal view) with anthers attached and petals removed, stigma (ventral view) and petals (scale in mm). **D.** Detail of petals (side view). Photographed at Singapore Botanic Gardens, *SBG 20104107*. (Photos: Jana Leong-Škorničková)

transferred it to the genus *Lowia* (Baker, 1894). Finally, Schumman made the transfer to *Orchidantha* in 1900.

Turner (2000) published an account of all Zingiberalean taxa ever published by H.N. Ridley and attempted to clarify typification of these names. The methods outlined in Turner's paragraph on typification of Ridley's names are generally sound. It stresses the facts that Ridley rarely used the term type, often did not indicate collectors, collection numbers or herbaria, and was lax regarding annotating specimens, resulting in the need to lectotypify most of the names coined by Ridley. While Turner's paper certainly serves as a good overview, further refinement through lectotypifications is needed for numerous names. One of such names is *Protamomum maxillarioides*, for which Turner's entry reads as:

TYPE: Peninsular Malaysia, Pahang, Pulau Tawar Woods, *H.N. Ridley 2399* (holotype, SING!; isotype K!).

In the protologue, Ridley (1893) only cited the locality 'Pulau Tawar woods', with no particular reference to a collection number, where the herbarium material was deposited, or the number of sheets collected. The protologue was included in an article dealing with the flora of the Eastern Coast of the Malay Peninsula and it is obvious from the context that Ridley was the collector. Holttum (1970) indicated that *Ridley 2399* was the type but did not comment further on the number or distribution of the specimens. The search for original material yielded four sheets collected by Ridley in Pulau Tawar in 1891 (all labelled as *Ridley 2399*), of which two are located at SING and two at K. It is the only Ridley collection of this taxon available from this location. Both specimens at SING are labelled 'holotype' in Turner's handwriting. As both sheets contain entire plants with flowers/flower and fruits, and they are not labelled as parts of a single specimen (ICN 8.3., McNeill et al., 2012), they must, along with the two sheets at K, be considered to be syntypes. SING 0043128, with flowers and fruits, has been selected here as the lectotype.

The shape and colour of the floral parts of Lowiaceae (labellum, petals and stigma in particular) are critical for identification of the species but preserve poorly in dry material. Designation of an epitype for such cases, as outlined by Leong-Škorničková et al. (2010), is therefore desirable if any suitable high-quality drawings/paintings exist. Two colour paintings directly linked to the original material are available in this case. The existence of the above mentioned coloured lithograph, based on the original living material Ridley sent to Kew and published in *Botanical Magazine* (t. 7351), is already well known. There is, however, another fine colour painting of this species which is less well known.

Ridley's paper (1893) containing the protologue included a black and white lithograph (t. 66). This was prepared by J.N. Fitch [J.N. Fitch lith & imp.; right bottom corner] who based it on a painting made from a living specimen by James de Alwis [J.D. Alwis ad viv.; left bottom corner]. From Ridley's letter to Sir Joseph Hooker (dated 30 September 1893, Singapore; attached to one of the specimens at K) it is clear that Ridley sent a drawing of *Protamomum maxillarioides* from Singapore to the Linnean Society to be included in his paper on the flora of Pahang which was yet to be published when Ridley wrote the letter. A search in the Archive collections of Singapore Botanic Gardens yielded an almost identical colour painting. The painting bears annotations 'Pahang, Sept. 1893' and lacks a signature of the artist. However, from its fine execution it seems beyond any doubt, that it was painted by James de Alwis who was employed by H.N. Ridley from 1890. It is not clear if two copies of this painting were prepared in Singapore, with one being sent to the Linnean Society, or if the Singapore painting is the only original and was returned after the lithograph was prepared. What is not in doubt is that it is directly linked to Ridley's original material and approved by Ridley, and hence an invaluable resource for the correct interpretation of the name. The painting, which shows the habit of the plant as well as some very fine flower details, is reproduced here (Fig. 5) and is designated as an epitype.



Fig. 5. The colour painting of *Protamomum maxillarioides* made from living material in Singapore Botanic Gardens by James de Alwis, designated as epitype. Reproduced with permission of the Singapore Botanic Gardens.

ACKNOWLEDGEMENTS. My foremost thanks are due to Dr Saw L.G. who introduced me to this new species and let me work on the spirit and living material that he collected in 2002, despite his own interest in the Zingiberales of Peninsular Malaysia. I also thank him for sharing his insights on this species and other Lowiaceae from Peninsular Malaysia. I am also grateful to Dr Ruth Kiew for her time and help during my visits to FRIM. My thanks are due to the curators of the AAU, BK, BKF, K, KEP, P and SING herbaria and to associated libraries for letting me examine Lowiaceae specimens and references. I am also grateful to the Singapore Botanic Gardens for granting permission to reproduce the painting and herbarium sheet. I also thank Dr Axel D. Poulsen and Dr David Middleton for detailed comments on this manuscript. The funding of my research by National Parks Board (Singapore) and by the Czech Science Foundation, GAČR [grant number 14-13541S] is gratefully acknowledged.

References

- Baker, J.G. (1894). *Lowia maxillarioides*. *Bot. Mag.* 120: t. 7351
- Beentje, H. (2012). *The Kew Plant Glossary, an illustrated dictionary of plant terms* (revised edition). Royal Botanic Gardens, Kew: Kew Publishing.
- Henderson, M.R. (1933). Additions to the flora of the Malay Peninsula. *Gard. Bull. Straits Settlement.* 7: 87–128.
- Holttum, R.E. (1970). The genus *Orchidantha* (Lowiaceae). *Gard. Bull. Singapore* 25: 239–247.
- Jenjittikul, T. and Larsen, K. (2002). *Orchidantha foetida* (Lowiaceae) a new species from Thailand. *Nord. J. Bot.* 22: 405–408.
- Larsen, K. (1961). New species of *Veratrum* and *Orchidantha* from Thailand and Laos. *Bot. Tidsskr.* 56: 345–350.
- Larsen, K., Ibrahim, I., Khaw, S.H. & Saw, L.G. (1999). *Gingers of Peninsular Malaysia and Singapore*. 135 pp. Kota Kinabalu: Natural History Publications (Borneo).
- Leong-Škorničková, J., Nguyen, Q.B. & Šída, O. (in press). *Orchidantha virosa* (Lowiaceae), a new species endemic to northern Vietnam. *Adansonia*.
- Leong-Škorničková, J., Šída, O. & Marhold, K. (2010). Back to types! Towards stability of names in Indian *Curcuma* L. (Zingiberaceae). *Taxon* 59(1): 269–282.
- McNeill, J. Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W.F., Smith, G.F., Wiersema, J.H. & Turland, N.J. (2012). *International Code of Nomenclature for algae, fungi and plants (Melbourne Code)*. 205 pp. Königstein: Koeltz Scientific Books. [Regnum Veg. 154]
- Nagamasu, H. & Sakai, S. (1999). *Orchidantha inouei* (Lowiaceae), a new species from Borneo. *Nord. J. Bot.* 19: 149–152.
- Pedersen, L.B. (2001). Four new species of *Orchidantha* (Lowiaceae) from Sabah. *Nord. J. Bot.* 21: 121–128.
- Ridley, H.N. (1893). On the flora of the eastern coast of the Malay Peninsula. *Trans. Linn. Soc. London, Bot.* 3: 267–408.
- Ridley, H.N. (1924). Lowiaceae. *The Flora of the Malay Peninsula* 4: 291–293. London: L. Reeve & Co.
- Schumann, K. (1900). Musaceae. In: Engler, H.G.A. (ed) *Das Pflanzenreich* IV, 45: 1–42. Leipzig: Engelmann.

- Scortechini, B. (1886). Descrizione di nuove Scitamineae trovate nella Penisola Malese. *Nuovo Giorn. Bot. Ital.* 18: 308–311.
- Trần, H.Đ. & Leong-Škorničková, J. (2010). *Orchidantha stercorea* sp. nov. (Lowiaceae) from Vietnam. *Nord. J. Bot.* 28: 299–303.
- Turner, I. (2000). The plant taxa of H. N. Ridley, 3. The Zingiberales. *Asian J. Trop. Biol.* 4(1): 1–47.

Two new species and one new variety of *Aspidistra* (Asparagaceae: Nolinoideae) from southern Vietnam

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ABSTRACT. Two new species and one new variety of *Aspidistra* Ker-Gawl. (Asparagaceae: Nolinoideae) from southern and central Vietnam, *A. ventricosa* Tillich & Škorničk., *A. mirostigma* Tillich & Škorničk., and *A. connata* Tillich var. *radiata* Tillich & Škorničk., are described and illustrated here.

Keywords. Asparagaceae, *Aspidistra*, Convallariaceae s. str., Nolinoideae, Ruscaceae s.l., Vietnam

Introduction

The genus *Aspidistra* Ker-Gawl. (Asparagaceae: Nolinoideae – formerly also placed in Convallariaceae and in Ruscaceae) ranges from Assam (India) in the west to southern Japan in the east, and from central China southwards to the Malay Peninsula. Its centre of diversity is in southeast China (Guangxi Province) and adjacent northern Vietnam (Tillich, 2005). The number of known species continues to grow as the Indochinese floristic region is better explored. Currently more than 100 species are recognised (Tillich & Averyanov, 2012) of which many were first reported from Vietnam only in the last decade (Bogner & Arnautov, 2004; Bräuchler & Ngoc, 2005; Tillich, 2005, 2006, 2008; Tillich et al., 2007; Tillich & Averyanov, 2008, 2012; Averyanov & Tillich, 2012, 2013, submitted; Tillich & Leong-Škorničková, 2013; Vislobokov et al., 2013). Forty-three *Aspidistra* species are currently known from Vietnam (Tillich, 2014). During recent joint expeditions conducted by the Vietnam National Museum of Nature and Singapore Botanic Gardens, we discovered yet another three taxa confirmed to be new to science by the second author.

In line with collecting practices as outlined by Tillich (2005), the spirit conserved flowers are part of the type specimens. These are labelled in conformity with ICN Art 8.3. (McNeill et al., 2012). The type specimens are also accompanied by colour

photo documentation of important characters including the flower dissection. The terminology follows Beentje (2012) and the standard *Aspidistra* works cited above.

***Aspidistra ventricosa* Tillich & Škorničk., sp. nov.**

Aspidistra ventricosa is similar to *A. cryptantha* Tillich (Tillich et al., 2007), but differs in the larger perigone (c. 17 mm in diam. with c. 6 mm apical opening versus 6–7 mm in diam. and 2–3 mm apical opening in *A. cryptantha*) and in the position of the anthers, which are positioned basally at the margins of a flat fleshy base (compared to anthers positioned halfway along tube in *A. cryptantha*).

TYPE: Vietnam, Ninh Thuận Province, Bình Tiên District, Công Hải Commune, Núi Chúa National Park, 11°46'44.8"N 109°10'44.5"E, 97 m asl, 31 Oct 2013, *Jana Leong-Škorničková, Nguyễn Quốc Bình, Aung Thame & Edward Ong JLS-2581* (holotype SING, including a flower in liquid collection; isotypes M, VNMN. (Fig. 1, 2)

Rhizomatous herb up to 50 cm tall. **Rhizome** epigeous, with very short internodes, 5–10 mm diam., with many swollen roots (up to 7 mm in diam). **Leaves** crowded, cataphylls deep purple when young, ribbed, up to 10 cm long; petiole up to 35 cm long, stout, stiff, ventrally with a furrow, deeper in apical part, shallower towards the base, basal 5–7 mm swollen; blade elliptic to ovate, slightly unequal, 15–25 × 4.5–9 cm, apex acute to attenuate, base obtuse to attenuate, mid-green, semi-glossy above, slightly lighter beneath with strongly protruding midvein, secondary veins visible but not prominent, margin very minutely serrate towards apex, making the margin somewhat sharp to touch. **Peduncle** up to 3.5 cm long, semi-erect, white, with 6 scales, 3 subtending the flower (white with purple tinge) and 3 along the scape (white). **Perigone** upright, tube urceolate, deep purple internally and externally, c. 17 mm in diameter, with nearly flat, fleshy base, distal opening c. 6 mm; lobes 6, triangular, reflexed, in a single whorl, upper surface finely verrucose, each with three sharp ridges, lobes c. 4–5 mm long, 5–6 mm wide at base. **Stamens** 6, inserted at base of the tube, completely covered by stigma; anthers on short white filaments, anther thecae c. 1 mm long; pollen bright yellow. **Pistil** table shaped; style cylindrical, c. 2 mm long, cream-coloured; stigma more or less circular, c. 15 mm in diameter, the upper surface is rough with projections, cream-coloured with purple tinge, the lower surface is smooth, its cream-coloured centre is star-shaped with 6 larger and 6 alternating smaller tips (see comment below), margin richly tinged with purple. **Fruit** almost spherical, 1.7–2 cm diam., green with purple tinge, more or less smooth at base, with irregular protrusions on the upper half; seeds 6, wedge-shaped, light brown.

Habitat and phenology. *Aspidistra ventricosa* is a fairly common species, occurring between 90–350 m in the understorey of semi-arid forest and growing among shrubby vegetation on stony slopes. Flowering in September–October, fruiting October–November.



Fig. 1. *Aspidistra ventricosa* Tillich & Škorničk. **A.** Habit. **B.** Flower. **C.** Fruit. **D.** Rhizome and basal part of the plant showing young purple cataphylls. **E.** Basal part of the plant with flower rising from the rhizome. From type *JLS-2581*. (Photos: Jana Leong-Škorničková)

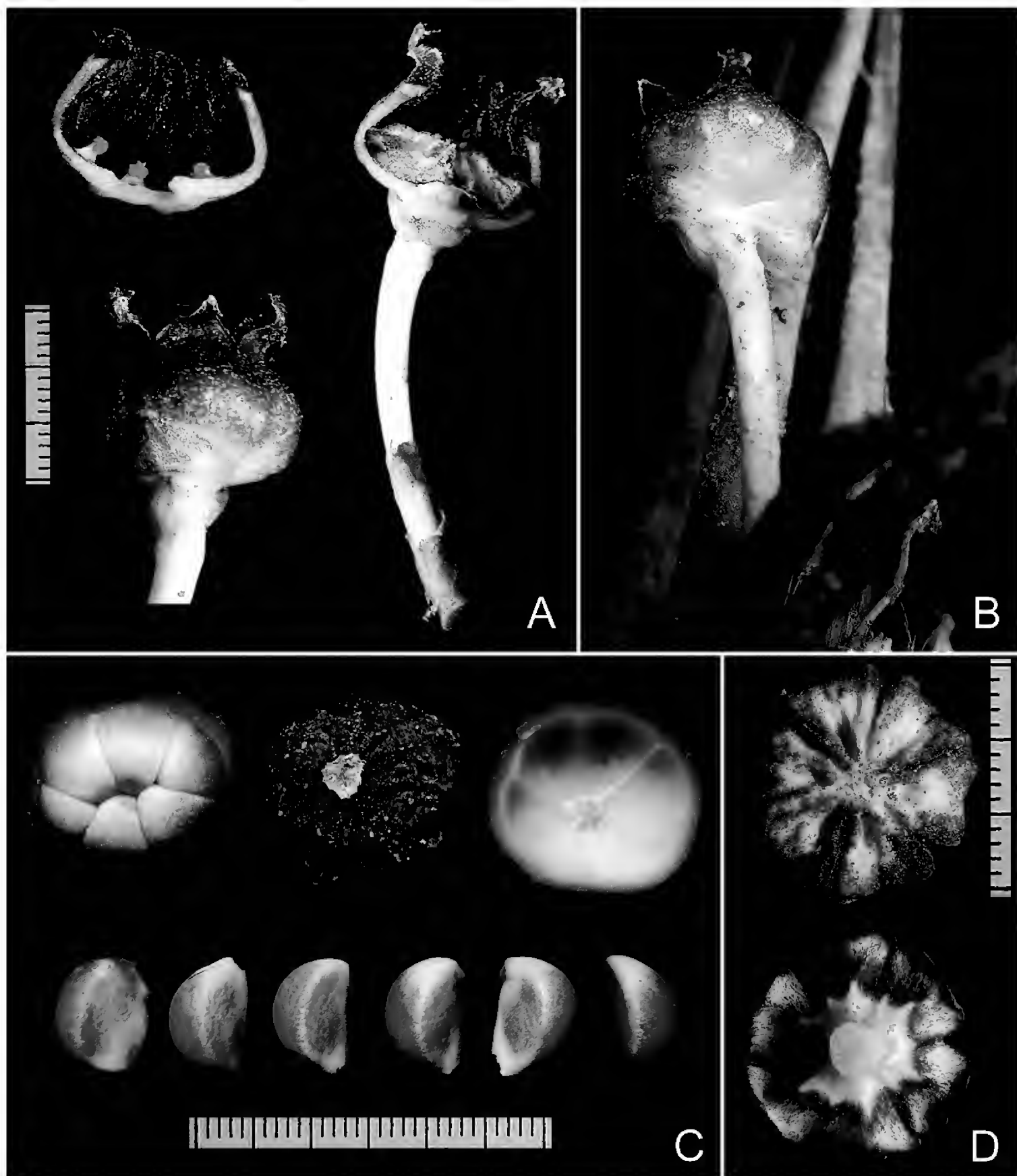


Fig. 2. *Aspidistra ventricosa* Tillich & Škorničk. **A.** Dissection of the flower (scale in mm). **B.** Detail of basal part of the flower showing subtending bracts. **C.** Dissection of fruit. **D.** Detail of stigma (top and bottom view). From type *JLS-2581*. (Photos: Jana Leong-Škorničková)

Distribution. So far known only from the type locality where it is locally abundant.

Etymology. The specific epithet denotes the shape of the flower.

Notes. The morphology described above for the stigma indicates that it is composed of three broad lobes, each lobe consisting of two sublobes. The larger star tips point to the 6 sublobes, the smaller tips to the incisions between lobes and sublobes, respectively.

Aspidistra ventricosa differs from *A. cryptantha* in the features outlined in the diagnosis, as well as in habitat and ecological requirements. *Aspidistra cryptantha* is so far known only from the type locality in Cao Bằng Province in northern Vietnam where it occurs in remnants of evergreen forests on limestone mountains at 600–800 m asl.

***Aspidistra connata* Tillich var. *radiata* Tillich & Škorničk., var. nov.**

The new variety differs from the type variety in the lobes which open upon maturity compared to the type variety where the lobes remain connate until senescence of the flower. The flowers of *Aspidistra connata* var. *radiata* are larger, with the bowl-shaped base of the perianth c. 1.8–2 cm diam. (3.5–5 cm when lobes are open), compared to *A. connata* var. *connata* with the bowl-shaped base of the perianth 1 cm diam. (2–3 cm when lobes are open).

TYPE: Vietnam, Ninh Thuận Province, Ninh Hải District, Vĩnh Hải Commune, trek from Kiên Kiên village to Núi Chúa peak, 11°44'09.4"N 109°07'06.8"E, 595 m asl, 1 Nov 2013, *Jana Leong-Škorničková, Nguyễn Quốc Bình, Aung Thame & Edward Ong JLS-2594* (holotype SING, including flowers in liquid collection; isotypes M, VNMN, both including flowers in liquid collection). (Fig. 3, 4)

Rhizomatous herb up to 40 cm tall. **Rhizome** epigeous, with very short internodes, c. 7 mm diam., with numerous rigid roots, velamen visible on young roots. **Leaves** few at the actively growing apex of the rhizome, cataphylls light green, weakly ribbed, up to 10 cm long; **petioles** up to 30 cm long, stout, stiff, ventrally with a furrow, deeper in apical part, shallower towards the base, base swollen; blade elliptic, slightly unequal, up to 30 × 8 cm, apex acute, base asymmetrical, cuneate to attenuate, mid-green or sometimes with white blotches, glossy above, slightly lighter beneath with strongly protruding mid-vein, secondary veins visible but not prominent. **Peduncle** up to 4 cm long, or flowers subsessile, semi-erect to erect, white, with 6 cream to light green scales, 3 subtending the flower and 3 along the scape. **Perigone** upright, divided almost to the base, with almost flat, widely bowl-shaped, fleshy base, c. 1.8–2 cm diam., internally white, externally red-purple; perigone including lobes 35–50 mm diam.; lobes 8 (rarely 9 or 10), arranged in two whorls (two whorls are clearly visible only in late bud stage and are rather inconspicuous once the lobes open), lobes c. 2–2.5 cm long, 4–8 mm wide at base, narrowly triangular with blunt apex and revolute margins, internally deep purple-red, finely verrucose, externally light greenish, mottled with red-purple, glabrous. **Stamens** 8(–10), inserted near the base of the tube, completely covered by stigma; anthers on short white filament, anther thecae bean-shaped,

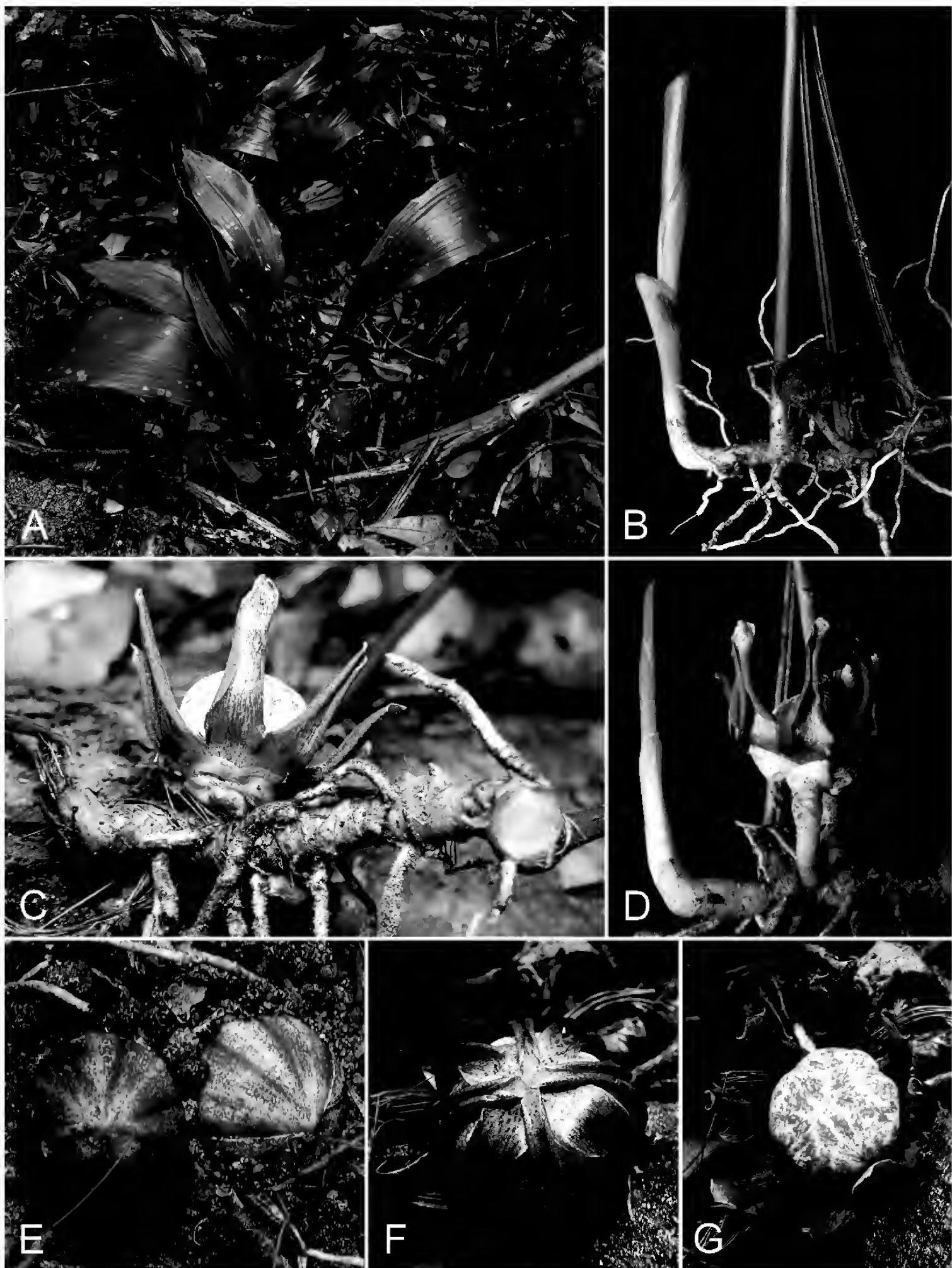


Fig. 3. *Aspidistra connata* Tillich var. *radiata* Tillich & Škorničk. **A.** Habit. **B.** Detail of cataphyll. **C.** Flower arising directly from rhizome (sessile; in side view). **D.** Flower on a peduncle (side view). **E.** Young flower bud. **F.** Flower bud just before anthesis. **G.** Fully open flower. From type *JLS-2594*. (Photos: Jana Leong-Škorničková)

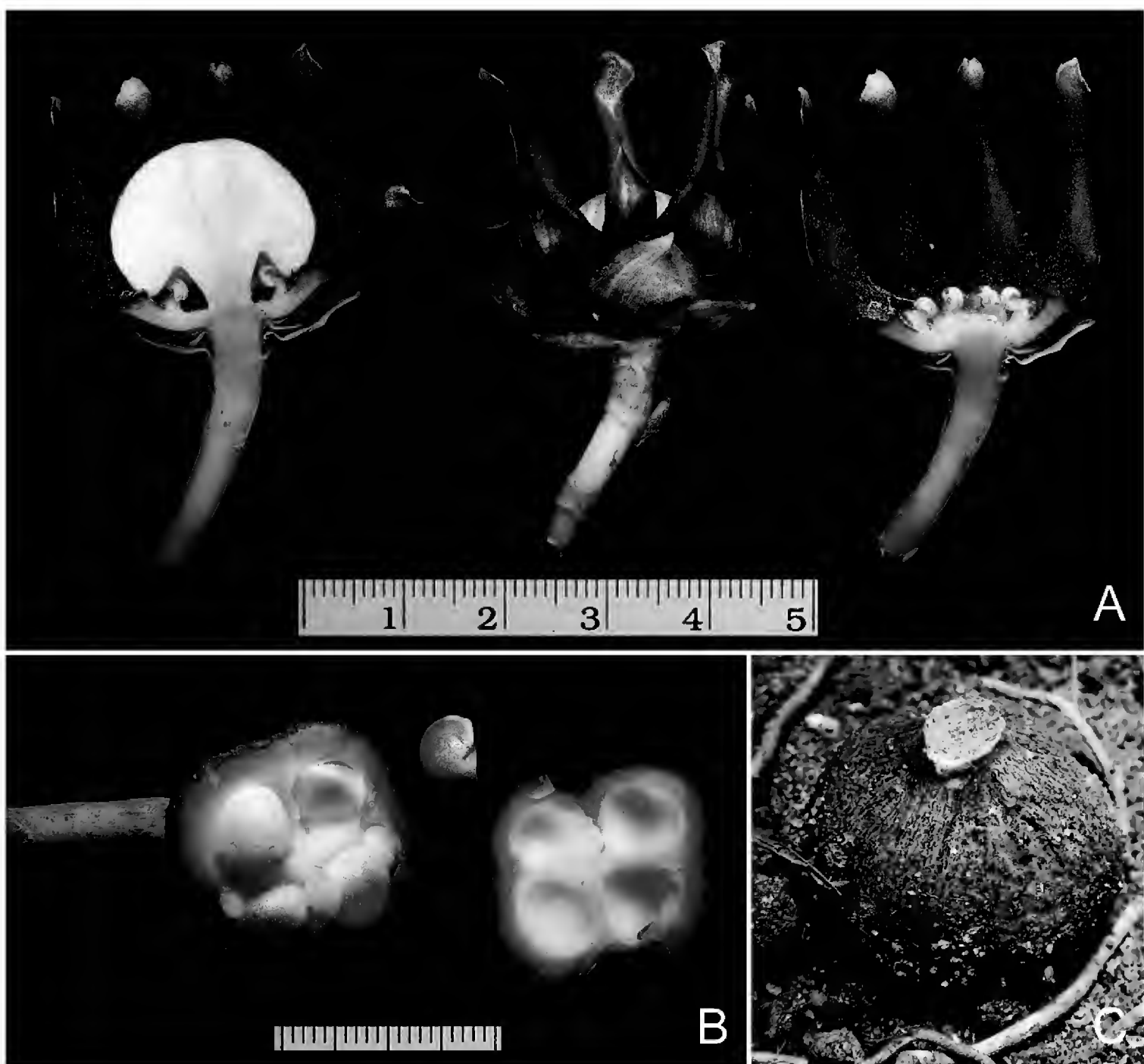


Fig. 4. *Aspidistra connata* Tillich var. *radiata* Tillich & Škorničk. **A.** Dissection of the flower & detail of the basal part of the flower (scale in mm). **B.** Dissection of fruit (scale in mm). **C.** Fruit. From type *JLS-2594*. (Photos: Jana Leong-Škorničková)

c. 2 mm long; pollen cream white. **Pistil** mushroom-shaped; style 4–5 mm long, cream-coloured; stigma dome-shaped, 15–20 mm in diameter, cream-coloured with purple mottling on the upper exposed side, cream-white on the lower side facing anthers. **Fruit** almost spherical, up to 2.3 cm diam., green with fine purple-black mottling, mildly irregularly verrucose; seeds c. 8, light brown.

Habitat and phenology. Abundant in lower montane broad-leaved evergreen forest at altitudes between 500–800 m. Flowering in October–November, fruiting observed at the end of October and estimated to continue to December.

Distribution. So far known only from the type locality where it is locally abundant.

Etymology. The varietal epithet denotes the radiating perigone lobes (compared to the connate lobes in *Aspidistra connata* var. *connata*).

Notes. In the late bud stage (Fig. 3E) *Aspidistra connata* var. *radiata* resembles the type variety (compare to Tillich, 2005, fig. 2C, D) but, unlike the latter, the petals of *Aspidistra connata* var. *radiata* open fully at maturity into a star-shaped flower, while the petals of *A. connata* var. *connata* remain connate until senescence. The petal margins of *Aspidistra connata* var. *radiata* are strongly revolute, while in those of *A. connata* var. *connata* only a narrow marginal strip is revolute.

The nominal variety of *Aspidistra connata* was described in 2005 from Central Vietnam and is known to occur in Gia Lai and Kon Tum Provinces, while *A. connata* var. *radiata* is so far known only from Ninh Thuận Province.

***Aspidistra mirostigma* Tillich & Škorničk., sp. nov.**

Similar to *Aspidistra phanluongii* N. Vislobokov in shape and colour of the perigone tube, but differs in a pistil shape that is unique in the genus, and triangular yellow-green lobes with 4 keels (versus ligulate white lobes with two keels in *Aspidistra phanluongii*).

TYPE: Vietnam, Kon Tum Province, Kon Plông Dist., Xã Hiếu, 14°39'02.2"N 108°24'46.7"E, 1266 m asl, 25 Apr 2012, Jana Leong-Škorničková, Nguyễn Quốc Bình, Trần Hữu Đăng, Eliška Závěská JLS-1571 (holotype SING, including a flower in liquid collection; isotype VNMN). (Fig. 5)

Rhizomatous herb up to 15–30 cm tall. **Rhizome** epigeous, horizontal to slightly ascending, with very short internodes, 3–5 mm diam., with numerous rigid roots. **Leaves** few (2–3) at the actively growing apex of the rhizome, cataphylls 3, dark maroon-purple, finely ribbed, up to 6 cm long; petioles up to 17 cm long, stout, stiff, ventrally with a shallow furrow, base swollen; blades lanceolate, slightly unequal, up to 12.5 × 4.5 cm, apex attenuate, base asymmetrical, obtuse, mid-green to dark green both sides, beneath with strongly protruding mid-vein and two secondary veins (one on each side of the midvein; clearly visible as depressions on upper surface), margin entire except very minutely serrate apex, making it somewhat sharp to touch. **Peduncle** 1–3 cm long, dark purple, with 3 dark purple scales along the scape and 2 scales (green with more or less rich dark purple tinge) subtending the flower. **Perigone** upright, tube urceolate, 13–15 mm diam. (at widest point), internally and externally deep purple (almost black); lobes 6 arranged in one whorl, triangular with blunt apex, c. 4 mm long, 4–5 mm wide at base, thick, suberect to slightly curving outwards, externally deep purple (almost black) with bright green margin, almost smooth, internally greenish-yellow, with 4 prominent ribs, the two median ones running down to lower third of tube, the submarginal ones fusing with the neighbouring rib of the adjoining lobe. **Stamens** 6, inserted near the base of the tube, completely covered by stigma; anthers sessile, anther thecae bean-shaped and arranged in v-shape, c. 2.5 mm long; pollen bright yellow. **Pistil** c. 12–14 mm diam., entire surface dark purple with



Fig. 5. *Aspidistra mirostigma* Tillich & Škorničk. **A.** Habit. **B.** Flower (top view). **C.** Flower (semi-side view). **D.** Dissected flower. **E.** Flower arising from rhizome (side view). From type *JLS-1571*. (Photos: Jana Leong-Škorníčková)

velvety appearance; style inconspicuous; stigma sessile, lower half obconical, with 6 prominent longitudinal ridges in contact with the tube wall, ending in 6 triangular teeth (in upper view), upper half a truncated cone with numerous longitudinal grooves. **Fruit** echinate (only a very young fruit seen).

Habitat and phenology. *Aspidistra mirostigma* grows in the undergrowth of primary montane broad-leaved evergreen forest at about 1260 m altitude. Flowering is in April–May, fruiting May–June.

Distribution. So far known only from the type locality where it is locally abundant.

Etymology. The specific epithet refers to the strange yet wonderful stigma with its unique shape and dark purple velvety surface.

Notes. *Aspidistra mirostigma* differs from *A. phanluongii* in the features outlined in the diagnosis, especially in its unique pistil shape. (Sub)sessile obconoid pistils are also known in *Aspidistra marginella* D.Fang & L.Zeng and *A. longanensis* Y.Wan from Guangxi Province in China. However, the stigma surface in *Aspidistra marginella* is slightly convex and smooth, the perigone lobes are linear (9 × 2 mm) and without keels. In *Aspidistra longanensis* the stigma surface is flat, with 4 central ovoid appendages, and the perigone lobes are 9–11 mm long with two indistinct basal keels and a basal 2–3-fid appendage.

ACKNOWLEDGEMENTS. The research of the first author is funded by the National Parks Board, Singapore. We would like to thank the People's Committee of Kon Tum and Ninh Thuận Provinces, the Agriculture and Rural Development Department of Kon Tum and Ninh Thuận Provinces, Mr Đặng Kim Cương, the Director of Núi Chúa NP, and Mr Trần Văn Tiếp, the Head of the Department of Science (Núi Chúa NP), for issuing permits and for giving various logistical and manpower support to our fieldwork. We thank Prof. Nguyễn Đình Công and Prof. Lưu Đàm Cư from the Vietnam National Museum of Nature for their support of our collaborative research. We thank Mr Aung Thame and Mr Edward Ong from Singapore Botanic Gardens and Mr Trần Hữu Đăng for their assistance in the field, Ms Ng Hui Lin, Republic Polytechnic (Singapore) for her help in assembling the colour plates, and Mr Peter C. Boyce, Dr Li Heng and Dr David Middleton for their helpful comments on the manuscripts.

References

- Averyanov, L.V. & Tillich, H.-J. (2012). New taxa of *Aspidistra* (Asparagaceae) from Central Vietnam. *Turczaninowia* 15: 5–10.
- Averyanov, L.V. & Tillich, H.-J. (2013). *Aspidistra truongii* – a new species of Asparagaceae (Convallariaceae s.str.) from southern Vietnam. *Taiwania* 58(2): 108–111.
- Averyanov, L.V., & Tillich, H.-J. (submitted). Four new species of *Aspidistra* (Asparagaceae, Convallariaceae s. str.) from Indochina. *Nord. J. Bot.*
- Beentje, H. (2012). *The Kew Plant Glossary, an illustrated dictionary of plant terms* (revised edition). Royal Botanic Gardens, Kew: Kew Publishing.
- Bogner, J. & Arnautov, N.N. (2004). *Aspidistra locii* (Convallariaceae), an unusual, new species from Vietnam. *Willdenowia* 34: 203–208.
- Bräuchler, C. & Ngoc, L.H. (2005). *Aspidistra renatae* (Ruscaceae) – A new species from Central Vietnam. *Blumea* 50: 527–529.
- McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W.F., Smith, G.F., Wiersema, J.H. & Turland, N.J. (2012). *International Code of Nomenclature for algae,*

- fungi, and plants (Melbourne Code)*. Königstein: Koeltz Scientific Books. [Regnum Veg. 154]
- Tillich, H.-J. (2005). A key for *Aspidistra* (Ruscaceae), including 15 new species from Vietnam. *Feddes Repert.* 116 (5–6): 313–338.
- Tillich, H.-J. (2006). Four new species of *Aspidistra* (Ruscaceae) from China, Vietnam, and Japan. *Feddes Repert.* 117: 139–145.
- Tillich, H.-J. (2008). An updated and improved determination key for *Aspidistra* Ker-Gawl. (Ruscaceae, Monocotyledons). *Feddes Repert.* 119: 449–462.
- Tillich, H.-J. (2014). The genus *Aspidistra* Ker-Gawl. (Asparagaceae) in Vietnam. *Taiwania* 59(1): 1–8.
- Tillich, H.-J. & Averyanov, L.V. (2008). Two new species and one new subspecies of *Aspidistra* Ker-Gawl. (Ruscaceae) from Vietnam. *Feddes Repert.* 119: 37–41.
- Tillich, H.-J. & Averyanov, L.V. (2012). Four new species of *Aspidistra* Ker-Gawl. (Asparagaceae) from China and Vietnam with a comment on *A. longifolia* Hook.f. and *A. hainanensis* W.Y.Chun & F.C.How. *Gard. Bull. Singapore* 64(1): 201–209.
- Tillich, H.-J., Averyanov, L.V. & Dzu, N.V. (2007). Six new species of *Aspidistra* (Ruscaceae) from northern Vietnam. *Blumea* 52: 335–344.
- Tillich, H.-J. & Leong-Škorničková, J. (2013). *Aspidistra jiewhoei* (Asparagaceae), a new species from north Vietnam. *Gard. Bull. Singapore* 65(1): 101–105.
- Vislobokov, N.A., Kuznetsov, A.N., Sokoloff, D.D. (2013). A new species of *Aspidistra* (Ruscaceae s.l., Asparagales) from southern Vietnam, field observations on its flowering and possible pollination by flies (Phoridae). *Pl. Syst. Evol.* 299: 347–355.

***Siliquamomum alcicorne* (Zingiberaceae: Alpinioideae), a new species from central Vietnam**

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ABSTRACT. *Siliquamomum alcicorne* (Zingiberaceae: Alpinioideae) from central Vietnam is described and illustrated here. It is compared to the other two species so far known in the genus, *S. tonkinense* and *S. oreodoxa*. A key to the three species and a map of their distribution are given. The genome size of each species has been estimated by FCM analysis. The occurrence of flexistyly in the genus *Siliquamomum* is reported here for the first time.

Keywords. Alpinioideae, flexistyly, flow cytometry, genome size, *Siliquamomum oreodoxa*, *Siliquamomum tonkinense*, Vietnam, 2C value

Introduction

The genus *Siliquamomum* Baill. was described by Baillon (1895) from northern Vietnam and was considered monotypic for over a century. Its only species, *Siliquamomum tonkinense*, was later also found in Yunnan in southeastern China (Wu & Larsen, 2000; Gao et al., 2005). A second member of this genus, *Siliquamomum oreodoxa* N.S.Lý & Škorničk., was discovered four years ago in Bidoup Núi Bà National Park, Lâm Đồng Province, southern Vietnam (Lý et al., 2010). Subsequently this species has also been found 30 km further east at Hòn Bà Nature Reserve, Khánh Hòa Province (Leong-Škorničková et al. HB-32 - PR, SING, VNM). A more detailed introduction to *Siliquamomum* was presented in Lý et al. (2010) and is, therefore, not repeated here.

On examination of the Zingiberaceae material in HN herbarium the first author came across an unidentified sheet (*D.K.Harder et al. 4618*) which, together with a single photograph of flowers supplied by Prof. Leonid Averyanov, hinted at the existence of a third *Siliquamomum* species in central Vietnam. Initially insufficient material prevented its formal description. We revisited the locality twice, in July 2010 and April 2012, and now with flowering and fruiting material to hand, the species is

described below as *Siliquamomum alcicorne* Škorničk. & Trần H.Đ. The key to the species of *Siliquamomum* is updated. The terminology follows Beentje (2012).

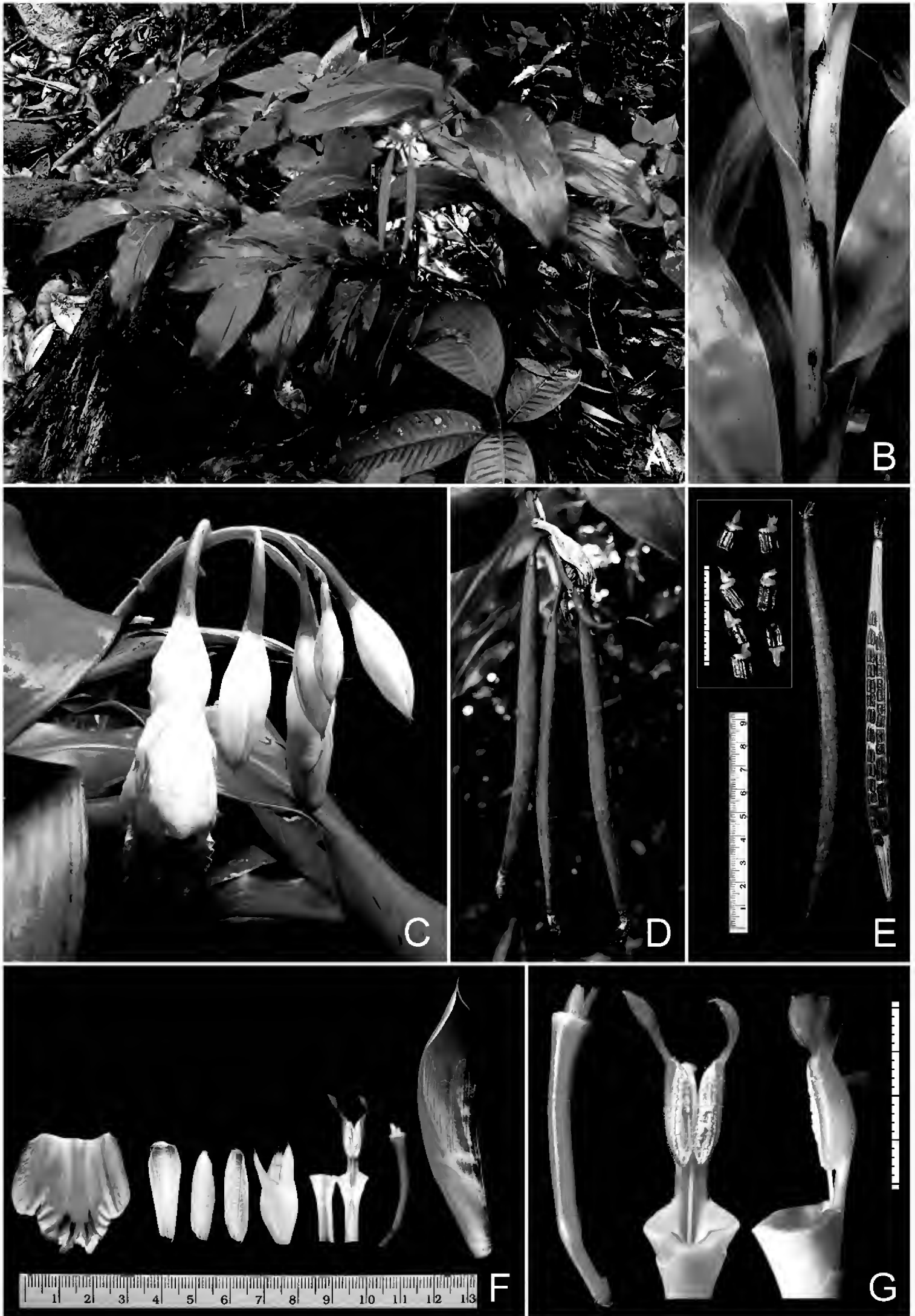
***Siliquamomum alcicorne* Škorničk. & Trần H.Đ., sp. nov.**

Similar to *Siliquamomum tonkinense* Baill. in its robust habit, but differs in having more leaves per leafy shoot (8–11 vs. 3–6), sessile leaf blades (vs. petiolate) and an anther which is deeply divided up to 1/3 from apex with two spatulate, green lobes (as opposed to an emarginate apex without a prominent anther crest).

TYPE: Vietnam, Kontum Province, Kon Plong Dist., Xã Hiếu, 14°38'57.7"N 108°24'57.7"E, 1223 m, 24 April 2012, J. Leong-Škorničková, Nguyễn Q.B., Trần H.Đ., E. Závěská JLS-1560 (holotype SING; isotypes E, PR, VNMN). (Fig. 1)

Terrestrial rhizomatous herb forming loose clumps. **Rhizome** shallowly subterranean, branched, up to 2 cm in diam., creamy white with violet-black tinge externally, cream white internally, slightly aromatic with cinnamon and camphor scent (notable also in crushed leafy shoot); scales papery, brown to black. **Leafy shoots** c. 3–5 cm apart, up to 2 m long, leafless for about 20–45 cm from the base with 3–5 sheathing bracts, with 8–11 leaves per shoot; **sheaths** green, glabrous, slightly reticulate, margin dark (almost black); **ligule** 2–3 mm long, bilobed, dark brown to black, becoming papery and brittle with age, glabrous; **petiole** inconspicuous; **lamina** elliptic to narrowly elliptic, up to 40 × 9 cm, dark green with greyish sheen and glossy above, slightly lighter beneath, glabrous on both sides, apex attenuate, base attenuate, margin entire. **Inflorescence** terminal; **peduncle** enclosed by leaf sheaths of the pseudostem, terminated by a lax pendulous thyrse with 7–10 flowers, **first** (lowermost) and **second bract** at the base of thyrse boat-shaped, c. 9 × 3.7 cm, light green, glabrous, mucronate (c. 4 mm long), enclosing the inflorescence when flowers in bud, soon caducous, leaving semicircular scars on the axis; **fertile bracts** usually minute or completely reduced, whitish green, soon dehiscent (best seen in young inflorescences with unopened buds); **axis of thyrse** to 15 cm long (measured from the lowermost caducous bract to the top of the axis), light green, pruinose, glabrous; **cincinni** 1-flowered; **bracteoles** absent; **pedicels** 3–6 mm long, c. 1 mm diam., light green, glabrous, with a minute white extrafloral nectary. **Flower** c. 7–8 cm long; **calyx** barrel-shaped c. 26–30 mm long, to c. 13 mm diam., unilaterally slit c. 9–11 mm, translucent cream-white, glabrous, 3-toothed at apex, teeth

Fig. 1. *Siliquamomum alcicorne*. **A.** Habit. **B.** Detail of ligules. **C.** Inflorescence (side view). **D.** Fruits. **E.** Fruit dissected (scale bar in cm) with detail of seeds (inset; scale bar in mm). **F.** Dissection (from left): labellum, dorsal corolla lobe, lateral corolla lobes, calyx, floral tube with anther (front view with tube dissected and opened), ovary with epigynous glands, bract (scale bar in cm). **G.** Detail of ovary with epigynous glands and anther (front and side view; scale in mm). Based on JLS-1560. (Photos: Jana Leong-Škorničková)



7–10 mm long; *floral tube* c. 14 mm long, cream-white and entirely glabrous externally and internally; *staminal tube* 6–7 mm long, greenish yellow and glabrous externally and internally, with two bulges covered with glandular hairs clasping the style; *dorsal corolla* lobe broadly elliptic, concave, c. 28 × 20 mm, cream-white, glabrous on both sides, *lateral corolla lobes* elliptic, concave, c. 27 × 17 mm, cream-white, glabrous on both sides; *labellum* obovate, c. 32 mm long, c. 24 mm wide at broadest (c. 40 mm wide incl. staminodes), apex rounded, irregularly crisped, sulphur-yellow with green patches at apical free part, adaxially with a few glandular hairs in centre in upper third and on the green patch, glabrous abaxially; *lateral staminodes* connate to labellum in basal 2/3, oblong-obovate, apex rounded, c. 24 × 8 mm, greenish-sulphur yellow, glabrous, margin slightly undulate. **Stamen** to 22 mm long, *filament* c. 3 × 3 mm, greenish-white, sparsely hairy at back; *anther* 18 × 5.5–6 mm, attached to filament at an 180° angle, greenish to cream-white at the back, yellow towards the apex and thecae, with short and fairly dense glandular hairs on connective, apex deeply divided in upper third, each lobe ending in spatulate green *anther crest* 3–7 × 3–6 mm, each of which may be either entire or divided into 2 lobes; *anther thecae* c. 11 mm long, light cream, dehiscing longitudinally for their entire length, glabrous. **Epigynous glands** two, each c. 4 mm long, c. 1.5 mm in diam., apex irregularly truncate, cream to light brown. **Style** c. 35 mm long, white, glabrous, flexistylous, basal half fully adnate to the flower tube; *stigma* c. 1.8 mm in diam., club-shaped, ciliate on top; *ostiole* ciliate, sub-apical, transverse elliptic, c. 1.5 mm wide, facing forwards to upwards. **Ovary** narrowly cylindrical, 20–25 mm long, c. 2.5 mm in diam. at base, up to 4 mm at apex, mid-green, glabrous, trilocular, placentation axile. **Fruit** green, up to 20 cm long, c. 1 cm in diam., with numerous seeds, seeds 7–10 mm long, bluntly ridged, rusty-brown with cream to light brown aril.

Phenology. The phenology of this species is not yet well understood. The presence of flowers has been confirmed from early March and rarely extending into April. However, the presence of fruit in various stages of ripeness in April suggests that flowering perhaps starts much earlier, possibly in January. The flowers last for two days.

Distribution & Ecology. So far known only from two locations in Kon Plong District, Kontum Province (central Vietnam), where it is locally common on slopes in montane evergreen broadleaved forest at an elevation of 1100–1300 m. It also occurs near shallow streams.

Provisional IUCN conservation assessment. Endangered EN B1ab(iii) (IUCN, 2012). *Siliquamomum alcicorne* is currently known from three populations in two locations. Two large populations are within a 1 km radius, while the third small population is about 20 km away in a NW direction. Logging activities have been noticed in the area, which is not protected by any legislative status. We, therefore, propose to treat this species as Endangered.

Etymology. The specific epithet ‘*alcicorne*’ refers to the peculiar shape of the anther crest which extends above each anther thecae and is reminiscent of the antlers of the Eurasian elk (*Alces alces*).

Other specimens examined (paratypes). VIETNAM. **Kontum Province:** Kon Plong Dist., Hiếu Municipality, Mang La Forest Enterprise Station, 14°38’55.7”N 108°25’15”E, 1186 m, 1 Mar. 2000, *Harder et al.* 4618 (E, HN, MO n.v.); *ibidem*, 14°42’34.3”N 108°14’35.9”E, 1257 m, 20 July 2010, *Trần et al.* 364 (PR, SING, VNM).

Notes. *Siliquamomum alcicorne* has a uniquely shaped anther. While a deeply divided apex to the anther is also seen in other Alpinioideae, an anther crest with spatulate lobes seems so far to be unique in the family (see Fig. 1G). In its robust habit *Siliquamomum alcicorne* is similar to *S. tonkinense*, but differs in having more leaves per leafy shoot (8–11), leaf blades with no petioles, and an anther divided up to 1/3 from apex with each lobe ending in a spatulate green anther crest. *Siliquamomum tonkinense* has leafy shoots with 3–6 leaves, clearly petiolate leaf blades and an anther with a weakly divided apex without a prominent anther crest. In the shape of the leaf blades it is also similar to the second known species, *Siliquamomum oreodoxa*, which is, however, much smaller in habit with leafy shoots up to 0.9 m long and with petiolate leaf blades up to 18 × 4.5 cm, compared to leafy shoots up to 2 m long with leaf blades up to 40 × 9 cm. The flowers of *Siliquamomum oreodoxa* are more open and the anther is weakly divided at apex (c. 1/6 way from the apex) and, while the two tips may end in sharp teeth, it does not form the prominent spatulate anther crest. The colour of the labellum in *Siliquamomum alcicorne* is sulphur-yellow with green patches, while the labellum of the other two species is white or cream-white with yellow and olive-green patches.

Of the three species, *Siliquamomum tonkinense* is the most widely distributed, with herbarium records from six provinces in northern Vietnam (Hà Giang, Lào Cai, Tuyên Quang, Vĩnh Phúc, Phú Thọ and Hòa Bình) as well as from southern Yunnan (all confirmed specimens are from close proximity to the Vietnam border across from Hà Giang and Lào Cai provinces). While *Siliquamomum oreodoxa* and *S. alcicorne* are each known only from two locations (in each case the populations are separated by 20–30 km), it is predicted that with further floristic exploration of southern and central Vietnam, these species will be reported from adjacent areas as suitable habitats for these species still exist in the region (Fig 2.).

The genome size of all three *Siliquamomum* species has been estimated following the methodology as outlined in Leong-Škorničková et al. (2007). The genome size of *Siliquamomum alcesinum* has been estimated at 2C=3.83 pg (internal standard *Bellis perennis* 2C=3.42 pg). This value is nearly identical (4% difference) to the genome size of *Siliquamomum oreodoxa* (2C=3.99 pg), while *S. tonkinense* has a much larger genome size (2C=5.38 pg). These data suggest closer affinity of the southern and central Vietnamese species to each other than to the northern *Siliquamomum tonkinense*.

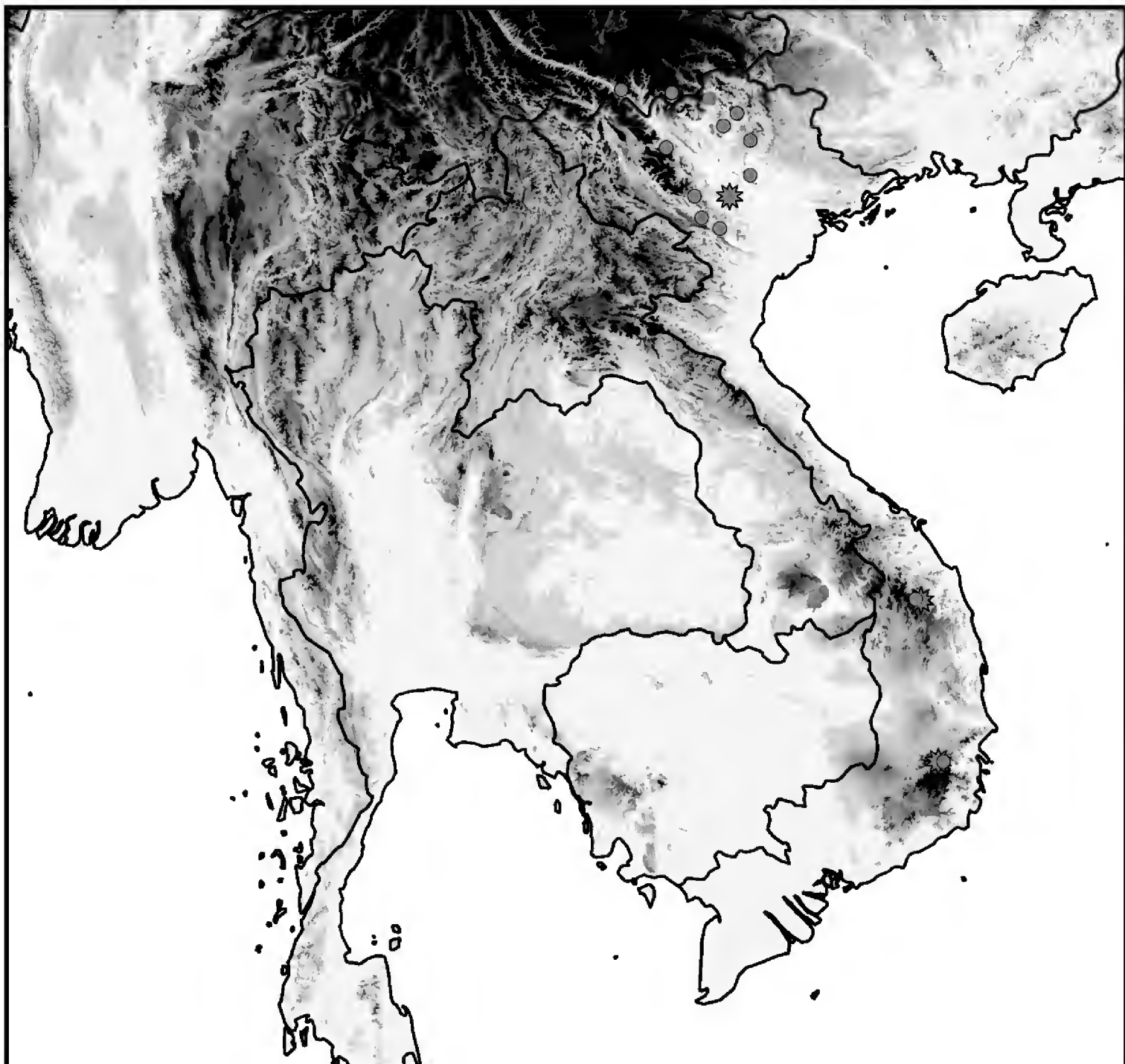


Fig. 2. Distribution of the three *Siliquamomum* species. *Siliquamomum tonkinense* (red), *S. alcicorne* (blue) and *S. oreodoxa* (green); type localities (star symbol), distribution records supported by specimens at HN, IBSC, KUN, P, SING and VNMN (circle).

Flexistyly, a special form of stylar behaviour promoting outcrossing in Zingiberaceae, has so far been reported to occur in more than 10 species in three Alpinioideae genera, namely *Alpinia*, *Amomum* (including *Paramomum petaloideum*) and *Etlingera* (e.g. Li et al., 2002; Takano et al., 2005; Ren et al., 2007). It is reported here for the first time that flexistyly also occurs in all three species of *Siliquamomum*. Both anaflexistylous and cataflexistylous flowers were observed in the field. More field observations and further studies at the population level are needed to better understand floral and pollination biology of *Siliquamomum* species.

Key to the species of *Siliquamomum*

- 1a. Pseudostem with 3–6 leaves; petiole 2.5–9 cm long (northern Vietnam & southeastern Yunnan, China) *S. tonkinense*
 1b. Pseudostem with 8–13 leaves; petiole inconspicuous or up to 2 cm long 2
- 2a. Pseudostems up to 2 m long, petiole inconspicuous, anther with prominent spatulate crest-lobes above each theca (central Vietnam) *S. alcicorne*
 2b. Pseudostems up to 0.9 m long, petiole up to 2 cm long, anther with minute sharp point above each theca (southern Vietnam) *S. oreodoxa*

ACKNOWLEDGEMENTS: The authors thank the Asian Zingiberaceae Information Centre at Singapore Botanic Gardens and the Zingiberaceae Resource Centre at the Royal Botanic Garden Edinburgh (<http://elmer.rbge.org.uk/ZRC/>) for providing protologues and various Zingiberaceae related references. The first author thanks Prof. Leonid Averyanov for sharing extensive numbers of localised images, which, in conjunction with his specimens, are an invaluable resource to revise Vietnamese Zingiberales. Dr Mark F. Newman and Dr Axel D. Poulsen are acknowledged for helpful remarks on our manuscript, and Dr Robert Mill for advice on the formation of the Latin epithet. Our research is funded by the National Parks Board, Singapore, the Czech Science Foundation, GAČR (grant number 14-13541S) and the Ministry of Culture of the Czech Republic (DKRVO 2014/11, National Museum, 00023272). We thank the Agriculture Department of Kontum province for granting the permission for our fieldwork and for providing support in various ways, and to Prof. Lê Công Kiệt, Mr Nguyễn Duy Linh and Mr Vũ Huy Đức for their help during the field trips. We are grateful to Prof. Nguyễn Đình Công and Prof. Lưu Đàm Cư from the Vietnam National Museum of Nature for support given to our collaborative research.

References

- Baillon, M.H. (1895). Une Musacée-Zingibérée à fruit siliquiforme. *Bull. Mens. Soc. Linn. Paris* 2: 1193–1194.
- Beentje, H. (2012). *The Kew Plant Glossary, an illustrated dictionary of plant terms* (revised edition). Royal Botanic Gardens, Kew: Kew Publishing.
- Gao, J.-Y., Xia, Y.-M., Huang, J.-Y. & Li, Q.-J. (2005). *The Zingiberaceae of China*. Beijing: Scientific Publisher.
- IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1*. Second edition. Switzerland, Gland and UK, Cambridge: IUCN.
- Leong-Škorničková, J., Šída, O., Jarolímová, V., Sabu, M., Fér, T., Trávníček, P. & Suda, J. (2007). Chromosome numbers and genome size variation in Indian species of *Curcuma* (Zingiberaceae). *Ann. Bot. (Oxford)* 100: 505–526.
- Li, Q.-J., Kress, W.J., Xu, Z.-F., Xia, Y.-M., Zhang, L., Deng, X.-B. & Gao, J.-Y. (2002). Mating system and stigmatic behaviour during flowering of *Alpinia kwangsiensis* (Zingiberaceae). *Pl. Syst. Evol.* 232:123–132.

- Lý, N.S., Hul, S. & Leong-Škorníčková, J. (2010). *Siliquamomum oreodoxa* (Zingiberaceae): a new species from Southern Vietnam. *Gard. Bull. Singapore* 61: 359–367.
- Ren, P.-Y., Liu, M. & Q.-J. Li (2007). An example of flexistyly in a wild cardamom species (*Amomum maximum* (Zingiberaceae)). *Pl. Syst. Evol.* 267:147–154.
- Takano, A., Gisil, J., Yusoff, M. & Tachi, T. (2005). Floral and pollinator behaviour of flexistylous Bornean ginger, *Alpinia nieuwenhuizii* (Zingiberaceae). *Pl. Syst. Evol.* 252: 162–173.
- Wu, T.-L. & Larsen, K. (2000). Zingiberaceae. In: Wu, C.-Y. & Raven, P.H. (eds) *Flora of China*. 24: 322–377. Beijing: Science Press.

***Margaritaria* (Phyllanthaceae), a new generic record for the Singapore flora**

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ABSTRACT. The Warren Golf Club in south-central Singapore, established in 1962 and sandwiched between Dover Road and the Ayer Rajah Expressway (AYE), retained some tree stands that could have unwittingly served as a refugium for some forest species before it was relocated elsewhere in 2000 to make way for the development of University Town, or UTown, an extension of the National University of Singapore. At this locality, *Margaritaria indica*, a new genus and species record for Singapore, was discovered. The distribution, rarity, and conservation status of this taxon for Singapore and Peninsular Malaysia are discussed.

Keywords. *Margaritaria*, new genus record, Peninsular Malaysia, Phyllanthaceae, rare plant, Singapore

Introduction

Singapore is an island nation located in Sundaland, one of the world's richest biodiversity hotspots. This floristically diverse region also includes Brunei, Indonesia, and Malaysia, and is estimated to harbour about 25,000 species of plants (Myers et al., 2000). Singapore's land area as of 2013, taking into account some land reclamation, is more than 715 km² (Department of Statistics, Singapore, 2014; Chou, 2011). In a recent enumeration of Singapore's total flora by Chong et al. (2011) they recorded 4173 species, of which 2141 species are native to the island. Tan (2008) indicated that close to 89% of Singapore's native flora requires immediate conservation attention in the remaining forest reserves of Singapore.

As NParks, the National University of Singapore (NUS) and other local tertiary education institutions, as well as non-governmental organisations (NGOs) such as the Nature Society (Singapore), continue to monitor the present flora of Singapore, many new and exciting discoveries have come to light, including the rediscovery of taxa once thought extinct. Several recent examples are *Ampelocissus ascendiflora* and *A. thyrsiflora* (Vitaceae) (Yeo et al., 2013); *Ficus stricta* (Moraceae) (Yeo et al., 2012); *Marsdenia maingayi* (Apocynaceae) (Yeoh et al., 2013); and *Vrydagzynea lancifolia* (Orchidaceae) (Lim et al., 2014).

The new genus and species record highlighted in the present paper illustrates how a tree-conservation enactment was able to protect a rare taxon despite changes in land use. The Warren Golf Club, before being relocated to its current location at Choa Chu Kang in 2000, was located at the south-central part of Singapore, between Dover Road and the Ayer Rajah Expressway (AYE). The club site was earmarked for development as an extension of the NUS complex located at Kent Ridge. This new extension, named University Town or UTown was functional by 2011, except for the north-west portion of the site which is now still under construction. As the site is located within one of the Tree Conservation Areas gazetted under the Parks and Trees Act, (Preservation of Trees) Order 1991, trees growing within the site with a girth size of more than one meter are protected by law. In 2012, an unidentified tree at the construction site of UTown was discovered by the developers and was cordoned off by the site managers. A herbarium voucher consisting of a leafy branch with fruits was forwarded to NParks' Streetscape Division, and then on to Singapore Botanic Gardens, for identification. At the Singapore Herbarium (SING) this specimen was matched to *Margaritaria indica* (Dalzell) Airy Shaw which is a new genus and species record for the Singapore flora.

The IUCN conservation status of *Margaritaria indica* is assessed for Singapore based on Davison (2008); and for Peninsular Malaysia using GeoCAT (Bachman et al., 2011), an IUCN Red List (IUCN, 2001) compliant software that generates the IUCN threat categories based on (i) extent of occurrence (EOO) and (ii) area of occurrence (AOO). Data used for the assessment here are based on herbarium records that are represented in SING.

Taxonomic notes on the new record

Margaritaria L.f., Suppl. Pl. 66 (1781); Webster, J. Arnold Arbor. 60: 403 (1979); Webster, Ann. Missouri Bot. Gard. 81: 44 (1994); Barker, Blumea 46: 506 (2001).

The genus is pantropical (excluding the Pacific Islands), with 14 species, of which only two (*Margaritaria indica* and *M. luzoniensis* (Merr.) Airy Shaw) occur in Malesia. Webster (1979) revised the entire genus and Barker (2001) treated the Malesian species. The species are variously found in deciduous forest, dry forest and evergreen forest in the lowlands, as well as on limestone or in riparian vegetation, and also in secondary forests.

Margaritaria species are dioecious. The distichous leaf arrangement, axillary flowers produced singly or in small clusters, four sepals in two series, absence of petals, annular disc and absence of a pistillode in the staminate flower, bifid or bipartite stigmas in the pistillate flower, capsular 3-locular fruits, bluish purple sarcotesta around the seed, and thick bony endotesta, are characteristic features (Webster, 1979; Barker, 2001). It was formerly placed in Euphorbiaceae subfamily Phyllanthoideae Asch. by Webster (1994) and is now in the Phyllanthaceae (APG III, 2009). It is distinguished from *Phyllanthus* L. by its annular (instead of lobed) disc in the staminate flower,

sarcotesta and thick bony endotesta; and from *Flueggea* Willd. by its four (not five) sepals, absence of a pistillode in the staminate flower and sarcotesta.

Margaritaria indica (Dalzell) Airy Shaw

Kew Bull. 20: 398 (1966); Airy Shaw, Kew Bull. 25: 492 (1971); Barker, Blumea 46: 507 (2001). – *Prosorius indicus* Dalzell, Hooker's J. Bot. Kew Gard. Misc. 4: 345 (1852). – *Phyllanthus indicus* (Dalzell) Müll.Arg., Linnaea 32: 52 (1863). – TYPE: India, Deccan, *Dalzell s.n.* (holo K).

Barker (2001) recognised two forms: *Margaritaria indica* f. *indica* is completely glabrous, with leaves drying dark brown, acute to acuminate leaf apices, and slender fruiting pedicels of 0.3 mm diameter (in dried material); and *Margaritaria indica* f. *vestita* (known only from East Java), is sparsely pubescent on at least the pedicels, with leaves drying olive brown, obtuse to rounded leaf apices, and thicker fruiting pedicels c. 1 mm diameter (in dried material). The Singapore material is clearly *Margaritaria indica* f. *indica* (Fig. 1 & Fig. 2).

Below we provide an augmented description of *Margaritaria indica* f. *indica* adapted from Barker (2001) with additional information based on the Singapore collection:

Tree, up to 30 m high with a solitary or multiple trunks, clear trunk height c. 4–15 m, trunk diameter c. 45–80 cm, buttresses absent to a few, c. 1.2 m high, c. 15 cm wide and c. 25 cm thick. **Bark** smooth, finely cracked, or scaly, pale to greyish brown, to red-brown or orange-brown, the bark scales irregularly peeled to give a dippled appearance and exposing newer bark of various shades ranging from fawn to orange-brown; all parts glabrous. **Twigs** generally terete, distal parts somewhat sub-compressed, older portions greyish brown and sometimes peeling to expose newer orange-brown bark, the younger distal parts dark green to reddish brown, densely lenticellate throughout, lenticels elongate, pale grey. **Stipules** triangular to lanceolate, 2–4.5 mm long, scarious, caducous, leaving behind a semi-circular scar on the twig, apex acuminate. **Leaves** alternate; petiole adaxially channelled, 3.5–7(–11) mm long; lamina elliptic to obovate, smaller at the more proximal nodes on a twig, larger more distally, 3–17 × 1.8–8.3 cm, chartaceous, adaxially medium green, abaxially pale green, very slightly glaucous, midrib pale green on both sides, slightly raised above, prominent below, secondary veins 6–12 pairs, distinct on both sides, faintly looped towards the leaf margin, tertiary venation barely visible on both sides, reticulate; apex acute, acuminate to apiculate, base cuneate to rounded, sometimes slightly oblique, very slightly decurrent; margin entire, sometimes slightly undulate. **Staminate flowers** minute, in clusters of 2–28; pedicels up to 7 mm long; inner sepals obovate, 1.2–1.6 × 1–1.4 mm wide; outer sepals ovate, 0.8–1.3 × 0.8–1 mm wide; disc large, flattened, slightly lobed, diameter c. 0.6–1.3 mm; filaments 0.8–1.5 mm long; anthers oblong, 0.7–0.8 mm long. **Pistillate flowers** in clusters of 1–7; pedicels up to 2.2 cm long; inner and outer sepals obovate to oblong, inner sepals c. 1.5–2 × 1–1.8 mm, outer sepals c. 1.5–2 × 1–1.3 mm; disc diameter 1.8–2.6 mm; stigmas spreading, sessile, flat,



Fig. 1. *Margaritaria indica*: a several-stemmed tree with a characteristically scaly-dippled bark with grey-fawn and orange-brown patches. (Photo: P.K.F. Leong)

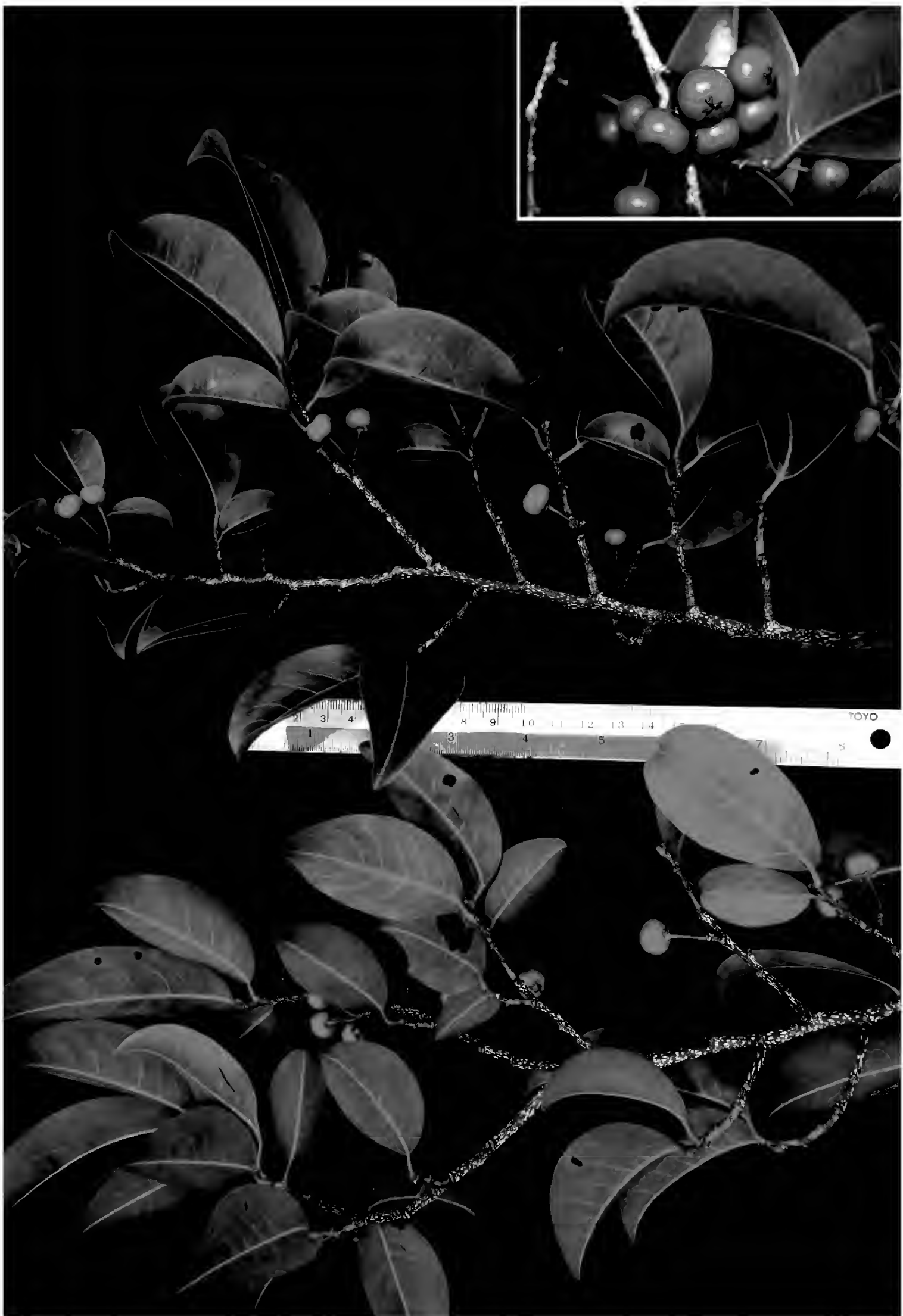


Fig. 2. *Margaritaria indica*: leafy fruiting twigs. (Photo: P.K.F. Leong) *Inset*: Close-up of a cluster of immature tri-locular fruits with conspicuous fine suture running longitudinally along the length of each locule. (Photo: Y.W. Low)

1.5–2 mm long, apically bifid to about a third its length. *Fruits* solitary or in pairs from leaf axils, superior, subglobose, very slightly 3-lobed with a pale fine longitudinal suture along the median of each lobe, (0.6–)0.9–1.2 cm diameter, pale to medium green before maturity, drying ochreous brown; stigmas persistent, columella occasionally persistent; pedicels 0.8–2 cm long, 0.3–1 mm diameter, pale green. *Seeds* (immature) plano-convex, 3.5–5 × 2.8–4 mm, pale yellowish brown, with a thin translucent bluish purple sarcotesta.

Specimens examined: SINGAPORE. South-central Singapore, between Dover Road and Ayer Rajah Expressway, National University of Singapore, University Town, 29 May 2012, *Leong et al.* SING 2012-252 (SING! barcode no. SING0166292).

PENINSULAR MALAYSIA. **Pahang**. Pulau Berhala, 15 Jun 1932, *Corner s.n.* (SING! barcode no. SING0166291); northwest of Pulau Tioman, Pulau Chibeh, sea level, 19 Aug 1935, *Corner SFN29829* (SING! 2 sheets, barcode nos. SING0166290 & SING0165787). **Johor**. Pulau Sibiu, Jun 1992, *sine coll. P.P. Kumar 101* (SING! 2 sheets, barcode nos. SING0166010 & SING0166011).

Distribution. From India (Deccan plateau), Sri Lanka, through Myanmar, Thailand, northern Vietnam, southern China (SW Guangxi) and Taiwan, across Malesia, to Australia (N Queensland). In Malesia, it has been recorded from Sumatra, Peninsular Malaysia (Chibeh Island, Berhala Island and Sibiu Island off the east coast, and not recorded on the mainland) and Singapore (this contribution) (see Fig. 3 for the distribution of *Margaritaria indica* in the Malay Peninsula), Java, Borneo (Sarawak), the Philippines (Luzon, Palawan, Mindanao, Sulu Islands), Lesser Sunda Islands (Sumba), Moluccas (the Sula Islands of Mangoli and Tanimbar), and the Aru Islands.

The distribution of *Margaritaria indica* has been described by Barker (2001) as “rare and very scattered in primary forests, in riverine forests and peat swamps” and also “on limestone...up to 650 m altitude”. Earlier, Webster (1979) remarked: “This widespread species has a curious spotty distribution which perhaps reflects vagaries of collecting.” That the Singapore record has been elusive until now lends some support to the notion that local populations occur at low frequencies. However, the species is indeed generally rare in Malesia, apparently occurring only on the smaller islands or around the coastline on the bigger island of Borneo (see Map 1 showing the distribution in Barker (2001)).

Relationships. The only other congener of *Margaritaria indica* in Malesia is the Philippine *M. luzoniensis*. That species, restricted to Luzon Island, has small leaves up to 4 cm long only, with petioles that are not adaxially channelled, small fruits of 6–8 mm diameter, and a smooth seed endotesta. In contrast, *Margaritaria indica* has larger leaves to 17 cm long, petioles that are adaxially channelled, larger fruits of 9–12 mm diameter, and a rugose seed endotesta (Barker, 2001). The taxa overlap in the Philippines, where Barker (2001) suspects some degree of “intergradation” (introgression) could have taken place, accounting for somewhat intermediate forms.

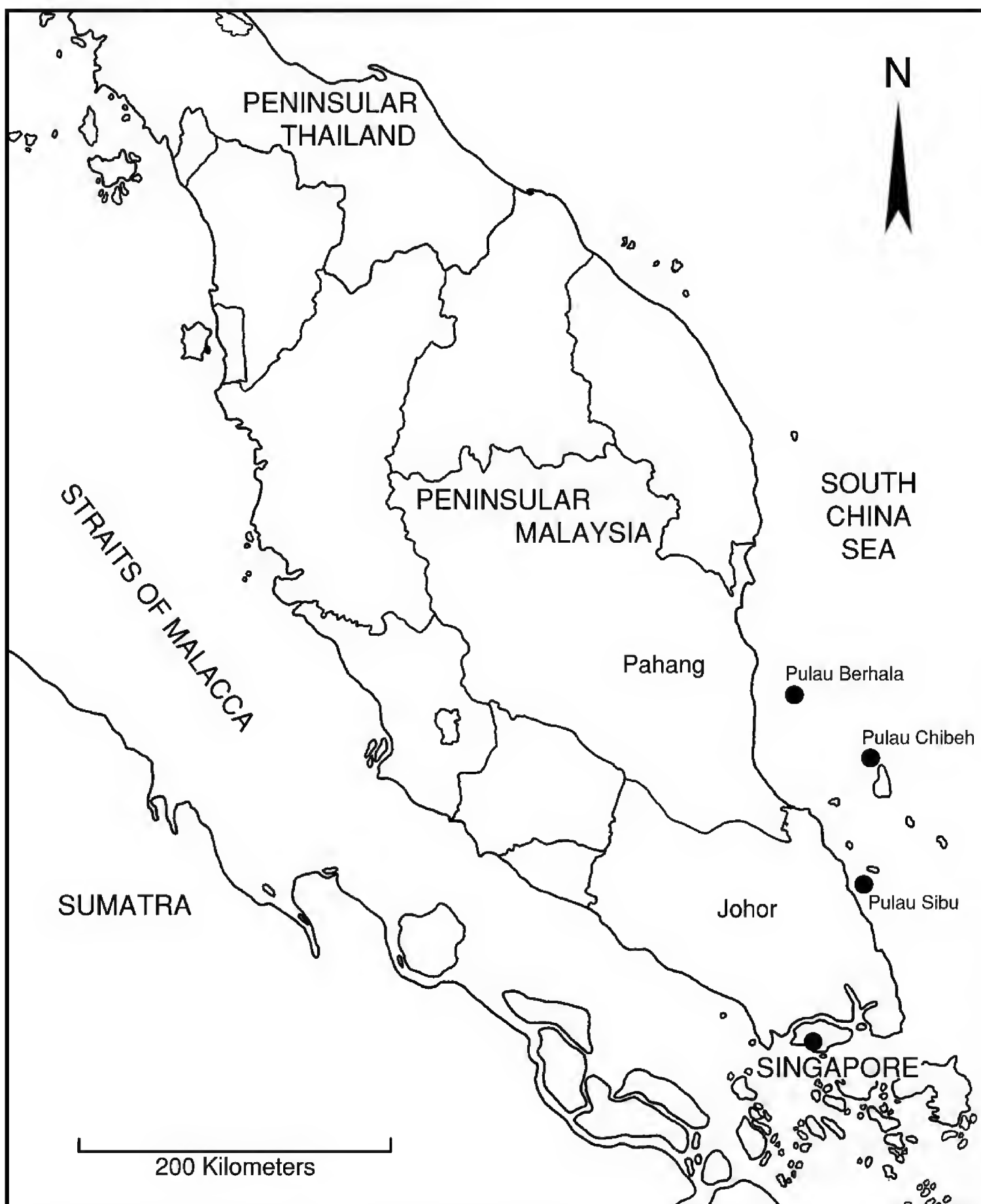


Fig. 3. Distribution of *Margaritaria indica* in the Malay Peninsula, indicated by black dots.

Proposed IUCN Conservation Assessment. The *Margaritaria indica* individual discovered for Singapore is the only one known, hence the national conservation status assessment, based on Davison (2008), is Critically Endangered (CR) with the designation Category D. The category 'D' designation is for fewer than 50 mature

individuals known with some evidence of decline or fragmentation (in fact this is the only mature and living individual known for Singapore).

In contrast, based on all the distribution known for Peninsular Malaysia, the IUCN conservation status assessed using GeoCAT categorised *Margaritaria indica* as Endangered (EN) (IUCN, 2001), with the designation B2ab(iii,iv). The 'B2' designation results from an area of occurrence (AOO) estimated to be less than 500 km² (about 12 km² for *M. indica*); 'a' is due to a severely fragmented distribution and occurrence in three locations, namely, Pulau Berhala and Pulau Chibeh (Pahang), and Pulau Sibul (Johor); and 'b(iii, iv)' considers likely continuing decline in area, extent and quality of habitat, and number of locations. Habitat loss is a major concern for the species especially in Peninsular Malaysia as islands and coastal areas are becoming more disturbed, not free from human activities.

Notes. The earliest records of *Margaritaria indica* for Peninsular Malaysia came from Pulau Berhala and Pulau Chibeh, tiny islands northwest of Tioman Island in the South China Sea, off the eastern Pahang coast. Corner (1985) described Pulau Chibeh as consisting "of immense granite blocks more or less *in situ*, immense fallen boulders, a bare granite face above tide level, and more or less of a submerged talus of boulders and pebbles". He characterised Pulau Berhala as "a flat granite platform, roughly circular, about 400 ft wide, raised a foot or more above sea level and, probably, awash at highest tides or in storms." Corner's collection from Chibeh, *SFN 29829*, was "a frequent small tree on rocks at the top of the island and on the west slope". He described it as resembling the guava-tree (*Psidium*) with slightly papery-flaky bark and collected it as "Aporosa?" although later in the herbarium Henderson thought it was possibly a species of *Celastrus* (Celastraceae) (Corner, 1985: 15). In his records comparing species distributions among the different islands surveyed (Corner, 1985: 17), Corner recorded this taxon as present in Pulau Chibeh and Pulau Sepoi, but not Pulau Berhala; we cannot explain this apparent discrepancy with the herbarium vouchers available.

The seed sarcotesta is reported to ripen a glistening bluish purple suggesting it would attract bird dispersers (Barker, 2001).

Possible medicinal and economic value. Little is known about the medicinal properties of *Margaritaria indica*, although Burkill (1935) mentioned it as an example (under *Phyllanthus*) of a poisonous taxon, explaining only that medicinal uses of various *Phyllanthus* spp. are "chiefly for external application". Webster (1979) suggests that it is closely related to the African *Margaritaria discoidea*, the healing and anti-inflammatory properties of which are known (Dickson, 2010). Ekuadzi et al. (2013) have demonstrated that flavonoid glycosides from stem bark of *Margaritaria discoidea*, traditionally used in Ghana for the management of skin infections and wounds, helped reduce microbial load in wounds and facilitated healing. Kaaya et al. (1995) found that water soluble extracts of that species induced high mortalities in some ticks; and Cho-Ngwa et al. (2010) showed that such extracts are potential sources of microfilaricidal compounds for the treatment of onchocerciasis, a parasitic disease of man caused by

a filarial worm. Continuing research (Obiri et al., 2014) has found that *Margaritaria discoidea* suppresses allergy and promotes anti-inflammatory responses in mice.

ACKNOWLEDGEMENTS. The National Parks Board provided the opportunity to extend studies on this rare and biogeographically interesting species. We are grateful to ArborCulture Pte. Ltd. for assistance rendered in the field. Finally, we would like to express our appreciation to the two reviewers, Prof. Dr Peter van Welzen and Dr Chong Kwek Yan, for their constructive comments in improving this manuscript.

References

- APG III (2009). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Bot. J. Linn. Soc.* 161: 105–121.
- Bachman S., Moat J., Hill A.W., de la Torre J., Scott B. (2011). Supporting Red List threat assessments with GeoCAT: Geospatial Conservation Assessment Tool. In: Smith, V. & Penev, L. (eds) e-Infrastructures for data publishing in biodiversity science. *ZooKeys* 150: 117–126. (Version BETA)*
- Barker, C. (2001). *Margaritaria* (Euphorbiaceae) in Malesia. *Blumea* 46: 505–512.
- Burkill, I.H. (1935). *A Dictionary of the Economic Products of the Malay Peninsula* 2: 1717. London: Crown Agents for the Colonies.
- Cho-Ngwa, F., Abongwa, M., Ngemenya, M.N. & Nyongbela, K.D. (2010). Selective activity of extracts of *Margaritaria discoidea* and *Homalium africanum* on *Onchocerca ochengi*. *BMC Complementary & Alternative Medicine* 10: 62.
- Chong, K.Y., Tan, H.T.W. & Corlett, R.T. (2011). A summary of the total vascular plant flora of Singapore. In: Wong, K.M., Leong-Škorničková, J., Lee, S. & Low, Y.W. (eds) Proceedings of the 8th Flora Malesiana Symposium. *Gard. Bull. Singapore* 63: 197–204.
- Chou, L.M. (2011). Coastal Ecosystems. In: Ng, P.K.L., Corlett, R.T. & Tan, H.T.W. (eds) *Singapore Biodiversity: An Encyclopedia of the Natural Environment and Sustainable Development*. Pp. 64–75. Singapore: Editions Didier Millet and Raffles Museum of Biodiversity Research.
- Corner, E.J.H. (1985). The botany of some islets east of Pahang and Johore. *Gard. Bull. Singapore* 38: 1–42.
- Davison, G.W.H. (2008). The Red List categories. In: Davison, G.W.H., Ng, P.K.L. & Ho, H.C. (eds) *The Singapore Red Data Book: Threatened plants and animals of Singapore, 2nd ed.* Pp. 1–4. Singapore: The Nature Society (Singapore).
- Department of Statistics, Singapore (2014). *Singapore in Brief*. Singapore: Singapore Department of Statistics. <http://www.singsat.gov.sg/sib2014/> (accessed on 13 Mar 2014)
- Dickson, R.A. (2010). Antibacterial, antioxidant and anti-inflammatory properties of *Margaritaria discoidea*, a wound healing remedy from Ghana. *Pharmacognosy J.* 2(17): 32–29.
- Ekuadzi, E., Dickson, R., Fleischer, T., Annan, K., Pistorius, D., Oberer, L. & Gibbons, S. (2013). Flavonoid glycosides from the stem bark of *Margaritaria discoidea* demonstrate antibacterial and free radical scavenging activities. *Phytotherapy Research*, DOI: 10.1002/ptr.5053

- IUCN (2001). *IUCN Red List Categories and Criteria: Version 3.1*. 2nd ed. Switzerland, Gland and UK, Cambridge: IUCN.
- Kaaya, G.P., Mwangi, E.M. & Malonza, M.M. (1995). Acaricidal activity of *Margaritaria discoidea* (Euphorbiaceae) plant extracts against the ticks *Rhipicephalus appendiculatus* and *Amblyomma variegatum* (Ixodidae). *Intern. J. Acarology* 21(2): 123–129.
- Lim, R.C.J., Ng, X.Y., Leong, P.K.F., Kurzweil, H., Duistermaat, H., Chung, Y.F., Chen, J., Yeoh, Y.S. & Tan, H.T.W. (2014). Rediscovery in Singapore of *Vrydagzynea lancifolia* (Orchidaceae). *Nat. Singapore* 7: 1–7.
- Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858.
- Obiri, D.D., Osafo, N., Oppong-Sarfo, J. & Prah, J.K. (2014) *Margaritaria discoidea* (Euphorbiaceae) stem bark extract attenuates allergy and Freund's adjuvant-induced arthritis in rodents. *Pharmacognosy Research* 6(2): 163–171.
- Tan, H.T.W. (2008). Flora: preamble. In: Davison, G.W.H., Ng, P.K.L. & Ho, H.C. (eds) *The Singapore Red Data Book: Threatened plants and animals of Singapore, 2nd ed.* Pp. 15–16. Singapore: The Nature Society (Singapore).
- Webster, G.L. (1979). A revision of *Margaritaria* (Euphorbiaceae). *J. Arnold Arbor.* 60: 403–444.
- Webster, G.L. (1994). Synopsis of the genera and suprageneric taxa of Euphorbiaceae. *Ann. Missouri Bot. Gard.* 81: 43–44.
- Yeo, C.K., Ng, X.Y., Ng, W.Q., Chong, K.Y., Ang, W.F. & Ali Ibrahim (2012). *Ficus stricta*: a new record in Singapore. *Nat. Singapore* 5: 351–358.
- Yeo, C.K., Ang, W.F., Lok, A.F.S.L. & Ong, K.H. (2013). The conservation status of *Ampelocissus* (Vitaceae) of Singapore, with a special note on *Ampelocissus ascendiflora*. *Nat. Singapore* 6: 45–53.
- Yeoh, Y.S., Yeo, C.K., Ang, W.F. & Low, Y.W. (2013). *Marsdenia maingayi* (Apocynaceae, Asclepiadoideae), a rare rainforest woody climber rediscovered in Singapore. *Gard. Bull. Singapore* 65: 241–249.

A new combination in *Liebigia* (Gesneriaceae)

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ABSTRACT. The new combination *Liebigia barbata* (Jack) D.J.Middleton is made for the species previously known as either *Chirita asperifolia* (Blume) B.L.Burtt or *Liebigia speciosa* (Blume) DC. The complex nomenclatural history of these latter names is discussed. *Liebigia barbata* is neotypified.

Keywords. *Chirita asperifolia*, *Didymocarpus*, lectotype, *Liebigia speciosa*, neotype, new combination, Sumatra, *Tromsdorffia*.

Introduction

The genus *Liebigia* Endl. was described by Endlicher (1841) but was reduced to a section of *Chirita* Buch.-Ham. ex D.Don by Clarke (1883). When Wood (1974) revised *Chirita* he synonymised *Chirita* sect. *Liebigia* (Endl.) C.B.Clarke within *Chirita* sect. *Chirita* and included most of Clarke's species from *Chirita* sect. *Liebigia* within a very broadly defined *Chirita asperifolia* (Blume) B.L.Burtt, the remaining species being insufficiently known or unrelated. Hilliard (2004) resurrected *Chirita* sect. *Liebigia* and recognised 12 narrowly defined species. Weber et al. (2011) provided a detailed phylogenetic analysis of the relationships of the species of *Chirita* to each other and to the rest of the Gesneriaceae and concluded that *Liebigia* should be recognised at generic rank. They provided new combinations for 11 of the 12 species included by Hilliard (2004) and listed only the type, which they called *Liebigia speciosa* "(Blume) Endl." with *Chirita asperifolia* in synonymy, as not requiring a new combination in *Liebigia*. This is a mistake and a new combination for this species is still required in *Liebigia*.

***Liebigia barbata* (Jack) D.J.Middleton, comb. nov.**

Basionym: *Didymocarpus barbatus* Jack, Trans. Linn. Soc. London 14: 38 (1823).
TYPE: Sumatra, Sumatra, Lintang River, *Forbes* 2579 (neotype BM, designated here).

Agalmyla asperifolia Blume, Bijdr. Ned. Ind. 767 (1826). – *Busea asperifolia* (Blume) Miq., Fl. Ned. Ind. 2: 733 (1858). – *Dichrotrichum asperifolium* (Blume) C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 54 (1883). – *Tetradema asperifolium* (Blume)

Schltr., Notizbl. Bot. Gart. Mus. Berlin 7: 361 (1920). – *Didymocarpus asperifolius* (Blume) Bakh.f. in Backer, Beknopte Fl. Java, Afl. ix a. Fam. 195, 8 (1949); Bakh.f., Blumea 6: 394 (1950). – *Chirita asperifolia* (Blume) B.L. Burtt, Notes Roy. Bot. Gard. Edinburgh 24: 41 (1962). TYPE: Java, *Blume* (lectotype L, designated by Wood (1974: 182)).

Tromsdorffia speciosa Blume, Bijdr. Ned. Ind. 763 (1826). – *Liebigia speciosa* (Blume) DC., Prod. 9: 259 (1845). – *Chirita blumei* C.B. Clarke in A.DC. & C.DC., Monogr. Phan. 5: 122 (1883). TYPE: Java, *Blume* (lectotype L [L0003333], designated here).

Further synonyms are listed by Hilliard (2004) under the name *Chirita asperifolia* (Blume) B.L. Burtt.

Blume (1826) published the two new genera *Agalmyla* Blume and *Tromsdorffia* Blume which included, amongst others, the species *Agalmyla asperifolia* Blume and *Tromsdorffia speciosa* Blume. Endlicher (1841) replaced *Tromsdorffia* by the new generic name *Liebigia* Endl. because *Tromsdorffia* Blume is a later homonym of *Trommsdorffia* Bernh. Clarke (1883) and Weber et al. (2011) treated *Liebigia speciosa* as having been published by Endlicher. However, Endlicher (1841) did not mention any species names in his publication of *Liebigia* so the supposed combination “*Liebigia speciosa* (Blume) Endl.” (1841) does not in fact exist. Instead, the first valid publication of this combination was by Candolle (1845). Clarke (1883) transferred *Tromsdorffia speciosa* Blume, and combinations based on it, to *Chirita* under the name *C. blumei* C.B. Clarke due to the unavailability of the epithet *speciosa* in *Chirita*.

Bakhuizen van den Brink (1950) later noted that *Agalmyla asperifolia* and *Tromsdorffia speciosa* are conspecific and synonymised them under the name *Didymocarpus asperifolius* (Blume) Bakh.f. Burtt (1962) agreed with the synonymy and transferred the species back to *Chirita* as *C. asperifolia* (Blume) B.L. Burtt. Wood (1974) and Hilliard (2004) also recognised the synonymy and treated this species as *Chirita asperifolia*. Weber et al. (2011), when resurrecting *Liebigia*, took up the name *Liebigia speciosa*, presumably believing that in *Liebigia* the epithet *speciosa* could again be used as it would not be a later homonym and had priority over *asperifolia*.

Agalmyla asperifolia Blume and *Tromsdorffia speciosa* Blume were simultaneously published by Blume and have equal priority. Under Art. 11.5 of the ICN (McNeill et al., 2011) the author who first places one name in synonymy of the other establishes the priority. This was done by Backhuizen van den Brink (1950) when making the combination *Didymocarpus asperifolius*. He included *Tromsdorffia speciosa* in synonymy, thereby establishing the priority of *Agalmyla asperifolia* over *Tromsdorffia speciosa*. Even if Endlicher (1841) had validly made the combination *Liebigia speciosa* this would not have established the priority of that epithet. Despite the backwards and forwards competition between the epithets *speciosa* and *asperifolia* it is quite clear that *asperifolia* has priority and that, in the absence of other factors, a new combination in *Liebigia* would have been necessary.

The most important element of this problem, however, was also overlooked

by Weber et al. (2011) in that neither *Agalmyla asperifolia* Blume nor *Tromsdorffia speciosa* Blume is the oldest name for this taxon. Hilliard (2004) included *Didymocarpus barbatus* Jack in synonymy of *Chirita asperifolia* whilst noting that this conclusion was based on the description alone as the type material is lost. *Didymocarpus barbatus* Jack from 1823 has priority over *Agalmyla asperifolia* Blume from 1826 but in *Chirita* the epithet *barbata* is not available due to *Chirita barbata* Sprague (which is now *Microchirita barbata* (Sprague) A. Weber & D.J. Middleton). However, in *Liebigia* there is no such impediment and a new combination can be made. Although the type material, which was collected in southern Sumatra, is lost Jack (1823) provided a very thorough and unmistakable description such that we can be confident it is the same taxon. Therefore, as well as the new combination, a neotype is proposed for this name. The specimen chosen as neotype, *Forbes 2579*, is also a syntype of *Chirita forbesii* Ridl. *nom. illeg.* and *Chirita ridleyandra* S. Moore.

ACKNOWLEDGEMENTS. This research is funded by the National Parks Board, Singapore. I am very grateful to Jana Leong-Škorničková for guiding this paper through the review process and to John McNeill for alerting me to a name I had overlooked when tackling this problem. I also thank Roxali Bijmoer of Naturalis in Leiden, Netherlands, for her help with specimens in Naturalis.

References

- Bakhuizen van den Brink, R.C. (1950). Notes on the Flora of Java VI. *Blumea* 6: 363–406.
- Blume, C.L. (1826). *Bijdragen tot de Flora van Nederlandsch Indie*. Batavia: Lands Drukkerij.
- Burt, B.L. (1962). Studies in the Gesneriaceae of the Old World XXII: Miscellaneous transfers and new species. *Notes Roy. Bot. Gard. Edinburgh* 24: 41–49.
- Candolle, A.P. de (1845). *Cyrtandraceae. Prodromus systematis naturalis regni vegetabilis* 9: 258–286, 564. Paris: Treuttel & Würtz.
- Clarke, C.B. (1883). *Cyrtandreae*. In: Candolle, A. de & Candolle, C. de (eds) *Monographiae phanerogamarum* 5: 1–303. Paris: Masson.
- Endlicher, S.L. (1841). *Genera Plantarum*, suppl. 1. Wien: Fr. Beck.
- Hilliard, O.M. (2004). A revision of *Chirita* sect. *Liebigia* (Gesneriaceae). *Edinburgh J. Bot.* 60: 361–387.
- Jack, W. (1823). On Cyrtandraceae, a new natural order of plants. *Trans. Linn. Soc. London* 14: 23–45.
- McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W.F., Smith, G.F., Wiersema, J.H. & Turland, N.J. (2012). *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code)*. Königstein: Koeltz Scientific Books. [Regnum Veg. 154]
- Weber, A., Middleton, D.J., Forrest, A., Kiew, R., Lim, C.L., Rafidah, A.R., Sontag, S., Triboun, P., Wei, Y.-G., Yao, T.L. & Möller, M. (2011). Molecular systematics and remodelling of *Chirita* and associated genera (Gesneriaceae). *Taxon* 60: 767–790.
- Wood, D. (1974). A revision of *Chirita* (Gesneriaceae). *Notes Roy. Bot. Gard. Edinburgh* 33: 123–205.

A new species of *Mallotus* (Euphorbiaceae) from Vietnam

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ABSTRACT. A new species of Euphorbiaceae, *Mallotus phongnhaensis*, is described from Phong Nha - Ke Bang National Park, Vietnam. This new species belongs to *Mallotus* sect. *Axenfeldia* and is distinguished from other species in several significant features including its shrubby habit up to 1 m high, submarginal extrafloral nectaries with 6–12 per side, and few-flowered, cauliflorous inflorescences.

Keywords. Euphorbiaceae, *Mallotus phongnhaensis*, *Mallotus* sect. *Axenfeldia*, new species, Phong Nha - Ke Bang National Park, Vietnam

Introduction

Mallotus Lour. is a large genus of c. 150 species in Euphorbiaceae, subfamily Acalyphoideae, subtribe Rottlerinae (Sierra et al., 2007). Although two species in the genus occur in Africa and Madagascar, most are from tropical Asia with over 34 species known from Vietnam (Thin, 1999, 2007).

During an expedition to Phong Nha - Ke Bang National Park in the summer of 2006, an undetermined collection of *Mallotus* with shrubby habit, many submarginal extrafloral nectaries and cauliflorous inflorescences and fruits in the lower stem was collected. Based on comparisons with herbarium specimens at HNU and HN, and a study of the pertinent literature (Airy Shaw, 1972, 1975; Pax & Hoffmann, 1914; Ho, 1999; Thin, 1999, 2007; van Welzen et al., 2007), we determined that this collection did not correspond to any previously known *Mallotus* species. This new species is thus described below.

***Mallotus phongnhaensis* Thin & Kim Thanh, sp. nov.**

This new species differs from other species in *Mallotus* sect. *Axenfeldia* by its shrubby habit, presence of submarginal extrafloral nectaries along the leaf margin, and relatively few-flowered, cauliflorous inflorescences. — TYPE: Vietnam, Quang Binh Province, Phong Nha - Ke Bang National Park, Doc Tau area, 17°32'24"N, 106°16'59"E, 83 m, 1 July 2006, *Nguyen Nghia Thin 20060701-09* (holotype HNU; isotype HN). (Fig. 1, 2)

Shrub up to 1 m high, dioecious. Indumentum scattered, composed of stellate hairs. Branches with scattered hairs, cylindrical. *Stipules* deciduous, triangular, c. 1.2 mm,



Fig. 1. *Mallotus phongnhaensis* Thin & Kim Thanh. **A.** Habit. **B.** Part of staminate inflorescence, the axis shown c. 3 cm long. **C.** Detail of staminate flower (scale in mm). **D.** Fruit, c. 1 cm across. (Photos: Nguyen Thi Kim Thanh)

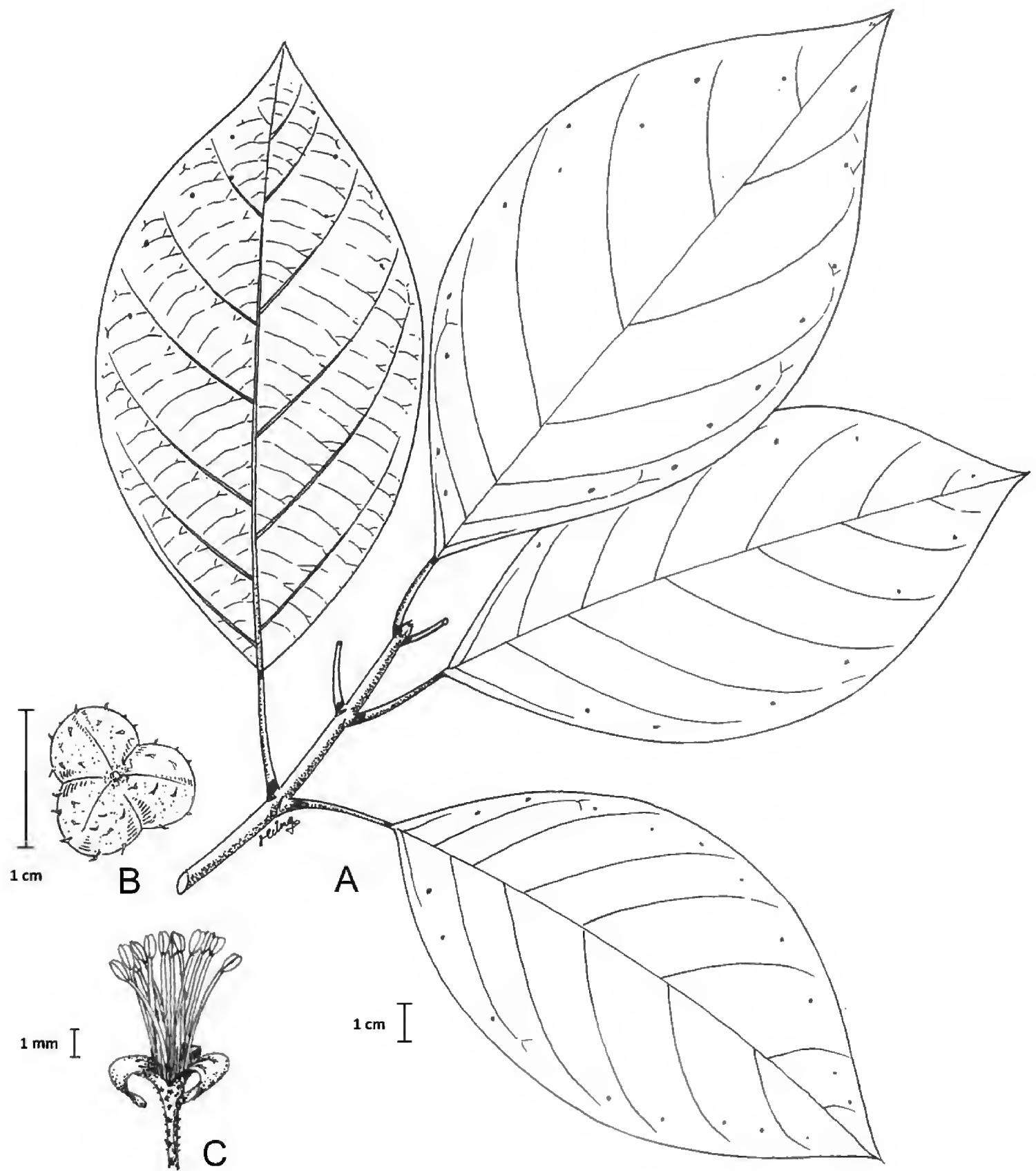


Fig. 2. *Mallotus phongnhaensis* Thin & Kim Thanh. **A.** Details of leaves with submarginal extra-floral nectaries. **B.** Top view of fruit. **C.** Staminate flower. (Drawn by Nguyen Quang Hung)

glabrous. **Leaves** opposite, equal in size; petiole 1.5–4 cm long, glabrous; blade elliptic, 11.5–21.5 × 5.5–11 cm, papery; base cuneate; apex acuminate, 1–1.5 cm long; margin entire or subentire; adaxial surface glabrous, extrafloral nectaries submarginal throughout blade, 6–12 per side, 0.3–1 cm from margin, elliptic to orbicular, 0.3–0.5 × 0.2–0.3 mm, conspicuous; abaxial surface glabrescent, with scattered glandular scales, mainly on basal or marginal nerves; venation pinnate, nerves 7–10 per side, arching and ending near margin, veins conspicuous. **Staminate and pistillate inflorescences** cauliflorous on lower stem, short and thick. **Staminate inflorescences** 2–3 cm long, with 10–15 flowers, one flower per bract; bracts triangular, 2.2–2.5 × 1.2–1.6 mm. **Staminate flower** with 3 sepals that are elliptic to obovate, 3.2–3.7 × 1–1.3 mm; petals and disc absent; stamens 15–20, filaments 4–5 mm long; pistillode present. Pistillate inflorescences 2.5–3 cm long with 2–4 flowers, one flower per bract; bracts triangular, c. 1.5 mm long. **Pistillate flower** with 3 sepals; petals and disc lacking; ovary 3-locular, covered with stellate hairs and dense spines, spines 0.5–1 mm long; styles 0.2–0.3 mm long, stigmas c. 1.5 mm long, plumose. **Fruit** a loculicidal-septicidal capsule, c. 1.2 × 0.9 cm, on a long (up to 2 cm long) pedicel, spines sparse, blunt, c. 0.5–1 mm long; style persistent. **Seed** unknown.

Distribution and ecology. This species is only known from one population near a small stream within a humid forest not far from the road in Doc Tau area, Phong Nha - Ke Bang National Park, Quang Binh Province, Vietnam.

Flowering and fruiting. *Mallotus phongnhaensis* was observed in flower and fruit from May to July.

Etymology. The new species is named after its type locality.

Provisional IUCN conservation assessment. The type locality, the only known site, occurs within Phong Nha - Ke Bang National Park and is, therefore, under protection. However, the population size of this new species is fewer than 100 mature individuals. We, therefore, assess it as Endangered EN D under the IUCN Red List categories and criteria (IUCN, 2001) because it has fewer than 250 mature individuals.

Notes. The most comprehensive revision of *Mallotus* in Vietnam was done by Thin (1999, 2007), who recognised six sections: *Axenfeldia* (Baill.) Pax & Hoffm., *Hancea* (Seem.) Pax & Hoffm., *Rottleropsis* Müll.Arg., *Philippinense* Pax & Hoffm. (formerly section *Rottlera* Airy Shaw), *Stylanthus* (Reichb.f. & Zoll.) Pax & Hoffm. and *Mallotus* Müll.Arg. With its opposite leaves and pinnate venation, *Mallotus phongnhaensis* clearly falls within section *Axenfeldia*, which currently includes eight known species in Vietnam. Our new species is different from others in this section by the occurrence of 6–12 extrafloral nectaries just behind the leaf margin and the cauliflorous flowering habit.

References

- Airy Shaw, H.K. (1972). The Euphorbiaceae of Siam. *Kew Bull.* 26: 292–308.
- Airy Shaw, H.K. (1975). Notes on Malesian and other Asiatic Euphorbiaceae. CXCIX. New or noteworthy species of *Mallotus* Lour. *Kew Bull.* 29: 401–407.
- Ho, P.H. (1999). *An Illustrated Flora of Vietnam*. 2: 248–256. Hanoi, Vietnam: Youth Publ. House.
- IUCN (2001). *IUCN Red List Categories and Criteria*, Version 3.1. Gland, Switzerland, and Cambridge, United Kingdom: IUCN Species Survival Commission. IUCN.
- Pax, F. & Hoffmann, K. (1914). Euphorbiaceae–Acalypheae–Mercurialinae. In: Engler, A. (ed) *Das Pflanzenreich*, IV, 147, vii: 145–208. Leipzig, Berlin: Wilhelm Engelmann.
- Sierra, S.E.C., Aparacio, M., Gebraad, M.J.H., Kulju, K.K.M. & van Welzen, P.C. (2007). The morphological range in *Mallotus* (Euphorbiaceae) and a taxonomic revision of its section *Rottlerpsis* (including *Axenfeldia*) in Malesia, Thailand and Africa. *Blumea* 52: 21–113.
- Thin, N.N. (1999). *Key to taxa and classification of Euphorbiaceae of Vietnam*. Hanoi, Vietnam: Agr. Publ. House.
- Thin, N.N. (2007). *Taxonomy of Euphorbiaceae in Vietnam*. Hanoi, Vietnam: VNU Publ. House.
- Welzen, P.C. van, Sierra, S.E.C., Slik, J.W.F. & Bollendorff, S. (2007). *Mallotus*. In: Welzen, P.C. van & K. Chayamarit, K. (eds) *Flora of Thailand* 8, 2: 384–437. Bangkok, Thailand: The Forest Herbarium, National Park, Wildlife & Plant Conservation Department.

The status of *Cryptocoryne annamica* (Araceae: Aroideae: Cryptocoryneae) in Vietnam

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ABSTRACT. *Cryptocoryne annamica* Serebryanyi, an endemic species from Gia Lai province in Vietnam, was first described in 1991. Until recently only two collections were known but a new collection has now been made in the Kon Ka King National Park, Gia Lai province. The species description is elaborated and notes on its biology, distribution, ecology and cultivation are given. A proposed IUCN conservation assessment is given. A key to the *Cryptocoryne* species of Vietnam is included.

Keywords. Conservation, cultivation, distribution, ecology, taxonomy

Introduction

Gagnepain (1942) recognised four species of the genus *Cryptocoryne* Fisch. ex Wydler for Vietnam, namely *C. ciliata* (Roxb.) Fisch. ex Wydler, *C. retrospiralis* (Roxb.) Kunth, *C. tonkinensis* Gagnep. and *C. balansae* Gagnep. Jacobsen (1991) reduced two of Gagnepain's species to varieties of *C. crispatula* Engl.: *C. crispatula* var. *tonkinensis* (Gagnep.) N.Jacobsen and *C. crispatula* var. *balansae* (Gagnep.) N.Jacobsen. *Cryptocoryne retrospiralis* has not subsequently been confirmed as occurring in Vietnam. Since then *Cryptocoryne annamica* Serebryanyi (1991) and *C. vietnamensis* Hertel & Mühlberg (1994) have been described. Therefore, there are four species of *Cryptocoryne* recorded for Vietnam, one of them with three varieties: *C. crispatula* var. *tonkinensis*, *C. crispatula* var. *yunnanensis* (H.Li) H.Li & N.Jacobsen, *C. crispatula* var. *balansae*, *C. ciliata*, *C. annamica*, and *C. vietnamensis*. Both *C. annamica* and *C. vietnamensis* are endemic to Vietnam (Nguyen, 2005). Confusion over the type locality of *Cryptocoryne annamica* was clarified by Bogner (2001) as Kon Ha Nung, K'Bang district of Gia Lai province. Recently it has become apparent that two type localities are much disturbed. Peter Boyce (then at K) and the first author exhaustively tried to relocate *Cryptocoryne annamica* at its type locality near Buon Luoi (Buoenloy) in 1996 but were unable to find it. It is likely that this species does not exist there anymore. The populations of *Cryptocoryne vietnamensis* near Ba Na have been damaged seriously by tourist activities such as cable car construction, house

building, etc. *Cryptocoryne vietnamensis* still exists near Ba Na but the plants are very scattered and it is highly threatened.

In light of the above it is good to report that a new locality for *Cryptocoryne annamica* was discovered in the Kon Ka King National Park, K'Bang district, Gia Lai province during an investigation of the medicinal plants used by the Ba Na minority in this area. Two other localities for *Cryptocoryne annamica* are known, also in Gia Lai province. In this paper the description of *Cryptocoryne annamica* is elaborated along with additional information on its distribution and habitat. An IUCN conservation assessment and a key to the Vietnamese species of this genus are included.

Key to *Cryptocoryne* in Vietnam

- 1a. Leaf blade linear to very narrowly lanceolate or elliptic, more than 5 × as long as wide; spathe limb few to several times twisted *C. crispatula*
- 1b. Leaf blade ovate, lanceolate or elliptic, not longer than 2–3 × as long as wide; spathe limb straight or only once to twice twisted 2
- 2a. Spathe limb with cilia along the margin (Mekong delta) *C. ciliata*
- 2b. Spathe limb without cilia along the margin 3
- 3a. Spathe limb straight, inside completely deep purple *C. vietnamensis*
- 3b. Spathe limb straight to once or twice twisted, inside yellow at margin and apex, red to red-brown in centre *C. annamica*

Description of the species

Cryptocoryne annamica Serebryanyi

Aqua-Pl. 16(3): 98 (1991). TYPE: Collected from a cultivated plant in Main Botanical Garden Moscow, Russia, *Serebryanyi N16*, (holotype MHA, spirit specimen); originally collected by N. Orlov in Vietnam, Gia Lai Province, Ankhe Dt, Buoenloy (now K'Bang distr.).

Rhizomatous aquatic plant 7–15 cm tall. Rhizome stout, 2–4(–10) cm long, 4–6 mm diam., covered by abundant roots and with one or two stolons per leaf tuft, these initially horizontal and creeping, 5–7 cm long, later turning upward and developing into a new plant. Leaves (4–)7–12 in a rosette, flowering specimens with several narrow triangular cataphylls, 2.5–3.5 cm long, light green to slightly reddish; petiole rather stout, 5–13 cm long, sheathed basally for (3–)5–7 cm long, lower part white (in the soil), upper portion slightly canaliculate, light to dark brown or dull grey-green in upper emergent parts but red-purple in submerged parts; leaf blade more or less elliptic, 7–10.5 cm long, (3–)4–4.5 cm wide in the middle, flat, uniformly green (more or less

pale to darker green) or sometimes with very light reddish spots, underneath light green in emergent plants but red to dark purple underneath and dark green on the upper side and bullate in submerged plants; blade acute at apex and obtuse to auriculate at base, midrib distinct, 3–4 primary lateral veins on each side. Inflorescences several in a plant; peduncle 3–6 cm long in emergent plants and up to 12 cm long in submerged plants, 2.5 mm diam., white; spathe (4–)5–7 cm long; kettle cylindrical, 1.5–2 cm long and c. 7 mm in diam., white inside and outside; tube between the kettle and the limb of spathe brown-violet to slightly reddish and narrower in diam. than the kettle; spathe limb triangular, 2–3 cm long, straight to once or twice twisted, apex cuspidate to acuminate, margin scattered with small teeth, brown-violet outside, surface inside rough, yellow at margin and apex, centre red to red-brown, collar lacking. Spadix 1.5–2 cm long; female portion 4 mm tall, sterile axis between female and male flowers slender, c. 8 mm long, smooth; male portion cylindrical, c. 2.5 mm long and 1.5 mm in diam., yellow, appendix conical, wide at base and suddenly acute apically; flap c. 2.5 mm long, yellowish. Female flowers 5–6, yellowish to cream coloured, style short, 1 mm long; stigma round; olfactory bodies roundish. Male flowers 30–50, 0.5 mm long; thecae with a horn, dehiscent by an apical pore. Chromosome number: $2n = 34$. (Fig. 1).

Notes on distribution. Serebryanyi (1991) cited an additional sterile collection, *Clemens 4310*, 28 Aug. 1927 (P) from Ba Na, 25 km from Da Nang, when he described this species. However, *Clemens 4310* is *Cryptocoryne vietnamensis*. The emergent leaves of *Cryptocoryne annamica* and *C. vietnamensis* are very similar. Kobayashi (2004) reported *Cryptocoryne annamica* from near Pleiku in Gia Lai province.

Ecology. *Cryptocoryne annamica* grows in or along small streams in tropical, partly deciduous forests at 600–750 m. Submerged plants can be found in water of shaded streams to a depth of 50 cm. (Fig. 2).

Preliminary IUCN conservation assessment. Based on known populations and the perceived or actual threats, *Cryptocoryne annamica* can be classified as Vulnerable VU A2a; B2ab(ii,iii); C1, according to IUCN criteria (IUCN, 2001).

Additional specimens examined: VIETNAM. **Gia Lai province:** K'Bang district, Kon Ka King National Park, 5 km southwest direction from forest station No. 5 of Kon Ka King NP., *Nguyen Van Du & others CTTN 84 & 85* (HN); Kon Ha Nung, Buoenloy [Buon Luoi], 16 May 1985 *Orlov LX-VN 1994* (LE, HN); *ibidem*, 18 Dec 1985, *Orlov LX-VN 2756* (LE, HN).

Plants of *Cryptocoryne annamica* which grow in water and plants which grow on stream banks produce quite different leaves. The submerged leaves are red to deep purple underneath and dark green on the surface, and the surface is bullate, whereas the leaves of emergent or terrestrial plants are green in all parts and the blades are flat. (Fig. 1. A–B).

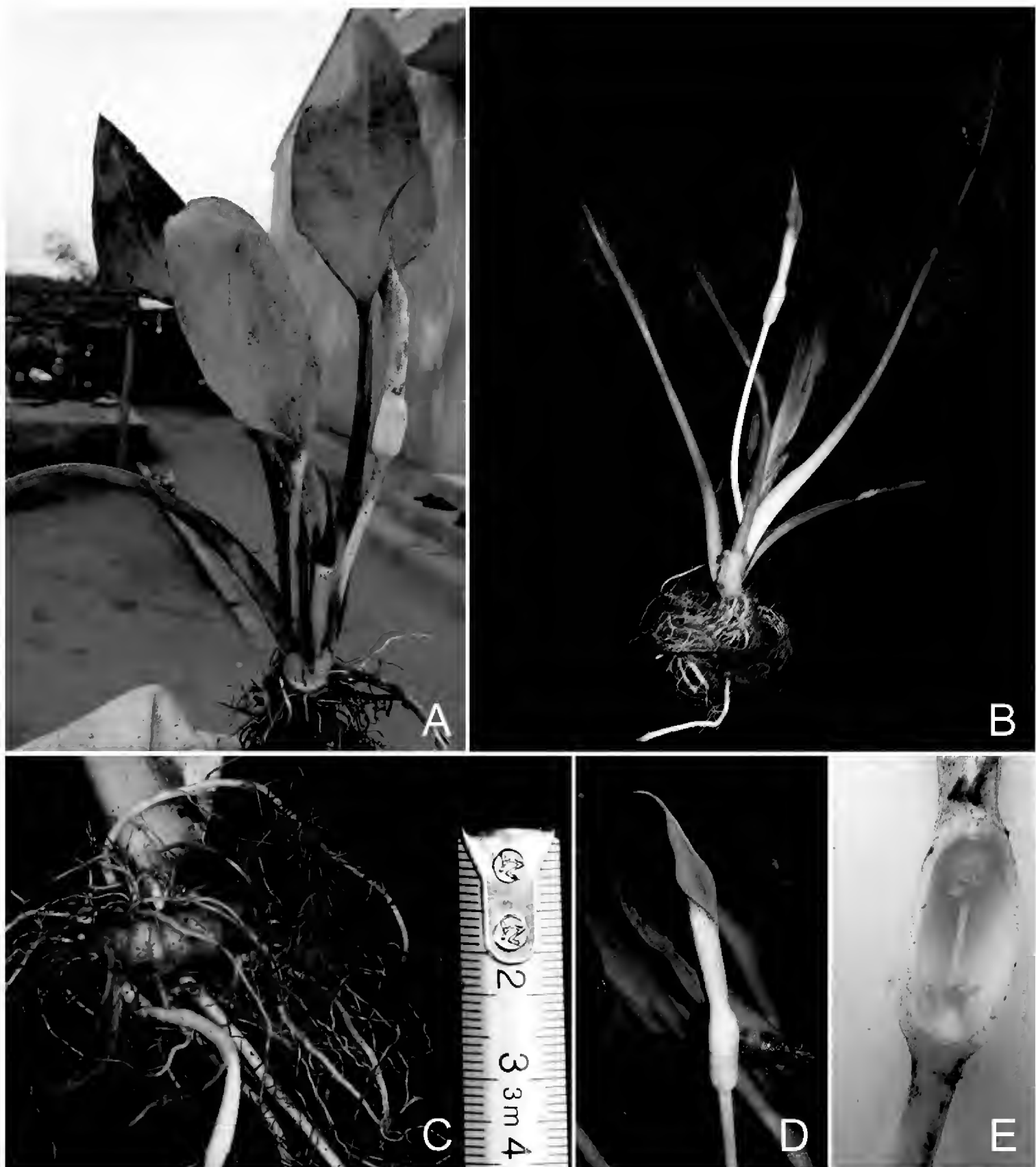


Fig. 1. *Cryptocoryne annamica* Serebryanyi. **A.** Flowering emergent plant - note the green flat leaf blades and the twisted spathe limb. **B.** Flowering submerged plant - note the bullate leaf blades, which are deep purple underneath, the purple petioles, the long peduncle, and the straight spathe limb. **C.** Rhizome with stolons and roots. **D.** Spathe of a submerged plant - note the long peduncle and the straight spathe limb which is yellow around the margin and apex, red-brown in the centre; the swollen part above the peduncle is the kettle with the spadix (not visible from outside). **E.** Section through the kettle of the spathe to show the spadix with female flowers below and the male flowers above. (Photos: Nguyen Van Du)



Fig. 2. *Cryptocoryne annamica* Serebryanyi. **A.** Emerged growing plant along a stream; note the green, flat leaf blades with red spots and the twisted spathe limb. **B.** Submersed plants growing in a stream, note the bullate leaf blades. (Photos: Nguyen Van Du)

Cryptocoryne annamica is grown as an ornamental plant in aquaria or in pots in Europe and elsewhere. The pot plants can be cultivated in a soil of leaf litter of *Fagus sylvatica* L. (Fagaceae) with the addition of sand and fertilizer, or in a sandy loam with some rough peat. It can be also kept in the aquarium with only sand on the bottom but then it also requires specialised aquatic plant fertiliser.

ACKNOWLEDGEMENTS. The first author is grateful for support from the National Geographic Society (grant No. 904011) and the National Program Tay Nguyen III (grant No. TN3/10) of Vietnam Academy of Sciences and Technology for the fieldwork in Kon Ka King National Park and other works for this paper.

References

- Bogner, J. (2001). *Cryptocoryne annamica* Serebryanyi. *Aqua Pl.* 26(1): 25–28.
- Gagnepain, F. (1942). Aracées. In Lecomte, H. (ed) *Flore Général de l'Indo-Chine* 6(9): 1075–1196. Paris.
- Hertel, I. & Mühlberg H. (1994). *Cryptocoryne vietnamensis* sp. nov. (Araceae) aus Vietnam. *Aqua Pl.* 19(2): 77–81.
- IUCN (2001). *IUCN Red List Categories and Criteria*, Version 3.1. Switzerland, Gland and U.K.: Cambridge: IUCN.
- Jacobsen, N. (1991). Die schmalblättrigen *Cryptocorynen* des asiatischen Festlandes. *Aqua Pl.* 16(1): 1–33.
- Kobayashi, K. (2004). *Cryptocoryne annamica*. *Aqualife* 2004–8: 132–133, 136–137.
- Nguyen, V.D. (2005). Araceae. In: Nguyen, T.B. (ed) *Checklist of Plants in Vietnam* 3: 883.
- Serebryanyi, M. (1991). Eine neue *Cryptocoryne*-Art (Araceae) aus Vietnam. *Aqua Pl.* 16(3): 98–101.

A revision of *Ornithoboea* (Gesneriaceae)

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ABSTRACT. The genus *Ornithoboea* C.B. Clarke (Gesneriaceae) from limestone habitats in Peninsular Malaysia, Thailand, Myanmar (Burma), Laos, Vietnam and Southern China is revised. It has 16 species, three of which are newly described: *Ornithoboea maxwellii* S.M. Scott from Thailand, *Ornithoboea puglisiae* S.M. Scott from Thailand and *Ornithoboea obovata* S.M. Scott from Vietnam. The plants are characterised by small, bilabiate flowers with a distinctive palatal beard on the lower lobes and a circlet of hairs around the mouth of the corolla tube. A key is provided, all species are described, and distribution maps and IUCN conservation assessments are given for all species.

Keywords. Karst limestone, *Ornithoboea*, taxonomic revision

Introduction

The genus *Ornithoboea* C.B. Clarke (Gesneriaceae) consists of a group of herbaceous plants on karst limestone from Peninsular Malaysia, Thailand, Myanmar (Burma), Laos, Vietnam and Southern China, its most northerly occurrence. No species have yet been recorded from Cambodia.

Ornithoboea was first described by Clarke (1883) from a specimen sent to him by the Rev. C. Parish from his collections in Burma. The specimen was accompanied by a drawing and analysis by Parish who commented on its resemblance to *Boea* except for the corolla and broader submembranous capsule. Clarke (1883) also compared it to *Boea* but stated that the capsule valves are more twisted, a comment that was probably why three more *Ornithoboea* species published soon thereafter, all of Chinese origin, were included in *Boea* rather than *Ornithoboea*. Three genera, now treated as synonyms of *Ornithoboea*, were also described: *Lepadanthus* Ridl., *BrachioSTEMON* Hand.-Mazz. and *Sinoboea* Chun. In the case of *Sinoboea*, Chun considered it to be closely related to *Ornithoboea* but that it differed in the rounded, not acuminate corolla lobes, the anther dehiscence and the pilose hairs on the inner surfaces of the corolla. *BrachioSTEMON* was considered to differ by its lanceolate sepals, branched filaments and many-valved capsules. Ridley (1909) never made any comparison of *Lepadanthus* to *Ornithoboea* but did liken it to the habit of *Rhynchotechum* Blume (“*Rhyncotecum*”)

with a capsular fruit. The fruits in the single species of *Lepadanthus*, *L. flexuosus* (= *Ornithoboea flexuosa*), are very short and show little sign of twisting. Burt (1958) suggested it may have been for this reason that Ridley never made the comparison with *Ornithoboea*. Burt (1958) also observed that had an amended generic description been available for the species already then known, then *Brachistemon* and *Sinoboea* might not have been proposed.

Molecular phylogenetic research in Gesneriaceae has consistently shown *Ornithoboea* to be monophyletic, sister to a clade of *Kaisupeeae* B.L.Burt and *Rhabdothamnopsis* Hemsl. (Möller et al., 2009, 2011; Puglisi pers. comm. [expanded unpublished sampling]). These studies also confirm *Ornithoboea* as belonging to subfamily Didymocarpoideae, tribe Trichosporeae, subtribe Loxocarpinae (Weber et al., 2013).

The last taxonomic account of the entire genus was by Burt (1958). Since then four new species have been described (Wu & Li, 1983; Burt, 2001; Middleton & L y, 2008) and an account of the genus for the *Flora of China* (Wang et al., 1998) has been published. To incorporate these new species into an overall view of the genus and to account for the many new collections from Thailand and Vietnam since the last revision (Burt, 1958), many of which have remained unidentified, *Ornithoboea* is revised anew.

Morphological characters

Burt (1958) gave detailed morphological information on the habit, leaves, indumentum of vegetative parts, inflorescence, gynoecium, and fruit. His work is an excellent introduction to *Ornithoboea* which we expand on slightly here. In summary *Ornithoboea* is readily recognised by the distinctive morphology of its flowers, more specifically the palatal beard and circlet of hairs round the mouth of the corolla tube (Fig. 1). Most species are rather similar in vegetative characters and, consequently, difficult to distinguish when sterile. The exceptions to this are *Ornithoboea arachnoidea* (Diels) Craib and *O. maxwellii* S.M.Scott due to their distinctive indumentums.

Habit: It is not clear whether most species are annual or perennial. They often have a base which has tightly packed persistent leaf bases, more than would grow in one season, with the bulk of the specimen taken up by the inflorescence. This would suggest a perennial growth pattern and this has been partly confirmed in cultivation. Plants will remain compact in habit until they are ready for flowering. This shoot dies after fruiting but in cultivation *Ornithoboea barbanthera* B.L.Burt produces new shoots at the base and flowers again in subsequent years. Field observations are necessary to ascertain whether the base of the stem does indeed survive the dry season and produce new shoots as the rains start.

Leaves: The leaves are thin and delicate except in *Ornithoboea arachnoidea*. In cultivation the leaves are thicker and fleshier than in the wild except in *Ornithoboea flexuosa* (Ridl.) B.L.Burt, *O. multitorta* B.L.Burt and *O. pseudoflexuosa* B.L.Burt where no observable difference has been noted. The leaves are always opposite, well developed, slightly anisophyllous, petiolate, more or less ovate in outline, crenate/bicrenate to dentate/duplicato-dentate on the margins (rarely serrate), and unequal

sided at the base which is usually cordate to rounded.

Vegetative indumentum: *Ornithoboea arachnoidea* and *O. maxwellii* have a covering of arachnoid hairs (spider web- or felt-like) over all parts of the plant except for the flowers. All other *Ornithoboea* species have glandular hairs. Hair length on any individual usually varies considerably.

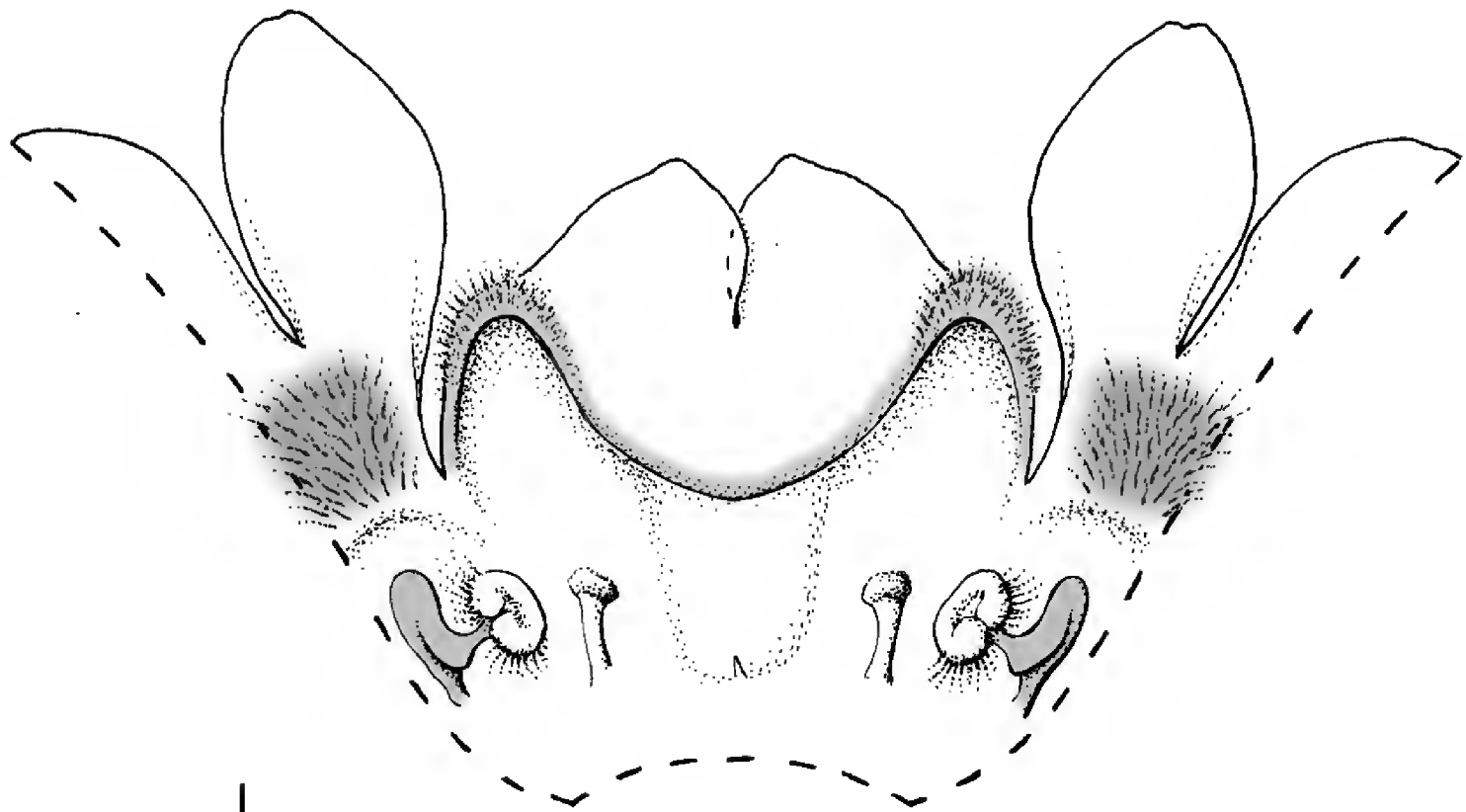
Inflorescence: *Ornithoboea* species have the characteristic “pair-flowered cymes”, found only in Gesneriaceae and a few genera of Scrophulariaceae (Weber, 2004). In this the terminal flower of each cyme unit is associated with an additional flower in a frontal position so that each cyme unit seems to end in a flower pair. In general, the front flower has no subtending bracteole, while the lateral flowers are usually subtended by bracteoles. In many instances this form of cyme is modified by suppression of one branch of the inflorescence on alternate sides of each node resulting in a pseudoracemose as in *Ornithoboea pseudoflexuosa* and *O. flexuosa*.

Calyx: The five lobes are always divided to the base, only weakly imbricate in bud and hairy. They are usually green but can be white, pink or purple. In some species, such as in *Ornithoboea arachnoidea*, they are reflexed when in flower, whilst in others, like *O. obovata* S.M.Scott, they are reflexed when in fruit.

Corolla and androecium: The most important diagnostic characters of the genus *Ornithoboea* are the palatal beard and the circlet of hairs round the mouth of the corolla tube (Fig. 1). Only in *Ornithoboea maxwellii* is there no obvious beard present. The lower lip of the corolla is three lobed and the palatal beard is located at the base of the lip before the division into lobes. On either side of the beard a line of hairs runs marginally across the sinus between the upper and lower lips of the corolla and then along the ridge of tissue at the base of the two-lobed upper lip. This forms a ring of hairs around the mouth of the corolla tube; this is called the circlet (circulus) (Fig. 1).

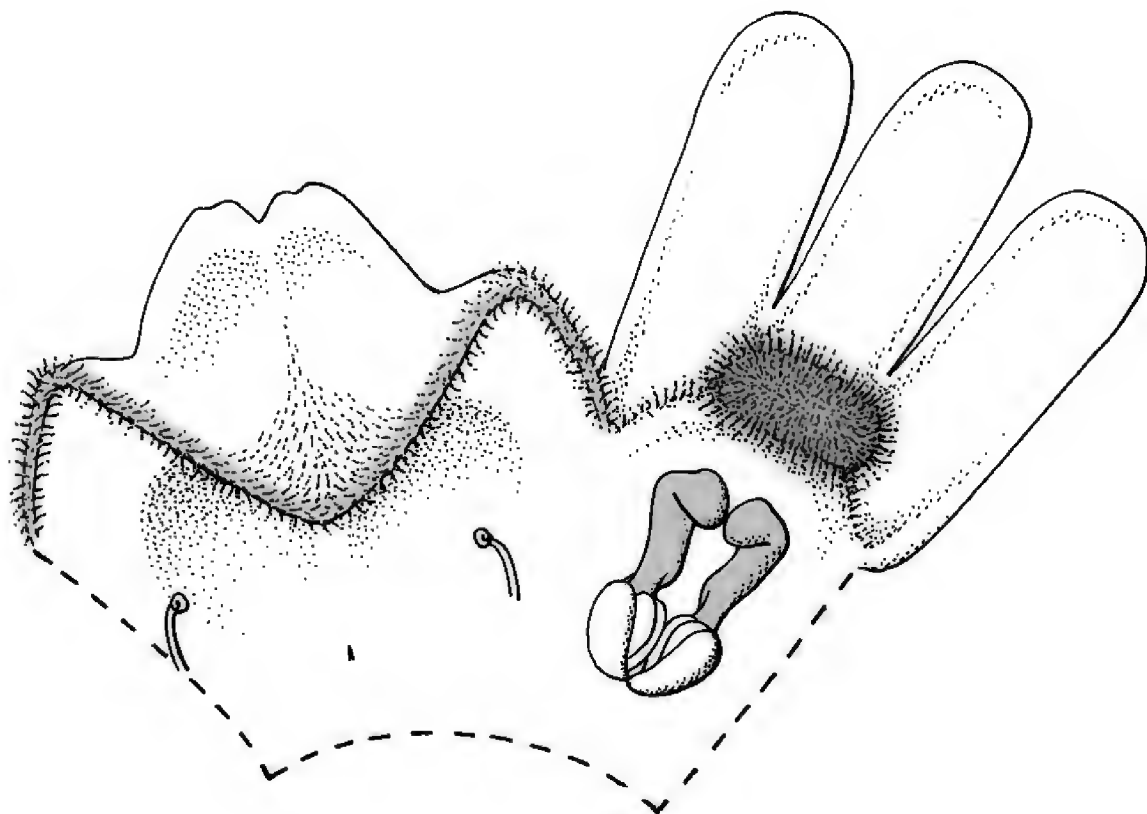
The hairs of the beard and circlet are remarkable structures and differ from the smaller multicellular hairs that form the indumentum on the rest of the plant. They are larger, unicellular, varying in length and colour, flattened to a certain degree, dilated at the tips and the wall has a covering of scattered tubercles (easier to observe on rehydrated flowers). Burt (1958) found very similar hairs when he compared those found at the base of the corolla lobes of *Ramonda myconi* (L.) Rchb. and on the filaments and mouth of the corolla tube in *Verbascum* L. Further comparisons were made with unicellular palatal hairs on *Mimulus* L. and other Scrophulariaceae which lacked the dilated tips.

Other characters of the corolla and androecium vary greatly between species. The most straightforward condition is found in *Ornithoboea feddei* (H.Lév.) B.L.Burt which has long straight filaments and a long tube which widens gradually and evenly towards the mouth. Other species vary from this simple form by the shortening of the corolla tube, the inflation of the tube in the upper part, the increase in size of the lower lip and the shortening and thickening of the filaments and the gradual retraction of the fertile arm so that finally it no longer points towards the mouth of the tube but upwards and backwards. Enantiostyly also occurs where the style is deflected to the left or right. In some species there is a well-marked thickened knee on each filament and the eventual production at the knee of a distinct sterile process and the formation



Ornithoboea barbanthera B.L. Burtt.

1cm



Ornithoboea puglisiae S.M. Scott.

Fig. 1. Illustrations highlighting the characters of the circling (blue); the pronounced sterile projections on the stamens (yellow); and the palatal beard (green). Drawn by Claire Banks.

of a pronounced sterile projection. This sterile process continues along the original line of the filaments along the floor of the corolla tube while the fertile arm branches off upwards and backwards to the roof of the tube. The sterile arm is swollen at the apex, often wrinkled and coloured yellow to blue: these are usually visible when the flower is open and can be mistaken for anthers. With the shortening of the filaments, and their change in direction, it means the anthers are held just below the dorsal side of the corolla tube at the point where the narrow basal tube expands into the upper inflated portion. The anthers of all species are coherent face to face and are connected at the tips by a short delicate process (easily damaged on herbarium specimens).

Gynoecium and fruit: *Ornithoboea* species have a superior ovary which is short and conical and which narrows into a well-developed style. The T-shaped parietal placentae are rather thin, of equal thickness throughout their length but with somewhat swollen curved ends where the production of ovules is usually confined (Weber, 2004). According to Burtt (1958), the sterile inner surfaces often abut closely on one another but apparently do not fuse.

The mature fruit varies greatly in length from 4.7–21 mm and also varies from straight to spirally twisted. Burtt (1958) suggested that the twisted fruit was a good generic character and that where it was not present this was due to the lack of opportunity for its expression, i.e. small fruits, rather than to its genuine absence. However, both *Ornithoboea maxwellii* and *O. obovata* have consistently non-twisted or almost non-twisted fruits with lengths of up to 5.8 and 11.3 mm respectively, longer than other species with twisted fruits. The style is also persistent in many *Ornithoboea* species and is a good species character.

Reproduction and Dispersal

It is not known what pollinates the flowers of *Ornithoboea* and nothing is written on the specimen labels to indicate a pollinator was observed prior to collection. From the shape of the corolla with its narrow corolla tube, the anthers located dorsally in the tube, and the curved style (enantiostyly) located at the mouth of the tube, bee pollination can be speculated?

Seed dispersal is likely to be over relatively short distances as there is no adaptation to wind or animal dispersal. The seeds are probably dispersed by the wind rocking the whole plant, rain washing the seeds away, and the untwisting of the fruit flinging the seeds for a short distance in response to drying conditions.

Materials and Methods

This work is based primarily on an examination of herbarium material from A, AAU, ABD, B, BK, BKF, BM, E, GH, HNU, K, KEP, KUN, L, MO, NY, P, PSU, SING, US, VNM (Thiers, continuously updated). All specimens have been seen except where indicated by “n.v.” for *non vidi*. The maps are based on coordinates recorded from the specimens or by geo-referencing the localities from gazetteers. Not all localities,

however, could be found so parts of the distribution for some species may be missing from the maps.

All morphological characters were observed or measured from the herbarium material. Floral measurements were taken from pickled or rehydrated flowers. As *Ornithoboea* flowers are morphologically fairly complex our interpretation of them was aided by living collections of *O. barbanthera* at the Royal Botanic Garden Edinburgh (RBGE) and photographs of several species taken by a number of photographers (see Acknowledgements). Measurements were made with an electronic digital caliper, a ruler and with the aid of a trinocular dissecting microscope. As such, measurements using the calipers and microscope were accurate to one tenth of a millimetre. All dissections were photographed using a Nikon Coolpix 4500 camera attached to the microscope.

This revision is based on a traditional taxonomic approach utilising a morphological species concept. Species are delimited based on discontinuous differences assessed by observations and measurements of herbarium specimens. Our knowledge of *Ornithoboea* species is only as good as the specimens that have been collected so far and yet collecting has been sporadic, particularly in Myanmar, Laos, Vietnam and southern China. New collections are necessary in these areas to both improve the descriptions here presented, to clarify difficult species delimitation problems, and potentially to uncover further new taxa.

Ornithoboea Parish ex C.B.Clarke

in A.DC. & C.DC., Monogr. Phan. 5(1): 147 (1883); Hook.f., Fl. Brit. Ind. 4: 365 (1884); Burtt, Notes Roy. Bot. Gard. Edinburgh 22: 287 (1958); Wang, Fl. Reipubl. Popularis Sin. 69: 476 (1990); Wang et al., Fl. China 18: 369 (1998); Weber in Kubitzki, Fam. Gen. Vasc. Pl. 7: 147 (2004). TYPE: *Ornithoboea parishii* C.B.Clarke.

Lepadanthus Ridl., J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 74(2): 782 (1909). TYPE: *Lepadanthus flexuosus* Ridl. (= *Ornithoboea flexuosa* (Ridl.) B.L.Burtt).

Brachistemon Hand.-Mazz., Sinensia 5: 9 (1934). TYPE: *Brachistemon macrocalyx* Hand.-Mazz. (= *Ornithoboea wildeana* Craib).

Sinoboea Chun, Sunyatsenia 6: 271 (1946). TYPE: *Sinoboea microcarpa* Chun (= *Ornithoboea feddei* (H.Lév.) B.L.Burtt).

Herbs, lithophytic, annual to perennial, to 200 cm tall, stems simple or branched, erect to decumbent. **Indumentum** of stems, leaves and inflorescences densely arachnoid (*Ornithoboea arachnoidea* and *O. maxwellii*), pilose or pubescent; all hairs are

glandular except those found in the palatal beard and circlet. *Leaves* opposite and petiolate, often slightly anisophyllous, more or less ovate, acute to narrowly acute, base often unequal; cordate to rounded, margin weakly to strongly crenate/bicrenate to dentate/duplicato-dentate; basal leaves often withered and persistent and variable in number, their position indicated by scars or persistent corky peg-like leaf bases. *Inflorescences* axillary, cymose, with paired flowers; sometimes pseudoracemose by abortion of one branch at each dichotomy; *bracts* small, linear to triangular, pubescent. *Calyx* 5-lobed, 3-veined, divided to the base, weakly imbricate, sometimes nearly as long as the corolla, ovate to elliptic, sometimes narrowly so, apex acute to narrowly acute, pubescent, often ciliate, persistent and often reflexed in flower and fruit or both. *Corolla* zygomorphic, with a short tube which is broadly funnel-shaped or distinctly inflated in the upper part, and a bilabiate limb; upper lip 2-lobed, short, often reflexed, with emarginate or notched lobes; lower lip 3-lobed and much larger, often partially reflexed, lobes obovate to oblong; base of lower lip bearded (palatal beard) with large unicellular hairs which are dilated at the tips; the same hairs run across the sinus of the upper lip and lower lip on a ridge of tissue towards the base of the lower lip, thus forming a circlet, a ring of short hairs around the mouth of the corolla tube. *Fertile stamens* 2, adnate to the tube near base of corolla tube; filaments simple and straight or geniculate, or with a pronounced sterile projection at the knee; when geniculate or with a sterile projection the fertile arm is erect or sloping backwards towards the base of the corolla tube; anthers reniform, cohering face to face, connected at the tips. *Staminodes* 3 (2 lateral and 1 medial), adnate to tube near base of corolla tube, 2 laterals well developed, medial small and inconspicuous. *Ovary* conical, puberulent or pubescent; placentae parietal, T-shaped, ovules present on the in-turned ends, not on the inner face. *Style* longer than the ovary, enantiostylous, puberulent to pubescent, ending in a swollen terminal stigma. *Fruit* a capsule, narrowly oblong to short and oblong, either twisting spirally or with a straight line of dehiscence, puberulous to pubescent or arachnoid. *Seeds* small.

Distribution. Southern China, Myanmar, Laos, Vietnam, Thailand and northern Peninsular Malaysia.

Ornithoboea is a genus of 16 species that typically grow on karst limestone in hollows where organic matter collects, in cave mouths and in fissures on vertical or sloping rock faces. They tend to grow near the base of cliffs or slopes of limestone formations rather than at the drier and more exposed summits. Some species have wide ranges of altitudes due to their occurrences in both lowland hills and in mountain ranges where the bases of the hills are still at much higher altitude. In each locality the species tend to occupy the same sort of elevations in the actual formations. The genus can be recognised by the glandular pubescence throughout and the bilabiate flowers with unicellular hairs with dilated tips. These hairs form a palatal beard on the lower corolla lip and a ring of hair around the mouth of the corolla tube (Fig. 1).

Key to *Ornithoboea* species

- 1a. Stems, petioles, leaves and inflorescence with arachnoid (spider web- or felt-like) indumentums 2
- 1b. Stems, petioles, leaves and inflorescence with puberulent, pilose or pubescent indumentums 3
- 2a. Dense arachnoid indumentum; sepals reflexed when in flower and fruit; filaments not thickened, 2–3 mm long; fruit twisted; plant 20–50 cm tall 1. *O. arachnoidea*
- 2b. Sparse arachnoid indumentum; sepals not reflexed; filaments thickened, 1–1.5 mm long; fruit with straight line of dehiscence; plant 6–10.5 cm tall..... 9. *O. maxwellii*
- 3a. Filaments straight or geniculate, without a sterile projection 4
- 3b. Filaments with a pronounced sterile projection 8
- 4a. Filaments 1.7–3.8 mm long, straight 5. *O. feddei*
- 4b. Filaments 1–2 mm long, geniculate 5
- 5a. Fruit with straight line of dehiscence, style persistent in fruit, characteristically curved through 180°; Vietnam 11. *O. obovata*
- 5b. Fruit weakly to strongly twisted, style not persistent in fruit; Thailand, Myanmar, China 6
- 6a. Corolla c. 14 mm long; fruit \leq 6.5 mm long; calyx lobes longer than fruit and slightly reflexed in fruit 12. *O. occulta*
- 6b. Corolla \leq 13 mm long; fruit 8.8–14 mm long; calyx lobes shorter than fruit and reflexed in fruit 7
- 7a. Corolla c. 9.3 mm long; lobes of lower lip narrowly obovate, central lobe slightly reflexed; upper lip lobes glabrous; fruit densely puberulent 7. *O. henryi*
- 7b. Corolla c. 13 mm long; lobes of lower lip oblong, central lobe fully reflexed; upper lip lobes puberulous; fruit puberulous 13. *O. parishii*
- 8a. Inflorescence pseudoracemose; corolla \leq 10 mm long 9
- 8b. Inflorescence a pedunculate cyme; corolla $>$ 10 mm long 11
- 9a. Corolla tube \leq 4 mm long; lobes of lower lip 3–4 mm long, central lobe not fully reflexed; anthers glabrous; fruit barely twisted, less than a quarter turn; sepals 4.5–5.5 mm long 6. *O. flexuosa*
- 9b. Corolla tube \geq 4 mm long; lobes of lower lip 2.2–3.5 mm long, central lobe fully reflexed; anthers bearded; fruit barely twisted to tightly twisted; sepals 5–7.3 mm long 10

- 10a. Corolla tube 4.5–5.1 mm long; sepals 5–6 mm long; fruit tightly twisted, 7.5–12.3 mm long 10. *O. multitorta*
- 10b. Corolla tube c. 6.7 mm long; sepals 5.7–7.3(–10.3) mm long; fruit twisted to over half turn or barely twisted, 6.1–9.6 mm long 14. *O. pseudoflexuosa*
- 11a. Filaments 1.4–1.6 mm long, anthers densely bearded; fruit twisted to barely twisted, densely pubescent 12
- 11b. Filaments 0.3–1.3 mm long, anthers glabrous to sparsely bearded; fruit twisted, puberulous to pilose 13
- 12a. Corolla c. 20 mm long, lower lip c. 13 mm long, lobes not emarginate; peduncle 8–30(–36) mm long; Thailand 2. *O. barbanthera*
- 12b. Corolla c. 16 mm long, lower lip c. 10.5 mm long, lobes distinctly emarginate; peduncle 6–16 mm long; Vietnam 4. *O. emarginata*
- 13a. Corolla 17–25 mm long, tube (6.5–)7.8–11.4 mm long; sepals ovate to elliptic; filaments 0.3–1 mm long; stems 30–150 cm tall 14
- 13b. Corolla 12.7–16.5 mm long, tube 6–8 mm long; sepals elliptic; filaments 1–1.3 mm long; stems 40–62 cm tall 15
- 14a. Corolla 22–25 mm long, pink/purple; each lobe of lower lip oblong, apices distinctly emarginate, central lobe not overlapping lateral lobes 8. *O. lacei*
- 14b. Corolla c. 17 mm long, blue/purple; each lobe of lower lip obovate, apices rounded, not emarginate, central lobe overlapping lateral lobes 16. *O. wildeana*
- 15a. Corolla c. 16.5 mm long, tube c. 8 mm long, deep violet/blue throughout, pubescent outside; lower lip reflexed through 90°, lobes 2.5–3.1 mm long, apices slightly triangular; tube c. 8 mm long; fruit 18–21 mm long, style not persistent 3. *O. calcicola*
- 15b. Corolla c. 12.7 mm long, tube c. 6 mm long, light purple/pink to white, glabrous outside; lower lip slightly reflexed, lobes 3.5–4.5 mm long, oblong, apices rounded; fruit 11.6–14.3 mm long, style often persistent 15. *O. puglisiae*

1. *Ornithoboea arachnoidea* (Diels) Craib

Notes Roy. Bot. Gard. Edinburgh 11: 251 (1920); Burtt, Notes Roy. Bot. Gard. Edinburgh 22: 294 (1958); Wang, Fl. Reipubl. Popularis Sin. 69: 477 (1990); Wang et al., Fl. China 18: 369 (1998); Burtt, Thai Forest Bull., Bot. 29: 100 (2001). — *Boea arachnoidea* Diels, Notes Roy. Bot. Gard. Edinburgh 5: 225 (1912). TYPE: China, Yunnan, Ming kwang valley, Near Pei sha, 1828–2137 m, October 1905, *G. Forrest* 929 (holotype E; isotypes BM, K). (Fig. 2, 3).

Ornithoboea lanata Craib, Bull. Misc. Info. Kew. 1914: 130 (1914); Pellegrin in Lecomte, Fl. Indo-Chine 4: 551 (1930). TYPE: Thailand, Doi Chiang Dao, 670 m, 27 January 1913, *A.F.G. Kerr* 2852 (holotype K; isotypes ABD, BM).

Ornithoboea forrestii Craib, Notes Roy. Bot. Gard. Edinburgh 11: 252 (1920). TYPE: China, Yunnan, Shwei-Salween divide, 1917–1919, *G. Forrest* 17557 (holotype E; isotypes BM, E, K, P).

Herb; stem 20–50 cm tall, to 2–5.4 mm diameter, brown to white glandular arachnoid throughout, leaf internodes (3.3–)5.5–10 cm. **Leaves** opposite; petiole (2–)4.3–9.8(–12.3) cm long; blade herbaceous, broadly to narrowly ovate, 7.8–16.3(–24) × 5–11(–22) cm, apex acute to acuminate, base unequal, oblique to rounded/cordate, margin narrowly crenate/bicrenate to dentate, the teeth 0.5–2.9 mm; 8–10(–12) pairs of secondary veins, tertiary venation reticulate; glandular puberulous above, lanate to arachnoid below. **Inflorescence** axillary, 3–7(–8.3) cm long, arachnoid throughout; peduncle 1.8–4.8 cm long; bracts linear to elliptic, c. 5 × 1 mm; pedicels 9.7–19.6 mm long. **Sepals** broadly elliptic, white to pink, 3-veined, c. 6.5–10 × 2.5–4 mm, apices acute to narrowly acute, puberulous on inside, arachnoid on outside, ciliate; sepals reflexed when in flower and fruit. **Corolla** bilabiate, c. 13 mm long, glabrous



Fig. 2. *Ornithoboea arachnoidea* (Diels) Craib. Photograph of *Middleton et al.* 4523 by Preecha Karaket.

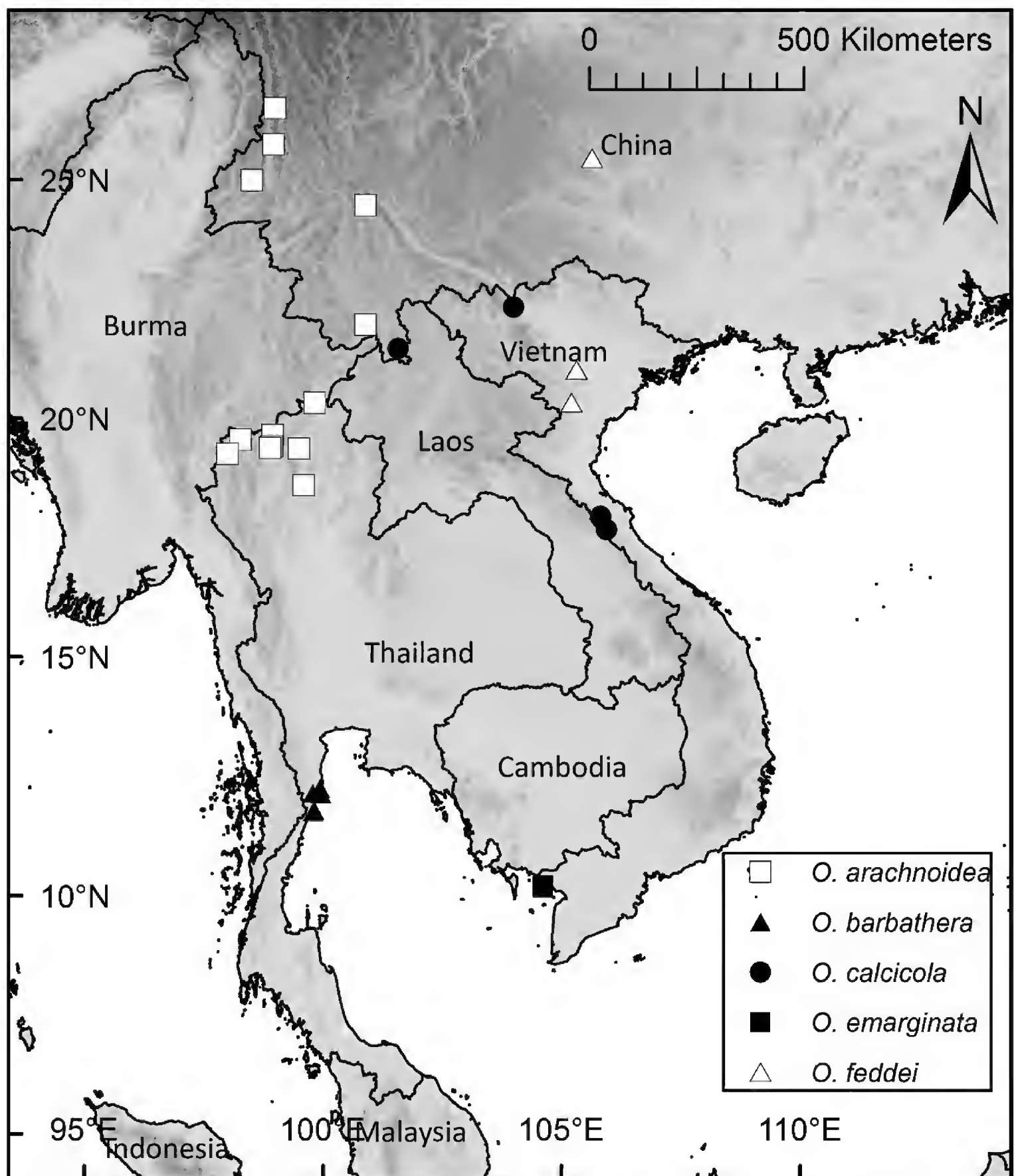


Fig. 3. Distribution of *Ornithoboea arachnoidea* (Diels) Craib (□); *Ornithoboea barbanthera* B.L.Burt (▲); *Ornithoboea calcicola* C.Y.Wu ex H.W.Li (●); *Ornithoboea emarginata* D.J.Middleton & N.S.Lý (■); and *Ornithoboea feddei* (H.Lév.) B.L.Burt (Δ).

outside; tube c. 5.2 mm long, white to blue, puberulent on inside; upper lip slightly 2-lobed, each lobe 0.2 mm long, blue, apices rounded, glabrous except for a ring of blue short hairs on the ridge of tissue at the base of the lip which runs down to the sinus

with the lower lip; lower lip 3-lobed, slightly reflexed, c. 8 mm long, blue, glabrous except for a large palatal beard at base of lobes, each lobe 3.5–4 × 2.4–3.5 mm, oblong to slightly obovate, apices broadly acute to rounded. **Stamens** without a pronounced sterile projection; filaments 2–3 mm long, geniculate and curved through 90°; anthers c. 1 × 2.1 mm, glabrous, lightly fused at the tips; staminodes 3, two of which 1.5–1.8 mm long, the third 0.2 mm long. **Ovary** c. 2 × 1.5 mm, densely glandular pubescent throughout; style c. 5 mm long; stigma globose/rounded. **Fruit** 9.1–16.7 × 1.9–2.2 mm, twisted, glandular pilose, style persistent.

Distribution. Southern China and Thailand. Very likely to also occur in Myanmar and Laos.

Ecology. On karst limestone, usually in shade or in cave mouths or soil pockets on cliffs and slopes, over a wide altitudinal range of 490–2420 m.

Provisional IUCN Conservation Assessment. Least Concern (LC). This species is widespread and locally common.

Additional specimens examined: CHINA. **Yunnan:** Unknown Yunnan, *Howell, E.B.* 67 (E); *ibidem*, Oct 1924, *Forrest, G.* 25273 (E, K); Baoshan, Tengchong, Oct 1912, *Forrest, G.* 9272 (E); Pu'er City, Jingdong Yi Autonomous County, 18 Aug 1959, *Unknown* 5134 (KUN); Salween-Chu-kiang divide, Aug 2013, *Forrest, G.* 11962 (BM); Xishuangbanna, Menghai County, 7 Oct 1989, *Unknown* 39452 (KUN).

THAILAND: **Chiang Mai:** Chiang Dao, Road to Wiang Haeng, 21 Sep 2008, *Middleton, D.J. et al.* 4538 (E); Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, 5 Nov 1961, *Bunchuai, K.* 1174 (BKF); *ibidem*, 4 Nov 1995, *Gardner, S. & Gardner, N.* H238 (L); *ibidem*, 15 Aug 1935, *Garrett, H.B.G.* 979 (E, K); *ibidem*, 10 Aug 1935, *Garrett, H.B.G.* 973 (A, ABD, L, P); *ibidem*, 17 Aug 1935, *Garrett, H.B.G.* 982 (K, P); *ibidem*, 8 Oct 1995, *Maxwell, J.F.* 95858 (A, BKF, L); *ibidem*, 13 Aug 1995, *Parnell, J. et al.* 95048 (BKF, K); *ibidem*, 23 Oct 1926, *Put, N.* 429 (ABD, BM, K); *ibidem*, 11 Sep 1967, *Tagawa, M. et al.* 9783 (BKF); Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, Pha Blong Cave area, 10 Sep 1989, *Maxwell, J.F.* 891070 (A, E, L, MO); Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, Tham Pha Phlong, 20 Sep 2008, *Middleton, D.J. et al.* 4523 (E); Mae Taeng, Doi Mawn Ngaw, 12 Aug 2002, *Palee, P.* 542 (L). **Chiang Rai:** Mae Sai, Doi Tung, 14 Nov 2010, *van de Bult, M.* 1122 (BKF); Wiang Pa Pao, 28 Sep 1996, *Pooma, R.* 1390 (BKF). **Lampang:** Mueang Pan, Jae Son National Park, Wang Di, Doi Pha Ngam, 25 Aug 1996, *Maxwell, J.F.* 961149 (BKF, L). **Mae Hong Son:** 10 Sep 1974, *Larsen, K. & Larsen, S.S.* 34327 (AAU, E); Pangmapha, Tham Lot cave area, *Middleton, D.J. et al.* 5232 (E).

Notes. This species is recognisable by the distinct arachnoid (woolly, spider-web-like) indumentum which covers the whole plant. *Ornithoboea maxwellii*, far smaller in size, is the only other species to have this type of indumentum, but not nearly as densely. The flowers of *Ornithoboea arachnoidea* might be mistaken for those of *O. occulta* but the corollas of the latter species are slightly larger, but with a shorter corolla tube and lower lip, and the sepals are longer and elliptic.

2. *Ornithoboea barbanthera* B.L.Burt

Notes Roy. Bot. Gard. Edinburgh 22: 297 (1958); Burt, Thai Forest Bull., Bot. 29: 101 (2001). TYPE: Thailand, Prachuap Khiri Khan, Sam Roi Yot, 50 m, 13 July 1926, *A.F.G. Kerr 10977* (holotype ABD; isotypes BM, E, K). (Fig. 3, 4, 5).

Herb; stem 11–32(–39) cm tall, to 2–5.6 mm diameter, glandular pubescent throughout, leaf internodes 7–48(–90) mm. **Leaves** opposite; petiole 2.4–7(–9) cm long, densely glandular pubescent; blade herbaceous, ovate, 3.5–7.5(–11) × 2.2–6.7 cm, apex acute, base slightly unequal, rounded to cordate, margin weakly to strongly crenate to bicrenate, the teeth 1.5–3.1(–7.6) mm; 7–10 pairs of secondary veins, tertiary venation reticulate; glandular puberulous above, more densely so beneath with hairs of various lengths throughout. **Inflorescence** axillary, 2.5–8 cm long, densely glandular pubescent throughout; peduncle 8–30(–36) mm long; bracts linear to triangular, 3.9–5.5 × 0.8–1.3 mm; pedicels 5–17 mm long. **Sepals** narrowly elliptic, green, 3-veined, 7–9.2 × 3.2–3.5 mm, apices narrowly acute, sparsely puberulous above, more densely so beneath, ciliate; sepals mostly reflexed when in fruit. **Corolla** bilabiate, c. 20 mm long, lilac throughout, glabrous outside; tube c. 7.5 mm long; upper lip slightly 2-lobed, erect, each lobe 1.5–3 mm long, apices rounded, glabrous except for a ring of short hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, slightly reflexed, c. 13 mm long, glabrous except for palatal beard at base of lobes, each lobe c. 6.5 × 6.5 mm, obovate, central lobe overlapping lateral lobes, lobes not ciliate. **Stamens** with a pronounced sterile projection, yellow, 1.8–2 mm long; filaments 1.4–1.6 mm long; anthers 1 × 2–2.2 mm, densely bearded, lightly fused at the tips; staminodes 3, two of which c. 1.5 mm long, yellow, the third 0.3 mm long. **Ovary** 2.8–3 × 1.7 mm, glandular puberulent; style c. 8.5 mm long, glandular puberulent; stigma globose/rounded. **Fruit** 4.7–12.4 × 2.2–3.4 mm, twisted to barely twisted, densely pubescent.

Distribution. Thailand (Prachuap Khiri Khan Province).

Ecology. Growing on karst limestone, often in full sun, at 0–500 m altitude.

IUCN Conservation Assessment. Least Concern (LC) (Middleton & Suksathan, 2012a). *Ornithoboea barbanthera* is restricted to a very small area, mostly within a national park. It is still common and no major threats are known to affect the species. However the mangrove areas around the national park have been converted to shrimp farms which could affect the local microclimate. The population needs to be monitored to ensure that this species is not impacted by this.

Additional specimens examined: THAILAND: **Prachuap Khiri Khan:** Muang Prachuap Khiri Khan, Khao Klong Wan, 23 Aug 1982, *Shimizu, T. et al. T-28746* (BKF); Khao Loom Muak, 5 Sep 2008, *Middleton, D.J. et al. 4274* (BKF, E); Pran Buri, Sam Roi Yot, 14 Sep 1926, *Put. N. 249* (ABD, BM, K); *ibidem*, 12 Jul 1926, *Kerr, A.F.G. 10956* (ABD, BM, K); *ibidem*, Jul



Fig. 4. *Ornithoboea barbanthera* B.L.Burtt. Photograph of RBGE cultivated collection 20081569 by David Middleton.

1966 - Aug 1966, *Larsen, K. et al.* 1236 (AAU, BKF, L); *ibidem*, 29 Jun 2000, *Newman, M.F. et al.* 1138 (BKF); *ibidem*, 29 Jun 2000, *Newman, M.F. et al.* 288 (E, KEP); *ibidem*, 14 Aug 1992, *Niyomdham, C.* 3012 (BKF); *ibidem*, 16 Aug 1992, *Niyomdham, C.* 3027 (BKF); *ibidem*, 3 Dec 1929, *Put, N.* 2513 (ABD, BM); Pran Buri, Sam Roi Yot, Ban Khao Daeng, 15 Jul 2004, *Pooma, R. et al.* 4288 (BKF, E); Pran Buri, Sam Roi Yot, Khao Chrongwan, 18 Aug 1967, *Shimizu, T. et al.* T-7675 (BKF); Pran Buri, Sam Roi Yot, Khao Daeng Trail, 17 Aug 2002, *Middleton, D.J. et al.* 1150 (BKF [2], E, SING); *ibidem*, 4 Sep 2008, *Middleton, D.J. et al.* 4257 (BKF, E); Pran Buri, Sam Roi Yot, Khao Pha Daeng, 30 Aug 2006, *Triboun, P.* 3639 (E).

Notes. This species is very similar to *Ornithoboea emarginata* from Vietnam. They both have light blue flowers with a pronounced sterile projection but *Ornithoboea barbanthera* has larger flowers with a longer corolla tube and larger corolla lobes. The fruit is also nearly twice as long as that found in *Ornithoboea emarginata*. The whole plant is small when compared to other species of *Ornithoboea*. The leaves are small and somewhat thicker than other species. In addition, the plant has remnants of the previous year's growth in the form of dried leaf bases and a corky base to the plant. This was evident in all specimens examined, including plants in the living collections at RBGE. This might indicate a perennial growth habit, as was suggested by Burtt (1958), and the thicker leaves may be an adaptation to exposed conditions.

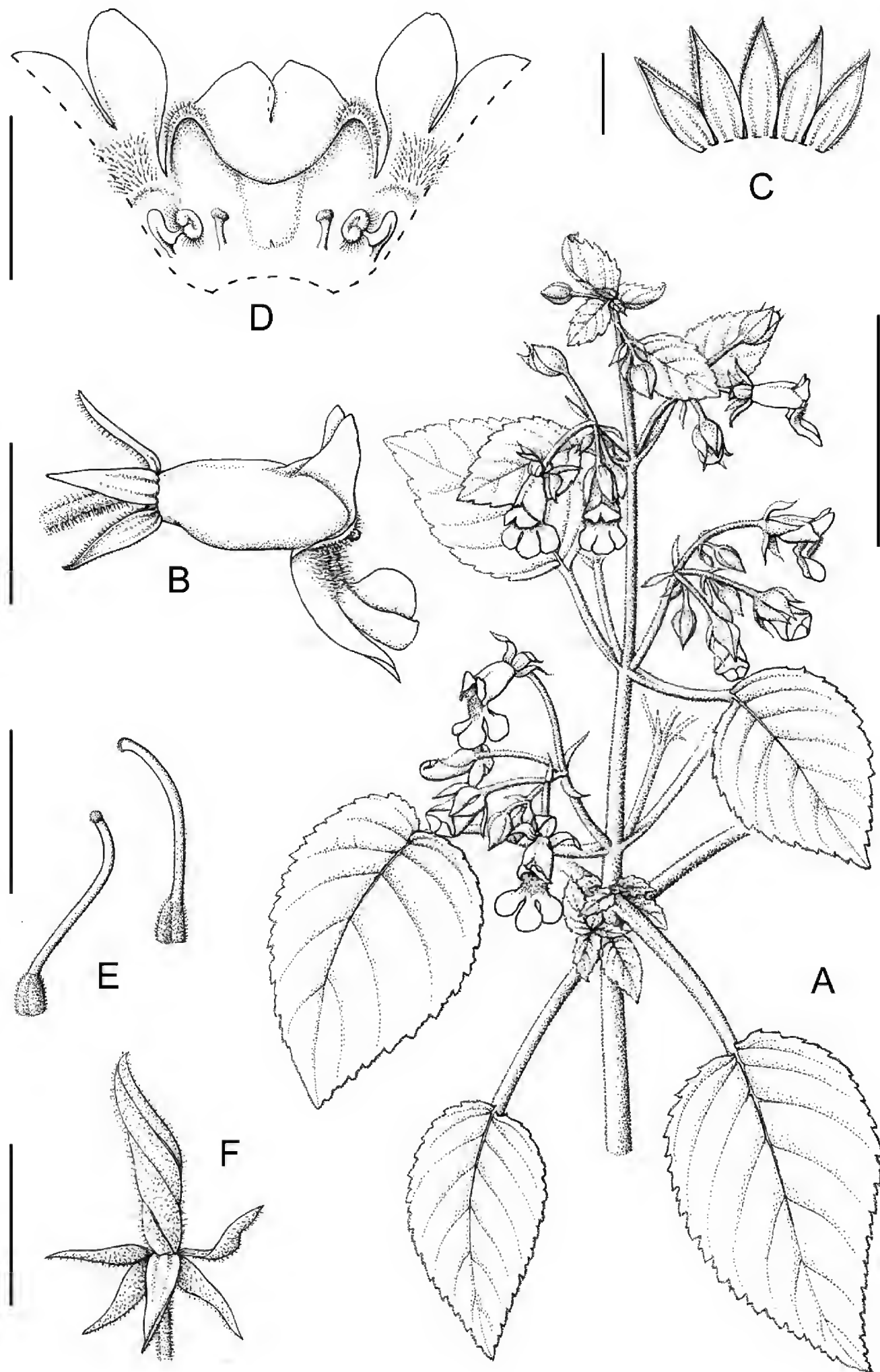


Fig. 5. *Ornithoboea barbanthera* B.L.Burt. **A.** Habit. **B.** Flower. **C.** Calyx opened out. **D.** Corolla dissection showing the two small lobes of the upper lip, the three larger lobes of the upper lip, two stamens and three staminodes. **E.** Pistil. **F.** Fruit. All parts from RBGE cultivated collection 20081569 except fruit from *Middleton et al.* 4257 (E). Scale bars: A = 5 cm; B, D–F = 1 cm; C = 0.5 cm. Drawn by Claire Banks.

3. *Ornithoboa calcicola* C.Y.Wu ex H.W.Li

Bull. Bot. Res., Harbin 3(2): 42 (1983); Wang, Fl. Reipubl. Popularis Sin. 69: 481 (1990); Wang et al., Fl. China 18: 370 (1998). TYPE: China, Yunnan, Mengla Xian, Yiwu, Xiangming, Manpei, 1000 m, 9 September 1959, *S.J. Pei 5910072* (holotype KUN *n.v.*; isotype KUN). (Fig. 3).

Herb; stem 50–62 cm tall, to 2.9–4.1 mm diameter, yellow glandular pilose throughout, leaf internodes 4.7–8.5 cm. **Leaves** opposite; petiole 5–10(–13) cm long; blade herbaceous, ovate to broadly ovate, 5.5–12 × 3.2–10 cm, apex acute to narrowly acute, base unequal, oblique to narrowly cordate, margin weakly to strongly crenate/bicrenate to dentate/duplicato-dentate, the teeth 1.2–4.5 mm; 8–10 pairs of secondary veins, tertiary venation reticulate; glandular puberulous above, more densely so beneath with hairs of various lengths throughout. **Inflorescence** axillary, 5.5–6 cm long, yellow glandular pilose throughout; peduncle 1.4–4.1 cm long; bracts elliptic, 7–14.3 × 1.4–3.9 mm; pedicels 11.8–16.8(–24.9) mm long. **Sepals** elliptic, green, 3-veined, 7.3–9.7 × 2–2.7 mm, apices narrowly acute, glandular puberulous above, more densely so beneath, ciliate. **Corolla** bilabiate, c. 16.5 mm long, blue/violet throughout, pubescent outside; tube c. 8 mm long, glabrous inside; upper lip slightly 2-lobed, triangular, erect, each lobe 0.6–0.7 mm long, apices acute to emarginate, glabrous except for a ring of blue short hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, reflexed 90° downwards, 7.3–9.5 mm long, glabrous except for blue palatal beard at base of lobes, each lobe 2.5–3.1 × 2–3 mm, orbicular, apices slightly triangular, central lobe overlapping lateral lobes. **Stamens** with a pronounced sterile projection, yellow, projection 1.5–1.7 mm long; filaments 1–1.3 mm long; anthers 0.5 × 2.3–2.5 mm, sparsely hairy, lightly fused at the tips; staminodes 3, two of which 1.5–2.3 mm long, the third 0.2(–0.5) mm long. **Ovary** 1.7–3 × 1.3–1.7 mm, glandular pubescent throughout; style 6.1–9 mm long; stigma globose/rounded. **Fruit** 18–21 × 1.7–2.4 mm, twisted, puberulous, style not persistent.

Distribution. China and Vietnam.

Ecology. Growing on karst limestone in seasonal evergreen and mixed forests at 150–1000 m altitude.

Provisional IUCN Conservation Assessment. Data Deficient (DD). This species has a wide Area of Occurrence but is known from fairly few collections in a region that is poorly collected. Its precise distribution, population stability, and potential threats are all unknown.

Additional specimens examined: VIETNAM: **Lao Cai:** 16 Nov 1963, *Unknown 3426* (HNU). **Quang Binh:** Minh Hoa, Thong Hoa Municipality, 17 May 1997, *Averyanov, L. et al. VH4770* (E); Tuyen Hoa District, Chuoi Village, 3 May 2011, *Averyanov, L. et al. CPC2708* (E); Tuyen Hoa District, Hung Village, 29 Apr 2011, *Averyanov, L. et al. CPC2501* (E).

Notes. Only an isotype was available to study but the holotype is also at KUN. This species was previously only known from Yunnan province in China. It is similar to two other species, *Ornithoboea lacei* and *O. wildeana*. However, it can be differentiated by its flowers that have a violet/blue corolla, the lower lip reflexed through 90°, and the lower lobes which are small and rounded with a slightly triangular apex. The plant is smaller in height and has longer fruits than *Ornithoboea lacei* and *O. wildeana*. From *Ornithoboea wildeana* it also differs in its smaller inflorescences and leaves which are broader and shorter. From *Ornithoboea lacei* it differs in its longer bracts, shorter corolla tube and longer filaments. The new collections from Vietnam confirm *Ornithoboea calcicola* as a distinct species and with a wider distribution than previously known.

4. *Ornithoboea emarginata* D.J.Middleton & N.S.Lý

Edinburgh J. Bot. 65: 354 (2008). TYPE: Vietnam, Kieng Giang Province, Kien Luong District, Hang Ca Sau Hill, 10–50 m. 14 July 2007, N.S. Lý 94 (holotype E). (Fig. 3).

Herb; stem 20–80 cm tall, to c. 4 mm diameter, glandular pubescent throughout, leaf internodes 18–26 mm. **Leaves** opposite; petiole 2.5–8.6 cm long, densely glandular pubescent; blade herbaceous, ovate to elliptic 3–11 × 2.4–7.3 cm, apex obtuse, base slightly unequal, rounded to cordate, margin weakly to strongly dentate to duplicato-dentate, the teeth 1.5–5.8 mm; 8–11 pairs of secondary veins, tertiary venation reticulate; glandular puberulous above, more densely so beneath with hairs of various lengths throughout. **Inflorescence** axillary, 3.3–8 cm long, densely glandular pubescent throughout; peduncle 6–16 mm long; bracts linear to triangular, c. 3.8 × 0.8 mm; pedicels 12–16 mm long. **Sepals** narrowly elliptic, green, 3-veined, 8.5–9 × 2–2.5 mm, apices narrowly attenuate, sparsely glandular puberulous above, more densely so beneath, ciliate; sepals not reflexed when in fruit. **Corolla** bilabiate, c. 16 mm long, lilac throughout, glabrous outside except lobes ciliate; tube c. 4.5 mm long; upper lip slightly 2-lobed, c. 2 mm long, somewhat erect to slightly reflexed, each lobe c. 0.6 mm long, apices rounded, each lobe slightly notched towards the sinus side, glabrous except for a ring of short hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, slightly reflexed, c. 10.5 mm long, glabrous except for palatal beard at base of lobes, each lobe c. 3.2 × 3.8 mm, ciliate, obovate, distinctly notched at each apex, central lobe overlapping lateral lobes. **Stamens** with a pronounced sterile projection, c. 1.7 mm long, yellow; filaments c. 1.5 mm long; anthers 1.8 × 2.5 mm, densely bearded, lightly fused at the tips; staminodes 3, two of which c. 1.5 mm long, the third 0.2 mm long. **Ovary** 1.8 × 1.5 mm, densely glandular puberulent; style 9 mm long, glandular puberulent; stigma globose/rounded. **Fruit** 6–7 × 3 mm, twisted to barely twisted, densely pubescent, style persistent.

Distribution. Southern Vietnam.

Ecology. In fissures and small soil pockets on karst limestone at 10–50 m altitude.

IUCN Conservation Assessment. Critically Endangered B1ab(i,ii,iii,v)+2ab(i,ii,iii,v) (Middleton, 2012a). The habitat where this species is found has suffered from human impacts such as small scale agriculture (Middleton & Lý, 2008). In at least one of the dolines there has been firewood collection, the caves are sometimes used, and there have been problems with invasive alien species. Lime exploitation and cement production have been especially devastating. Bai Voi Hill is scheduled for quarrying, with about two-thirds of the hill to be exploited for cement production (Truong *et al.*, 2004). By the time the limestone exploitation contract is completed, less than 2 km² in several separate limestone blocks will be left in the Vietnamese portion of the karst, making the Kien Giang hills one of the most threatened karst ecosystems in the world (Truong *et al.*, 2004).

Additional specimens examined: VIETNAM: **Kien Giang:** Kien Luong, Ba Tai Hill, 12 Jul 2007, Lý, *N.S.* 54 (VNM); Kien Luong, Bai Voi Hill, 19 Aug 2007, Lý, *N.S.* 108 (VNM).

Notes. This species is similar to *Ornithoboea lacei* Craib from Myanmar with which it shares the character of emarginate lower corolla lobe apices. It differs from *Ornithoboea lacei*, however, in its densely bearded anthers, barely twisted fruit, shorter corollas and much shorter peduncles. It shares the characters of densely bearded anthers and fruit barely twisted with *Ornithoboea barbanthera*. It differs from *Ornithoboea barbanthera* in having shorter peduncles, corolla lobes with emarginate apices and lacks the remnants of the previous year's growth in the form of dried leaf bases at the base of the stem. This species is from very close to the Cambodian border although no species of the genus are yet recorded from Cambodia.

5. *Ornithoboea feddei* (H.Lév.) B.L.Burtt

Notes Roy. Bot. Gard. Edinburgh 22: 296 (1958); Wang *et al.*, Fl. China 18: 369 (1998). – *Boea feddei* H.Lév., Repert. Spec. Nov. Regni Veg. 9: 449 (1911). – *Boea darrisii* H.Lév., Repert. Spec. Nov. Regni Veg. 11: 494 (1913). – *Ornithoboea darrisii* (H.Lév.) Craib, Notes Roy. Bot. Gard. Edinburgh 11: 252 (1920). TYPE: China, Kweichow [Ghuizhou], *J. Esquirol* 730 (lectotype E, designated here; isotype K). (Fig. 3).

Sinoboea microcarpa Chun, Sunyatsenia 6: 271 (1946). TYPE: China, Pin-Jao, Chenfeng, 23 September 1936, *S.W. Teng* 91032 (lectotype KUN, designated here; isotype A *n.v.*)

Ornithoboea leptonema B.L.Burtt, Notes Roy. Bot. Gard. Edinburgh 22: 295 (1958). TYPE: Vietnam, Hoa Binh, Cho Che, August 1887, *B. Balansa* 4310 (holotype P; isotype P).

Herb; stem 18–51(–100) cm tall, to 2.1–4.7 mm diameter, glandular pubescent throughout, leaf internodes 2.5–10 cm. **Leaves** opposite; petiole 1.6–8.7 cm long, pubescent; blade herbaceous, broadly to narrowly ovate, 2.5–11.5 × 2.4–8.9 cm, apex

acute to narrowly acute, base slightly cordate, occasionally oblique, margin crenate/bicrenate, the teeth 1.6–5.5 mm; 9–10 pairs of secondary veins, tertiary venation weakly percurrent; glandular puberulous above and below with hairs of various lengths throughout. **Inflorescence** axillary, 3.5–7.9 cm long, glandular pubescent throughout; peduncle 1.3–2.7 cm long; bracts linear to triangular, 3.1–4.5 × 0.4–0.9 mm; pedicels 6.7–15.3 mm long, weakly or strongly curved. **Sepals** ovate to elliptic, 3-veined, 4.5–8.1 × 2–2.4 mm, apices narrowly acute, sparsely puberulous above, more densely so beneath, ciliate. **Corolla** bilabiate, c. 15.5 mm long, light blue, glabrous outside, densely pilose inside; tube 5.4–6.5 mm long; upper lip 2-lobed, each lobe 2–3.5 mm long, apices retuse, pubescent inside in addition to the ring of thick short hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, 5.5–9.1 mm long, pubescent in addition to the palatal beard at base of lobes, each lobe 2–3.5 × 1.8–2.3 mm, lobes orbicular, apices broadly pyramidal. **Stamens** without pronounced sterile projection; filaments thin, long and straight, 1.7–3.8 mm long; anthers 0.5–1 × 1.5–1.8 mm, glabrous, lightly fused at the tips; staminodes 3, two of which 0.7–1.4 mm long, the third 0.1–0.2 mm long. **Ovary** 0.5–1.3 × 1.3–2.5 mm, conical, glandular puberulent; style 4.1–5 mm long, glandular puberulent, often persisting on the fruit; stigma swollen and flat headed. **Fruit** 6.3–14 × 2.3–2.7 mm, twisted, puberulous.

Distribution. China and Vietnam.

Ecology. On karst limestone at 500–550 m altitude.

Provisional IUCN Conservation Assessment. Data Deficient (DD). This species is known from a small number of localities in China and Vietnam. The precise localities of the Chinese specimens and all but one of the Vietnamese specimens is unknown. There is only one recent collection, in 2003, from Vietnam with most of the specimens dating back over a hundred years. Middleton (2012b) also published an assessment of DD for *Ornithoboea leptanema*, now treated as a synonym of *O. feddei*.

Additional specimens examined: CHINA: **Guizhou:** June 1912, *Cavalerie, J.* 3975 (E, P); ibidem, Aug 1911, *Esquirol, J.* 3012 (E).

VIETNAM: ‘Tonkin’, Apr 1908, *Alleizette, A.C.d.* 5412 (L). **Hoa Binh:** Cho Che, Sep 1887, *Balansa, B.* 4311 (K, P). **Thanh Hoa:** Ba Thuoc District, 15 Oct 2003, *Averyanov, L. et al.* HAL 4331 (MO).

Notes. Burt (1958) suggested that *Boea feddei* and *B. darrisii* were based on the same specimen, *Esquirol* 730 (E), and that, when describing *B. darrisii*, Lévillé (1913) failed to recognise it as a species he had already described based on the same collection. This may be true but as no single specimen is stated in either protologue and as there is more than one specimen of this collection there is no holotype for either name. Burt assumed the holotype for both names was the Edinburgh specimen, in which case they would be homotypic and *Boea darrisii* would be illegitimate under Art. 52.1 of the

ICN (McNeill et al., 2012). This is not correct because there is no holotype and when *Boea darrisii* was described it did not “definitely included the type of a name that ought to have been adopted” (Art. 52.1, McNeill et al., 2012) or “all syntypes” (Art. 52.2, McNeill et al., 2012) and must, therefore, be treated as legitimate. Burt (1958) did, however, effectively lectotypify both names on *Esquirol 730* (E).

This species is distinguished by the long and narrow corolla tube, which is densely pilose inside, and by its straight thin filaments. It has the simplest androecium structure found in the genus. *Ornithoboa feddei* is similar to *O. parishii* with which it shares the character of long filaments. However, in *Ornithoboa parishii* they are much thicker and geniculate. *Ornithoboa parishii* differs further in having a shorter corolla, oblong lower lobes and short inflorescences.

The specimen *Thorel 2347* (P) from Champasak in Laos was included in *Ornithoboa feddei* by Burt (1958). However, this specimen has stamens with a pronounced sterile projection rather than the straight filaments found in *Ornithoboa feddei*. The assignment of *Thorel 2347* to a species has still not been established and further collections from the region are necessary to clarify its status (see note under *Ornithoboa lacei*).

6. *Ornithoboa flexuosa* (Ridl.) B.L.Burt

Notes Roy. Bot. Gard. Edinburgh 22: 297 (1958); Burt, Thai Forest Bull., Bot. 29: 101 (2001). – *Lepadanthus flexuosus* Ridl., J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 74(2): 782 (1909); Ridley, Fl. Mal. Pen. 2: 538 (1923); Henderson, Journ. Malay. Br. Roy. As. Soc. 17: 61 (1939). TYPE: Malaysia, Kedah, Gunung Geriang [Keriang], March 1910, *H.N. Ridley* 14912 (neotype BM, designated here; isoneotypes E, K, SING, US). (Fig. 6).

Herb; stem 10–45(–200) cm tall, to 1.9–4.5 mm diameter, glandular pubescent throughout, leaf internodes (1.3–)2.5–5.5 cm. **Leaves** opposite; petiole (1.3–)2.8–11.5(–25.1) cm long, densely puberulous, blade herbaceous, ovate to elliptic, 6–20 × 4–12 cm, apex acute to broadly acute, base unequal, oblique to rounded, margin weakly to strongly crenate/bicrenate to dentate/duplicato-dentate, the teeth 1.9–4.7(–5.7) mm; 8–10 pairs of secondary veins, tertiary venation reticulate; light green above, paler below, glandular puberulous above, more dense beneath with hairs of various lengths throughout. **Inflorescence** axillary, 3–9.1(–10.8) cm long, pseudoracemose, densely glandular pubescent throughout; peduncle (1.5–)1.9–4.7(–5.7) cm long; bracts linear to lanceolate, c. 4 × 1 mm; pedicels 8–11(–13) mm long. **Sepals** ovate, green to white, 3-veined, 4.5–5.5 × 1.5–2.2 mm, apices narrowly acute, glandular puberulous outside, more densely so beneath, ciliate. **Corolla** bilabiate, c. 9.5–10 mm long, purple/lilac throughout, glabrous outside; tube 3.2–4 mm long; upper lip very slightly 2-lobed, 1.2 mm long, lobes c. 0.7 mm long, white, erect to reflexed, notched in centre, glabrous except for a ring of short white hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, c. 7 mm long, lip slightly reflexed, glabrous except for white palatal beard at base of lobes, each lobe c. 3–4 ×

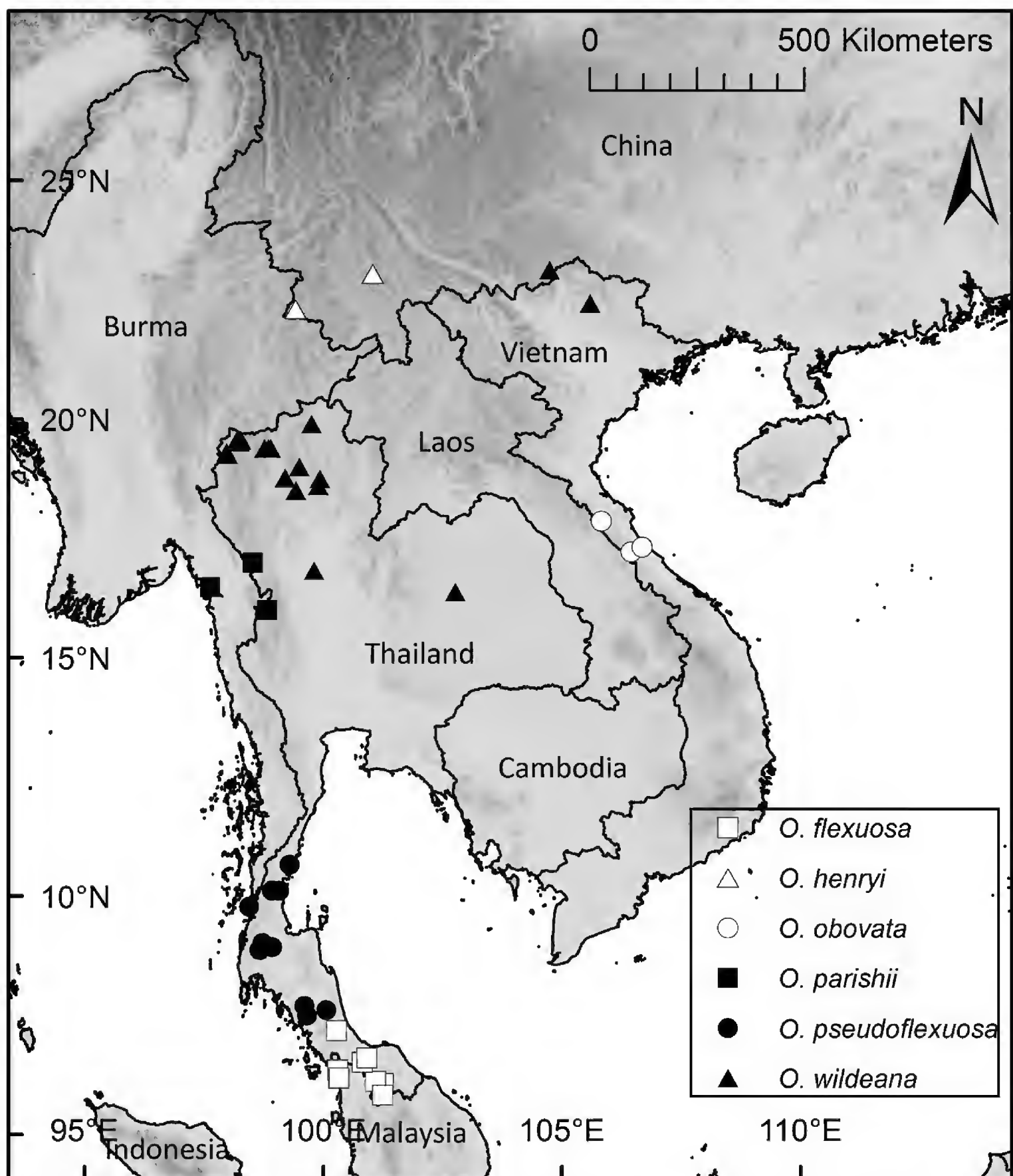


Fig. 6. Distribution of *Ornithoboea flexuosa* (Ridl.) B.L.Burt (□); *Ornithoboea henryi* Craib (Δ); *Ornithoboea obovata* S.M.Scott (○); *Ornithoboea parishii* C.B.Clarke (■); *Ornithoboea pseudoflexuosa* B.L.Burt (●); and *Ornithoboea wildeana* Craib (▲).

1.3–1.6(–2.5) mm, lateral lobes slightly falcate, apices narrowly rounded to acute, central lobe oblong to slightly ovate, apex narrowly rounded to acute. **Stamens** with a pronounced sterile projection, 1–1.5 mm long; filaments c. 1 mm long; anthers 0.5 × 1.5(–3) mm, glabrous, lightly fused at the tips; staminodes 3, two of which 1.2–1.4 mm long, the third 0.2 mm long. **Ovary** 1.2 × 0.7–1.2 mm, densely glandular puberulent;

style 3–5.5 mm long, densely glandular pubescent; stigma globose/rounded. **Fruit** 4.3–7(–8.2) × 1.6–2.5 mm, barely twisted by quarter turn to non-twisted, glandular puberulous.

Distribution. Peninsular Malaysia and Peninsular Thailand.

Ecology. Growing in fissures or small soil pockets on cliff faces and cave mouths on karst limestone at 10–150 m altitude.

Provisional IUCN Conservation Assessment. Endangered (EN B2ab(iii)). This species has an Area of Occupancy of about 32 km² and the known localities are mostly not in protected areas. Gunung Keriang in Kedah is heavily impacted by tourism.

Additional specimens examined: THAILAND: **Pattani:** 23 Jul 1923, *Kerr, A.F.G. 7307* (BM, K); *ibidem*, 26 Jul 1923, *Kerr, A.F.G. 7307A* (BM, K). **Songkhla:** Khao Chang Low, 24 Jul 1928, *Kerr, A.F.G. 15892* (BM, K); Saba Yoi, 25 Nov. 1990, *Larsen, K. et al. 41696* (AAU); *ibidem*, 4 Jun 2001, *Pooma, R. et al. 2052* (BKF). **Yala:** Bukit Tapang, May 1917, *Gwynne-Vaughan, D.T. 480* (K); Tham Talu, 16 Jun 1970, *Smitinand, T. 11008* (BKF); Than To, 22 Apr 2005, *Pooma, R. et al. 5147* (BKF); *ibidem*, 17 Jul 2004, *Poopath, M. 104* (BKF, E). PENINSULAR MALAYSIA: **Kedah:** Alor Star, Gunung Keriang, 15 Nov 1915, *Haniff, M. 640* (SING); *ibidem*, 18 May 1938, *Kiah 35419* (SING); *ibidem*, 18 May 1938, *Kiah s.n.* (SING); *ibidem*, 1986, *Weber, A. s.n.* (SING); Bukit Hantu, 23 May 1957, *Chew, W-L. CWL203* (SING).

Notes. The type of *Ornithoboea flexuosa* is *Fox 3811*. According to Ridley (1909) this was a poor specimen from Gunung Geriang [Keriang], Kedah. We have been unable to locate this specimen and it was also not referenced by Burt (1958) as having been seen. We, therefore, designate *H.N. Ridley 14912* (BM), collected near to the type locality, as a neotype.

This species is only found in northern Peninsular Malaysia and the far south of Peninsular Thailand. It is very similar to *Ornithoboea pseudoflexuosa* and *O. multitorta* with which it shares large delicate leaves, leaf margins crenate/bicrenate to dentate and stamens with a pronounced sterile projection. It differs from these species in the shape of the corolla.

When Burt (1958) described *Ornithoboea pseudoflexuosa* in 1958 he stated it bore a resemblance to *O. flexuosa*, but that its much larger flowers and bearded anthers distinguished it. Although the two species do indeed differ in the anther character we have found that the flowers do not differ appreciably in size. The character that most easily distinguishes the two species is whether the central lobe of the lower lip is reflexed or not: it is reflexed in *Ornithoboea pseudoflexuosa* (and in *O. multitorta*) but not reflexed in *O. flexuosa*. This is not always easily observed in herbarium specimens but is very evident in fresh material and we have seen no material or photographs of either species which contradicts this observation. The fruits also differ: *Ornithoboea flexuosa* generally has short straight fruits and any twist is no greater than a quarter turn; *O. pseudoflexuosa* can have a twist to over half turn; and *O. multitorta* is distinctly

twisted. The fruits of *Ornithoboea pseudoflexuosa* and *O. multitorta* are generally longer than those of *Ornithoboea flexuosa*. The distribution of *Ornithoboea flexuosa* does not overlap with any other species in the genus.

7. *Ornithoboea henryi* Craib

Bull. Misc. Info. Kew. 1913: 115 (1913); Burt, Notes Roy. Bot. Gard. Edinburgh 22: 297 (1958); Wang, Fl. Reipubl. Popularis Sin. 69: 479 (1990); Wang et al., Fl. China 18: 369 (1998). TYPE: China, Yunnan, Pu'er, 1350 m, *A. Henry* 13378 (holotype K; isotypes E, NY). (Fig. 6).

Herb; stem 9–23 cm tall, to 1.8–4.1 mm diameter, glandular pubescent throughout, leaf internodes 2.5–5.5 cm. **Leaves** opposite; petiole 2.5–11.2 cm long, puberulous; blade herbaceous, ovate to narrowly ovate, 4.5–13 × 3.5–6.5 cm, broadly attenuate, base slightly unequal, broadly oblique, margin weakly to strongly crenate/bicrenate to dentate/duplicato-dentate, the teeth 1.2–2.9 mm; 7–8 pairs of secondary veins, tertiary venation reticulate; glandular puberulous above and below with hairs of various lengths throughout. **Inflorescence** axillary, 3.5–8 cm long, colour unknown, glandular pubescent throughout; peduncle 8.1–11.5 mm long; bracts linear to triangular, 3.6–3.9 × 0.8–1 mm; pedicels 9–20 mm long. **Sepals** ovate to elliptic, 3-veined, 5–5.8 × 1.7–2.8 mm, apices attenuate, sparsely puberulous above, more densely so beneath, ciliate, sepals reflexed when in fruit. **Corolla** bilabiate, c. 9.3 mm long, glabrous outside; tube 4–4.8 mm long; upper lip 2-lobed, erect or slightly reflexed, each lobe c. 2 mm long, apices rounded, glabrous except for the addition of a ring of short hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, slightly reflexed, c. 5.5 mm long, glabrous except for palatal beard at base of lobes, lobes 2.5–3 × 2 mm, lobes obovate, apices rounded with occasional notch in central lobe. **Stamens** without pronounced sterile projection; filaments thickened and curved with slight twist, c. 1.7 mm long; anthers 0.4–0.7 × 1.2–1.7 mm, glabrous, lightly fused at the tips; staminodes 3, two of which 1–1.2 mm long, the third 0.1–0.3 mm long. **Ovary** 1.3–2.3 × 0.8–1.3 mm, glandular puberulent; style c. 1 mm long (immature), glandular puberulent; stigma globose/rounded. **Fruit** 8.8–14 × 2–3.2 mm, twisted, densely puberulent.

Distribution. Southern China.

Ecology. On karst limestone at around 1360 m.

Provisional IUCN Conservation Assessment. Data Deficient (DD). This species is known from very few collections and its precise distribution, population stability, and any potential threats are all unknown.

Additional specimens examined: CHINA: **Yunnan:** Pu'er City, Menglian Dai, Lahu and Va Autonomous City, 22 Aug 1973, *Unknown* 010292 (KUN); Xishuangbanna, Menghai County, 18 Aug 1959, *Unknown* 720 (KUN).

Notes. This species is recognisable by its short corolla, lower lip with a dense palatal beard and lobes which are short and narrowly obovate. It is similar to *Ornithoboea occulta* and *O. obovata* with which it shares the characters of thickened geniculate filaments, glabrous anthers, reflexed sepals, and crenate/bicrenate to dentate/duplicato-dentate leaf margins. It differs from both species particularly in the twisted fruits, from *Ornithoboea obovata* also in the lack of a persistent style in fruit and from *Ornithoboea occulta* in its lack of a red-glandular indumentum.

Burt (1958) suggested an affinity to *Ornithoboea flexuosa*. It differs from *Ornithoboea flexuosa* particularly in lacking a pronounced sterile projection on the stamens but also in the size of the leaves and overall size of the plant.

8. *Ornithoboea lacei* Craib

Bull. Misc. Info. Kew. 1913: 115 (1913); Craib, Curtis's Bot. Mag. t. 8627 (1915); Burt, Notes Roy. Bot. Gard. Edinburgh 22: 297 (1958). TYPE: Burma, Anisakan, Maymyo Plateau, 900 m, 25 August 1912, *Lace* 5926 (holotype K; isotype E). (Fig. 7).

Herb; stem 37–80 cm tall, to 2.5–5.2 mm diameter, glandular pubescent throughout, leaf internodes 3.7–7.6 cm. **Leaves** opposite, light green above, paler below; petiole 2.3–8.6 cm long, densely yellow-glandular puberulous; blade herbaceous, broad to narrowly ovate, 4–11.8 × 2.3–8 cm, apex acute or somewhat acuminate, base unequal, oblique to rounded, margin weakly to strongly crenate to bicrenate, the teeth 1–3.2 mm; c. 9 pairs of prominent secondary veins, tertiary venation reticulate; glandular puberulous above, more densely so beneath, red-glandular spots on the under surface of the leaf blades. **Inflorescence** axillary, 5–9.5 cm long, yellow-glandular pubescent throughout; peduncle 1.8–3.7 cm long; bracts linear to triangular, 5.3–8.8 × 1–1.8 mm; pedicels 11–20 mm long. **Sepals** elliptic, green with white tips, 3-veined, 7.5–10.1 × 2.5–3.5 mm, apices narrowly acute, red-glandular puberulous above, more densely so beneath, ciliate, sepals rarely reflexed when in fruit. **Corolla** bilabiate, 22–25 mm long, pink/purple throughout, glabrous outside; tube c. 11.4 mm long; upper lip barely 2-lobed, erect, tips white, each lobe 0.6–0.8 mm long, apices emarginate, puberulous at the base and the central part of the lobe towards the ring of thick white hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, slightly reflexed, c. 9.4 mm long, glabrous except for white palatal beard at base of lobes, each lobe c. 3.5 × 3–3.5 mm, oblong, apices distinctly emarginate. **Stamens** with a pronounced sterile projection, yellow, c. 1.9 mm long; filaments 0.3–0.7 mm long; anthers 1–1.2 × 2–2.5 mm, sparsely bearded, lightly fused at the tips; staminodes 3, two of which c. 1 mm long, yellow, the third 0.2 mm long. **Ovary** 1–1.8 × 1.8–2 mm, glandular puberulent; style 6–8.3 mm long, glandular puberulent; stigma globose/rounded. **Fruit** 10.1–16.1 × 1.8–3.1 mm, twisted, glandular puberulous, style persistent.

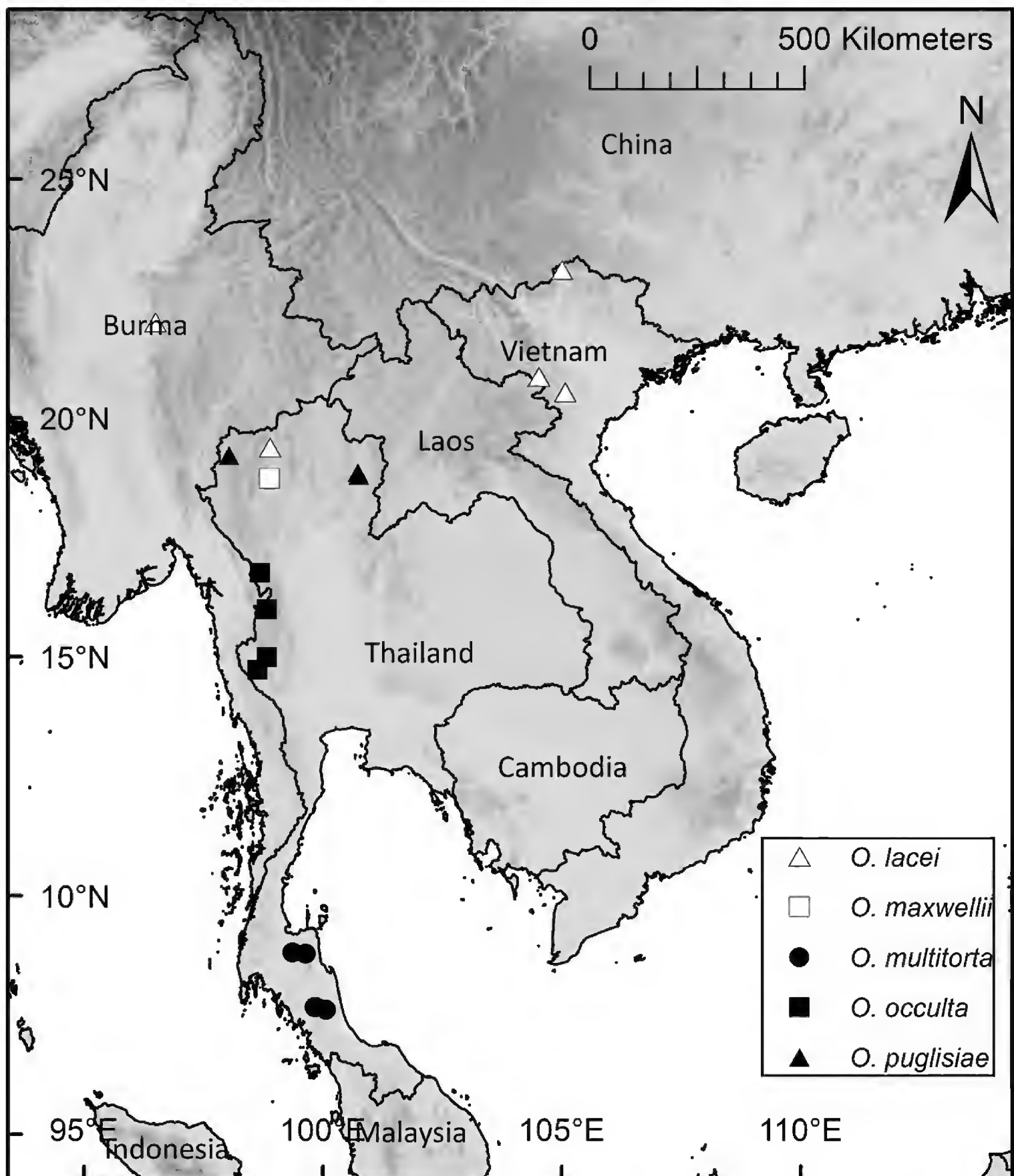


Fig. 7. Distribution of *Ornithoboea lacei* Craib (Δ); *Ornithoboea maxwellii* S.M.Scott (\square); *Ornithoboea multitorta* B.L.Burt (\bullet); *Ornithoboea occulta* B.L.Burt (\blacksquare); and *Ornithoboea puglisiae* S.M.Scott (\blacktriangle).

Distribution. Myanmar, Thailand and Vietnam.

Ecology. On karst limestone at around 1060 m.

Provisional IUCN Conservation Assessment. Data Deficient (DD). This species is known from very few collections and its precise distribution, population stability, and any potential threats are all unknown.

Additional specimens examined: THAILAND: **Chiang Mai:** Doi Chiang Dao, vouchered from cultivated collection, 4 Dec 1961, *Unknown C.4080* (E).

VIETNAM: **Ha Giang:** Hang Co mountain, vouchered from cultivated collection, 16 Apr 2004, *Scott s.n.* (E). **Son La:** Moc Chau, Chieng Hac Municipality, 31 Oct 2006, *Hiep, N.T. et al. HAL9419* (MO). **Thanh Hoa:** Quan Hoa District, Phu Le Municipality, Hang Village, 4 Oct 2003, *Averyanov, L. et al. HAL3889* (MO).

Notes. This species is known from very few collections but the description and material available is full and complete and is based on a specimen sent to Craib in 1923 by Mr J.H. Lace. The emarginate lower corolla lobes are very distinct and make it easy to recognise but it does closely resemble a few other species of *Ornithoboea*. It is similar to *Ornithoboea wildeana* in the sparsely bearded anthers and elliptic to ovate sepals. It differs from *Ornithoboea wildeana* in having a much longer corolla, emarginate corolla lobes, shorter pedicels, and sepals which are shorter with narrowly acute apices. *Ornithoboea lacei* is generally a smaller plant and has distinctive red-glandular spots on the leaves. It is also similar to *Ornithoboea calcicola* with the same elliptic sepals and short peduncles but it differs from *O. calcicola* in having shorter bracts, a longer corolla tube and shorter filaments. Its differences to the only other species with emarginate corolla lobes, *Ornithoboea emarginata*, are discussed under that species. *Munzinger 247* (P) from Champasak in southern Laos is very similar to this species but the flowers on the specimens are too poor to be certain and this collection is from much further south than the other collections. *Thorel 2347* (B, GH, K, P), also from Champasak, could also be *Ornithoboea lacei* but again the available material is too poor (see note under *O. feddei*).

9. *Ornithoboea maxwellii* S.M.Scott, **sp. nov.**

Differs from all other *Ornithoboea* species in not having the palatal beard found on the lower corolla lip and from all except *O. arachnoidea* in having an arachnoid indumentum. It is most similar to *Ornithoboea obovata* with which *O. maxwellii* shares the character of non-twisted fruits with straight dehiscence but differs in having lanceolate sepals and arachnoid indumentum throughout. TYPE: Thailand, Chiang Mai Province, Hang Dong Subdistrict, Ban Pong, 850 m, 3 September 2003, *J.F. Maxwell 03-268* (holotype E; isotypes A, CMU *n.v.*, L). (Fig. 7–9).

Herb; stem c. 6–10.5 cm tall, to 1.3–2.4 mm diameter, glandular arachnoid pubescence throughout, leaf internodes 2.5–8 mm. **Leaves** opposite, deep green above, purple/red below; petiole 2.2–5.5 cm long; blade herbaceous, orbicular, 2.6–5.6 × 3–3.5 cm, apex obtuse, base slightly unequal, oblique to cordate, margin weakly to strongly dentate to crenate, rarely bicrenate, the teeth 1.5–4.6 mm; 5–6 pairs of secondary veins, tertiary

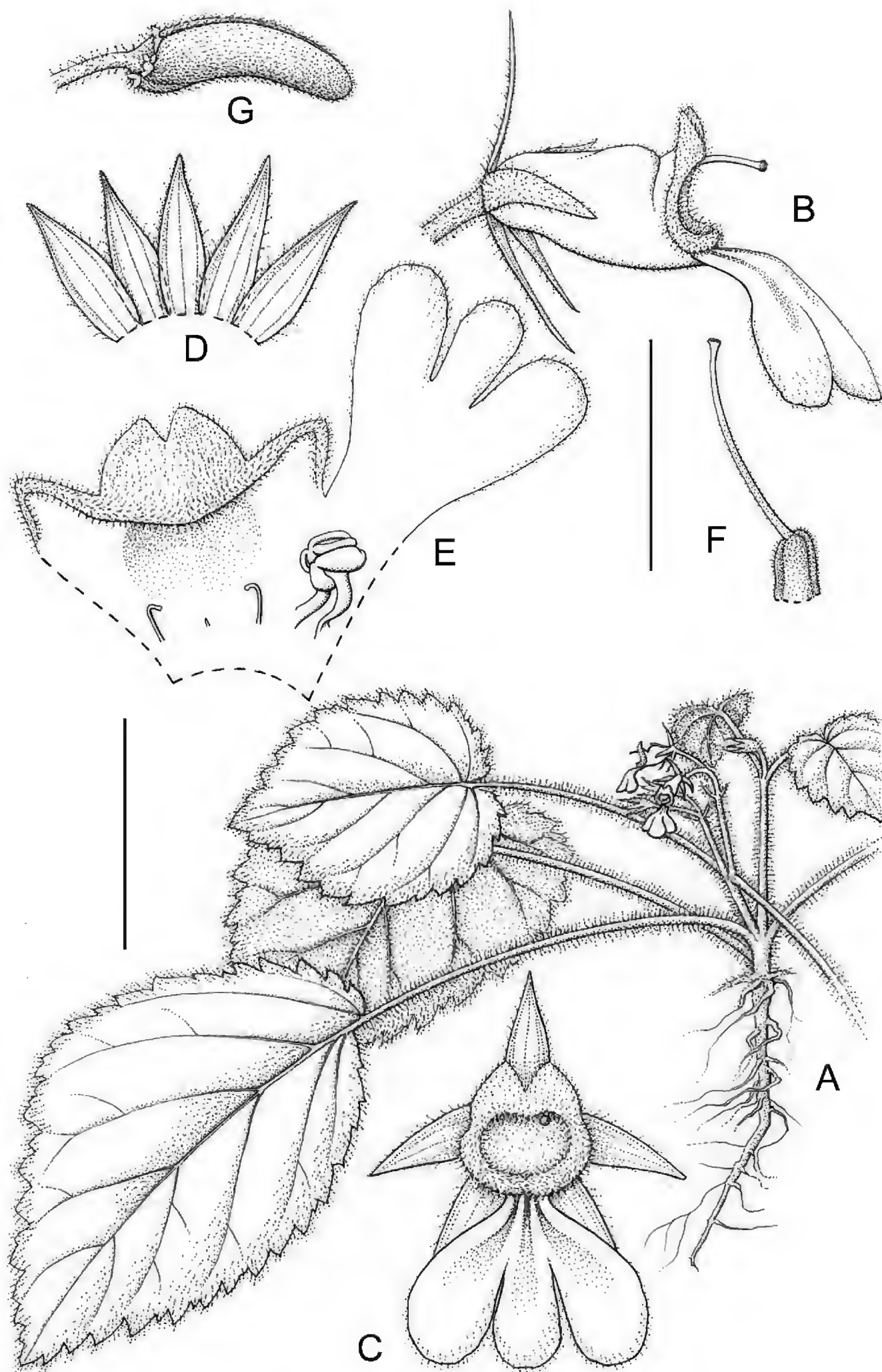


Fig. 8. *Ornithoboea maxwellii* S.M.Scott. **A.** Habit. **B.** Flower, side view. **C.** Flower, front view. **D.** Calyx opened out. **E.** Corolla dissection showing the two small lobes of the upper lip, the three larger lobes of the upper lip, two stamens and three staminodes. **F.** Pistil. **G.** Fruit. A = *J.F.Maxwell* 03-268 (E); B–F = *J.F.Maxwell* 694 (BKF); G = *M.Möller* 04-439 (E). Scale bars: A = 2.5 cm; B–G = 0.5 cm. Drawn by Claire Banks.



Fig. 9. *Ornithoboea maxwellii* S.M.Scott. (Photo: Pranee Nangngam).

venation reticulate. **Inflorescence** axillary, 18–31 mm long, glandular arachnoid pubescence throughout; peduncle 6.3–7.1 mm long; bracts lanceolate, c. 1.6×1 mm; pedicels 4.5–6 mm long. **Sepals** lanceolate, light green, 3-veined, $3.7\text{--}4 \times 1.2\text{--}1.7$ mm, apices narrowly acute, sparsely arachnoid above, more densely so beneath, ciliate. **Corolla** bilabiate, c. 14 mm long, white, glandular pubescence throughout; tube c. 4.3 mm long; upper lip slightly 2-lobed, erect, each lobe c. 0.5 mm long, apices rounded, hairy in addition to a ring of short white hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, slightly reflexed, c. 5 mm long, lobes hairy but without characteristic palatal beard, lobes c. $1.5\text{--}2.3 \times 0.6\text{--}1.7$ mm, slightly obovate, apices rounded. **Stamens** without pronounced sterile projection; filaments thickened, geniculate and curved through 90° , 1–1.5 mm long; anthers $0.6 \times 1.5\text{--}2.3$ mm, slightly hairy, lightly fused at the tips; staminodes 3, two of which c. 1 mm long, the third 0.2 mm long. **Ovary** c. $1\text{--}1.5 \times 1$ mm, glandular puberulent; style (5–)6–8 mm long, glandular puberulent; stigma globose/rounded. **Fruit** $5.8 \times 1.4\text{--}1.9$ mm, slightly curved with no twist, slightly arachnoid to densely puberulous.

Distribution. Northern Thailand.

Ecology. On karst limestone at 850–925 m altitude.

Etymology. Named after the prolific collector J.F. Maxwell (1945–).

Provisional IUCN Conservation Assessment. Data Deficient (DD). This species is known from very few collections from only one locality. It is not known if it also occurs in other areas or what the threats are where it is known.

Additional specimens examined: THAILAND: **Chiang Mai:** Hang Dong, Ban Pong, 19 Aug 2004, Maxwell, J.F. 694 (A, BKF); ibidem, 2004, Möller, M. 04-439 (E).

Notes. This new species differs from all other *Ornithoboea* species in not having the distinctive palatal beard found on the lower corolla lip. There is some hair present but it does not resemble the palatal beard found in all other *Ornithoboea* species. *Ornithoboea maxwellii* does have the circlet of hairs around the mouth of the corolla tube and geniculate filaments which curve through 90°. *Ornithoboea maxwellii* shares the distinctive character of an arachnoid indumentum with one other species, *Ornithoboea arachnoidea*. It is most similar to *Ornithoboea obovata* from Vietnam with which *O. maxwellii* shares the character of non-twisted fruits with a straight line of dehiscence. It differs from *Ornithoboea obovata* in having lanceolate sepals and an arachnoid indumentum throughout. It is also similar to *Ornithoboea calcicola* but differs in its short fruits and stamens without pronounced sterile projections.

Ornithoboea maxwellii is known from a small number of collections, all from the same area, the Hang Dong Subdistrict in Thailand.

10. *Ornithoboea multitorta* B.L.Burtt

Thai Forest Bull., Bot. 29: 101 (2001). TYPE: Thailand, Phatthalung, Amphoe Sii Ban Phot, Khao Pu-Khao Ya National Park, 140 m, 14 Jul 2000, D.J. Middleton, T. Boonthavikoon, S.J. Davies, C.Hemrat & M.F. Newman 444 (holotype E, untraced; lectotype K, designated here; isotypes AAU, BKF, P, SING). (Fig. 7).

Herb; stem 30–100(–150) cm tall, to 2.7–5.2 mm diameter, glandular pubescent throughout, leaf internodes 2–11.5 cm. **Leaves** opposite, green above, paler below; petiole 3.5–13(–17.5) cm long, densely glandular puberulous, blade herbaceous, ovate to broadly ovate, 4–17.8(–22) × 4–12.5 cm, apex narrowly acute to attenuate, base slightly unequal, oblique to slightly cordate, margin weakly to strongly crenate/bicrenate to dentate, the teeth 1.3–4.7 mm; 9–11 pairs of secondary veins, tertiary venation reticulate; glandular puberulous above, more dense beneath with hairs of various lengths throughout. **Inflorescence** axillary, 4–9.5 cm long, pseudoracemose, densely glandular pubescent throughout; peduncle 1.7–4.4 cm long; bracts linear to triangular, c. 3.5 × 0.4 mm; pedicels 7.1–10.9 mm long. **Sepals** ovate to lanceolate, green, 3-veined, 5–6 × 1.8–2.7 mm, apices narrowly acute, sparsely puberulous above, more densely so beneath, ciliate; sepals often reflexed when in fruit. **Corolla** bilabiate, c. 10 mm long, pale lavender/lilac throughout, glabrous outside; tube 4.5–5.1 mm long; upper lip very slightly 2-lobed, c. 1.5 mm long, reflexed, emarginate in centre, c. 0.6 mm deep, glabrous except for a ring of short white hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed,

c. 5 mm long, central lobe reflexed, glabrous except for palatal beard at base of lobes, each lobe c. 3.5×1.8 – 2.6 mm, lateral lobes slightly falcate, central lobe slightly ovate, apices rounded, fully reflexed. **Stamens** with a pronounced sterile projection, 0.7–1 mm long, yellow; filaments 1.2–1.6 mm long; anthers 0.6 – 1×1.5 – 2.1 mm, hairy, lightly fused at the tips; staminodes 3, two of which 1–1.5 mm long, the third 0.2 mm long. **Ovary** 1 – 1.4 (– 2) $\times 1.5$ – 2.1 mm, glandular pubescent; style 5.5–6.1 mm long, glandular pubescent; stigma globose/rounded. **Fruit** 7.5 – 12.3×1.9 – 2.4 mm, tightly twisted, pubescent to densely pubescent.

Distribution. Southern Thailand.

Ecology. On karst limestone, usually shaded, at 80–350 m altitude.

Provisional IUCN Conservation Assessment. Near Threatened (NT). The currently known EOO of this species is < 5000 km² and the AOO 16 km², both of which would qualify it for Endangered if there were associated threats. However, most of the known localities are in National Parks where there is some disturbance but the extent of which is not currently likely to qualify the species as Endangered. Therefore, it is given a category of Near Threatened and its status should be monitored. Middleton (2012c) gave this species an assessment of Data Deficient but at that time the species delimitation only included the type collection.

Additional specimens examined: THAILAND: **Nakhon Si Thammarat:** Nopphitam, Tham Lot Cave, 13 Feb. 2005, *Williams, K. et al.* 1460 (BKF, E, K, KEP). **Phatthalung:** 23 Sep. 1986, *Maxwell, J.F.* 86-700 (A, BKF, PSU); Ban Phot, 20 Dec. 1979, *Shimizu, T. et al.* T-27741 (BKF); Si Banphot, Khao Pu-Khao Ya National Park, 26 Oct. 1993, *Larsen, K. et al.* 44040 (A, AAU, BKF, K). **Surat Thani:** Tai Rom Yen National Park, Tham Khamin, 18 Dec. 2006, *Pooma, R. et al.* 6411 (A, BKF).

Notes. Even though the species was described only relatively recently the holotype at E could not be traced in spite of concerted effort. Therefore, the isotype at Kew has been designated as the lectotype.

This species, like *Ornithoboea pseudoflexuosa* and *O. flexuosa*, is only found in southern Thailand. It can be recognised by the fully reflexed central lobe of the lower corolla lip, tightly twisted fruit and short corolla tube. It shares the characters of a reflexed corolla lobe, a pseudoracemose inflorescence and ovate to lanceolate sepals with *Ornithoboea pseudoflexuosa*. There has been much confusion between *Ornithoboea flexuosa*, *O. pseudoflexuosa* and *O. multitorta* and the three species are often misidentified, especially when sterile (see notes on *O. flexuosa* and *O. pseudoflexuosa*). *Ornithoboea flexuosa* does not have the reflexed central lobe and its fruits are smaller and almost straight. In addition *Ornithoboea multitorta* has a longer corolla tube and sepals and bearded anthers. *Ornithoboea multitorta* shares a greater affinity to *O. pseudoflexuosa* but they can be distinguished by the tightly twisted fruits, longer internodes, shorter inflorescences, and longer sepals of *O. multitorta*.

11. *Ornithoboea obovata* S.M.Scott, sp. nov.

Most similar to *Ornithoboea maxwellii* in non-twisted fruits with straight dehiscence but differing in having fully reflexed sepals, shorter fruits and a palatal beard. It differs from *Ornithoboea barbanthera* in its smaller fruits and stamens without a pronounced sterile projection. TYPE: Vietnam, Quang Binh Province, Minh Hoa District, Hoa Tien municipality, La Van village, 200–450 m, 30 April 2011, L. Averyanov, P.K. Loc, N.Q. Hieu, P.V. The & N.T. Vinh CPC2552 (holotype E; isotype HN *n.v.*). (Fig. 6, 10).

Herb; 16–32(–40) cm tall, to (1.1–)2.3–3.4 mm diameter, red glandular pubescent throughout with hairs of various lengths, leaf internodes 5.4–16(–76) mm. **Leaves** opposite, bright green; petiole 12.1–13.1 cm long; blade herbaceous, ovate, 3.3–8.7 × 2.9–6.5 cm, apex acute, base slightly unequal, oblique to rounded, margin weakly to strongly crenate/bicrenate to dentate/duplicato-dentate, the teeth 1.4–4.2 mm; 6–7 pairs of prominent secondary veins, tertiary venation reticulate. **Inflorescence** axillary, 2.3–3 cm long, red glandular pubescent throughout; peduncle 9–26 mm long; bracts linear to lanceolate, c. 2.7 × 1 mm; pedicels 9–13 mm long, pilose. **Sepals** ovate, 3-veined, c. 4.5 × 2 mm, apices narrowly acute, puberulent above, puberulous below, ciliate; sepals fully reflexed when in fruit. **Corolla** bilabiate, c. 10.5 mm long, light to dark blue, glabrous outside; tube c. 4.5 mm long, light blue; upper lip slightly 2-lobed, 2 mm long, each lobe c. 1.5 mm long, broadly rounded and notched, pubescent with a ring of short hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, c. 6.2 mm long, glabrous except for palatal beard at base of lobes, lobes 2.5–3.5 × 2.8–3.5 mm, lobes distinctly obovate and overlapping, apices rounded. **Stamens** without pronounced sterile projection; filaments curved through 90°, 1.5–2 mm long; anthers 0.5 × 1.5–2 mm, white, glabrous, lightly fused at the tips; staminodes 3, two of which 1.2–1.8 mm long, the third 0.2–0.4 mm long. **Ovary** 1.2–1.5 × 1.2 mm, glandular puberulent; style 4.5–6 mm long, glandular puberulent; stigma globose/rounded. **Fruit** 8.1–11.3 × 1.8–2 mm, non-twisted, red glandular pubescent; style persistent and characteristically curved through 180°.

Distribution. Vietnam.

Ecology. On karst limestone at 200–450 m altitude.

Etymology. Named for the distinctly obovate lobes found on the lower corolla lip.

Provisional IUCN Conservation Assessment. Data Deficient (DD). This species is known from very few collections and its precise distribution, population stability, and any potential threats are all unknown.

Additional specimens examined: VIETNAM: **Quang Binh:** Minh Hoa, Hoa Tien municipality, la Van Village, 30 Apr 2011, Averyanov, L. et al. CPC2556 (E); Quang Ninh District, Truong Son, long Son Village, 12 Apr 2008, Averyanov, L. et al. HAL11510 (E); Van Xuan Village, 26 Mar 1936, Pételot, A. 2234 (P).

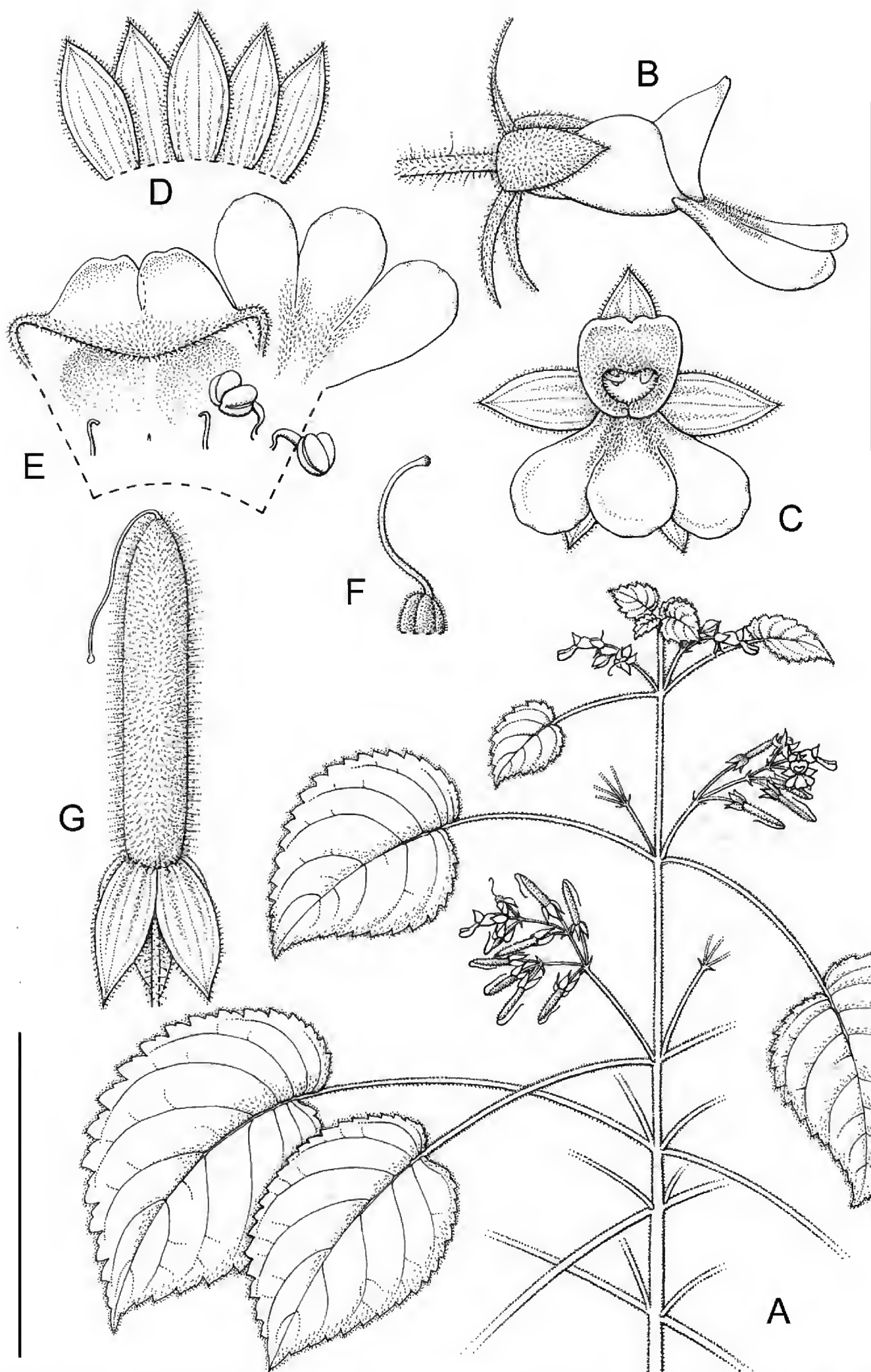


Fig. 10. *Ornithoboea obovata* S.M.Scott. **A.** Habit. **B.** Flower, side view. **C.** Flower, front view. **D.** Calyx opened out. **E.** Corolla dissection showing the two small lobes of the upper lip, the three larger lobes of the upper lip, two stamens and three staminodes. **F.** Pistil. **G.** Fruit. A–G = Averyanov et al. CPC2552 (E). Scale bars: A = 7 cm; B–G = 1 cm. Drawn by Claire Banks.

Notes. This new species is most similar to *Ornithoboea maxwellii* from Thailand with which it shares the character of non-twisted fruits with straight dehiscence. It differs from *Ornithoboea maxwellii*, however, in having fully reflexed sepals, shorter fruits and a palatal beard. It differs from *Ornithoboea barbanthera* B.L.Burt in its smaller fruits and stamens without a pronounced sterile projection.

This species can be distinguished by the lobes on the lower corolla lip which are large and obovate, fruits which are long and tubular with no twist and a straight dehiscence, and an indumentum of long red glandular hairs. These characters, and the small habit, make it easily recognisable.

12. *Ornithoboea occulta* B.L.Burt

Thai Forest Bull., Bot. 29: 101 (2001). TYPE: Thailand, Kanchanaburi, Between Huay Ban Kao and Kritee, 500 m, 4 July 1973, R. Geesink & C. Phengklai 6078 (holotype E; isotypes AAU, K, L, P). (Fig. 7, 11–13).

Herb; stem 9–30 cm tall, to 1.9–4.8 mm diameter, glandular pubescent throughout, leaf internodes 1.7–6.2 cm. *Leaves* opposite; petiole 4.5–11.5(–15) cm long, puberulous; blade herbaceous, ovate to elliptic, 4–21 × 2.5–12 cm, apex narrowly acute, base slightly unequal, broadly oblique, margin weakly to strongly crenate/bicrenate to dentate/duplicato-dentate, the teeth 1.3–4.8 mm; 7–10 pairs of secondary veins, tertiary venation reticulate; glandular puberulous above and below with hairs of various lengths throughout. *Inflorescence* axillary, 3–7 cm long, glandular pubescent throughout; peduncle 9–26 mm long; bracts linear to triangular, 2.5–5.1 × 0.8–1.3 mm; pedicels 9–21 mm long. *Sepals* ovate to elliptic, white, 3-veined, 5.8–7.3 × 2.5–3.2 mm, apices narrowly acute, sparsely puberulous above, more densely so beneath, ciliate; sepals slightly reflexed when in fruit. *Corolla* bilabiate, c. 14 mm long, dark blue, glabrous outside; tube 3.5–4.6 mm long, white; upper lip slightly 2-lobed, erect, each lobe c. 2 mm long, apices retuse, pubescent on inside lower half of lobe in addition to a ring of short hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, slightly reflexed, c. 6.8 mm long, glabrous except for palatal beard at base of lobes, lateral lobes c. 6.8 × 4.2 mm, central lobe c. 5.7 × 4.2 mm, lobes oblong, apices rounded with occasional notch. *Stamens* without pronounced sterile projection; filaments thickened, geniculate and curved through 90°, 1–1.7 mm long; anthers 0.6–0.8 × 1.2–1.8 mm, glabrous, lightly fused at the tips; staminodes 3, two of which 1–2.2 mm long, the third 0.3 mm long. *Ovary* c. 1.2 × 0.7–0.9 mm, glandular puberulent; style c. 5.5 mm long, glandular puberulent; stigma globose/rounded. *Fruit* 5–6.5 × 1.8–2.8 mm, smaller than the calyx lobes, barely twisted, densely pubescent.

Distribution. Western Thailand.

Ecology. On karst limestone at 500–800 m altitude.

IUCN Conservation Assessment. Data Deficient (DD) (Middleton & Suksathan, 2012b). This species is known from a relatively small area and most of the collections are from unprotected areas. However, the known localities are all in Thailand close to the border with Myanmar and the limestone areas on the Myanmar side of the border have not been explored for this species.

Additional specimens examined: THAILAND: **Kanchanaburi:** s.l., 16 Aug 1971, *Unknown* 2983 (BKF); Thong Pha Phum, 4 Jul 1973, *Maxwell, J.F. 73-105* (AAU); *ibidem*, *Maxwell, J.F. 73-105* (AAU); *ibidem*, 22 Aug 2006, *Triboun, P. 3638* (E); Thong Pha Phum, Huai Lam Khlong Ngu, *Suthasorn 2490* (BK). **Tak:** Khao Pha Wo, 23 Jul 1973, *Murata, G. et al. 16925* (L); Mae Sot, Phawo Shrine, 11 Sep 2009, *Middleton, D.J. & Triboun, P. 4858* (E); Umphang, 14 Apr 1999, *Chayamarit, K. 1588* (BKF).

Notes. There are many similarities between *Ornithoboea occulta* and *O. obovata* and they share the characters of geniculate filaments, long peduncles and slightly reflexed lower corolla lobes. However, *Ornithoboea occulta* has slightly twisted fruits, longer inflorescences, a large palatal beard, and oblong corolla lobes. *Ornithoboea obovata* differs in having almost non-twisted fruits with a distinctive persistent style curved through 180°, a shorter inflorescence, a small palatal beard, and obovate corolla lobes.



Fig. 11. Young fruit of *Ornithoboea occulta* B.L.Burtt. Photograph of *Middleton & Triboun 4858* by David Middleton.



Fig. 12. Flower of *Ornithoboea occulta* B.L.Burt. Photograph of *Middleton & Triboun 4858* by David Middleton.

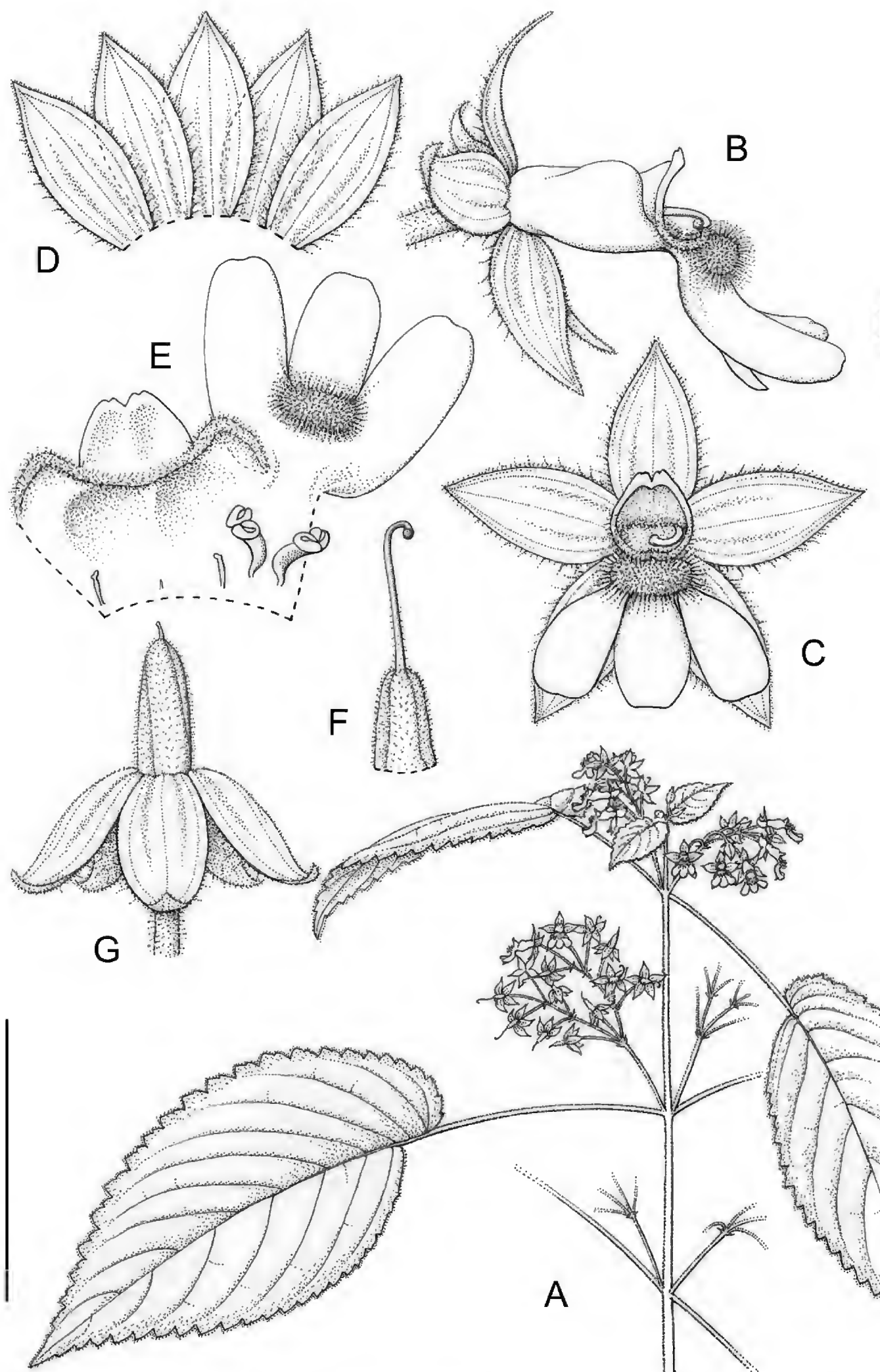


Fig. 13. *Ornithoboea occulta* B.L.Burtt. **A.** Habit. **B.** Flower, side view. **C.** Flower, front view. **D.** Calyx opened out. **E.** Corolla dissection showing the two small lobes of the upper lip, the three larger lobes of the upper lip, two stamens and three staminodes. **F.** Pistil. **G.** Fruit. From *Middleton & Triboun 4858* (E). Scale bars: A = 9 cm; B–G = 1 cm. Drawn by Claire Banks.

13. *Ornithoboea parishii* C.B. Clarke

in A.DC. & C.DC., Monogr. Phan. 5(1): 148 (1883); Hook.f., Fl. Brit. India 4: 366 (1884); Burt, Notes Roy. Bot. Gard. Edinburgh 22: 296 (1958). TYPE: Burma, Moulmein, 1060 m, 1862, *C.S.P. Parish 434* (holotype K). (Fig. 6).

Stem 18 cm tall, to 2.6 mm diameter, glandular pubescent throughout, leaf internodes 30–40 mm. *Leaves* opposite; petiole 5–8 cm long, puberulous; blade herbaceous, ovate to elliptic, 6–14 × 5–7 cm, apex acute, base oblique, rounded, margin weakly to strongly crenate/bicrenate to dentate, the teeth 1–1.5 mm; c. 10 pairs of secondary veins, tertiary venation reticulate; glandular puberulous above and below with hairs of various lengths throughout. *Inflorescence* axillary, 4.2–4.5 cm long, puberulent throughout; peduncle 1.4–1.8 cm long; bracts linear to triangular, 6.4–11.4 × 2.2–2.7 cm; pedicels 8.7–12.4 mm long. *Sepals* narrowly ovate, green, 3-veined, c. 5.7 × 2.2 mm, apices narrowly acute, sparsely puberulous above, more densely so beneath, ciliate; sepals mostly reflexed in mature fruit. *Corolla* bilabiate, c. 13 mm long, pale blue; tube c. 5.5 mm long, glabrous; upper lip slightly 2-lobed, erect, each lobe c. 1 mm long, apices obtuse, reflexed, puberulous in addition to a ring of short hairs on a ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, slightly reflexed with central lobe fully reflexed and flush against tube, glabrous except for a thick palatal beard at base of lobes, lateral lobes c. 9 × 1.8 mm, oblong, apices rounded, central lobe c. 7 × 2.3 mm, oblong, apices rounded. *Stamens* without a pronounced sterile projection; filaments 1.5 mm long, thickened, geniculate; anthers 0.5 × 2 mm, glabrous, lightly fused at the tips; staminodes 3, two of which c. 0.8 mm long, the third 0.2 mm long. *Ovary* 1.5 × 2 mm, glandular puberulent; style c. 4.5 mm long, glandular puberulent; stigma globose/rounded. *Fruit* c. 12 × 2 mm, green, slightly twisted, puberulous.

Distribution. Myanmar and Thailand.

Ecology. On karst limestone at 500–700 m altitude.

Provisional IUCN Conservation Assessment. Data Deficient (DD). This species is known from only the 19th century type collection from Burma and two more recent collections from western Thailand. Its true distribution is unknown, as are any potential threats.

Additional specimens examined: THAILAND: **Tak:** Umphang, 24 Apr 2004, *Pooma, R. et al.* 4644 (BKF); *ibidem*, 14 Jul 1999, *Wongprasert, T.* 99753 (BKF).

Notes. This species is known from very few and somewhat inadequate collections. It bears a resemblance to *Ornithoboea pseudoflexuosa* with its reflexed lobes. However, in *Ornithoboea pseudoflexuosa* only the middle lobe of the lower lip is reflexed whereas in *O. parishii* it would appear that all three lobes are reflexed. *Ornithoboea*

parishii also has geniculate filaments whereas *O. pseudoflexuosa* has pronounced sterile projections.

The hairs of the circlet are very short but none the less visible.

14. *Ornithoboea pseudoflexuosa* B.L.Burtt

Notes Roy. Bot. Gard. Edinburgh 22: 299 (1958); Burtt, Thai Forest Bull., Bot. 29: 101 (2001). TYPE: Thailand, Chumphon Province, Siepyuan, [Ban Siép Yuan], 6 September 1927, *N. Put 964* (holotype K (see note below); isotypes E, BM). (Fig. 6, 14).

Herb; stem 18–80 cm tall, to 2.1×5.2 mm diameter, glandular pubescent throughout, leaf internodes 2.8–7.7 cm. **Leaves** opposite, pale green above, paler below; petiole 2.8–12(–18.5) cm long; blade herbaceous, elliptic to ovate, $6\text{--}19\text{--}26 \times 3.9\text{--}9.7$ cm, apex acute to attenuate, base unequal, oblique to slightly rounded, margin weakly to strongly crenate/bicrenate to dentate/duplicato-dentate, the teeth 1.7–6.7 mm; 8–10 pairs of secondary veins, tertiary venation reticulate; densely to sparsely yellow-glandular puberulous throughout with hairs of various lengths. **Inflorescence** axillary, 3–8.2(–13.3) cm long, pseudoracemose, densely glandular pubescent throughout; peduncle 2.2–4.7(–6) cm long; bracts linear to lanceolate, $3.1\text{--}5.6\text{--}25.6 \times 1\text{--}4.9$ mm; pedicels 6–12.1(–16.4) mm long. **Sepals** ovate to lanceolate, green, 3-veined, $5.5\text{--}7.3\text{--}10.3 \times 2.1\text{--}2.5$ mm, apices narrowly acute, puberulous above, more densely so beneath, ciliate; some sepals reflexed when in fruit. **Corolla** bilabiate, c. 10 mm long, purple/white to violet throughout, glabrous outside; tube c. 6.7 mm long; upper lip very slightly 2-lobed, erect to reflexed, 1.5–2 mm long, lobes c. 0.5 mm long, emarginate in centre, c. 0.6 mm deep, glabrous except for a ring of short white hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, c. 6.6 mm long, central lobe completely reflexed, glabrous except for palatal beard at base of lobes, each lobe $2.2\text{--}3.5 \times 2.2$ mm, lateral lobes slightly falcate, apices rounded, central lobe slightly ovate. **Stamens** with a pronounced sterile projection, projection 1.5–1.9 mm long, yellow; filaments 0.6–1(–1.5) mm long; anthers $0.5\text{--}0.7\text{--}1.3 \times 1.8\text{--}2.2$ mm, hairy, lightly fused at the tips; staminodes 3, two of which 1.3–2 mm long, the third 0.2 mm long. **Ovary** $0.9\text{--}2.1 \times 0.9\text{--}1.2$ mm, glandular puberulent throughout; style 5.5–6 mm long; stigma globose/rounded. **Fruit** $6.1\text{--}9.6 \times 2.1\text{--}3.3$ mm, twisted to more than half a turn or barely twisted, glandular puberulous.

Distribution. Thailand.

Ecology. On karst limestone, usually in shade, at 30–200 m altitude.

IUCN Conservation Assessment. Least Concern (LC) (Middleton 2012d). This species has a fairly large extent of occurrence and is locally common. Some of the sites are found within protected areas and there do not appear to be any major threats at the moment.



Fig. 14. *Ornithoboea pseudoflexuosa* B.L.Burt. Photograph of *Middleton et al. 5545* by Preecha Karaket.

Additional specimens examined: THAILAND: **Chumphon:** Sawi, Khao Khai, Tham Thip Prida San Chang Len, 26 Dec 2006, *Pooma, R. et al. 6679* (A, BKF, E); Thung Tako, Ban Khao Talu, 4 Dec 2002, *Koonkhunyhod, N. & de Wilde-Duyffjes, B.E.E. 309* (BKF). **Phatthalung:** 12 Apr 1928, *Kerr, A.F.G. 15145* (BM, K). **Ranong:** Ko Thalu, 3 Feb 1927, *Kerr, A.F.G. 11790* (ABD). **Surat Thani:** Khao Wong, 24 Sep 1963, *Smitinand, T. & Sleumer, H.O. 1236* (BKF); Phanom, 16 Feb 2005, *Williams, K. & Pooma, R. 1546* (BKF); Phanom, Khao Sok National Park, 6 Sep 2008, *Middleton, D.J. et al. 4318* (E); Phanom, Khlong Phanom National Park, 21 Oct 2010, *Middleton, D.J. 5230* (E); *ibidem*, 26 Sep 2010, *Middleton, D.J. et al. 5545* (E); *ibidem*, 7 Sep 2008, *Middleton, D.J. et al. 4336* (E). **Trang:** Huay Yot, Wat Tham Iso, 9 Sep 2008, *Middleton, D.J. et al. 4426* (E, KEP); *ibidem*, 10 Aug 2005, *Pooma, R. et al. 5630* (BKF); *ibidem*, 14 Jun 2006, *Williams, K. et al. 1741* (A, BKF, E); Lamphura, 15 Nov 1990, *Larsen, K. et al. 41388* (AAU, BKF).

Notes. In the protologue Burt (1958) cited the holotype as being at ABD but no specimens of this collection could be found there. However, there is a specimen at K (over two sheets labelled sheet 1 and 2) which has clearly been labelled as the holotype by Burt. We consider this to have been an error in the protologue to be corrected rather than that the K material requires lectotypification.

This species is only found in the south of Thailand and is recognisable by its large leaves, longish pseudoracemose inflorescences and the distinct character of a fully reflexed central lobe on the 3-lobed lower lip, a character it shares with *Ornithoboea multitorta*. Many other *Ornithoboea* species have a reflexed central lobe, such as

O. calcicola, *O. emarginata*, *O. flexuosa* and *O. puglisiae*, but in none of these does the lobe reflex past 90° as in *O. multitorta* and *O. pseudoflexuosa*.

There has been much confusion between *Ornithoboea pseudoflexuosa*, *O. flexuosa* and *O. multitorta*. *Ornithoboea pseudoflexuosa* can be separated from *Ornithoboea flexuosa* by the fully reflexed central lobe of the lower corolla lip. In *Ornithoboea flexuosa* the central lobe is not or only slightly reflexed. It differs further in having a fruit which is longer and more twisted, and anthers which are distinctly bearded.

Ornithoboea pseudoflexuosa bears a strong resemblance to *Ornithoboea multitorta* but differs in the barely twisted fruit, the longer corolla tube and longer sepals.

15. *Ornithoboea puglisiae* S.M.Scott, sp. nov.

Most similar to *Ornithoboea calcicola* in the elliptic sepals with a narrowly acute apex but differs in having shorter fruits with a persistent style, glabrous anthers, and petioles up to twice as long. Differs from *Ornithoboea wildeana* in its shorter corolla, smaller lower lobes with triangular apices and shorter sepals. TYPE: Thailand, Nan, Muang Nan, Tham Pha Toop, Trail to Phra Cave, 300 m, 16 August 2012, D.J. Middleton, P. Karaket, S. Suddee & P. Triboun 5617 (holotype E; isotypes BKF, P). (Fig. 7, 15, 16).

Herb; stem 40–50 cm tall, to 2.7–6.5 mm diameter, pubescent, leaf internodes 3.8–6.7 cm. **Leaves** opposite, light green; petiole 6–20 cm long; blade herbaceous, ovate to elliptic, 4–21(–25) × 4–11.8 cm, apex acuminate to narrowly acute, base slightly unequal, oblique to narrowly cordate, margin weakly to strongly crenate to dentate, rarely bicrenate to duplicato-dentate, the teeth 0.8–3 mm; c. 8 pairs of secondary veins, tertiary venation reticulate; glandular puberulous above, more densely so beneath, ciliate. **Inflorescence** axillary, 7–13 cm long, glandular pubescent throughout; peduncle 2.3–3.6 cm long; bracts linear to lanceolate, 4.1–13 × 0.5–1.6 mm; pedicels 6.7–19.1 mm long. **Sepals** elliptic, pale green, 3-veined, 8.2–8.7 × 3–3.3 mm, apices narrowly acute, glabrous inside, densely glandular puberulous outside, ciliate. **Corolla** bilabiate, c. 12.7 mm long, light purple to white throughout, glabrous outside; tube c. 6 mm long; upper lip 2-lobed, erect, each lobe 0.2–0.4 mm long, apices notched, puberulous in addition to a ring of short hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, slightly reflexed, 6.8–9 mm long, glabrous except for palatal beard at base of lobes, each lobe 3.5–4.5 × 2.5–3 mm, oblong, apices rounded. **Stamens** with a pronounced sterile projection, projection 1.4–2 mm long, yellow; filaments c. 1 mm long; anthers 1.2–1.6 × 2.4–2.7 mm, slightly bearded, lightly fused at the tips; staminodes 3, two of which 1.8–2.5 mm long, the third 0.3–0.4 mm long. **Ovary** 1.5–1.8 × 1.2–1.5 mm, glandular puberulent throughout; style c. 9.2 mm long; stigma globose/rounded. **Fruit** 11.6–14.3 × 1.7–2.1 mm, twisted, puberulous, style often persistent.

Distribution. Northern Thailand.

Ecology. On karst limestone at 300–800 m.

Etymology. Named after Carmen Puglisi for her contribution to our understanding of the Loxocarpinae, the subtribe of Gesneriaceae that includes *Ornithoboea*.

Provisional IUCN Conservation Assessment. Data Deficient (DD). This species is only known from three collections with one of the collections quite widely disjunct from the others. Its occurrence between these areas, where there are many suitable habitats, is unknown.

Additional specimens examined: THAILAND: **Mae Hong Son:** Muang Mae Hong Son, Doi Pui, 23 Sep 1995, *Larsen, K. et al.* 46865 (AAU, BKF). **Nan:** Tham Pha Toop, 13 Sep 1995, *Larsen, K. et al.* 46424 (AAU).

Notes. In addition to the similarities noted in the diagnosis *Ornithoboea puglisiae* shares some similarities with *O. wildeana*: a long style, long peduncles and twisted fruits. It differs, however, in the shorter inflorescences, elliptic sepals and oblong lobes on the lower lip each having a rounded apex. *Ornithoboea puglisiae* is also small in stature compared to *O. wildeana* and *O. lacei*.

16. *Ornithoboea wildeana* Craib

Bull. Misc. Info. Kew. 1916: 268 (1916); Burtt, Notes Roy. Bot. Gard. Edinburgh 22: 298 (1958); Li, Bull. Bot. Res., Harbin 3(2): 42 (1983); Wang, Fl. Reipubl. Popularis Sin. 69: 479 (1990); Wang et al., Fl. China 18: 370 (1998); Burtt, Thai Forest Bull., Bot. 29: 101 (2001). TYPE: Thailand, Chiang Mai, Doi Chiang Dao, from cultivated collection at Trinity College Dublin Botanic Garden, 5 Aug 1914, *Unknown* s.n. (holotype K). (Fig. 6, 17).

Brachistemon macrocalyx Hand.-Mazz., Sinensia 5: 10 (1934). TYPE: China, Kwangsi, Pu-hi, 730m., 27 July 1928, *Ching* 6565 (lectotype W, designated by Burtt (1958); isoelectotypes A, NY).

Herb; stem 30–150 cm tall, to 2.5–5.3(–8.9) mm diameter, red glandular pilose throughout, leaf internodes 3–10.2 cm. **Leaves** opposite; petiole 2–11.5 cm long; blade herbaceous, ovate to narrowly ovate, 4–21(–25) × 4–11.8 cm, apex acuminate to narrowly acute, base slightly unequal, oblique to narrowly cordate, margin weakly to strongly crenate to dentate, rarely bicrenate to duplicato-dentate, the teeth 0.8–3 mm; 8–10 pairs of secondary veins, tertiary venation reticulate, ciliate; glandular puberulous throughout with hairs of various lengths. **Inflorescence** axillary, 3–15(–25) cm long, red glandular pilose throughout; peduncle 1.1–3.1(–5.2) cm long; bracts



Fig. 15. *Ornithoboea puglisiae* S.M.Scott. Photograph of *Middleton et al.* 5617 by Preecha Karaket.

linear to lanceolate, $6.5\text{--}18.3 \times 0.8\text{--}1.6$ mm; pedicels $(6.7\text{--})11.1\text{--}20.3$ mm long. **Sepals** ovate to narrowly ovate, purple/pink to purple/green, 3-veined, $8\text{--}14.6 \times 1.5\text{--}3.2$ mm, spreading, apices narrowly attenuate, glandular puberulous above, more densely so beneath, ciliate. **Corolla** bilabiate, c. 17 mm long, blue/purple throughout, glabrous outside; tube $(6.5\text{--})7.8\text{--}9$ mm long; upper lip slightly 2-lobed, erect, each lobe $0.5\text{--}0.7$ mm long, apices emarginate, glabrous except for a ring of short hairs on the ridge of tissue at the base of the lip which runs down to the sinus with the lower lip; lower lip 3-lobed, slightly reflexed, c. 8 mm long, glabrous except for pale palatal beard at base of lobes, each lobe $3\text{--}4(-5) \times 2.3\text{--}3$ mm, slightly obovate, apices rounded, central lobe overlapping lateral lobes. **Stamens** with a pronounced sterile projection, projection $1.5\text{--}1.6$ mm long, yellow to light blue; filaments $0.7\text{--}1$ mm long; anthers $(0.5\text{--})1\text{--}1.5 \times 2\text{--}2.8$ mm, sparsely bearded, lightly fused at the tips; staminodes 3, two of which c. $1.5\text{--}2(-2.5)$ mm long, the third 0.3 mm long. **Ovary** $1.3\text{--}2.4(-3) \times 0.9\text{--}1.5$ mm, glandular puberulent throughout; style $(6.1\text{--})9\text{--}12.4$ mm long; stigma globose/rounded. **Fruit** $9.8\text{--}17.4 \times 1.8\text{--}3.2$ mm, twisted, pilose.

Distribution. China, Thailand, Laos, (Vietnam?).

Ecology. On karst limestone at 150–2100 m altitude.

Provisional IUCN Conservation Assessment. Least Concern (LC). This species is widespread (even allowing the doubt over the distribution in Vietnam) and locally fairly common.

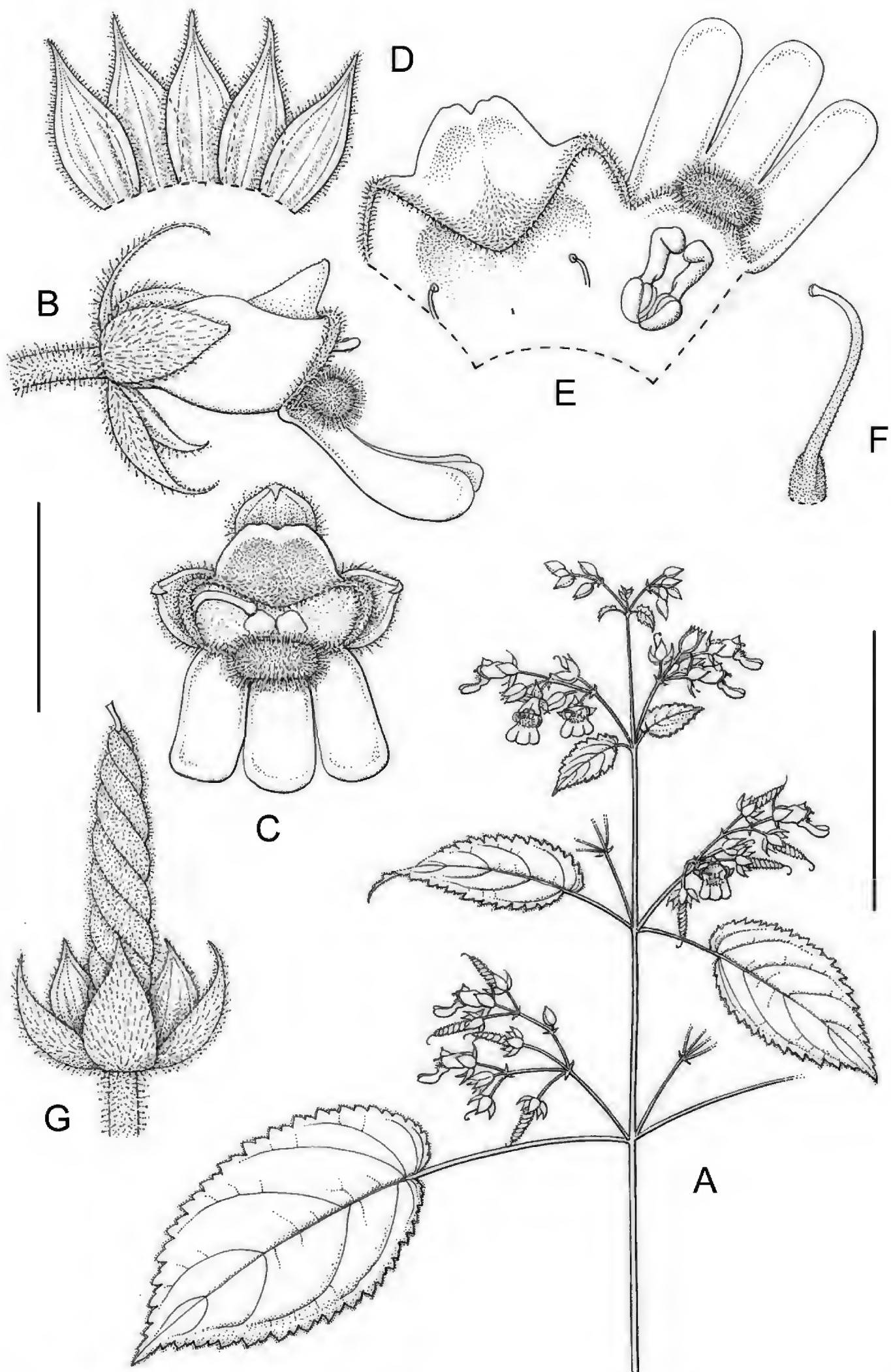


Fig. 16. *Ornithoboea puglisiae* S.M.Scott. **A.** Habit. **B.** Flower, side view. **C.** Flower, front view. **D.** Calyx opened out. **E.** Corolla dissection showing the two small lobes of the upper lip, the three larger lobes of the upper lip, two stamens and three staminodes. **F.** Pistil; **G.** Fruit. From *Middleton et al.* 5617 (E). Scale bars: A = 9 cm; B–G = 1 cm. Drawn by Claire Banks.

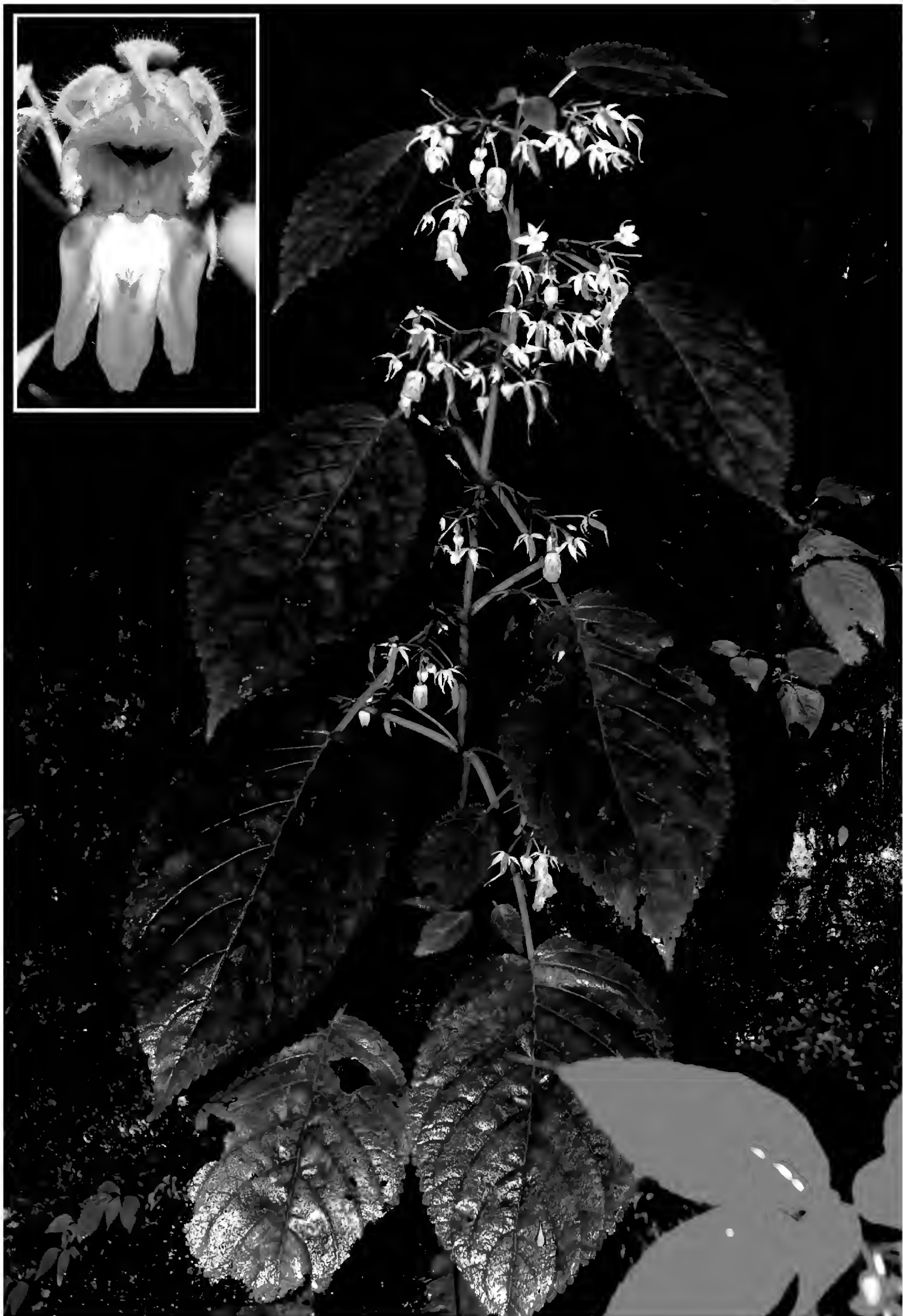


Fig. 17. Habit of *Ornithoboea wildeana* Craib. Inset: close up of flower. Photographs of Middleton *et al.* 5000 by David Middleton.

Additional specimens examined: CHINA: **Yunnan:** Mar-li-po, 5 Nov 1943, *Feng, K.M. 14074* (KUN).

THAILAND: **Chiang Mai:** Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, 6 Nov 1961, *Bunchuai, K. 1177* (BKF); *ibid.*, 3 Dec 1922, *Kerr, A.F.G. 6552* (ABN, BM, K); *ibid.*, 25 Sep 1971, *Murata, G. et al. T14927* (BKF); *ibid.*, 26 Sep 1971, *Murata, G. et al. T15257* (AAU, BKF); *ibid.*, 18 Oct 1926, *Put, N. 394* (BM, K); *ibid.*, 4 Dec 1961, *Smitinand, T. & Anderson, J.A.R. 7361* (BKF); *ibid.*, 10 Nov 1962, *Smitinand, T. et al. 7786* (BKF); *ibid.*, 11 Sep 1967, *Tagawa, M. et al. T9787* (BKF); *ibid.*, 16 Aug 2006, *Triboun, P. 3632* (E); *ibid.*, acc. no. 3 vouchered as Jan 1962, *Unknown 9562* (US); Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, Trail to summit of Doi Chiang Dao, 27 Sep 2009, *Middleton, D.J. et al. 5000* (E); Chiang Dao, Doi Chiang Dao Wildlife Sanctuary, Way to Muang Kong, 20 Sep 2008, *Middleton, D.J. et al. 4531* (E); San Kamphaeng, Sahagon, Doi Muang Awn, 29 Oct 1992, *Maxwell, J.F. 92651* (A, L). **Chiang Rai:** 21 Sep 1924, *Garrett, H.B.G. 200* (ABN, BM, E, K). **Khon Kaen:** 9 Sep 1963, *Smitinand, T. & Sleumer, H.O. 1126* (BKF, E, L, SING). **Lampang:** Ngao, 28 Aug 1922, *Winit 755* (ABN, K); Tham Pha Thai, 23 Sep 1967, *Tagawa, M. et al. T10625* (BKF); Wang Nuea, Chae Son National Park, Bassac, 3 Oct 1996, *Maxwell, J.F. 96-1283* (B); Wang Nuea, Chae Son National Park, summit above Maw Cave, 3 Oct 1996, *Maxwell, J.F. 96-1283* (A). **Mae Hong Son:** 10 Sep 1974, *Larsen, K. & Larsen, S.S. 34335* (AAU, SING); Muang Mae Hong Son, Doi Mae Sakut, 23 Sep 1995, *Nanakorn, W. et al. 4690* (E); Pang Mapha, Tahm Lawt, 10 Nov 2004, *Palee, P. 768* (BKF); Pangmapha, Tham Lot Cave, 23 Sep 2009, *Middleton, D.J. et al. 4975* (BKF, E); Pangmapha, Ban Jah Bo, Mae La Nah Cave, 30 Sep 2003, *Maxwell, J.F. 03304* (BKF). **Sukhothai:** Khiri Mat, 27 Nov 77, *Phengklai, C. et al. 3930* (BKF).

LAOS: s.l., 12 Sep 1929, *Poilane, E. 16931* (P).

VIETNAM: **Bac Kan:** Ba Be District, Nam Mau Municipality, Nam Dai Village, Ba Be National Park, 12 Jul 2004, *Atha, D.E. et al. 4723* (NY).

Notes. The identification of the collection from Vietnam is not without doubt and further collections are necessary from Vietnam to be sure of its presence there.

Ornithoboea wildeana has one of the widest geographical distributions in the genus and is also one of the most variable, particularly in the flowers, especially in the degree of development of the sterile processes on the stamens. There is also variation in the shape and size of the sepals with some being ovate and short and others being narrowly ovate to over 14 mm long.

It shares similarities to *Ornithoboea lacei* in having a long corolla, short filaments, and the same tall stature. It differs in *Ornithoboea lacei* in having much shorter inflorescences, shorter sepals and fruit with a persistent style.

ACKNOWLEDGEMENTS: We give particular thanks to Hannah Atkins for providing many helpful comments as the revision progressed; Pranee Nangngam for her insights on the genus and for her help with the geography of Thailand and the region in general; Mark Hughes for the maps; and Claire Banks for her excellent illustrations. We also thank the curatorial staff of RBGE for their help with the herbarium materials, Martin Pullan for help with the database, and Carmen Puglisi for sharing her molecular phylogenetic work. Many thanks also to Pranee Nangngam and Preecha Karaket for the additional photographs. We are very grateful to Jana Leong-Škorničková for guiding this paper through the review process and to Low Yee Wen, Ruth Kiew and Pranee Nangngam for their comments on the manuscript.

References

- Burtt, B.L. (1958). Studies in the Gesneriaceae of the Old World XI: The Genus *Ornithoboea*. *Notes Roy. Bot. Gard. Edinburgh* 22: 287–298.
- Burtt, B.L. (2001). Flora of Thailand: annotated checklist of Gesneriaceae. *Thai For. Bull., Bot.* 29: 81–109.
- Clarke, C.B. (1883). Cyrtandreae. In: Candolle, A.L.L.P de & Candolle, A.C.P. de, *Monographiae Phanerogamarum* 5: 1–303.
- Léveillé, H. (1913). LXVIII. Decades plantarum novarum CI–CIII. *Repert. Spec. Nov. Regni Veg.* 11: 492–496.
- McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawkworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W.F., Smith, G.F., Wiersema, J.H., Turland, N.J., International Botanical Congress (2012). *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code)*. Königstein: Koeltz Scientific Books. [Regnum Veg. 154]
- Middleton, D.J. (2012a). *Ornithoboea emarginata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 14 March 2014.
- Middleton, D.J. (2012b). *Ornithoboea leptonema*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 14 March 2014.
- Middleton, D.J. (2012c). *Ornithoboea multitorta*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 14 March 2014.
- Middleton, D.J. (2012d). *Ornithoboea pseudoflexuosa*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 14 March 2014.
- Middleton, D.J. & Lý, N.S. (2008). A new species of *Ornithoboea* (Gesneriaceae) from Vietnam. *Edinburgh J. Bot.* 65: 353–357.
- Middleton, D.J. & Suksathan, P. (2012a). *Ornithoboea barbanthera*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 14 March 2014.
- Middleton, D. & Suksathan, P. (2012b). *Ornithoboea occulta*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 14 March 2014.
- Möller, M., Pfosser, M., Jang, C.-G., Mayer, V., Clark, A., Hollingsworth, M.L., Barfuss, M.H.J., Wang, Y.-Z., Kiehn, M., Weber, A. (2009). A preliminary phylogeny of the “didymocarpoid Gesneriaceae” based on three molecular data sets: Incongruence with available tribal classifications. *Amer. J. Bot.* 96: 989–1010.
- Möller, M., Forrest, A., Wei, Y.-G. & Weber, A. (2011). A molecular phylogenetic assessment of the advanced Asiatic and Malesian didymocarpoid Gesneriaceae with focus on non-monophyletic and monotypic genera. *Pl. Syst. Evol.* 292: 223–248.
- Ridley, H.N. (1909). Gesneriaceae. In: King, G. & Gamble, J.S. Materials for a Flora of the Malayan Peninsula. *J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist.* 74(2): 730–793.
- Thiers, B. [continuously updated]. *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>. (accessed on 1st Apr. 2014)

- Truong, Q.T., Diep, D.P., Hoang, M.D., Le, B.T. & Nguyen, P.N. (2004). Biodiversity in the limestone area of Ha Tien and Kien Luong, Kien Giang province. In: Batalaan, O., Dusar, M., Masschelein, J., Van, T.T., Tam, V.T. & Khien, N.X. (eds) *Proceedings of Trans-KARST 2004 International Transdisciplinary Conference on Development and Conservation of Karst Regions, Ha Noi, Vietnam, 13–18 September 2004*, pp. 233–234. Hanoi: Research Institute of Geology and Mineral Resources (RIGMR).
- Wang, W.T., Pan, K.Y., Li, Z.Y., Weitzman, A.L. & Skog, L.E. (1998). Gesneriaceae. In: Wu, Z.Y. & Raven, P.H. (eds) *Flora of China (Scrophulariaceae through Gesneriaceae)* 18: 244–401. Beijing, and St. Louis: Science Press, and Missouri Botanical Garden Press.
- Weber, A., (2004). Gesneriaceae. In: Kubitzki, K. (ed) *The Families and Genera of Vascular Plants. Vol. 7. Flowering plants. Dicotyledons. Lamiales (except Acanthaceae including Avicenniaceae)*. Berlin, Heidelberg: Springer-Verlag.
- Weber, A., Clark, J.L. & Möller, M. (2013). A new formal classification of Gesneriaceae. *Selbyana* 31: 68–94.
- Wu, C.Y. & Li, H.W. (1983). Notulae De Gesneraceis Yunnanensibus. *Bull. Bot. Res. Harbin* 3(2): 42–44.

