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APPENDIX A. Detailed information about the trait database and the phylogeny.

Functional traits

We used the functional trait database ANDROSACE (AlpiNe Database ResOurce for Species And eCosystems fEatures, Thuiller et al., *unpublished*). The database includes trait information for Alpine plants from individual projects (Albert et al. 2010*a*, 2010*b*) and freely available databases such as LEDA (Knevel et al. 2003), BioFlor (Kühn et al. 2004), Ecoflora (Fitter and Peat 1994), CATMINAT (Julve 1998) and Kew Gardens (Royal Botanic Gardens Kew 2008).

Phylogeny

A genus-level phylogeny of alpine plants was extracted from Thuiller et al. (2014). For this phylogeny, the authors followed the workflow proposed in Roquet et al. (2013) with DNA sequences downloaded from Genbank: three conserved chloroplastic regions (rbcL, matK and ndhF) and 8 regions for certain families or orders (atpB, ITS, psbA-trnH, rpl16, rps4, rps4-trnS, rps16, trnL-F) which were aligned separately by taxonomic clustering. All sequences were aligned with 3 methods: MUSCLE (Edgar 2004); MAFFT, (Katoh et al. 2005); Kalign, (Lassmann and Sonnhammer 2005) and checked by eye. The best alignment for each region was selected and depurated with TrimAl (Capella-Gutiérrez et al. 2009). Phylogenetic inference by maximum-likelihood (ML) was conducted with RAxML (Stamatakis 2006) applying a supertree constraint at the family-level based on Davies et al. (2004) and Moore et al. (2010). In order to obtain a phylogenetic tree with branch lengths equal to absolute evolutionary time, we dated the best ML tree with penalized-likelihood using r8s (Sanderson 2003) and 25 fossils constraints (Table A1). Finally, the tips of the phylogenetic tree were resolved with polytomies to obtain a species-level phylogeny.

TABLE A1. Fossil information and age constraints used to calibrate the branch length in the phylogeny. All the fossils were used as minimum age constraints.

Clade	Age	Stem/Crown	References
Tracheophytes	421	crown	Garrat and Rickards 1987; Hueber 1992; Kenrick and Crane 1997

LITERATURE CITED

Albert, C. H., W. Thuiller, N. G. Yoccoz, R. Douzet, S. Aubert, and S. Lavorel. 2010*a*. A multi-trait approach reveals the structure and the relative importance of intra-vs. interspecific variability in plant traits. Functional Ecology 24:1192–1201.

Albert, C. H., W. Thuiller, N. G. Yoccoz, A. Soudant, F. Boucher, P. Saccone, and S. Lavorel. 2010*b*. Intraspecific functional variability: extent, structure and sources of variation. Journal of Ecology 98:604–613.

Batten, D. J., M. E. Collinson, and A. P. R. Brain. 1998. Ultrastructural interpretation of the Late Cretaceous megaspore Glomerisporites pupus and its associated microspores. American Journal of Botany 85:724–735.

Call, V. B., and D. L. Dilcher. 1992. Investigations of angiosperms from the Eocene of southwestern North America: samaras of Fraxinus wilcoxiana berry. Review of Palaeobotany Palynology 74:249–266.

Capella-Gutiérrez, S., J. M. Silla-Martínez, and T. Gabaldón. 2009. trimAl: a tool for automated alignment trimming in large-scale phylogenetic analyses. Bioinformatics 25:1972–1973.

Crane, P. R., E. M. Friis, and K. R. Pedersen. 1994. Palaeobotanical evidence on the early radiation of magnoliid angiosperms. Plant Systematics and Evolution 8:51–72.

Crepet, W. L., and N. C. Nixon. 1998. Fossil Clusiaceae from the Late Cretaceous (Turonian) of New Jersey and implications regarding the history of bee pollination. American Journal of Botany 85:1122–1133.

Davies, T. J., T. G. Barraclough, M. W. Chase, P. S. Soltis, D. E. Soltis, and V. Savolainen. 2004. Darwin's abominable mystery: insights from a supertree of the angiosperms. Proceedings of the National Academy of Sciences of the United States of America 101:1904–1909.

Doyle, J. A. 1992. Revised palynological correlations of the lower Potomac Group (USA) and the Cocobeach sequence of Gabon (Barremian-Aptian). Cretaceous Research 13:337–349.

Edgar, R. C. 2004. MUSCLE: a multiple sequence alignment method with reduced time and space complexity. BMC bioinformatics 5:113.

Fitter, A., and H. Peat. 1994. The ecological flora database. Journal of Ecology 82:415–425.

Friis, E. M., K. R. Pedersen, and P. R. Crane. 2006*a*. Cretaceous angiosperm flowers: Innovation and evolution in plant reproduction. Palaeogeography, Palaeoclimatology, Palaeoecology 232:251–293.

Friis, E. M., K. R. Pedersen, and J. Schonenberger. 2006*b*. Normapolles plants: a prominent component of the Cretaceous rosid diversification. Plant Systematics and Evolution 260:107–140.

Galtier, J., S. J. Wang, C. S. Li, and J. Hilton. 2001. A new genus of filicalean fern from the Lower Permian of China. Botanical Journal of the Linnean Society 137:429–442.

Garrat, M. J., and R. B. Rickards. 1987. Pridoli (Silurian) graptolites in association with Baragwanathia (Lycophytina). Bulletin of the Geological Society of Denmark 35:135–139.

Herendeen, P. S., and P. R. Crane. 1992. Advances in Legume Systematics. Pt. 4. The Fossil Record. pp 57–68. Royal Botanic Gardens, Kew, UK.

Hermsen, E. J., M. A. Gandolfo, K. C. Nixon, and W. L. Crepet. 2003 Divisestylus gen. Nov. (aff. Iteaceae), a fossil saxifrage from the late Cretaceous of New Jersey, USA. American Journal of Botany 90:1373–1388.

Hueber, F. M. 1992. Thoughts on the early lycopsids and zosterophylls. Annals of the Missouri Botanical Garden 79:474–499.

Hughes, N. F., and A. B. McDougall. 1990. Barremian-Aptian angiospermid pollen records from southern England. Review of Palaeobotany and Palynology 65: 145–151.

Jarzen, D. M. 1978. Some Maastrichtian palynomorphs and their phytogeographical and palaeoecological implications. Palynology 2:29–38.

Julve, P. 1998, ff. Baseflor. Index botanique, écologique et chorologique de la flore de France.

Katoh, K., K. Kuma, H. Toh, and T. Miyata. 2005. MAFFT version 5: improvement in accuracy of multiple sequence alignment. Nucleic acids research 33:511–518.

Kenrick, P., and P. R. Crane. 1997. The origin and early diversification of land plants—a cladistic study. Washington (DC): Smithsonian Institution Press.

Knevel, I., R. Bekker, J. Bakker, and M. Kleyer. 2003. Life-history traits of the Northwest European flora: The LEDA database. Journal of Vegetation Science 14:611–614.

Knobloch, E. D. and D. H. Mai. 1986. Monograph of the fruits and seeds in the Cretaceous of Central Europe. Rozpravy Ústreõdního Ústavu Geologického, 47:1–219.

Krassilov, V., and F. Bacchia. 2000. Cenomanian florule of Nammoura, Lebanon. Cretaceous Research 21:785–799.

Kühn, I., W. Durka, and S. Klotz. 2004. BiolFlor — a new plant-trait database as a tool for plant invasion ecology. Diversity and Distributions 10: 363–365.

Lassmann, T., and E. L. Sonnhammer. 2005. Kalign–an accurate and fast multiple sequence alignment algorithm. BMC bioinformatics 6:298.

Lupia, R., H. Schneider, G. M. Moeser, K. M. Pryer, and P. R. Crane. 2000. Marsileaceae sporocarps and spores from the Late Cretaceous of Georgia, U.S.A. International Journal of Plant Sciences 161:975–988.

Magallon, S. 1997. Affinity within Hydrangeaceae of a structurally preserved Late Cretaceous flower (Coniacian-Santonian of Georgia, U.S.A). American Journal of Botany 84 (Suppl.): 215.

Manchester, S. R., and M. J. Donoghue. 1995. Winged fruits of Linnaceae (Caprifoliaceae) in the Tertiary of western North America: Diplodipelta gen. nov. International Journal of Plant Sciences 156:709–722.

Mapes, G., and G. W. Rothwell. 1984. Permineralized ovulate cones of Lebachia from Late Paleozoic Hamilton Quarry area in southeastern Kansas. Palaeontology 27:69–94.

Mapes, G., and G. W. Rothwell. 1991. Structure and relationship of primitive conifers. Neues Jahrbuch fűr Geologie und Palaeontologie 183:269–287.

Miller, C.N. 1971. Evolution of the fern family Osmundaceae based on anatomical studies. Museum of Paleontology of the University of Michigan [Contribution 28:105–169]

Miller, C.N. 1999. Implications of fossil conifers for the phylogenetic relationships of living families. The Botanical Review. 65:239–277.

Moore, M. J., P. S. Soltis, C. D. Bell, J. G. Burleigh, and D. E. Soltis. 2010. Phylogenetic analysis of 83 plastid genes further resolves the early diversification of eudicots. Proceedings of the National Academy of Sciences 107:4623–4628.

Muller, J. 1981. Fossil pollen records of extant angiosperms. The Botanical Review 47:1–142.

Nixon, K. C., and W. L. Crepet. 1993. Late Cretaceous fossil flowers of ericalean affinity. American Journal of Botany 80:616–623.

Phipps, C. J., T. Taylor, E. Taylor, R. Cúneo, L. Boucher, and X. Yao. 1998. Osmunda (Osmundaceae). from the Triassic of Antarctica: an example of evolutionary stasis. American Journal of Botany 85:888–895.

Pryer, K. M. 1999. Phylogeny of marsileaceous ferns and relationships of the fossil Hydropteris pinnata reconsidered. International Journal of Plant Sciences 160:931–954.

Roquet, C., W. Thuiller, and S. Lavergne. 2013. Building megaphylogenies for macroecology: taking up the challenge. Ecography 36:013–026.

Rößler, R., and J. Galtier. 2002. First Grammatopteris tree ferns from the Southern Hemisphere—new insights in the evolution of the Osmundaceae from the Permian of Brazil. Review of Palaeobotany and Palynology 121:205–230.

Rothwell, G.W., and S. E. Scheckler. 1998. Origin and Evolution of Gymnosperms. Pp 85–134. Columbia University Press, New York, New York, USA.

Royal Botanic Gardens Kew. 2008. Seed Information Database (SID). Version 7.1. Available from: http: //data.kew.org/sid/

Sanderson, M. J. 2003. r8s: inferring absolute rates of molecular evolution and divergence times in

the absence of a molecular clock. Bioinformatics 19:301–302.

Stamatakis, A. 2006. RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. Bioinformatics 22:2688–2690.

Takahashi, M., P. R. Crane, and H. Ando. 1999. Esgueiria futabensis sp. nov., a new angiosperm flower from the Upper Cretaceous (lower Coniacian) of northeastern Honshu, Japan. Paleontological Research 3:81–87.

Thuiller, W., M. Guéguen, D. Georges, R. Bonet, L. Chalmandrier, L. Garraud, J. Renaud, C. Roquet, J. Van Es, N. E. Zimmermann, and S. Lavergne. 2014. Are different facets of plant diversity well protected against climate and land cover changes? A test study in the French Alps. Ecography:10.1111/ecog.00670.

Van Uffelen, G. A. 1991. Fossil Polypodiaceae and their spores. Blumea 36:253–272.

Wolfe, J. A. 1976. Stratigraphic distribution of some pollen types from the Campanian and lower Maestrichtian rocks (Upper Cretaceous) of the middle Atlantic states. U.S. Geological Survey Professional Paper 997:1–108.

Yamada, T., and M. Kato. 2002. Regnellites nagashimae gen. et sp. nov., the oldest macrofossil of Marsileaceae, from the Upper Jurassic to Lower Cretaceous of Western Japan. International Journal of Plant Sciences 163:715–722.

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