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Exploiting vibrational communication for more efficient trapping of *Halyomorpha halys* (Heteroptera: Pentatomidae)

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Extended Abstract: *Halyomorpha halys*, or the Brown Marmorated Stink Bug (BMSB) is commonly recognized as one of the most notorious invasive insect species. After the population outbreak in some areas of North America, a locally severe population outbreak is also occurring in the north Italy's Po valley (Maistrello et al., 2018), where BMSB has quickly become a key pest in fruit orchards (Maistrello et al., 2017). Its invasion potential is a cause of great concern among farmers and plant protection services in areas with suitable climate worldwide (Kriticos et al., 2017).

Control measures against *H. halys* currently consist of frequent applications of broad-spectrum insecticides, which is adding to environmental pesticide burden and disrupting IPM programs in affected areas (Leskey et al., 2012). Control efforts are hampered by incredible polyphagy of *H. halys*, its high dispersion potential, high reproductive potential and general robustness. Aside from biological control, behavioral manipulation using attraction to male-emitted sexual pheromones is one of the more promising approaches. The male-emitted aggregation pheromone has been identified recently (Khrimian et al., 2014) and is commercially available, although pheromone attraction of *H. halys* has the same shortcoming as in other species of stink bugs: traps' efficiency is more suited for monitoring than mass trapping purpose (Morrison et al., 2015) because attraction to the pheromone source is not precise in this family.

The likely reason for low efficiency of pheromone traps is that communication in stink bugs is bimodal. Pheromones attract males, females, and late-instar nymphs to general vicinity of the emitter (Khrimian et al., 2014), but the final approach during the courtship of stink bugs is mediated by substrate-borne vibrational signals (Virant-Doberlet and Čokl, 2004). Thus, we argue that mechanical vibrations can be used as a "bridge" connecting long-range attraction towards the source of synthetic pheromones and actual elimination.

To explore this possibility, an ongoing research effort was started in 2015, beginning with the basic description of vibration-mediated sexual behaviour of *H. halys*. Courtship involved a stereotypical exchange of signals between a male and a female, which started with the male spontaneously producing vibrational pulses (labeled MS-1), to which receptive females replied. A duet was formed, characterized mainly by sequences of shorter, regularly repeated female signals (FS-2), to which males reacted by searching for the source. Both partners emitted other types of signals during this time as well, ending with copulation (Polajnar et al., 2016).

We then performed a series of laboratory trials in which we reproduced male and female signals using an electromagnetic "shaker". In particular, we tested the potential aggregation function of the long, spontaneously produced MS-1 signals, and the male attraction to the regularly repeated FS-2 signals. We did not observe any effect of MS-1 playback, but FS-2 signals were attractive to adult males on several types and geometries of substrate (both

natural and artificial). We observed a so-called "loitering effect", where the male circled continuously around the exact location where the minishaker was attached to the experimental arena, and never left the area (Mazzoni et al., 2017). Thus, the FS-2 was selected for field trials. A trap prototype was constructed (Biogard®, CBC Europe S.r.l.), implementing a commercial aggregation pheromone dispenser, an electromagnetic "shaker" continuously vibrating the whole trap with the FS-2 sequence, and a circuit emitting electric shocks on top of the standard pyramid panel construction. The males were attracted to the trap by the pheromone and then driven inside cavities in its head, where they were killed by electrocution. Preliminary results show highly male-biased capture rates, thus proving the effect of vibrational playback *per se*.

Further work in the following seasons will focus on improving capture rate, which is crucial if the devices are to be used in mass trapping of *H. halys*. In particular, attractiveness to adult males only needs to be compensated to achieve meaningful reduction of population density.

Key words: biotremology, invasive pest, behavioural manipulation, multimodal trap, IPM

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