



Petrocodon hunanensis (Gesneriaceae), a new species identified by both morphological and molecular evidence from limestone area in Hunan, China

XUN-LIN YU^{1*}, MING LI¹, JIAN-JUN ZHOU¹ & PENG-WEI LI²

¹The Dendrological Teaching and Research Team, School of Forestry, Central South University of Forestry & Technology, CN-410004, No. 498, Shaoshan South road, Changsha city, Hunan province, China. E-mail: csfuyuxl@163.com *(author for corresponding), limingjx@126.com, zhoujianjun00188@126.com

²State key Laboratory of Systematic and Evolutionary Botany, Institute of Botany, Chinese Academy of Sciences, Xiangshan Road, Nanxincun 20, Beijing 100093, China. E-mail: pdlc@163.com

Abstract

Petrocodon hunanensis, a new species of Gesneriaceae from limestone area in Hunan Province, China, is described and illustrated. The new species is morphologically similar to *Petrocodon coriaceifolius*, but readily differs from the latter one in the growth form with terrestrial stems and distinct internodes, both surfaces of leaf densely with white pubescence, petiole densely with reddish-purple or white pubescence, zygomorphic corolla white or pale purple and 2–3 cm long, pedicels 0.3–2 (2.8) cm long, 4 stamens and 1 staminode, ovary and capsule stipitate. Molecular evidences indicate that it is systematically similar to *P. hispidus*, but the morphologies of two relatives are obviously different.

Key words: *Calcareoboea*, *Didymocarpus*, *Dolicholoma*, *Lagarosolen*, limestone flora, molecular evidence, new species, *Paralagarosolen*, *Petrocodon*, *Tengia*, *Wentsaiboea*

Introduction

Based on the recent molecular studies (Wang *et al.* 2010; Möller *et al.* 2011; Wang *et al.* 2011; Weber *et al.* 2011a, 2011b; Xu *et al.* 2014), several genera have been integrated into *Petrocodon* Hance (1883: 167), including the monotypic genera *Calcareoboea* C.Y. Wu ex H.W. Li (1982: 241), *Paralagarosolen* Y.G. Wei (2004: 528), *Tengia* Chun (1946: 279), *Dolicholoma* D. Fang & W.T. Wang in Wang (1983: 18), all the species of *Lagarosolen* W.T. Wang (1984: 11), one species of *Wentsaiboea* D. Fang & D.H. Qin (2004: 533) (*Wentsaiboea tiandengensis* Yan Liu & B. Pan 2010: 739), three species of *Didymocarpus* Wall. (1819: 378) (*Didymocarpus niveolanosus* D. Fang & W.T. Wang in Wang & Pan 1982: 133, *Didymocarpus mollifolius* W.T. Wang 1984: 21, *Didymocarpus hancei* Hemsl. 1890: 229) and one species of *Primulina* Hance (1883: 169) (*Primulina guangxiensis* Yan Liu & W.B. Xu in Liu *et al.* 2011: 682). Consequently, the number of species in the genus *Petrocodon* increased to 26, including nine new species published recently, mainly distributed in southern China and northern Vietnam (Wei *et al.* 2010; Jiang *et al.* 2011; Weber *et al.* 2011a; Wen *et al.* 2012; Chen *et al.* 2014; Hong *et al.* 2014; Xu *et al.* 2014). The re-circumscription of *Petrocodon* increased the morphological variability of this genus (Weber *et al.* 2011a). For instance, *Petrocodon scopulorus* (Chun) Y.Z. Wang has an actinomorphic corolla with 4 or 5 stamens, while the other species have zygomorphic corollas and 2 stamens and 2 or 3 staminodes. Moreover, the corolla color and shape now include more types compared to the white and urceolate to campanulate forms of original *Petrocodon*.

During field investigations of the limestone areas of Hunan Province in 2013 and 2014, we collected plants with a corolla shape and leaf blade shape most similar to *Petrocodon coriaceifolius* (Y.G. Wei 2006: 273) Y.G. Wei & Mich. Möller in Weber *et al.* (2011a: 59). However, these plants have 4 stamens and 1 staminode which readily differentiates it from *P. coriaceifolius* (with 2 stamens and 2 staminodes). Eventually, we confirm it as a new species of the newly re-circumscribed genus, *Petrocodon* based on the morphological and molecular data and some relevant literatures (Wang 1984; Wei 2006; Wei *et al.* 2010; Jiang *et al.* 2011; Weber *et al.* 2011a; Wen *et al.* 2012; Chen *et al.* 2014; Hong *et al.* 2014; Xu *et al.* 2014;). Molecular evidences indicate that it is systematically similar to *P. hispidus* (W.T. Wang 1984: 12) A. Weber & Mich. Möller in Weber *et al.* (2011a: 60), but the morphologies of these two relatives are obviously

References

- Chen, W.H., Möller, M., Shui, Y.M., Wang, H., Yang, J.B. & Li, G.Y. (2014) Three new species of *Petrocodon* (Gesneriaceae), endemic to the limestone areas of Southwest China, and preliminary insights into the diversification patterns of the genus. *Systematic Botany* 39(1): 316–330.
<http://dx.doi.org/10.1600/036364414X678189>
- Chun, W.Y. (1946) Gesneriacearum novae Sinicarum. *Sunyatsenia* 6: 271–304.
- Fang, D. & Qin, D.H. *Wentsaiboaea* D. Fang & D. H. Qin (2004) A new genus of the Gesneriaceae from Guangxi, China. *Journal of Systematics and Evolution* 42 (6): 533–536.
- Farris, J.S., Källersjö, M., Kluge, A.G. & Bult, C. (1994) Testing significance of incongruence. *Cladistics* 10(3): 315–319.
<http://dx.doi.org/10.1111/j.1096-0031.1994.tb00181.x>
- Felsenstein, J. (1985) Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 783–791.
<http://dx.doi.org/10.2307/2408678>
- Hance, H.F. (1883) New Chinese Cyrtandreae. *Journal of Botany* 21: 165–170.
- Hemsley, W.B. (1890) Gesneriaceae. In: Forbes, F.B. & Hemsley, W.B. (Eds.) An enumeration of all the plants known from China proper, Formosa, Hainan, Corea, the Luchu Archipelago, and the Island of Hongkong, together with their distribution and synonymy, part VIII. *Journal of the Linnean Society, Botany* 26: 224–234.
<http://dx.doi.org/10.1111/j.1095-8339.1890.tb00106.x>
- Hong, X., Zhou, S.B. & Wen, F. (2014) *Petrocodon villosus* (Gesneriaceae), a new species from Guangxi, China. *Blumea* 59: 33–36.
<http://dx.doi.org/10.3767/000651914X682378>
- Jiang, Y.S., Zhang, Y., Wang, Y. & Wen, F. (2011) *Petrocodon multiflorus* sp. nov. (Gesneriaceae) from Guangxi, China. *Nordic Journal of Botany* 29: 57–60.
<http://dx.doi.org/10.1111/j.1756-1051.2010.00874.x>
- Larkin, M.A., Blackshields, G., Brown, N.P., Chenna, R., McGettigan, P. A., McWilliam, H., Valentin, F., Wallace, I.M., Wilm, A., Lopez, R., Thompson, J.D., Gibson, T.J. & Higgins, D.G. (2007) Clustal W and Clustal X version 2.0. *Bioinformatics* 23(21): 2947–2948.
<http://dx.doi.org/10.1093/bioinformatics/btm404>
- Li, H.W. (1982) Two new genera and one little known genus of Gesneriaceae from Yunnan. *Acta Botanica Yunnanica* 4: 241–247.
- Li, J.M. & Wang, Y.Z. (2007) Phylogenetic reconstruction among species of *Chiritopsis* and *Chirita* sect. *Gibbosaccus* (Gesneriaceae) based on nrDNA ITS and cpDNA *trnL-F* sequences. *Systematic Botany* 32: 888–898.
<http://dx.doi.org/10.1600/036364407783390764>
- Liu, Y., Xu, W.B. & Huang, Y.S. (2011). *Primulina guangxiensis* sp. nov. (Gesneriaceae) from a karst cave in Guangxi, China. *Nordic Journal of Botany* 29(6): 682–686.
<http://dx.doi.org/10.1111/j.1756-1051.2011.01089.x>
- Liu, Y., Xu, W.B. & Pan, B. (2010) *Wentsaiboaea tiandengensis* sp. nov. and *W. luochengensis* sp. nov. (Gesneriaceae) from Karst caves in Guangxi, southern China. *Nordic Journal of Botany* 28(6): 739–745.
<http://dx.doi.org/10.1111/j.1756-1051.2010.00893.x>
- 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. *Plant Systematics and Evolution* 292: 223–248.
<http://dx.doi.org/10.1007/s00606-010-0413-z>
- 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. *American Journal of Botany* 96: 989–1010.
<http://dx.doi.org/10.3732/ajb.0800291>
- Nylander, J.A.A. (2004) MrModeltest v2. Program distributed by the author. Evolutionary Biology Centre, Uppsala University, Sweden. Available from: <http://www.downloadatoz.com/developer-johan-nylander.html/> (12 February 2011).
- Rogers, S.O. & Bendich, A.J. (1988) Extraction of DNA from plant tissues. In: Gelvin, S.B. & Schilperoort, R.A. (Eds.) *Plant Molecular Biology Manual*. Dordrecht: Kluwer Academic Publishers A6.
- Ronquist, F. & Huelsenbeck, J.P. (2003) MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics* 19(12): 1572–1574.
<http://dx.doi.org/10.1093/bioinformatics/btg180>
- Swofford, D.L. (2002) *PAUP*: phylogenetic analysis using parsimony (*and other methods)*. version 4. Sinauer, Sunderland, Massachusetts.
- Taberlet, P., Gielly, L., Pautou, G. & Bouvet, J. (1991) Universal primers for amplification of three non-coding regions of chloroplast

- DNA. *Plant molecular biology* 17(5): 1105–1109.
<http://dx.doi.org/10.1007/bf00037152>
- Wallich, N. (1819) Notice of the progress of botanical science in Bengal. *Edinburgh Philosophical Journal* 1: 376–381.
- Wang, W.T. (1983) Three new genera of Gesneriaceae from China. *Bulletin of Botanical Research* 1: 15–24.
- Wang, W.T. (1984) Notulae de Gesneriaceis Sinensibus VI. *Acta Botanica Yunnanica* 6: 11–26.
- Wang, W.T. & Pan, K.Y. (1982) Notulae de Gesneriaceis Sinensibus (III). *Bulletin of Botanical Research* 2(2): 121–152.
- Wang, Y.Z., Liang, R.H., Wang, B.H., Li, J.M., Qiu, Z.J., Li, Z.Y. & Weber, A. (2010) Origin and phylogenetic relationships of the Old World Gesneriaceae with actinomorphic flowers inferred from ITS and *trnL-trnF* sequences. *Taxon* 59(4): 1044–1052.
- Wang, Y.Z., Mao, R.B., Liu, Y., Li, J.M., Dong, Y., Li, Z.Y. & Smith, J.F. (2011) Phylogenetic reconstruction of *Chirita* and allies (Gesneriaceae) with taxonomic treatments. *Journal of Systematics and Evolution* 49: 50–64.
<http://dx.doi.org/10.1111/j.1759-6831.2010.00113.x>
- 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. (2011b) Molecular systematics and remodelling of *Chirita* and associated genera (Gesneriaceae). *Taxon* 60(3): 767–790.
- Weber, A., Wei, Y.G., Puglisi, C., Wen, F., Mayer, V. & Möller, M. (2011a) A new definition of the genus *Petrocodon* (Gesneriaceae). *Phytotaxa* 23: 49–67.
- Wei, Y.G. (2004) *Paralagarosolen* Y.G. Wei, a new genus of the Gesneriaceae from Guangxi, China. *Journal of Systematics and Evolution* 42: 528–532.
- Wei, Y.G. (2006) A new species of *Lagarosolen* W.T. Wang (Gesneriaceae) from Guangxi province, China. *Kew bulletin* 61: 273–275.
- Wei, Y.G., Wen, F., Möller, M., Monro, A., Zhang, Q., Gao, Q., Mou, H.F., Zhong, S.H. & Cui, C. (2010) *Gesneriaceae of South China*. Guangxi Science and Technology Publishing House, Nanning, 777 pp.
- Wen, F., Liang, G.Y. & Wei, Y.G. (2012) *Petrocodon lancifolius* (Gesneriaceae), a new species endemic to a central subtropical zone of Guizhou Province, China. *Phytotaxa* 49: 45–49.
- Wendel, J.F., Schnabel, A. & Seelanan, T. (1995) Bidirectional interlocus concerted evolution following allopolyploid speciation in cotton (*Gossypium*). *Proceedings of the National Academy of Sciences* 92(1): 280–284.
<http://dx.doi.org/10.1073/pnas.92.1.280>
- Xu, W.B., Meng, T., Zhang, Q., Wu, W.H., Liu, Y. & Chung, K.F. (2014) *Petrocodon* (Gesneriaceae) in the limestone karsts of Guangxi, China: three new species and a new combination based on morphological and molecular evidence. *Systematic Botany* 39(3): 965–974.
<http://dx.doi.org/10.1600/036364414X681437>

Appendix 1. GenBank accession numbers (Species: *trnL-F* / ITS).

Petrocodon coriaceifolius (Y.G. Wei) & Mich. Möller: HQ632943/ HQ633040; *Petrocodon dealbatus* Hance: FJ501537/ FJ501358; *Petrocodon hancei* (Hemsl.) A. Weber & Mich. Möller: HQ632944/ HQ633041; *Petrocodon hispidus* (W.T. Wang) A. Weber & Mich. Möller: HQ632939/ HQ633036; *Petrocodon niveolanosus* (D. Fang & W.T. Wang) A. Weber & Mich. Möller: JF697588/ JF697576; *Petrocodon scopulorum* (Chun) A. Weber & Mich. Möller: HQ632947/ HQ633044; *Chirita anachoreta* Hance: DQ872820/ DQ872837; *Chirita pumila* D. Don: FJ501491/ FJ501327; *Didymocarpus cortusifolius* (Hance) Levl.: HQ632898/ HQ632995; *Primulina heterotricha* (Merr.) Y.Z. Wang: DQ872816/ DQ872826; *Primulina tabacum* Hance: AJ492300/ FJ501352.

Appendix 2. Voucher with collection locality and herbarium where deposited in.

Petrocodon hunanensis X. L. Yu & Ming Li: J.J. Zhou 14082801, Hunan, China (CSFI); *Petrocodon mollifolius* (W.T. Wang) A. Weber & Mich. Möller: LJM 2012001, Yunnan, China (PE); *Didymocarpus yunnanensis* (Franch.) W.W. Smith: LPW 2012028, Sichuan, China (PE).