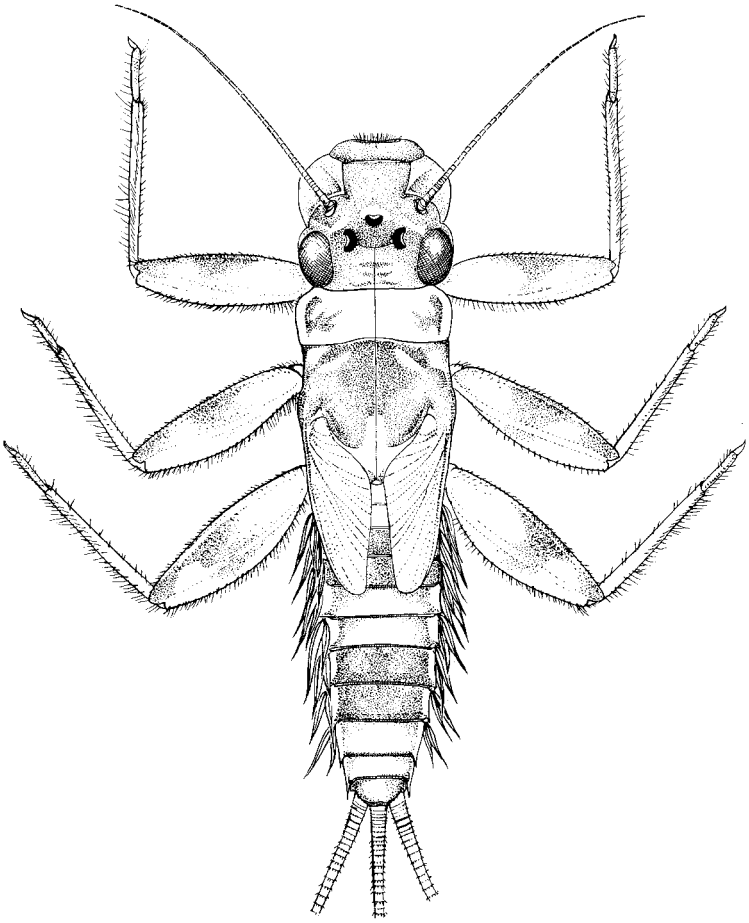
Systematics, Phylogeny and Ecology of Australian Leptophlebiidae (Ephemeroptera)



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in May 2003

for the degree of Doctor of Philosophy
in Zoology and Tropical Ecology
within the School of Tropical Biology
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ABSTRACT

An understanding of the processes that govern patterns of distribution and abundance of organisms remains a central goal in ecology. Ecologists have traditionally focussed on proximate factors to explain patterns in community structure; however, the importance of historical factors in determining some present-day ecological patterns is increasingly being recognised. In this thesis I examine phylogenetic relationships among the Australian Leptophlebiidae (Ephemeroptera) and use the phylogenetic hypotheses obtained to investigate the role of evolutionary history in shaping selected ecological and morphological traits of these stream dwelling mayflies.

A cladistic parsimony analysis based on 43 morphological characters was used to explore phylogenetic relationships among the Leptophlebiidae genera from Australia, and selected genera from South America and New Zealand. The outcomes from this analysis were consistent with higher-level relationships previously proposed by Pescador and Peters (1980). The only point of conflict was the monophyly of the *Hapsiphlebia* lineage. Although the basal position of genera assigned to this lineage was confirmed, these genera did not form a monophyletic group in the present analysis. Clarification of the affinities of four Australian genera (*Neboissophlebia*, *Bibulmena*, *Loamaggalangta* and *Kaninga*) suggested that they belong to lineages not previously recognised among the Gondwanan Leptophlebiidae.

Three new species of *Austrophlebioides* were described from the Wet Tropics bioregion. Phylogenetic relationships among species of the genus *Austrophlebioides* were examined using cladistic analyses based on morphological characters of the nymph and the adult. The results from these analyses support the recognition of three monophyletic species groups within the genus, the "wet tropics", "*pusillus*" and "*marchanti*" clades. The "*marchanti*" clade was the most basal clade within the genus, and the "*pusillus*" clade was sister to the "wet tropics" clade. Congruence among phylogenies derived from different life-history stages and combined adult and nymph data, along with good bootstrap support, indicated that the proposed relationships within the genus were robust.

Minimal overlap was observed in the geographic distribution of the three *Austrophlebioides* clades. The "wet tropics" clade is confined to the Wet Tropics bioregion of north-eastern Queensland. The "*pusillus*" clade is restricted to eastern Queensland and northern New South Wales with the exception of *A. pusillus*, which extends to Victoria. The "*marchanti*" clade occurs in southern New South Wales, Victoria and Tasmania. Distributional limits of the three clades correspond with the presence of recognised biogeographic barriers (Burdekin Gap, Hunter Valley and Bass Strait), strongly suggesting that vicariance has been important in the differentiation of the group and in determining present-day distributions of species.

The phylogenetic hypothesis for the genus *Austrophlebiodes* was used to infer the pattern of evolution of labrum morphology in the genus, and evaluate the importance of flow regimes in the evolution of labrum shape. Reconstruction of ancestral character-states suggests that a broad labrum and use of high flow environments are ancestral features that have evolved only once, early in the evolutionary history of the genus. A narrow labrum and the use of slow flow habitats appear to have evolved secondarily on two independent occasions. Retention of a broad labrum in species that occur in fast flow, and evolutionary changes from a broad to a narrow labrum with shifts from fast to slow flow habitats, suggest that flow has been an important selective factor in the evolution of labrum morphology in *Austrophlebioides*. However, high levels of conservatism were observed within individual clades, indicating that phylogenetic history is also an important determinant of labrum morphology and habitat use in this genus.

The incorporation of phylogenetic information into the ecological study of leptophlebiid mayfly assemblages of four streams in the Wet Tropics revealed that substrate and habitat use among species often reflected phylogenetic relationships. The high levels of segregation observed on the basis of substrate type, with stones and leaf litter supporting distinct assemblages, appears to be the result of historical differences among lineages in the use of substrate type. The leaf litter fauna was dominated by species of the *Nousia* lineage, whereas the stone fauna was dominated by species of the *Meridialaris* lineage. Similarly, the association of species within some lineages to certain habitat types contributed to the distinctiveness of mayfly assemblages of pools, runs, and riffles. These findings suggest that phylogenetic history is important in

determining some ecological traits of leptophlebiid species and their present-day distributions among substrate and habitat types. However, patterns of habitat and substrate use did not always reflect phylogenetic relationships. Within the *Meridialaris* lineage, coexisting species often differed in their use of pool, run or riffle, and tended to separate along a velocity gradient. Similar trends in habitat segregation were observed among the *Nousia* species (*Nousia* lineage). In such instances present-day ecological factors may play an important role in determining the distributions of species.

Overall, the present-day structure of tropical mayfly assemblages in the four study streams appears to be the outcome of a combination of historic (phylogenetic) and contemporary ecological processes. Without knowledge of phylogenetic relationships among species, the historical basis for some present-day patterns of substrate and habitat use would have gone unrecognised. The integration of phylogenetic and ecological approaches has provided a greater understanding of the processes that shape contemporary ecological patterns in Leptophlebiidae mayfly assemblages.

ACKNOWLEDGMENTS

I would like to thank my supervisors Richard Pearson, Peter Cranston and John Dean for their guidance and support during this project. Their advice was invaluable at all stages of this project. I am grateful to John Dean (EPA Victoria), Kyla Finlay (Monash University), Emily Bolitho (James Cook University), Terry Houston (Western Australian Museum), Bill Peters (Florida A&M University, USA), Trevor Crosby (Land Care, New Zealand) and David Goodger (Natural History Museum, England) for providing some of the specimens used in this study. I would also like to thank Gunther Theischinger and Alice Wells for their help in accessing the mayfly collection at the Australian National Insect Collection (Canberra). I am grateful to Peter Cranston for making available Sybil Monteith's wonderful drawings of mayfly nymphs. I would like to thank Robert Hoare and David Blair for their help with classical Greek and nomenclature issues. I thank Heather Winsor, Sue Reilly and Kevin Blake for advice and assistance with the preparation of specimens for light and electron microscopy. I am indebted to Steve Delean, Dan Ryan and Mike Steele for their advice on statistical matters. I am very grateful to Land and Water Australia for the PhD scholarship and research funds that enabled me to undertake this project. I am also grateful to James Cook University for their financial support, and the Rainforest CRC for a travel award that enabled me to present my research at the IXth International conference on Ephemeroptera. I would like to thank my friends and colleagues for their support and advice: Jackie Wolstenholme, Michelle Guzik, Lyn Van Herwerden, Selma Klanten, Vicki Hall, Agnes Rotais, Angie Shuetrim, Simon Cook, Dave Slaney, Laura Castell, John Dowe, Orpha Bellwood, Fred Ford, Claudia Arango, Brendan McKie and Niall Connolly. Finally, I would like to thank my family, my parents Agapi and Vassili, and my sisters Avgi and Xanthi, for their encouragement. Special thanks go to Alistair for his assistance in the field, enthusiasm and endless support throughout the project.

Front cover: *Austrophlebioides* nymph (Illustrator: Sybil Monteith)

TABLE OF CONTENTS

LIST OF FIGURES

Chapter 2. Phylogenetic relationships of the Australian Leptophlebiidae.

Chapter 3. Three new species of *Austrophlebioides* Campbell and Suter (Ephemeroptera: Leptophlebiidae: Atalophlebiinae) from the Wet Tropics region of north-eastern Australia.

Chapter 4. Phylogeny and distribution of the genus *Austrophlebioides* Campbell and Suter (Ephemeroptera: Leptophlebiidae: Atalophlebiinae).

Chapter 5. Habitat use and the evolution of labrum shape in the genus *Austrophlebioides* (Leptophlebiidae: Atalophlebiinae).

Chapter 6. A phylogenetic perspective on patterns of substrate and habitat use among leptophlebiid mayflies (Ephemeroptera: Leptophlebiidae).

LIST OF TABLES

Chapter 2. Phylogenetic relationships of the Australian Leptophlebiidae.

Chapter 4. Phylogeny and distribution of the genus *Austrophlebioides* Campbell and Suter (Ephemeroptera: Leptophlebiidae: Atalophlebiinae).

Chapter 6. A phylogenetic perspective on patterns of substrate and habitat use among leptophlebiid mayflies (Ephemeroptera: Leptophlebiidae).

STATEMENT OF SOURCES

DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references given.

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Faye Christidis 21-5-03