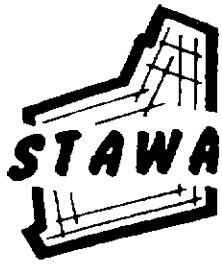
Ant Experiments

J.D. MAJER

Science
Teachers'
Association of
Western Australia



ANT EXPERIMENTS

J.D. MAJER

1st Edition - August 1984

ISBN 0949820 07 5

Production, Publication and Sales by Services Division,
Science Teacher's Association of Western Australia,
Box S1501, Perth, 6001.

Printed by Park Printing Co., 968B Albany Highway,
East Victoria Park, 6101.

CONTENTS

EXPERIMENTS AND OBSERVATIONS USING ANTS FOR HIGH SCHOOL STUDENTS

J.D. MAJER*

ABSTRACT

A series of field experiments and observations using ants are described which may be performed in high schools by students undertaking special projects or class practical sessions. They are specifically designed for Western Australian conditions but most exercises could be adapted for use elsewhere in Australia.

The exercises illustrate the following subject areas: classification and naming of species, invertebrate sampling techniques, distribution of animals, co-existence of animals, animal feeding habits, daily and seasonal activity patterns, animal habitat preferences, plant - animal interactions and the influence of habitat modification on animals.

---

* School of Biology, Western Australian Institute of Technology, Bentley, Western Australia, 6102.

INTRODUCTION

Ants are a particularly abundant and diverse component of most Western Australian terrestrial ecosystems. Their prominence makes them ideal subjects for school children to undertake biological investigations.

For the past 10 years the author has been undertaking research on this insect family. Many of the techniques which have been used for these investigations lend themselves to use by high school students to illustrate various topics which exist within the Tertiary Admissions Examination (T.A.E.) Biology syllabus.

Teachers often contact the School of Biology for information on how to carry out student field exercises. Therefore there appears to be a demand for handbooks on field experiments and observations which may be undertaken at the high school level. Two papers concerning educational exercises using ants are already available (Bates 1973, King and Woodell 1975) although they are more relevant to European conditions.

This paper describes a series of field exercises and observations which may be performed on ants. Each experiment or observation is described in the following format:

1) Title
2) Concepts or principles which it is designed to illustrate
3) Key reference or references
4) Materials required
5) Procedure
6) Suggested treatment of results
7) Example of results wich may be obtained (where possible).

Sufficient information is given for teachers to try out the exercises or to guide their students to perform them. The additional references are quoted so that teachers or students may read more about the subject.

The exercises are designed for Western Australian conditions. However, most may be adapted for use elsewhere in Australia. They are best performed during the summer months (daily maximum temperatures above 25°C) when ants are most active. A small area of bush, waste ground, park or garden (about 0.1ha) will house a sufficient variety of ants to carry out most of these exercises.

EXERCISE NUMBER 1

HOW TO IDENTIFY ANTS

Science Content

In this exercise, the student groups ants together on the basis of characteristics they share. With the use of reference books and keys the ants are then named to genus level and possibly to species level.

Further Reading

Greenslade, P.J.M. (1979) - A Guide to the Ants of South Australia. Adelaide: South Australian Museum Special Education Bulletin Series. pp.44.

This publication was written for the lay person and contains illustrated keys to most genera occurring in the south of Western Australia. It may be purchased from the Western Australian Museum.

Materials Required

A selection of ants from Exercise 2, stereo-microscope, lamp, mounted needles and the above mentioned publication.

Procedure

To carry out the following exercises the student will need to recognise the different types of ants. This may be done by observing them under the stereo-microscope and separating the species on the basis of overall shape, colour, size, presence or absence of sting or segmentation of the waist. However, it would be better to use the keys provided in the above mentioned publication which enable the ants to be placed in the appropriate subfamily and genus. The student will probably find several members of the same genus and these may be given code numbers(e.g. Iridomyrmex sp. 1, Iridomyrmex sp. 2 etc.)

EXERCISE NUMBER 2

HOW TO SAMPLE ANTS

Science Content

In this exercise, the student learns to select appropriate techniques for sampling particular habitats.

Further Reading

Southwood, T.R.E. (1978) - Ecological Methods With Particular Reference to the Study of Insect Populations. London: Chapman and Hall. pp.524.

An excellent book which contains information on most insect sampling methods and the appropriate ways to design such programmes.

Materials Required

A 70/30 v/v mixture of ethanol/glycerol, small screw top vials for placing specimens in, 18mm internal diameter medium thickness Pyrex test tubes, an old umbrella or $1m^2$ calico sheet mounted on a square frame, a butterfly-type net with strong calico bag and forceps.

Procedure

Different species of ants forage in particular vertical strata. For instance some species are confined to the soil, others to the litter, open ground, the shrub layer or trees. Many species traverse the various strata (Figure 1). The soil and litter ants require specialised equipment for sampling (Berlese and Tullgren funnels) and these are described in Southwood's book. The following techniques are considered to be more suitable for sampling ants.

Ants which forage on the open ground may be sampled by pitfall traps (Figure 2). A trap may be made by placing a test tube full of alcohol/glycerol mix in the ground with it's mouth flush with ground level. A suitable design using 18mm internal diameter, medium thickness, rimmed test tubes is shown in Figure 2. These may be inserted in the ground using a trowel or alternatively the pitfall trap inserter and sleeve illustrated in Figure 2 may be used. This is a turned steel pointed rod which is placed in a 15cm long piece of P.V.C. electrical conduit or reticulation piping. The rod is struck with a mallet to insert the pipe in the ground. The rod is then withdrawn so that the test tube may be inserted within the piping. The resulting trap may be used over a period of time since the soil does not collapse when a test tube is withdrawn and replaced with a fresh trap. Pitfall traps may be run for 24 hours, 48 hours, or 1 week.

The shrub and herb foraging ants may be sampled with a

calico sweeping net. The net is brushed horizontally through the undergrowth with an oscillating motion as the operator walks forward. A 30m by 2m swathe makes a convenient sampling unit.

Ants on trees may be dislodged onto an old umbrella or $1m^2$ calico beating tray placed beneath, by giving branches a sharp rap with a stout baton.

Finally, ants from all strata may be collected with forceps and placed in vials of alcohol. The students should collect for equal time intervals at each site so that the results are comparable with those from other areas. As with the other sampling methods, specimens should be killed by placing in alcohol and labelled by dropping a pencil or indian ink written label into the vial.

Treatment of Results

Ants should be sorted, identified and counted. The numbers of each species may then be tabulated for particular habitats or strata, depending on the nature of the investigation.

Specimen Example of Results

A table of ants collected in nature reserves at Kojonup is reproduced in Table 1. The species code numbers given are those used in the W.A.I.T. reference collection.

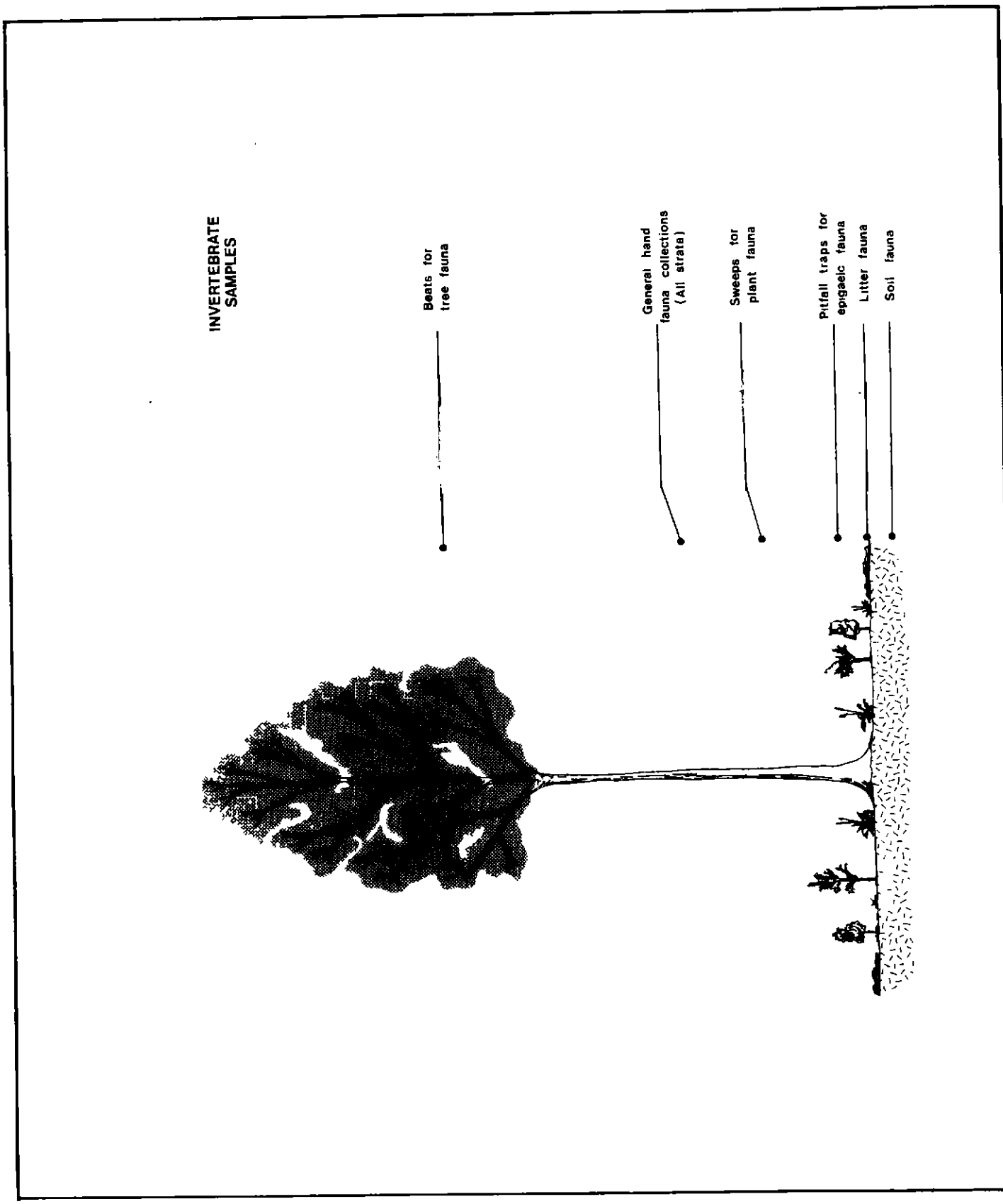


FIGURE 1

TYPICAL PROFILE OF NATIVE VEGETATION SHOWING STRATA IN WHICH ANTS MAY BE FOUND AND APPROPRIATE SAMPLING METHODS.

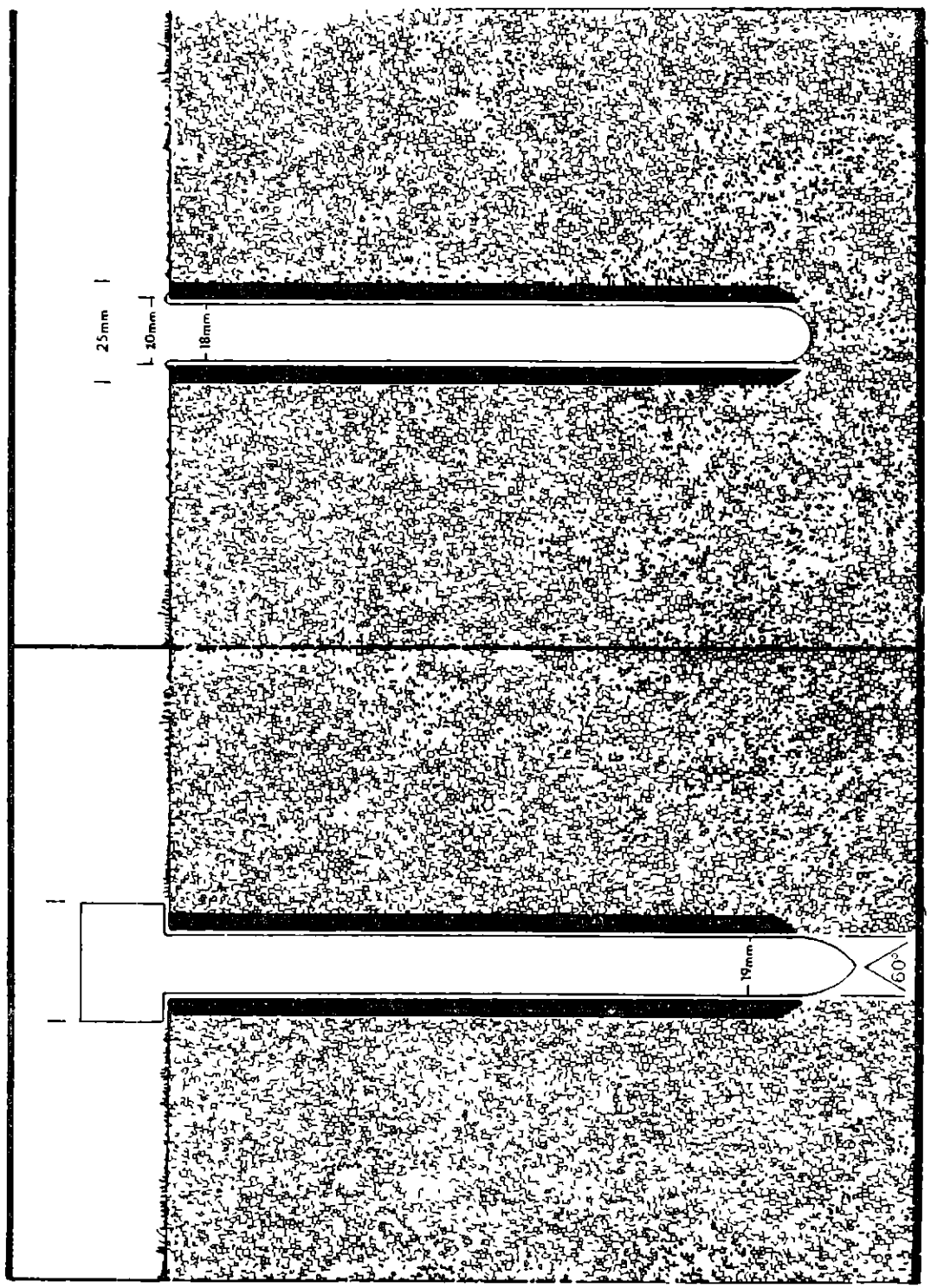


FIGURE 2

DIAGRAM OF PITFALL TRAP INSERTER WITH SLEEVE IN SOIL (LEFT) AND PITFALL TRAP PLACED IN SLEEVE (RIGHT).

			Reserve comparison survey					17760 monitoring program	
			3243	8617	15388	17759	17760	Control	Burn
Myrmecinae		*Myrmecia ? nigriceps* Mayr							
		M. chasei (Forel)							
		M. urens sp.			•				
Ponerinae	Ectatommini	*Rhytidopenera inornata* Crawley	•	•	•	•	•	•	•
		R. violacea (Forel)	•	•	•	•	•	•	•
		Heteroponera irbellis (Emery)						•	•
	Ponerini	*Brachyponera lutea* (Mayr)							•
		Hypoponera ? confina (Wheeler)	•		•		•		•
Myrmicinae	Myrmicini	*Chelaner* sp. 390 (J.D.M.)							•
		Oligomyrmex sp. 440 (J.D.M.)							•
		Podomyrma sp. 426 (J.D.M.)							
		P. sp. 427 (J.D.M.)							
		Pheidole latigena Forel		•	•			•	•
		P. sp. 379 (J.D.M.)		•		•	•	•	•
		P. sp. 429 (J.D.M.)							•
		Solenopsis sp. 438a (J.D.M.)						•	•
		Tetramorium sp. 6 (A.N.I.C.)					•	•	•
		Monomorium sp. 1 (A.N.I.C.)	•	•	•	•	•	•	•
		M. sp. 2 (A.N.I.C.)	•	•	•	•	•	•	•
		Genus near *Monomorium* sp. 438b (J.D.M.)						•	
	Meranoplini	*Meranoplus* sp. 11 (A.N.I.C.)						•	•
		M. sp. 12 (A.N.I.C.)							
	Crematogastrini	*Crematogaster* sp. 4 (A.N.I.C.)	•			•			
		C. sp. 42 (J.D.M.)				•	•	•	•
		C. sp. 50 (J.D.M.)		•				•	•
	Dacetini	*Colobostruma* sp. 437 (J.D.M.)							•
		Epopostruma sp. 159 (J.D.M.)							
Dolichoderinae	Tapinomini	*Iridomyrmex conifer* Forel						•	•
		I. darlingtonus (Forel)						•	•
		I. purpureus (Fr.Smith)	•	•	•	•	•	•	•
		I. glaber (Mayr)					•	•	•
		I. sp. 19 (A.N.I.C.)	•		•	•	•	•	•
		I. sp. 20 (A.N.I.C.)		•	•	•	•	•	•
		I. sp. 21 (A.N.I.C.)	•	•	•	•	•	•	•
		I. sp. 8 (J.D.M.)					•		
		I. sp. 373 (J.D.M.)							
		I. sp. 433 (J.D.M.)						•	
		I. sp. 434 (J.D.M.)						•	
Formicinae	Melophorini	*Notoncus hickmani* Clark						•	•
		N. gilberti Forel	•			•	•	•	•
		Prolasius sp. 376 (J.D.M.)		•					
		Melophorus sp. 1 (A.N.I.C.)	•		•	•	•	•	•
		M. sp. 171 (J.D.M.)		•		•	•	•	•
		M. sp. 209 (J.D.M.)	•	•	•		•	•	•
		M. sp. 304 (J.D.M.)							
		M. sp. 383 (J.D.M.)			•	•	•	•	•
		M. sp. 384 (J.D.M.)	•	•	•	•	•	•	•
		M. sp. 385 (J.D.M.)	•	•	•	•	•	•	•
	Plagiolepidini	*Stigmacros aeruta* Forel						•	•
		S. sp. 188 (J.D.M.)							
	Camponotini	*Camponotus michaelseni* Forel		•		•		•	•
		C. ? obniger Forel						•	•
		C. sp. 107 (J.D.M.)							
		C. sp. 110 (J.D.M.)	•			•		•	•
		C. sp. 182 (J.D.M.)	•					•	•
		C. sp. 199 (J.D.M.)	•		•				
		C. sp. 288 (J.D.M.)							
		C. sp. 393 (J.D.M.)							
		C. sp. 394 (J.D.M.)							•
		C. sp. 430 (J.D.M.)							
		C. sp. 431 (J.D.M.)		•					
		C. sp. 432 (J.D.M.)						•	
		C.(Colobopsis) sp. 359 (J.D.M.)							
		Notostigma sanguinea Clark							
		Polyrhachis sp. 390 (J.D.M.)							•
		TOTAL SPECIES	17	17	17	19	21	35	40

TABLE 1

CHECKLIST OF ANTS COLLECTED DURING THE SURVEY OF FIVE LARGE NATURE RESERVES AND ALSO IN A FIRE MONITORING PROGRAMME IN RESERVE 17760. SPECIES WHICH HAVE NO LOCATION MARKED WERE HAND COLLECTED FROM UNSPECIFIED KOJONUP NATURE RESERVES.

EXERCISE NUMBER 3

MEASURING ANT DISTRIBUTION

Science Content

In this exercise, the student learns how the distribution of ants is influenced by the resources available, by the nature of the habitat and by members of their own or other species.

Further Reading

Briese, D.T. & Macauley, B.J. (1977) - Physical structure of an ant community in semi-arid Australia. Australian Journal of Ecology, 2: 107 - 20.

Materials Required

One litre of alcohol/glycerol mixture and a set of test tube pitfall traps.

Procedure

A grid of pitfall traps is installed in the habitat under investigation. A 6 x 6 grid of traps spaced at 3m intervals is a suitable configuration. Traps are left in the ground for 1 week and then the catch in each trap is sorted, counted and identified.

Treatment of Results

The numbers of ants of each species should be plotted on individual grid diagrams. The territories of most ants should show up clearly and the gradients in numbers caught should indicate the proximity of the nest entrances. Lines may be drawn around the ranges of each species to illustrate their colony boundaries. Diagrams may then be constructed to show how distributions of individual species interact with those of others. The student may then classify the distribution patterns as localised, widespread, restricted by paricular species etc.

Specimen Example of Results

Figure 3 shows the distribution of ants in a Jarrah Forest plot at Dwellingup. Each number indicates the quantity of each species found in the individual pitfall traps.

PLOT 14
WEEK 5 December 1975

7 6 1 4 3 2	• 1 1 8 3 1	• • • • • •
2 1 3 7 2 1	• • 1 • • •	• • • • • •
10 4 9 6 1 •	• • • • • •	• • • • • 7
1 3 9 3 • 1	3 1 • • 1 •	• • • • • •
13 18 • 4 5 •	• • • 3511 •	• • • • • 1
6 1 31 • 5 •	1 • • • • 7	• 7 • • 59 •
Iridomyrmex conifer	**Iridomyrmex darwinianus**	**Iridomyrmex sp.20 (ANIC)**

• 1 2 2 2 1	• • • • • 2	• • • • • •
1 • 1 1 1 1	• • • • • •	• • • • • •
• • • • • 1	• • • • 3 •	• • • • • •
• • • • 1 •	• • 9 1 • 1	2 • • • • •
• • • • 1 1	• • • • • •	• • • 2 • •
2 • • • 1 •	• • • • • •	• • 10 1 1 •
Monomorium sp. 1 (ANIC)	**Iridomyrmex sp. 19 (ANIC)**	**Iridomyrmex sp. JDM 83**

• • 1 • • •	• • • • • •	• • • • • 2
• • • • • •	• • • • • •	• • • • • •
• • 1 • • •	• • 1 • • •	• • • • 2 •
1 • • 1 • •	• • 1 2 • •	• • • • • •
• 2 • • • •	• • 1 • • •	• • 1 • • •
• 2 • • • •	• • • 1 • •	• • 1 • • •
Monomorium sp. 3 (ANIC)	**Monomorium sp. JDM 100**	**Camponotus sp. JDM 68**

FIGURE 3

NUMBERS OF ANTS SAMPLED IN A 6 x 6 GRID OF PITFALL TRAPS SITUATED IN FOREST AT DWELLINGUP DURING DECEMBER 1975.

EXERCISE NUMBER 4

HOW MANY ANTS CO-EXIST IN A PLOT?

Science Content

In this exercise, the student obtains insight into how part of an animal community is constructed.

Further Reading

Majer, J.D. (1983) - Ants: bio-indicators of minesite rehabilitation, land use, and land conservation. Environmental Management, 7: 375 - 83.

The reference given for Exercise 3 is also useful for this investigation.

Materials Required

One litre of alcohol/glycerol mixture and a set of test tube pitfall traps.

Procedure

In this exercise the 6 x 6 grid of traps already described, or a 100m transect of 20 traps, spaced at 5m intervals is installed and left in the ground for 1 week. The plot or transect should also be hand collected for ants for a 2 hour period in the daytime and preferably also at night. The ants are then sorted, counted and identified.

Treatment of Results

The number of ants of each species may then be tabulated in taxonomic order (see Greenslade's book). The student can then record the number of species in the habitat, the total ants obtained and also note the variation in numbers between species. How many species are trapped in large numbers and how many appear to be rare? The species may be ranked in terms of numbers to indicate their relative numerical importance.

Specimen Example of Results

Table 2 shows the total number of ants trapped in 20 pitfall traps and also those obtained by hand collection in Jarrah forest during March 1979.

Species Name	Numbers Caught
Rhytidoponera inornata	60
Iridomyrmex agilis	31
Iridomyrmex darwinianus	18
Iridomyrmex sp. J.D.M. 200	17
Iridomyrmex sp. 20 (ANIC)	12
Iridomyrmex sp. J.D.M. 450	8
Tetramorium bicarinatum	4
Pheidole sp. J.D.M. 453	4
Notoncus gilberti	4
Monomorium sp. 2 (ANIC)	3
Iridomyrmex glaber	3
Adlerzia froggatti	1
Prolasius sp. J.D.M. 356	1
Prolasius sp. J.D.M. 367	1
Melophorus sp. 1 (ANIC)	1
Melophorus sp. J.D.M. 221	1
Brachyponera lutea	H
SPECIES RICHNESS	17
TOTAL INDIVIDUALS	169

TABLE 2

TOTAL SPECIES TRAPPED IN 20 PITFALL TRAPS (NUMBERS) OR HAND COLLECTED (H) IN JARRAH FOREST AT WAGERUP DURING MARCH 1979.

EXERCISE NUMBER 5

WHAT DO ANTS FEED ON?

Science Content

In this exercise, the student learns something about the feeding preferences of different species of ants, how those of co-existing species may compliment each other and also the trophic level at which different ant species function.

Further Reading

Briese, D.T. & Macauley, B.J. (1981) - Food collection within an ant community in semi-arid Australia, with special reference to seed harvesters. Australian Journal of Ecology, 6: 1 - 19.

Materials Required

Forceps, watch, trowel, polythene bags and paper labels.

Procedure

Two techniques are used in this exercise. First the student observes an ant nest for a 30 minute period and collects all ants which are carrying food, together with their food item. Ants with swollen gasters (abdomen) should also be counted if the student first checks to see whether these have been drinking sap from flowers, aphids or other sucking bugs.

Since ants tend to discard uneaten fragments of food around their nest entrance the student may scoop up these soil/debris mounds and place them in a labelled polythene bag. Food debris may be separated from the soil with the naked eye.

Food items obtained from either method may then be sorted into seeds, other parts of plants and insect or other animal remains with the aid of the stereo microscope. The items in each category are then counted and tabulated against the appropriate species of ant.

Treatment of Results

Tables may be constructed showing the number of fragments carried, or fragments per nest, in the various food categories. One problem which will be encountered is the shattering by feeding ants of one insect food item into several parts. Students should be encouraged to design ways for compensating for this source of bias in the data. The mean values for several sets of observations may then be calculated and the feeding preferences of two or more species of ants may be compared. Species may be classified as seed feeders, carnivores, nectarivores or combinations of these specialisations.

Specimen Example of Results

The composition of food fragments in nest dumps of Melophorus sp. 1 (ANIC) is shown in Table 3.

	NEST NUMBER										
	1	2	3	4	5	6	7	8	9	10	Mean
Arthropod fragments	15	1	4	67	10	33		5	1	28	16.4
Seeds											
Eucalyptus marginata (Myrtaceae)			1	6	4					2	1.3
Acacia strigosa (Leguminoseae)					1					1	0.2
Phyllanthus calycinus (Euphorbiaceae)						1				3	0.4
Trymalium ledifolium (Rhamnaceae)	60					2					6.2
Miscellaneous spp.	13			6	5	33		13	5	3	7.8
% of all items	49% seeds, 51% arthropods										

TABLE 3

COMPOSITION OF FOOD FRAGMENTS IN *MELOPHORUS* sp. 1 (ANIC) NEST DUMPS COLLECTED AT KARRAGULLEN IN NOVEMBER 1978.

EXERCISE NUMBER 6

MEASURING THE FEEDING PREFERENCES OF ANTS

Science Content

This exercise builds on Exercise 5 and shows students how to design experiments to quantify the reliance of ants on different food sources.

Further Reading

The reference given for Exercise 5 is useful for this investigation.

Materials Required

Petri dish lids with masking tape ramps running from edge to the inside, tin of pilchards, honey, crushed wheat and some Acacia seeds.

Procedure

A grid (4 x 4, spaced 3m apart) is marked out in a suitable habitat and, at each grid point, four petri dish lids are set in the ground with the sides flush with the soil surface. At each grid point a piece of pilchard, some dilute honey, some crushed wheat and some Acacia seeds are placed on separate dishes. The ants observed at each bait are then collected and subsequently counted and identified.

Treatment of Results

The total number of feeding observations at each bait is calculated for each species. A table of feeding preference of each species may then be constructed and the species may then be classified by feeding habit e.g. carnivore (fish), nectarivore (honey), seed predator (wheat) and elaiosome collector (Acacia). The latter two categories are explained in Exercise 11.

The results of this exercise may be compared with the observations made in Exercise 5.

Specimen of Example Results

No local example is available for this exercise.

EXERCISE NUMBER 7

MEASURING THE DAILY ACTIVITY PATTERN OF ANTS

Science Content

In this exercise,the student investigates how ants interact with their environment by spacing out their foraging patterns throughout the daily cycle.

Further Reading

Briese, D.T. & Macauley, B.J. (1980) - Temporal structure of an ant community in semi-arid Australia. Australian Journal of Ecology, 5: 121 - 34

Materials Required

Stopwatch, hand counter (optional), torch, alcohol/glycerol mixture and set of test tube pitfall traps, pitfall trap sleeves and pitfall trap inserter.

Procedure

The daily foraging pattern of ants may be quantified by two different methods. The first involves placing a set of pitfall traps within P.V.C. sleeves in a suitable habitat. These are left open during daylight hours and then replaced with fresh tubes which are left open during the night. The catch from both trap sets is then sorted, counted and identified.

In the second technique the student marks a series of nests of each ant species under investigation. The number of ants leaving or entering the nest are then counted over a 3 minute period at 2 hour intervals. The intervals may be increased during night time if observers are not able to stay in the field.

Treatment of Results

For the first method the mean number of ants per trap for each species is plotted as a histogram for the night and day trapping periods. For the second method the mean number of ants per observation interval is plotted against time for each species.

Each species may be classified as diurnal (day foraging), nocturnal, crepuscular or continuously foraging. The complimentary foraging habits of species which overlap in range (see Exercise 3) may then be considered. Students may also look at the size, colour and foraging habits of the ants to see if there is any trend with type of activity pattern.

Specimen Example of Results

Examples of results obtained by the first and second methods are shown in Figures 4 and 5 respectively.

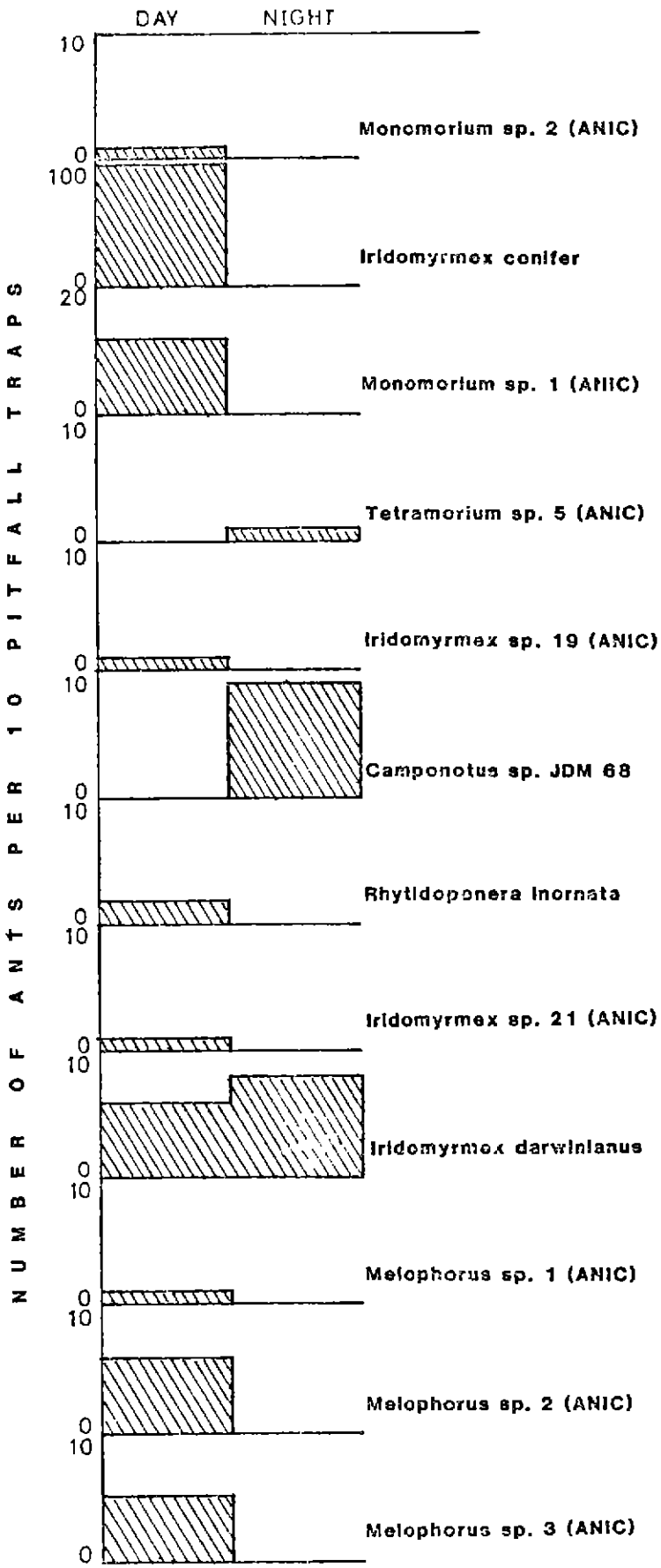


FIGURE 4

TOTAL NUMBER OF ANTS OF PARTICULAR SPECIES SAMPLED IN 10 PITFALL TRAPS RUN SEPARATELY DURING DAYTIME AND NIGHT-TIME AT DWELLINGUP.

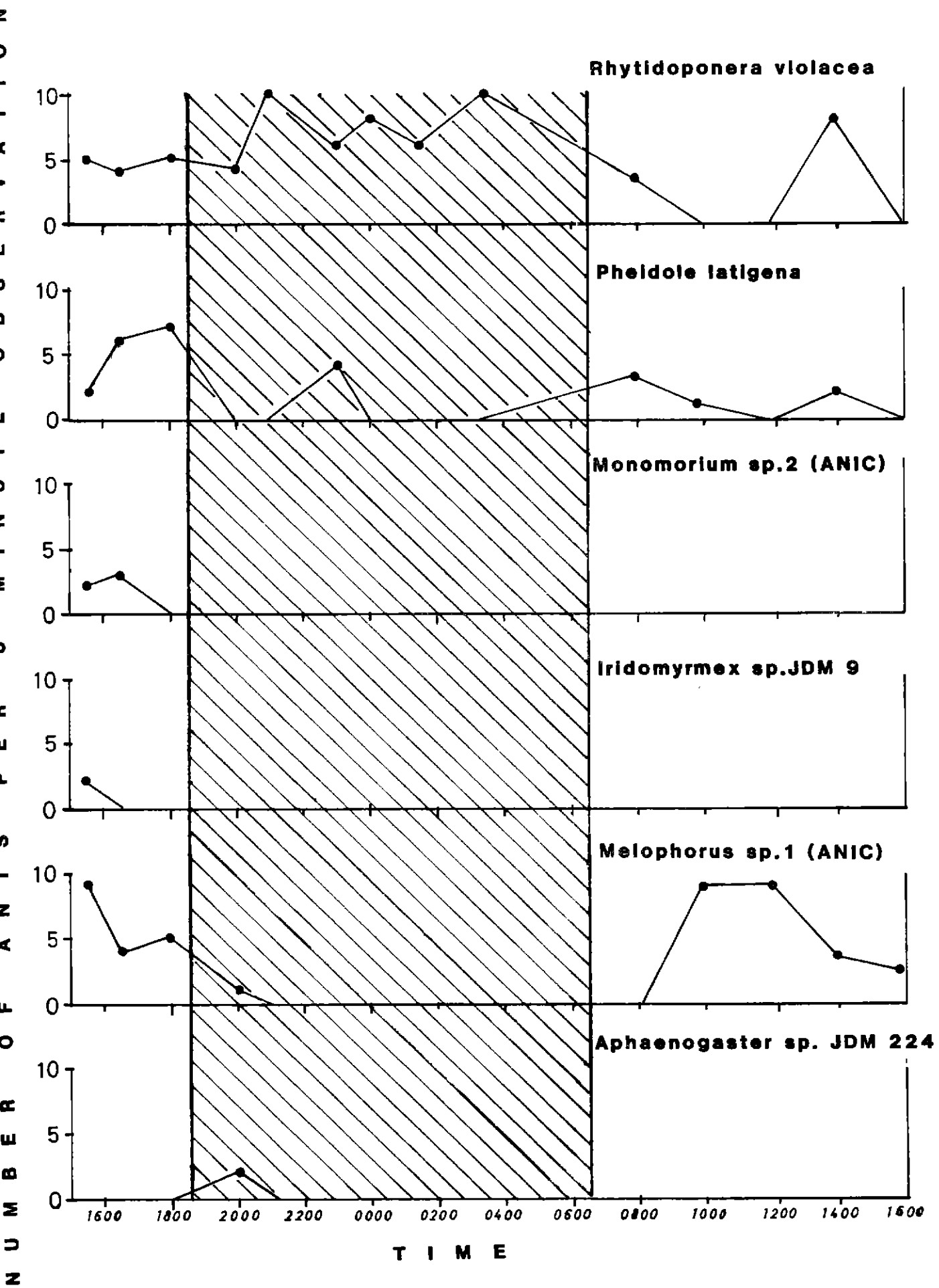


FIGURE 5
MEAN NUMBER OF ANTS OF PARTICULAR SPECIES RECORDED TRAVERSING NEST ENTRANCE PER 3 MINUTE INTERVAL OVER A 24 HOUR PERIOD AT DWELLINGUP.

EXERCISE NUMBER 8

MEASURING THE SEASONAL ACTIVITY PATTERN OF ANTS

Science Content

In this exercise, the student observes long-term cyclical changes in ant community composition. These may be related to the ants' feeding habitats or other behavioral and structural characteristics.

Further Reading

The reference used for Exercise 7 is useful here.

Materials Required

Alcohol/glycerol mix, two sets of test tube pitfall traps, pitfall trap sleeves and pitfall trap inserter.

Procedure

Grids of 6 x 6 pitfall traps are installed in plastic sleeves in a suitable habitat. Traps are run for 7 days per month over a 1 year period and the catch from each trap is sorted, counted and identified. A corked pitfall trap may be left in the sleeve during the 3 week non-sampling period in order to prevent the sleeve filling up with soil.

Treatment of Results

The total ants of each species trapped per month is plotted against time of year. Species may then be classified as summer foragers, winter foragers, active all year around etc. The community may be assessed for complimentary or overlapping foraging times and foraging times of particular species may be considered in terms of feeding habits (see Exercises 5 and 6). For instance, seed feeding species may be most active in summer when seeds tend to be shed from plants.

Specimen Example of Results

The total ants trapped per species per month in a set of pitfall traps situated in a ryegrass paddock at Katanning are shown in Figure 6. The graphs are scaled with respect to the maximum monthly catch which is indicated on the right of the figure.

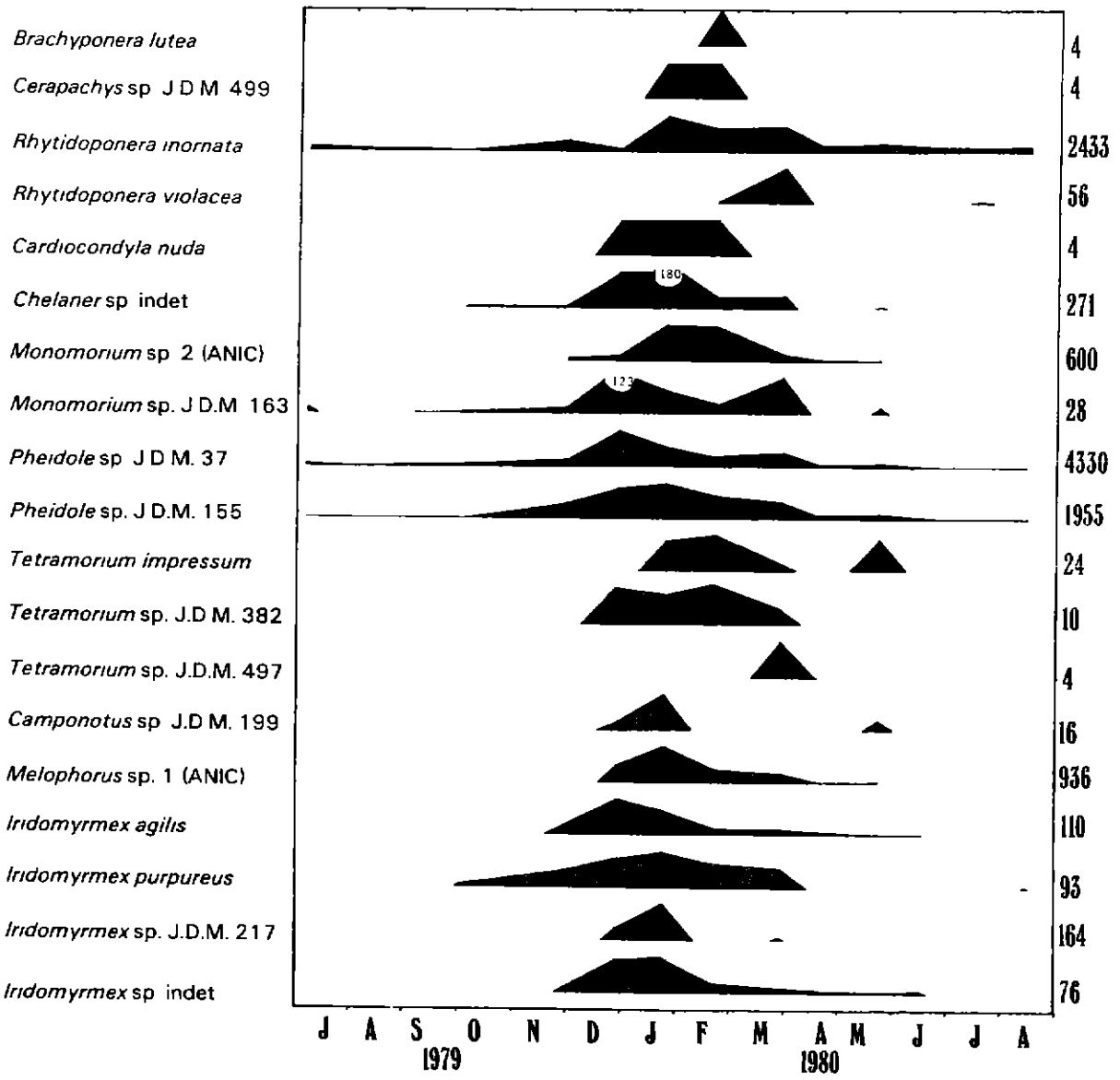


FIGURE 6

TOTAL ANTS TRAPPED PER MONTH IN A RYEGRASS PADDOCK AT KATANNING.

EXERCISE NUMBER 9

MEASURING THE HABITAT PREFERENCES OF ANTS

Science Content

In this exercise, the student can observe how different species of ants interact with their environment in different and often complimentary ways.

Further Reading

Majer, J.D. (1976) - The ant mosaic in Ghana cocoa farms: further structural considerations. Journal of Applied Ecology, 13: 145 - 55.

Materials Required

Tape measure and 1m^2 quadrat.

Procedure

One of the principal influences on ant distribution is the availability of sunlight. Since the amount of shade is therefore also important this makes an ideal investigation. Two or three species of ants are selected which commonly occur in the habitat under investigation and which have conspicuous and easily recognisable nests. Place out a 100m tape measure and at 10m intervals count the number of nests of each species in a 2.5m radius circle. The percentage of ground cover is visually assessed at this point using a 1m^2 quadrat and the percentage tree canopy cover is also visually quantified. Upon completion of the transect the tape is moved across 10m and the observations are repeated. The tape is moved as many times as the scope of the project permits.

Treatment of Results

The data may be treated in a number of ways and the teacher may need to assist the student with some statistical analysis. First, a scattergram of nest numbers per 2.5m radius circle versus ground cover or tree cover may be drawn up. This may be visually inspected or analysed using Spearman's rank correlation analysis.

Trends may not show up in a linear fashion so alternative methods may be required. One is to split the cover values into four or more categories (e.g. 0-5%, 5-10%, 10-25%, $\geq$25%). A table may then be constructed with these values as column headings and the number of nests of a particular species recorded for each 2.5m circle under the appropriate column. Zero values should also be included. The data may be simply treated by calculating the mean number of nests in each cover category or alternatively a chi square analysis may be performed.

The ground or tree cover preferences of the species may then be tabulated and the responses of the various species to these

variables may be compared.

Specimen Example of Results

The distribution of four dominant ants in West African cocoa farms, recorded under three canopy density regimes, is shown in Table 4. The data have been assessed by chi square analysis and three species are significantly affected by tree canopy density.

	COCOA CANOPY DENSITY				
	Dense	Complete but thin	Broken or absent	Total	Chi square value & P
Oecophylla longinoda	44 0.34 (40.32)	37 0.10 (35.15)	45 0.60 (50.53)	126	1.04 P=N.S.
Macromischoides aculeatus	31 4.62 (21.12)	19 0.11 (18.41)	18 2.71 (26.47)	66	7.44 P=0.02
Camponotus acvapimensis	5 4.48 (12.48)	13 0.41 (10.88)	21 1.84 (15.64)	39	6.73 P=0.03
Crematogaster depressa	4 4.35 (10.88)	10 0.02 (9.49)	20 2.98 (13.63)	34	7.34 P=0.02
C.striatula	8 0.87 (5.76)	5 0.01 (5.03)	5 0.67 (7.21)	18	1.55 P=N.S.

TABLE 4

DISTRIBUTION OF THE COMMON DOMINANT AND SUB-DOMINANT ANTS UNDER DIFFERENT COCOA CANOPY DENSITIES; THE OBSERVED DISTRIBUTIONS ARE EXTRACTED FROM A 240 x 10 M^2 QUADRAT SURVEY IN DECEMBER 1970; FIGURES IN BRACKETS ARE THE EXPECTED FREQUENCIES OF ANTS, DECIMAL FIGURES ARE THE CELL CONTRIBUTION TO THE TOTAL CHI SQUARE VALUE IN THE LAST COLUMN (N.S. = NOT SIGNIFICANT)

EXERCISE NUMBER 10

HOW DO SO MANY SPECIES CO-EXIST?

Science Content

This exercise synthesises the results of Exercises 2 - 9. The student compares the distribution, feeding habits, daily and seasonal foraging patterns and habitat preferences of ants in order to understand how large numbers of species can co-exist in the same community.

Further Reading

Culver, D. C. (1974) - Species packing in Caribbean and north temperate ant communities. Ecology, 55, 974 - 88.

Materials Required

This exercise uses the data collected previously so no materials are required.

Procedure

The data obtained from all, or some, of Exercise 2 - 9 are tabulated for all species found in the habitat under investigation. Certain data (e.g. feeding habits) will inevitably be lacking for the less commonly occurring species.

Treatment of Results

A large summary table may be constructed with ant species representing the rows and "feeding habits", "daily foraging period", "annual foraging period", "ground cover preference" and "tree cover preference" as the columns. Suitable summary comments should then be entered into the table; data on some species will inevitably not be available. The concept of the ecological niche may then be applied to some of the better recorded species and the student should review the various species - habitat interactions and discuss how these enable so many species to co-exist in a relatively small area.

Specimen Example of Results

No local example is available for this exercise.

EXERCISE NUMBER 11

ANT - SEED INTERACTIONS

Science Content

In this exercise, the student observes two highly developed plant - animal interactions, one opportunistic (seed predation) and the other mutualistic (elaiosome collecting).

Further Reading

Buckley, R. C. (ed.) (1982) - Ant - Plant Interactions in Australia. The Hague: Dr W. Junk. pp.162.
This book contains many interesting articles on Australian ant-seed interactions.

Materials Required

Ten x 10cm masonite® boards, 200 Acacia (e.g. Acacia saligna) and 200 Eucalyptus (e.g. Jarrah, Eucalyptus marginata) seeds of similar size.

Procedure

Acacia spp. seeds possess an aril, or ant attracting structure termed an elaiosome. This usually appears as a white, cream or red fleshy appendage on the testa. Ants which take such seeds usually consume the elaiosome but discard the seed, thereby benefitting the seed by dispersing it and planting it in the soil around the ant nest. Such ants are termed elaiosome collectors Eucalyptus seeds lack an elaiosome and, if taken by ants, are usually eaten. These ants are termed seed predators.

To compare the two types of seed taking a set of 10 masonite® boards are set flush on the ground with their rough sides uppermost. Twenty seeds of Acacia sp. and an equivalent sized Eucalytpus sp. are placed on the boards during early morning. The boards are revisited at 1 or 2 hour intervals and the number of seeds removed are counted. Ants observed taking seeds are removed for later identification and the seed which is removed is noted.

Treatment of Results

The mean number of seeds of each species removed per time interval is calculated and plotted against time. This enables a comparison of the progressive removal of each species to be made. Removal rates may be compared in terms of the seed possessing or lacking an elaiosome and the significance of this may be considered by the student. The ant species responsible for removing the two types of seed may be compared and the results tallied up with those obtained in Exercise 5 and/or 6.

Specimen Example of Results

Figure 7 shows the mean cumulative numbers of seeds removed from boards established at Del Park, near Dwellingup over a 24 hour interval.

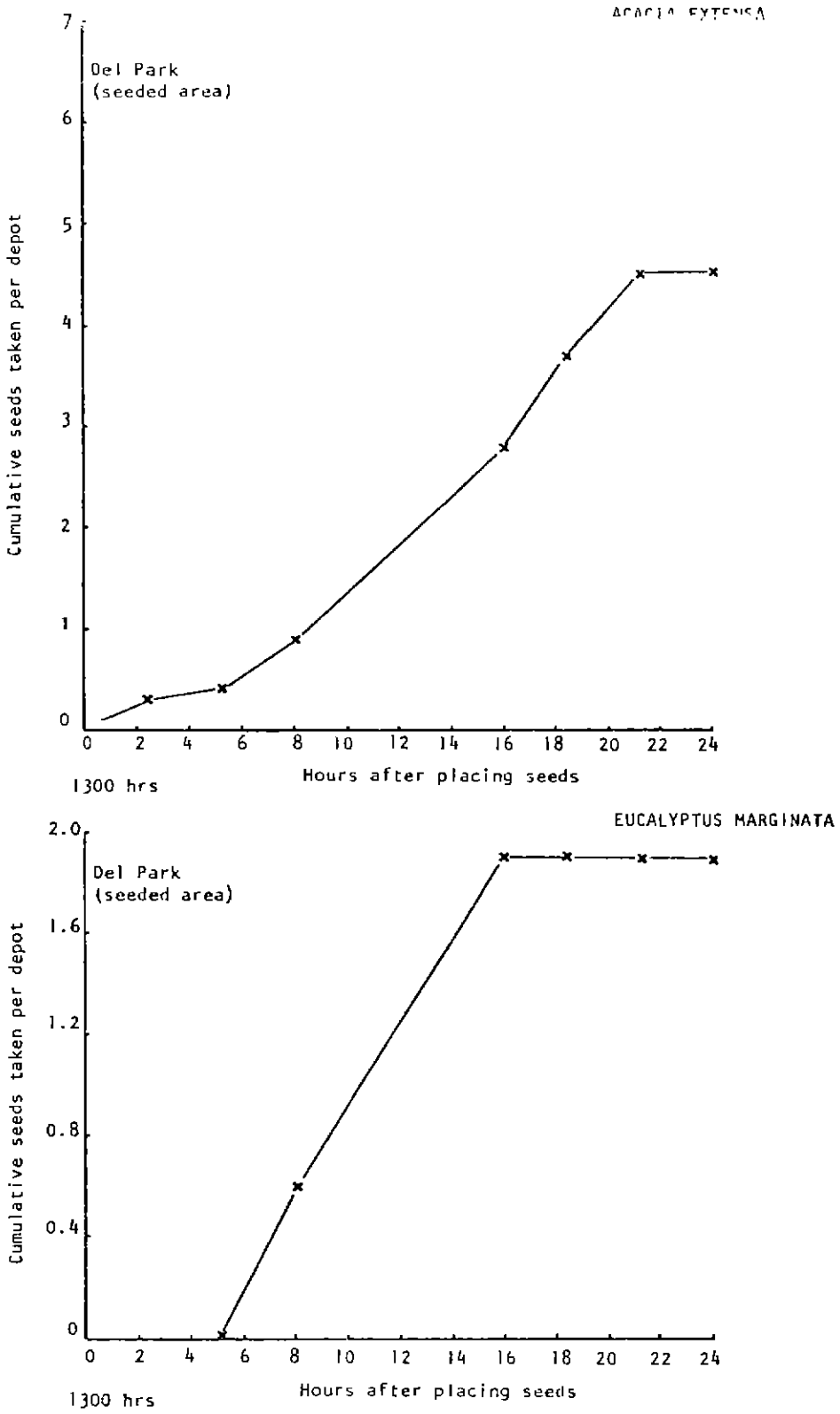


FIGURE 7

MEAN CUMULATIVE NUMBER OF SEEDS REMOVED BY ANTS FROM DEPOTS ESTABLISHED IN FOREST AT DEL PARK. THE UPPER GRAPH SHOWS DATA ON ACACIA EXTENSIA, THE LOWER ON EUCALYPTUS MARGINATA (JARRAH).

EXERCISE NUMBER 12

DISCOVERING THE FATE OF SEEDS IN ANTS NESTS

Science Content

This exercise builds on Exercises 11. It enables the student to design an investigation which answers some of the questions which arose in the previous exercise.

Further Reading

Majer, J. D. (1982) - Ant-plant interactions in the Darling Botanical District of Western Australia. In ed. R. C. Buckley Ant-Plant Interactions in Australia pp. 45 - 61. The Hague, Dr W. Junk.

Materials Required

Blowlamp, ruler, trowel and sieve.

Procedure

Select one of the most important Acacia seed gathering ants and locate a number of nests. Remove 15 x 15cm squares of soil around each nest to a depth of 3cm. Repeat at 3cm depths down to 12cm. Extract the seeds by sieving the soil. Count and, if possible, identify the seeds in the soil at each depth.

Since most Acacia sp. seeds require heat treatment before they will germinate the effects of fire may be simulated by heating the soil around appropriate ant nests with a blowlamp. This should be done in autumn and the nest should be heated for about 5 minutes. A similar number of non-ant-nested sites should also be heated as controls. The heated areas should then be observed at 2 week intervals during winter in order to observe and count seedling emergence.

Treatment of Results

The mean number of seeds per ant nest is calculated in order to give an idea of the importance of ants as seed takers. The mean number of seeds per 3cm depth interval may be plotted against depth to indicate where the seed is stored. The significance of this in relation to soil heating during fires may be considered by the student. This observation leads on to the results of the second experiment in which seedlings of certain species contained within the ant nest will emerge within 1 or 2 months of the opening rains.

The density of seeds on ant nests and un-nested soil may be compared in order to obtain an idea of the importance of ants in seed distribution and survival.

Specimen Example of Results

Figure 8 shows the occurrence of legume seeds in

Rhytidoponera inornata nests situated near Dwellingup and Figure 9 shows seedlings which germinated on heated nests of this ant.

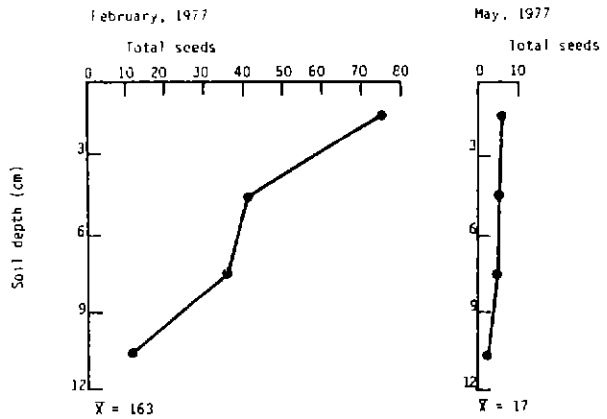


FIGURE 8

OCCURRENCE OF LEGUME SEEDS AT VARIOUS SOIL DEPTHS IN RHYTIDOPONERA INORNATA NESTS SITUATED NEAR DWELLINGUP. COUNTS FOR FEBRUARY 1977 AND MAY 1977 ARE SHOWN SEPARATELY AND THE MEAN NUMBER OF LEGUME SEEDS PER NEST ARE INDICATED.

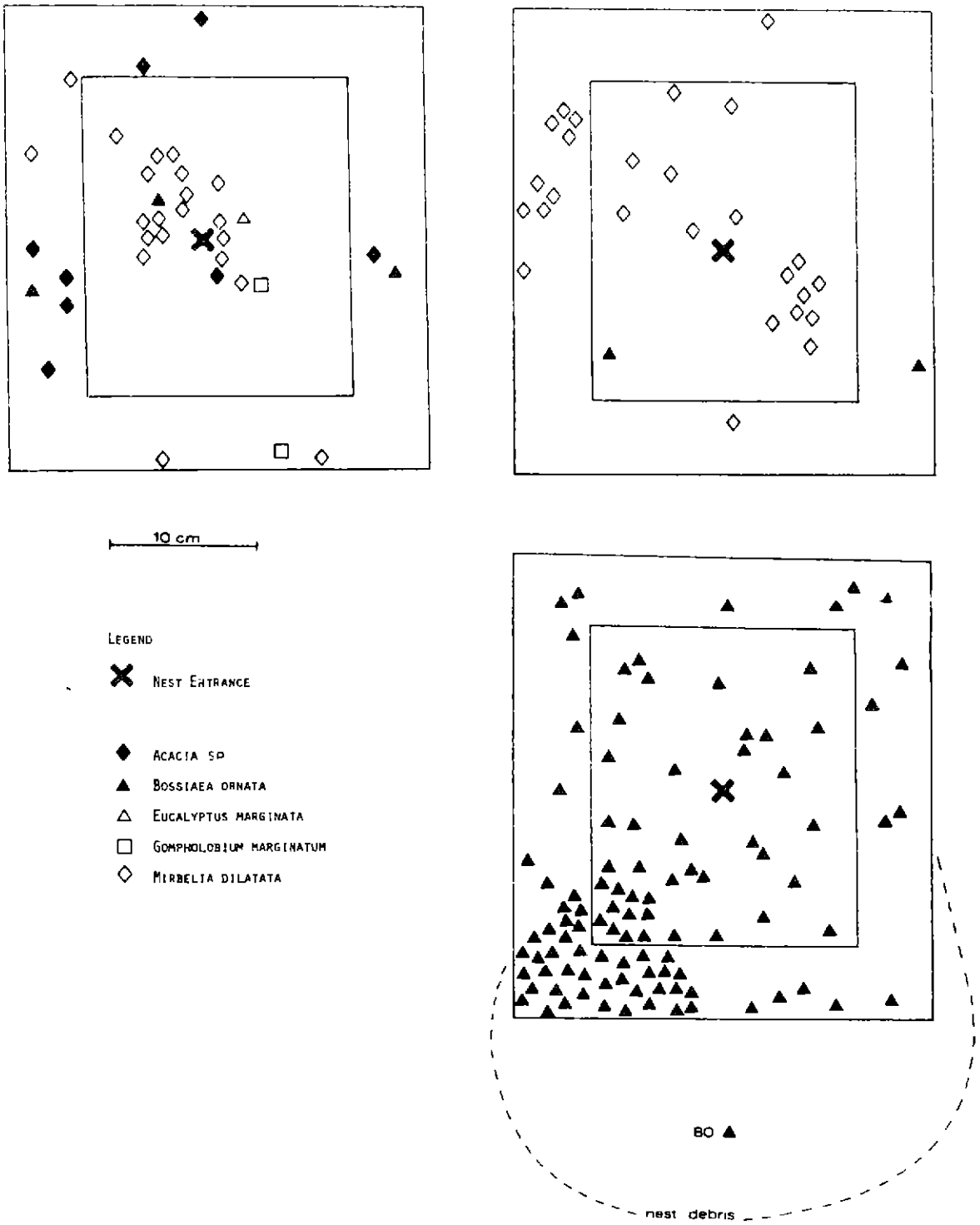


FIGURE 9

MAPS OF SEEDLINGS WHICH HAVE GERMINATED NEAR THE ENTRANCES OF THREE RHYTIDOPONERA INORNATA NESTS WHICH WERE HEATED UP TO 100°C AT 2CM DEPTH. THE INNER RECTANGLE REPRESENTS THE AREA OF THE HEATING APPARATUS, THE OUTER RECTANGLE INCORPORATES SOIL WHICH WAS HEATED BY LATERAL CONDUCTION FROM THE HEAT SOURCE.

EXERCISE NUMBER 13

STUDYING THE STRUCTURE OF ANTS NESTS

Science Content

This exercise builds on Exercises 11 and 12 and enables the student to answer further questions arising from the investigation.

Further Reading

The reference given for Exercise 12 is useful here.

Materials Required

Gas heater or camp fire, large metal pot with spout, scrap roofing lead and trowel. The roofing lead may be obtained from a scrap metal dealer.

Procedure

Select some ant nests which have nest entrances of at least 5mm diameter. Heat a quantity of lead until molten and pour into ant nest until it is full to the opening. Leave the lead for 30 minutes to cool and dig cast out. This exercise is best performed in sandy or loamy soils under the supervision of the teacher. Care should be taken to avoid breathing fumes from the molten lead.

Treatment of Results

The lead cast may be photographed or drawn. It's volume may be obtained by immersing in water and, since seeds may be visible in galleries, the shape of the nest in relation to seed profiles, obtained from Exercise 12, may be compared.

Specimen Example of Results

Figure 10 is a tracing from a photograph of a Melophorus sp. 1 (ANIC) ant nest.

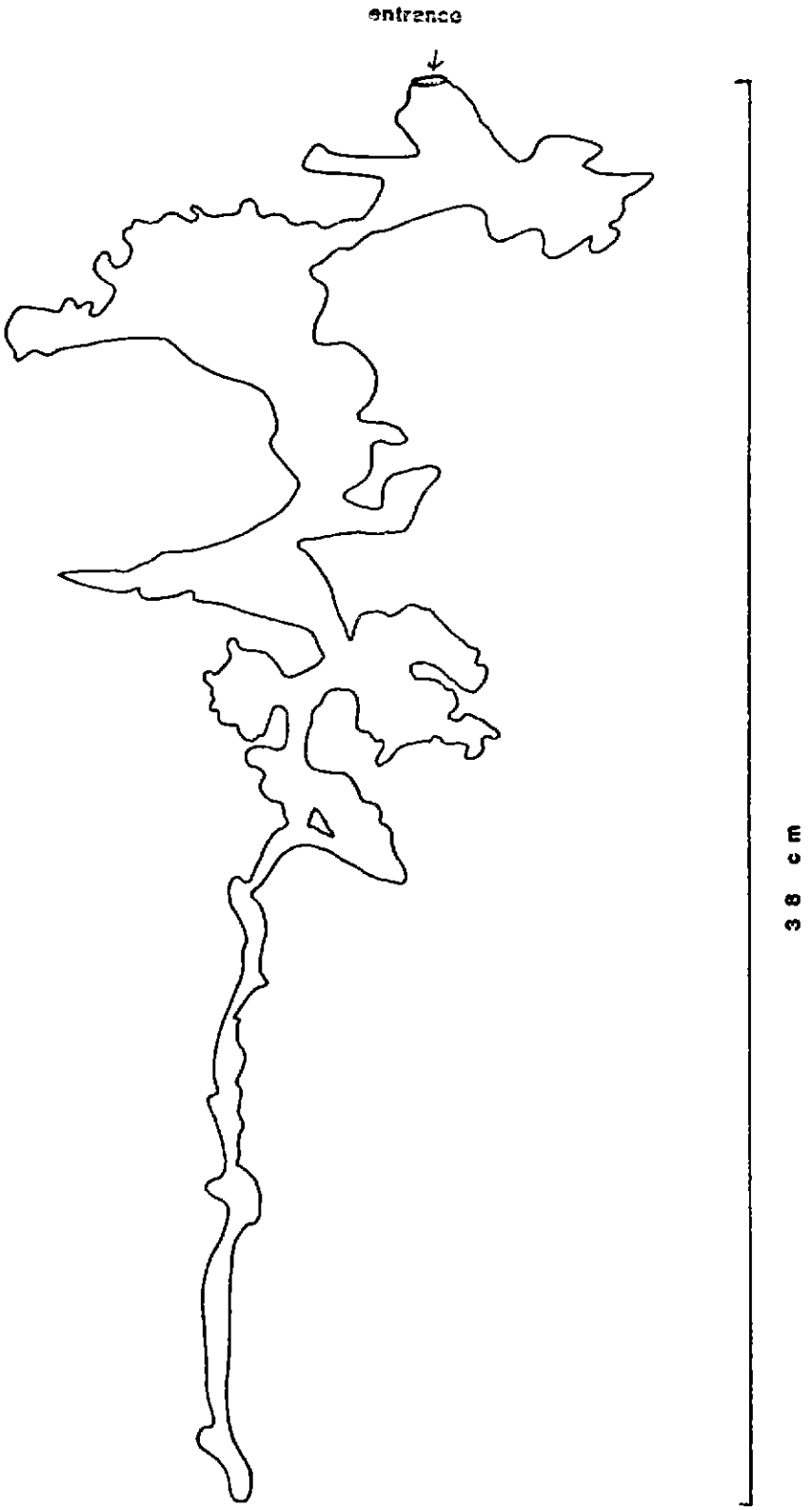


FIGURE 10

TRACING FROM PHOTOGRAPH OF A MELOPHORUS sp. 1 (ANIC) ANT NEST CAST OBSERVED IN YALGORUP NATIONAL PARK.

EXERCISE NUMBER 14

ANT - NECTARY INTERACTIONS

Science Content

In this exercise, the student observes a suspected mutualistic relationship between a plant and various species of ant.

Further Reading

Bentley, B. L. (1977) - Extrafloral nectaries and protection by pugnacious bodyguards. Annual Review of Ecology and Systematics, 8: 407 - 27.

Materials Required

Source of Acacia saligna plants, beating tray and thick grease or sticky resin.

Procedure

In America a number of studies have shown that certain plants exude sugary sap from nectaries situated on leaves which in turn attract ants. This is believed to be a mutualistic relationship since the ant obtains nutrition and the plant may be protected from herbivores as a result of the aggressive behaviour of the ants.

Acacia saligna, (which occurs in the south-west of Western Australia), and probably many other Acacia spp., have well developed nectary glands at the base of their phyllodes (leaves). These are usually attended by ants.

The student should select a range of study plants and chart the foraging route of ants on the vegetation. How is its route influenced by the nectaries? Does it forage anywhere else on the leaf? What proportion of its time is spent at the nectaries?

A simple exclusion experiment may then be performed in which five experimental plants are paired with five control plants of equivalent size. The number of winged invertebrates per plant are then quantified by dislodging the animals onto a beating tray. Ants on experimental plants are then excluded by pasting a grease or resin band around the stem at approximately 15cm above ground level. Access routes for ants from adjacent plants are removed by pruning the vegetation. The subsequent change in winged animal numbers on plants are then monitored by beating tray samples taken at 2 week intervals. Wingless animals are excluded from the count since their incidence on the plant is also influenced by the grease or resin band.

Treatment of Results

The student should be able to construct a diagram of ant foraging routes on the plant which may be annotated to show the

activity of the ant at various places on the plant. The animals sampled by beating trees may simply be recorded as number of winged insects or, alternatively, the student may attempt to classify some of them. The counts are then averaged for the five trees in each treatment and plotted against time. If ants have a protective role on the plant there should be a relative increase in numbers of winged insects on plants where ants have been excluded.

Specimen Example of Results

No local example for this exercise is available.

EXERCISE NUMBER 15

STUDYING THE INFLUENCE OF HABITAT MODIFICATION ON ANT COMMUNITY COMPOSITION

Science Content

This exercise enables the student to observe the effects of habitat alteration by man on the structure of ant communities.

Further Reading

Majer, J. D. (1981) - The role of invertebrates in bauxite mine rehabilitation. Forests Department of Western Australia Bulletin Number 93, pp. 29.
The reference given for Exercise 4 is also useful here.

Materials Required

Alcohol/glycerol mix and set of test tube pitfall traps.

Procedure

A pristine habitat (e.g. Jarrah forest, Eucalyptus marginata) and a disturbed habitat (e.g. farm, pine plantation, garden or quarry) are selected. A 100m transect of 20 pitfall traps is then installed in each habitat and left in the ground for 1 week. Hand collections of ants are also made in each habitat for 2 person hours during the daytime and preferably also at night. The resulting collections are then sorted, counted and identified.

Treatment of Results

The species present and the numbers caught should be tabulated for the pristine and disturbed habitats. Each habitat may then be compared in terms of number of species, number of ants trapped, which species are most numerous and which species are unique to particular areas.

A large difference in fauna should be evident in the two areas and the student may consider these in terms of habitat modification.

Specimen Example of Results

Table 5 shows the numbers of ants obtained in pitfall traps situated in unburnt Jarrah and areas subject to various types of disturbance at Dwellingup.

	Amphion unburnt jarrah	Plavins burnt jarrah	Jarrah dieback area	Hollyoak town site	Pine plantation	Bauxite mined area	Fa la
Rhytidoponera violacea (Forel)		5	38	2			
Rhytidoponera inornata (Crawley)	9	22	8	50	12		2
Heteroponera imbellis (Emery)	1		2				
Brachyponera lutea (Mayr)				2			
Trachymesopus rufonigra (Clark)		1					
Pheidole latigena (Forel)	1		9	5	25		10
Anisopheidole antipodum (Fr. Smith)		1					
Cardiocondyla nuda (Mayr)				1			
Xiphomyrmex sp. 5 (A.N.I.C.)	1	1	3	2			
Xiphomyrmex sp. 6 (A.N.I.C.)			1				
Monomorium sp. 1 (A.N.I.C.)	3			2	8		
Monomorium sp. 3 (A.N.I.C.)	10	5	3		1		
Monomorium sp. 2 (A.N.I.C.)			2		2		
Meranoplus sp. 11 (A.N.I.C.)			1				
Meranoplus sp. 12 (A.N.I.C.)	9	8	15				
Meranoplus sp. 13 (A.N.I.C.)		1	8				
Crematogaster sp. 4 (A.N.I.C.)	21						
Iridomyrmex darwinianus (Forel)	26	28	13		1	1	
Iridomyrmex sp. 18 (A.N.I.C.)						1	
Iridomyrmex sp. 19 (A.N.I.C.)	15	5	10		1		
Iridomyrmex purpureus (A.N.I.C.)				13		2	3
Iridomyrmex conifer (Forel)	101	56	11	1	1058	16	
Iridomyrmex glaber (Mayr)	3	1					
Iridomyrmex sp 20 (A.N.I.C.)	6	9	38	16	1	1	
Iridomyrmex sp. 21 (A.N.I.C.)	1	2	12	1		120	
Iridomyrmex sp. 22 (A.N.I.C.)		7	9	4			
Iridomyrmex sp. 23 (A.N.I.C.)			37				
Prolasius sp 3 (A.N.I.C.)	2						
Melophorus sp. 1 (A.N.I.C.)				7	2		15
Melophorus sp. 2 (A.N I.C.)	1	4	1	1			
Melophorus sp. 3 (A.N I.C.)		2	5				
Melophorus sp. indet	2	1	3				
Melophorus sp 4 (A.N.I.C.)			1				
Melophorus sp. 5 (A.N.I.C.)		1					
Camponotus michaelseni Forel	2	2					
Camponotus?obniger Forel	1			1			

TABLE 5

NUMBERS OF THE VARIOUS ANT SPECIES TAKEN IN PITFALL TRAPS SITUATED IN DIFFERENT LAND USE TYPES IN THE DWELLINGUP AREA.

ACKNOWLEDGEMENTS

This paper is modified from a workshop presented at CONASTA 33, Perth during May 1984. Julie Agars kindly typed the final copy of the paper.

REFERENCES

Bates, M. R. (1973) - Aggression and niche-separation in ants. A suggestion for a student project. Journal of Biological Education, 7: 16 - 23.

King, T. J. & Woodell, S. R. J. (1975) - The use of the mounds of Lasius flavus in teaching some principles of ecological investigation. Journal of Biological Education, 9: 109 - 113.