



## **Long live the queen: eusociality and the evolutionary theory of ageing**

Author(s): Boris H. Kramer, Boris H. Kramer , Ido Pen , G. Sander van Doorn

Institution(s): Theoretical Research in Evolutionary Life Sciences, University of Groningen ; Theoretical Research in Evolutionary Life Sciences, University of Groningen ; Theoretical Research in Evolutionary Life Sciences, University of Groningen ; Theoretical Research in Evolutionary Life Sciences, University of Groningen

The extraordinarily long lifespans of queens in eusocial insects and the strikingly large differences in life expectancy between workers and queens, given identical genetic background, challenge our understanding of the evolution of aging and provide unique opportunities for studying the causes underlying adaptive variation in lifespan within species. Traditionally, the evolution of distinct worker and queen ageing phenotypes have been explained by invoking classical evolutionary ageing theory: well-protected inside their nests, queens are much less exposed to external hazards than foraging workers, and this provides natural selection the opportunity to favour queens that perform well at advanced ages. Although quite plausible, these verbal arguments have not been backed up by mathematical analysis. Here, for the first time, we provide quantitative models for the evolution of caste-specific ageing patterns. First, we show that, due to the colony structure of social insects, the force of selection against increased age-specific mortality is inherently stronger in queens with non-reproducing workers than in solitary breeders with otherwise identical age schedules of reproduction and mortality. Second we apply the mutation accumulation theory by expanding its scope to social insects to predict lifespan patterns of queens and workers. We show that, even without the protection against extrinsic mortality afforded by defensible nests, queens are expected to evolve longer lifespans than workers. In addition, caste specific extrinsic mortality can amplify the divergence between worker and queen ageing phenotypes. We further discuss the influence of social organisation (monogyny and polygyny) as well as the effect of worker fecundity on the evolved lifespan phenotypes.