Aggression, Primer Pheromone, and Biogenic Amines

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Nestmate recognition is a crucial element in the social organization of ants, operating as the first line of defense in maintaining colony integrity by excluding intruders. Adaptations of an animal's behavior to environmental and developmental change result from functional modifications in their central nervous system, which in turn is modulated by the release of various neurotransmitters and neurohormones. Octopamine (OA) and tyramine (Tyr) are considered the functional equivalents of norepinephrine and epinephrine in invertebrates. In insects studied to date, OA acts as a neurohormone, neurotransmitter, and/or a neuromodulator. Accumulating evidence suggests that OA increases pheromone acuity in insects by lowering the threshold of response and increasing the sensitivity of pheromone specific neurons, but not neurons for general odors. We are working to unravel the role of OA and other biogenic amines in the social behavior of ants, specifically processes related to nestmate recognition in the red imported fire ant. We determined the roles of the queen and workers in nestmate recognition and the modulatory effects of biogenic amines on this process by manipulating biogenic amine levels in workers. Ten queenright colonies were separated into the following three sub units: A) queenright (QR) - fed crickets and 20% aqueous sucrose solution; B) queenless (QL) - fed crickets and 20% aqueous sucrose solution; and C) queenless (QL) – fed crickets and an aqueous solution containing 20% sucrose and 1%

OA. Aggression bioassays were carried out weekly. The level of OA in worker brains was analyzed (t = 9-10 weeks). The level of OA decreases significantly in the absence of the colony queen. QL ants experience a significant reduction in OA levels that is redeemed by feeding the ant with OA. QR colonies maintain aggression levels between 5 and 7 while QL workers fed only crickets and aqueous sucrose had mean aggression levels between 2 and 4. Workers fed OA initially showed decreased aggression levels, as expected for QL worker groups, but aggression levels increased until they were not significantly different from the QR. Feeding OA to fire ant workers was adequate to simulate the presence of the queen, in terms of nestmate recognition, and presumably the release of the recognition primer pheromone. Thus, we have strong evidence that the queen recognition primer pheromone acts on workers to maintain high levels of OA that up - modulates worker sensitivity to the subtle changes in intraspecific nestmate recognition cues. This work represents a major step in unraveling the physiological effects of an ant primer pheromone.