Pest management in the urban forest

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Public demands have led to stepped-up research on biological control

America's urban forests include an estimated 57 million street trees, and they pose many challenging pest management problems. Unlike the economic criteria for agricultural pest control, the importance of urban tree pests is determined by the public's often conflicting and not readily quantified aesthetic demands. Urban forest pest management is subject to constraints such as the need to minimize pesticide use in densely populated areas. The extreme diversity of urban landscapes also makes new pest control strategies necessary.

Although such pests as the smaller European elm bark beetle, which transmits Dutch elm disease, and the gypsy moth have received considerable research attention, urban forest entomology has generally lagged far behind the investigation of insects that interfere with our production of food and fiber. The same principles of sound pest management apply to urban environments as to agriculture or forestry, but ecologically based approaches have been neglected. Several projects now in progress can serve as examples of ecological pest management in urban environments. Pest biology and the development of reliable sampling procedures are stressed in these studies.

Elm leaf beetle

The elm leaf beetle, *Xanthogaleruca luteola*, is considered one of California's worst urban tree pests. Elms can be sprayed every year to prevent defoliation, but for many people this cost is prohibitive. Clair and Dahlsten are developing a pest management system that attempts to reduce beetle densities and unnecessary pesticide use by predicting the degree of damage before it occurs and by establishing effective natural enemies.

Through the establishment of different parasitoids in small towns of northeastern California, each can be evaluated separately. Parasitoids complete their immature-stage development by consuming a single host and are distinguished from parasites by the fact that their host is typically killed.

The most likely candidates are a tachinid fly, *Erynniopsis antennata,* which parasitizes elm leaf beetle larvae, and two strains of an eulophid egg parasitoid, *Tetrastichus gallerucae.* Two other promising parasitoids, *Medina collaris* and *Tetrastichus celtidis,* may be introduced from southern France in 1985.

Preliminary sampling was done in Adin, California, in 1982 to determine distribution of the beetle within the tree and to develop a sampling scheme for subsequent use. Egg density and defoliation were generally highest on the south side of trees. Although no significant difference in egg density was found between the lower inner and upper outer canopy, defoliation was higher in the upper outer crown, suggesting either differential egg mortality or movement of larvae.

In 1983 more intensive sampling was done in three towns to develop a damage prediction model and document beetle mortality before establishment of natural enemies. In general, as beetle egg density ranged from 0 to 3.5 per sample early in the season, cumulative damage by the end of the season ranged from no defoliation to completely skeletonized leaves or premature leaf drop. Periodic sampling to determine maximum egg density for a given tree makes possible a reasonably accurate prediction of the defoliation that will occur by the end of the summer.

The effectiveness of single and dual parasitoid introductions in 1984 will be evaluated by comparisons of beetle mortalities and densities before and after parasitoid establishment.

California oakworm

The California oakworm, *Phryganidia californica,* is a native defoliator of oaks. Conventional oakworm control consists of spraying on a calendar basis with chemical pesticides, whether needed or not. Recently, the bacterium *Bacillus thuringiensis* has shown promise in managing oakworm populations if applied on early larval stages. A need still exists, however, for early predictions of oakworm numbers and the resulting leaf damage sustained by trees.

A method of predicting treatment need is being developed by Lewis and W. Jan A. Volney. The seasonal progress of oakworm numbers and leaf damage is being studied on coast live oaks, *Quercus agrifolia,* on the University of California Berkeley campus. Tagged shoots at random locations throughout the crown are checked weekly for feeding damage, which is correlated with oakworm frass pellets collected on sticky plates beneath the tree canopy. Greater numbers of larvae produce more frass and greater leaf damage. Leaf damage and the number of new-growth leaves vary within and between trees.

Aesthetic injury levels may be established by surveys that measure public response to varying degrees of defoliation. Frass monitoring in conjunction with local weather data should provide a rapid and inexpensive method of predicting whether aesthetically acceptable oakworm injury levels will be exceeded, and should help in timing treatments.

Aphids on white birch

European white birch trees, *Betula pendula,* are common throughout California. Three species of birch tree aphids, *Euceraphis betulae, Callipterinella calliptera,* and *Betulaphis brevipilosa,* frequently develop high populations, producing honeydew that becomes a nuisance. Urban birch trees are often sprayed preventively. Such control practices are costly and often unnecessary, but the use of alternatives has been frustrated by a lack of knowedge about this ecosystem in northern California.

Hajek and Dahlsten are studying the biology and ecology of birch aphids on homeowners' trees in Albany and Walnut Creek. Variation in aphid populations within and between trees has been used to develop sampling techniques for different sample costs and precision levels (fig. 1). These techniques allow accurate monitoring so that control practices

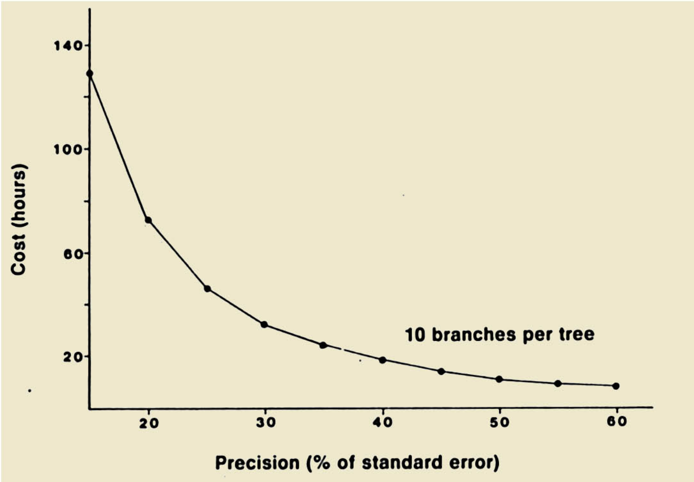

Fig. 1. The cost (in hours) of sampling aphids on European white birch increases with the level of precision.

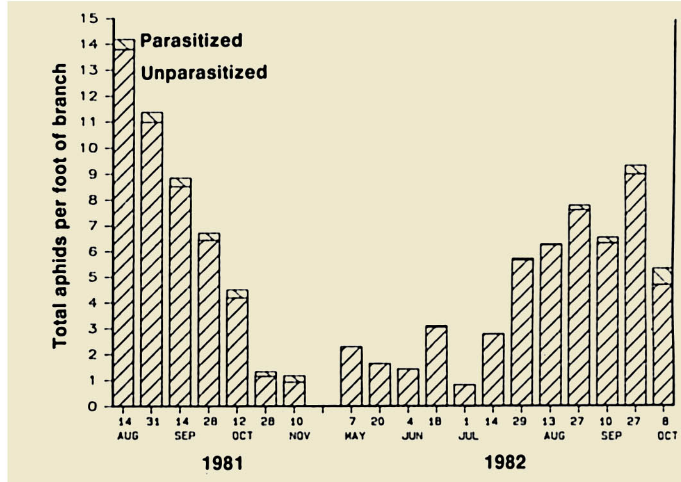

Fig. 2. Total number of aphids and parasitoids per foot of branch on linden trees in Berkeley, 1981 and 1982.

are used only when aphid populations exceed aesthetic injury levels.

The effect of natural enemies on aphid populations has also been studied in the laboratory and field. This birch is native to Europe. Birch aphids were accidentally introduced to California, and few European predators and parasitoids accompanied them. Previous successful introductions of shade-tree aphid parasitoids have led to investigation of the possibilities for biological control of birch aphids.

Linden aphid sampling

A sampling method developed by Dahlsten and Rowney is being used in a long-term study of the effectiveness of introduced parasitoids of the linden aphid, *Eucallipterus tiliae.* Beginning in 1981, all insects were recorded bi-weekly from the leaves on 24 branch terminals (1 foot long) from each of five randomly chosen linden trees on Mathews Street in Berkeley. One inner and one outer branch were sampled in each of four compass directions from the lower and upper canopy.

Statistical analysis indicated that significant differences in aphid densities occurred by level and between inner and outer areas of the crown, and that these differences changed throughout the season. The data made it possible to reduce the number of samples taken per tree while still accounting for aphid variation in the canopy.

Since the introduction of aphid parasites, the City of Berkeley no longer receives complaints about linden aphid honeydew. However, linden aphid and parasite monitoring has demonstrated no clear association between aphid and parasite numbers. Evaluating the efficacy of linden aphid parasitoids is complicated by problems of biology and taxonomy. For example, *Trioxys curvicaudus,* thought to be specific to the linden aphid when introduced in the early 1970s, is now known to have several hosts. The linden aphid is also parasitized by *T. pallidus,* an important parasitoid of the walnut aphid, and by a *Mesidiopsis* species that may have been accidentally introduced with the aphid or during previous biological control efforts. The feeding on numerous hosts, difficult taxonomy, and uncertain origin of the *Mesidiopsis* make it difficult to evaluate these important biological control agents.

The linden aphid and its parasitoids have been monitored regularly since 1981 (first two years shown in fig. 2). Continued monitoring is critical to the evaluation of these parasitoids and any new natural enemies that may be introduced and become established.

Tuliptree aphid honeydew

The tuliptree aphid, *Macrosiphum liriodendri,* can produce copious honeydew, which creates a sticky mess on sidewalks and parked automobiles. Dreistadt and Dahlsten are developing a sampling scheme that accurately reflects aphid densities on tuliptrees, *Liriodendron tulipifera,* along Berkeley's University Avenue. Intensive weekly insect surveys throughout the canopies are being conducted in combination with honeydew monitoring beneath the trees. To establish aesthetic injury levels and determine treatment need, aphid and honeydew monitoring may be correlated with public complaints about honeydew.

Deciding when to implement aphid honeydew management depends in part on which control strategies are available. Therefore, the cost and effectiveness of periodic releases of predacious larvae of the green lacewing, *Chrysopa carnea,* are being evaluated as a method of suppressing populations of street-tree aphids. Preliminary field trials and laboratory work during 1984 revealed deficiencies in the quality of commercially available green lacewing eggs. Technologies for efficiently releasing lacewing eggs in trees must also be improved for this strategy to become as cost effective as other environmentally acceptable methods of suppressing the aphids, such as the application of insecticidal soap sprays.

Conclusion

Very little is known of the pests that interfere with aesthetic qualities of the landscape. The challenge of urban forest pest research must be met through an understanding of pest biology and the development of reliable sampling methods. Public demands for a pleasing urban forest and environmental safety have led to these continuing studies of biological controls and the least toxic pesticides.

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