

Susceptibility of the Ootheca of the American Cockroach, *Periplaneta americana* (L.), to Various Insecticides^{1, 2}

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The American cockroach, *Periplaneta americana* (L.), is considered an economic pest; therefore, it is subject to control measures which will minimize its numbers. There are several ways by which this insect is reduced in population; the most common one is by an application of an insecticidal spray or dust directly to the cockroach or to an area where it is likely to come in contact with the insecticide.

Three stages of development in the life of an American cockroach are the egg, nymph, and adult. The eggs of the cockroach are enclosed in a structure which is referred to as an ootheca or egg capsule. Insecticidal applications at present are concentrated against the nymphs and adults rather than the eggs. This is probably due to a knowledge of the insect's habits and habitat. During regular control operations the oothecae are often found and sprayed. There is very little known, however, regarding the response of eggs within the ootheca to insecticides. Therefore, it was the purpose of these tests to determine the effectiveness of commonly used insecticides against American cockroach oothecae.

The number of eggs per ootheca varies with the different females. An ootheca properly formed and filled contains 16 eggs, but with the exception of the first ootheca produced they seldom have this number. Studies by Gould and Deay (2) revealed that an average of 13.6 cockroaches emerged per ootheca from 511 fertile oothecae. The normal ootheca is chocolate brown in color and bean-shaped. The top of the ootheca (or keel) is not rounded, but instead the two sides are tightly pressed together and crimped on the edge. Within the innerface of each half of this keel there are scooped-out depressions and grooves which meet to form a series of cells and tubes. Roth and Willis (3) state that these cavities are respiratory chambers which, with associated ducts, convey air to the membranes around the eggs.

Brunet and Kent (1) conducted some work on the composition of the oothecal wall and concluded that the wall was composed entirely of a tanned protein which they called sclerotin. Therefore, the composition of the oothecal wall is slightly different from the body wall of the adults and nymphs.

Methods and Materials

There are several factors which can cause the embryos in an ootheca to respond differently to outside stimuli. After reviewing certain references, the following factors should be considered in the insecticidal

¹The data presented here was obtained in preparation of a Master's thesis at Purdue University.

²Purdue University, Agricultural Equipment Station, Journal Paper No. 1357.

treatment of the oothecae, namely method of treatment, length of exposure to the solution of the insecticide, temperature during incubation, age of oothecae at the time of treatment, different insecticides, and different concentrations of each insecticide. Eight oothecae were used in each test.

Method of Oothecal Treatment. Two methods were used; one consisted of submerging the ootheca in a solution of the desired insecticide and the other of topical applications to a portion of the ootheca. Submergence time was either one second or fifteen seconds. In one test the oothecae were submerged for one minute. In the topical treatments, only one of the four areas on the oothecal wall was treated in each test. These areas receiving topical treatment were the keel, side, bottom, and end.

Temperature During Incubation. The oothecae were incubated at 85° F. or 76° F. This difference of 9 degrees resulted in approximately two and one-half weeks difference in hatching.

Age of Oothecae at Time of Treatment. Oothecae were treated at one of three different ages, immediately after formation, approximately halfway through incubation, or just before hatching.

Insecticides, Concentrations, and Carrier. There are a number of commercial insecticides which are used to control cockroaches. Six of those in common use were selected for treating the oothecae. The concentrations used in this experiment were similar to those commonly used in control practices. These insecticides and their concentrations were: DDT at 2, 4, and 8 percent; chlordane at 1, 2, and 4 percent; dieldrin at 0.5 and 1 percent; lindane at 0.75 and 1 percent; malathion at 1, 2, and 4 percent; and diazinon at 0.5, 1, and 2 percent. This experiment was designed to determine if the insecticide, without the aid of a carrier, could penetrate the oothecal wall and stop embryonic development. Acetone was used as a carrier as it evaporated quickly and left the oothecae coated only with the insecticide.

Results and Conclusions

(1). Embryonic development of the American cockroach eggs was not inhibited by DDT, chlordane, dieldrin, lindane, or malathion. Oothecae which were submerged for either 15 seconds or one minute in a 2 percent acetone solution of diazinon just before they would normally hatch showed inhibition of hatching.

(2). Some of the oothecae exposed to the various treatments had malfunctioning nymphs emerge. These nymphs appeared to be completely developed but did not shed their embryonic skin; also, they died shortly after emergence. All of the insecticides used, except DDT, caused some malfunctioning nymphs to emerge. Topical treatments indicated that this condition was caused by the presence of insecticides in the tubes of the keel, the chemical being first available to the insects as they started emerging. The results obtained with diazinon indicated that a deeper toxic penetration was realized through the keel which prevented completion of embryonic development in some eggs. Neither embryonic development nor normal nymphal emergence was inhibited

in oothecae receiving topical treatments on either the side or bottom. Therefore, it appeared that the insecticide did not gain entrance directly through the oothecal wall.

(3). More abnormal nymphs emerged from oothecae treated close to "hatching-time" than from those treated immediately after formation or those treated halfway through incubation. Probably two factors were involved, the residual life of the insecticide in the tubes in the keel and the degree of development that the embryo had achieved at the time of treatment.

(4). Temperature during incubation had no effect on the action of the materials tested.

(5). With the exception of DDT and diazinon, the different concentrations of the insecticides caused about the same amount of abnormality. A 2 percent diazinon solution caused more abnormality than either the 0.5 or 1 percent. None of the concentrations of DDT caused abnormality.

(6). Time of exposure to the various insecticides had little effect on the results obtained except in the case of diazinon which produced greater toxic response with longer exposure.

(7). The percentage of normal cockroaches that emerged in these tests indicated that satisfactory control could not be obtained by the application of an acetone solution of these insecticides to the American cockroach ootheca.

References Cited

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