Western Australian Institute of Technology

Department of Biology
Bulletin Number 8

The Influence of Spraying on Argentine (Iridomyrmex humilis) and Native Ants (Hymenoptera Formicidae)

by J.D. Majer and R. Flugge

Published 1984

ISSN 0158 3301

PREFACE

Biologists who wish to publish the results of their investigations have access to a large number of journals. For a variety of reasons, however, the editors of most of these journals are unwilling to accept articles that are lengthy or contain information that is preliminary in nature. Nevertheless, some material of this type could be of immense interest and value to other scientists, and should be published. For this reason, the School of Biology at the Western Australian Institute of Technology has decided to produce a series of occasional papers. Although the first few papers will be produced by members of the School of Biology, it is hoped that other scientists who have had some association with the School will submit material for consideration. Regardless of the source of any contributions, all papers will be considered by an editorial board and appropriate referees. All publications will be funded by external agencies.

Dr B.G. Collins
Head of the School of Biology.

CONTENTS

THE INFLUENCE OF SPRAYING ON ARGENTINE (IRIDOMYRMEX HUMILIS) AND NATIVE ANTS (HYMENOPTERA : FORMICIDAE)

J.D. MAJER* AND R. FLUGGE*

ABSTRACT

Experiments and observations on the ecology of the Argentine ant (*Iridomyrmex humilis*) and the effect of heptachlor spraying on this, and native ant species were performed over a 1 year period.

The aim was to:-

a) Investigate the distribution pattern of the Argentine ant and to relate this to that of sympatric native ants, and

b) To investigate the immediate effect of spraying on Argentine and native ants and to follow the subsequent recovery in ant fauna over a 1 year period.

The ant was observed colonizing large contiguous tracts of land. It exhibited a summer foraging peak but activity decreased greatly and distribution became more localised during winter. Only eight species of native ants were found in the *Iridomyrmex humilis* dominated plot which was studied (low species richness) and most ants sampled were *Iridomyrmex humilis* (low species evenness). Some native ant species in the plot occurred in gaps in the Argentine ants' distribution, others were distributed independently of this ant and *Adlerzia froggatti* was positively associated with *Iridomyrmex humilis*.

Jet spraying of 0.5% heptachlor totally eradicated *Iridomyrmex humilis* and two other species of ants in one plot. *Iridomyrmex humilis* had not returned by the final survey date, almost 1 year later. Its range had largely been replaced by the meat ant, *Iridomyrmex purpureus*. As a result of this finding, some possible methods of limiting *Iridomyrmex humilis* by replacing it with native ants are suggested.

---

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

INTRODUCTION

The Argentine ant, Iridomyrmex humilis, was first described in 1868 from specimens collected in Argentina, its probable centre of origin. It is a tramp species and has successfully established itself around the world, although it is most successful in areas between 30° and 36° latitude North or South (Fluker and Beardsley, 1970). Publications concerning the establishment of this ant have emanated from such diverse regions as Southern California, U.S.A. (Woodworth, 1980), Hawaii (Fluker and Beardsley, 1970), Bermuda (Haskins and Haskins, 1965; Crowell, 1968; Lieberburg, Kranz and Siep, 1975), South Africa (Hattingh, 1945), and Australia (Pasfield, 1968).

The first Australian record of this ant was in Victoria in 1939; by 1941 it had been reported from Albany in Western Australia (Jenkins, 1948; Anon, 1973). It soon spread to other localities such as Perth and Bunbury, as a result of colony dissemination by man's activities. Within a locality the ant showed a remarkable capacity to expand its range; a 500 square metre outbreak in Bunbury expanded to 12 hectares in less than 3 years (Anon, 1973).

The occurrence of Argentine ants is considered undesirable for a number of reasons. It tends aphids and other Homoptera for their honeydew sources and, in doing so, encourages these sap sucking insects. An additional consequence of the ants' presence is that it deters beneficial insects such as coccinellid beetles and parasitic wasps from limiting Homoptera numbers in orchards (Jenkins, 1948). Its Homoptera tending and beneficial insect deterring habits can result in the deterioration of orchard trees (Jenkins, 1948; Jenkins and Forte, 1951). The ant is also considered to be a household pest both because it swarms throughout dwellings (Jenkins, 1948) and also because it may transmit disease (Ipinza-Regla, Figueroa and Osorio, 1981).

Another concern is that because Iridomyrmex humilis displaces those species of native ants which may disperse and bury plant seeds, the normally beneficial myrmecochorous ant - seed interaction (Berg, 1975) may be disrupted. Bond and Slingsby (in press) in South Africa, have demonstrated that where Iridomyrmex humilis is present seeds are carried by ants for shorter distances than elsewhere, are no longer buried and, as a result, are often eaten by predators.

Also of potential ecological importance is the fact that Iridomyrmex humilis out-competes and displaces native ants from its territory. This has been reported in California (Erickson, 1971), Bermuda (Crowell, 1968), South Africa (Hattingh, 1945) and Australia (Forte and Greaves, 1953).

In view of the serious threat of the Argentine ant in Western Australia, a programme of control has been in force since the late-1940's. The ant was included in the schedule of the Vermin Act in 1948 and in 1949 a joint campaign to control the ant was undertaken by the Departments of Health and Agriculture. From 1954 onwards responsibility for control of this ant was shifted to the Argentine Ant Act which, although rewritten several times, continues to the present day (Anon, 1973). There has been a progression of chemicals used to control this species from arsenical baits in the first instance, through DDT, dieldrin, chlordane to the currently used chemical, heptachlor (Jenkins, 1973). Spraying is generally performed by treating the ground with a grid pattern of pesticide in such a way that ants cross the grid-lines whilst foraging and are poisoned (Forte and Greaves, 1953). In areas of dense undergrowth the entire area may be jet-sprayed since ants are less likely to cross grid-lines in a more layered habitat.

The use of chlorinated hydrocarbon pesticides to control Argentine ants has been criticized for a number of reasons. Amongst these are the documented effects of the pesticide on native ants (Forte and Greaves, 1953), other wildlife (Jenkins, 1969, 1973) and also the possibility of residues accumulating in the enviroment (Porter, 1982). This may be true for DDT, dieldrin and chlordane although heptachlor volatilizes over a relatively short period of time; 90% of residues may be lost within 3 days (Taylor, 1979).

Since the original Argentine ant research was performed in this State, a considerable body of information has accumulated on the taxonomy and ecology of native ants (see Majer and Chia, 1980). It was felt that benefit may arise from repeating some of the original Argentine ant observations in the light of this improved knowledge of the Western Australian ant fauna.

The aim of the present work is as follows:-

1) To investigate the distribution pattern of *Iridomyrmex humilis* and to relate this to that of sympatric native ants, and

2) To investigate the immediate effect of spraying on Argentine and native ants and to follow the subsequent recovery of the ant fauna over a 1 year period.

The results of the second part of this investigation may provide information which may be used in devising alternative control strategies, possibly involving native ants.

METHODS

Plot Selection and Ant Spraying

An infestation of *Iridomyrmex humilis* on Burswood Island, Perth was selected for investigation. It extended from the Swan River foreshore, where low growing native vegetation and introduced grasses were found, across a road into an area of land-fill which was solely covered with introduced grasses.

A 26 metre x 76 metre plot was marked out within the ant infestation area in order to elucidate the distribution patterns of Argentine and other ants. This plot was designated "ant distribution plot" and extended 12 metres into the native vegetation/grassland heath area and 64 metres into the landfill/grassland area (Figure 1).

It was originally anticipated that the entire ant distribution plot would be treated for Argentine ants. However, the difficult terrain and availability of labour necessitated spraying only the native vegetation/grassland on the foreshore side of the road. This area was jet-sprayed with 0.5% heptachlor in mid-February 1984 in an attempt to ensure complete eradication of Iridomyrmex humilis. The more commonly practised grid-spraying method was considered unsuitable for this area in view of the large amount of rubble and plant growth present. The location of the sprayed area in relation to the ant distribution plot is shown in (Figure 2).

The position of the sprayed area enabled two 28 metre x 12 metre sub-plots to be selected within the ant distribution plot for subsequent monitoring of post-spray changes in ant distribution. One plot was situated on the foreshore side of the road and was designated "sprayed heath plot", the other was in the grassland/land-fill area and was designated "unsprayed grassland plot". In view of the different terrain and ant fauna in these two plots, a second unsprayed plot was selected. This was also in the native vegetation/grassland area, just south of the sprayed heath plot. It was designated "unsprayed heath plot". The distribution of the three spray monitoring plots is shown in Figure 2.

Ant Sampling Techniques

The ant distribution plot was gridded out at 4 metre intervals and wire pegs were placed at each intersect. A plastic sleeve was inserted next to each wire into which a pyrex pitfall trap was placed. Pitfall traps comprised 15cm long, 1.8cm internal diameter test tubes containing a 10ml mixture of alcohol and glycerol (70/30v/v). Following a 1 week settling-in period the traps were run for 7 days from 24th - 31st January, 1983. The ants contained in the pitfall traps after these sampling periods were hand sorted and counted in the laboratory using a stereo-microscope. The ant collections were identified to species level where possible. When ant species were obtained that had not previously been described they were either coded with the Western Australian Institute of Technology (J.D.M.) code numbers or, if voucher species were deposited there, with Australian National Insect Collection (ANIC) codes.

Data obtained from the ant distribution plot were also used as the pre-spray sampling period data for the sprayed heath and unsprayed grassland plots. These two plots were resampled immediately following spraying on 17th - 24th February, 1983. The unsprayed heath plot was sampled for the first time between 10th - 17th March, 1983, so no data for the pre-spray sampling period are available for this treatment. Hereafter, all three plots were sampled simultaneously during April, August and October, 1983 and January, 1984.

Treatment of Data

The species of ants obtained from the ant distribution plot were plotted on individual 7 x 19 pitfall trap grid diagrams in order to visually assess their overall distribution patterns.

The overall ant community in this plot was described in three

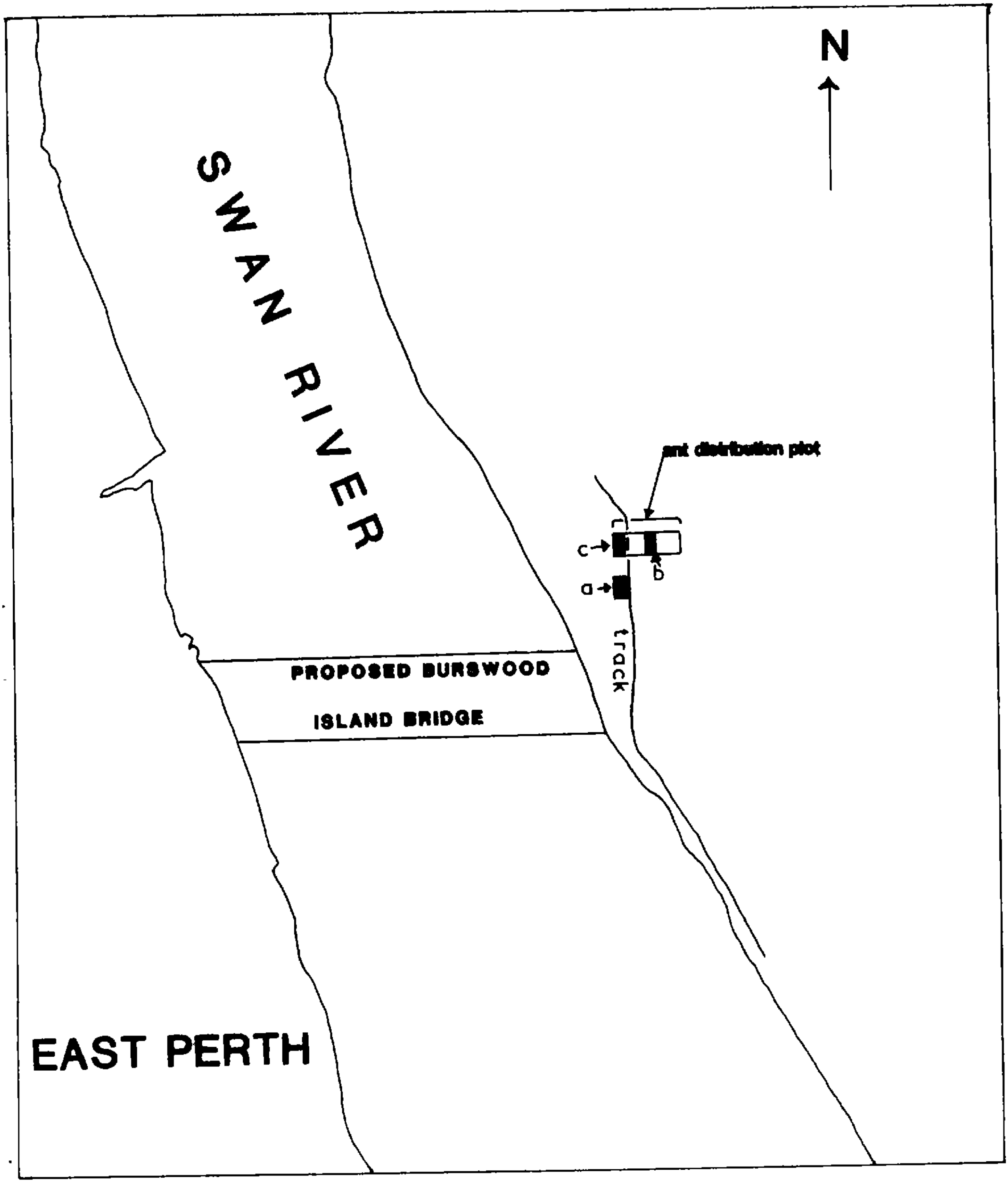

FIGURE 1
POSITION OF ANT DISTRIBUTION PLOT, UNSPRAYED HEATH PLOT (a), UNSPRAYED GRASSLAND PLOT (b) AND SPRAYED HEATH PLOT (c) IN RELATION TO SWAN RIVER AND EAST PERTH.

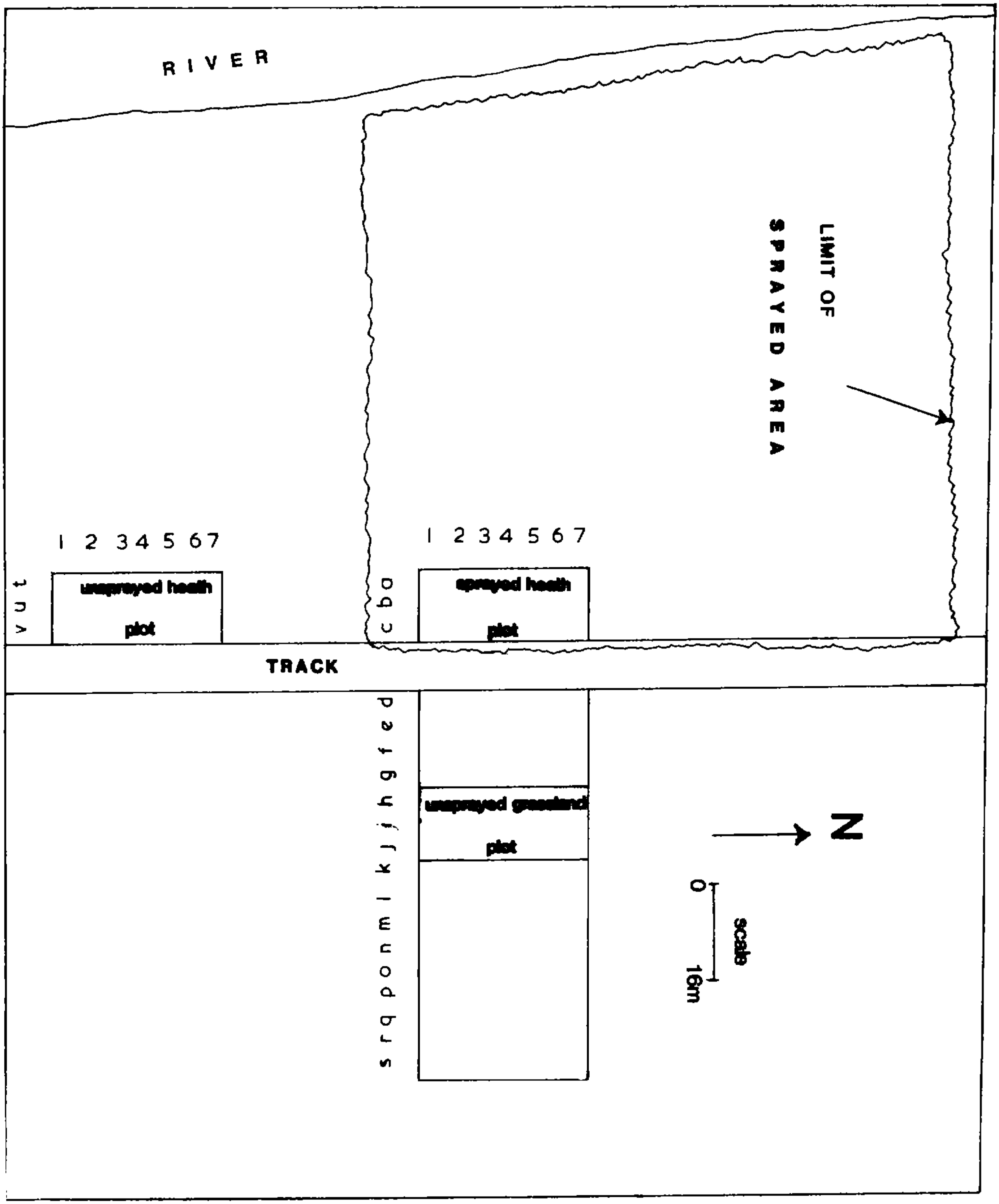

FIGURE 2
LARGER-SCALE MAP OF ANT DISTRIBUTION PLOT, UNSPRAYED HEATH PLOT, UNSPRAYED GRASSLAND PLOT AND SPRAYED HEATH PLOT SHOWING LIMIT OF HEPTACHLOR SPRAYED AREA. THE PITFALL TRAP CO-ORDINATE ROWS (a - v) AND COLUMNS (1 - 7) ARE ALSO SHOWN.

ways:-

1) Ant species richness (S) — the total species obtained in the plot.

2) Ant species diversity (H') — a measure which expresses both the number of species present and the relative numbers of each species. It was calculated by the following formula:

$$H' \text{ (decits)} = (N \log N - \sum_i n_i \log n_i) / N$$

where N is the total number of ants in the traps and ni is the number of each individual species.

3) Ant evenness index (J') — a measure of the apportionment of individuals between the various species present. It was calculated by the following formula:

$$J' = H' \text{ (decits)} / \log S.$$

The influence of Iridomyrmex humilis on the distribution of other ants present in the plot was investigated by the use of 2 x 2 chi square contingency tables. This test was only performed on the more frequently found ants. The remainder were investigated by visually comparing their distribution pattern with that of Iridomyrmex humilis.

The seasonal trends and post-spraying changes in ants in the three spray monitoring plots were investigated by plotting the following parameters against sampling time:

1) Total number of ants caught.
2) Mean number of ant species per trap.
3) Ant species richness (S).
4) Ant species evenness (J').

RESULTS

Ant Distribution Plot

Nine species of ant were obtained in the ant distribution plot. Their distribution patterns are shown in Figure 3. Iridomyrmex humilis was the most abundant species (482 ants trapped) followed by Adlerzia froggatti (317 ants), Cardiocondyla nuda (106), Iridomyrmex purpureus (45), and Monomorium sp. JDM 102 (35). Two other Iridomyrmex spp., Anisopheidole antipodum and Pheidole latigena were found in low numbers in the plot.

The plot species richness (S), diversity (H') and evenness (J') values were 9, 0.58 and 0.60 respectively.

Inspection of Figure 3 reveals the tendency of Iridomyrmex humilis to colonize wide areas; it was present in every row of the ant distribution plot. Its density was lowest in the heath part of the plot, to the west of the road, and also to the extreme east of the plot. It is perhaps noteworthy that Cardiocondyla nuda reached its highest density in the heath part of the plot (Figure 3).

The chi square test was only performed on the distribution patterns of Adlerzia froggatti, Cardiocondyla nuda and Monomorium sp. JDM 102. The test indicated that Adlerzia froggatti was positively associated with Iridomyrmex humilis (chi square = 6.41 $p < 0.05$) whilst the distribution of the other two species was independent of that of Iridomyrmex humilis.

Visual inspection of Figure 3 indicates that Anisopheidole antipodum occurred in a lacuna in the Iridomyrmex humilis distribution, while Iridomyrmex purpureus was found in areas where Iridomyrmex humilis was sparse or absent.

Spray Monitoring Plots

The January pre-spray survey of the sprayed heath and unsprayed grassland plots is shown in Figure 4. Six species were found in the former plot and five in the latter.

The February post-spray samples are shown in Figure 5 (the unsprayed heath plot was surveyed in mid-March). Comparison of ant numbers and species present in the January (Figure 4) and February (Figure 5) unsprayed grassland plot indicated that ant activity had not changed appreciably during the 1 month period. By comparison only two species of ants, Cardiocondyla nuda and Iridomyrmex humilis, remained active in the sprayed heath plot. The catch in the unsprayed heath plot (Figure 5) resembled that in the sprayed heath plot prior to spraying (Figure 4). This suggests that, despite the absence of pre-spray samples from the former plot, these two plots were well paired.

The April samples are shown in Figure 6. Ant numbers had generally decreased in all plots and this was probably associated with the cooler seasonal conditions. It is interesting to note that although Iridomyrmex humilis was not trapped in the sprayed heath plot, Iridomyrmex purpureus had extended its distribution and the hitherto absent Adlerzia froggatti was now present.

The August data are shown in Figure 7. Ant activity was at a very low level and no ants were trapped in the unsprayed heath plot. A single Iridomyrmex humilis was trapped in the sprayed heath plot and Iridomyrmex sp. 18 (ANIC) was once again present here. Ant activity had started to increase in October (Figure 8) due to the oncoming warmer conditions. No ants were active in the sprayed heath plot.

The result of the final, January 1984, survey are shown in Figure 9. Iridomyrmex humilis appeared to have been eliminated from the sprayed heath plot and Pheidole latigena and Iridomyrmex agilis were trapped in low numbers. The most striking feature of the plot was the fact that the previously restricted Iridomyrmex purpureus (Figure 4) was now present throughout the plot. The numbers and types of ants trapped in the two unsprayed plots (Figure 9) were now comparable with those found in the previous summer (Figures 4 and 5).

	1	2	3	4	5	6	7
A							
B							
C							
ROAD							
D							
E		1					
F							
G							
H							
I							
J							
K							
L							
M							
N							
O							
P							
Q							
R							
S							

Anisopheidole antipodum

	1	2	3	4	5	6	7
A	25	22	2	1	4	2	17
B	1	1			3		2
C	1	1		5	1	5	1
ROAD							
D							
E							
F							
G							
H					5		
I	3						
J							
K							
L							
M							
N							
O	1						
P		1					
Q						2	
R							
S							

Cardiocondyla nuda

	1	2	3	4	5	6	7
A							
B							
C							
ROAD							
D							
E							
F							
G	1	1		1	1		
H	1		1		3		
I							
J					1	1	
K		2					
L				14			
M							
N		1					1
O		1					
P		4					
Q					1		
R							
S							

Monomorium sp. (JDM) 102

	1	2	3	4	5	6	7
A						4	5
B							1
C							
ROAD							
D							
E	2						
F							
G							
H							
I							
J							
K							
L							
M							
N							
O							
P							
Q							
R							
S							

Pheidole latigena

	1	2	3	4	5	6	7
A							
B							
C							
ROAD							
D	9	6	3	3			
E	25	20	20	50	22	6	2
F		6	14	8	3	3	
G				1			
H	4						
I	1	2					
J	1						
K					3		
L							
M					12	9	1
N						15	1
O					2	30	13
P						8	3
Q				1		2	1
R							5
S						1	1

Adlerzia froggatti

	1	2	3	4	5	6	7
A							
B		2					
C				1	1		1
ROAD							
D							
E							
F							
G							
H							
I				1	1		
J							
K							
L							
M		1			1		
N							
O	2						
P							
Q							
R							
S							

Iridomyrmex agilis

	1	2	3	4	5	6	7
A	1	3	1		4	2	2
B		3		4	3		
C				5		2	
ROAD							
D	2	3	3	1	1		2
E	2		1	4	1	3	5
F	4	6	23		5	4	2
G	3	3	8	8	3	1	5
H	3	2	2	31	12	1	3
I	2	2	18	7	4		4
J	2	2	3	2	25	2	
K	1	2	5	5	6		1
L	3	1	2	16	2	1	3
M			2	3	20	8	3
N	4				3	2	6
O	3		8		21	9	2
P			1	1	1	3	1
Q		43		10	2	6	2
R	1		6		2		
S						1	

Iridomyrmex humilis

	1	2	3	4	5	6	7
A							1
B							
C							
ROAD							
D							
E							
F							
G							
H							
I							
J							
K							
L							
M							
N							
O							
P							
Q							
R					1	6	5
S						3	29

Iridomyrmex purpureus

	1	2	3	4	5	6	7
A							1
B							
C							
ROAD							
D							
E							
F							
G							
H							
I							
J							
K							
L							
M							
N							
O							
P							
Q							
R							
S							

Iridomyrmex sp. 18 (ANIC)

FIGURE 3

DISTRIBUTION OF ARGENTINE AND NATIVE ANTS IN PITFALL TRAPS RUN BETWEEN 24 - 31 JANUARY 1983 IN THE ANT DISTRIBUTION PLOT. NUMBERS SHOWN ARE THE QUANTITY OF ANTS IN EACH PITFALL TRAP.

Figure 10 compares the percentage composition of each ant species in the sprayed heath plot in January, 1983 with that 1 year later. It indicates a change from dominance by Cardiocondyla nuda and Iridomyrmex humilis to dominance by Iridomyrmex purpureus (the meat ant); both of the former two species were eliminated from the plot after spraying. Two other species, Iridomyrmex agilis and Pheidole latigena had maintained their restricted abundance following spraying while the less abundant Iridomyrmex sp. 18 (ANIC) was no longer present 1 year after spraying.

Figure 11 shows the plot values of total ants trapped, total species trapped (S), mean number of species per trap and ant species evenness (J') plotted against sampling time. Ant species diversity (H') is not shown here since the trends were similar to those of ant species richness.

With the exception of species evenness, all unsprayed plot variables declined in winter and returned to the higher summer values during the following summer. Ant species evenness values fluctuated throughout the year but returned to close to their initial values by January 1984 (Figure 11).

Although sprayed heath plot values were comparable with those in the unsprayed plots during January 1983, the numbers of ants trapped, the number of species trapped and the mean number of species per trap all declined to very low levels after the heath plot was sprayed. While these variables exhibited similar seasonal trends to those in unsprayed plots, they had not returned to the higher unsprayed plot values by January 1984 (Figure 11). Ant species evenness initially increased following the spraying to levels greater than those generally found in the unsprayed plots. In October 1983 and January 1984, however, the sprayed heath plot values were much lower than those in the unsprayed plots.

DISCUSSION

Ecology of Iridomyrmex humilis

While knowledge of the ecology of Iridomyrmex humilis is well documented in the northern hemisphere (Makin, 1968; 1970), published information on its ecology in Western Australia is limited to descriptive comments (Jenkins, 1948; Jenkins and Forte, 1951). The ecological information on the ant and its relationship with native ants is therefore discussed here in order to provide quantified information for this State.

The distribution of Iridomyrmex humilis in the ant distribution plot (Figure 3) indicates that it can colonize large contiguous tracts of land. This pattern is quite unlike that exhibited by most other native ants whose distribution is usually in the form of small discrete blocks, interspersed with colonies of other ant species (Briese and Macauley, 1977; Majer, unpublished data). The reason why Iridomyrmex humilis can occupy such large tracts of land is that queens establish nests adjacent to existing ones, hence expanding the existing range of the species. Workers continue to forage between nests occupied by different queens

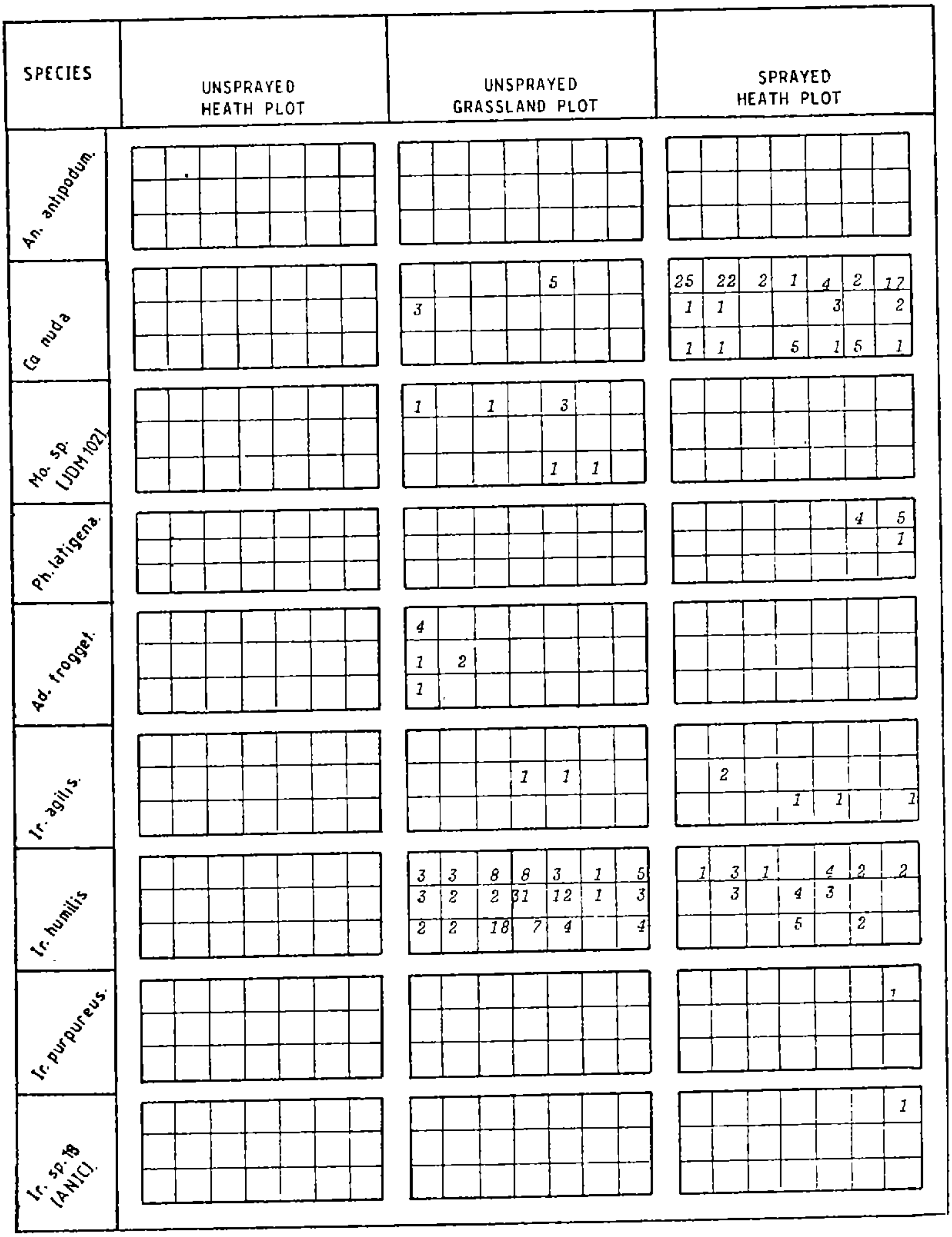

FIGURE 4

DISTRIBUTION OF ARGENTINE AND NATIVE ANTS IN THE UNSPRAYED GRASSLAND AND SPRAYED HEATH PLOT TRAPS WHICH WERE RUN FROM 24 – 31 JANUARY 1983 PRIOR TO PESTICIDE SPRAYING.

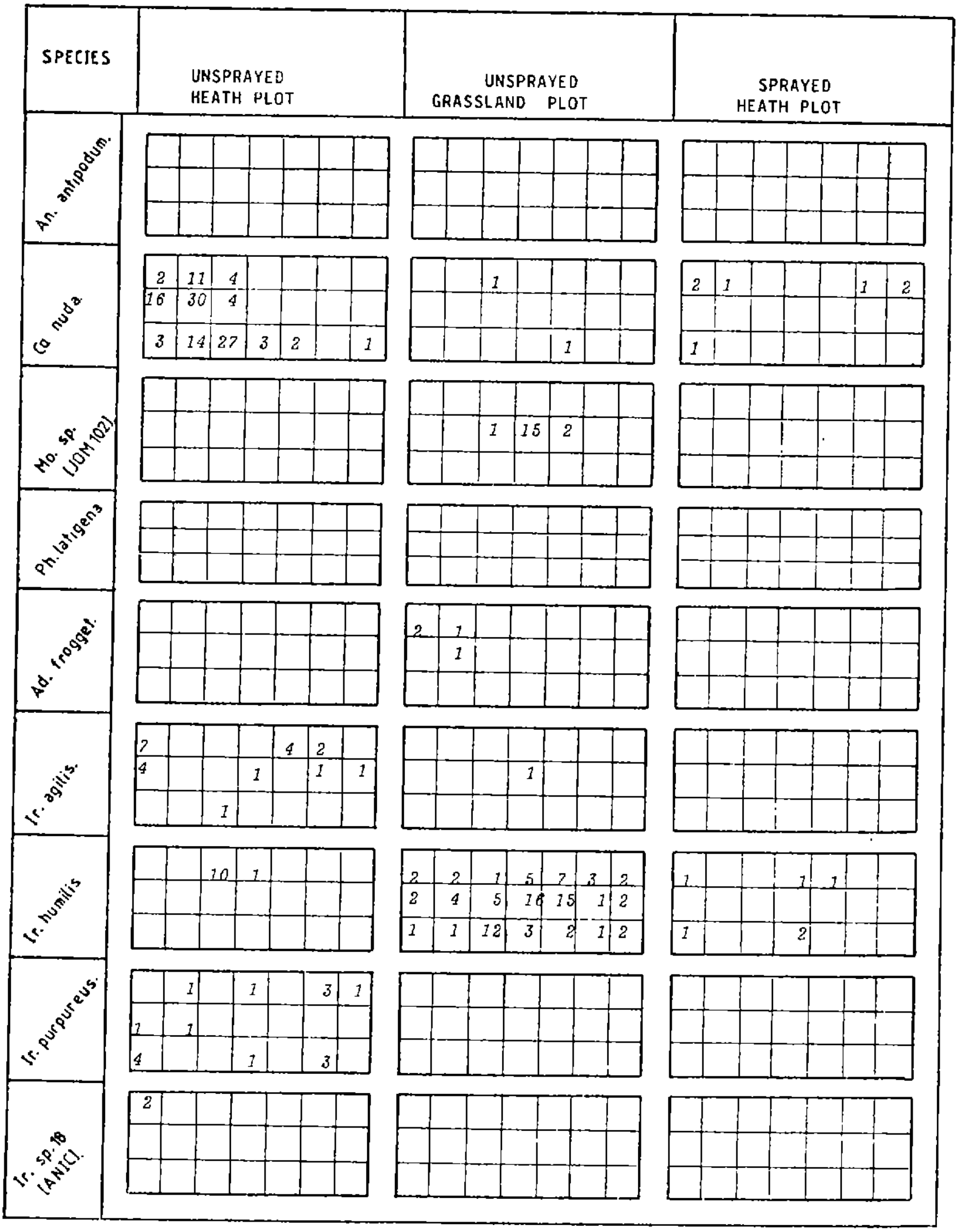

FIGURE 5

DISTRIBUTION OF ARGENTINE AND NATIVE ANTS IN THE THREE SPRAY MONITORING PLOTS. TRAPS WERE RUN FROM 17 - 24 FEBRUARY 1983 IN THE UNSPRAYED GRASSLAND AND SPRAYED HEATH PLOTS AND FROM 10 - 17 MARCH 1983 IN THE UNSPRAYED HEATH PLOT. THE SPRAYED HEATH PLOT WAS SPRAYED IN MID-FEBRUARY, PRIOR TO THIS SURVEY.

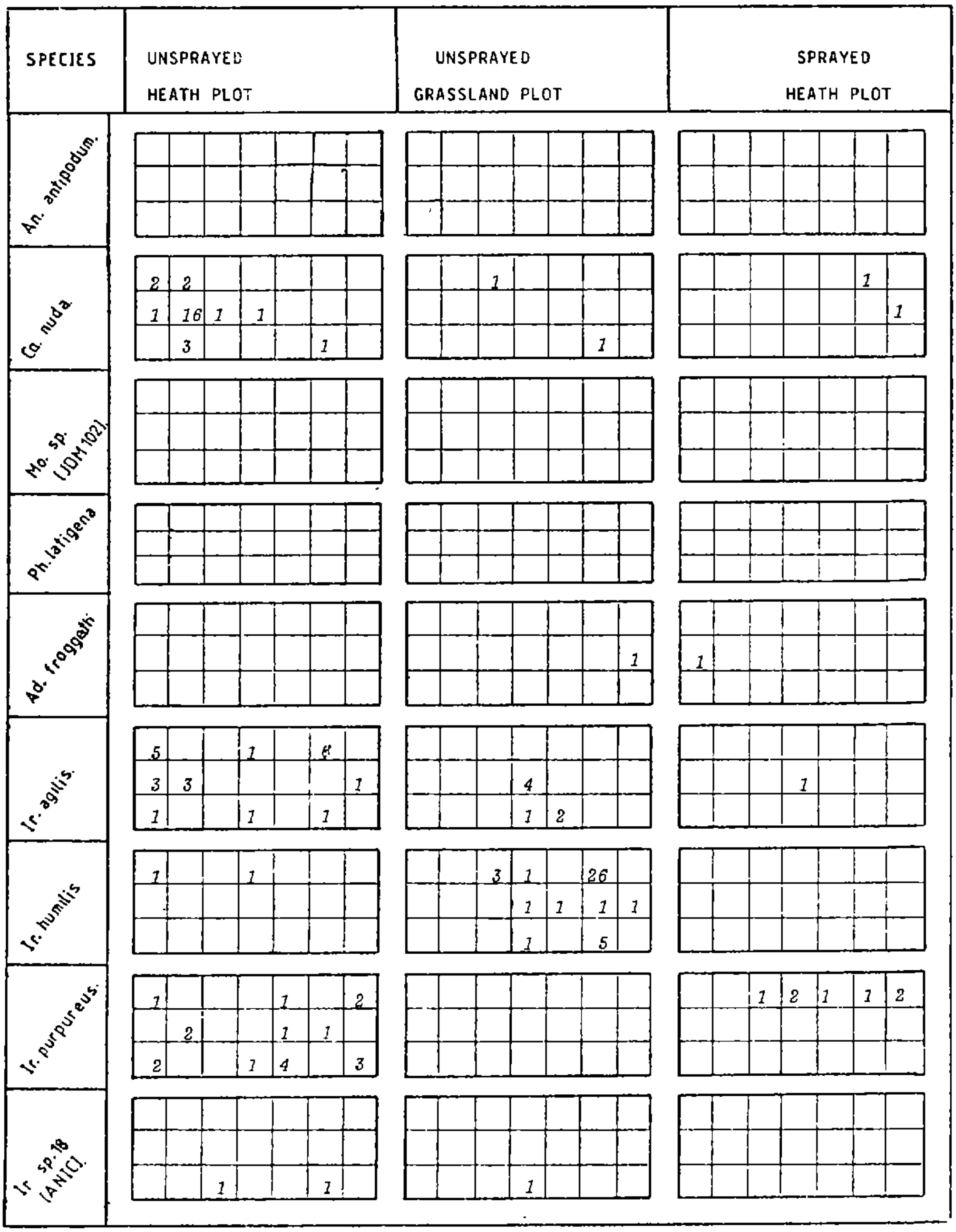

FIGURE 6

DISTRIBUTION OF ARGENTINE AND NATIVE ANTS IN THE THREE SPRAY MONITORING PLOT TRAP SETS WHICH WERE RUN FROM 13 - 20 APRIL, 1983.

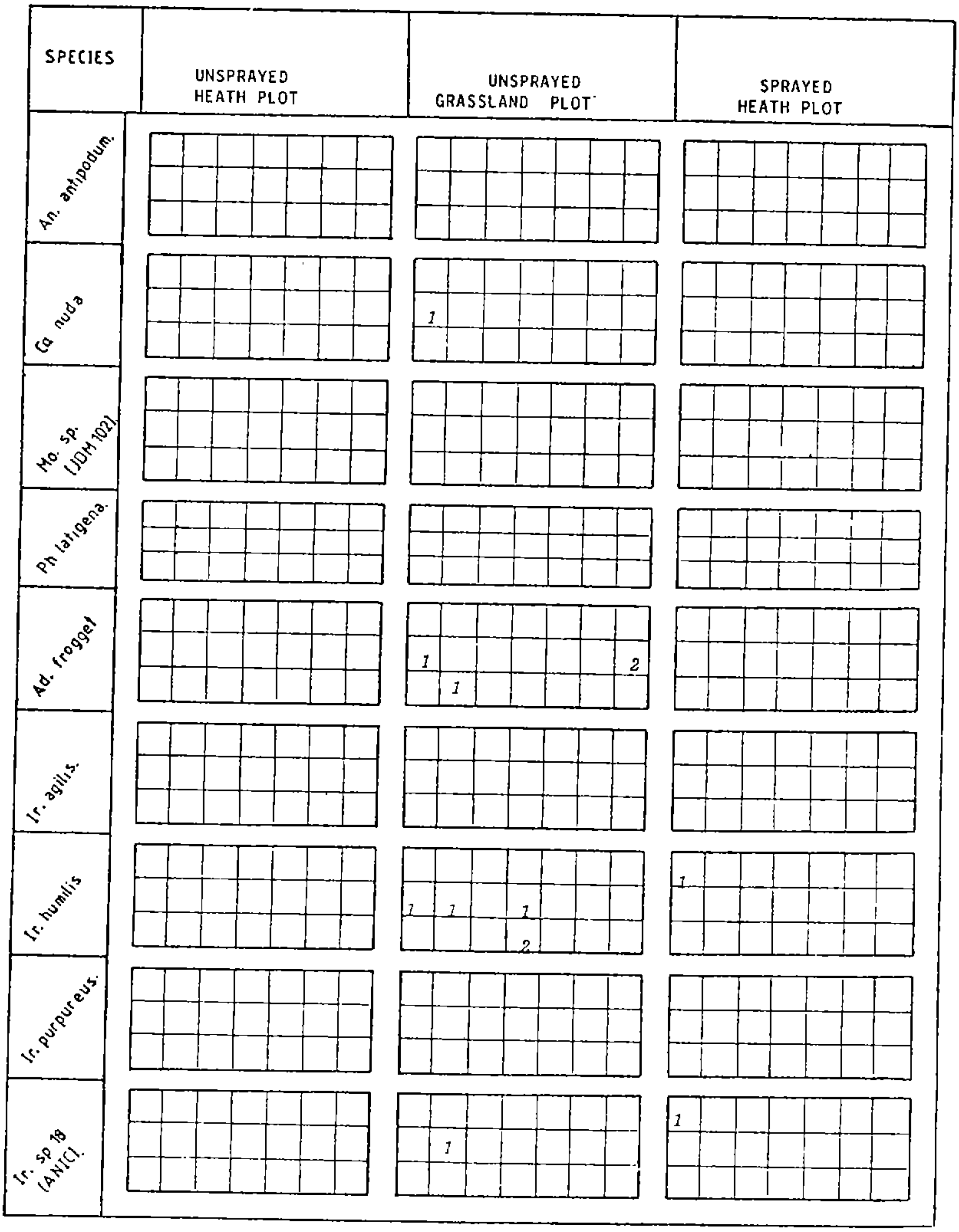

FIGURE 7

DISTRIBUTION OF ARGENTINE AND NATIVE ANTS IN THE THREE SPRAY MONITORING PLOT TRAP SETS WHICH WERE RUN FROM 19-26 AUGUST, 1983.

SPECIES	UNSPRAYED HEATH PLOT							UNSPRAYED GRASSLAND PLOT							SPRAYED HEATH PLOT						
An. antipodum.																					
Ca nuda																					
	1		1		1																
Mo. sp. (JDM 102)																					
													11								
Ph. latigena.																					
Ad. frogget																					
Ir. agilis.					1																
								1	1		1										
					1																
Ir. humilis												1	1	1							
								2						4							
											6										
Ir. purpureus.			1		1																
								1	4												
							1		7	1	2										
Ir. sp. 18 (ANIC)			1					1													
											1										

FIGURE 8

DISTRIBUTION OF ARGENTINE AND NATIVE ANTS IN THE THREE SPRAY MONITORING PLOT TRAP SETS WHICH WERE RUN FROM 13-20 OCTOBER, 1983.

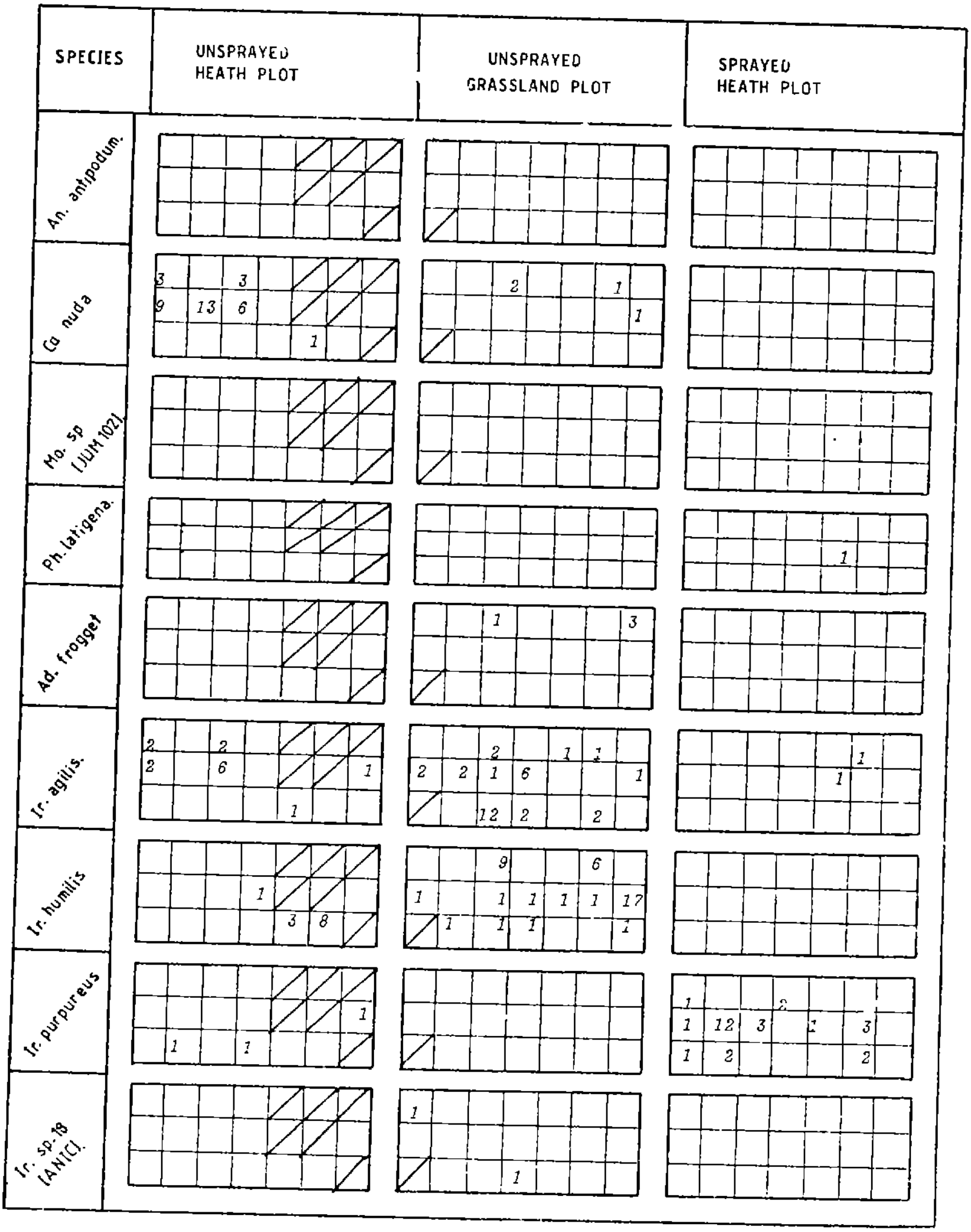

FIGURE 9

DISTRIBUTION OF ARGENTINE AND NATIVE ANTS IN THE THREE SPRAY MONITORING PLOT TRAP SETS WHICH WERE RUN FROM 15-22 JANUARY, 1984.

SQUARES WITH DIAGONAL LINE INDICATE THAT TRAPS WERE DESTROYED BY TRAMPLING.

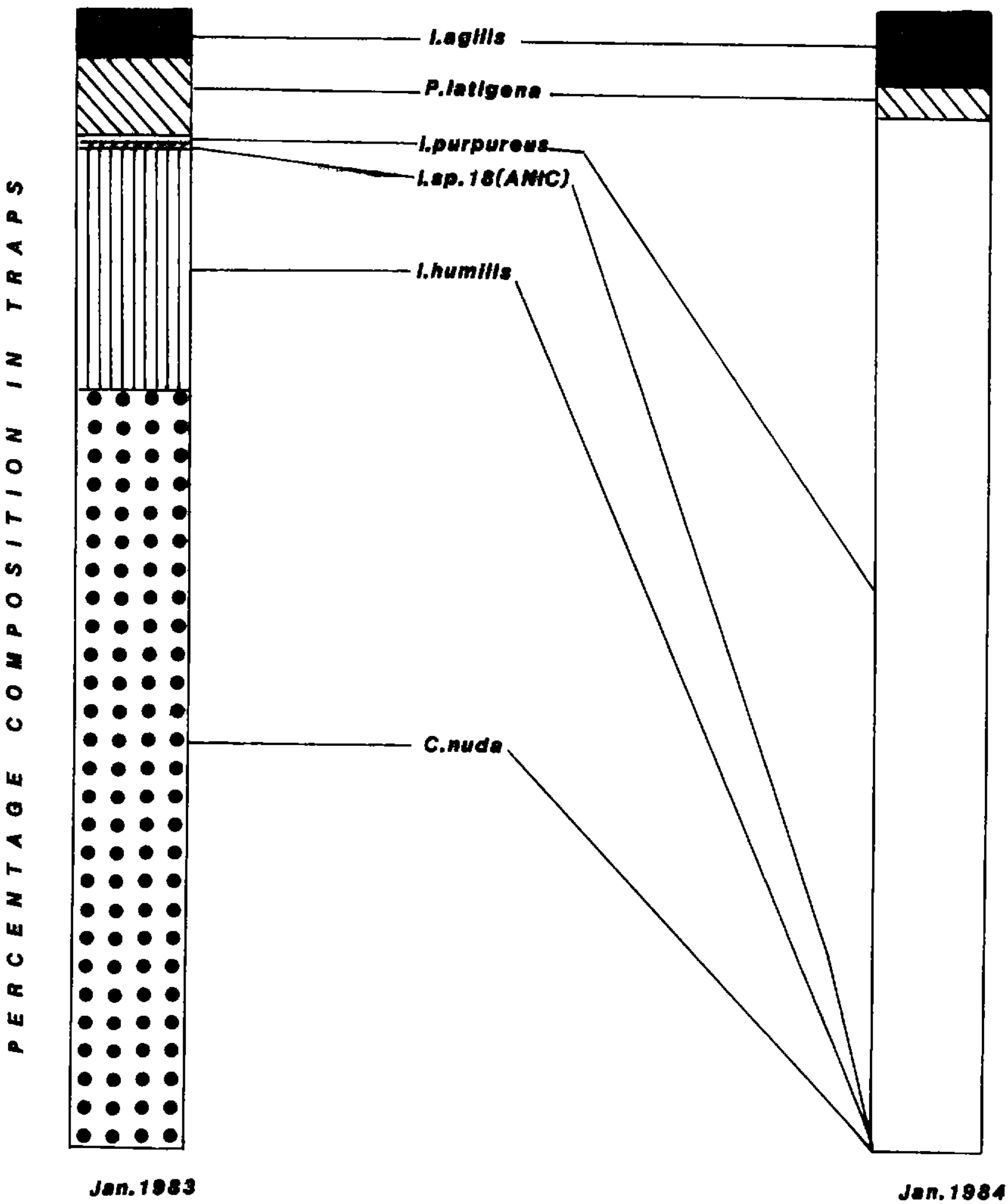

FIGURE 10
PERCENTAGE COMPOSITION OF TRAP CATCH IN THE SPRAYED HEATH PLOT IN JANUARY 1983, PRIOR TO SPRAYING, AND IN JANUARY 1984, ALMOST 1 YEAR AFTER SPRAYING.

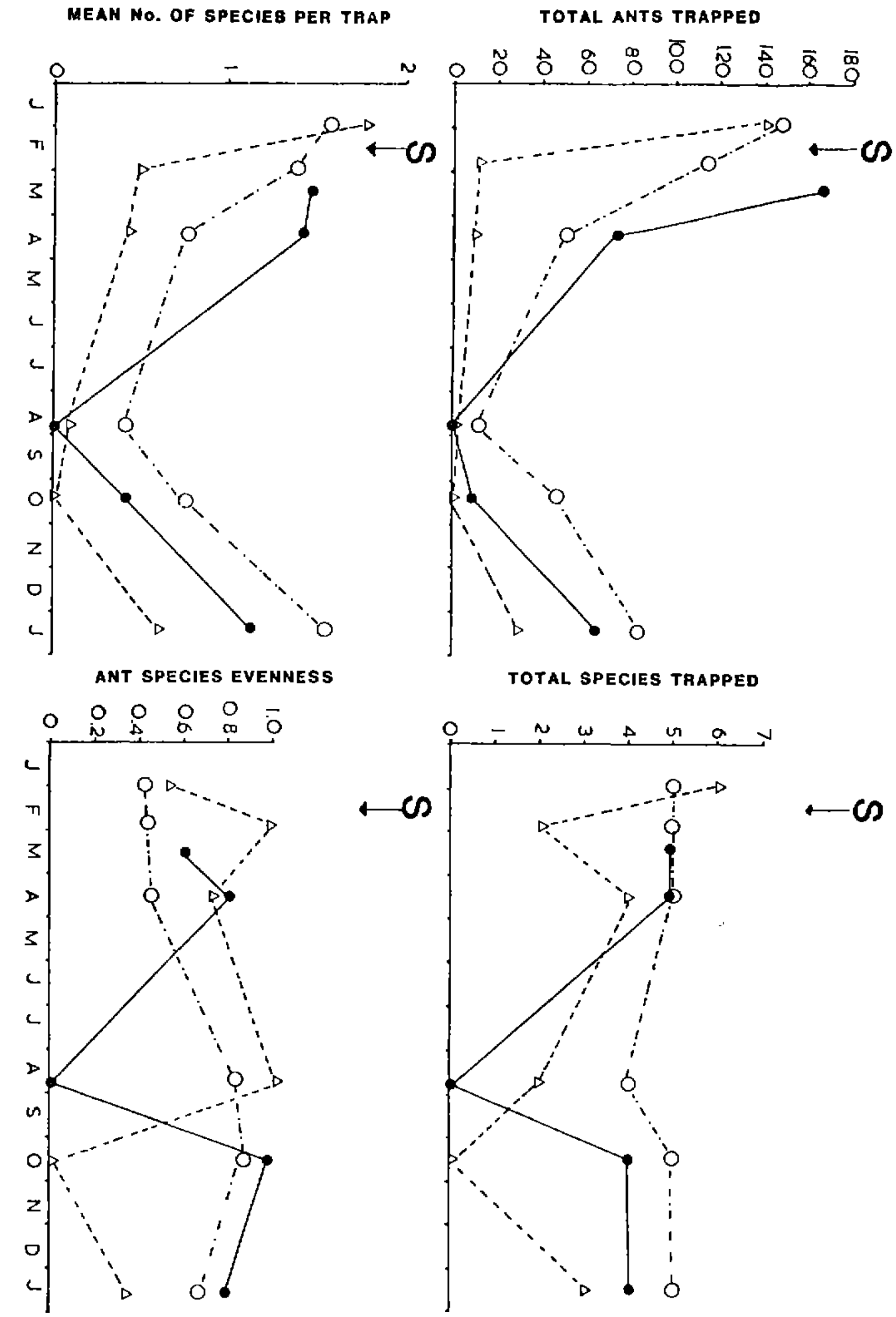

FIGURE 11

TRENDS IN TOTAL ANTS TRAPPED, TOTAL ANT SPECIES TRAPPED (S), MEAN NUMBER OF ANT SPECIES PER TRAP AND ANT SPECIES EVENNESS (J') IN THE THREE SPRAY MONITORING PLOTS. KEY: o-·-·-o UNSPRAYED GRASSLAND PLOT; ●——● UNSPRAYED HEATH PLOT; △---△ SPRAYED HEATH PLOT; S, SPRAY.

resulting in the formation of an enormous compound colony or community (Makin, 1968).

The ants' activity is influenced by temperature and humidity. It is extremely active in the summer while in winter its activity declines and it seeks dry sheltered conditions (Jenkins and Forte, 1951). The seasonal life cycle of the species has been elucidated in California by Makin (1970). There, worker production starts about mid-March and numbers increase to their highest level in October before decreasing steadily over the winter months. Haney (1984) reports that in Californian orchards, when temperatures drop to 10°C, the ants consolidate their nesting sites into two main areas, the primary nest at the base of citrus trees and the secondary nest which may be in the tree itself. In summer the ants once again expand their range.

The present data for the unsprayed grassland plot (Figures 4 - 9) confirm the summer foraging peak of Iridomyrmex humilis. During January and February 1983 high numbers were trapped, reflecting high foraging activity. Their presence in almost every pitfall trap in this plot (Figures 4 - 5) confirms the widespread nature of the ant during the summer months. The numbers trapped during the cooler months of April, August and October 1983 dropped (Figures 6 - 8) and the ant became much more localised within this plot, thus confirming the Californian observations on reduced winter numbers and distribution range. By January 1984 numbers and distribution had returned to levels similar to those observed 1 year previously.

The composition of the ant community in the ant distribution plot is most unlike that found where Iridomyrmex humilis is absent. For instance, comparable one-off pitfall trap surveys in undisturbed areas with no Argentine ants would be expected to yield well in excess of 30 species (9 in this survey) and with evenness index values of around 0.75 (0.60 in this survey) (Majer, 1983). These atypical richness and evenness values may partly be attributed to the site being highly disturbed although even in annual rye grass (Lolium rigidum) pastures at Katanning, W.A., Twigg (1982) sampled 19 species of ant. The low richness values in the ant distribution plot must therefore be attributed in part to the presence of Iridomyrmex humilis.

The displacement of native ants by Iridomyrmex humilis is clearly shown when ant distribution patterns are compared to those of Iridomyrmex humilis in the ant distribution plot (Figure 3). For instance, Anisopheidole antipodum and Iridomyrmex purpureus were only found in areas where Iridomyrmex humilis was absent or rare and many other species which are normally expected to be found in such areas (eg Rhytidoponera spp., Camponotus spp. and Melophorus spp.) were completely absent. The remaining species in the plot were presumably those which, for one reason or another, were able to tolerate the presence of Iridomyrmex humilis. No conclusive explanation may be advanced for the positive association between Iridomyrmex humilis and Adlerzia froggatti although it may be associated with their similar habitat requirements. Bond and Slingsby (in press) in South Africa have noticed a similar co-existence between Iridomyrmex humilis and Tetramorium quadrispinosum.

Although exhibiting considerable overlap in territory, Iridomyrmex humilis were trapped in lower numbers where Cardiocondyla nuda was present. The latter is also a tramp species but it is not clear how much the reduced Iridomyrmex humilis numbers were due to antagonism between species or to their differing habitat optima.

Influence of Spraying on Ants

Consideration of the heptachlor spraying trial should take account of the fact that the entire Argentine ant outbreak area was not sprayed and also that the jet-spraying rather than the grid-spraying technique was used; the method was therefore not typical of that used by the Argentine Ant Unit.

The post-spray surveys indicated that Iridomyrmex humilis was totally eradicated from the sprayed heath plot after August 1983. Spraying was accompanied by an intial reduction in the abundance of Cardiocondyla nuda, Pheidole latigena, Iridomyrmex agilis, Iridomyrmex purpureus, and Iridomyrmex sp. 18 (ANIC) (Figure 5). Iridomyrmex purpureus commenced spreading into the vacated foraging space by April 1983 (Figure 6) and occupied most of the plot by January 1984 (Figure 9). The overall change, one year after spraying, was a complete replacement of Cardiocondyla nuda Iridomyrmex humilis and Iridomyrmex sp. 18 (ANIC) by Iridomyrmex purpureus. There was no overall change in the abundance of Iridomyrmex agilis and Pheidole latigena when the pre-spray and January 1984 catches were compared (Figure 10).

Forte and Greaves (1953) have noticed similar trends following ant spraying in their plots. Iridomyrmex perthensis and Melophorus turneri perthensis increased following spraying and Iridomyrmex suchieri was eradicated. They attributed these trends to the similar habitat requirements of Iridomyrmex suchieri and Iridomyrmex humilis and the different foraging strategies of Iridomyrmex perthensis and Melophorus turneri perthensis. Similar explanations may apply here and the large size of Iridomyrmex purpureus workers may lessen their susceptibility to residual heptachlor of low concentration.

In terms of total ants trapped, total species trapped, mean number of species per trap and ant species evenness (Figure 11) the sprayed heath plot had not recovered to the pre-spray level, even after one year. The paucity of species per trap suggests that the habitat is not yet saturated with ants. It is expected that more species will colonize the sprayed heath plot or existing species will become more widespread within the plot. The important question is whether one of these species will be Iridomyrmex humilis. The current situation is very desirable since the incumbent native ant may protect the area from Iridomyrmex humilis invasion. In Bermuda, Lieberburg, Kranz and Seip (1978) have noted that Pheidole megacephala, while normally losing territory to Iridomyrmex humilis, may under certain circumstances replace the latter species. Possibly if Iridomyrmex humilis colonies could be weakened by pesticide spraying (Jenkins, 1973), pesticide baiting (Makin, O'Neal and Collins, 1974), by insect growth regulators (Edwards, 1982) or by pheromone disruption, this species could be replaced by native ants which may be able to hold territory against subsequent reinvasion.

ACKNOWLEDGEMENTS

We wish to thank the Department of Agriculture's Argentine Ant Unit for assisting us in plot selection and also for carrying out the experimental spray treatment. Mr Keith Brown carried out some of the initial field work and ant sorting. The project was partially funded by the W.A.I.T. Environmental Studies Group. We thank Julie Agars for typing the manuscript.

REFERENÇES

Anon (1973) - Ant pests in Western Australia. W.A. Department of Agriculture Bulletin, 3114, 7pp.

Berg, R.Y. (1975) - Myrmecochorous plants in Australia and their dispersal by ants. Australian Journal of Botany, 23, 475 - 508.

Bond, W. & Slingsby, P. (in press) - Collapse of an ant-plant mutualism - the Argentine ant, Iridomyrmex humilis, and myrmecochorous Proteaceae. Ecology.

Briese, D.T. & Macauley, B.J. (1977) - Physical structure of an ant community in semi-arid Australia. Australian Journal of Ecology, 2, 107 - 120.

Crowell, K.L. (1968) - Rates of competitive exclusion by the Argentine ant in Bermuda. Ecology, 49, 551 - 555.

Edwards, J.P. (1982) - Control of Monomorium pharaonis (L) with Methoprene baits: implications for the control of other ant species. In, (M.D. Breed, C.D. Michener and H.E. Evans eds.) The Biology of Social Insects. Colorado, Westview Press.

Erickson, J.M. (1971) - The displacement of native ants by the introduced Argentine ant Iridomyrmex humilis Mayr. Psyche, 78, 257 - 266.

Fluker, S.S. & Beardsley, J.W. (1970) - Sympatric associations of three ants: Iridomyrmex humilis, Pheidole megacephala and Anoplolepis longipes in Hawaii. Annals of the Entomological Society of America, 63, 1290 - 1296.

Forte, P.M. & Greaves, T. (1953) - New insecticides for the control of the Argentine ant in Western Australia. Journal of Agriculture of Western Australia, 2, 267 - 280.

Haskins, C.P. & Haskins, E.F. (1965) - Pheidole megacephala and Iridomyrmex humilis in Bermuda, equilibrium or slow replacement? Ecology, 46, 736 - 740.

Hattingh, C.C. (1945) - Argentine ant versus indigenous ants. Journal of the Entomological Society of South Africa, 8, 25 - 34.

Ipinza - Regla, J., Figueroa, G. & Osorio, J. (1981) - Iridomyrmex humilis "Hormiga Argentina" como vector de infecciones intrahospitalarias .1., Estudio bacteriologico. Folio Entomologica Mexicana, 50, 81 - 96.

Jenkins, C.F.H. (1948) - The Argentine ant (Iridomyrmex humilis Mayr) Journal of the Department of Agriculture of W.A., 25, 245 - 258.

Jenkins, C.F.H. (1969) - The effect of pesticides on beneficial forms of life. Western Australian Yearbook No. 8, 90.

Jenkins, C.F.H. (1973) - Chemicals for Argentine ant control.

Journal of Agriculture of Western Australia, 14, 195 - 196.

Jenkins, C.F.H. & Forte, P.N. (1951) - The Argentine ant in Western Australia. Journal of the Department of Agriculture of Western Australia, 28, 324 - 335.

Lieberburg, I., Kranz, P.M. & Seip, A. (1975) - Bermudan ants revisited; the status and interaction of Pheidole megacephala and Iridomyrmex humilis. Ecology, 56, 473 - 478.

Majer, J.D. (1983) - Ants; bioindicators of minesite rehabilitation, land use, and land conservation Environmental Management, 7, 375 - 383.

Majer, J.D. & Chia, J. (1980) - An inventory of information of terrestrial invertebrates occurring in Western Australia. W.A.I.T Department of Biology Bulletin 1, 211 pp.

Markin, G.P. (1968) - Nest relationship of the Argentine ant, Iridomyrmex humilis (Hymenoptera; Formicidae). Journal of the Kansas Entomological Society, 41, 511 - 516.

Markin, G.P. (1970) - The seasonal life cycle of the Argentine ant, Iridomyrmex humilis (Hymenoptera; Formicidae), in Southern California. Annals of the Entomological Society of America, 63, 1238 - 1242.

Markin, G.P., O'Neal, J. & Collins, H.L. (1974) - Effects of Mirex on the general ant fauna of a treated area in Louisiana. Environmental Entomology, 3, 895 - 898.

Pasfield, G. (1968) - Argentine ants. Australian Natural History 16, 12 - 15.

Porter, B. (1982) - Heptachlor and Argentine ant control. Department of Conservation and Environment Bulletin, 112, 22 pp.

Taylor, A.W. (1979) - Volatilization and pesticide disappearance. In, (W.R. Bontoyan ed.) CIPAC Proceedings Symposium Papers Series, 1, 256 - 263.

Twigg, L.E. (1982) - The influence of seed harvesting ants in annual rye grass pastures and their possible effects on the epidemiology of rye grass toxicity. W.A.I.T. School of Biology Bulletin, 5, 27 pp.

Woodworth, C.W. (1908) - The Argentine ant in California. University of California Agricultural Research Station Circular, 38, 11 pp.