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**Assessing the utility of the Bugo sticky traps in trapping the common bed bug (*Cimex lectularius* L.)**

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## Objectives:

1. To determine the efficiency of Bugo sticky traps in trapping various life stages of the bed bug.


2. Comparing the bed bug trapping efficiency of Bugo traps to other commercially available sticky traps.

## Methods:

***Test protocol:*** Bugo sticky traps and the Harris bed bug traps were assembled on carpet and wood surfaces as per the manufacturer's protocol (Figs. 1 and 2). For Harris traps, carpet or wood surfaces with traps were placed in square shaped Pyrex® glass dish (Fig. 2A). Thirty Harlan laboratory strain bed bugs (10 adults, 10 large nymphs and 10 small nymphs) held in a 35 x 15 mm plastic Petri dishes were released in the center/non-sticky portion of the Bugo traps. In case of the Harris traps, bed bugs held in Petri dishes were released on the carpet and wood substrates right next to the assembled Harris traps (Fig. 2A). Bed bugs used in these assays were fed with defibrinated rabbit blood three days before the test. Observations on number of bed bugs getting trapped on the Bugo and Harris traps were recorded at 1,2,3,4,5,10,15,30,45,60 and 120 min and then at 16, 20 and 24 hours after the assay start time. A total of three replicates were performed for each treatment (see below).

***Treatments (4 total):*** (1) Bugo carpet units (2) Bugo solid wood units (3) Harris traps placed on carpet **(4)** Harris traps placed on wood.

***Data analysis:*** Numerical data on number of bed bugs trapped on Bugo or Harris traps at various time points were transformed to percentage data and averaged across three replicates for each treatment. Analysis of variance (ANOVA) followed by a Tukey's means separation test (*P<0.05*) was then performed to determine the statistical difference in percentage of insects trapped between different treatments. The average percentage of bed bugs trapped over the 24 h assay period was calculated for different treatments by averaging the trap data from all

time points. Similar statistically analysis as explained above was then performed to determine the statistical significance of overall trap data. Percentage of insects confined by the Bugo traps to the release area were calculated for carpet and wood substrates and a paired t-test (*P< 0.05*) was performed to determine the statistical difference between the two treatments.

## Results and Discussion

Five minutes after releasing the bed bugs to the center (non-sticky portion) of the Bugo traps as many as 40% of the bed bugs were stuck to the inner edge of the Bugo traps on carpet (Figs. 3 and 4). At the same time point, 80% of the bed bugs released were trapped on the inner edge of the Bugo trap placed on wood surface (Figs. 3 and 4). In general, at various time points the wood units trapped significantly more bed bugs than the carpet units did (*P<0.05*; Tukey's test). The number of bed bugs trapped on the Bugo trap peaked at ~5 min (42% trapped) on carpet units and at 120 min and 16 h intervals (87 to 90% trapped) on wood units. Bed bugs released in the center of the Bugo trap attempted to walk on the trap almost immediately and were trapped instantaneously. However, most bed bugs (especially adults and large nymphs) trapped on the carpet units were able to pull themselves off the sticky portion of the Bugo traps (see video provided in the Report folder).

In case of the Harris traps placed of carpet substrate, none of the bed bugs were trapped/stuck on the sticky portion of the trap (Fig. 4). Some insects that were stuck to the sticky portion of the Harris trap were actually able to walk on the sticky surface and free themselves. The Harris traps placed on the wood substrate also performed poorly and trapping efficiency peaked at 5% or below that (Fig. 4). In some instances, bed bugs used non-sticky portion of the Harris traps as harborage.

Comparison of 24 h bed bug trapping efficiency between the four different treatments revealed that Bugo wood units trapped highest percentage of bed bugs followed by Bugo carpet units and the Harris traps placed on wood and carpet substrates were least effective (Fig. 5).

Ability of the Bugo carpet and wood units to act as a barrier for bed bug movement by either trapping or limiting them within the release area was also analyzed using the 0 to 24 h observation data (Fig. 6). Wood units served as effective barriers for bed bug movement either by trapping bed bugs or by limiting them to the release area. Carpet units also effectively limited bed bug movement, but some bed bugs (~10%) were able to escape by going deep down in the carpet and crawling under the Bugo traps. Although, the current data suggests potential of Bugo traps in limiting bed bug movement away from the infested furniture, these results are not realistic. Under field conditions bed bugs may have other avenues (other than furniture legs) to crawl away from the infested furniture such as contact between furniture and wall or bed linens, comforters/clothes on the furniture/bed touching the floor. The present data also does not depict the efficiency of bed bug traps in preventing bed bugs from walking on to an uninfested piece of furniture or bed. Long-duration (7-10 days) mock bed experiments will be required to ascertain the capability of Bugo traps in preventing bed bugs from climbing up on the legs of uninfested furniture and also ensuring their ability to escape from the infested furniture.

## Summary and Conclusions:

1. Bugo traps are more efficient than Harris traps in trapping bed bugs.

2. Wood units are more efficient than carpet units in trapping bed bugs (78% vs 34%) mainly because wood surface is more smooth than the carpet surface. Trapped bed bugs cannot easily free themselves or pull themselves off the traps when the substrate is relatively more smooth (e.g., wood surface).

3. Preliminary analysis shows that Bugo traps can keep bed bugs from leaving the infested furniture or bed by limiting their movement (through trapping and acting as a barrier). However, additional, long duration mock bed experiments will be required to confirm the potential of Bugo traps to act as barrier for bed bug movement both from the infested furniture to the outside and from the outside to the uninfested furniture.

**Figure 1:** Pictures showing experimental layout for Bugo carpet and wood units. (A) Depicts Bugo traps installed on wood and carpet substrates. (B and C) Shows bed bugs trapped/stuck on the inner edges on the Bugo wood and carpet units, respectively.
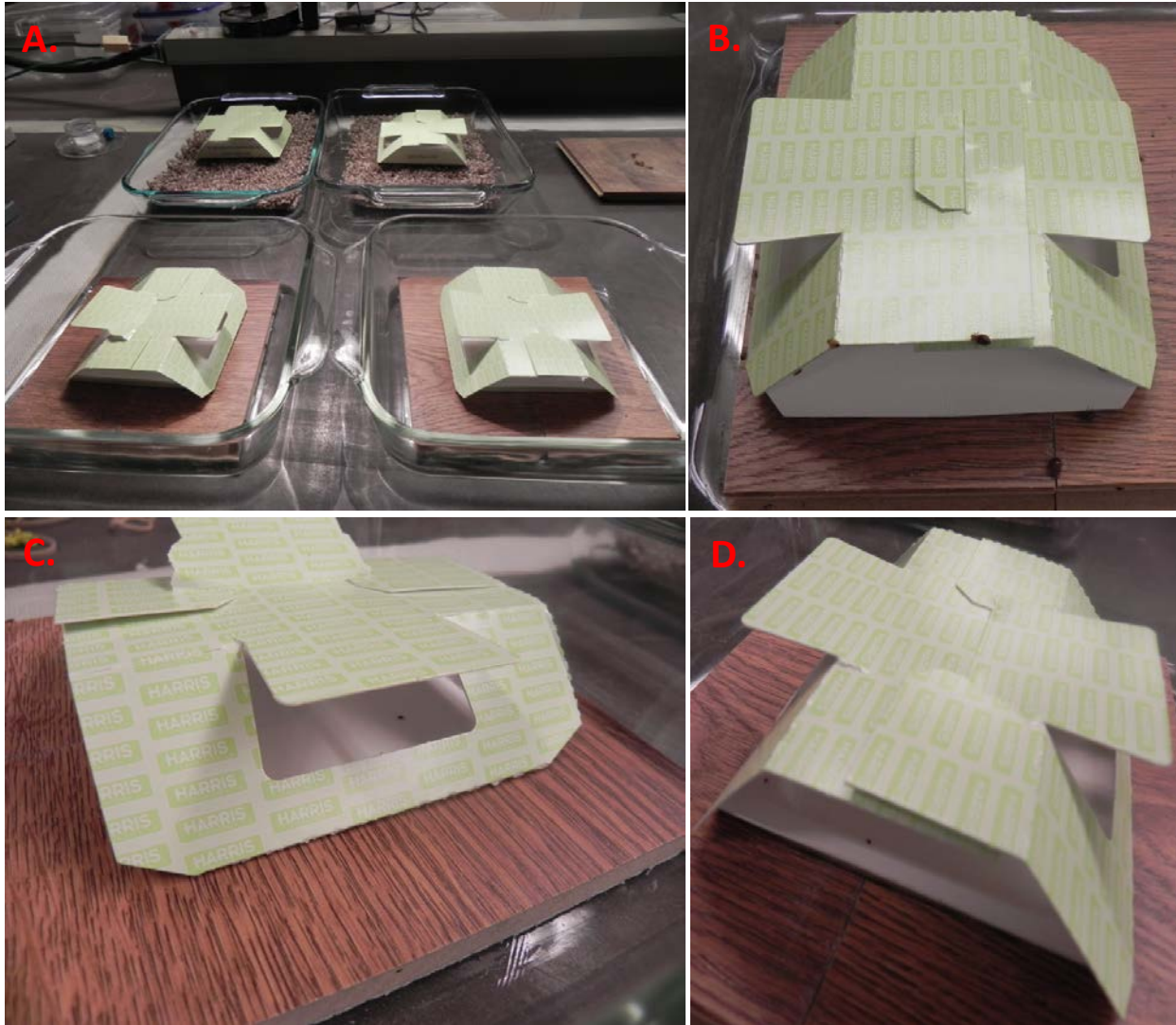
**Figure 2:** Overview of bioassay set-up for Harris bed bug traps. (A) Shows Harris traps on carpet and wood substrates. (B) Shows bed bugs crawling on the non-sticky portion of the Harris trap (Note: in some instances bed bugs harbored/aggregated on the non-sticky portion of the Harris traps). (C) and (D) Shows one and two bed bugs trapped on the sticky portion of the Harris trap, respectively.
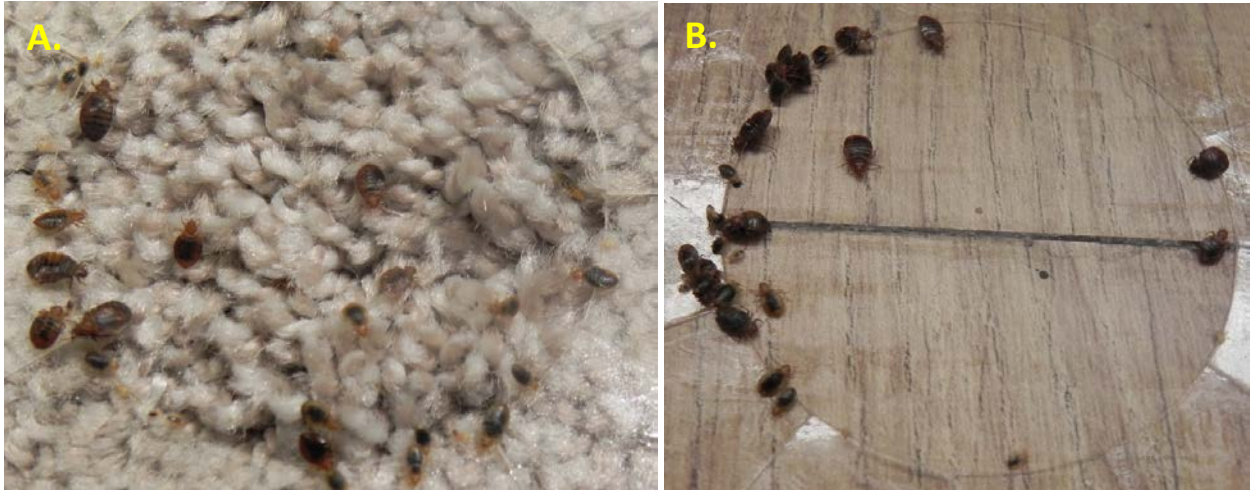
**Figure 3:** Bed bugs confined/ trapped or limited to the non-sticky or release area of the Bugo traps. (A) Carpet unit and (B) Wood unit.
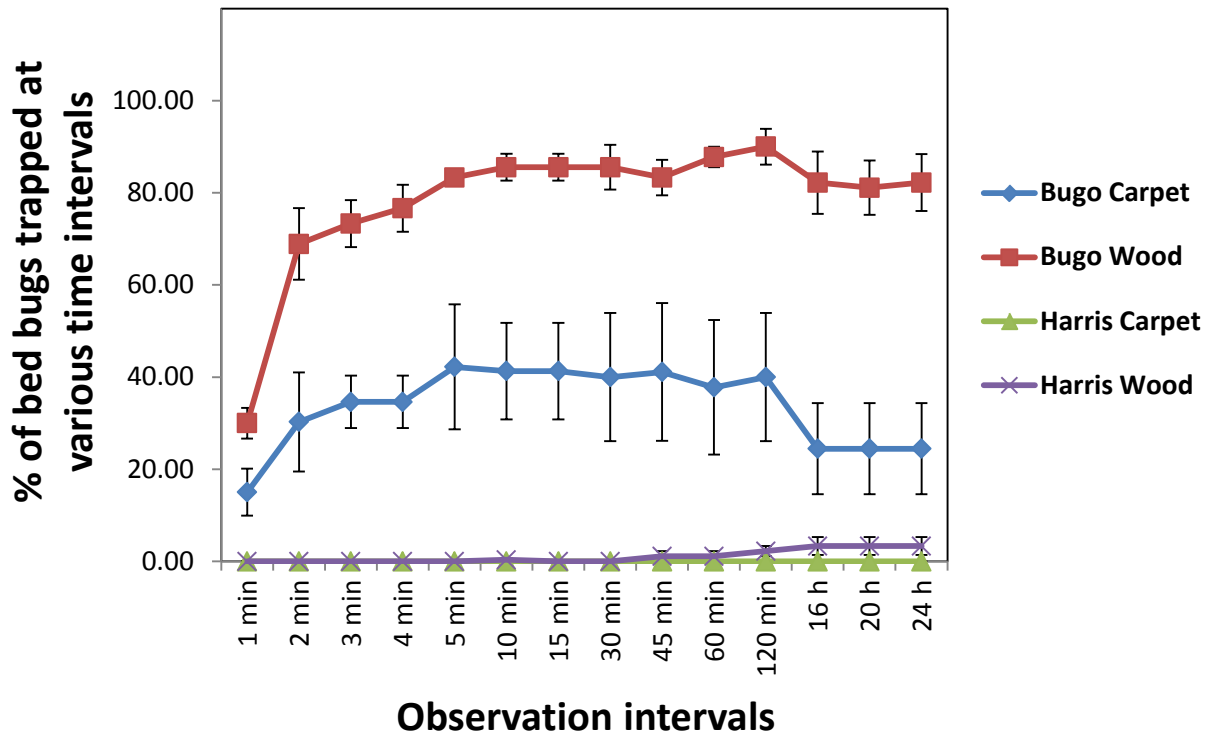
**Figure 4:** Bed bug trapping efficiency of Bugo and Harris traps on wood and carpet substrates. Bugo wood units (red line) trapped significantly higher bed bugs than the Bugo carpet units (blue line) (*P<0.05*). Both Bugo units (wood and carpet) trapped significantly more bed bugs than Harris traps placed on either wood (purple line) or carpet (green line) substrates (*P<0.05*). Error bars represent (±) standard error values.
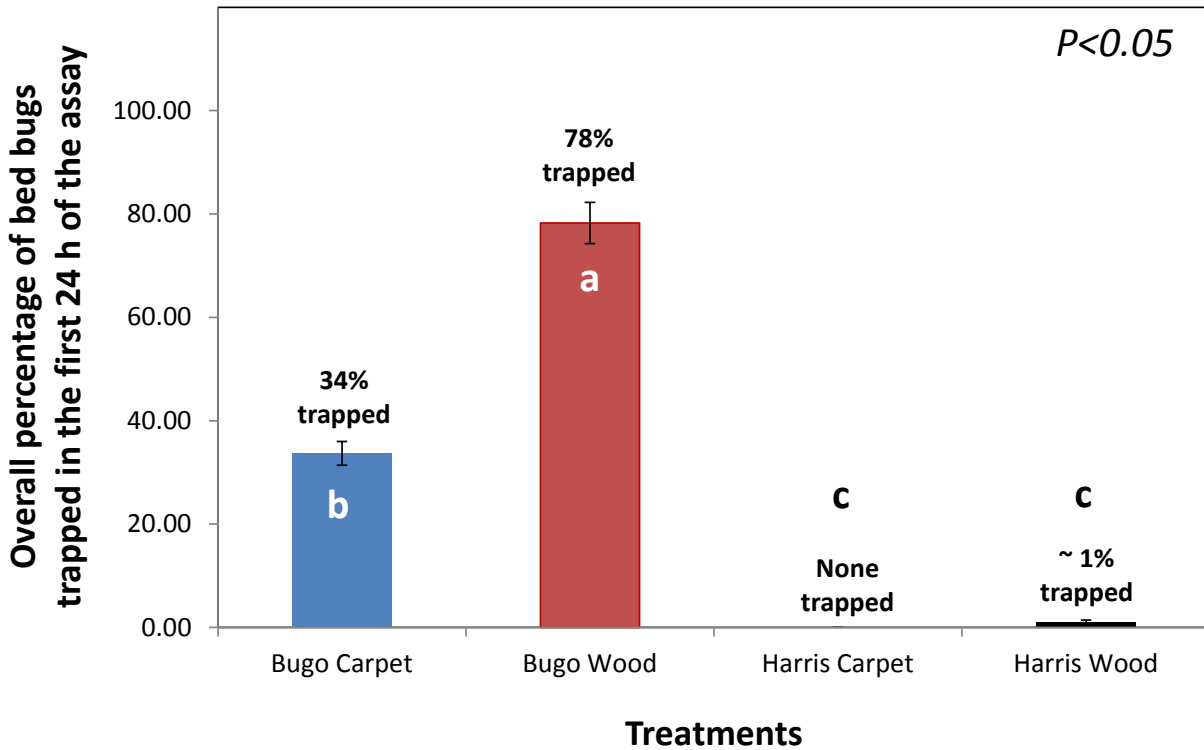
**Figure 5:** Average percentage of bed bugs trapped on Bugo and Harris traps during the first 24 h of the assay. As shown in the figure, Bugo wood units were more efficient in trapping bed bugs than the Bugo carpet units (*P<0.05*). Harris traps were least effective in trapping bed bugs. Bars connected with different letters are significantly different. Error bars represent (±) standard error values.
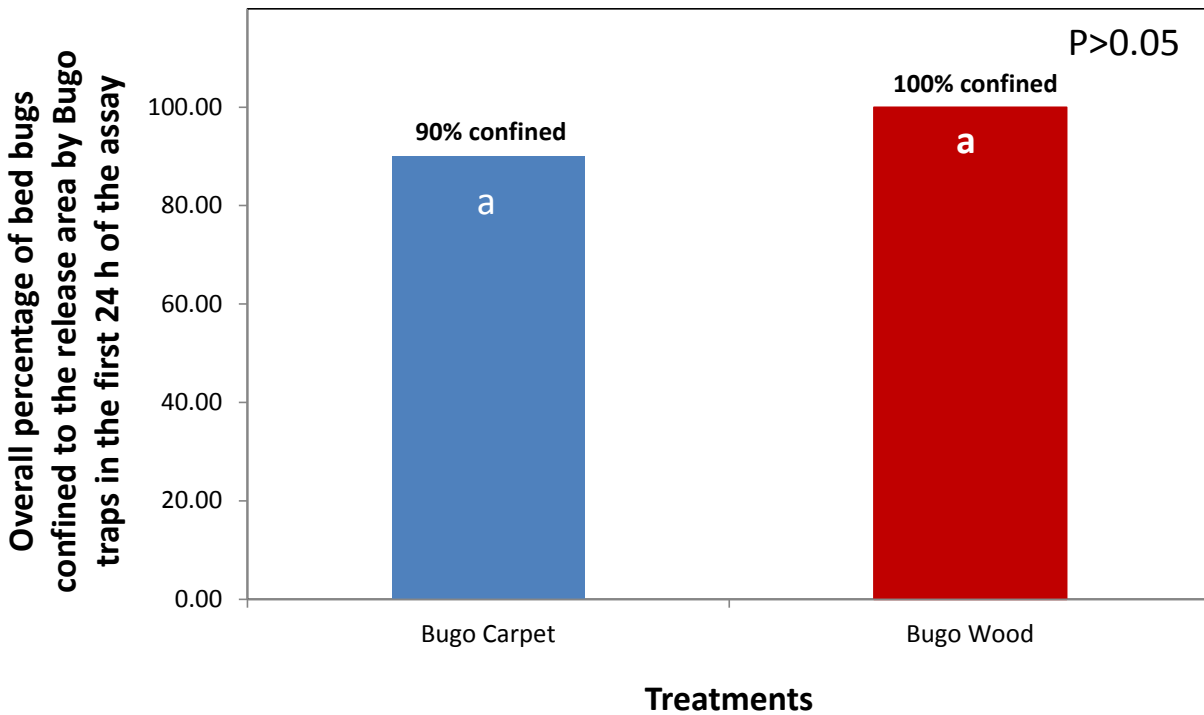
**Figure 6:** Preliminary laboratory testing data depicting efficiency of Bugo traps to confine bed bugs to the release area either by trapping them on the inner/sticky edge of the trap or by limiting their movement. Bars connected with different letters are significantly different.

NOTE: Due to the preliminary nature of this data, J. T. Eaton or Fantastak LTD., should use this data for internal development purposes only. The PI (Ameya Gondhalekar) or the Urban Center do not support the use of the data shown in Fig. 6 for marketing purposes until long-duration experiments with mock beds are conducted.