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A Diagnosis for Monotremata, Tachyglossidae and Ornithorhynchidae

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The relationships of extinct monotremes to one another and to living monotremes are ambiguous. For example, the Early Cretaceous Australian fossil, *Teinolophos trusleri* has been identified as a basal monotreme and as a relative of the platypus, having extreme implications on the divergence date between the platypuses and the echidnas. Part of the ambiguity may be due to a lack of diagnostic morphological characters for Monotremata, Ornithorhynchidae and Tachyglossidae.

I examined and compared the cranial and postcranial skeletal anatomy of extant monotreme species to identify characters that are uniquely shared among living monotremes. I identified a total of 41 new characters to diagnose Monotremata, Ornithorhynchidae, and Tachyglossidae. Of those new characters, 26 are cranial and 15 are post-cranial. These new characters were incorporated into a published morphological matrix of mammals. Most parsimonious trees (MPTs) were estimated with a heuristic method under the parsimony criterion setting using PAUP4b10 with 1000 random sequence additions and Tree-bisection Reconnection (TBR) branch swapping. Two analyses were conducted, one under the accelerated transformation (ACCTRAN) optimization setting, and another under the delayed transformation (DELTRAN) optimization setting. The ACCTRAN search recovered 6 MPTs and the DELTRAN search recovered 6 MPTs, with a minimum tree length of 1261, a consistency index of 0.5757 and a homoplasy index of 0.4243.

Monotremes were recovered as a single, monophyletic group outside of the group containing marsupials and placentals, known as Theria, and extinct therian relatives. In the strict consensus tree, the echidnas, Tachyglossidae, diverge earliest from the platypus and the extinct monotremes, *Obdurodon*, *Teinolophos*, and *Steropodon*. The extinct echidna, *Megalibgwilia*, is basal to the extant *Zaglossus* and *Tachyglossus*. The extinct monotreme, *Teinolophos*, is basal to the extinct monotremes, *Steropodon*, *Obdurodon*, and the extant *Ornithorhynchus*. The relationship among these latter three taxa is unresolved. Bootstrap analysis shows insignificant support for a *Steropodon-Ornithorhynchus* sister relationship.

New characters support a monophyletic relationship of Monotremata outside of Theria. New characters support the hypothesis that the extinct Early Cretaceous monotremes are of the platypus lineage, Ornithorhynchidae, and support an Early Cretaceous divergence-date for Tachyglossidae and Ornithorhynchidae. A confident assignment of fossils to Ornithorhynchidae, Tachyglossidae, or basal Monotremata will offer insight into the evolution of mammals and the time of divergence between the two living, yet disparate, groups of monotremes.

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