Evaluation of various models of propane-powered mosquito traps

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ABSTRACT: Large cage and field studies were conducted to determine the efficacy of various models of propane-powered mosquito traps. These traps utilized counterflow technology in conjunction with catalytic combustion to produce attractants (carbon dioxide, water vapor, and heat) and a thermoelectric generator that converted excess heat into electricity for stand-alone operation. The cage studies showed that large numbers of *Aedes aegypti* and *Ochlerotatus taeniorhynchus* were captured and that each progressive model resulted in increased trapping efficiency. In several field studies against natural populations of mosquitoes two different propane traps were compared against two other trap systems, the professional (PRO) and counterflow geometry (CFG) traps. In these studies the propane traps consistently caught more mosquitoes than the PRO trap and significantly fewer mosquitoes than the CFG traps. The difference in collection size between the CFG and propane traps was due mostly to *Anopheles crucians*. In spring 1997 the CFG trap captured 3.6X more *An. crucians* than the Portable Propane (PP) model and in spring 1998 it captured 6.3X more *An. crucians* than the Mosquito Magnet Beta-1 (MMB-1) trap. Both the PP and MMB-1 captured slightly more *Culex* spp. than the CFG trap. *Journal of Vector Ecology* 27(1): 1-7. 2002.

Keyword Index: Mosquito trap design, propane traps, trapping efficiency.

INTRODUCTION

Attractant-baited traps are being considered as an alternative to the use of chemical insecticides in certain situations for mosquito population management, and this has stimulated private industry to develop new trap types. Kline (1999) reported on the efficacy of one promising new trap developed by American Biophysics Corporation (ABC), (East Greenwich, RI), known as the Counterflow Geometry trap (CFG). The CFG trap is very efficient in attracting most species of mosquitoes. Its major drawbacks are that it requires an external source of power and mosquito attractants, such as heat and carbon dioxide (CO₂), must be provided. Therefore, ABC has been developing a series of propane-powered traps as an alternative option for mosquito management. These traps utilize the patented counterflow technology of the CFG trap to capture mosquitoes and catalytic combustion of propane to produce its own attractants, which include CO₂, heat and water vapor. A thermoelectric generator uses excess heat from the combustion process to generate electricity to run the traps' fans. The specific objectives of the present study were: (1) to determine if propane-powered traps could attract and capture laboratory-reared *Aedes aegypti* (Linnaeus) and *Ochlerotatus taeniorhynchus* (Wiedemann) released into an outdoor cage, and (2) to measure their capture efficacy compared with ABC's professional surveillance (PRO) and CFG traps against natural populations of woodland mosquito species.

MATERIALS AND METHODS

Traps Tested

**Professional (PRO) trap.** The PRO trap is a relatively new trap that is similar in design to the Centers for Disease Control (CDC) trap (Sudia and Chamberlain 1962). It is described in detail by Kline (1999) and McNelly (1995). The trap is powered by a 6-V, 10-ampere-hour rechargeable gel-cell battery (Figure 1A).

**Counterflow Geometry (CFG) trap.** This trap design utilizes a new mosquito capturing principle known as counterflow, first described by Kline (1999). In operation the trap utilizes 2 fans energized by a 12-V DC battery to provide counterflow at the trap entrance. A 40-mm fan (Delta model DFB0412M) creates a CO₂-enriched airflow plume from CO₂ supplied from a compressed gas cylinder, which exits vertically down a center pipe. An upflow is created by an 80-mm fan (Delta model DFB0812H) that causes any mosquito in the vicinity of the trap entrance with a flight speed less than ca. 3.5 m/sec to be entrained into the upflow and forced into the
trap interior. The CFG trap was hung from a pole so that the bottom of the attractant plume was ca. 50 cm above the ground (Figure 1B).

**Propane-1.** This trap utilizes the same trap body as the CFG trap, but its attractants (CO₂, heat and water vapor) are produced by external catalytic combustion of propane. Excess heat is utilized by an external thermoelectric generator to produce electricity to power the 2 fans (Figure 1C).

**Portable-CO₂ (PC) Trap.** This trap uses the same principle of counterflow technology as the CFG trap, but the counterflow is produced by a different trap design. The fans are contained within a durable metal housing. This trap is designed to compare the efficacy of CO₂ supplied from a compressed gas cylinder with that produced from catalytic combustion of propane. The fans are powered by 12-V DC gel cell batteries. This design also allows the use of the same amount of CO₂ as that supplied to the CFG and PRO traps (Figure 1D).

**Portable Propane (PP).** This trap has the same basic design as the PC trap, but utilizes a catalytic combustion unit to convert propane into CO₂, heat and water vapor. The trap uses the same metal housing construction for the fans and catalytic burner as the PC trap. The trap also incorporates a thermoelectric generator, which uses a portion of the heat to produce electricity to power the two fans. This self-generation of electricity allows the trap to be a totally stand-alone unit, which can run unattended for 20 days when a standard (9 kg) barbecue grill propane tank is used. This also allows placement of the trap where the mosquito problems are rather than where a convenient power supply may exist (Figure 1E).

**Mosquito Magnet Beta-1 (MMB-1).** This trap utilizes a more efficient catalytic converter. The housing unit was redesigned and constructed from a durable plastic. A clip was provided to attach ABC’s standard 1-octen-3-ol (octenol) release pack. This trap was briefly marketed in 1999 as the Counterflow 2000™ (Figure 1F).

**Mosquito Magnet Beta-2 (MMB-2).** This trap was basically the same as the MMB-1 model, but the attractant release tube was modified to incorporate a chamber within the CO₂ outflow tube to entrain octenol in the attractant plume rather than having an octenol packet attached near the trap entrance.

**Mosquito Magnet (MM).** This version of the trap is commercially available. The power generator/converter has been modified for easy field service and higher reliability. This model has a more robust, molded plastic housing unit, but its basic design is similar in appearance to the MMB-1.

**Nicosia Device.** This trap is an experimental device (patent # 5,657,576) based on pulsed liquid technology that produces an acoustical signal, similar to that produced by the circulatory system of a host animal; the details of what attractant signals are produced are not completely understood. Although this trap attracts some mosquitoes without CO₂, the combination of acoustic signal and CO₂ is recommended for maximum effect. The trap utilizes an electrocution grid to kill the attracted mosquitoes. It is included in this study because it introduces a new technology that shows promise and will be refined as its mode of attraction is better understood.

**Large Cage Studies**

Evaluations of each model of propane trap were made in a large outdoor screened enclosure (9.2 m wide x 18.3 m long x 4.9 m high on the sides and 6.1 m high at the peak) where 1,000 3- to 4-d-old laboratory-reared *Oc. taeniorhynchus*, and on some nights an equal number of *Ae. aegypti*, were released ca. 2 h before sunset, 250 of each test species into each corner. Each release night the mosquitoes were marked with a different color of fluorescent powder so that they could be followed through time. Trap collections were retrieved approximately 90 min after sunrise and the number of mosquitoes caught in the traps was determined. Only the mosquitoes with the previous release night’s marking were included in trap efficiency determinations.

The impact that test traps had on mosquito landing rates in the test cage was also determined. Landing counts were taken along a transect extending from the southwest (SW) to northeast (NE) corners of the test cage. Three sampling stations were established along this transect: the 2 corners (SW and NE) and the midpoint of the transect, which was where the test traps were located. For 6 min at each station, mosquitoes were aspirated into a collection tube with a modified portable vacuum cleaner as they attempted to land on the human host. A different collection tube was used at each station. The mosquitoes were killed with cold and counted.

The Propane-1 trap was evaluated for two nights (November 20-22, 1996). One thousand *Oc. taeniorhynchus* and *Ae. aegypti* were released each night. The PC trap was operated for four nights between December 17, 1996 and January 24, 1997. One thousand *Oc. taeniorhynchus* were released each night, but 1000 *Ae. aegypti* were available for release on only the first night (December 17-18, 1996). Initial studies of the PP trap were conducted for 10 nights from March 5 - May 6, 1997. *Oc. taeniorhynchus* were utilized all 10 nights, but *Ae. aegypti* were only available for 5 of these nights.
Sustained studies were conducted for 20 nights from September 21-November 15, 1997. *Oc. taeniorynchus* were used each night; *Ae. aegypti* were available for 14 nights scattered throughout this testing period. Initial evaluations of the MMB-1 trap were conducted for 4 consecutive nights (April 28 through May 1, 1998). *Oc. taeniorynchus* were available for testing each night, but *Ae. aegypti* were only available on the first night. Frequent evaluations were conducted from October 27-December 11, 1998. During 21 nights of testing, *Oc. taeniorynchus* were available each night, but *Ae. aegypti* were available only for 5 test nights. The MMB-2 trap became available for testing in May 1999. It was evaluated for 11 nights from May 25 - June 11, 1999. Both species were evaluated each night. The MM trap, a commercially produced model of the propane traps, became available for testing in late June 1999. It was evaluated for 9 nights between June 22 and July 14, 1999. *Aedes aegypti* was utilized each night and *Oc. taeniorynchus* all nights except the first.

**Field Studies**

Several field trapping experiments were conducted against natural populations of mosquito species associated with wooded wetlands located near a water management area in Gainesville, FL. Three replications of a 4 x 4 Latin square experiment were conducted during March through April 1997. In this experiment four trap types were compared (PRO, CFG, PC and PP). In each replication the four trap types were alternated so that each trap type occupied each trap station for a single night. Trap stations were located 18 m apart. Carbon dioxide was supplied to the PRO, CFG and PC traps from 9 kg compressed gas cylinders. The flow rate used for all 3 trap types was 500 ml/min. Control of CO₂ flow rate was achieved with FLOWSET1 (ABC, East Greenwich, RI) which is comprised of a pressure regulator with output fixed at 15 psig, a 10 micron line filter, a 500 ml/min flow control orifice, and quick-connect luer fittings. The CO₂ produced (350 ml/min) for the PP trap was by catalytic combustion of propane, which was determined by ABC to be ca. 350 ml/min. This combustion process also produced heat and water vapor. One package of OCT 1 Slow Release 1-Octen-3-ol (octenol with a release rate of ca. 0.5 mg/h) (ABC, East Greenwich, RI) was taped to each trap. A fresh package was used for each experiment.

Another 4 x 4 Latin square experiment was conducted at this woodland site with collection dates May 11-15, 1998. The four trap types used in this experiment were the PRO, CFG, Nicosia Device and the MMB-1. While the MMB-1 trap generated its own CO₂ through the catalytic combustion of propane, CO₂ was supplied to the PRO, CFG and Nicosia Device in the same manner as in the previous field experiments. An octenol package was taped to each trap.

Data for all field experiments were analyzed with Statistical Analysis System (SAS) PROC GLM and Means/REGWQ for the analysis of variance and means comparisons (SAS Institute 1985).

**RESULTS**

**Large Cage Studies**

In these studies, 19.8-62.6% of *Ae. aegypti* and 26.1-71.2% of *Oc. taeniorynchus* were captured by these propane-powered traps, and the larger the collection, the more the landing count was reduced (Table 1). These data, indicate with a few exceptions, that the progressive development of the propane-powered traps resulted in better trapping efficiency. This was especially true for *Oc. taeniorynchus* where the first trap model (Propane-1) caught an average of 261 specimens over a 2 night period, and the most recent model tested in the cage (MM) caught an average of 712.3 specimens for 8 nights of evaluation. The exception to this was that the average catch for the PP model was 413.5 compared to 371 for the MMB-1 trap. The continuous improvement trend was not as clear for *Ae. aegypti* where the PP trap caught an average of 469.2 specimens compared to 378.5 and 378.3 for the MMB-1 and MMB-2 models, respectively. However, the latest model tested (MM) caught greater than 3X as many (626.1 vs 197.5) as the Propane-1, and 25% more specimens than the PP.

**Field Studies**

In the first replicate of the 1997 Latin square experiment, 4389 mosquitoes were collected. The CFG trap captured the most specimens (3230), followed by PP (834), PC (789), and PRO (446). Fifteen species of mosquitoes were collected. The number of mosquito species collected in each trap type was 13 for PC, 12 each for PP and CFG and 11 for PRO. Only 3 species had at least 100 total specimens caught. These were in order of decreasing abundance, *Anopheles crucians* Wiedemann (3015), *Ochlerotatus canadensis* (Theobald) (666), and *Culex salinarius* Coquillett (339). Eight species, *Oc. canadensis*, *Ochlerotatus dupreellii* (Coquillett), *Ochlerotatus inermatus* Dyar and Knab, *Ochlerotatus sticticus* (Meigen), *An. crucians*, *Coquillettidia perturbans* (Walker), *Culex erraticus* Dyar and Knab, and *Culex salinarius* (Coquillett), were collected in all four trap types. Three species, *Aedes vexans* (Meigen), *Anopheles quadrimaculatus*, and *Psorophora ferox* (Von Humboldt) had at least 1 specimen in 3 trap types. *Ae. vexans* was not collected.
Figure 1. Trap types tested in either large cage and/or field studies: A. Professional; B. Counterflow Geometry; C. Propane-1; D. Portable Cylinder; E. Portable Propane; F. Mosquito Magnet Beta-1.
in the PP trap; *Anopheles quadrimaculatus* Say was not collected in the CFG trap, and *Ps. ferox* was not collected in the PRO trap. *Ochlerotatus mitcchellae* (Dyar) was only collected in the PC and PP traps. *Anopheles punctipennis* (Say) was only collected in the PP and PRO traps. *Oc. triseriatus* (Say) was only collected in the PC trap. *Culiseta melanura* (Coquillett) was only collected in the CFG trap.

In the second 1997 replicate, 3164 mosquitoes were collected. The CFG trap again collected the most specimens (1343) and the PRO the least (119), but the PC trap collected more than the PP trap (1170 vs 532). Fifteen species were again collected. No *Oc. triseriatus*, *An. punctipennis* or *Cs. melanura* were collected, but a single specimen of three species not collected in the first replicate, *Ochlerotatus atlanticus* Dyar and Knab, *Aedes albopictus* (Skuse) and *Psorophora columbiae* (Dyar and Knab) was collected in the PP, CFG, and PRO traps, respectively. Two specimens of *Ps. ferox* were collected in the CFG trap. At least one specimen of *Oc. canadensis*, *An. crucians*, *Cq. perturbans*, *Cx. erraticus*, and *Cx. salinarius* was collected in all four trap types. *Ochlerotatus dupreei* and *An. quadrimaculatus* were collected in all trap types except the PRO. A single specimen of *Oc. mitcchellae*, *Oc. sticticus*, and *Ae. vexans* was captured in both the CFG and PP traps. The CFG trap had the greatest species diversity (13), followed in decreasing order by the PP (12), PC (8), and PRO (7) traps. Five species were collected in sufficient numbers for further analyses. In order of decreasing abundance, these were *An. crucians* (2433), *Cq. perturbans* (301), *Cx. salinarius* (169), *Oc. canadensis* (113), and *Cx. erraticus* (98).

In the third 1997 replicate, a total of 2755 specimens was collected. The CFG caught the most (1613), followed in decreasing order by PC (552), PP (480), and the PRO (116). Sixteen species were captured. The CFG and PP each caught 13 different species; the PRO and PC each captured 11 species.

### Table 1

Mean (±SD) responses of laboratory reared *Oc. taeniorhynchus* and *Ae. aegypti* to various traps in large outdoor cage studies.

<table>
<thead>
<tr>
<th>Trap Type</th>
<th>n</th>
<th>Landing Count</th>
<th>Net</th>
<th>Trap Type</th>
<th>n</th>
<th>Landing Count</th>
<th>Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propane-1</td>
<td>2</td>
<td>90.0 (48.1)</td>
<td>261.0 (166.9)</td>
<td>2</td>
<td>28.0 (39.6)</td>
<td>197.5 (82.7)</td>
<td></td>
</tr>
<tr>
<td>PC</td>
<td>4</td>
<td>123.0 (30.9)</td>
<td>314.2 (149.6)</td>
<td>1</td>
<td>0.0</td>
<td>229</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>30</td>
<td>70.0 (63.6)</td>
<td>413.5 (192.9)</td>
<td>19</td>
<td>12.9 (14.7)</td>
<td>469.2 (226.3)</td>
<td></td>
</tr>
<tr>
<td>MMB-1</td>
<td>25</td>
<td>100.2 (71.1)</td>
<td>371.0 (234.4)</td>
<td>6</td>
<td>55.2 (53.4)</td>
<td>378.5 (232.1)</td>
<td></td>
</tr>
<tr>
<td>MM-1</td>
<td>11</td>
<td>38.3 (36.8)</td>
<td>520.1 (200.9)</td>
<td>11</td>
<td>11.0 (15.3)</td>
<td>378.3 (168.7)</td>
<td></td>
</tr>
<tr>
<td>MM-2</td>
<td>8</td>
<td>13.0 (8.4)</td>
<td>712.3 (141.4)</td>
<td>9</td>
<td>2.6 (3.5)</td>
<td>626.1 (198.0)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2

Mean (±SD) response of total mosquitoes collected and 5 most commonly collected species to various trap types located in a woodland wetland in Gainesville, FL, in Spring 1997.

<table>
<thead>
<tr>
<th>Species</th>
<th>CFG</th>
<th>PP</th>
<th>PC</th>
<th>PRO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>422.6(200.9) a</td>
<td>153.1(174.5) bc</td>
<td>211.8(174.5) b</td>
<td>56.4(49.3) c</td>
</tr>
<tr>
<td><em>Ochlerotatus canadensis</em></td>
<td>40.9(44.6) a</td>
<td>9.5(10.5) b</td>
<td>13.3(12.7) b</td>
<td>9.3(11.0) b</td>
</tr>
<tr>
<td><em>Anopheles crucians</em></td>
<td>328.3(156.9) a</td>
<td>91.4(61.3) bc</td>
<td>173.3(169.1) b</td>
<td>27.2(27.0) c</td>
</tr>
<tr>
<td><em>Cq. perturbans</em></td>
<td>21.3(19.0) a</td>
<td>17.2(16.2) a</td>
<td>12.8(12.4) ab</td>
<td>5.1(4.7) b</td>
</tr>
<tr>
<td><em>Cx. erraticus</em></td>
<td>5.3(6.2) a</td>
<td>5.7(7.6) a</td>
<td>4.1(5.9) a</td>
<td>1.1(1.9) a</td>
</tr>
<tr>
<td><em>Cx. salinarius</em></td>
<td>19.7(12.7) ab</td>
<td>23.5(16.3) a</td>
<td>5.2(3.4) c</td>
<td>9.7(13.7) bc</td>
</tr>
</tbody>
</table>

*n* = 12 nights. Means in the same row followed by the same letter are not significantly (*P* > 0.05) different; Ryan-Einot-Gabriel-Welsh multiple range test (SAS Institute 1985).
caught 8 species. No specimens of either *Ae. albopictus* or *Ps. columbiae* were captured. At least one specimen of *Oc. canadensis*, *Oc. dupreei*, *An. crucians*, *Cq. perturbans*, *Cx. erraticus*, and *Cx. salinarius* were collected in all four trap types. *Ochlerotatus infirmatus* was collected in all trap types except the PC. *Oc. triseriatus* and *An. quadrimaculatus* were collected in all types except the PRO. *Oc. atlanticus* and *An. punctipennis* were only collected in the CFG and PP traps. *Ochlerotatus mitchellae* and *Ps. ferox* were only collected in the CFG trap. *Oc. sticticus* and *Ae. vexans* were only collected in the PP trap. *Cs. melanura* was only collected in the PRO trap.

In terms of total *Ae. canadensis* and *An. crucians* collected, the CFG collections were significantly different (*P < 0.05*) than the other trap collections (Table 2) for all 3 replicates combined. There were no significant differences among trap types for *Cx. erraticus*. There was no significant difference between the CFG and PP trap collections for *Cx. salinarius*, but both trap types caught significantly more than either the PC or PRO. The PP trap caught more specimens of both *Cx. salinarius* and *Cx. erraticus* than any of the other trap types. There was no significant difference (*P > 0.05*) between the CFG, PP, and PC in their *Cq. perturbans* collections, but the collections of this species by all 3 were significantly (*P < 0.05*) greater than the collections of the PRO trap.

In May 1998, seventeen species of mosquitoes were collected, 13 by the Nicosia Device, 12 by the CFG, and 9 each by the MMB-1 and PRO traps. Overall, sixteen males and 4161 females were captured during 4 nights of trapping. The 16 male specimens consisted of 3 *An. punctipennis* (1 in MMB-1 and 2 in PRO), 6 *Cq. perturbans* (3 in MMB-1 and 3 in CFG), and 7 *Cx. salinarius* (6 in MMB-1 and 1 in the Nicosia Device). The majority of female mosquitoes were collected in the CFG trap (2613) followed in decreasing order by the MMB-1 trap (790), Nicosia Device (592) and the PRO trap (166). Seven species (*Oc. canadensis*, *Oc. infirmatus*, *An. crucians*, *An. punctipennis*, *Cq. perturbans*, *Cx. erraticus*, and *Cx. salinarius*) were collected by all four trap types. Two species (*An. quadrimaculatus* and *Cs. melanura*) were collected by 3 trap types. *An. quadrimaculatus* was not caught by the PRO trap; *Cs. melanura* was not caught by the MMB-1 trap. *Ae. vexans* was collected only by the PRO and Nicosia Device. Only one specimen of the seven other species was collected by different trap types: *Ae. albopictus* by MMB-1; *Ae. aegypti*, *Oc. sticticus*, and *Oc. triseriatus* by CFG; *Oc. atlanticus*, *Orthopodomyia signifera* (Coquillett), and *Ps. columbiae* by the Nicosia device. Only 4 species had at least 100 specimens collected during the 4 nights and their response to the various trap types were statistically analyzed. In order of decreasing abundance they were *An. crucians* (2535 females), *Cq. perturbans* (6 males, 796 females), *Cx. salinarius* (7 males, 581 females), and *Oc. canadensis* (110 females). *An. quadrimaculatus* was also statistically analyzed.

These analyses showed that the total mosquito collection was significantly greater (*P < 0.05*) with the CFG trap than any of the other trap types (Table 3). In terms of total mosquitoes collected, none of the other trap types were statistically different from each other. Much of the difference between the CFG and MMB-1 traps was the large disparity in the number of *An. crucians* caught in each trap type. This was the only species in which there was a statistical difference between the CFG and the MMB-1. In fact, the CFG caught 6.3X more

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Table 3. Mean (±SD) response of total mosquitoes collected and 5 most commonly collected species to various trap types located in a woodland wetland in Gainesville, FL, in Spring 1998.

<table>
<thead>
<tr>
<th>Species</th>
<th>CFG</th>
<th>MMB-1</th>
<th>NICOSIA</th>
<th>PRO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>653.3 (253.4) a</td>
<td>197.5 (86.9) b</td>
<td>148.0 (73.9) b</td>
<td>41.5 (13.2) b</td>
</tr>
<tr>
<td><em>Ochlerotatus canadensis</em></td>
<td>10.5 (5.1) a</td>
<td>6.5 (5.3) a</td>
<td>6.3 (3.5) a</td>
<td>4.3 (3.9) a</td>
</tr>
<tr>
<td><em>Anopheles crucians</em></td>
<td>496.8 (175.9) a</td>
<td>78.3 (63.9) b</td>
<td>50.3 (32.8) b</td>
<td>8.5 (5.5) b</td>
</tr>
<tr>
<td><em>Coquillettidia perturbans</em></td>
<td>83.0 (49.4) a</td>
<td>57.5 (10.4) ab</td>
<td>38.0 (25.4) ab</td>
<td>20.5 (9.0) b</td>
</tr>
<tr>
<td><em>Anopheles quadrimaculatus</em></td>
<td>4.3 (3.8) a</td>
<td>1.3 (1.3) a</td>
<td>0.8 (0.9) a</td>
<td>0.0 (0.0)a</td>
</tr>
<tr>
<td><em>Culex salinarius</em></td>
<td>48.0 (27.9) a</td>
<td>51.5 (16.3) a</td>
<td>42.3 (21.9) a</td>
<td>3.5 (3.1) b</td>
</tr>
</tbody>
</table>

\(^1\text{n = Four nights. The means in the same row followed by the same letter are not significantly (P > 0.05) different; Ryan-Einot-Gabriel-Welsh multiple range test (SAS Institute 1985).}\)
DISCUSSION

The data reported here indicate that propane-powered traps can capture up to 71.2% of host-seeking mosquitoes released into a confined space such as the test cage. They also collect a diversity of mosquito species under field conditions. In fact, the propane traps caught 17 of the 21 species caught in the field studies. The only trap that performed better was the CFG, which caught 19 different species. Neither the CFG nor the propane traps caught any Or. signifera, a species rarely caught in any trap, or Ps. columbiae, which was not abundant during these studies. In terms of the most abundant species, compared to the CFG, the propane traps did not do well in capturing An. crucians, but captured slightly more Cx. erraticus and Cx. salinarius. So these data do indicate that there may be a problem getting some species to respond in proportion to their abundance. This needs to be investigated further.

These studies were not designed to directly evaluate the potential of the propane traps for use as mosquito management tools, but do suggest that this may be a worthwhile endeavor. The field data show that the propane-powered traps collected 2.7X and 4.8X more mosquitoes than the MMB-1 in the spring 1997 and 1998 experiments, respectively, than the PRO traps. PRO traps are very similar in design and efficacy to CDC traps which, when baited with octenol and less CO2 (200 ml/min compared to 350 ml/min for the propane traps), were used to cause significant reduction in heavy mosquito populations in Collier County, FL (Kline and Lemire 1998).

Some attributes which make this a viable option are that these traps produce their own basic attractants (CO2, heat, and water vapor) and electricity. The trap’s catalytic combustion process converts twenty pounds of propane into 60 pounds of CO2, thus reducing the bulk of supplies to be carried to the field. This production of the basic attractants eliminates the need to find a commercial source of CO2, either as a compressed gas or as dry ice, which can be a difficult task to achieve in many areas of the USA and other places in the world. When it can be obtained, the use of compressed gas from cylinders requires the use of expensive regulators and flow devices to control the CO2 release rate and a rental fee is often required for the cylinders. Dry ice is often even more difficult to obtain than compressed gas. If the dry ice option is used, it needs to be resupplied to the traps that utilize this technique on a daily basis. Obtaining and storing the necessary quantities of dry ice can be a problem. Production of its own electricity means that the placement of the trap is not restricted to a source of line electricity. It also means that batteries and battery chargers are not required. This portability means the traps can be strategically placed in remote areas where mosquito problems occur. These traps also do not require daily maintenance. They will operate continuously as long as the propane fuel supply lasts. Because propane is readily available almost everywhere in the world, these traps can be transported and used almost anywhere. Another favorable feature is that few nontarget organisms are collected, so these traps are environmentally friendly.

With the uses and availability of chemical insecticides likely to become more restricted and more mosquito species becoming resistant to the available insecticides, alternatives such as attractant-baited traps need to be evaluated for their control potential. Studies need to be initiated now before the insecticide options become even more limited. Although it will take time to develop more efficient traps, these data show a progressive improvement in the efficacy of the propane-powered traps.

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