ALKALOID CONTENT OF PARASITOIDS REARED FROM PUPAE OF AN ALKALOID-SEQUESTERING ARCTIID MOTH (*UTETHEISA ORNATRIX*)[1]

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ABSTRACT: A number of parasitoids reared from pupae of *Utetheisa ornatrix*, an arctiid moth that sequesters pyrrolizidine alkaloids from its larval foodplant, were analyzed chemically to see whether they sequester pyrrolizidine alkaloids from this host. None proved to do so in substantial measure. The highest alkaloid concentration detected in a parasitoid was about one-tenth that in the host. The parasitoids were from Florida and North Carolina, and included four species of Tachinidae (*Lespesia aletiae, Lespesia* sp., *Chetogena claripennis*, and *Archytas aterrimus)*, one species of Chalcididae (*Brachymeria ovata*), and an undescribed species of Ichneumonidae (*Corsoncus* sp.). The genus *Corsoncus* has not previously been recorded from the eastern USA.

The moth *Utetheisa ornatrix* (L.) (Arctiidae) sequesters pyrrolizidine alkaloids [henceforth referred to as alkaloid(s)] from its larval foodplants (legumes of the genus *Crotalaria*). It stores the compounds systemically, retains them through the pupal stage into adulthood, and as an adult, bestows them in part upon the eggs (Eisner and Meinwald 1995). We recently (January/February, 1999) had occasion to study a population of *U. ornatrix* at the Archbold Biological Station, Lake Placid, Highlands County, Florida, where the moth was abundant in the environs of stands of its primary local foodplant (*Crotalaria mucronata* Desvaux). We were able to rear a number of parasitoids from pupae of the moth. Specifically, from 40 pupae that we collected in the field, we obtained 6 specimens of Tachinidae [5 *Lespesia aletiae* (Riley) and 1 *Archytas aterrimus* (Robineau-Desvoidy)] and two of Ichneumonidae (*Corsoncus* sp.). To see whether these parasitoids sequester alkaloid from this host, we analyzed all specimens except one for alkaloid content. The exception was one individual of *Corsoncus* which was kept as a voucher specimen because we learned that the species is undescribed. We also analyzed the 26 adult *U. ornatrix* that emerged from the unparasitized pupae (6 pupae died without giving rise to either adult or parasitoid).

Extraction Procedure. The adult parasitoids and adult moths were weighed shortly after emergence and killed by freezing. Each was macerated and extracted with phosphate buffer (with riddelliine added as internal standard) for

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24 h at room temperature while stirred. After centrifugation, the residue was re-extracted with phosphate buffer for another 24 h. The two extracts were pooled, filtered (0.45 μm filter membrane), and subjected to high performance liquid chromatography (HPLC).

Alkaloid Analyses. HPLC analyses were performed with a Hewlett-Packard HP 1090 Series II instrument, equipped with a diode array detector (λ = 205 nm), using a C-18 column (Keystone Sci. BDS Hypersil, 250 x 4.6 mm, 5 μm particle size, 120 Å bore size). Injection volume was 25 μl. The column was eluted at 40° C with a phosphate buffer-acetonitrile mixture (92 : 8; 1 ml/min). The phosphate buffer was prepared by dissolving 2.72 g of potassium phosphate (monobasic), 2 mL of triethylamine, and 0.4 mL of trifluroacetic acid, in 4 L of water (HPLC grade). The pH was adjusted to 3.0 with phosphoric acid.

The identity of the *N*-oxide and free base of usaramine was confirmed by co-injection with authentic samples. The calibration curves for usaramine (*N*-oxide and free base) were constructed with riddelliine as internal standard. Sensitivity of detection by this techinque was 25 ng alkaloid per sample.

RESULTS

As is clear from Fig 1, the 3 parasitoids did not acquire alkaloid at substantial levels. *Archytas aterrimus*, in fact, proved to be alkaloid-free, as did another individual of this species, also emergent from *U. ornatrix*, but from North Carolina, that we analyzed earlier (Iyengar et al. 1999). *Lespesia aletiae* and

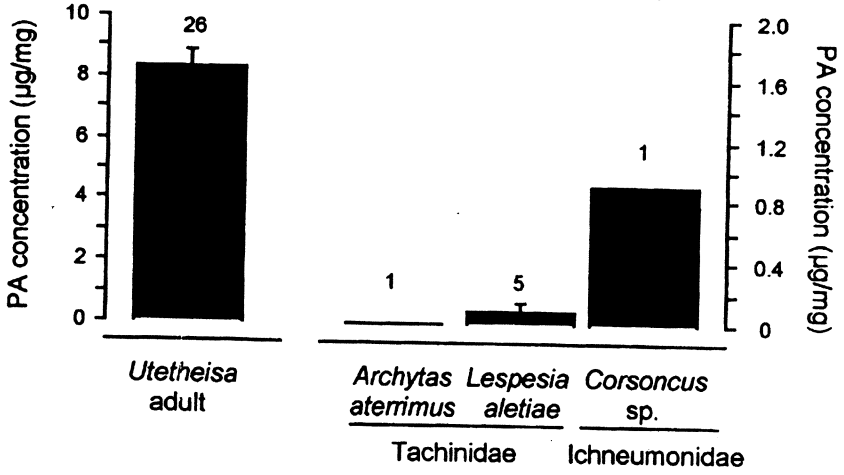

Fig. 1. Pyrrolizidine alkaloid (usaramine) content of *Utetheisa* and its parasitoids. Numbers above columns give sample size; error bars give one standard error. Sample wet weight (mean ± SE) was as follows: *Utetheisa* = 87.1 ± 23.9 mg; *A. aterrimus* = 70.2 mg; *L. aletiae* = 17.0 ± 2.0 mg; *Corsoncus* sp. = 13.9 mg.

Corsoncus sp. contained detectable quantities of alkaloid, but at levels lower by about an order of magnitude than the host. The specific alkaloid detected, both in *U. ornatrix* and the parasitoids, was usaramine, the principal pyrrolizidine alkaloid in *C. mucronata* (Sauthon and Buckingham 1989). The alkaloid was present in the samples in both *N*-oxide and free base forms. The alkaloid values given in Fig. 1 are sums of the two forms.

CONCLUSIONS

Utetheisa ornatrix is well protected by its acquired alkaloid, certainly against predation. The adult and larvae are protected against spiders (Eisner and Eisner 1991; González et al. 1999), and the eggs against ants and coccinellid beetles (Hare and Eisner 1993; Dussourd et al. 1988). In contrast, the vulnerability to pupal parasitism appears to be high. If the 20% parasitism rate manifested by our sample is indicative of the norm, then pupal loss to parasitism may be one of the chief sources of mortality in *U. ornatrix*.

It is impossible to say whether the low levels of alkaloid acquired by *L. aletiae* and *Corsoncus* sp. might suffice to provide these parasitoids with some protection. But even if not, it would be erroneous to conclude that these insects derive no advantage from parasitizing an alkaloid-laden host. The protection they derive from spending their developmental period within a host that is chemically protected must in itself be adaptive. To be unprotected chemically as a winged adult, must not be nearly as disadvantageous as to be unprotected as a larva. It is possible, of course, that a parasitoid such as *Corsoncus* does derive some protection from what little alkaloid it contains. Spiders are extremely sensitive to pyrrolizidine alkaloids (González et al. 1999) and could conceivably find *Corsoncus* unpalatable.

The finding of an undescribed species of *Corsoncus* from the southeastern U.S. is noteworthy, since in the U.S. the genus was recorded previously from the Southwest only. The present species appears to be most similar to *C. minori* Gauld from Costa Rica (D. Wahl, pers. comm.).

Recently, we analyzed another set of pupal parasitoids from *U. ornatrix*, but from a population of moths in Moore County, North Carolina. No wet weights were available for these parasitoids, so we were able to express alkaloid concentration values only as μg per mg dry weight. The parasitoids, and their body alkaloid concentration, were as follows (the alkaloid, where detected, was usaramine):

Lespesia sp. (Tachinidae)	0.46 μg/mg (N = 1)
Chetogena claripennis (Tachinidae)	0.29 ± 0.03 μg/mg (N = 2)
Brachymeria ovata (Chalcididae)	no alkaloid detected (N = 2)

Evidently these parasitoids, like those from Florida, took up only minimal amounts of alkaloid from their host.

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