The Place of the Australian Nacophorini in the Geometridae

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The Australian Geometridae include approximately 1300 described species in 275 genera. The largest subfamily is the Ennominae with about 480 described species placed in 114 genera. Southern Australia is rich in endemic species and a large group of the Ennominae from this region have been assigned to the Nacophorini, a tribe with strong representation in southern South America.

Several groups of Australian geometrids have reportedly Gondwanan origins. The Australian nacophorines are considered to have 'primitive' characteristics such as stout hairy bodies, generalized male genitalia and larvae with a full complement of prolegs. They are well-adapted to the characteristic Australian flora and may be closely related to South American and African taxa. The Nacophorini have been proposed as a candidate for a primitive group within the Geometridae. Tasmania is the global centre of diversity of the Archiearinae, the putatively basal geometrid sub-family, with seven species. These geometrids inhabit alpine areas, are conifer-feeders and may be related to similar South American species. Australia also has the richest diversity in another geometrid sub-family, the robust-bodied Oenochrominae, which probably co-evolved with plants belonging to the Gondwanan families Proteaceae and Myrtaceae. Australia also has a large number of endemic species placed into the tribe Nacophorini.

In this study, taxonomic, systematic and ecological aspects of approximately 100 nacophorine and related ennomine species were studied. The preliminary results from a molecular study using the nuclear gene fragments 28SD2 and EF-1a were presented in this seminar. The main aims of this analysis were as follows:

1) To clarify relationships between the Nacophorini and the rest of the Geometridae.
2) To elucidate evolutionary relationships between the major sub-families and other groups of the Geometridae.

73 genera were represented in the 28S D2 analysis. Outgroup species were 3 noctuids and 2 drepanid species were included as the Drepanidae is a possible sister group to the Geometridae. The ingroup consisted of taxa from the following ennomine tribes: 22 nacophorines, 9 boarmiines, 2 lithinines, 1 azelinine, 1 colotoine, 2 caberines 1 ennomine, 2 macariines. 8 archiearine species (3 genera), 2 oenochromines s.str., 2 oenochromines s.l., 5 geometrines (including 3 of the 'grey-bodied geometrines), 2 sterrhines and 5 larentiines were also included as representatives of other major sub-families. The result of a combined 28S D2 and EF-1a using a smaller sub-set of the species listed above (17 taxa) was also presented.

The main results of these analyses are presented as phylogenetic hypotheses as follows:

(a) Drepanidae as sister-group to the Geometridae.
(b) Larentiinae as basal group within the Geometridae.
(c) Sterrhinae as next basal group.
(d) *Dichromodes* (Oenochrominae *sensu lato*) basal to the Ennominae plus Geometrinae.
(e) *A. parthenias* most likely in a basal position within the Ennominae.
(f) Oenochrominae *sensu stricto* and Geometrinae possible sister groups.
(g) Boarmiini probably basal to Australian Nacophorini.
(h) Australian Nacophorini and Tasmanian Archiearinae probably sister groups and are the most derived groups in the analysis. The Tasmanian Archiearinae are most probably not closely related to the Northern Hemisphere Archiearinae.
(i) Australian Nacophorini most likely not closely related to the American Nacophorini.
(j) *Alsophila* probably belongs within the Boarmiini and is mot likely not a separate sub-family.
(k) The tribe Lithinini most likely belongs within the Australian Nacophorini.
(l) These results largely support the topology of the tree obtained by Abraham et al. (2001), ex-

cept that the Ennominae are shown to be largely monophyletic (assuming *Alsophila* has been misplaced into its own sub-family) and not paraphyletic as shown by Abraham.

The smaller combined gene analysis largely supports the 28SD2 analysis in that, the Larentiinae are in a basal position within the Geometridae and the Tasmanian Archiearinae are closely related to the Australian Nacophorini. The latter group hold a derived position in the phylogeny. Similarly the Oenochrominae s.str. hold a sister group position to the Geometrinae.

References

Abraham, D., Ryrholm, N., Wittzell, H., Holloway, J. D., Scoble, M. J. & C. Löfstedt (2001): Molecular Phylogeny of the Subfamilies in Geometridae (Geometroidea: Lepidoptera). – Mol. Phylo. Evol. **20**(1): 65-77

The Foodplant relationships of the Australian Geometridae

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Australian Geometridae have diversified in a unique foodplant landscape, which features unusual plant taxa and extensive monogeneric tree canopies of low nutrient status. Sclerophylly and novel plant toxins are widespread in the flora. In addition, larvae must cope with an unpredictable climate, high fire frequency and large numbers of aggressive ants. However, there are few arboreal noctuids as potential competitors, except in the Queensland wet tropics. *Eucalyptus* (Myrtaceae) dominates the tree flora over much of the continent, while *Acacia* s.l. (Mimosaceae) dominates the extensive semi-arid shrublands.

A molecular phylogeny (28S D2) of a cross section of Australian geometrid genera gives some insight into their patterns of plant use, and indicates a complex pattern of host exploitation, involving apparent diversification within clades on some host genera, as well as some instances of putative host capture by individual taxa.

Myrtaceae, of Gondwanan origin, is the most widely used foodplant family, followed by Mimosaceae. This is not surprising given their vast geographical range across the continent. It is noteworthy that most taxa which feed on *Eucalyptus* do not feed on other Myrtaceae. *Leptospermum* and other myrtaceous shrubs have a distinct geometrid fauna. Interesting associations on other hosts include *Archephanes* on primitive Winteraceae, and *Dirce*, *Acalyphes* and *Corula* on Cupressaceae. Austral Proteaceae are exploited by *Oenochroma* and its allies, while Epacridaceae supports *Poecilasthena*.

Some associations appear to be global. Australian Caberini are associated with Mimosaceae and Rhamnaceae as elsewhere, while austral Macariini occur on Mimosaceae and Sapindaceae. Polyphagy on diverse woody plants is uncommon in Australia but has arisen in a few Boarmiini and the "nacophorine" genera *Chlenias* and *Androchela*.

Some widespread plant families, such as Casuarinaceae and Chenopodiaceae, are inexplicably poor in species of Geometridae, although the unusual monophagous genus *Rhynchopsota* has been reared from *Allocasuarina*.

The re-appearance of extra prolegs in some geometrid clades associated with *Eucalyptus* may be in response to leaf mimicry in an evergreen canopy and the challenge of traction on waxy sclerophyllic leaves.