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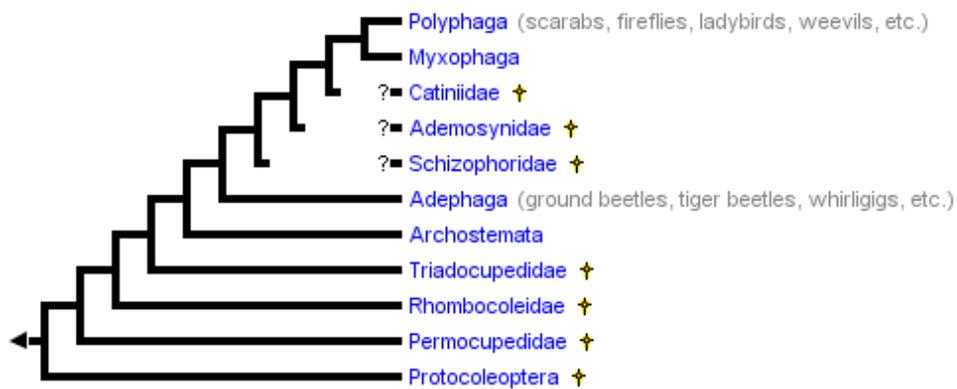
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David R. Maddison



Tree from Beutel (1997) and Beutel and Haas (2000).

Containing group: [Endopterygota](#)

## Introduction

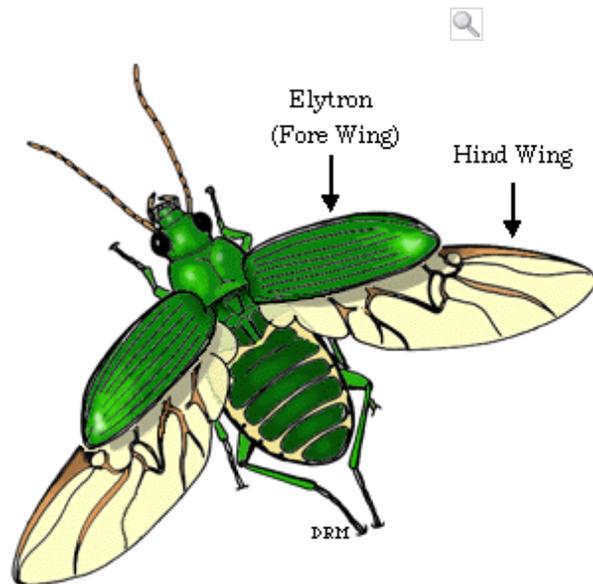
The Coleoptera, or beetles, includes many commonly encountered insects such as ladybird beetles (family Coccinellidae), click beetles (Elateridae), scarabs (Scarabaeidae), and fireflies (Lampyridae). They live throughout the world (except Antarctica), but are most speciose in the tropics.

The oldest beetle fossils are from the Lower Permian (about 265 million years old; Ponomarenko, 1995); since then the group has diversified into many different forms. They range in size from minute featherwing beetles ([Ptiliidae](#)), adults of which are as small as 0.3 mm long, to the giant Goliath and Hercules beetles (Scarabaeidae), which can be well over 15 cm. While most species are phytophagous, many are predacious, or fungivores, or are parasitoids. They communicate to one another in many ways, either by use of chemicals (e.g. pheromones), sounds (e.g. stridulation), or by visual means (e.g. fireflies). They live in rainforest canopies, the driest deserts, in lakes, and above treeline on mountains.

In one sense the most unusual property of beetles is not some aspect of their structure or natural history, but their sheer number. There are more known species of Coleoptera than any other group of organisms, with over 350,000 described species. Perhaps the most famous [quote about beetles](#) comes from the great population geneticist J.B.S. Haldane, who was asked what might be learned about a Creator by examining the world. His response: "an inordinate fondness for beetles" (Fisher, 1988).

## Characteristics

The most distinctive feature of beetles is the hardening of the forewings into elytra; it is from this that they get their formal name (koleos - sheath, pteron - wing). The elytra serve to protect the more delicate hind wings, as well as the dorsal surface of the abdomen, and may have been a key factor allowing them to exploit narrow passageways (for example, in leaf litter and under bark). During flight the forewings are opened enough to allow the hind wings to unfold and function:



Other derived characteristics of beetles are:

- hind wings folded under elytra, with reduced venation
- hind two thoracic segments (mesothorax + metathorax = pterothorax) broadly connected with abdomen, so that the primary functional units of body are head / prothorax / pterothorax + abdomen, rather than the more typical head / thorax / abdomen of many other insects.
- genitalia retracted into abdomen
- adult antenna with 11 articles

Beetles are holometabolous insects, normally with adecticous, exarate pupae. Most species have chewing mouthparts. There is a gula present on the undersurface of the head.

## The Suborders of Coleoptera

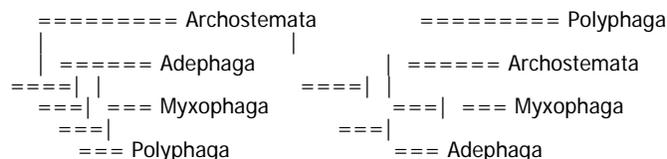
The four living suborders of beetles diverged from one another in the Permian and early Triassic, and are substantially different from one another. Adults differ in the structure of the prothorax, hind wing, abdomen, ovary, testes, and so on. [The major differences are summarized in a table.](#)

[Polyphaga](#) is by far the largest suborder, containing 85% of the known species, including rove beetles, scarabs, stag beetles, metallic wood-boring beetles, click beetles, fireflies, blister beetles, mealworms, ladybirds, leaf beetles, longhorn beetles, and weevils. Many are phytophagous. [Adephaga](#) includes ground beetles, tiger beetles, predacious diving beetles, and whirligig beetles; most adephagans are predacious. [Myxophaga](#) is a small suborder, containing less than 100 known species, whose members are small or minute, and associated with hygropetric habitats, drift material, or interstitial habitats among sand grains. [Archostemata](#) contains several families of beetles, most associated with wood; members of this family are somewhat similar to some of the earliest, Paleozoic beetle fossils.

## Discussion of Phylogenetic Relationships

Compared to the other four large orders of insects ([Hemiptera](#), [Hymenoptera](#), [Diptera](#), and [Lepidoptera](#)), the phylogenetic relationships of the major lineages of beetles are relatively poorly known. Only recently has some of the morphological data been examined phylogenetically (e.g., Beutel, 1997; Beutel and Haas, 2000), and molecular sequence information is only now being gathered.

There are several competing hypotheses regarding subordinal relationships. The two most widely discussed differ most strikingly in their placement of the suborder Polyphaga: this suborder is either the sister group of Myxophaga (Crowson, 1960, 1981; Machatschke, 1962; Klausnitzer, 1975; Beutel, 1997; Beutel and Haas, 2000), or the sister group of all remaining beetles (Lawrence and Newton, 1982; Kukulová-Peck and Lawrence, 1993), as shown in the following two figures:



"Polyphaga+Myxophaga" hypothesis      "Basal Polyphaga" hypothesis

Evidence for a close relationship of Polyphaga to Myxophaga includes the shared reduction in the number of larval leg articles (Crowson, 1960, 1981). Klausnitzer (1975) further considered the Adephaga as sister to Myxophaga + Polyphaga, based on completely sclerotized elytra, reduced number of crossveins in the hind wings, and folded (as opposed to rolled) hind wings of those three suborders.

Evidence for the alternative hypothesis, that Polyphaga is the sister group to remaining beetles, is based primarily on characters of wing structure, and on the loss of the cervical sclerites in the three suborders other than Polyphaga (Lawrence and Newton, 1982; Kukulová-Peck and Lawrence, 1993).

Recent cladistic analyses of some of the morphological data (Beutel, 1997; Beutel and Haas, 2000) supports the Polyphaga + Myxophaga hypothesis.

The composition of the clade Coleoptera is not in dispute, with the exception of the twisted-wing parasites, Strepsiptera. These odd insects have been regarded as related to the beetle families Rhipiphoridae and Meloidae, with which they share first instar larvae that are active, host-seeking triungulins and later instar larvae that are endoparasites of other insects (Crowson, 1981), or as the sister group of beetles (e.g. Kukulová-Peck and Lawrence, 1993), or more distantly related to insects (see further discussion in [Strepsiptera](#)).

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## Information on the Internet

- [Assembling the Beetle Tree of Life \(BTOL\)](#).
- [The Coleopterists Society](#).
- [The Coleoptera Home Page](#).
- [Beetles \(Coleoptera\) and Coleopterists. Zoological Institute of the Russian Academy of Sciences.](#)
- [Beetles](#). By A. Bochdansky & M. Kriftner
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- [Coleoptera families \(INBIO, Costa Rica\)](#).
- [Checklist of Beetles of Canada and Alaska](#).
- [A Distributional Checklist of the Beetles \(Coleoptera\) of Florida](#).
- [Coleoptera of Rhode Island: An on-line database](#).
- [The Beetles of the Virgin Islands](#).
- [Southeast Asian Beetles](#).
- [Shapes and Colors from the World of Beetles](#). *Thais Entomology*.
- [An Inordinate Fondness for Beetles \(A. V. Evans & C. L. Bellamy\)](#).

## Title Illustrations



Scientific Name  *Hydroscapha*  
 Location USA: Arizona: Tucson  
 Specimen Condition Dead Specimen  
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Scientific Name *Hydroscapha natans*  
 Location USA: Arizona: Sycamore Canyon  
 Specimen Condition Live Specimen  
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*Scientific Name* Bembidion confusum  
*Location* USA: Iowa: Manchester  
*Sex* Male  
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*Scientific Name* Priacma serrata  
*Specimen Condition* Live Specimen  
*Sex* Male  
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