ovipositional success and an ablation of egg viability. Interestingly, goup C engorged females weighed greater than 300 mg, similar to those individuals from groups A and B, but only 6 of the 10 females from this group oviposited. This finding indicates only some females were mated. but all had normal weights. When only females were present (group D), mean engorgement weight was significantly reduced (93 ± 3.3 mg), and all ticks had to be forcibly removed by day 20. This process resulted in removal of considerable amount of host skin indicating abscess formation, a typical inflammatory response to non-feeding attached ticks. A single female from group D oviposited, but the egg mass weighed only 18 mg and was not viable.

During daily observations on tick behavior within the feeding capsules it was noticed that some unmated females detached and reattached after having fed for 4–5 days. While this is a unique finding for females, it is a well known behavior for males[8]. It was also noticed that males would mate with more than one female and would actively fight other males for mating position with a female.

Discussion. Female *Amblyomma americanum* ticks attach and feed for several days and then stop, but generally remain attached until they are mated and then continue to feed[9]. Upon engorging with blood, females drop from the host and enter the preovipositional phase leading to egg deposition. Therefore, the greater the disparity in time between initial attachment of the sexes to a host, the more prolonged the female feeding period becomes (table). A similar finding was reported for *Dermacentor variabilis*[10].

Since mating must occur before the 2nd phase of feeding commences, it appears that the act of mating and not necessarily the transfer of a spermatophore is sufficient stimulus to initiate refeeding. That is, since only 60% of the females from group C (males added on day 10) oviposited, it may be assumed that spermatophore transfer occurred in 6 of the 10 mating episodes. In any event, feeding by all 10 females commenced after the males left their ventral surface as indicated by the high mean tick weights. However, the eggs deposited by these females were not viable suggesting a) spermatophore transfer did not occur during any mating episode yielding unfertile eggs, suggesting the act of mating was a proper stimulus to resume feeding, or b) spermatophore transfer did occur, but prolonged attachment ot the host prior to mating, was deleterious to some component critical to embryo development.

The observation that all females from groups A and B were mated, whereas only some individuals from group C were mated, indicates a difference in female attractiveness. The longevity of pheromone production by attached females is not known, but it is known that maximum production for *Amblyomma americanum* is 2 weeks post-eclosion[10]. The ticks used in this study were 4 weeks post-eclosion. However, since females from groups A and B were mated and obviously attractive to males, it is assumed that the lack of attractiveness by some females from group C was the result of prolonged attachment prior to exposure to males. Since mating is essential for fertility, it also seems reasonable that females could compete with other females for males by altering their pheromone in a way to make themselves more attractive. This theory has not yet been examined.

From this study, and others[5–10], it is apparent that male ticks are very important to the feeding success of female ticks, and ultimately responsible for the production of viable eggs. To impede the aggregation of the sexes by altering pheromone production, secretion or desemination is to severely diminish the reproductive capabilities of the females, a result that has significant implications on tick biology. This weak link in the tick life cycle would appear to be an excellent target site for tick control, either with the use of isecticides or artificial immunization.

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Anti-feedant activity of the polyacetylene, phenylheptatriyne (PHT), from the Asteraceae to *Euxoa messoria* (Lepidoptera: Noctuidae)

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Summary. Phenylheptatriyne (PHT), a polyacetylene from various species of Asteraceae reduced feeding and weight gain of larvae of the polyphagous insect *Euxoa messoria* when incorporated into an artificial diet at concentrations of 10–300 ppm. These results suggest a role as insect antifeedants for the widely distributed polyacetylenes of the Asteraceae.

In a recent article Eisner et al.[2] demonstrated the antifeedant properties to the predatory jumping spider *Phidippus sp.* of a polyacetylene found in soldier beetles (*Chauliognathus* supp.). Since polyacetylenes find their widest occurrence in nature in the plant family Asteraceae[3], Eisner et al.[2] have speculated that acetylenic compounds may also serve, in plants, as antifeedants that are effective against phytophagous insects.

We have been making a systematic study of the biological activity of polyacetylenes including their activity towards insects[4,5] and report, in this communication, the antifeedant activity of the polyacetylene phenylheptatriyne (PHT) (fig. 1) to the dark-sided cutworm, *Euxoa messoria* (Lepidoptera: Noctiudae), polyphagous species. PHT is found in the leaves and stems of *Bidens pilosa* as well as numerous other composites where it can also be present in roots[3].

Material and methods. Isolation of PHT has been described previously[6], as have rearing conditions on artificial diets for *Euxoa*[7,8]. Groups of 8 larvae in their late instars were selected for uniform size (approximately 0.5 g) and were starved for 24 h before being offered a diet cube treated

with the appropriate amount of PHT (10 mg/ml EtOH). The control diet was treated with EtOH only. Larval weights and diet cube weights were recorded at the beginning and end of a 48-h trial period.

Results and discussion. The presence of PHT at concentrations of 10-300 ppm in artificial diets interferes with the feeding activity of *Euxoa messoria* larvae (fig. 2). Even at the lowest concentrations tested feeding was only $^1/_3$ that of larvae given EtOH treated diets (control). Feeding rates declined linearly with log PHT and were 10% of control rates at the highest concentrations tested (300 ppm). This level is within the range we have found in plants but is by no means the highest level detected[6]. Obviously PHT is a potent antifeedant at levels well below its endogenous concentration in *Bidens pilosa.*

Larval weight gain also declines with log PHT (fig. 3) though not in a linear fashion. Growth was only 40% of the control rate at the lowest concentration tested and was completely arrested at 300 ppm.

Previous studies have indicated that polyacetylenes possess other biological activities towards insects. For example, 2 compounds have been reported to be ovicidal, both to the fruit fly *Drosophila melanogaster* and the house fly *Musca domestica.* The 2 compounds are cis-dehydromatricaria ester and tri-dec-1-ene 3, 5, 7, 9, 11, pentayne from *Xanthium canadense*[9,10]. We have recently discovered the photosensitizing activity of polyacetylenes and demonstrated the phototoxicity of 9 of 14 compounds tested against larvae of the mosquito *Aedes aegypti*[4].

The present findings of the antifeedant properties of these compounds represents a 3rd type of activity towards insects. In suggests that polyphagous insects such as *Euxoa* may detect and avoid food containing these compounds in nature. The protective advantage of polyacetylenes may be an important factor in the success of the Asteraceae, the largest plant family. An interesting question is whether the activating wavelengths for photosensitization (near UV) can affect the antifeedant properties of polyacetylenes, and forms the basis of our current investigations.

The antifeedant effects reported here resemble the action of other secondary plant substances on *Euxoa.* When larvae of the dark-sided cutworm were exposed to diet containing various concentrations (0.01-1%) of the alkaloids atropine, berberine, nicotine and veratrine, detrimental effects were observed on growth, development rates and survival[7]. The susceptibility of phytophagous insects to the negative or antibiotic effects of many secondary plant substances are well documented[11]. Polyacetylenes may be an important factor in controlling populations of phytophagous insects as well as influencing the evolution of their detoxifying mechanisms. The current findings open a new avenue in the study of co-evolution by genetic feedbyck. Considering the distribution of Asteraceae and the number of insect species that feed on them, it would be of interest to establish what mechanisms these insects use to cope with various concentrations of polyacetylenes.

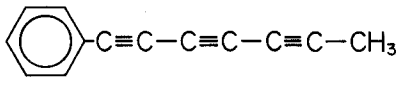

Figure 1. Phenylheptatriyne.

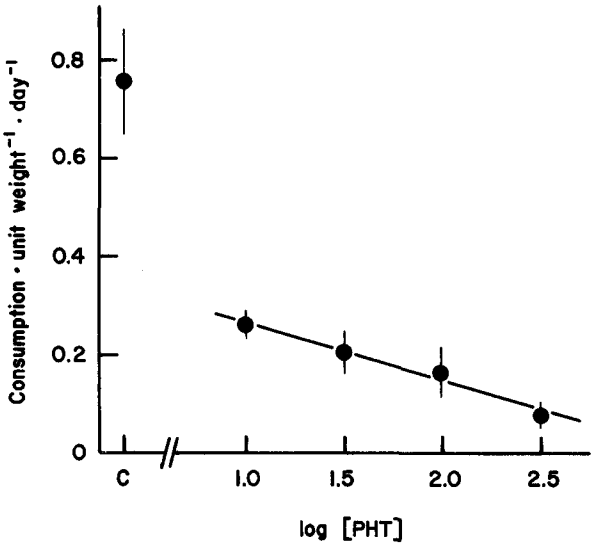

Figure 2. Daily consumption of artificial diet by *Euxoa messoria* larvae as a function of concentration of PHT in their diet (log scale). Vertical bars are SE and horizontal bar indicates range of PHT found in leaves of *Bidens pilosa.*

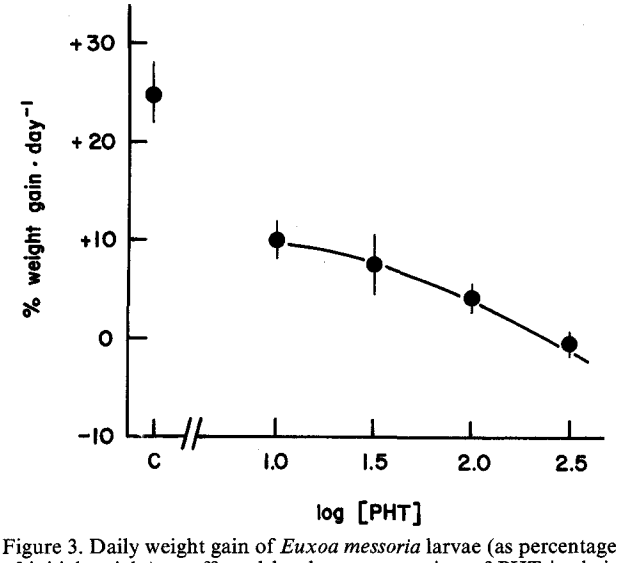

Figure 3. Daily weight gain of *Euxoa messoria* larvae (as percentage of initial weight) as affected by the concentration of PHT in their diet (log scale).

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