Phytotaxa 158 (3): 275–282
www.mapress.com/phytotaxa/

Article

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

http://dx.doi.org/10.11646/phytotaxa.158.3.7

Friesodielsia sahyadrica (Annonaceae), a peculiar new species from the Western Ghats, India

NAVENDU V. PAGE & SIDDHARTHAN SURVESWARAN
Centre for Ecological Sciences, Indian Institute of Science, Bangalore - 560012, Karnataka, India; E-mail: navendu.page@gmail.com

Introduction

Annonaceae are one of the largest families of the magnoliid angiosperms, comprising trees, shrubs and lianas. Although they exhibit a pantropical distribution, relatively high levels of generic endemism are observed at the continental scale (Doyle and Le Thomas 1997). In India, they are represented by 24 genera and ca. 125 species (Kundu 2006).

During recent field studies in the northern Western Ghats of India, the authors collected some unusual specimens of Annonaceae. These specimens resembled species of the *Desmos* Loureiro (1790: 352) group, with respect to their scandent habit and glaucous abaxial leaf surface, whereas flower morphology resembled that of *Goniothalamus* (Blume 1830: 28) Hooker & Thomson (1855: 105), due to the presence of a coherent inner whorl of petals that conceal reproductive structures by forming a vault over stamens and carpels. However, a thorough investigation of literature on Indian Annonaceae revealed it to be a species of *Friesodielsia* Steenis (1948: 458), which is represented by two other species in India, namely *F. fornicata* (Roxburgh 1814: 94) Das (1963: 93), distributed from the northeastern part of India to Bangladesh and Myanmar, and *F. khoshooi* Vasudeva & Chakrabarty (1985: 435), endemic to the Andaman and Nicobar islands. This report is the first ever record of this genus for the Western Ghats.

Friesodielsia comprises about 51 species (Wang 2009, Chatrou *et al.* 2012), of which ten are recorded from tropical Africa whereas the rest are distributed across tropical Asia. Recent molecular phylogenetic studies (Richardson *et al.* 2004, Couvreur *et al.* 2011, Wang *et al.* 2012) have shown that *Friesodielsia* is polyphyletic with African and Asian species falling into different clades. The African species of *Friesodielsia* are related to the African genus *Monanthotaxis* Baillon (1890: 878), whereas the Asian species are related to the Asian genus *Dasymaschalon* Dalla Torre & Harms (1901: 174) (Couvreur *et al.* 2011, Wang *et al.* 2012). Palynological studies (Walker 1971) have also indicated that African and Asian *Friesodielsia* are distinct in their exine morphology (Table 1). Based on these results, the African species of *Friesodielsia* are likely to be transferred to *Monanthotaxis* or the African *Friesodielsia-Monanthotaxis* clade will be segregated into two or more genera (Wang *et al.* 2012) with the name *Friesodielsia* being retained by the Asian species, which is where the type of the genus occurs. It was therefore essential to assess the position of this new species from the Western Ghats with respect to the existing phylogenetic data.

Certain morphological features observed in the species from Western Ghats such as relative length of outer and inner petals as well as number of seeds per monocarp were consistent with those observed in many African species of *Friesodielsia*. Pollen exine morphology, on the other hand, was similar to that of the Asian group (Table 1, Fig. 2). Biogeographic evidence and molecular dating (Couvreur *et al.* 2011) suggested that clades such as the one consisting of *Friesodielsia* are younger than the time of the Gondwanan breakup and therefore more likely to have dispersed into India from Southeast Asia (Couvreur *et al.* 2011). Under this scenario, the species of *Friesodielsia* from the Western Ghats can be expected to cluster with the Asian group. Due to potentially conflicting evidence from morphology and biogeographic hypotheses, we used a molecular phylogenetic approach to ascertain the position of the new species from the Western Ghats; we wish to assign it to either the African or Asian group. Since *Desmos* shows similar patterns in diversity and distribution to that of Asian *Friesodielsia*, we included *Desmos lawii* Safford (1912: 506), an endemic species confined to the Western Ghats.

Accepted by Mark Chase: 11 Jan. 2014; published: 4 Feb. 2014

Notes:—Based on the molecular results, it is clear that *Friesodielsia sahyadrica* belongs to the Asian desmoid clade, which consists of *Dasymaschalon*, Asian *Friesodielsia* and *Desmos*. The Asian and the African *Friesodielsia* group are distinguished primarily based on three morphological characters: echinate pollen exine (Fig. 2), relative length of outer to inner petals and number of seeds per monocarp (Verdcourt 1971, Walker 1971). Features such as differences in petal lengths and number of seeds per monocarp (Table 1) are contrary to what has been documented so far in the Asian species, but instead are characteristic of the African group that is related to *Monanthotaxis*. In Asian *Friesodielsia*, however, the outer petals are much longer than the inner petals (Verdcourt 1971), which are not observed in *F. sahyadrica*. Wang *et al.* (2012) inferred multiple transitions from multi-seeded monocarps to maximally one to two-seeded monocarps within the desmoid clade. All species of Asian *Friesodielsia* known previously exhibit one or maximally two-seeded monocarps (Verdcourt 1971, Wang *et al.* 2012). *Friesodielsia sahyadrica* is unique among Asian species of *Friesodielsia* in having five-seeded monocarps. African *Friesodielsia,* however, often have monocarps with up to five seeds. Another peculiar feature of *F. sahyadrica* is its cylindrical sausage-shaped monocarps with no distinct constrictions between seeds (Fig.3, 4). All species belonging to the Asian desmoid clade as well as African *Friesodielsia* exhibit distinctly moniliform monocarps when the number of seeds per monocarp is equal to or greater than two. Further and broader studies are required to determine the phylogenetic relationships of these and other taxa endemic to India.

Acknowledgements

We thank Rufford Foundation for their financial support and Karnataka Forest Department for granting research permits. SS was funded by Council for Scientific and Industrial Research (CSIR) and Science and Engineering Research Board (SERB) project. Special thanks to Venkataramana for his assistance in the field, Ashok Hegde for providing logistic support, Lakshminath Kundanthi for help with the SEM and Shreekant Deodhar for making the illustration. I would also like to express my deepest gratitude to Richard Saunders, Guo Xing and Praveen Karanth for their valuable comments and guidance. Milind Sardesai and Sneha Vijayakumar helped in greatly improving the quality of the manuscript. We would like to thank Kartik Shanker, Ravi Kumar, Shrikant Ingalhalikar, and K. Sankara Rao for all their support and encouragement. Finally, we would like to thank the editor, Mark Chase, and the two anonymous reviewers for their comments and suggestions.

References

Baillon, H.E. (1890) Observations sur quelques nouveaux types du Congo. *Bulletin mensuel de la Société linnéenne de Paris* 2: 878–879.

Blume, C. L. von (1830) *Flora Javae nec non insularum adjacentium*. Frank, Brussels, 416 pp. http://dx.doi.org/10.5962/bhl.title.48445

Chatrou, L.W., Pirie, M.D., Erkens, R.H.J., Couvreur, T.L.P., Neubig, K.M., Abbott, J.R., Mols, J.B., Maas, J.W., Saunders, R.M.K. & Chase, M.W. (2012) A new subfamilial and tribal classification of the pantropical flowering plant family Annonaceae informed by molecular phylogenetics. *Botanical Journal of the Linnean Society* 169: 5–40. http://dx.doi.org/10.1111/j.1095-8339.2012.01235.x

Couvreur, T.L.P., Maas, P.J.M., Meinke, S., Johnson, D.M. & Kesler, P.J.A. (2012) Keys to the genera of Annonaceae. *Botanical Journal of the Linnean Society* 169: 74–83. http://dx.doi.org/10.1111/j.1095-8339.2012.01230.x

Couvreur, T.L.P., Pirie, M.D., Chatrou, L.W., Saunders, R.M.K., Su, Y.C.F., Richardson, J.E. & Erkens, R.H.J. (2011) Early evolutionary history of the flowering plant family Annonaceae: steady diversification and boreotropical geodispersal. *Journal of Biogeography* 38: 664–680. http://dx.doi.org/10.1111/j.1365-2699.2010.02434.x

Dalla Torre, K. W. von & Harms, H. A. T. (1901) *Genera siphonogamarum ad systema Englerianum*. Engelmann, Leipzig, 921 pp. http://dx.doi.org/10.5962/bhl.title.26684

Das, D. (1963) Studies on Indian and Burmese Annonaceae. *Bulletin of the Botanical Survey of India* 5: 43–93.

Doyle, J.A. & Le Thomas, A. (1997) Phylogeny and geographic history of Annonaceae. *Geographie Physique et Quaternaire* 51: 353–361. http://dx.doi.org/10.7202/033135ar

Edgar, R.C. (2004) MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Research* 32: 1792–1797.
http://dx.doi.org/10.1093/nar/gkh340
Hooker, J. D. & Thomson, T. (1855) *Flora Indica*: being a systematic account of the plants of British India. Pamplin, London, 285 pp.
IUCN Standards and Petitions Subcommittee. (2010) Guidelines for using the IUCN Red List Categories and Criteria. Version 8.1. Prepared by the Standards and Petitions Subcommittee in March 2010. Downloadable from http://www.iucnredlist.org/documents/RedListGuidelines.pdf. (accessed: 8 August 2013).
Kundu, S.R. (2006) A synopsis of Annonaceae in Indian subcontinent: Its distribution and endemism. *Thaiszia Journal of Botany* 16: 63–85.
Loureiro, J. de (1790) *Flora Cochinchinensis*. Ulyssipone, Lisbon, 353 pp.
Posada, D. (2008) jModelTest: phylogenetic model averaging. *Molecular Biology and Evolution* 25: 1253–1256.
http://dx.doi.org/10.1093/molbev/msn083
Rambaut, A. (2002) Se-Al v.2.0a11: Sequence alignment editor. Available from
http://tree.bio.ed.ac.uk/software/seal/ (accessed: 7 January 2014)
Rambaut, A. & Drummond, A.J. (2007) Tracer v1.5. Available from http://beast.bio.ed.ac.uk/Tracer (accessed: 7 January 2014)
Richardson, J.E., Chatrou, L.W., Mols, J.B., Erkens, R.H.J. & Pirie, M.D. (2004) Historical biogeography of two cosmopolitan families of flowering plants: Annonaceae and Rhamnaceae. *Philosophical Transactions of the Royal Society of London, Series B,* 359: 1495–1508.
http://dx.doi.org/10.1098/rstb.2004.1537
Ronquist, F. & Huelsenbeck, J.P. (2003) MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics.*19: 1572–1574.
http://dx.doi.org/10.1093/bioinformatics/btg180
Roxburgh, W. (1814) *Hortus Bengalensis*. Carey, Oxford, 105 pp.
Safford, W. E. (1912) *Desmos* the proper generic name for the so-called *Unonas* of the Old World. *Bulletin of the Torrey Botanical Club* 39: 501-508.
http://dx.doi.org/10.2307/2479122
Stamatakis, A. (2006) RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. *Bioinformatics* 22: 2688–2690.
http://dx.doi.org/10.1093/bioinformatics/btl446
Steenis, C. G. G. J. van (1948) Remarks on some generic names used for Malaysian phanerogams 1. *Bulletin du Jardin Botanique de Buitenzorg* 17: 457–464.
Swofford, D.L. (2003) PAUP*. Phylogenetic analysis using parsimony (*and other methods). Version 4. Sinauer, Sunderland.
Vasudeva, R. & Chakrabarty, T. (1985) A new species of *Friesodielsia* (Annonaceae) from Great Nicobar Island. *Journal of Economic Taxonomic Botany* 6: 435–436.
Verdcourt, B. 1971. Notes on East African Annonaceae. *Kew Bulletin* 25: 1–34.
http://dx.doi.org/10.2307/4103132
Walker, J.W. (1971) Pollen morphology, phytogeography, and phylogeny of the Annonaceae. *Contributions from the Gray Herbarium of Harvard University* 202: 1–132.
Wang J. (2009) Systematics and phylogeny of *Dasymaschalon* (Annonaceae). Ph.D. Thesis, University of Hong Kong, 260 pp.
http://dx.doi.org/10.5353/th_b4308542
Wang, J., Thomas, D.C., Su, Y.C.F., Meinke, S., Chatrou, L.W. & Saunders, R.M.K. (2012) A plastid DNA phylogeny of *Dasymaschalon* (Annonaceae) and allied genera: Evidence for generic non-monophyly and the parallel evolutionary loss of inner petals. *Taxon*: 545–558.