DEFENSIVE ADAPTATIONS OF EGGS AND ADULTS OF *Gastrophysa cyanea* (COLEOPTERA: CHrysomelidae)

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Abstract—Egg clusters and adults of *Gastrophysa cyanea* are conspicuous and, like their larvae, are chemically protected. The eggs owe their bright yellow color primarily to β-carotene and, in addition, contain substantial quantities of oleic acid. At natural concentrations oleic acid effectively deters many species of ants from feeding. The use of fatty acids as deterrents against ants is discussed as a possible widespread phenomenon among insects. During defensive confrontations, adults of *G. cyanea* exhibit avoidance behavior and may also feign death. In addition, the adults may autohemorrhage or secrete a fluid from elytral or pronotal pores in response to traumatic stimuli. The secretions are effective against ants and contain a mixture of hydrocarbons as well as terpenoid components. The pattern of ontogenetic modification in the defensive chemical repertoire of *G. cyanea* is discussed.

Key Words—Defensive secretions, oleic acid, hydrocarbons, terpenoids, eggs, deterrents, ants, predation, Chrysomelidae, Coleoptera, *Gastrophysa cyanea*, reflex bleeding, elytral glands.

INTRODUCTION

Studies on the defensive chemistry of insects often emphasize a single stage in the life cycle, usually either the larva or adult. Although useful, this approach can provide little insight into the changes in chemical defense that transpire as an insect undergoes metamorphic development.

Information on the ontogeny of predator deterrents in leaf beetles

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(Chrysomelidae) is particularly sparse. Many chrysomelid species deposit bright orange or yellow egg clusters on the host plant (Klausnitzer and Forster, 1971). However, except for reports of cardinolides in the ova of *Chrysolina polita* and *C. coerulans* (Pasteels and Daloze, 1977; Daloze and Pasteels, 1979), the defensive chemistry of chrysomelid eggs has been almost completely ignored. Whereas the larvae of some leaf beetle species possess eversible tergal glands and the chemistry of these secretions has received considerable attention (Matsuda and Sugawara, 1980, and references therein), the defensive attributes of the other developmental stages of these species have only been examined in a few isolated cases. For example, some pupae retain the larval cuticle as a holdfast and gain protection from the secretory reservoirs it holds (Bromley, 1947; Hinton, 1951; Wallace and Blum, 1969). Furthermore, many adult chrysomelids are equipped with defensive glands, but only in *C. polita* have both adult and most juvenile stages been chemically assessed (Daloze and Pasteels, 1979).

Previous investigations on defenses in the chrysomelid *Gastrophysa cyanea* have been restricted to the larvae, demonstrating that eversible glands produce potent deterrents against small arthropodan predators such as ants. The secretions contain two major components: chrysomelidial, a cyclopentenoid monoterpene, and another iridoid compound, gastrolactone (Blum et al., 1978; Jones et al., 1980).

We had reason to suspect that other stages of the life cycle of *G. cyanea* are also endowed with chemical defenses. The adult beetles are conspicuous on the foliage of their host plant, *Rumex crispus* (Force, 1966), their elytra and pronotum varying in hue from metallic green to a lustrous steel-blue. The eggs are also easily noticeable, being deposited in gleaming yellow clusters on the underside of host plant leaves. The pupae are yellow as well, but they pupate unobtrusively beneath the soil. The bright coloration of these stages could constitute aposematic displays, advertising the presence of noxious or toxic compounds. We tested the possibility that eggs and adults are chemically protected, using ants which frequent the beetle's host plant as potential predators and analyzing these stages for the presence of defensive allomones.

**METHODS AND MATERIALS**

Interactions between *G. cyanea* and ants were observed in dense stands of *Rumex* sp. from April to June, 1980 in various localities of Georgia and Florida. The ants were often attracted to the host plant in significant numbers by honeydew-excreting aphids.

Feeding deterrence of egg or adult extracts was assessed by comparing the numbers of ants feeding on 3-mm lengths of mealworms (*Tenebrio molitor*) treated with extracts or solvent controls. The mealworm baits were