MOSQUITO TRAPS

A CONFIDENTIAL review covering an analysis of the scientific basis of the Mosquito Trap operations

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Background

Mosquitoes are creating problems all over the world and people are dying from diseases transmitted by insects. Mosquitoes are carrying more diseases and becoming resilient to chemicals and repellents. The global problem is being tackled from many physical, chemical, cultural and biological fronts.

Investment into research and development of trapping devices for proximal mosquito control appears to have increased massively in the past 5 years leading to the development of several systems that rely on CO_2 release as the primary attracting mechanism. Bantix's mosquito traps (www.bantix.com.au) use scientifically-proven technology based on measured CO_2 release (in the Master system) and other complementary attractants that simulate the cues produced by humans and warm-blooded animals.

Local and international trials of the various configurations of these units demonstrates that the Bantix Worldwide technology (using a Master and Satellite system) is the "state of the art" and has the best catching performance for a range of mosquitoes and biting insects. A summary of some of the recent trials follows and the papers in full are appended.

Comparative tests

Dr. Dan Kline is a world-recognised expert in mosquito trapping technology. In a US study in 2001, he compared the Bantix's designed beta version mosquito trap, licensed for production in New Zealand, with the American Biophysics company's Mosquito Magnet. The MegaCatch is an early version of Bantix's Mosquito-slayer and does not have the subsequent improvements in the light and audio capabilities.

Large Cage and Field Comparison Tests of *MegaCatch™ and Mosquito Magnet™ Traps

(Bantix's designed beta version)

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Abstract. The relative efficacy of various configurations of the MegaCatch™ and Mosquito Magnet™ mosquito traps were evaluated at three study sites: a large outdoor screen cage, a suburban residential backyard and a wildlife refuge. Laboratory reared Aedes

aegypti, Culex quinquefasciatus and Ochlerotatus taeniorhynchus were used in the large cage studies.
In these studies CO_2-baited **MegaCatch™ traps caught nearly 2x as many** Ae. aegypti and nearly equal numbers of the other two species as the Mosquito Magnet™ Pro trap.

The MegaCatch™ trap **without** CO_2 caught several hundred less Ae. aegypti and only about 0.25x as many Oc. taeniorhynchus as the **CO_2-baited configuration**.

Studies conducted in a suburban residential backyard indicated that the MegaCatch™ trap, whether baited with CO_2 or not, **caught a larger variety of mosquitoes** than the Mosquito Magnet™ Pro; without CO_2 it caught about the same quantity of mosquitoes as the Pro; with CO_2 it **caught ca. 3x as many mosquitoes** as the Pro.

In the wildlife refuge several configurations of the Mega-Catch™ trap were compared to the Mosquito Magnet™ Pro and Residential models. The CO_2 baited configurations of the Mega Catch™ traps (dry and wet collection methods) **caught many more mosquitoes** than either the Pro or Residential traps.

Mixed results were obtained in comparative trials with the no CO_2 configurations. The Residential unit was the least effective in trapping mosquitoes in these trials. With the exception of the wet CO_2 -baited configuration, the Pro and Residential units caught more Culicoides spp biting midges.

Scientists at the Mosquito Research Laboratory, School of Pharmaceutical Molecular and Biomedical Sciences, conducted a study that compared Bantix's Mosquito traps (with and without CO_2 configurations); with two US and one other Australian Mosquito trap in a well designed field trial.

"A comparison of the effectiveness of some commercially available insect traps for mosquito capture"

by

C.R. Williams, H.L.S. Roberts and M.J. Kokkin

University of South Australia

"The Bantix Master and Satellite twin unit was clearly the **most effective** for mosquito capture, followed by the EVS Trap and the Bug Eater respectively."

"In terms of catching female mosquitoes, the Bantix twin unit was clearly the **most specific** for females opposed to males."

"In a comparison between the Master and the Satellite of the Bantix twin unit trap, no detectable difference in mosquito trap numbers was detected. This demonstrates that both units are of equal value."

"Of the traps tested here, only the Bantix Master and Satellite twin unit appeared to cause some significant reduction of mosquito numbers."

Dr Scott A.Ritchie, on behalf of the Edward Koch Foundation, Cairns Qld, recently (2002) conducted a field trial to evaluate mosquito and biting insect-trapping capabilities of the world's leading trap designs

Comparison of the BANTIX MOSQUITO SLAYER, MOSQUITO MAGNET PRO and the CDC LIGHT TRAP in North Queensland

Scott A Ritchie
PO Box 2964
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"The results clearly indicate that the Mosquito Slayer (MS) collects large numbers of mosquitoes and sandflies (biting midges). **With the addition of the satellite unit, the MS collected considerably more mosquitoes than the other units**. This strategy also allows for trapping in front and back yards from a single gas cylinder, a significant advantage."

What makes a mosquito trap work?

It is only the female Mosquitoes that bite humans and they are drawn to an essential life cycle blood feed by a combination of molecular factors relating to emissions from warm-blooded animals.

The attraction-cues are probably multiplicative and synergistic although some of the competitive trapping systems catch some species of insects very well without the full complement of physical and chemical attractants in the Bantix system.

Three very important biological cues control Mosquito blood feeds.

1. *Arousal to become airborne*; then,
2. *orientation of the mosquito* to fly toward the host; and,
3. to *select feeding site* on the host.

A good trap must contain physical and chemical features to initiate and consolidate all three cues, kill the insect and must be more attractive that a human host.

Attractant principles

The attractant elements used in Bantix's systems are as follows and the company offers two models, either with (Master) or without (Satellite) CO_2 dispersion mechanism.

Insects are attracted to by CO_2, lactic acid, octenol, temperature, light, sound, and perceived movement.

A fan disables flight and forces drowning in the water tray. Drowning is accelerated by reduced surface tension created by inclusion of a surfactant.

Carbon Dioxide

CO_2 alone will not necessarily attract mosquitoes. Too much CO_2 can have a negative effect.

Ambient background CO_2 levels are well mixed and relatively uniform in the atmosphere at <0.5%. Human breath usually contains <5% CO_2, (approximately a ten-fold increase). Mosquitoes can detect changes of the order of 0.01%. It is probably the changing concentrations that stimulate the insect.

Independent research indicates that pulsing of CO_2 release at 20-30 sec intervals is essential to get mosquitoes airborne and to seek and orient towards CO_2 source. A rough calculation indicates that the Bantix design creates a downwind plume of CO_2 from approx 1cc pulsed release at 20 sec intervals for time that gas release system is active (clock controlled eg 1hr dawn, 2 hr dusk).

- 1cc pulsed CO_2 (every 20 secs) at 1 atmos is equivalent to 100cc will increase CO_2 in 1 cubic metre of air 1%. (3 cu m/min).
- Human breath at 5 litres/min at 5% CO_2 would produce 250cc CO_2 / min (2.5cu m/min)

Therefore the pulsing rate and volume is slightly higher than a single (?average?) human breath, (which is also estimated to be 0.1gm CO_2/ breath).

It is difficult to be more precise than this as ambient situations of variable wind turbulence, different numbers of people of differing metabolism, and resting state of the insect. However, there is no compelling evidence presented that the CO_2 release-rate should be altered.

Gas bottle issues

Food-grade bottles of CO_2 (20-30 kgs = approx upto 10,000 minutes of operation, or 100 minutes per day for 100 days). Estimates in advertising of a bottle lasting 2-3 months ($10/mth bottle rental and $30-40/ refill) seem reasonable.

Competitors (Mosquito Magnet Pro) uses BBQ-grade Propane (9.5kg) to produce CO_2 after burning. The combustion also produces moisture and heat and a bottle lasts 10-20 days, cost $25/ refill.

Bottled CO_2 needs to be supplied to users at regular intervals and appears (and clock-controlled mains/external 12V power supply) to have some advantages over manually controlled and ignited Propane based systems.

Trolley mounted unit and gas bottle is possible with trailing power cord. Stability in suspension to avoid spillage could be an issue

Could CO_2 release be suspended or directionally controlled in windy conditions but this would require a digital wind-speed/direction instrument to be interfaced to the clock. (maybe worthwhile future development especially in multiple installations)

Cascaded multiple units (hotels gardens, units/villas, campgrounds, Minesites) could be reticulated from single large storage CO_2 tanks and water/power supplies to reduce servicing?

There are some possibilities of producing CO_2 from inert chemical reactions within the unit. This would require more R+D and probably approvals.

Lactic Lure (L-lactic acid)

Purpose; synthesise body odours (major component of Sweat), is added to the water tray in the Bantix unit to provide drowning medium for insects

Lactic acid most effective when coupled with warm moist surfaces/airflows. Without CO_2 it is reported to be ineffective. Lactic acid excites neurones in a wide range of female mosquitoes and biting insects.

Investigations are continuing for information on other components of skin-pore emissions (NaCl) as the formulation of the "Lactic-lure" used in the traps appears to be about 10-15% glucose-based syrup, 1-2% surfactant (non-odorous industrial detergent?), <1% citric acid and 83% water.

This process is messy and the units require topping-up regularly. In an attempt to limit intervention necessity could reticulation through garden system be used.

The Lactic lure should be added in a concentrated form or the components could be concentrated to slow-release tablet/ paste/ drip form? (Such as pool additives?) Further investigation that should not have any effect on design is needed here.

Octenol (1-octen-3-ol)

A pheromone attractant (perspired decay enzyme) derived from mushrooms (fungi bi-product/composting slime) in tablet form. A close analogy is human body odour (or the smell of sweaty socks). About 1.5cc of octenol concentrate is absorbed into a porous block and adhered to inside of the unit.

Like Lactic acid, the reviewed literature indicates that octenol seems to work best in conjunction with CO_2 and other physical attractants. Evidence shows that it may be selectively attractive for some mosquito species and varieties of insects. (eg. *Aedes* but not *Culex).* However, some of the literature indicates that Octenol is a "must have" and seems to react symbiotically with CO_2.

The tablet needs replacing every 3 months but this may be highly variable depending on conditions. If it is as important as some studies suggest need to consider source and block-size to limit intervention necessity? It's compatibility with the lactic lure should be investigated. Ideally this user intervention should be a single task.

Thermal attraction (humidity)

A heating element coupled with the light unit produces a radiating warm surface and probably increases volatilisation of attractant molecules. There is some conjecture in the literature on the actual role of moisture and humidity. Perspiration at body temperatures seems ideally attractive. (NB. accumulated sweat/ BO is attractive to mosquitoes)

Heat alone will not attract mosquitoes but moist heated airflow in the range of 30-40 deg C may, and it appears to complement molecular dispersion and the catching capabilities of other attractants. The touch surface of the small heating element appears to stabilise in this temperature range.

The design of the Bantix traps intrinsically involves water, an option of a net collection bag is feasible (and desirable to reduce servicing frequency), but should be considered with care as efficiency and contribution of the warm/moist airflow combined molecularly with CO_2.may be compromised.

Light unit/s

Mosquitoes have a complex ocular system that is sensitive in low light conditions covering the approximate spectral regions 320-620nm (UV- green/yellow not into the red-IR) with sensitivity peaks in the UV (330-345nm) and in the green (523nm). Some work suggests that lights covered with yellow and red filters (630+nm) make the light invisible to most mosquitoes.

A 12-volt UV (fluorescent) tube in the 350-370 nm region is well-accepted technology and entomologically supported. The light used has a peak wavelength of 365 nm.

An additional multi-spectral source is provided by 4 Light-Emitting Diodes (LEDs) connected into a collimated 60 deg prismatic disperser/refractor. These white, blue (468), green (520) and red (626) are sequentially pulsed producing the perception of movement that is also thought to assist mosquito orientation.

It is not clear what this cycling does in terms of spectral attraction but the disperser may provide a wider spectrum of attractive wavelengths that may be selective to some other insects. It would be valuable to analyse midge catch with this light source as a variable.

Early work suggests that Black-surfaced traps catch most mosquitoes.

Audio unit

Purpose: to mimic blood feeding audio emission frequencies of female mosquitoes

Chip freq. 80 Hz to 680 Hz. Cycles through frequency range every 5 seconds and its volume is amplified.

Studies at University of SA showed high success rate with trapping of Female mosquitoes and attributed this to the audio chip. Some research may refute the audio contribution.

Other personal observations

My overall impression of the Bantix's Mosquito Traps (See <<www.bantix.com.au>> or <<www.mosquito-slayer.com>>) is that it is the culmination of many years of innovative and competent development. The science behind the design is well considered and thoroughly adapted.

It is a complex piece of equipment that is not easy to manufacture and will need ongoing interaction by an operator to perform at its undoubted potential. Robust manufacture and a structured QA process, probably by competent distributor networks, will be essential

Refinements and site specific adaptations will always be tempting but I believe that any radical changes to the current unit designs should be delayed until this version is thoroughly tested in the worldwide marketplace.

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Note <<www.bantix.com.au>> & <<www.mosquito-slayer.com>> are website domains owned by Bantix Worldwide Pty Ltd.