

### Sampling Biologically in Forest Insect Populations<sup>1</sup>

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Establishment of a reliable sampling method is generally recognized as a first prerequisite to any scientific study of insect populations. The method appropriate to a particular problem will depend not only upon the habit of the insect species, the type of environment, and the nature of the distribution of the insect throughout the environment, but must also meet the requirement of practicability for use under actual field conditions.

There is a more conscious effort today, than a few years ago, to present forest insect population data that have been appraised for their statistical reliability, and to develop sampling methods having a reasonable degree of precision. Population data collected by any sampling method should be appraised for statistical reliability, and also should be as meaningful biologically as they are statistically.

The effect of an individual upon its host varies greatly and this fact leads to inaccurate comparisons within the current methods. Henson and Stark (1959) suggested the criterion of "the biological balance between the productivity of the host and the attrition of the host by the insect." Waters (1959) suggested that "the occurrence of an insect in natural units of its habitat usually is expressed as a frequency series . . ." These statements are correct to an extent—but they have not defined, nor is it a simple matter to define, the "natural unit" as related to the environment of the insect. The use of areal samples probably has no real biological meaning in reference to a particular insect. The number of bark beetles per unit area or defoliators per length of branch merely

states the density of the insect population by a measurement convenient to the sampler. To express a population with respect to an area (i.e., as absolute density) does not describe either the differing biological implications of individuals living in an association or the insect-host biological relationship.

It has been profitable for population ecologists to sample the space in which the insect occurs and to record the composition of each sample. True, censusing by space-sampling provides density estimates, relates the reliability of estimates, and gathers information on the pattern or arrangement of the insects in a particular space. Biologically, we need to know not the densities for a unit of space but the mode of life of the insect unit (individual, family, or cluster) that is the basic unit of a population.

#### THE BIOLOGICAL SAMPLE

This paper describes and discusses a technique for sampling a forest insect. This technique is based on the belief that the appropriate method for studying an individual population problem should depend upon the feeding habits, general environment, and particular habitat of the species concerned. Possibly, proper observation should concern itself with the relation of the insect with its habitat or the pattern in which separate insects are related to space and time.

An example of the biological unit is the use of a single family of the mountain pine beetle, *Dendroctonus ponderosae* (= *monticolae*) Hopkins. The female beetle bores into the tree, the male follows, and the female is mated. She then proceeds upward, longitudinally boring a gallery, depositing eggs along the edge of the gallery. The eggs hatch and the larvae bore away from the egg gallery at approximately right angles. Upon larval maturity the insect constructs a pupal chamber, pupates, and emerges through the bark as an adult.

Thus, in studies of mountain pine beetle populations, the egg gallery is the beginning of the biological unit. The pattern of egg deposition within this gallery not only sets the stage for future relationships within and between egg galleries but is determined, to an extent, by the proximity of other egg galleries.

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#### EXAMPLES

The results expressed here were obtained in the laboratory under optimum growth conditions. This procedure eliminated all other factors of brood reduction except intraspecific competition because of closeness of individuals.

Length of the egg gallery was found to be inversely proportional to the proximity of attacks (i.e., crowding of attacks tends to restrict gallery construction by the female). At a density of 3 attacks/ft<sup>2</sup>, the female beetles bored an average of 8.3 in.; at 9 attacks/ft<sup>2</sup>, 6.0 in.; and at 18 attacks/ft<sup>2</sup>, only 4.6 in. of gallery. Crowding also influenced the pattern of egg deposition within the gallery. At 3 attacks/ft<sup>2</sup>, the pattern of egg deposition within galleries showed a rather round curve leveling from the second to fifth inch of gallery and averaged 6 eggs/in. At 9 attacks, a skewed-to-the-left curve occurred, with a definite peak of 8 eggs/in. deposited between the second and third inches of gallery. At 18 attacks/ft<sup>2</sup>, the egg deposition curve failed to descend with length of egg gallery, and remained somewhat fluctuating between 6 and 10 eggs/in., between the second and tenth in. of gallery. Evidently, the female beetle senses the closeness of another gallery, whether it is under construction or already exists, and deposits her eggs accordingly. The fewer eggs laid per gallery, the less the influence of between-family competition.

In the past, we have judged the intensity of the population upon the number of attacks/ft<sup>2</sup>. Our experiments, comparing the single gallery and proximity approach, have shown the illusion of this unit of area. Studies using 1-gallery units have shown that the egg deposition curve peaks between the third and fifth inches of gallery. Sur-

vival of the brood to adulthood because of within-family competition tends to be uniformly dispersed along the gallery. Adult survival, or emergence, averaged from 1 to 2 beetles/inch for the entire gallery length at all attack densities, and regardless of egg deposition pattern or numbers.

A comparison of the high and low attack densities demonstrates the inverse relationship between attack density and new adults. One attack grid spaced 4 by 12 in. apart (which was the equivalent of 3 attacks/ft<sup>2</sup>) produced a ratio of 1 ♀ parent to 2 new ♀ adults—an increase. Attacks grid spaced 2×4 in. apart (which would be equivalent of 18 attacks/ft<sup>2</sup>) produced a ratio of 1 ♀ parent to 0.3 new ♀ adult—a decrease. However, it is conceivable that inhibiting factors affecting young larvae in natural populations could reduce the brood arising from the greater attack density to a point where competition is not important.

#### RECOMMENDATION

As is evident, further work is needed in relating the quality and quantity of food, predators, parasites, etc., to the host insect. It is my belief that such work should be done to determine these relationships within a family or biological unit.

#### REFERENCES CITED

- Henson, W. R., and R. W. Stark. 1959. The description of insect numbers. *J. Econ. Entomol.* 52: 847-50.  
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