Preliminary Ecological Studies: Testing Pitfall and Winkler Methods With Ants From The Forest Floor Of Nagzira Wildlife Sanctuary, Maharashtra

Mayukh Sarker
WBES
Department of Zoology
Acharya Prafulla Chandra Roy Government College, Himanchal Vihar, Matigara, Siliguri, Dist. Darjeeling, West Bengal, India

Abstract: The biodiversity found on Earth today consists of many millions of distinct biological species. Insects (ants) create the biological function for all terrestrial ecosystems. The present study reveals the ant diversity from the forest floor of the Nagzira Wildlife Sanctuary. The sampling efficiency and consistency of pitfall traps and winkler methods for bioindicator and ecological studies in forest habitats using ants was compared. Pitfall traps were more efficient and productive than winkler sampling with a greater total species richness and higher abundance of ants recorded. The main focus of this study is the forest development depending upon the insect biodiversity, as well as provides opportunities for enhancing the resilience of soil ecosystem services by conserving soil biodiversity.
Index Terms: Nagzira, Ant, Pitfall trap, Winkler, Sampling

INTRODUCTION

Ants are recognized as important components of global biodiversity terms of their considerable biomass, species richness and play a significant role as bioindicator. (Hölldobler and Wilson, 1990). In addition, because ants are responsive to changing environmental conditions and relatively easy to sample and identify, they have been frequently used for conservation assessment purposes, to monitor environmental impact, ecosystem management, and the recovery of ecosystems (Majer, 1983; Folgarait, 1998; Andersen and Majer, 2004). For sampling of ant species, the most commonly employed method is pitfall trapping. Pitfall traps provide a relatively simple, quick and cost-effective sampling method for collecting ants, and allow for continuous day and night sampling (Southwood, 1978; Andersen, 1991; Majer, 1997). Pitfall trapping is most productive in open habitats because catch can be compromised by vegetation complexity (Greenslade, 1964; Majer, 1997; Melbourne, 1999).

The Winkler method is particularly useful for collecting litter and soil fauna that are not caught as readily with pitfall traps and is highly recommended for use in forested habitats where litter is plentiful (Nadkarni and Longino, 1990; Olson, 1991; Fisher, 1996, 1999). Sampling using the Winkler method in rainforest habitats has proved very successful, yielding significantly better results than pitfall trapping alone (Olson, 1991; Fisher, 1999). Although traditionally used in forest systems, the Winkler method could be used in forest floor of Nagzira wild life sanctuary where a litter layer also accumulates. The relative efficiency of Winkler extractors compared to other sampling methods in such habitats still requires investigation. Hence, the aims of the current study were to test the relative merits of pitfall traps and Winkler sampling for assessing the diversity (richness and abundance, and size composition of catch) of ants in Nagzira forest ecosystem, and to assess the effects of differences in quadrat size and number on the efficacy of the Winkler sampling method. In so doing, recommendations for the most appropriate sampling technique(s) for inventories and for other quantitative studies in Nagzira forest are made.

MATERIALS AND METHODS

Sampling of ants was undertaken on a forest floor of Nagzira Wildlife Sanctuary located in the Gondia District of Maharashtra. A total of 30 pitfall traps (fifteen 62mm diameter (large), and fifteen 18mm diameter (small) were set at 2m intervals along six randomly placed transects, covering an area of approximately 500 sq meter. Each transect consisted of five traps, with large and small traps alternating. Each trap contained a 50% propylene glycol solution, and was open for three days. Propylene glycol is non-toxic to larger animals, and is not known to significantly attract or repel ants (Adis, 1979). Vegetation around the pitfall traps was not cleared. Following the pitfall trapping, Winkler litter samples were collected in the same area. Fifteen samples were collected for each of the following Winkler quadrat: $1m^2$ (total $15m^2$), ½ m^2 (total 7½ m^2), Collection quadrats were spaced at 2m intervals along randomly placed transects. Where more than one quadrat was used per Winkler sample, the litter from all quadrats was mixed and sieved together, and then 2 litres taken for hanging. Each set of Winkler samples was suspended for 48 h; this being the hanging time in many other studies (e.g. Olson 1991; Fisher 1998, 1999).

Ant samples collected with both techniques were stored in 80% alcohol. All ant samples were sorted and identified to morphospecies level on the basis of characters previously established to be important at the species level for each genus. The maximum head width of each species was measured to 0.01mm with an ocular micrometer mounted on a dissecting microscope. Head width provides a standard and accurate measure of overall body size (Holldobler and Wilson, 1990; Kaspari, 1993). In order to provide an indication of the body size frequency distribution for each sampling method, ant species were placed into 0.2mm size based on head size: 1=0.30-0.50 mm, 2=0.51-0.70 mm, 3=0.71-0.90 mm, 4=0.91-1.10 mm, 5=1.11-1.30 mm, 6=1.31-1.50 mm, 7= 1.51-1.70 mm. The mean abundance of ants/sample and standard error for each size class were calculated.

RESULTS

A total of 08 ant species comprising three subfamilies was recorded with pitfall traps and Winkler samples combined (Table 2). Species richness was greatest with pitfall trapping. A total of 06 ant species was recorded from pitfall trapping alone, with the most abundant species was *Pheidole* sp. A total of 02 ant species was recorded from Winkler samples, with the richest genus being *Pachycondyla* sp. In the Winkler sampling protocols, with the 1m^2 quadrats, the mean number of ants per sample was lower than that found in both the large and small pitfalls (Table 1). Total species richness was greatest for large pitfall samples (06 species), and lowest for Winkler quadrat size ½ m^2 (02 species). The mean number of ants per sample and mean number of species per sample was highest for large pitfall traps (24.2±5.4 and 4.9±0.4 respectively) (Table 1).

Table1 Species richness and abundance (total and mean with standard error(SE) for pitfall traps (62 mm and 18 mm diameter) and Winkler samples

Winkler & Pitfall sizes	Number of samples	Mean no. ants/sample (±SE)	Mean no. species/sample (±SE)
1m^2	15	12.5±4.2^a	2.2±0.6^a
½ m^2	15	3.9±1.7^b	1.8±0.2^b
62 mm	15	24.2±5.4^c	4.9±0.4^c
18mm	15	14.3±3.9^d	3.5±0.5^d

Means followed by different lower case letters in column are significantly different at p>0.05 using t-test

Pitfall sampling was more consistent and less variable than Winkler sampling for both number of ants/sample. This emphasizes the relative inefficiency of Winkler sampling where a high effort yields low output. In the case of species richness/sample there were large differences between the sampling methods (Table 1).

DISCUSSION

In the Nagzira forest ecosystem, pitfall traps proved more efficient and consistent than Winkler sampling in collecting ants. Pitfall traps produced higher total species richness. Greater proportion of pitfall samples contained higher ant abundances and species richness than Winkler samples. Large pitfalls were consistently more effective than all other sampling methods. The 1m^2 quadrat Winklers performed more efficiently than ½ m^2 Winkler combinations (Table 1). The fact that large pitfalls performed better than small pitfalls indicates that although pitfall traps may be used in preference to Winkler samples in the forest habitats, they must be of a sufficiently large diameter to allow for good catch. Pitfall trapping is thought to favour large, mobile ants, while Winkler sampling should be more efficient at collecting smaller, more cryptic ants. This is because small ants are likely to be slower moving due to the nature of their foraging habits (Kaspari and Weiser, 1999), and hence more likely to be caught with Winkler litter sampling. This study showed that although there was no significant difference in ant size frequency distribution with the different sampling techniques, some trends could be discerned. Thus, in terms of relative abundances of ants, Winkler sampling catches greater numbers of smaller ants than pitfall trapping, and pitfall trapping catches more, larger ants. Olson (1991) also found that litter samples contained a greater proportion of smaller species. Winkler sampling was much more time-consuming, and labour intensive than pitfall trapping since samples had to be collected in the field, and processed to extract the ants.

Table 2 List of species collected in pitfall traps and Winkler samples

Subfamily	Species	Pitfall samples		Winkler samples	
		large	small	1 sq mt	½ sq mt
Myrmicinae	*Pheidole* sp 1	++++	+++	+	+
	Pheidole sp 2	++++	+++	+	+
	Cataulacus sp.	++	++	+	--
	Crematogaster sp.	+	+	+	+
Formicinae	*Camponotus* sp.	++	++	++	-
	Oecophylla smaragdina	++	++	+	+
Ponerinae	*Pachycondyla* sp 1	--	--	+++++	++
	Pachycondyla sp 2	--	--	++++	+

(+) denotes abundance

Many studies using Winkler sampling have been carried out in forests, particularly rainforests (Olson, 1991; Didham, et al., 1998; Fisher, 1999) where leaf litter typically forms a very thick and continuous ground layer. In such areas, vegetation complexity is likely to influence pitfall catch negatively (Greenslade, 1964; Majer, 1997; Melbourne, 1999), making Winkler sampling the more efficient method of collection for both surface-active and cryptic ant species. Some rainforest studies have demonstrated that Winkler sampling can replace pitfall trapping entirely (Fisher, 1999). In contrast, in more open, patchy and less complex environments, that have variable litter loads, such as Nagzira forest floor, it appears that pitfall traps perform better, and reduce the usefulness of Winkler sampling in adding new species. It is highly probable that with a larger pitfall diameter, sampling efficiency would have increased and when using Winkler sampling alone, we suggest collecting litter from $1m^2$ quadrats for each sample instead of ½ m^2 . So, in summary, pitfall sampling alone is more efficient, productive and consistent than Winkler sampling for ants in the Nagzira forest ecosystem.

REFERENCES

Adis, J. 1979. Problems of interpreting arthropod sampling with pitfall traps. Zoologischer Anzeiger, 202, 117–184.

Andersen, A.N. and Majer, J.D. 2004. Ants show the way down under: Invertebrates as bioindicators in land management. Frontiers in Ecology and the Environment, 2: 291-298.

Andersen, A.N. 1991. Sampling communities of ground-foraging ants: pitfall catches compared with quadrat counts in an Australian tropical savanna. Australian Journal of Ecology, 16, 271–279.

Didham, R.K., Hammond, P.M., Lawton, J.H., Eggleton, P. and Stork, N.E. 1998. Beetle responses to tropical forest fragmentation. Ecological Monographs, 68, 295–323.

Fisher, B.L. 1996. Ant diversity patterns along an altitudinal gradient in the RKeserve Naturelle IntKegrele d'Andringitra, Madagascar. Fieldiana Zoology, 85, 93–108.

Fisher, B.L. 1998. Ant diversity patterns along an elevational gradient in theRKeserve SpKeciale d'Anjanaharibe-Sud and on the western Masoala Peninsula, Madagascar. Fieldiana Zoology, 90, 39–67.

Fisher, B.L. 1999. Improving inventory efficiency: a case study of leaf-litter ant diversity in Madagascar. Ecological Monographs, 9, 714–731.

Folgarait, P.J. 1998. Ant biodiversity and its relationship to ecosystem functioning: A review. Biodiversity and Conservation, 7: 1221- 1244.

Greenslade, P.J.M. 1964. Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). Journal of Animal Ecology, 33, 301–310.

Hölldobler, B. and Wilson, E.O. 1990. The ants. Belknap Press, Cambridge, Mass.

Kaspari, M. 1993. Body size and microclimate use in Neotropical granivorous ants. Oecologia, 96, 500–507.

Kaspari, M. and Weiser, M.D. 1999. The size-grain hypothesis and interspecific scaling in ants. Functional Ecology, 13, 530–538.

Majer, J.D. 1997. The use of pitfall traps for sampling ants – a critique. Memoirs of Museum Victoria, 56, 323–329.

Majer, J.D. 1983. Ants: Bio-indicators of minesite rehabilitation, land-use and land conservation. Environmental Management, 7: 375- 383.

Melbourne, B.A. 1999. Bias in the effect of habitat structure on pitfall traps: An experimental evaluation. Australian Journal of Ecology, 24, 228–239.

Nadkarni, N.M. and Longino, J.T. 1990. Invertebrates in canopy and ground organic matter in a Neotropical montane forest, Costa Rica. Biotropica, 22, 286–289.

Olson, D.M. 1991. A comparison of the efficacy of litter shifting and pitfall traps for sampling leaf litter ants (Hymenoptera, Formicidae) in a tropical wet forest. Biotropica, 23, 166–172.

Southwood,T.R.E. 1978. Ecological Methods. London: Chapman & Hall.