CHEMOORIENTATION OF EASTERN TENT CATERPILLARS TO TRAIL PHEROMONE, 5β-CHOLESTANE-3,24-DIONE

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(Received April 22, 1991; accepted June 18, 1991)

Abstract—Chemoorientation behavior of the larval eastern tent caterpillar, Malacosoma americanum, was studied using the synthetic trail pheromone 5β-cholestane-3,24-dione. Divergent arms of Y mazes were treated with various concentration ratios of the pheromone. At application rates of $10^{-10}$ to $10^{-9}$ g/mm of trail, larvae showed a significant preference for stronger trails when concentration ratios differed by as little as 4:1. At application rates of $10^{-8}$ and greater there was no significant difference in trail choice even when trails differed in strength by a full order of magnitude. Other studies showed that the caterpillars abandon the pattern of choosing stronger over weaker trails when they repeatedly fail to find food at the end of a stronger trail. Experiments in which larvae were required to choose trails separated by a gap demonstrated orientation by chemoklinotaxis. Caterpillars that had one of the maxillary palps ablated looped in the direction of their intact chemoreceptor when placed on filter paper treated uniformly with pheromone, indicating that they may also orient by tropotaxis. The relevance of these findings to the tent caterpillar communication system is discussed.

Key Words—Chemoorientation, pheromone, eastern tent caterpillar, Malacosoma americanum, trail following, klinotaxis, tropotaxis, 5β-cholestane-3,24-dione, Lepidoptera, Lasiocampidae.
INTRODUCTION

Previous behavioral experiments with eastern tent caterpillars, *Malacosoma americanum* (Fitzgerald, 1976), and caterpillars of the lackey moth, *Malacosoma neustria* (Peterson, 1988), demonstrated that larvae deposit chemical markers to facilitate orientation to and from feeding sites. A major component of the pheromone system of the eastern tent caterpillar, 5β-cholestane-3,24-dione, was identified recently and shown to elicit trail following at threshold levels of $10^{-11}$ g/mm of trail (Crump et al., 1987). Caterpillars mark exploratory trails as they move to food by dragging a ventral secretory site against the substrate (Fitzgerald and Edgedy, 1982). Successful foragers overmark these trails as they return to the tent (Fitzgerald and Peterson, 1983). Overmarked trails are analogous to the recruitment trails used by ants and serve to lead siblings to food finds.

Observations made in earlier studies indicated that the trail system of the eastern tent caterpillar consists of chemical trails of variable age and strength. For example, both the availability and the quality of foliage affect the marking intensity of caterpillars (Fitzgerald and Peterson, 1983). Moreover, although the chemical marker is long-lived and may persist for weeks under field conditions, it declines in effectiveness as it ages (Fitzgerald and Gallagher, 1976; Peterson, 1988). As caterpillars move over this trail system, they must choose between the divergent trails that occur at forks in the branches. Previous studies showed that caterpillars choose newer over older trails at these choice points (Fitzgerald and Gallagher, 1976), but the effect of pheromone concentration on trail selection behavior has not been assessed previously. We therefore undertook studies to determine how caterpillars respond to trails containing different quantities of the synthetic marker.

A second study was undertaken to investigate the orientation mechanisms of trail-following tent caterpillars. 5β-Cholestane-3,24-dione is perceived by contact chemoreception mediated by the maxillary palps (Roessingh et al., 1988), which are bilateral mouthpart chemoreceptors (Schoonhoven, 1987). Generally, organisms that perceive stimuli via bilateral receptors may use tropotactic or klinotactic orientation mechanisms (Bell, 1984; Bell and Tobin, 1982; Kennedy, 1986). In tropotaxis, animals orient to spatial gradients of stimuli by sampling simultaneously left and right from the paired sensory receptors (instantaneous comparisons) (Bell and Tobin, 1982). In klinotaxis, sampling is done successively (temporal comparisons) (Bell and Tobin, 1982), either along a path (longitudinal klinotaxis) or from side to side (transverse klinotaxis). In both klinotaxis and tropotaxis, locomotory output may take the form of turning to the more stimulated side (Kennedy, 1986). Thus, manipulations of the sensory system, the stimulus field, or both, are necessary to determine if tropotactic or klinotactic mechanisms are being used.