REVISIONARY STUDIES IN SYNOSTEMON
(PHYLLANTHACEAE, PHYLLANTHEAE)

Morphological and molecular data corroborate generic recognition of
_Synostemon_ and with increased species diversity

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Declaration

I, Ian Robert Hall Telford, certify that the substance of this thesis has not been submitted for any degree for myself, and is currently not being submitted for any other degree or qualification.

I also certify that any assistance in preparing this, and all sources used, have been duly acknowledged in this thesis.

Ian R. H. Telford
Abstract

Phylogenetic analysis using an expanded data set of nrDNA ITS and PHYC and cpDNA accD and trns sequence data retrieves a monophyletic Synostemon F.Muell. (*Phyllanthaceae, Phyllantheae, Flueggeineae*), previously subsumed into Sauropus Blume or Phyllanthus L. Sauropus s. str., excluding Synostemon, is shown to be nested within Breynia J.R.Forst. & G.Forst. (Chapter 2). Morphological data clarifies infrageneric relationships within Sauropus and its species are transferred to Breynia in a new subgenus, B. subgenus Sauropus (Blume) Welzen & Pruesapan (Chapter 3).

Synostemon hamersleyensis I.Telford & Naaykens, a recently discovered new species endemic to ironstone detrital formations of the Hamersley Range in the Pilbara, central Western Australia, is named, its distribution, habitat and contentious conservation status discussed (Chapter 4).


Morphometric analyses using PATN of the widespread, mainly eremaean Synostemon ramosissimus F.Muell. and the putative new species Sauropus sp. Woolgorang (M.Officer s.n. 10/8/94) indicate clinal variation across the continent; the western populations warrant subspecific rank and are named Synostemon ramosissimus subsp. occidentalis I.Telford & J.J.Bruhl. Similarly, *S. rigens* F.Muell. demonstrates a longitudinal cline and the most easterly populations are named as *S. rigens* subsp. virgatus I.Telford & J.J.Bruhl. Phylogenetic analysis using nrITS sequence data points to the close relationship of *S. ramosissimus* and *S. rigens* and justifies the rank proposed for the new subspecies of each (Chapter 6).

Synostemon trachyspermus (F.Muell.) Airy Shaw is shown by morphological studies, corroborated by phylogenetic analysis using nrITS sequence data, to be a heterogeneous
species assemblage (Chapter 7). Included in the clade with *S. trachyspermus* but warranting reinstatement as species are *Phyllanthus rhytidospermus* F.Muell. ex Müll.Arg., with a new combination provided as *Synostemon rhytidospermus* (F.Muell. ex Müll.Arg.) I.Telford & Pruesapan, and *Sauropus hubbardii* Airy Shaw, with a new combination as *Synostemon hubbardii* (Airy Shaw) I.Telford & Pruesapan and *Synostemon lissocarpus* (S.Moore) I.Telford & Pruesapan, the new combination provided for *Phyllanthus lissocarpus* S.Moore. *Synostemon umbrosus* I.Telford & J.J.Bruhl, sister to *S. trachyspermus*, is named as new. *Synostemon hamersleyensis* I.Telford & Naaykens and *Sauropus aphyllus* J.T.Hunter & J.J.Bruhl are shown to be closely related and atypical members of the *S. trachyspermus* clade, with the new combination *Synostemon aphyllus* (J.T.Hunter & J.J.Bruhl) I.Telford & Pruesapan provided for the latter. *Sauropus* sp. A of “Flora of the Kimberley Region” shows a more distant relationship and is named as *Synostemon judithae* I.Telford & J.J.Bruhl.


Prologue

Format

The bibliographic style was formatted using Endnote 9 software. Formatting of the papers which constitute the major part of the thesis follows the editorial style of the relevant journal. For other chapters, the format follows that of Australian Systematic Botany.

Nomenclature
The unpublished new names and combinations contained in this thesis are not to be considered validly published following Article 30.8 of the international code of nomenclature for algae, fungi and plants (Melbourne Code) <http://www.iapt-taxon.org/nomen/main.php/page=title>.

Thesis layout
The main body of the thesis is made up of a series of related papers, the current status of each presented below in the table of contents, together with my % contribution. Each published paper is presented as a printed pdf carrying the original pagination from the journal. Papers submitted and unpublished or those yet to be submitted are presented in the style required by each relevant journal and with the tables and figures at the end. The proposed position of these tables and figures are indicated within the text by the inserted caption. This renders redundant a separate ‘List of Tables’ and ‘List of Figures’ for the thesis as a whole. Similarly, references for each manuscript are included in their respective chapter and a combined bibliography is therefore not presented. The general introduction and aims (Chapter 1) sets out the aims of the project and shows the links between the papers, and the general conclusions (Chapter 10) tie the research project together. The Appendix presents a precursor paper to this study and a biogeographic spin-off.

History of the project
This research project had its origin in the on-going treatment for the Flora of Australia project of several genera previously included in the Euphorbiaceae. The Australian Biological Resources Study provided funding for a revisionary treatment of Sauropus
(together with Phyllanthus and the other genera of Phyllanthaceae tribe Phyllantheae) to Jeremy Bruhl, who employed John Hunter to undertake the study through 1994–95. Although several papers were published on the taxonomy and nomenclature of Sauropus (then including Synostemon) and Phyllanthus, the research was not completed. The huge amount of herbarium material on loan from Australia and overseas, including many type specimens, remained at the N.C.W. Beadle Herbarium.

Meanwhile Kanchana Pruesapan had begun her PhD research project at the University of Leiden with Professor Peter van Welzen as principal supervisor. A major aim of Kanchana’s research was the clarification of generic boundaries in Sauropus. The N.C.W. Beadle Herbarium contributed leaf samples of several Australian species for Kanchana’s DNA dataset and Jeremy Bruhl and I collaborated with them on the research. The preliminary phylogenetic analysis indicated a monophyletic Synostemon, the major Australian component of Sauropus sens. lat., worthy of reinstatement to generic rank.

Professor Jeremy Bruhl considered that a combined morphological and phylogenetic approach should be used to strengthen our Flora treatment and considered a revision of Synostemon would provide a suitable research project for me towards a PhD.
Acknowledgements

I gratefully acknowledge the support and encouragement from my principal supervisor, Professor Jeremy Bruhl, who first persuaded me to complete a Masters, and then suggested this PhD project.

To Professor Peter van Welzen, I must give sincere thanks for the invitation to collaborate on Kanchana’s research project and for then agreeing to co-supervise my studies.

To Dr Kanchana Pruesapan I express my gratitude for allowing me to collaborate in her research and for her continuing provision of DNA data after the completion of her own PhD research project.

The Directors of herbaria A, BM, BRI, CANB, DAV, DNA, MEL, NSW and PERTH are acknowledged for the loan of specimens and for allowing their Phyllanthaceae material to be held at NE for so long. Particular thanks to the Director, BRI, for assistance during visits, and the Chief Botanist, DNA, for chasing additional collections.

Receipt of an Australian Postgraduate Award, a UNE Botany Top-up Scholarship and research support from the School of Environmental and Rural Science are gratefully acknowledged.

The Australian Biological Resources Study is thanked for partial funding for field work and laboratory costs for this study through the Bush Blitz program.

This thesis is dedicated to my partner of 42 years, Douglas Hunter Moffatt (1943–2013). Doug unselfishly insisted I continue with this project after his being diagnosed with an aggressive, terminal cancer when I should have been his full-time carer at home during his last months.
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Chapter 6 (paper 5): Ian R. H. Telford, Peter C. van Welzen and Jeremy J. Bruhl. Clinal variation across Australia in two eremaean species of Synostemon (Phyllanthaceae, Phyllantheae) demonstrated using morphological and molecular data. (to be submitted to *Australian Systematic Botany*) ................................................................................................................................. 92

Chapter 7 (paper 6): Ian R. H. Telford, Kanchana Pruesapan, Peter C. van Welzen and Jeremy J. Bruhl. Morphological and molecular data show *Sauropus trachyspermus* to be a heterogeneous species assemblage in Synostemon (Phyllanthaceae, Phyllantheae). (to be submitted to *Australian Systematic Botany*) .............................................................. 133

Chapter 8 (paper 7): Ian R. H. Telford, Kanchana Pruesapan, Peter C. van Welzen and Jeremy J. Bruhl. Morphological and molecular data corroborate an enlarged crown radiation in Synostemon (Phyllanthaceae, Phyllantheae) in tropical Australia concealed by heteromorphic species concepts. (to be submitted to *Australian Systematic Botany*) ....................................................................................................................... 176

Chapter 9 (paper 8): Ian R. H. Telford, Peter C. van Welzen and Jeremy J. Bruhl. Synopsis of Synostemon (Phyllanthaceae, Phyllantheae, Flueggiinae) including the description of two new species, four new combinations and emended descriptions (to be submitted to *Phytokeys*) ........................................................................................................................................... 240

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