German cockroaches and allergen-laden fecal smears in a cabinet corner of an infested home.

Something To SNEEZE At

The first-place winner of Bayer and NPMA's Young Scientist of the Year contest discusses German cockroaches as a public health pest. *By J. Chad Gore and Coby Schal*

Editor's note: The following is the second in a series of three stories by the winners of the Young Scientist of the Year contest, sponsored by Bayer and the National Pest Management Association. The first story appeared in the February issue of PCT; watch for the other remaining story in an upcoming issue.

The German cockroach, with its long history of close association with humans, is most often regarded as merely an unpleasant pest with the potential to transmit disease-causing microbes. However, recent research has demonstrated that this insidious pest has a much greater impact on public health than was once thought. German cockroaches, first implicated in allergic disease nearly 40 years ago, produce several proteins that exacerbate allergic responses and asthma in sensitive individuals, especially among children and the elderly.

The overall goal of our research is to reduce these allergens in homes below harmful levels. Toward this goal, we integrate fundamental and applied research to 1) develop innovative strategies to control cockroaches; 2) understand the basic biology of German cockroach allergens; and 3) devise practical approaches to reduce allergens in cockroach-infested homes.

ALTERNATIVE CONTROL STRATEGIES. Although insecticide baits have largely displaced other formulations for German cockroach control — especially as components of IPM programs — cockroach management in some commercial settings continues to rely heavily on calendar-based applications of broad-spectrum insecticides. Our research in confinement swine production aims to forestall the develop-

Boric acid liquid bait treatments reduced cockroach populations by 90 to 99 percent with sustained reduction over a 10-month period at this pig farm nursery.

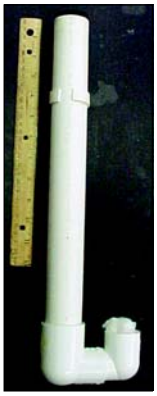
ment of insecticide resistance and to reduce risk to workers, animals, consumers and the environment. We examined two alternative strategies to conventional cockroach control.

Boric acid dust has a long history of use against cockroaches, in part due to its favorable safety record, low cost and lack of resistance. In a recent study, we showed that boric acid dust was as effective as a pyrethroid insecticide for cockroach control in infested swine farms (Zurek et al. 2003). However, dust formulations have their share of practical limitations. In the laboratory, we showed that liquid formulations of boric acid and sugar provided excellent control of the German cockroach (Gore and Schal 2004a). This formulation was evaluated in an infested nursery of a pig farm using a prototype J-shaped bait feeding station *(see photo at right)*. The results of this two-year field study showed that the cockroach population was reduced by more than 90 percent within one to two months. When baits were used continuously for about 10 months *(see chart below)*, the cockroach populations declined by 90 to 99 percent and were maintained at low levels (Gore et al. 2004).

Insect growth regulators, although not as fast acting as conventional insecticides, can result in substantial reductions in German cockroach populations. To counter this delay, insecticides can be mixed with IGRs, resulting in enduring reductions in populations. We are currently examining the efficacy of IGRs (hydroprene and pyriproxifen) mixed with the pyrethroid cyfluthrin for cockroach control in farrowing barns of an infested pig farm. The study's preliminary results show that while populations in rooms treated only with cyfluthrin began increasing seven to eight months after the start of the study, populations in IGR-treated rooms continued to decline. Even after a year, populations in IGR-treated rooms remain low.

ALLERGEN BIOLOGY. Bla g 1 (*Blattella germanica* allergen 1) is one of six known human allergens produced by the German cockroach. Using molecular approaches, we showed that it is made only in the midgut of the digestive system, and ultimately secreted into the feces in large amounts and expelled into the environment (Gore and Schal 2004b). Because more Bla g 1 is produced when cockroaches feed, and adult females eat much more than nymphs and adult males, adult females make and excrete in their feces much more Bla g 1 than other cockroaches. Nevertheless, adult males tend to forage over larger distances and therefore may spread their allergen-laden feces over a broader area in the home. Small nymphs produce small amounts of allergen, but because they produce much smaller fecal pellets the allergen may more easily become airborne and taken into the lungs. We plan to determine the contribution of each life-stage of the cockroach to the total allergen load in homes.

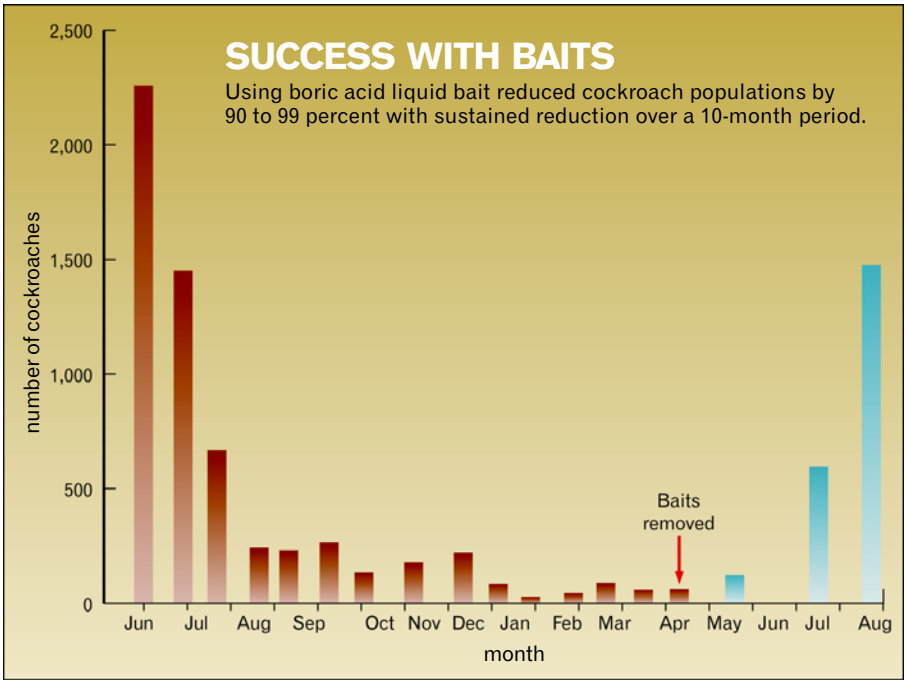
Using similar molecular approaches, we showed that unlike Bla g 1, Bla g 4, another human allergen, is found only in the adult male's reproductive system, and is transferred with the sperm package to the female during mating (Fan et al. 2005). Such limited production and dissemination of this allergen might imply that it would be less pervasive in the environment. However, 40 to 60 percent of asthmatics who are allergic to cockroaches react to Bla g 4, suggesting extensive exposure to this protein. Although adult males constitute a relatively small fraction of a cockroach population, they tend to be more mobile than other stages. Therefore, adult males are more likely to encounter pesticides and die, disseminating their Bla g 4 contents in the household environment.



The J-shaped liquid bait feeding station.

Further research is needed to allow us to not only identify the biological functions of allergens in the German cockroach, but also to provide insight into how current pest management approaches might affect allergen accumulation in infested structures. For example, our research indicates that both Bla g 1 and 4 increase with greater exposure to juvenile hormone. It is plausible that IGRs that mimic the action of juvenile hormone (e.g., methoprene, hydroprene, pyriproxifen) might also stimulate allergen production. This hypothesis can be tested by determining whether different cockroach-produced allergens accumulate disproportionately in the environment in response to different pest control treatments.

MITIGATION EFFECTS ON ALLERGENS. Exposure to cockroach allergens in homes has received much attention from the medical community. Clinical research has shown that very low levels of cockroach allergen are needed to sensitize and exacerbate existing asthmatic conditions. Allergen mitigation is a reasonable goal, but several studies have seen only limited success. In collaboration with the National Institute of Environmen-



German cockroaches feeding at bait station.

tal Health Sciences (NIEHS), we evaluated the efficacy of an intensive and targeted mitigation program to reduce levels of German cockroach allergens in infested homes.

In the first half of our year-long study, we used a three-pronged approach to reducing allergens. Infested homes were treated with gel bait to reduce (and hopefully eliminate) cockroach populations and then professionally cleaned to remove allergens. Also, residents were provided educational material outlining ways to improve sanitation and prevent infestations. Our results showed that this combined — but costly — approach resulted in 96 percent reduction in trapped cockroaches and dramatic reductions in household allergen levels (Arbes et al. 2003).

We next wanted to determine whether allergen reductions could be sustained for another six months with cockroach management alone, and whether using only baits, instead of the combined approach, could reduce allergen levels. The results of the second half of our study were very surprising and contrary to previously published reports. In short, we found that clinically relevant reductions, similar to those when using the combined approach, occurred with insecticide bait use only (Arbes et al. 2004). This study also showed that keeping an apartment essentially cockroach-free could sustain the allergen reductions.

BENEFITS TO THE INDUSTRY. The goal of our research with boric acid and IGRs was to reduce the dependence upon conventional insecticides for pest management while providing safe, effective means for the control of German cockroaches. We demonstrated that large-scale reductions of German cockroach infestations could be achieved using inexpensive, reduced-risk, targeted approaches. These tactics not only reduce cockroach populations and allergens they disseminate, but also have the direct benefit of dramatically reducing the amount of active ingredient needed for effective control, thereby reducing the risk of exposure to humans, animals and the environment. Furthermore, these approaches require little labor input, resulting in a labor savings for the end-user. This technology can be extremely valuable in sensitive environments, such as schools, nursing homes, pet shops and even homes, where conventional insecticides may not be an option.

In recent years we have seen a renewed interest in public health in the pest management industry. Our research on German cockroach allergens highlights the impor-

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ALLERGENS

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tance of this ubiquitous insect as a public health pest, and provides pest management professionals a better understanding of its biology as it relates to the health of consumers. These data, combined with results from our collaborative study with the NIEHS, which showed that cockroach population management alone can reduce allergen levels in infested homes, allows the pest management professional to better educate clients. Our research emphasizes the need for an informed pest management professional workforce familiar with both the biology of target pests and the technology that reduces pest populations and their public health impact with minimal pesticide input.

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PROBLEMS & SOLUTIONS

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mite activity *in* wood." Then, I guess we'd also have to say there was previous activity *in* the wood, when live termites are not found.

This brings us to another term: "activity." To me, determining "activity" means finding live insects. The rest is "evidence of activity." Yes, I am splitting hairs but that's what attorneys do.

This brings us back to the comments by the attorney, which I mentioned previously. While I guess I can appreciate his opinion, I sure want a guide from him as to what we should say. We cannot just walk away from the term "damage." "Damage" is a part of our industry's jargon. Should we change it? Yes. And we should start now!

This means changing a few things like those Xs and Ts with circles around them on diagrams and field worksheets. I believe every WDI inspection or treatment report I have looked at over the years had an X to denote "damage." I've never been involved in a lawsuit where someone was suing the PCO because he explained where the damage and evidence was visible.

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