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Social insect antimicrobial secretions: prevention rather than cure

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Fossil entomopathogenic fungi provide evidence that microbial pathogens were present in the environments in which insect sociality first evolved and consequently may have been major selective agents affecting the very earliest colonies. If fungi such as these were sociality's primordial enemies, then some evidence of this may remain in the form of covariance between levels of sociality and antifungal defences in extant lineages: antifungals becoming stronger with group size and increasing social organisation. Our work shows this to be generally true with respect to cuticular anti-entomopathogenic fungal activity in bees, wasps, thrips - and social spiders. In bees the greatest increment in antifungal activity appears in the transition from solitary to primitively social organisation, suggesting the necessity for antifungals from sociality's earliest stages. In some thrips and termites, soldier anti-fungal activity may be as critical to colony survival as their physical ability to repel larger enemies. These findings suggest the importance of cuticular secretions as the front-line mechanism in the prevention of disease and prompt at least two lines of thought. First, we suggest that elevated levels of activity of antimicrobial compounds were so crucial to social evolution that the traits that produce them should be considered to be part of the shortlist of major traits conventionally thought to be essential for social evolution. Second, the evolutionary arms race between nascent colonies and microbial pathogens might have been a driver of increasing colony size as limits to the potency of antimicrobial compounds could have been offset by increasing the numbers of individuals producing those secretions. Our data provide insights into these possibilities but leave us with the question: Was there a role for the arms race between microbial pathogens and insect antimicrobials in social evolution?