Phytotaxa 376 (1): 060–067
http://www.mapress.com/j/pt/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

https://doi.org/10.11646/phytotaxa.376.1.6

The true *Tectaria chinensis* (Tectariaceae): morphology, distribution, and allied species

SHI-YONG DONG[1*], SHI-SHI TAN[1,2], VAN THE PHAM[3] & KE LOC PHAN[4]

[1]*Key Laboratory of Plant Resources Conservation and Sustainable Utilization, South China Botanical Garden, Chinese Academy of Sciences, Guangzhou 510650, China.*
[2]*University of Chinese Academy of Sciences, Beijing 10093, China.*
[3]*Center of Scientific Research and Practice, Thu Dau Mot University, Binh Duong, Vietnam.*
[4] *VNU University of Science, Hanoi, Vietnam.*
[*]*Author for correspondence (dongshiyong@scib.ac.cn)*

Abstract

Tectaria chinensis is a poorly known species from China, with its type being the sole authentic voucher to date. Recent field observations and morphological comparisons reveal its type being an incomplete frond, which resulted in the constant misinterpretation of some morphological characters and the allied species to *T. chinensis*. In fact, *T. chinensis* is a very special species restricted in southern China and northern Vietnam and featured by the unique long and erect caudex and the rare combination of partly free venation and vein-dorsal sori. Phylogenetically, *T. chinensis* was revealed by our previous analyses of five plastid regions to be in the *Ctenitopsis* group (Clade III or *T.* subg. *Ctenitopsis*), forming a sister clade to the lineage of *T. fuscipes*. A detailed description, explanatory illustrations, as well as distribution and habitat information of *T. chinensis* are provided.

Keywords: China, morphology, taxonomy, *Tectaria*, Vietnam

Introduction

Tectaria Cavanilles (1799: 115; Tectariaceae) is a large pantropical genus of about 250 species, with most species diversity in SE Asia (Holttum, 1991). It had been one of the most controversial genera of ferns in terms of generic circumscription before the advent of molecular data in recent years (Ding *et al*. 2014). Most segregates allied to *Tectaria*, such as *Aenigmopteris* Holttum (1984: 3), *Cionidium* T. Moore (1857: xcviii), *Ctenitopsis* Ching ex Tardieu & C. Chr. (1938: 86), *Dictyoxiphium* Hooker (1840: 62), *Fadyenia* Hooker (1840: 53), *Hemigramma* Christ (1907: 170), *Heterogonium* C. Presl (1851: 142), *Psomiocarpa* C. Presl (1851: 161), *Quercifilix* Copeland (1928: 408), and *Tectaridium* Copeland (1926: 329), were strongly supported to be among *Tectaria* by molecular studies (Schuettpelz & Pryer 2007, Ding *et al*. 2014, Wang *et al*. 2014, Zhang *et al*. 2016 & 2017, Chen *et al*. 2018, Dong *et al*. 2018, Zhou *et al*. 2018). The monophyletic *Tectaria* was resolved to four major lineages, with one occurring in the Neotropics and three in the Old World (Ding *et al*. 2014, Zhang *et al*. 2017, Dong *et al*. 2018). Of the three major clades in the Old World, Clade III (*Ctenitopsis* group, Ding *et al.* 2014; or *T.* subg. *Ctenitopsis* (Ching ex Tardieu & C. Christensen 1938: 86) Li Bing Zhang & Liang Zhang (2018: 195); Zhang & Zhang 2018) is generally characterized by the fully or partly free venation and the regularly arranged sori which are terminal on free veins and in two rows between main lateral veins; Clade IV (Core *Tectaria* or *T.* subg. *Phlebiogonium* (Fée) Li Bing Zhang & Liang Zhang (2018: 196) is featured mainly by fully anastomosing veins (with sori variously arranged between veins); while the species in Clade II (*T. subtriphylla* group or *T.* sect. *Lenda* (Koidz.) Li Bing Zhang & Liang Zhang (2018: 197) are morphologically the most diverse, lacking a common, supporting character (Dong *et al*. 2018).

When conducting field observations for a taxonomic revision of *Tectaria* from China and neighbouring areas in recent years, we found a very interesting species at the border between China and Vietnam. In the shape and division of lamina and in venation, it resembles *T. multicaudata* (Clarke 1880: 540) Ching (1931: 20) but differs in having the constantly long, erect caudices (up to 40 cm long) and sori being dorsal on anastomosing or free veins and exindusiate. The remarkable long caudex and the combination of partly free venation (just forming costal and costular areoles,

 Accepted by Li-Bing Zhang: 6 Nov. 2018; published: 15 Nov. 2018

additional areoles few and without included veinlets) and vein-dorsal sori render this species very special in all known species of *Tectaria*. We thought it doubtlessly an undescribed species since there is no such a long, erect caudex recorded for a species in *Tectaria* and for those with similar architecture of lamina and venation in China and Vietnam, such as *T. multicaudata*, *T. coadunata* (Smith 1842: 184) C. Christensen (1931:331)*, T. remotipinna* Ching & Chu H. Wang (1981: 129), the sori are uniformly terminal on free veins (included in areoles or not) and indusiate.

To determine the systematic position and possible affinity of this unknown species, we conducted phylogenetic analyses based on the sequences of five plastid regions. The sample of this species (labelled as *Tectaria* sp. 4 in Dong *et al.* 2018) was resolved in Clade III (*Ctenitopsis* group), forming a sister to the lineage of *T. fuscipes* (Wallich ex Beddome 1876: 15) C. Christensen (1931: 290) (Dong *et al*. 2018). When reviewing the sampling of our phylogenetic analyses to ensure that all known species (rather than those with similar morphology to the unknown species) in China had been included, we found our neglect of a significant species, *T. chinensis* (Ching & Chu H. Wang 1981: 124) Christenhusz (2010: 58). *Tectaria chinensis* is hitherto poorly presented in herbarium, with its type as the sole authentic voucher. The type was collected in 1955 from southern Yunnan (just at the border to Vietnam) and was described with the basal pinnae having the peculiar shape as in *Heterogonium* (the basal pinnae with their basal basiscopic segments reduced) (Ching & Wang 1983, Wang 1999, Cheng 2005, Xing *et al*. 2013). When we compared the intended new species with the type of *T. chinensis*, we immediately realized that they are conspecific because *T. chinensis* has the rare combination of partly free venation and vein-dorsal sori; such combination has not been found in other species of *Tectaria* from China and Vietnam. A thorough examination showed that the type of *T. chinensis* is an incomplete frond, with the basal pinnae missing. Since the description of *T. chinensis* in either regional flora (e.g. Cheng 2005) or national flora (Wang 1999, Xing *et al*. 2013) was based on a misinterpreted type specimen, we think it is necessary and meaningful to provide accurate knowledge for this species in morphology and in specific relationship. Geographically, *T. chinensis* is also updated to be in southern Yunnan, China and in northern Vietnam (Ha Giang and Lao Cai), instead of being endemic to China.

Taxonomic Treatment

Tectaria chinensis (Ching & Chu H. Wang) Christenhusz (2010: 58). Fig. 1, 2.

Basionym:—*Ctenitopsis chinensis* Ching & Chu H. Wang (1981: 124).

Type:—CHINA. Yunnan: Hekou, in 1955, elev. 100 m, *Department of Biology, Yunnan University* (*DBYU*) *512* (holotype PE!)

Caudex erect, usually 15–40 cm long, 1–2 cm thick. Stipe 40–60 cm long, stramineous or dark brown, minutely hairy and scaly throughout, scales lanceolate, 7–8 × 1.2–1.5 mm at base, rather copious, becoming smaller and fewer to rachis, dark brown or light castaneous. Fronds more or less dimorphic, with fertile laminae little contracted and smaller than sterile ones, lamina ovate, 25 × 20 to 85 × 50 cm, 2- to 3-pinnatifid, round at base, terminal part pinnatifid and acute at apex; free pinnae 2–5 (6) pairs, opposite or nearly so, deeply lobed to costae or 1-pinnate at base, basal pinnae the largest, 14 × 6 to 35 × 22 cm, ovate or triangular, broadest at base, with stalks 0.5–3.5 cm long, pinnatifid and acute toward apex, upper pinnae narrowly triangular or oblong, 12 × 3 to 25 × 17 cm, deeply lobed to the wing of costae; free pinnules 0–2 pairs, falcate, lobed halfway or more deeper to costules, the basal basiscopic one on basal pinna the largest, 8 × 2 to 18 × 6 cm, sessile or nearly so, basiscopic pinnules much longer than acroscopic ones on basal pinna, ultimate lobes entire, acute at apex. Veins anastomosing along costae and costules, forming a row of areoles on either side of costae and costules, additional areoles few, no free veinlets included in areoles, veins outside costular areoles free; adaxial surface more densely hairy on midribs of pinnae, no hairs present on abaxial surface except those on costae and costules. Sori round or rarely slightly elongated, separate, less than 1 mm in diam., dorsal on anastomosing veins or free veins near margin of lamina, mostly in two rows between lateral veins in ultimate lobes, exindusiate.

Distribution:—Restricted to southern China and northern Vietnam. In China: southern Yunnan (Hekou, Jinping, Lüchun, Mengla, and Xichou); in Vietnam: Ha Giang (Cao Bo, Vi Xuyen Distr.), Lao Cai (Nam Xe, Van Ban Distr.). This is the first time to confirm *T. chinensis* in Vietnam. It is also highly expected to find this species in northern Laos.

Habitat:—Terrestrial, on slope beside stream in closed forest in valley, elev. 120–1250 m.

Additional specimens examined:—CHINA. **Yunnan**: Hekou (Nanxi), 27 March 1987, *W.M. Chu et al. 21939* (PYU!); Jinping (Ma'andi), 103°29′19″E, 22°46′38″N, 30 Oct 2017, *S.Y. Dong 4789* (IBSC!); Lüchun (Qimaba), 22°49′12″N, 102°15′15″E, 28 Oct 2015, *S.Y. Dong 4343* (IBSC!); Mengla (Mengla Town), 21°36′N, 101°35′E, Mar

2000, *B.G. Li 0908247* (HITBC!); ibid., 21°35′N, 101°34′E, 23 Oct 2015, *S.Y. Dong 4291*, *4310 & 4312* (IBSC!); ibid., 21°36′N, 101°33′E, 24 Oct 2015, *S.Y. Dong 4335* (IBSC!); Xichou (Bolin), 18–19 March 1987, *W.M. Chu et al. 21809 & 21811* (PYU!).

FIGURE 1. Holotype of *Tectaria chinensis* (Ching & Chu H. Wang) Christenh (*DBYU 512* at PE), an incomplete frond with the basal pinnae missing.

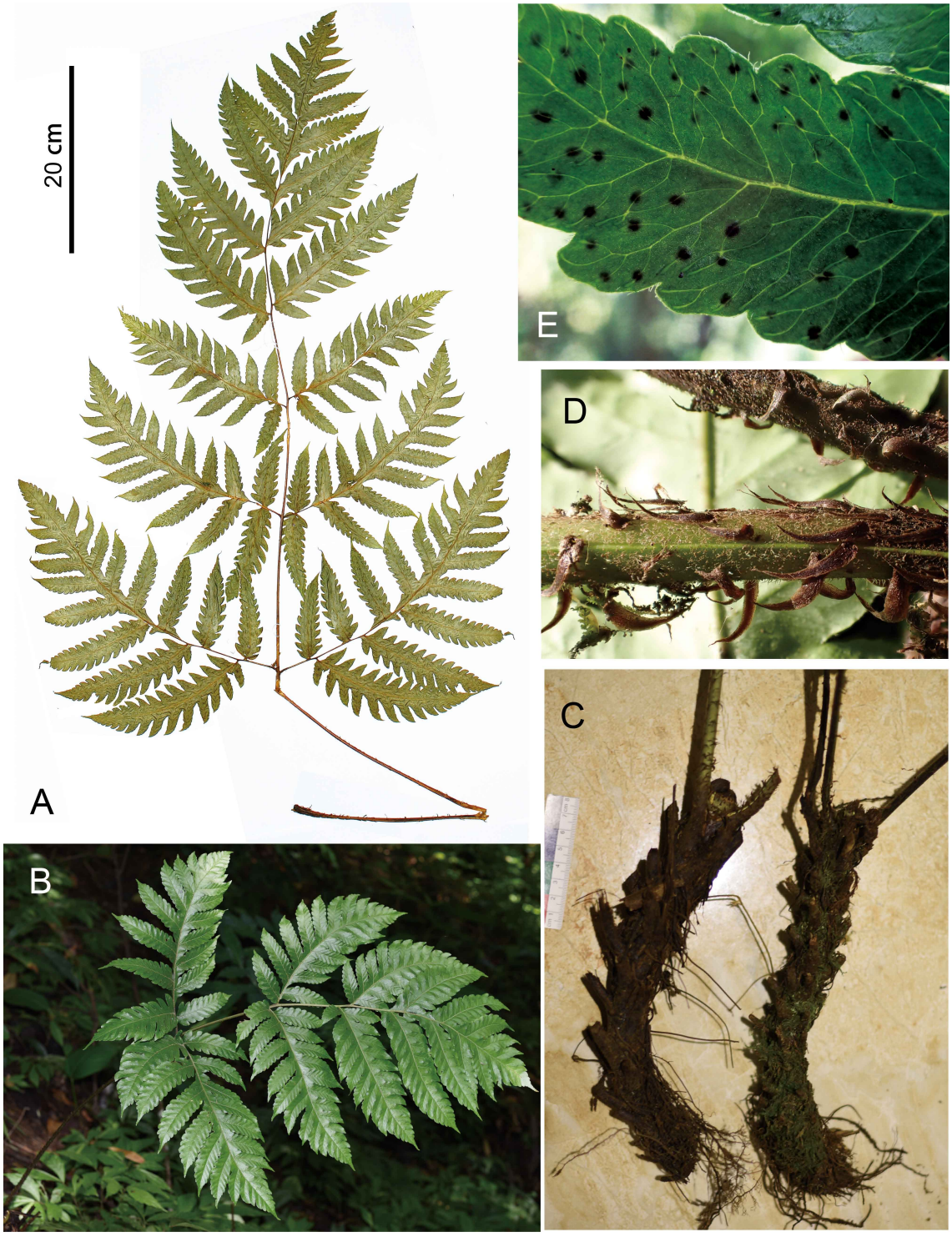

FIGURE 2. *Tectaria chinensis* (Ching & Chu H. Wang) Christenh. A & B, habit. C, two long, erect caudices. D, scales on lower stipe. E, part of fragment on upper lamina, showing veins forming costal areoles and sori on anastomosing veins or dorsal on free veins. (A from *Dong 4343* at IBSC, B–E from *Dong 4789* at IBSC).

VIETNAM. **Ha Giang**: Tham Ve Village nearby, Cao Bo, Vi Xuyen Distr., 22°44′36″N, 104°54′09″E, 19 Nov 2017, *S.Y. Dong 4855* (HNU!, IBSC!). **Lao Cai**: Nam Si Tan Village, Nam Xe, Van Ban Distr., 22°02′31–57″N, 103°58′32-35″E, 26 Feb 2001, *D.K. Harder et al. 6911* (HN!).

Note:—The type of *Tectaria chinensis*, *DBYU 512* (PE), is actually an incomplete frond that consists of a broken stipe and a lamina without basal pinnae (Fig. 1). The lowest pinnae seen on the sheet of type specimen was mistakenly regarded as the basal pinnae by Ching & Wang (1981), which leaded them and later authors (Wang 1999, Cheng 2005, Xing *et al*. 2013) to associate this species with *Ctenitopsis subsageniacea* sensu Ching (1938: 311) [= *T. austrosinensis*

(Christ 1907: 145) C. Christensen (1934: 177) (Dong 2017)], a species with the basal basiscopic lobes reduced on basal pinnae. Based on the misinterpretation of *T. chinensis*, we had never associated our new collections featured by long-erect caudices with *T. chinensis* because in the new collections the basal basiscopic pinnules of basal pinnae are constantly produced (Fig. 2). On the other hand, of all known species in *Tectaria* from China *T. chinensis* is the only dubious species which is poorly presented in herbarium; this fact reminded us to connect our new collections featured by remarkable long caudex with *T. chinensis*. The overall similarity, especially the consistent venation and sori positions between the new collections and the type of *T. chinensis* makes it sure that our new collections are just the individuals of *T. chinensis*. Now it is clear that *T. chinensis* is with the basal basiscopic pinnules being produced on basal pinnae and is not at all similar to *T. austrosinensis*.

Tectaria chinensis is very special by having remarkable caudices (up to 40 cm), which, as far as we know, was not observed or recorded for any other species in *Tectaria*. Based on our observations in the field and in herbaria, the rhizome in *Tectaria* can be determined as two basic states, erect and creeping (Ding *et al*. 2014). For the erect state, the rhizome measures generally 2–3 cm tall or rarely to c. 8 cm; in the latter cases, the erect rhizome is as thick as c. 5 cm in diameter and mainly consists of the remained, crowded stipe-bases of old fronds in many years. The caudex, however, occurring in *T. chinensis* is a different state which is not very thick and apparently long, measuring 1–2 cm in diameter and 15–40 cm tall. As mentioned above, the long, erect caudex is not occasional in *T. chinensis*; it stably occurs in all seven populations we have met in the field. As the seven populations all were found in closed forest where the light is poor, we suppose that the erect caudex of *T. chinensis* might be a habitat adaptation which allows the plant to get more sunlight in the deep shade of rainforest in valley.

Besides the long, erect caudex, the combination of the partly free venation and the vein-dorsal sori position in *T. chinensis* is also very rare. *Tectaria chinensis* is the sole species in *Tectaria* from China and Vietnam which is featured by the veins forming costal and costular areoles (lacking free included veinlets) combined with sori dorsal on anastomosing veins (as well dorsal on free veins). In the whole range of Indochina, there are only two species, *T. chattagramica* (Clarke 1880: 548) Ching (1931: 35) and *T. tenerifrons* (Hooker 1864: 104) Ching (1931: 34), possessing the similar venation and the sori feature as in *T. chinensis*. Evidently *T. chinensis* is very different from the two species in other characters, such as the long-erect caudex (short in *T. chattagramica* or long-creeping in *T. tenerifrons*), copiously scaly stipe (glabrous in both *T. chattagramica* and *T. tenerifrons*), and dark brown stipe and rachis (polished and castaneous in *T. chattagramica* or light stramineous in *T. tenerifrons*). These two species (*T. chattagramica* and *T. tenerifrons*) have not been recorded in either China or Vietnam. The former is distributed mainly in northeastern India and nearby regions (Tagawa & Iwatsuki 1988), with one collection so far known from northern Thailand (*Hansen et al. 11254* at K!); and *T. tenerifrons* is known in northern and southwestern Thailand, southern Burma, and Laos (Tagawa & Iwatsuki 1988, Lindsay & Middleton 2012). As for the sympatric species which share similar lamina division and venation with *T. chinensis*, such as *T. coadunata*, *T. devexa* (Kunze 1848: 259) Copeland (1907: 415)*, T. multicaudata*, and *T. remotipinna* Ching & C.H. Wang (1981: 129), the sori in these species are mostly terminal on free veins (included in areoles or not) and are not dorsal on those forming costal and costular areoles as in *T. chinensis*. In addition, the sori are large and distinctly indusiate in these sympatric species, making the sori-exindusiate *T. chinensis* very remarkable in *Tectaria* from China and Vietnam.

Morphologically *T. chinensis* is most close to *T. multicaudata*, both having the same pattern of lamina division, the similar venation (veins forming costal and costular areoles), and with copious scales throughout stipe. However, molecular evidence did not support the very close relationship between *T. chinensis* and *T. multicaudata*. In the phylogenetic tree based on five plastid regions (Fig. 1 in Dong *et al*. 2018), *T. multicaudata* was placed on the base of one of two subclades in Clade III (*Ctenitopsis* group), being sister to the remaining species including *T. austrosinensis* and *T. chinensis*; while *T. chinensis* (then labelled as *T.* sp. 4) was supported as sister to the *T. fuscipes* lineage which includes free-veined *T. dissecta* (Forster 1786: 81) Lellinger (1968: 156), *T. setulosa* (Baker 1890: 265) Holttum (1988: 479), and an undescribed species (labelled as *T.* sp. 1). *Tectaria chinensis* seems to be an isolated species in *Tectaria* and so far the close affinity of *T. chinensis* has not been found.

Key to *Tectaria chinensis* and those with similar pattern in lamina shape (basal pinnae prolonged at basal basiscopic side) and venation (partly free, with costal areoles) in China and Indochina

1. Sori dorsal on anastomosing veins, exindusiate 2
- Sori terminal on free veinlets either included in or outside areoles, indusiate 4
2. Rhizome long-creeping; stipe and rachis slender, stramineous; lamina thin herbaceous, much hairy abaxially ..... *T. tenerifrons* (Hooker 1864: 104) Ching (1931: 34)
- Erect caudex present; stipe and rachis dark brown or castaneous; lamina thick herbaceous, abaxially hairless 3
3. Caudex 15–40 cm tall; stipe and rachis dark brown, with quite a few scales ..... *T. chinensis* (Ching & Chu H. Wang 1981: 124) Christenhusz (2010: 58)
- Caudex less than 5 cm tall; stipe and rachis castaneous, without scales beyond base of stipe ..... *T. chattagramica* (Clarke 1880: 548) Ching (1931: 35)
4. Veins forming one row of areoles along either side of costae, additional areoles few; lamina thin herbaceous ..... *T. devexa* (Kunze 1848: 259) Copeland (1907: 415)
- Anastomosis much more; lamina thick herbaceous 5
5. Stipe scaly throughout, scales ovate, more or less appressed ..... *T. multicaudata* (Clarke 1880: 540) Ching (1931: 20)
- Scales restricted on base of stipe, spreading 6
6. Stipe scales lanceolate, not very firm; costae and costules obviously hairy on abaxial surface ..... *T. coadunata* (J. Smith 1842: 184) C. Christensen (1931: 331)
- Stipe scales narrowly lanceolate or acicular, firm and straight; costae and costules abaxially glabrous or nearly so ..... *T. remotipinna* Ching & Chu H. Wang (1981: 129)

Acknowledgements

We would like to thank the curator and staff at BM, BO, E, GAUA, HITBC, HN, HNU, IBK, IBSC, K, KEP, KUN, L, LAE, P, PE, PNH, PYU, SAN, SING, SNP, TAIF, and UKMB for allowing access to their collections. We are grateful to Yan-Fen Chang, Jian-Ying Xiang, and Gui-Liang Zhang for their assistance in the field of Yunnan. This study is supported by National Nature Science Foundation of China (grant nos 31270258 & 31670203).

References

Baker, J.G. (1890) Tonquin ferns. *Journal of Botany, British and Foreign* 28: 262–268.

Beddome, R.H. (1876) *Supplement to the Ferns of Southern India and British India*. Gantz Brothers, Madras, 28 pp. & 46 pls.

Cavanilles, A.J. (1799) Helechos propiamente dichos, esto es, Helechos dorsíferos. *Anales de Historia Natural* 1: 109–115.

Chen, C.-W., Rothfels, C.J., Mustapeng, A.M.A., Gubilil, M., Karger, D.N., Kessler, M. & Huang, Y.-M. (2018) End of an enigma: *Aenigmopteris* belongs in *Tectaria* (Tectariaceae: Polypodiopsida). *Journal of Plant Research* 131: 67–76. http://dx.doi.org/10.1007/s10265-017-0966-9

Cheng, X. (2005) Aspidiaceae. *In*: Cheng, X. (Ed.) *Flora Yunnanica*, *vol. 21*. Science Press, Beijing, pp. 160–212.

Ching, R.-C. & Wang, C.-H. (1981) Breviarum plantarum novarum Aspidacearum Sinicarum. *Acta Phytotaxonomica Sinica* 19: 118–130.

Ching, R.-C. & Wang, C.-H. (1983) Materiae ad floram filicum Sinensium. *Acta Phytotaxonomica Sinica* 21: 211–218.

Ching, R.-C. (1931) The studies of Chinese ferns VII, a revision of the genus *Tectaria* from China and Sikkim-Himalaya. *Sinensia* 2: 9–36.

Ching, R.-C. (1938) A revision of the Chinese and Sikkim Himalaya *Dryopteris* with reference to some species in the neighbouring regions. 7. *Ctenitopsis*. *Bulletin of the Fan Memorial Institute of Biology, Botany* 8: 304–322.

Christ, H. (1907) Filices Yunnanenses Duclouxianae. *Bulletin de l'Académie Internationale de Géographie Botanique* 1907: 129–151.

Christ, H. (1907) Spiciligium filicum Philippinensium novarum aut imperfecte cognitarum. *The Philippine Journal of Science* 2: 153–188.

Christenhusz, M.J.M. (2010) New combinations in the fern genus *Tectaria* (Tectariaceae) for the Flora of China. *Phytotaxa* 10: 58–59. http://dx.doi.org/10.11646/phytotaxa.10.1.9

Christensen, C. (1931) Asiatic Pteridophyta collected by Joseph F. Rock 1920–1924. *Contributions from the United States National Herbarium* 26: 265–337.

Christensen, C. (1934) *Index Filicum*, *Supplementum Tertium*. H. Hagerup, Copenhagen, 219 pp.

Clarke, C.B. (1880) A revision of the ferns of northern India. *The Transactions of the Linnean Society of London II, Botany* 1: 425–611.

Copeland, E.B. (1907) A revision of *Tectaria* with special regard to the Philippine species. *The Philippine Journal of Science* 2: 409–

418.
Copeland, E.B. (1926) Filices aliquot novae orientales. *The Philippine Journal of Science* 30: 325–331.
Copeland, E.B. (1928) *Leptochilus* and genera confused with it. *The Philippine Journal of Science* 37: 333–416.
Ding, H.-H., Chao, Y.-S., Callado, J.R. & Dong, S.-Y. (2014) Phylogeny and character evolution of the fern genus *Tectaria* (Tectariaceae) in the old world inferred from chloroplast DNA sequences. *Molecular Phylogenetics and Evolution* 80: 66–78.
http://dx.doi.org/10.1016/j.ympev.2014.06.004
Dong, S.-Y. (2017) Correction to the misapplication of the name *Tectaria subsageniacea* (Tectariaceae) in China. *Phytotaxa* 313: 217–221.
http://dx.doi.org/10.11646/phytotaxa.313.2.8
Dong, S.-Y., Chen, C.-W., Tan, S.-S., Zhao, H.-G., Zuo, Z.-Y., Chao, Y.-S. & Chang, Y.-H. (2018) New insights on the phylogeny of *Tectaria* (Tectariaceae), with special reference to *Polydictyum* as a distinct lineage. *Journal of Systematics and Evolution* 56: 139–147.
http://dx.doi.org/10.1111/jse.12292
Forster, G. (1786) Florudlae Insularum Australium Prodromus. Gottingae, 103 pp.
https://doi.org/10.5962/bhl.title.10725
Holttum, R.E. (1984) Studies in the fern-genera allied to *Tectaria* III. *Aenigmopteris* and *Ataxipteris*, two new genera allied to *Tectaria* Cav., with comments on *Psomiocarpa* Presl. *Blumea* 30: 1–11.
Holttum, R.E. (1988) Studies in the fern genera allied to *Tectaria* Cav. VII. Species of *Tectaria* sect. *Sagenia* (Presl) Holttum in Asia excluding Malesia. *Kew Bulletin* 43: 475–489.
https://doi.org/10.2307/4118979
Holttum, R.E. (1991) *Flora Malesiana, series II, Pteridophyta, vol. 2, part 1, Tectaria group.* Rijksherbarium / Hortus Botanicus, Leiden, 132 pp.
Hooker, W.J. (1838–1842) *Genera Filicum*. Henry G. Bohn, London, 120 pp.
http://dx.doi.org/10.5962/bhl.title.108655
Hooker, W.J. (1864) *Species Filicum, vol. 5.* London, 314 pp.
Kunze, G. (1848) In filices Javae Zollingerianas. *Botanische Zeitung (Berlin)* 6: 258–263.
Lellinger, D.B. (1968) Notes on Ryukyu ferns. *American Fern Journal* 58: 155–158.
http://dx.doi.org/10.2307/1545950
Lindsay, S. & Middleton, D.J. (2012) Ferns of Thailand, Laos and Cambodia. Available from: http://rbg-web2.rbge.org.uk/thaiferns/ (accessed 12 July 2012)
Moore, T. (1857) *Index Filicum: A Synopsis, with Characters of the Genera and an Enumeration of the Species of Ferns.* William Panplin, London, 396 pp.
Presl, C. (1851) *Epimeliae Botanicae*. A. Haase, Prague, 264 pp.
Schuettpelz, E. & Pryer, K.M. (2007) Fern phylogeny inferred from 400 leptosporangiate species and three plastid genes. *Taxon* 56: 1037–1050.
http://dx.doi.org/10.2307/25065903
Smith, J. (1842) Arrangement and definition of the genera of ferns, with observations on the affinities of each genus. *Hooker's Journal of Botany* 4: 147–198.
Tagawa, M. & Iwatsuki, K. (1988) Dryopteridaceae. *In*: Smitinand, T. & Larsen, K. (Eds.) *Flora of Thailand, vol. 3*. Royal Forest Department, Royal Bangkok, pp. 327–392.
Wang, F.-G., Barratt, S., Falcón, W., Fay, M.F., Lehtonen, S., Tuomisto, H., Xing, F.-W. & Christenhusz, M.J.M. (2014) On the monophyly of subfamily Tectarioideae (Polypodiaceae) and the phylogenetic placement of some associated fern genera. *Phytotaxa* 164: 1–16.
http://dx.doi.org/10.11646/phytotaxa.164.1.1
Wang, C.-H. (1999) Aspidiaceae. *In*: Wu, S.-H. (Ed.) *Flora Reipublicae Popularis Sinicae, vol. 6, part 1*. Science Press, Beijing, pp. 1–103.
Xing, F.-W., Yan, Y.-H. & Christenhusz, M.J.M. (2013) *Tectaria*. *In:* Wu, C.-Y., Raven, P.H. & Hong, D.-Y. (Eds.) *Flora of China, vols. 2–3.* Missouri Botanical Garden Press, St. Louis; Science Press, Beijing, pp. 733–746. Available from: http://efloras.org/florataxon.aspx?flora_id=2&taxon_id=132367 (accessed 20 July 2013)
Zhang, L., Schuettpelz, E., Rothfels, C., Zhou, X.-M., Gao, X.-F. & Zhang, L.-B. (2016) Circumscription and phylogeny of the fern family Tectariaceae based on plastid and nuclear markers, with the description of two new genera: *Draconopteris* and *Malaifilix* (Tectariaceae). *Taxon* 65: 723–738.
http://dx.doi.org/10.12705/654.3
Zhang, L. & Zhang, L.-B. 2018. A classification of the fern genus *Tectaria* (Tectariaceae; Polypodiales). *Annals of the Missouri Botanical Garden* 103: 188–199.

https://doi.org/10.3417/2017007

Zhang, L., Zhou, X.-M., Chen, D.-K., Schuettpelz, E., Knapp, R., Lu, N.T., Luong, T.T., Dang, M.T., Duan, Y.-F., He, H., Gao, X.-F. & Zhang, L.-B. (2017) A global phylogeny of the fern genus *Tectaria* (Tectariaceae: Polypodiales) based on plastid and nuclear markers identifies major evolutionary lineages and suggests repeated evolution of free venation from anastomosing venation. *Molecular Phylogenetics and Evolution* 14: 295–333.
http://dx.doi.org/10.1016/j.ympev.2017.05.020

Zhou, X.-M, Zhang, L., Lu, N.T., Gao, X.-F. & Zhang, L.-B. (2018) Pteridryaceae: A new fern family of Polypodiineae (Polypodiales) including taxonomic treatments. *Journal of Systematics and Evolution* 56: 148–173.
http://dx.doi.org/10.1111/jse.12305