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Malaise trap and insect sampling: Mini Review

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ABSTRACT: Malaise trap is commonly used sampling technique for low flying insects. Being passive, it does not require an observer to observe throughout the day; hence it is economical and time saving. Though there are many prominent models of the trap viz. Gressitt trap, Schacht trap, Townes trap, however, Townes model is commonly used in the field studies due to its light weight and higher output. In this paper, we are trying to put together the different aspects of Malaise trap into a single window system.

Key words: Ethanol; Hymenoptera; Malaise trap; Townes trap; Vespidae.

INTRODUCTION

Biodiversity and taxonomy are closely related and are dependent on each other. Biodiversity can only be determined by having a vast knowledge about the taxonomy. On the other hand, selection of proper sampling methods is important to scrutinize the diversity of a particular group of fauna in a particular habitat (Russo *et al.*, 2011; Sheikh *et al.,* 2016a). Insects being the largest group of animals, hence a large number of sampling techniques are employed for their collection. Among various sampling techniques sweep net, light trap, pitfall trap, Winkler sampling and malaise trap are common and very effective for the collection of different insect groups (Malaise, 1937; Marinoni and Dutra, 1997; New, 1998; Szentkiralyi, 2002; Mason and Bordera, 2008; Aguiar and Santos, 2010; Sheikh et al., 2016bc). Among the above mentioned insect collection methods Malaise trap is commonly used for the sampling of low flying insects (Malaise, 1937). In combination with other sampling techniques Malaise traps have been used widely for insect sampling (Brown and Freener, 1995; Triplehorn and Johnson; 2005; Namaghi and Husseini, 2009; Abdullah and Shamsulaman, 2010; Khadijah *et al.*, 2013). While scrutinizing the published literature, there is not an extensive review about the different aspects of Malaise trap. We are presenting an overview of Malaise trap in the present paper.

Malaise trap

Swedish Hymenopterist, Dr. Rene Edmond Malaise was the first to develop a Malaise trap in 1934 in Burma (Malaise, 1937) and later on three types of Malaise traps were proposed viz. original unilateral, a bilateral type equipped with a lateral collector and other one with a collector in the center (Achterberg, 2009). It is relatively unbiased insect collection trap for flying insects. Malaise traps are commonly used standardized method for sampling of flying insects (Marinoni and Dutra, 1997; Mason and Bordera, 2008; Aguiar and Santos, 2010). From last few decades many designs of Malaise trap have been developed. Among which, smaller Townes design and larger Gressitt design are prominent (Achterberg, 2009).

The principle structure of Malaise trap consists of a tent with two wide openings, one at front and second one at the back and exactly opposite to the first one. In the centre is a fabric barrier to intercept the flying insects. While trying to escape, insects move upwards and finds themselves trapped into the collecting jar filled with a killing agent which is fitted right above at the summit. The arrangement of fabric is installed on four logs or poles and supported by ropes (Campos *et al*. 2000).

Townes trap

Dr. Henry Keith Townes devised a simple design of Malaise trap, which is most common in use due to its handy design and light weight (Townes, 1962). The trap is open at both the ends with a central diaphragm and a lateral collector at the summit. The colour of the trap is usually back and white or completely black. Most insects being positive phototropic, after entry into the trap, hit the diaphragm and moving upwards to a light opening and eventually gets trapped into the collector (Achterberg, 2009).

The efficiency of Malaise trap virtually depends up on mesh size, microhabitat and design of the trap (Darling and Packer, 1988). Among the above three factors, trap design is most important along with placement of the trap in correct position. The mesh size should be very fine and depends up on the size of the target insect to be collected (Achterberg, 2009). Commercially available traps mostly have an opening of (total sampling surface of both the sides) of $3m^2$ (Matthews and Matthews, 1983), roughly a sampling surface of 1.92 m^2 per length of diaphragm.

Gressitt trap

Gressitt trap is an enlarged version of Malaise trap. It is actually a combination of two Malaise traps joined at the rear end and thus has two summits with two collectors eventually resulting into a large trap (Gressett and Gresset, 1962). The opening of the trap is about 6 m, thus 2.3 times larger than Townes trap.

Schacht trap

Schacht trap is without a diaphragm and works on the principle that insects hitting on oblique surface will walk to the collecting bottle. The diaphragm is absent because it will act as a deterrent to the insects (Schacht, 1988). The trap has shown promising results so far particularly for Diptera sampling (Achterberg, 2009).

Malaise trap do not use any kind of attracting devices but exploits the natural tendency of insects to fly upwords, get trapped in to the collecting container (Breeland and Pickard, 1965). It is efficient means of sampling for flying insects for composition and seasonal occurrence patterns of insects (Matthews and Matthews, 1970, 1971). This trap is useful for the sampling of Hymenoptera (Townes, 1962), Diptera (Roberts, 1971; Breeland and Pickard, 1965) and Lepidoptera (Walker, 1978).

Studies reveal that Malaise traps collect more insects than other flight intercept traps (Hosking, 1979) and are widely used for catching flying insects (Ganho and Marinoni, 2003), especially Dipteran and hymenopteran insects (Selfa *et al.*, 2003). Malaise trapping along with pan traps is frequently used for wasp collection (Noyes, 1989; Namaghi and Husseini, 2009; Santos *et al.*, 2014) and Malaise traps collect more species of Hymenoptera than Pan traps (Santos *et al.*, 2014).

Askew (1980) operated Malaise trap (Model 300 Health-EE-X) for insect collection in between bushes of *Conocarpus* and other shrubs growing at the base of the northern face of the beach ridge and the ground vegetation dominated by *Sporobolus* and *Ambrosia.* However, Cooksey and Barton (1981) used square traps with a 2.44 m center support, helped with four central vanes to direct the insects into the collecting head. The killing agent 2, 2-dichlorovinyl dimethyl phosphate was used as killing agent and traps were emptied every week.

Hutcheson (1999) used Malaise traps with the same dimension as advocated by Townes (1972) for the insect sampling. Traps with a gauze screen of 1.2 m high × 2 m long and 70% alcohol as killing agent were installed while Brown and Freener (1995) employed 10 Malaise traps, black colour with a white roof as that used by Townes (1972). Similarly, Clapperton (1999) installed Malaise traps developed by Townnes (1972) and Hutcheson (1991) at Lake Ohia study sites with a spacing of 100 m for the sampling of paper wasps and traps were emptied on weekly and fortnightly bases. The traps were installed in such a way so that the base of the trap touches the ground.

Hughes *et al*. (2000) operated 12 Malaise traps at four locations within a complex of habitat, aspen, meadow and conifer. Three traps installed at each of the three sites (aspen, meadow and conifer) in each locality to bestow adequate number of replications. Locations were separated by four km from each other. The trap surroundings were with uniform and similar vegetation up to 100 m and each trap was operated for two days every other week for four 2-day samples at each site.

Sally *et al*. (2008) used 30 black colour Malaise traps having a height of 1.8 m at the level of collection head and tapering towards the other end to 1 m. Thirty Malaise taps were allocated between two woodlands to provide a better replication. Traps were installed in core and edge habitats 10-20 m apart to access the effect of habitat differences and sampling comparison between two woodlands with respect to vespidae diversity. Similarly, Santos *et al.* (2014) marked two 400 m transects and installed 10 Malaise traps with five traps in each transect. The traps were spaced 100 m apart and were set for six consecutive days before inspecting.

Namaghi and Husseini (2009) used a Malaise trap with a mesh panel and collecting head attached at the higher end of the panel in a similar way as demonstrated by Townes (1972). Traps emptied twice every week. While as Brown (2005) installed Malaise traps at four sampling habitats viz., primary forest, forest edge, degraded second-growth forest and tree fall gaps in the forest to access the comparable insect abundance of certain groups of insects particularly Diptera. Malaise traps collected thousands of the large samples.

Morinière *et al*. (2016) collected insect samples by Malaise trap techniques and subjected the specimens to DNA bar coding. The traps were installed in the anthropogenic nutrient poor grass vegetation very close to the edge of a mixed forest. Farahani and Barahoei (2015) employed Malaise traps for sampling of Hymenoptera parasitoids of aphids and the specimens were collected on weekly basis. Rahman, *et al*. (2016) collected Hymenoptera (28.5%), Homoptera (28.5%), Diptera (14.5%) and Hemiptera (14.5%) through Malaise trap sampling.

Gnanakumar *et al.* (2012) employed two Malaise traps at the edge of paddy fields for the collection of Hymenoptera for duration of three weeks and traps were emptied once in a week. Three subsets of the data replicates were obtained from two fields for statistical analysis. While as Ghahari and Huang (2012) sampled 19 localities using Malaise trapping technique in Iran for Chalcidoidea (Hymenoptera).

Malaise traps are very fruitful for the collection of diverse insect groups, including Bess and other Hymenoptera (Sugar et al. 1998; Bartholomew and Prowell, 2005; Ozanne 2005; Ngo *et al.* 2013). Parasitic Hymenoptera have been widely sampled through Malaise traps and provide numerically large catches (Townes, 1972; Fraser et al., 2007). The efficiency of the trap depends up on the insect group targeted (Noyes, 1989). The traps are very useful for inventory programmes (Gauld, 1991). Malaise traps are used singly or with low replication due their relative bulk and cost (Fraser *et al*., 2007). However, little is known about how many traps may be installed at a site and how long the traps provide an adequate sample (Noyes, 1989).

Malaise traps are effective for low-flying insects. Traps can be installed in any terrestrial habitat hence comparative information about the insect populations in different habitats can be gathered (Hutcheson, 1996). Traps collect more number of common species than the rear ones in a habitat (Hutcheson, 1999). Traps are independent of habitat and operate passively when compared with other sampling techniques like bait and light traps. However, habitat characteristics in the immediate surroundings of trap affect the catch composition considerably (Dugdale and Hutcheson, 1997).

Collector

Collection apparatus is attached at the summit usually at lateral position into which insects enter, get trapped and finally killed. Collectors have a horizontal entrance and the size of the bottle is comparatively small. Due to prolonged use, the connection between upper and lower part of collector may often deteriorate (Achterberg, 2009)

Trap Location

One of the important aspects of Malaise trap efficiency is correct placement. The trap should block a corridor or placed perpendicular to a barrier for example forest border with the collecting head directed to the border and the sun. Small differences in the placement results larger changes in the collection efficiency (Matthews and Matthews, 1983).

Effect of Trap dimensions

Commercially available Malaise traps being smaller thus provide insufficient samples. Therefore, large traps are recommended to obtain large sample to provide a clear discrimination among habitat types (Dugdale and Hutcheson, 1997). In indigenous forests, the vertical catching zone demonstrated to be within about 1 m of the ground within which most insect activity occurs (Hutcheson, 1996). Therefore, it could be suggested that large traps provide good results.

Killing agents

Though many killing agents have been used for the killing of insects in Malsise traps like Cyanide, 2, 2-dichlorovinyl dimethyl phosphate (Cooksey and Barton, 1981) and others chemicals. However, ethanol is widely used killing agent (Askew, 1980; Brown and Freener, 1995; Cresswell, 1995; Hutcheson, 1999; Gnanakumar *et al.* 2012; Ghahari and Huang, 2012; Rahman *et* *al*., 2016). Priority of a killing agent should depend up on its effectiveness against the target and must have least harm to the nature.

CONCLUSION

Malaise trap was invented early during the twentieth century but its use is limited as compared to other sampling techniques. Certain groups of insects which are least attracted to the light (Hymenoptera etc), Malaise trap could be very handy for the collection of such insects. One of the main aspects is the weight of the trap. The manufacturing agencies should provide light weight trap designs so that to carry it easily in the sampling areas devoid of transportation. Scientific knowledge is important to provide a sophisticated design for a particular group of insects. Certain insects are very attractive to a particular colour. So the colour of the trap should be designed according to the insect group to be sampled.

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