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The evolution of chemosensory proteins in ants

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Chemical communication has been extensively studied in social insects, yet studies have only begun to look at the genes underlying these sophisticated behaviors. Large gene families contribute to the first steps of receiving chemical messages. Chemosensory proteins (CSPs) and odorant binding proteins (OBPs) are the first ones to interact with the chemical messages. These proteins bind and transport the insoluble odorants to odorant receptors. CSPs are particularly interesting in ants, as they have a role in binding the nest-mate recognition cues. I have studied the evolution of CSPs in ants, and found that the number of functional CSP genes has increased in all the seven ant species studied. Those CSPs that are specific to ants evolve under positive natural selection, suggesting different CSP copies have adapted to slightly different tasks. Furthermore, the ant-specific CSP expansion has originated from the nest-mate cue binder or a protein similar to that, suggesting the expanded genes have adapted to tasks in ant chemical communication. To put these results into a functional context, protein models were built. I was especially interested in which parts and properties of chemosensory proteins have been affected by positive selection. CSPs differ in size, binding pocket and harbor extensive variation in their surface charge. Interestingly, positive selection has targeted the surface rather than the binding pocket, and natural selection seems to drive variation in CSP surface charge. Variable surface charge likely has functional importance for example by affecting ligand binding, interaction between CSPs and odorant receptors, or is connected to the cellular environment of CSP expression. Protein modeling is rarely used in evolutionary context. Yet, these studies show that protein modeling together with comparative genomics can offer unique insights into the evolution and function of genes and proteins.