

Sorptive Dusts on Cockroaches

easily applied compounds harmless to animals and humans effectively control cockroaches and other household pests

I. Barry Tarshis

Of 78 compounds screened in laboratory investigation to determine the effectiveness of sorptive dusts for killing and controlling cockroaches, two compounds, a silica aerogel designated as SG 67—Dri-Die 67—and a silica gel called SG 77 were outstandingly effective.

Sorptive dusts kill certain insects by removing the outer waterproof layer—or cuticle—of the insect through a continual adsorption of the lipid elements or by the abrasion of the cuticle. Both phenomena intensify the loss of water from the body of insects, causing them to die by desiccation.

The cuticle covers the outermost surface of the insect body and makes up the exoskeleton and consists of two major parts: a relatively thick inner layer, the procuticle, and a thinner outer layer, the epicuticle. The epicuticle is a complex structure and in some insects is divided into four distinct sublayers: the cuticulin layer being innermost; the polyphenol layer next; the wax, or lipid, layer third; and the cement or tectocuticular layer on the outside. Other insects have only three layers, the cuticulin, the polyphenol and a waxy, or lipid, layer. There is a great deal of variation in the structure of the epicuticle in various insects, particularly in the structure of the wax and cement layers. The waxes range from soft greases to hard waxes. The lipid por-

tion of the epicuticle is usually a wax layer about 0.2–3 micra thick, but ranges from 0.1 to 0.4 to about 0.6 micron for grease layers. The cockroach epicuticle is in three layers and the lipid layer is a soft grease, freely exposed on the surface.

Four of the most common species of cockroaches in the United States—the German, *Blattella germanica* (Linne.)—the oriental, *Blatta orientalis* (Linne.)—the brown-banded, *Supella supellec-tilium* (Serville)—and the American, *Periplaneta americana* (Linne.)—have spread throughout the country. The German cockroach, or Croton Bug, is perhaps the most familiar. Several generations of this species are produced each year and it has adapted itself to living in the habitations of man. The oriental cockroach—often referred to as the water bug or black beetle—is becoming increasingly abundant in many areas of the United States. It is commonly found out-of-doors under leaves and wood and in sewers, but frequently enters man's dwellings. The brown-banded cockroach, previously common in the southeastern states, is making its appearance in the northeastern and southwestern states. The American cockroach is not commonly found in dwellings but is somewhat of a problem in commercial and industrial establishments.

German cockroach resistance to chlor-

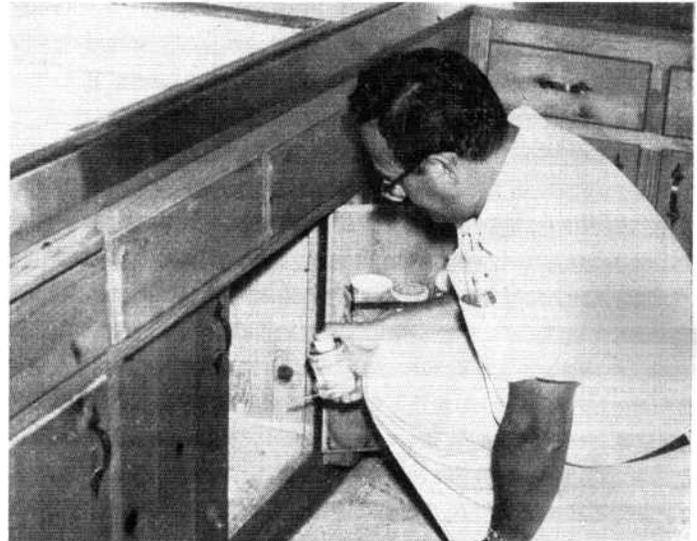
dane and to other chlorinated hydrocarbon insecticides is now nation wide and there are reports that these cockroaches are becoming resistant to the organic phosphates also. Other reports indicate that the oriental and the brown-banded species are showing resistance to a number of insecticides. Because of the problems of resistance, short residual, and high mammalian toxicity of the newer insecticides, cockroach control has become a severe problem.

Although cockroaches have never been positively incriminated in disease transmission, over 40 disease-causing organisms have been isolated from cockroaches. The fact that cockroaches have a natural propensity for human food and habitations—along with an affection for garbage dumps, sewers and cesspools—makes belief in the danger of their potential for transmitting disease credible.

In the spring of 1958 an extensive series of experiments was undertaken to determine if sorptive dusts—so effective as drywood termite desiccants—would be equally effective against nonstructural household pests becoming resistant to insecticides. The laboratory work on dusts was done almost entirely with the German cockroach because it reproduces in greater numbers and is easier to handle and rear.

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Application of dust. Left—with rotary duster through sub-floor vents for ant and cockroach control. Right—with a hand duster beneath sink.



COCKROACHES

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The two outstandingly effective compounds tested—SG 67 and SG 77—are finely divided, pure noncrystalline types of silica formed as a result of the primary chemical reaction of sodium silicate and sulfuric acid. The two liquids combine to make a firm hydrogel, which may be washed free of reaction salts. Upon drying, the purified hydrogel forms a granular dehydrated silica gel which can be reduced to very small particle size. During the course of manufacture, these compounds are treated chemically to achieve unique characteristics. It is the combination of the gel and aerogel structure plus the chemical treatment which results in the unique insecticidal action of SG 67 and SG 77.

The lethal action of SG 67 and SG 77 is believed to be twofold. While the initial physical action of dehydration is the primary factor, the process treatment of these compounds enhances the killing power by promoting a physical-chemical action. The insect need not eat the powder; simply crawling over the dust is sufficient. The chemical composition of the silica compounds is such that the compounds, once applied, can last indefinitely without decomposing and without losing their ability to kill pests.

SG 77 is approximately 2.5 times heavier in weight than SG 67 and consequently, the coverage with a given quantity is not so great as with SG 67. Both compounds leave a fair film of dust on such surfaces as wood, glass, masonite, Firtex, linoleum, aluminum, galvanized sheet metal, cast iron, cloth, paper, all types of painted surfaces, and wallpaper.

In the laboratory tests German cockroaches allowed to crawl through 200 mg—milligrams—of SG 67 in a quart size wide-mouth ball mason jar, were down in 15 minutes and dead at the end of 45 minutes. When identically treated with SG 77, cockroaches were down in 30–45 minutes and dead in 60–90 minutes. Brown-banded cockroaches treated

in the same manner with SG 67 were down in 45 minutes and dead at the end of 75 minutes. With SG 77 brown-banded cockroaches were down in two hours and dead at the end of 150 minutes.

American cockroaches crawling through 500 mg of SG 67 in a gallon-size wide-mouth jar were down in five hours and were all dead in seven hours. Oriental cockroaches, treated in the same manner, were down in three hours and dead in eight hours. When these two species of roaches were treated in the same manner with SG 77 the orientals were down in 90 minutes and dead in five hours. The Americans were down in six hours and dead in 10 hours.

In experiments run to determine how small a quantity of material would kill German cockroaches, a test chamber floor, having an area of 500 square inches, was dusted with only 250 mg—one quarter gram—of SG 67. Eighty-two male and female adults and nymphs in various stages of development were placed into the test chamber. Sixty percent were down and 20% were dead in 30 minutes, 98% were down and 84% dead in 60 minutes, 100% were down and 93% dead in 90 minutes, and 100% were down and dead in 120 minutes.

Experiments to determine the amount of water loss by weight in cockroaches treated with SG 67 revealed that this compound caused the insects to lose abnormal quantities of water in comparatively short periods of time.

It was found during the studies that it was immaterial whether the cockroaches had food and water available or not during treatment with these dusts. The insects killed in test chambers containing food and water died in exactly the same period of time—two hours—and with the same amount of water loss as those deprived of food and water. The males in both groups had lost 27% of their water by weight at time of death and the females, 23%.

German cockroaches allowed to crawl over a wet suspension of SG 67 died in the same period of time—three quarters hour—as those that were allowed to

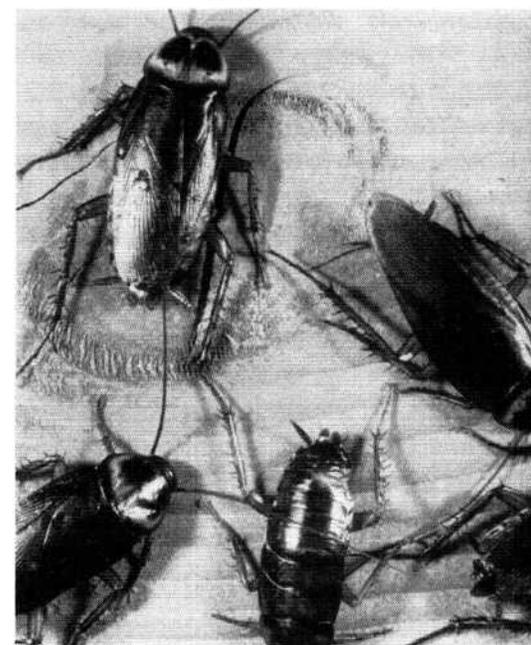
crawl over the dry material. Additional experimentation, however, has shown that material that has been soaked and then dried again still will kill cockroaches but the killing time is somewhat lengthened. Therefore, if the dust in treated areas does become wet, it should either be replaced, or allowances made for the somewhat slower action of the compound when again dry.

Comparative studies between 20 conventionally used insecticides and SG 67 and SG 77 proved the silicas to be the faster killers.

Because the action of the silicas is physical, producing death by desiccation, rather than chemical, it is believed that there is little likelihood of insects becoming resistant to them.

In addition to killing drywood termites and cockroaches, laboratory studies have shown these silicas to be equally effective in killing wasps; bees; ants; bedbugs; cat, dog and rodent fleas;

American cockroaches before being treated with SG 67.



Loss of Weight in Adult Male and Female German, Brown-Banded, Oriental and American Cockroaches Dusted with SG 67

Cockroaches dusted	Time required to kill (minutes)		Per cent weight loss at death		Per cent weight loss after complete desiccation	
	Males	Females	Males	Females	Males	Females
German	45	95	20	20	66	61
Brown-banded	160	190	35	25	64	66
Oriental	180	240	19	17	64	66
American	270	450	21	28	70	67

The German and brown-banded cockroaches (10 of each species and each sex) were weighed and then were placed into quart size, wide mouth ball mason jars, each jar containing 200 mg. of SG 67. The cockroaches were allowed to crawl on the dust for 60 seconds, after which time they were removed from the jars, the excessive dust removed from the cockroaches and the insects were then weighed at varying intervals to determine weight loss. The orientals and Americans were treated in the same manner, except they were allowed to crawl through 500 mg. of SG 67 in gallon sized jars. Five roaches of each species and each sex were used.

Temperatures: 75–80° F.

Humidity: 50–58%.

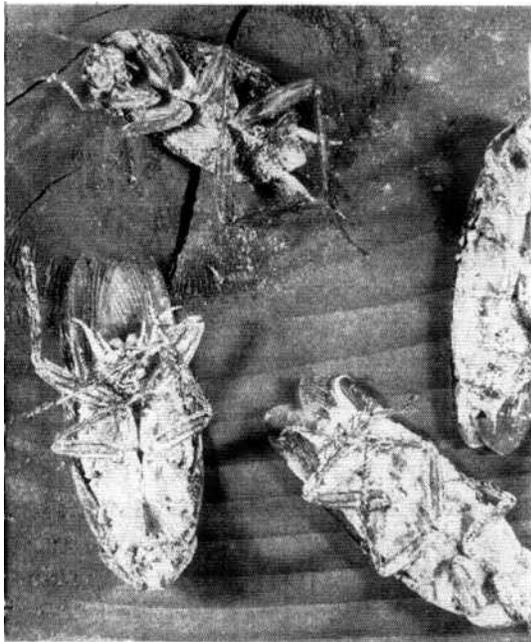
dog ticks; chicken, rat and rose bush mites; vinegar, mushroom and house flies; moths; grasshoppers; chicken lice; greenhouse thrips; European earwigs; spiders; scorpions; sow and pill bugs and European brown snails. All indications are that this list will grow as fast as the screening of more arthropods will permit. However, this is not meant to imply that in all cases practical control measures can be worked out that are as effective as those already in use.

In April of 1958 a southern California home infested with oriental cockroaches was treated with SG 77. The dust was applied in various areas of the kitchen, where live orientals had been seen, and on the service porch. The occupant let

the dust material remain for a month in exposed areas. In the concealed areas—such as under stoves, refrigerators, behind cupboards—the dust was to be left for an indefinite time. Three days following application, the home was inspected and a number of dead cockroaches were found in the dusted areas. The occupants reported that no live roaches had been seen but they had found a good number of dead cockroaches. The home was under observation for nine months and the occupants reported their home to be completely free of cockroaches for the first time.

Since the first field test with the silica dust, 60 other establishments in southern California, including homes, apartments, libraries, sanitariums, fire stations and restaurants have been treated with SG 67 and SG 77 for German, oriental and brown-banded cockroach infestations. Excellent control has been obtained in all establishments treated.

American cockroaches after treatment with SG 67.



No field trials have been made on the control of American cockroaches with silica compounds. Laboratory findings, however, show that these cockroaches can be killed in approximately the same period of time as the oriental species. It would, therefore, be possible to treat infestations of American cockroaches in homes and commercial establishments in the same manner as those of the oriental species.

In no home or establishment where the dust material has been applied has there been any objection by the occupants to the dust.

Although sorptive dusts have remarkable insect-killing power, long industrial experience has shown them to be non-

toxic to human beings. However, an industrial dust mask should be worn by anyone applying the materials over prolonged periods, or in very confined areas, to avoid any unpleasant drying of the nose and throat tissues that comes from working with any dust in a confined area.

In homes and apartments one half to three fourths pound of dust may be applied with a small hand duster; in commercial establishments, amounts proportional to the building size should be used.

A visible film of dust should be applied—because it is necessary for the cockroaches to get the dust on their bodies to ensure death—on cupboard walls and shelves, in drawers, under drainboards, refrigerators, stoves, dryers, washers, heaters and furnaces, behind electrical switch plates, behind wall cabinets, in air and furnace vents and in small wall and ceiling cracks and crevices, as well as in any other places cockroaches are apt to be found.

Cockroaches frequently hide in walls during the daytime and, therefore, it is a good practice to dust thoroughly between walls when possible. These areas sometimes may be dusted, with an electric or other suitable type duster, through large wall cracks and crevices and through openings left by removal of medicine cabinets and electrical switch plates from walls. In severe infestations an additional pound of dust per 1,000 square feet should be blown into the attic and sub-floor spaces, through the crawl holes.

During the first week following dusting there may be an increase in the number of cockroaches because the dust

flushes out many late-stage nymphs and adults that otherwise would remain in hiding. However, by the beginning of the second week, most of the flushed-out cockroaches will be dead. By the beginning of the third week, if any cockroaches remain, they will be young-stage nymphs because the dust has little effect on the egg cases. Some eggs may be deposited during treatment, so young, newly emerged cockroaches may be found several weeks after all adults are dead. Therefore, it is essential to leave dust in treated areas until all cockroaches have disappeared. In concealed places the dust should be left permanently.

In homes and food establishments, all items should be removed from all cupboards and drawers during dusting. Before utensils or dishes that have been dusted accidentally are used they should be rinsed off, at least. In restaurants, areas under large appliances, steam tables, cabinets and refrigerators should be cleared of all debris before dusting.

Dust drifted onto places where it would be undesirable to have dust can be cleaned with a damp cloth or mop right after treatment.

Silicas seem to fit some of our insecticide needs admirably, and, additionally, to offer a new approach to some of our most vexing insect control problems.

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Walter Ebeling, Professor of Entomology, University of California, Los Angeles, conducted the experiments with sorptive dusts for the control of drywood termites.

Field Experiments on the Use of Sorptive Dusts for the Control of Oriental Cockroaches

Location	Infestation	Material used	Areas dusted	Date dust applied	Results (No live roaches seen after date given)
One-story home Hollywood	M*	SG 77	Kitchen, service porch	4-18-58	4-28-58
One-story home Brentwood	M	SG 77	Garage, service porch	4-28-58	5- 6-58
One-story home Mar Vista	M	SG 77	Kitchen, service porch	4-29-58	5- 1-58
One-story home Mar Vista	M	SG 77	Kitchen, service porch	5-16-58	5-26-58
Two-story apt. Beverly Hills	M	SG 77	Garage, furnace room	6- 9-58	6- 9-58
Duplex—upper Hollywood	M	SG 77	Kitchen, service porch	5-16-58	5-16-58
Duplex—lower Hollywood	M	SG 77	Kitchen, service porch	5-16-58	5-16-58
One-story home Mar Vista	M	SG 67	Kitchen, service porch, bathroom	5-29-58	5-29-58
One-story home Mar Vista	M	SG 77	Kitchen, service porch	6- 9-58	7-16-58
One-story home Culver City	M	SG 67	Kitchen, service porch	7- 2-58	7-23-58
Two-story apt. upper floor Pacific Palisades	M	SG 67	Kitchen, bathroom	8- 4-58	8- 4-58
One-story home Mar Vista	M	SG 67	Kitchen, service porch, garage	7-18-58	8- 7-58
Fire Station Glendale	H*	SG 67	Kitchen, recreation room, laundry room, shop	8-13-58	8-13-58

* M = Moderate; H = Heavy.