



# Phylogeny of Burmanniaceae

## Preliminary results based on 18S rDNA sequences

Vincent Merckx<sup>1</sup>, Peter Schols<sup>1</sup>, Paul Maas<sup>2</sup>, Hiltje Maas-van de Kamer<sup>2</sup> & Erik Smets<sup>1,3</sup>

<sup>1</sup> Laboratory of Plant Systematics, Institute of Botany and Microbiology, K.U.Leuven, Kasteelpark Arenberg 31, B-3001 Leuven, Belgium

<sup>2</sup> Nationaal Herbarium Nederland, Utrecht University Branch, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands

<sup>3</sup> Nationaal Herbarium Nederland, Leiden University Branch, Einsteinweg 2, 2333 CC Leiden, The Netherlands

LABORATORY OF PLANT SYSTEMATICS

vincent.merckx@bio.kuleuven.be • <http://www.kuleuven.be/bio/sys>

### Introduction

Mycro-heterotrophy ('saprophytism') has evolved independently in several families of flowering plants. In the Monocots, heterotrophic species can be found in Orchidaceae, Petrosaviaceae, Triuridaceae, Corsiaceae and Burmanniaceae (Leake 1994). In Burmanniaceae, which are the focus of this study, both autotrophic and obligate myco-heterotrophic species have been described. This relatively small family includes about 160 species divided into 13 genera (Maas-van de Kamer 1998), with most species occurring in the Neotropics and Paleotropics. A lot of Burmanniaceae are remarkably rare: many species are only known from the type collection and some species are presumed to be extinct.

Phylogenetic studies based on molecular data indicated that Burmanniaceae are sister to Dioscoreaceae (Caddick et al. 2000, 2002). Due to the extreme reduction of most myco-heterotrophic species and the scarcity of material for molecular phylogenetic studies very little is known about the relationships between the genera of the family.

We present a preliminary phylogeny of 41 Burmanniaceae taxa based on nuclear 18S rDNA sequences. DNA was extracted from silica-dried and herbarium specimens using a Puregene DNA extraction kit (Gentra Systems). The 18S rDNA region was amplified with PCR using the primers from White et al. (1990). We included several Dioscoreaceae taxa to investigate the sistergroup relationship with Burmanniaceae and we selected some Nartheciaceae taxa as the outgroup for the analyses. Phylogenetic estimations were obtained using the maximum parsimony criterion and in a Bayesian framework.

### Results

#### Burmanniaceae not monophyletic

In both topologies Burmanniaceae are split into two distinct groups: the orders Burmannieae and Thismieae. Due to the inclusion of Thismieae in Dioscoreaceae both Burmanniaceae and Dioscoreaceae are not monophyletic.

#### Tribe Burmannieae

Both phylogenetic reconstructions show a moderately supported Burmannieae clade. Within this clade lies a well supported *Apteria* and *Gymnosiphon* clade. The inclusion of the neotropical genus *Cymbocarpa* in *Gymnosiphon* is striking but not surprising from a morphological point of view. The position of *Burmannia* species are different between the maximum parsimony (Fig. 1) and the Bayesian analyses (Fig. 2).

In both topologies, however, there is a well supported clade of species with prominently winged flowers (except *B. capitata* and *B. alba*).

#### Tribe Thismieae

The position of Thismieae to Burmannieae and the other genera of the Dioscoreaceae is less clear. In the maximum parsimony topology this tribe consists of a monophyletic clade sister to *Tacca*, making Burmanniaceae and Dioscoreaceae polyphyletic and paraphyletic respectively. In the Bayesian topology the sampled species of the

African genus *Afrothismia* is not placed with the *Thismia* species leaving both Burmanniaceae and Dioscoreaceae as polyphyletic groups.

#### Loss of chlorophyll

With respect to the evolutionary pattern of the loss of chlorophyll in Burmanniaceae current results indicate that this loss has evolved independently on more than one occasion.

The preliminary results of this study question the monophyletic character of the Burmanniaceae and Dioscoreaceae, but both extra molecular data and additional taxon sampling are needed to construct a more robust hypothesis on the evolution of Burmanniaceae and related taxa.

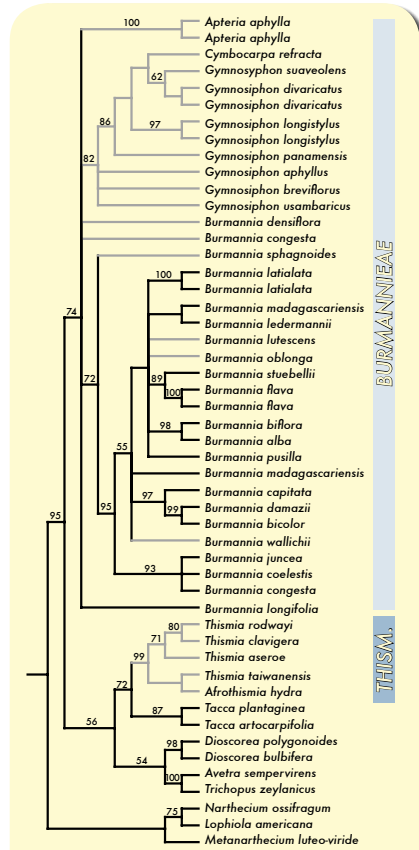


Fig 1. Phylogenetic relationships of Burmanniaceae based on parsimony analysis of 18S rDNA data. Numbers above branches indicate bootstrap values (values < 50% not shown). There are 1683 characters and 662 shortest trees (strict consensus shown), with length 1160, consistency index (CI) = 0.454 and retention index (RI) = 0.666. Achlorophyllous taxa are indicated with grey branches.

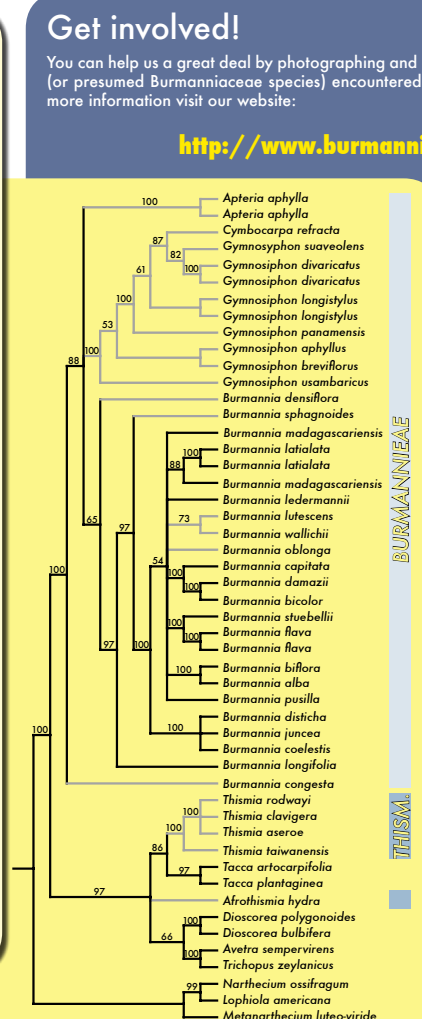
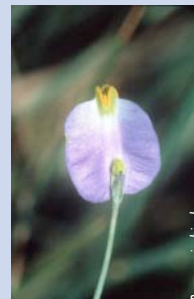
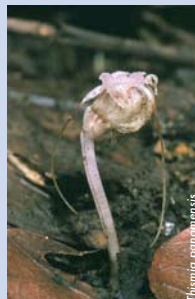
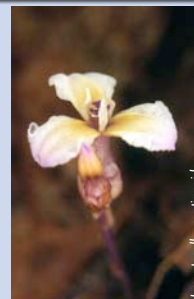
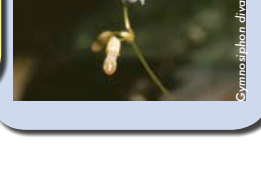
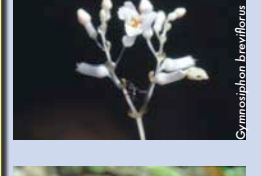


Fig 2. Burmanniaceae phylogeny based on Bayesian analysis of 18S rDNA data. Numbers above branches indicate Bayesian posterior probabilities. Achlorophyllous taxa are indicated with grey branches.

### Get involved!

You can help us a great deal by photographing and collecting Burmanniaceae species (or presumed Burmanniaceae species) encountered on expeditions or field trips. For more information visit our website:

<http://www.burmanniaceae.org>



### Acknowledgments

The authors would like to thank Axel Poulsen, Mark Wapstra, Steven Dessen, Sean Graham, Thassilo Franke, William Hahn, Dan Nickrent, Roy Neyland, Bob Harwood, Lubbert Westra Ek, Carel Jongkind and Sheng-Zehn Yang for supplying material for this study. We would like to thank Kariboe and Easyware NV for their support. Vincent Merckx holds a grant from the Institute for the Promotion of Innovation through Science and Technology in Flanders (IWT Vlaanderen n° 31536).

### References

Caddick, L.R., Rudall, P.J., Wilkin, P. & M.W. Chase (2000) Yams and their allies: systematics of Dioscoreales. In: Wilson, K.L. & D.A. Morrison (eds.) Monocots: Systematics and Evolution, 475-487. CSIRO, Melbourne

Caddick, L.R., Rudall, P.J., Wilkin, P., Hedderson, A.J. & M.W. Chase (2002) Phylogenetics of Dioscoreales based on combined analyses of morphological and molecular data. *Bot. J. Linn. Soc.* 138: 123-144

Leake, J.R. (1994) The biology of myco-heterotrophic ('saprophytic') plants. *New Phytol.* 127: 171-216

Maas-van de Kamer, H. (1998) Burmanniaceae. In: Kubitzki, K. (ed.) The families and genera of vascular plants. Vol.3, Liliaceae (except Orchidaceae). Springer-Verlag, Berlin

White, T.J., Burns, T., Lee, S. & J. Taylor (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis, M., Gelfand, D., White, T. & T. White (eds.) PCR protocols: a guide to methods and applications, 315-322. Academic Press, San Diego