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Field evaluation of a semi-automatic funnel trap targeted the medically important non-biting flies

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ABSTRACT

Bait-trapping is a useful approach for monitoring fly population dynamics, and it is an effective tool for physical control of pest species. The aim of this study was to test a newly developed semi-automatic funnel fly trap with some modifications of the former prototype fly trap to study medically important fly population density. The efficacy of the semi-automatic funnel trap was assessed by field sampling during July 2013-June 2014 using 1-day tainted beef offal as bait. The modified semi-automatic funnel traps were able to capture a total of 151,141 adult flies, belonging to the families: Calliphoridae (n = 147,248; 97.4%), Muscidae (n = 3,124; 2.1%) and Sarcophagidae (n = 769; 0.5%), which are the medically important fly species. Among the total of 35 species collected, *Chrysomya megacephala* (Diptera: Calliphoridae) (n = 88,273; 59.95%), *Musca domestica* (Diptera: Muscidae) (n = 1,324; 42.38%) and *Boettcherisca peregrina* (Diptera: Sarcophagidae) (n = 68; 33.01%) were the predominant species of each family. High number of flies was captured in forest area, representing 42.47% (n = 64,197) of total specimens. Female flies were trapped more than male with total sex ratio of 0.37 male/female. Flies were trapped throughout the year with peak population in summer. Peak activity was recorded in the afternoon (12.00–18.00 h). In summary, the modified semi-automatic funnel fly trap can be used for field collection of the adult fly. By setting the timer, population dynamics, diversity, and periodic activity of adult flies were determined.

1. Introduction

Non-biting filth-breeding flies [blow flies (Diptera: Calliphoridae), house fly and their allies (Diptera: Muscidae), and flesh flies (Diptera: Sarcophagidae)] have evolved to live closely associated with humans (synanthropic flies) as nuisance pests (Graczyk et al., 2001). They are medically important flies worldwide playing a major role in spreading enteric pathogens. From a medical point of view, some species have a positive aspect as a forensic tool since larvae collected from human corpses can be used as entomological evidence in forensic investigations, particularly when estimating the minimum postmortem interval (PMI_{min}) (Sukontason et al., 2007; Syamsa et al., 2015). Conversely, in a negative sense, adults are not only mechanical carriers of various pathogens to humans (e.g., bacteria, viruses and parasites), but their larvae also act as myiasis-producing agents (Sacca, 1964; Norris, 1965). Because fly populations increase rapidly due to their relatively short developmental cycles and large egg production in females (Spradbery and Vogt, 1993; Sukontason et al., 2008), control of excessive fly populations is needed to prevent negative impact of these pests.

Several fly control methods [e.g., chemical (insecticides), biological (parasites and predators), and mechanical methods (baited trap and sticky trap) have been reported previously (Thomas and Jespersen, 1994; Hogsette, 1999; Nurita and Abu Hassan, 2010). Daily trapping of insects generates important information on target population dynamics that may help in determining control strategy (Aldridge et al., 2015).Sampling fly populations by hand netting is possible when there

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are visible concentrations of flies (Norris, 1965). Tent-trapping is limited for general application (Macleod and Donnelly, 1957) and commonly used to study haematophagous dipterans (Krajacich et al., 2014). Grill-counting and adhesive papers/sticky traps allow quantification of population of insects (Raybould, 1966), but cause problems in species identification. Bait-trapping is the most useful method for studying adult fly population (Norris, 1965), and is generally used for qualitative measurement of populations, but the kind of flies caught depends on the material used as bait (Bishopp, 1916; Schoof, 1952). Additionally, trapping can be a cost-effective method to reduce the number of adult flies without negative impacts on humans and environment (Thomas and Jespersen, 1994).

A wide variety of bait-trapping have been used for monitoring or reducing adult fly populations. For instance, the standardized bait trap reported by Vogt and Havenstein (1974) was designed for blow fly studies. The bottle trap was successfully used to study variability of necrophagous Diptera in urban and rural settings (Hwang and Turner, 2005). The Alsynite trap, LuciTrap, and Terminator trap were employed for trappings in the cattle feedlots in Australia (Urech et al., 2012). A fly monitoring program using baited traps would be most effective when the traps are used during the periods of greatest fly activity. In Thailand, little information pertaining periodic activity of medically important flies has been reported (Sucharit and Tumrasvin, 1981a), because previous studies in Thailand commonly involved use of sweeping nets (Sucharit and Tumrasvin, 1981b; Bänziger and Pape, 2004; Vitta et al., 2007; Moophayak et al., 2014Sucharit and Tumrasvin, 1981b) and funnel bait traps (Sucharit and Tumrasvin, 1981a; Lertthamnongtham et al., 2003; Bunchu et al., 2012; Chaiwong et al., 2012, 2014). Recently, a prototype "easy-to assemble" funnel trap was developed (Ngoen-klan et al., 2011; Klong-Klaew et al., 2014). Although it is lightweight and portable, making it ideal for use in remote areas (Ngoen-klan et al., 2011), installing and replacing bait/traps to monitor population dynamics within 1 day is labor intensive. Moreover, if the study sites are in remote locations, it may be difficult to reach the sites especially for studies on the nocturnal insect activity. Therefore, we developed and field evaluated a semi-automatic funnel fly trap by modifying an in-house prototype of "easy-to assemble" funnel trap to study medically important fly population density.

2. Materials and methods

2.1. Study site

We assessed the ease-of-installation of a novel semi-automatic funnel trap and its potential to collect the adult flies in the field. To evaluate the performance of the semi-automatic funnel trap, adult fly collections were carried out at Mae Hia Agricultural Research, Demonstration and Training Center, located in Mueang Chiang Mai district, Chiang Mai province, northern Thailand (Figs. 1 and 2).Three different habitats were chosen as study sites including a forest area (N18°46′01.08″, E98°56′08.3″; 344 m altitude), a palm plantation (N18°45′27.841″, E 98°55′48.515″; 330 m altitude), and longan orchard (N 18° 45′56.66″, E 98°55′40.13″; 374 m altitude) (Fig. 3).

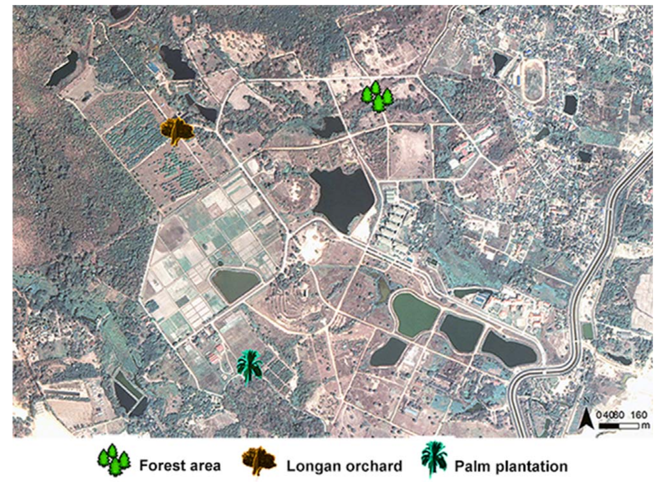

Fig. 2. Satellite imagery of the study area consisting of three different microenvironments; forest area, palm plantation, and longan orchard.

2.2. Trap modification

The semi-automatic funnel fly trap contained the following modifications from the prototype easy-to-assemble funnel trap kits (Table 1) (Ngoen-klan et al., 2011).The modified device consists of five basic parts: (1) an external metal case (40 × 40 × 60 cm), (2) a fly entrance module, a square funnel made of transparent plastic board, (3) a black fly net (36 × 36 × 85 cm) sewing the entrance with an elastic waistband to fit the net with an entrance module, (4) timer, and (5) CD player tray (Fig. 4A). Attractive bait (~300 g of tainted beef offal) was placed onto a plastic container and located at the base of the trap (Fig. 4B).

The operation of a semi-automatic funnel trap is controlled by a timer which was adapted from a semi-automatic funnel fish food feeder (Warmtone Electricity and Hardware factory, China) powered by 1.5 voltage alkaline battery. A timer is connected to the electric relay, which is an electrically operated switch used to control a circuit by releasing a low-power signal. At the onset of trap operation, a timer rotates a food hopper axle and triggers the relay. Then, electric power, from a 12-V battery (Spark Intertrade Co., Ltd., Thailand), is released to supply the CD-player tray and let it slide from the slot loading drive. Because the tray is connected to fly entrance module by a string, the movement of fly entrance module is synchronized with the sliding of the tray. When the tray slides out of the slot, it pulls the string, the fly entrance module is lifted up allowing flying insects to approach to luring bait. After fully fed, flies fly up into the trap and are retained in the fly net. At the set time, the timer triggers the relay again, and the tray slides back into the loading slot. The string is released, let the entrance module slides down and closes the fly entrance. Therefore, all captured files are retained inside the fly net.

The trap was manually emptied by removing the fly net from the external metal case and installing a new one for the next repetition of the experiment. After each repetition, the 12-V battery can be charged using a battery charger (AC-DC adaptor spectrum 10A, Chatchawan electronics Co., Ltd., Thailand).

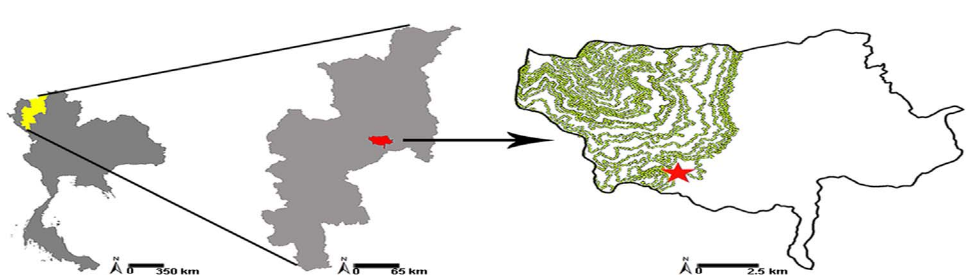

Fig 1. Map of Chiang Mai, northern Thailand showing study site located in Mueang Chiang Mai district of Chiang Mai province, northern Thailand. Green lines represent mountainous area. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)