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TWO NOVEL FLIGHT-INTERCEPTION TRAP DESIGNS FOR LOW-COST FOREST INSECT SURVEYS

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ABSTRACT

This paper introduces two passive trap designs for the survey of flying Coleoptera and other insects which can be constructed on very low budgets at < £1 per trap. A trunk window trap and an aerial flight-interception trap are presented, based on commonly used designs, but using much cheaper materials than standard. Construction diagrams are given, along with a description of trap installation, operation and beetle species found using these methods during a survey of Ayr Gorge Woodland, South-West Scotland. The traps were found to be robust and easy to operate. It is hoped that these trap designs will be of use to charitable organisations, students and amateurs who may previously have been unable to consider monitoring flying insects at large scales due to the prohibitive cost of equipment.

INTRODUCTION

The cost of carrying out large-scale invertebrate surveys is recognised as one of the most limiting factors for their inclusion in biodiversity studies (Oliver and Beattie 1996). In addition many groups of insects can be difficult to sample at large spatial and temporal scales, often requiring specialist field knowledge and identification skills which are declining in the professional sphere (Hopkins and Freckleton 2002). These factors combined mean that many groups of insects are often completely ignored in large-scale biodiversity surveys (Kim 1993).

One passive insect survey method, pitfall trapping, is widely used for surveys of Carabidae and Araneae (Southwood and Henderson 2000). However, passive trapping methods for other groups such as Diptera, Hymenoptera and flying Coleoptera require equipment such as Malaise traps and flight-interception traps which can be prohibitively expensive for large-scale surveys. This paper describes two novel trap designs for a trunk-window trap and an aerial flight-interception trap which can be made with widely available materials and which require no specialist equipment or skills to construct. The traps were constructed for less that £1 per trap, making them a viable option for studies that require highly replicated, inexpensive trapping regimes. There is a long history of entomologists designing, sharing and modifying trap designs for the needs of individual surveys (Carrel 2002; Schulten, Ismay et al. 2005; Alexander and Chandler 2011) , it is hoped that these traps will add to this literature and will be of use to entomologists in a variety of settings.

TRAP CONSTRUCTION

Trunk Window Trap

Trunk window traps have been shown to be one of the most effective methods for surveying saproxylic beetles (Grove 2000). The traps require a transparent solid surface fixed at a right-angle to a tree trunk, with a collecting tray below containing a preservative. The trap works on the principle that adult beetles in flight will be attracted to the tree trunk either in search of food, a mate or a suitable site for laying eggs; the beetle hits the transparent surface whilst flying around the tree and either falls into the collecting tray or flies down into it whilst trying to navigate around the obstruction.

The transparent material used in trunk window trapping is usually Perspex as it is solid and durable. In this trial A4 (297 x 210 x 0.14 mm) acetate sheets, such as those commonly used for overhead projectors, were used in place of Perspex as they are cheap and readily available.

This trap design consists of two wooden stakes, one tied against a tree trunk and the other placed into the ground; between these a piece of acetate is stapled and a collecting tray filled with Antifreeze (containing propylene glycol preservative) is fixed with drawing pins below. The collecting tray is a thin plastic food container, which can be bought in large quantities from discount stores, with a small hole cut near the top. Muslin cloth is stapled over this hole on the inside of the tray to allow rainwater to overflow without loss of the trap contents. The traps trialled here stood one metre above the ground, but the height can be adjusted to suit the needs of a particular survey. To empty the traps the collecting tray is simply unpinned from the trap and the contents poured into a jar.

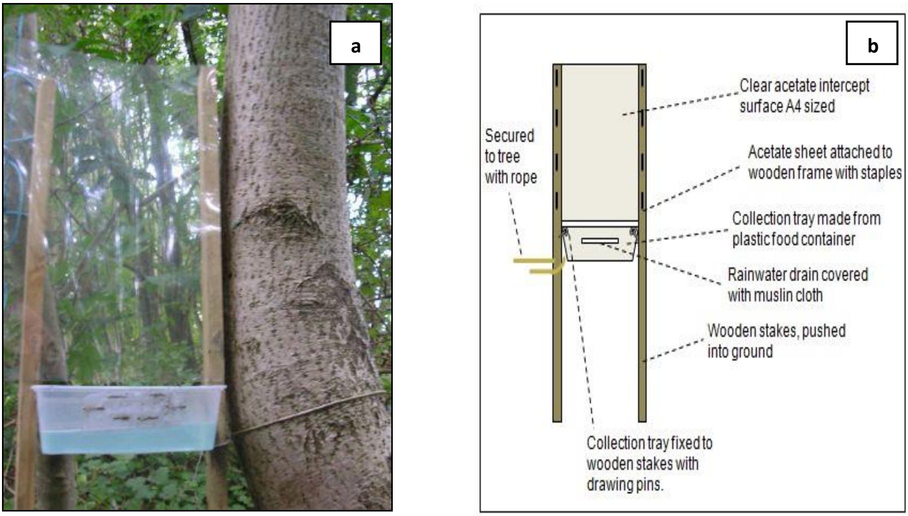

Figure 1. Trunk window trap in the field (a) and construction diagram (b)

Aerial Flight-Interception Trap

Flight-interception traps work on exactly the same principle as trunk window traps but allow for trapping in the canopy or away from tree trunks, where a different insect community is likely to be found.

This trap is made using two parallel pieces of wood (48 x 4 x 2 cm approx) fixed with an adjoining batten (28 x 4 x 2 cm approx.) at right angles across the top. An A4 sheet of acetate is stapled across the wooden frame and a collecting tray as described previously is pinned beneath the acetate. Two large screws are inserted into the sides at the top of the trap, from which the trap can be hung. Another two screws are fixed either side at the bottom of the trap, to which guide ropes are attached so that the bottom of the trap can be secured against the wind.

This trap can be placed high in the canopy by attaching a weight to the end of a rope and throwing the rope over the desired tree branch. The trap is then attached to the rope, hauled up into the canopy and secured in place by tying the guide ropes to lower limbs of the tree.

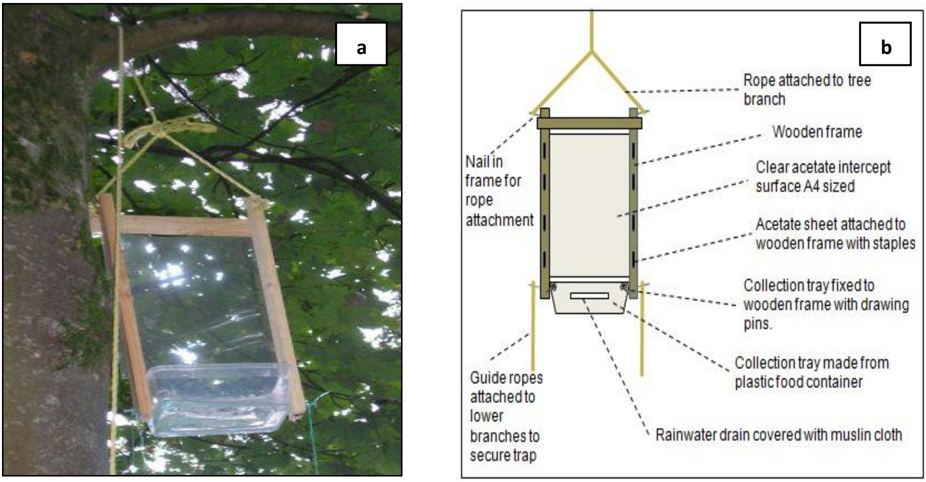

Figure 2. Aerial flight-intercept trap in the field (a) and construction diagram (b)

TRAP OPERATION

These traps were trialled in a survey of the saproxylic beetles of Ayr Gorge, a 57.4 ha mixed woodland site 3 km north-east of Ayr (grid reference NS 457 249). The site is owned and managed by the Scottish Wildlife Trust and has one of the richest saproxylic faunas in Scotland. Ayr Gorge has a long history of entomological recording, including notable records from the beetle taxonomist Roy Crowson, known for his studies on Coleoptera classification (Crowson 1962; Crowson 1979).

Sixty traps in all, thirty trunk window traps and thirty aerial flight-interception traps were installed throughout the site in the summer of 2007. Installing sixty traps took approximately ten days for one person, but could be considerably faster with assistance as the task of carrying large numbers of traps into the field was the prohibitive factor. Trunk-window traps were very easy to install, but the aerial flight-interception traps required more time due to the difficulty of locating appropriate canopy branches and installing the ropes. Emptying and re-filling all sixty traps took two people one to two days.

Traps were initially emptied on a weekly basis, but it was quickly found that the traps could be left for up to one month and still function successfully. Two weeks was found to be the ideal visitation rate in terms of balancing time spent visiting the site against the likelihood of traps becoming full or damaged.

The traps functioned successfully during the peak summer months, but in the autumn they became filled with dead leaves, so the addition of a roof to the traps would be recommended for surveying at this time of year. The traps are not robust to extremely high winds, with acetate sheets sometimes becoming torn away from the wooden frame. The traps can be easily repaired *in situ* by carrying spare acetate sheets, scissors and a stapler when visiting traps so that torn acetate sheets can be removed and new acetate sheets simply stapled in place.

TRAP CATCH

During July 2007 these sixty traps caught 428 beetles from 90 species, of which half were saproxylic. Two thirds of the beetle species recorded were new records for the site and of these twenty six species were new saproxylic records. This increased the number of saproxylic records for this site by 50%. Most new site records were of small species such as those in the Ptilidae, Nitidulidae and Tetratomidae families which can be difficult to find with hand-searching methods.

Traps caught an average of just over seven beetles per trap per month, which appears to be a low catch rate, but since we have been unable to find any comparable surveys for Southern Scotland, it is difficult to tell if this represents a poor catch rate or is simply typical for lowland deciduous woodland in Scotland at this time of year. Looking at species accumulation curves for the species caught in the different trap types indicates that even sixty traps in a 57.4 ha site is insufficient to catch all potential species present as accumulation curves had not yet reached an asymptote (Figure 3).

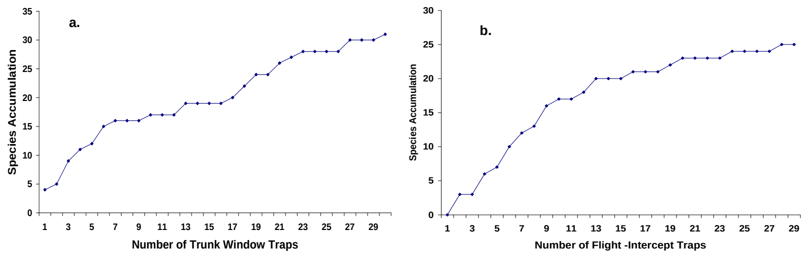

Figure 3. Coleoptera species accumulation with respect to number of trunk window traps (a) and aerial flight-interception traps (b).

A wide range of saproxylic beetle families were represented in the survey. Aerial flight-interception traps caught fewer individuals than trunk window traps, but the catch in the canopy represented a different community (Figure 4). Some notable species found included *Anaspis thoracica* (Linneaus), *Ptinus subpilosus* Sturm ,*Malthodes guttifer* Keisenwetter, *Rhagonycha translucida* (Krynicki), *Epuraea terminalis* (Mannerheim), *Tetratoma ancora* Fabricius and *Orchesia minor* Walker.

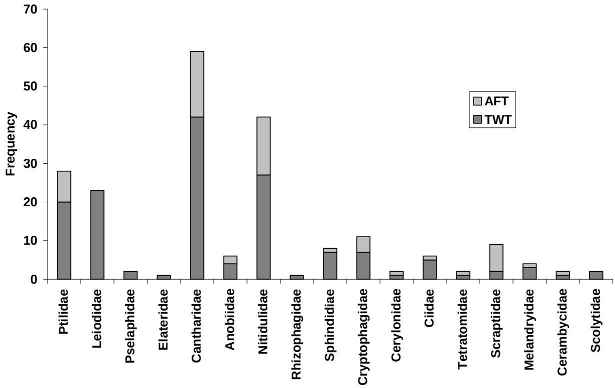

Figure 4. Number of beetles caught from saproxylic families in aerial flight-interception traps (AFT) and trunk window traps (TWT) during July 2007.

CONCLUSION

This trial showed that large scale passive trapping surveys for flying insects can be carried out on extremely low budgets. It also demonstrated that even for well studied sites with a long history of hand collection surveys (Crowson 1962; Entotax Consultants UK 2003) trapping can find unusual and rare insects infrequently captured using other methods.

This trial focused on saproxylic beetles, but the traps also caught large numbers of other flying Coleoptera groups, Hymenoptera and Diptera. These trap designs are not as sturdy as those using Perspex or other rigid plastics, but they are ideal for surveys being carried out with minimal funding during the summer months.

Full Species List for Ayr Gorge Survey, July 2007:

Carabidae: *Loricera pillicornis* (Fabricius)**,** *Pterostichus madidus* (F.), *Platynus assimilis* (Paykull)**,** *Amara aena* (De Geer)**,** **Hydrophilidae:** *Cercyon haemorrhoidalis* (F.)**,** *Cercyon impressus* (Sturm*)***,** *Cercyon melanocephalus* (F.)**,** *Megasternum concinnum* (Marsham), *Sphaeridium scaraboides* (L.), **Ptilidae:** *Ptenidium laevigatum* Erichson*,* *Ptenidium pusillum* (Gyllenhal)**,** *Ptenidium nitidum* (Heer), *Euryptilium saxonicum* (Gillmeister),*Ptinella cavelli* (Broun)**,** *Ptinella errabunda* Johnson**,** *Acrotrichis thoracica* (Waltl), **Leiodidae:** *Anisotoma humeralis* (F.), *Agathidium nigripenne* (F.), *Catops tristis* (Panzer), **Silphidae:** *Aclypea opaca* (L.)**,** *Silpha atrata* L., **Staphylinidae:** *Bibloporus bicolour* (Denny)**,** *Bryaxis curtisii* (Leach), *Neuraphes elongatulus* (Müller & Kunze) **,** *Neuraphes talparum* Lokay**,** *Stenichnus collaris* (Müller & Kunze)**,** *Tachinus rufipes* (L.), **Scarabaeidae:** *Aphodius rufipes* (L.)**,** *Serica brunnea* (L.)**,** **Scirtidae:** *Elodes minuta* (L.), *Cyphon coarctatus* Paykull**,** **Throscidae:***Trixagus dermestoides* (L.), **Elateridae:** *Denticollis linearis* (L.), *Athous haemorrhoidalis* (F.), *Athous vittatus* (F.)**,** *Dalopius marginatus* (L.), *Agriotes pallidulus* (Illiger)**,** *Agriotes acuminatus* (Stephens),*Melanotus villosus* (Geoffroy in Fourcroy), **Cantharidae:** *Cantharis livida* L.**,** *Cantharis rufa* L.**,** *Rhagonycha translucida* (Krynicki), *Malthinus seriepunctatus* Kiesenwetter**,** *Malthinus flaveolus* (Herbst)**,** *Malthodes flavoguttatus* (Kiesenw.)**,** *Malthodes mysticus* (Kiesenw.)**,** *Malthodes fuscus* (Waltl.)**,** *Malthodes marginatus* (Latreille), *Malthodes guttifer* (Kiesenw.), **Ptinidae:** *Ptinus subpilosus* Sturm, *Dryophilus pusillus* (Gyllenhal)**,** *Ernobius mollis* (L.), **Sphindidiae**: *Aspidiphorus orbiculatus* (Gyllenhal), **Nitidulidae:** *Epuraea marseuli* Reitter**,** *Epuraea melanocephala* (Marsham)**,** *Epuraea terminalis* (Mannerheim)**,** *Soronia punctatissima* (Illiger), **Monotomidae:** *Rhizophagus bipustulatus* (F.)**,** *Rhizophagus dispar* (Paykull), **Cryptophagidae:** *Cryptophagus dentatus* (Herbst), *Cryptophagus pubescens* Sturm, **Cerylonidae:** *Cerylon ferrugineum* Stephens, **Coccinelidae:** *Calvia quattuordecimguttata* (L.) **,** *Halyzia sedecimguttata* (L.), *Aphidecta obliterata* (L.)**,** **Latridiidae:** *Cartodere (Aridius) bifasciata* (Reitter), *Cartodere (Aridius) nodifer* (Westwood), **Ciidae:** *Octotemnus glabriculus* (Gyllenhal), *Cis boleti* (Scopoli), **Tetratomidae:***Tetratoma ancora* F., **Melandryidae:** *Orchesia minor* Walker, *Orchesia undulata* Kraatz**,** **Scraptiidae:** *Anaspis maculata* (Geoffroy in Fourcroy)**,** *Anaspis rufilabris* (Gyllenhal)**,** *Anaspis thoracica* (L.) *Anaspis regimbarti* Schilsky, **Cerambycidae:** *Grammoptera holomelina* Pool**,** *Grammoptera ruficornis* (Fabricius)**,** *Alosterna tabacicolor* (De Geer), *Leiopus nebulosus* (L.), **Curculionidae:** *Strophosoma melanogrammum* (Forster), *Otiorhynchus singularis* (L.), *Phyllobius argentatus* (L.), *Phyllobius glaucus* (Scopoli), *Polydrusus pterygomalis* Boheman, *Barypeithes araneiformis* (Schrank)**,** *Barypeithes pellucidus* (Boheman)**,** *Hylurgops palliates* (Gyllenhal).

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