The IPM Practitioner
Monitoring the Field of Pest Management
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IPM Reduces Pesticides, Cockroaches, and Asthma

By William Quarles

Cockroaches are major structural pests and are an ongoing part of urban life. Because of their contact with sewers and unsanitary conditions, they can spread pathogens. And in multiunit buildings of inner city areas, they are the leading cause of childhood asthma, a debilitating and even deadly respiratory disease (Rosenstreich et al. 1997; Wang and Bennett 2009).

Asthma causes about 500,000 hospitalizations and 5,000 deaths every year in the U.S. (Weiss and Sullivan 2001). Somewhere between 5.8 to 7.2% of the population may be affected—about 18-22 million, including 9 million children under age 18. Costs have been estimated at $12.7 billion annually (Gore and Schal 2007; Wang et al. 2008).

The nature of asthma and its causes have been reviewed elsewhere (Quarles 1999; Boushey and Fahy 1995). Asthma can be triggered by allergens, and cockroaches are a major source. About 26% of the U.S. population 6-59 years old is sensitized to German cockroach allergens, and the allergens are present in 63% of U.S. homes (Nalyana et al. 2009; Cohn et al. 2006). (See Box A. Cockroach Allergens and Asthma.)

Photo courtesy of Pestec and Finger Design

Carlos Agurto of Pestec IPM applies a cockroach bait as part of an IPM program for cockroaches. Cockroach IPM includes monitoring, exclusion, sanitation, education, baits and other least-toxic chemicals.

Ineffective Pest Control

Widespread exposure to cockroaches and allergens is due to conducive cockroach breeding conditions, poor building maintenance, and ineffective pest control. Cockroaches are important pests especially in multiunit buildings. To satisfy legal requirements for cockroach abatement, building managers hire pest control companies to apply calendar applications of sprayed pesticides. Cockroaches have become resistant to these sprays and populations have surged. Once multiunit buildings are infested, cockroaches are rarely eliminated, and sprays may do nothing more than spread the infestation (Owens and Bennett 1982; Koehler et al. 1987; Schal and Hamilton 1990; Miller and Meek 2004).

In one experiment, cockroaches doubled as a result of monthly sprays. In another report, roaches may have dropped from about 13,000 per apartment to half that number (Koehler et al. 1987; Miller and Meek 2004). As well as being ineffective, sprayed pesticides themselves may cause asthma symptoms

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Update

(Quarles 1999; Etzel 1995; Ott and Roberts 1998; O'Malley 1997; Deschamps 1994), and sublethal encounters cause roaches to produce larger amounts of allergens (Gore and Schal 2007). (see Box A.Cockroach Allergens)

In contrast to calendar sprays, IPM methods can significantly reduce and or even eliminate cockroaches. A number of studies have now shown that IPM methods can reduce cockroaches, allergens, and amount of pesticides applied (Greene and Breisch 2002; Miller and Meek 2004; Wang and Bennett 2009; Wang and Bennett 2006; Sever et al. 2007). Success has been seen in single homes, multi-unit dwellings, schools, and other areas. The purpose of this article is to document the success with IPM methods in reduction of cockroaches and allergens in the hopes that pest management professionals (PMPs) will provide IPM services on a larger scale.


Photo courtesy of Pestec and Finger Design

Carlos Agurto of Pestec IPM checks a sticky trap.

What are IPM Methods?

IPM methods can significantly reduce and or even eliminate cockroaches, but what exactly are they? Generally accepted IPM programs for the German cockroach, *Blattella germanica*, include monitoring, prevention, exclusion, sanitation, education, and application of boric acid, cockroach baits, and insect growth regulators (IGRs)(Olkowski et al. 1991; Schal and Hamilton 1990).

Cost and effectiveness of an IPM program can vary with the number of treatment components needed and implemented. Monitoring is an essential part of any IPM program, since it is used to measure efficacy and target treatments. The most basic professional IPM program is targeted baiting. This approach is almost always successful and cost effective, but it may not be sustainable in the long run because roaches could become resistant to the bait (Quarles 2002; Quarles 2005).

Sanitation is important, since denial of food and water and removal of clutter can reduce harborages, reduce allergen production, and drive the roaches to consume baits (Gore and Schal 2007; Schal and Hamilton 1990; Kaakeh and Bennett 1997). Sanitation can be provided by professionals, or residents can be educated to provide it themselves. Exclusion of roaches through caulking and good building maintenance is desirable, but PMPs often have no control over this IPM component (Brenner et al. 2003).

IPM Monitoring of Cockroaches

Key to the success with IPM is a monitoring program. Monitoring allows targeting of pest abatement efforts and provides a way to measure success. Most of the studies reviewed here used sticky traps to monitor cockroach populations. Sticky traps are useful and inexpensive, but the approach has not been standardized. Some brands of sticky traps are more effective than others. Foraging ecology of the German cockroach is variable, and there are seasonal fluctuations in populations (Quarles 1997; Smith and Appel 2008; Miller and Meek 2004).

There is no general agreement on how many traps to use, where exactly to put them, and how long should traps be out before counting the roaches. However, good results are obtained with placement behind stoves and refrigerators, under kitchen and bathroom sinks and similar areas. Generally, 24 hours can give a good population estimate (Schal and Hamilton 1990; Kaakeh and Bennett 1997).

Ballard and Gold (1984) found that large numbers of sticky traps could catch about 30% of a German roach population in the field. Sticky traps have been improved since then, and Kaakeh and Bennett (1997) were able to reduce German roach populations by about 80% just with Victor pheromone sticky traps. The traps were more effective than pyrethroid sprays (68.5% reduction). Whatever their drawbacks, if the same number of the same kind of sticky traps are used both to establish baseline and to measure success, they should give a reasonable estimate of efficacy (Wang and Bennett 2009; Miller and Meek 2004).

IPM Reduces Pesticide Applications

Several studies have shown that IPM methods can reduce pesticides and provide more effective pest control than calendar sprays. The Bio-Integral Resource Center (BIRC) applied structural IPM methods to 140 buildings on 1700 acres at NASA's Ames Research Center, in Mountain View, CA, reducing applied pesticides by 87% (Daar 1997). Greene and Breisch (2002) converted more than 100 government buildings in Washington, DC to IPM management. Before IPM, 99.6% of all service calls resulted in spray applications of organophosphates. Conversion to IPM methods resulted in a 93% reduction in amounts of applied pesticides. Use of cockroach baits and IPM resulted in an 89% reduction in pesticide service requests, and presumably a similar reduction in cockroaches.

IPM Methods Effective for Cockroaches

To save money, IPM programs containing only basic components are often implemented and tested. One basic program combined monitoring with an initial vacuum cleanout and use of cockroach baits. In a public housing project, 50 apartments were treated with traditional baseboard crack-and-crevice treatments (TBCC) and 50 received IPM methods over the course of a year.

IPM methods worked to reduce cockroaches even without an ongoing sanitation program. Average cockroach populations were reduced by about 84% (average 24.7 per apartment to 3.9) over the period of a year. TBCC methods were totally ineffective, and average cockroach populations measured in traps actually doubled (from 13.1 to 25.3) (Miller and Meek 2004).

The IPM methods led to a 95.8% reduction in the amount of pesticides applied. However, the IPM treatments cost more, due mainly to labor costs needed for the initial clean out. Averaged over the course of a whole year, labor costs of each IPM treatment was $3.08 and each TBCC was $1.45. However, since IPM treatments were mostly quarterly and TBCC was monthly, the cost per apartment did not differ that much (Miller and Meek 2004).

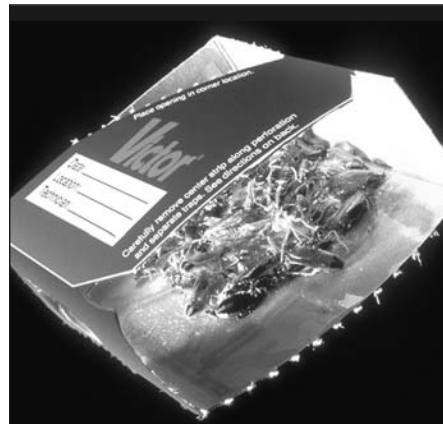
Wang and Bennett (2009) used a more complete IPM program of monitoring, targeted baits, boric acid dust, and education in low income apartments in Gary, IN. In 191 apartments the IPM plan was implemented by university entomologists (E), in 251 apartments the same protocol was used by pest management companies (C).

This work is the most effective large scale IPM program for roaches reported so far. At 12 months, the number of cockroach infested apartments dropped by about 74% in both groups. Average cockroach numbers dropped by 99.6% in the entomology intervention and by 98.3% in the commercial intervention. Cockroach allergens on the kitchen floor dropped by 92% in the E group and 58.6% in the C group. The average cost over 12 months was $7.50 month for each apartment. However, because cockroaches were eliminated from many apartments, quarterly costs for the total program had dropped by as much as 78% by the end of the year.

Brenner et al. (2003) found that application of IPM methods in multiunit buildings in East Harlem reduced average cockroach populations by 50% and completely eliminated cockroaches in half the units within six months. IPM included education, repairs, monitoring, and the use of cockroach baits. Annual cost was $46-49 per apartment ($3.8-$4.1/mo).

IPM versus Baits

An important part of cockroach IPM is baiting technology. Baiting is so important, it has even been tested as a standalone technique. But efficacy is improved when monitoring is used to target the treatment. Sever et al. (2007) found that intensively targeted baiting could reduce German cockroach populations by 99 to 100% in 30 cockroach infested homes in North Carolina over the course of a year. There were significant reductions in cockroach allergens. Average concentrations were reduced 91% in kitchens,



A sticky trap full of cockroaches

Photo courtesy Woodstream Inc.

89.6% in living rooms, 82% on bedroom floors and 36% on the beds.

Though baits were the only active treatment, an important component was the monitoring traps. When 30 other homes were treated by professional pest control companies using baits and sprays, but without monitoring traps to target placement, allergen levels were not reduced and cockroach reductions ranged from 63% in the bedrooms to 81% in living rooms and kitchens.

Wang and Bennett (2006) compared IPM versus targeted baiting in 66 apartments over a 7 month period. IPM included an initial cleanout by flushing with pyrethrins and vacuuming followed by baits and monitoring with sticky traps. Residents were educated about roach biology and sanitation. Efficacy was checked with sticky traps six times over the 29 week period.

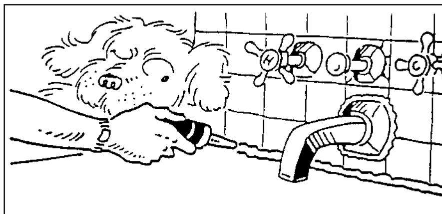
After 16 weeks there was a 100% reduction of cockroaches in the IPM apartments and 94.6% reduction in the bait only units. At the end of the study, 16% of the IPM apartments and 28% of the bait only apartments still had a few cockroaches. Average IPM costs for each apartment for 7 months were $64.8 ($9.26/month) and for bait only $35 ($5/month). IPM costs were initially higher, but at the end of the study costs were less, because less bait was needed (see Costs of IPM below).

Cockroach IPM in Schools

Cockroaches are more of a problem in homes than schools. However, children spend up to one-third of their time in school situations. Surveys have shown the presence of cockroach allergens in schools, especially in food production areas (Tranter 2005). One study found cockroach allergens in 71% of the dust samples and in 95% of the classrooms on at least one occasion (Chew et al. 2005).

Williams et al. (2005) found that an IPM program of monitoring and baits was just as effective as a conventional program of calendar sprays of the organophosphate propetamphos. Calendar sprays were often applied when they were not needed, and residues were found in non-target areas. The IPM program used 1000 times less pesticide. The overall infestation rate was very low, only 23 of 354 sticky traps showed cockroaches over a 12 month period. Costs of the IPM program ($8.57/treatment) and the conventional program ($7.49/treatment) were similar.

Nalyanya et al. (2009) found that IPM methods applied in a school situation reduced monitoring trap catches of German cockroaches to zero. IPM methods included monitoring, remediation of conducive conditions, and application of baits plus occasional crack and crevice aerosols. Conventional methods involved monthly sprays of pesticides and monitoring with sticky traps to check effectiveness. Traps at conventional schools averaged about 83 cockroaches/trap/week.



Caulking and exclusion are part of cockroach IPM.

IPM methods also controlled cockroach allergens. Only 1.4% of settled dust samples from the IPM treatment showed concentrations above the threshold (Bla g 1>2U/g) known to trigger allergic sensitization. About 35% of the conventional samples were above the threshold, and 20% were above the morbidity threshold (Bla g 1>8U/g) known to trigger asthma attacks.

Cleaning or Pest Control?

Since many asthma attacks are caused by sensitization and exposure to cockroach allergens, it makes sense that removal of the allergens should mitigate the problem. Allergens can be removed by a combination of roach eradication and cleaning (Gore and Schal 2007). Cleaning should be helpful because allergens are destroyed by bleach (Chen and Eggleston 2001), but according to Adgate et al. (2008), education and cleaning by itself had little effect on cockroach allergen levels in low income inner city households in Minneapolis, MN. On the other hand, McConnell et al. (2003) found that cleaning alone could reduce allergen levels, but clearly if roaches are not eliminated, allergens will continue to accumulate.

So cockroach reduction must be part of any cockroach allergen reduction plan. Whether pest control by itself can do the job is an important question. Interventions involving professional cleaning and monitoring for allergen levels can be very expensive. So if pest control alone can eliminate both roaches and allergens, costs are substantially lower (Gore and Schal 2007).

Allergen Reduction—IPM and Cleaning

Peters et al. (2007) were able to reduce cockroach allergens levels in 39 kitchens in multiunit buildings by 71% (Bla g 1) and 86% (Bla g 2), but infestations were so intense they were not able to reduce levels below asthma trigger thresholds (Bla g 1>8U/g). Levels dropped for six months, then began to increase. IPM included education, caulking, monitoring and baits. Professional cleaning and mattress replacements were part of the intervention.

Eggleston et al. (1999) used baits and cleaning in 13 homes. Pest control efforts reduced roaches by more than 90% in five homes and eliminated them in eight. Bla g 1 levels were reduced by 78-93%, but were still above the morbidity threshold for asthma.

Arbes et al. (2003) combined cleaning and baits to reduce cockroaches and allergens in severely infested multiunit dwellings. Sticky traps showed initial average levels of about 137 cockroaches in kitchens and levels six months later were near zero. By six months, 6 of 16 homes had no cockroaches. Allergens were reduced by 96% in the kitchens, and 83-84% elsewhere. Levels in beds were reduced below sensitivity levels (Bla g 1>2U/g).

Combined cleaning and pest control efforts cost about $2900 per home. Even though this amount is cost effective when compared to the average cost of asthma hospitalization of about $3100, it is rather expensive (Weiss and Sullivan 2001). This experiment shows the importance of IPM. Wang and

Bennett (2009) were able to use IPM methods alone to reduce allergens below morbidity thresholds—a 92% reduction—for about $7.5 dollars per apartment per month.

One Time IPM Intervention

In a number of high rises and townhouses in New York City, half the apartments in each building were selected for treatment. Researchers were able to recruit 63% (323) of these apartments for the study. At least 90% of these

Box A. Cockroach Allergens and Asthma

Cockroach allergens are proteins produced by cockroaches. The proteins are associated with digestion, reproduction, and metabolic inactivation of toxins and pesticides. A cockroach allergen is identified by using abbreviated Latin cockroach names combined with a number. For instance, a major allergen produced by the German cockroach, **Bla**ttella **g**ermanica, is Bla g 1. This protein is produced in the midgut, and it probably helps with digestion. The allergen is eliminated in roach feces. The more the roaches eat, the more of this allergen is produced. Bla g 2 is also associated with cockroach digestion.

Sublethal encounters with pesticides can lead to insecticide resistance, and the roaches' revenge—increased allergen production. The allergen Bla g 5 is produced when a cockroach encounters a pesticide. The more pesticides are used ineffectively, the more of this allergen is produced. And sublethal doses of boric acid can lead to increased production of Bla g 2 (Gore and Schal 2007; Zhang et al. 2005)

Allergens are collected by vacuuming up settled dust samples, by sampling the air, or by swabbing surfaces. Allergens are identified by standard antibody tests such as ELISA (Enzyme Linked Immunosorbent Assay). Settled dust samples are most commonly chosen for assay. Concentration thresholds are associated with cockroach allergens in dust samples. Levels of Bla g 1 above 2 units per gram of dust (Bla g 1>2U/g) are likely to cause allergic sensitivity. Levels above 8 units per gram (Bla g 1>8U/g) are likely to trigger an asthmatic attack in a sensitized individual (Gore and Schal 2007).

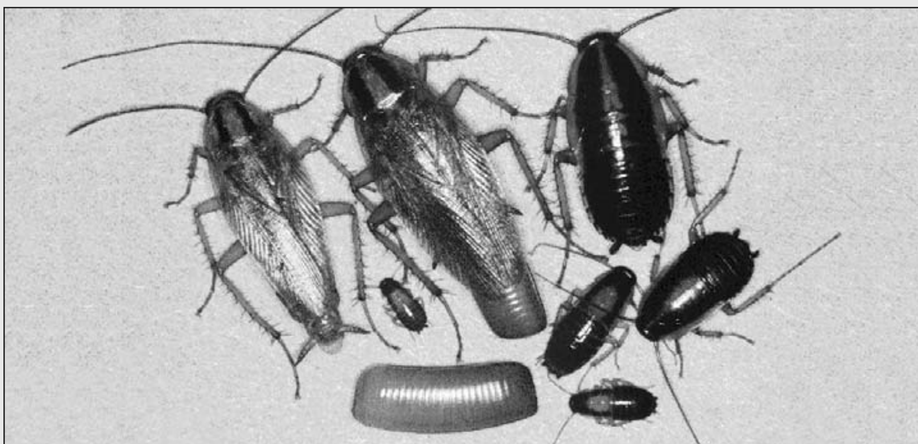


Photo courtesy University of Nebraska

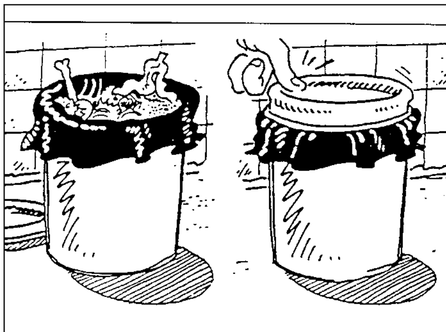
The German cockroach, *Blattella germanica*. On the left is an adult male, the large roach immediately to the right is a female. At the bottom is an egg case. The other roaches are immature stages, or nymphs.

A representative sampling of U.S. homes found detectable levels of cockroach allergens in 63% of them, and about 13% of U.S. homes had cockroach allergen levels above the allergic sensitization thresholds (Bla g 1 >2U/g) (Cohn et al. 2006). Kitchen floors had the highest concentration, with 10% having levels above the asthma morbidity threshold (Bla g l>8U/g). About 11% of living room floors had concentrations above the sensitivity threshold (2U/g), and 3% were above the morbidity threshold (8U/g)(Cohn et al. 2006).

Do Cockroaches Cause Asthma?

The association between allergy and cockroaches has been known for about 50 years (Bernton and Brown 1964). Within the last 15 years, cockroaches have been identified as one of the major causes of childhood asthma in U.S. inner cities. Rosenstreich et al. (1997) studied 1528 asthmatic children in inner city urban areas. About 50% of them had bedrooms with levels of cockroach antigens above the asthma morbidity thresholds (Bla g 1 >8U/g). Skin tests showed that 36.8% of the children were allergic to cockroaches. Asthma hospitalization rates were 3.4 times higher for those that were both sensitive and exposed. Sensitive children exposed to levels above the morbidity threshold had 78% more unscheduled visits to doctors, more days of wheezing, and more days of lost school time.

Similarly, 937 asthmatic children from 7 cities were enrolled in the Inner City Asthma Study. About 39.5% had cockroach allergen levels above sensitivity thresholds (Bla g 1 >2U/g) on their bed or in the bedroom. Skin tests showed 68.6% were sensitive to cockroach allergen. Cockroach sensitivity was highest in New York (81%). Positive skin tests were correlated with allergen exposure. Cockroach exposure was the most important cause of asthma, and "children who were allergic to cockroaches and exposed to cockroach allergen had more asthma symptoms, more school days missed because of asthma, and more unscheduled [clinic and emergency room] visits for asthma than children in the other categories of exposure and sensitization" (Gruchalla et al. 2005) apartments were infested with cockroaches, and tenants had been using various sprays and pest products for control. Apartments were either given one intensive 8-12 hr IPM treatment involving cleaning, caulking, baits, or the unit received conventional quarterly treatments involving kitchen baseboard sprays of pyrethroids. IPM units were also



Sanitation is an important part of cockroach IPM.

supplied with cleaning supplies and garbage containers with tight fitting lids.

Results showed that one IPM intervention led to an 88% reduction in cockroaches and a 41% reduction in pesticide spray use by tenants six months later. Compared to conventional treatments, IPM cockroach populations were 43% lower at three months and 14% lower at six months. Cockroach allergens in IPM bedrooms and kitchens were significantly lower six months later compared to conventional treatments. Residents of IPM apartments rated building services more positively (Kass et al. 2009).

Does Cockroach Control by Itself Reduce Allergens?

Whether or not cockroach elimination alone is effective at reducing allergens may depend on the intensity of the eradication efforts, whether IPM methods are used, and whether or not treatments are targeted. One important study was the National Cooperative Inner City Asthma Study (NCICAS). NCICAS reported no allergen reduction with pest control, but treatments consisted only of two kitchen applications of abamectin (Avert®) along with similar applications in other areas where heavy cockroach infestations were sighted. The two treatments were four weeks apart, and no attempt was made to monitor cockroaches or target pesticides. Presumably, treatments reflected conventional pest control, not IPM, and methods were essentially “the usual and customary practice of pest control technicians working in the NCICAS cities” (Gergen et al. 1999). Williams et al. (1999) found that cockroach elimination with hydramethylnon bait stations reduced Bla g 1 levels after about six months, but Bla g 2 was unaffected.

Arbes et al. (2004) used targeted baits and monitoring to reduce cockroach and allergen levels. An earlier study (Arbes et al. 2003) had shown that pest control plus cleaning reduced cockroaches to near zero and allergens were reduced by about 80-90% within six months in 16 heavily infested apartments of multiunit buildings in North Carolina.

After six months, previously untreated apartments were added to the study. Both the original and the newly added units were treated at that time with targeted baits. All units were treated again with targeted baits three months later. At the end of 12 months, allergen levels in the two sets of homes were not significantly different. Bla 1 g levels were reduced below the asthma morbidity levels (8U/g) in all areas except the kitchen floor. Beds had levels below the sensitivity threshold (Bla g 1>2U/g). These studies (Arbes et al. 2003; 2004) seem to suggest that targeted baiting and monitoring and competent professional pest control may be enough to reduce cockroach allergens below asthma risk levels.

Sever et al. (2007) showed that monitoring and cockroach baits reduced cockroaches by 99%. Allergens were reduced by 91% in kitchens; 89.6% living rooms, 82.2% bedroom floors; 36% on beds with no other intervention necessary. All treatments were in multiunit dwellings and 50-1000 cockroaches/home were trapped over three days at the start of the study.

Does Allergen Reduction Stop Cockroach Induced Asthma?

Clearly cockroach allergen concentrations are correlated with allergic sensitivity and asthma (Rosenstreich et al. 1997; Gruchalla et al. 2005), but can intervention to reduce concentrations lead to reduction of asthma symptoms? Many experiments reviewed here were concentrating on the first step, actually reducing cockroaches and allergen levels. There are fewer studies establishing the relationship between interventions and asthma levels. However, the Inner City Asthma study showed that “allergen levels can be successfully reduced in the homes of inner-city children with allergic asthma and that this reduction is associated with a decrease in asthma related morbidity” (Morgan et al. 2004). Future studies will probably find similar results.

Costs of IPM

Costs of IPM greatly depend on time needed for treatment. A complete program takes more time than partial programs. In one quick or partial IPM program, there was an initial clean out in each apartment that took about 12 minutes. After that, treatment was targeted baits. Averaged over the whole year, each IPM treatment took about 3 minutes, about $3.08 per treatment. Even this level of IPM effort brought results. Roaches were reduced by 84% (Miller and Meek 2004). The IPM program described by Wang and Bennett (2009) took on average about 15.5 minutes per treatment. Average costs were $18.6/treatment or about $7.5 per apartment per month. Roaches were reduced by 99.6%. and the number of roach infested apartments decreased by 74%.

Estimated costs for IPM vary due to the scope of services and region of the country. A major cost of IPM is labor, and this can vary extremely. Also, the definition of an IPM service can influence cost. For instance, in North Carolina schools, IPM treatments were defined as monitoring plus baits. The average cost of this was $8.57 per service, starting when the PMP walked in and ending when the PMP walked out. Cost of conventional service, which involved spraying with the organophosphate propetamphos was $7.49. Similar efficacy was seen with each method, but the IPM service used 1000x less pesticide active ingredient (Williams et al. 2005). Rambo (1998) estimated contract costs of IPM at $80/hr and conventional service at $65/hr.

A full-scale IPM treatment in New York City involved 8-12 hours of cleaning, caulking, and applying baits, followed by monitoring. No estimated costs were given, but six months later the one-time intervention was still more effective than ongoing conventional treatments (Kass et al. 2009). Sever et al. (2007) showed that targeted baiting and monitoring alone reduced cockroaches by 99%, and costs per apartment were $281/year ($23.4/mo). Conventional methods cost $475/year ($39.6/mo), which was almost twice as much, and reduced cockroaches by only 63 to 81%.

Wang and Bennett (2006) found IPM costs of $64.8/unit/7 mo ($9.26/mo) and bait-only costs of $35/unit/7mo ($5/mo). IPM costs were higher initially due to initial cleanout costs. When apartments were grossly infested, costs were driven higher. One IPM apartment needed $233 worth of work.

Brenner et al. (2003) found that IPM costs for the first year were $46-$69/unit ($3.8-$5.75/mo). For following years estimates were $24/unit ($2/mo), which was the cost of conventional pest control.

If IPM is so Good, Why Doesn't Everybody Do It?

A number of studies have now shown that IPM methods can reduce cockroaches, allergens, and pesticides (Wang and Bennett 2009; Kass et al. 2009; Greene and Breisch 2002). Since this is true, why isn't the method applied more often? Costs are one of the arguments against IPM, but well executed studies have shown that there may be no cost difference in the long run (Williams et al. 2005; Brenner et al. 2003; Miller and Meek 2004). If partial IPM programs are used, costs may even be less (Sever et al. 2007). Unfortunately, the problem may be that many PMPs are stuck in a calendar spray business model. They are making money with business as usual, and they may be unable or unwilling to sell IPM methods to their customers (Quarles et al. 2002). Another problem is that there is no universal agreement among PMPs about what IPM means. In North Carolina 89% of the companies with school contracts said they used IPM. However, 75% of the companies actually used calendar applications of pesticides (Nalyana et al. 2005).

Photo courtesy of Pestec and Finger Design

Carlos Agurto of Pestec IPM places a sticky trap.

Hidden Costs

And even though the long range costs of IPM can be competitive, landlords may refuse to pay the higher initial cost. They may choose to pay $2/month for ineffective pest control rather than $7.5/month to get rid of roaches because they do not have to confront the hidden costs. Ineffective sprays may be worse than no treatment at all because tenants are unnecessarily exposed to pesticide residues, and roaches exposed to sublethal pesticides secrete larger amounts of allergens. If landlords had to bear the added costs of asthma hospitalizations and deaths, they would probably choose the more effective program (Miller and Meek 2004; Wang and Bennett 2009; Weiss and Sullivan 2001). Annual costs of asthma in the U.S. are $12.7 billion (Gore and Schal 2007; Wang et al. 2008).

According to Miller and Meek (2004), "the most important requirement for making IPM a practical method of pest control would be a policy change on the part of public housing." Pest control contracts are awarded to the lowest bidder. "The responsibility of cockroach control then becomes the purview of the pest management company." The situation could be changed by setting efficacy standards in contracts or by requiring that companies have IPM training and certification (Quarles 2009; Gore and Schal 2007).

Conclusion

IPM methods can reduce pesticides, effectively control roaches, and reduce cockroach allergen levels. Pest management professionals (PMPs) have trying to convert to IPM methods for cockroaches since the 1990s. Conventional methods are still used because initially they may cost less, and PMPs may be unable to sell a more effective, slightly more expensive solution. Change could come if efficacy standards are made part of pest management contracts. Since cockroaches can trigger expensive, debilitating or deadly asthma attacks, ineffective pest control is potentially a source of liability for both a landlord and a pest management company.

Update

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Purified Cedar Oil Stops Ticks

Ticks carry pathogens and cause Lyme disease. A number of IPM solutions for ticks are available, including habitat modification, personal protection, and bait stations that reduce tick populations on deer and mice. There is a market for a natural product that could help with direct tick suppression. Previous studies have shown that cedar oil is effective. Now researchers have found the purified cedar oil is even more effective. Field tests with a backpack sprayer show that 2% sprays of the cedar oil component, nootkatone, knocks populations of the Lyme disease tick, *Ixodes scapularis*, in half for 28 days. When a high pressure sprayer is used, there is more than 96% suppression of the nymphal tick population for 42 days.

Dorlan, M.C., R.A. Jordan, T.L. Schultz et al. 2009. Ability of two natural products, nootkatone and carvacrol to suppress *Ixodes scapularis* and *Amblyomma americanum* (Acari: Ixodidae) in a Lyme disease endemic area of New Jersey. *J. Econ. Entomol.* 102(6):2316-2324.

Tick and Mosquito Repellents

Recognizing the public health importance of tick and mosquito repellents, the EPA has established a webpage containing information on these products. Information includes the most effective repellents available, whether they are tick or mosquito repellents, a list of commercial formulations, and duration of effectiveness for each application. The URL is http://www.epa.gov/pesticides/health/mosquitoes/insectrp.htm

EPA Moves to Disclose Inert Ingredients

Pesticides contain active ingredients and inert ingredients. The inert ingredients may actually have toxicity, but EPA does not currently require that inerts be part of pesticide labels. On December 22, 2009, the EPA asked for "public comment on options for disclosing inert ingredients in pesticides." EPA's Advanced Notice of Proposed Rulemaking was published in the Federal Register on December 23, 2009. Comments were accepted through April 23, 2010, and now the EPA is working on a Final Rule to list inerts on pesticide labels. The URL for further information is http://www.epa.gov/opprd001/inerts

Repellents for the Japanese Beetle

Forty-one plant essential oils were tested under field conditions as repellents for the Japanese beetle, *Popillia japonica*. Anise, bergamot mint, cedarleaf, dalmation sage, tarragon and wormwood oils repelled Japanese beetles. But the two most effective repellents tested were wintergreen and peppermint oils. Oil of wintergreen, methyl salicylate, has the added feature that it attracts beneficial insects such as lacewings and lady beetles. It is sold commercially in a controlled release formulation called Pred A Lure®. A mixture of wintergreen and ginger oil was the most effective repellent tested.

Youssef, N.N., J.B. Oliver, C.M. Ranger et al. 2009. Field evaluation of essential oils for reducing attraction by the Japanese beetle (Coleoptera: Scarabaeidae). *J. Econ. Entomol.* 102(4):1551-1558.

Field Test of Thrips Attractant

Previous research has shown that nicotine esters are attractive to thrips. These esters are effective lures for western flower thrips, *Frankliniella occidentalis*, in commercial greenhouse pepper crops. This experiment tested attraction for thrips in a commercial onion crop. Traps baited with ethyl isonicotinate caught 18x more onion thrips, *Thrips tabaci*, than traps without the lure. The lure also caught 10x more *Thrips obscuratus* than unbaited traps.

Davidson, M.M., R.C. Butler and D.A.J. Teulon. 2009. Pyridine compounds increase thrips (Thysanoptera: Thripidae) trap capture in an onion crop. *J. Econ. Entomol.* 102(4):1468-1471.

Testing Starts on Endocrine Disruptors

After several years of delay, the EPA has finally starting testing for endocrine disruption effects of pesticides. Initially, 67 active ingredient chemicals will be screened. Progress on testing and further information can be tracked at the following URL: http://www.epa.gov/endo/

Healthy Schools Act of 2010

In California, on February 18, 2010, the Healthy Schools Act, SB 1157 was introduced into the California Senate. The Act would ban the use of the most highly toxic pesticides in California schools. Among those banned would be organophosphates, carcinogens, and those that cause reproductive harm, birth defects, and developmental harm. If the Bill passes, it will likely trigger similar laws throughout the U.S.

Imidacloprid and Honey Bee Colony Collapse

Imidacloprid seed treatment produces plants that secrete the pesticide in pollen and nectar. The pollen and nectar contains sublethal amounts that may contribute to honey bee colony collapse disorder (see *IPMP* Sept/Oct 2008). Italian researchers have now found that sap secreted from leaves of treated corn plants is lethal to honey bees for a period of about 3 weeks. Amounts of pesticide in the sap can be hundreds of times larger than that found in pollen and nectar. In the absence of adequate drinking water in the fields, bees would be exposed to these lethal droplets.

Girolami, V. et al. 2009. Translocation of neonicotinoid insecticides from coated seeds to seedling guttation drops: a novel way of intoxication for bees. *J. Econ. Entomol.* 102(5):1808-1815.

Conference Notes

ESA 2008 Annual Meeting Highlights—Final Installment

By Joel Grossman

These Conference Highlights are from the Nov. 16-19, 2008, Entomological Society of America (ESA) annual meeting in Reno, Nevada. ESA's latest meeting was December 13-16, 2009, in Indianapolis, Indiana. Highlights from that meeting will appear in the IPM Practitioner later in 2010. For more information contact the ESA (10001 Derekwood Lane, Suite 100, Lanham, MD 20706; 301/731-4535; http://www.entsoc.org

Fungal Fly Control

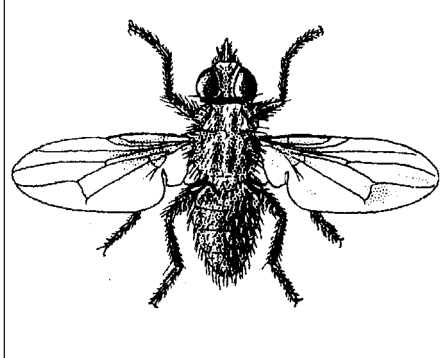
"*Beauveria bassiana* (strain GHA) and *Metarhizium anisopliae* (strain F52) appear to be pathogenic to adult horn flies, *Haematobia irritans*, within relatively short periods of time," said Kimberly Lohmeyer (USDA-ARS, 2700 Fredericksburg Rd, Kerrville, TX 78029; kim.lohmeyer@ ars.usda.gov). *Metarhizium anisopliae* (strain F52) killed 9.3% of adult horn flies in 3 days; 64% in 4 days; and 100% in 5 days. *Beauveria bassiana* (strain GHA) was equally effective and fast-acting against adult horn flies.

"Both of these fungi may be potential alternatives to traditional insecticide control tactics," said Lohmeyer. "Use of *Beauveria bassiana* and *Metarhizium anisopliae* in dust bags or back rubbers for treatment of horn flies on cattle in the field needs to be evaluated."

Emerald Ash Borer Biocontrol

"The emerald ash borer (EAB), *Agrilus planipennis*, was first discovered in 2002 near Detroit, MI, probably arriving in solid packing materials on cargo ships arriving from Asia," said John Vandenberg (USDA-ARS, Tower Rd, Cornell Univ, Ithaca, NY 14853; jdv3@cornell.edu). EAB has since spread over much of the Northeast, killing 25 million ash trees, *Fraxinus* spp. Adult beetles feed only on foliage but the key damage is inflicted by larvae feeding on the inner bark of ash trees. Tunneling by a sufficiently high number of larvae effectively girdles the tree, resulting in death.

According to Andrew Tluczek (Michigan State Univ, 243 Nat Sci Bldg, East Circle Dr, East Lansing, MI 48824; tluczek@msu.edu), woodpeckers are the most important biocontrol, causing about 30% EAB larval mortality. However, other biocontrols are being sought.



Horn fly, *Haematobia irritans*

According to George Kyei-Poku (Great Lakes Forestry Centre, 1219 Queen St East, Sault Ste. Marie, ON, Canada P6A 2E5; gkyeipok@nrcan.gc.ca), "eradication of this exotic pest is no longer practical and efforts to prevent its spread may be too late to be effective," and EAB "control strategies are now shifting to how we can manage established populations in the longer term," particularly with microbes for biocontrol. The most common microbial natural enemies of EAB in Ontario, Canada are the fungi *Beauveria bassiana, Lecanicillium lecanii, Metarhizium anisopliae, Paecilomyces* sp. and a *Steinernema* nematode.

Indigenous strains of *B. bassiana* in Michigan are effective. According to Louela Castrillo (Cornell Univ, Ithaca, NY 14853; lac48@cornell.edu), "Bioassay studies confirm pathogenicity," and "these data show that there are indigenous *B. bassiana* isolates in MI virulent against EAB and have potential as biological control agents."

Vandenberg et al. tried sprays of the commercial microbial, *Beauveria bassiana* strain GHA. This formulation was sprayed onto canopies and tree trunks at a Michigan ash nursery to combat EAB. *B. bassiana* multiplied in the field, infected and killed EAB. "These results suggest that preemergent sprays on ash trunks could be a practical means to target adults during emergence or oviposition," said Vandenberg.

Rhizobia Suppress Soy Aphids

"Soybeans commonly interact both with rhizobia from commercial inoculants applied by growers and with rhizobia strains occurring naturally in the soil," said Beth Irwin (Pennsylvania State Univ, 538 Ag Sci & Industries Bldg, University Park, PA 16802; bai107@psu.edu). "We recently found that rhizobia, *Bradyrhizobium* spp., in addition to providing nitrogen in a form usable by plants, can confer enhanced resistance against phloem-feeding herbivores and that the strength of resistance conferred varies among rhizobia strains."

Tree of Heaven, Insect Hell

Leaf tissue of tree of heaven, *Ailanthus altissima*, has "anti-herbivory properties" against larval fall webworm, *Hyphantria cunea*, a generalist herbivore feeding on a wide variety of deciduous trees, said Amanda Ritz (Millersville Univ, PO Box 1002, Millersville, PA 17551; amanda.ritz@gmail.com). In choice experiments, as well as forced feeding trials, tree of heaven water or

Conference Notes

methanol leaf extracts applied to leaves of other trees produced feeding deterrence and mortality. However, timing is important, as young webworm instars are very susceptible, and last instar larvae are "highly resistant."

Japanese Beetle Biocontrol Wasps

"During the 1920s and early 1930s USDA entomologists imported *Tiphia vernalis* from Korea and *Tiphia popilliavora* from Japan for Japanese beetle control," said Ana Legrand (Univ of Connecticut, 1376 Storrs Rd. U-4067, Storrs, CT 06269; ana.legrand@uconn.edu). Originally released from 1921 to 1949, the parasitoids are established in Connecticut and parasitize Oriental and Japanese beetles.

Public park and golf course surveys in 2007 and 2008 involved "digging out white grubs at sample points along a transect" in the counties where *Tiphia* were originally released between 1921 and 1949. "Larvae collected during the survey were from European chafers, Asiatic garden beetles, Japanese and Oriental beetles," said Legrand. Both *Tiphia popilliavora* and *T. vernalis* are attracted to turf sprayed with sugar water. So, a 10% sugar water solution "was sprayed on 4x6 areas marked on the turfgrass and on shrubs adjacent to large turfgrass areas," and after 30 minutes sugar-water spray sites were surveyed for *Tiphia*.

"As expected, only the Japanese beetle and Oriental beetle larvae were parasitized by *T. vernalis*," said Legrand. Oriental beetle parasitism rates ranged from 0% to 33%. Japanese beetle parasitism rates ranged from 0% to 100% at the various survey sites. Hence, "*T. vernalis* can be a significant source of mortality...and should be integrated with other management tactics."

Golf Course Grub Biocontrol

White grub species feeding on grass roots into the fall months are Kentucky's top golf course pests, said Carl Redmond (S-225 Ag Sci Center North, Lexington, KY 40546; carl.redmond@uky.edu). Pesticide use is common, but controversial.

Kentucky's white grub problem is complex, as this is a transition zone for warm- and cool-season grasses. Fairways mix warm- and cool-season grasses; greens use cool-season grasses. Northern states are mainly plagued by Japanese beetles. But when Kentucky golf course supervisors were sent grub collection kits, the samples revealed a mix of 30% Japanese beetles and 65% masked chafers, *Cyclocephala* spp.

Masked chafer natural enemies in Kentucky golf turf include: *Tiphia* wasps; entomopathogenic nematodes; gregarines (protozoa); *Bacillus popilliae* (milky disease); *Serratia* (amber disease); and *Metarhizium* fungi. *Tiphia* parasitism was as high as 30% on chafers and 9.4% on Japanese beetles. Milky disease infections were as high as 20% for chafers and 26% for Japanese beetles.

Fertilizers and White Grub IPM

White grubs are the most damaging pests of turf, said Robert Williamson (Univ of Wisconsin, 246 Russell Lab, 1630 Linden Dr, Madison, WI 53706; rcwillie@entomology.wisc.edu). White grub pests vary by geographic region and include immatures of Japanese beetles, Asian garden beetles, Oriental beetles, green June beetles, European chafers and various masked chafers.

Vertebrate predators can do considerable damage to turf in the course of digging out grubs. White grub predators include skunks, raccoons, moles, deer, badgers and birds such as crows, grackles, and turkeys. Vertebrate deterrents that have been tried include Deer Stopper™, Deer Off™, mustard seed powder, garlic oil, hot pepper wax and animal fecal matter. Aromatics from organic fertilizers could potentially also deter vertebrate predators with their stench or aroma; though some animals, such as turkeys, are not deterred.

Calendar

May 11-13, 2010. IOBC Workshop, Biocontrol in the Americas, Niagra Falls. Contact: www.iobc-nrs.com/event_5-11-10.htm

July 1-3, 2010. 67th Annual Convention, Pest Control Operators of CA. Monterey, CA. Contact: www.pcoc.org

August 1-6, 2010. 95th Annual Ecological Society of America Conference. Pittsburg, PA. Contact: ESA, 1900 M St. NW, Suite 700, Washington, DC; 202/833-8773; esahq@esa.org

August 7-11, 2010. Annual Meeting American Phytopathological Society. Opryland, Nashville, TN. Contact: APS, 3340 Pilot Knob Rd., St. Paul, MN 55121; 651/454-7270; www.aps.net

September 17, 2010. Bay Friendly Landscape Conference. San Francisco, CA. Contact: Joanne Connelly, 510/207-8643; Joanne@bayfriendly-coalition.org.

October 15-17, 2010. 21st Annual Bioneers Conference. San Rafael, CA Contact: www.bioneers.org

October 19-22, 2010. Joint Meeting IOBC and Association Natural Biocontrol Producers (ANBP). Arthropod Rearing and Quality Assurance. Vienna, Austria. Contact: ANBP, www.anbp.org

October 20-23, 2010. Pestworld, Annual Meeting National Pest Management Association (NPMA), Honolulu, HI. Contact: NPMA, 10460 North St., Fairfax, VA 22031; 800/678-6722; www.npmapestworld.org

October 31-November 4, 2010. Annual Meeting Entomological Society of Canada, Vancouver, BC. Contact: Ento. Soc. Canada, www.esc-sec.ca

December 12-15, 2010. Entomological Society of America Annual Meeting, San Diego, CA. Contact: ESA, 9301 Annapolis Road, Lanham, MD 20706; Fax 301/731-4538; www.entsoc.org

January 26-29, 2011. 31th Annual Ecofarm Conference. Asilomar, CA. Contact: Ecological Farming Association, 406 Main St., Suite 313, Watsonville, CA 95076; 831/763-2111; www.eco-farm.org

February 24-26, 2011. 22nd Annual Moses Organic Farm Conference. La Crosse, WI. Contact: Moses, PO Box 339, Spring Valley, WI 54767; 715/778-5775; www.mosesorganic.org

Conference Notes

Spring and fall treatments of natural fertilizers doubling as vertebrate deterrents were tested at the Oconomowoc and Naga-waukee golf courses in Wisconsin. Greens Grade Milorganite (6-2-0) and Nature Safe (12-2-6) at varying rates were compared to untreated controls. Spring applications were effective for 28 days. Fall treatments were effective longer, in part perhaps because there were no irrigations and no rain to wash away aromatic compounds. Repeat applications may be needed for sustainability, depending on the grub populations. "The superintendent was just astonished" at the lack of vertebrate damage in treatment plots, versus the visible raccoon and skunk damage in the unfertilized areas, said Williamson.

Hemlock Woolly Adelgid Biocontrol

"Eastern hemlock, *Tsuga canadensis*, is a climax species capable of reaching 800 years in age and holds a crucial niche in the forest, especially riparian areas," said Jessica Holland (Univ of Georgia, 413 Biol Sci, Athens, GA 30602; jessdholland@gmail.com). The hemlock woolly adelgid (HWA), *Adelges tsugae*, has spread to 17 states since its 1951 eastern U.S. discovery. Reduced tree growth, needle loss and branch dieback escalate into eastern hemlock tree mortality in 4-8 years.

"A complex of natural enemies is needed for maintaining HWA populations at low levels preventing hemlock mortality," said Holland. Classical biological control of HWA with the Derodontidae beetle, *Laricobius nigrinus*, an abundant predator in the Pacific Northwest, has been complicated by high lab mass rearing mortalities that might be bypassed by releasing twigs with *L. nigrinus* eggs. "As a supplement to lab rearing, egg releases can allow more HWA predators to be reared and released overall."

In sleeve-cage field experiments, "releasing *L. nigrinus* eggs in late winter/early spring along the southern range of hemlock can increase survival because arthropod densities are generally lower and temperatures are more favorable for *L. nigrinus* survival," said Holland. In 2009, sleeve-cage forest trials will add the lady beetle, *Scymnus sinuanodulus*, to the natural enemy complex.

Mass Trapping Mosquitoes

According to Daniel Kline (USDA-ARS, 1600 SW 23rd Dr, Gainesville, FL 32608; dkline@gainesville.usda.ufl.edu), mass trapping for mosquitoes has its origins in the 1980s Zimbabwe Tsetse Project. Mass trapping black salt marsh mosquitoes, *Ochlerotatus taeniorhynchus*, meant ringing the perimeter of a village with carbon dioxide (CO_2) traps to intercept mosquitoes emerging from an adjacent salt marsh breeding site.

The first mosquito mass trapping in the U.S. was in Florida's relatively isolated and wealthy Key Island in 1994-95. Huge numbers of mosquitoes were caught and resort workers were "extremely happy" with the results.

By 1999 a wide variety of CO_2 traps were commercially available. At a Cedar Key island, Atsena Otie Key, propane combustion CO_2 traps baited with octenol were tested on 22 acres (8.9 ha). Mosquito reductions were so great that by 2004 the Mosquito Magnet Pro traps were being used with the small collection net rather than the larger collecting jar modifications needed in 2002. "Preliminary analyses indicates excellent sustained control," said Kline, noting that at the beginning every bit of exposed skin was covered with mosquitoes within 15 seconds. By the end of the experiment a grad student in shorts could walk the trail and get only three mosquito bites.

In more urban Gainesville neighborhoods, trapping success was moderate, only about a 50% reduction in mosquitoes. "One size does not fit all," said Kline, noting that the greater diversity of mosquito species in Gainesville made the trap developed in Atsena Otie for salt marsh mosquitoes insufficient.

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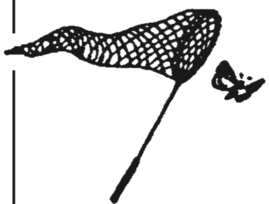

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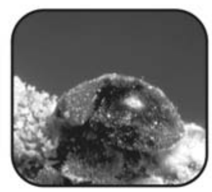

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