EVOLUTION OF THE BEETLE HIND WING, WITH SPECIAL REFERENCE TO FOLDING (INSECTA, COLEOPTERA)

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INTRODUCTION

The beetles, Coleoptera, or Scarabaeida, is the most diverse insect order comprising about 360,000 extant species. These are arranged into four suborders, a few series, 16 superfamilies and ca 160–170 families in the most recent classifications (e.g. Lawrence & Newton, 1995). Among holometabolan insects (Endopterygota), the Coleoptera is prominent because its origin seems to have been a direct result of strong transformations of its flight apparatus. More specifically, archetypal beetle features, especially the adult external structure transformed into a durable protective construction, resulted immediately from a strongly increased defensive function of the fore wings. Having transformed into rigid elytra, these reliably prevented the hind wings in repose and the hindbody terga from damage or some other troubles when the imago penetrated into any liquid, closed or running substrate, or, on the contrary, left a confined space after preimaginal development.

Formation of such a structural plan of the adult body brought about profound change in the entire flight apparatus. Functional posteromotorism, the hind wings longer than the elytra and thence reducible in length when not in use were the main sequels to this process. The great variety of body shapes and sizes, together with the immense taxonomic diversity of Coleoptera, contributed much to the diversity of hind wing venation and folding patterns. Nevertheless, the understanding of the general trends that defined this diversity is far from complete. Many studies have been restricted to hind wing venation in separate beetle families or, more seldom, superfamilies. Comparative analyses of venational characters across the order are singular. Some of them are out of date while some others seem superficial. In particular, Ganglbauer’s (1892) well-known venational typology has been shown to be largely artificial, with its carabidiform, cantharidiform and staphylinidiform venation types often being only stages of successive veinal reductions (Ponomarenko, 1972). A comparatively recent typology introduced by Wallace & Fox (1980) has not been widely adopted. Special emphasis was put on folding patterns by Forbes (1926), but with no or minimum relation to wing venation. As a result, Forbes’ typology proved to largely be functional. Nonetheless, the placement of a few families in the Adephaga, for which a separate suborder, Myxophaga, was afterwards
erected (Crowson, 1955), as well as the incorporation of the Hydraenidae into the Staphylinoida, and the Haplogastria shown to be a natural group became greatly appreciated novelties of his classification based on this typology (Lawrence et al., 1995).

Thus, phylogenetic reconstructions and higher level classifications of the order, proposed to date from analyses of wing structure, have been supported by separate characters regarded as set elements, not parts of the whole, these being interrelated and thence interdependent in their changes through evolution. Such an approach obscures the intrinsic trends of evolution both of the wing as a whole and of its integral parts, forbidding the separation of synapomorphies from homoplasies. Hence, it leads to warped results and is less efficient. The objective of this work is to fill in this gap.