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MOLECULAR AND MORPHOLOGICAL ANALYSES CONFIRM THAT ALL LOONS (AVES: GAVIIFORMES) FORM A SINGLE HOLOBARAMIN

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ABSTRACT

Loons or divers (Aves: Gaviiformes), a group of waterbirds found primarily in the Northern Hemisphere, are comprised of several extinct taxa as well as an extant family (Gaviidae) with one genus (*Gavia*) and five species. Recent phylogenetic studies suggest that the Sphenisciformes (penguins) and Procellariiformes (petrels, albatrosses, and shearwaters) form a sister group to the loons. Our previous research, based on hybridization, morphological, and vocalization data, found that all extant loons form a single holobaramin (i.e., created kind). This previous study, however, was inconclusive as to the membership of fossil taxa within the kind. The goal of the present study is to verify the baraminic status of the extant loons using new molecular baraminology techniques and to further evaluate extinct loon morphology to determine whether they also belong to the loon holobaramin. DNA sequences from four mitochondrial genes (CO1, CYTB, NADH1, and NADH2) were gathered, for all extant loons and several outgroups, from the BOLD and GenBank databases and aligned with ClustalW in MEGA. Corrected distance matrices were created with the TN93 + Gamma model and analyzed using hierarchical clustering, classic multi-dimensional scaling, and medoid partitioning in R software. A newly published dataset of skeletal characters, from extinct and extant loons as well as several outgroups, was also analyzed using statistical baraminology clustering methods (BARCLAY: DCA, MDS, PAM, FANNY). Extant loons consistently formed significant/separate clusters across all genes and molecular analyses, confirming they share significant continuity with one another and significant discontinuity from the outgroups. Morphological analyses demonstrated that all loons, extant and extinct, were positively associated/correlated with one another, sharing significant continuity, and negatively associated/correlated, displaying significant discontinuity, with several key avian outgroups. Based on considerable evidence of both continuity among loon species and discontinuity from other avian groups (including the supposed sister groups, Sphenisciformes and Procellariiformes), we conclude that all loons (Aves: Gaviiformes), both extant and extinct species, form a single holobaramin. These results are consistent with our previous research and Answers in Genesis's brief analysis of loon hybridization for their Ark Encounter Project.

KEYWORDS

Loons, gaviiformes, statistical baraminology, molecular baraminology, holobaramin

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Timothy R. Brophy is a Professor of Biology and Director of the Center for Creation Studies at Liberty University in Lynchburg, VA. He has a Ph.D. in Environmental Science and Public Policy (Natural Sciences) from George Mason University, an M.S. in Biological Sciences from Marshall University, and an M.A. in Theological Studies (Biblical Studies) from Liberty University. Tim has published over 20 papers in the conventional literature related to the ecology and systematics of salamanders and turtles as well as a dozen papers, abstracts, and presentations on the baraminology of landfowl, loons, turtles, mole salamanders, horses, and other vertebrate taxa.

Mary-Clark A. Matthews is an undergraduate student at Liberty University studying Zoology, with minors in Creation Studies and Psychology. She has conducted baraminology research on loons and has presented some of these results at both the Creation Biology Society's Origins conference and Liberty University's Research Week.

McKayla M. Guillory is a recent graduate of Liberty University who majored in Zoo and Wildlife Biology and minored in Military Science and Psychology. She has done research in baraminology and has presented her preliminary findings on extant loon species at Liberty University's Research Week and the Creation Biology Society's Origins conference. McKayla also has considerable experience using EXCEL for graphical and statistical analysis of quantitative ecological data.

Alexis M. Ramerth is an undergraduate student at Liberty University with a major in Zoology (Pre-Veterinary Science). She has served as vice president of both the Biology and Pre-Veterinary clubs. Alexis has conducted research on Northern Saw-whet Owl migration patterns and baraminology of the loon family. She presented portions of her loon research at Liberty University's Research Week and the Creation Biology Society's Origins conference.