An Integrated Phylogenetic Analysis of Turtles

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Background. Testudines is a reptilian order with unique morphological features among vertebrates. This order is currently divided into two suborders: Pleurodira and Cryptodira; which comprises approimately 14 extant families with 95 genera, about 320 species. Phylogenetic affinities below the family level remain largely unresolved. The main discrepancies among previous studies concern the position of the superfamily Trionychoidea and the families Chelydridae and Platystenidae. The recent improvement in combined phylogenetic inference and divergence time estimates, as well as the increased taxon sampling available in databases, prompted us to investigate their evolutionary relationships.

Methods. In order to clarify the phylogenetic relatioships of Testudines, we inferred phylogenies from two datasets: (1) molecular dataset based on 12 genes, including 294 species; and (2) total evidence based on 12 genes plus 235 morphologic caracteres from the matrix of Sterli et al. (2013), including 28 extant and 69 extinct taxa. Maximum likelihood phylogenetic inference was performed with the data set partitioned into: (1) molecular nuclear data under GTR model of substitution, and (2) morphological data under Mk model. Statistical support for clades was assessed with 2000 nonparametric bootstrap replicates (BT).

Results. Our results supported a split between Pleurodira and Cryptodira (BT > 97). In Cryptodira, we inferred an early split between Trionychoidea and all other Cryptodira, known as Durocryptodira (BT = 100). The monophyly of all families and superfamilies were recovered with high support (BT=100), except for the family Podocnemididae (BT=59). In both analyses, Chelydridae was recovered as sister-group to the superfamily Kinosternoidae (BT=99). With regard to Platysternidae, this monotypic asian family would split from Emydidae in the molecular phylogeny (BT = 81), whereas in the total analysis this split was between Emydidae and all remaining Testudinoidea: Emydidae + Geomydidae + Testudinidae.

Discussion. All 14 families were represented in both analyses, although the molecular analysis contains 294 species-level taxa and total-evidence one has only 29 genus-level taxa.

Pleurodira and Cryptodira were recovered as monophyletic as in most previous works. Trionychoidea was recovered as a clade within Cryptodira, in contrast to previous hypotheses, which placed this superfamily either as sister to Pleurodira or Cryptodira, or as sister group of all Testudines altogether. Chelydridae was recovered as sister-group of Kinosternoidae, whereas Platysternidae, a monotypic Asian family, was recovered as a member of Testudinoidae; although his position within the group was conflicting. This position of Platysternidae was the only conflict between crown groups found between our datasets.

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