Several distorted structures, which appeared to be partial expressions of female traits, occurred adjacent to the inner margin of sternum 8. In the opposing half of segment 8, normal female structures were evident. The inner edge of sternum 9 was twisted and folded into a semblance of a third valve (Fig. 2, 3 vl?). Both second valvulae were present. Directly behind the left second valve there was a sclerotized, hoodshaped structure which did not resemble any of the structures normally present in either sex. Intercalary sclerites and paraprocts were present on both sides. Unfortunately, the paucity of male tissue in the external genitalia made it difficult to compare male and female structures in this region.

The gynander was dissected, and on the right side there was an ovary containing 5 very large and a few smaller ovarioles. This ovary differed from normal ovaries both in the size disparity between ovarioles, and in their rather small number (a maximum of 10 as opposed to the typical 18–22). On the left side there was a very large, well-developed testis of the bulbous type characteristic of *B. germanica*. No attempt was made to study the ducts leading from either gonad.

It seems evident that cockroach gynanders are rather uncommon. Perhaps as work continues new occurrences will permit further study of gynandromorphism in *B. germanica*.

REFERENCE CITED

McKittrick, F. A. 1964. Evolutionary studies of cockroaches. Cornell Univ. Agr. Exp. Sta. Mem. 389: 1–197.

Sampling Biologically in Forest Insect Populations[1]

WALTER E. COLE[2]

Intermountain Forest and Range Experiment Station, Forest Service, USDA, Ogden, Utah

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.

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^2, the female beetles bored an average of 8.3 in.; at 9 attacks/ft^2, 6.0 in.; and at 18 attacks/ft^2, only 4.6 in. of gallery. Crowding also influenced the pattern of egg deposition within the gallery. At 3 attacks/ft^2, 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^2, 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^2. 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. Survival of the brood to adulthood because of within-family competition tends to be uniformly dispersed along the gal-

[1] Accepted for publication October 11, 1966.

[2] Project Leader, Mensurational Aspects of Population Dynamics of Forest Insects.

lery. 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^2) 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^2) 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.

Waters, W. E. 1959. A measure of aggregation in insects. J. Econ. Entomol. 52: 1180–4.

Compounds Found in the Defensive Scent Fluid of *Dicaelus splendidus* and *D. dilatatus* (Coleoptera: Carabidae)[1, 2, 3]

BRO. THOMAS McCULLOUGH, C.S.C.

St. Edward's University, Austin, Texas

One of the earliest ground beetles to appear in late winter around Austin, Texas, is the richly tinted *Dicaelus splendidus* (Say). This insect has an attractive, metallic sheen, a rather docile temperament, and a pair of potent scent glands. A second species, *D. dilatatus* (Say), can be found a month or two later, especially after a soaking spring rain. This species is quite similar to *D. splendidus* in temperament and chemical defense, but lacks the metallic coloration.

Both species were subjected to procedures already described in detail (McCullough 1966), with 1 slight improvement: spotting the chromatographs with a filled microcapillary was more convenient than puncturing the whole gland directly on the paper. The results of these procedures are described in Table 1.

Tests on the fluid residue showed reducing sugars and amino acids to be present in both species. To characterize the sugars, 2-dimensional paper chromatography was tried, with 2-butanol saturated with water as the first solvent and 1-butanol : 50% acetic acid (1 : 1) as the second solvent. Development of the dried paper chromatogram with aniline hydrogen phthalate in glacial acetic acid (Partridge 1949) revealed 5 distinct brown spots for both species. In both species, 1 of these spots compared well with glucose in color and R_f value.

Two-dimensional paper chromatography revealed at least 5 different amino acids for *D. dilatatus*, and 9 or 10 for *D. splendidus*. The presence of alanine is strongly indicated in the fluid of *D. dilatatus*, and both species quite likely contain proline. The most useful solvents for the amino acid separations were phenol saturated with water, and 60% tertiary butyl alcohol. Whatman no. 1 paper was used for all the chromatographs.

Table 1.—Characteristics of *Dicaelus* defensive scent fluid.

	D. splendidus	*D. dilatatus*
Sp. grav.$^{30/30}$	1.19–1.23	1.16–1.22
Formic acid, wt (%)	73–75	73–77
Solid residue (%)	19	8

REFERENCES CITED

McCullough, Bro. T. 1966. Compounds found in the defensive scent glands of *Harpalus caliginosus* (Coleoptera: Carabidae). Ann. Entomol. Soc. Amer. 59: 1020–1.

Partridge, S. M. 1949. Aniline hydrogen phthalate as a spraying reagent for chromatography of sugars. Nature 164: 443.

[1] Accepted for publication October 20, 1966.

[2] This work was supported financially by Academic Year Extension Grant GE-6893 of the National Science Foundation.

[3] The beetles were identified by Dr. George E. Ball and Mr. Richard Freitag, Department of Entomology, University of Alberta, Edmonton, Alberta, Canada.

The Influence of a Blood Meal on Copulation in *Aedes triseriatus* (Diptera: Culicidae)[1]

JAMES E. WRIGHT[2] AND CARL E. VENARD

Department of Zoology and Entomology,
The Ohio State University, Columbus

Observations of the sexual behavior of laboratory colonies of *Aedes triseriatus* (Say), a common, tree-hole-breeding mosquito in North America east of the Rocky Mountains, gave the impression that females with a blood meal would copulate more readily than those which had not had blood. It was observed also that blood-fed females averaged 55 sec in the copulating position, whereas the average for non-blood-fed females was 25 sec. (Wright et al. 1966). Thus, males would copulate with both blood-fed and non-blood-fed females, but the incidence of copulations with blood-fed females appeared to be higher. To determine the influence, if any, of the blood meal in relation to copulation, an investigation was undertaken to study the level of insemination in populations of blood-fed and non-blood-fed females of this mosquito.

Eight-day-old mosquitoes were placed in 2 separate observational cages, made of Plexiglas(tm), which were 12 in. wide, 12 in. deep, and 18 in. high. In each cage, the rear wall was of white muslin, and 1 side wall had an

[1] This investigation was supported in part by Grant AI-00528 from the National Institutes of Health. Accepted for publication September 15, 1966.

[2] Present address: Entomology Research Division, Agr. Res. Serv., USDA, Kerrville, Texas 78028.

Table 1.—Levels of insemination in populations of blood-fed (Cage A) and non-blood-fed females (Cage B) of *Aedes triseriatus*.

	Cage A	Cage B
No. females in cage:		
blood-fed	141	0
nonblood-fed	0	503
No. males in cage	460	386
Percent females[a] inseminated	95	84

[a] In a sample of 100 ♀ from each cage, removed on the 12th day.