IDENTIFICATION OF SENSILLA INVOLVED IN TASTE MEDIATION IN ADULT WESTERN CORN ROOTWORM

(Diabrotica virgifera virgifera LeConte)

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Abstract—A group of sensilla present on the maxillary galea of adult western corn rootworm, Diabrotica virgifera virgifera LeConte (Coleoptera: Chrysomelidae) beetles has been identified morphologically and physiologically to be involved in taste mediation. There are approximately 15 chemosensory hairs on each galea. Bilateral removal of these structures resulted in a significantly reduced consumption of a strongly phagostimulant triterpenoid, cucurbitacin B, and led to increased ingestion of a phagodeterrent alkaloid, strychnine. Electrophysiological responses obtained via tip-recording of galeal chemosensilla with submillimolar concentrations of host and nonhost plant compounds resulted in dose responses overlapping with the effective behavioral ranges. Cucurbitacin B was found to evoke chemosensory responses at levels as low as 0.1 μM. Since γ-aminobutyric acid (GABA) is an agonist, (−)-β-hydrastine and strychnine are antagonists, and cucurbitacin B has been proposed to act at a separate modulatory site of classical synaptic GABA and glycine receptor-channel complexes, results reported here raise the possibility that there are peripheral chemosensory receptor sites that may resemble, functionally and structurally, synaptic receptor sites in the central nervous system.

Key Words—Insect-plant interactions, chemoreception, feeding behavior, phagostimulant, deterrent, antifeedant, GABA, cucurbitacins.

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INTRODUCTION

Western corn rootworm (*Diabrotica virgifera virgifera* LeConte) is a major pest of corn (*Zea mays* L., Gramineae) in the midwestern United States. Despite intensive insecticide applications, the geographical range of this species has been expanding eastward in recent decades. The annual costs of pesticide treatments and crop losses due to this insect amount to about one billion dollars in the United States. Most damage is done by the monophagous larvae, which attack the root system of young corn, leading to plant lodging. The polyphagous adult beetles feed on corn pollen, silk, tassels, and sometimes leaves, or flowers and foliage of alternative host plants, e.g., squash (Krysan and Miller, 1986; Metcalf and Metcalf, 1992, 1993). Although adults exert less damage on corn, this obligatory feeding leads to the production of about 500–1000 eggs per female that overwinter and constitute the next season’s generation of rootworm larvae.

Despite the clear and long-standing agricultural pest status of *D. virgifera virgifera*, little is known about the physiological basis of its feeding, especially the sensory aspects of host-plant recognition. Cucurbitacin, a family of triterpenoids found in Cucurbitaceae, are the most powerful feeding stimulants established for this and closely related leaf beetles (Metcalf et al., 1980). On the other hand, compounds that reduce food intake in adult corn rootworms have only recently been discovered (Mullin et al., 1992, 1994). These findings contribute to other recent developments in antifeedant design and technology that have opened new opportunities for biological and chemical insect control, particularly as pest-specific formulations (Jermy, 1990; Frazier and Chyb, 1995).

We have previously shown that a number of sesquiterpenoid epoxides isolated from cultivated sunflower (*Helianthus annuus* L., Compositae), a marginal host plant for adults (Siegrfried and Mullin, 1990), are able to reduce food intake by adult *D. virgifera virgifera* in a squash disk consumption bioassay (Mullin et al., 1992). In turn, isoquinoline alkaloids, commonly found in spring wildflowers of the northeastern United States (Papaveraceae, Fumariaceae, Ranunculaceae, and Berberidaceae) and thus temporally unavailable for consumption by adult rootworms, were potent antifeedants for *Diabrotica*. The antifeedant potency of selected terpenoids and alkaloids was high enough to counteract and overcome the phagostimulatory action of cucurbitacins present in the medium. Some of the deterrents identified to date are well-known antagonists of γ-aminobutyric acid (GABA) and glycine receptor-channel complexes in synaptic sites of the vertebrate central nervous system (CNS) (see for example Hall, 1992). GABA, glycine, and other agonists of these receptors are at least weakly phagostimulatory for *Diabrotica* (Mullin et al., 1994). These observations opened the possibility that a neurotransmitter receptor structurally related to one found in the insect CNS might be localized peripherally, within insect sensilla, and therefore be more susceptible to chemicals designed for insect control.