LOCAL DIVERSITY OF TROPICAL AND TEMPERATURE ANT FAUNAS (HYMENOPTERA, FORMICIDAE).

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SUMMARY

*Qualitative and quantitative collections of ants made in the region of Manaus, Brazil (evergreen tropical humid forest), and in western North Carolina, USA (deciduous temperate/wet forest), were undertaken to investigate latitudinal patterns of ant diversity and community organization on regional and local scales. We have found to date 307 ant species in the Municipality of Manaus. Totals ranging from 134 to 270+ spcies have been reported in the literature for other tropical regions of less than 10,000*km^2*. In contrast, temperate ant surveys generally report only 50 to 150 species in similar or larger areas. Sampling at sardine baits set 10m apart on square grids, we found forest ecosystems near Manaus to be much richer and more diverse in ants than those sampled in North Carolina: 28 species* ***vs***. *5-10 species in 50 collections and 16 vs. 3 previously unrecorded species discovered with each doubling of sample size. Room's (1975a) results from climatically similar Papua New Guinea forest agree closely with those from Manaus. We suggest that one important factor contributing to the increased diversity of tropical omnivorous ants may be greater variety of nest sites available for specialization.*

INTRODUCTION

Ants are a ubiquitous and abundant element of lowland tropical systems (Brown, 1973; Fittkau & Klinge, 1973) and engage in important community processes well into temperate regions (Petal, 1978). These insects frequently compete for food and foraging space (Wilson, 1971; Levings & Traniello, 1981; pers. obs.) suggesting that competition, competitive exclusion and ecological shifts, may be of great importance in structuring ant communities. Moreover, since ants seem to be relatively immune to control by predators and show a strong propensity for omnivory, the potential for competitive interactions is accentuated.

As is the case of many other taxa (Pianka, 1966), the number of ant species increases

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gradually but dramatically from higher to lower latitudes (Kusnekov, 1957). Why this should be so is not entirely clear. In the tropics the evolution of specialized arboreal ant faunas no doubt contributes to this trend; however, local ant faunas inhabiting tropical forest litter also seem to be unusually rich in species (Room, 1975 a; Levings, 1983), suggesting that factors beyond substrate specialization are involved.

In an attempt to determine how tropical and temperate guilds of scavenging ants are spatially and temporally organized, standardized samples were taken to provide comparative measures of diversity in local faunas. The results are compared with data recalculated from published surveys and used to draw preliminary conclusions concerning diversity and coexistence in ant faunas.

METHODS

Scavenging ants were collected at sardine baits set out in a regular pattern on 60 x 60 m sample grids. Grid points were marked every 10 m along each of seven 60m long parallel lines, 10 m apart, and aligned perpendicularly to a baseline with the aid of a compass. A grid contained 49 paired baiting stations, one on the litter surface at each grid point and one on vegetation neighboring the point. Baits consisted of a few grams of sardine canned in vegetable oil placed on a small piece of absorbent paper. Each sample point was assigned a number and each bait accompanied by a corresponding label. Vegetation baits were generally placed 1-2 m above soil level on plants growing into the canopy or on vegetation in physical contact with such plants.

Baits were set out in timed sequence during 90 minutes or less and all ants collected at each bait 90 (± 2) minutes later. A given grid was generally sampled twice, more than 24 hs apart, once during the day (9-12 hs) and once at night (21-24hs). Temperate zone night sampling was started 15 to 30 minutes later to allow time for darkness to fall. In no instance were samples taken during or immediately after heavy rainfall.

Ant samples were obtained by firmly grabbing bait, paper, label and associated debris and ants and throwing these rapidly into a plastic bag containing a few drops of ethyl acetate to kill the ants, and tightly knotting the bag. Samples were sorted in white plastic trays and all ants transferred to labeled vials with 80% ethanol. Lost and fallen samples were repeated when possible. A series of each ant species in each sample was mounted on triangles on labeled pins and subsequently identified to genus and ascribed to a morphospecies. Standard series from selected collections were established to define morphospecific categories for future comparisons. Specific identifications were obtained when possible.

The presence of a given species at a bait, independent of the number of individuals collected, was counted as a collection of that species, and the number of times a species was collected at a set of 49 baits was defined as its frequency. Data on the numerical abundance of ant species at different baiting stations are not considered in this report.

Study Areas

Tropical forest samples were taken at Fazenda Esteio, km 24 of Municipal Road ZF-3, approximately 80 km NE of Manaus, Amazonas, Brasil (ca. 2°40'S., 59°30'W.). The grid sites, at an elevation of near 100 m were occupied by 20-30 m tall broadleaf evergreen rain forest (tropical moist forest -- classification of Holdridge, 1967). Although day and night samples were collected from five sample grids in the area, this report treats results from three grids in the 1 and 10 ha WWF/INPA experimental forest fragments isolated approximately 7 months before the samples were taken (reserves 1104 and 1202, respectively). The four samples considered in this report are:

1. Area 1104A, day, collected on 9.11.1981.
2. Area 1202A, night, collected on 8.11.1981.
3. Area 1202B, day, collected on 7.11.1981.
4. Area 1202B, night, collected on 29.1.1981.

Temperate forest samples were collected at the Coweeta Hydrologic Laboratory (35° 04'N., 83°26'W.), near Murphy, North Carolina, USA. The two grid sites sampled were occupied by 15-20 m tall broadleaf deciduous forest mixed with evergreen conifers (warm temperate moist/wet forest -- classification of Holdridge, 1967). Day and night collections were obtained at the two sites about a kilometer apart, one in old successional hillside forest (Watershed 2) at approximately 870 m elevation on the south slope of Saunders Knob and the second in somewhat disturbed heterogeneous riparian habitat at approximately 680 m elevation by the south margin of Coweeta Creek near the laboratory entrance. The former habitat possessed a closed canopy dominated by yellow poplar (**Liriodendron tulipifera**) with other hardwoods and a very open understory with dogwoods (**Cornus** sp.) especially common. The riparian habitat had an open canopy and was particularly dense in pines (**Pinus** sp.) and sweet-gum (**Liquidambar** sp.), with about half the area occupied by a rhododendron thicket and the other half by brambles. The samples were collected during hot, humid weather in late spring:

1. Watershed 2, day, collected on 5.VI.1982.
2. Watershed 2, night, collected on 9.VI.1982.
3. Riparian, day, collected on 6.VI.1982.
4. Riparian, night, collected on 7.VI.1982.

The temperate forest sample sites were chosen for their general similarity to forest and edge conditions at the tropical site and for their contrasting structure, composition and drainage characteristics, these being much more pronounced than between the tropical sites. Tropical samples were all taken on relatively flat though well drained upland areas, and in this regard were very homogeneous. The marked differences betweem the temperate habitats would tend to exaggerate average faunal differences in the region.

Data Analysis

Species collection curves are used to characterize the ant communities. These curves describe the increase in species as the number of collections increase. Expected species curves were calculated from frequency data using the rarefaction method of Shinozaki (1963) and Hurlbert (1971). Each point on a curve gives the expected number of species in a randomly constituted sub-sample of a given size from the sample being described.

Preliminary analyses revealed that two widely used descriptive functions generally gave good fits to ant species curves. These are the power function ($S = c \cdot N^{z}$), where S is the cumulative number of species, N is the cumulative number of collections, z is a parameter expressing the rate of encounter of previously unrecorded species and c is a parameter that positions the curve. The linear form of the equation is $\log S = \log c + z \cdot \log N$. The second is the logarithmic function: $S = a + b \cdot \log N$. We have used logarithms to the base 2 and express the estimate of the slope parameter as b_2 to reflect this fact.

The slope parameters b and z seem to be useful measures of species diversity. Both increase in value as more species are added to a community and as the species abundances become more equitable. The parameter b is mathematically related (Horn, 1963; May, 1975) to α, the diversity index proposed by Fisher, Corbet & Williams (1943), which we have also calculated for the ant data. The parameter b_2 is directly interpretable as the number of previously uncollected species added to a sample with each doubling of sample size. Although z is more difficult to interpret directly, the related measure $Z_2 = 2^{z} - 1$ is the proportional increase due to previously unrecorded species with each doubling of sample size.

Estimates of curve parameters were obtained by linear least square regression (HP-41C Stat Pac) of logarithmic and power functions fit to the rarefaction curves. Only points from the right-hand ascending segments of curves were used in the regressions. The form of the lower left-hand segment is sensitive to the relative abundances of a few common species and may contribute to a mathematically poor fit. Coefficients of determination (r^2) were used to evaluate the relative descriptive precision of logarithmic and power functions for the same sets of data points. The good fit provided by the linear models over a range of sample sizes indicates their general usefulness for comparative purposes. However, in our use of these measures we in no way imply that they are characteristic of large samples or of the ant community *as a whole. Due to the large number of* very rare species in our samples, we have avoided commonly used diversity indices which depend upon a good characterization of the relative abundances of species to give accurate unbiased measures. Since the points in the rarefaction curves are not mathematically independent, no statistical properties can be ascribed to the curve parameters, and each estimate must be treated as a simple observation. The values of z were estimated independently as the proportion of species in a sample represented by only one collection (Coleman **et al.**, 1982).

As a measure of species richness we have used the expected number of ant species in a standard subsample of 50 collections.

Regional Ant Diversity

We have collected ants at different localities in the Municipality of Manaus since 1976 and to date have recognized 307 morphological species in our collections. Of these, 199 have been confirmed for the principal study area at Fazenda Esteio and 120 identified so far among the ants captured at sardine baits set out in undisturbed forest habitats. The genera collected and the number of species represented in each is given in Table 1. For each of the areas considered, the total number of ant species is without doubt far below the real value, perhaps by a factor of two or three.

Reasonably intensive surveys of tropical and sub-tropical ant faunas are uncommon. The State of São Paulo, Brazil, a much larger area sitting astride the Tropic of Capricorn, has been collected by dedicated myrmecologists over many years (Kempf, 1978) and yielded more than 500 ant species. A square degree quadrat in the middle of the state possesses more than 270 ants and more than 240 have been reported for the quadrat including the city of São Paulo (Kempf, 1978). At least 134 ants occur on the island of Trinidad (Wheeler, 1922). Levings (1983) found 123 ant species in Berlese and bait samples from Barro Colorado Island, Panamá, and states that well over 200 species are known for this $15.5 km^2$ area. Room (1975 a, b) in a survey of New Guinea ants, obtained results very similar to those for Manaus and Panamá. In a series of quantitative samples, he collected a total of 191 ants in the region surrounding Popondetta, Northern Territory, among the 570 known for Papua-New Guinea and estimates that 1000 ant species inhabit this topographically varied country. Taking into account the different methods and intensites of collection at Manaus, Barro Colorado and Popondetta, the values are in remarkable agreement and suggest that restricted geographic areas of continuous tropical moist forest habitat may typically contain 300 to 500 or more ant species.

Extratropical regions of comparable size, although in general much better studied, appear to have many fewer species. Kusnezov (1957) presents data for New World ant species richness at different latitudes, showing clearly that ant faunas increase from fewer than 10 species at high latitudes (Alaska, Tierra del Fuego) to values between 50 and 150 species in temperate areas (Patagonia, Buenos Aires, Iowa, Utah). Cole (1940) lists some 60 species for the Great Smoky Mountain Park in Tennessee. During the week in the North Carolina study area, 26 ant species were collected, 16 of which were captured at baits.

Although the data in hand are imprecise, they suggest a 3- to 10-fold increase in ant species richness between topographically and physiognomically similar temperate and tropical regions. The exceptional ant richness in the tropics is somewhat unexpected considering the rather generalized feeding habitats attributed to ants, and it therefore seems pertinent to examine and contrast ecological patterns found in these faunas.

Local Diversity

Diversity measures for ant fauna samples are presented in Tables 2 ans 3. Undisturbed tropical moist forest habitats seem to be specially rich in ants. Daytime samples from Manaus (baits) and Popondetta (manual collections) yield about 28 species in 50 collections of ground inhabiting ants and approximately 16 additional species are recorded with each doubling of sample size. The slope constant (z) of the power function tends to be greater in Manaus, and the power curve gives a slightly superior fit in the Manaus data. The latter differences may well be due to variation in sample procedures. In Manaus the number of nocturnal ant species is reduced about 20% and the diversity measures b_2 and z are consistently lower than daytime values.

Room's (1975 a) data suggest that litter ant diversity is relatively constant in wooded habitats whether these are natural or anthropogenic (rubber, cocoa, coffee). On the other hand, as woody vegetation becomes sparse and habitats are structurally simplified, faunal diversity falls precipitously (Table 2).

Ants were rather infrequent on understory forest plants at Manaus and sample sizes were inadequate for even preliminary analyses in the night collections. The two daytime vegetation samples from Manaus are similar in diversity to the ground samples at the same sites. Room's (1975 b) very large knockdown samples for cocoa trees in New Guinea give the rather lower $\underline{z}$ values, although the number of species in 50 collections and species added with increasing sample size are similar to those documented in ground samples. Too much weight should not be given to the apparent similarities and differences, given the small quantity of data.

The bait samples from North Carolina are markedly less diverse than the tropical ones. About eight species were found in 50 collections and the slope constants of the rarefaction curves were low. Diversity measures for ants collected in vegetation were somewhat higher; however, these were calculated from the combined data from four samples, thereby increasing heterogeneity. In general, tropical ground and vegetation samples have 3 to 4 times the number of species as temperate samples of 50 collections and species accretion rates ($\underline{b}_2$) are 3 to 10 times greater in the tropical forest (Table 3).

Additional results calculated from published ant survey data from temperate regions (Table 3), mostly from desert ant communities, are very similar to those from the temperate mesic sites. These data suggest that ant species diversity does not vary markedly with vegetation changes in temperate regions.

Estimates of $\underline{z}$ obtained using the method of Coleman **et al**. (1982) closely agree with those obtained by least square fitting in the more diverse tropical samples (Table 4).

DISCUSSION AND CONCLUSIONS

The relationship between sample size and the number of species present in a taxonomic collection has stimulated sucessive rounds of interest since its recognition more than 60 years ago (McGuinness, 1984). Recently attention has centered on questions concerning species equilibria, particularly on islands (MacArthur & Wilson, 1967; Conner & McCoy, 1979; Wright, 1981). These and other authors have noted that $\underline{z}$-values obtained from islands of different sizes in archipelagos are frequently in the range of 0.15 to 0.40 whereas within continuous habitat values are typically lower, often in the range of 0.10 to 0.20. However, this latter generalization is based largely on temperate communities and on support for the hypothesis provided by a mathematical model (Preston, 1962) incorporating premises now admitted to be invalid (Preston, 1980). Our data and those of Room (1975 a) giving consistent results for tropical ants in the range of 0.5 to 0.7 agree with trends reported by Preston (1980) and contradict previous generalizations. Obviously the slope parameter of the power function, like the Fisher **et al**. (1943) and the slope parameter $\underline{b}$ of the logarithmic curve, is a diversity index which varies with the number of species in a sample and their relative abundances (Preston, 1962). It is no surprise that diverse communities give large z-values or that tropical averages are greater than temperate ones.

What is unusual with our results is that they show 30 or more ecologically similar species coexisting in small areas of relatively uniform tropical habitat. Expressed as samples of standard size, about 25 species of litter-inhabiting scavenging ants can be found in 50 collections at Manaus while only 5 to 10 are present in temperate forest samples. Moreover, tropical ant diversity seems to decrease rapidly with habitat simplification (Room, 1975 a), while this does not seem to be so pronounced in temperate faunas. These results, and the data suggesting that regional ant faunas in the tropics are proportionately even richer, indicate that latitudinally separated ant faunas may be organized in fundamentally different ways.

Many ant species in our collections differ markedly in size and foraging behavior, and these may be sufficient to eliminate serious food competition. However, these mechanisms do not seem adequate to account for coexistence among species of **Pheidole**. Two species of **Pheidole** at the same bait may fight and kill one another (pers. obs.), and, as if to deride competition theory, baits on each of our grids sampled in Manaus attracted 14 or more species of litter-inhabiting **Pheidole** of similar size (1-4mm long) and type of recruitment. Levings & Franks (1982) report that in Panamá, ground-scavenging ponerine and myrmicine ants (principally **Pheidole**) tend to have regularly spaced nests, indicating that interspecific competition is strong within subfamilies. To explain the high species diversity in their plots, they suggest that intraspecific interference may be great enough to reduce colony density and thereby allow additional species to occupy the opened space. Although this may be so, it does not explain why temperate faunas should not be similarly benefited.

A number of factors seem to be involved in the increased local diversity of tropical ants. Perhaps of greatest importance are the types of restraints on nest sites in each region. In the tropics leaf litter and dead wood, including twigs, branches and limbs, on the ground and retained on erect plants, can serve as nesting sites, whereas in temperate regions, cold and destruction of nests during winter would make these sites strainful and risky. Similarly risky arboreal nesting with concomitant substrate specialization is common in the tropics but rare or absent elsewhere. We suspect that since use of leaf litter is intrinsically less demanding than excavating, soil-nesting ants may often be at a disadvantage. Nest site specialization geared to the variety of shelters on the forest floor may simultaneously result in increased intraspecific population regulation and reduce food competition among species with similar needs. In temperate regions, soil may provide the only secure nesting option. Since this substrate provides virtually unlimited nest space and seems too homogeneous to permit much specialization that could restrict population sizes below those set by food, unrestrained food competition among temperate omnivorous ants may strongly limit coexistence. This hypothesis needs to be evaluated with appropriate experiments.

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RESUMO

Coletas qualitativas e quantitativas de formigas foram realizadas na região de Manaus, Brasil (floresta úmida tropical), e no oeste do estado da Carolina do Norte, EUA (floresta úmida/muito úmida temperada) para investigar os padrões de diversidade e organização comunitária destes insetos em escalas regionais e locais. Até o momento, encontramos 307 espécies de formigas no município de Manaus enquanto totais de 134 a 270 espécies foram assinaladas na literatura para outras regiões tropicais em áreas menores de 10.000 km². Em contraste, levantamentos de formigas em regiões temperadas geralmente citam apenas 50 a 150 espécies para áreas similares ou maiores. Em amostras obtidas utilizando iscas de sardinha separadas por 10 m entre si em parcelas quadrangulares, verificamos que ecossistemas florestais próximos a Manaus são muito mais ricos e diversos em espécies do que aqueles amostrados na Carolina do Norte: 28 espécies contra 5 - 10 espécies em 50 coletas e 16 contra 3 espécies inéditas descobertas a cada duplicação do tamanho da amostra. Os resultados de Room (1975a) para florestas tropicais úmidas em Papua Nova Guiné concordam com aqueles de Manaus. Sugerimos que uma maior variedade de locais de nidificação disponíveis para especialização pode ser um fator importante contribuindo ao aumento em diversidade de formigas onívoras tropicais.

Table 1. Ant genera and numbers of species collected in the Municipality of Manaus and at the Fazenda Esteio study area.

Family	Total nº of Species	Nº of Species Captured at Sardine Baits (Faz. Esteio)	Additional Species From Fazenda Esteio	Additional Species Other Localities
PONERINAR				
Platythyrea	1	0	0	1
Paraponera	1	0	1	0
Ectatomma	4	3	1	0
Gnamptogenys	10	4	4	2
Pachycondyla	15	4	8	3
Hypoponera	1	0	1	0
Leptogenys	2	0	1	1
Anochetus	2	0	1	1
Odontomachus	8	2	2	4
DORYLINAE				
Nomamyrmex	2	0	1	1
Labidus	1	0	1	0
Eciton	3	0	3	0
Neivamyrmex	3	0	1	2
PSEUDOMYRMECINAE				
Pseudomyrmex	31	0	11	20
MYRMICINAE				
Hylomyrma	1	0	1	0
Pheidole	63	48	5	10
Crematogaster	21	19	2	0
Monomorium	1	0	0	1
Megalomyrmex	2	1	0	1
Allomerus	5	1	1	3
Ochetomyrmex	2	2	0	0
Solenopsis	8	7	0	1
Oligomyrmex	1	1	0	0
Leptothorax	1	1	0	0
Wasmannia	2	2	0	0
Blepharidatta	1	1	0	0
Procryptocerus	3	0	0	3
Cephalotes	1	1	0	0
Eucryptocerus	1	0	1	0
Zacryptocerus	5	0	1	4
Daceton	1	0	1	0
Strumigenys	1	1	0	0
Sericomyrmex	2	0	1	1
Apterostigma	3	1	2	0
Cyphomyrmex	5	1	1	3
Acromyrmex	7	3	1	3
Atta	3	0	2	1
DOLICHODERINAE				
Dolichoderus	5	0	4	1
Monacis	8	2	2	4
Hypoclinea	6	0	4	2
Azteca	20	5	5	10
Conomyrma	1	0	0	1
Tapinoma	2	1	0	1
FORMICINAE				
Myrmelachista	1	0	0	1
Brachymyrmex	1	0	1	0
Gigantiops	1	0	1	0

Table 2. Measures of local diversity calculated for tropical ant fauna samples.

Region (Climate)	Habitat§	Nº of Ant Colls.	Nº of Ant Spp.	α	Diversity Measures		Exp. Nº of Spp. in 50 Collections	Sample Method	Reference
					$b_2(r^2)$	$z(r^2)$			
Neotrop.-Brazil Manaus, AM $2^{o}40$'S.,$59^{o}30$'W. (Tropical Moist Forest)	Forest:D/S (1104A)	70	39	36.3	15.0(.998)	.668(.998)	31.2	49 sardine samples from leaf litter, 10 m apart on square grid, exposed 90 min	This study
	Forest:D/S (1202B)	103	43	27.7	17.7(.999)	.675(.999)	26.1		This study
	Forest:N/S (1202B)	64	25	15.1	8.7(.999)	.572(1.00)	21.7		This study
	Forest:N/S (1202A)	76	32	20.8	12.1(1.00)	.619(1.00)	24.7		This study
	Forest:D/V (1104A)	39	22	20.9	8.3(.999)	.674(.999)	26.3^{+}	Same, but samples from vegetation, 1-2 m above grond	This study
	Forest:D/V (1202B)	31	22	33.8	9.2(.997)	.785(1.00)	32.1^{+}		This study
Aust.-New Guinea Popondetta, N. Dist. $8^{o}45$'S.,$148^{o}14$'E. (Tropical Moist Forest)	Forest: D/S	139	50	28.0	16.3(1.00)	.517(.999)	27.8	30 (60 in cocoa) manual collections from leaf litter, in 1 m2 quadrats > 30 m apart,10min duration (oil palm with regular grids in 2 areas)	Room, 1975a
	Rubber: D/S	121	49	30.6	15.9(1.00)	.515(.999)	29.9		Room, 1975a
	Cocoa : D/S	250	70	32.3	22.2(.999)	.559(1.00)	26.1		Room, 1975a
	Coffee: D/S	99	41	26.2	14.5(1.00)	.569(.997)	27.4		Room, 1975a
	Oil Palm: D/S	92	29	14.6	9.1(.999)	.530(1.00)	21.0		Room, 1975a
	Eucaly.Sav.: D/S	158	40	17.3	9.3(1.00)	.368(1.00)	24.7		Room, 1975a
	Grass Sav.: D/S	177	39	15.5	8.5(1.00)	.354(.998)	23.5		Room, 1975a
	Urban Lawn: D/S	105	18	6.3	4.0(1.00)	.343(1.00)	14.0		Room, 1975a
	Cocoa: D/V	612	81	25.0	20.8(.998)	.454(1.00)	22.0	200 pyrethrum knockdown samples from trees > 30 m apart	Room, 1975a
	Cocoa: D/V	383	42	12.0	9.4(.999)	.374(1.00)	18.6	135 manual collections from trees > 30 apart, 5 min duration, plants selected	Room, 1975a

§D = day; N = night; S = soil; V = vegetation; sample area in parentheses.

(+) Value extrapolated from rarefaction curve.

Table 3. Measures of local diversity calculated from temperate ant fauna samples.

Region (Climate)	Habitat	Nº of Ant Colls.	Nº of Ant Spp.	α	Diversity $b_2(r^2)$	Measures $z(r^2)$	Exp. Nº of Spp. in 50 Collections	Sample Method	Reference
Nearct.-U.S.A.	Forest:D/S(Slope)	59	6	1.7	1.1(.996)	.291(.993)	5.8	49 sardine bait from leaf litter, 10 m apart on square grid, exposed 90 min	The Study
Otto, NC	Forest:D/S(plain)	77	11	3.5	1.5(.995)	.211(.993)	10.1		The Study
$35^{\circ}3'$N.,$83^{\circ}27'$W.	Forest:N/S(slope)	66	6	1.6	0.8(1.00)	.208(.993)	5.7		The Study
(Temperate Moist-	Forest:N/S(Plain)	67	10	3.3	2.6(1.00)	.433(1.00)	8.9		The Study
Wet Forest	Forest:S(Combined)	269	16	3.7	2.8(.998)	.294(1.00)	9.5		The Study
Transition)	Forest:V(Combined)	46	11	4.6	2.3(.999)	.354(.995)	11.3+	Same, but samples from vegetation 1-2 m above ground	The Study
Portal, AZ	D-N/S(1)	285	16	3.7	1.9(.996)	.185(.991)	10.9	66 honey & peanut bait traps, ground, 30.3 m apart on rectangular grid, exposed 24 h	Chew, 1977
$31^{\circ}55'$N.,$109^{\circ}10'$W.	D-N/S(11)	390	17	3.7	2.4(.973)	.225(.996)	10.5		
Mohave Desert, CA	$33^{\circ}44'$N., 75 m:S	106	5	1.1	All values near 0		4.9	All nests mapped in 1.6- 2.3 ha areas	Bernstein & Gobbel,1977
	$33^{\circ}54'$N., 500 m:S	61	7	2.0			6.9		
	$34^{\circ}00'$N., 600 m:S	100	7	1.7			6.8		
	$33^{\circ}56'$N., 825 m:S	326	7	1.3	All values near 0		5.7		
	$33^{\circ}44'$N., 875 m:S	182	8	1.7			7.2		
	$33^{\circ}59'$N.,1150 m:S	400	7	1.2			5.2		
	$34^{\circ}00'$N.,1500 m:S	311	10	2.0	All values near 0		8.3		
NW Arizona	$36^{\circ}45'$N.,1500 m:S	290	6	1.1			5.8		
NE Nevada	$40^{\circ}48'$N.,1500 m:S	463	3	0.4			3.0		
SW Montana	$44^{\circ}36'$N.,1500 m:S	448	3	0.4	All values near 0		3.0		
Aust.-Australia	Scrub Steppe:S	195	22	6.4	3.8(.998)	.286(.994)	14.3	All nests mapped in 20 x 25 m quadrat,	Briese & Macauley, 1977, 1980
Deniliquin, NSW $35^{\circ}6'$S.,$144^{\circ}48'$E.	Grassland:S	161	17	4.8	2.3(1.00)	.212(.999)	13.2		

§0 = day; N = night; S = soil; V = vegetation; sample area in parentheses.

(+) Value extrapolated from rarefaction curve.

Tabela 4. Slope parameter z obtained by least square fitting of power curves and proportion of species represented by one collection P(1) for ant community samples. (Data sources given in Tables 2 and 3).

	z	P(1)
Manaus, AM, Brazil		
Forest D/S (1104A)	.668	.667
Forest D/S (1202B)	.675	.651
Forest N/S (1202B)	.572	.560
Forest N/S (1202A)	.619	.563
Forest D/V (1104A)	.674	.652
Forest D/V (1202B)	.785	.773
Popondetta, Papua New Guinea		
Forest D/S	.517	.480
Rubber D/S	.515	.490
Cocoa D/S	.559	.514
Coffee D/S	.569	.561
Oil Palm D/S	.530	.517
Eucalyptus Sav. D/S	.368	.350
Grass Savanna D/S	.354	.301
Urban Lawn D/S	.343	.333
Cocoa (knockdown) D/V	.454	.420
Cocoa (manual) D/V	.374	.357
Coweeta, NC, USA		
Forest (Slope) D/S	.291	.167
Forest (plain) D/S	.211	.167
Forest (slope) N/S	.208	.091
Forest (plain) N/S	.433	.400
Portal, AZ, USA		
Desert Scrub D-N/S I	.185	.125
Desert Scrub D-N/S II	.225	.177
Deniliquim, NSW, Australia		
Scrub Steppe (nests)	.286	.182
Grassland (nests)	.212	.177

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