GENERAL NOTES

Journal of the Lepidopterists' Society
48(4), 1994, 381–386

STICKY INTEGUMENTAL COATING OF A DALCERID CATERPILLAR: A DETERRENT TO ANTS

Additional key words: Chemical defense, *Dalcerides ingenita*, Lepidoptera, larva, *Camponotus floridanus*.

Dalceridae are a small group (85 species) of mostly neotropical moths with sluglike larvae covered with a gelatinous coating (Dyar 1925, Hopp 1928, Stehr & McFarland 1987, Miller 1994). Nothing was known about the chemistry or function of this coating, although it had been proposed to serve for defense (Stehr & McFarland 1987). We here present evidence, based on staged encounters between a dalcerid caterpillar and ants, that the larval coating can indeed serve as an effective deterrent to attack.

The larvae were offspring of gravid females of *Dalcerides ingenita* (Hy. Edwards), the only species of Dalceridae native to the United States, collected at Ash Canyon in the Huachuca Mountains, Cochise County, Arizona. They were raised on mature foliage of one of their host plants, *Arctostaphylos pungens* (H.B.K.) (Ericaceae), as well as on leaves of various oaks [*Quercus emoryi* Torrey (Fagaceae) figures in the moth's natural diet]. Voucher specimens of adults and larvae are deposited in the entomological collection of the National Museum of Natural History, Washington, D.C.

The dorsal investiture of *D. ingenita* has the warty appearance (Fig. 1) characteristic of dalcerid larvae (Dyar 1925, Stehr & McFarland 1987). The investiture is moderately sticky and can be readily pulled from a larva by rolling it onto a glass rod (Fig. 2). Pulling on a single wart with forceps typically results in detachment of a string or cluster of warts (Fig. 2). If a larva is artificially denuded by removal of the entire complement of warts, a coating of semi-liquid material is exposed (Fig. 1).

The ants used in the encounters were from a laboratory colony of *Camponotus floridanus* (Buckley) (Formicidae), originally taken near Lake Placid, Florida. We previously had used this species in predation experiments with other insects (Eisner 1972).

The tests were carried out in 15 × 50 mm glass petri dishes. For each test, a number of ants (5–10) were first added to a dish, following which a piece of *Quercus* leaf was introduced bearing a single *D. ingenita* larva. Events were monitored with a Wild M400 photomicroscope and were consistent for each of the 5 larvae tested. Ants repeatedly came in contact with the larvae and inspected these with antennae and palps, but in most cases they withdrew without attempting to bite. There was no evidence of repellency on near contact. Ants seemed to back away from larvae only after directly palpating them. Actual bites or attempted bites occurred only in a few cases, but the results in these instances were dramatic. Ants either became temporarily stuck to the larval coating and had to struggle briefly to free themselves, or they pulled away quickly, but with their mouthparts encumbered by detached dabs of coating (Fig. 3). Such ants never persisted in their assault, but engaged instead in protracted, eventually successful, cleansing activities.

Two samples of coating, each representing strippings from several larvae, were extracted respectively with methanol and ether, and examined by gas chromatography (using a non-polar liquid phase). No evidence was obtained of presence of volatile or volatilizable components. Given that the coating appeared to effect its deterrency by mechanical action rather than repellency, this finding was perhaps to be expected.

Caterpillars possess a multiplicity of chemical defenses, including eversible (Brower 1989) and dischargeable glands (Attygalle et al. 1993), urticating spines (Kawamoto & Kumada 1984), and glandular hairs (R. Rutowski & T. Eisner personal observation, *Eurema* and *Pieris*). In addition, some derive protection from forcible emission of enteric

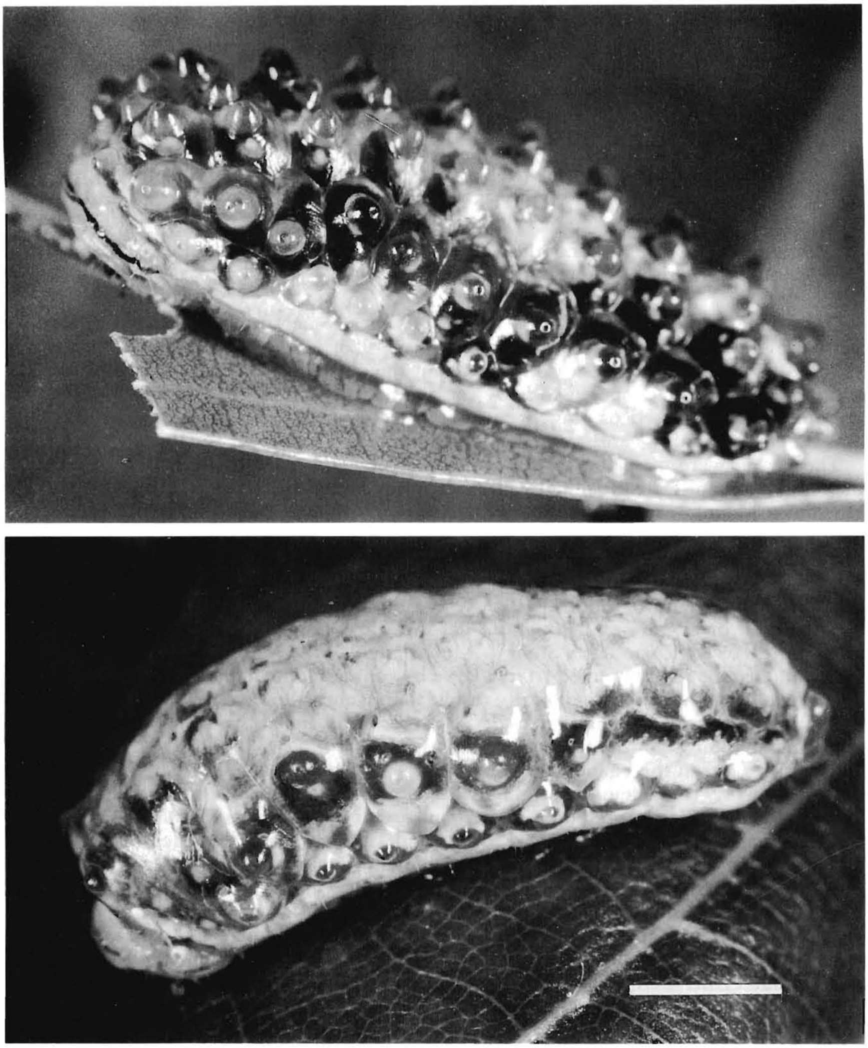

FIG. 1. Typical larva, showing rows of dorsal gelatinous warts (top). Larva from which middorsal warts have been removed, exposing the semi-liquid material beneath (bottom). [Scale bar = 2 mm]

fluid (Smedley et al. 1993) or possession of systemic toxins acquired from the diet (Bowers 1993). To our knowledge, dalcerid larvae are exceptional among caterpillars in possessing a sticky integumental coating, essentially comparable to that of slugs (Mollusca: Gastropoda). *Olona* spp. of the family Limacodidae, a group related to the Dalceridae, also possess a gelatinous coating (Holloway et al. 1987). The integument of molluscan slugs has itself been shown to be deterrent to ants (Eisner 1970). Sticky integumental coatings are generally rare among insects. They occur in certain sawfly larvae (*Caliroa* spp., Tenthredinidae), in which they also may be defensive, although there appears to be no evidence to that effect (Nordin et al. 1972). In some cockroaches, the last abdominal

FIG. 2. A "wart" has been grasped with forceps and is being pulled away, causing a strand of warts to be detached from the investiture (top). A cluster of warts has been taken up by a glass rod; to remove the cluster the rod was pushed into the investiture and slowly rolled (bottom). [Scale bars: top = 1 mm; bottom = 2 mm]

tergites are covered with a proteinaceous slime of proven physical deterrency to ants (Plattner et al. 1972). A number of arthropods produce sticky secretions as products of dischargeable glands. Examples include certain syrphid fly larvae, which protect themselves by use of a viscous glue that they discharge from salivary glands (Eisner 1972), and geophilid centipedes, which eject a proteinaceous cyanogenic slime when disturbed (Jones et al. 1976). A classic example is that of onychophorans (*Peripatus* and its relatives),

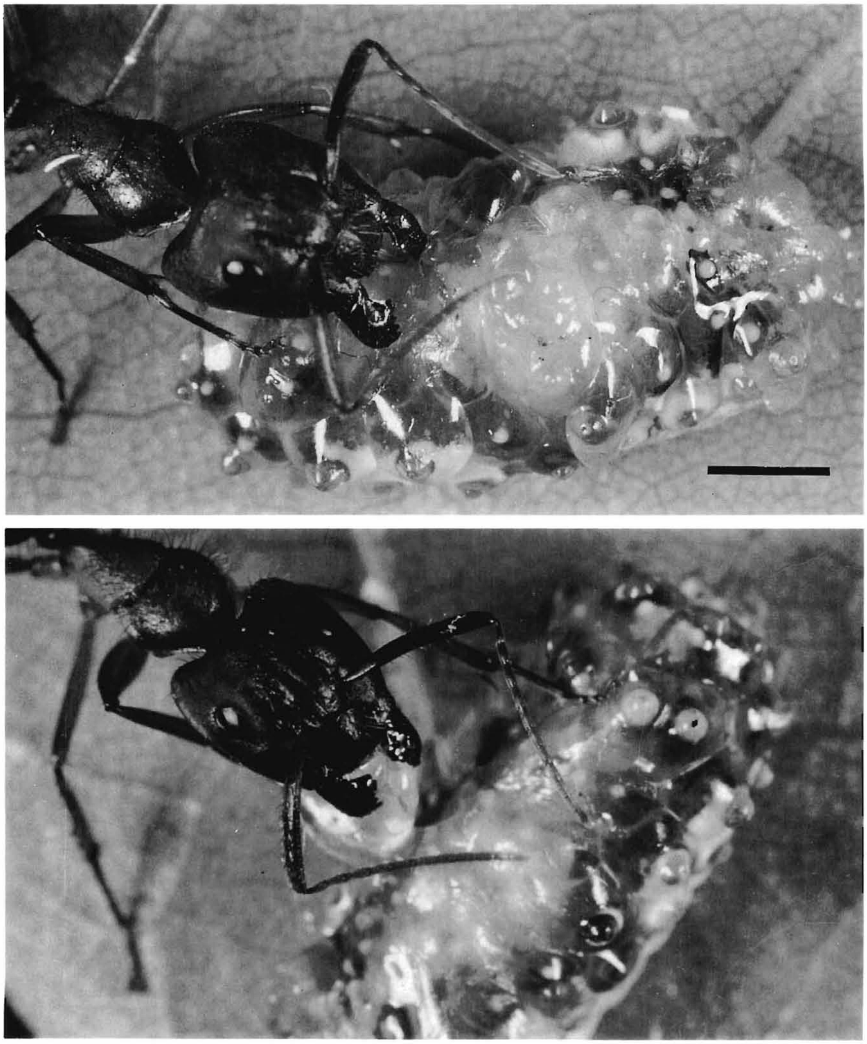

FIG. 3. *Camponotus floridanus* biting a larva; the left mandible has become entangled in the sticky slime (top). *Camponotus floridanus* backing away after having bitten into the larva's investiture; a wad of slime has become stuck to the ant's mouthparts (bottom). [Scale bar = 2 mm]

which eject aimed jets of a rapidly hardening glue from a pair of cephalic glands (Alexander 1957, Eisner 1970). The fluid literally cements attacking ants and spiders to the substrate when these are hit by the spray (Eisner, unpublished laboratory observations with unidentified onychophorans from Panamá).

Insufficient *D. ingenita* were available to determine precisely how the integumental coating is engendered. Evidence presented so far about the presumed underlying secretory mechanism suggests that the coating may consist in part of sloughed integumental layerings (Hopp 1928).

This is paper no. 123 of the series *Defense Mechanisms of Arthropods*; no. 122 is McCormick, K. D. et al. (in press), *Tetrahedron*. This study was supported in part by grant AI02908 from NIH. We thank Maria Eisner for preparation of the illustrations, Athula Attygalle for the chromatographic data, and Noel McFarland for providing the gravid moths. The ant colony was collected at the Archbold Biological Station, Lake Placid, Highlands County, Florida.

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Received for publication 28 December 1993; revised and accepted 10 April 1994.

Journal of the Lepidopterists' Society
48(4), 1994, 386–388

HOST PLANTS OF *POANES MELANE* (HESPERIIDAE)

Additional key words: grasses, Poaceae, skipper, biology.

Poanes melane (Edwards), the umber skipper [formerly *Paratrytone melane* (Burns 1992)], is found along the Coastal Range of California and in the foothills of the Sierra Nevada. In rural areas adults are found in grassy habitats along streams and in forests (Emmel & Emmel 1973). This species is common in urban and suburban areas, most likely because its host plants (grasses; Poaceae) are abundant and well-maintained in lawns (Heppner 1972, Brown 1984). This source of host plants could become especially important during the summer generation, a dry season in California when many grasses are no longer green. *Poanes melane* larvae are known to feed on several C_3 and C_4 grasses, including *Cynodon dactylon* (L.) Pers. (C_4), *Deschampsia caespitosa* (L.) Beauv. (C_3), *Lamarckia aurea* L. (Moench) (C_3), and *Stenotaphrum secundatum* Kuntze (C_4), and one sedge (Cyperaceae), *Carex spissa* Bailey (Brown 1984, Scott 1986).

Adult female *P. melane* lay eggs singly on the undersurfaces of grass blades. The mature larva is approximately 30 mm long with a brown head and dusky yellow-green or tan body mottled with black punctations of varying sizes (Comstock & Dammers 1931, Emmel & Emmel 1973). Larvae have a blackish mid-dorsal line, a cream lateral stripe, and three dark lines on each side (Scott 1976). Larvae also construct tubular shelters by tying two or more leaves of their host plants together with silk or by rolling single broad leaves into tubes secured with silk along their edges. Mature larvae feed nocturnally, generally at the distal ends of tied or rolled leaves. This association between shelter formation and feeding activity was used in several cases in this study to determine the use of host plants by *P. melane*. I report here several new host records from Berkeley, California made during a four year study of the relative performance of *P. melane* larvae on C_3 and C_4 grasses. All plants used in feeding experiments were grown from seed available commercially or from the U.S. Department of Agriculture Soil Conservation Service, unless otherwise noted.

Poanes melane larvae were observed feeding on a hedge of bamboo, *Phyllostachys bambusoides* Sieb. and Zucc. (Poaceae, C_3), for three generations in 1985 and 1986. Complete development to adults was inferred from the presence of pupal cases in larval shelters. Oviposition by adults on *P. bambusoides* was observed on several occasions in the field.

Ehrharta erecta Lam. (Poaceae, C_3) is commonly used by larvae in the field (observed from 1985 to 1989). In laboratory experiments, *P. melane* grew well on *E. erecta* grown from seed collected in the field (Barbehenn and Bernays 1992). Oviposition was observed on several occasions on *E. erecta* in the field.

Late-instar larvae were observed feeding on *Lolium multiflorum* Lam. (Poaceae, C_3) on two occasions in 1985. Adult *P. melane* (one male and one female) were reared from these larvae. *Lolium multiflorum* also supported growth to adulthood in laboratory experiments (Barbehenn and Bernays 1992), and adults in 0.5 m^3 cages readily oviposited on potted plants. However, in two subsequent years larvae fed one-month-old *L. multiflorum* commonly rejected it or were unable to grow.