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Sampling Ground-dwelling Ants: Case Studies from the World's Rain Forests

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Contents

Chapter 2 - Ants species diversity in the Western Ghats, India

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Introduction

There are very few long-term studies of tropical insect species diversity. This may in part be attributed to lack of economic development of most tropical countries, the lack of adequate facilities for research, and sometimes to the lack of tradition in modern scientific work. However, we felt that, at least sometimes, this is due to the lack of appropriate research methodology suitable for tropical countries. We therefore developed a standardized package of methods for quantitative sampling of insects by tropical ecologists with modest research budgets. This methodology combines the use of a small, locally fabricated, battery-operated light trap as well as vegetation sweeps, pitfall traps and scented traps. We have used this package of methods to sample insect species diversity patterns in several areas of India.

During this study, we encountered 16,852 adult insects belonging to 1789 species, 219 families and 19 orders. Application of a variety of statistical analyses suggested that this package of methods is adequate for reliably sampling insects and for differentiating habitats on the basis of the distribution of insect species (Gadagkar et al. 1990).

Encouraged by the success of this package of methods for insects as a whole, we then focused our attention more specifically on ants, with the dual aims of documenting ant diversity patterns and exploring the possibility of using ants as indicators of biodiversity (Gadagkar et al. 1993).

Materials and methods

Study Sites

Our study sites were located in the Uttara Kannada district of the state of Karnataka, India. The forested study sites fall broadly into two categories reflecting different levels of disturbance, namely, the "Reserve Forests" (R.F.) (relatively less disturbed) and the "Minor Forests" (M.F.) (relatively more disturbed). Sites representing both categories were chosen in the coastal plains, as well as at higher elevations (approximate altitude 600 m). Sites were selected to ensure that they represented different habitats and levels of disturbance. In addition to these forested habitats, three monoculture plantations (PL.) and a forest which was regularly harvested to produce leaf manure (Betta land) were also chosen for study. At each of these sites, sampling was carried out in three one hectare plots. Thus a total of 36 one hectare plots from 12 habitat types were sampled. A brief description of each study site is given in Table 1. The study was carried out during December, January, February and March 1983-5, which is part of the dry season in these localities.

Sampling methods

Four trapping methods were employed:

(1) Light trap - A portable light trap which can be easily assembled and dismantled was fabricated using locally-available inexpensive materials. The light trap uses a 10 inch fluorescent light source (Eveready Fluorolite; 6 Watts) powered by 1.5 Volt battery cells. The main framework of the trap consists of four iron legs, an aluminium roof and two aluminium baffles, between which the light source is placed. Insects attracted to the light were collected through a funnel in a cyanide jar, below the light. One light trap was placed in the centre of the plot. The light was switched on at dusk and allowed to burn itself out as the batteries drained after about seven hours. The insects trapped in the jar were collected the next morning and preserved in 70% alcohol.

(2) Vegetation Sweeps - Sweeps were carried out to collect insects off vegetation. The nets were made of thick cotton cloth with a diameter of 30 cm at the mouth and a bag length of 60 cm. The plot was divided into 100 quadrats, measuring 10m x 10m each. Six such quadrats were chosen at random and the entire ground level vegetation was swept with the net. Sweeps were always done between 1000 h - 1200 h.

Table 1. A brief description of study sites

Sites	Vegetation type	Dominant tree species	Remarks
Santagal R.F.	Evergreen	*Cinnamomum, Bischofia* and *Diospyros* spp.	Thick tree canopy, understorey of Cane breaks.
Nagur R.F	Evergreen	*Holigarna* and *Hopea* spp.	Thick tree canopy, understorey of saplings.
Mirjan M.F.	Scrub	*Ixora, Buchnania* and *Terminalia*	Highly degraded semi-evergreen.
Chandavar M.F.	Semi-evergreen	*Ixora, Aporosa* and *Hopea* spp.	Degraded, understorey of frequently lopped saplings.
Bengle M.F.	Moist deciduous	*Terminalia* spp.	Degraded, thick under- growth of grass and annual herbs.
Bidaralli R.F.	Moist deciduous	*Terminalia, Xylia* and *Lagerstromia* spp.	Undergrowth of herbs and shrubs, mainly *Clerodendrum*.
Sonda R.F.	Moist deciduous	*Terminalia, Xylia* and *Aporosa*	Understorey mainly of *Psychotria* spp.
Bhairumbe M.F.	Moist deciduous	*Caryea, Ziziphus* and *Randia*	Degraded, undergrowth of *Chromelina*.
Betta land	Moist deciduous	*Terminalia* and *Lagerstromia*	Cleared of all undergrowth, maintained for leaf manure.
Eucalyptus Pl.	Monoculture	*Eucalyptus* spp.	Thick undergrowth of grass and herbs, surrounded by extensive moist-deciduous forest.
Teak Pl.	Monoculture	*Tectona grandis*	Little or no undergrowth except *Lantana* and *Chromelina*.
Areca Pl.	Monoculture	*Areca catechu*	Plantations in valleys, surrounded by evergreen forest on hills.

(3) Pitfall traps - These consisted of a 2.5 litre plastic jar with an opening of 9 cm in diameter, buried at ground level and protected from rain by a tripod stand carrying a plastic plate of about 30 cm diameter, situated 15 cm above the ground. One pitfall trap was placed in each of five randomly-chosen 10 m x 10 m quadrats. Each jar carried 25 ml of 0.05% methyl parathion. The traps were set up between 1500 h and 1700 h and were collected the next morning.

(4) Scented traps - A plastic jar of 2.5 litre capacity was used to fabricate a scented trap. The mouth of the jar was shielded from rain water using a plastic plate, with a gap of 6 cm between the mouth of the jar and the plate to enable insects to freely move into the jar. The trap was baited with 200 ml of saturated jaggery (unrefined cane sugar) solution with two tablets of baker's yeast, 0.05% methyl parathion emulsion and 0.5 ml of pineapple essence. The traps were hung at about 1 m from the ground on wooden pegs. Five such traps were used, one each in the centre of a randomly-chosen 10m x 10m quadrat. The scented traps were also set

between 1500 h and 1700 h and collected the following morning. Insects trapped in the solution were filtered, washed and preserved in 70% alcohol.

In addition to trapping insects by the methods described above, an intensive hand collection was made in each one hectare plot to collect representatives of as many species of ants as possible. Two persons made the search for one hour between 1400 h and 1500 h in every case. No attempt was made to estimate abundance by this method.

Data analysis

As an index of (within site) diversity, we computed ∞ of the log series (Fisher et al. 1943) by the equation:

$S = \log_e (1 + N/\infty)$

where S is the number of species in the sample, N is the number of individuals in the sample, and ∞ is the index of diversity. The standard deviation of ∞ was estimated as ∞/{-log(1-X)} where X = N/(N + ∞) (Anscombe 1970). Using the standard deviation, significant differences in diversity between habitats were judged by the z test. This index is often recommended as a useful measure of within site diversity, even when the underlying distribution is not necessarily a log series (Krebs 1985).

ß (between sites or between method) diversity was estimated as coefficients of similarity given by the Morishita-Horn index (Wolda 1981):

$$C = \frac{2\sum(\mathbf{n}_{1i}\mathbf{n}_{2j})}{(\lambda_1 + \lambda_2).N_1N_2}$$

where $\lambda_j = \dfrac{\sum n_{ji}^2}{N_j^2}$

and where n_{ji} is the number of individuals of species i in sample j and nj is the number of individuals in sample j. The index was computed with data logarithmically transformed as ln (n_{ji} + 1). Cluster analysis was performed using a simple-linkage algorithm. Where only presence-absence data were available, such as with hand collecting, the Jaccard index was used to compute similarity (Ludwig and Reynolds 1988):

$$J_{AB} = \frac{a}{a + b + c}$$

where a = the no of species common to both sites, b = the no of species found only at A and c = the no of species found only at B.

Results and Discussion

This study provides the first estimates of ant diversity and abundance for any forest locality of India. Overall, we obtained 140 species of ants belonging to 32 genera and 6 sub-families in the 12 localities (Table 2). Each 3 ha locality yielded between 8 to 16 genera and 13 and 33 species (Table 3). Ants accounted for 5.4 - 12.8% of all insect species caught and 5.1 - 43.2% of all insect numbers caught in these localities (see Gadagkar et al. 1990, for data on other insect groups sampled in these plots). It is not easy to compare these numbers with other regions of the world because the number of studies is few and they have used different methods.

Comparison of trapping and hand collecting

The combination of the four trapping methods used was somewhat more successful than hand collecting, yielding 120 species from 31 genera while hand collecting yielded 101 species from 27 genera. More significant is the fact that the traps and hand collecting yielded different species; while 78 species were obtained by both methods, the traps yielded 42 unique species and hand collecting yielded 20 unique species. It appears therefore, that in spite of the efficacy of the traps, a combination of trapping and hand collecting may be desirable.

Of the four trapping methods used, pitfall traps sampled the most species, followed by vegetation sweeps, scented traps and light traps in that order. The fact that pitfall traps and vegetation sweeps were more successful is not surprising, indeed the fact that scented traps and light traps yielded as many ants as they did is surprising. Not only did the scented traps and light traps yield more ants than expected, they yielded an ant fauna rather different from that obtained by the other methods. The combination of several trapping methods that we have used is therefore of particular value (Figure 1).

Table 2. Summary of ant species collected from twelve localities in Western Ghats by a combination of quantitative sampling methods and hand collection.

Subfamilies	Genera	Number of species
Ponerinae	*Diacamma*	1
	Leptogenys	2
	Pachycondyla	5
Aenictinae	*Aenictus*	2
Dorylinae	*Dorylus*	3
Pseudomyrmecinae	*Tetraponera*	3
Myrmicinae	*Aphaenogaster*	1
	Cardiocondyla	3
	Cataulacus	2
	Crematogaster	14
	Rhoptromyrmex	2
	Lophomyrmex	2
	Meranoplus	2
	Monomorium	17
	Myrmicaria	1
	Pheidole	24
	Pheidologeton	3
	Solenopsis	1
	Tetramorium	5
	Recurvidris	1
Dolichoderinae	*Iridomyrmex*	1
	Tapinoma	9
	Technomyrmex	1
Formicinae	*Lepisiota*	4
	Anoplolepis	1
	Camponotus	12
	Oecophylla	1
	Paratrechina	2
	Plagiolepis	5
	Polyrhachis	6
	Prenolepis	4
TOTAL: 7	31	140

Table 3. Comparison of ant abundance and diversity in different localities

Locality	No.of subfamilies	No.of genera	No.of species	No.of individuals	Diversity index (∞of log series)	% ant species among all insect species trapped	% ants among all insects trapped
Santagal	2	10	25	104	10.44	12.7	18.2
Nagur	5	15	32	159	12.07	21.2	21.9
Mirjan	5	16	27	149	9.64	12.6	5.1
Chandavar	5	16	30	118	12.98	12.8	7.0
Bengle	4	15	29	344	7.55	9.2	22.5
Bidaralli	3	16	33	423	8.37	10.0	32.4
Sonda	5	12	21	132	7.04	11.4	20.9
Bhairumbe	4	14	19	124	6.26	11.0	19.0
Betta	4	14	25	267	6.75	10.6	24.2
Eucalyptus	4	16	25	368	6.06	6.1	11.6
Teak	3	8	16	155	4.48	13.7	43.2
Areca	4	9	13	419	2.54	5.4	19.2

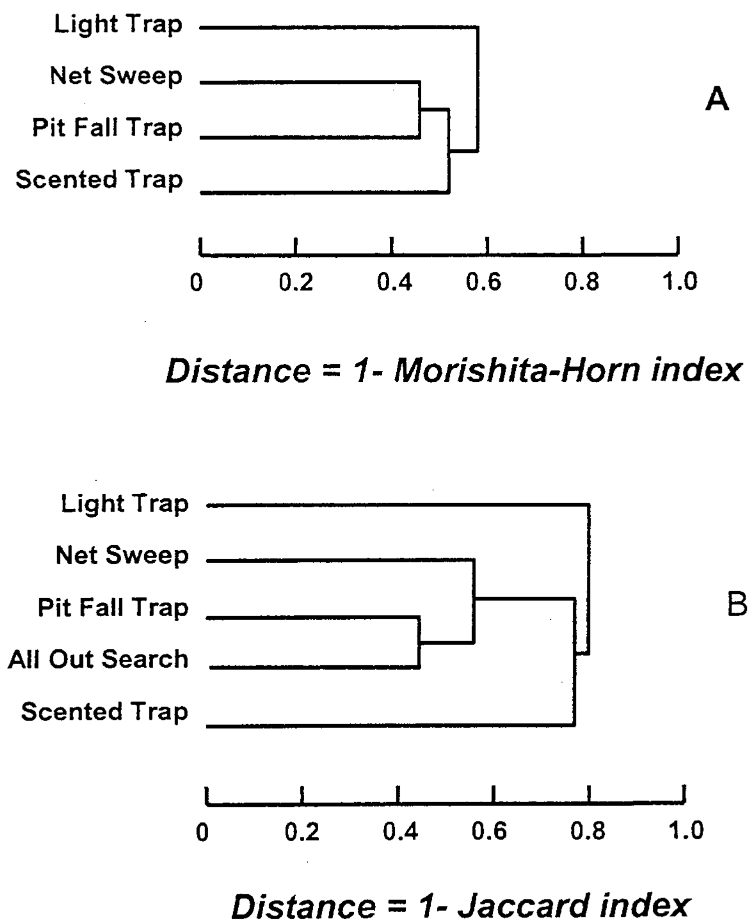

Figure 1. Dendrograms comparing different sampling methods by ant species trapped. Data pooled from 36 plots for each sampling method. A, distance = 1 - Morishita - Horn index of similarity. B, distance = 1 - Jaccard index.

Comparison of localities based on ant fauna

The diversity of the ant fauna varied sufficiently between the 12 localities that several pairs of localities could be distinguished from each other by statistically comparing their levels of ant diversity (Table 4). This ability to discriminate between localities inspires confidence that our methodology is adequate and reproducible.

Although the preliminary nature and small sample sizes of this study preclude us from drawing any firm conclusions regarding the possible causes of variation in ant diversity between localities, two preliminary conclusions may be drawn. One is that relatively disturbed localities show relatively lower richness and diversity in their ant fauna than those which are less disturbed. This trend is evident in the monoculture plantations and the Betta land (Table 3). There is similar evidence in the literature for

Table 4. Comparison of localities in Western Ghats by their respective ant species diversity levels. Pairs of sites that are significantly different from each other in their levels of ant species diversity as measured by of the ∞log series. A "+" in any cell indicates that the site mentioned in the row is significantly more diverse than the site mentioned in the column ($p < 0.05$). Numerals (1) and (12) in row and column headings refer to different sites. The mean and standard deviation for each site are given in the row titles. Names of sites in row and column titles are ordered according to diversity.

		Site											
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1.	Chandavar M.F. 12.98 ± 2.37						+	+	+	+	+	+	+
2.	Nagur R.F. 12.07 ± 2.13								+	+	+	+	+
3.	Santagal R.F. 10.44 ± 2.09											+	+
4.	Mirjan M.F. 9.64 ± 1.85											+	+
5.	Bidaralli R.F. 8.37 ± 1.46												+
6.	Bengle M.F. 7.55 ± 1.40												+
7.	Sonda R.F. 7.04 ± 1.54											+	+
8.	Betta Land 6.75 ± 1.35												+
9.	Bhairumbe M.F. 6.26 ± 1.43												+
10.	Eucalyptus PL 6.06 ± 1.21												+
11.	Teak PL 4.48 ± 1.12												
12.	Areca PL 2.54 ± 0.70												

reduction in ant diversity due to disturbance. For example, a significant reduction in ant species richness was found after slashing and burning of a tropical forest in Mexico (Mackey et al. 1991). The second conclusion is that there is a weak, but statistically significant, positive correlation between ant species diversity and plant species diversity (Figure 2). This is in contrast to an inverse correlation between bird species richness and plant species richness observed in the same general locality (Daniels et al. 1992). Note that plants and bird species diversity were simultaneously studied by our colleagues in the same localities at the same time (Bhat et al. 1986, 1987; Chandrashekara et al. 1984).

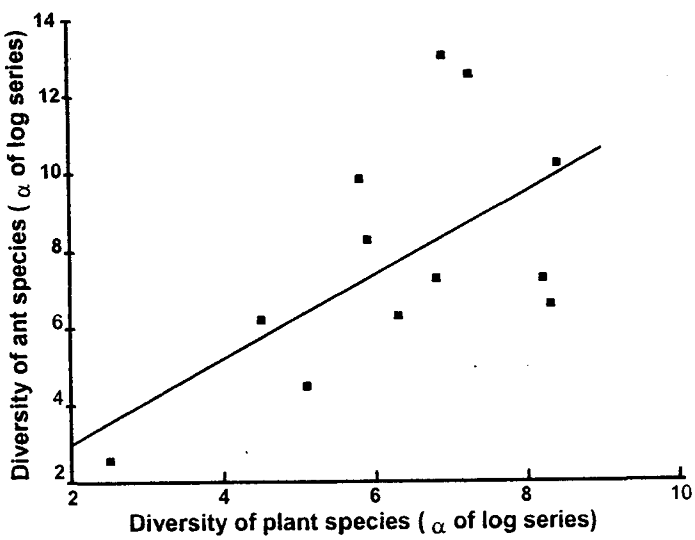

Figure 2. Scatter plot showing the relationship between plant and ant species diversity. For both ants and plants, diversity is measured by ∞ of the log series. The fitted line is given by the equation Y = 0.99 + 1.08X. The slope is significantly greater than zero, $p < 0.02$. The relationship between ant and plant species diversity is also evident from a correlation analysis: Pearson product moment correlation = 0.63, $p < 0.05$; Kendall's rank correlation coefficient = 0.42, $p = 0.05$.

Comparison of the ant fauna sampled in different seasons in the two selected localities shows that seasonal variation within the locality is negligible when compared with variation between localities. This suggests that the ant fauna is highly locality specific. The tight clustering in the dendrograms of the ant fauna from different months within a locality, and the wide separation of the fauna between the two localities (Figure

3), inspires further confidence in the ability of our methods to adequately sample and thus permit comparison of habitats.

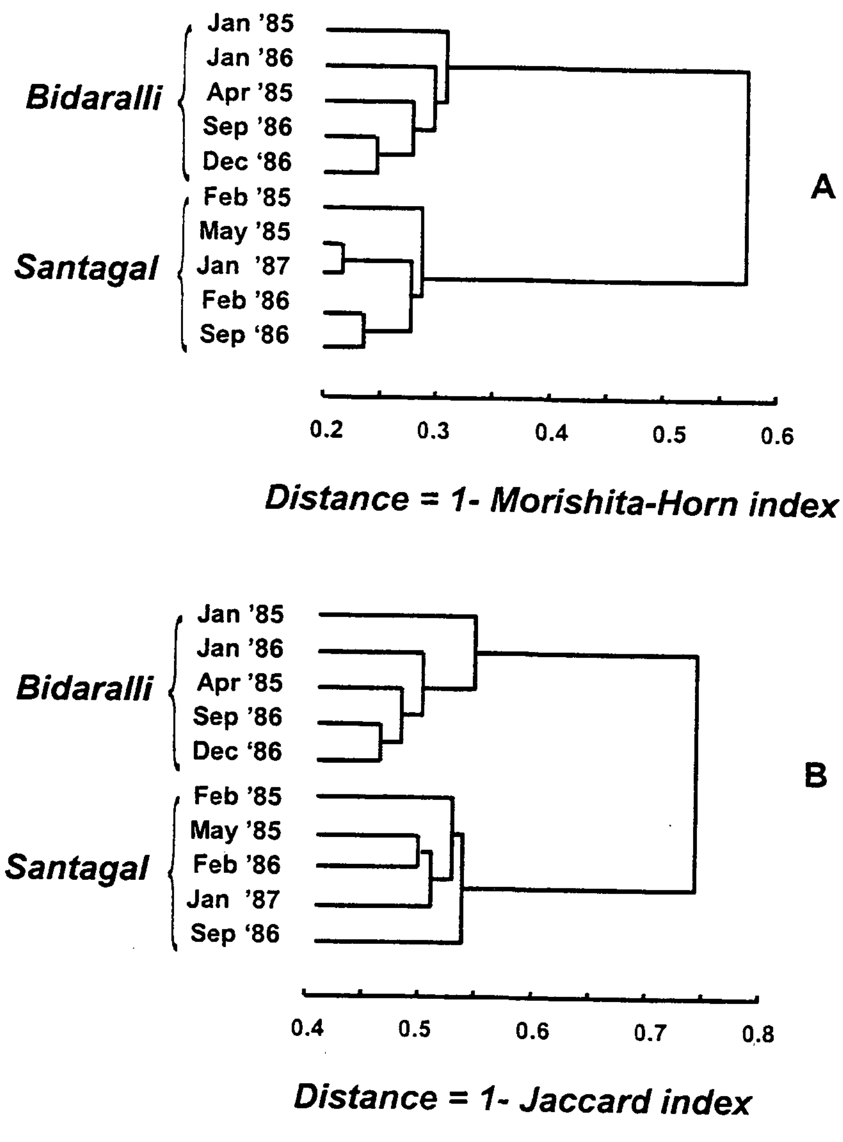

Figure 3. Dendrograms comparing ant fauna in different seasons sampled from two localities. Data pooled from six repeated samplings from a single one hectare plot for each season in each locality. A, distance = 1 - Morishita - Horn index of similarity. B, distance = 1 - Jaccard index.

In conclusion, although these studies are at a very preliminary stage, they suggest that the ant fauna of the Western Ghats is sufficiently rich to warrant more detailed investigations on ant biodiversity, ecology and behaviour. There is also reasonable evidence that ants may be good candidates as indicator species for insect biodiversity in this region.

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