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PITFALL TRAPPING FOR SURVEYING ANT ASSEMBLAGES: LESSONS FROM A STUDY AT MOUNT PIPER, VICTORIA

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Abstract

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Ants were sampled by grids of pitfall traps from six main sites and four subsidiary sites at Mount Piper, Victoria, at intervals over a year. A total of 137 morphospecies, including representatives of 39 genera, were captured. Variations in catch between sites and seasons are discussed in relation to: completeness of sampling accomplished by pitfall traps; the amount of sampling effort needed to provide adequate inventory data; and possibilities of rapid sampling of ant assemblages. Short term sampling of ant assemblages may be inadequate for sound assessment of species diversity in assemblages.

Introduction

Surveys of ants of Mount Piper, Broadford, Victoria, (37°12′S, 145°00′E) have been an integral part of documenting the resource and critical habitat needs of rare Lycaenidae listed under Victoria's Flora and Fauna Guarantee Act 1988, and of defining the parameters of a 'Threatened Butterfly Community' (Jelinek et al., 1994; Britton et al., 1995, New et al., 1996). This isolated volcanic plug, reaching 456 m in altitude and being an enclave of natural woodland in a largely pastoral landscape, is now one of the most intensively surveyed areas for ants in Victoria. In this paper, we summarise results from a survey undertaken from March 1993–February 1994 and discuss their implications for survey design and interpretation. Aims of the survey, in addition to detecting ant hosts for *Acrodipsas* butterflies (Britton, 1997) were:

1. to determine the richness of the ant fauna of the Mount Piper educational reserve;
2. to assess distribution and diversity of ants at different sites in the reserve; and
3. to assess the amount of trapping needed to obtain reasonably accurate data on ant assemblages in the region.

Methods

Pitfall traps (plastic cups 7.4 cm diameter and 8.8 cm deep) were used in grids of 20 (5 × 4, 5 m spacing between traps — see Andersen, 1990) at six main sites and four subsidiary sites (the latter not treated in detail here) in and near the reserve (Fig. 1). Traps contained 70% alcohol and ethylene glycol and were emptied at approximately fortnightly intervals from March to September 1993 and again from November 1993 to February 1994 (Table 3). Each grid was treated as the sampling unit; ants were sorted and identified to genus and morphospecies using keys by Andersen (1991), Hölldobler and Wilson (1990), Shattuck (1992) and Bolton (1994). A voucher collection is held at La Trobe University. The sites were chosen as representative of the open woodland of the region (Table 2). Limited amounts of direct searching for ants were undertaken at all sites.

Results

Overview

The total ant fauna from the 10 sites comprised 137 morphospecies in 39 genera (Table 1), of which 127 morphospecies were captured in pitfall traps, and the other 10 found only by direct searching.

Each of sites 1–6 supported more than 50 morphospecies, and each site yielded taxa not captured at any other site. Over the 10 sites, 47 morphospecies were found only at single sites. By far the greatest number and richness of ants (71 morphospecies) occurred at site 1 (Table 3), but any trapping occasion yielded no more than half the species recorded overall from a site, sometimes considerably fewer. Numbers of species and individuals trapped declined considerably from June to September and samples over this period reflected lessened ant activity during winter: the seasonal extremes over the

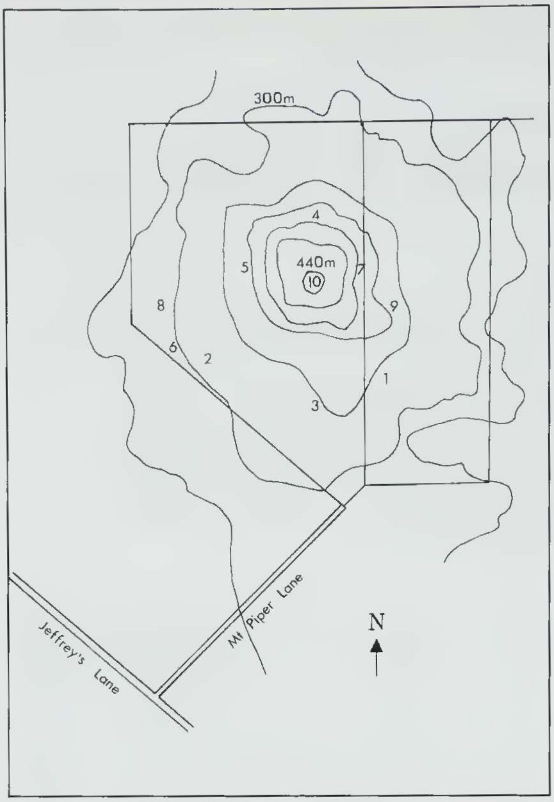

Figure 1. The Mount Piper reserve, showing sites 1–6, used for pitfall trapping grids in this survey, and sites 7–10, used for shorter-term augmentative survey.

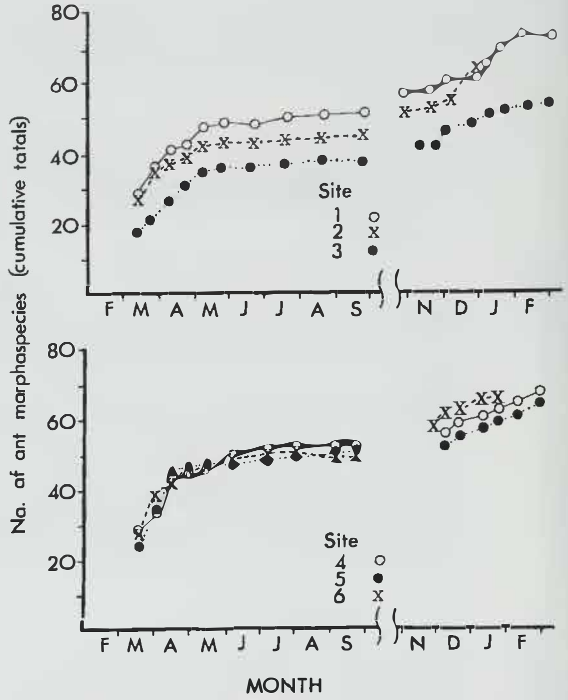

Figure 2. Accumulation curves for ant morphospecies from pitfall traps at sites 1–6 at Mount Piper, 1993–1994.

survey were 3 morphospecies (site 3, September) and 32 morphospecies (site 1, December).

Species richness

Morphospecies accumulation curves for each site (Fig. 2) showed clear asymptotes by the end of the initial sampling period, implying (by current standards) that sampling had been effective. However, resumption of sampling led to capture of further species at all sites and 'new' ants were accumulated progressively through the second trapping period. The last samples taken at four of the six sites provided morphospecies new to those sites and, at two, to the entire survey.

Site complexity

Number of morphospecies plotted against the 'habitat complexity score' (Fig. 3) gave no clear relationship between these parameters. Nevertheless, the pattern of the sites was changed somewhat by comparing the total sample with the first sampling period. Site 1 became relatively richer, and site 3, not as disparate.

Site similarity

Jaccard's index of similarity ([$Cj = j/(a + b — j)$], where j is the number of morphospecies common to sites A, B and a, b are the numbers of morphospecies in sites A, B, respectively; values range from 0 [no species in common] to 1 [all species shared]) was calculated for each pair of sites. The index (Table 4) confirmed that the spectrum of species at each site differed considerably, with only one site pair (2, 6) exceeding 0.5 over the whole sampling period. The mean Jaccard index value for each site against all others was not clearly related to species richness, but these values declined as sampling proceeded (Fig. 4), suggesting that increased sampling effort revealed greater relative distinctiveness of the ant fauna at each site as decreased similarity with any other site.

'Dominant' species

The most abundant morphospecies at each site (Table 5) and the number of traps in which a species was captured on each occasion (a measure of dominance which, in part, overcomes the bias due to numbers alone), differed considerably at different sites, both in the species involved and the duration/extent of

Table 1. Number of ant morphospecies from each genus, and the number of morphospecies from each genus found only at one site, collected by pitfall trapping and direct sampling at Mt Piper (* denotes 1, or if number in parentheses, more, morphospecies found only by direct sampling).

Subfamily	Genus	Total	No. found at 1 site
Myrmeciinae	*Myrmecia**	15	7
Myrmicinae	*Aphaenogaster*	1	—
	Colobostruma	1	—
	*Crematogaster**	2	1
	Epopostruma	3	3
	Mayriella	1	1
	Meranoplus	1	—
	Monomorium	4	—
	Orectognathus	1	—
	Pheidole	2	—
	*Podomyrma**	6	4
	Strumigenys	1	—
	Tetramorium	3	2
Ponerinae	*Amblyopone*	5	1
	Discothyrea	1	1
	Heteroponera	1	—
	Hypoponera	3	2
	Cerapachys	1	—
	*Ponera**	2	1
	Rhytidoponera	4	—
Formicinae	*Camponotus*(3)*	20	9
	Melophorus	11	5
	Myrmecorhynchus	1	—
	Notoncus	4	—
	Paratrechina	3	1
	Plagiolepis	1	—
	Polyrachis	5	2
	Prolasius	5	1
	Pseudonotoncus	1	—
	Stigmacros	10	3
Dolichoderinae	*Dolichoderus**	3	1
	*Iridomyrmex**	8	4
	Doleromyrma	1	—
	Anonychomyrma	1	—
	Ochetellus	1	—
	Papyrius	1	1
	Leptomyrmex	1	—
	Tapinoma	1	—
	Technomyrmex	1	—

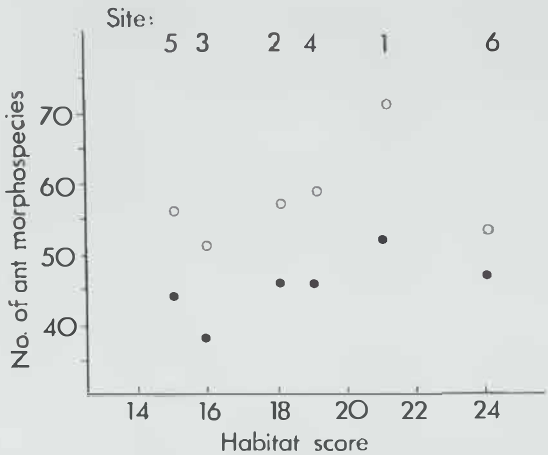

Figure 3. Number of ant morphospecies in pitfall traps plotted against habitat complexity score for initial (solid spots) and total (open circles) trapping periods. (Habitat complexity assessed from: canopy cover [1–5, increasing 20 % intervals from 0–100]; structural diversity of vegetation [1–5: 1 (grass only), 2 (grass and trees), 3 (grass, trees, shrubs), 4 (grass, trees, shrubs, ground covers), 5 (grasses, trees, small trees, shrubs, groundcovers); litter, dry weight (1–5: successive 50 g counts on 30 cm squares); rocks (1–5: 1 (none), 2 (few), 3 (numerous, even-sized), 4 (numerous, two or more sizes), 5 (very numerous)], vascular plant richness (1–5: successive accumulations of 6 spp.); bare ground [1–5, increasing 20% intervals from 0–100): in sequence for each site scores are (1) 4, 5, 2, 2, 5, 2, (2) 2, 4, 2, 3, 5, 2, (3) 3, 4, 1, 3, 4, 1, (4) 2, 2, 2, 5, 4, 3, (5) 2, 3, 1, 4, 5, 1, (6) 3, 5, 3, 3, 4, 4].

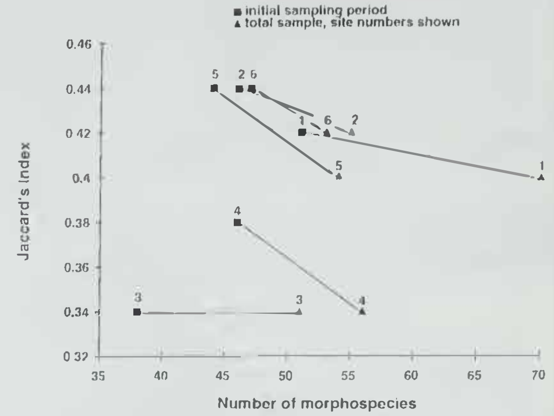

Figure 4. Jaccard's index of similarity against number of ant morphospecies at each site for initial and total trapping periods.

dominance, reflecting seasonal patterns of activity. Thus, although *Aphaenogaster longipes* was the most abundant species at site 2 for the first 10 sampling occasions, it was then supplanted by other taxa. Collectively, 13 morphospecies are included as 'most abundant ants', and 12 as 'most frequently trapped' in these rankings.

Discussion

Andersen's (1993) designation of ants as 'arguably the most important faunal group in the Australian environment' was prompted by series of studies on ant assemblage in many parts of the country, and the realisation that functional group analysis (included for this survey in New et al. 1996) can provide considerable ecological information of great value in conservation assessment. Increased emphasis and interest in rapid measurement of diversity has recently prompted investigation of use for short-term surveys of ants, mainly using pitfall traps as the prime sampling method — in itself open to severe reservation and difficulty of standardisation (Andersen 1990, Majer, 1997).

The survey reported here has led to Mount Piper having one of the best-documented ant assemblages in Victoria, and a morphospecies diversity which is apparently unusually high for the region. The high richness is much more representative of arid areas than of mesic Victoria, and may reflect the meeting of the ant faunal sets, as Mount Piper is near the boundary of these regions. More than 150 species of ants can occur on small areas in the northwest mallee region (Andersen, 1984), and the outlying Long Forest mallee near Melton supports 77 species in 21 genera (Andersen et al., 1991) and, like Mount Piper, shows aspects of the interaction of Bassian and Eyrean ant faunas. Including surveys by Miller and New (1997) and related collections (New et al. 1996), Mount Piper and its immediate environs are known to harbour at least 145 ant morphospecies including a very high proportion of the genera recorded from southeast Australia; and it is likely that further taxa (such as cryptic taxa not amenable to pitfall trapping) also occur.

However, the intensity of sampling for this survey has been considerably higher than that in many related assessments of ants (summarised by Andersen, 1995), and some important points emerge in relation to site evaluation and sampling adequacy.

In particular, the question of 'how much sampling is enough?' is becoming critical in

Table 2. Measurements for a number of environmental parameters at ant trapping sites 1–6 on Mount Piper.

	SITE					
	1	2	3	4	5	6
Aspect	SE	SSW	SSE	N	WSW	SW
Altitude (approx. m)	270	270	360	360	360	270
Canopy cover (%)	70	40	60	40	25	50
Area of bare ground (%)	25	40	5	55	10	65
Ground covers (%)	2	3	5	0	6	2
Grasses/herbs (%)	61	35	82	40	77	2
Shrubs (%)	5	15	3	0	0	25
Trees (%)	7	7	5	5	7	6
No. of plant species	25	28	21	21	26	23
Rocks	scarce	very few large, many small	many hand sized	all sizes and numerous	common, but < site 4	numerous hand sized
Leaf litter ($g/30\ cm^2$, dry weight)	83.9	61.9	47.1	76.8	40.2	130.3

invertebrate conservation assessment, be it for inventory (i.e. seeking to capture as many species as possible, including rare taxa) or to assess representativeness or 'typicalness' (i.e. seeking to define the 'most usual' taxa living in an area and which may be used to define the condition of a habitat or site). At present, Mount Piper, appears to have many highly localised and rare species. The key points include:

1. that any single sample retrieved only a small proportion of the taxa associated with a site;
2. that each of the six sites had a distinctive ant complement, so that a single plot could not represent the greater area adequately;
3. that increased sampling effort changed perception of the ant assemblage of each site and the extent of similarity of different sites;
4. rendered each site more distinctive; and
5. that seasonal variability in catches may influence accumulation curves used to interpret sampling adequacy.

These points counsel against uncritical adoption of rapid pitfall surveys for ants and suggest the need for appraisal of these in relation to long term trapping surveys. Olsen (1991) suggested that obtaining 75 % of the species present constitutes a 'reasonable sample success', but this (or any similar proportional figure) can be defined only with hindsight. For most of the sites investigated here, this level was reached after 3–5 sampling occasions in summer, but at site 3 was not achieved during the whole of the first sampling period. The heterogeneity between assemblages at the different sites implies a mosaic pattern of ant taxa in the region, leading us to echo Samways' (1990) plea for longterm studies of ant assemblages, even to define the relativity between apparently similar sites for ranking purposes or for faunal documentation. Cross-season sampling and extensive sampling over warmer parts of the year are needed to accumulate even reasonably complete species listings.

Despite widespread (and, sometimes, wishful) advocacy, in the interests of promoting rapid biodiversity assessment, that ant assemblages can be defined adequately over short term surveys, there is clear implication that this may not always be so.

Table 3. Numbers of ant morphospecies and individuals (given as 'species/individuals' captured in pitfall traps at Mount Piper at sites 1–6, 1993–1994.

Sampling date		Site					
sites 1–3	sites 4–6	1	2	3	4	5	6
10.iii	14.iii	27/1059	28/733	17/821	25/460	21/855	25/1049
21.iii	28.iii	29/675	27/314	13/194	28/555	26/531	25/789
5.iv	12.iv	29/448	22/354	16/259	26/405	24/384	25/418
19.iv	26.iv	25/378	24/274	17/207	29/568	22/318	26/395
3.v	9.v	26/316	25/280	17/156	21/389	16/181	21/270
19.v	31.v	16/88	16/175	12/71	18/137	13/45	18/98
13.vi	1.vii	6/18	7/44	5/12	12/74	9/23	13/69
12.vii	27.vii	7/15	9/46	5/23	15/34	5/14	10/75
12.viii	25.viii	5/12	9/41	7/23	9/37	9/27	12/51
10.ix	10.ix	12/27	15/45	3/19	12/75	8/33	16/50
(all) 26.xi		25/661	21/411	—	—	—	23/282
7.xii		19/717	23/194	17/362	27/666	12/70	26/455
17.xii		32/1239	24/377	18/325	29/489	28/338	22/542
3.i		23/1933	25/394	21/311	24/305	—	24/491
16.i		29/1655	—	18/283	—	26/586	15/151
30.i		31/1549	—	16/435	21/463	26/502	—
14.ii		28/1021	—	15/218	25/552	23/405	—
28.ii		23/557	—	8/99	22/405	19/439	—
Total no.		71	57	51	59	56	53
No. only at site		6	4	8	7	6	4

Table 4. Jaccard's index (Cj), calculated using the total results of the total sampling period, for ant morphospecies collected from sites 1–6 at Mt Piper.

Site	1	2	3	4	5	6
1	—					
2	0.47	—				
3	0.34	0.29	—			
4	0.30	0.36	0.31	—		
5	0.41	0.38	0.41	0.39	—	
6	0.48	0.55	0.34	0.35	0.40	—
Mean	0.40	0.42	0.34	0.34	0.40	0.42

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Table 5. Most common ant morphospecies collected from sites 1–6 on Mt. Piper over first 10 sampling periods (Feb.–Sept. 1993) and in later sampling.

Site	Most common morphospecies	Sampling period 1	2	3	4	5	6	7	8	9	10
1	*Rhytidoponera victoriae*	√	√	√	√	√	√	√			√
	Pheidole sp. 1								√	√	
2	*Aphaenogaster longiceps*	√	√	√	√	√	√	√	√	√	√
3	*Rhytidoponera victoriae*	√	√	√	√	√	√				√
	Prolasius pallidus sp. 1							√			
	Monomorium leae								√	√	
4	*Pheidole* sp. 1	√	√		√	√	√	√		√	
	Rhytidoponera tasmaniensis			√							
	Tapinoma minutum								√		√
5	*Rhytidoponera victoriae*	√	√	√	√						
	Aphaenogaster longiceps					√	√	√	√	√	
	Notoncus hickmani								√		
	Pheidole sp. 2										√
6	*Rhytidoponera victoriae*	√									
	Aphaenogaster longiceps		√	√	√	√	√	√	√	√	√

Site	Most common morphospecies	11	12	13	14	15	16	17	18
1	*Plagiolepis* sp.	√							
	Anonychomyrma itinerans	√	√	√	√	√	√	√	√
2	*Plagiolepis* sp.	√			√				
	Crematogaster sp.		√	√					
3	*Crematogaster* sp.	√							
	Plagiolepis sp.		√						
	Rhytidoponera victoriae			√	√	√	√	√	√
4	*Crematogaster* sp.	√							
	Monomorium sp. 1		√	√					
	Pheidole sp. 1				√	√	√		
5	*Plagiolepis* sp.	√							
	Rhytidoponera victoriae		√	√	√	√	√		
6	*Plagiolepis* sp.	√	√	√					
	Rhytidoponera victoriae				√	√			

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