EFFICACY TRIALS AND PERFORMANCE EVALUATION OF FIVE FLEA TRAPS IN BAMAKO, MALI

MOHAMED M. TRAORE¹, AMY JUNNILA², EDITA E. REVAY¹, ALEXEY M. PROZOROV⁶, AIDAS SALDAITIS⁴, RABIATOU A. DIARRA¹, ROMAN V. YAKOVLEV⁵,⁶, ASSITAN DIAKITE¹, GERRGELY PETRANYI¹, AND GUNTER C. MULLER¹,²

¹Malaria Research and Training Center, Faculty of Medicine, Pharmacy and Odonto-Stomatology, University of Bamako, BP 1805 Bamako, Mali
²Northwestern Scientific, Thunder Bay ON, Canada P7G 0K9
³Kuvin Center for the Study of Infectious and Tropical Diseases, Hebrew University, Hadassah Medical School, Jerusalem, Israel, 91120
⁴Nature Research Centre, Akademijos str. 2, 08412 Vilnius-21, Lithuania.
⁵Altai State University, Lenina pr. 61, 656049 Barnaul, Russia.
⁶Tomsk State University, Laboratory of Biodiversity and Ecology, Lenina pr. 36, 634050 Tomsk, Russia.

Corresponding author: Gunter C. Müller: Guntercmuller@hotmail.com
Subject Editor: Rui-de Xue

ABSTRACT

Five off the shelf commercially available flea traps were tested for their efficacy against the cat/dog flea Ctenocephalides felis. Two traps were significantly better at catching fleas than the remaining three which performed very poorly. It is presumed that the unique combination of attractive features of the best performing Flea Catcher trap are what makes it so effective, including three large, intermittently illuminated light panels simulating host movement and additional synchronized lights in green wavelength pointed downwards to the flea catching base. Additionally, the Flea catcher has the largest surface area. Only two traps, the Flea Catcher and myFleaTrap were non-attractive to non-target insects, while the other traps caught large amounts of other insects quickly blocking the glue panels.

Key Words: Ctenocephalides felis, attractive features, flea traps, intermittent light, 510-550 nm light, non-target insects.

INTRODUCTION

The biting flea Ctenocephalides felis, also known as the “cat flea”, is a major nuisance to dogs and cats as well as their owners by causing flea-related dermatitis (Rust and Dryden, 1997) as well as several diseases of medical and veterinary importance. C. felis transmits Dirofilaria immitis (dog tapeworm; Rust 2017) and the rickettsial diseases Rickettsia felis (Nelson et al. 2018; flea-borne spotted fever) and Rickettsia typhi (Blanton et al. 2016; murine typhus) (Bitam et al. 2010; Rust 2017).

Cat flea infestations on dogs and cats can be treated using oral or topical chemicals such as methoprene and pyriproxyfen, fipronil and imidacloprid respectively (Rust 2010). Topical products do not always stop fleas from engorging and causing flea allergy dermatitis and this was recognized as a reason for trapping before fleas get on the host (Dryden 2009). There are, however, problems with using chemicals to control fleas. For example, even though fipronil and imidacloprid can be up to 95% effective in killing adults for more than 28 days, reinfestations after this period can occur (Shipstone and Mason 1995). Most of these can be attributed to non-compliance with application instructions. Resistance of flea populations to several chemical agents has been shown to occur, including permethrin (Bossard et al. 2002, Lemke et al. 1989), pyrethroid, and organo-phosphates (Bossard et al. 1998).

The adverse effects of chemical control have driven the need to develop efficient flea-traps that can supplement, if not match, the effectiveness of chemical controls on the market. Since fleas use both thermal and visual cues (Müller et al. 2011) for targeting hosts, most traps available on the market use incandescent light bulbs for attracting stimuli (unpublished observations). Following a thorough investigation by Dryden and Broce (1993), it was discovered that the optimal light wavelength to attract C. felis was in the range of 510-550 nm), and that
periodic interruption of the light source dramatically increased the trapping efficiency. This feature led to comparative trials testing of several commercially available flea traps (Müller et al., 2011), including “myFleaTrap,” and “Flea Catcher.” Both use intermittent light in the correct wavelength. The current study is a comparative study of five commercially available traps in heavily cat flea infested environment in Mali, West Africa.

MATERIALS AND METHODS

Traps were delivered in their original packages. Four of them originated from China (instructions in Chinese), and one from Europe with an English user’s manual. The traps tested and their attractive features are listed below (some names may differ from the original Chinese). For an overview, see figure 1, table 1.

Table 1. Overview of traps used for this study.

<table>
<thead>
<tr>
<th>Trap name</th>
<th>Light source</th>
<th># of lights</th>
<th>Moving/non-moving</th>
<th>Additional features (if any)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flea Catcher</td>
<td>510 nm Green LEDs</td>
<td>6</td>
<td>non</td>
<td>Lights blink intermittently; larger than My Flea Trap</td>
</tr>
<tr>
<td>My Flea Trap</td>
<td>525 nm Green LEDs</td>
<td>2</td>
<td>non</td>
<td>Lights blink intermittently</td>
</tr>
<tr>
<td>Bulb Trap</td>
<td>White LED</td>
<td></td>
<td>non</td>
<td>Strong Light; No other apparent features</td>
</tr>
<tr>
<td>Biomimicry FT</td>
<td>White and Blue LEDs; 4 white; 1 blue pendulum</td>
<td>moving</td>
<td>No other apparent features</td>
<td></td>
</tr>
<tr>
<td>JinXin Trap</td>
<td>White LED</td>
<td></td>
<td>non</td>
<td>No other apparent features</td>
</tr>
</tbody>
</table>

*All traps utilize a sticky glue-board to capture attracted fleas

Trap descriptions

1: Flea Catcher. This trap can be opened in laptop like mode. It is equipped with a glue board protecting grid, three green LEDs independently oriented down and to the left, down and towards the middle and down and to the right (covering a total an angle of almost 180 degrees). Three independent light panels at the backside of the trap with different pet shapes illuminated by green LEDs (510 nm). In operation mode, the upper LEDs are synchronized with the corresponding backside panels (in pairs: left, center right), each pair is illuminated for several minutes before off time of 5 seconds followed by illumination of the next pair to be followed again by an off period. This on-off mode is repeated during trap operating time.

2: My Flea Trap. Features are similar to the Flea Catcher but with significant differences. The Flea Catcher is considerably larger being therefore a better target for jumping fleas. Furthermore, this trap has 3 LEDs and 3 corresponding light panels versus only 2 LEDs of my Flea Trap. The Flea Catcher covers a wider angle (180 degrees) compared to my Flea Trap.

3: Bulb Trap. A simple white and strong LED light source, bulb like, mounted above a glue board without any other apparent features.

4: Biomimicry FT. Square large trap body with a glue board on the bottom, illuminated by 4 white LEDs from above. In the center is a moving pendulum illuminated by a blue LED. Attraction features consist of the light in combination with movement (ie: a moving pendulum).

5: JinXin Trap: A simple white LED light source (panel-like) mounted above a glue board without any other apparent features. This trap, while similar to the Bulb Trap, is significantly smaller.

Experimental set-up

The traps were tested in five different storage rooms (A, B, C, D, E), of 20 m² each, within the same farm in rural Mali. Rooms were rotated clockwise to avoid positional bias. There were more than a dozen cats and several dogs on this farm. The animals were regularly visiting the storage rooms for sleeping and catching rodents.

The animals and rooms were infested with cat fleas (Ctenocephalides felis). The traps were operated
separately in five of these storage units and rotated to different rooms daily to avoid positional bias. The traps were operated for ten consecutive days/night, rotating twice through the five selected rooms resulting in ten repetitions, for 24 h. Fleas and other collected insects were counted daily and removed from the glue boards.

Statistics
Student t-tests were performed to check for statistical differences between the efficiencies of the five traps while One Way Analysis of Variance (ANOVA) was used to rank significance. All statistical tests were performed with GraphPad Prism 9.00 for windows (GraphPad Software, La Jolla California, USA).

RESULTS
The two white LED “only” traps (JinXin and Bulb traps) performed very poorly at catching fleas. At the same time, they attracted large numbers of other flying insects resulting in covered, useless glue boards within one or two days (not shown). The Biomimicry FT performed slightly better at catching fleas (Figure 2) but still caught far more other non-target insects resulting in covered glue boards within 3 or 4 days. My Flea Trap caught, on average, 7.2 times more fleas than the Biomimicry trap with few non-target insects; the glue board was less than 10% covered with fleas and other small insects, (mainly beetles) after the 10 days study.

The best performing flea trap was the Flea Catcher (Figure 2), outperforming the Biomimicry trap 12.3 times. Compared to my Flea Trap, its flea catches were approximately 70% higher. During the trial, fleas were observed to jump into the trap as soon as light was switched off. The presumed mechanism of action of the trap: the fleas were reacting to the relative darkness as a potential host passing in front of a light source. This trap is mainly catching fleas and very few other flying insects. The Flea Catcher caught also slightly more non-target insects, mainly small beetles, as my Flea Trap but this was not an issue because of the larger glue board area.

DISCUSSION
With the demand for alternatives to chemical pest control, increasing numbers of flea traps have come to the market. There have been few peer reviewed publications (Müller et al. 2011) confirming the efficacy of flea traps. In this study, we tested five commercially available traps for their ability to attract and catch the common cat flea. The Flea Catcher and my Flea Trap by far outperformed all other tested flea traps. This may be because of the contrast of light pulses the traps use to mimic a host passing by (Rust and Dryden 1997; Kramer and Menke 2012) or to the wavelength of light to which the fleas are attracted (Müller et al 2011). In 1993, Dryden and Broce developed a trap which had a yellow-green light (515 nm) and a 10 min-5 sec on-off cycle, and this trap was able to 86% clear a 10 m² room of C. felis in 20 h.

Another important point is that the two traps were mainly attracting fleas and not large amounts of other insects, such as moths, clogging the glue board. Interestingly, the smaller attracted storage beetles looked very much like fleas which can give consumers the impression of higher efficacy.

Also noted is that the Flea Catcher significantly outperformed my Flea Trap (Table 2). Some possible reasons for this are: the Flea Catcher has pulsing light as well as large, illuminated panels creating color contrast, and catching the attracted fleas on a much larger glue board base. Interestingly, the best performing traps were the ones with a green-yellow light source and the best trap had this light blinking for 10 min on 5 sec off in intervals (Dryden and Broce., 1993)

The label claims of the XinJin trap, the Bulb Trap, and the Biomimicry traps, that they could effectively catch fleas, could not be confirmed in this study. On the contrary

<table>
<thead>
<tr>
<th>Trap Name</th>
<th>Mean Diff</th>
<th>Adjusted P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomimicry vs. JinXin</td>
<td>0.5</td>
<td>0.9768</td>
</tr>
<tr>
<td>Biomimicry vs. Bulb Trap</td>
<td>1</td>
<td>0.7693</td>
</tr>
<tr>
<td>Biomimicry vs. My Flea Trap</td>
<td>-10.2</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Biomimicry vs. Flea Catcher</td>
<td>-17</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>JinXin vs. Bulb Trap</td>
<td>0.5</td>
<td>0.9768</td>
</tr>
<tr>
<td>JinXin vs. My Flea Trap</td>
<td>-10.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>JinXin vs. Flea Catcher</td>
<td>-17.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Bulb Trap vs. My Flea Trap</td>
<td>-11.2</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Bulb Trap vs. Flea Catcher</td>
<td>-18</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>My Flea Trap vs. Flea Catcher</td>
<td>-6.8</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

****Highly significant
ns - not significant

Figure 2: Observed flea catches of the 5 traps during 10 repetitions (24 hrs. operation time).
these traps attracted large numbers of non-target insects including moths which clogged the complete glue boards within a few days.

In conclusion, there is wide variety in the effectiveness of flea traps on the market, all of which claim to be effective at catching these pests. The traps in this study, which half-heartedly followed scientific research into attractive features, caught 10X+ fewer fleas and many more non-targets. On the other hand, the Flea Catcher be considered user friendly.

REFERENCES CITED


Rust MK. 2010. How do flea control products kill fleas. NAVC Clinical Brief, 8:82-4.

Rust MK. 2017. The biology and ecology of cat fleas and advancements in their pest management: a review. Insects, 8:118.


Received: 30 December, 2022. Accepted: 20 March, 2023. Published: 30 June, 2023.