

Phylogenomic insights into the evolution of Neuropterida (Insecta: Holometabola)

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Background

- 1) The insect superorder Neuropterida contains more than 6,500 described species in three orders: Megaloptera, Neuroptera, and Raphidioptera.
- 2) Previous phylogenomic analyses of Neuropterida have suggested a robustly resolved phylogeny of Neuropterida that is in part incompatible with phylogenies inferred from analyzing morphological characters.
- 3) We generated new transcriptomic data in an effort to resolve the persisting phylogenetic incongruencies.

Orthology assignment and calculation of pairwise alignment completeness scores

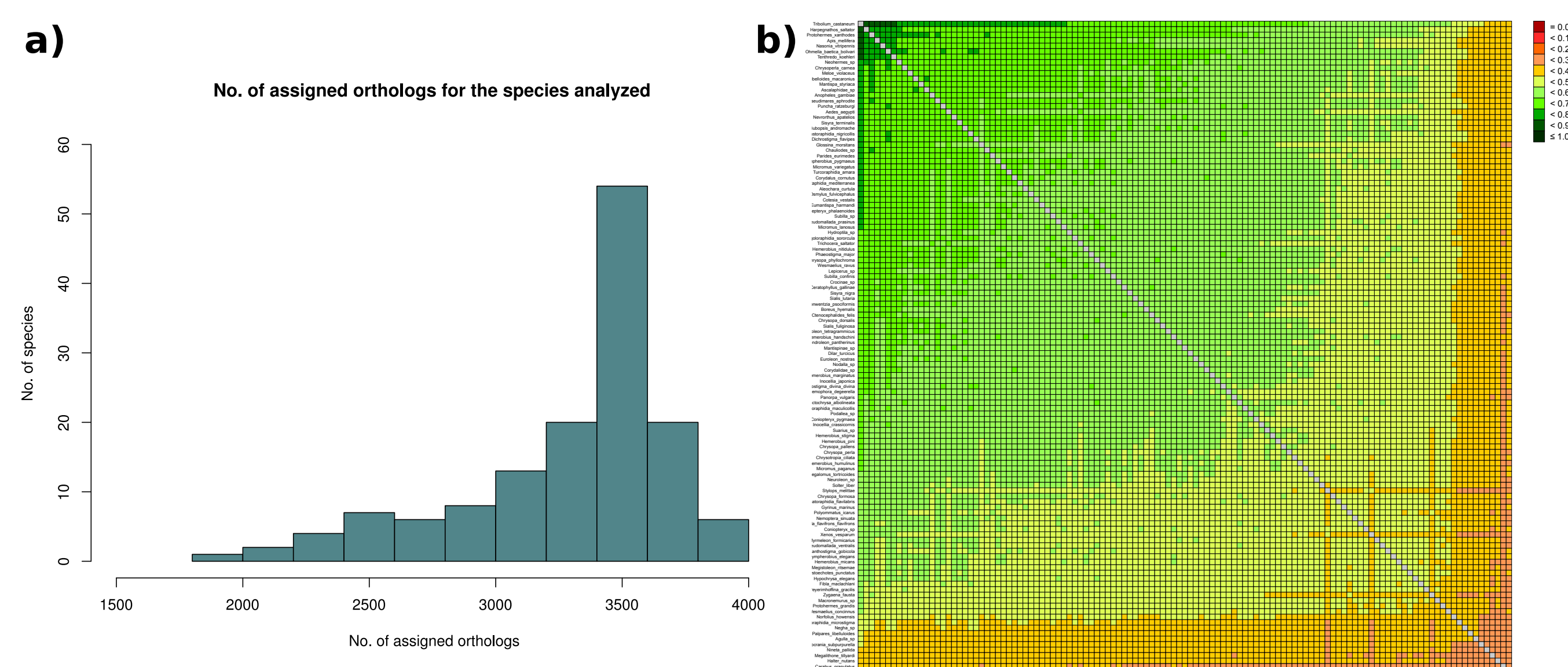


Fig. 1: a) Summarized results of the orthology assignment for all ingroup and outgroup taxa that were included in the analyses. b) Rectangular heatmap showing pairwise alignment completeness scores for all species included in the analyzed supermatrix. Values closer to 1 indicate higher completeness scores for the pairwise sequence comparisons.

Quartet-based analyses support Megaloptera + Neuroptera and Coniopterygidae as sister to all other Neuroptera

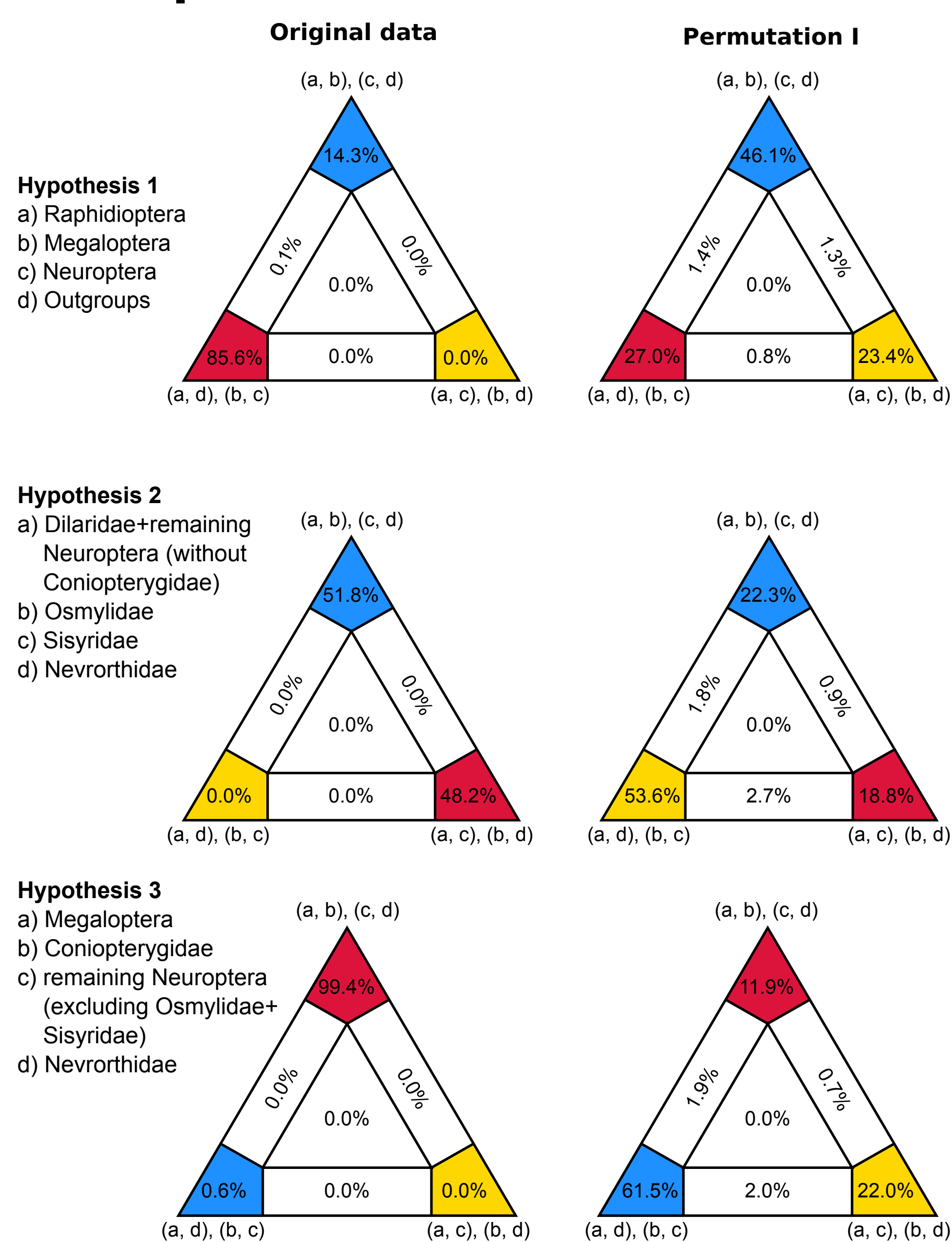


Fig. 2: Results of four-cluster likelihood mapping (FCLM) analyses for a selection of phylogenetic hypotheses applied at the amino-acid sequence level. The first column shows the results of FCLM when the original amino-acid supermatrix was analyzed. The second column shows the results of FCLM after phylogenetic signal had been eliminated from the amino-acid supermatrix (i.e. permutation no. 1).

Divergence time analyses date the common origin of extant Neuropterida in the middle of the Carboniferous.

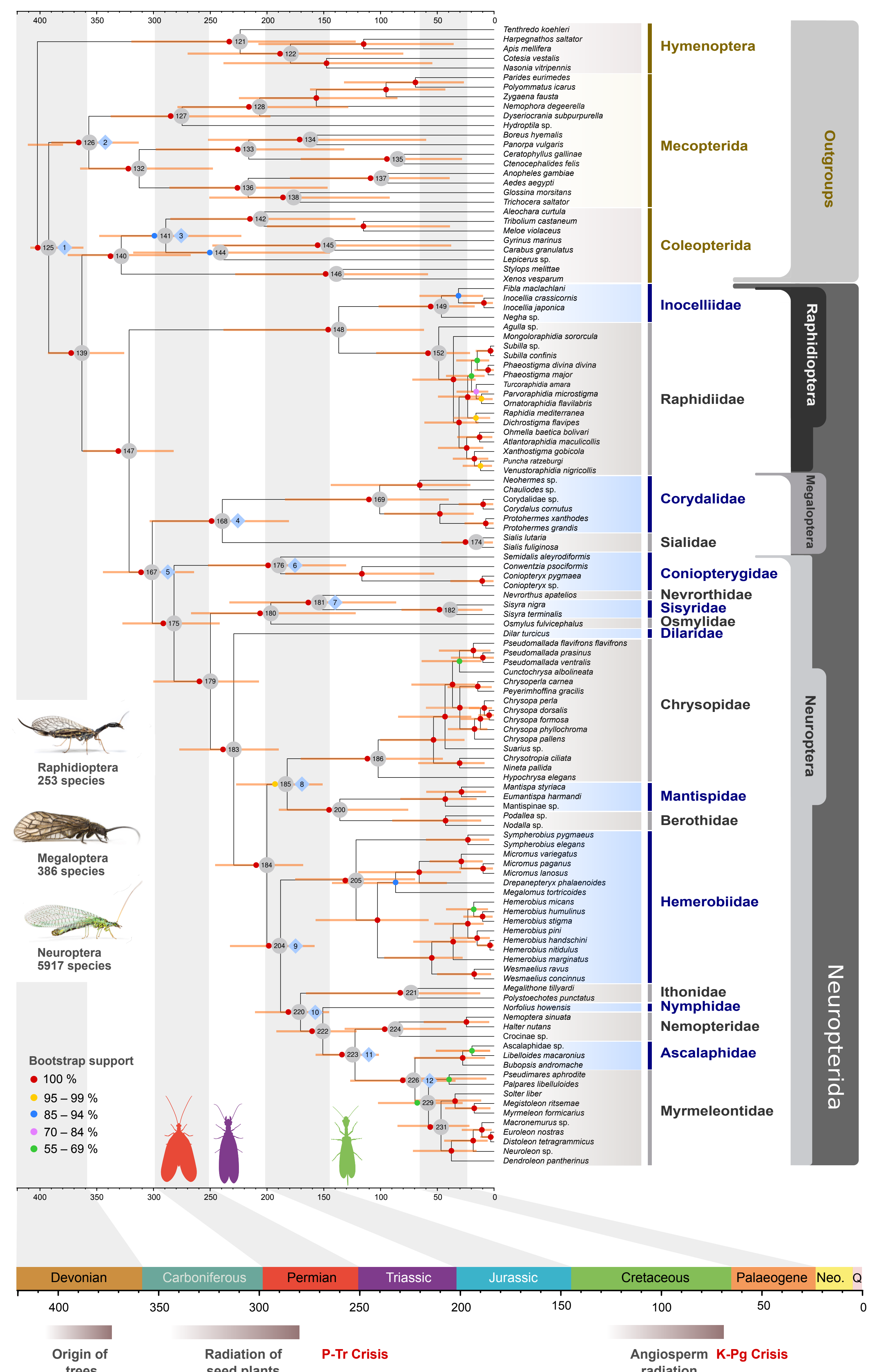


Fig. 3: Phylogenetic relationships of Neuropterida based on the analyses of protein domain-based partitioned amino-acid sequence data (931,450 alignment sites). Colored circles depict phylogenetic branch support values based on 100 bootstrap replicates. Bars on the individual nodes show the 95 % confidence intervals (equal-tail CI) of the posterior divergence time estimates. Insect photos from top to bottom: *Dichrostigma flavipes*, *Sialis lutaria*, *Chrysopa perla* (all photographs by O. Niehuis).

Summary

- 1) Coniopterygidae are robustly inferred as sister to all other Neuroptera. This suggests that larval cryptonephry might be an apomorphic feature of Neuroptera.
- 2) The families Nymphidae, Nemopteridae, Ascalaphidae, and Myrmeleontidae constitute a monophylum.
- 3) The relationships within Osmyloidea remain ambiguous.
- 4) Some phylogenetic splits within Neuroptera are older than previously suggested.