

Molecular and morphological evidence for a remarkable new species of *Leptopus* (Phyllanthaceae) from Southeast Yunnan, China

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Abstract

Leptopus malipoensis, a remarkable new species of Phyllanthaceae from Southeast Yunnan Province, China, is described. The phylogenetic position of the new species within the genus *Leptopus* was analyzed based on nuclear ribosomal **Internal Transcribed Spacer** (nrITS) and plastid *matK* **sequence data**. The results show that *L. malipoensis* is highly supported to be the sister of *L. fangdingianus* (P. T. Li) Voronts. & Petra Hoff., a species endemic to **western** Guangxi Province, China. Morphologically, the new species can be distinguished from all known congeneric taxa by its long and slim branches usually pendulous or procumbent, large leaves up to 15 cm long and 7 cm wide, and further differs from its sister species by its hirsute stems, leaves and pedicel of female flowers, longer pedicel of male flowers, 3-locular ovary and 3 styles. A key to all the *Leptopus* species is provided.

Subjects Biodiversity, Molecular Biology, Plant Science, Taxonomy

Keywords: *Leptopus*, Phyllanthaceae, Poranthereae, taxonomy, Yunnan, China

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Introduction

Leptopus Decne. is a small genus in the tribe Poranthereae, subfamily Phyllanthoideae of Phyllanthaceae and distributed mainly from the Caucasus to Malesia (Vorontsova & Hoffmann, 2009; Webster, 2014). In the latest taxonomic revision of *Leptopus*, nine species were accepted and six among them were recorded in China (Vorontsova & Hoffmann, 2009). Results from molecular phylogenetic analyses showed that *Leptopus* was sister to *Actephila* Blume with high support (Vorontsova et al., 2007; Vorontsova & Hoffmann, 2008). Morphologically, the genus *Leptopus* can be distinguished from its sister clade by its leaves membranous to papery (vs. leathery, rarely papery), disk lobed evidently (vs. annular), fruit less than 10 mm in diameter (vs. more than 10 mm in diameter), exocarp adnate to endocarp (vs. free from endocarp) and mature seed with copious endosperm (vs. seed without endosperm) (Li et al., 2008).

During field investigations in Malipo Hsien, ~~southeast~~ Yunnan Province of China, in March 2018, two of the authors (E.D. Liu and X.X. Zhu) collected a Phyllanthaceae specimen ~~belonging~~ to *Leptopus*, and the same species was collected again in the same locality by another author (G. Yao) in July 2020. The species superficially differs from all the other members of *Leptopus* in morphology. After detailed morphological investigation and molecular phylogenetic analyses of *Leptopus*, it was concluded that the ~~specimens represent a~~ species ~~that~~ is new to science, ~~and~~ formally described here.

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Materials & methods

Ethics statements

The collection location of the new species reported in this study is outside any natural conservation area and no specific permissions were required for the location. Since this species is currently undescribed, it is not currently included in the China Species Red List (Wang & Xie, 2004). Our field studies did not involve any endangered or protected species. No specific permits were required for the present study.

Nomenclature

The electronic version of this article in Portable Document Format (PDF) will represent a published work according to the International Code of Nomenclature for algae, fungi, and plants (ICN), and hence the new names contained in the electronic version are effectively published under that Code from the electronic edition alone. In addition, new names contained in this work which have been issued with identifiers by IPNI will eventually be made available to the Global Names Index. The IPNI can be accessed and the associated information contained in this publication viewed through any standard web browser by using the web address "<http://ipni.org>". The online version of this work is archived and available from the following digital repositories: PeerJ, PubMed Central, and CLOCKSS.

Material collection

Flowering and fruiting specimens of the new species were collected in the mountain

area, in Nandong to Bajiaoping, Laoshan, Malipo Hsien of Yunnan Province, China, for morphological study. Leaf materials for DNA extraction were collected and dried using silica gel in the field.

Morphological study

Specimens of *Leptopus* deposited in the herbaria GXMG, IBK, IBSC, KUN and PE were carefully examined for the present study. Field investigation of Chinese *Leptopus* species were also conducted in recent years. Morphological characters of stems, leaves, flowers and fruits of relevant species were photographed and measured. In addition, morphological comparisons between the new species and all the nine *Leptopus* species accepted by Vorontsova & Hoffmann (2009) were also conducted.

Phylogenetic study

Phylogenetic relationships among species of *Leptopus* were previously investigated by Vorontsova et al. (2007) based on analysis of two DNA regions, viz. the nuclear ribosomal Internal Transcribed Spacer (ITS) and plastid *matK*. To study the phylogenetic position of the new species within the genus *Leptopus*, the two above mentioned DNA regions of the new species were sequenced. Relevant DNA sequences of *Leptopus* species included in Vorontsova et al. (2007) were obtained from GenBank (<https://www.ncbi.nlm.nih.gov/>) and used in the present phylogenetic analyses. Additionally, outgroups were selected from the other seven genera of the tribe Poranthreae [*Actephila* Blume, *Andrachne* L., *Meineckia* Baill., *Notoleptopus* Voronts. & Petra Hoffm., *Phyllanthopsis* (Scheele) Voronts. & Petra Hoffm., *Pseudophyllanthus* (Müll. Arg.) Voronts. & Petra Hoffm. and *Poranthera* Rudge] and the genus *Heywoodia* Sim of the tribe Wielandieae, based on previously published phylogenetic frameworks (Kathriarachchi et al., 2005; Vorontsova et al., 2007). DNA sequences of outgroups were also downloaded from GenBank. Detailed information about the species sampled and DNA sequences are provided in Table 1.

Total DNA of the new species was extracted and then sequenced by genome skimming following the protocol of Zeng et al. (2018). Plastid and the nrITS sequence reads were assembled using the software GetOrganelle (Jin et al., 2020), with the reference plastid genome of *Glochidion chodoense* C.S. Lee & Im (GenBank accession number: NC_042906) and nrITS sequence of *Leptopus chinensis* (Bunge) Pojark. (MH710764), respectively. Genes in the plastid genome obtained were annotated in the software PGA (Qu et al., 2019). The *matK* sequence was then extracted from the assembled whole plastid genome.

Sequences were aligned using MAFFT v. 7.221 (Katoh & Standley, 2013) and then three data sets were constructed: the *matK* dataset, the nrITS dataset and the combined dataset (including *matK* and nrITS). All the three datasets were analyzed using two approaches: Bayesian Inference (BI) and Maximum Likelihood (ML). Detailed information about the parameter settings in the BI and ML analyses referred the phylogenetic analyses conducted in Yao et al. (2020). The models of nucleotide substitution of the two DNA regions used were selected under the Akaike Information Criterion (AIC) using jModelTest v. 3.7 (Posada, 2008): TVM+G for *matK* and

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GTR+I+G for nrITS.

Results & discussion

Phylogenetic analysis

The *matK* dataset, nrITS dataset and combined dataset [alignments](#) contained 2000 bp, 812 bp and 2812 bp, respectively. Conflicted topologies were found between the *matK* and nrITS frameworks ([Fig. 1](#)), but relevant conflicted phylogenetic nodes were all [poorly](#) supported in analyses of the nrITS dataset ([Fig. 1B](#)). Phylogenetic relationships derived from the combined dataset were much better resolved compared with those obtained from analyses based on the other two datasets, and phylogenetic relationships among *Leptopus* species sampled here were all resolved with high [support values](#) ([Fig. 2](#)). Thus we focus on describing phylogenetic relationships based on the result derived from the combined dataset.

Phylogenetic results showed that the genus *Leptopus* was sister to *Actephila* with high support values ([bootstrap](#), BS, = 100%, [posterior probability](#), PP = 1.00), and the monophyly of *Leptopus* was strongly supported (MLBS = 100%, PP = 1.00). Within *Leptopus*, three major clades were recovered. *Leptopus australis* (Zoll. & Moritz) Pojark. represents the earliest divergent clade within this genus. The new species is strongly supported [as](#) the sister of *L. fangdingianus* (P.T. Li) Voronts. & Petra Hoffm. (MLBS = 100%, PP = 1.00) and [this pair in turn](#) sister to *L. clarkei* (Hook. f.) Pojark. (MLBS = 100%, PP = 1.00). *Leptopus chinensis* (Bunge) Pojark. and *L. cordifolius* Decne. formed the third clade and sister to the (new species-*L. fangdingianus*)-*L. clarkei* clade with strong support (MLBS = 100%, PP = 1.00). Furthermore, the sister relationship between the new species and *L. fangdingianus* was highly supported in both of the *matK* ([Fig. 1A](#)) and nrITS ([Fig. 1B](#)) [analyses](#).

Morphological comparisons

Morphologically, the new species has pendulous or procumbent stems ([Fig. 3A–B](#)) and large leaves up to 15 cm long and 7 cm wide. These characters [distinguish](#) it easily from all the other *Leptopus* members, which usually have ascendant or erect stems and smaller leaves less than 10 cm long and 5 cm wide. The procumbent habit is also recorded in *L. clarkei*, a species widely distributed from southern China, extending west to Assam and Burma, and south to northern Vietnam ([Vorontsova & Hoffmann, 2009](#)). [It is](#) also [closely](#) related to the pair of the new species and *L. fangdingianus* [in the phylogenetic analyses](#) ([Figs. 1 and 2](#)). However, the new species differs from *L. clarkei* by having straight and not ribbed stems ([Fig. 3C–F](#)) (vs. flexuous and longitudinally strongly ribbed stems), larger leaves up to 15 cm long and 7 cm wide (vs. less than 10 cm long and 3 cm wide), leaves hirsute on both surfaces ([Figs. 3C–E & 4D](#)) (vs. glabrous adaxially and glabrous to sparsely hirsute abaxially), margin of leaves densely hirsute ([Figs. 3C–E & 4D](#)) (vs. glabrous to hirsute). While the new species differs from its sister *L. fangdingianus* by its leaves hirsute on both surfaces ([Figs. 3C–E & 4D](#)) (vs. glabrous to sparsely hirsute on both surfaces), pedicel of male flowers 10–25 mm long (vs. usually less than 10 mm long), pedicel of female flowers hirsute ([Fig. 4D](#)) (vs. glabrous), ovary 3-locular (vs. 4–5) and styles 3

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(vs. 4–5).

Four species of *Leptopus* [viz., *L. micans* (Dunn) Pojark., *L. hainanensis* (Merr. & Chun) Pojark., *L. pachyphyllus* X.X. Chen and *L. robinsonii* Airy Shaw] were not sampled in the present phylogenetic analyses. Morphologically, the new species also can be easily distinguished from these four congeneric species based on its above-mentioned pendulous or procumbent stems and large leaves. Additionally, the new species has hirsute indumentum, not ribbed branches, chartaceous leaves with 4 (or rarely 5) pairs of secondary veins. In contrast, *L. micans* has glabrous branches longitudinally ribbed and 8–10 pairs of secondary veins in leaves. *Leptopus hainanensis* also has glabrous branches and leaves, as well as 2–3 pairs of secondary veins in leaves. While the other two species *L. pachyphyllus* and *L. robinsonii* both have glabrous and bilaterally flattened branches, and the leaves of *L. pachyphyllus* are glabrous on both sides and almost succulent.

Taxonomic treatment

***Leptopus malipoensis* W.H. Zhang & Gang Yao, sp. nov. (Figs. 3–4)**

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Type. CHINA. Yunnan Province, Wenshan State, Malipo Hsien, Laoshan, Nandong to Bajiaoping, on stone slopes near the roadsides of the semi-shady forests, at the elevation of ca. 1200 m, 15 July 2020, *G. Yao YGYN2020071501* (holotype: IBSC; isotypes: KUN, CANT).

Diagnosis. The species is similar to *L. fangdingianus* (P.T. Li) Voronts. & Petra Hoffm. in morphology, but differs from the latter by its procumbent habit with long and slim branches usually pendulous, larger leaves up to 15 cm long and 7 cm wide, hirsute stems, leaves and pedicel of female flowers, longer pedicel of male flowers, 3-locular ovary and 3 styles.

Description. Shrub, monoecious. Stems straight, terete, hirsute; branchlets long and slim, sometimes up to 1.5 m long, usually pendulous or procumbent, hirsute. Leaves alternate, chartaceous, elliptic to ovate, 2–15 cm long and 1.2–7 cm wide, both surfaces hirsute, densely hirsute when young, margin densely hirsute, base cuneate to round, apex acuminate; midvein adaxially impressed, abaxially raised; secondary veins usually 4 pairs, rarely 3 or 5 pairs, adaxially slightly impressed, abaxially raised, obliquely ascending, sometimes arcuately anastomosing near margins. Petiole 4–12 mm long, hirsute. Stipules narrowly triangular, apically acuminate. Inflorescences unisexual or bisexual, **axillary, fasciculate**. Male flowers 1–3 per fascicle, ca. 3 mm in diameter, light yellow to slightly green; pedicel 10–25 mm long, glabrous; sepals 5, oblong, apically round, adaxially glabrous, abaxially sparsely hirsute, 0–3-veined; petals 5, clavate to slightly linear, alternating with sepals; **disc extrastaminal** with 5 contiguous regular segments deeply **bilobed**, **apices** of lobes truncate to rounded; stamens 5, opposite sepals; filaments 5, free; anthers 5, longitudinally dehiscent. Female flowers usually 1 per fascicle, 3.5–4 mm in diameter; pedicels usually 15–25 mm long, sparsely hirsute, apically dilated **evidently**; sepals 5, oblong to ovate-triangular, apically acute to round, adaxially glabrous, abaxially glabrous or sparsely hirsute, usually 0–5-veined; petals 5, **linear**, alternating with sepals; **disc** with

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256 5 contiguous regular segments deeply bilobed, ~~apices~~ of lobes truncate to rounded;
257 ovary 3-locular, globose, glabrous; styles 3, free, deeply bifid, lobes usually recurved.
258 Fruiting pedicel 2–3 cm long, hirsute; capsules depressed globose, smooth, glabrous
259 or sparsely hirsute when young, 4–6 mm in diameter, 2.5–3 mm high, persistent
260 sepals oblong; seeds 6, brown to dark-brown, hemispheric or laterally compressed, ca.
261 2.5 mm long and 2 mm wide, ~~lacking appendages~~.

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262 **Etymology.** *Leptopus malipoensis* is named after its type locality, Malipo Hsien.
263 Malipo Hsien is a hotspot for biodiversity research in Yunnan Province, China, and
264 many new species ~~have been~~ described recently from there, ~~including~~ *Bredia*
265 *malipoensis* D. H. Peng, S. Jin Zeng & Z.Y. Wen (Wen et al., 2019), *Habenaria*
266 *malipoensis* Q. Liu & W.L. Zhang (Zhang et al., 2017), *Primulina malipoensis* L.H.
267 Yang & M. Kang (Yang et al., 2018), ~~and~~ *Salacia malipoensis* X.D. Ma & J.Y. Shen
268 (Ma et al., 2020).

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269 **Phenology:** Flowering in April to August, ~~and~~ fruiting in May to October.

270 **Paratype:** CHINA. Yunnan Province, Wenshan State, Malipo Hsien, Laoshan,
271 Nandong to Bajiaoping, under the semi-shady forests, at the elevation of 1171 m, 5
272 March 2018, Z.D. Wei, F.Z. Shangguan, X.X. Zhu, et al. LiuED8755 (KUN).

273 **Distribution and habitat:** The species is known only from its type locality, Malipo
274 Hsien in ~~southeast~~ Yunnan Province, China (Fig. 5).

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275 **Habitat.** The species grows on ~~stone~~ slopes near the roadsides of the semi-shady
276 forests or under the semi-shady forests, in limestone environments, at ~~an~~ elevation of
277 1171–1200 m.

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278 **Chinese name.** Ma Li Po Que She Mu (麻栗坡雀舌木)

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280 **Key to species of *Leptopus*, modified from Vorontsova & Hoffmann (2009)**

281 1a. Leaf blades coriaceous, almost succulent; endemic to Guangxi Province,
282 China *L. pachyphyllus*

283 1b. Leaf blades membranaceous to thick chartaceous, never
284 succulent 2

285 2a. Leaf blades with 8–10 visible pairs of secondary veins; fruit strongly reticulate;
286 seed with orange micropylar appendage *L. emicans*

287 2b. Leaf blades with 0–6 (7) visible pairs of secondary veins; fruit smooth to faintly
288 reticulate; seed without appendage 3

289 3a. Ascendant herb to subshrub up to 0.5 m high; female pedicels 2–5 mm in flower,
290 5–9 mm in mature fruit *L. australis*

291 3b. Erect to procumbent herb or shrub 0.5–4 m; female pedicels 5–30 mm in flower,
292 7–36 mm in mature fruit 4

293 4a. Male pedicels less than 3 mm in length 5

294 4b. Male pedicels no less than 3 in length, and usually up to 10 mm or longer 6

295 5a. Branches white to light brown; male petals, filaments and styles mostly
296 glabrous; seeds smooth; endemic to Hainan Province,
297 China *L. hainanensis*

303 5b. Branches reddish; male petals, filaments and styles hirsute; seeds transversely
 304 to irregularly ridged, sometimes pitted; endemic to Khanh Hoa Province,
 305 Vietnam *L. robinsonii*
 306 6a. Stem flexuous; branches strongly ribbed *L. clarkei*
 307 6b. Stem straight; branches terete to moderately ribbed 7
 308 7a. Leaves usually less than 3 cm in length, and never longer than 5
 309 cm *L. chinensis*
 310 7b. Leaves usually longer than 5 cm in length, sometimes even longer than 10 cm
 311 in length 8
 312 8a. Leaves less than 10 cm in length and less than 3.5 cm in width; leaf blades with
 313 4–7 pairs of secondary veins; leaf apex rounded *L. cordifolius*
 314 8b. Leaves sometimes longer than 10 cm and wider than 3.5 cm; leaf blades 4 or 5
 315 pairs of secondary veins; leaf apex acute or acuminate 9
 316 9a. Stems and branchlets usually pendulous or procumbent; ovary 3-locular; styles
 317 3; endemic to Yunnan Province, China *L. malipoensis*
 318 9b. Stems and branchlets ascendant or erect; ovary 4–5-locular; styles 4–5; endemic
 319 to Guangxi Province, China *L. fangdingianus*

320
 321 Adhikari et al. (2010) described the new species *Leptopus nepalensis* B. Adhikari,
 322 R.P. Chaudhary & S.K. Ghimire from Nepal, the holotype (*B. Adhikari* 224, TUCH)
 323 of which had been originally identified as *Phyllanthus griffithii* Müll.Arg. On the
 324 basis of the morphological description provided by Adhikari et al. (2010), the new
 325 species is characterized by its 6 petals in two whorls, 6 stamens (or 3 as observed
 326 from the illustration drawn based on the holotype), and 3 styles connate into a column
 327 up to about halfway. However, all of these characters are very different from those of
 328 the genus *Leptopus* as currently circumscribed (Vorontsova & Hoffmann, 2009;
 329 Webster, 2014). Thus the species *L. nepalensis* is not included in the above key, and
 330 the taxonomic status of the species needs to be clarified in further study, especially in
 331 molecular phylogenetic analysis.

333 Acknowledgements

334 The authors are grateful to the curators and staff of the herbaria GXMG, IBK, IBSC,
 335 KUN and PE for hosting our visits or providing images of specimens, and to Mr.
 336 Long in Malipo Hsien, Laoshan, Yaowang Valley for help in field investigations.

338 REFERENCES

- 339 Adhikari B, Chaudhary RP, Ghimire SK. 2010. A new species of *Leptopus*
 340 (Euphorbiaceae) from Nepal. *Blumea* 55, 162–163. DOI
 341 10.3767/000651910X526898
 342 Jin JJ, Yu WB, Yang JB, Song Y, dePamphilis CW, Yi TS, Li DZ. 2020.
 343 GetOrganelle: a fast and versatile toolkit for accurate de novo assembly of
 344 organelle genomes. *Genome Biol.* 21, 241. DOI 10.1186/s13059-020-02154-5
 345 Kathriarachchi H, Hoffmann P, Samuel R, Wurdack KJ, Chase MW. 2005.
 346 Molecular phylogenetics of Phyllanthaceae inferred from five genes (plastid

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- atpB*, *matK*, *3'ndhF*, *rbcL*, and nuclear *PHYC*). Mol. Phylogenet. Evol. 36, 112–134. d DOI 10.1016/j.ympev.2004.12.002
- Katoh K, Standley DM. 2013.** MAFFT multiple sequence alignment software version 7: improvements in performance and usability. Mol. Biol. Evol. 30, 772–780. DOI 10.1093/molbev/mst010
- Li PT, Qiu HX, Ma JS, Zhu H, Gilbert MG, Esser HJ, Dressler S, Hoffmann P, Gillespie LJ, Vorontsova M, McPherson GD. 2008.** Euphorbiaceae. In: Wu ZY & Raven PH (eds) Flora of China 11. Science Press & Missouri Botanical Garden Press, Beijing and St. Louis, 163–314.
- Ma XD, Wang WG, Shi JP, Shen JY. 2020.** *Salacia malipoensis* (Celastraceae), a new species from Yunnan, China. Ann. Bot. Fenn. 57(1-3), 109–113. DOI 10.5735/085.057.0115
- Posada D. 2008.** JModelTest: phylogenetic model averaging. Mol. Biol. Evol. 25, 1253e1256. DOI 10.1093/molbev/msn083
- Qu XJ, Moore MJ, Li DZ, Yi TS. 2019.** PGA: a software package for rapid, accurate, and flexible batch annotation of plastomes. Plant Methods 15, 50. DOI 10.1186/s13007-019-0435-7
- Vorontsova MS, Hoffmann P, Maurin O, Chase MW. 2007.** Molecular phylogenetics of tribe Poranthereae (Phyllanthaceae; Euphorbiaceae sensu lato). Am. J. Bot. 94(12), 2026–2040. DOI 10.3732/ajb.94.12.2026
- Vorontsova MS, Hoffmann P. 2008.** A phylogenetic classification of tribe Poranthereae (Phyllanthaceae, Euphorbiaceae sensu lato). Kew Bull. 63, 41–59. DOI 10.2307/20443408
- Vorontsova MS, Hoffmann P. 2009.** Revision of the genus *Leptopus* (Phyllanthaceae, Euphorbiaceae sensu lato). Kew Bull. 64, 627–644. DOI 10.2307/27821983
- Wang S, Xie Y. 2004.** China species red list. Beijing: Higher Education Press.
- Webster GL. 2014.** Phyllanthaceae. In: Kubitzki, K. (ed.) Flowering Plant. Eudicots. The Families and Genera of Vascular Plants (Vol. 11). Springer, Berlin, Heidelberg, 74–80.
- Wen ZY, Zen SJ, Fan WL, Zhang GQ, Peng DH. 2019.** *Bredia malipoensis* (Melastomataceae), a new species from Yunnan, China. Phytotaxa 425(3), 127–136. DOI 10.11646/phytotaxa.425.3.2
- Yang LH, Chen JL, Wen F, Kang M. 2018.** *Primulina malipoensis* (Gesneriaceae), a new species from Sino-Vietnamese border area. PhytoKeys 94, 107–116. DOI 10.3897/phytokeys.94.20861
- Yao G, Xue B, Liu K, Li YL, Huang JX, Zhai JW. 2020.** Phylogenetic estimation and morphological evolution of Alsineae (Caryophyllaceae) shed new insight into the taxonomic status of the genus *Pseudocerastium*. Plant Diversity DOI 10.1016/j.pld.2020.11.001
- Zeng CX, Hollingsworth PM, Yang J, He ZS, Zhang ZR, Li DZ, Yang JB. 2018.** Genome skimming herbarium specimens for DNA barcoding and phylogenomics. Plant Methods 14, 43. DOI 10.1186/s13007-018-0300-0
- Zhang WL, Gao JY, Pan B, Qiang L. 2017.** *Habenaria malipoensis* (Orchidaceae: Orchidoideae: Orchidinae), a new orchid species from Yunnan, China. Phytotaxa

401 332(1), 93–97. DOI [10.11646/phytotaxa.332.1.11](https://doi.org/10.11646/phytotaxa.332.1.11)