International Journal of Mosquito Research

ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2022; 9(2): 44-50

www.dipterajournal.com
Received: 16-01-2022
Accepted: 18-02-2022

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# Laboratory and Field Evaluation of an innovated adult-larval mosquito trap for the capture of dengue vector mosquitoes

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**DOI:** https://doi.org/10.22271/23487941.2022.v9.i2a.600

**Abstract**
The exact dates of the introduction of *Aedes aegypti* and dengue in the Philippines are unknown; however, the first records of the circulation of dengue in the Philippines among accounts from military hygiene records after the Philippine-American War were recorded in 1903 among U.S. soldiers stationed in bases in Manila. So dengue has long been confronting the country, but in 1953, dengue hemorrhagic fever was reported for the first time in this part of Asia. From then on, sporadic dengue cases have been reported in several parts of the country, and control measures were instituted only when necessary. Three (3) trap prototypes, trap x, y, and z, with different trap entrances, were tested for both adult and larval capture of dengue vector mosquitoes in the laboratory and field. Prototype trap x had openings for capture at the sides, prototype y had both side and top outlets for capture, and prototype z had a top entrance only for capture.

Release-and-recapture testing on the three trap prototypes revealed that prototype x (side entrance only) captured more *Aedes* mosquitoes at a low (n=3) to medium (n=25) number of mosquitoes released. Trap z (with top mosquito entrance only) captured more mosquitoes at high densities (n=50).

In the field, capture performances on *Aedes* dengue vector mosquitoes had no significant differences, including the comparator, Ovicatch™. Non-target mosquito capture and non-mosquito capture were comparatively lesser than the capture of *Aedes aegypti* and *Aedes albopictus*.

The prototype x showed *Aedes* capture performance most comparable to Ovicatch™.

**Keywords:** Dengue, *Aedes*, prototype, traps

## 1. Introduction

The exact dates of the introduction of *Aedes aegypti* and dengue in the Philippines are unknown; however, the first records of the circulation of dengue in the Philippines among accounts from military hygiene records after the Philippine-American War were recorded in 1903 among U.S. soldiers stationed in bases in Manila [1]. So dengue has long been confronting the country, but in 1953, dengue hemorrhagic fever was reported for the first time in this part of Asia [2, 3]. From then on, sporadic dengue cases have been reported in several parts of the country, and control measures were instituted only when necessary. From a national budget of $1.6 million in 1997 [4], the cost of dengue infections in the Philippines has risen to $345 million from data between 2008-2012, ranking fourth among the top 10 countries that have incurred the highest economic loss due to dengue [5, 6].

Dengue is an epidemic in the Philippines and ranks as one of the eight pervasive infectious diseases [5]. Dengue surveillance in the Philippines mainly depends on disease reporting units, direly wanting in systematic and sustainable vector control and management [7]. Last 2019, a dengue outbreak occurred with 429,409 cases, including 1,607 deaths reported nationwide [8].

In 2011, DOST and DOH, Philippines, developed a passive type of mosquito trap, the Presidential award-winning Ovicidal/Larvicidal Trap System, better known as O.L. Trap [9,10]. A massive provincial campaign was successfully launched between 2011 and 2013, but regrettably, the country-wide use for *Aedes* mosquito control and surveillance was not sustained. It was sold at an affordable price in the local drugstores 4-6 years ago, but it never landed in the local households of Cagayan de Oro City, where dengue is endemic. Part of the shortcoming of the O.L. trap was maybe its design. It was a small, black, tumbler-shaped mosquito trap that could easily topple and spill. Even if it was designed with an insecticide as a lethal ovitrap and coupled to a nationwide surveillance system network, it was a flawed design at the start. It was based on the old and classic Fay and Eliason's 1956 ovitrap design that required weekly maintenance and servicing. It could only hold a glassful of water as a growing medium for *Aedes* larvae. The potent component was mainly the organic insecticidal pellets that would stop larval development as soon as larvae emerged from eggs. But because the O.L. trap was an "open" type of trap, rain would quickly dilute the efficacy of its insecticide (pers comm, BHW).

Currently, the threat posed by the dengue vector mosquitoes, *Ae. aegypti*, and *Ae. albopictus*, has multiplied exponentially because these same mosquitoes have been documented as the very same vectors of Chikungunya and Zika [11, 12, 13, 14]. There are also has complications brought about by CoViD-19 that make definitive diagnosis difficult and health care management dangerous because of contamination threats.

Nowadays, there is so much development of innovative mosquito traps, many of which unfortunately are out of reach to the ordinary Filipino because they are too expensive. Most of the costly mosquito traps in the market today are either powered (electric or battery-dependent), scented (attractant-dependent), and lethal (insecticide-laced) traps. None of these are locally manufactured and even affordable to ordinary Filipinos, most of whom are below the poverty line.

The trap that was evaluated here was a passive type of trap. Passive traps are devices that do not use electrical sources. So, it can be used over and over again. This trap was considered inexpensive because it was fabricated with cheap, local materials that included ordinary, black plastic dippers, thin black slice foam (rubber), a typical nylon window screen, and a few short pieces of wires. The only material that was momentarily challenging to obtain was the glue board, which was the critical component for capturing adult mosquitoes. If the evaluation finds the trap favorable for mass utilization, there might be a chance for local production of this adhesive material.

Most vector control programs in the Philippines emphasize the reduction of immature *Aedes* density, the so-called "source reduction" method. However, researchers in vector control find this logistically challenging to sustain for long periods because the larval relationship to disease transmission is weak. Still, the dengue vector mosquitoes are best at breeding in cryptic habitats, and "search-and-destroy" is not always practical [15]. The active capturing and surveillance of adult *Aedes* density, on the other hand, is also problematic since mosquitoes on the wing are superbly elusive to capture, and their population dynamics are challenging to measure [16]. There is a need for developing and evaluating *Aedes* mosquito trap that is ideal for community-wide *Aedes* and dengue control and, at the same time, affordable and usable to low-income people. Generating a passive, safe, and inexpensive intervention tool may be just what is needed. Unlike the traditional ovitrap tool that mainly works to reduce dengue vector mosquitoes' offspring or larval population, the device tested here also captures gravid female Aedes vector mosquitoes. For the lack of an official name, the prototypes evaluated for testing were arbitrarily called traps x, y, and z. The study was primarily aimed to determine and compare the capture efficacy of each trap prototype on adult *Aedes* mosquito vectors at varying numbers of released *Aedes* female mosquitoes in caged tests. Furthermore, we also determined and compared the capture performance of each trap prototype and a commercial passive mosquito trap in field conditions based on the number of captured adult *Aedes* mosquitoes and the capture of non-target and non-target organisms other than mosquitoes. We also conducted further observations on larvae capture, water retention, luminance, and cost-benefit analysis of the trap utilization against the cost of dengue.

## 2. Methods and Materials

### 2.1 Establishment of Insectary

Adult female *Aedes aegypti* and *Aedes albopictus* were required for caged evaluation of trap prototypes in this study; hence adult mosquitoes were continuously reared from wild-caught larvae and pupae collected from tires. While at their pupal stages, *Aedes aegypti* and *Aedes albopictus* were laid in shallow trays and separated and transferred to different rearing boxes equipped with screened tops and sleeves for easy extraction of adults. The adult *Aedes* mosquitoes were collected from hatching boxes using a battery-operated vacuum cleaner and separately transferred based on species and sex to 12in x 12 in cages. The method used a handheld bulb aspirator with clear tubes to confirm the appropriate species based on scutal markings and other morphological traits by Savage's method [17]. The *Aedes* adult mosquitoes were sustained with 10%-sucrose soaked in flat cotton pads that were laid at the cage tops. Before egg-laying induction of *Aedes* females, these were sugar-deprived for 2-3 days in their separate cages, feeding them only water while maintaining the 10%-sucrose feeding for the males. In late afternoon hours, the female *Aedes* mosquitoes were blood-fed and, after an hour, transferred to another cage for breeding with males of the same species. Small and shallow water-filled glassware with filter paper cones were installed in the same cage to collect viable eggs. The eggs were then induced in simultaneous hatching in deoxygenated 10% nutrient broth, and the larvae were transferred to rearing bottles. After roughly two weeks, cohorts of emerged adult *Aedes* mosquitoes were sorted by sex, and the females were transferred to separate cages to be used for caged tests of mosquito trap prototypes.

### 2.2. Fabrication of the mosquito trap prototypes

The mosquito trap prototypes were arbitrarily designated as trap-x, trap-y, and trap-Z for the lack of a better name. These traps were fabricated from black-colored standard and ordinary polyethylene (plastic) water dippers. The prototype traps were a combination of two popular traps for mosquitoes: a) an upper *sticky trap* and b) a lower *autocidal (larval) trap* (Fig.1). The trap design's novelty was nested because it was a relatively inexpensive composite of two standard traps out in the market: a sticky trap and an autocidal larval trap. The upper sticky trap had a 2-in x 20.4-in non-toxic and non-drying glue board inside its interior wall that can stay sticky for at least 2months. The glue board material was made of black styrene board with an inner surface coated with a non-settling polybutylene adhesive (purchased from Atlantic Glue & Paste, Co, NY, USA). The lower larval trap portion had a thin screen and rubber ring floating on the water's entire surface, called "float," that kept any emergent mosquito from flying off its surface when they developed. This blockade to emerging adults drowns the eclosing adult mosquito without using chemical insecticide. So the trap can capture gravid, adult female *Aedes* mosquitoes by the glue-board inside its upper part, and at the same time, it can kill emerging adult mosquitoes by drowning. The last action of the trap helps prevent the onset of insecticidal resistance in vector species. The main difference between the prototypes was mainly the entrances by which the mosquitoes could enter the traps. Trap x had openings at the upper sides, trap y had side and top openings, and trap z had an opening at the top portion of the trap. The trap prototypes' lower component was poured with 1 liter of 4-wks old stored water. This mixture will serve as the only attractant for gravid female Aedes mosquitoes and a growing substrate. The prototype traps' dimension was 16 cm (diameter) x 22 cm (height), which allowed portability for indoor and outdoor installation of said trap if such traps were successfully proven useful.

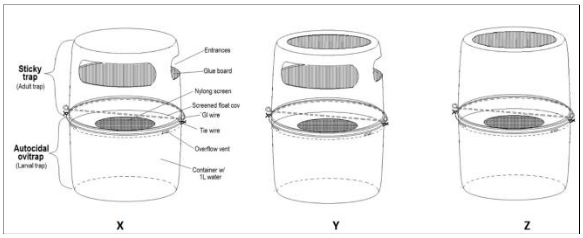


**Fig 1:** Trap prototypes for evaluation on their *Aedes* mosquito capture

### 2.3 Determination of capture efficacy of trap prototypes in caged tests

The efficacy of the trap prototypes in capturing target mosquitoes was determined by a release-and-recapture experiment, which was done daily for one month. Three (3) trap prototypes were placed inside three separate 1 m x 1.5 m x 1 m insect cages at three equidistant points inside the cage. The adult *Aedes* mosquitoes were released in the middle, top portion of the cage. In the three cages, the release of mixed *Ae. aegypti* and *Ae. albopictus* were in three categories: low (3), medium (25), and high (50). The release of *Aedes* mosquitoes was done in the early hours of the morning and terminated an hour after dusk. The number of *Aedes* captured at the glue boards was recorded each evening. One-way ANOVA was used to analyze capture performance in these caged tests.

### 2.4 Determination of capture efficacy of trap prototypes in field conditions

After the caged tests, groups of three trap prototypes were tested at ten different outdoor household locations in the village of Barangay Lumbia, following a randomized block design for testing capture efficacy on *Ae. aegypti* and *Ae. albopictus.* As a comparator, ten (10) US-patented autocidal gravid ovitraps, Ovicatch™ were also placed at nearby locations of the prototype trap clusters. The autocidal gravid ovitrap from the U.S. (Ovicatch™) served as the standard by which the trap prototypes' performance was compared [18].

During sampling, the glue boards containing adhered adult mosquitoes and larvae were collected once a month for 12 months. Sampling was always carried out at noon to limit exposure to Aedes mosquito bites and obtain independent variable data over a consistent period. Water in the traps was replenished every sampling time with 2-3 weeks old stored tap water from constantly covered buckets. No attractants were necessary, as was shown by preliminary tests. Glue boards containing adhered mosquito species and other organisms (non-target mosquitoes and non-mosquitoes) from the upper sticky trap as well as larval samples from the bottom autocidal ovitrap were collected monthly and brought to the laboratory in sealable and re-usable containers to be examined, identified, and counted under Andonstar examination digital microscope. Only the target mosquitoes, *Ae. aegypti,* and *Ae. albopictus,* were strictly identified. All other captured organisms were lumped together as either "non-target mosquitoes" (male or female) or "non-mosquito" organisms because picking them out of the adhesive often did not make further morphological identification possible. The counts of female target *Aedes* mosquitoes (*Ae. aegypti*, *Ae. albopictus*), female non-target mosquitoes, and all non-mosquito from the prototype traps and the Ovicatch™ were subjected to statistical analysis as the basis for the evaluation of the capture performance of the prototype traps. Photographs were taken on most samples for additional documentation and presentation. Relative humidity, temperature, and luminance (in trap interior) were taken and recorded on-site, while rainfall measurements were recorded a month ahead and lag-correlated. Analysis of variance was calculated on the monthly means of trap prototype captures and Ovicatch™ and their linear correlations to independent variables using PAST 4.02 software [19].

## 3. Results and Discussion

### 3.1 Determination of release and recapture efficacy of trap prototypes at indoor, caged tests

Trap performance is affected by the density of its target species, so the first order of investigation was to determine how many mosquitoes each prototype could capture [20]. The Ovicatch™ was not used during a laboratory preliminary release-and-recapture test because the AGO traps were designed for outdoor trapping. The different trap prototypes performed differently in capturing *Aedes* mosquitoes (Table 1). Analysis shows that at a low number of mosquitoes released for capture, traps x, y and z have significantly different means at low (3), medium (25) to high (50) based on the release and recapture method on *Aedes* mosquitoes. Results showed that prototype x performed well at a low and medium number of releases and recapture of *Aedes* mosquitoes. Still, at high densities of mosquito release, the prototype z did better.

**Table 1:** *Aedes* mosquitoes that were captured at low, medium, and high densities by trap prototypes x, y, and z.

| | Mean Capture | | | |
|---|---|---|---|---|
| **Trap prototype** | **Low N(3)** | **Medium N(25)** | **High N(50)** | ***p* values** |
| X | 1.32±0.09 | 6.13±0.28 | 12.77±1.08 | $2.63 \times 10^{-15} < 0.05$) |
| Y | 0.4±0.06 | 4.08±0.27 | 13.57±0.74 | $2.79 \times 10^{-09} < 0.05$ |
| Z | 0.67±0.07 | 3.93±0.26 | 17.53±1.08 | $7.79 \times 10^{-05} < 0.05$ |

Significant differences were detected between *Aedes* mosquito captures of the three trap prototypes in caged release-and-recapture experiments. *Aedes* captures were significantly different between prototype traps at low number released, n=3 ($p = 2.63 \times 10^{-15} < 0.05$), at medium number of mosquitoes released, n=25 ($p$= 2.79x10$^{-09}$<0.05), and high number of mosquito release, n=50 ($p$= 0.0007796<0.05). Figure 2 shows the relative means of mosquito capture by prototype z, x, and y in caged tests for fifteen days.

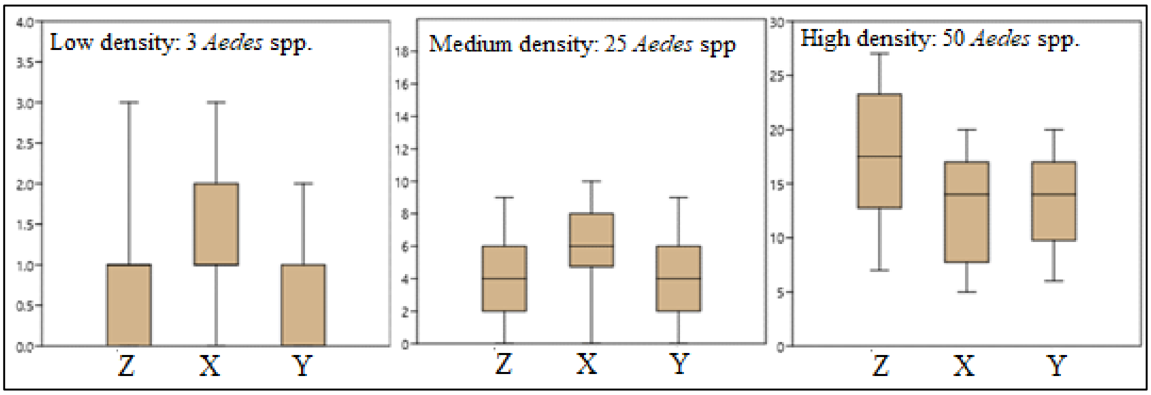


**Fig 2:** Mean capture of trap prototype x, y, and z

### 3.2 On the number of *Aedes* mosquito traps captured by the trap prototypes and commercial passive autocidal gravid ovitrap at field conditions

Between October 2018 to November 2019, there was ample rainfall. Fig 3 shows a few target mosquitoes, *Ae. aegypti*, and *Ae. albopictus* caught by the trap prototypes x, y, z, and Ovicatch™.

Means of the monthly catch of adult *Aedes* mosquitoes did not show significant differences between all traps tested (p=0.079>0.05). Although the Ovicatch™ topped the proportion of *Aedes* mosquito capture, all other prototype traps captured *Aedes* mosquitoes equally well. Interestingly, however, means of *Aedes* capture of the prototype trap-x had a remarkably comparable mean of captured *Aedes* mosquitoes to the *Aedes* capture in the Ovicatch™, even if their capture surface areas were massively different (40 sq.in., trap-x < 124 sq.in, Ovicatch™). A large number of *Aedes* mosquitoes captured over a one-year study period prove that the prototypes have competent capture performance on their target organisms: dengue vector mosquitoes (Table 2). Some samples of captured mosquitoes are shown in Fig 3.

**Table 2:** Total number of *Aedes* mosquito vectors, non-target mosquitoes, and non-mosquitoes captured by the trap prototypes in one year period, November 2018 to October 2019.

| Trap prototype | *Aedes* mean capture (no significant difference) | Nontarget mosquitoes | Non-mosquitoes |
|---|---|---|---|
| X | 32.07 ± 3.86 | 8.60 ± 0.84 | 10.06 ± 0.50 |
| Y | 24.83 ± 1.31 | 6.80 ± 0.89 | 9.55 ± 0.54 |
| Z | 19.89 ± 1.16 | 5.25 ± 0.73 | 9.57 ± 0.52 |
| Ovicatch™ (AGO) | 32.03 ± 4.00 | 8.48 ± 0.71 | 5.55 ± 0.33 |

**Fig 3:** *Aedes aegypti* and *Aedes albopictus* caught by trap prototypes and AGO

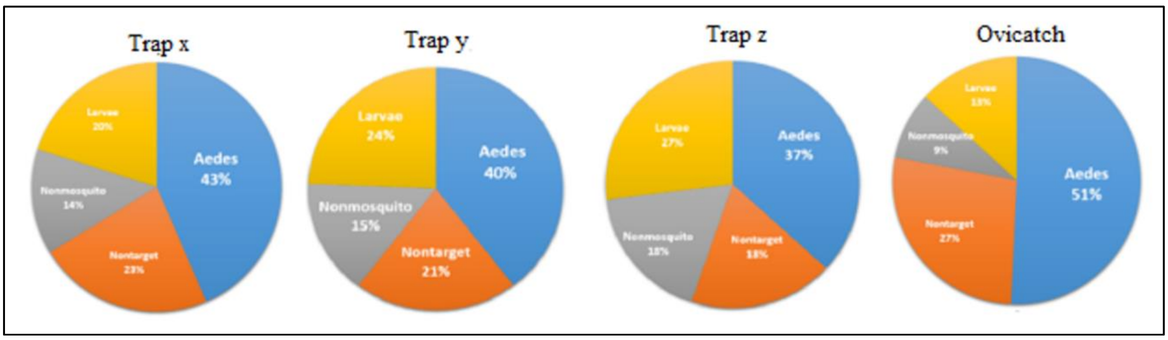


**Fig 4:** Relative percentage capture of *Aedes* mosquitoes, non-target mosquitoes, and non-mosquitoes in the trap prototypes y, z and Ovicatch

**3.3 The number of non-target mosquitoes caught by the trap prototypes and commercial autocidal gravid ovitrap.**

Non-target mosquitoes were also captured abundantly in the prototype traps and commercial autocidal gravid ovitrap, including other *Aedes* and *Culex* mosquitoes (Table 3, Fig 4). The highest number of female non-target mosquitoes caught were by prototype trap-x, followed by the Ovicatch™. Means of adult female non-target mosquitoes in the traps were found to have significant differences (p 0.023<0.05%). Tukey's pairwise post hoc test showed significant difference in Trap x ($p$= 0.042<0.05%) and trap z ($p$= 0.042<0.05%). The total number of non-target mosquitoes captured was highest in trap x, followed by Ovicatch™; Trap z captured the least number of adult female non-target mosquitoes (Table 3). Non-target mosquitoes caught also included suspected *Heizmannia*, *Uranotaenia*, and *Tripteroides* (Fig 5). Morphological examination of these specimens was hard because picking them out of the glue boards had not been mostly successful due to the non-yielding adhesive. Nevertheless, the prototype traps' capacity to capture other non-*Aedes* mosquitoes offers a great potential for the surveillance of other disease vector mosquitoes that are endemic. DNA barcoding would probably allow quick and easier identification of captured mosquito species.

**Table 3:** Total number of non- mosquito captured by the trap prototypes and AGO

| Trap | Total non-mosquito captures |
|---|---|
| Prototype Trap x | 120.8 ± 10.00 |
| Prototype Trap y | 114.6 ± 9.55 |
| Prototype Trap z | 114.9 ± 9.57 |
| Ovicatch™ | 66.7 ± 5.55 |

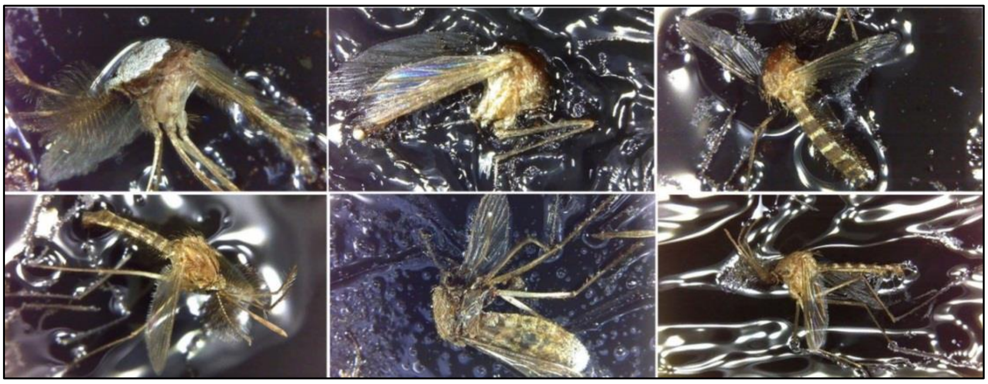

**Fig 5:** Non-target mosquitoes caught by prototype traps and AGO

**3.4 On the number of non-mosquitoes captured by trap prototypes and AGO**

The non-mosquito specimens captured by the prototypes and Ovicatch™ consisted of various insects and a few small invertebrates and vertebrates. Among the non-Culicidae (non-mosquito) caught, as shown in fig 6, were leafhoppers (A, Cicadellidae), midges (B, Chironomidae), ladybird beetles (C, Coccinellidae), ants (D, Formicidae), darkling beetles (E, Tenebrionidae), skipper flies (F, Piophilidae), termites (G, Hodotermitidae), spiders (H, unclassified). On a few occasions, lizards, snails, and small frogs were also found on the glue boards of the traps. The most common non-mosquito captured were the midges abundant in household gutters or canals.

The highest non-mosquito capture was obtained by trap-x, and the least was by Ovicatch™ (Table 4, below). Significant differences between captures of non-mosquito organisms were detected between the traps (p=5.15 x $10^{-08}$<0.05). Tukey's pairwise test showed significant differences in non-mosquito captures was between all trap prototypes and Ovicatch™.

The high capture of non-mosquitoes provides evidence of the usability of the traps for surveillance of other arthropods, especially insects if these traps were to be installed in the wild. The traps could be used for insect diversity studies in forests or grass fields where the relative abundance of different insects is required.


**Fig 6:** Some of the non-mosquito species captured by the trap prototypes and AGO in the field: A, Cicadellidae, B, Chironomidae, C, Coccinellidae, D, Formicidae, E, Tenebrionidae, F, Piophilidae, G, Hodotermitidae, H, Arachnid

**3.5 On the number of larvae captured by the trap prototypes and commercial autocidal gravid ovitrap**

The larvae collected from the traps (N=6,363) comprised only 1.18% of all the different specimens caught by the traps from one year of field testing. The highest larvae collection was by trap-y with a monthly mean of 15.29 ± 1.13, and the lowest larval catch was by the Ovicatch™, monthly mean was 7.2 ± 1.36 (Table 4). The larvae caught in the trap prototypes, with a few collections of chironomids and non-identifiable larvae, were mostly *Ae. aegypti* or *Ae. albopictus.* Larval development was robust in the prototypes. During subsequent monthly samplings, some remnants of detached wings and carcasses could be seen floating on the water's surface, indicating that its autocidal function was working well. It had an excellent capacity to kill developing or emerging mosquitoes by drowning them under the rubber and nylon netting ring floating on the water's surface. The Ovicatch did not have this feature; but instead, it had a screen over its container. Relatively few larvae were caught in the bucket.

**Table 4:** Total number of larvae caught by the trap prototypes x, y, z and Ovicatch

| Traps | Total larvae | Mean |
|---|---|---|
| Prototype x | 1778 | 14.81 ± 1.38 |
| Prototype y | 1835 | 15.29 ± 1.13 |
| Prototype z | 1749 | 14.57 ± 0.99 |
| Ovicatch™ | 1001 | 7.28 ± 1.47 |

**3.6 On the amounts of water retained in the trap prototypes and commercial autocidal gravid ovitrap**

Among the traps, the highest water retention was shown to be Ovicatch™, due mainly to the large water capacity (5 liters). The water capacity of all prototype traps was only 1.4 liters. Among the trap prototypes, trap x retained the most water, and the least retention of water was in trap z.

Significant differences in water retention were detected among the trap prototypes ($p=9.76x10^{-11}<0.05$). Tukey's pairwise test indicated substantial differences between trap x and trap z ($p=8.15x10^{-11}<0.05\%$) and between trap x and trap y ($p=3.30x10^{-07}<0.05\%$). The least significant differences detected were between trap-y and trap-z ($p=0.01203<0.05$). Higher water retention in trap x than in traps y and z is probably due to its openings at the sides; water evaporation is less likely lost than through the top openings of traps y and z.

**3.7. comparison of luminance of the prototype traps**

*Ae. aegypti* is typically a diurnal mosquito that may rely more on optical cues, such as the contrast between dark container openings and water surface (specular) reflections, for the selection of resting and oviposition sites than night active mosquito species [21]. In indoor surveillances and sampling, it was commonly observed that adult *Ae. aegypti* prefer to rest in darker locations and on dark, non-reflective surfaces such as clothing [22, 23].

Test of equality between means of luminance measured at the interior of the trap prototypes has shown significant differences between lumen measurements between traps ($p=5.45x10^{-50}<0.05$) (Table 5). Tukey's pairwise test indicates a significant difference between prototype x and the two other prototypes.

**Table 5:** Luminance of Prototype Traps in the Interior

| | Prototype | | |
|---|---|---|---|
| | x | y | z |
| Mean | 640.5 ± 16.0 | 1840.12 ± 83.6 | 1630.93 ± 100.4 |

**3.8 Cost-Benefit analysis if traps are to be used for community-wide dengue vector mosquito control:**

During this investigation, a request following Health Privacy Code A.O. 2016-0002, Rule No. 10 entitled "Health Research" was submitted to the head of hospitals requesting information on actual billing and cost of medical assistance provided to confirm admitted dengue cases. The request letter also included the purposes of the requested information with clear assurance to the hospital authorities and board members of the observance of non-disclosure of any personal information. And that apart from the costs, only the patient's address will be obtained from the records. However, only one hospital responded to the request. It allowed the divulgence of past hospital records of dengue patient billing and medical assistance for research on the cost of dengue in terms of personal expenses and government financial aid.

For the purposes of establishing a cost-benefit analysis for the trap system described in this study, a one-year monthly costing in dengue cases from hospital records was analyzed. In that one-year record of hospitalizations and medical management of confirmed dengue cases, monthly patient expenses and government medical assistance entailed an average of PhP 21, 518.43 (~$400), and 8,679.86 (~ $200), respectively. The smallest hospital bill for dengue patients was PhP 4,416.65 (~ $90), and the most prominent hospital bill was PhP 604,188.35 (~ $125).

During the said year, 1,413 dengue cases were admitted to that hospital with a total hospitalization cost of PhP 44,066,465.00 (~ $850) and a total government subsidy of PhP 12,055,871.00 (~ $220). The total one-year personal cost for families of the 1,413 patients was PhP 32,010,594.00 (~ $625)! However, no costing of lost person-hours was obtained due to the boundaries defined by the Health Privacy Code.

As for the Fabrication and utilization of the dengue mosquito traps under investigation, the costs for each trap was PhP 45.00 (~ $0.85), and if fabricated to the minimum required number for a small 2-3 bedroom household which was 4-8 units of mosquito traps, the actual household cost for the traps would be between PhP 182.00 (~ $3) to 364.00 (~ $7) per household.

This cost of PhP 316.00 (~ $6)for obtaining an efficient dengue mosquito capture and protection for the entire family far outweighs the financial burden a family suffers when a member is hospitalized due to dengue. And if the cost of the current trap were compared to the cost of commercial traps in the market, the cost would be more affordable and practical. Commercial traps in the market are not cheap. The cost of installing these commercial traps based on mosquito trapping protocol would make it even more financially problematic for the more vulnerable sectors of society.

**4. Summary and Conclusions**

Based on the analysis results, two prototype traps performed best at indoor capture: trap x captured adult female *Aedes* best at low to medium indoor densities. In contrast, trap z captured mature female *Aedes* best at high indoor densities. However, since adult *Aedes* mosquitoes are naturally low-density mosquitoes in households, trap x is the best indoor trap prototype.

Adult female *Aedes* capture was equally high at field testing in all trap prototypes and the Ovicatch™. However, based on the capture of non-target mosquitoes, non-mosquitoes, larvae, and comparisons on water retention and luminance at the trap interior, prototype x excels in all these criteria.

This study provides a preliminary analysis of the performance of a locally made mosquito trap that captures both adult and immature mosquitoes. Being a composite of both the sticky trap and autocidal ovitrap, the trap evaluated in this study may be helpful in control and surveillance.

As an innovative mosquito trap, additional improvements can be made: e.g., captured adult mosquitoes can be detached from the glue boards and subjected to biochemical analysis to detect dengue viruses and other pathogens. The float of the trap can be treated with pyriproxyfen to contaminate ovipositing adults. If they successfully fly from the trap, they can unwittingly disseminate the larvicide to cryptic and challenging to reach larval habitats and inhibit adult emergence in those habitats.

Because the traps are very portable and small, these traps can be used both indoors and outdoors. Since it is a passive trap, no electrical power input is required by the trap. These traps can be installed for sustainable periods.

**Acknowledgments**

The authors wish to thank the following: the Atlantic Paste & Glue Company, Inc, New York, for providing the Ovicatch® as a comparator trap and the glue boards needed for this study; Dr. Astrid L Sinco, of XU-Biology Department for providing the raw materials of the adult-larval traps of this study; the Angels of Cebu social group and Mr. Caesar Acenas for providing the funds for mobilization and other materials; to Dr. Meneleo Navarro for the accommodations and storage of the traps before their deployment in selected communities in CDO; to Mrs. Gina Malferrari Obsina for the financial assistance; the barangay council and chairpersons of the local government units of barangay Carmen and Kauswagan for granting the barangay council resolutions and BHW support needed for the conduct of this study.

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