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The evolution and loss of complex behaviours in social insects: silk weaving and arboreal nesting in *Polyrhachis* ants.

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To investigate the evolution of complex behaviours we derived phylogenetic hypotheses for the ant genus *Polyrhachis* (based on 3 nuclear and 3 mitochondrial gene sequences from 37 *Polyrhachis* species representing all 13 subgenera and 5 outgroup species) and inferred the evolutionary history of nesting behavior and nest location using ancestral state reconstruction and correlation. The monophyly of the genus and all thirteen subgenera are supported, but one subgenus (*Cyrtomyrma*) appears nested within the *Myrmhopla* and sister to the *mucronata* group. In contrast to previous hypotheses nest-weaving via the use of larval silk is ancestral within the genus and strongly correlated with arboreal nesting habits. Transitions away from the ancestral state have occurred frequently, with ground nesting (which is strongly correlated with the lack of larval silk in the nest) evolving on at least 5 separate occasions. Larval cocoons (the ancestral state) have also been lost on at least two occasions, and most surprisingly, transitions back to arboreal nesting have also occurred, including the revolution of silk nests (albeit from spider rather than larval sources). Together, these patterns show a remarkable flexibility in the evolution, loss and regaining of complex behaviours.

Keywords: complex systems, behavior, *Polyrhachis*, phylogeny