

## Molecular Phylogeny of Monachine Seals (Pinnipedia: Phocidae) With Implications for Their Origin and Diversification

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Monachine seals (Family Phocidae) include three diverse groups, Lobodontini (Antarctic seals), *Mirounga* (elephant seals), and *Monachus* (monk seals). Despite the inclusion of two of the most endangered pinnipeds in the world (*Monachus tropicalis* and *M. schuainslandi*) phylogenetic relationships among monachine seals remain unclear. To date, existing molecular studies exhibit poor taxon sampling while those studies utilizing morphological data have poorly supported nodes that suggest conflicting phylogenetic hypotheses. The primary objective of this study is to determine relationships among monachine seals. Secondly, the inferred phylogeny together with fossil data and estimated divergence dates will be used to explore monachine seal historical biogeography. Molecular sequence data used in this study were from three mitochondrial genes (*cyt b*, ND1, and 12S), and one nuclear marker (an intron from the  $\alpha$ -lactalbumin gene).

Phylogenetic methods included maximum likelihood and partitioned Bayesian inference with separate nuclear and mitochondrial data sets, as well as combined (nuclear + mitochondrial) data sets. These data provided strong support for the monophyly of the Monachinae, the monophyly of the three main groups within Monachinae (*Mirounga*, *Monachus* and Lobodontini), and the sister relationship between Lobodontini and *Mirounga*. Historical biogeographic hypotheses for monachines based on a phylogenetic framework developed herein suggest that the first split within the Monachinae (Lobodontini + *Mirounga* and *Monachus*) occurred between 11.8-13.8 Ma in the North Atlantic. Fossil evidence supports *Monachus* having evolved in the Tethys Sea with dispersal of this clade to Hawaii by 10-11.6 Ma. Basal *Mirounga* and lobodontine seal clades diverged by 10.8-12.6 Ma followed by lobodontine migration to the colder Antarctic region where they diversified into the present day fauna. *Mirounga* shows an anti-tropical distribution either reflective of a once cosmopolitan range that was separated by warming waters in the tropics or a dispersal event from the Atlantic to Pacific between 2.7-3.4 Ma.