BAGWORMS EAT (ALMOST) EVERYTHING

by Frank S. Santamour, Jr.

Abstract. Larvae of the evergreen bagworm continue to feed after they are transferred from one host plant species to another. Periods as long as three generations on a single host plant apparently do not bring about any significant dependence on that host. Trees of host species that are uninfested or lightly infested in areas of high insect depredation may be marginally resistant to the local insect population, but are probably not genetically resistant to the insect species as a whole.

A recent paper in *Science* posed some interesting problems for scientists seeking to select or breed insect-resistant trees. In a well-conceived series of experiments, Edmunds and Alstad (1978) demonstrated the coevolution of populations of the black pineleaf scale, *Nuculaspis californica*, with individual host trees of *Pinus ponderosa* such that members of the differentiated insect populations were practically incapable of colonizing neighboring trees of the same species. In such situations, the uninfested trees appeared to be "resistant" to the scale, even when crawlers were purposely transferred to them.

Edmunds and Alstad (1978) stated that "insects that track individual tree defenses should show adaptations which confine a large proportion of their progeny to a host individual and reduce the flow of genes between insects on different trees." Many scale insects fit this description well. Other insect pests, including the so-called evergreen bagworm, *Thyridopteryx ephemeraeformis*, have similar habits.

The female bagworm begins to lay eggs immediately after mating in late summer, the eggs being deposited within the bag. Following oviposition, the female crawls out of the bag, falls to the ground, and dies. Thus the larvae of the next generation hatch the following spring on the same host plant on which their female parent was feeding. Bagworm larvae are probably more active than scale insect crawlers, but real long-distance transport by wind is probably rare in both insects. In addition, male bagworm moths probably mate most frequently with females on the same host plant. Thus, the gene flow between bagworms on different trees is minimal.

Davis (1964) stated that "even though the host range of most bagworms is frequently rather extensive, several species show a great reluctance to change food plants abruptly within the larval life. For many of these insects there seems to be a very definite preference for a single food plant, usually the host upon which the young larva first commenced to feed." Jones and Parks (1928) believed that "food plant choice by the young larva rests on an inherited preference as well as on early proximity and reluctance to change. In this way impermanent food plant races persisting for a number of years often result." Furthermore, they considered changes of food plant within the larval life of a bagworm to be "rather exceptional; and, experimentally, it is often difficult to persuade a larva to accept any plant species other than the one upon which it has been feeding."

Most careful bagworm observers have, probably, noted heavy infestations on individual trees while adjacent trees of the same species were virtually untouched. I have witnessed the death by defoliation over 2 seasons of a 30-foot tree of eastern white pine. During the height of the infestation, neighboring white pine trees whose branches interlaced with those of the infested tree supported very sparse bagworm populations. Two years after the death of that particular tree, no bagworms could be found on the other pines in the windbreak row.

Thus, there is some evidence that bagworm populations may become adapted not only to certain species but to individual trees of a given species. Uninfested or lightly infested trees adjacent to a tree supporting a large bagworm population would, therefore, not be truly "resistant" to the insect, but merely "non-preferred" by that particular population during that particular year.

Bagworm hosts. The host plants of the evergreen bagworm given in two of our more

popular reference works cover a rather broad botanical range. Pirone (1970) listed 11 genera, including 6 conifers and 5 broadleaved, deciduous trees. Westcott (1973) mentioned only 6 coniferous and 2 broadleaved deciduous genera. Jones and Parks (1928), in Texas, noted that the bagworm attacked "most species of trees and shrubs; frequently defoliating" plants of four conifers and eight broadleaved genera.

These references may be evidence enough of the varied hosts of the bagworm, but even they do not tell the whole story. The carefully documented work of Tietz (1951?), cited in Davis (1964), listed 9 genera in 3 families of conifers; a single species in each of 3 families of monocotyledons (including iris and corn); and 74 genera belonging to 40 families of dicotyledons.

With such a wide range of host plants, it would seem unlikely that true "resistance" could be found within any of the host species. Still we decided to test one aspect of the "host-tracking" adaptation by artificially transfering bagworm larvae from one host species to another.

Materials and Methods

The basic bagworm donor population consisted of larvae of the third consecutive generation infesting a row of clonal Leyland cypress, × *Cupressocyparis leyandii,* in the author's back yard. No control measures had been used on this population.

During the last two weeks of July 1979, active larvae were removed from these trees and were transported about 10 miles to the National Arboretum, where they were offered a varied, and sometimes exotic, change of diet. Most host transfers were made with 10 larvae on each of two occasions. Only active larvae were placed on the foliage of the new host plants, and they were watched until they had become attached on the plant. Daily observations were made for three days following the transfers (to observe feeding) and at weekly intervals thereafter. Final determinations were made after pupation in September.

Results

Larval transfers to the same Leyland cypress clone at the National Arboretum were 60% successful. Similar success was achieved with transfers to known conifer hosts, such as *Taxodium distichum, Pinus strobus,* and *Cedrus atlantica.* Transfers to *Metasequoia glyptostroboides* and *Glyptostrobus pensilis* established these species as new conifer hosts.

Among known broadleaved deciduous hosts, continued larval feeding and pupation were noted on *Acer negundo, A. rubrum, Fagus sylvatica, Gleditsia triacanthos, Hamamelis virginiana, Platanus* × *acerifolia, Tilia americana,* and *T.* × *euchlora.*

Some feeding, but no pupation, was observed on *Taxus cuspidata, Quercus phellos,* and *Ulmus parvifolia.* No feeding was noted on *Ginkgo biloba, Eucommia ulmoides, Fraxinus pennsylvanica, Morus alba, Nyssa sylvatica, Phellodendron amurense, Sophora japonica,* and *Zelkova serrata.* It should be stressted that the failure of the bagworm to complete its normal life cycle on the plants listed above did not mean that some bagworms, at other places and other times, would not attack these plants.

The varied ornamentation of the bags (Figure 1) attest to the success of these transfers. The basic construction of the larval case or bag is of silk, but the evergreen bagworm larvae usually decorate the outside of these bags with fragments of foliage (and often, fruit) of their host plant. Some double transfers from Leyland cypress to *Tilia* and *Platanus* and thence to *Pinus strobus* were also successful.

Discussion

The results of this not-too-extensive study indicate that a search for bagworm resistance within the more common host plant species would be rather futile. There may be some plant species that are truly resistant, perhaps some that were not fed upon in this study. However, with enough attempts, some bagworm larvae might be induced to feed even on *Eucommia ulmoides,* although it is unlikely that the bag would show any elasticity.

So we have seen that the evergreen bagworm does not "track" individual host plants like the black pineleaf scale, although it is possible that host preferences may be established at an earlier larval stage. Still, "apparent" resistance of host

species to both insects is not true resistance. Other insects mentioned by Edmunds and Alstad (1978) that may have coevolved with their hosts in a manner similar to the black pineleaf scale include the spruce gall aphids, the spruce budworm, and the Douglas-fir tussock moth. Geneticists, foresters, or horticulturists searching for resistance to these insect pests should be forewarned.

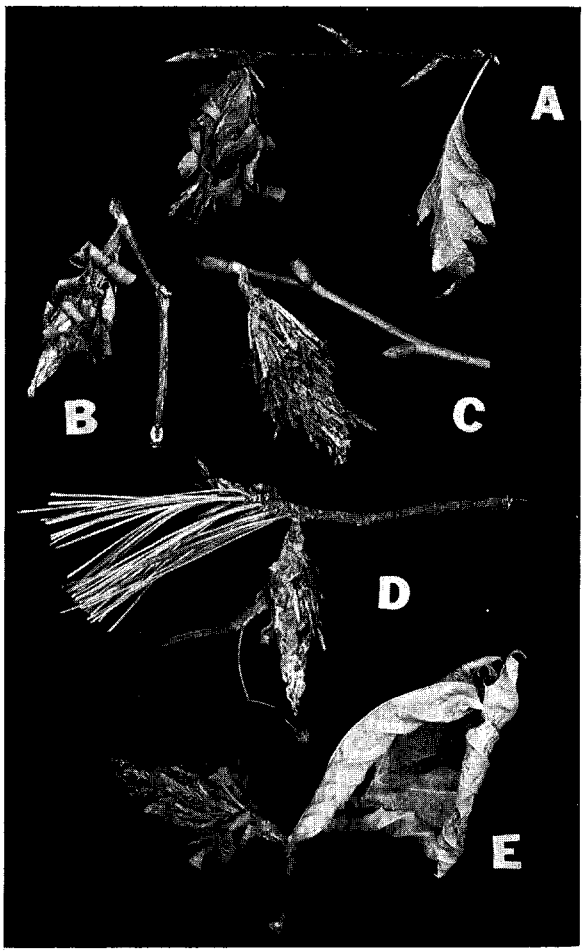

Figure 1. Larval cases of the evergreen bagworm developed after feeding on different host plants: (A) cypress-beech; (B) honeylocust; (C) cypress-linden, note use of linden petioles rather than leaves; (D) cypress-linden-eastern white pine, note linden fruit; (E) cypress-planetree. The lower portion of the bag is ornamented by material from the first host and upper portions by succeeding host plants.

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