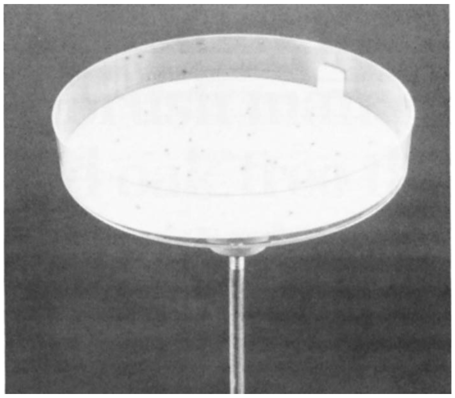

Sampling for California oakworm on landscape oaks

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A simple device to collect larval droppings indicates oakworm activity.

California oakworm populations periodically erupt, defoliating both deciduous and evergreen oaks over widespread areas of coastal California. More often this insect occurs at low to only moderate densities and in some years can hardly be found at all in any one locality. Causes of oakworm population fluctuations are not well understood, but population declines have been variously attributed to natural enemies, naturally occurring diseases, starvation, and changes in genetic "quality" of larvae in the outbreak phase.

The common name of this insect, California oakworm (*Phryganidia californica* Packard), was an unfortunate choice, because it invites the opportunity to consider any "worm" that occurs on oak to be termed an oakworm. Several dozen lepidopterous larvae commonly feed on oak, but in most parts of the state only the California oakworm is able to defoliate trees. Nevertheless, many property owners have their oak trees sprayed with insecticides every year on the basis that the "worms" present must be California oakworms. Actually, a tree in a given area probably needs protection against oakworm damage in only two or three consecutive years out of every eight or nine.

Satisfactory criteria for judging when an oak needs protection are lacking. Sampling oak shoots from various parts of the tree for larval counts, a procedure designed for use by highway crews responsible for large numbers of trees, requires equipment for sampling foliage high in the crown. Because of the difficulty of sampling the few trees on the average homeowner's property, oaks may be routinely sprayed without determining the need for treatment. Such practices may result in unnecessary pesticide use.

Apart from destroying foliage, the oakworm produces fecal material that drops from infested trees, fouling outdoor furniture, patios, and swimming pools. Most lepidopterous larvae produce rather hard, ovoid to cylindrical fecal pellets whose appearance and shape are often quite specific to insect species, genus, or family, and whose size increases as larvae grow.

It occurred to us that timely collections of larval feces on sticky cards placed beneath trees might accurately indicate oakworm activity above and facilitate control decisions. Variations of the proposed method of pellet collection and analysis have been used before, more in Europe than in this country, and primarily for forest insect research. Fecal or frass characteristics are routinely used in identification or detection of wood-infesting insects such as drywood termites and powderpost beetles.

The sampling card selected was circular, 13.7 cm (5⅜ inches) in diameter, with backing that could be peeled off to expose its adhesive surface. It was placed in an open 14 cm (5½ inches) plastic petri dish with its sticky surface upward. The underside of the dish was attached horizontally to a suction cup affixed to a short metal rod, which was pushed into the ground beneath the oak tree.

Field trials

Soon after the summer-generation flight of oakworm moths was noted in mid-June 1981, we put sampling cards beneath three California live oaks, *Quercus agrifolia* Neé, in Kensington, Contra Costa County. Once each week, cards 3 feet apart in lines radiating from the tree trunk and extending to the drip line were set out and left there for one day. We then took them to the laboratory to count the oakworm fecal pellets on each card and classify them according to size. This process was repeated until moths of that generation appeared.

For each tree, pellet numbers were extremely low on July 2, the first sampling date, and rose to a maximum in July to early August (fig. 1). Thereafter, numbers of pellets declined, because larval feeding ceased, pupation began, and some larvae were probably killed by natural enemies. The last pellets were collected in late September to early October. Oakworm moths were seen flying on October 15. None of the three trees had noticeable injury caused by oakworm larval feeding.

As anticipated, fecal pellet size increased as sampling progressed. For tree 1, for example, pellets up to 0.75 mm in length were found from July 2 to September 3; pellets of 0.76 to 1.25 mm from July 30 to September 29; and those larger than 1.26 mm from September 3 to October 7, the last sampling date.

A similar experiment under three trees on the University of California Berkeley campus was conducted to monitor the hourly variation in fecal pellet deposition. Four cards were assigned to random positions in each of four quadrants of areas defined by the drip line of each tree. Cards were changed every two hours for the entire 24-hour period of July 15, 1981. There was considerable variation in the rate of pellet fall (fig. 2), some of which may be accounted for by fluctuation in temperature. For example, at noon the temperature was 62°F and pellet fall was 0.136 pellet per square centimeter per hour, but only 0.038 at 6 pm when the temperature had fallen to 53°F. Thus, in using this device, the effects of temperature on pellet fall should be considered.

Laboratory experiments

To assist in interpreting field data, we performed laboratory tests to study variation in fecal pellet size and production, by rearing larvae on excised foliage taken from new shoot growth of California live oak. One such larva hatched on April 15 and pupated May 15. Every few days fecal pellets produced were removed from the rearing container; fresh food was added as needed. Air-dried pellets were counted and their lengths measured.

Production of pellets began soon after

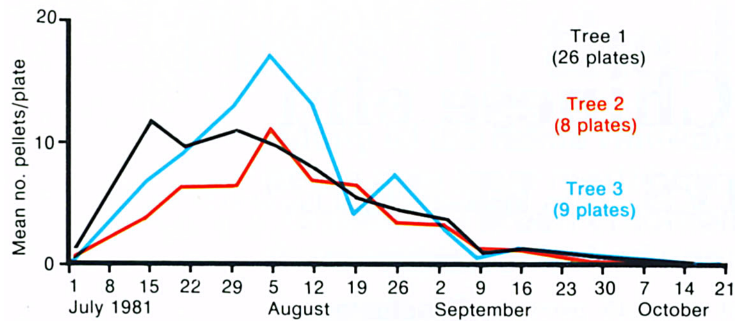

Fig. 1. Oakworm fecal pellet production rose to a maximum in July to early August, then declined.

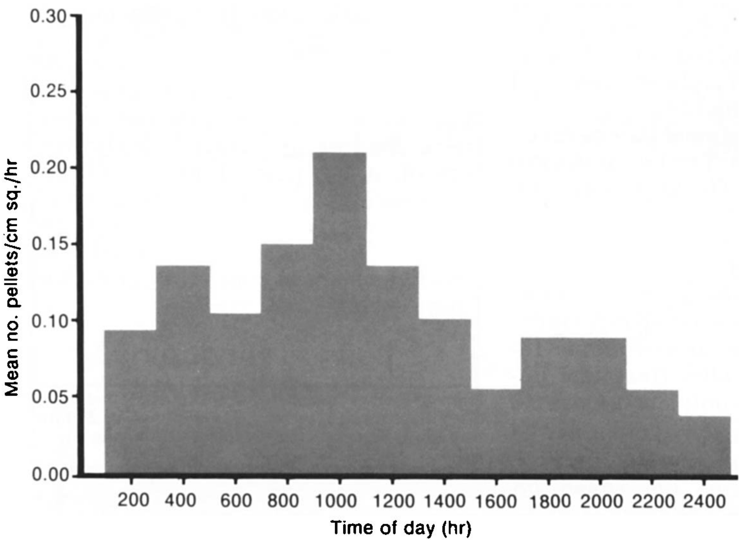

Fig. 2. Pellet production fluctuated during a 24-hour period, partly because of temperature changes.

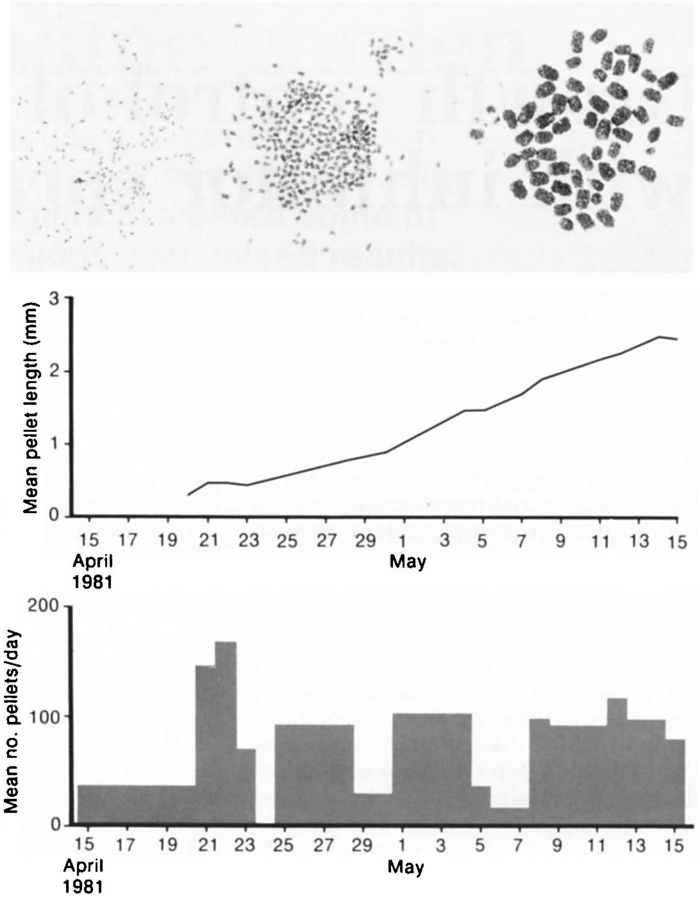

Fig. 3. Typical larva reared indoors produced increasingly larger pellets (upper graph and photo). Daily production (lower graph) fluctuated through the larval stage. Width of bars indicates number of days between pellet collections.

larval feeding started and concluded with pupation (fig. 3). Several abrupt depressions in fecal pellet production were associated with larval molting from one instar to the next. Mean pellet size increased throughout the feeding period.

Other feeding studies indicated that leaf quality affects pellet production. Larvae fed expanded and hardened leaves from a tree supporting a high oakworm population produced more fecal pellets than those fed similar leaves from a tree supporting a sparse population. It appears that damage induces the tree to produce a factor that interferes with the insect's digestive processes. To compensate for this, oakworm larvae feed at a greater rate and so produce feces at a greater rate. If this is a common phenomenon, the effect of compensatory feeding would tend to make the pellet collection procedure most sensitive in detecting populations that were going to damage trees severely.

Heavy infestations of the oakworm larva may defoliate oak trees.

Discussion and conclusion

Most oakworm pellet collections in the field and laboratory followed predictable patterns, coinciding with the considerable literature and observations already accumulated on the biology of this insect in coastal California. Larval development in the laboratory, of course, proceeded more rapidly than it did outdoors.

Pending the outcome of additional field and laboratory trials already in progress, we believe the card device will become a practical, useful tool for homeowners and others in detecting and sampling oakworm larvae to decide whether, or when, treatment is needed. In comparison with using equipment to take samples in the tree canopy, the cards offer a safe, easy means of sampling large or small trees.

Of most importance are experiments designed to correlate pellet size and number with degree of foliage damage. Because oak trees vary in species, size, form, and foliage density, pellet collection and interpretation guidelines that take these variables into account need to be developed. It should be possible to predict the extent of probable defoliation from counts of small pellets collected early in the larval feeding period, even if the effects of compensatory feeding were not evident at this stage.

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