UC Research Update on **Bed Bug Monitors**

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Fig. 1. Examples of active (top) and passive (bottom) monitors.

Bed Bug Resurgence in the State

In case you haven't been paying attention, bed bugs are here in California. Regardless of public informational outlets: newspaper, Internet, television, radio and even chatter around the office water cooler, all say the same thing—that bed bugs are back and with a vengeance. Although pest control industry publications in California have also been reporting the growing bed bug problem (*PCOC Voice* articles in 2007 and 2010; *PCOC News Briefs* in 2010), much of the public is still in disbelief or denial. We are not alone in our bed bug problem and phobias associated with it. Nationally, the problem has been more severe and has resulted in the closing and evacuation of some department stores and hotels.

Why More Bed Bugs?

Researchers, PMPs and regulators are not in agreement on the exact causes for the recent bed bug resurgence. Debates on the current outbreak include the prevalence of cheap travel (especially from overseas), pesticide resistance and the public's apprehension on pesticides in their bedrooms. More recently, molecular genetics research from several East Coast university scientists theorized that bed netting impregnated with pesticides to protect US military personnel overseas may be the culprit for the widespread resistance and resurgence now being reported across the US. Undoubtedly, the debates on the origins of bed bugs in California and the nation will continue; however, all parties and stakeholders do agree that regardless of bed bug origins, something must be done to control them.

Board and Industry Proactive Response

Two decades ago the board, through PCOC and industry support, created a structural pest research fund. This industry self-tax was a proactive move to ensure that the industry would have a mechanism for product testing that was science-based, independent and unbiased. The amount of the tax is small—$2.50 per pesticide use report per company per county worked in each month—but can accumulate tens of thousands of dollars per year to use towards research considered important by the industry. This mechanism and process was utilized for the current bed bug resurgence, starting with an industry plea for research at a board meeting in January 2010. After board discussion, a request for proposals was authorized and finalized by the board for bed bug research in July 2010. That September, the Lewis laboratory submitted a research proposal featuring lab and field studies in the Villa Termiti on the performance of bed bug monitors. The board gave final approval of the research and contract in October and the Department of Pesticide Regulation and UC Berkeley finalized the contract for research on March 1, 2011. Work first began on the contract on April 1, 2011. Currently, the lab is 11 months into the research. A no-cost extension of four months ending June 30, 2012 was recently awarded to the Lewis laboratory.

Bed bugs are back and with a vengeance.

UC Berkeley Study

Initial UCB laboratory activities consisted of gathering monitors for testing. The lab has acquired (through donations) 10 different bed bug monitors. The monitors we currently have in our inventory include BB Alert® Active and BB Alert® Passive (MidMos Solutions Ltd., Brierly Hill, West Midlands, UK), Bed Bug Beacon (PackTite, Laporte, Colo.), Bed Bug Dome (Stern Environmental Group, LLC, Secaucus, N.J.), NightWatch™ (BioSensory,

Bed Bugs	Passive						Active						Grand Total
	Harborage		Other		Monitor		Harborage		Other		Monitor		
	F	M	F	M	F	M	F	M	F	M	F	M	
Fed	13	17	17	20	15	8	3	4	5	4	7	7	120
Starved	4	14	18	12	23	19	2	2	8	6	5	7	120
Grand Total	**17**	**31**	**35**	**32**	**38**	**27**	**5**	**6**	**13**	**10**	**12**	**14**	**240**

Table 1. Number of bed bugs (C. lectularius) in passive and active monitors for fed and starved females and males by location in testing chambers. Results for three passive and one active monitor are shown.

Inc., Putnam, Conn.), BB Catch™ (BioTrap™ Science, Portland, Ore.), Climbup® Insect Interceptor (Susan McKnight, Inc., Memphis, Tenn.), BDS™ Bedbug Detection System (Catchmaster™, AP&G Co., Inc., Brooklyn, N.Y.), First Response Bed Bug Monitor and First Response Bed Bug Trap (SpringStar, Inc., Woodinville, Wash.). The monitors are divided between passive (3), meaning they do not contain bed bug attractants, and active (7), claiming attractive capabilities for bed bugs (Fig. 1).

Regardless of bed bug origins, something must be done to control them.

We obtained bed bugs through a local supplier, Sierra Research Laboratories in Modesto, Calif. For my lab at the UC Richmond Field Station, we have established an insectary where live bed bug colonies are maintained. We currently have several hundred live bed bugs (Fig. 2). Since bed bugs require weekly feeding, we have developed an artificial feeding method for keeping our bed bugs alive and healthy. Our system involves the use of heated pork blood and a plastic membrane that allows bed bugs easy access to blood. We do not use human volunteers or live animals to feed our bed bug colonies. To ensure the safe handling of live bed bugs and to prevent their escape, they are maintained in shatterproof 8 oz. polystyrene jars (US Plastic Corp., Lima, Ohio) with screw top lids modified for feeding. Several pieces of rigid cardboard (3" by 4") were provisioned to each jar as harborages for bed bugs.

Fig. 2. Bed bug nymphs in colony.

Monitor Screening

Three large containment chambers have been built to screen monitor performance for bed bug foraging movement and behavior. The dimensions (lwh) of each testing chamber are 7' by 1' by 1' (Fig. 3). The vertical

walls are made of polycarbonate plastic and the bottom area is made of pine. To further ensure no bed bugs escape, the top three inches of the vertical plastic containment walls were treated with anti-crawling liquid material and to prevent other creatures from falling into the testing chambers the entire containment chamber is covered with screen netting. The laboratory screening trials are still in progress and involve putting five female and five male bed bugs at one side of each testing arena and placing a monitor at the opposing side. After acclimating overnight in their harborages, the bed bugs are released and allowed to move and forage all day, overnight and into the following day. During the two-day observation period, at least four visual observations are conducted, counting the number of bed bugs inside the harborage, inside the monitor and within the general testing chamber. Temperature at the time of observation is also recorded. All monitor assignments are random. Surfaces of the testing chambers are wiped down with 70 percent ethyl alcohol between monitor tests to minimize any lingering bed bug odors. The performance of monitors will be tested with both starved and fed bed bugs and all monitor testing combinations will be replicated at least three times.

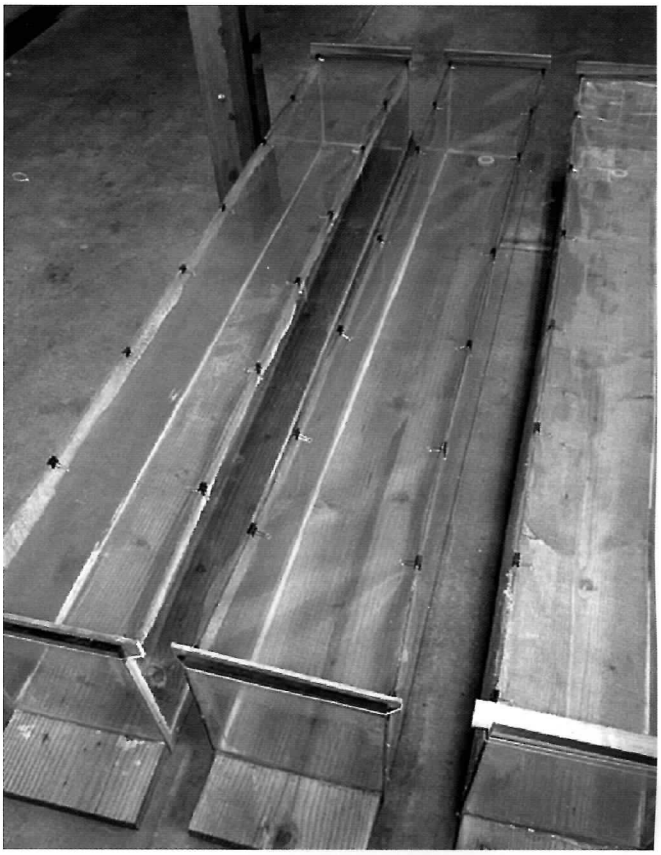

Fig. 3. Monitor testing chambers. Bed bugs placed at one end and monitors at the opposing end.

What We Know Thus Far

We have completed the screening of four monitors, including three passive and one active monitor, for both starved and fed bed bugs. Preliminary results obtained have been enlightening (Table 1). First, male and female bed bugs will move actively in test chambers during the day and even during the cooler months of fall and winter. There also appear to be sexual differences in movement response to monitors; the females show more inclination than males to explore test chambers and

inhabit monitors and when bed bugs are starved, more of both sexes were found outside of the harborage. On average, there was more bed bug dispersal from the harborage for the active monitor than the passive monitors tested. These observations fall in line with other published research that showed monitors with lures (heat, CO_2 or chemical attractants) resulted in greater numbers of females and males, especially for replications that involved starved individuals. Surprisingly, bed bugs were "away" from their harborages at least 66 percent of the time; roughly half of this "away" time was spent in the monitors.

Additional Planned Research

The Villa Termiti has been remodeled to accommodate the mass release of bed bugs for field testing of monitor performance. Currently, small furniture items and sticky barriers are being installed to ensure that the bed bugs will not escape during testing. Starting in February 2012, varying densities of five, 50 and 100 bed bugs will be released and their attraction toward and inhabitation of monitors will be measured. The data gathered from these investigations are important for creating population models to better gauge the performance or lack of performance of bed bug monitors when used under field conditions in the state. All data gathering and final report writing will be completed and submitted to the board by June 30, 2012.