



Short communication

## A novel window entry/exit trap for the study of endophilic behavior of mosquitoes



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### ABSTRACT

To overcome the limitations of currently used window entry/exit traps, we developed an efficient new glue net entry/exit trap (GNT) that is economical, easily transported and assembled, and can be utilized for a variety of studies which aim to investigate the dynamics of mosquito movements between indoor and outdoor habitats. Cage experiments were conducted to determine what percentage of mosquitoes trying to pass through the netting are actually being caught. The GNT caught 97% of female and 98% of male *Anopheles gambiae* s.s., as well as 97.5% of female and 98% of male *Culex pipiens* attempting to cross into a bait chamber adjoining the release cage. During a six day field study, the bedroom windows of 12 homes in Mali were fitted with entry/exit GNTs. Traps without glue were fitted over the inside and outside bedroom windows of an additional 12 homes as a control. A total of 446 *An. gambiae* s.l. were caught attempting to exit dwellings while 773 *An. gambiae* s.l. were caught attempting to enter. The number of males and females attempting to exit dwellings were roughly similar (215 and 231 respectively) while there was a slight difference in the number of males and females trying to enter (382 and 430 respectively). Pyrethrum spray catches (PSC's) conducted inside the dwellings on the last day of the experiment yielded only six females and a single male.

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### 1. Introduction

There are a wide variety of traps available for sampling populations of exophilic mosquito species (for review see Silver, 2008). However, many of the important vector species carrying malaria, filariasis, arboviruses and other pathogens are endophilic and so for epidemiological studies, samples of subpopulations such as blood fed females, those old enough to vector pathogens, and males closely associated with them might be more desirable than sampling the mosquito population as a whole (Bradley et al., 1949; Akiyama, 1973; Dimena et al., 2006). Indoor sampling is usually performed with different types of manual and battery powered

aspirators, light traps, hand nets, and pyrethrum spray catches (PSC), while mosquitoes moving either in or out of houses are traditionally collected with different types of entrance and exit traps (WHO, 1975; Silver 2008). The latter are of great importance, as they can provide information on the state of the investigated specimens at crucial physiological stages, before or after interaction with human or animal hosts.

According to Silver (2008), the most commonly used window exit/entrance traps are the Muirhead-Thompson traps, and their various modifications, which are fitted over windows to catch mosquitoes (Muirhead-Thomson, 1947; Muirhead-Thomson, 1948). However, these traps are bulky to transport and the opening on the trap sometimes allows mosquitoes to escape back into the home. Rachou exit traps (Rachou et al., 1965) are also fitted over windows and have a non-restrictive opening which prevents escape of mosquitoes back into the home, but because of this type

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**Fig. 1.** Close-up of two *An. gambiae* s.l. caught in the GNT. Mosquitoes trying to pass the netting get caught by the glue. Note the body almost never touches the glue.

of opening, frequently needs to be changed over a collection period and requires much manpower. Because the previous traps were too bulky to transport to the field in large numbers, Shidrawi (1965) developed the collapsible window trap. The drawback of these traps is that they are complicated to construct, requiring that wire mesh be welded to a collapsible metal frame.

Our research on mosquito sugar-feeding behavior in rural areas of West Africa necessitated simple means of specimen collection in and around houses. Specifically, we required a simple method for trapping mosquitoes while trying to enter or exit human dwellings. Our goal was to design and test a new window entry/exit trap that can be easily constructed, easily transported, is cost effective and, at the same time, provides a reliable measure of the number of mosquitoes attempting to enter or exit human homes.

## 2. Materials and methods

This study was conducted in two parts. First, cage experiments were conducted to test the efficiency of the trap design, specifically if the mesh size and glue paint were effective at capturing different species of mosquito without destroying the specimen. This was accomplished by using colored dye to mark the percentage of mosquitoes that escaped capture by the net. Importantly, this also provided a prediction of what percentage of mosquitoes should be caught once the trap was deployed in the field. Next, a six day field study in Kenieroba village, southern Mali was conducted to evaluate the trap's ease of use and effectiveness at catching mosquitoes entering or exiting local dwellings.

### 2.1. Trap construction

Our glue net traps (GNTs) were assembled from rigid, dark green plastic garden fencing with 0.2 cm wide net separated by 0.8 cm square holes (True Traders Ltd, Great Yarmouth, UK). Frames were constructed by overlapping two layers of 1.0 cm thick plywood fixed with nails and wood glue (LePage® Wood Glue, Henkel Consumer Adhesives Inc. Avon, OH, USA). The netting was sandwiched between the two wooden frames and secured with screws. Next, the net was painted with glue (Tanglefoot® Glue, Tanglefoot Company, Grand Rapids, MI, USA) to capture insects trying to land or pass (Fig. 1).

The dimensions of the fully constructed GNT's used in the field studies were 70.0 cm length x 60.0 cm width x 2.2 cm thick and were designed to fully cover typical local windows. Traps were mounted over the windows by suspension from rope secured by a nail (Fig. 2a, b). By mounting one GNT outside the window and

### a) Exterior window GNT



### b) Interior window GNT



**Fig. 2.** Installation of GNTs on the (a) exterior of a bedroom window, and (b) the interior window.

one inside, both entering and exiting mosquitoes could be collected separately. GNTs were mounted simultaneously on inside and outside bedroom windows of 12 homes, and traps without glue were mounted over bedroom windows of an additional 12 control dwellings. Collection of trapped specimens was performed each day for 5 consecutive days; day 6 of the study was reserved for PSC catches.

### 2.2. Cage experiments

Before widespread deployment in the field, it was critical to test how effective a GNT would be at capturing mosquitoes by determining what percentage would be caught trying to pass the net. For this purpose, a two-chamber system was constructed from strong wire and mosquito netting. The release chamber was rectangular with dimensions of 1.2 m length x 0.6 m width x 0.6 m high, with an opening of 0.4 m x 0.4 m in the center of one of the 0.6 m x 0.6 m sides. A wooden frame (as described above) was attached with wood glue to the 10 cm wide gauze flaps surrounding this opening, which could be closed at the external side of the wooden frame with a sliding door made from Plexiglas. The feeding chamber was a nearly exact copy of the release chamber but instead was a cube with dimensions of 0.6 m length x 0.6 m width x 0.6 m high. It was equipped with two 250 ml beakers with cotton wicks, one

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