CHEMICALLY MEDIATED BEHAVIOR IN ACARI:
Adaptations for Finding Hosts and Mates

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Abstract—Ticks and mites respond to a limited spectrum of stimuli in their
search for hosts and mates. Airborne chemical signals include carbon dioxide,
ammonia, organic acids, terpenoids, 2,6-dichlorophenol, and other phenolic compounds. These are detected primarily by sensilla in and adjacent to Haller's organ. Most ixodid species examined have one or more multiporose sensilla that detect such volatiles. These olfactoreceptors enable the ticks to respond to remote volatile chemicals from hosts and from the other ticks, e.g., sex pheromones. Other sensilla, probably mechanogustatory in function, also occur on the tarsi. Gustatory sensilla on the palps detect assembly pheromones that enable ticks and mites to respond to conspecific or heterospecific chemical stimuli in their environment. Responses to those stimuli in ticks result in clustering, i.e., arrestant behavior. Arrestant behavior also occurs in certain mites. Finally, cheliceral chemosensilla enable ticks to recognize specific phagostimulants in host blood, e.g., ATP and glutathione, that stimulate feeding. In Dermacentor variabilis and D. andersoni, these same cheliceral chemosensilla recognize species-specific genital sex pheromones in the vulvae of conspecific mates, without which they do not copulate.

Key Words—Dermacentor variabilis, Dermacentor andersoni, Amblyomma spp., semiochemicals, behavior, sensilla, Haller's organ, phenols, genital sex pheromone, 2,6-dichlorophenol.

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Acarines are a remarkably diverse group of animals, comprising tens of thousands of species that are found in an immense variety of terrestrial and freshwater habitats. Mites are major components of soils, where they feed on fungi, dead and decaying leaves and, occasionally, one another. Others are parasitic, attacking numerous mammals, birds, reptiles, and even insects. Many infest nests, burrows, and human habitations. Plant mites are notoriously destructive pests, affecting many of our most valuable fruits and ornamentals. As vectors of animal diseases, the ticks are without peer among the Acari in terms of the variety and sheer destructive potential of the pathogenic agents that they transmit.

An assemblage of such diversity may be expected to have numerous semiochemicals and behavioral adaptations. However, relatively few such behavior-modifying compounds have been found to date, a fact which may reflect the paucity of our knowledge rather than a dearth of chemical communication in nature. Acarines produce a variety of arrestant pheromones, a limited spectrum of sex pheromones, several dispersal pheromones, and an unusual pheromone for the genus *Amblyomma*, specific for the genus *Amblyomma*, for regulating attachment and clustering of feeding ticks. Absent are trail pheromones, food-finding pheromones, the innumerable defensive compounds (Staddon, 1979) and the great variety of androconia, hair pencils, and other devices for sexual display and pheromone dispersal. As Blum (1981) has noted, the insects "are remarkable chemists" and have evolved an incredible cornucopia of compounds to deal with the need to communicate information.

This review will examine the variety of acarine semiochemicals and the behavioral adaptations regulated by them. Special attention will be given to ticks, where the greatest amount of new knowledge has accumulated. We will limit ourselves almost entirely to chemoreceptors and the semiochemicals that they perceive, although the potential role of other receptor types can hardly be excluded.

PERCEPTION OF PHEROMONES AND HOST ODORS

Three organs are used for detection of chemical cues in ticks, (1) the Haller's organ on the first leg tarsi, (2) the terminal segment of the palps, and (3) the cheliceral digits. Little is known of the organs used for pheromone perception in mites.

*Haller's Organ.* This complex organ consists of an anterior trough with six or seven setiform sensilla, completely exposed to the atmosphere, and a posterior capsule with both setiform and pleomorphic sensilla, exposed only by a small pore or narrow slit (Figure 1). The anterior trough (Figure 2) in most