ORIGINAL RESEARCH PAPER

Entomology

DIVERSITY AND ABUNDANCE OF CRAWLING INSECTS IN DIFFERENT HABITAT TYPES OF BIDHANNAGAR AREA OF NORTH 24 PARGANAS, WEST BENGAL, INDIA

KEY WORDS: Epigeal insects, Pitfall trapping, Diversity, One-Way ANOVA analysis, Dendrogram, Bidhannagar, West Bengal

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ABSTRACT

Due to the importance of epigeal insects in the conservation of terrestrial habitats, special attention is given to them in this paper. Between October 2022 and April 2023, this primarily study recorded a total of 906 insects belonging to 24 families of 7 orders using pitfall traps from 4 different ecosystems: Sewage area, Mango Orchard, Agricultural field and Mixed vegetation. Higher richness and abundance were observed in native forests (31 species and 782 individuals) and lower richness and abundance were observed in degraded areas (14 species, 86 individuals). Scarabaeidae was the richest family, with nine morph-species, and the most frequent family was Nitidulidae (1,113 individuals).

INTRODUCTION

A pitfall trap is a trapping pit for small animals, such as insects, amphibians and reptiles. Pitfall traps are a sampling technique, mainly used for ecology studies and ecologic pest control (Dilip *et al.*, 2014). Animals that enter a pitfall trap are unable to escape. This is a form of passive collection, as opposed to active collection where the collector catches each animal (by hand or with a device such as a butterfly net). Active collection may be difficult or time-consuming, especially in habitats where it is hard to see the animals such as thick grass.

Pitfall traps come in a variety of sizes and designs. They come in 2 main forms: dry and wet pitfall traps. Dry pitfall traps consist of a container (tin, jar or drum) buried in the ground with its rim at surface level used to trap mobile animals that fall into it. Wet pitfall traps are basically the same, but contain a solution designed to kill and preserve the trapped animals. The fluids that can be used in these traps include formalin (10% formaldehyde), methylated spirits, alcohol, ethylene glycol, trisodium phosphate, picric acid or even (with daily checked traps) plain water. A little detergent is usually added to break the surface tension of the liquid to promote quick drowning. The opening is usually covered by a sloped stone or lid or some other object. This is done to reduce the amount of rain and debris entering the trap, and to prevent animals in dry traps from drowning (when it rains) or overheating (during the day) as well as to keep out predators.

One or more fence-lines of some sort may be added to channel targets into the trap (Goncalves and Pereira, 2012). Traps may also be baited. Lures or baits of varying specificity can be used to increase the capture rate of a certain target species or group by placing them in, above or near the trap. Examples of baits include meat, dung, fruit and pheromones.

Pitfall traps can be used for various purposes, such as, when used in series, these traps may also be used to estimate species richness (number of species present) and abundances (number of individuals), and this combined information may be used to calculate biodiversity indices (e.g. the Shannon index).

There are inevitably biases in pitfall sampling when it comes to comparison of different groups of animals and different habitats in which the trapping occurs. An animal's trap ability depends on the structure of its habitat (e.g., density of vegetation, type of substrate). Gullan and Cranston (2005) recommend measuring and controlling for such variations. Intrinsic properties of the animal itself also affect its trap ability: some taxa are more active than others (e.g., higher physiological activity or ranging over a wider area), more likely to avoid the trap, less likely to be found on the ground (e.g., tree-dwelling species that occasionally move across the terrain), or too large to be trapped (or large enough to escape if trapped). Trapp ability can also be affected by conditions such as temperature or rain, which may alter the animal's behaviour. The capture rate is therefore proportional not only to how abundant a given type of animal is (which is often the factor of interest), but how easily they are trapped. Comparisons between different groups must therefore take into account variation in habitat structure and complexity, changes in ecological conditions over time and the innate differences in species.

Very few numbers of works on the diversity of epigeal insects using pitfall trapping methodare available from India and abroad. Some of those are cited as follows:

A pitfall trap is a method of trapping crawling and running ground dwelling insects. They were first mentioned more than 110 years ago (Dahl, 1896). They were developed to collect insects whose foraging habits are characterized by continuous displacement in search of food resources (Danchin *et al.*, 2008). Compared to other mechanisms used for collection, pitfall trapping has been considered the ideal method for sampling of ground-dwelling arthropods most commonly insects such as ants and beetles (Bestelmeyer *et al.*, 2000; Southwood and Henderson, 2000; Arbogast *et al.*, 2000; Phillips & Cobb, 2005; Sabua and Shiju, 2010). Insects are present in almost all the habitats of the planet and are showing the most diverse types of eating habits; therefore, constitute one of the groups of greatest abundance and diversity in studies using pitfall traps (Westberg, 1977; Favila and Halffter, 1997; Dilip *et al.*, 2014). The size of the traps has been modified to suit the body mass of the target organisms for capture, resulting in a range of prototypes increasingly more efficient and diversified (Hancock and Legg, 2012; Skvarla *et al.*, 2014). It has been suggested that ground dwelling arthropods are useful in ecosystem monitoring because they are diverse and abundant. Furthermore, ground dwelling arthropods can be used for monitoring environmental and seasonal changes because of their high species abundance, richness and habitat fidelity (Anderson and Majer, 2004). Ground beetles (Coleoptera, Carabidae) have been widely used as bioindicators for monitoring habitat disturbance (Rainio and Niemelä, 2003; Koivula, 2011) or as early warning indicators of the effect of environmental changes triggered by global warming, especially in mountains (Bässler *et al.*, 2013; Brambilla and Gobbi, 2014; Pizzolotto *et al.*, 2014).

Through this survey in 4 ecosystems of Bidhannagar, different types of terrestrial insects were recorded according to their orders and families. Also, their relative abundance and distribution are compared.

MATERIAL AND METHODS

Sites of collection

The survey was conducted to study the diversity of various epigeal insects from 4 different ecosystems of Bidhannagar of North 24 Parganas, West Bengal, India viz. garden of bidhan sarani college campus (Vidyasagar college), garden of Chingrighata, garden of Joghadipota, and pond site area of Dhapa during October to April, 2022-2023 for occurrence of insects.

Materials adopted for collection and preservation of Insects

Plastic container with 8 cm height and 6cm, soapy water solution, collecting glass vials with lids, 70% alcoholic solution for keeping specimens, Digging materials, Forceps, Brush, Cloth, Dropper.

Methodology adopted for collection and preservation of Insects

A hole just big enough for the cups was created by digging procedure. The top edge of the cup was kept open and it was buried so that the top is at ground level. ¼ part of each cup were poured with soapy water so that insects fallen inside could not go out. Traps were placed in the morning and kept there for two nights. The temperature and humidity of the particular site was recorded. After two nights, next morning traps were removed from the particular site. Collected specimens were stored in glass vials containing 70% alcoholic solution and labelled. Sorting out, identification up to orders, families (genus, species of some collections) were done in the laboratory and study of these insects properly as far as possible at this level was also done. At last, all the observed data of the pitfall trap were tabulated.

Identification

The insects were identified up to family level (due to the lack of available literatures) by the following Imm's (1977) under the guidance of the supervisor.

Insect Diversity Index

The statistical Analysis of data, were analysed by during the present study using various diversity indices, following Chakraborty, and Mondal (2022).

Cluster analysis was performed to analyze the extent of similarity of total insect abundance (on the basis of families) among 4 different ecosystems of North 2 Parganas using the Bray Curtis similarity index. One-Way ANOVA was calculated using Microsoft Excel 2021 to observe the difference in insect species composition across the four different ecosystems of Bidhannagar. All the statistical analysis were calculated in Past (Version 4.13) andMicrosoft Excel 2010.

RESULTS

Survey and documentation of different epigeal insect fauna recorded during the present study:

During the present study by means of pitfall trapping procedure, a variety of insect were trapped from all the sites. A total of 24 families from total 7 orders were collected. With 8 families each coleoptera was the most diverse orders. Diptera had 4 families and Hymenoptera and Hemiptera had 3 families under them. Collembola and orthoptera had 2 families under them. Lepidoptera had one family (**Table 1&2**).

Table 1: Details of insect collection

Family	Order
Isotomidae	Collembola
Entomobryidae	
Cecidomyiidae	Diptera
Phoridae	
Drosophillidae	
Stratiomyidae	
Curculionidae	Coleoptera
Cydnidae	
Tenebrionidae	
Scarabidae	
Carabidae	
Chrysomelidae	
Cerambycidae	
Staphylinidae	
Coccinellidae	
Formicidae	Hymenoptera
Braconidae	
Aphidae	
Aphidae	Hemiptera
Pentatomidae	
Coreidae	
Rhaphidophoridae	Orthoptera
Gryllidae	
Tineidae	Lepidoptera

Table 2: Comparing Relative Abundance of Orders of all epigeal Insects Found in 4 different ecosystems of North 24 Parganas District, West Bengal

Order	Family	Number of insects found				
		Sewage area	Mango Orchard	Agricultural field	Mixed vegetation	Total
Coleoptera	Curculionidae	0	1	0	19	20
	Cydnidae	0	2	1	0	3
	Tenebrionidae	0	0	46	21	67
	Scarabidae	1	1	1	0	3
	Carabidae	0	0	1	10	11
	Chrysomelidae	0	0	0	4	4
	Cerambycidae	0	1	0	0	1
	Staphylinidae	0	0	0	2	2
	Coccinellidae	0	1	0	0	1
Collembola	Isotomidae	0	1	0	0	1
	Entomobryidae	0	113	0	53	166
Orthoptera	Rhaphidophoridae	0	4	0	0	4
	Gryllidae	0	2	0	0	2
Hymenoptera	Formicidae	20	87	230	110	500
	Braconidae	1	0	0	0	8
	Apidae	0	0	0	1	45
Hemiptera	Aphidae	0	4	0	0	4
	Pentatomidae	0	0	0	1	1
	Coreidae	0	0	0	2	2
Diptera	Cecidomyiidae	0	1	0	0	2
	Phoridae	0	19	0	36	55
	Drosophillidae	0	0	0	1	1
	Stratiomyidae	0	0	0	1	2

Lepidoptera	Tineidae	0	0	0	1	1
Total						906

Data analysis:

Table.3: Relative abundance of orders of all insects

SL No	Order name	Total no of insects	Relative abundance (%)
1	Collembola	167	18.4326711
2	Diptera	60	6.62251656
3	Coleoptera	112	12.3620309
4	Hymenoptera	553	61.0375276
5	Hemiptera	7	0.772626932
6	Orthoptera	6	0.662251656
7	Lepidoptera	1	0.110375276
Total		906	100

Fig.1: Order-wise Relative Abundance in 4 different Ecosystem

Table 3 shows analysis of pitfall trap collection of insects. The mentioned table reveals that many types of insects were trapped during my project work and subsequently observed different insect orders, families as far as possible within this short time period. Pitfall trap collection from four different sites of north 24 parganas, consisting four different ecosystems- mango orchard, sewage area, agricultural field, mixed vegetation.

On the basis of collection, it can be observed that the dominant order of insects in pitfall trap collection were collembola (18%), Diptera (6%), coleoptera (12%), Hymenoptera (61%), Hemiptera (0.7%), orthoptera (0.6%), lepidoptera (0.1%) **(Fig.1)**.

Table 4: Comparing relative abundance of order of insects found in 4 different sites of north 24 parganas

	Sewage area		Mango Orchard		Agricultural field		Mixed vegetation	
Insect Order	Number of insects	Relative abundance	Number of insects	Relative abundance	Number of insects	Relative abundance	Number of insects	Relative abundance
Collembola	0	0	114	35.07	0	0	53	13.80
Diptera	0	0	20	6.15	0	0	40	10.41
Coleoptera	1	2,63	6	1.84	49	30.81	56	14.58
Hymenoptera	37	97.36	175	53.84	110	69.18	231	60.15
Hemiptera	0	0	4	1.23	0	0	3	0.78
Orthoptera	0	0	6	1.84	0	0	0	0
Lepidoptera	0	0	0	0	0	0	1	0.26
Total	38	100	325	100	159	100	384	100

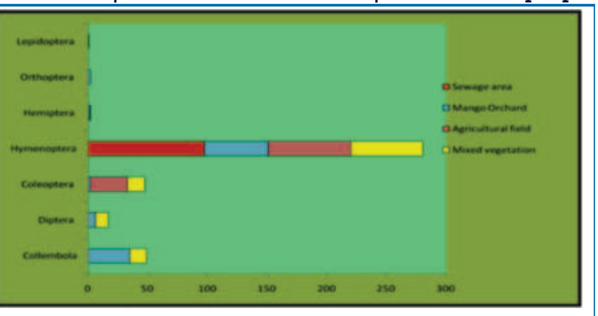

Fig 2: Relative abundance (%) of different insect orders collected at different sampling sites during the present study periods

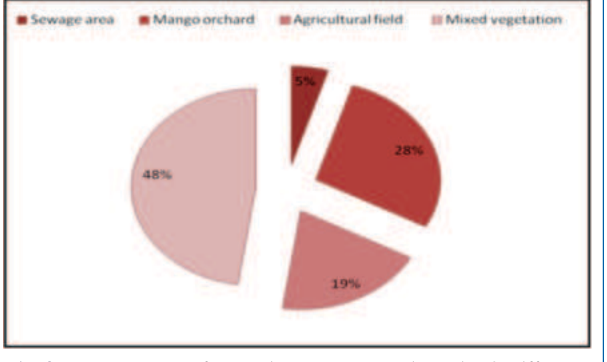

Fig.3: Percentage of total insect populations in 4 different Ecosystems

Table 5: Distribution of epigeal insect collected using Pitfall Trap from 4 habitat types

Site	Population of insects	Percentage	Mean±SE
Sewage area	40	4.76758045	13.33±5.783
Mango Orchard	236	28.1287247	78.66±11.050
Agricultural field	163	19.4278903	54.33±28.427
Mixed vegetation	400	47.6758045	80±24.488
Total	839	100	

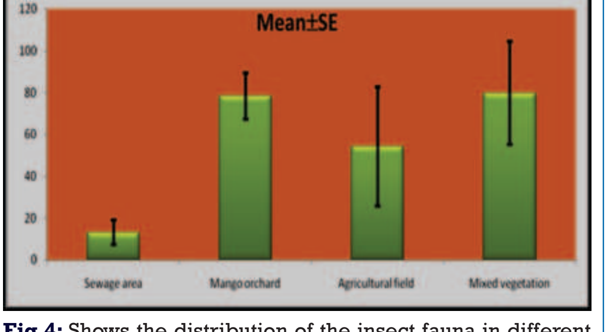

Fig 4: Shows the distribution of the insect fauna in different Ecosystems

Table 5 and the subsequent chart show the mean number of insects found in 4 different ecosystems in North 24 Parganas. According to number, mango orchard is the richest ecosystem and Sewage area is the least ecosystem.

Table 6: Comparing Biodiversity Indices of 4 different Ecosystems in North 24 Parganas

Index	Mango orchard	Sewage area	Agricultural field	Mixed vegetation
Simpson's Index(D)	0.9474	0.4158	0.5709	0.4116

Shannon-Weiner index(H)	0.1349	1.082	0.6208	1.155
Evenness index (E	0.5722	0.4916	0.9302	0.5292
Margalef Richness index(R)	0.2749	0.8645	0.1973	0.8402

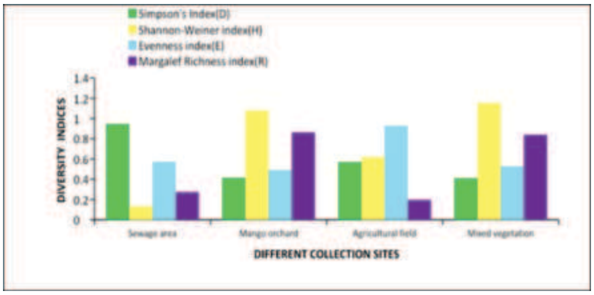

Fig.5: Biodiversity Indices of the different Ecosystems

All the biodiversity indices show a very little variation numerically but impose a greater significance. The value of Simpson's index ranges from 0 to 1 with value closer to 0 are equally present and values closer to 1 indicates high values closer to 1 indicates high level of dominance i.e., one order dominates. The Simpson's Index in sewage area shows a higher value than in mango orchard, agricultural field, mixed vegetation that means this area shows more inclination to dominance than other three sampling area. The Shannon Wiener Index is higher in mixed vegetation reflects a higher order diversity or occurrence than mango orchard, sewage area, agricultural field. The Evenness Index in mango orchard shows a higher value than in sewage area, agricultural field, mixed vegetation. The Margalef Richness Index in mango orchard shows in higher value than 3 different values **(Table 6 and Fig.5)**.

The Cluster analysis of four different ecosystems based on the abundance of insect orders sampled during the present study shows that Sewage area and Agriculture area similar to each other but, they were significantly different from those of other two ecosystem. Again, the Mixed vegetation area had higher similarity with Mango orchard **(Fig.6)**.

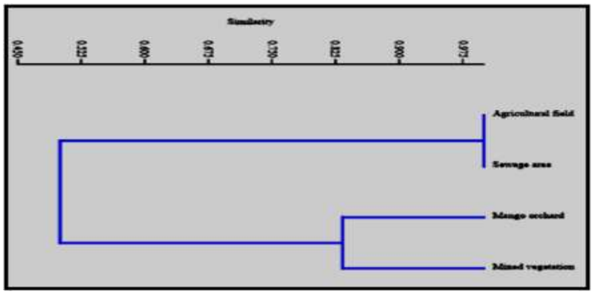

Fig.6: Dendrogram based on cluster analysis using the Bray–Curtis percentage similarity of the insect orders with the pooled data recorded from four different types of ecosystems of North 24 Parganas during the present study.

The Analysis of Variant (ANOVA) study during the present study showed that there was no significant variation among the insect orders at $P < 0.05$ in case of four different Ecosystems in North 24 Parganas **(Table 7)**. There is no significance difference at 5% level of significance.

Table 7: ANOVA analysis

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	10656.71	3	3552.238	1.053507	0.387142	3.0087 87
Within Groups	80923.71	24	3371.821			
Total	91580.43	27				

Fig.7: Pictures of collection of some insects by using Pitfall trap method; A. Order: Collembola (Family: Isotomidae), B. Order: Collembola (Family: Entomobryidae), C. Order: Diptera (Family: Stratiomyidae), D. Diptera (Family: Cecidomyidae), E. Order: Diptera (Family: Phoridae), F. Order: Diptera (Family: Drosophilidae), G. Order: Coleoptera (Family: Curculionidae), H. Order: Coleoptera (Family: Tenebriodae), I. Order: Coleoptera (Family: Scarabaiedae), J. Order: Coleoptera (Family: Carabidae), K. Order: Coleoptera (Family: Carabidae), L. Order: Coleoptera (Family: Chrysomeidae), M.Order: Coleoptera (Family: Cerambycidae), N. Order: Coleoptera (Family:Cydnidae), O. Order: Coleoptera (Family: Coccinelilidae), P. Order: Hymenoptera (Family: Formicidae), Q. Order: Hymenoptera (Family: Formicidae), R. Order: Coleoptera (Family: Staphylinidae), S. Order: Hymenoptera (Family: Apidae), T. Order: Hymenoptera (Family: Braconidae), U. Order: Hemiptera (Family: Pentatomidae), V. Order: Hemiptera (Family: Coreidae), W. Order: Hemiptera (Family: Aphididae), X. Order: Orthoptera (Family: Rhaphidphoridae), Y. Order: Orthoptera (Family: Gryllidae), Z. Order: Lepidoptera (Family:Tineidae)

DISCUSSION

This study was designed to obtain information about the soil arthropods fauna biodiversity. The results are completely dominated by order Hymenoptera which can be also seen in the few works that's been done. 24 families from 7 orders were collected throughout the project. The dominating order of insects in pitfall trap collection were Hymenoptera (61%), Hemiptera (0.7%), collembola (12%), Diptera (6%), coleoptera (12%), orthoptera (0.6%), lepidoptera (0.1%). Mango orchard produced highest number of individuals whereas sewage area produced lowest number of individuals. All 4 ecosystems were dominated by the order Hymenoptera followed by Collembola and Coleoptera. The present data are compared with kind of similar work carried out in. The mango orchard is the only ecosystem that's been managed to maximize the yield. The sewage area had ample shade as well as the grass land was undisturbed by human activity but were but were natural hence the latter showed a gradually decreasing lower catch. During the study, conducted between March 2009 and March 2015, pitfall trapping was undertaken in five study sites of different habitats in Abu Dhabi Emirate. During the study period a total of 94 monitoring visits were made to collect data from the pitfall traps at five localities in

Abu Dhabi. A total of 36238 individuals of ground-dwelling arthropods of 121 different species belonging to 14 orders and 46 families were recorded from all the study sites using pitfall traps. The order Coleoptera (beetles) was recorded to be the most dominant order with 46 species followed by Hymenoptera (ants, bees & wasps) with 24 species.

Fagundes *et al.* (2011) a total of 1,812 individuals were collected from the five different environments in Santa Maria, RS, Brazil, attributed to 45 morph-species and 14 families. The higher richness and abundance were observed in native forest (31 species and 782 individuals) and the lower richness and abundance in degraded area (14 species, 86 individuals). Scarabaeidae was the richest family captured, with nine morph-species, and the most frequent family was Nitidulidae (1,113 individuals). During the case study, Gadagkar *et al.* (1990) encountered 16,852 adult individuals belonging to 1,789 species. 219 families and 19 orders of insects with the use of a small light trap as well as net sweeps, pitfall traps and scented traps from three replicate one-hectare plots each in twelve selected sites in the Uttara Kannada district of Karnataka, India. Jaganmohan *et al.* (2013) recorded a large number of insects, 2,185 insects from 10 orders, of which ants, bugs, beetles and flies were the most common. The abundance of captured beetles in Pitfall Traps in the Şinca Old-Growth Forest, Braşov County, Romania: Forest Reserve versus Managed Forest was about 17% higher in the forest reserve (16,393 individuals) than in the managed forest (14,008 individuals), while species richness was higher in the managed forest (44 species), where 19.1% more taxa were identified than in the forest reserve (37 species). A total of 173 individuals of 35 species of insects belonging to 12 orders and 24 families were successfully identified from Tanjung Leman Jetty (site 1), coastal lowland hills (site 2), coconut groves, bush and village areas (Site 3), and rocky shores near Rimba Resort (Site 4). The best represented insect orders are Hymenoptera (ants, bees and wasps), Odonata (dragonflies and damselflies), Hemiptera (bugs), Isoptera (termites), Lepidoptera (butterflies and moths) and Orthoptera (grasshoppers and leafhoppers). A small number of species of Diptera (flies), Coleoptera (beetles), Homoptera (cicadas), Blattaria (cockroaches), Phasmatodea (stick insects) and Mantodea (praying mantises) were also collected. Order Hymenoptera (Formicidae) is one of the orders of the highest relative abundance which were obtained using the five-soil insect trapping methods. Order Hymenoptera (Formicidae) or ants is known as one of the insects that have a high level of resistance to environmental changes. These conditions make it as one of the indicators of agroecosystem (Peck *et al.*, 1998) as well as indicators of environmental assessment programs, such as forest fires, disturbance to vegetation, deforestation, mining, waste disposal and land use factor (Wang *et al.*, 2000). Formicidae is a group of fauna living on the soil surface which also likes moist, warm, and protected places (Wallwork, 1970; Setiadi, 1989). A pronounced difference occurred among the three tested sampling methods. Pitfall traps yielded the maximal capture (both frequency and abundance) of 12 out of 24 taxa, followed by the Winkler method for 02 out of 24 taxa, and the Berlese method for 0 out of 24 taxa; and for larvae of insects and Acari all the methods are equally effective. The Berlese method proved the least effective among the three methods for any taxa. Pitfall traps become indispensable for Diplopoda and Opiliones and for Orthoptera and Diptera with exceptionally high abundance and frequency of capture. These percentages (effective capture of 50% of the whole taxa) indicate that the pitfall trap is the most useful arthropod collection method for ecological studies of ground-dwelling arthropods, when compared with Berlese and Winkler methods. Non-significant differences in the capture of minor taxa (9 out of 24) among the different trap types are difficult to interpret because of their low frequency of occurrence and abundance possibly related to the low population densities of these taxa in the wet forests of the Western Ghats (Anu, 2006; Vineesh, 2007; Anu *et al.*, 2009). However, a strong bias was apparent in the samples obtained with pitfall traps compared with the Berlese and Winkler methods. Pitfall trap traps captured more taxa of surface-active invertebrates: Orthoptera, Diptera, Araneae, Collembola, Coleoptera (with more of Staphylinidae), other Hymenoptera, Chilopoda, Diplopoda, and Opiliones (Dennis *et al.*, 1997; Bignell *et al.*, 2000; Prasifka *et al.*, 2007) in comparison to their relatively low frequency of capture in Berlese and Winkler methods.

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