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Evolutionary history of the burnet moth genus *Zygaena* Fabricius, 1775 (Lepidoptera: Zygaenidae) inferred from nuclear and mitochondrial sequence data: phylogeny, host-plant association, wing pattern evolution and historical biogeography FREE

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Abstract

Burnet moths of the genus *Zygaena* are a striking group of primarily diurnal Lepidoptera displaying an exceptional phenotypic plasticity. Previous attempts to elucidate the phylogenetic history of the group had been confounded by a perplexing pattern of characters or insufficient taxon sampling. In the present study, we infer a phylogeny of the genus *Zygaena* by analysing 5.4 kb of their nuclear and mitochondrial DNA. Eighty-four of the 98 currently recognized species in this genus are considered, including representatives of all described species groups. RNA coding sequences are aligned with reference to zygaenoid moth specific secondary structure models of corresponding molecules. We conduct phylogenetic analyses within a Bayesian framework applying partition specific substitution parameters; covariation of paired sites in RNA gene sequences is accommodated by using doublet substitution models. The molecular data reveal that a considerable number of currently recognized species groups in *Zygaena* are not monophyletic. The traditional subgeneric classification proves to be artificial as well; *Agrumenia* and *Zygaena* (*sensu stricto*) are polyphyletic. Only the subgenus *Mesembrynus* can be confirmed as a monophyletic species cluster. Optimization of larval host–plant associations and forewing patterns on sampled trees of the Bayesian

analyses suggest convergent evolution of similar wing pattern types in distantly related species clusters and a shift from cyanogenic to acyanogenic host-plants. The phylogenetic results challenge the classic assumption that early species diversification in *Zygaena* took place in the Irano–Turkestanian region. Rather, the molecular data point to the western Mediterranean area as the geographical origin of the group and imply a subsequent colonization of the Middle East and Central Asia. We discuss the apparently convergent evolution of similar wing patterns in context with the chemical defence system of burnet moths and suggest a species group concept for the genus *Zygaena* that accounts for the recent findings.

Keywords: [Bayes factors](#), [character evolution](#), [doublet substitution models](#), [mimicry](#), [molecular systematics](#), [partition specific substitution models](#), [Zygaenoidea](#)

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