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# Controlling **Cockroaches** in Insect-Rich Environments

In a particularly sensitive location, N.C. State researchers found a way to control cockroaches and prevent a public relations nightmare.



Brownbanded cockroaches perching on leaves in the conservatory at night.

Across the country, butterfly conservatories and arthropod zoos have become popular tourist attractions in many cities. These facilities capitalize on a growing public interest in insects of all sorts, offering arthropod-themed displays housed in an artificial, yet realistic, tropical environment where visitors are able to wander amidst butterflies from exotic locales.

These conservatory environments are highly conducive to the growth of cockroach infestations; they typically maintain a relatively high temperature, have ample water provided by small ponds and misters, and food (placed in open containers) is replenished daily and remains available overnight for the conservatory fauna. Furthermore, the artificial nature of their construction, such as faux rocks and housing for plumbing, creates numerous large voids that serve as excellent refugia for cockroaches. These exhibits also are served by arthropod-rearing facilities that store food items. In other words, it is a cockroach nirvana.

#### **A TRIO OF COCKROACH PROBLEMS.**

The staff of one such conservatory discovered a unique cockroach infestation that was all but invisible during normal operating hours, but would manifest when the lights went out. A night-time inspection revealed that the conservatory was infested by not one, but three cockroach



One of the authors, Chad Gore, prepares PVC bait tubes in the lab.

species: the brownbanded cockroach (*Supella longipalpa*), a common pestiferous roach found throughout the United States; the smokybrown cockroach (*Periplaneta fuliginosa*), a large mahogany-colored roach typically found outdoors but which occasionally enters structures; and the Surinam cockroach (*Pycnoscelus surinamensis*), an unusual roach that likely entered by way of the tropical plants used to create the tropical dry forest atmosphere. The conservatory would often host groups and donors for behind-the-scenes evening tours of the butterfly conservatory. Strangely, these visitors, who found the brush of a butterfly wing so intoxicating, did not experience the same rapture when faced with the hordes of cockroaches swarming forth from their hidden recesses to scavenge on the walkways.

Managing these pests in such an insect-rich and high-profile environment poses serious challenges. For example, how do we reduce or eliminate cockroaches without harming butterflies or creating unnecessary exposure to visitors in an enclosed space? Which treatment approach will be least visible to the public, yet still effective?

In these situations, traditional approaches to cockroach management (e.g., residual sprays, crack-and-crevice bait treatments and IGRs) may not be feasible for various reasons, including undesirable, non-target effects. Therefore, this unique habitat requires alternative thinking and approaches to solving such an unusual pest problem. The brownbanded cockroach population was already under a natural management program: A tiny parasitoid wasp, *Comperia merceti*, places its eggs in the ootheca (egg case) of the cockroach and its young devour the cockroach eggs. Because these cockroaches spend a great amount of time in the ootheca — up to three to four months — these wasps nicely complement other management tools that target the mobile stages, nymphs and adults. But the *Comperia* wasps, which live only two to four days, also need to be protected during the implementation of the cockroach management program. Thus our objectives in this study were to:

- 1) Evaluate the efficacy of monitoring traps and gel baits in homemade PVC containers, and
- 2) Develop, implement, and demonstrate a low-impact, reduced-risk cockroach control and pheromone-based monitoring program in a sensitive environment that is under intense public scrutiny.



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## COCKROACHES TRAPPED

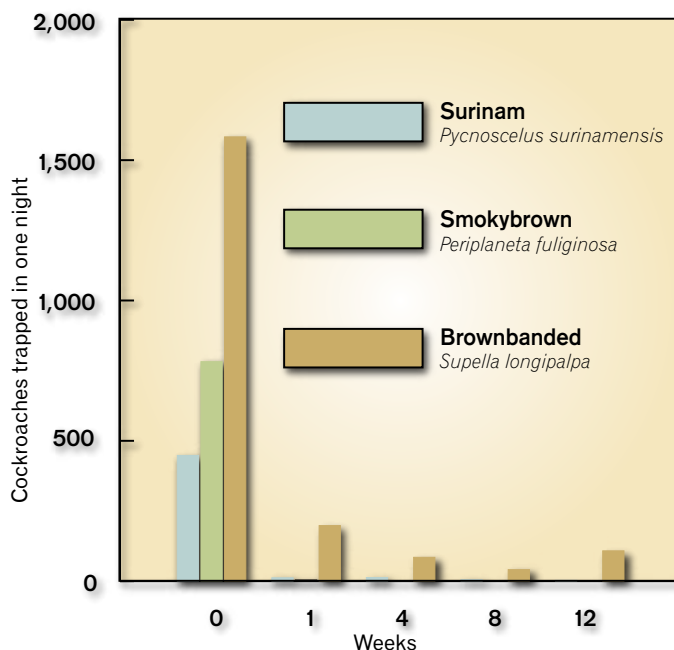


Figure 1. The decline in the three cockroach species in the 12 weeks after baiting.

**MANAGEMENT APPROACH.** What would you do? To monitor the cockroach populations, we used 34 pitfall traps overnight (from 3 p.m. to 9 a.m.) in the 1,296-square-foot conservatory. The traps were baited with various food items (fruits, granola) and half of the traps also received supellapyrone, the sex pheromone of the brownbanded cockroach, in a slow-release plastic laminate formulation at 1 microgram per trap. Cotton sleeves were fitted on the outside of the traps to allow easy entry, especially for the fossorial *Pycnoscelus*, while a thin film of petroleum jelly around the inner rim prevented escape. Wire mesh over the opening excluded butterflies and hummingbirds. We carefully noted the placement of the traps on blueprint maps provided by the museum.

Insecticide treatments consisted of gel bait placed in the center of 6-inch lengths of ½- or ¾-inch diameter PVC tubes; Maxforce cockroach gel baits formulated with 0.003-percent fipronil or 2.15-percent hydramethylnon were both used for the initial treatment, but only the hydramethylnon formulation was used during our follow-up treatments. The rationale for using fipronil was to collapse the cockroach populations rapidly — in a week or so — during which time the turtles were secluded in a terrarium in a different room to avoid any possibility of secondary toxicity from ingesting intoxicated or dead cockroaches. The purpose of the PVC “bait stations” was to deliver containerized bait in a device that could be recovered, cleaned and re-baited. More importantly, however, it excluded butterflies and vertebrates while allowing even the largest of the cockroaches access to the bait inside. These feeding stations, approximately 70 total, were distributed throughout the conservatory, out of sight inside artificial rocks, camouflaged by plant debris and soil within flower beds and hidden in other locations where aggregations were detected. Again, their placement was noted on maps. At each trapping interval, bait stations were removed overnight while traps were in place, cleaned and replaced with fresh bait the following day when traps were collected. We also arranged for the open butterfly feeding stations (bananas, sugar-soaked sponges) to be removed overnight for the duration of the baiting

program; cockroaches enthusiastically feed on these, in competition with our baits.

Follow-up trapping with the baited jars allowed us to monitor the efficacy of this program and to identify the areas of highest roach concentrations and target them accordingly. PVC tubes could then be transferred from areas with low roach numbers to spots with higher trap catches. The amount

of bait consumed between visits also was checked and adjusted in spots where the roaches were consuming greater quantities of the gel (smokybrown roaches consume considerably more bait than brownbanded cockroaches).

**RESULTS.** In May of 2004, this study began with a pretreatment assessment of



Chad Gore places a monitoring trap in the conservatory.

the cockroach populations in the conservatory. This initial trapping caught about 3,000 total cockroaches in just an 18-hour period while the exhibit was closed to the public. More than half of those trapped at this pretreatment evaluation were brownbanded cockroaches (see Figure 1, page 84). As expected, the traps baited with brownbanded sex pheromone, in addition to fruit and granola, caught more than 8-fold more males than those without the sex attractant (see Figure 2, page 88). Just one week after introducing the bait stations into the conservatory, total cockroaches were reduced by 92 percent, down to just 214; *Supella* were reduced by 87 percent, smokybrowns by 99 percent, and *Surinams* by 97 percent. Many of the PVC stations had been completely cleaned out — probably due to the hefty appetites of the bigger roaches as well as their sheer numbers in the conservatory — and staff reported sweeping up large numbers of dead cockroaches on the walkways prior to opening. By August of 2004, three months after the first bait application, brownbandeds were reduced by 93 percent, smokybrowns were undetectable in our traps (100 percent reduction), and *Surinams* were down by 99 percent. This translated to a 96 percent reduction to 106 trapped cockroaches. We then transferred responsibility for follow-up treatment to the staff, who are currently using this approach to maintain the infestation at an acceptable level.

**CONCLUSIONS.** Living conservatories, especially those with insect fauna, are unique environments requiring careful consideration when dealing with pest management issues. In these environments, cockroach management approaches we typically use in residential and commercial accounts are likely not our best options. For example, we can immediately reject

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residual sprays for obvious reasons (non-target mortality and visitor exposure risk in a confined room). IGRs may have been a viable option because only adult insects are used in the conservatory and IGRs are not toxic to vertebrates. However, due to the proximity of the rearing facilities, the risk of translocation of the residual insecticide was too great, as would the potential harm to the beneficial wasp *Comperia*. Moreover,

was a simple, environmentally friendly approach to administering bait throughout the conservatory that would restrict accessibility to only its intended target.

The PVC tubes with bait in the center proved very efficacious. This strategy excluded butterflies because the proboscis of butterflies is too short to be able to reach the center of the tube when extended. This method essentially eliminated smokybrown

As a testament to the success of this program, no adverse, non-target effects have been observed and evening visitors to the butterfly conservatory no longer encounter hordes of foraging roaches.

the environmental persistence of IGRs would rule out future releases of immature insects into the conservatory. Baits are the next logical choice; however, it's unclear whether butterflies are attracted to or will feed on exposed gel bait. Even a conventional crack-and-crevice bait treatment, which might be accessible to butterflies, may result in undesirable mortality if the bait proved attractive to the butterflies. What was needed

and Surinam cockroaches. Although brown-banded cockroaches persist in the conservatory, the population is markedly reduced compared with pretreatment levels.

As a testament to the success of this program, no adverse, non-target effects have been observed and evening visitors to the butterfly conservatory no longer encounter hordes of foraging roaches. We used little fipronil, and only in the first treatment,

ONE NIGHT'S CATCH

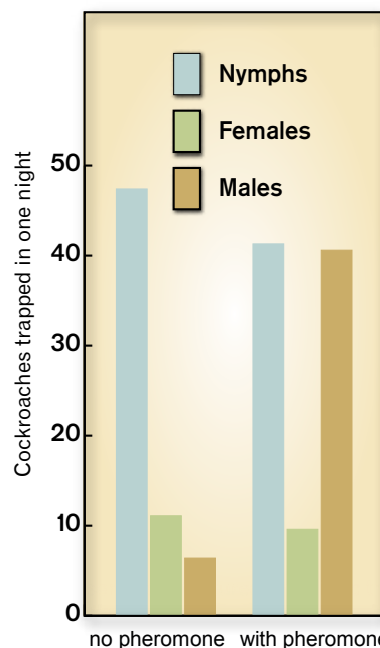


Figure 2. This graph, based on one random day of monitoring, indicates that traps containing a pheromone lure caught significantly more male roaches than traps without the lure.

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because we were concerned about potential indirect detrimental effects. Fipronil is a contact insecticide, and we feared that butterflies might alight on dead cockroaches or their feces and die. This proved not to be the case, but we opted for hydramethylnon in subsequent baiting and our recommendations to conservatory staff because this insecticide is active solely by ingestion and not contact.

The results from this research project and demonstration highlight the need for unconventional approaches to pest control in environments that are extremely sensitive to the effects of traditional pest management. Furthermore, this provides pest management professionals with an alternative treatment approach should they find themselves with an account of similar sensitivity and under such public scrutiny. Long-term management of *Supella* may incorporate more elements, such as the parasitoid wasp *Anastatus tenuipes*, which nicely complements *Comperia*.



A feeding tray covered in cockroaches.

Major points:

- Monitoring-based pest management is more effective than calendar-based approaches because specific problem areas are easily identified.
- Sex pheromones offer a powerful tool for detection and monitoring pest populations, particularly incipient or small infestations.

tions.

- It is important to utilize innovative and flexible approaches in sensitive environments. Placing gel baits in custom-made containers allows better targeting of the pest species and makes possible the removal of the bait, if necessary.

- Removal of animal food at night serves to focus cockroaches on the insecticide baits.

- Highly effective baiting can reduce cockroach populations by more than 90 percent within just one week. 🐜

*The authors are all affiliated with North Carolina State University: Rick Santangelo is lab manager. Dorit Eliyahu recently completed her Ph.D. and is now a post-doctoral researcher at Arizona State University. Chad Gore also completed his Ph.D. at NCSU and is with JC Ehrlich/Rentokil in Pennsylvania. Mike Waldvogel is extension specialist. Coby Schal is Blanton J. Whitmire Distinguished Professor of Urban Entomology at N. C. State University and can be reached at cschal@giemedia.com.*



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