Short reviews

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Necrophoresis: The funeral ways of social insects

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Social insects are the only animals, apart from humans, that have sophisticated behavioural strategies for the final disposal of dead conspecifics, known since ancient times. Nestmates that die inside the nests represent a high epidemiological risk for insect societies because of the opportunistic microbial proliferation they may cause, especially when they die due to some infectious agent (Cremer *et al*., 2007). The four major behavioural strategies known in social insects towards dead conspecifics include necrophoresis, intraspecific necrophagy, burial and necrophobia. Among these, necrophoresis, the distant removal of corpses is the main strategy employed largely by social Hymenoptera and scarcely by termites (Lopez-Riquelme and Fanjul-Moles, 2013).

The extreme division of labour in social insects has produced individuals who engage in the specialized task of 'undertaking', which involves disposal of dead nestmates or those mortally sick due to infections. The individuals engaged in undertaking are known as 'undertakers'. *Apis mellifera* which exhibits temporal polyethism has dedicated undertakers. In the common red ant, *Myrmica rubra* (*Fig. 1*), undertakers are short term specialists that split their time between disposing of the dead and foraging (Diez *et al.*, 2013). Specialized undertakers have several neurobiological adaptations for efficient processing of death stimuli such as specializations in antenna and brain, as well as additional neural pathways and neurotransmitters.

***Fig. 1. Myrmica rubra* involved in necrophoresis**

(Source: https://antpestcontrol.com/dead-ants-why-do-live-ants-carry-their-dead-away/)

Necrophoresis proceeds through three stages *viz.,* corpse recognition, processing of death-related stimuli and the final transport of the corpse. Presence of necromones, as well as absence of certain 'lifeness signals' in corpse, aid in death recognition. In *A. mellifera,* a blend of oleic acid and β-ocimene is more consistent in triggering necrophoric behaviour than either of the fatty acids alone (McAfee *et al.,* 2018).

On detection of the corpse, the undertakers analyse information from the corpse by peripheral and central nervous mechanisms. Information extracted by sensory organs on antennae are processed and coded, first in the antennal lobes and then in higher brain centres, mainly the mushroom bodies. Necrophoresis terminates with abandoning the corpses out of the hive as seen in bees or dumping them in refuse dumps called 'cemeteries' or 'middens' as in the Indian black ant, *Camponotus compressus* (Banik *et al*., 2010) or using them as a 'corpse boundary' against competing species, as in *Formica cinerea* (Fig. 2) and *F. rufa*. (Czechowski, 2009).

***Fig. 2. Formica cinerea* involved in necrophoresis**

(Source: https://www.bwars.com/ant/formicidae/formicinae/formica-rufa)

Necrophoresis confers social insects with social immunity and survival advantage which very much contribute to the success of social life. In *M. rubra,* significance of necrophoresis in colony survival is evident from the increased survival rate of nestmates recorded in free removal colonies than in limited removal colonies (Diez *et al*., 2014).

Through necrophoric behaviour, insect societies prevent the proliferation of pathogens and the risk of infection among the members of the society, mainly the queen and the brood, on whom the fitness of the society depends. Necrophoresis, despite its complexity and sophistication, represents an altruistic behaviour in social insects for the survival and success of the colony.

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