



## Phylogenetic relationships of Elateridae inferred from adult morphology, with special reference to the position of Cardiophorinae

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### Abstract

A phylogeny is presented for the Elateridae, inferred from parsimony and Bayesian analyses of 175 adult morphological characters. Analyses using non gap-weighted morphological data yielded results compatible with each other and some published classifications, while gap-weighted parsimony analysis did not. Bayesian posterior probabilities for the monophyly of the Elateridae and the elaterid subfamilies Athoinae (*sensu* Dolin 1975), Cardiophorinae (including *Exoeolus* Broun), Denticollinae (*sensu* Stibick 1979a), Elaterinae (*sensu* Stibick 1979a), Hypnoidinae (*sensu* Stibick 1976) and Lissominae (*sensu* Calder *et al.* 1993) were less than 0.05. The bioluminescent genus *Pyrophorus* was found to be an apical member of the mostly non-bioluminescent Agrypninae, supporting the hypothesis of at least one independent origin of bioluminescence in the Elateridae. The closest relatives to the Cardiophorinae minus *Exoeolus* were found in the Negastrinae. The subfamilies Cardiophorinae + Negastrinae + *Tropihypnus* Reitter together rendered the Hypnoidinae (or the tribe Hypnoidini of Denticollinae) paraphyletic. *Lesnelater madagascariensis* Fleutiaux (the type species of *Lesnelater* Fleutiaux) is synonymised under the type species of *Pachyelater* Lesne: *P. madagascariensis* (Lesne) so that *Lesnelater* is a new synonym of *Pachyelater*. The genus *Exoeolus* Broun is transferred from the Cardiophorinae to the Hemipoinae; the fossil genus *Crioraphes* Iablokoff-Khinzorian is transferred to the Elaterinae *incertae sedis*; the fossil genera *Pseudocardiophorites* Dolin, and *Protocardiophorus* Dolin are transferred to Elateroidea *incertae sedis*. Dolin's (1976) hypothesis of a Jurassic origin of the Cardiophorinae was not supported by fossil evidence.

**Key words:** Elateroidea, Bayesian, parsimony, gap-weighting, bioluminescence

### Introduction

Elaterids are among the most abundant beetles in many terrestrial habitats. With approximately 10,000 species (Johnson 2002b), this remains one of the largest beetle groups for which there are no well-supported general phylogenetic hypotheses. Such hypotheses are needed to understand the evolution of bioluminescence and diverse feeding ecologies within this group including herbivory, carnivory (Calder 1996) and possibly fungivory. A primary goal of this paper was to test existing contradictory hypotheses about elaterid phylogeny. A further goal was to identify close relatives of the elaterid subfamily Cardiophorinae to use as outgroups in future phylogenetic studies. I also tested the reliability of fossil-based evidence that Cardiophorinae is known from Jurassic fossils.

Some initial questions of this study concerned the monophyly and internal relationships of clicking Elateroidea *sensu* Muona (1995), the clade thought to contain the Elateridae. However, Bocakova *et al.* (2007) have since demonstrated that clicking Elateroidea is almost certainly rendered non-monophyletic by Cantharoidea, a possibility that was not considered when planning this study. The question of clicking elateroid monophyly was dealt with only briefly to reflect the small amount of additional information that a morphological data set that includes all clicking elateroid families, but that includes no Cantharoidea, can provide.

It is becoming increasingly clear that Elateridae, as long defined (e.g., Candèze 1857, Stibick 1979a) is rendered paraphyletic by one or more smaller taxa. However, it is uncertain how Elateridae is non-monophyletic. Findings by Calder *et al.* (1993) based on a matrix of 26 taxa and 94 morphological characters suggest that the Elateridae includes *Lissomus* Dalman and *Drapetes* Dejean, making Throscidae *sensu* Crowson (1955) polyphyletic.