Division of labor in darkness and in light: adaptive visual system evolution in Atta cephalotes

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Evolution shapes peripheral sensory systems and their primary and integrative neural support in relation to the physical environment and requirements for information processing. In social insects, work environments may influence the neuroecology of division of labor. Workers of Atta cephalotes, a fungus-growing ant that shows remarkable worker polymorphism, perform tasks spatially distributed inside and outside the nest in strikingly different light conditions. Visual environments of task performance correlate with worker body size. We hypothesized that the visual system in A. cephalotes workers evolved adaptively in association with division of labor by morphological subcastes that show behavioral differentiation. We analyzed variation in compound eye structure in workers ranging from 0.6 to 3.5 mm in head width by imaging eyes and recording ommatidia number and size, interommatidial angle, and calculating the eye parameter, a metric reflecting the trade-off between sensitivity and resolution.We found that ommatidia number and size increased allometrically with worker head width, suggesting greater eye investment in larger workers, which are primarly active outside the nest. Interommatidial angle and eye parameter values were significantly larger only in the smallest workers that specialize on tending fungi deep inside the nest. These data suggest A. cephalotes minim worker eyes are adapted to enhance sensitivity rather than resolution. We also analyzed the brain investment in the optic lobe (primary processing area) and the scaling relationship of its structures, by imaging neuropil. Comparisons among polymorphic workers show that relative investment in optic lobe increased allometrically with body size. Genomic studies complement our neuroanatomical work. Visual structures and primary processing brain areas appear to be adapted to different light conditions related to division of labor among morphologically differentiated A. cephalotes workers.