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An innovative height adjustable contraption designed to sample bees from forested areas of lateritic tracts of Midnapore, West Bengal, India.

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Abstract

Sampling bees in forested areas from floral assemblages at different heights above ground possess serious problems to bee researchers. Active netting is not possible at that height. Passive trapping using food baits and water, although more promising, yield low catch-rates due to their restrictive placement. A unique adjustable contraption, an adaptation and modification of existing designs, has been devised to trap bees by placing the same in the flight-path of the bees. Four month long sampling from deciduous forests of lateritic tracts of West Midnapore district of West Bengal, India, shows significant success in trapping pollinator bees at canopy height using this device, with minimum effort and trouble on part of the sampler, thereby increasing sampling efficiency and reducing sampler bias.

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Introduction

Studying bees involve trapping them from varied vegetations in varied landscapes. Such sampling techniques usually are classified as active and passive. Active sampling techniques involve netting at floral assemblages. Passive techniques include baiting with food (sugar or molasses solution) and water; using attractants (pheromone traps) and various flight interception devises (malaise traps) (Droege, 2009). Although, active netting has been in application the longest and is indeed an indispensable part of insect research, passive trapping techniques are gaining popularity steadily (Tuell and Isaacs, 2009), probably due to the high degree of flexibility in adopting such techniques. Besides, passive trapping also carries with it an enormous scope for combining interdisciplinary fields of study in devising and adopting the techniques to suit individual requirements. The diversity of vegetated terrains and climatic parameters necessitate newer sampling techniques to be developed on a regular basis. The abundance of literature on application of such varied passive trapping methods in diverse ecosystems all over the world, to catch and study bees and other insects, add testimony to the rising importance of such techniques in the ever expanding field of entomology (ref. Drummonds, 1984; Roulston *et al.*, 2007; Grundel *et al.*, 2011).

Passive trapping of bees in diverse ecosystems has enabled sampling of specimens over extended periods, overcoming the restraints posed by active netting, chiefly collectors' bias and problems caused by exhaustion and fatigue in extreme weather conditions. However, there are certain disadvantages to passive trapping, especially using pan/bowl traps. The bowls, since usually placed on the ground, get toppled over and lose the baiting solution frequently, losing any insects caught therein. There is considerable difficulty in placing the bowls in sloping terrains due to the obvious effect of gravity. In heavily canopied areas and in areas with dense undergrowth, the visibility of the bowls to the bees in flight is reduced and this may further decrease the chance of trapping the bees, especially, if the floral assemblages of shrubs and trees are at some height from the ground, thereby discouraging the bees foraging on the flowers to alight to ground level to where the bowl traps (with water) are set (Droege, 2009; Tuell and Isaacs, 2009).

Solving the problems would involve placing the bowls at height, closer to the flowers, on some even platform. Apart from overcoming these hurdles in passive sampling, such an arrangement could enhance insect researches. For instance, different species of bees may forage at different aerial levels in areas of mixed vegetation, which might be an interesting study in itself, if the bees are sampled from different aerial strata.

A similar experiment sampling insects from different heights using an adjustable pan trap was conducted in Mexico by Vega *et al.* (1990). The trap was made from wooden strips and yellow plastic bowls and sampled Aphids and Cicadellids up to a height of 2.2 meter. Another devise, designed by Surcica and Droege (2010), especially for trapping bees, uses wooden planks arranged in a cross and secured to rebar with screw arrangements so as to adjust the height of the bowls placed on the four arms of the cross. This seems to be an efficient devise for sampling bees, especially from cultivated fields. However, it leaves room for modifications, if it is to be adapted for field use in tropical deciduous lateritic Sal (*Shorea* sp.) forests of West Midnapore, West Bengal, India.

Study of bee fauna in the open canopied Sal forests of this district has not been done (it forms part of the doctoral research of the first author of this paper). The field conditions here necessitate passive sampling, especially in the dry pre-monsoon months, when the Sal (*Shorea* sp.) trees are in bloom. Temperatures quickly increase soon after sunrise and stay high all through the day till late afternoon. The trees provide little shade and have most of the flowers blooming at a minimum height of three metres from the ground. So, passive sampling of bees is preferred here. To sample bees along the different heights of the Sal trees and associated vegetation, an adjustable trap sounds ideal.

The present paper details one such newly designed inexpensive, adjustable bee trap, for sampling bees from heights of three metres or more, which is completely portable for field studies and easily installable anywhere. The devise is ideally designed to suit passive sampling in semi-arid areas like West Midnapore district of West Bengal, India, and promises to be a great aide in insect research.

Materials & method

The contraption is an adaptation and modification of the height adjustable bee-traps devised by Alex Surcica and is adapted especially for open canopied tropical deciduous Sal forests of latertic West Midnapore, West Bengal, India. Flowers usually grow at heights of about ≈ 3 metres from the ground, where sampling of bees by netting is difficult. Passive trapping using soap-water solution in bee bowls has proved more effective in these areas (Bhattacharyya and Chakraborty, 2012). However, when compared with observational records, catch rates were not promising. It was theorized that most of the foraging bees were not alighting to the ground level where the bowls were placed, and that if the bowls could be placed in or closer to the flight-path of the foraging bees, the catch-rate would increase significantly. The first step in testing the hypothesis was devising a contrivance that would allow setting up the traps at specific heights from the ground. The present paper documents the unique devise designed for the purpose which has proved successful in bee sampling in four month long field studies in the lateritic forest tracts of West Midnapore, West Bengal, India.

Construction of the unique adjustable trap

The trap constitutes of several detachable segments, made from mild steel and iron, and can be roughly divided into main body (***i***), grouting (***ii***) and display (***iii***) parts. The initial design used PVC pipes, but these were found to buckle under the weight of the water-filled bowls at elevated heights, and therefore were replaced with mild steel (GI) pipes. The details of the different parts of the trap are described below.

Main Body (Middle part) of the trap

For the main body (***i***), three pieces of standard GI water pipes (***a***) of diameter 2.54 cm and length 100 cm are used. These three pieces can be connected with each other through smaller GI pipe segments of length 30cm each (***b***). The inner diameter of these linker pipe segments (***b***) conform to the outer diameter of the main body pipes (***a***) (of 100 cm length as previously mentioned), to fit the pipes closely. Locking pins (***c***) of approximately 4 cm length and 6 mm diameter, made from mild steel, are used to hold the segmented body pipes (***a***) together in conjunction with the joining segments (***b***). This whole unit forms the main body of the trap for height adjustment.

Grouting Part (Lower part) of the Trap

For the grouting part (***ii***), a mild steel pipe segment (***d***) of approximately 30 cm length is chosen with internal diameter suitable to accommodate the main body pipes (***a***) (of 2.54 cm diameter). Suitable spikes (***e***) of 6 mm diameter rod are welded with this mild steel segment (***d***) to form proper base which is grouted in the soil. The span of the spikes (***e***) is approximately 50 cm. This entire unit forms the basal grouting part (***ii***), which anchors the entire trap to the soil.

Display Portion (Upper/Top part) of the trap

The top display portion (***iii***) holds the bowl traps (***f***) which contain the actual bait to trap the bees. To construct this portion, another mild steel pipe segment (***g***) of approximately 30 cm length and 2.54 cm diameter is used, which can be fitted at the top of the uppermost main body pipe (***a***) segment. Four horizontal arms (***h***), made from mild steel rods of 6 mm diameter are welded with the mild steel segmented pipe (***g***) at right angles. The four arms (***h***) are supported by welded stiffener rods (***j***) of 6 mm diameter. Four rings (**k**) made from 6 mm rod are welded to the outer edge of the trap arms (***h***). UV blue trap bowls (***f***), made from plastic, are placed inside the ring and contain the bee bait (food or water). This whole unit forms the topmost display and baiting (***iii***) portion.

The entire contraption is painted with Aluminum paint, since it is almost odourless and not prominently visible. The whole thing can be easily dismantled for carrying purposes as a compact unit and installed in the field with ease.

Schematic diagram of the adjustable contraption is provided showing line sketches of the top display/baiting part, bottom grouting part and the assembled lateral view of the entire devise, with parts labeled for easy identification (Figs. 1 & 2). The photographs of the fully installed trap in the study site and the parts of the trap while dismantling are depicted in figs. 3 and 4 respectively.

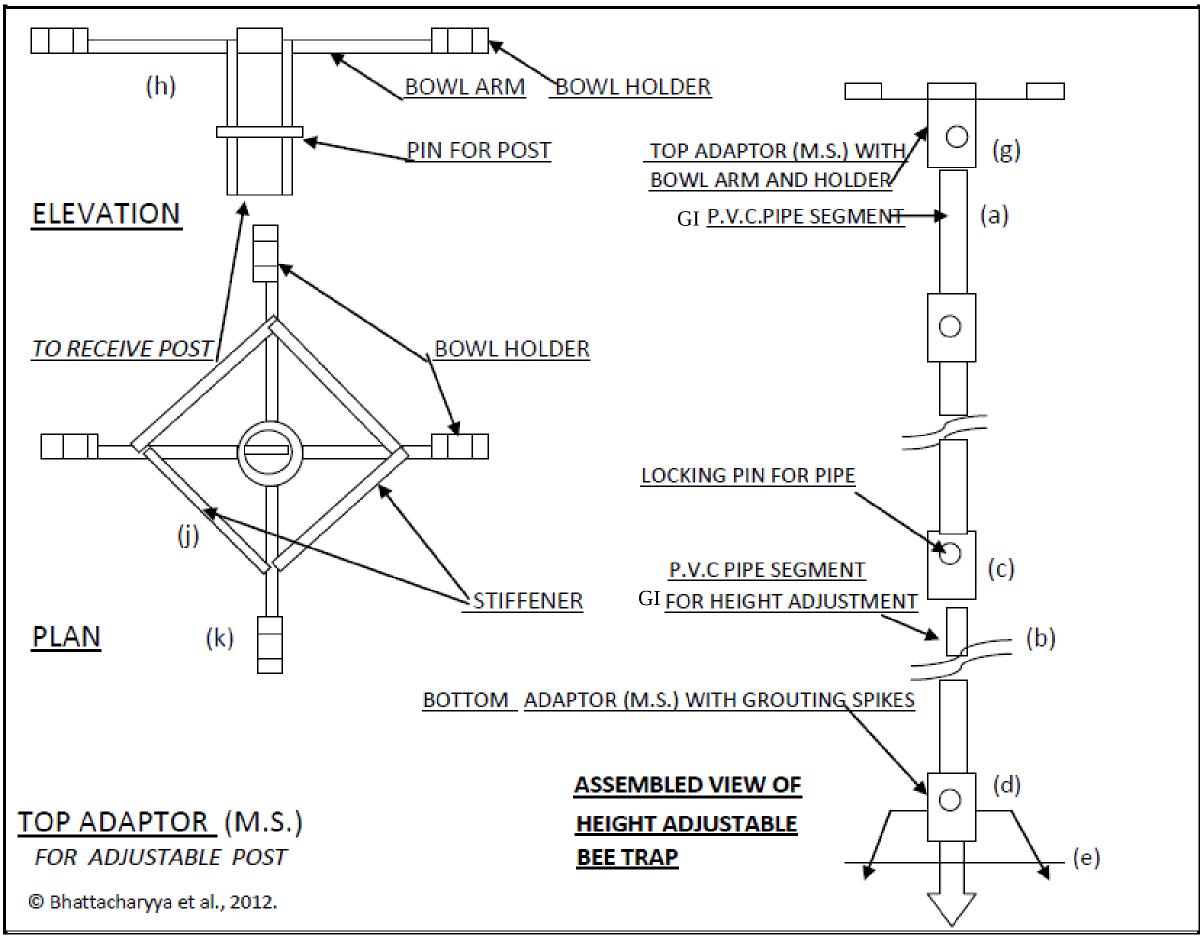

Fig. 1. Lateral view of the assembled trap (on the right) and separate plan and elevation of the top display/baiting part (on the left). For labels, see text.

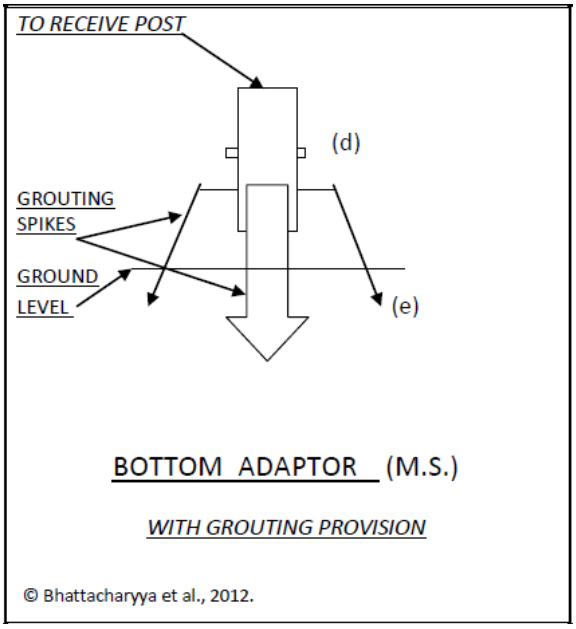

Fig. 2. Elevation of bottom grouting part of the adjustable trap (For labels see text)

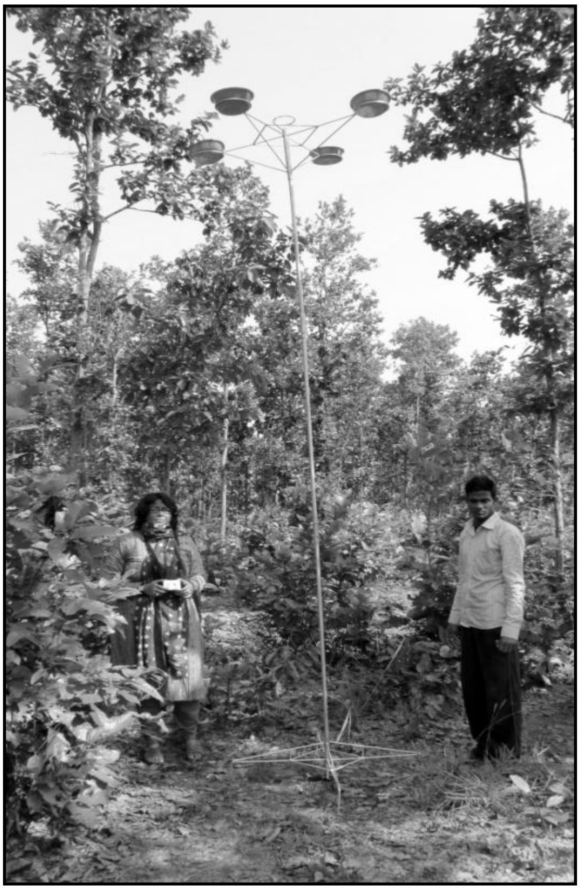

Fig. 3. Fully installed unique adjustable trap set up for sampling bees in the study site

Fig. 4. Dismantled parts of the unique adjustable bee trap

Setting the trap in field

The trap was set up in the lateritic tropical deciduous Sal forest tract at Jogeswarpur (Lat. 22°33'16.55" N; Long. 87°19'40.66" E) in the Godapiasal forest range of West Midnapore district of West Bengal, India, from 9 am till 2 pm on 12 sampling events on clear days, spanning four months, from February, 2013, to May, 2013, to test the efficacy of the trap at height of about 10 metre. The sampling period coincided with the flowering period of the Sal (*Shorea*) trees and the trees were largely devoid of leaves and flowers typically started at around ≈ 3.3 metre from the ground. Therefore, the trap was set up at the height of the blooms at about ≈ 5 metre from the ground. The specimens found drowned in the soap-water bait were strained and stored in 70% alcohol for identification.

Results and discussion

Effectiveness of the unique adjustable trap in sampling bees

Since the main objective of this study was to determine the effectiveness of the innovation in sampling bees from forest settings, sampling was done for only four months, viz., when the flowers of the Sal tree were in bloom. Several specimens belonging to the order Hymenoptera were found drowned in the soap-water bait. These included bees and wasps, as identified by observation. The bee species identified taxonomically are listed in Table 1.

It becomes evident that the unique contraption is quite suited to sample bees from the open canopied

Sal (*Shorea*) forests of lateritic West Mindpaore district, at heights of floral blooms. And since the trap is adjustable, if necessary, its height may be varied to sample from convenient heights.

Table 1. Number and types of species of pollinator bees sampled from study site from Feb. 2013 to May 2013.

Sample occasion	Sampled Species	Number sampled	Comments
February 2013	*Lasioglossum (Ctenonomia) albescens*	09	*Climate*: 28°C (mean avg). Mist; Weak sunlight. *Forest feature:* Scanty foliage, growing blooms
	Xylocapa (Biluna) auripennis	04	
	Apis cerana indica	23	
	Apis mellifera	17	
March 2013	*Nomia (Acunomia) elegans*	03	*Climate*: 32°C (mean avg). Mist; Bright sunlight later. *Forest feature:* Scanty foliage, abundant blooms.
	Lasioglossum (Ctenonomia) albescens	12	
	Xylocapa (Biluna) auripennis	14	
	Apis cerana indica	29	
	Apis mellifera	22	
April 2013	*Lasioglossum (Ctenonomia) albescens*	10	*Climate*: 35°C (mean avg). Bright sunlight. *Forest feature:* Growing foliage, abundant blooms.
	Xylocapa (Biluna) auripennis	17	
	Nomia (Acunomia) elegans	02	
	Apis cerana indica	19	
	Apis mellifera	14	
May 2013	*Lasioglossum (Ctenonomia) albescens*	14	*Climate*: 38°C (mean avg). Hot; Bright sunlight. *Forest feature:* Scanty blooms, greater foliage.
	Xylocapa (Biluna) auripennis	11	
	Apis cerana indica	13	
	Apis mellifera	09	

Detailed data collections for quantifying the effectiveness of the trap in comparison to other sampling methods are currently under way.

Trends in species diversity as indicated by sample data

Data collected from four months of sampling indicates certain patterns in the species diversity and abundance of pollinator bees as documented in the open canopied Sal forests of lateritic West Midnapore district of West Bengal, India.

Fig. 5 indicates the proportion of the five individual species in the total number of bees sampled during the 12 sampling events. The honeybees (*Apis* bees - *A. cerana indica* and *A. mellifera*) form majority of the trapped specimens as compared to the non-*Apis* bees (*Lasioglossum, Xylocapa* and *Nomia* sp.). This is probably because of the greater abundance of flowers as compared to leaves, during the sampling period. Detailed investigation is needed to further and explain this observation.

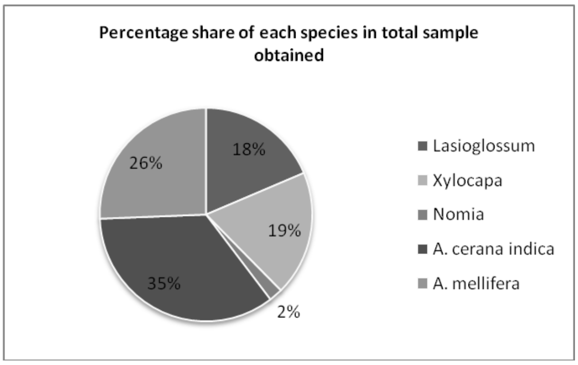

Fig. 5. Percentage share of each species in total sample obtained during the sampling period (from Feb. 2013 to May, 2013)

The monthly variation of the total number of *Apis* and Non-*Apis* bees indicate a gradual rise in Non-*Apis* bees with increasing air temperature, and subsequently lesser floral blooms, while the *Apis* bee numbers declined sharply in the month of May, when the flowers were almost gone (Fig. 6).

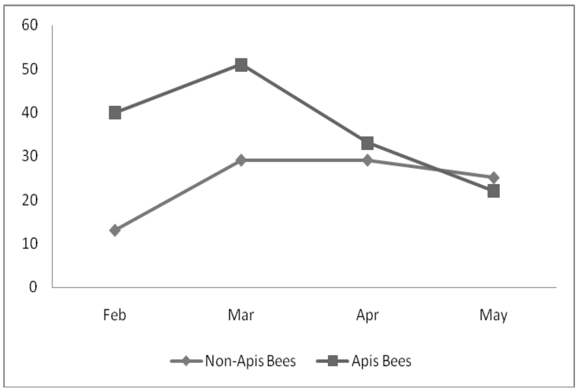

Fig. 6. Monthly variation in number of *Apis* (*A. cerana indica* & *A. mellifera*) bees and Non-*Apis* (*Lasioglossum, Xylocapa* and *Nomia*) bees as measured across 4 months from Feb. 2013 to May 2013.

It can be hypothesized that since the *Apis* bees are the principle foragers of *Shorea* blooms in the study area, their numbers and diversity increase with increasing growth of the flowers, and decrease with increasing air temperature. The increase in the number of Non-*Apis* bees with increasing air temperature may be explained by the significant rise in the number of *Xylocapa* bees which are more resistant to higher air temperatures than other solitary or colonial bee species. *Lasioglossum* bees increase with increase in foliage. These hypotheses are currently being tested in the study area.

Conclusion

The unique adjustable contraption for catching wild bees in forest areas yielded positive results. Sampling, using UV blue bowls placed on the ground in the same area, had previously yielded positive results as well (Bhattacharyya and Chakraborty, 2012). The present devise is supposed to add to that result by sampling at heights from which trapping bees was not possible previously. It remains to be seen if the adjustable trap is more efficient than the conventional pan/bowl traps in attracting and catching greater diversity and number of bees. More field observations are necessary to statistically quantify the greater efficiency of the adjustable trap, compared to bowl trapping of bees at ground level.

The trap was shown to have some advantages over conventional ground level bowl trapping.

1. Since the bowls with the baiting solution were placed above ground, the chance of the solution being lost due to toppling of the bowls was minimal.
2. The researchers could set the trap up under bright sunlight and leave it for hours unattended.
3. The height of the trap being adjustable, several such traps can be arranged in gradually increasing heights to sample bees across a landscape gradient.
4. Finally, the diversity of bees foraging at different heights on the same vegetation can be documented using this unique contraption.

Extensive studies to test the above mentioned hypotheses are being currently conducted as part of the doctoral studies of the first author. The authors believe that in the inhospitable outdoor weather conditions of tropical countries like India, especially in the dry, semi-arid districts like West Midnapore of West Bengal, India, passive sampling of hymenopteran insects through this unique adjustable trap will prove to be immensely helpful.

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