The Evolution of Group Feeding Behavior in a Lepidopteran Species

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Egg clustering by females and subsequent gregarious behavior of larvae is common among insect species (4). Numerous hypotheses have been advanced to explain this pattern (4). The hypothesis that gregarious feeding by larvae overwhelms plant defenses (feeding facilitation) and the hypothesis that group defense decreases predation/parasitism (natural enemies), have received notable attention (1,3,5). The distribution of host plant, as well as the commonness of the insect, has been hypothesized to affect egg clumping by females (4). I plan to evaluate the feeding facilitation, natural enemies, and distribution hypotheses using larvae of Doa ampla Dyar (Lepidoptera:Doidae). Female D. ampla oviposit in variable size clutches on the leaves of Stillingia texana (Euphorbiaceae), a common perennial found in calcareous soils in central Texas.

Experiment 1 Justification: A wide range of insects exhibit behavioral adaptations such as, vein and trench cutting, and lactifer avoidance which serve to circumvent the secretory defenses of plants (2). Moreover, variation in group size has been shown to affect larval performance (1,3,5), suggesting that gregarious feeding may overwhelm plant defenses. However, no studies have examined the consequences of variation in feeding group size for insect species which exhibit behavioral adaptations for circumventing secretory plant defenses. S. texana, like many euphorbs, "bleeds" a white, milky substance when injured. Multiple wounds, from group feeding, may decrease the flow of this substance and hence decrease the amount of plant toxin ingested by individual larvae. To test the hypothesis that group feeding gives the larvae of D. ampla an advantage in dealing with plant defenses, I will place variable size groups (3,9,27 larvae/group) of first instar larvae on caged unwounded plants and measure growth rate, development time, pupal weight, and percent mortality weekly. Each treatment will be replicated 10 times, and the entire experiment will be repeated twice through the summer. ANOVA, followed by a comparison of means, will be used to determine the effect of group size on larval performance.
Experiment 2 Justification: When disturbed, larvae of D. ampla exhibit a defensive behavior in which they writhe and excrete a liquid (noxious?). The combined exhibition of defensive behavior may be a successful deterrent to potential predators or parasitoids. In at least one lepidopteran species, large groups have fewer predators per larva than do small groups (3). To test the hypothesis that group behavior gives the larvae of D. ampla an advantage in defense, I will place larva, marked with fluorescent powder which can be visualized using an ultraviolet light, in variable size cohorts on plants. I will encircle individual plants with a plastic "fence" coated in TangleFoot® to trap emmigrating larvae (larvae move between plants by crawling). This experiment will use the same design as experiment 1, with the addition of the fence and the removal of the cage. Through a weekly census of all cohorts I will be able to determine the contribution of removal by natural enemies and emmigration on the change in group size. This experiment will be analyzed using regression analysis in an attempt to predict percent alive over time.

Experiment 3 Justification: The host plant, S. texana, is extremely common but patchily distributed, while preliminary surveys show that D. ampla is locally common but rare across the host range. To quantify my initial observations on the distribution of D. ampla, I will conduct a bi-monthly census of local S. texana populations. For this census I will look for larvae during the day and use a black light to attract adult moths at night. If the preliminary surveys are correct, the question of why D. ampla occur in some host plant patches but not in others arises. There are two possible answers to this question, plant/environmental effects will not allow the insects to survive in all patches, or the insects have simply not colonized all patches. To gather preliminary data on this question, I plan to collect eggs and place them on plants in areas where the insects do not occur. These plants will be checked daily for two weeks (while eggs hatch and early larvae establish) then every two days for four weeks. The results of this survey will differentiate whether the distribution of D. ampla is due to plant/environmental effects, or lack of colonization.

The experiments described herein will determine whether the facilitation and natural enemies hypotheses, individually or simultaneously, explain gregarious behavior. The distribution study will provide information invaluable for planning a future, more in-depth study of the factors affecting distribution. Detailed studies of this type are required to understand the evolution of oviposition behavior.
This study will take place at several different locations including: Freeman Ranch, SWTSU; Pollard Refuge, SWTSU; Wimberly Ranch, SWTSU; and Honey Creek State Natural Area, Guadalupe State Park. The study will begin in April 1996 and continue through September 1997.

References:

Proposed Budget:
The proposed study will require support in two areas, equipment and travel. Support has been provided/requested from three sources:

Southwest Texas State University: lab/greenhouse supplies and space, and graduate support in the form of a teaching assistantship= $9000/year.

Sigma Xi Society: travel and equipment for the natural enemies and feeding facilitation experiments requested = $600.00

Theodore Roosevelt Memorial Fund:

Travel:
Round-trip to Freeman Ranch, Pollard Refuge, and Honey Creek for census:1 trip/2 weeks for 28 weeks = 14 trips(110 mi. round-trip * $0.25/mile * 14 trips) = $385.00
Round-trip to Wimberly Ranch for distribution study: daily for 1 week, then 1 trip/week for 7 weeks * 2 replicates = 28 trips @35 mi. round-trip * $0.25/mile * 28 trips = $245.00

Equipment:
Plastic Edging and TangleFoot adhesive to be used as a fence in experimental study: $50.00
Lumber and material for cages: $50.00
Battery Pack to be used with a 15 watt black light for collecting adult moths: Pack + Replacement Battery = $202.00

Total Requested= $932.00