Lasiorhinus latifrons

A *Myoporum-Stipa* Community Grazed by wombats - with particular reference to Herbage Production

by

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DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University. To the best of my knowledge no material is contained herein previously published or written by any other person, except where due reference is made in the text.

Peter Lehmann

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This project could not have been successfully completed without the assistance readily given by many people -

- the considerable financial support given by the Brookfield Zoological Society, Chicago, USA, was instrumental in obtaining some of the necessary materials for the project, and making of many visits to the Reserve possible.
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SUMMARY

Studies are reported of wombat grazed vegetation of the Brookfield Zoological Society Reserve near Blanchetown, South Australia where wombats occurred naturally, persisted throughout a history of livestock grazing and other disturbances attributed to man, and are now protected.

Study aims were to analyse and describe the vegetation of the Reserve, to investigate its growth dynamics in areas where wombat grazing was pronounced, and to demonstrate the nature and impress of such grazing.

The vegetation of the whole 65 Km^2 Reserve was sampled closely for the distribution of all taxa in the higher-plant flora and the data were analysed to reveal community structure using a computer method for association analysis. A very highly significant pattern was revealed which, on analysis, showed that the visually similar vegetation consisted of five subtle but distinct community types intermingled. Their distributions did not correlate directly with natural habitat variables such as topography and soils. It was concluded that the Reserve vegetation was in a state of gross, complicated and probably unstable disclimax following timber cutting, sheep grazing and other historical disturbances of which there was insufficient documentation to unravel individual influences.

Over the period February 1972 - April 1974, the short-term ongoing changes in vegetation about selected active warrens were followed in detail with particular attention to fluctuations in the above-ground biomass of all the main plant species in the herbage stratum. These data were related to concurrent information about likely driving variables such as rainfall, soil moisture and other climatic effects such as season. The general circumstances of herbage growth dynamics was thus revealed.

Special arrangements were made separately to reveal the impress of wombat grazing upon this background picture of herbage dynamics. These involved comparative observations at different distances from the active warrens, and a system of shifting exclosures which permitted cross-fence comparisons aimed at demonstrating wombat grazing effects, month by month.

Main conclusions are as follows: Wombat grazing effects upon Reserve vegetation during the study were slight and the animals were unobtrusive, except for pronounced effects close to their warrens. Since abundant grass between warrens was untouched, there was no evidence that the quantity of food supply was limiting the wombat populations. From the evidence of the exclosures, the wombats apparently ate only grass, mainly *Stipa nitida*.

Their grazing impress was expressed both by depletion of the quantity of herbage near warrens and by an influence on grass regrowth. Grazed *Stipa* butts reacted more slowly than ungrazed in the production of new foliage, so that a gradient in *Stipa* vitality away from the warren was generated.

The growth of *Stipa* 1972-1974 showed a distinctive seasonal pattern modified by strong episodic influences. The reaction of *Stipa* to rainfall varied depending on time of year. Rainfall in June-July was not essential for stimulating a growth episode, but September rains enhanced growth. Later rain tended to have little effect and *Stipa* tended to mature and die off by the following February regardless of rainfall.

Observations on a variety of lesser issues connected with the study also are reported in this thesis.

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APPENDICES

CHAPTER 1

INTRODUCTION AND DESCRIPTION OF THE BLANCHETOWN AREA

This chapter consists of the following :

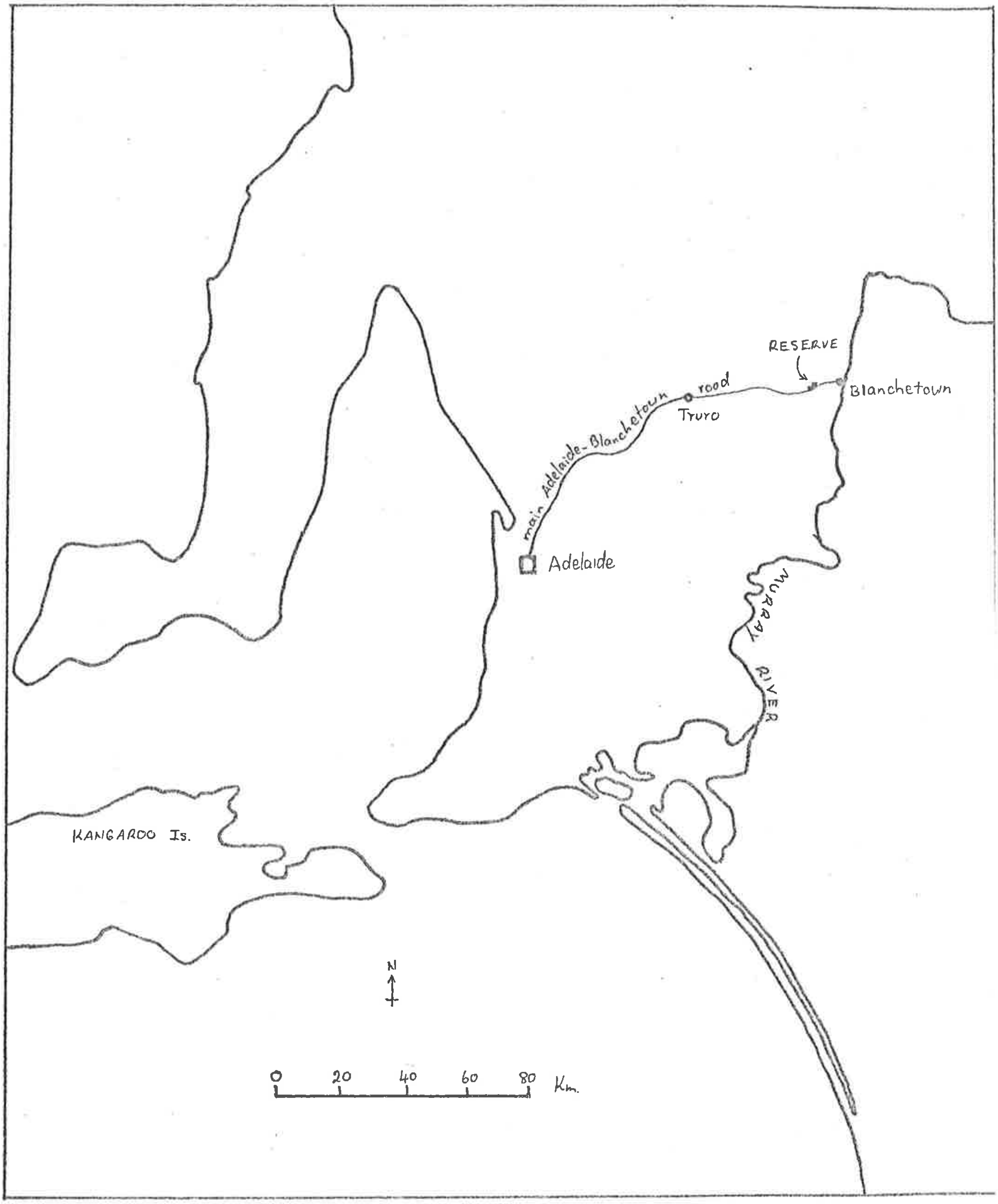
1. A brief recent history of the purchase of and intentions for the Brookfield Zoological Society's Wombat Reserve near Blanchetown in South Australia.
2. (a) How the decision for the topic of this thesis came about.
   (b) Outline of the aims of this study.
3. A series of photographs to enable the reader to better appreciate the methods used, and data obtained in this study.
4. The physical context of the Reserve, including
   (a) the need for a base map
   (b) the landform
   (c) a brief description of the Geology of the area
   (d) a brief description of the climate of the area with special reference to rainfall data collected in the Reserve over a period of time
   (e) a brief description of the broadscale vegetation classification of the region in which the Reserve occurs.

1. LOCATION AND HISTORY OF THE BROOKFIELD ZOOLOGICAL SOCIETY'S WOMBAT RESERVE.

The existence of the Brookfield Zoological Society's Wombat Reserve near Blanchetown in South Australia was brought to my attention in 1972. The Reserve was purchased at the instigation of the Curator of the Brookfield Zoo in Chicago, U.S.A., Dr. Peter Crowcroft, the recent Curator of Adelaide Museum. The property, occupying 65 sq. km., was originally developed as a sheep-grazing farm situated 11 km. west of Blanchetown. Map 1.1 indicates the position of the Reserve

MAP 1·1

Portion of South Australia showing the location of the study area with respect to Adelaide and Blanchetown.



with respect to Blanchetown and Adelaide.

The land had been extensively cleared prior to the mid 1950's to allow for an increase in the area of grassland, and timber cutters had removed all but a few small stands of larger Eucalypt trees. As a consequence the mallee is now in the main regenerated growth. Two large coke pits have been left as reminders of earlier times. A number of scars occur along the southern boundary where limestone was quarried during the construction of the Truro-Blanchetown road.

The property was obtained for the purpose of investigating the hairy-nosed wombat (*Lasiorhinus latifrons*, an endangered species), and developing a management programme to ensure its continued existence in the face of man's encroachment in the area. When the sheep were removed competition for food was greatly reduced and the wombats again had a chance to survive.

A local committee of management was anxious to foster research activity on the Reserve. Dr. Crowcroft was in Adelaide at that time, and Mr. R. Wells (now Dr. R. Wells) of Zoology Department, University of Adelaide, was actively researching some behavioural and physiological facets on the site.

2. RESEARCH PROGRAMME

Dr. R.T. Lange of Botany Department, University of Adelaide, had for some time been involved in studies of arid and semi-arid pasture, and had some interest in the vegetation of the locality. It was suggested that I might undertake a study of the flora of the Reserve and in particular pay attention to the herbaceous strata which presumably was the food source for these wombats, and if possible find out something about the vegetation dynamics and grazing interactions generally.

As the basis of an external Master of Science programme, the situation offered substantial challenges and posed some novel and interesting situations. The challenges were obvious enough - the Reserve is fairly remote from Adelaide, and field work would have to be accomplished in small concerted field trips. At the same time I was beginning my career as a secondary school teacher, and had to cope with developing family commitments. But on the other hand, the property was partly at least a reclaimed farm, and offered an opportunity for a first detailed study of disclimax vegetations.

A lot has already been established about the hairy-nosed wombat from studies by landowners and interested naturalists, but much of the data is subjective and anecdotal. Research by R.Wells (1973) showed that the wombat maintains a stable thermal environment by emerging at night when temperatures are lower and water loss is diminished. Wombats can tolerate hypothermia and have a low metabolic rate and water turnover compared with other mammals of similar size. Egesta water loss is low, and urine is relatively concentrated. By spending the hottest part of the day in the confines of a high humidity, low temperature warren respiratory water loss can be reduced.

"In summary, a low oxygen consumption, low thermal conductance, basking behaviour, limited and variable periods of above-ground activity and a relatively labile body temperature are all consistent with energy frugality."

There was,then, the gap concerning the vegetation dynamics of the wombat-inhabited areas to be filled. With this in mind I set about with the following aims :-

(a) To regularly measure quantitatively the changes in the vegetation around wombat warrens over a period of time
  (i) according to the different taxa
  (ii) at different distances from the warren
  (iii) exposed to wombat grazing, and protected from it.

(b) To establish the importance of the data obtained in the light of various active agents, namely
  (i) rainfalls
  (ii) soil moistures and depths
  (iii) time of year
  (iv) wombat activity, egesta and influences of other fauna.

(c) To survey the Reserve and develop a picture of the vegetation pattern by
  (i) collecting an herbarium
  (ii) investigating species interactions
  (iii) producing community maps.

3. APPEARANCE

One can better appreciate the present study by actually seeing the area. For this reason I have carefully selected a series of colour photographs that show the range of vegetation types that typify the Blanchetown area.

Plate 1.1 shows a *Myoporum-Stipa* plain.

Plate 1.2 shows a mallee-grassland (*Eucalyptus-Stipa*) area. Note the exposed limestone and many small rocks. The soil overlying the limestone is very shallow throughout.

Plate 1.3 mallee-bluebush-saltbush (*Eucalyptus-Maireana-*

Plate 1.1 <u>Myoporum - Stipa</u> plain.

Plate 1.2 Mallee grassland (<u>Eucalyptus - Stipa</u>)

Plate 1.3 Mallee - bluebush - saltbush community.

Plate 1.4 Bluebush (Maireana) community.

Atriplex) region.

Plate 1.4 bluebush grassland (*Maireana-Stipa*) with the occasional bullock bush (*Heterodendron*) and sandalwood (*Myoporum*).

Plate 1.5 *Geijera-Melaleuca-Eucalyptus-Lycium-Stipa* interaction.

4. PHYSICAL CONTEXT OF THE RESERVE

(a) Base map

A base map is essential for a detailed survey of such a region. It is necessary in the compilation of data and in the illustration of that data. An air-photograph, taken in 1971 for the Department of Lands, was an invaluable aid in the production of the base map, and in recognising different flora species. Plate 1.6 is a photograph of the Reserve.

The base map (Map 1.2) consisted of the position of the property boundaries being marked on a square grid reference system in keeping with Army Survey Maps on the area. Major tracks are also marked.

(b) Landform

A second map (Map 1.3) was produced from analysis of stereo-airphotographs, and shows contours marked at 25 ft. (8 metre) intervals. Altitude is in feet above sea level. It is interesting to note that the land slopes generally away from the River Murray and not towards it, i.e. from east to west. A dam near the homestead collects run off from a small occasional stream that flows in a north-westerly direction from the road. In the northern part of the property a ridge runs north-south. It drops a vertical distance of over 25 ft. rather steeply to the west. Plate 1.7

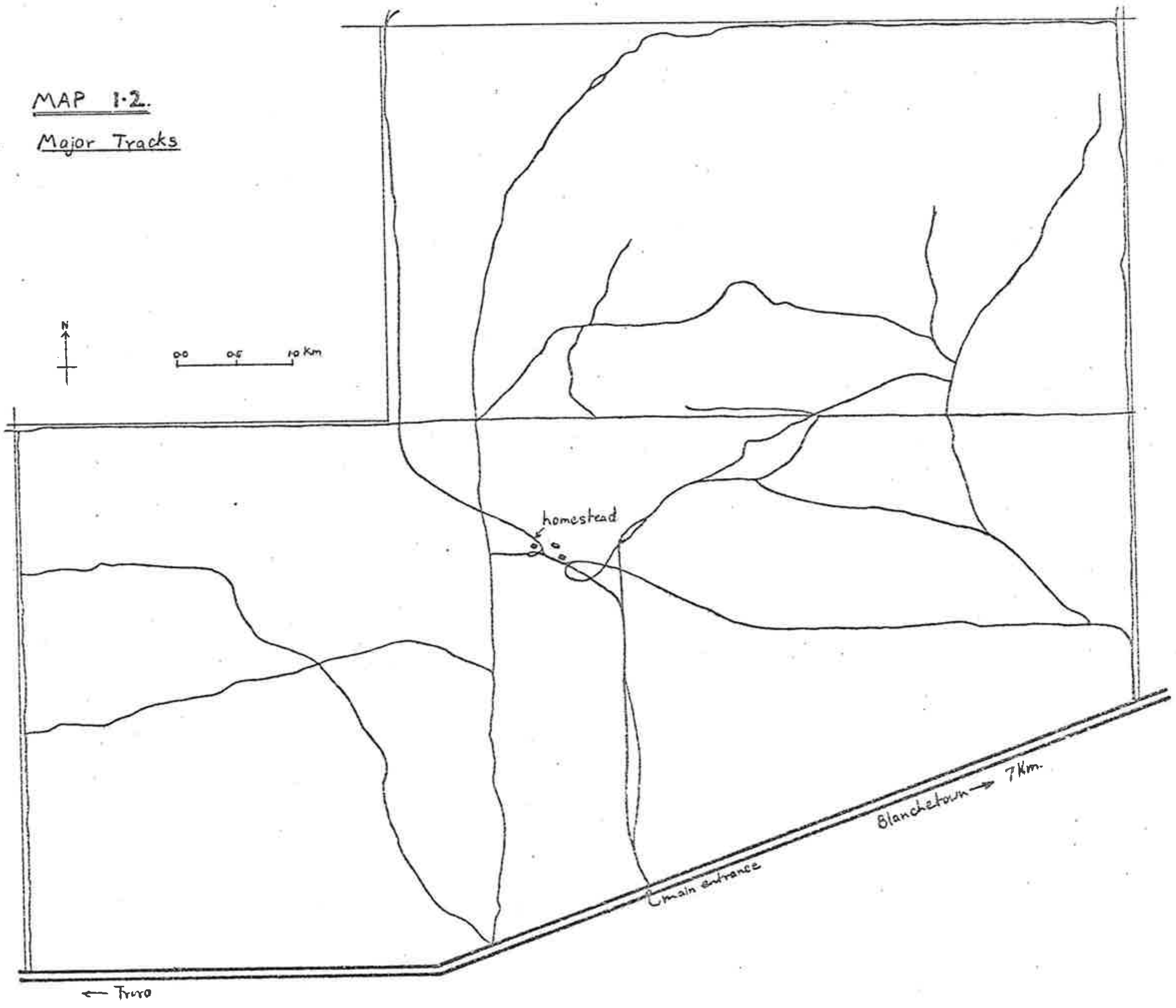
Plate 1·5 Shrub grassland.

Plate 1.6 Aerial photograph of Reserve, 1968.

Plate 1.7 Spinifex on sandy slope of ridge.

MAP 1·2.

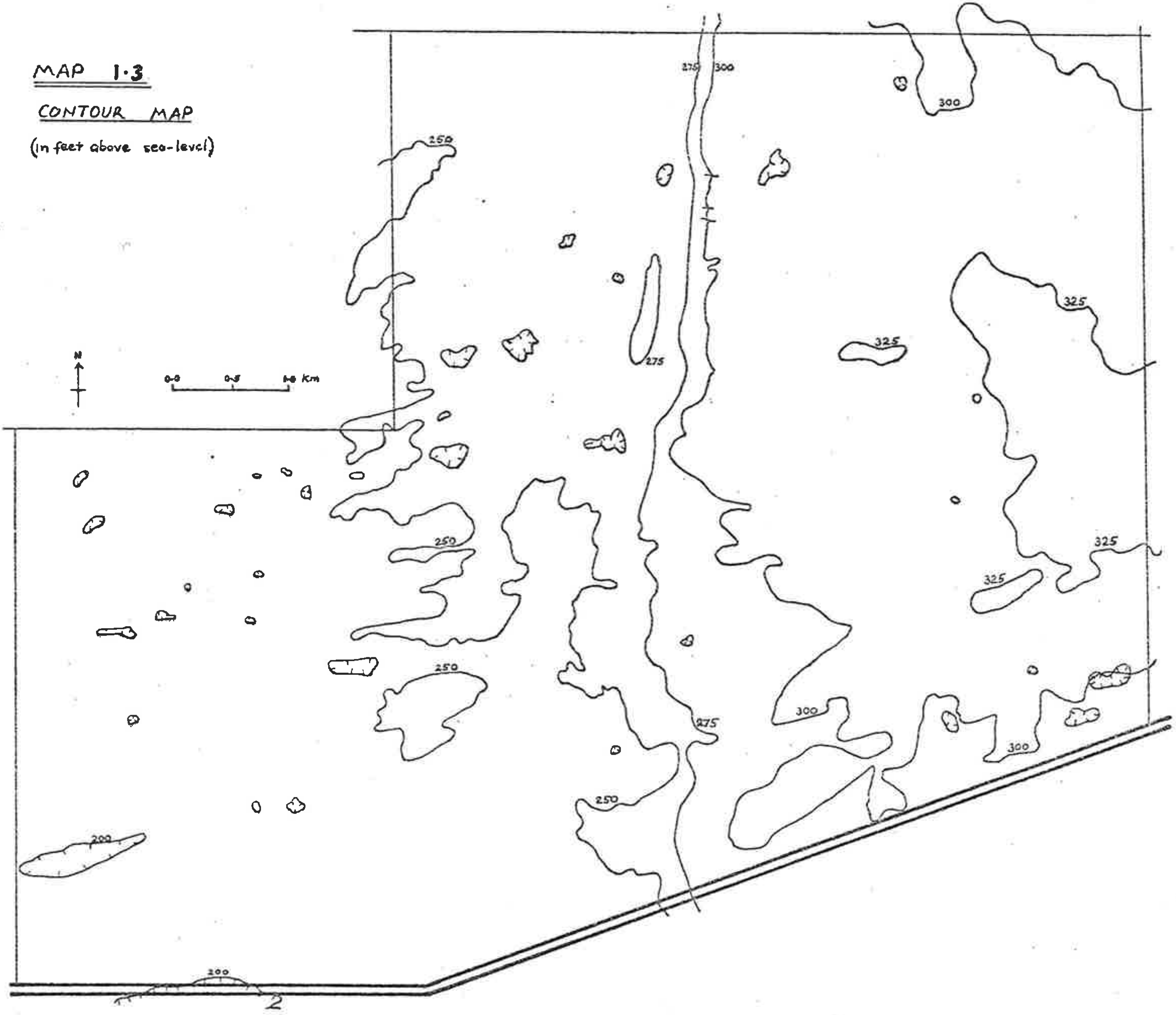
Major Tracks



MAP 1·3

CONTOUR MAP

(in feet above sea-level)



shows part of this western slope. Note the sandy soil and spinifex (*Triodia*) that occurs for a short distance south along the slope, and nowhere else in the Reserve

(c) Geology

The geology of the area was described generally by Jessup, R.W. (1948), as "mallee plains ..... composed of level-bedded Tertiary limestones, overlain by shallow brown solonized soils. .... They are usually sandy loams averaging a depth of about 6 inches (15 cm.), and overlaying a layer containing abundant nodular limestone and a small amount of hardpan. Beneath this layer is a zone containing much friable lime and clay." There are also a large number of small limestone depressions which have a high clay content.

(d) Climate

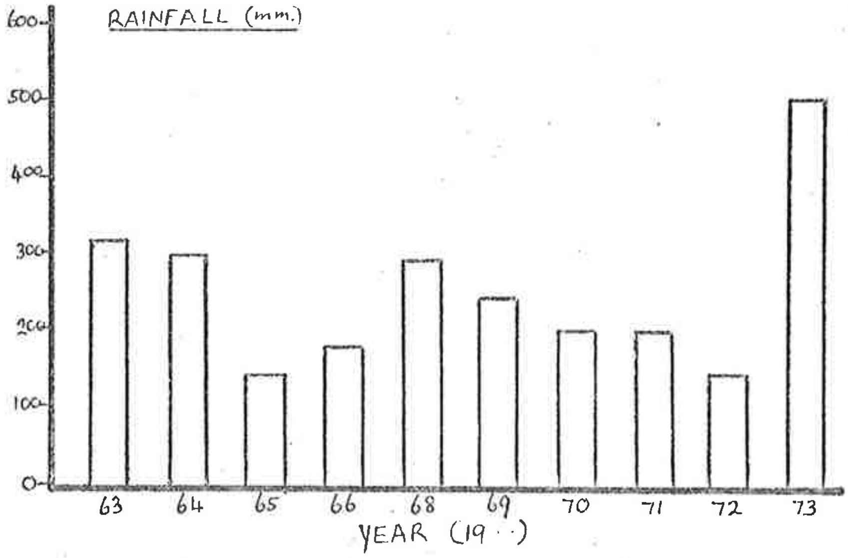
While the area has a typical Mediterranean climate with rainy winters and dry summers, summer rains also occur. Jessup (1948) associates summer rains with thunderstorms and air masses from tropical regions. "A characteristic of much of the rain associated with summer thunderstorms ..... is the scattered nature and sharply defined limits of the showers."

Rainfall data were obtained at the Reserve during the period from 1963 to 1973 inclusive (except for 1967). These data appear in Appendix 1.1 and are summarised in Table 1.1 Yearly rainfall totals and the distribution patterns (in terms of days when rain occurred) are shown in Graphs 1.1 and 1.2 respectively. The picture is one of great variation from year to year, making the average of 258 mm. over

YEAR	RAINFALL (mm.)	NO. OF DAYS RAIN FELL
1963	320	41
1964	308	23
1965	145	12
1966	185	21
1968	299	23
1969	252	51
1970	207	58
1971	206	71
1972	149	50
1973	514	72
AVE.	258	42

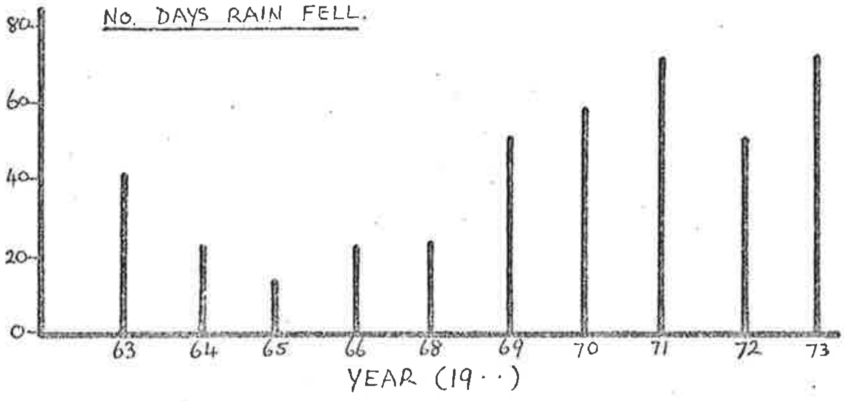
TABLE 1·1.

Rainfall recorded at the Reserve from 1963 – 1973.



GRAPH 1·1

Rainfall Distribution at the Reserve, 1963–1973 (m.m.)



GRAPH 1·2

Pattern of number of days on which rain fell at the Reserve, 1963-1973.

the 10 year period almost meaningless. Similarly the distribution is quite irregular in terms of timing during the year (see Appendix 1.1) and also in the number of days on which rain occurred (namely from 12 in 1965 to 72 days in 1973), giving another almost meaningless average of 42 days.

Temperature data for any length of time do not exist at the Reserve. However, the Bureau of Meteorology at Adelaide was able to supply the average maximum and minimum daily temperatures per month for Nildottie. This is a small township further south, but having very similar conditions as at Blanchetown. The data, (shown in Table 1.2) was obtained from a broken record from 1965-1971. A linear regression with the records of Tailem Bend provided an estimate of the remainder. Graph 1.3 shows the typically hot summers and cold winters, with monthly maximum temperatures ranging from 15.3°C to 31.5°C, and monthly minimum temperatures ranging from 14.2°C to 17.4°C. The generally cloudless nights allow rapid radiation of heat, and temperatures often drop below condensation point. Dew often occurs in the early hours of the morning and rapidly disappears after sunrise.

(e) Vegetation

The vegetation is similarly described as a *Myoporum platycarpum-Kochia sedifolia* association in the south-east, bordering a *Eucalyptus oleosa-Eucalyptus gracilis* association in the north. This is generally described as a mallee scrub-shrub steppe. Jessup found that the two Eucalypts occur as codominants, although where limestone is near the surface,

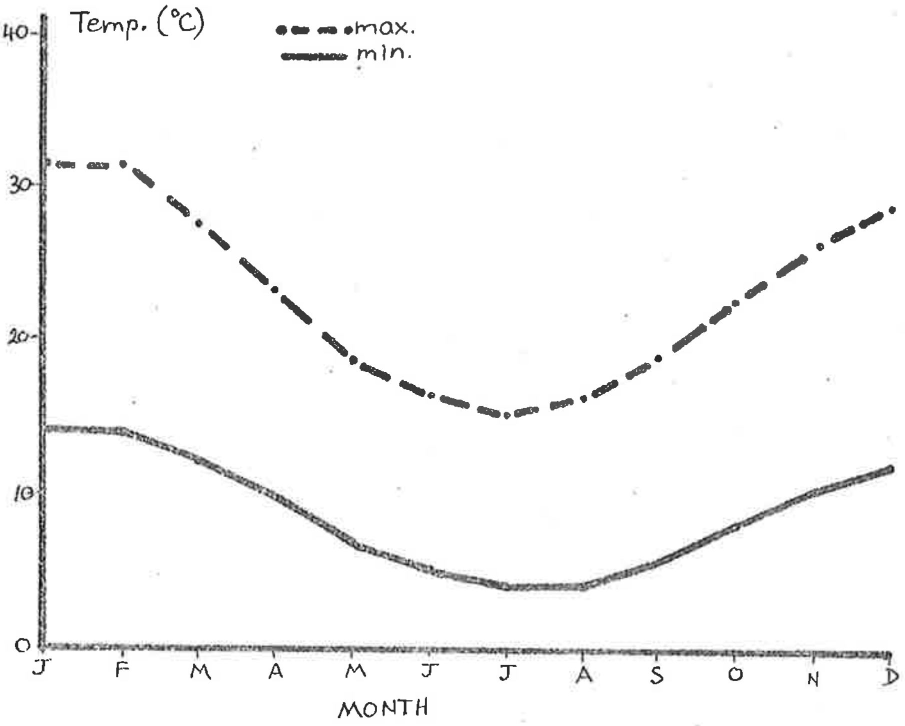
TABLE 1·2

Average daily maximum and minimum temperatures per month (in °C) for Nildottie, S.A.

Month	Max. Temp.	Min. Temp.
J	31·6	14·2
F	31·5	14·1
M	27·7	12·3
A	23·3	9·8
M	18·7	6·7
J	16·3	5·0
J	15·3	4·2
A	16·4	4·0
S	19·1	5·6
O	22·8	7·9
N	26·5	10·3
D	28·9	12·1

GRAPH 1·3

Average maximum and minimum monthly temperatures at Nildottie. (Note the large diurnal range.)



Eucalyptus gracilis is perhaps more prominent. A detailed discussion of species occurrence and distribution is given by Jessup (pp. 50-55 incl.) and a species checklist is given in Chapter 3 of this thesis.

Further taxenomic studies of *Eucalyptus oleosa* and *Eucalyptus gracilis* have shown that such variation exists within themselves, and a grading into other species occurs, that they have been recently accepted as variants of other species, namely *Eucalyptus porosa* and *Eucalyptus socialis* respectively. Similarly *Kochia sedifolia* has been placed in a new genus and is now known as *Maireana sedifolia*.

CHAPTER 2

METHODS

Methods described in this chapter relate to the following phases of the data-collection programme :

1. Studies of pasture about wombat warrens and the influence of wombat grazing.
2. Broadscale vegetation survey of the Reserve.

1. PASTURE STUDIES

(a) Site Selection

The desirability of obtaining as much data as possible on many replicates was well-recognised. However, the practical limits to resources and man hours available had to be acknowledged and a compromise had to be reached involving a few replicates studied as carefully as possible.

A feature of the warren pasture system was that very many warrens were available for study, nearly all of them in the one sort of pasture situation. (Most warrens occurred on the grassed plains, with fewer and smaller warrens near or amongst Eucalypt stands and in the predominantly bluebush area. (In these cases, grassland was within ten metres of the warrens anyway.) Visual observation indicated that the differences in the composition and abundance of pasture about typical warrens were found to be very slight indeed. This led to the opinion that it did not matter very much which warrens were studied so far as pasture was concerned, since it was essentially the same throughout.

Warren selection involved principally the factors of apparent activity, distance from neighbouring warrens, warren size, and terrain unevenness. Clearly, it was desirable to simplify studies by avoiding complications introduced by overlapping grazing zones, minor topographic complications, infrequent use, surrounding vegetation type and the like.

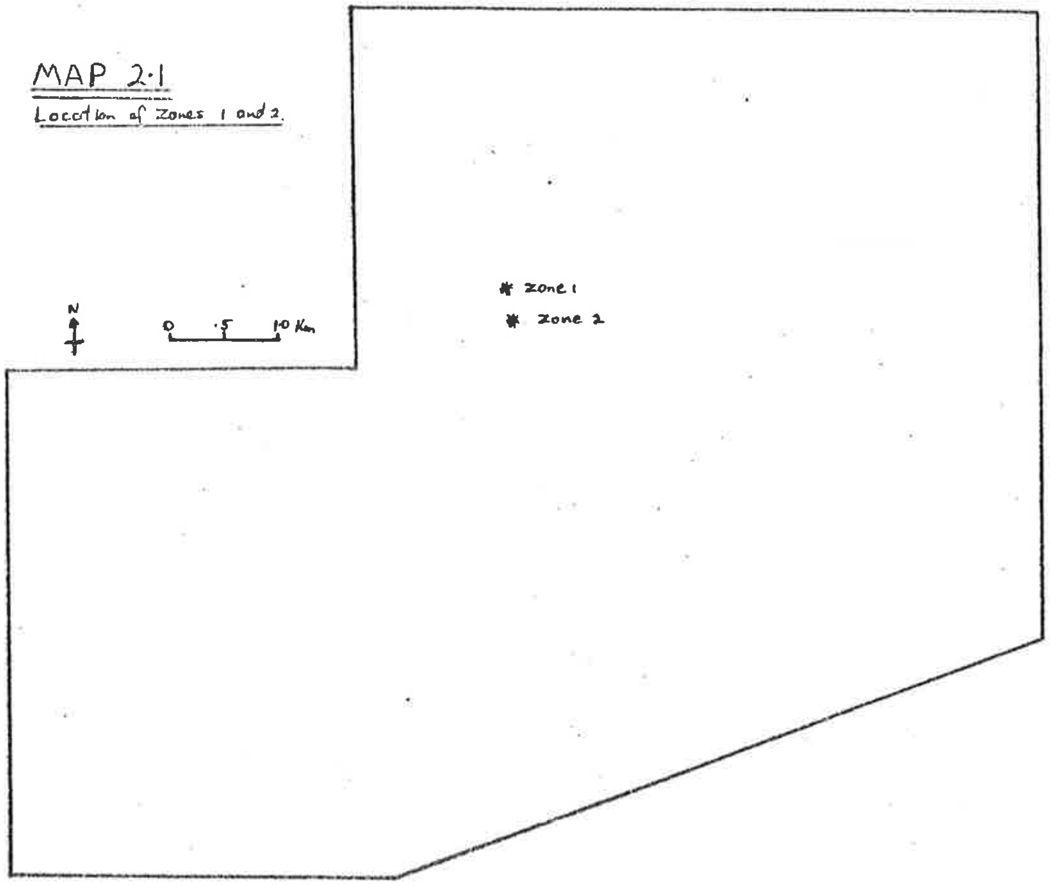
Accordingly, the method used for site selection was to walk through the area extensively, building an impression of what was typical, and noticing and avoiding the complications mentioned, to produce a short list of typical, yet uncomplicated sites. Of these, two were eventually selected. Their locations are shown in Map 2.1. The first, which was called Zone 1, was of medium-large size and located in the typical *Myoporum-Erodium-Stipa* country which occurs on the shallow soils overlaying limestone. It appeared to be very active, from observations at successive visits before this study proceeded. It was regarded as epitomizing the typical Blanchetown region habitat. The second, (Zone 2), was established later, and was a smaller warren in the same *Myoporum-Erodium-Stipa*, country. There was less activity apparent from visual observation of tracks, diggings, egesta and the like.

(b) Recording the Grazing Zone

Reconnaissance had established that pasture about active warrens displayed a circular halo of grazing effects, easily noticed, and that the outer limits of this halo were fairly sharply defined. It was possible to say within 20-30 cm. where the grazed halo ended and the ungrazed surrounding grass started.

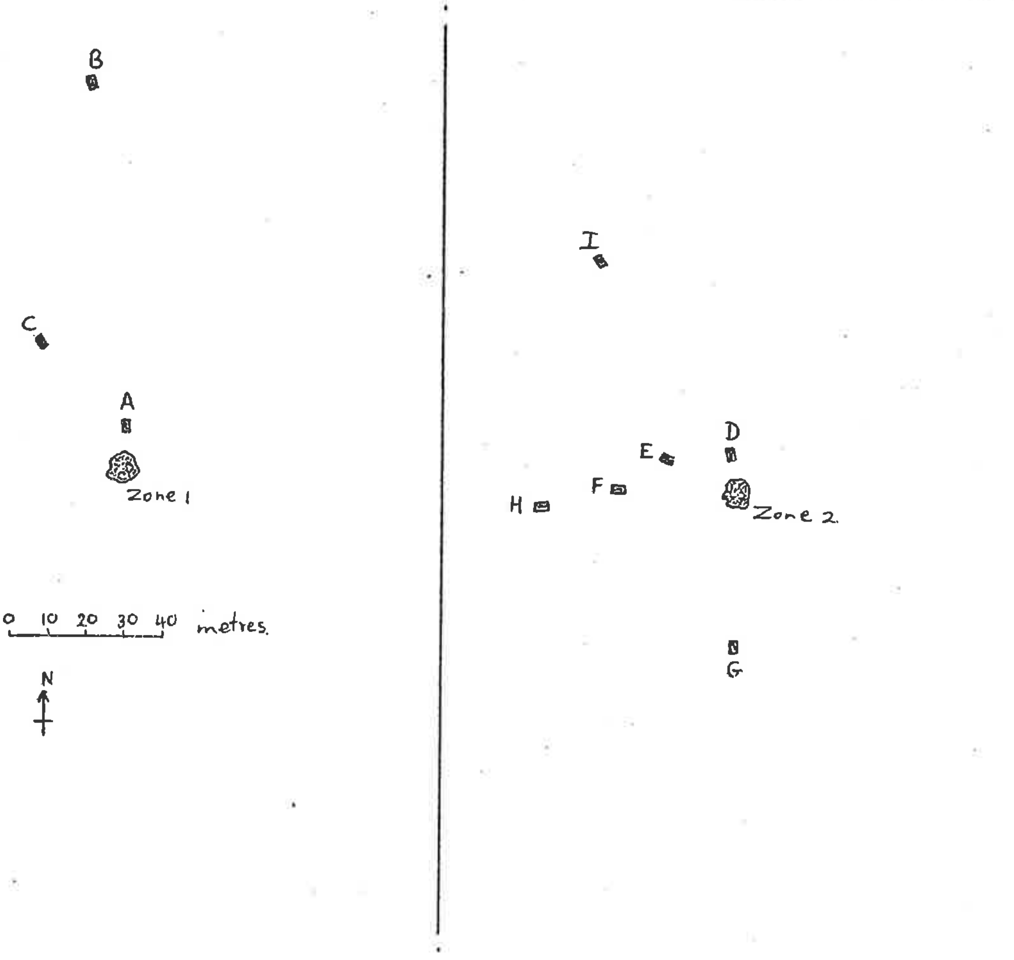
MAP 2·1

Location of Zones 1 and 2.



MAP 2.2.

Locations of Quadrats (permanent) around warrens in Zones 1 and 2.



By measuring-tape and compass survey, six traverses radiating from the centre of the warren were marked out with permanent steel pegs. These traverses were spaced at 60° intervals and pegged at 10 m. intervals in the range to 90 m., for ease of locating positions quickly and accurately.

Thus on the occasion of each visit it was possible note the position of the halo perimeter and build up a history of its position as time passed. These data were accumulated.

A similar method for delineating grazed and ungrazed pasture has been used by Lynch, J.J. (1974), where he studied the behaviour of grazing vertebrates around watering points. The same principles are expected to apply around warrens.

(c) Quadrats

In order to make quantitative measurements of the composition and abundance of pasture it was necessary to demarcate ground quadrats of precise measurements of area commensurate with the abundance and variability of the herbage.

Reconnaissance showed that in any area successive square metres of pasture differed from each other in composition and abundance by only a very small extent. Typically, the lowest biomass of three successive square metres fell short of the highest by only 4.8 % (averaged for 10 such measurements), which was almost within the limits of the measuring technique. Thus the situation was fairly analogous to an improved pasture, and the problem of replication was to a large extent minimized by this homogeneity.

It was felt that a quadrat of 2 square metres would provide as accurate and reliable a picture of the biomass as need be achieved. After considering the available resources and estimating manpower hours, this size was increased to a 3 x 1 m. quadrat, in which vegetation could be bulk harvested or estimated. Obviously the larger the sample size, the more accurate and reliable is the biomass picture.

Quadrat corners were marked with small pegs driven into the ground, but protruding just enough to allow a taut string to be attached around them at reading time. Careful inspection yielded no evidence that wombats noticed these pegs.

In order to measure the effects of wombats on pasture at any one place, comparison had to be made between quadrats that were available to wombats for grazing, and quadrats in which wombats were excluded for periods of a month or more. Accordingly, portable fencing was designed using lengths of "weldmesh", a light steel fabric of 15 x 15 cm. mesh (wide enough to allow rabbits). Lengths of this mesh were wired together to produce a free-standing structure 4.5 m. x 2.5 m. x 1 m. high. It was recognised that any "edge effect" around the 3 x 1 m. quadrat was not desirable, and so a larger area than the quadrat itself was exclosed to wombats.

Quadrats and exclosures were established in Zone 1 at distances of 20 m., 200 m. and later 40 m. from the centre of the warren. Reconnaissance showed that at 20 m. there was heavy grazing, while at 200 m. there was no evidence of wombat activity. The 40 m. quadrats occurred in an interzonal area with varying evidence of wombat activity over the period of this study. In Zone 2, which was established a few months later, the resources and manpower allowed for the inclusion of more sampling points. Accordingly, quadrats and exclosures were established at distances of 10 m., 20 m., 30 m., 40 m., 50 m. and 70 m. from the centre of the warren. Map 2.2 shows the positions and labels of quadrats in each Zone. It was considered that the closer regions would be most affected by grazing, while the more distant regions would be less affected. Photograph series 2.1 - 2.4 shows the quadrat placement about Zone 1 (22/7/72), while Photograph series 2.5 - 2.8 shows the typical appearance around Zone 2 (19/8/72).

(d) Marking out Quadrats

The quantity of herbage on any quadrat will vary greatly as time goes by, regardless of wombats. This variation will reflect the periodic sharp increases in herbage due to growth episodes, periods where cured herbage is static (more or less like a haystack), and periods of decline due to a wide variety of degradation processes.

The effect on pasture biomass by grazing wombats has to be measured against this changing background, and for present purposes a special means of demonstrating it was devised. The technique rests on the standard idea that contrasts will develop between protected and unprotected quadrats in consequence of grazing, and can be measured. Tribe, D.E. (1950) reviews the basic methods of determining what free-grazing animals eat. A specific example of quadrat studies of sheep effects

Plate 2·1 Zone 1 warren

Plates 2·2-2·4 Zone 1. Panoramic view from warren; Stations A & C.

Plates 2.5 – 2.7. Zone 2. Panoramic view from warren.
Stations D, E & I.

Plate 2.8. Zone 2 warren.

on pasture is given by Leigh, J.H. and Mulham, W.E. (1966). They made measurements of progressive effects of sheep-grazing upon the quantity of plant matter available.

Thus if one of two quadrats installed in homogeneous pasture is protected and the other is not, and both are left for a month, the measured difference in final biomass between them can be attributed to wombat grazing. At this time, however, it is also very likely that the pasture as a whole has changed to a new condition no longer represented by the protected quadrat. Hence it is necessary to shift the protecting enclosure to a fresh site so that for the beginning of the ensuing month, protected and unprotected quadrats again start from an equivalent condition. This calls for a pattern of shifting quadrats. The contrasts generated month by month, thus reflect wombat grazing month by month, in a pasture that is changing, month by month.

At any one visit, then, three quadrats were sampled :

- the "enclosed" quadrat from the previous month.
- the "open" quadrat from the previous month. (This quadrat was then "enclosed").
- the fresh quadrat. (This quadrat was left "open").

(e) Sampling Techniques

It was recognised that, once sampled, a quadrat should not be used again until it had completely / recovered. By recording the vegetation in each quadrat on each of two successive visits, the need to do this would not arise over the two-year period, even at a distance of 10 m. from the warren. At the same time, man hours would be reduced by setting up one quadrat at each visit instead of two.

However, this approach requires that the only quadrat which could be bulk harvested is the "enclosed" one; the vegetation of the "open" and "fresh" quadrat could only be estimated. Nor was it desirable, anyway, to denude so many quadrats of their vegetation, especially nearer the warrens, where by doing so would certainly alter the wombat-vegetation interaction over a period of time.

When dealing with a number of flora species of differing habits it is obvious that different techniques for sampling or estimating the species biomass need be employed. While the desirability of obtaining much data based on the whole quadrat was well recognised, the practical limits to resources and man hours had to be acknowledged and a compromise reached. It was expected that the herbage in any one sampling area would vary greatly with time, so a variety of techniques were devised to estimate the amount of each species. Thus it would be expected that even for the same species, a modification of the technique, or even a different technique would be employed from time to time, depending on resources, man hours, and the state of the herbage.

The methods of sampling decided upon and used are described as follows :

(i) Bulk Harvesting

Whenever possible the herbage of the "enclosed quadrat" was completely harvested. When excessive herbage was judged to be present, however, a visually representative sample was bulk-harvested instead. Proportions of from 1/10 to 1/3 size were used at different times as determined by the plant species, size and number of plants, the amount of herbage and the time factor.

In the other quadrats, whenever this technique was used, it was not desirable that the herbage inside the quadrat be removed. Accordingly, a sample area outside of the quadrat was selected and harvested. It was recognised that the sample had to be homogeneous in all respects with the quadrat vegetation of as large a size as could be accommodated, and a short distance away to avoid any "edge effects".

This method was used consistently with *Stipa*, ground litter, small to medium *Erodium* and medium-sized *Zygophyllum* species, but was unsatisfactory for *Bassia* and larger *Erodium* and *Zygophyllum* plants.

(ii) Hand Specimen

Because of the variation in size and shape of *Bassia* plants, and the occasional larger *Stipa*, *Erodium* and *Zygophyllum* plants, a different technique had to be used for these situations. A hand specimen was selected and a method of estimating described and used by Pechanec, J.F. and Pickford, G.D. (1937), was employed. In essence, a "useful" sample was obtained from outside the quadrat and a visual estimate made of the number of "hand samples" present in the quadrat by holding the hand sample alongside each relevant quadrat plant in turn. A "useful" sample was one having identical characteristics to the herbage being sampled. At times more than one hand specimen was required to estimate the amount of plant matter in the one quadrat because of the conditions of different plants.

It was recognised that the method requires constant practice and checking. For this reason, after an initial practice session each visit, the same two recorders made independent estimates throughout the entire research programme. Any variation greater than 10% between the two estimations was closely examined and a collective re-estimation made. (This method proved quite suitable and there was very good agreement (93%) between both estimators during the two year programme.)

A number of problems with sampling were foreseen. Reconnaissance showed that the wombat appeared to consume only above-ground herbage. Consequently only above-ground herbage was measured. To facilitate this, all vegetation was cut off at ground level by knife. (By leaving the root-stock, *Stipa* was given an opportunity to regenerate).

It proved very difficult to distinguish one *Stipa* plant from another, as parent plant and vegetative offspring occur in a clump. However, the clumps were not large, and each clump at least represented the growth from one plant, so for this reason and simplicity of recording, one *Stipa* plant was defined as the leafy foliage arising from a clump or group of attached root stock. As a "working definition" this was quite adequate.

Difficulty also occurred when considering the "ground litter". Some herbage was quite desiccated and brittle while other material appeared to be composed of both living and dried-off plant matter. Consequently it was decided that all plant matter that was dried, non-green and brittle would be considered as part of the "ground litter". This involved separating the dead parts of *Stipa* from the remainder. In practice this again proved to be a sensible "working definition".

(f) Soil Samples

In order to fully appreciate the changes in the vegetation, some indication of soil moisture would be useful for comparison with. Rainfall amounts and distribution patterns were recorded on the Reserve for the years 1963-1973 inclusive (except for 1967 when no records were made). Soil moisture would be a reflection of total precipitation, i.e. rainfall and dew. Accordingly, a number of soil samples were obtained from the same areas around each of the warrens under study. It was felt that surface soil moisture data would be useful to have because of availability to germinating seeds, and that moisture data in the first 20 cm. or so would indicate availability to root systems of the flora species under observation. However, it was found that the soil overlying the limestone base was typically only about 10 cm. deep, so in practice soil samples were obtained from 0 cm. and 10 cm. depths. Care was taken to exclude most stones and to obtain the same size sample of approx. 150 grams each visit.

(g) Weighing Samples

It was recognised that when plant matter is cut, it continues metabolic activities, including transpiration, for some time after. The production (and consequent loss during drying) of some substances such as gases and volatile liquids would cause a lowering of the dry weight of such samples. Kermondy, E.J. (1976) describes the basic principles and techniques involved with obtaining dry weight of cut herbage. It was imperative, then, that the following occur as soon as possible after picking :

(i) Placing collected material in air-tight containers, suitably labelled, into a box. Thus any plant product would be sealed in the jar and photosynthesis reduced.

(ii) Weighing of the freshly cut samples.

(iii) Placing the open jars and samples in an incubator.

Due to the limitation of time on site at each visit, no weighing occurred at the Reserve. Samples were transported to laboratory facilities in Adelaide and weighed (at the most) within 6 hours of picking. The following procedure was adopted :

(i) Weigh jar + lid + freshly cut herbage.

(ii) Remove lid and place jar + lid + herbage in an incubator set at 85°C for a period of 7 days.

(iii) Allow the incubator to cool to room temperature and weigh jar + lid + dried herbage.

(iv) Remove herbage and weigh jar + lid.

From this data the dry weight and % moisture were extracted and compiled throughout the program.

Soil samples were treated in a similar manner, and soil moisture data extracted and compiled.

(h) Counting Plants

It was desirable to count the numbers of plants for the following reasons :

(i) absolute density in each quadrat

(ii) obtain the average biomass per plant

(iii) as a means for extrapolating quadrat biomass from sample biomass.

Two methods were employed, depending on the numbers present, and man-hours available. On occasion it was possible to use both methods and cross check.

(i) When numbers were relatively low, a count was made of the numbers of each species in each quadrat. This was achieved for all species (at least most of the time).

(ii) When numbers were relatively high, an estimate was obtained by using a fine metal grid similar in construction to the "weldmesh" enclosure mentioned earlier, but having overall dimensions of 30 x 25 cm. It was relatively easy to count all specimens inside this sampling device. It was felt that 3 such samples, at carefully selected places that were representative of the species characteristics in the quadrat would give a very accurate overall picture of the numbers. A graph was constructed so that estimated quadrat numbers could be obtained from sample numbers.

It was earlier stated that in many situations, a sample area was bulk-harvested and the quadrat biomass obtained on a per area basis. At the same time it was possible to count the numbers in the sample, and extrapolate estimated biomass of the quadrat from this. This was a useful exercise as a check on the observer's accuracy in selecting homogeneous areas outside a quadrat as the sample area, and in over 80% of such checks there appeared to be very little discrepancy. In the remaining cases a third recording was made and the data adjusted by sensible compromise. The data for *Stipa* and *Erodium* are particularly accurate (within the bounds of the technique and estimators' capabilities) as both methods were used to obtain most of these data during the programme.

(i) Photopoints

It was thought that any noticeable wombat effect would probably be fairly small from month to month and so it would be useful to compare wombat-grazed and wombat-excluded quadrats over a longer period of time. At the same time it would be of value to exclude rabbits (although few occurred near the two selected warrens) and observe changes in the vegetation due to the factors mentioned earlier in Section (d) namely, periodic increases due to growth episodes, periods where the herbage is static, and periods of decline due to a wide variety of degradation processes (except in this case the larger mammalian herbivores). This would prove a useful tool in the final analysis of quadrat data.

Accordingly, 4 x 2 m. permanent fencing was erected around 5 selected permanent quadrats using 80 cm. high chicken wire (approx. 3.5 x 3.5 cm. mesh) attached around 4 steel star droppers hammered into the ground. These five exclosures were situated at Stations A, B and C in Zone 1, and D and E in Zone 2. Any data from A and D would provide information from the areas closest to the warrens, which were almost devoid of herbage at the outset of this study. C and E represent fringe-grazing areas, and B was typical of an area almost unaffected by wombats as far as could be observed.

In order to collect data from these quadrats, a photographic method was used. Being permanent, the herbage could not be harvested. Nor would the herbage inside the exclosures be the same as that outside after a month or two from the start. Consequently eight permanent photopoints were set up. The technique follows the idea that when photographs are taken of the same area at each of two places 20 cm. apart, and at a distance of approximately 1 m. away, the two photographs constitute a stereo pair. Stereo pairs can be viewed under a stereo viewer to obtain a 3-dimensional image. The principles of the use of stereo pairs are exemplified by Galloway, R.W., Gunn, R.H., and Pedley, L. (1974) in a vertical stereo pair analysis of the Balonne-Maranoa area of Queensland. The same principles apply to stereo photographs taken of a smaller area of vegetation in a more or less horizontal plane.

All pegs were driven into the ground and made permanent. The camera was attached to a tripod which was centred over the two marker pegs. A backing board with mm. graph paper attached was placed behind the area being photographed in order to record quantitatively the size-changes from month to month.

(j) Egesta

In order to identify the type of herbage and quantify the amount ingested, wombats would have to be extensively tested. Due to their nightly feeding pattern this would prove very difficult. Studies would necessarily have to be carried out in a laboratory situation, either located at, or removed from the Reserve. Oesophageal or ruminal fistulation (Leigh, J.H. and Mulham, W.E. 1966) would not be a satisfactory approach because of the surgery-recovery costs and the abrasing action of the burrow habitat. Attempts have been made to relate undigested plant cuticle material to voucher cuticle preparations for the purpose of quantifying. Storr, G.M. (1960) examined microscopically the faeces of some herbivorous mammals and obtained cuticle fragments from which he ascertained their diet.

After discussion with my supervisor, Dr. Lange, it was decided that investigation in this direction would go beyond the scope and depth of the present study. Furthermore it would constitute research far beyond the resources available to me.

However, at each visit, fresh egesta pellets were collected, air-dried, and transported to the Botany Department, University of Adelaide. It is the intention of the author to further study their composition in the near future.

2. VEGETATION SURVEY

(a) Transects

Again the desirability of obtaining as much data as possible on many replicates was well recognised. However, the practical limits to man hours in particular had to be acknowledged. Even so, an ambitious project was undertaken and achieved. To adequately survey an area of approximately 50 sq. km. it was obvious that a regular pattern had to be employed. Consequently a map of the Reserve was divided up by transect lines using the track A-B on Map 2.3 as the base-line. North-south traverses were marked either side of the base-line and sampling points located along these. The base-line was divided up into approximately .7 km. intervals and pegged, and each transect line was subdivided into .35 km. intervals. This provided what was considered to be the most effective technique that could be used with the resources available, and gave rise to 285 sampling points, i.e. 5 sq. km. Map 2.3 shows these stops, numbered according to the order in which they were traversed.

(b) Voucher Specimens

Before starting the survey it was necessary to reconnoitre the Reserve very extensively and build up a picture of the number of flora species present and their prominence and distribution. This was carried out by vehicle and on foot. Accordingly, voucher specimens were obtained for 64 species which were more or less obvious to an observer, and occurred at a number of places in the Reserve. These small specimens were given a number, fixed onto heavy-duty cardboard and sealed under clear "contact" sheeting (Plates 2.9 - 2.10).

(c) Data collected

It is obvious that information concerning the density of each species would be most desirable. With such a large number to record at each of the 285 stops this would be an impossible task. However, 6 species that appeared to be most prominent in that they were present over most

MAP 2.3

TRANSECT ROUTES & STOPS.

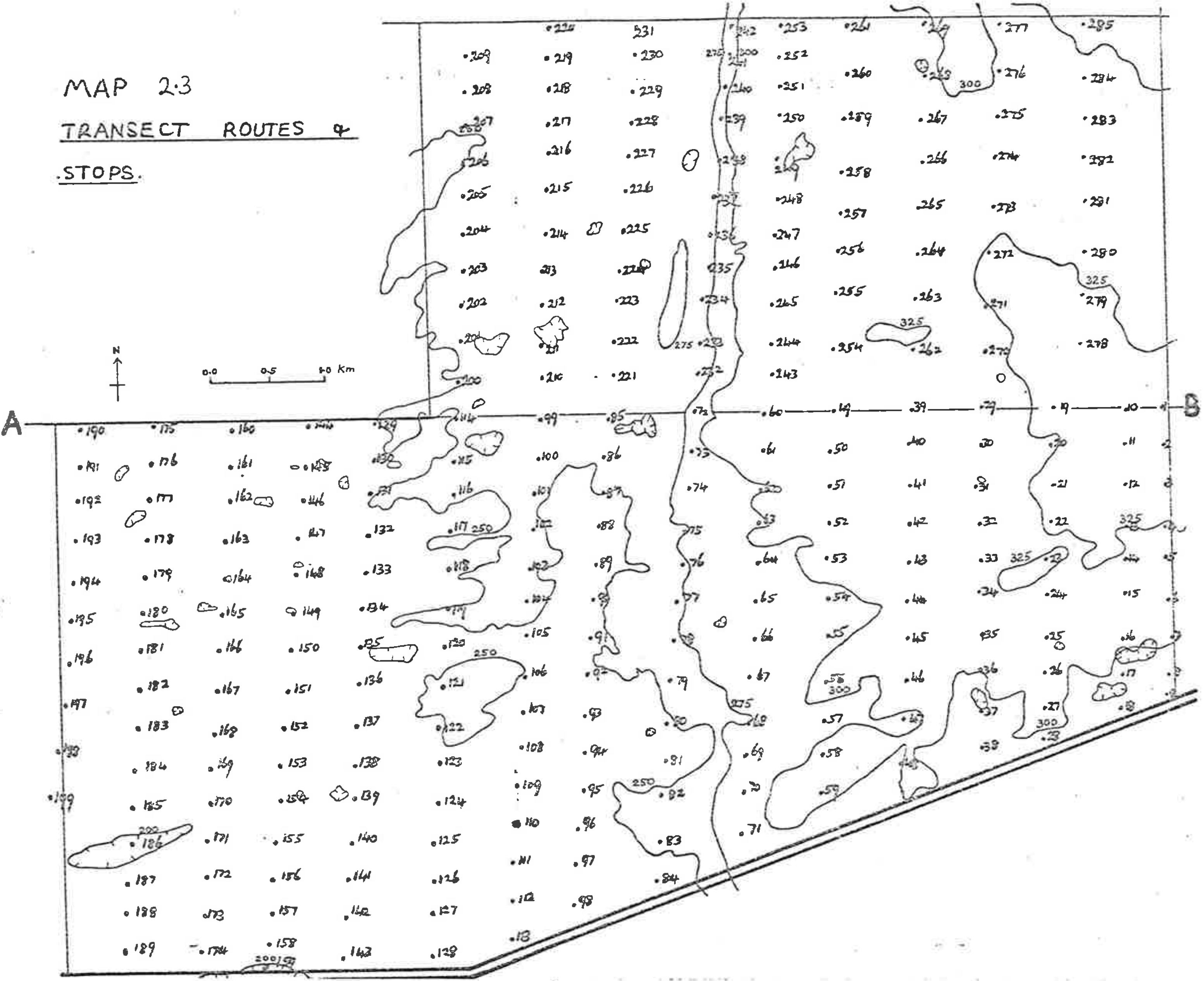
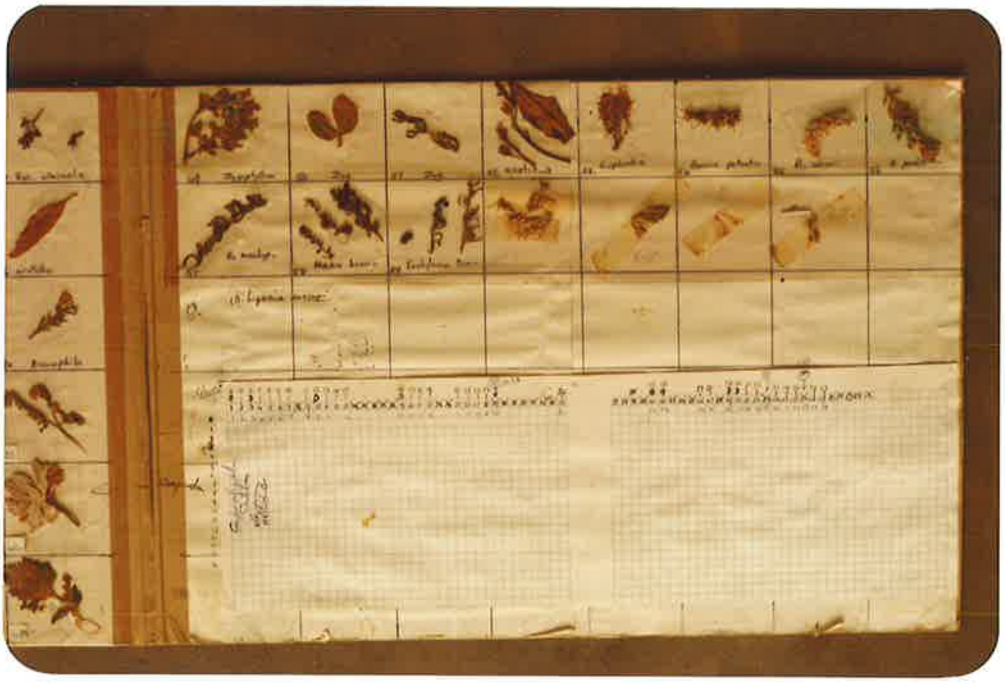


Plate 2.9 Voucher specimens, mounted on board and numbered for quick reference.

Plate 2.10 Recording grid, and voucher specimens.

of the area in large numbers or that they were trees or large bushes and therefore noticeable, were selected out and a measure of density recorded.

Again a simple method was required. It was decided that a satisfactory procedure would be to rate the density on an arbitrary 1-2-3-4 scale whose constancy was maintained by comparison with photographs representing the density ratings (Fatchen, T.J. 1971). Examples of these photographs appear in Chapter 3.

For the remaining 58 species, all that could be expected was the compiling of incidence data based on presence or absence at each sampling point.

(d) Recording data

In order to carry out the survey, trail bikes were used. In much of the Reserve, larger vehicles would not be able to find free passage, and one could not cover the distance of over 110 km. on foot. Motor bikes had the advantages of

(i) being small enough to pass easily between the vegetation

(ii) capable of going over the top of obstacles that would normally be impossible for a 4-wheeled vehicle to traverse,

(iii) speed in such conditions.

Thus it was possible to travel in an almost straight line along transects.

Two trail bikes and the same two observers were used for the survey for reasons that will become obvious. It was felt that the survey should be carried out at a time when growth of many of the annual plants occurred. Two consecutive weekends in March-April of 1973 were chosen.

One observer, using a compass bearing, sighted a distant object and proceeding in a straight line, used the bikes' odometer to locate each stop. (The compass and bike were always kept in the same relative positions and direction when compass readings were made so that the bearing error due to the steel of the bike would be constant).

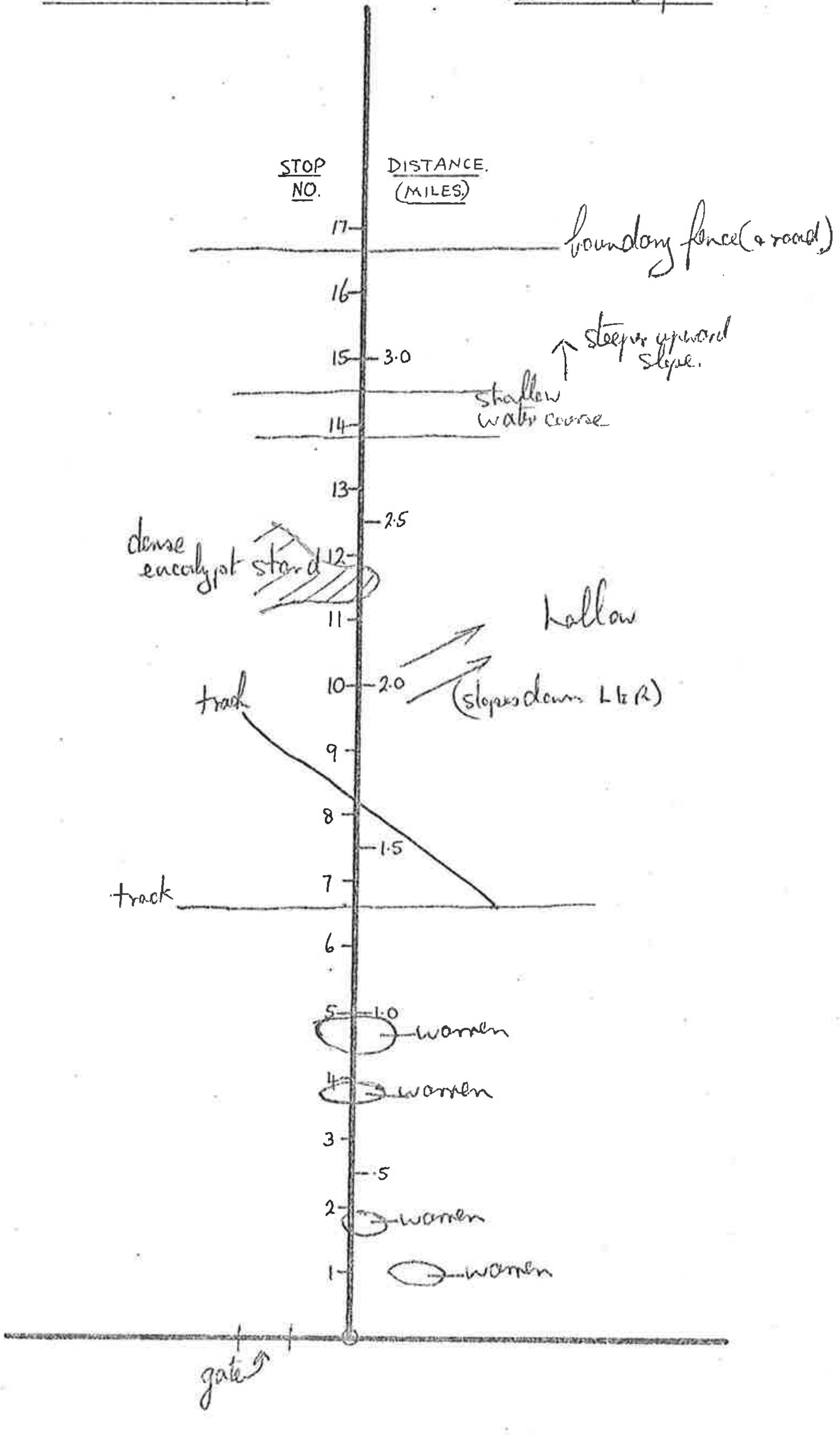
Records were made at each stop and between stops.

(i) At each stop a record was made of the vegetation in area of approximately 300 metres either side, and 150 metres to the front and rear. In other words, the stops marked on Map 2.3 represent the centres of quadrats 600 x 300 m. A quick visual reconnaissance of each block region was made from the centre point by reference to the Voucher Specimens, and any unusual features visited and checked by the second observer. A more detailed survey was made on foot in a smaller area of about 50 m. diameter around each stop point.

(ii) Between stops any noticeable changes in vegetation, warrens, tracks, claypans and other such features were separately recorded by Observer 1 on a Transect map. Map 2.4 is one such example. Obviously, as each transect line progresses, the margin of error in locating stop points could increase. In order to compensate for this, reference was later made with the aerial photograph (a much larger version of Plate 1.6), and the actual location marked on the Transect Route Map 2.3. It is for this reason that the stops are not in an exact straight line, or evenly spaced.

MAP 2·4
Example.

Transect Map. Number 24



(e) Herbarium

It was felt that it would be desirable that plant material be collected and labelled so that visitors to, and future users or researchers in the Reserve would have immediate access to samples of the flora occurring there.

Large size herbarium sheets for over 130 specimens were carefully prepared and labelled. Unfortunately, although kept in naphthalene flakes, small insects entered and destroyed the majority. What could be was recovered and remounted on smaller cards as voucher specimens for future use on the Reserve. They were mounted on white card and covered with clear "contact" sheeting. The under surface was left unsealed and labelled with the family and species names of the plant. (No moisture would accumulate and cause further destruction.) These are now lodged at the Reserve, with the authors' intention of making additions to and replicating for use as identification vouchers which should have a useful and extensive lifetime.

CHAPTER 3

THE FLORA AND ITS DISTRIBUTION

This chapter includes a flora species checklist for the Reserve. The voucher specimens are also listed. The data obtained from the Vegetation Survey is analysed and discussed.

1. THE FLORA

Over the period of research, herbarium specimens were collected, pressed, dried, mounted and named as far as possible using the specimens at hand. At the same time J.Z. Weber collected and identified a large proportion of the species for the South Australian Museum. Below is the Species Checklist to date, as collected and identified by P. Lehmann (and using Weber's list as a part reference).

(a) Species Checklist (Black, J.M. 1943-57)

AIZOACEAE

Tetragonia eremaea Ostenf.

AMARANTHACEAE

Ptilotus spathulatus (R.Br.)Poir

APIACEAE

Bupleurum semicompositum L.

Daucus glochidiatus (Labill.)Fisch.Mey.& Ave-Lall.

ASTERACEAE

Angianthus preissianus (Steetz)Benth.

Angianthus strictus (Steetz)Benth.

Angianthus tomemtosus Wendl.

Arctotheca calendula (L.)Levyns

Athrixia athrixioides (Sond.& FvM.)Druce

Brachyscome ciliaris (Labill.)Less

Brachyscome lineariloba (DC.)Druce

Calotis hispidula (FvM.)FvM.

ASTERACEAE (contd.)

Centipeda minima (L) A. Braun & Aschers

Crepis sp.

Gnaphalium luteo-album L.

Elachanthus pusillus FvM.

Gnephosis scirrophora (Sond. & FvM.) Druce

Isoetopsis graminifolia Turcz

Helichrysum leucopsidium DC.

Helipterum jessenii FvM.

Helipterum pygmaeum (DC.) Benth.

Leptorhynchus tetrachaetus (Schld.) Black

Minuria leptophylla DC.

Reichardia tingitana (L.) Roth

Olearia muelleri (Sond) Benth.

Onopordon acaulon L.

Picnomon acarna (L.) Cass.

Senecio aff. lautus Forst. f. ex Willd

Senecio quadridentatus Labill.

Sonchus asper (L.) Hill

Vittadinia cuneata DC.

Vittadinia megacephala (FvM. ex Benth.) Black

Vittadinia triloba (Gaudich.) DC.

BORAGINACEAE

Echium lycopsis L.

Halgania lavandulacea Endl.

Omphalolappula concava (FvM.) Brand

BRASSICACEAE

Sisymbrium erysimoides Desf.

Sisymbrium orientale

Sisymbrium irio L.

Stenopetalum lineare R. Br. ex DC.

CAMPANULACEAE

Wahlenbergia communis Carolin

CARYOPHYLLACEAE

Herniaria hirsuta L.

Silene apetala Willd.

Spergularia diandra (Guss.)Heldr.

CHENOPODIACEAE

Atriplex acutibractea Anders.

Atriplex nummularia (Lindl.)

Atriplex suberecta Verdoorn

Atriplex vesicaria

Bassia parallelicuspis Anders.

Bassia patenticuspis Anders.

Bassia sclerolaenoides (FvM.)FvM.

Chenopodium cristatum (FvM.)FvM.

Chenopodium murale L.

Duriala villosa (FvM.)Ulbrich

Enchylaena tomentosa R.Br.

Maireana brevifolia (R.Br.)P.G. Wilson

Maireana excavata Black

Maireana pentatropis Tate

Maireana radiata Wilson

Maireana sedifolia (F.Muell)P.G. Wilson

Rhagodia parabolica R.Br.

Rhagodia spinescens var. deltophylla (R.Br.)FvM.

Rhagodia spinescens var. spinescens (R.Br.)

Salsola kali L.

CASUARINACEAE

Casuarina cristata Miq.

CONVOLVULACEAE

Convolvulus erubescens Sims

CRASSULACEAE

Crassula colorata (Nees)Ostenf.

Crassula pedicellosa (FvM.)Ostenf.

EUPHORBIACEAE

Euphorbia drummondii Boiss.

FABACEAE

Acacia colletioides Benth.

Acacia oswaldii FvB.

Astragalus hamosus L.

Cassia nemophila var. coriacea (Cunn.ex Vogel)

Cassia nemophila var. nemophila (" " ")

Cassia nemophila var. platypoda (" " ")

Eutaxia microphylla (R.Br.)ex Ait. Black

Medicago minima var. brevispina Benth.

Medicago polymorpha var. vulgaris (Benth.) Shinners

GERANIACEAE

Erodium cicutarium (L.)L'Her.ex Ait.

Erodium cygnorum var. cygnorum Nees.

GOODENIACEAE

Goodenia pusilliflora FvM.

Velleia paradoxa R.Br.

IRIDACEAE

Romulea longifolia (Salisb.)Baker

LAMIACEAE

Ajuga iva Schnel

Marrubium vulgare L.

Prostanthesa (aff baxteri) A.Cunn.ex Benth.

Salvia lanigera Poir.

Teucrium racemosum R.Br.

Westringia rigida R.Br.

LILIACEAE

Anguillaria dioica R.Br.

LORANTHACEAE

Amyema miquelii (Lehm.ex Miq.) TIEGH

Amyema preissii (Miq.) Van TIEGH

Lysiana exocarpi (Behr.) TIEGH

LYTHRACEAE

Lythrum hyssopifolia L.

MALVACEAE

Malva verticillata L.

Selenothamnus squamatus (Nees ex Miq.) Melville

Sida cardiophylla FvM.

MYOPORACEAE

Eremophila glabra (R.Br.)Ostenf.

Eremophila scoparia (R.Br.)FvM.

Myoporum montanum R.Br.

Myoporum platycarpum R.Br.

MYRTACEAE

Eucalyptus porosa FvM.ex Miq.

Eucalyptus socialis FvM.ex Miq.

Eucalyptus viridis

Melaleuca acuminata FvM.

Melaleuca lanceolata Otto

OXALIDACEAE

Oxalis corniculata L.

PITTOSPORACEAE

Bursaria spinosa Cav.

Pittosporum phillyreoides DC.

PLANTAGINACEAE

Plantago drummondii Dene.

POACEAE

Bromus rubens

Danthonia auriculata Black.

POACEAE (contd.)

Danthonia caespitosa Gand.inFreyc.

Hordeum leporinum Link

Lophochloa phleoides (Vill.) Rchb.

Lophochloa pumila (Desf.) Bor.

Schismus barbatus (L)Thell.

Stipa drummondii Steud

Stipa nitida Summerhayes et Hubbard

Stipa platychaeta Hughes

Triodia irritans R.Br.

PORTULACACEAE

Calandrinia eremaea Ewart

RESEDACEAE

Reseda lutea L.

RUTACEAE

Geijera linearifolia (DC.)Black

SAPINDACEAE

Dodonaea attenuata A. Cunn.

Heterodendron oleifolium Desf.

SANTALACEAE

Exocarpos syrticolus (FvM.exMiq.)Stauffer

SOLANACEAE

Lycium australe FvM.

Nicotiana glauca GRAH.

Nicotiana velutina Wheeler

Solanum coactiliferum Black.

Solanum nigrum L.

VERBENACEAE

Verbena officinalis L.

ZYGOPHYLLACEAE

Zygophyllum apiculatum FvM.

ZYGOPHYLLACEAE (contd.)

Zygophyllum aurantiacum (Lindl.ex Mitch.)FvM.

Zygophyllum ovatum Ewart & White

2. THE TRANSECT - VOUCHER SPECIMENS

64 species for which voucher specimens were obtained and mounted in a large folder, numbered, and sealed under clear "contact" are listed in Table 3.1 as far as possible.

3. DISTRIBUTION OF THE FLORA

A first look at the data collected in the broadscale vegetation survey of the Reserve shows a number of aspects worth following :

(a) Prominent Species

The vegetation is dominated by a number of more prominent trees and bushes, and many less prominent shrubs, forbs and grasses. It would be useful for an interested observer to be able to recognise these more obvious species in the broad picture. Obviously early botanists would have used just such species lists in order to produce general vegetation maps of a large area of land. Table 3.2 is a short list for the Reserve, divided into the groups listed above.

(b) Distribution according to Density

As described in the previous chapter, data for the distribution of 6 species was in the form of an arbitrary density rating according to a 1-2-3-4 scale. 1 means highest density and 4 means absence; 2 and 3 are in-between values. (See APPENDIX 3·1).

These data were plotted onto base maps and isotels were drawn to demark areas of one density rating from all other areas of different density rating. It was recognised that the isotels were influenced by the need

TABLE 3.1 - LIST OF VOUCHER SPECIMENS USED IN TRANSECT

1.	*Geijera linearifolia*
2.	(tree parasite on *Geijera linearifolia*)
3.	*Myoporum platycarpum*
4.	*Heterodendron oleifolium*
5.	*Eucalyptus porosa*
6.	*Eucalyptus socialis*
7.	hybrid *Eucalyptus porosa-Eucalyptus socialis*?
8.	*Eucalyptus viridis*
9.	*Exocarpos syrticolus*
10.	*Melaleuca lanceolata*
11.	*Pittosporum phillyreoides*
12.	*Acacia colletioides*
13.	*Acacia oswaldii*
14.	*Casuarina cristata*
15.	*Cassia nemophila* (varieties)
16.	*Amyema miquelii*
17.	*Lysiana preissii*
18.	*Lysiana exocarpi*
19.	*Maireana sedifolia*
20.	*Maireana pentatropis*
21.	*Salsola kali*
22.	*Olearia muelleri*
23.	?
24.	*Eremophila glabra*
25.	*Atriplex nummularia*
26.	*Atriplex sp.*
27.	*Rhagodia spinescens var. deltaphylla*
28.	*Rhagodia spinescens var. spinescens*
29.	*Lycium australe*
30.	*Centipeda minima*

31. ?
32. ?
33. *Chenopodium cristatum*
34. *Atriplex sp.*
35. *Reseda lutea*
36. *Ajuga iva*
37. *Oxalis corniculata*
38. *Medicago polymorpha*
39. *Erodium cicutarium*
40. *Onopordon acaulon*
41. *Marrubium vulgare*
42. *Nicotiana glauca*
43. *Malva verticillata*
44. ?
45. ?
46. *Sisymbrium* species
47. *Erodium cygnorum*
48. *Sonchus* species
49. *Zygophyllum ovatum*
50. *Zygophyllum apiculatum*
51. *Zygophyllum aurantiacum*
52. *Nicotiana velutina*
53. *Euphorbia drummondii*
54. *Bassia patenticuspis*
55. *Bassia sclerolaenoides*
56. *Bassia parallelicuspis*
57. (*Bassia* or *Maireana sp.*)
58. *Maireana brevifolia*
59. *Enchylaena tomentosa*
60. *Atriplex sp.*
61. *Cassia sp.*

62. ?

63. *Maireana radiata*

64. ?

TABLE 3.2 - PROMINENT SPECIES

Trees	*Eucalyptus porosa*
	Eucalyptus socialis
	Heterodendron oleifolium
	Myoporum platycarpum
Shrubs	*Acacia colletioides*
	Acacia oswaldii
	Geijera linearifolia
	Lycium australe
	Maireana sedifolia
	Melaleuca lanceolata
	Rhagodia spinescens var. deltaphylla
	Rhagodia spinescens var. spinescens
Low shrubs, grasses, forbs	
	Bassia patenticuspis
	Bassia sclerolaenoides
	Erodium cygnorum
	Maireana tomentosa
	Nicotiana velutina
	Sisymbrium spp.
	Stipa drummondii
	Stipa nitida
	Zygophyllum ovatum

for a sensible compromise of accuracy with simplicity. Thus instead of a map with rectangular shapes, corners have been rounded out. This is, of course, a source of possible error, but at least a fairly accurate picture of the density distribution pattern can be produced.

A second source of error exists in the selection of photographs for the density ratings, and the observer's interpretation as the survey proceeded. Again it was felt that this possibility was of minor importance. The completed maps have been spot-tested at a number of sites in the Reserve and appear to be reasonably accurate.

The species for which density data were obtained are:

Geijera linearifolia	(Plates 3.1-3.3	Map 3.1)
Maireana sedifolia	(Plates 3.4-3.6	Map 3.2)
Melaleuca lanceolata	(Plates 3.7-3.9	Map 3.3)
Myoporum platycarpum	(	Map 3.4)
Zygophyllum apiculatum	(	Map 3.5)
Zygophyllum ovatum	(	Map 3.6)

Distribution maps and a selection of density rating photographs appears in brackets. (See Appendix 3.1 for original data.)

Because a subjective density rating was applied, and not an absolute density rating, valid comparison can be made between densities of each species but not between densities of different species. For example, the highest density of *Maireana sedifolia* is greater (in terms of cover, or number of plants per unit area) than the highest density of *Myoporum platycarpum*. For this reason each species must be considered independently.

(i) *Geijera linearifolia* (Map 3.1) occurs in 73.3% of the samples, remaining clear of the area occupied

Geijera linearifolia density ratings.

Plate 3.1
High density

Plate 3.2
Med. density

Plate 3.3
Low density.

Maireana sedifolia density ratings.

Plate 3.4
High density

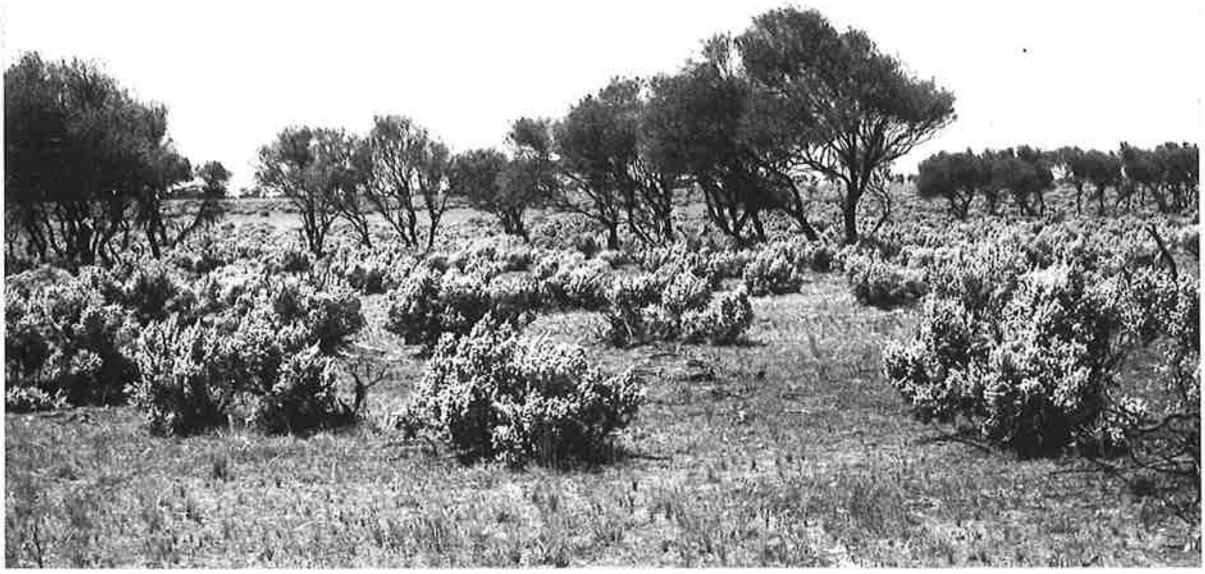


Plate 3.5
Med. density

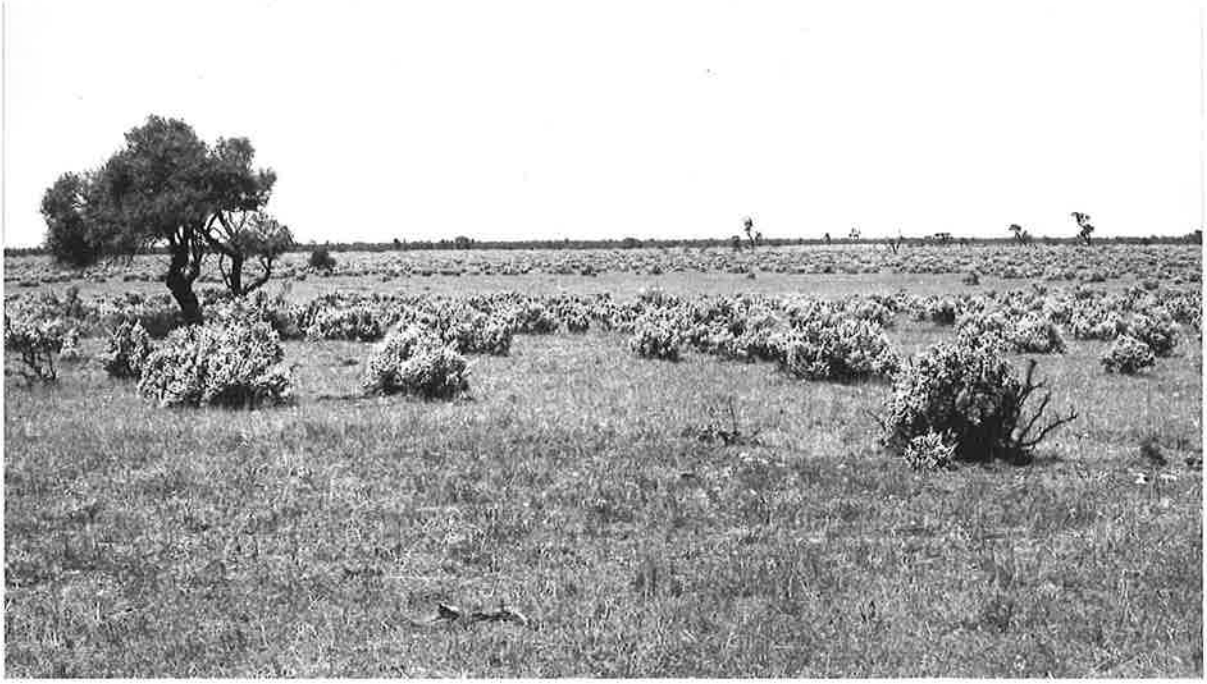


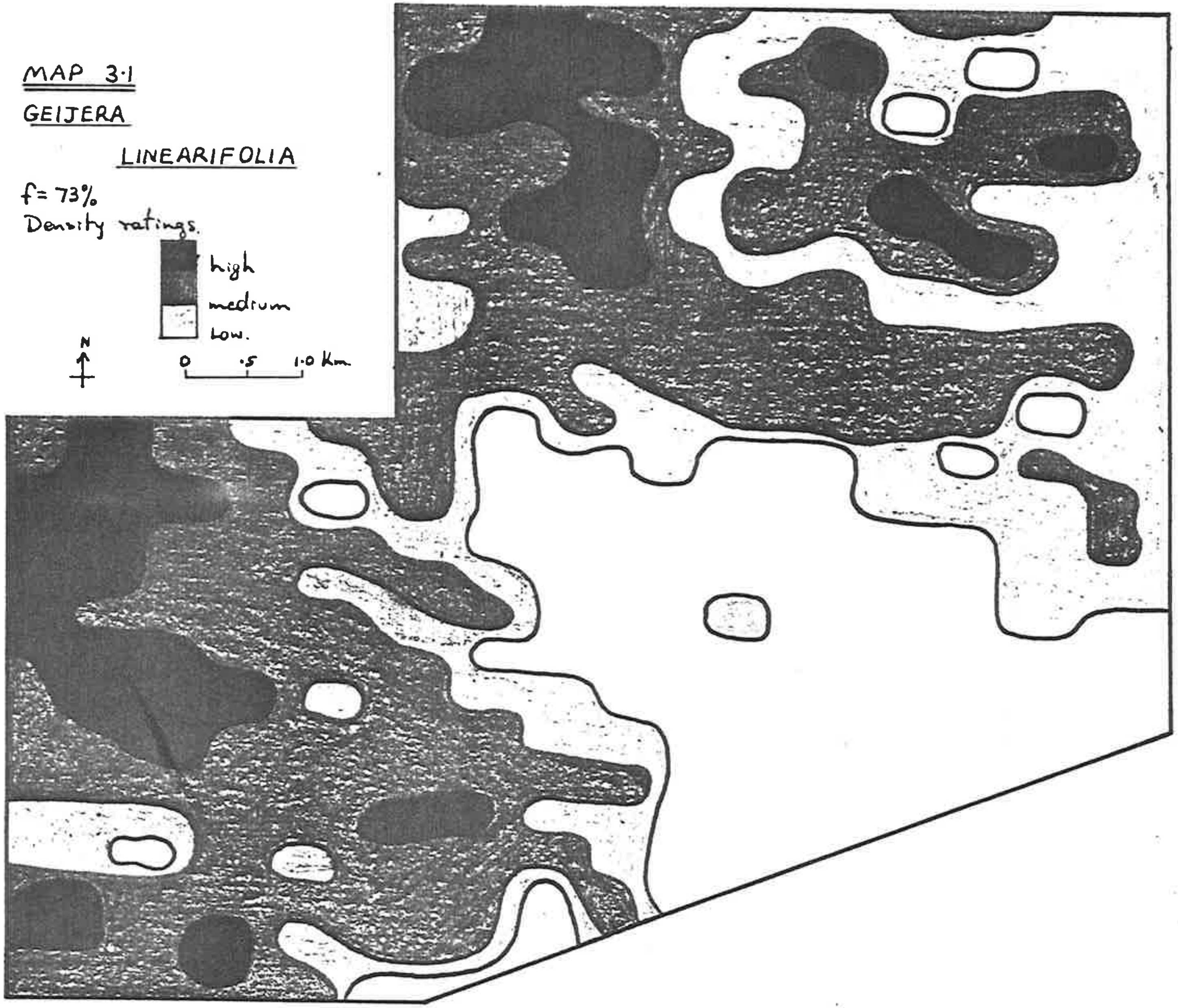
Plate 3.6
Low density

Melaleuca lanceolata density ratings.

Plate 3·7
High density

Plate 3·8
Med. density

Plate 3·9
Low density



MAP 3·1

GEIJERA LINEARIFOLIA

f= 73%

Density ratings.

by *Maireana sedifolia* (Map 3.2). Greatest density occurs in areas along the northern and western boundaries.

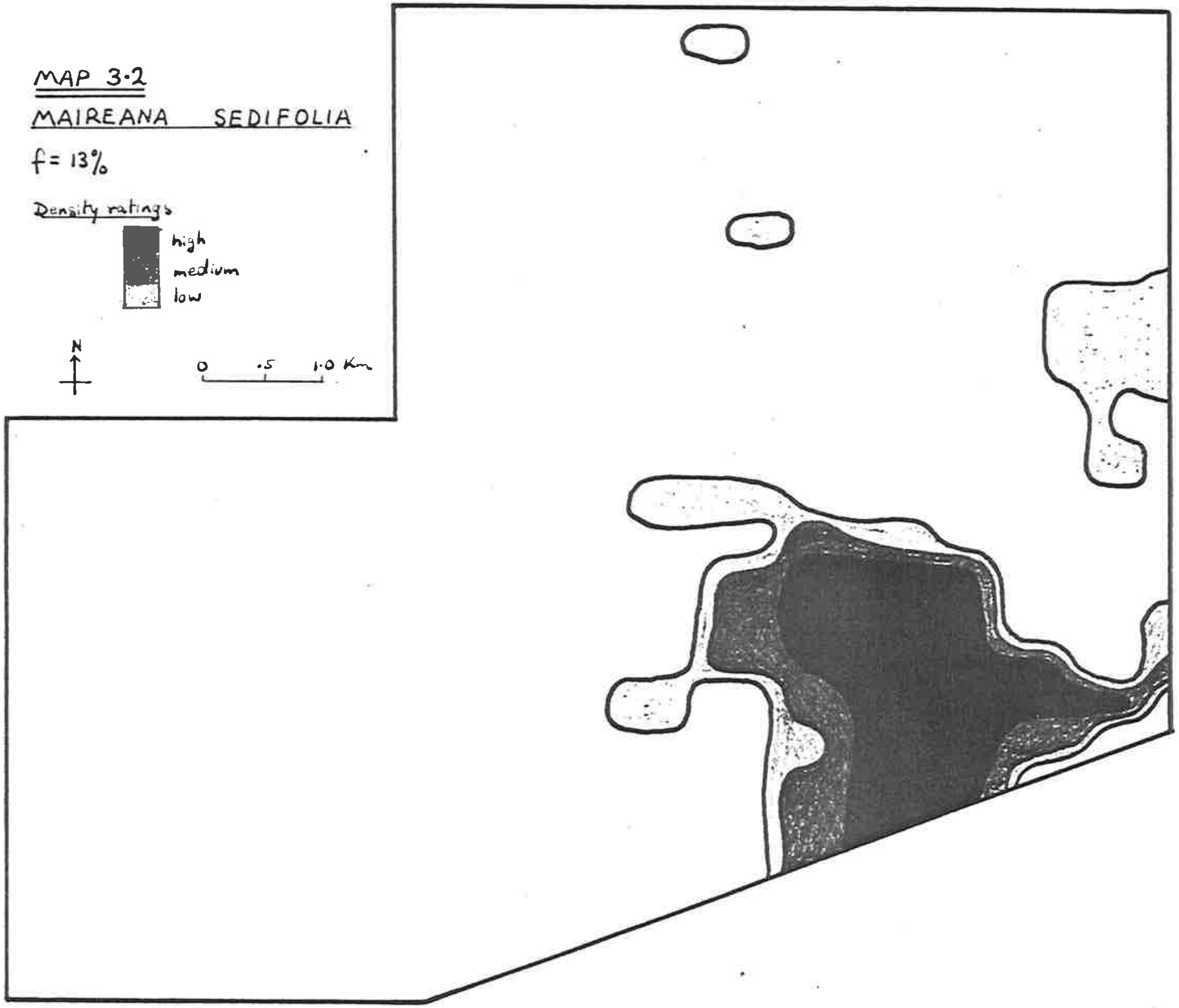
(ii) *Maireana sedifolia* (Map 3.2) occurs in 13% of the area and is concentrated in a dense patch along the southern boundary. From the dead remains of plants it can be seen to have once covered a wider region to the north and west, but it is thought that the pressure of sheep grazing has reduced the area. The area occupied by bluebush is almost devoid of taller species, possibly due to tree-cutting activities of earlier times.

(iii) *Melaleuca lanceolata* (Map 3.3) occupies 35.4% of the Reserve, and occurs in irregular patches throughout the northern and western areas, where overall vegetation density is also greatest. However, regions of greatest *Melaleuca* density do not show any obvious distribution pattern.

(iv) *Myoporum platycarpum* (Map 3.4) occurs in 65.6% of quadrats and is widespread. It does not occur where the *Eucalyptus* species are densest and in the area occupied by *Maireana sedifolia*.

(v) *Zygophyllum apiculatum* (Map 3.5) occurs in 22.8% of quadrats, situated mainly in the northern sector, together with a closely related species *Zygophyllum aurantiacum* (Map 3.14).

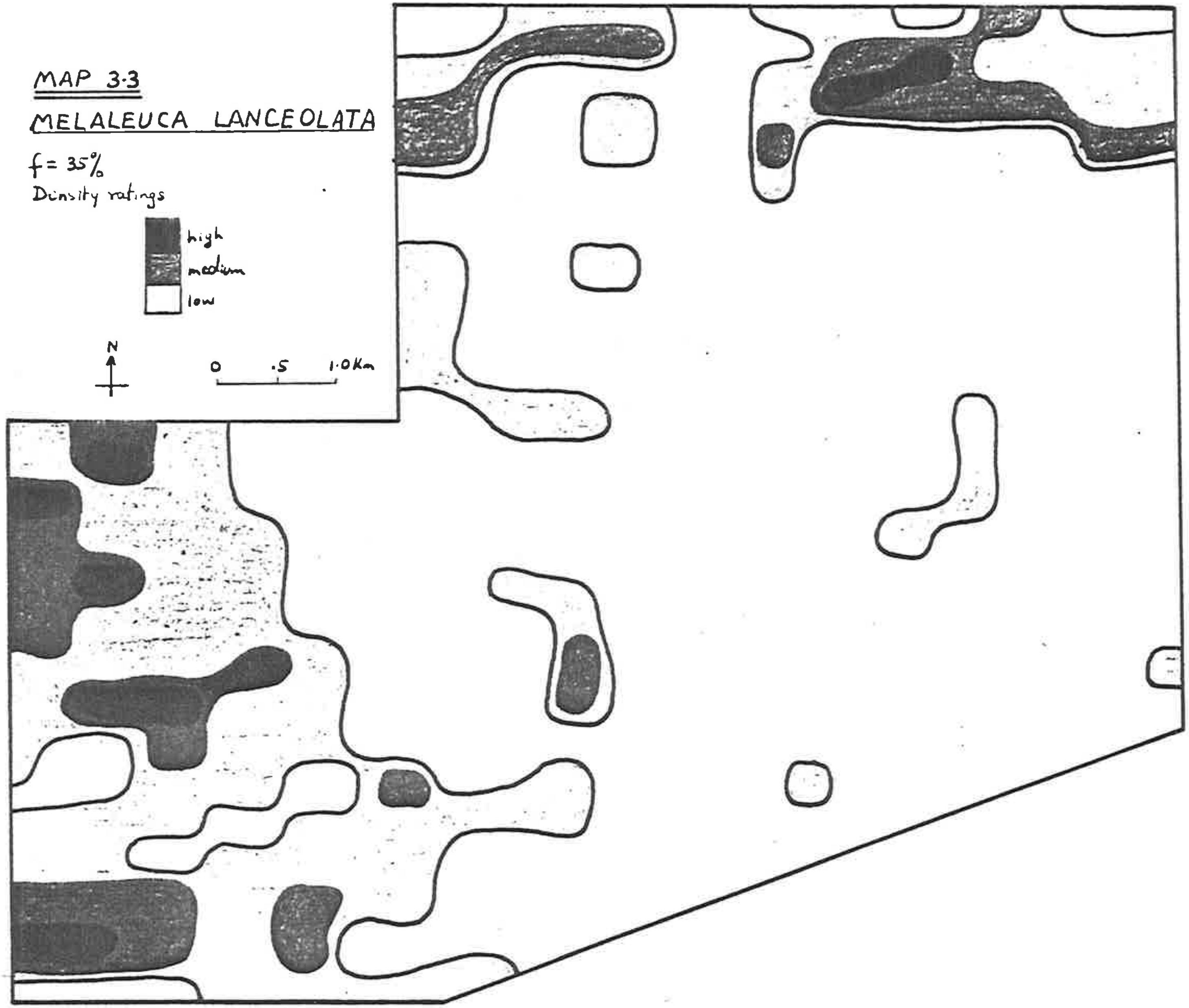
(vi) *Zygophyllum ovatum* (Map 3.6) on the other hand, occurs in 75.1% of samples, and is obviously better suited to the southern region of the Reserve. There appears to be a difference in the environment of this species with that of the other two species of



MAP 3·2

MAIREANA SEDIFOLIA

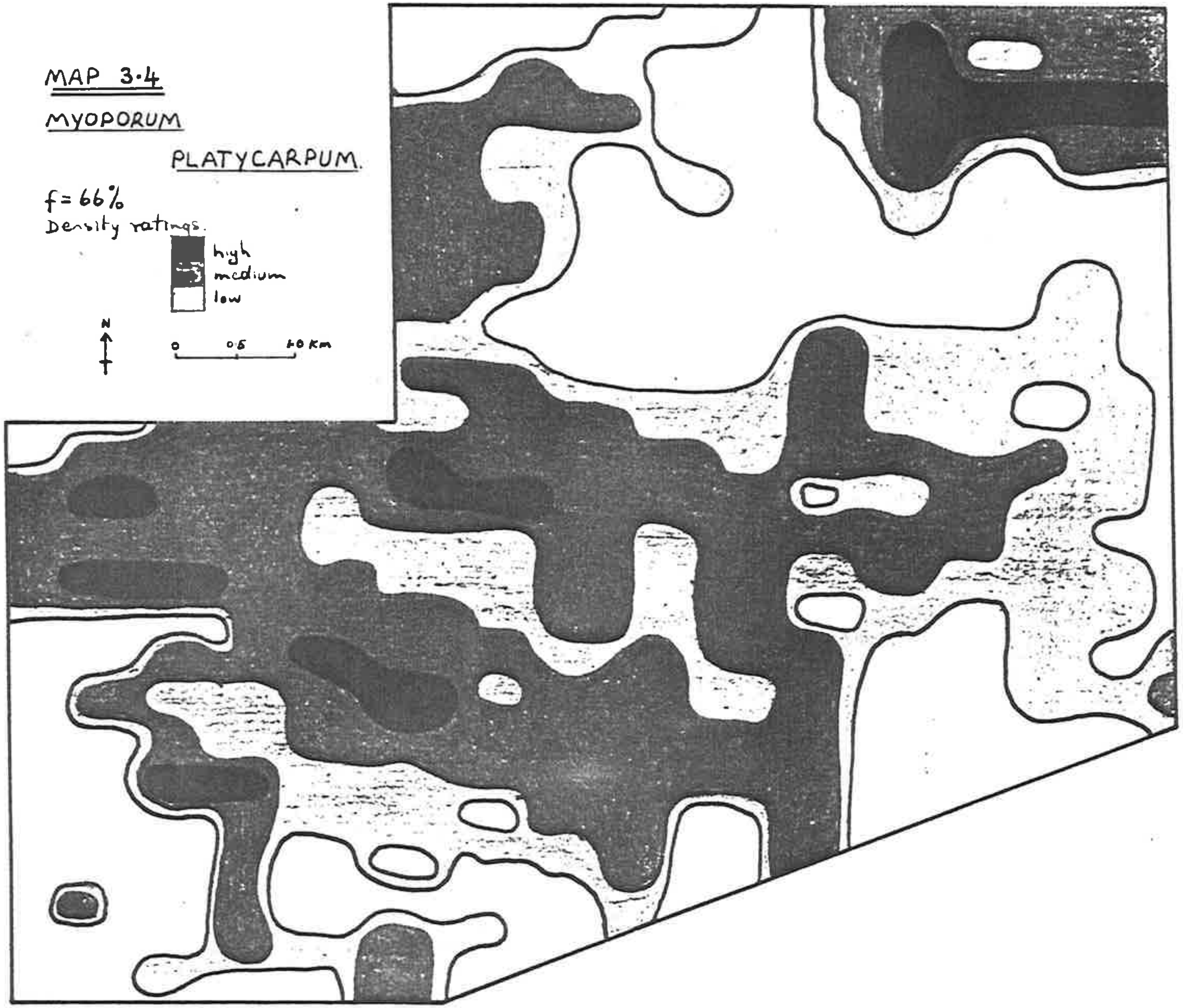
f= 13%



MAP 3·3

MELALEUCA LANCEOLATA

f = 35%

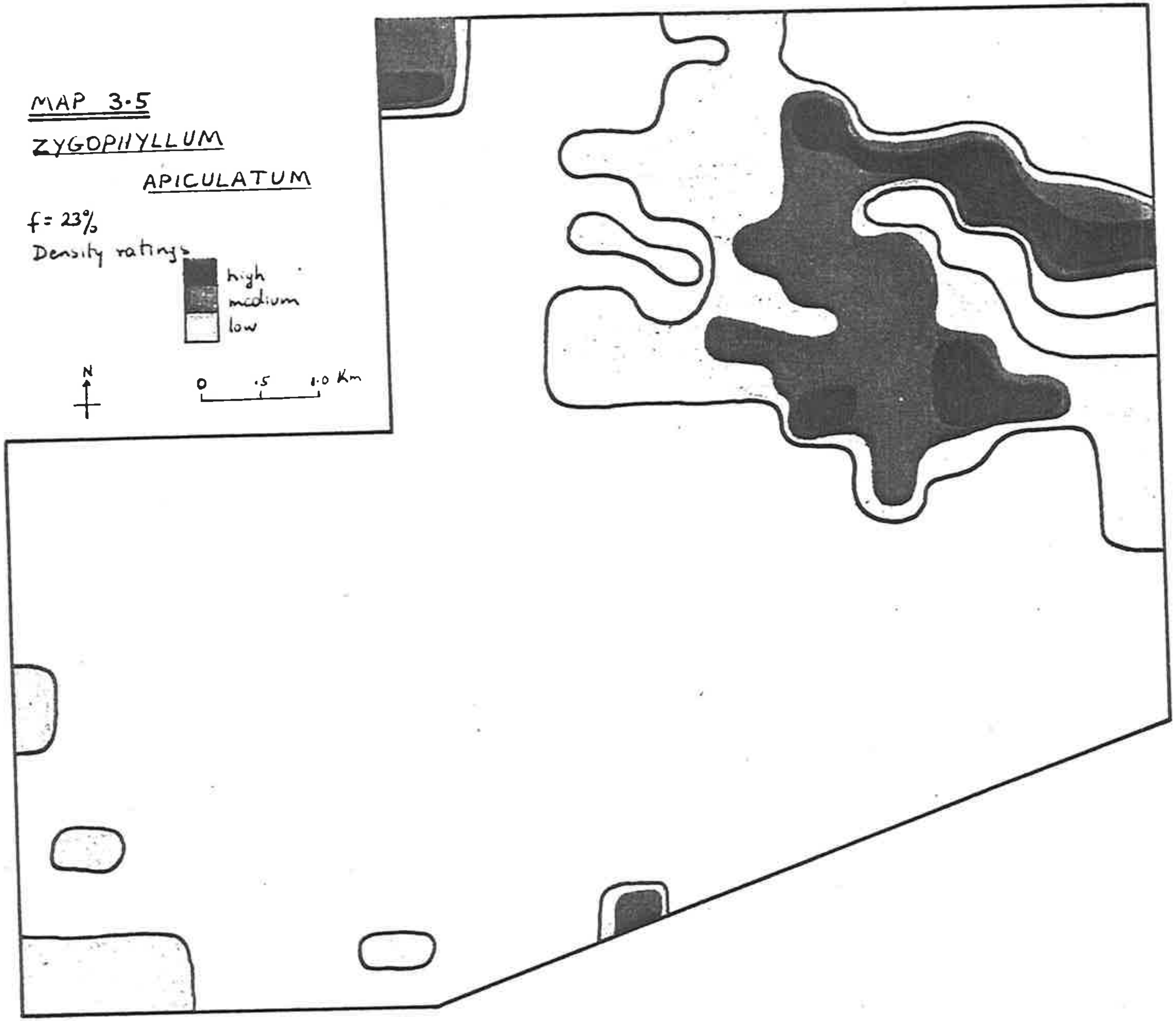


MAP 3.4

MYOPORUM PLATYCARPUM.

f = 66%

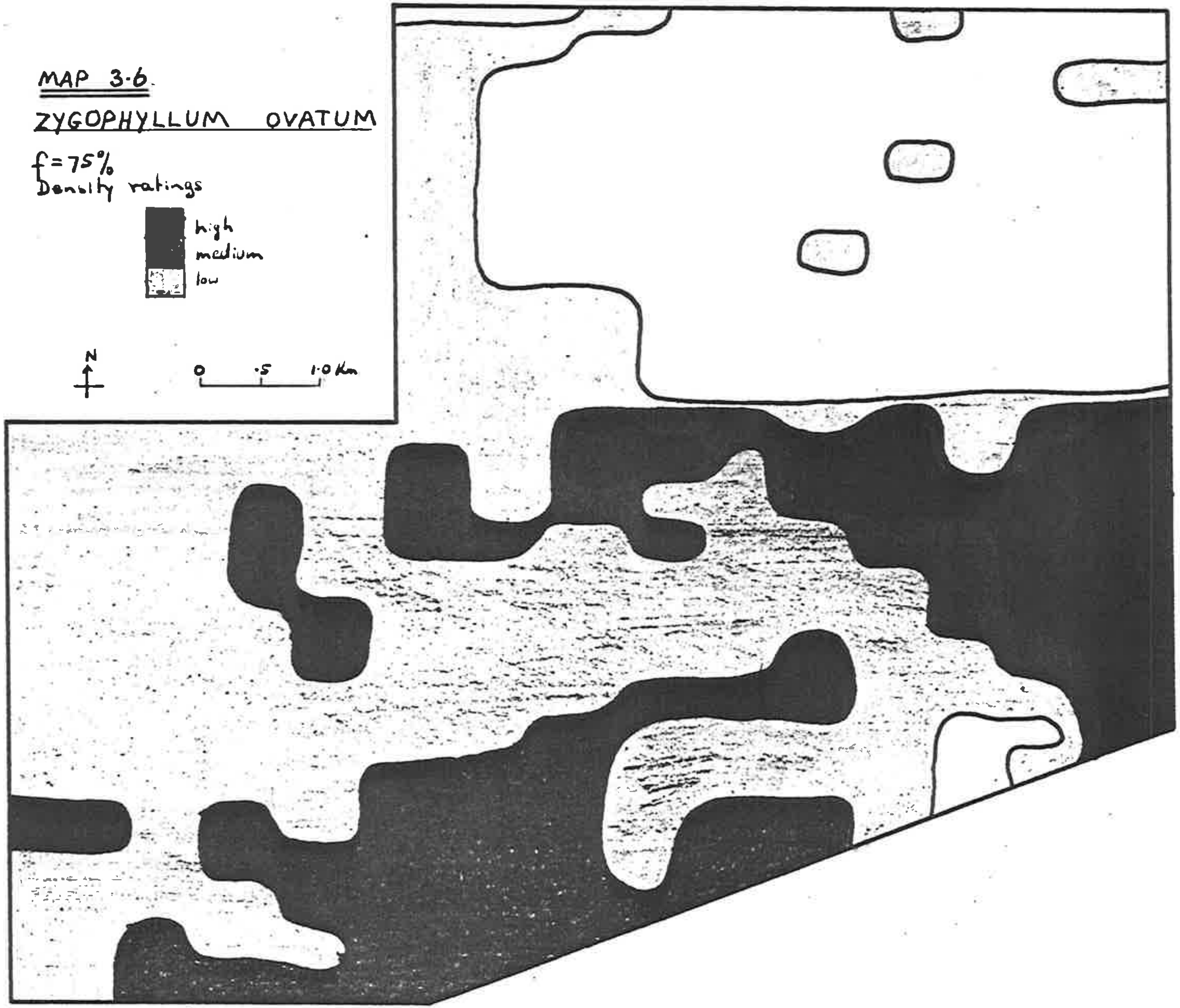
Density ratings.



MAP 3·5

ZYGOPHYLLUM APICULATUM

f = 23%



MAP 3·6.

ZYGOPHYLLUM OVATUM

f = 75%

Zygophyllum; what it might be is not at all obvious.

(c) Distribution according to Incidence

Of the remaining 58 species for which data were recorded during the vegetation survey, a few have been selected on the basis of their prominence, to have their distribution plotted in a similar way to the previous 6 species. (The original data for all 64 species can be found in Appendix 3.2).

These species are :

Acacia colletioides	(Map 3.7)
Bassia parallelicuspis	(Map 3.8)
Erodium cygnorum	(Map 3.9)
Eucalyptus porosa	(Map 3.10)
Eucalyptus socialis	(Map 3.11)
Heterodendron oleifolium	(Map 3.12)
Maireana tomentosa	(Map 3.13)
Zygophyllum aurantiacum	(Map 3.14)

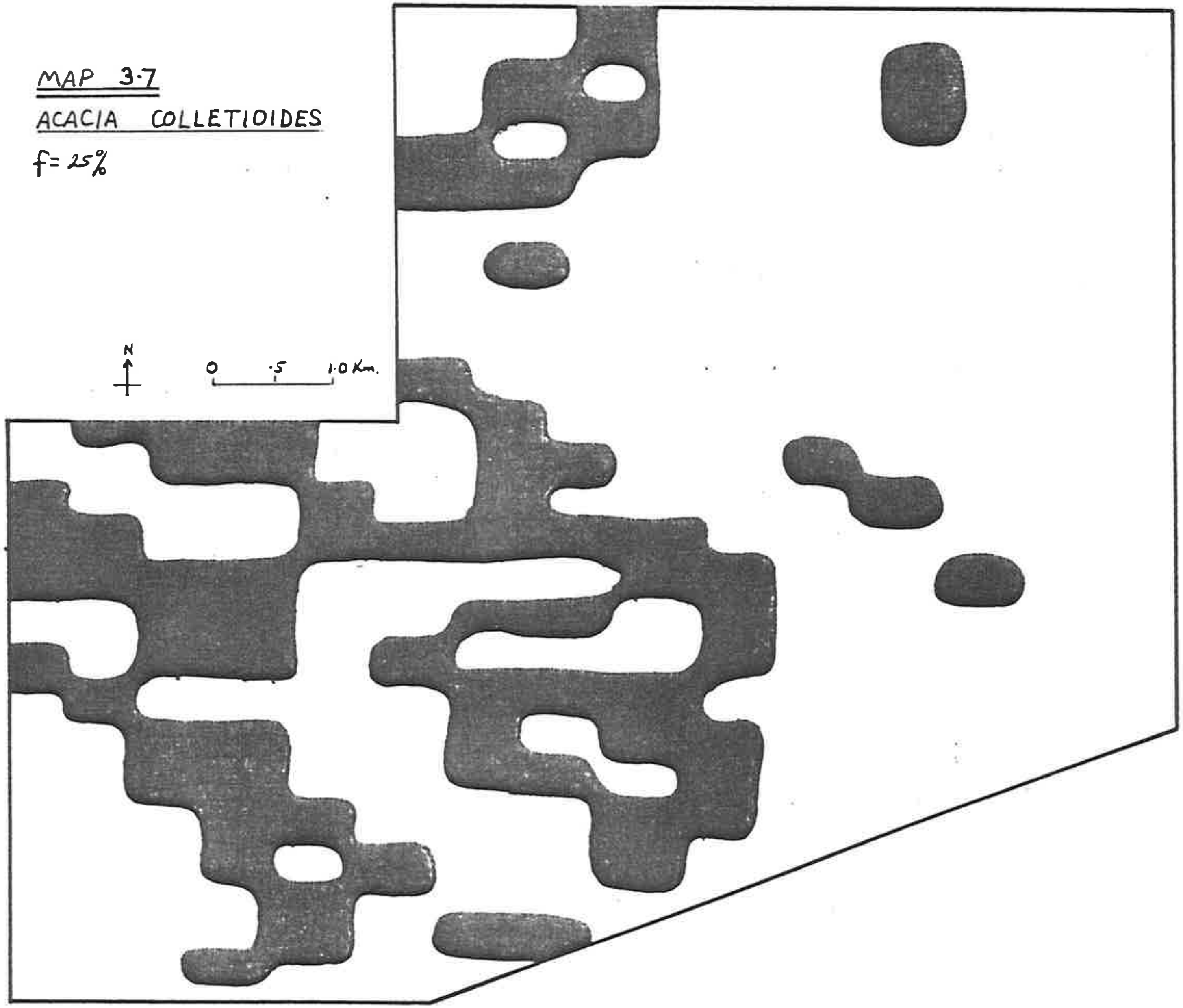
Of particular interest are *Eucalyptus porosa* (Map 3.10) having an incidence of 45.3% and *Eucalyptus socialis* (Map 3.11; 55.4%), which occur together in the northern sector and western boundary. Perhaps there is a very close positive association between these species. The absence of any sign of regeneration in the clearer areas suggests that this may be the case; timber-cutting does not appear to have been the cause for this pattern. The disclimax vegetation has resulted in multi-trunked regenerated *Eucalyptus* species.

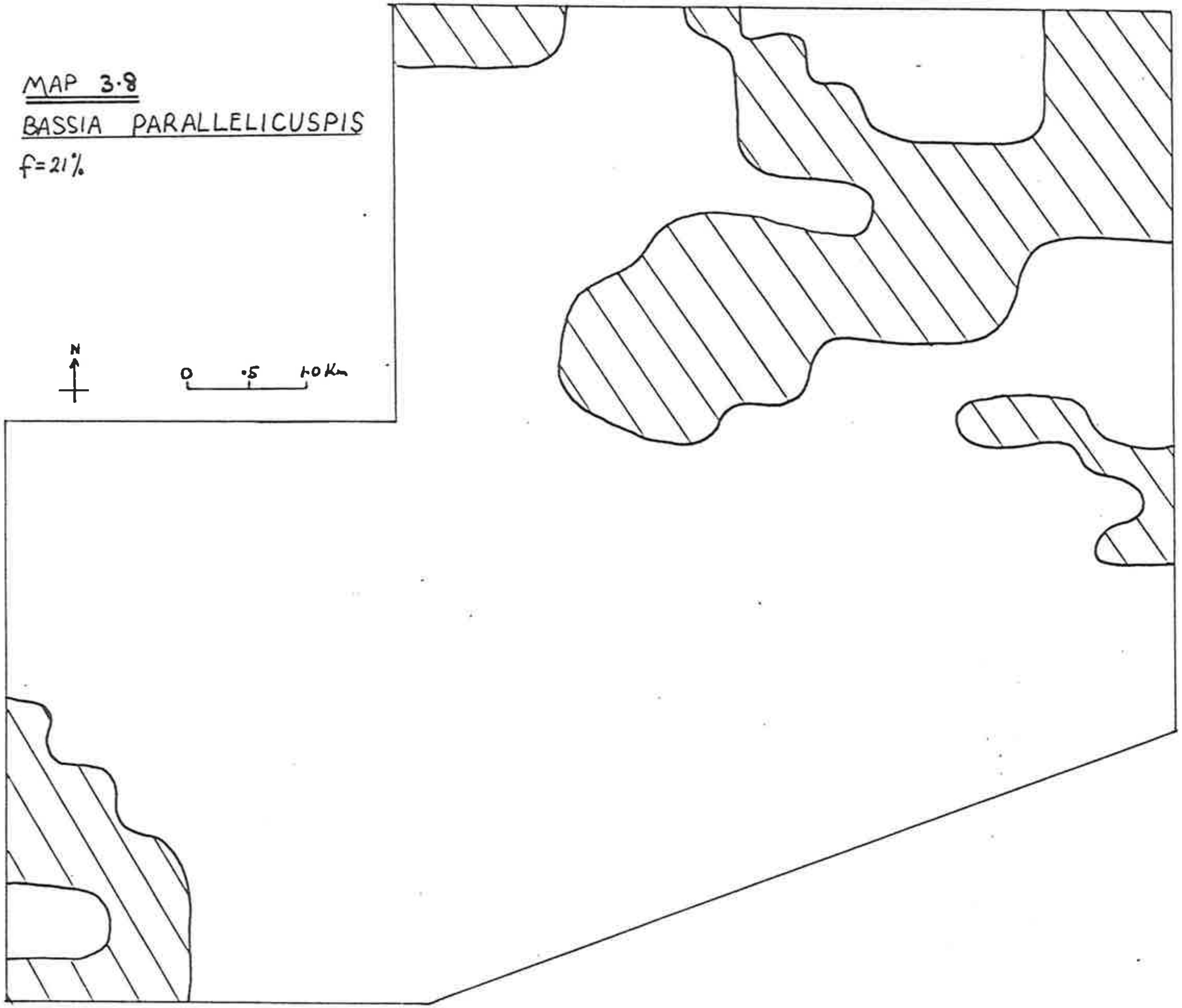
Bullock Bush, *Heterodendron oleifolium* (Map 3.12), has a frequency of 49.5%, and occurs throughout the property, with no apparent relationship with other environmental

MAP 3·7

ACACIA COLLETIOIDES

f= 25%





MAP 3·8

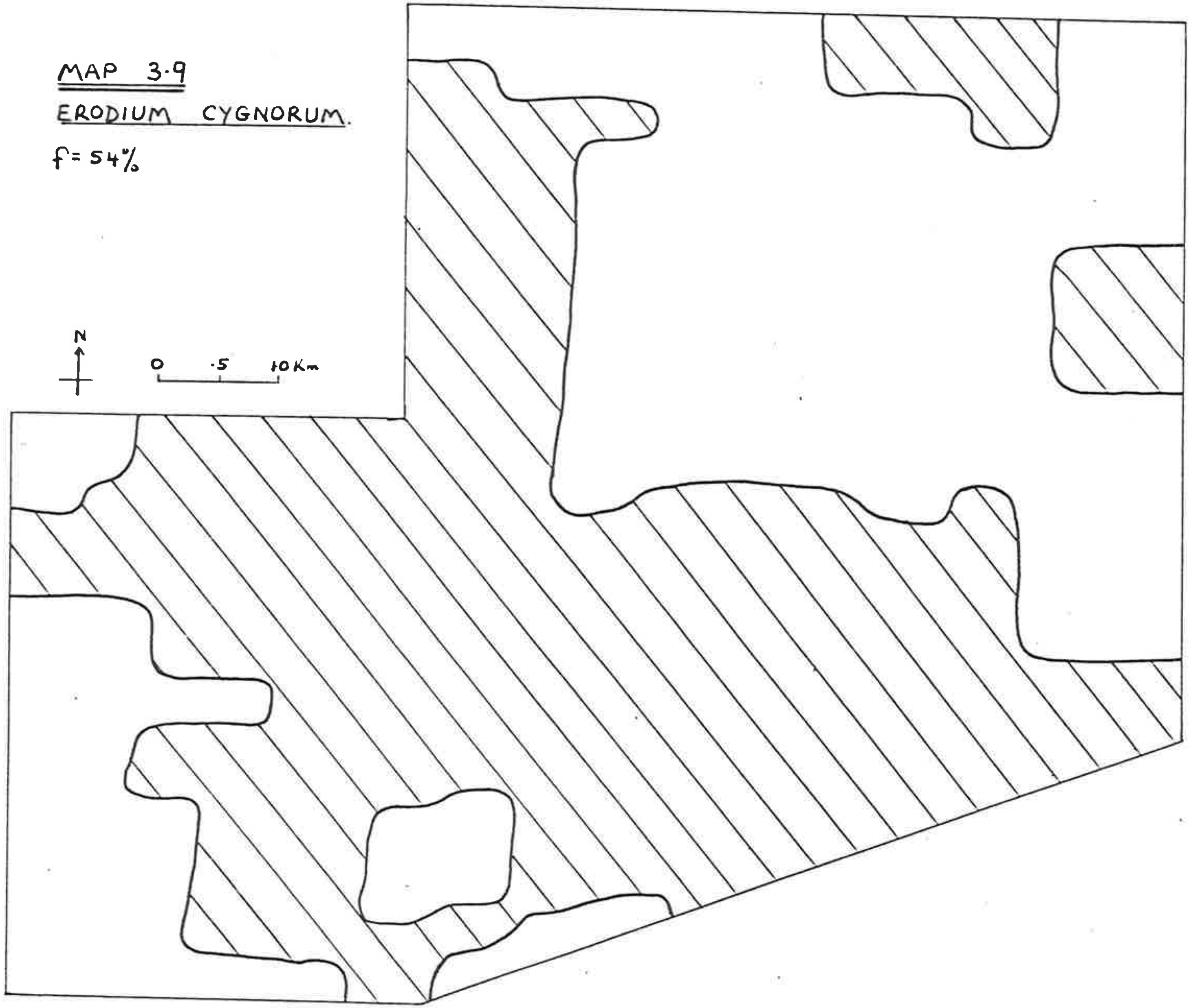
BASSIA PARALLELICUSPIS

f=21%

MAP 3·9

ERODIUM CYGNORUM.

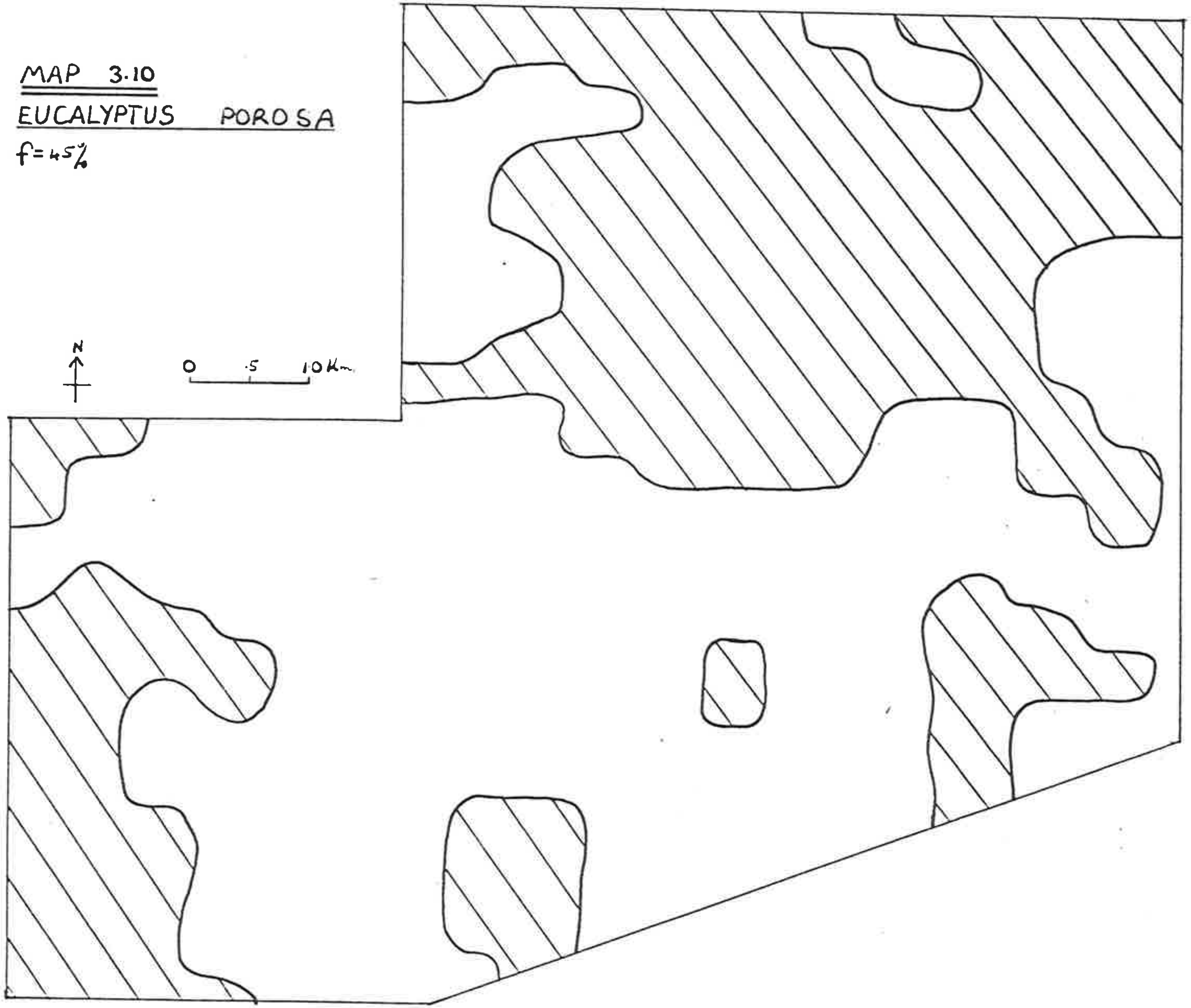
f = 54%

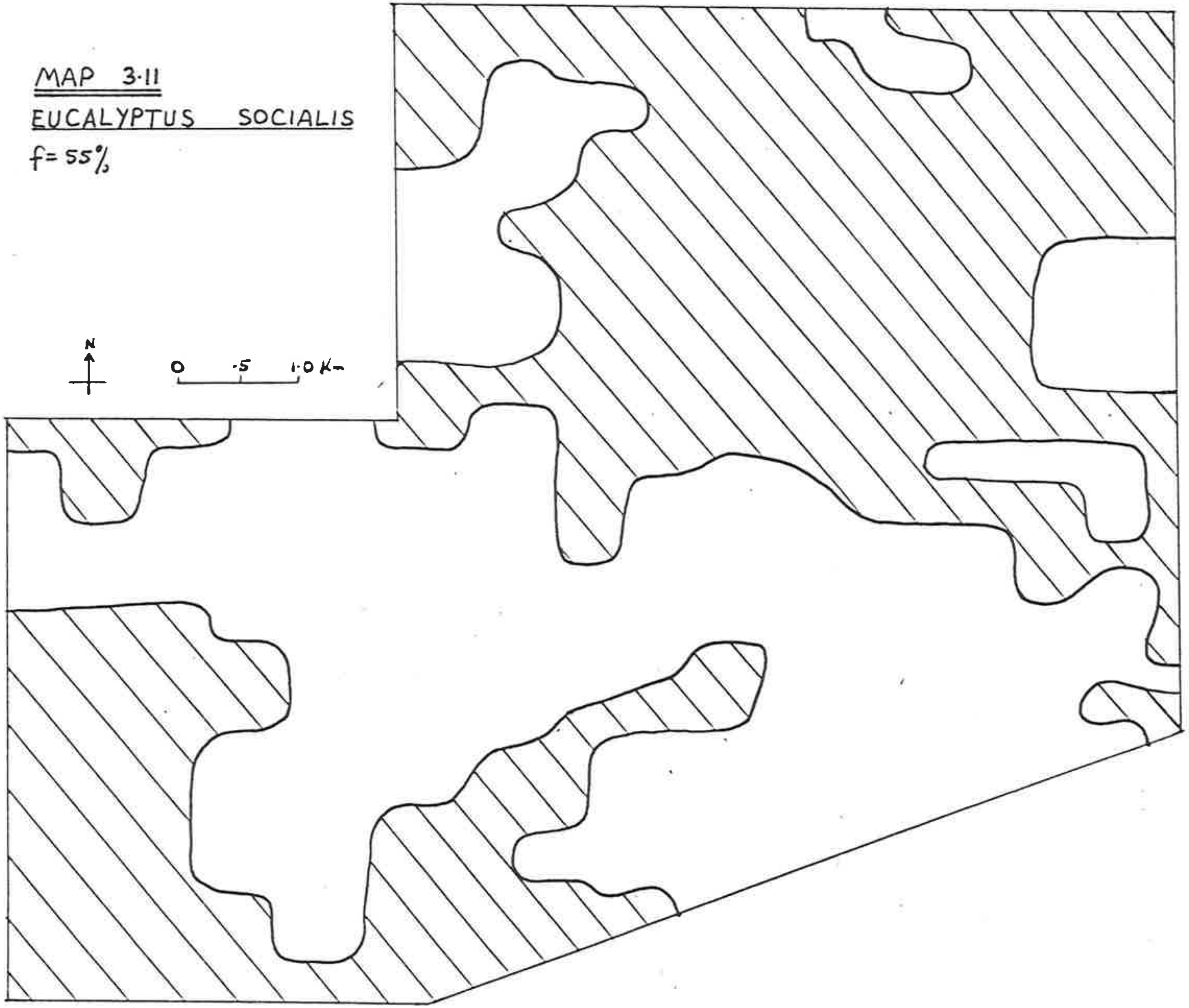


MAP 3.10

EUCALYPTUS POROSA

f= 45%





MAP 3·11

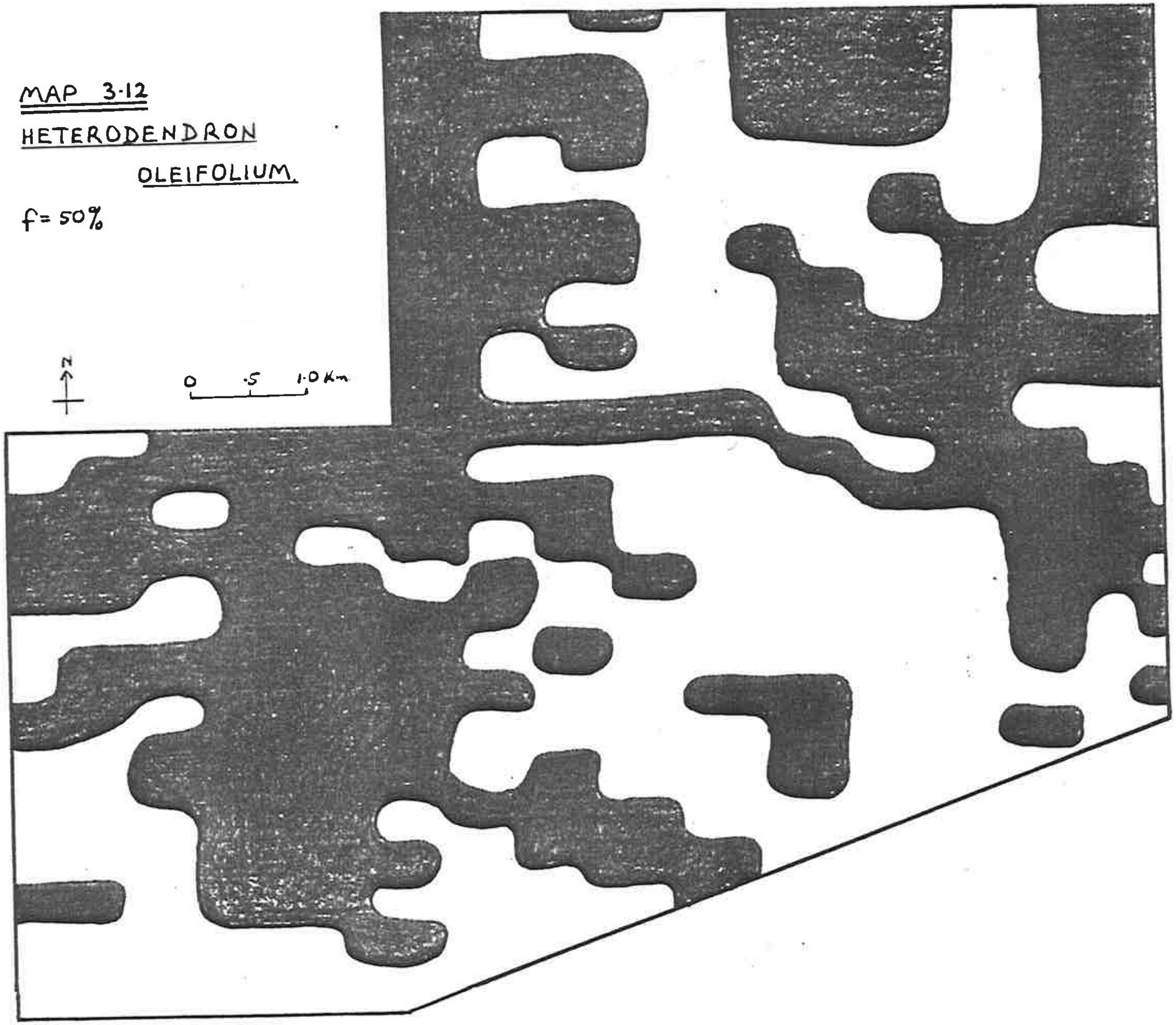
EUCALYPTUS SOCIALIS

f= 55%

MAP 3·12

HETERODENDRON
OLEIFOLIUM.

f = 50%



factors. Three other species with fairly widespread distribution are *Acacia colletioides* (Map 3.7; 25%), *Maireana tomentosa* (Map 3.13; 34.7%) and *Bassia parallelicuspis* (Map 3.8; 20% incidence).

Erodium cygnorum (Map 3.9) occupies 53.7% of the area and occupies a similar region as *Myoporum platycarpum*.

No record was made for *Stipa* species since in the early reconnaissance these species occurred in every area of the Reserve. *Danthonia* species were nowhere near as dense, but similarly occurred throughout the property.

From the two foregoing sections, a number of interesting association questions are posed. For example, how strong is the positive association between the two Eucalypt species? Similar investigations can be made between *Erodium* and *Myoporum*, and *Geijera* and *Maireana sedifolia*. These associations and others are examined in Chapter 4.

(d) Microhabitat Variations

Part of the landscape has been cleared for stock grazing, other parts have been severely lopped and as a result a pattern of vegetation emerges that does not seem to follow any ecologically-based rules. Furthermore, complications have been caused by the introduction of sheep, wombat activity, introduced "weeds", and the existence of claypans and the north-south ridge described in Chapter 1. Taking each in turn :

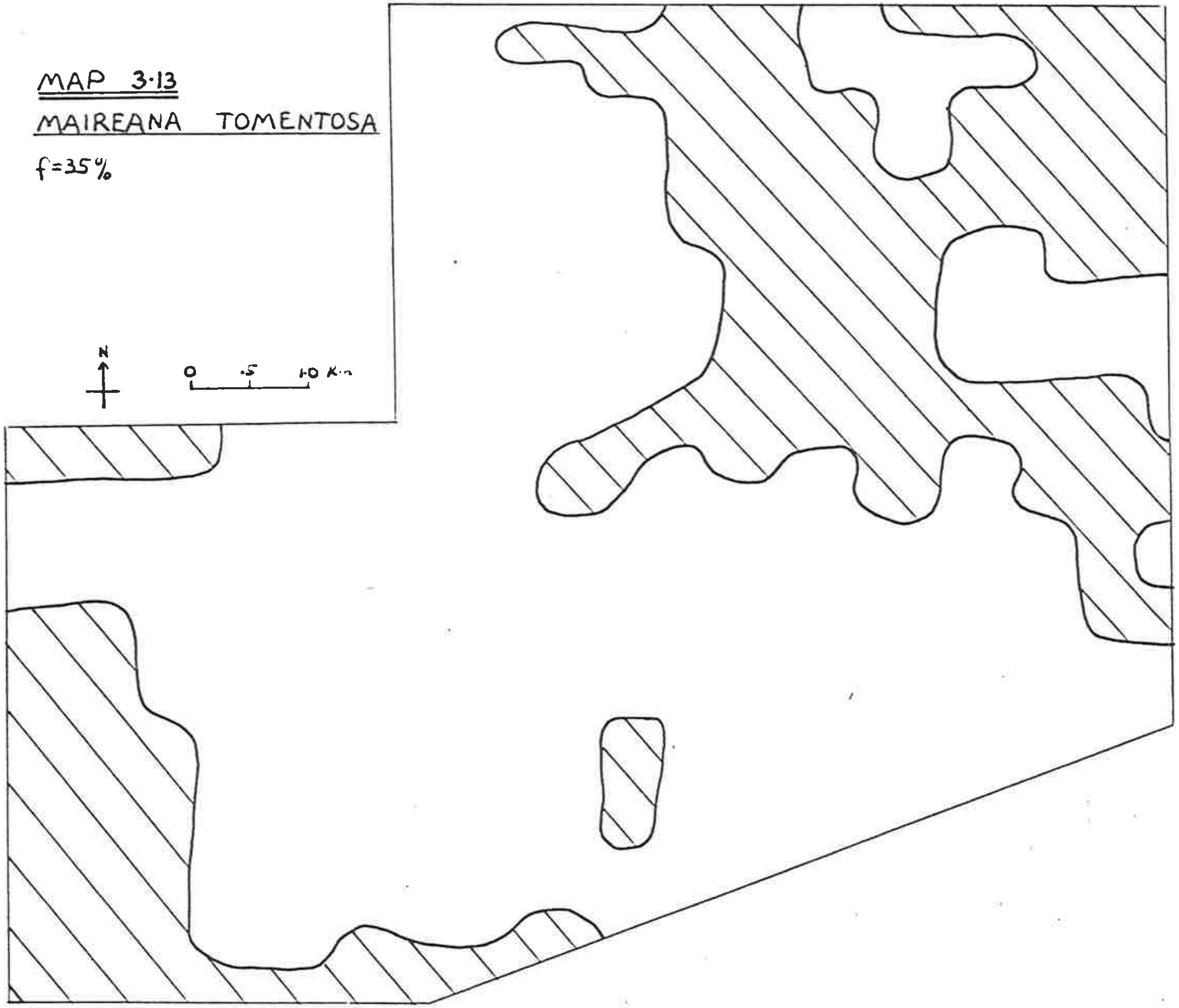
(i) Animal effects

Eremophila glabra, *Cassia nemophila* and Old Man Saltbush (*Atriplex nummularia*), all favoured by sheep, are found scattered mainly in the denser woodland where grasses are more scarce, and in corners of the property where sheep would not

MAP 3·13

MAIREANA TOMENTOSA

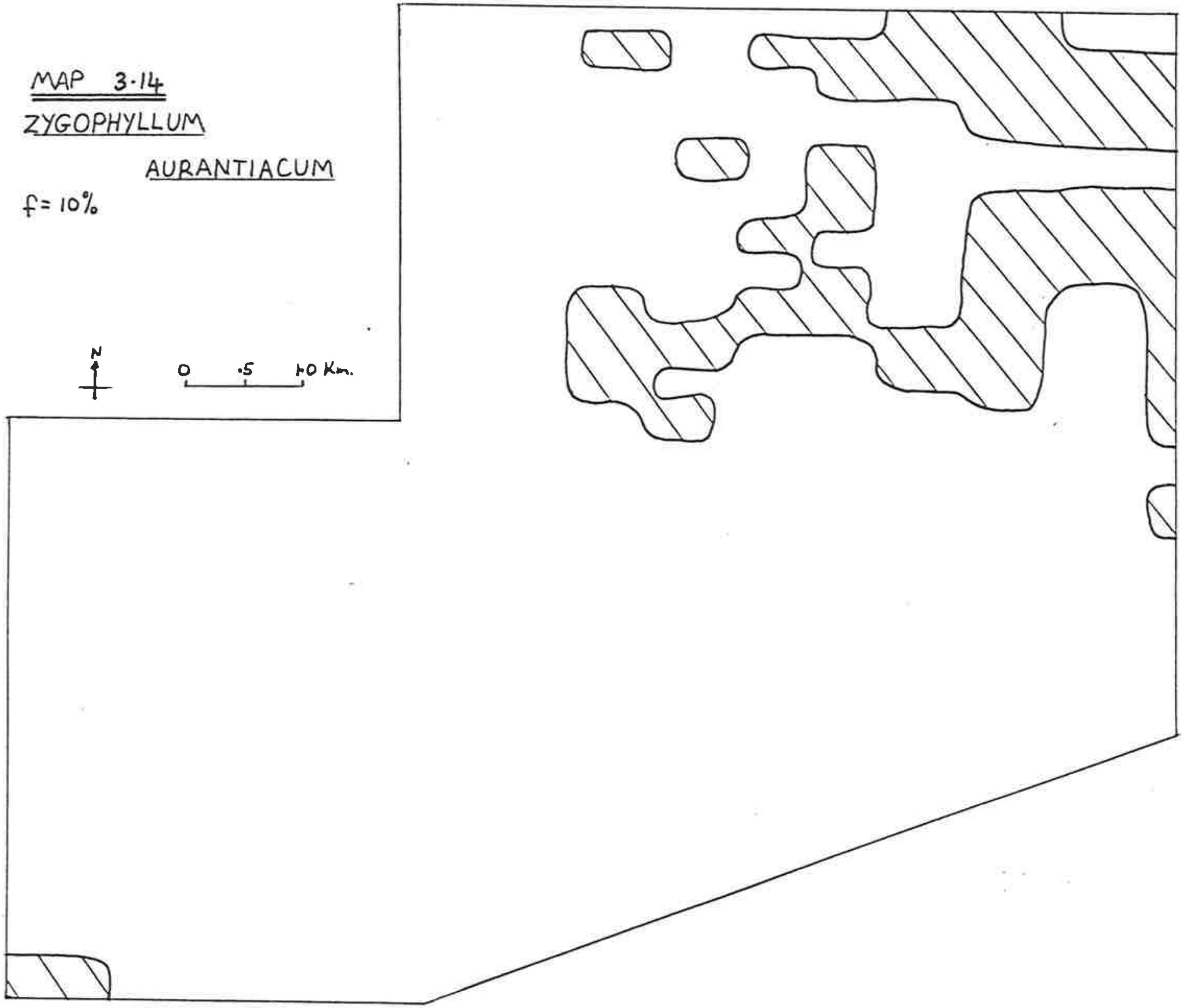
f=35%



MAP 3·14

ZYGOPHYLLUM AURANTIACUM

f= 10%



usually congregate. *Maireana sedifolia* has already been mentioned. The many seedlings encountered during the survey suggests that these species may be able to revive and not be eliminated from the flora of the Reserve.

Around the wombat warrens of the open woodland and grassland, *Stipa*, *Danthonia* and *Schismus* populations are depleted and *Erodium*, *Bassia* and *Zygophyllum* populations flourish. Obviously the grazing and earth-moving habits of the wombats have altered the vegetation dynamics in these localised areas. The grasses are eaten out and the less edible plant species thrive, but to a far greater extent than would be thought reasonable. Perhaps the earth mounds produced by the wombats act as a moisture reservoir, so sustaining lusher populations particularly of *Erodium*. Maybe the removal of competition for resources such as water, has allowed the existence of the distinctive vegetation around warrens. (Plate 3.10.)

This microhabitat is examined in depth in Chapter 5.

(ii) Landforms

Porcupine grass (*Triodia irritans*) occurs along the top and sandy slope of the north-south ridge found in the northern sector. It appears to be well suited to the deeper relatively stable sand that only occurs in this region. (Plate 3.11.)

In lower-lying areas, water tends to be trapped in basins of limestone. Runoff carries clay particles into these basins and claypans are formed.

Plate 3.10 Zone 1 warren (13/10/73).

The soil conditions of this microhabitat appear to sustain a unique flora consisting mainly of *Centipeda minima*, *Ajuga iva* and *Reseda lutea*, none of which occur in other areas of the Reserve. (Plate 3.12.)

(iii) Introduced Plants

A microhabitat exists around fallen trees and living trees, especially *Myoporum* over most of the open woodland and grassland. Presumably, sheep gathered at these spots for shade on hot days, and the exotic plant species brought there in their wool. These microhabitats with their own microclimates sustain a unique flora which includes a number of species of the family Brassicaceae. Even after removal of the sheep these annuals remain in large numbers. The lack of spread indicates unsuitable conditions in the remainder of the Reserve for their existence.

The greatest effect of introduced species occurs along the southern boundary as a result of the sealed highway and transport of seeds by vehicles. These plants include : *Salsola kali*, *Nicotiana glauca*, *Onopordon acaulon*, *Marrubium vulgare*, *Malva verticillata*, *Sisymbrium spp.*, *Sonchus spp.*, *Picnomon acarna*, *Echium lycopsis*, *Hordeum leporinum*. Some have spread northward, probably by the action of sheep movement (attachment to wool or trotters) and wind, but the concentration is on the roadside where runoff from the road increases the available water to this microhabitat.

Plate 3.11 *Triodia* on the sandy rise.

Plate 3.12 Typical claypan vegetation.

CHAPTER 4

COMMUNITY ORGANISATION AND THE VEGETATION MAP

From the previous chapter it will be self-evident that the vegetation of the Reserve is complex since there are over 120 species each with its individual distribution pattern. No ecologist can envisage all of the patterns simultaneously. In the Reserve, as elsewhere, it is necessary to determine which of the many features of the vegetation should be noticed first, because they seem to be the most important and to produce some form of map which displays these features.

A very great deal has been written about the production of vegetation maps. For broad-scale work, notice is usually given to the structure of the vegetation for the floristics of the predominant species only. To take notice of more than these features produces more details that can be accommodated conveniently at any reasonable mapping scale. However, at smaller scales structural maps are insufficiently perceptive of the details and ecologists can afford a more perceptive analysis with confidence that its main features are capable of being mapped. A further feature that determines the kind of map that can be made is man-hour cost. In the present case we have an area of about 65 sq. km. within which information is required at a scale of a few hundred metres. Situations like this are highly ammenable to influence analysis which combines the best features of objectivity, minimal cost for maximal information and adaptability for mapping purposes.

The 2 best known strategies for influence analysis, or more generally, association analysis, are those of Goodall (1953), Williams & Lambert (1959-61). These have been discussed and disseminated in the major text book of "Quantitative Plant

Ecology", Grieg-Smith 1964. Lange (1968 & 1971) discussed these techniques and pointed out certain modifications that he considered necessary for their use in S.A. vegetation. First, he pointed out that the original strategies are preoccupied with sorting vegetation samples into a single set of mutually exclusive groups, according to a criterion of group homogeneity. These strategies, he argued, are not suitable for analysis as in the present case, where interspecific interactions may exist, but may be mutually exclusive, i.e. to say, within the one target area, one set of interactions may relate for example to soil types while a second interdependent set of interspecific interactions may reflect the grazing factor, and there may be no interactions between the 2 groups. It would appear that the strategies of Goodall (1953) and Williams & Lambert (1959) make no provision to discriminate between 2 such independent sets of interactions in the one target area.

The work of Welbourn & Lange (1968) on vegetation of the Lower S.E. of S.A. shows clearly that these limitations do apply to the two afore-mentioned strategies. The influence analysis recommended by Lange (1971), on the other hand, is demonstrably capable of discriminating between independent sets of interactions in the one target area (see Lange (1971) fig. 2). For these reasons a similar form of analysis has been adopted for use in the present study. Influence analysis requires the collection of incidence data from quadrats representing the diversity of situations in the Reserve. Data as collected in the preceding chapter are ideal for the purpose. Lange, Stenhouse & Offler (1965), however, established that data on incidence which are either too infrequent or too frequent, are of no use for the purposes of influence analysis because they lead to spurious χ^2 values. Accordingly, data collected in the present chapter were vetted to eliminate, or set to one side, those species for which the scores were either less than 20 or more than 220. This left 30 species capable of supporting an influence analysis of the Reserve.

37 species appear on the computer printout (Appendix 4.1), but 7 were omitted because their inclusion would not be meaningful. Computer number 7 was left out for ease of distinguishing between 5 and 6. 15 and 22 occur mainly along the road and appear to have been introduced, 17 occurs in small pockets where sheep have not had easy access; it was probably more widespread before the introduction of sheep. 21 occurs only in claypans, 23 around wombat warrens and along the roadside, and 24 covers species introduced to selected habitats by sheep. It is likely that 37 covers a mixture of species, whose younger stages appear similar.

Table 4.1 lists the 30 species and their frequencies in the 285 quadrats.

Data on the incidence of these 30 species over the 285 quadrats were punched for computation using program Lange, a program written for the CDC6400, computer at Adelaide University.

Program Lange, in effect, compiles the 2x2 contingency tables for each species pair in turn, computes the χ value for association with the sign negative or positive, and prints a species by species matrix of which cell entries are the signed χ values. (Table 4.2). The program then sorts species pairs in descending order of χ value, starting with the highest positive χ values and printing out pairs in descending order to non-significant levels of positive association and then ascending levels of negative association, terminating with the pair having the highest negative association. (Table 4.3).

TABLE 4·1

	Voucher Specimen Number	Computer Number	Species	No of quadrats found/285	% frequency
	1	1	Geijera linearifolia	209	73·3
*	2	2	?	30	10·5
	3	3	Myoporum platycarpum	187	65·6
	4	4	Heterodendron oleifolium	141	49·5
	5	5	Eucalyptus porosa	129	45·3
	6	6	Eucalyptus socialis	158	55·4
*	7	7	hybrid Eucalyptus		
	9	8	Exocarpos syrticolus	115	40·4
	10	9	Melaleuca lanceolata	101	35·4
	11	10	Pittosporum phillyreoides	34	11·9
	12	11	Acacia colletioides	82	28·8
	13	12	Acacia oswaldii	52	18·2
	19	13	Maireana sedifolia	37	13·0
	20	14	Maireana pentatropis	99	34·7
*	21	15	Salsola kali		
	22	16	Olearia muelleri	30	10·5
*	25	17	Atriplex nummularia		
	26	18	Atriplex sp.	36	12·6
	27	19	Rhagodia spinescens. var. delt	56	19·6
	28	20	Rhag. spines. var. spinescens	22	7·7
	36	21	Ajuga iva	128	44·9
*	41	22	Marrubium vulgare		
*	42	23	Nicotiana glauca		
	46	24	Sisymbrium sp.	128	44·9
	47	25	Erodium cygnorum	153	53·7
	49	26	Zygophyllum ovatum	214	75·1
	50	27	Zygophyllum apiculatum	65	22·8
	51	28	Zygophyllum aurantiacum	29	10·2
	52	29	Nicotiana velutina	23	8·1
	54	30	Bassia patenticuspis	173	60·7
	55	31	Bassia sclerolaenoides	193	67·7
	56	32	Bassia parallelicuspis	60	21·1
	58	33	Maireana brevifolia	23	8·1
	59	34	Enchylaena tomentosa	36	12·6.
	29	35	Lycium australe	64	22·5
	53	36	Euphorbia drummondii	22	7·7
*	57	37	?		

* omitted.

TABLE 4·2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1																																					
2	34																																				
3	-25	-2																																			
4	41	23	51																																		
5	44	9	-84	-37																																	
6	56	-2	-76	-24	84																																
7	-16	-3	-13	10	-9	-11																															
8	45	31	6	38	16	12	-8																														
9	44	17	7	39	-1	17	-7	18																													
10	12	8	18	22	-34	-25	-3	19	7																												
11	-12	10	52	19	-34	-45	-6	15	18	25																											
12	-45	-17	44	3	-26	-33	-4	-3	-10	13	30																										
13	-84	-22	28	-39	-13	-40	-3	-6	-37	-23	-2	33																									
14	46	-1	-62	-24	65	72	-7	0	4	-26	-45	-32	-25																								
15	-7	-11	-7	-15	-12	5	-2	-15	7	-2	5	15	-13	7																							
16	34	17	-55	-30	48	48	-3	11	-10	-15	-28	-22	-10	55	-11																						
17	12	-6	3	10	1	-2	-1	24	6	8	-12	3	-7	-4	-4	9																					
18	5	1	-28	-17	16	21	-3	-5	-10	9	-13	-30	-3	35	14	24	7																				
19	36	19	-52	-14	58	44	-4	28	-2	-12	-26	-31	-14	58	-1	34	2	44																			
20	-5	4	-16	-17	35	12	-2	27	-22	-17	8	11	40	15	13	48	-5	28	37																		
21	4	-0	16	-12	-16	-35	-1	-13	3	-1	7	9	-12	10	10	-11	50	-2	-7	-9																	
22	9	18	10	0	-12	-1	-0	2	4	16	22	-6	-5	-10	-2	-4	-1	-5	-7	-4	-2																
23	-12	0	14	-9	-7	-13	-1	2	-1	-11	-4	-5	-1	6	-6	-10	-3	-11	10	-8	49	-2															
24	48	44	17	39	-4	-14	-9	46	6	32	13	-13	-37	-13	0	-9	22	-7	26	0	16	15	6														
25	-51	-4	96	38	-98	-102	9	-13	11	39	57	55	39	-97	0	-54	18	-33	-62	-16	29	-1	14	15													
26	-40	-24	44	5	-71	-48	5	-37	11	6	31	28	13	-44	12	-46	-11	-28	-65	-23	3	8	17	-47	55												
27	45	9	-73	-23	61	70	-5	10	-26	-16	-42	-39	-22	66	-11	69	1	3	54	26	-17	-7	-8	5	-87	-61											
28	25	6	-41	-13	42	35	-3	17	-9	-2	-27	-6	-16	32	-1	50	43	19	40	27	10	-4	-10	19	-29	-66	57										
29	5	11	27	15	-32	-25	-2	-10	8	35	16	-6	-19	-18	1	-17	-5	13	-13	-6	25	21	3	20	29	13	-22	-2									
30	-7	-0	34	10	-32	-14	8	0	-23	1	-4	13	-26	-5	14	-44	5	4	-3	-33	6	-3	10	5	17	22	-24	-14	0								
31	21	-1	-31	-3	42	61	-14	-10	-3	-19	-37	-30	-19	47	3	23	-7	9	35	-13	-32	-5	6	0	-57	-26	51	18	-16	30							
32	45	12	-86	-36	78	72	-5	8	-15	-14	-52	-37	-16	76	-2	69	1	28	62	40	-16	-7	-7	-2	-90	-60	91	57	-25	-28	38						
33	15	4	-0	2	2	22	-2	3	12	-4	-7	-6	-6	27	12	4	-5	26	24	9	-9	-4	15	7	-32	-11	14	4	1	13	11	27					
34	30	12	-17	18	34	32	-3	27	12	-1	-9	-16	-14	43	-3	24	7	29	71	14	-2	-5	-1	31	-36	-57	37	25	-12	-14	17	32	20				
35	6	5	50	26	-34	-24	-5	9	9	45	61	15	-13	-39	3	-21	-10	-8	-19	-5	-1	9	-0	15	38	29	-45	-30	25	23	-16	-39	-0	-17			
36	-5	-9	21	0	-26	-5	-2	-17	10	2	22	-0	0	-26	-9	-16	-5	-11	-12	-14	14	22	16	-17	23	28	-5	-9	42	7	0	-25	-6	-18	10		
37	3	6	-21	-4	15	20	-1	-0	2	5	-14	-10	-8	11	-4	-7	-2	5	34	-6	-4	-1	-4	6	-24	12	19	22	-6	8	5	-0	-6	-8	-1	10	

TABLE 4·3

90L	25, 3	32, 27								
80L	6, 5									
70L	14, 6	27, 6	32, 5	32, 6	32, 14	34, 19				
60L	14, 5	27, 5	27, 14	27, 16	31, 6	32, 16	32, 19	35, 11		
50L	4, 3	6, 1	11, 3	16, 14	19, 5	19, 14	21, 17	25, 11	25, 12	26, 25
50L	27, 19	28, 16	28, 27	31, 27	32, 28	35, 3				
40L	4, 1	5, 1	8, 1	9, 1	12, 3	14, 1	16, 5	16, 6	19, 6	19, 18
40L	20, 13	20, 16	23, 21	24, 1	24, 2	24, 8	26, 3	27, 1	28, 5	28, 17
40L	28, 19	31, 5	31, 14	32, 1	32, 20	34, 14	35, 10	36, 29		
30L	2, 1	8, 2	8, 4	9, 4	12, 11	13, 12	16, 1	18, 14	19, 1	19, 16
30L	20, 5	20, 19	24, 4	24, 10	25, 4	25, 10	25, 13	26, 11	28, 6	28, 14
30L	29, 10	30, 3	31, 19	31, 30	32, 31	34, 1	34, 5	34, 6	34, 24	34, 27
30L	34, 32	35, 25	37, 19							
20L	4, 2	10, 4	11, 10	13, 3	17, 8	18, 6	18, 16	19, 8	20, 8	20, 18
20L	22, 11	24, 17	24, 19	25, 21	26, 12	27, 20	28, 1	28, 20	29, 3	29, 21
20L	29, 22	29, 24	29, 25	30, 26	31, 1	31, 16	32, 18	33, 6	33, 14	33, 18
20L	33, 19	33, 32	34, 8	34, 16	34, 18	34, 28	34, 33	35, 4	35, 26	35, 29
20L	35, 30	36, 3	36, 11	36, 22	36, 25	36, 26	37, 6	37, 28		
10L	7, 4	8, 5	8, 6	9, 2	9, 6	9, 8	10, 1	10, 3	10, 8	11, 2
10L	11, 4	11, 8	11, 9	12, 10	15, 12	16, 2	16, 8	17, 1	17, 4	18, 5
10L	18, 15	19, 2	20, 6	20, 12	20, 14	20, 15	21, 3	21, 14	21, 15	22, 2
10L	22, 3	22, 10	23, 3	23, 19	24, 3	24, 11	24, 21	24, 22	25, 9	25, 17
10L	25, 23	25, 24	26, 9	26, 13	26, 15	26, 23	27, 8	28, 8	28, 18	28, 21
10L	28, 24	29, 2	29, 4	29, 11	29, 18	29, 26	30, 4	30, 12	30, 15	30, 23
10L	30, 25	31, 28	32, 2	33, 1	33, 9	33, 15	33, 23	33, 27	33, 30	33, 31
10L	34, 2	34, 4	34, 9	34, 20	34, 31	35, 12	35, 24	36, 9	36, 21	36, 23
10L	36, 35	37, 5	37, 14	37, 26	37, 27	37, 36				
0L	5, 2	8, 3	9, 3	10, 2	10, 9	12, 4	14, 8	14, 9	15, 6	15, 9
0L	15, 11	15, 14	17, 3	17, 5	17, 9	17, 10	17, 12	17, 16	18, 1	18, 2
0L	18, 10	18, 17	19, 17	20, 2	20, 11	21, 1	21, 2	21, 9	21, 11	21, 12
0L	22, 1	22, 4	22, 7	22, 8	22, 9	23, 2	23, 8	23, 14	24, 9	24, 15
0L	24, 20	24, 23	25, 7	25, 15	26, 4	26, 7	26, 10	26, 21	26, 22	27, 2
0L	27, 17	27, 18	27, 24	28, 2	29, 1	29, 9	29, 15	29, 23	30, 2	30, 7
0L	30, 9	30, 10	30, 17	30, 18	30, 21	30, 24	30, 29	31, 15	31, 18	31, 23
0L	31, 24	32, 8	32, 17	33, 2	33, 3	33, 4	33, 5	33, 8	33, 16	33, 20
0L	33, 24	33, 28	33, 29	34, 17	35, 1	35, 2	35, 8	35, 9	35, 15	35, 22
0L	35, 23	35, 33	36, 4	36, 10	36, 12	36, 13	36, 30	36, 31	37, 1	37, 2
0L	37, 8	37, 9	37, 10	37, 18	37, 24	37, 30	37, 31	37, 32		
-10L	3, 2	6, 2	7, 2	7, 5	8, 7	9, 5	9, 7	10, 7	11, 7	12, 7
-10L	12, 8	12, 9	13, 7	13, 8	13, 11	14, 2	14, 7	15, 1	15, 3	15, 7
-10L	15, 10	16, 7	16, 9	16, 13	17, 2	17, 6	17, 7	17, 13	17, 14	17, 15
-10L	18, 7	18, 8	18, 9	18, 13	19, 7	19, 9	19, 15	20, 1	20, 7	20, 17
-10L	21, 7	21, 10	21, 18	21, 19	21, 20	22, 6	22, 12	22, 13	22, 14	22, 15
-10L	22, 16	22, 17	22, 18	22, 19	22, 20	22, 21	23, 4	23, 5	23, 7	23, 9
-10L	23, 11	23, 12	23, 13	23, 15	23, 16	23, 17	23, 20	23, 22	24, 5	24, 7
-10L	24, 16	24, 18	25, 2	25, 22	27, 7	27, 22	27, 23	28, 7	28, 9	28, 10
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-10L	30, 1	30, 11	30, 14	30, 19	30, 22	31, 2	31, 4	31, 8	31, 9	31, 17
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-10L	34, 23	35, 7	35, 17	35, 18	35, 20	35, 21	36, 1	36, 2	36, 6	36, 7
-10L	36, 15	36, 17	36, 27	36, 28	36, 33	37, 4	37, 7	37, 12	37, 13	37, 15
-10L	37, 16	37, 17	37, 20	37, 21	37, 22	37, 23	37, 29	37, 33	37, 34	37, 35
-20L	7, 1	7, 3	7, 6	11, 1	12, 2	13, 5	15, 2	15, 4	15, 5	15, 8
-20L	15, 13	16, 10	16, 15	17, 11	18, 4	18, 11	19, 4	19, 10	19, 13	20, 3
-20L	20, 4	20, 10	21, 4	21, 5	21, 8	21, 13	21, 16	22, 5	23, 1	23, 6
-20L	23, 10	23, 18	24, 6	24, 12	24, 14	25, 8	25, 20	26, 17	27, 10	27, 15
-20L	27, 21	28, 4	28, 13	29, 13	29, 14	29, 16	29, 19	30, 6	30, 28	31, 7
-20L	31, 10	31, 13	31, 20	31, 29	32, 9	32, 10	32, 13	32, 21	33, 26	34, 3
-20L	34, 12	34, 13	34, 29	34, 30	35, 13	35, 19	35, 31	35, 34	36, 8	36, 16
-20L	36, 19	36, 19	36, 20	36, 24	36, 34	37, 11				
-30L	3, 1	6, 4	10, 6	12, 5	13, 2	13, 10	14, 4	14, 10	14, 13	16, 4
-30L	16, 11	16, 12	18, 3	18, 12	19, 11	20, 9	26, 2	26, 18	26, 20	27, 4
-30L	27, 9	27, 13	28, 11	28, 25	29, 6	29, 27	30, 9	30, 13	30, 27	31, 12
-30L	31, 26	32, 29	32, 30	35, 6	35, 16	35, 28	36, 5	36, 14	36, 32	37, 3
-30L	37, 25									
-40L	5, 4	10, 5	11, 5	12, 6	13, 4	13, 6	13, 9	14, 12	19, 12	21, 6
-40L	24, 13	25, 18	26, 1	26, 8	27, 12	29, 5	30, 5	30, 20	31, 3	31, 11
-40L	31, 21	32, 4	32, 12	33, 25	34, 25	35, 5	35, 14	35, 32		
-50L	11, 6	12, 1	14, 11	26, 6	26, 14	26, 16	26, 24	27, 11	28, 3	30, 16
-50L	35, 27									
-60L	16, 3	19, 3	25, 1	25, 16	31, 25	32, 11	32, 26	34, 26		
-70L	14, 3	25, 19	26, 19	27, 26	28, 26					
-80L	6, 3	26, 5	27, 3							
-90L	5, 3	13, 1	27, 25	32, 3	32, 25					
100L	25, 5	25, 14								
110L	25, 6									

This printout allows the observer to cluster species firstly according to very high levels of interaction and then admitting further species at lower levels of interaction. In the present case this results in Tables 4.4 and 4.5. Table 4.4 shows the positive interaction pattern. At $\chi>90$ there are 2 strong nodes, and it is not until we get to value of 50 that a third node occurs. Table 4.5 shows strong negative associations involving 4 species at $\chi>90$. Table 4.6 shows firstly species which have interactions at χ values on 1 degree of freedom greater than 100 and then the development of these nodes on interactions as the level drops to greater than 90, greater than 80, etc. to greater than 50, by which time 20 species are involved in the constellation of interactions. At χ values of greater than 100 on 1 degree of freedom (which is very significant indeed), only 2 species show such interaction. These are species 6, *Eucalyptus socialis*, and species 25, *Erodium*, and the association is negative. Both are native species (Table 4.6a). Map 4.1 shows a plot of this distribution in which the isotels are developed to reflect the classification both present, 0; one present but not the other, 1; and the other present but not the first, 2; with a no-score area for mutual absence. So far as can be seen this remarkably strong negative interaction bears no close relationship to landform, soils or landuse patterns so far as we know and reflects nothing so much as our general ignorance of the ecology of the species in the Reserve.

At $\chi>90$ the pattern develops substantially. (Table 4.6b). First, *Erodium* (25) the species which had strong negative association with *Eucalyptus socialis* (6), develops a positive interaction with species (3), *Myoporum platycarpum*. At the same time, species (25), *Erodium*, develops negative associations with species (5), *Eucalyptus porosa*, species (6), *Eucalyptus*

Table 4.4 Positive Interaction.

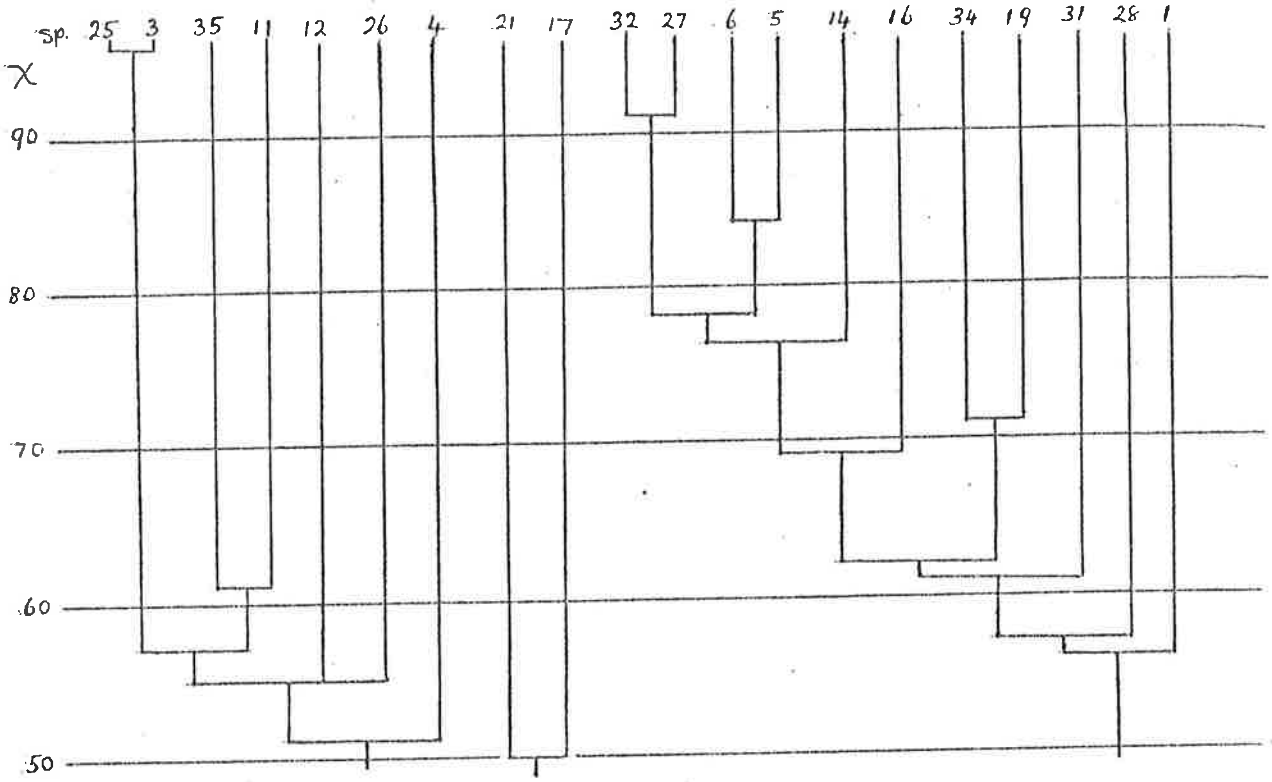


Table 4.5 Negative Interaction.

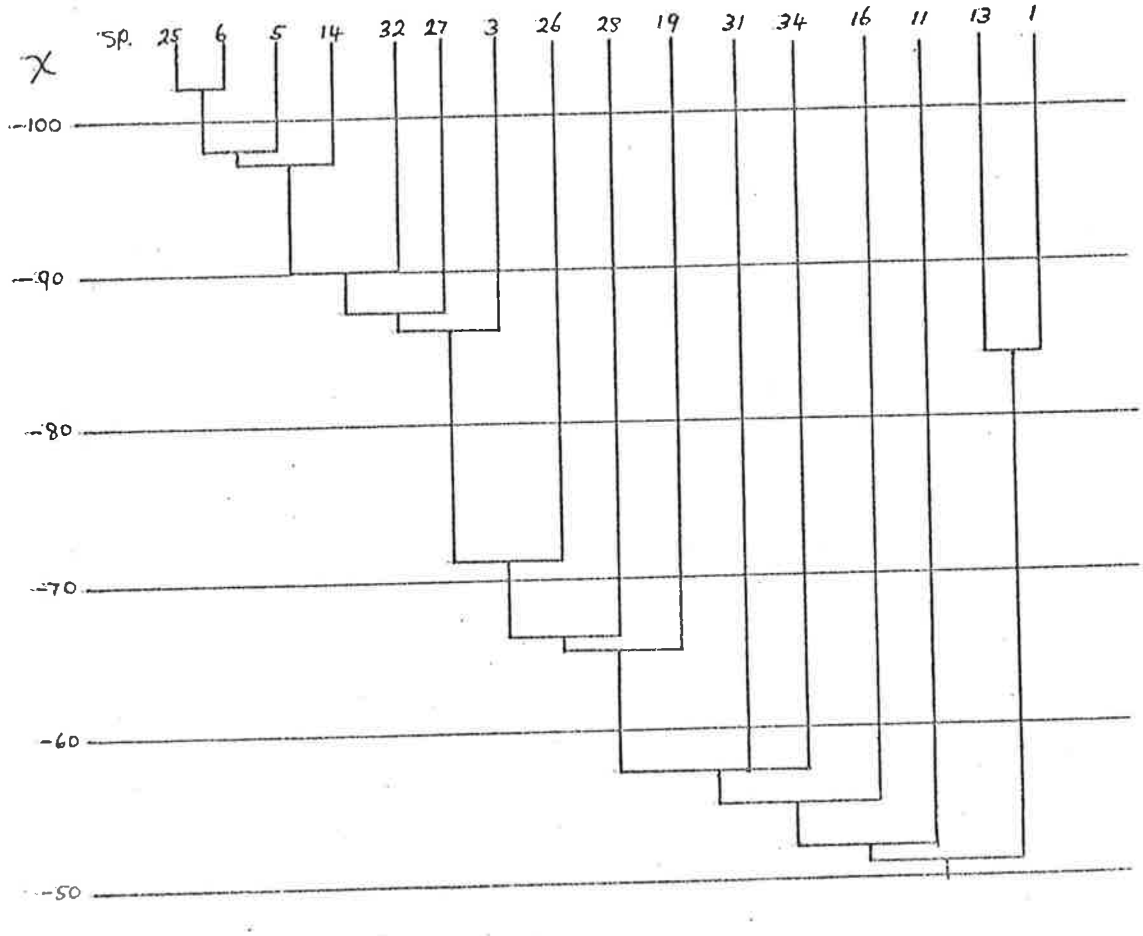
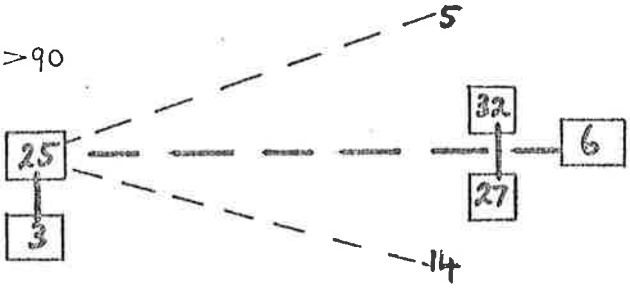


TABLE 4·6

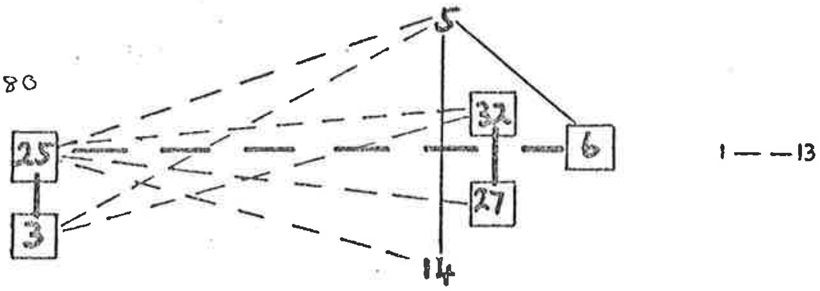
(a) $|\chi| > 100$

——— positive association
– – – negative association

(b) $|\chi| > 90$



(c) $|\chi| > 80$



(d) $|\chi| > 70$

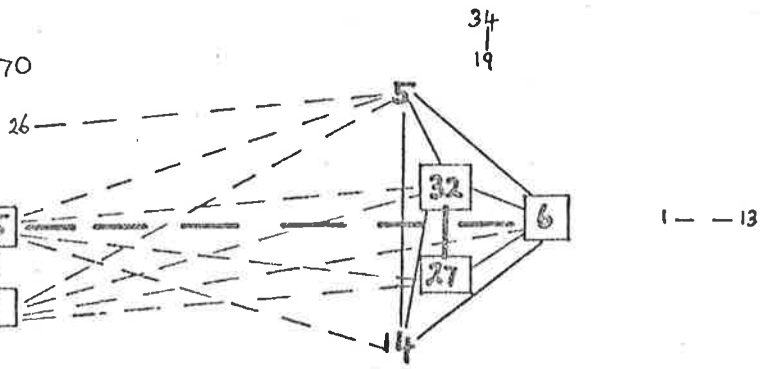
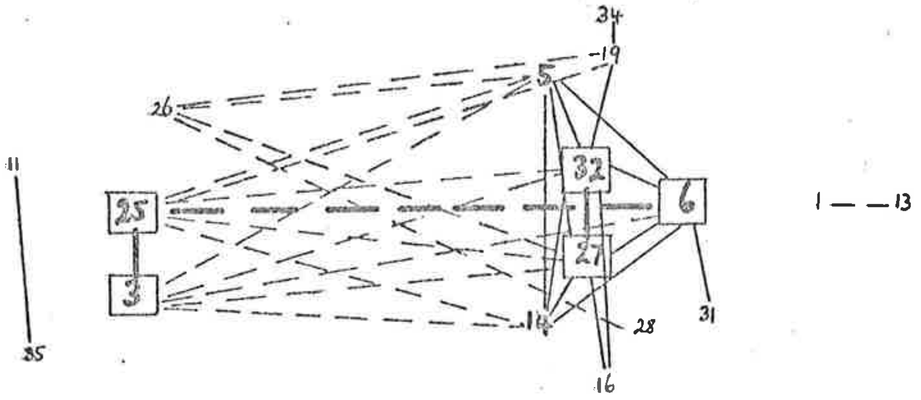
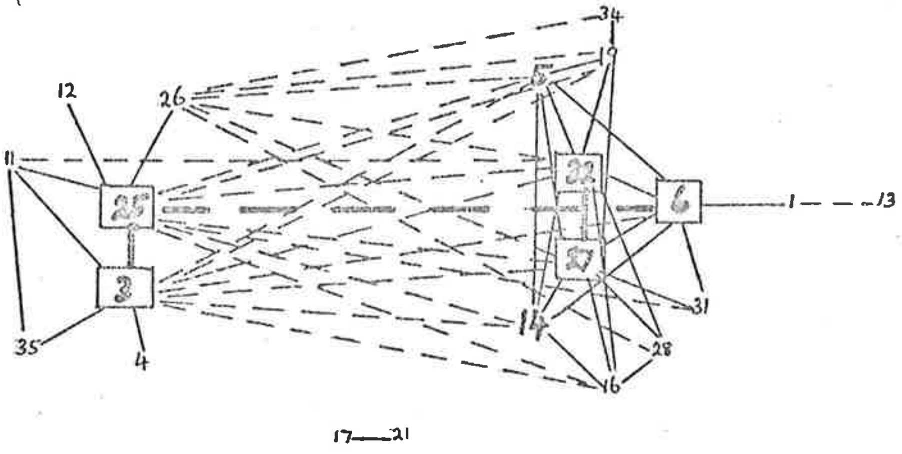


Table 4.6 cont

(e) $|X| > 60$

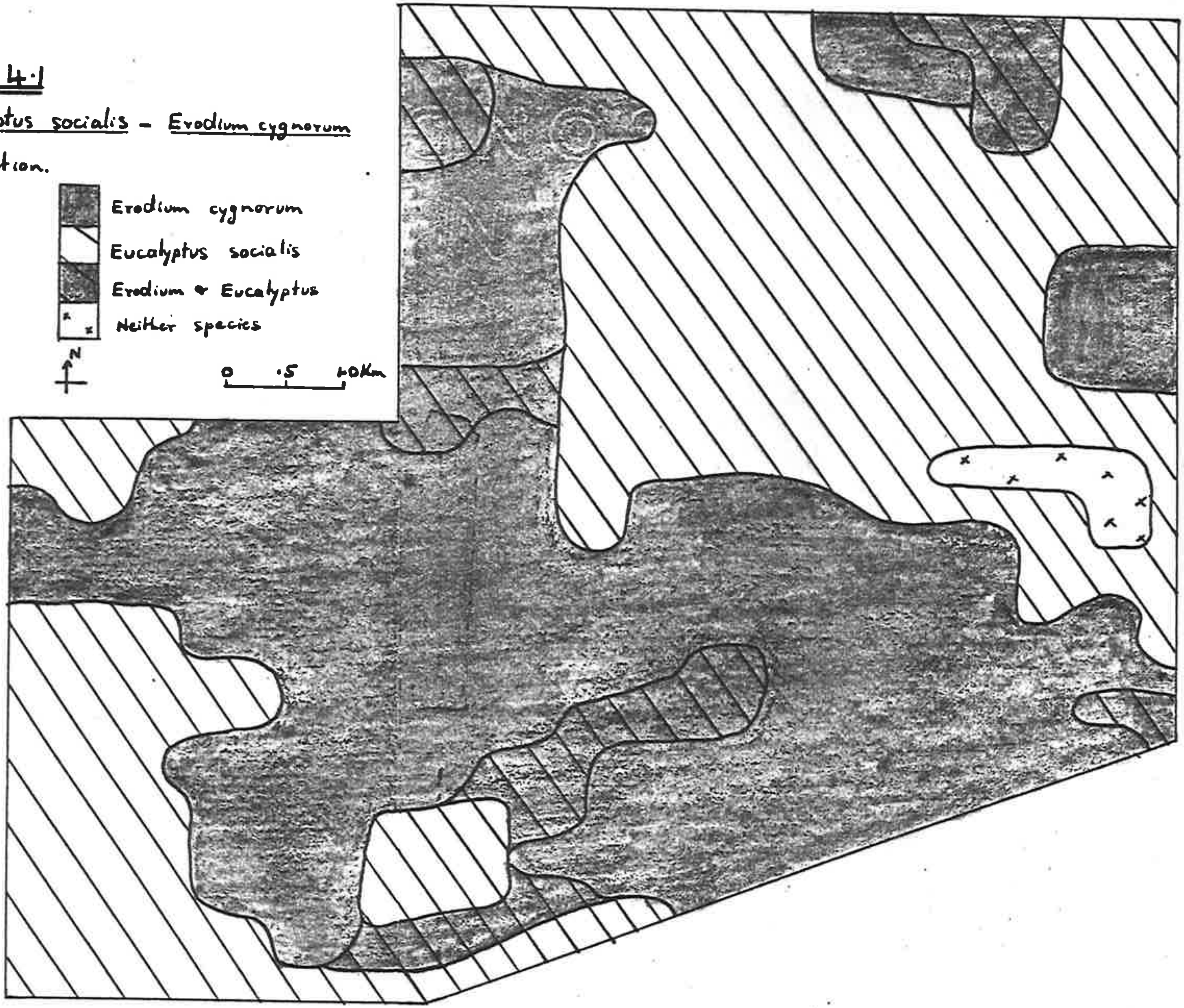


(f) $|X| > 50$



MAP 4·1

Eucalyptus socialis - Erodium cygnorum Interaction.

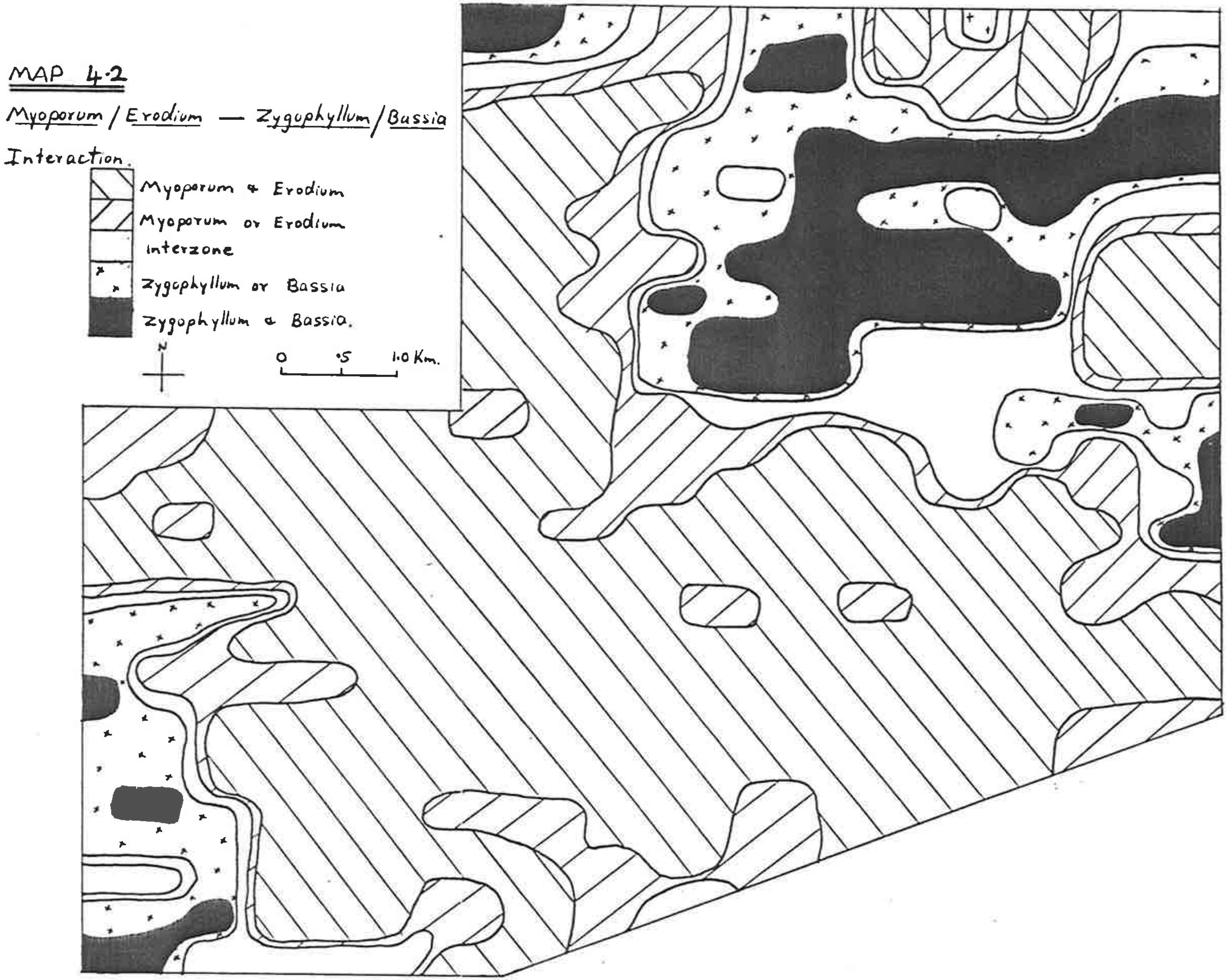


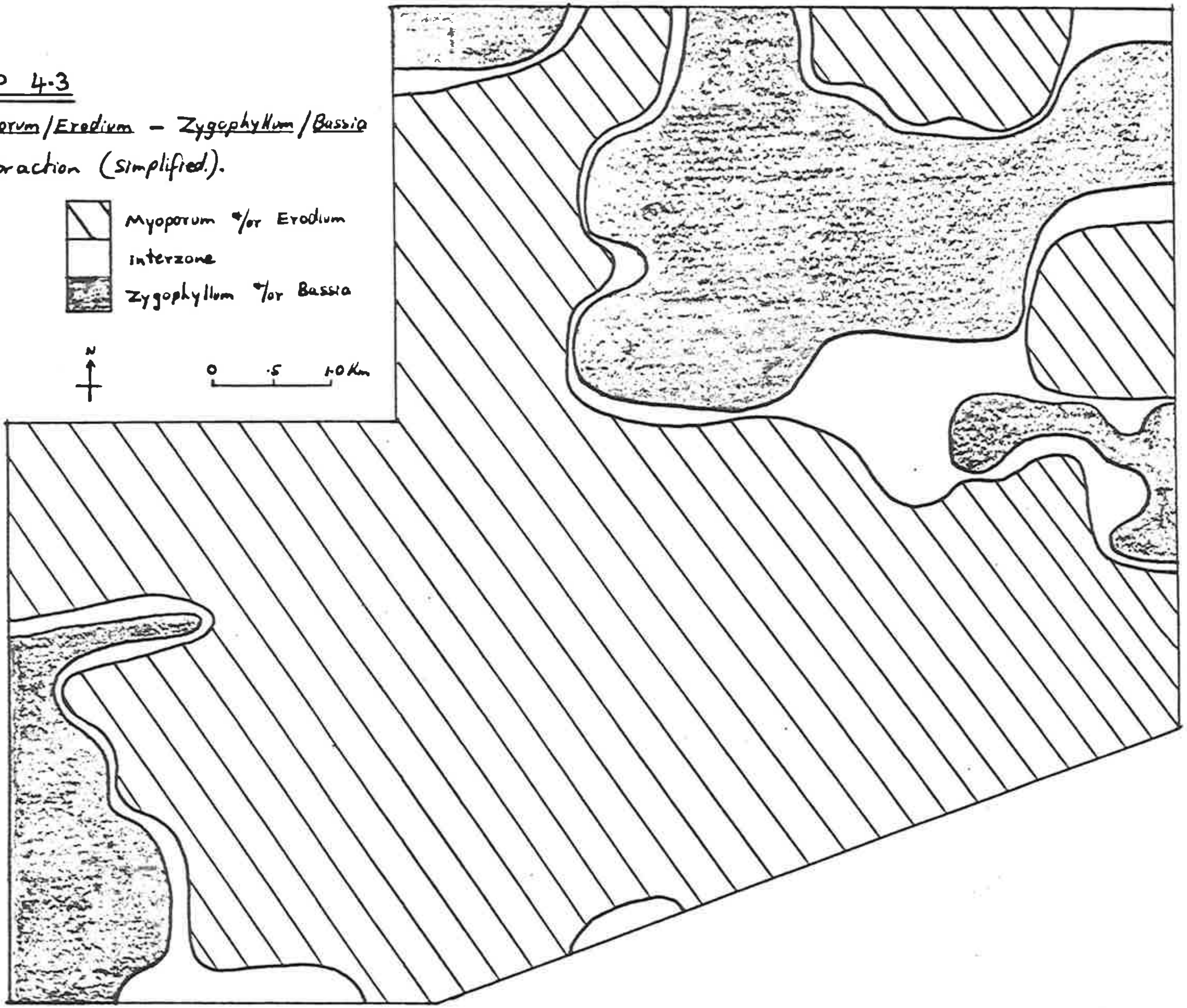
socialis, and species (14), *Maireana pentatropis*. Independently, species (32), *Bassia parallelicuspis*, and species (27), *Zygophyllum apiculatum*, develop a positive association.

At the next lower level of χ>80, the nodes of interaction develop as follows: positive associations develop between *Eucalyptus socialis* (6),*Eucalyptus porosa* (5), and *Maireana pentatropis* (14), and negative interactions as shown in Table 4.6c. These negative interactions involve the fusing of the 2 nodes of interactions which above χ=90 were separate. These interactions were developed for plotting as follows. Quadrats scoring *Myoporum* (3) and *Erodium* (25) and the absence of *Bassia parallelicuspis* (32) and *Zygophyllum apiculatum* (27) were regarded as one pole of the analysis, and vice versa, for the other pole. Map 4.2 is quite complicated and so a further Map 4.3, was produced to simplify the situation by amalgamating ratings 0 and 1, and 3 and 4. This is a justifiable simplification, and has led to the very clearcut community pattern structure shown in Map 4.3. Independent of the fore-going interactions a second node of interacting species emerges, namely *Geijera linearifolia* (1), has a negative interaction with *Maireana sedifolia*, species (13). Thus at χ>80 it is necessary to account for the information in two, not one, nodes of interacting species, one a fairly large node, the other a relatively small one which at that level of interactions, are independent. Map 4.4 displays the plot of isotels for this second node in which a rating of 0 implies bluebush present, *Geijera* absent, 2 is *Geijera* without bluebush, a rating of 1 means bluebush and *Geijera*, and a rating of 3 implies no score. This plot is rather remarkable because it shows a no-score area between the *Geijera* and bluebush populations rather than an ecotonal area where the two are mixed. As the map shows,

MAP 4·2

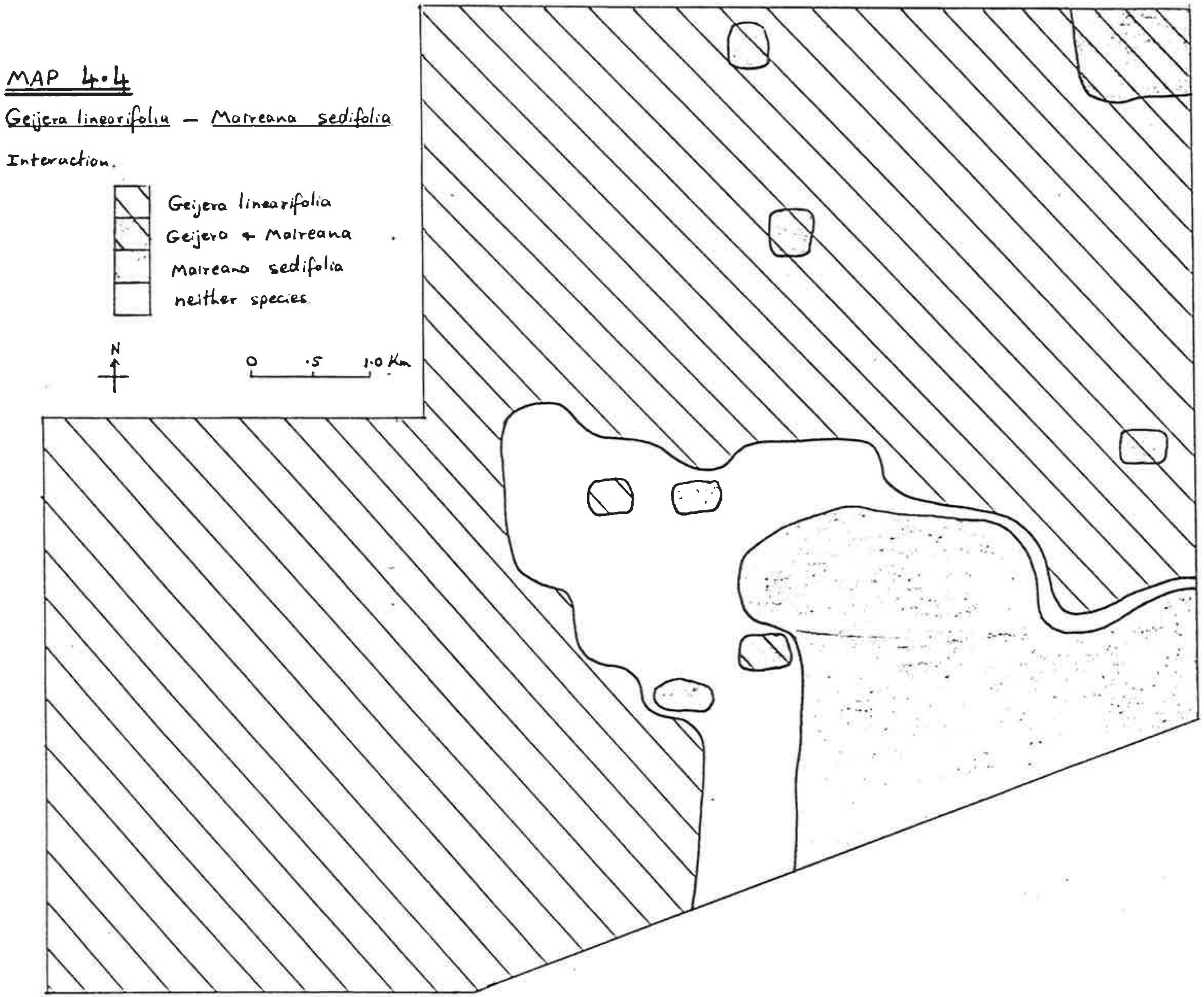
Myoporum / Erodium — Zygophyllum / Bassia Interaction.





MAP 4·3

Myoporum/Erodium – Zygophyllum/Bassia Interaction (simplified).



MAP 4.4

Geijera linearifolia – Maireana sedifolia

Interaction.

only a very few widely scattered quadrats involve an ecotonal situation. In accordance with the philosophy of multiple classifications of quadrats, which is inherent in influence analysis, the first order vegetation map of the Reserve must take account of the two independent nodes of information.

We then have two maps representing the two nodes of interaction. These are both independent. This situation can occur only with an influence analysis. One block of interactions is happening for some ecological reason, and this cause is quite different and independent of the cause that produces the second block of interactions.

From the point of view of making a map which summarises this information, it is necessary to combine the two in some useful way. Technically speaking, it is arguable that we should combine them; the purist would argue that one map cannot summarise these two independent blocks. However, the average user is going to require one map.

From Map 4.3, the three influence ratings were cross-classified with influence ratings 0, 1, 2 and no-score of Map 4.4, giving a 4x3 matrix which identifies 12 vegetation mapping units. Analysis of the data gave Table 4.7, which shows that only five mapping units in effect exist. This is not surprising because *Geijera* and *Maireana* are virtually mutually exclusive (eliminating 3 units) the *Myoporum-Erodium* species occupy the region of no-score for both *Geijera* and *Maireana* (accounting for another two units) and the *Myoporum-Erodium* species occur in the bluebush region to the exclusion of *Zygophyllum* and *Bassia* (accounting for the remaining two).

Map 4.5 shows the distribution of these mapping units.

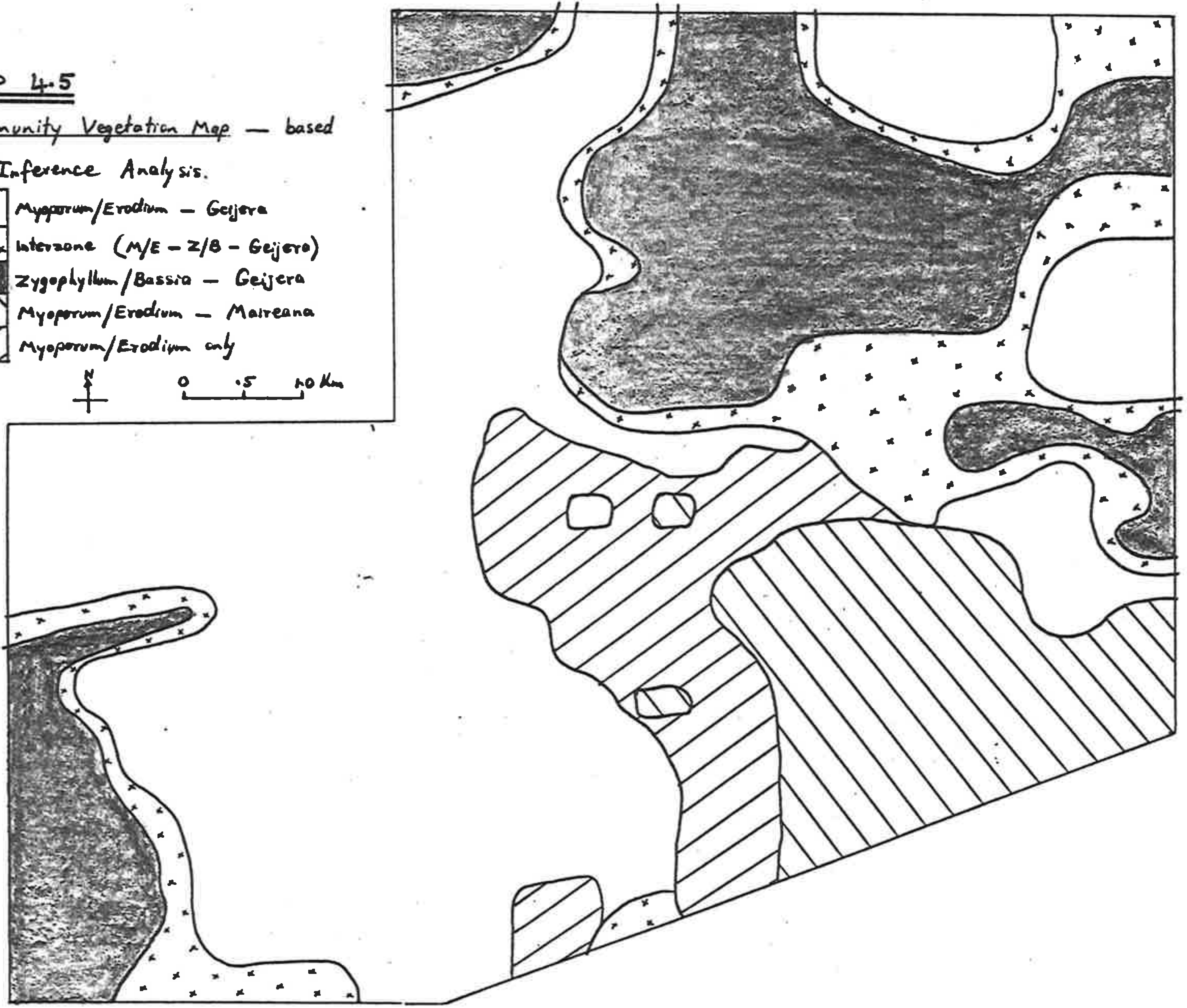
Unit 1 - *Myoporum platycarpum* and/or *Erodium cygnorum* and *Geijera linearifolia*

Table 4·7 Mapping Units

	Geijera only	*Geijera* & *Maireana*	*Maireana* only	Neither *Geijera* or *Maireana*
Myoporum &/or *Erodium*.	1	☒	4	5
Ecotone of *Myoporum*/*Erodium* & *Zygophyllum*/*Bassia*	2	☒	☒	☒
Zygophyllum &/or *Bassia*.	3	☒	☒	☒

MAP 4.5

Community Vegetation Map — based on Inference Analysis.



Unit 2 - Ecotone of *Myoporum* and/or *Erodium*, *Zygophyllum* and/or *Bassia*, and *Geijera*.

Unit 3 - *Zygophyllum apiculatum* and/or *Bassia parallelicuspis*, and *Geijera linearifolia*.

Unit 4 - *Myoporum* and/or *Erodium*, and *Maireana sedifolia*

Unit 5 - *Myoporum* and/or *Erodium* only.

All the other species that have not come into consideration in the fore-going are all obviously affected by the same influences that have affected the key species. A table was drawn up, using the mapping units of the general vegetation map, and finding the percentage of each species' occurrence for each vegetation rating. These are summarised in Table 4.8. Table 4.8 shows the data for the remaining 24 species that were computer-analysed. Plant species found predominantly in Mapping unit 1 with *Geijera*, *Myoporum* and *Erodium*, are *Pittosporum* (70%) *Nicotiana* (84%) and *Lycium* (72%). There are no prominent species in Zone 2 (the *Geijera* zone having the ecotone of *Myoporum*, *Erodium*, *Zygophyllum* and *Bassia*) the highest frequency being 22% for *Maireana pentatropis*.

Prominent species in Zone 3 (*Geijera*, *Zygophyllum* and *Bassia*) are *Olearia* (70%), *Rhagodia spinescens var deltaphylla* (54%) *Rhagodia spinescens var spinescens* (52%) *Zygophyllum aurantiacum* (63%). *Acacia oswaldii* (31%) and *Rhagodia spinescens var spinescens* (28%), are the most prominent species in Zone 4 (*Myoporum*, *Erodium* and *Maireana*), while the *Acacia* species and *Pittosporum* have the highest frequencies (15% and 16%) in Zone 5.

Having produced a base map, it is fitting that associations of other species with the mapping units be examined. Analysis of the table indicate that there are a number of species that occur in Mapping Unit 1 with a frequency of four times (or better) the frequency in any other Mapping Unit.

TABLE 4·8

Species	No of quadrats in which observed/285	% incidence in various mapping unit areas				
		1	2	3	4	5
2	30	63	10	27	0	0
4	141	67	11	13	4	5
5	129	25	17	50	5	4
6	158	28	18	42	5	7
8	115	54	9	27	8	2
9	101	60	13	23	2	2
10	34	70	8	11	0	11
11	82	63	9	4	9	15
12	52	49	4	0	31	16
14	99	21	22	50	3	4
16	30	18	11	70	0	1
18	36	37	12	33	9	9
19	56	29	14	54	1	2
20	22	15	5	52	28	0
24	128	58	12	21	5	4
26	214	47	12	14	16	11
28	29	30	7	63	0	0
29	23	84	4	4	0	8
30	173	47	12	16	12	13
31	193	36	16	29	10	9
33	23	37	21	37	5	0
34	36	44	19	33	3	1
35	64	72	6	5	6	11
36	22	63	9	9	14	5

These are 29 (84%), over 10 times more frequent here than in any other Mapping Unit, 35 (72%), 10 (70%) and 4 (67%) all over 6 times, 11 (63%) and 36 (63%) over 4 times.

In Mapping Unit 3, 16 (70%) is almost 4 times more frequent than in other Mapping Units. 5 (50%) is only 2 times more frequent than in other Mapping Units.

In Mapping Units 2, 4 and 5, the best we can find is less than .7 the frequency in other Mapping Units.

Hence Map 4.5 can be modified by the addition of other interactions. Table 4.9 indicates the community associations with decreasing significance of association of species for each Mapping Unit.

SUMMARY

A. Any researcher can go to a "place" on the Reserve, find the mapping unit designated to that area and can expect to find certain species present there (on average) and can compare this site with any other site, e.g. an entomologist, in observing a particular insect finds that it is exclusive to a particular mapping unit.

B. The virtue of this table which summarises all the ancillary data to the vegetation map is that it would let any kind of observer whether of soils, etc., go to the Reserve, locate himself on the map, and know what kind of a system he is in and where he must go to get into a different kind of a system, and how it will differ.

A further map can be produced to indicate the distribution of the more prominent (tree) species, namely *Myoporum* (3), *Eucalyptus porosa* (5) and *Eucalyptus socialis* (6). Fortunately the values of interactions between these three species is significant (all beyond x=±75), making a comparison

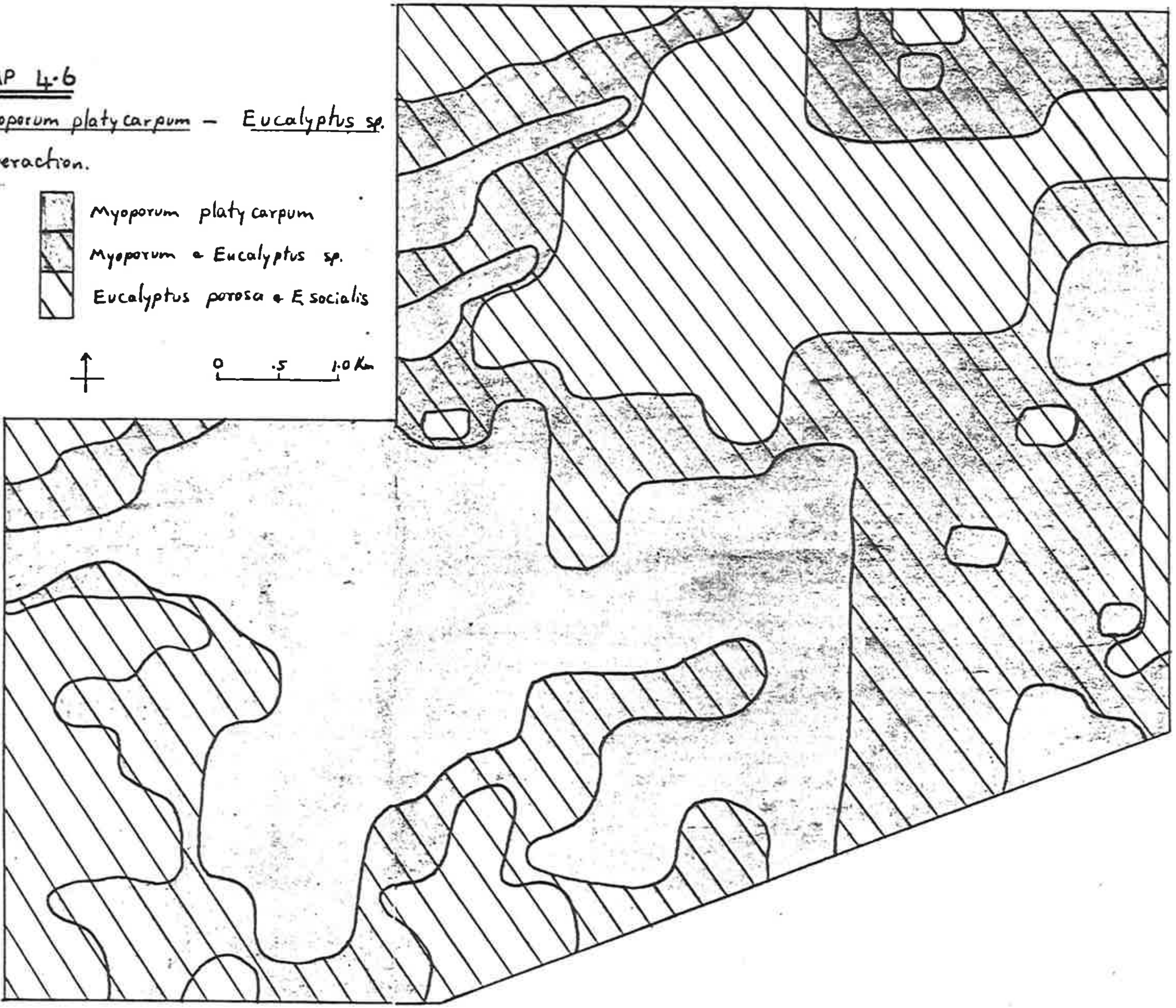
TABLE 4.9

Mapping Unit	Species Associations (in descending order of significance)
1	*Myoporum platycarpum, Erodium cygnorum* and *Geijera linearifolia* *Nicotiana velutina* *Lycium australe* *Melaleuca lanceolata* *Heterodendron oleofolium* *Pittosporum phillyreoides* *Euphorbia drummondii*
2	*Myoporum platycarpum, Erodium cygnorum, Zygophyllum apiculatum, Bassia parallelicuspis* and *Geijera linearifolia*
3	*Zygophyllum apiculatum, Bassia parallelicuspis, Geijera linearifolia* *Olearia muelleri*
4	*Myoporum platycarpum, Erodium cygnorum,* and *Maireana sedifolia*
5	*Myoporum platycarpum* and *Erodium cygnorum* only

that is both statistically valid, and a sensible tool in the field. Map 4.6 shows this distribution pattern. (Because both species 5 and 6 occur together (χ=84%) it is useful to lump both together, and compare with species 3).

MAP 4.6

Myoporum platycarpum – Eucalyptus sp. Interaction.



CHAPTER 5

VEGETATION DYNAMICS AROUND WOMBAT WARRENS

The presentation and discussion of data in this chapter relates to the quantitative changes in the vegetation around wombat warrens over a period of two complete seasonal cycles.

(i) according to the different taxa,
(ii) at different distances from the warren,
(iii) exposed to wombat grazing and protected from it.

An attempt is made to relate the data to rainfalls throughout the study period.

1. VEGETATION AT DIFFERENT DISTANCES FROM WARRENS

From Chapter 2 it can be seen that two warrens were closely investigated. The first to be set up was called Zone 1, and the "stations" radiating out from it were labelled as follows :

A (20m.), B (200m.), C (40m.).

The second warren, Zone 2, had "stations" as follows :

D (10m.), E (20m.), F (30m.), G (40m.), H (50m.) and I (70m.).

These are shown in Map 2.2, and some of the stations appear in Plates 2.1 - 2.8.

The raw data collected as described in Chapter 2 can be found in Appendix 5.1. (An explanation of the method of recording precedes this data.) Analysis of the raw data has resulted in further tables which are referred to in the text.

Because sampling occurred in 2 "open" quadrats each visit, and both were subjected to the same environmental conditions, it is obvious that these data can be combined and an average obtained. We then have two replicates, not one, thus making the following discussion more meaningful.

The species found in the area under study are listed in Table 5.1. This list includes the ground litter (as defined in Chapter 2) and species to occur in low numbers at various times over the two-year period from 18/3/72 to 6/4/74.

In the following discussion a number of relevant points to be considered are dealt with first, before proceeding to analysis of the biomass data. One can appreciate data far more if presented in a visually-stimulating form. Accordingly, a series of graphs has been produced from the raw data to indicate changes from time to time.

(a) Precipitation

Rainfall data appears in Appendix 5.2. Because of the relatively low rainfall and staggered distribution for the area it was thought that it might be difficult relating month by month herbage changes to rainfall. Obviously the duration and amount of rain, and the time of year would have an effect on vegetation growth.

A series of rainfall graphs was drawn in an attempt to correlate them with vegetation trends. These were the rain in the previous week (Graph 5.1) and 2 weeks (Graph 5.2) before a visit. Where a large single fall, or smaller accumulating falls occurred, their effect was expected to last longer than perhaps one or two weeks. Thus it could be reasonably expected that this "effective" rain would produce growth. Graph 5.3 indicates "effective" rainfall and must be considered keeping its subjectivity in mind.

It is well-known that dew regularly occurs in the early morning (Wells, R. 1973), and would certainly

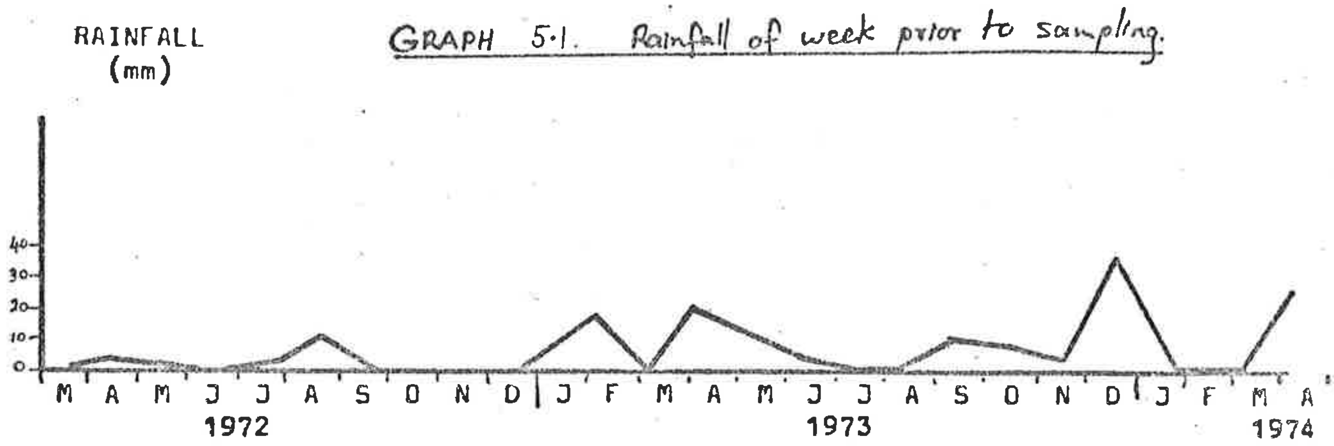
TABLE 5.1

SPECIES NUMBER	SPECIES NAME
1.	ground litter
2.	*Helipterum pygmaeum*
3.	*Schismus barbatus*
4.	*Stipa nitida*
5.	*Erodium cygnorum*
6.	*Isoetopsis graminifolia*
7.	*Euphorbia drummondii*
8.	*Zygophyllum ovatum*
9.	*Bassia patenticuspis*
10.	*Athrixia athrixioides*
11.	*Helipterum jessenii*

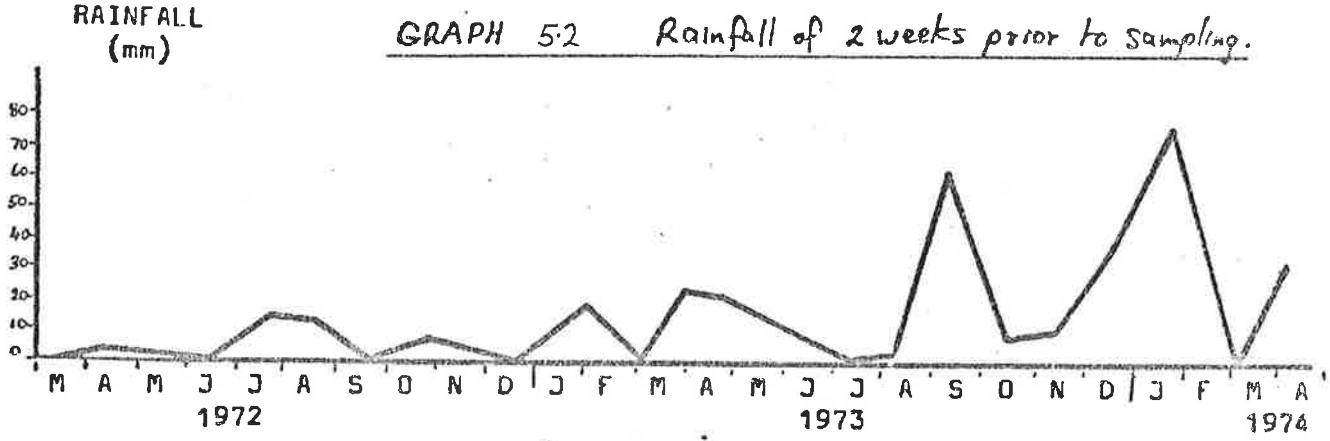
Other species to occur at various times:

Bassia sclerolaenoides
Gnephosis scirrophora
Brachyscome lineariloba
Angianthus dioica
Erodium cicutarium
Elachanthus pusillus

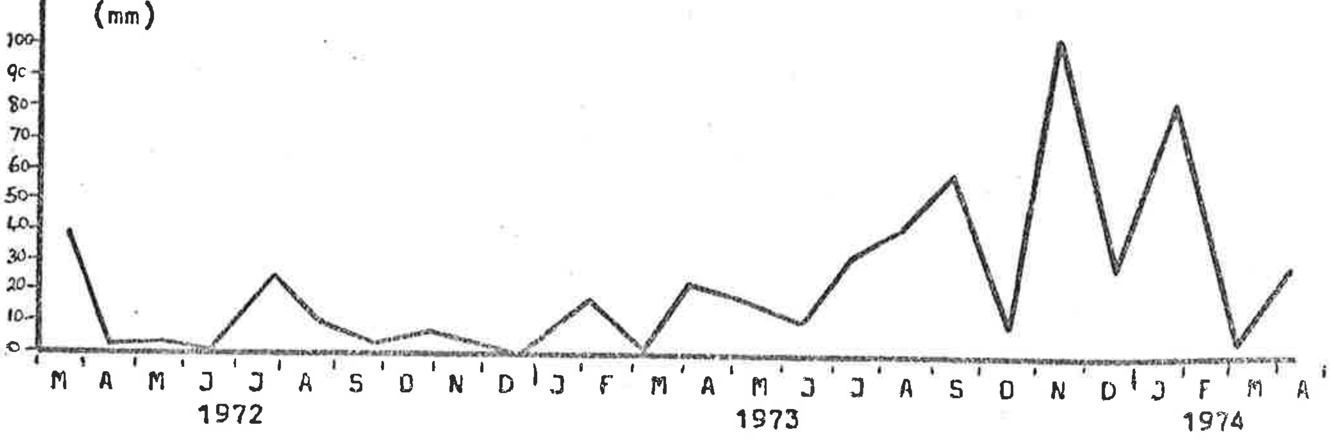
GRAPH 5·1. Rainfall of week prior to sampling.



GRAPH 5·2 Rainfall of 2 weeks prior to sampling.



GRAPH 5·3 "Effective" rainfall prior to sampling.



affect surface soil moisture and possibly leaf moisture during the early hours of daylight by decreasing evaporative loss from the plant. Unfortunately data could not be collected, and the significance of dew is not considered in this study.

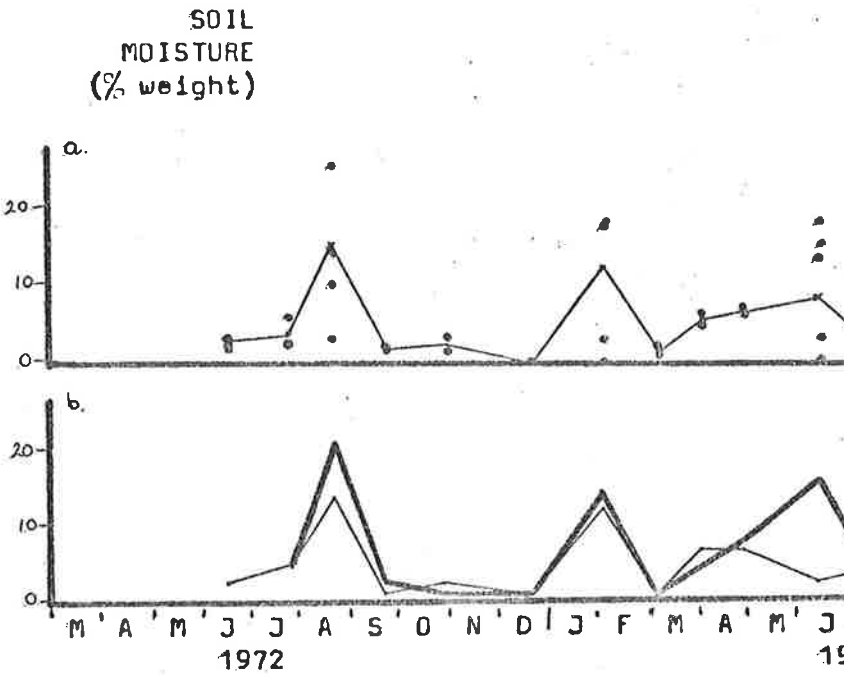
(b) Soil water

Soil moisture data appear in Appendix 5.3. The average for each zone was obtained for the 0cm. and 10cm. depths. The two zones are compared in Graphs 5.4 and 5.5 respectively. Graph 5.6 compares the overall averages at the two depths.

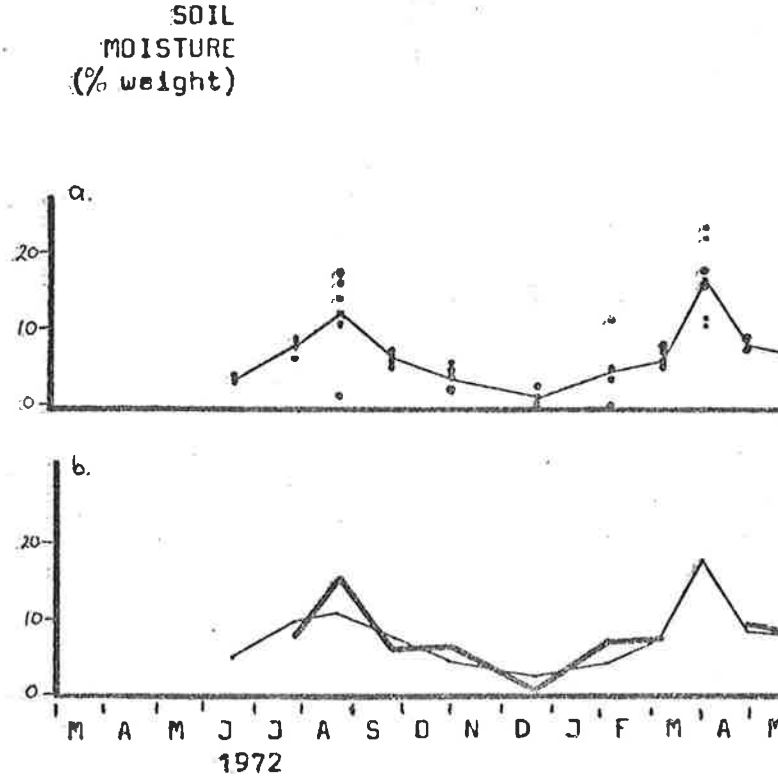
Soilwater vs. rainfall

At the surface level (Graph 5.4), the only discrepancy between the two zones was in June 1973 when Zone 1 was lower than Zone 2. (It rained on that day and soil samples were taken from Zone 1 before the rain and from Zone 2 after the rain had set in.) The soil picture obtained fits in without much difficulty with the rainfall data. In some months it appears that dew, or moisture from deeper down, reached the surface (Wells, R. 1973) in the early morning, and higher water content than expected is observed. At the 10cm. level (Graph 5.5) both zones show parallel trends, and again the picture fits the rainfall data closely. When the data for both depths are compared (Graph 5.6) with respect to rainfall it can be seen that the distribution and amount both play a significant part in the figures. For example, (a) from July to August 1972, 43 points had fallen in the previous 4 days to the August sampling. Both the 0 and 10cm. soil water levels rose accordingly, but the 0cm. level rose more. (It was also raining at

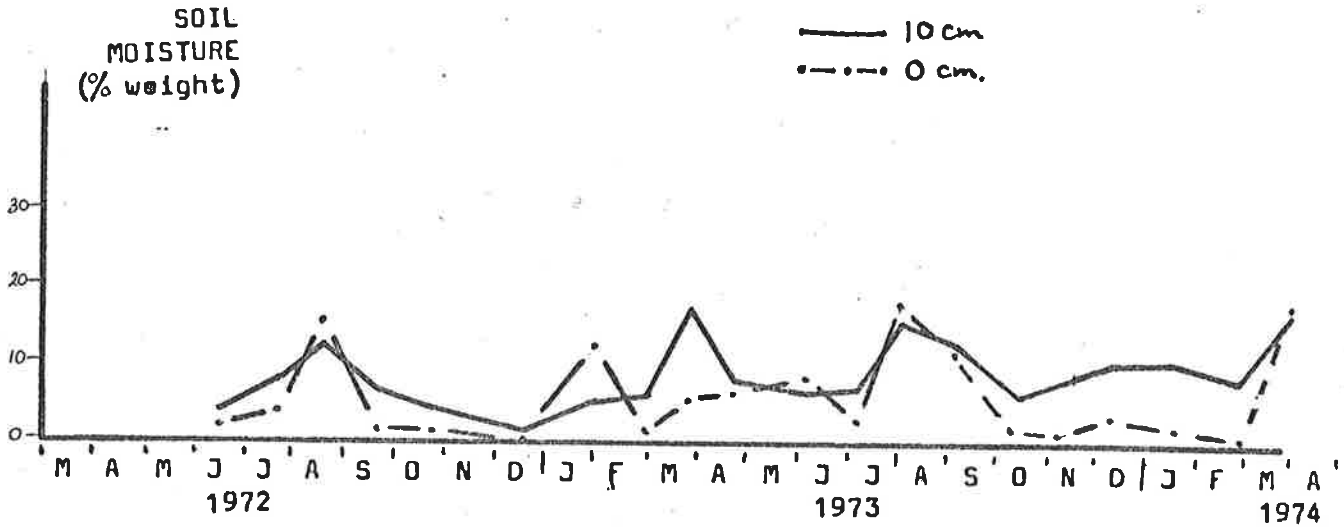
GRAPH 5·4. Soil Moisture (0 cm. depth) (a) Sample distribution pattern and average of water content. (b) Comparison of average soil moistures, zones 1,2.



GRAPH 5·5. Soil Moisture (10 cm depth) (a) Sample distribution pattern and average of water content. (b) Comparison of average soil moistures, zones 1 and 2.



GRAPH 5·6. SOIL MOISTURE . Comparison of average soil moistures, 0cm and 10cm depths



the time of sampling.)

(c) Biomass

Biomass data (in grms/quadrat i.e. grms/3 sq.m.) appears in Appendix 5.1. For each zone a series of graphs showing trends in each station was drawn. A trend in the average biomass was obtained for each zone, and these were compared in another graph. Finally, a graph of biomass as an average of all stations in both zones was drawn. This was as close to being representative of the vegetation about warrens as could be obtained.

The number of plants of each species per quadrat were compared between zones, and a graph was produced to show the average of all stations in both zones. Biomass was also considered in the context of species numbers from month to month.

Plant water content (as a %) was compared with soil water content (as a %), and biomass was considered in relation to both. Distribution graphs were drawn for the average water content for each zone and also graphs of both zones were represented for each species.

Considering each species in turn,

(i) *Stipa nitida*

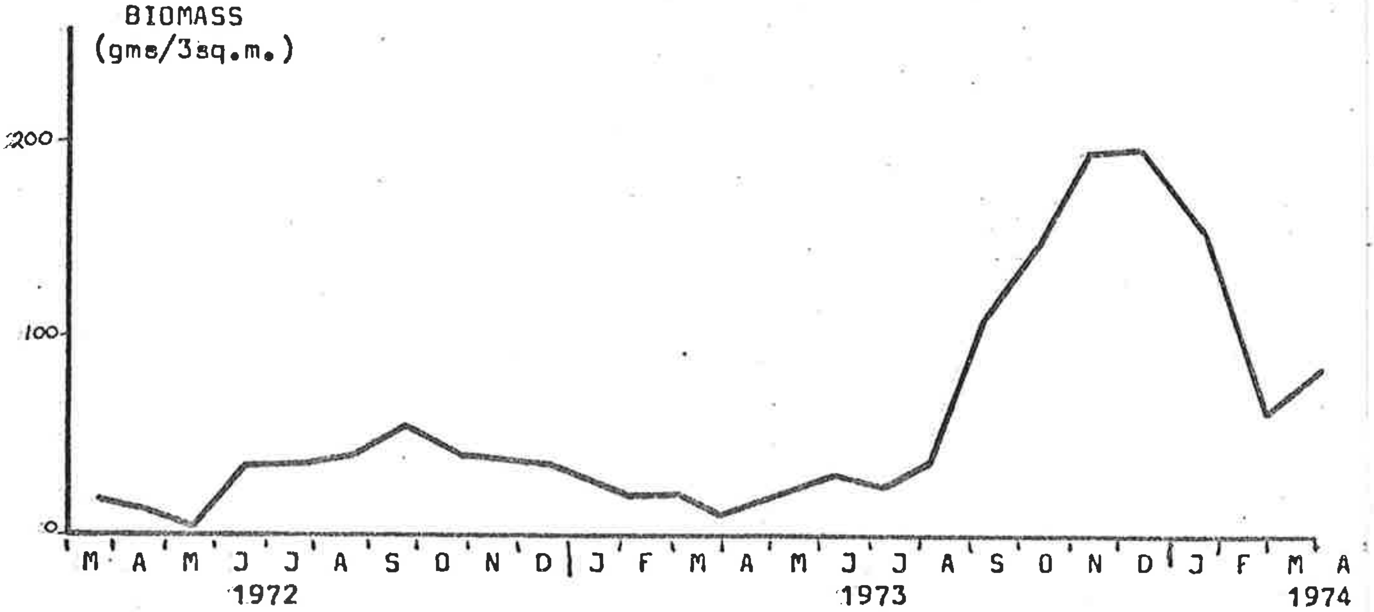
Processed biomass data appears in Appendix 5.4. Generally the biomass of *Stipa* (Graph 5.7) showed two peaks in the period of the exercise - a small one in the dry 1972-3 season, and a much more pronounced one in the wetter 1973-4 season. Biomass increased from an average of 4 grm/quadrat in May 1972 to 37 grm/quadrat in June, peaking at 54 grm/quadrat in September. After this time there was a gradual decrease to April 1973. The second season saw an increase from 24 grm/quadrat in July 1973 to peak at 194 grm/quadrat around November. A more rapid decrease occurred to 61 grm/quadrat in March 1974

Relation with Rainfall

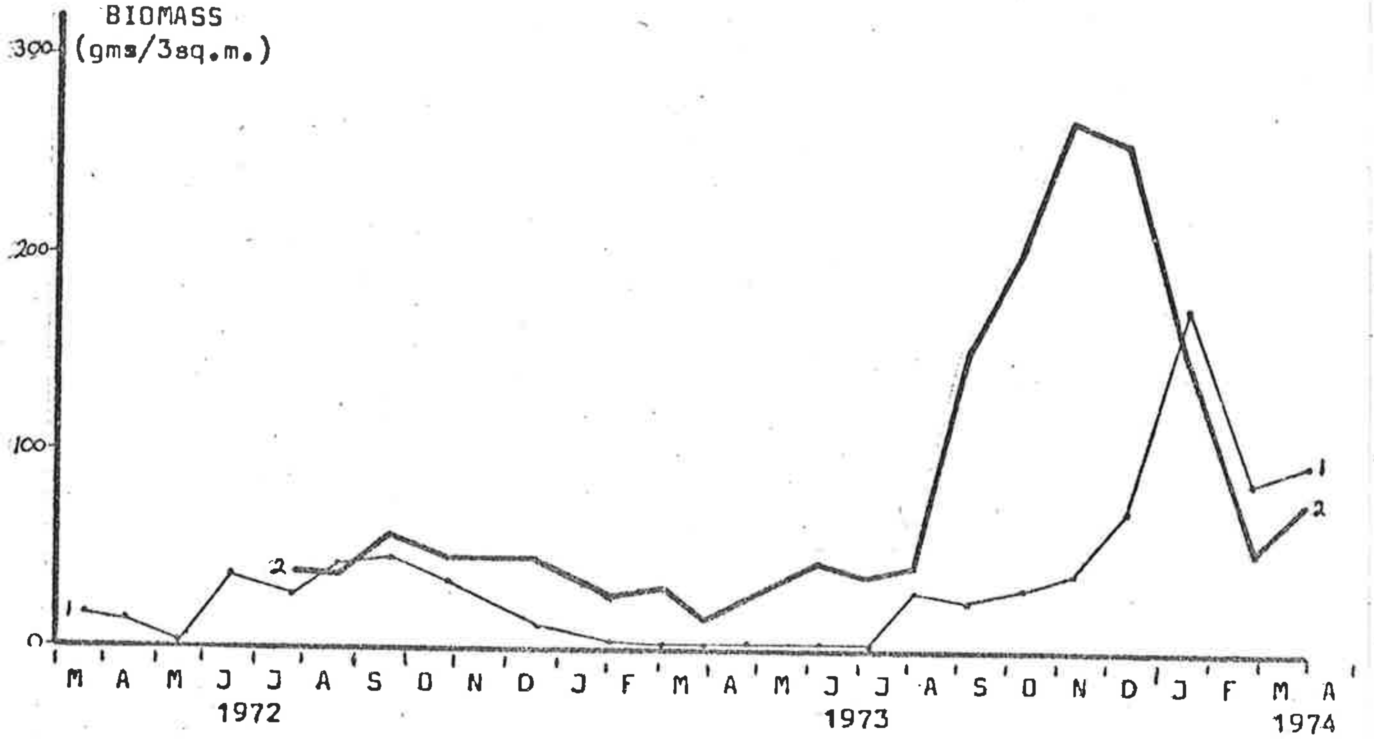
Examination of the rainfall data implies that rain is not of prime importance in triggering growth in June or July. The length of day and/or night may be more important. However, heavy rains in September appear to be important for a build-up of biomass, although further rain after September does not appreciably affect biomass, it only tends to prolong drying off.

Comparing the 2 Zones

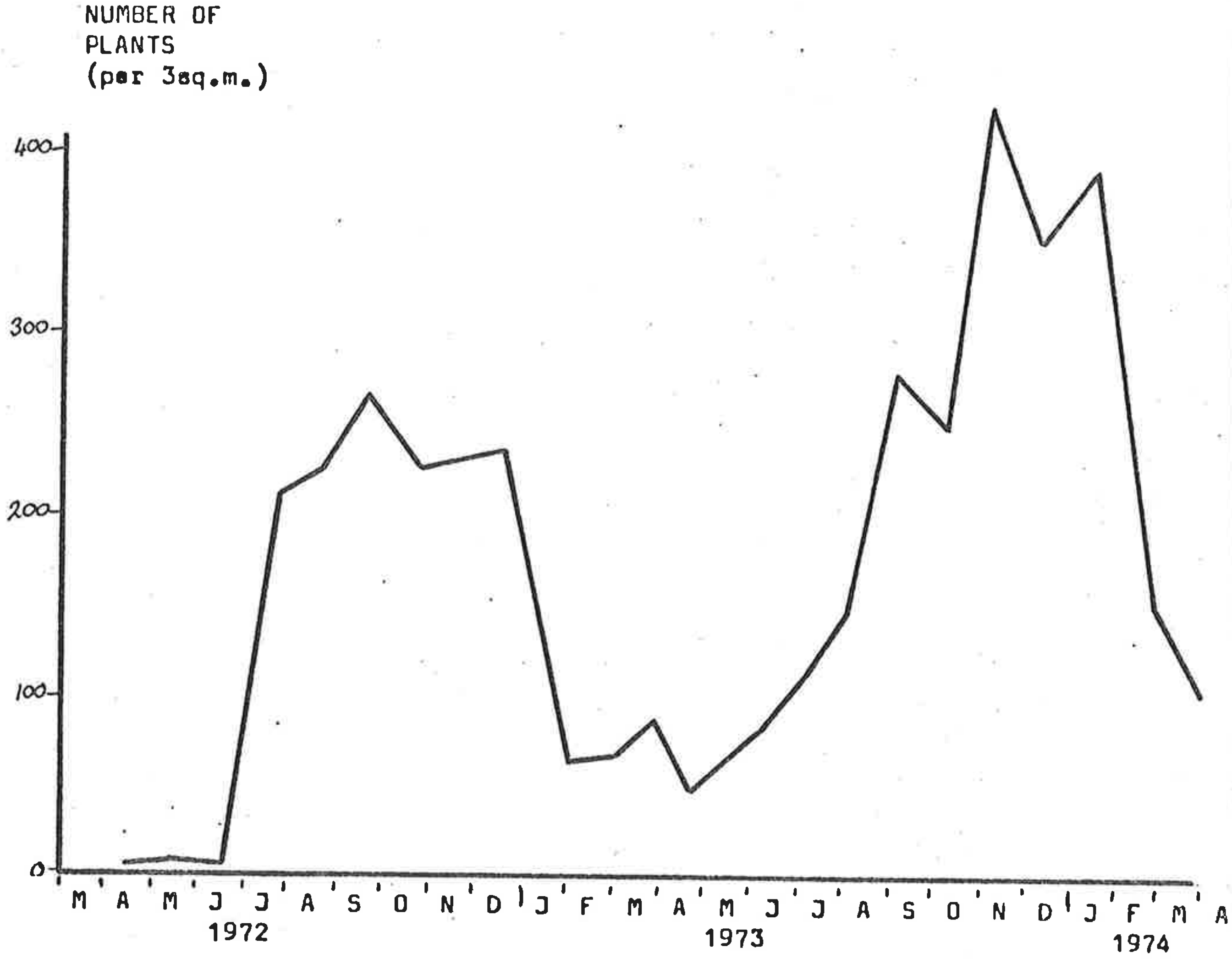
From Graph 5.8 it can be seen that there is a close relationship between the biomass until September 1973, when Zone 2 biomass increased dramatically and peaked at 269 grm/quadrat in November, but the Zone 1 biomass improved much more slowly at first, peaking at 173 grm/quadrat in January 1974. Further, Zone 1 biomass lags behind Zone 2 biomass with respect to time. Growth starts from a much lower biomass initially, and the same climatic effect may produce less obvious growth, at least in terms of biomass. Further information can be found in the number of plants occurring at each month in the two zones (Graph 5.9). Their similarity implies that biomass should be similar also. Another source of evidence is the fact that Station B is significantly higher in biomass than Station C, GRAPH 5·7. Average biomass of Stipa nitida.



GRAPH 5·8. Comparison of average biomass of Stipa nitida in zones 1 and 2.



GRAPH 5·9. Average number of *Stipa nitida* plants.



(Graph 5.10), and C is much higher than A. The wombat grazing effect which, subjectively, is much more obvious in Zone 1, means the zone average will be far lower than for Zone 2. Another argument worth considering could be that there is natural variation between the two zones anyway in terms of soil, depth of soil, texture, structure, and slopes.

Initial biomass is larger in B than C, and in C than in A, implying that growth could be dependent on old stock plants as well as on new plants germinating. Similarly stations H and I (Graph 5.11) have significantly higher biomass than stations closer to the warren in Zone 2. Due to the sampling technique (i.e. green parts only), H and I *Stipa* "died off" early in 1974. There was probably a lot of competition between plants for both space and water.

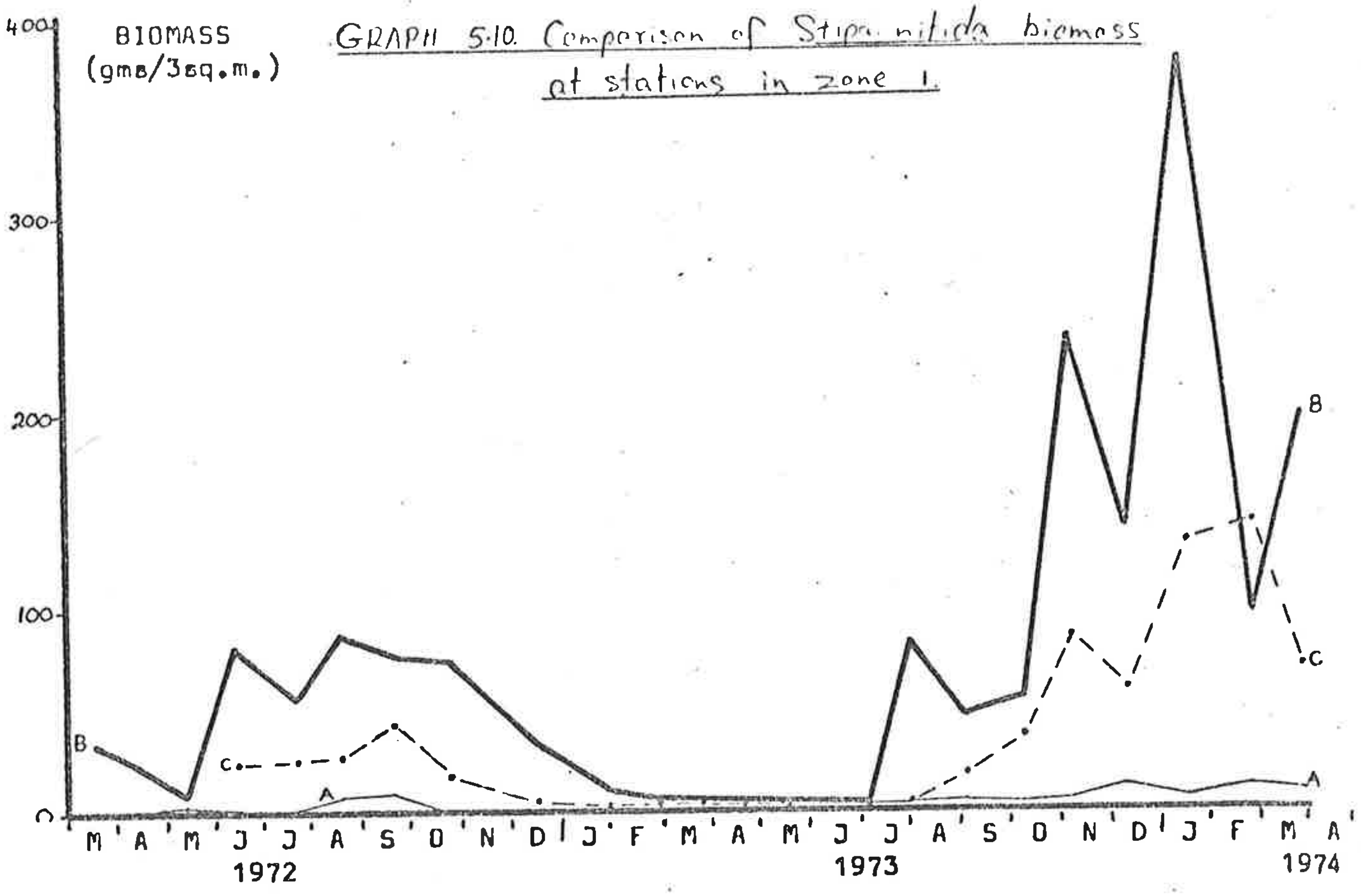
Relation with Locusts

The four fold increase from the maximum biomass reached in 1972 to that of 1973 cannot be solely due to the different seasonal climatic conditions that occurred. The presence of locusts in plague proportions in September and October 1972 would certainly have removed a significant proportion of the grasses. No objective data was obtained on the extent of the damage to *Stipa*, but the grass certainly appeared to be severely affected.

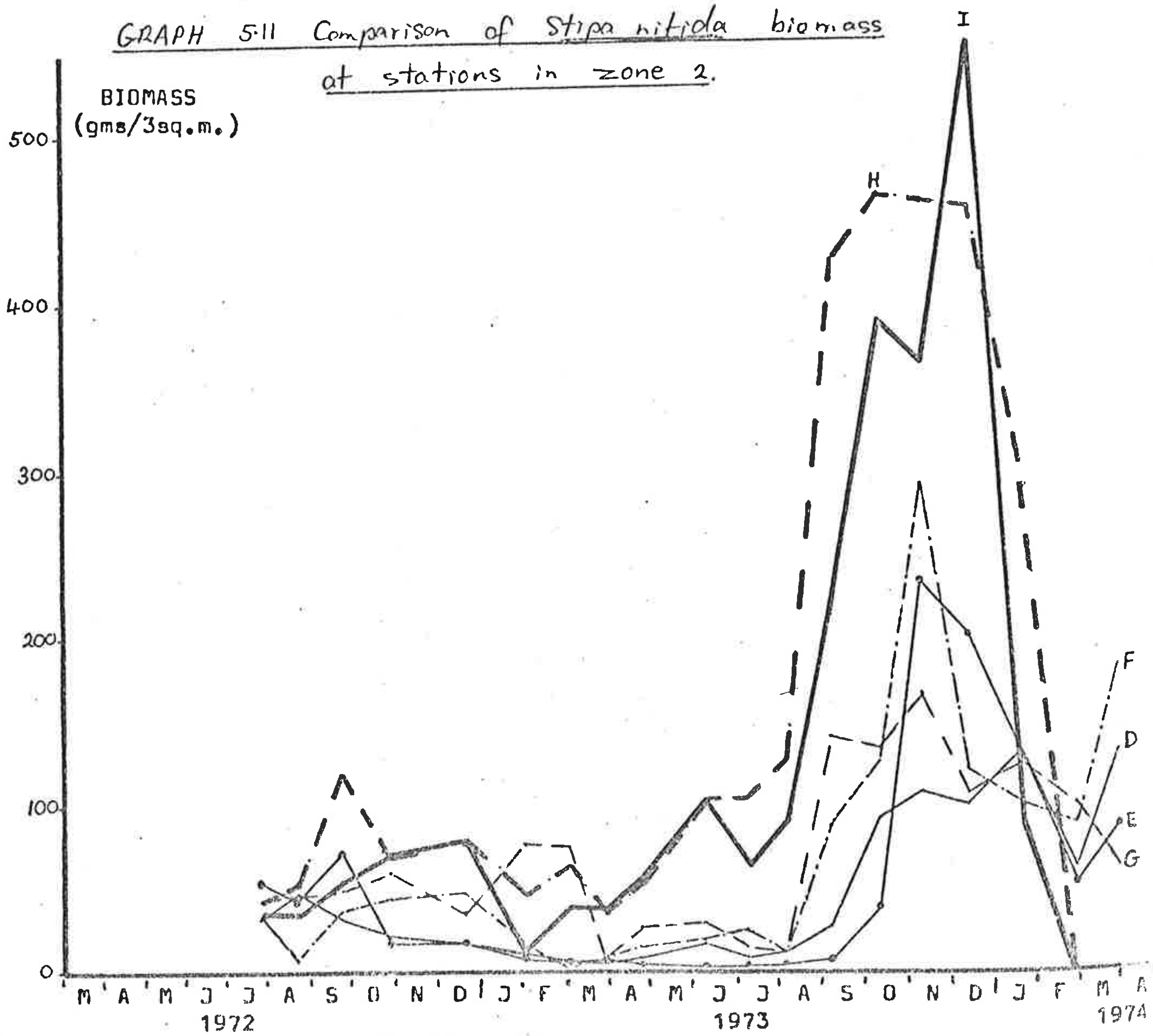
Relation with Soil Water

The soil water (Graph 5.6) does not appear to affect the biomass and the data implies there is no simple

GRAPH 5.10 Comparison of *Stipa nitida* biomass at stations in zone 1.



GRAPH 5.11 Comparison of *Stipa nitida* biomass at stations in zone 2.



relationship between soil water and biomass.

Relation with Plant Water (Appendix 5.5)

Similarly the amount of water (Graph 5.12) in the plant does not appear to bear any relationship with the biomass; plants can be drier and have a higher biomass while at other times they can be very turgid yet not gain significantly in dry weight.

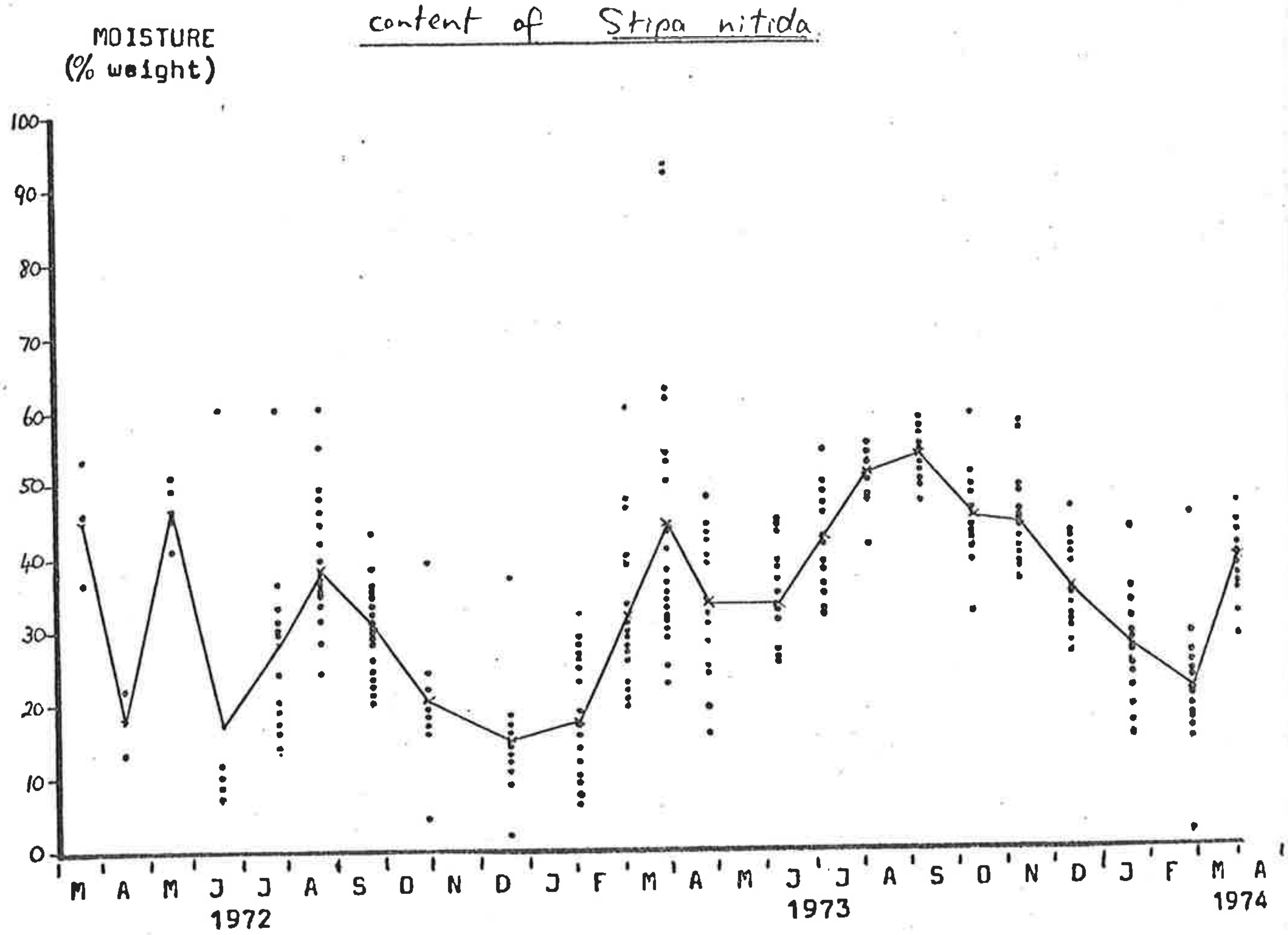
The amount of water in the plants appears to closely parallel the moisture changes at the 10cm. depth; there is less correlation with the surface soil moisture. At every sampling time, the % plant water content was very much higher than soil water at both 0cm. and 10cm. depths. This implies that water is being absorbed by the plants with the expenditure of energy.

The readings for both zones (Graphs 5.13, 5.14) were very similar. In conjunction with the biomass data it appears that the plants are stimulated by seasonal changes, and rain and the natural variation from one station to another have little effect. The plant water content is more closely related to the distribution of rain than to the actual amount. There were not enough samples in March to May 1972 for any useful discussion of these months. Variation in the % water in Zone 1 was greater than in Zone 2, probably because of greater natural variation of soil, topography, shade, vegetation cover and so on.

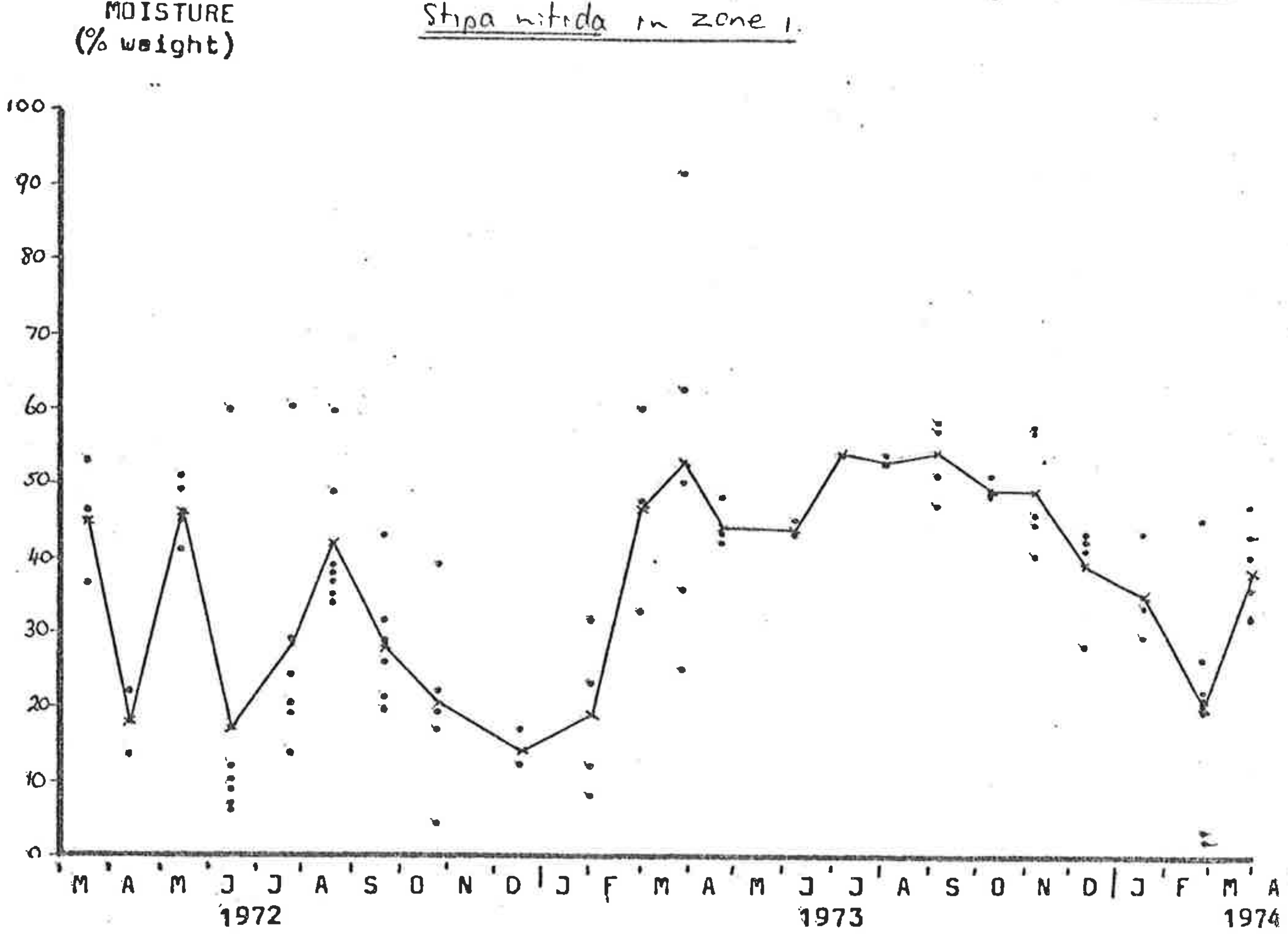
Relation with the number of plants (Appendix 5.6)

In 1972 the number of plants (Graph 5.9) peaked

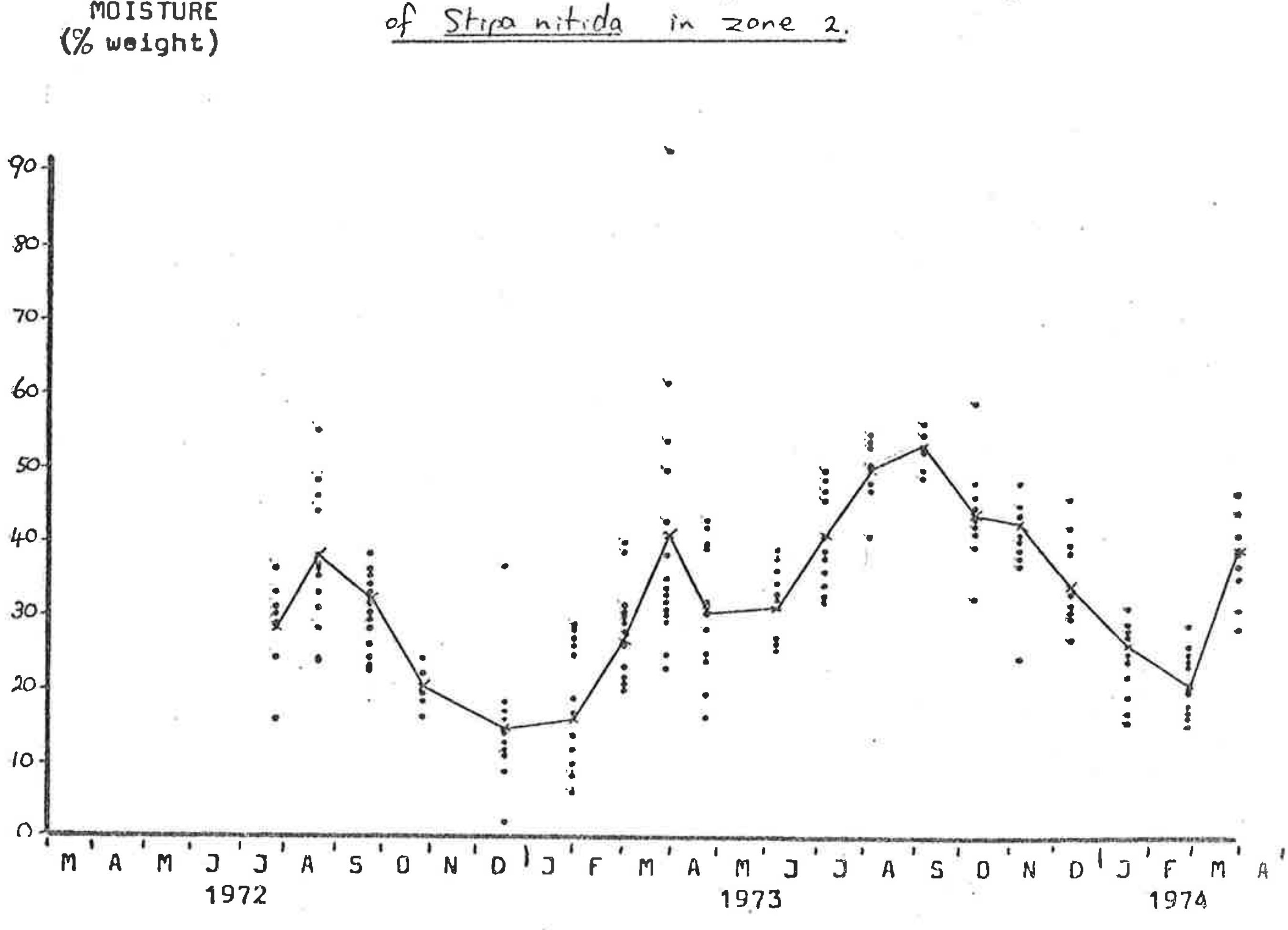
GRAPH 5·12. Sample distribution pattern and average of water content of *Stipa nitida*.



GRAPH 5·13 Sample distribution pattern and average of water content
Stipa nitida in zone 1.



GRAPH 5·14. Sample distribution pattern and average of water conten
of Stipa nitida in zone 2.



in September when biomass was at its maximum, in 1973 the number rose to a maximum in November, as did the biomass. In 1973 there was a dramatic drop in number in January, with biomass falling off more gradually from its previous peak, and in 1974, with the same dramatic drop in numbers, there was an accompanying decrease in biomass. The data indicates that the number of plants increase and decrease at the same time as the biomass, i.e. new growth and new germinations occur at about the same time, and cessation of germination and drying off also parallel each other.

The number of plants seem to vary according to season. Rainfall does little to modify this seasonal effect. For example, in 1972 where there was little effective rain the numbers remained fairly high, and in 1973 where there was much more effective rain, there was no tremendously significant effect on the number of plants.

The 1972 peak was not as great possibly because of the locusts' preference for young shoots, this would have occurred in September and October. Perhaps less plants were there to start off with or there was less overall moisture available.

Many plants germinated in August 1973, but few survived to become very large. Perhaps there was a water problem and only those plants which could get adequate moisture could survive to a reasonable size.

There appears to be little relationship with soil water except for an increase of both soil water and new plants in April and August of 1973.

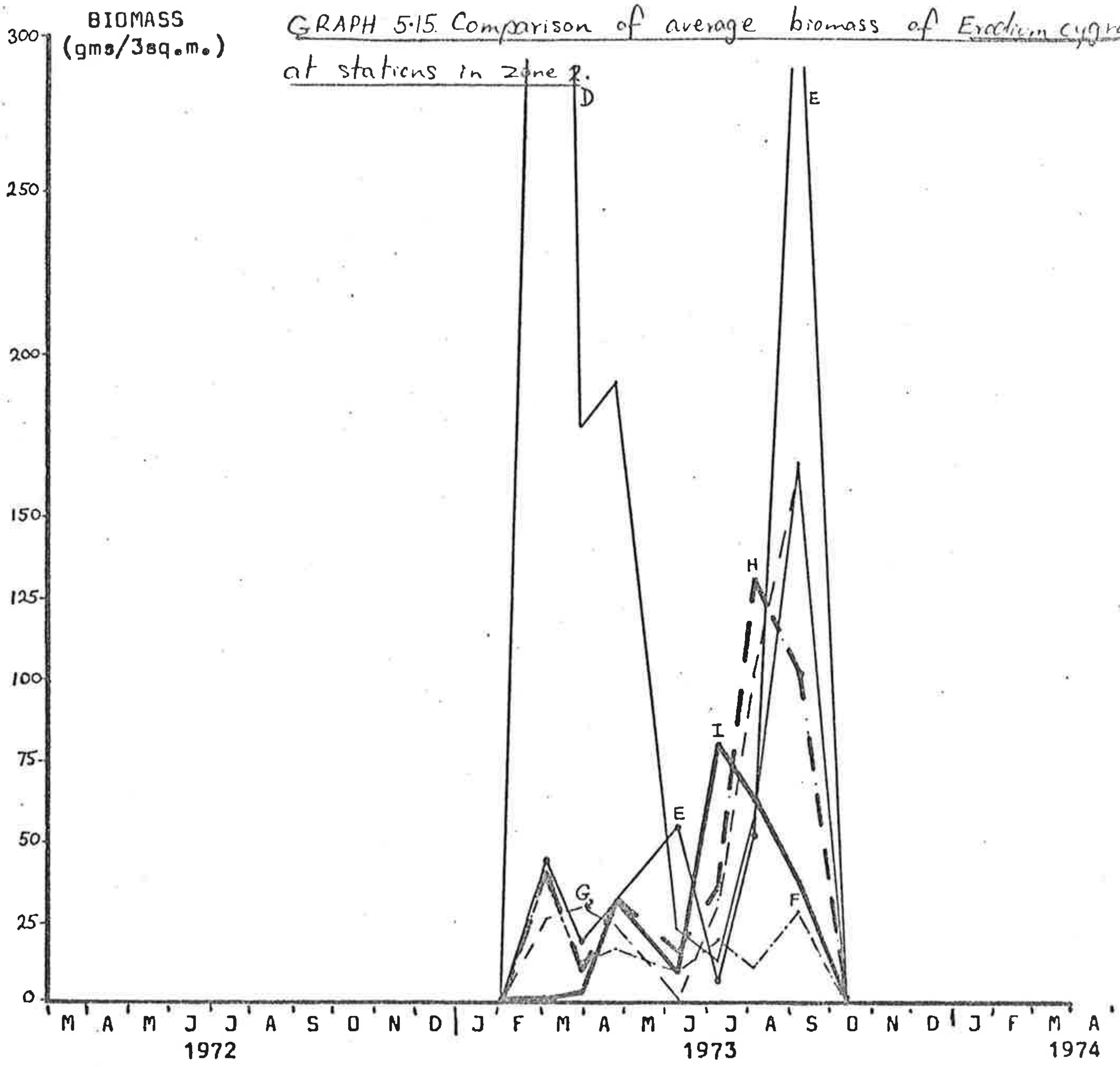
(ii) *Erodium cygnorum*

Generally: Before the biomass data can be discussed in general it is necessary to look at the variation between stations because station D has such an enormous biomass value for March and April 1973 that it can be regarded as atypical of the region as a whole (Graph 5.15, Appendix 5.7). It appears that close in around each warren there is a significant development of *Erodium* and *Bassia*, to the exclusion of *Stipa* which is presumably eaten by wombats. For the purposes of a general discussion, without involving wombat effects, the data for station D was not used during these months. The modified data are indicated by the dotted lines in Graphs 5.17 and 5.18. (Graph 5·16 shows Zone 1 biomass.) From Graph 5.18 it can be seen that there was growth in March 1973, followed by a slight slump in early April. The biomass then rose gradually to July, took a leap to September, and had died off by October. It is interesting, and puzzling, that measurable growth occurred only in one of the three seasons that it may have been expected in. This occurred after the dry summer of 1972-3. Perhaps there should have been growth by April 1974 after a wetter summer.

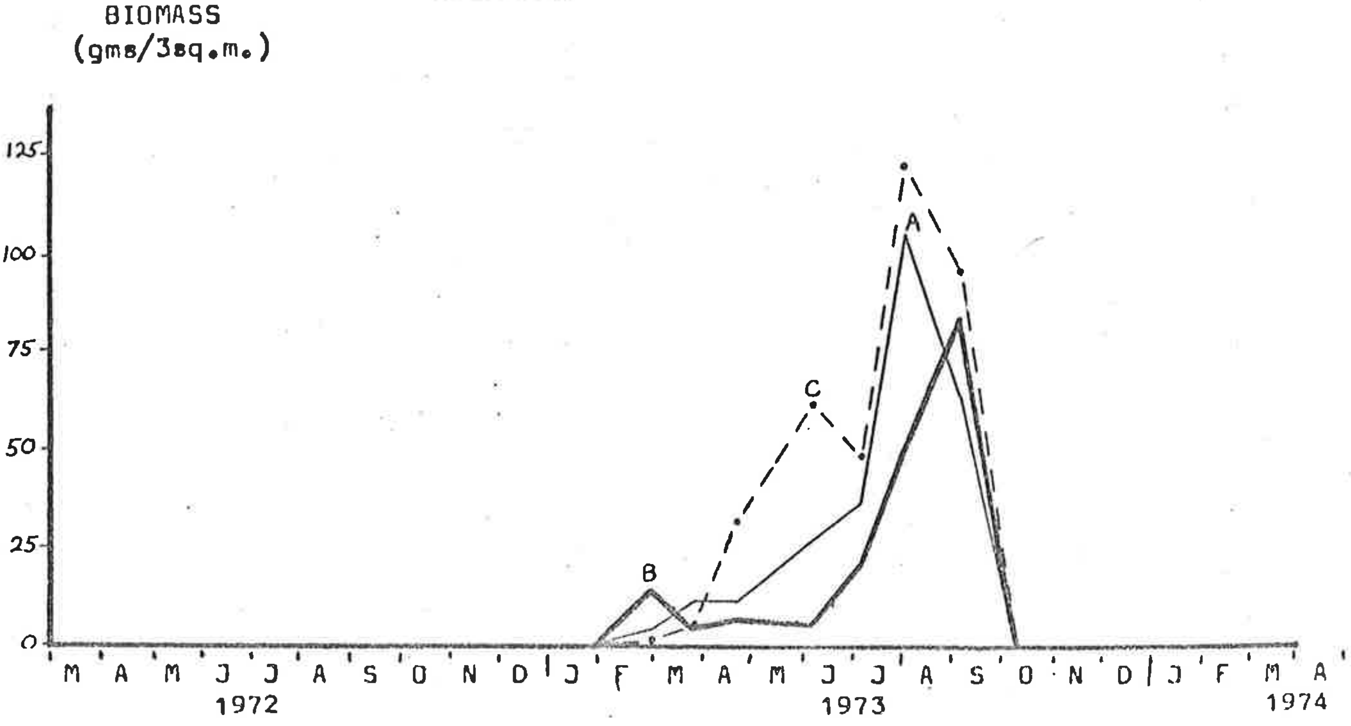
Relation with rainfall

The biomass does not seem to be affected by the rainfall greatly up until June 1973. After this there was a dramatic biomass increase associated with regular, higher rainfall. When "effective" rain in October was low, the biomass decreased to

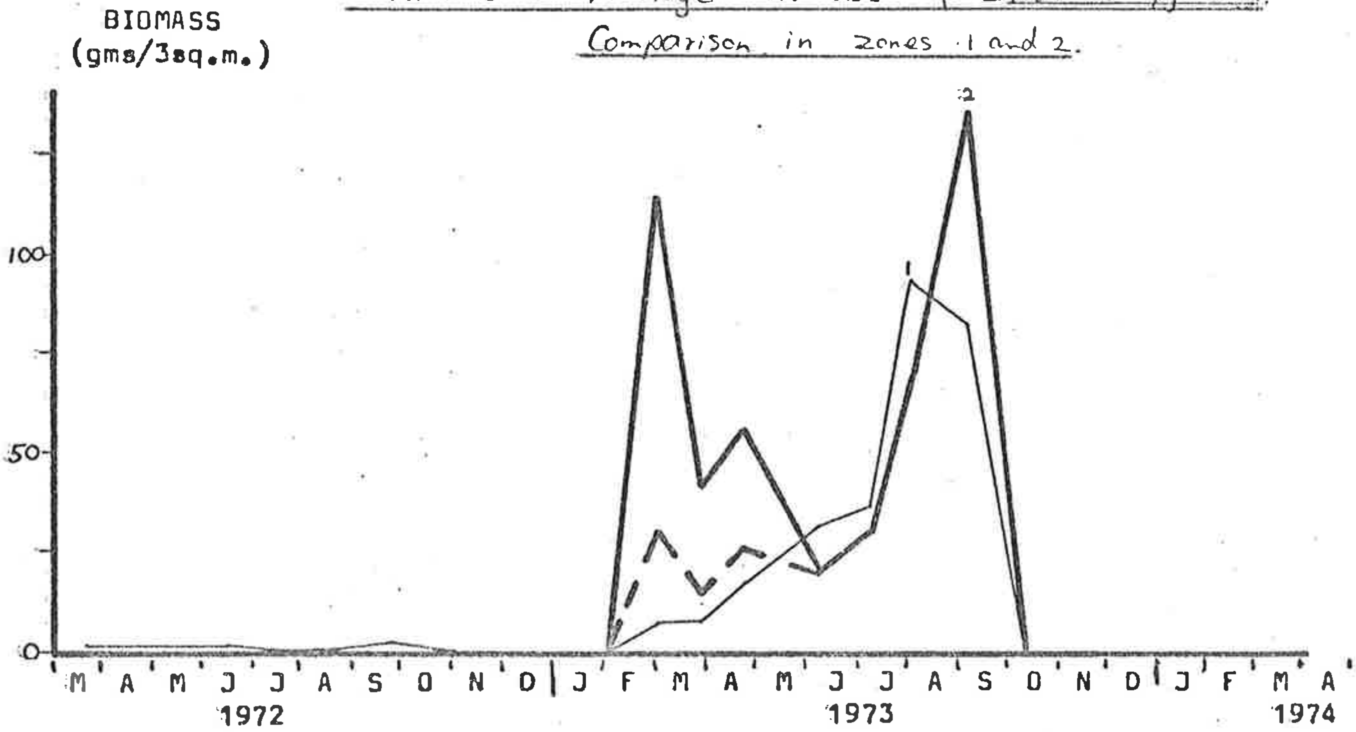
GRAPH 5·15. Comparison of average biomass of *Erodium cygnorum* at stations in zone 2.



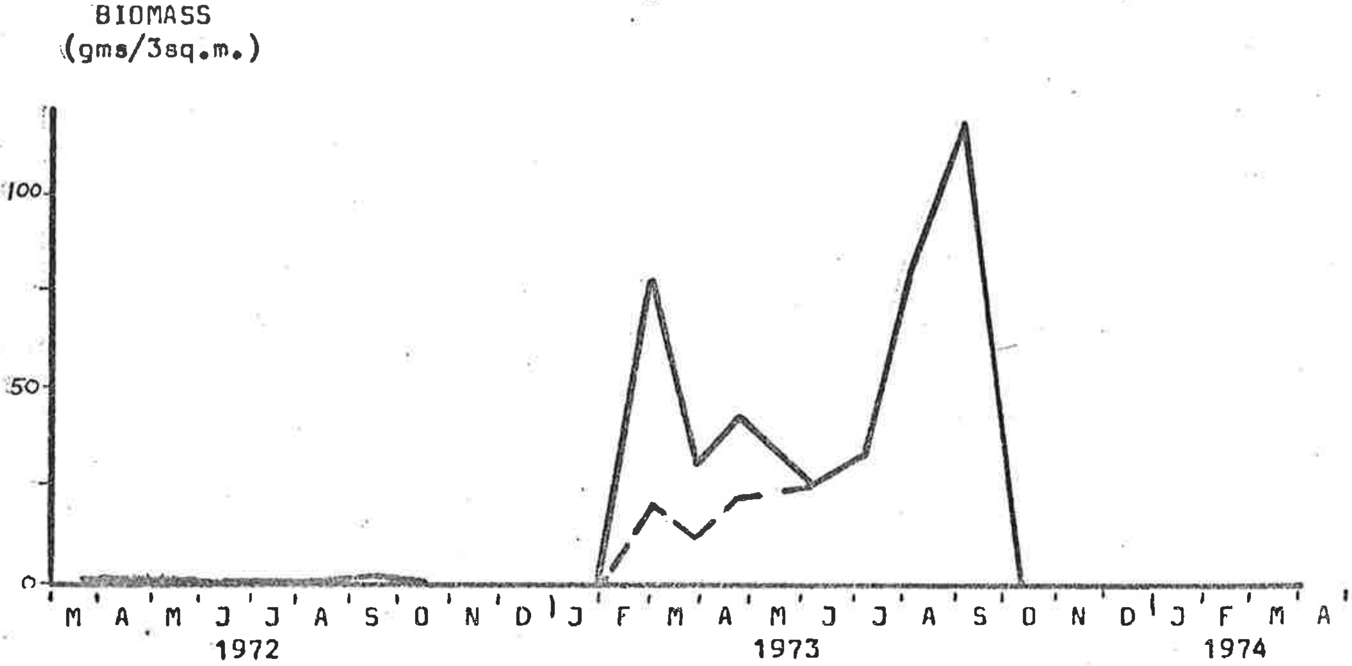
GRAPH 5·16. Comparison of average *Erodium cygnorum* biomass at stations in zone 1.



GRAPH 5·17. Average biomass of Erodium cygnorum. Comparison in zones 1 and 2.



GRAPH 5·18. Average biomass of Erodium cygnorum in zone 2.



zero. The implication here is that something else other than rain triggers the initial growth

Relation with soil water

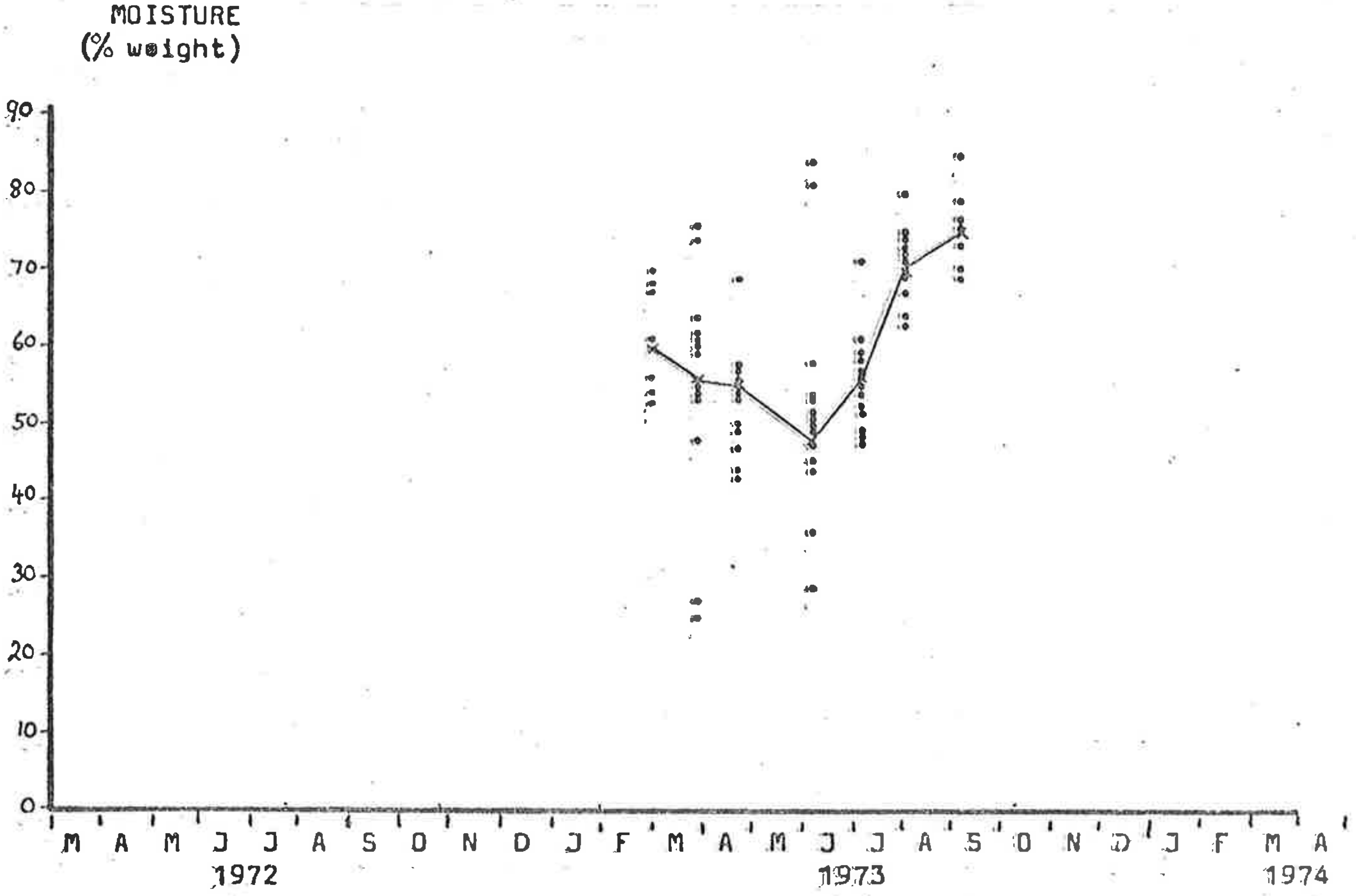
Generally increasing soil water content after December 1972 led to a gradual increase in plant biomas but there was over a month's delay between the soil water rising to a level that could easily support the species, and the time that they grew. This further supports the suggestion that some factor other than water, triggers initial growth.

A high soil water content in August and September produced rapid increase in biomass. However, the 10cm. depth soil water remained fairly even from then on, yet the plants died off. There does not appear to be a simple explanation for these events.

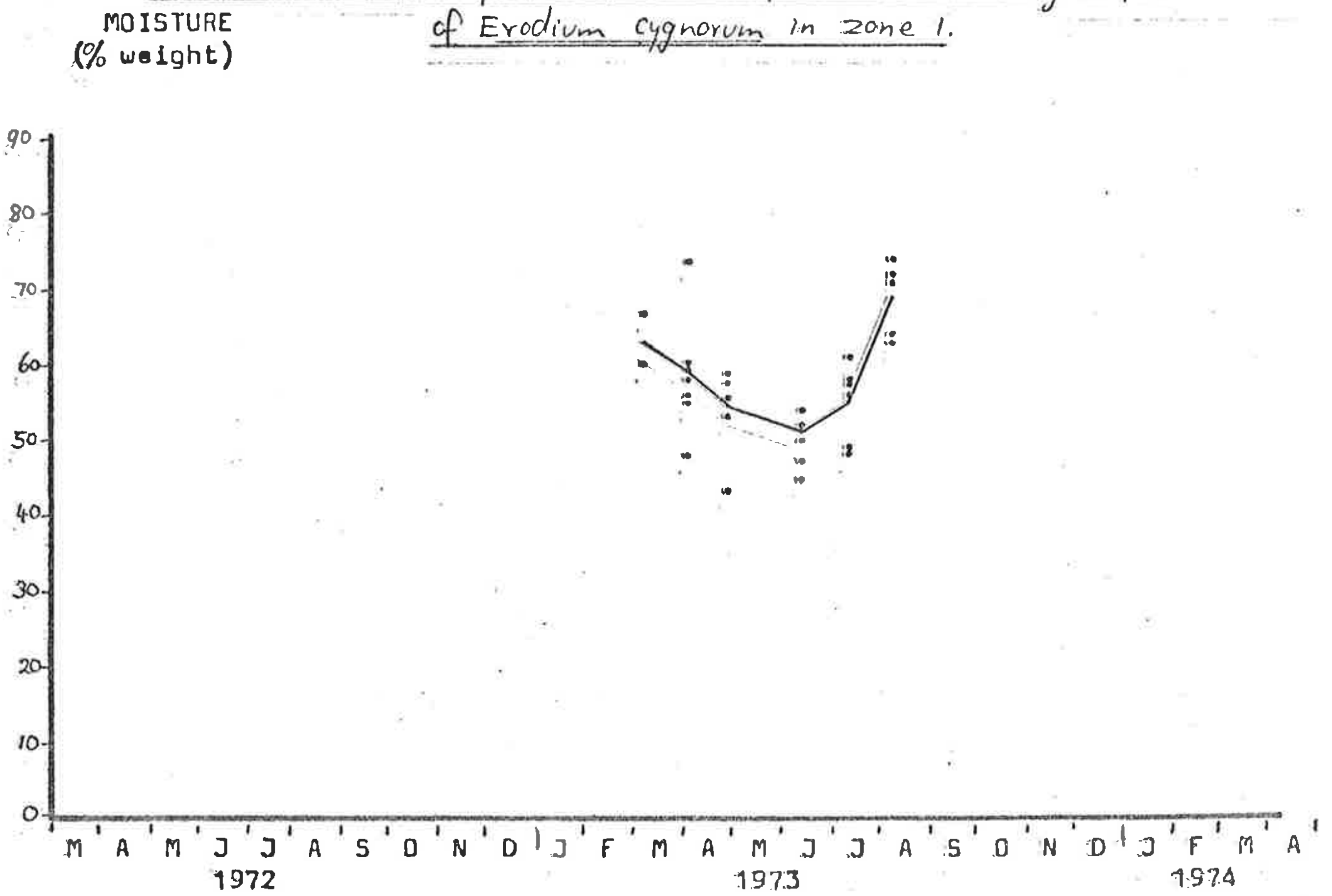
Relation with plant water (Appendix 5.8)

The plant moisture actually decreased from March to June 1973, and then rose more rapidly to September (Graph 5.19). In the initial drop the biomass increased, while in the latter increase in moisture, biomass also increased. Perhaps some factors (possibly involving photoperiodic responses to seasonal changes) allowed initial germination and growth but the water available in latter months enhanced growth. Then other factors again led to the dying off of the species. Comparing the plant water content for the two zones (Graphs 5.20, 5.21) the graphs are virtually identical in both value, and trend, although Zone 2 had a broader distribution pattern, implying a greater degree of varia-

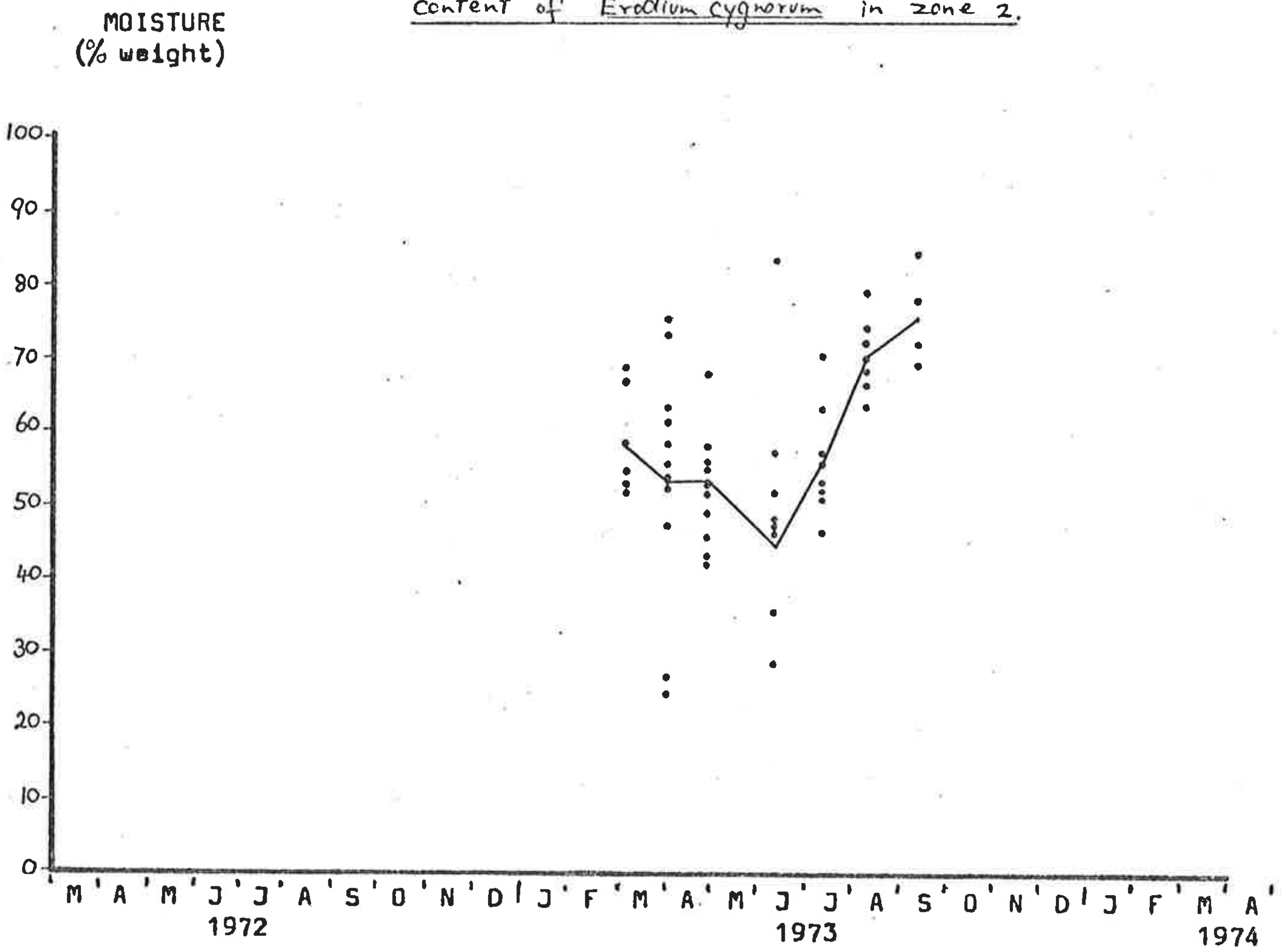
GRAPH 5·19 Average water content, and distribution of *Erodium cygnorum*



GRAPH 5·20 Sample distribution pattern and average of water content of *Erodium cygnorum* in zone 1.



GRAPH 5·21 Sample distribution pattern and average of water content of *Erodium cygnorum* in zone 2.



tion within the region.

In March 1973 the plants' water content was above the level suggested by the soil water content; the soil water content only very roughly illustrates a similar trend as the plant water content.

Relation with the number of plants (Appendix 5.9)

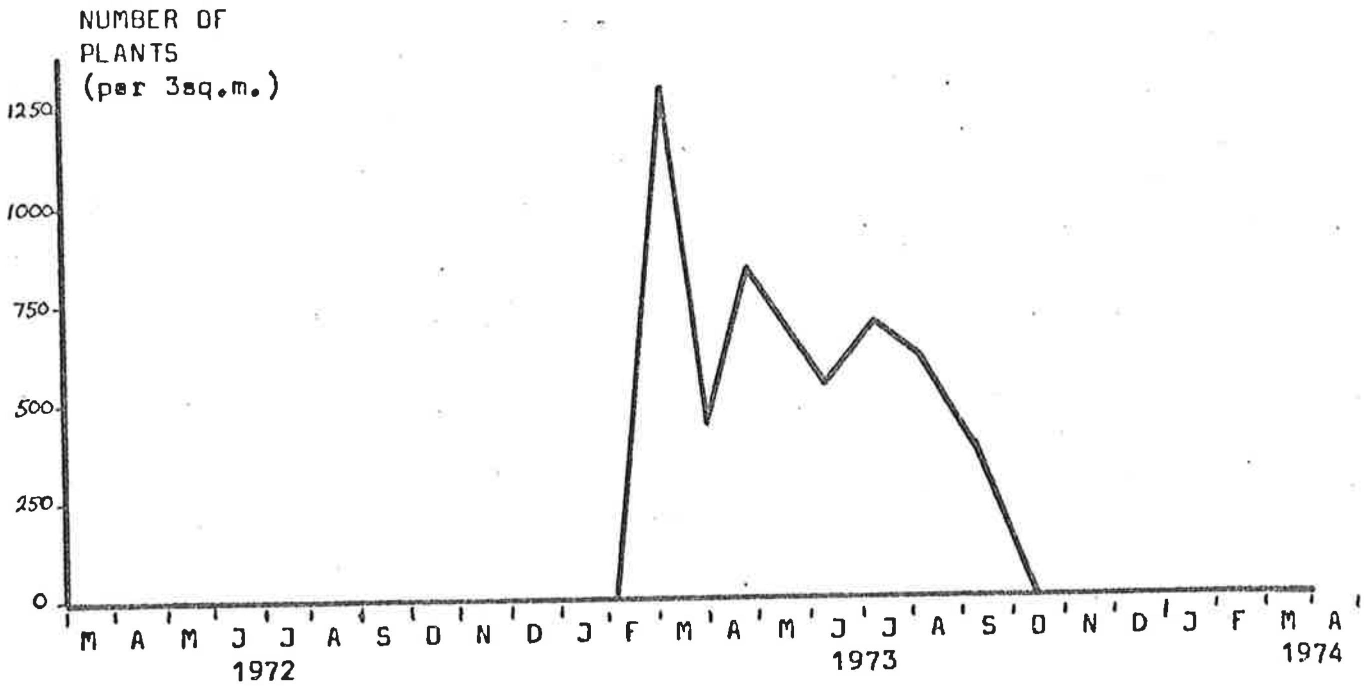
The number of plants appears to be related proportionably to the biomass from February to July 1973 (Graph 5.22), but although the numbers fluctuate dramatically, the biomass does not alter all that significantly. After July, however, the number drops to almost zero in October, yet the biomass continues increasing to September, and at an ever-increasing rate. It appears that the smaller and/or less viable plants are being selected out, while established plants are still growing. This could be a case of competition for resources, namely space, moisture, minerals.

Comparing the number of plants in each zone (Graph 5.23) there are significant differences. Zone 1 numbers increase generally to a peak of 1215 in July, while Zone 2 reaches 1815 in March, then the number decreases generally. The discrepancies are not explained by soil water, or plant moisture differences, which leads us to believe that there must be some other variable that has not been monitored, such as those mentioned earlier or a wombat effect on the vegetation since each warren had quite different amounts of activity.

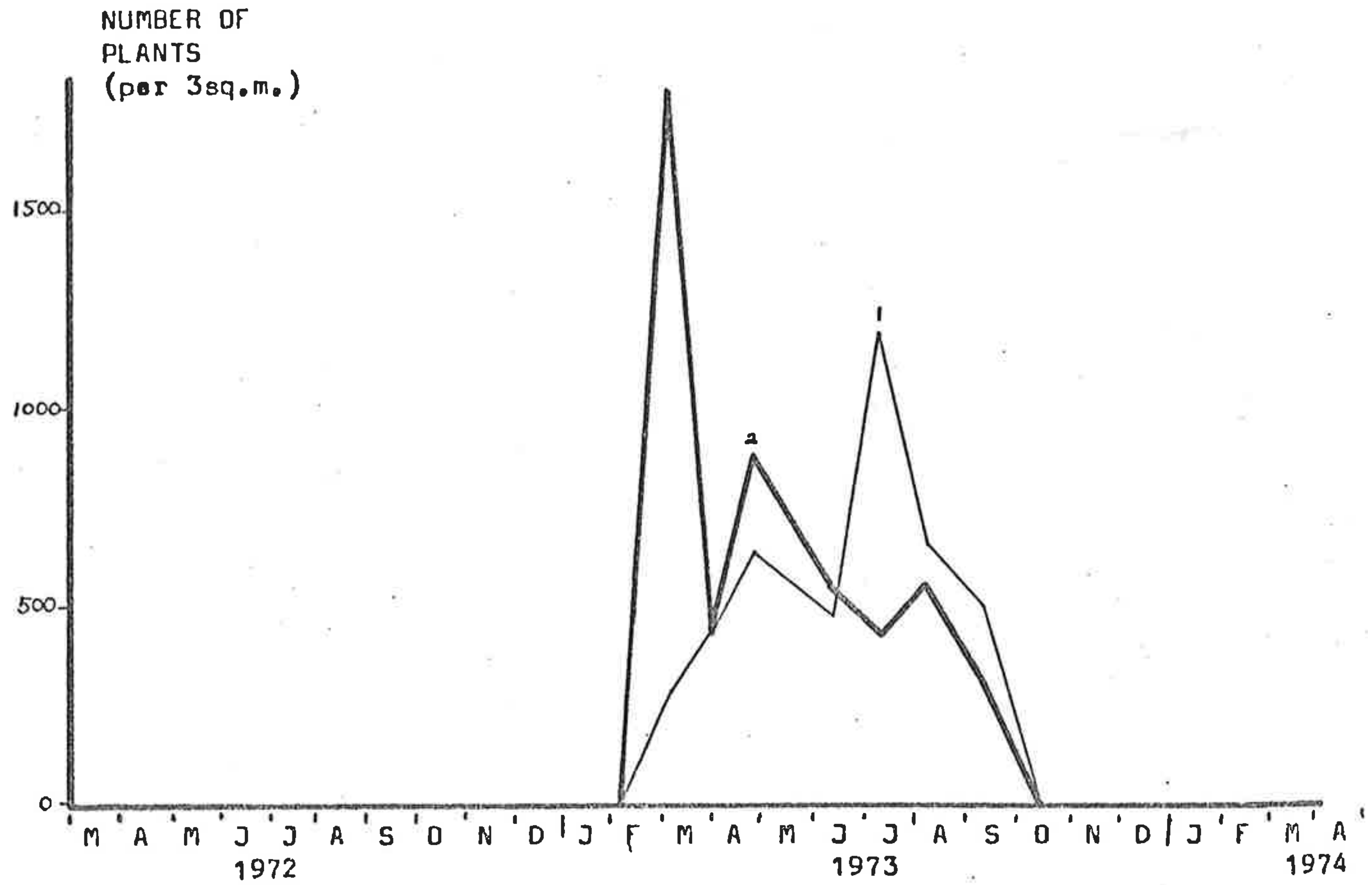
(iii) *Zygophyllum* (Biomass data Appendix 5.10)

Generally: Graph 5.24 shows a low peak at April

GRAPH 5·22 Average numbers of *Erodium cygnorum*.



GRAPH 5·23 Comparison of *Erodium cygnorum* numbers, zones 1 and 2.



1972, followed by a gradual decline to zero in October. Biomass again increased in February 1973, peaked in July, dwindled slightly until September, then peaked suddenly in October before dying out by November 1973. The data suggests very rigid adherence to some growth pattern. Comparing both zones (Graph 5.25) similar trends occurred. However, within Zone 1 (Graph 5.26) there was tremendous variation. Station A appears to lag about a month or two behind station B, and station C illustrates quite a different pattern from the others. Station B also had the greatest average biomass. Similarly in Zone 2 (Graph 5.27) there is a large amount of variation from one station to another. This is probably due to the fact that there were relatively few of this species compared with *Stipa*, and they were not distributed as evenly as *Stipa*. Even so, by averaging all the stations, a fairly reasonable representative picture can be obtained.

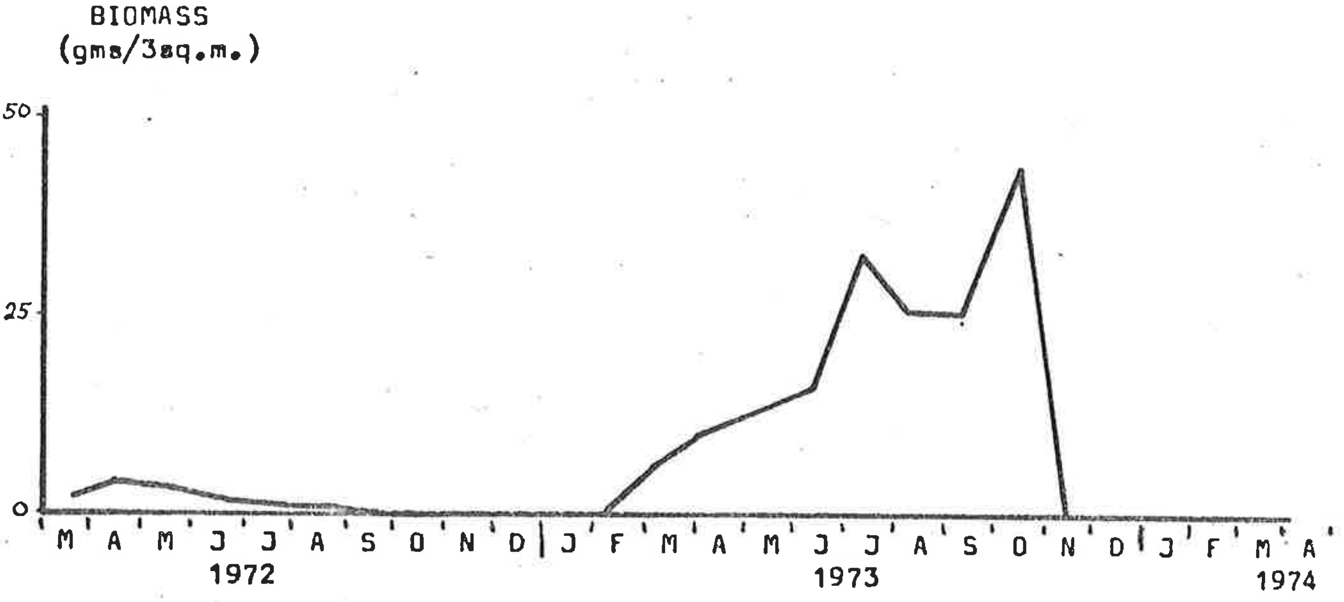
Relation with rainfall

Comparison with the rainfall data shows that effective rain will produce marked growth in 4 to 6 weeks time. Rainfall appears to be at least partly responsible for triggering growth. Perhaps seasonal changes also have some effect, since growth started near March 1972, and in March 1973 but not in March 1974.

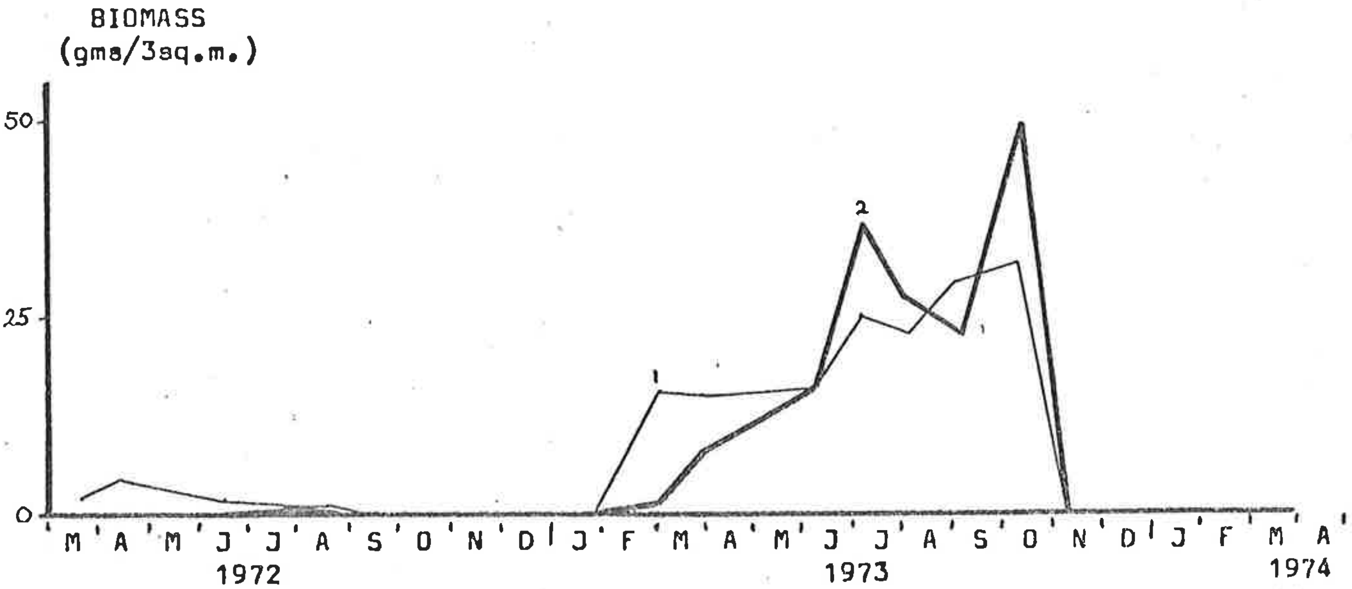
Relation with soil water

There does not appear to be any relation other than initial growth in 1973, where growth does not

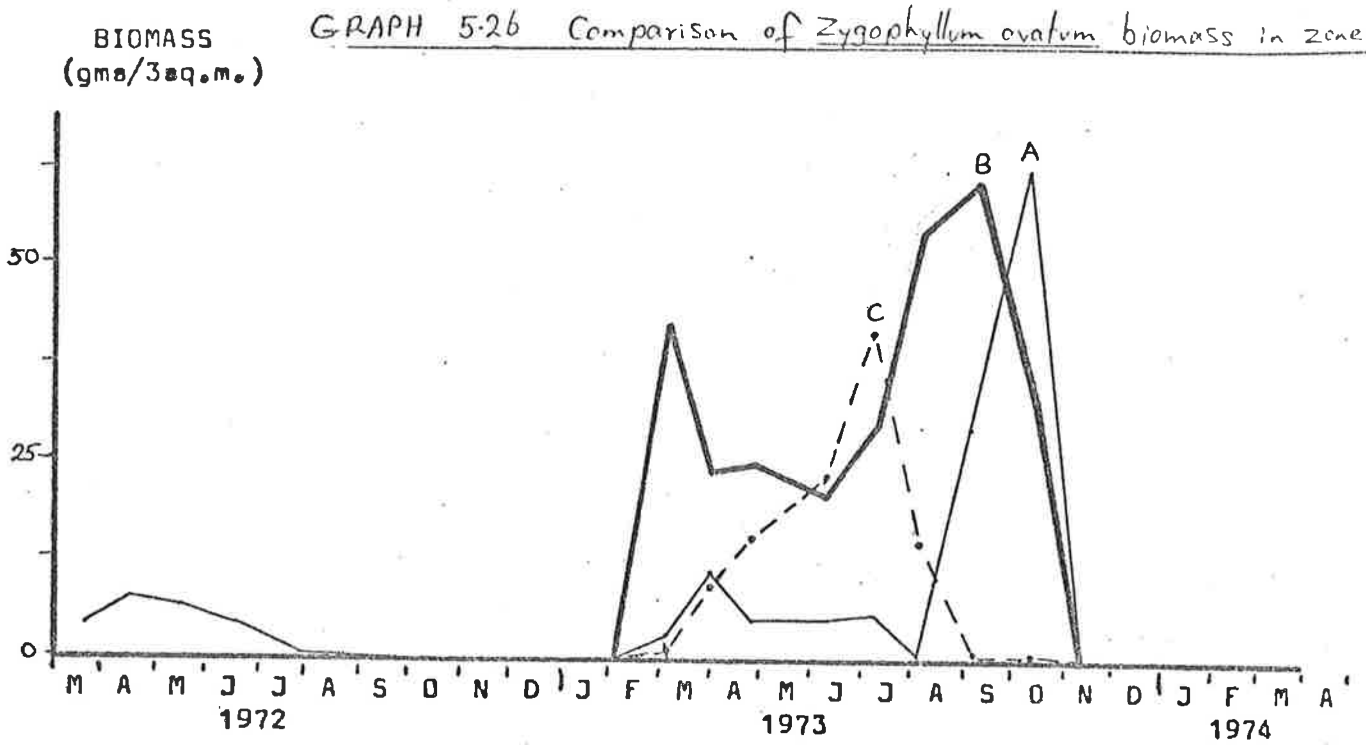
GRAPH 5·24 Average biomass of *Zygophyllum ovatum*.



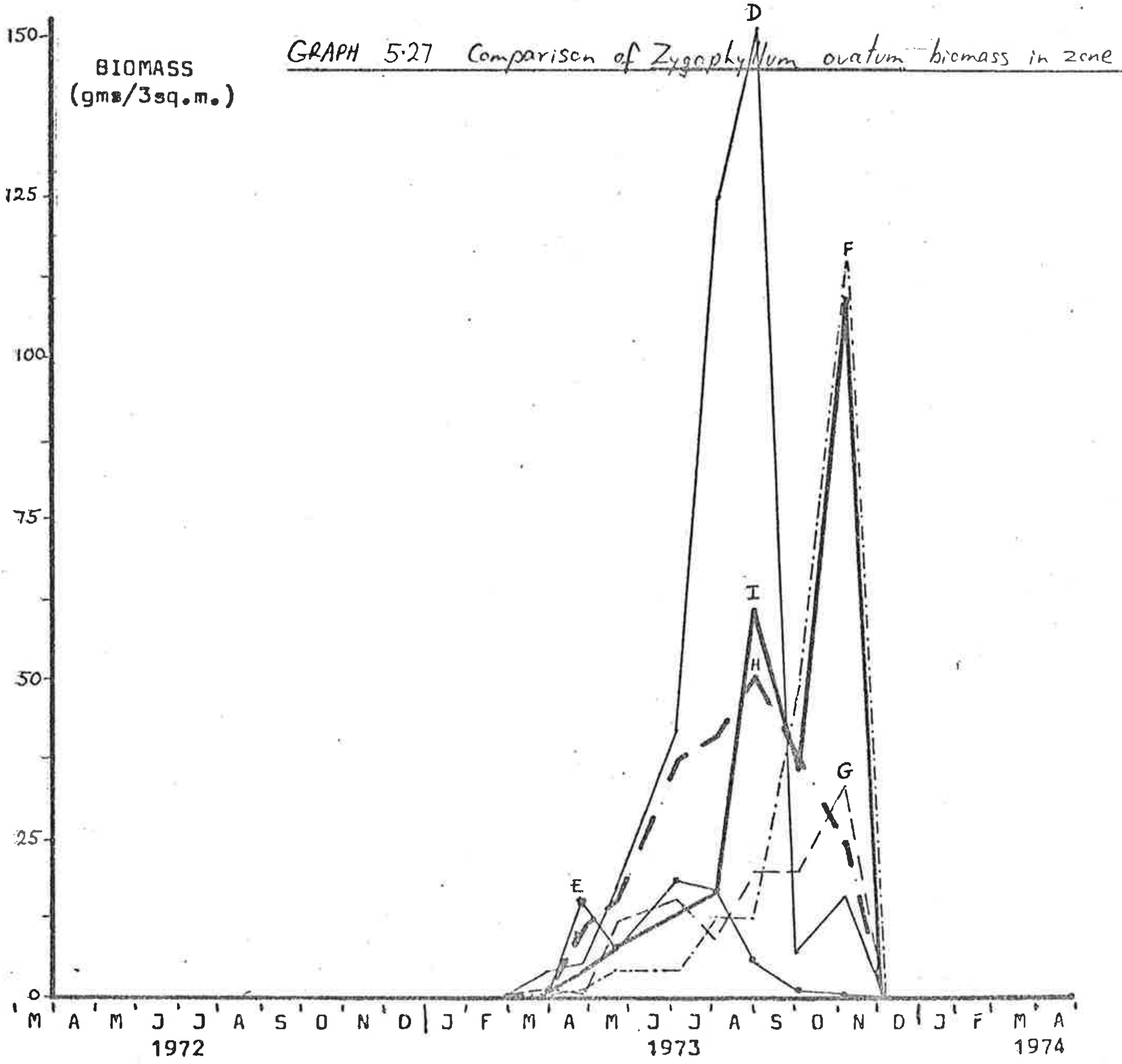
GRAPH 5·25 Comparison of average *Zygophyllum* biomass, zones 1+2.



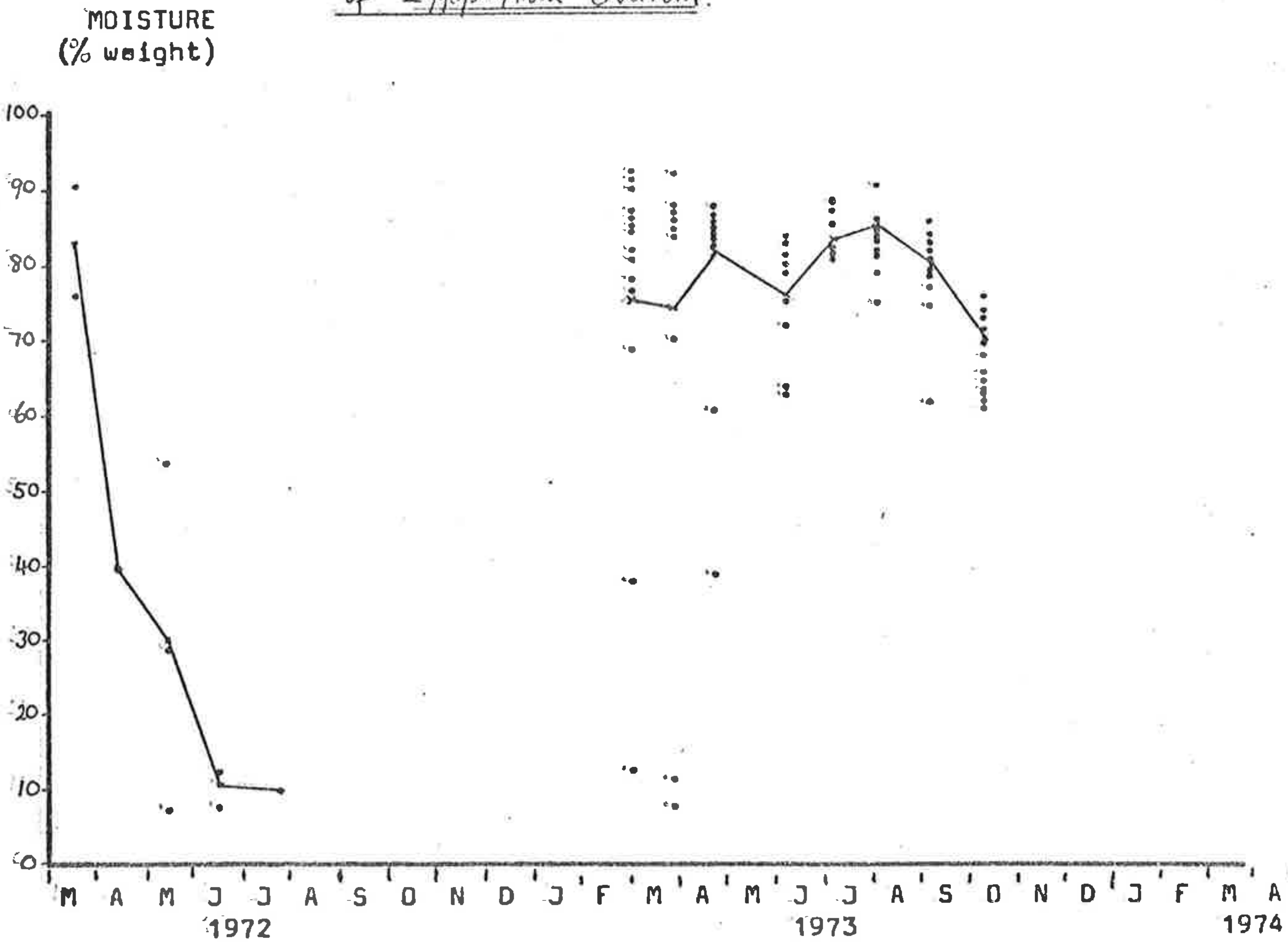
GRAPH 5·26 Comparison of Zygophyllum ovatum biomass in zone 1.



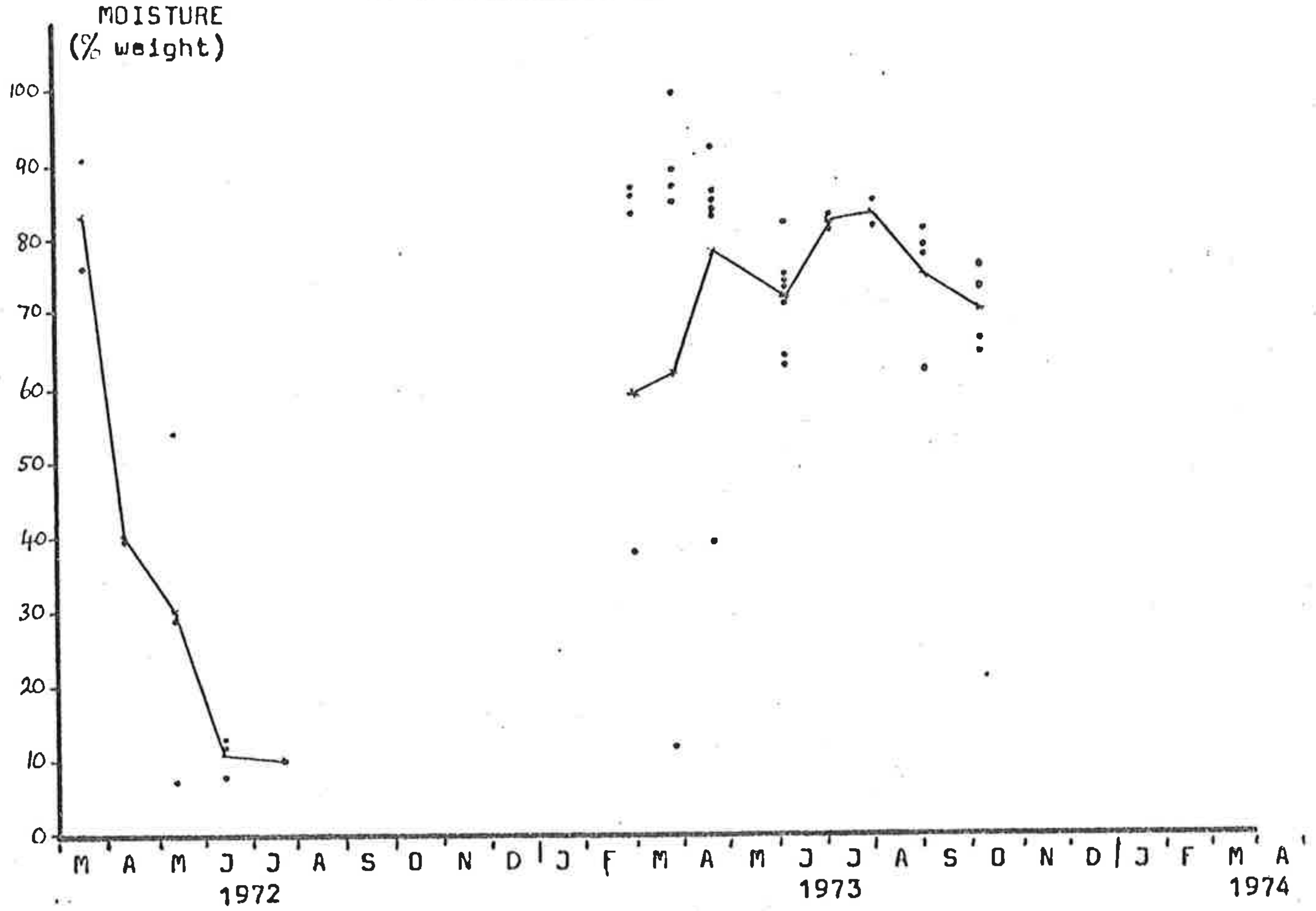
GRAPH 5·27 Comparison of Zygophyllum ovatum biomass in zone 2.



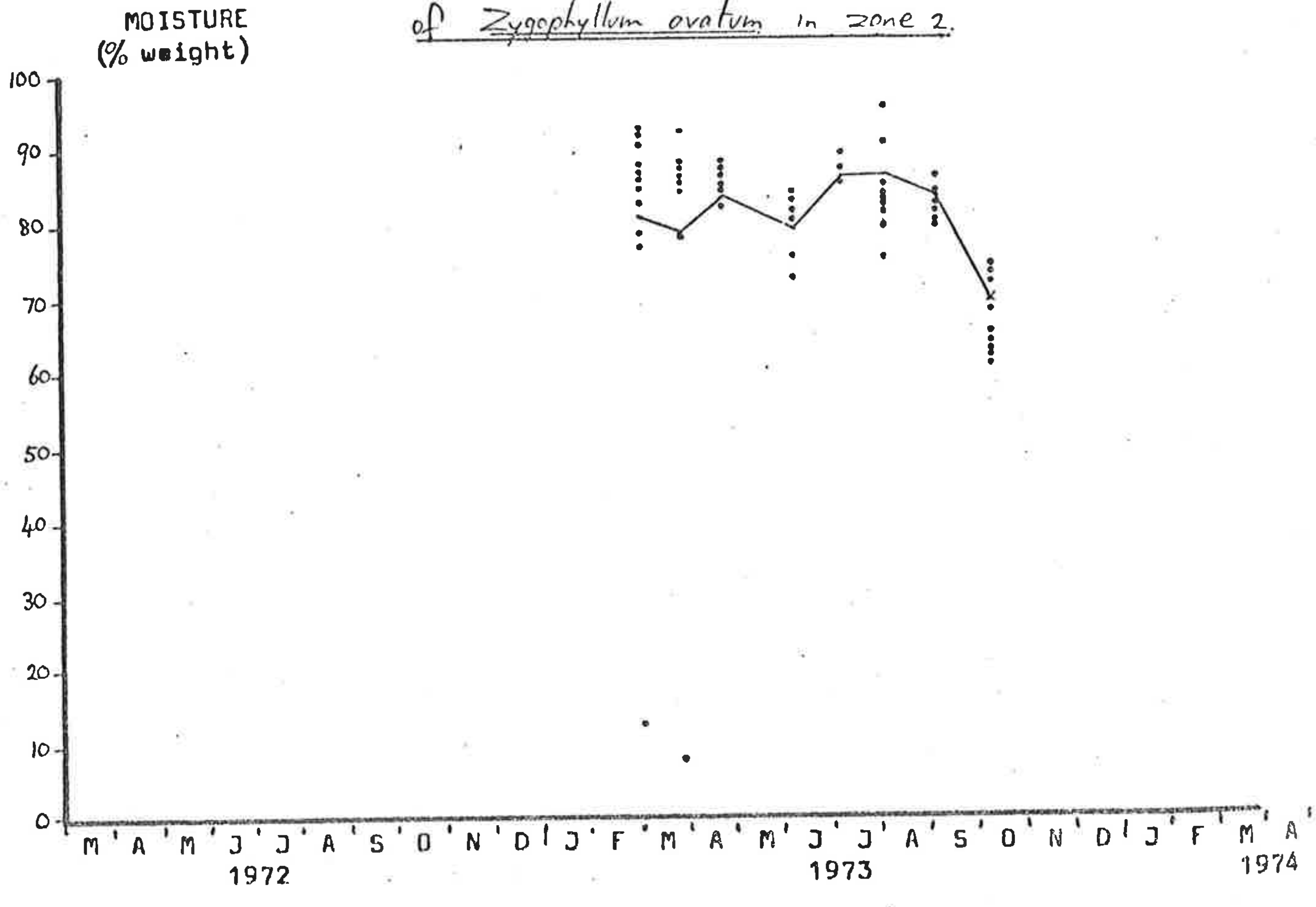
GRAPH 5·28 Sample distribution pattern and average of water content of Zygophyllum ovatum.



GRAPH 5·29 Sample distribution pattern and average of water content of *Zygophyllum ovatum* in zone 1.



GRAPH 5·30 Sample distribution pattern and average of water content of *Zygophyllum ovatum* in zone 2.



occur until there is some water in the soil after the hot dry summer of 1972-3.

Relation with plant water (Appendix 5.11)

Similarly, no simple relation can be observed in the data, (Graph 5.28). Comparing plant water content with soil water, however there is a strong parallel with the 10cm. depth content, except for March and early April 1973. Here a very low plant content was obtained, possibly from a typical quadrat that contained many specimens that appeared to be dying off. If these data are eliminated from the samples the average is somewhat improved. (Compare Graphs 5.29, 5.30). Comparison with "effective rain" (Graph 5.3) shows a very close parallel correlation with plant water content. Variation between zones can be eliminated if we remove the samples that are very different from the average. The distribution pattern is then very similar for each zone.

Relation with number of plants (Appendix 5.12)

There appears to be almost an inverse relation between the numbers and biomass. (Compare Graphs 5.31 and 5.24.) In March and April 1973 a large number of new plants dramatically appeared but the number declined steadily to November. On the other hand the biomass gradually increased to October, before falling again dramatically to zero in November. The data implies that plant growth is triggered by some seasonal factor other than rain alone, and new germinations occur. As plants grow and mature, only the strong survive to reproduce and then die off quickly.

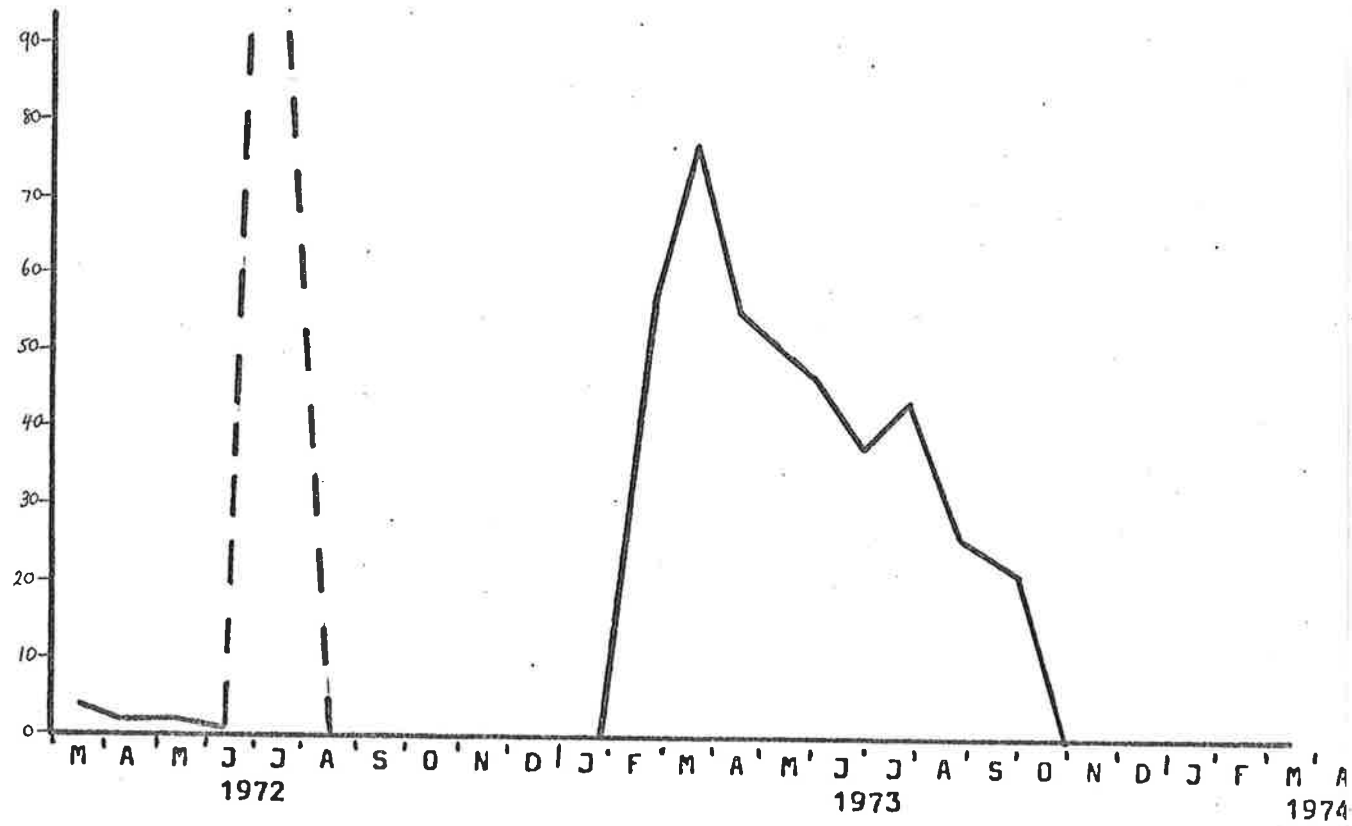
The very large number of new plants germinating in July 1972 is probably due to the high rainfall prior to it. However, follow up rains in August do not appear to have stimulated continued growth. It is interesting to note that despite the fact that the plants' moisture content remained fairly even, the number of plants decreased markedly. There is no obvious relation between the two. The 10cm. depth soil water content appears to be proportional with the number of plants, where soil water fluctuates the number of plants vary accordingly. It appears that when there is water available in the soil in February 1973, that the plants started germinating; a relatively damp soil in early April supported a large number of plants. The soil moisture decreased gradually, then peaked again at August, paralleled by the number of plants. However, after August the number decreased while the soil water content remained fairly high. This implies that the availability of water does not seem to trigger the end of growth. Perhaps it is temperature or length of day and night.

Comparing the two zones, (Graph 5.32) there is very little difference between them, the main one being the fact that in Zone 1 the peak germination period in March produced twice the number that germinated in Zone 2.

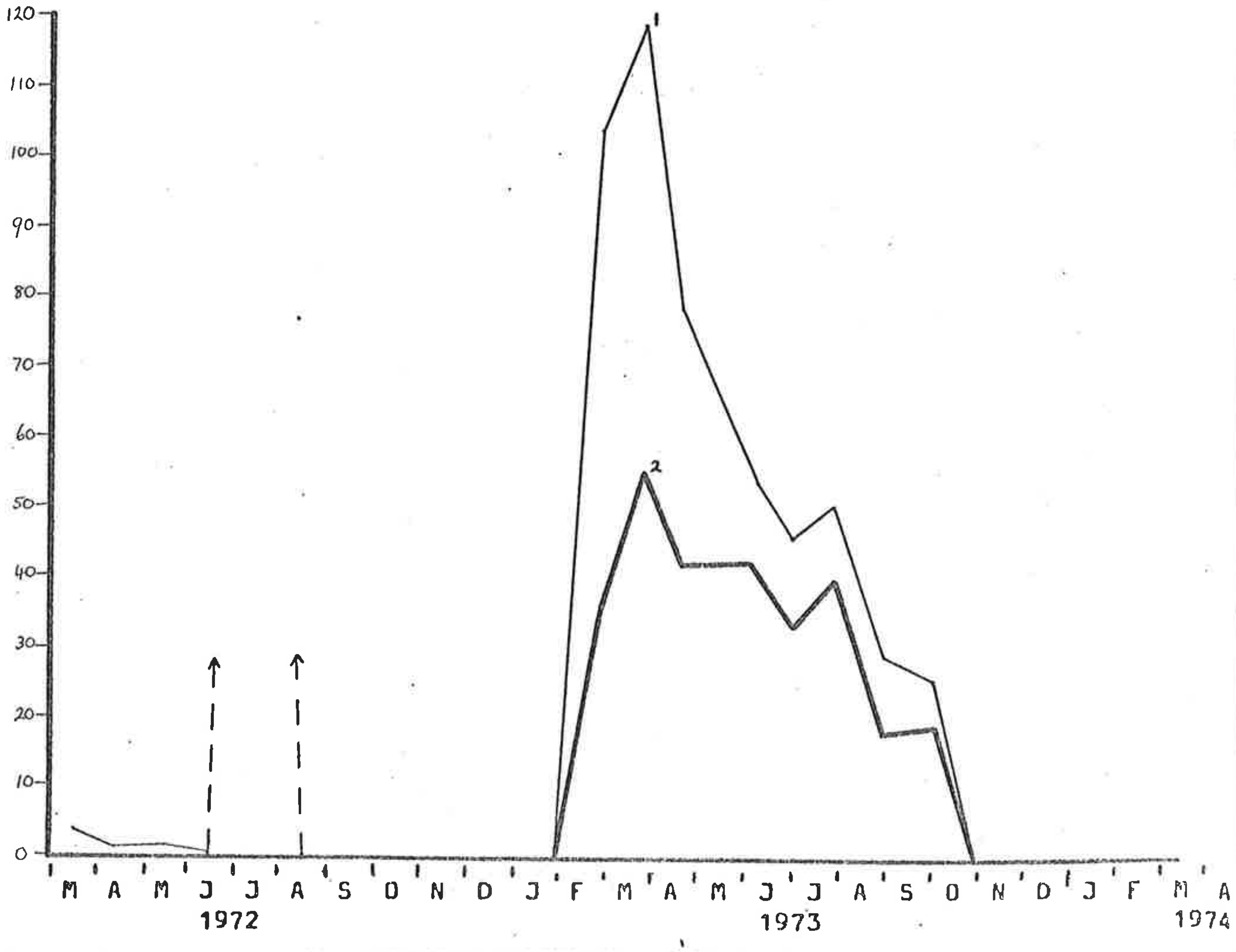
(iv) *Bassia patenticuspis*

Generally the biomass fluctuated dramatically with peaks in growth in May and December 1972.

GRAPH 5·31. Average numbers of *Zygophyllum ovatum*.



GRAPH 5·32. Comparison of average numbers of *Zygophyllum ovatum* in zones 1 and 2.



(Graph 5.33.) June and December of 1973 and lows in between. The biomass was very low (less than 20 grm/quadrat) and the distribution of the plants was not random but more congregated around warrens and under trees. Stations A and D had by far the greatest densities and quality, implying that wombats are affecting this species quite noticeably.

Relation with other Factors

There does not seem to be any relation between biomass and rainfall, (Graph 5.34) soil water, and plant content. There appears to be only a vague relation to numbers, mostly in 1973, and less so in 1972.

Other relations

There does not seem to be any relation between the water content and rain, soil water or number. There were too few specimens for our sample size and no valid comparison can be made. Even so there are no obvious trends. (Compare Graphs 5.33, 5.34, 5.35.)

(v) *Euphorbia drumondii* (Appendix 5.13)

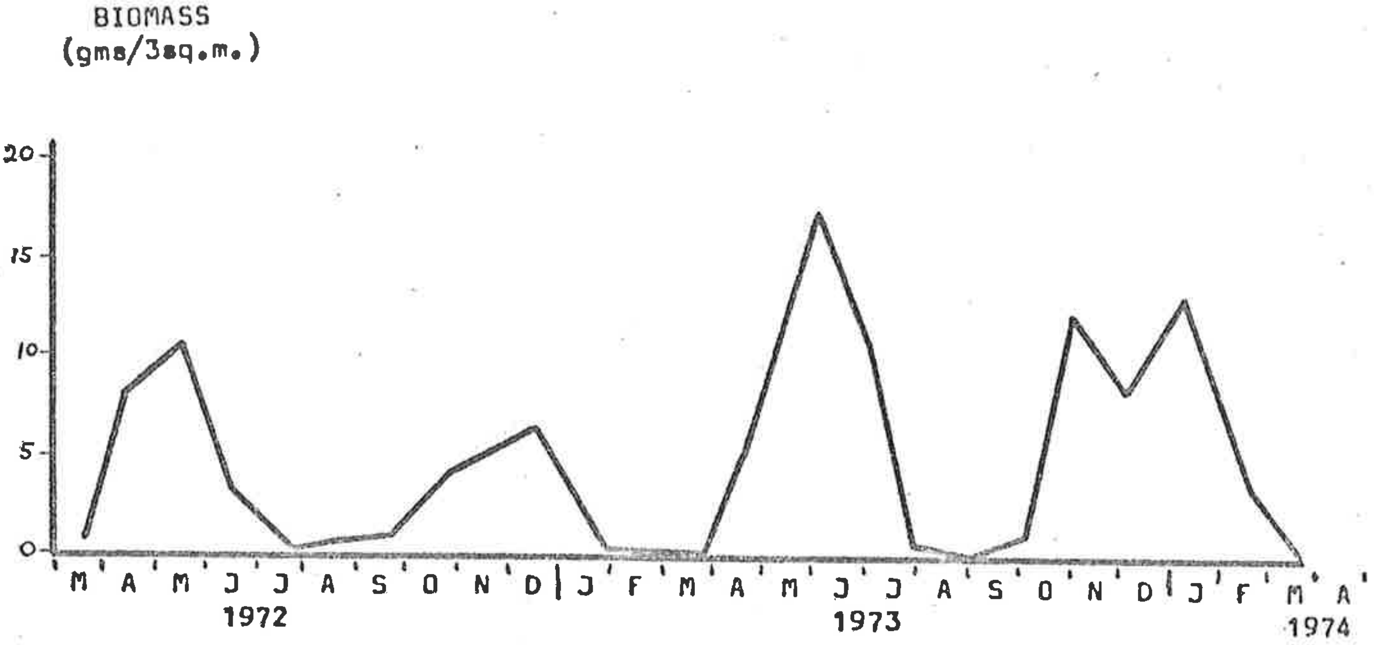
Generally there was a high biomass in March 1972, followed by a rapid drop (Graph 5.36). A second peak occurred from April to June 1973. A seasonal relationship is possibly operating here.

Comparing both zones, Graph 5.37, shows similar trends. However, there is a lot of variation between stations, with no regular pattern apparent. (Graphs 5.38, 5.39.)

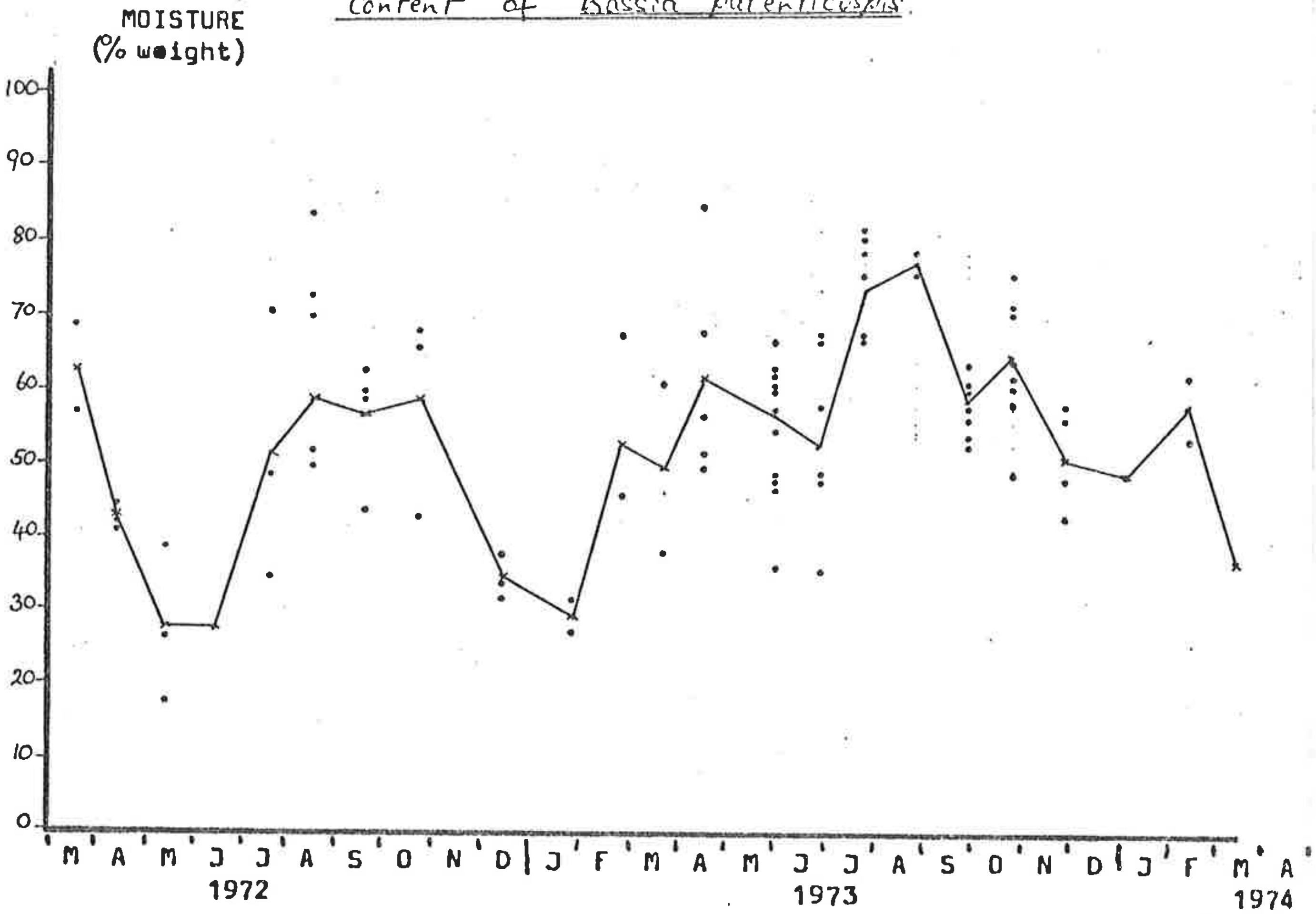
Relations with other factors

There does not appear to be any relation between biomass and rainfall,soil water or plant water

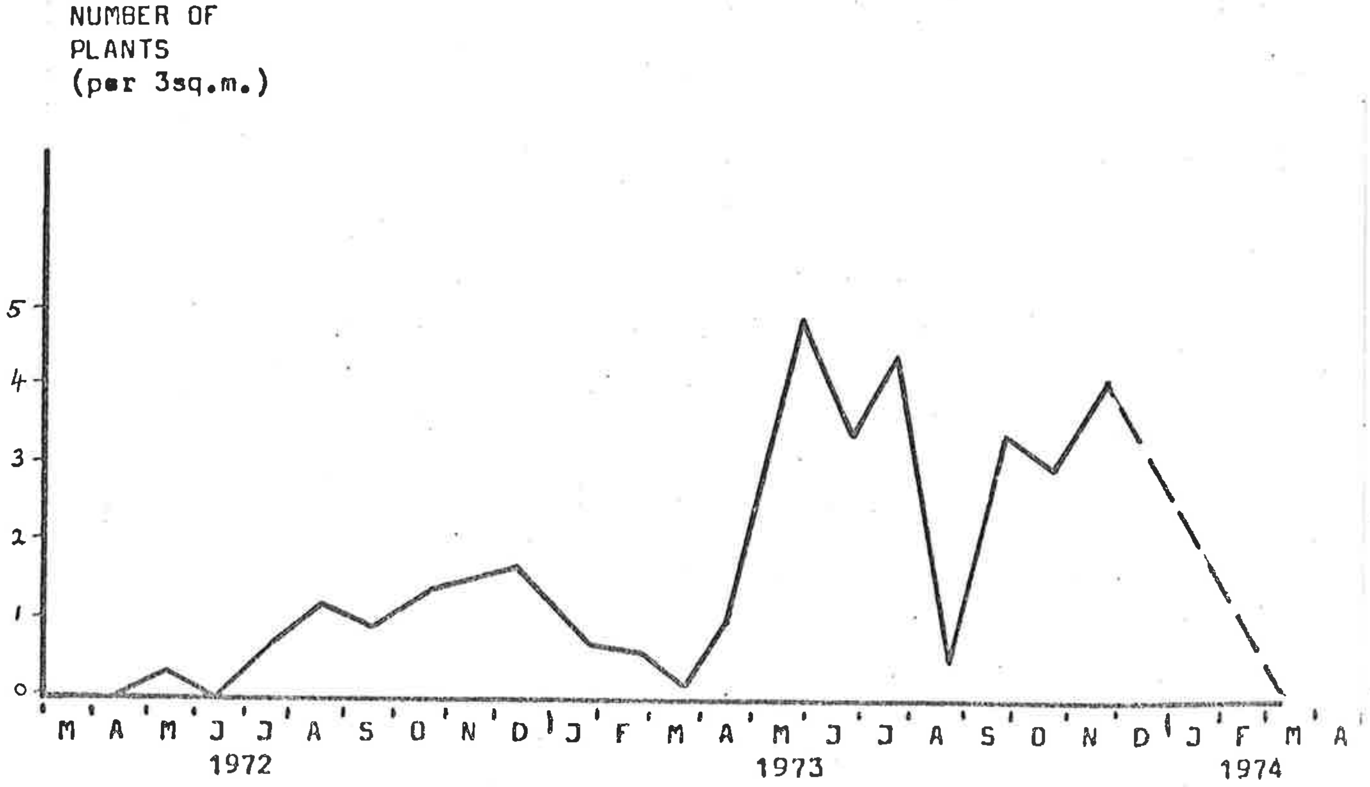
GRAPH 5·33 Average biomass of *Bassia patenticuspis*



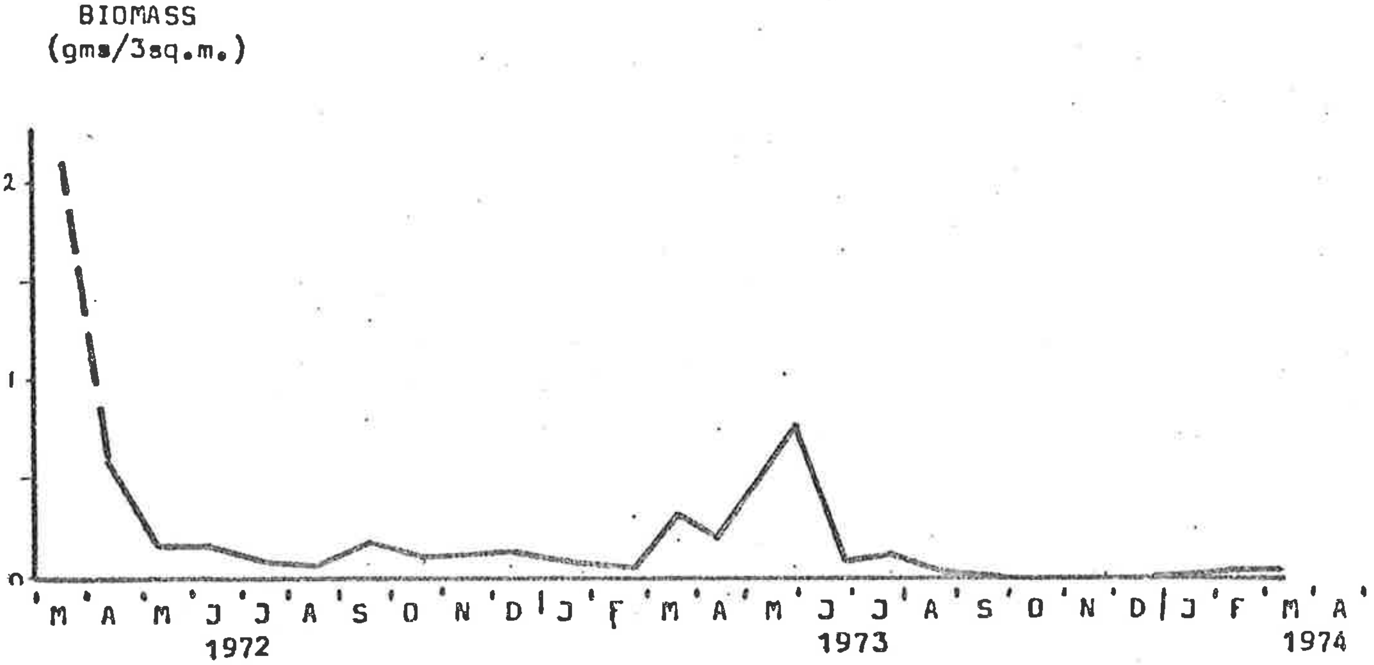
GRAPH 5·34 Sample distribution pattern and average of water content of *Bassia patenticuspis*



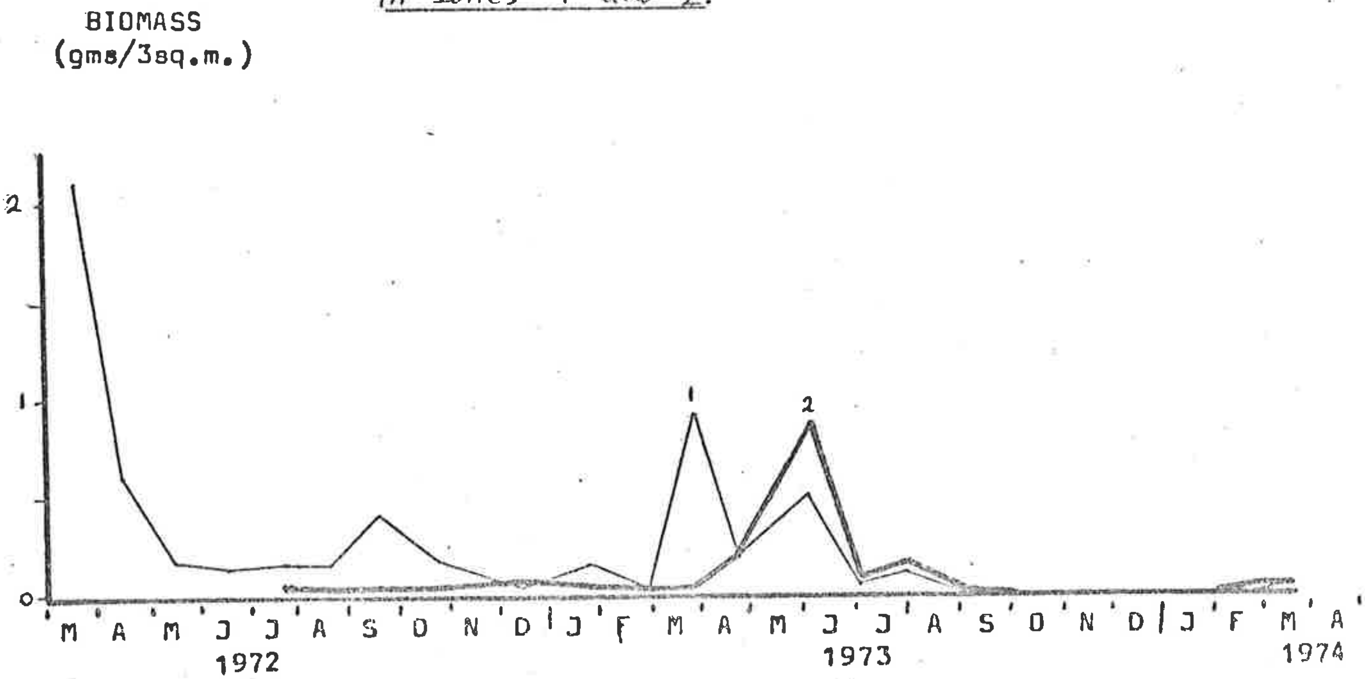
GRAPH 5·35 Average numbers of *Bassia patenticuspis* (over 2cm.)



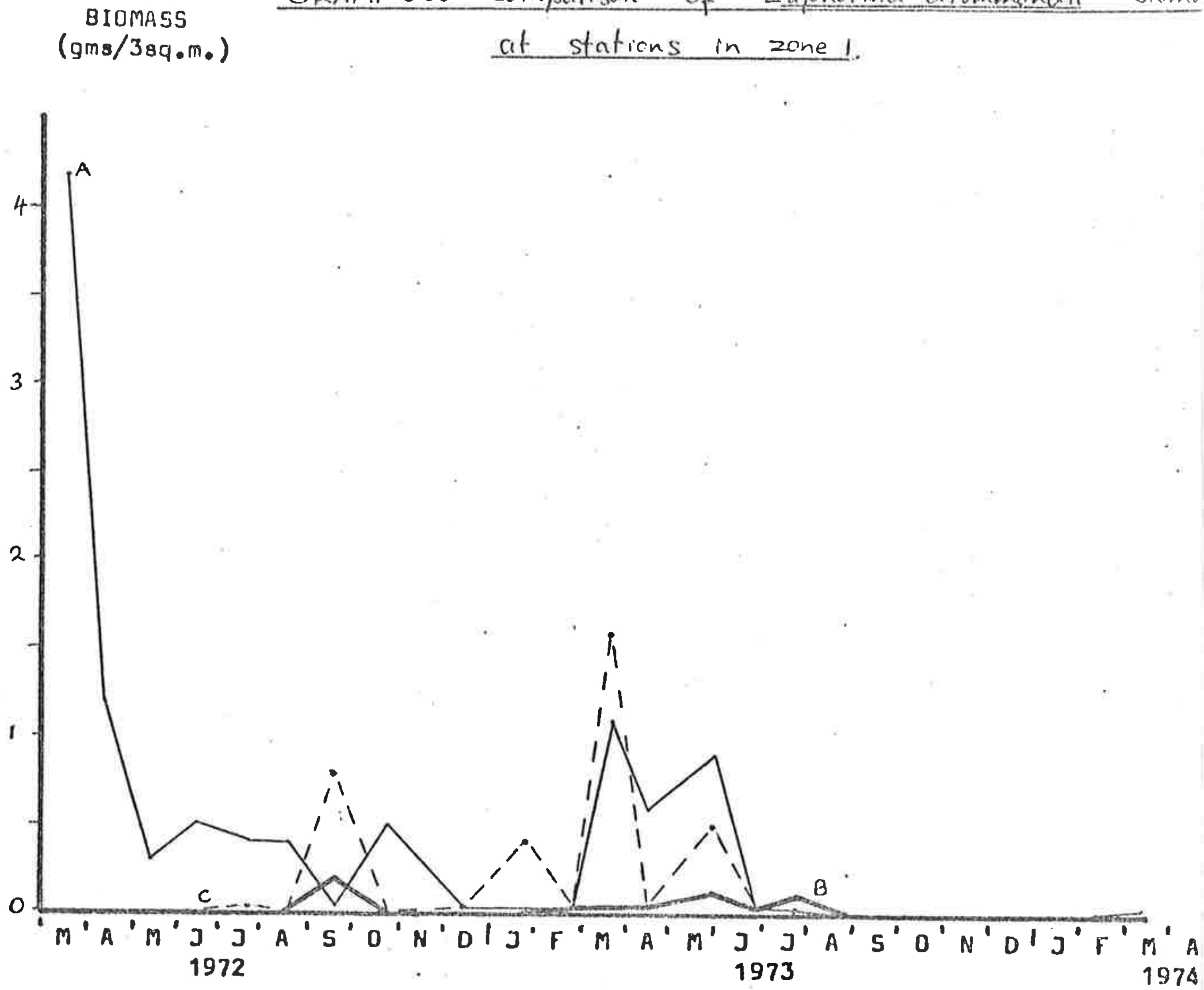
GRAPH 5·36 Average biomass of *Euphorbia drummondii*



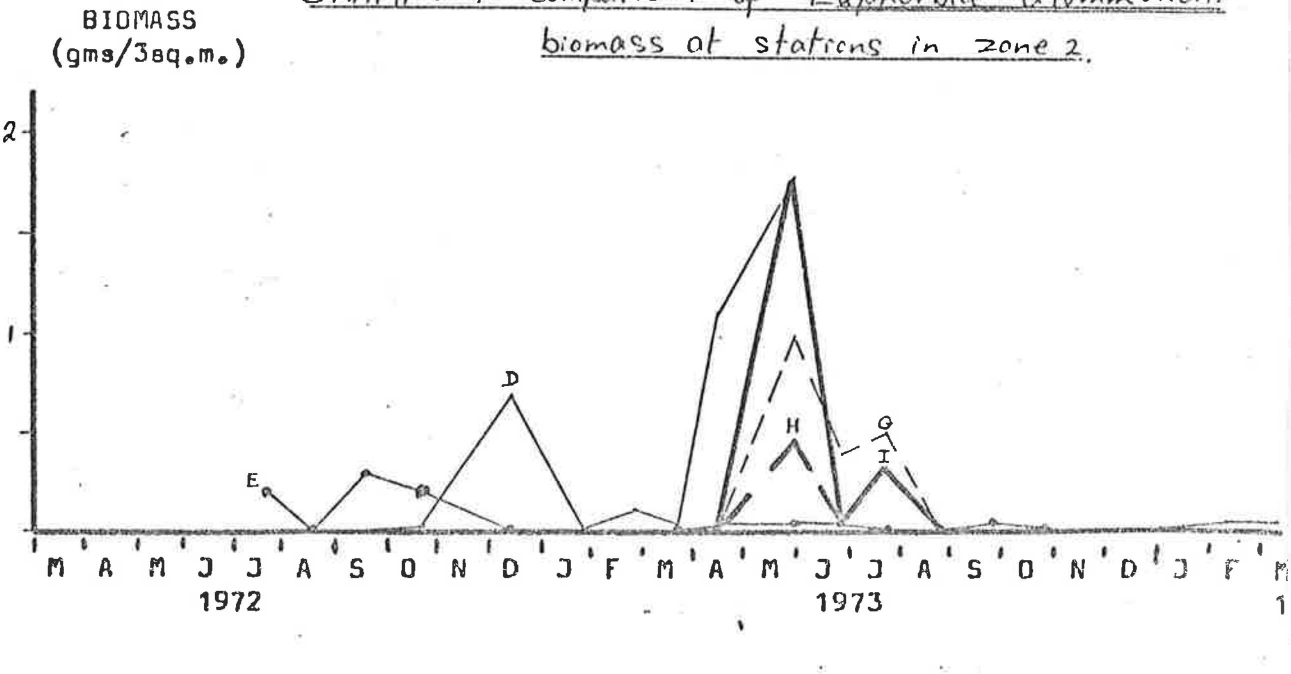
GRAPH 5·37 Comparison of average *Euphorbia drummondii* biomass in zones 1 and 2.



GRAPH 5·38 Comparison of *Euphorbia drummondii* bioma
at stations in zone 1.



GRAPH 5·39 Comparison of *Euphorbia drummondii*
biomass at stations in zone 2.



(Graph 5.40), but there is a parallel relationship with the number of plants. (Graph 5.41.) An increase in numbers is accompanied by an increase in biomass and vice versa for a decrease. The plants are very small and so biomass is increased by the presence of new plants rather than growth of those already established.

Other relations

The data supports the suggestion that "effective" rain affects the water content of the plants to a degree, but a positive relationship is by no means obvious.

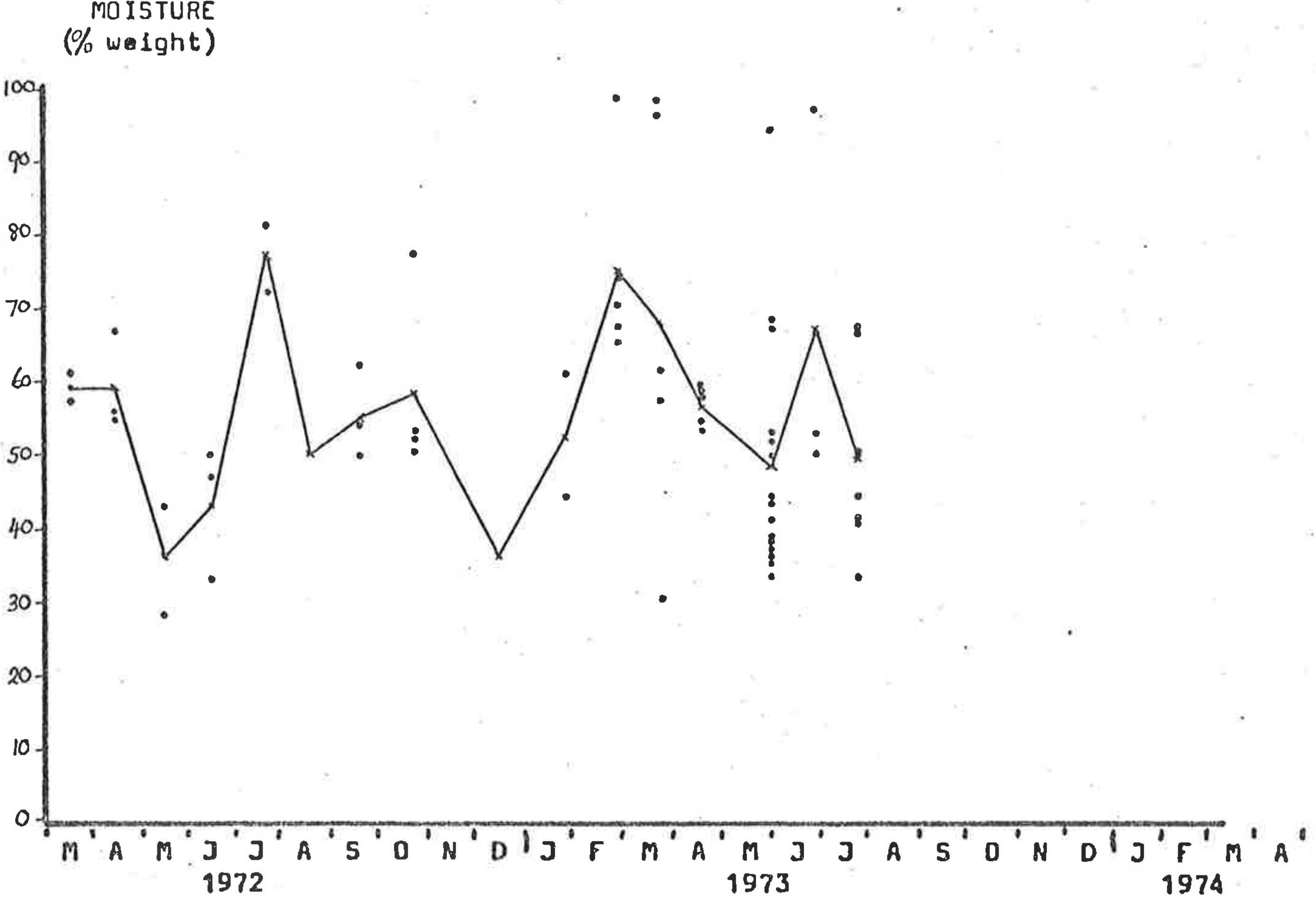
There does not appear to be any relationship between plant water content, soil water and numbers. The plant is so small and probably grows only in niches where moisture content is higher such as in deeper soils. Graph 5.40 shows a lot of fluctuations, and a broad distribution pattern of water content from the various station samples. This implies that there are unnoticeable regional variations which could only be investigated with a great deal of difficulty.

(vi) (Species 2 & 11) *Helipterum* species. (Appendix 5.14)

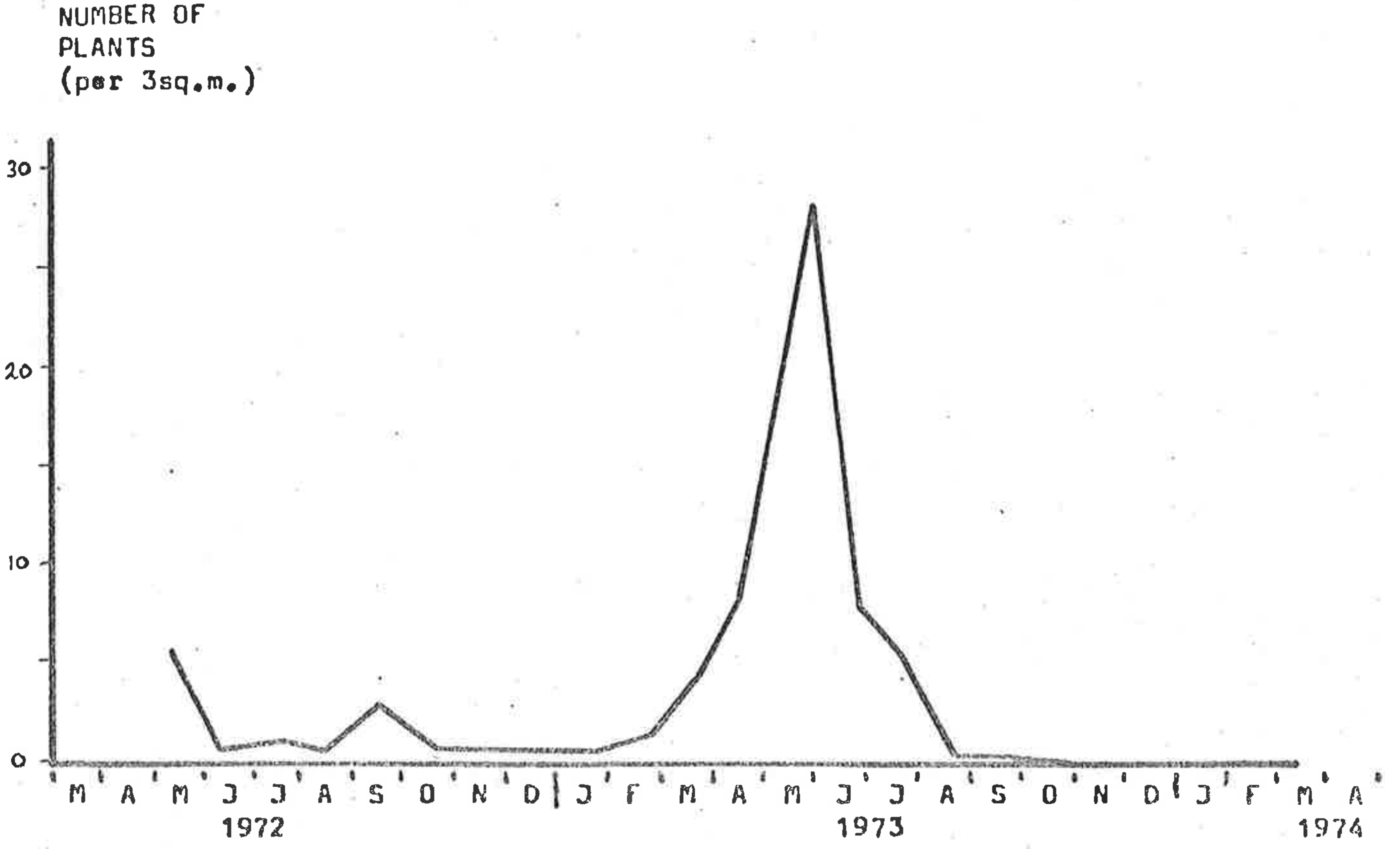
In March 1972, there were dead or dying remains of what appeared to be one species of composite. It was not until September 1973 when it was noticed that this species was really two. Fortunately the species were not prominent, and had the same growing patterns, and so they are dealt with as a single unit rather than separate.

Generally there was really only one complete growth

GRAPH 5·40. Sample distribution pattern and average of water content of *Euphorbia drummondii*.



GRAPH 5·41. Average numbers of *Euphorbia drummondii*.



cycle from July to September 1973. (Graph 5.42.) The 1972 equivalent was far lower in amount, and in growth period.

The two zones show similar trends, with similar variation between stations, except for an exceptionally high September 1973 value in station I, (371 grm. Graph 5.44), which gives the Zone 2 average a higher peak than the Zone 1 average. (Graph 5.45.)

Relations with rainfall

The biomass appears to follow the rainfall trends in 1973 from June to October. The fact that there is more "effective" rain in November 1973 and January 1974, but no growth of these species suggests that other factors trigger growth.

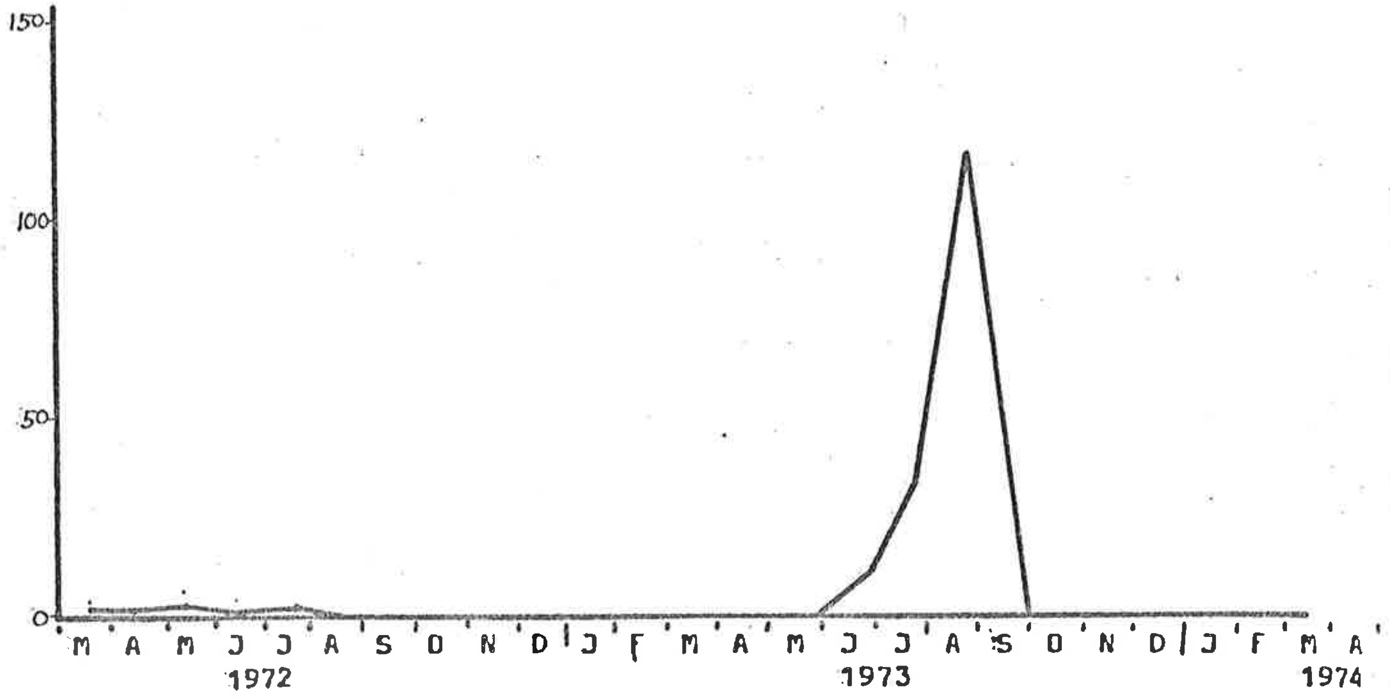
Relation with number of plants

The number increased rapidly and the biomass increased also, but more slowly. (Graph 5.46.) The plants became established and added further growth before dying off. Comparing zones, (Graph 5.47) growth occurred in the same months but was erratic from station to station, suggesting local variation. The high soil water in August and September 1973 tie in positively with the large number of plants. However, water does not appear to be a trigger for initiating growth in June, although "effective" rain increased from June to September. Compare with Graph 5.48.

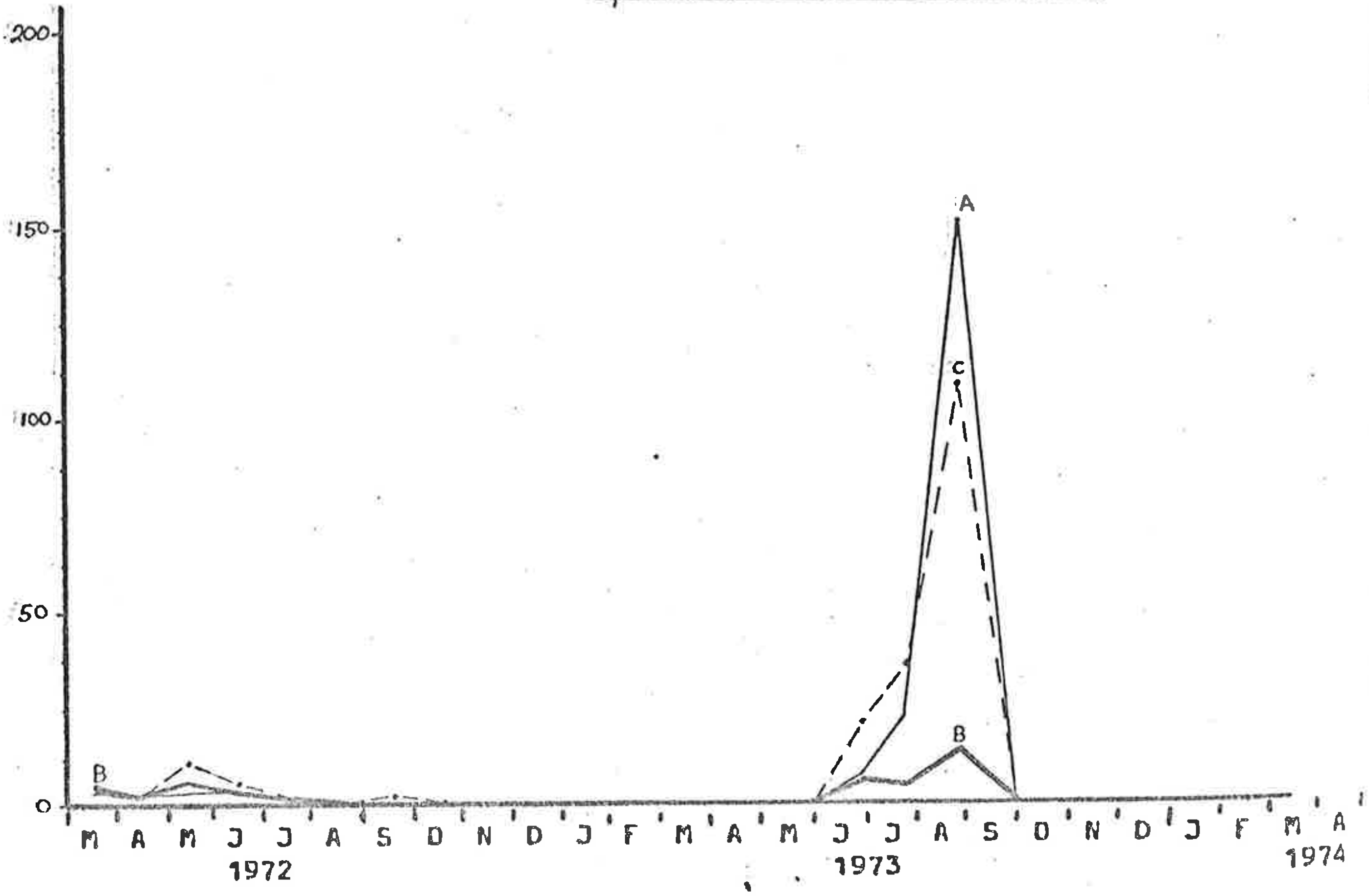
Ground litter (Appendix 5.15)

There was an overall increase in biomass after September of each year, associated with a prior

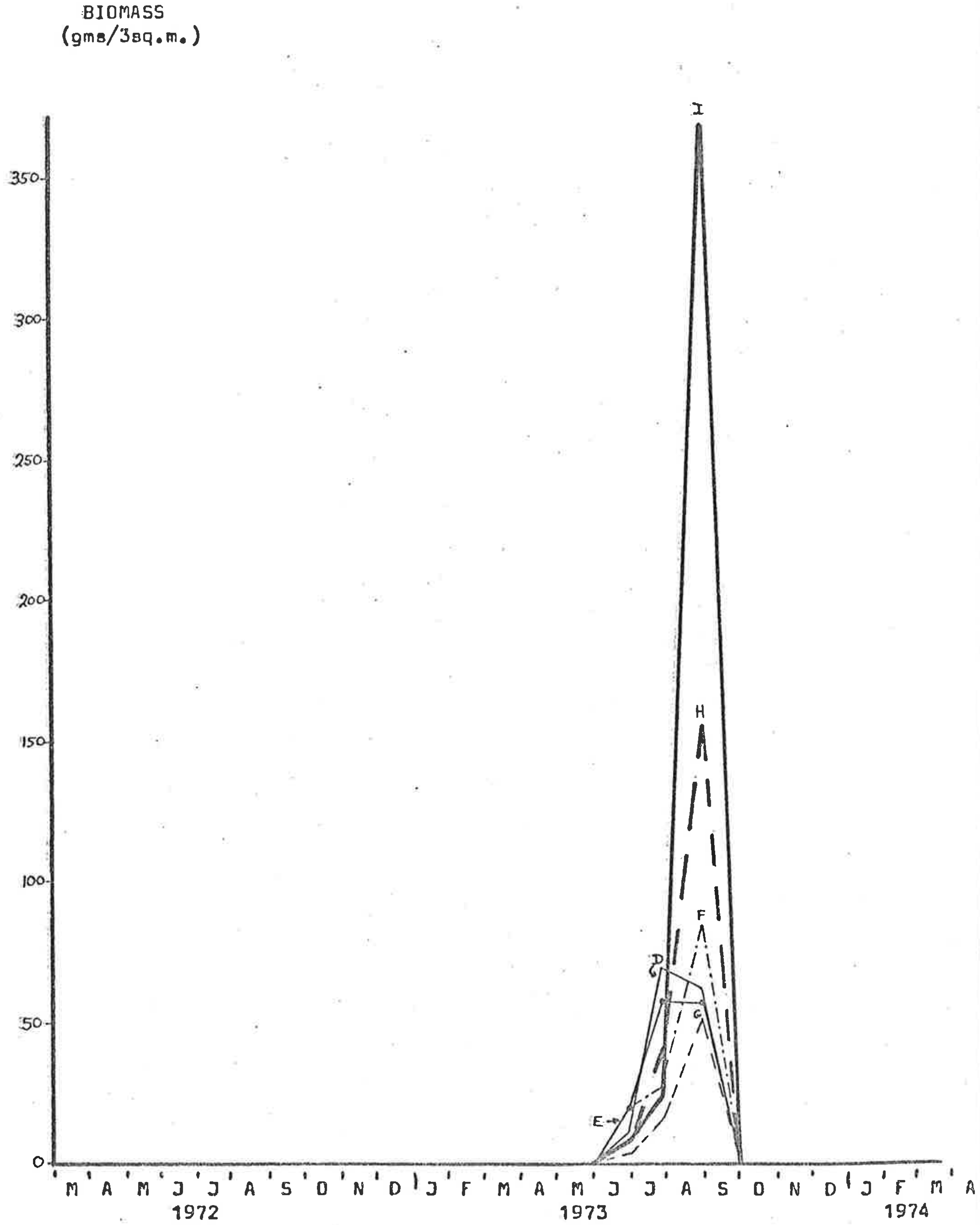
GRAPH 5·42 Average biomass of Helipterum species



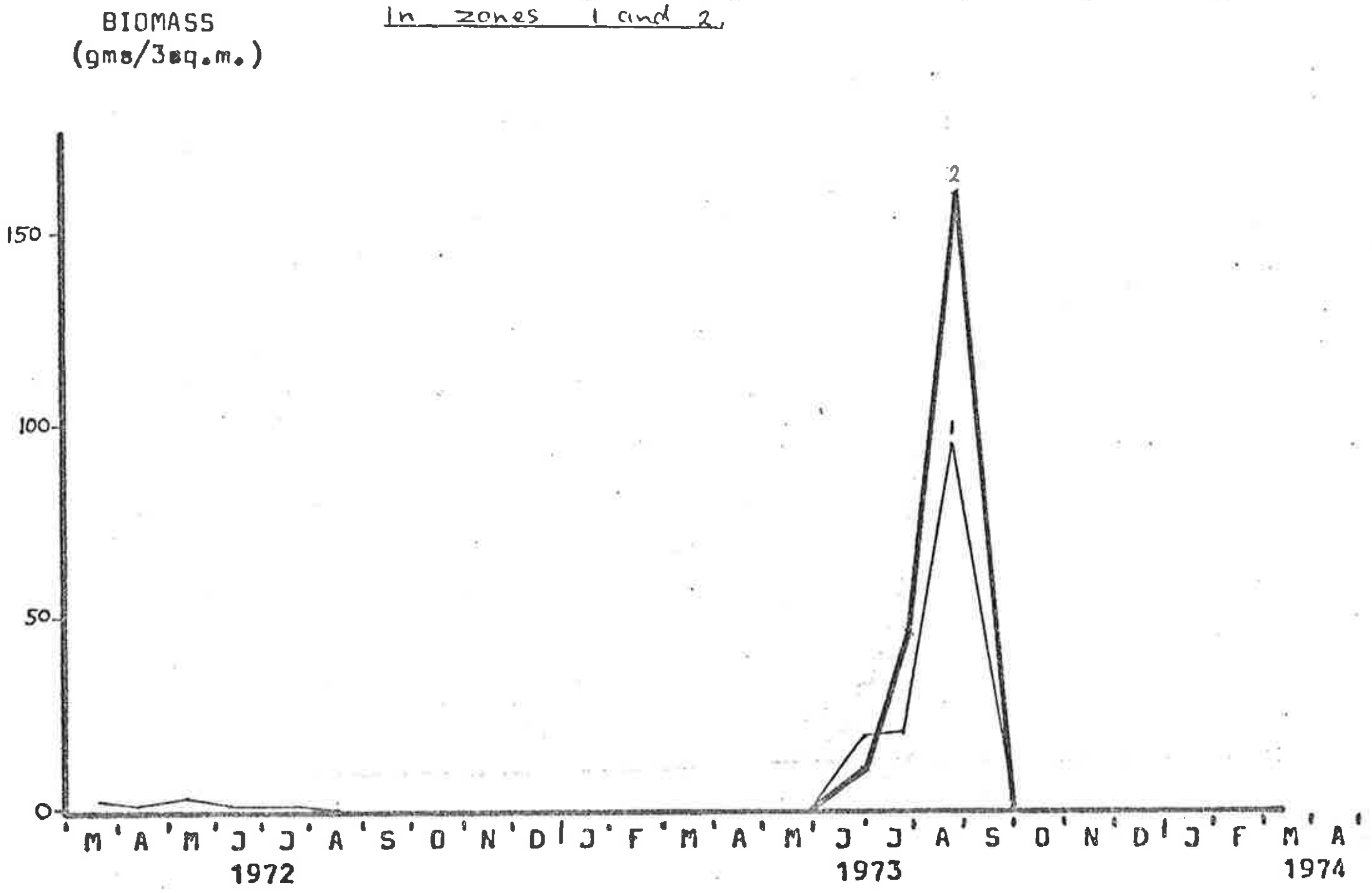
GRAPH. 5·43. Comparison of biomass of Helipterum species at stations in zone 1.



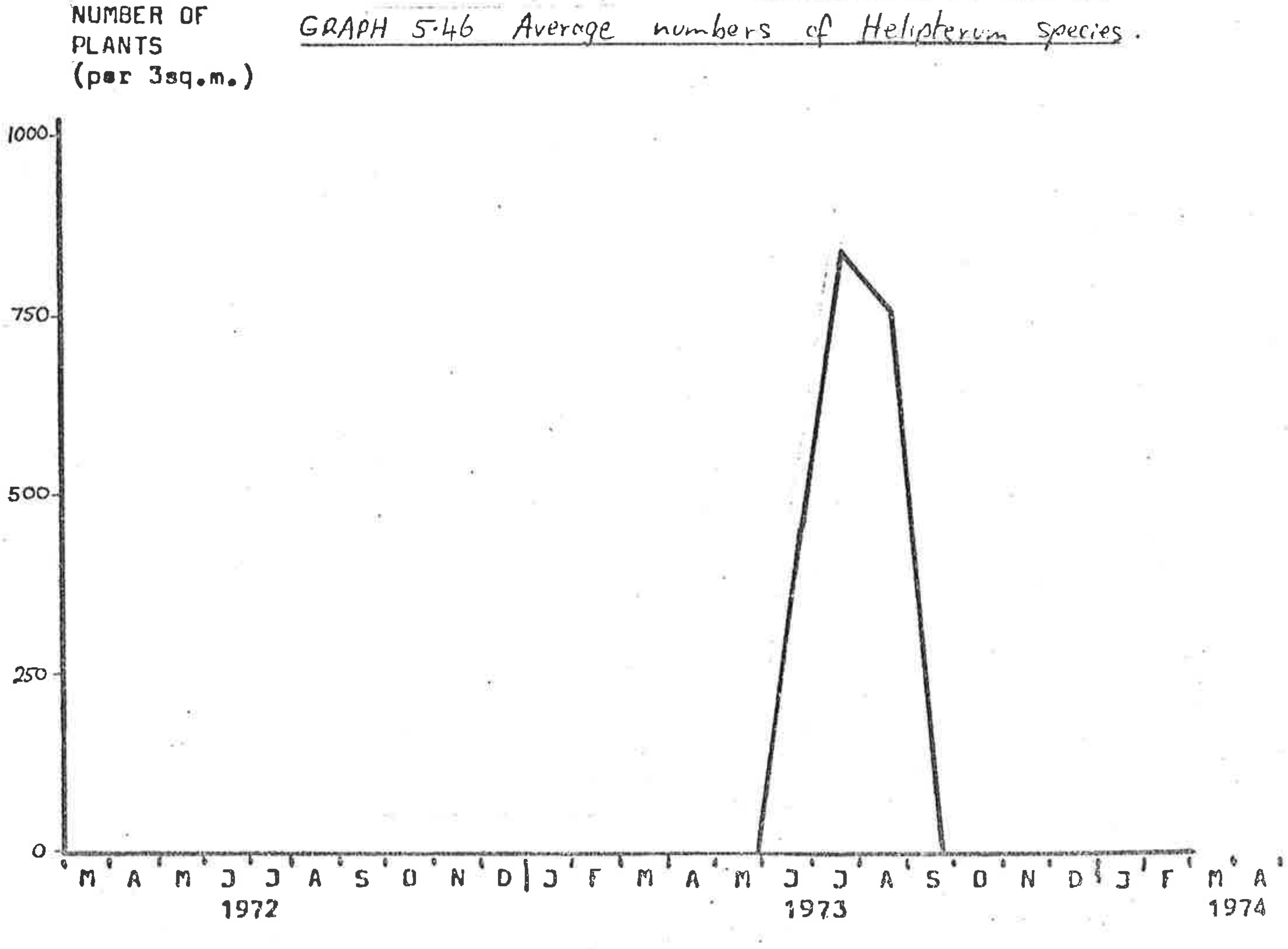
GRAPH 5·44. Comparison of biomass of Helipterum species at stations in zone 2.



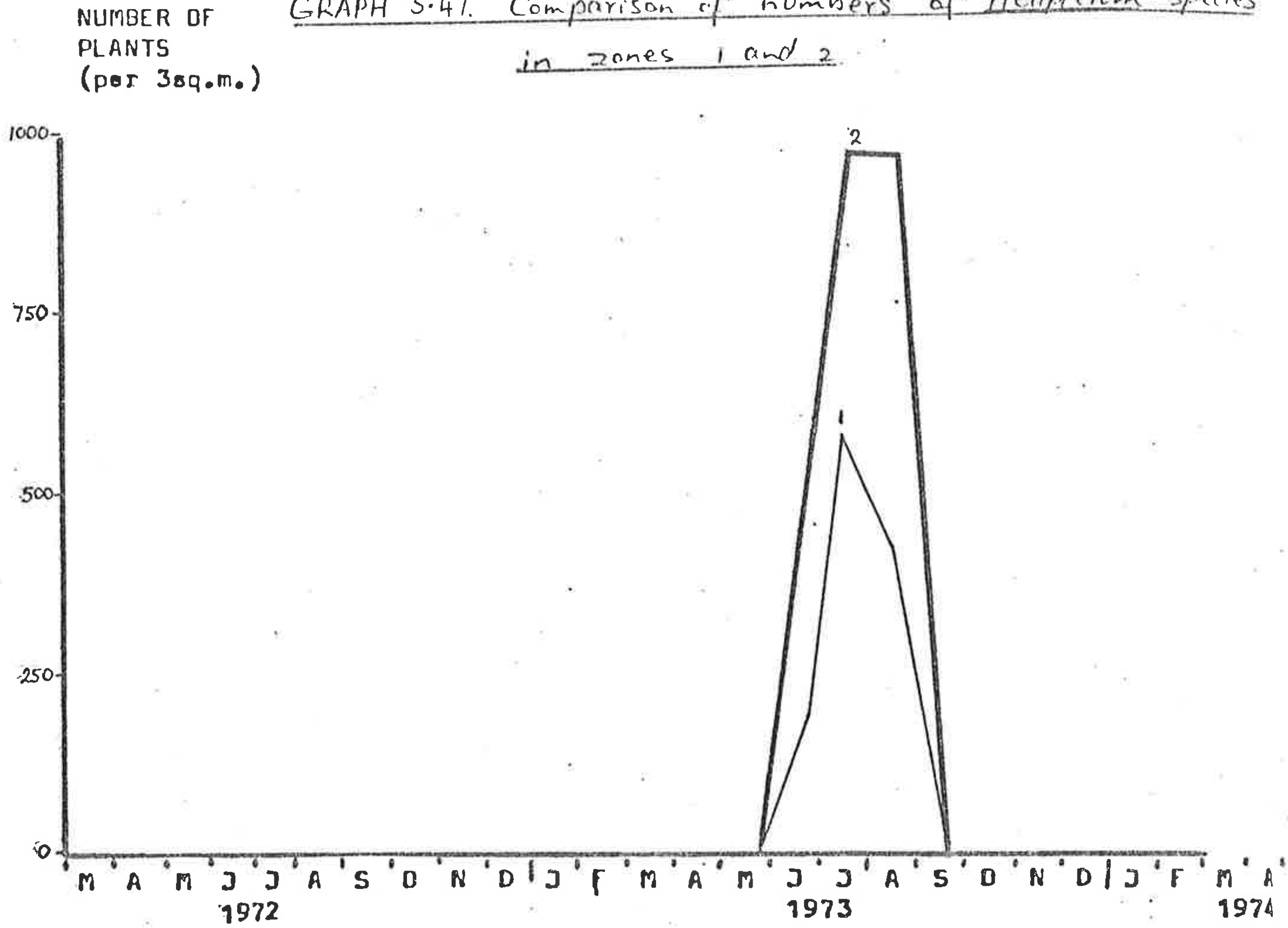
GRAPH 5·45 Comparison of average biomass of Helipterum species in zones 1 and 2.



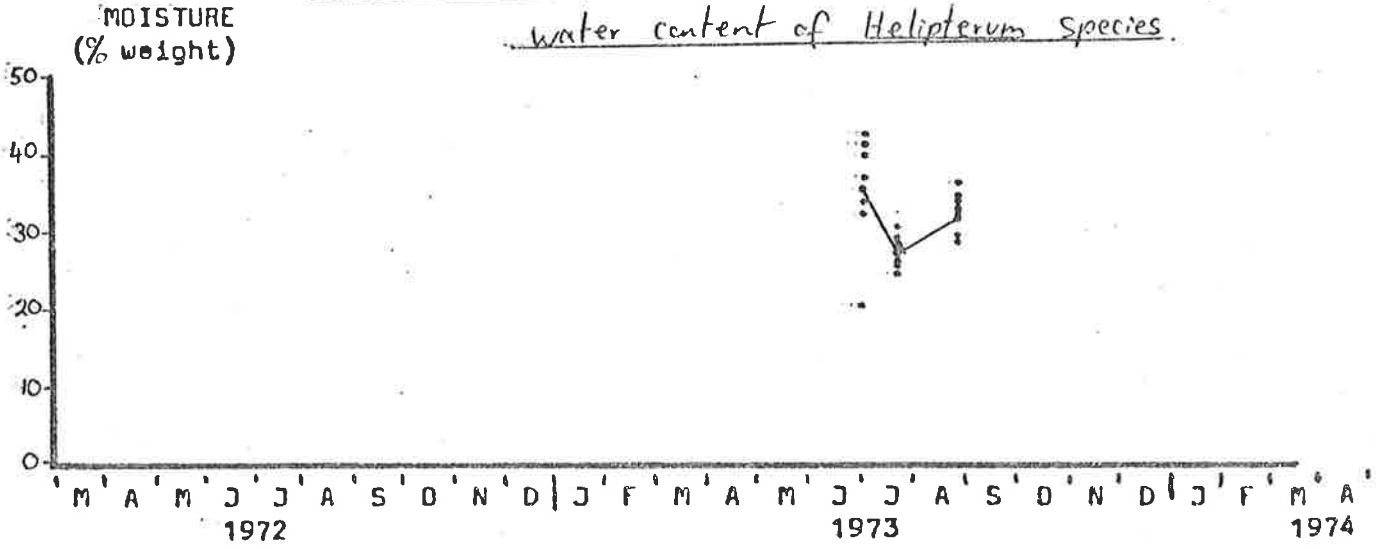
GRAPH 5·46 Average numbers of Helipterum species.



GRAPH 5·47. Comparison of numbers of *Helipterum* species in zones 1 and 2.



GRAPH 5·48. Sample distribution pattern and average of water content of *Helipterum* species.



growth period, (Graph 5.49). The amount was greater during 1973-74 since the rain had produced more growth. Graph 5.50 compares both zones, which follow similar trends until November 1973 when Zone 1 biomass drops and never recovers, while the Zone 2 biomass continues to increase.

Analysis of Graphs 5.51 and 5.52 shows that the trends in Zones 1 and 2 are somewhat opposite in effect. The exceptional high readings in station H and I after December 1973 distort these trends further. At that time there was a large amount of dried off *Stipa* in the distant stations of Zone 2.

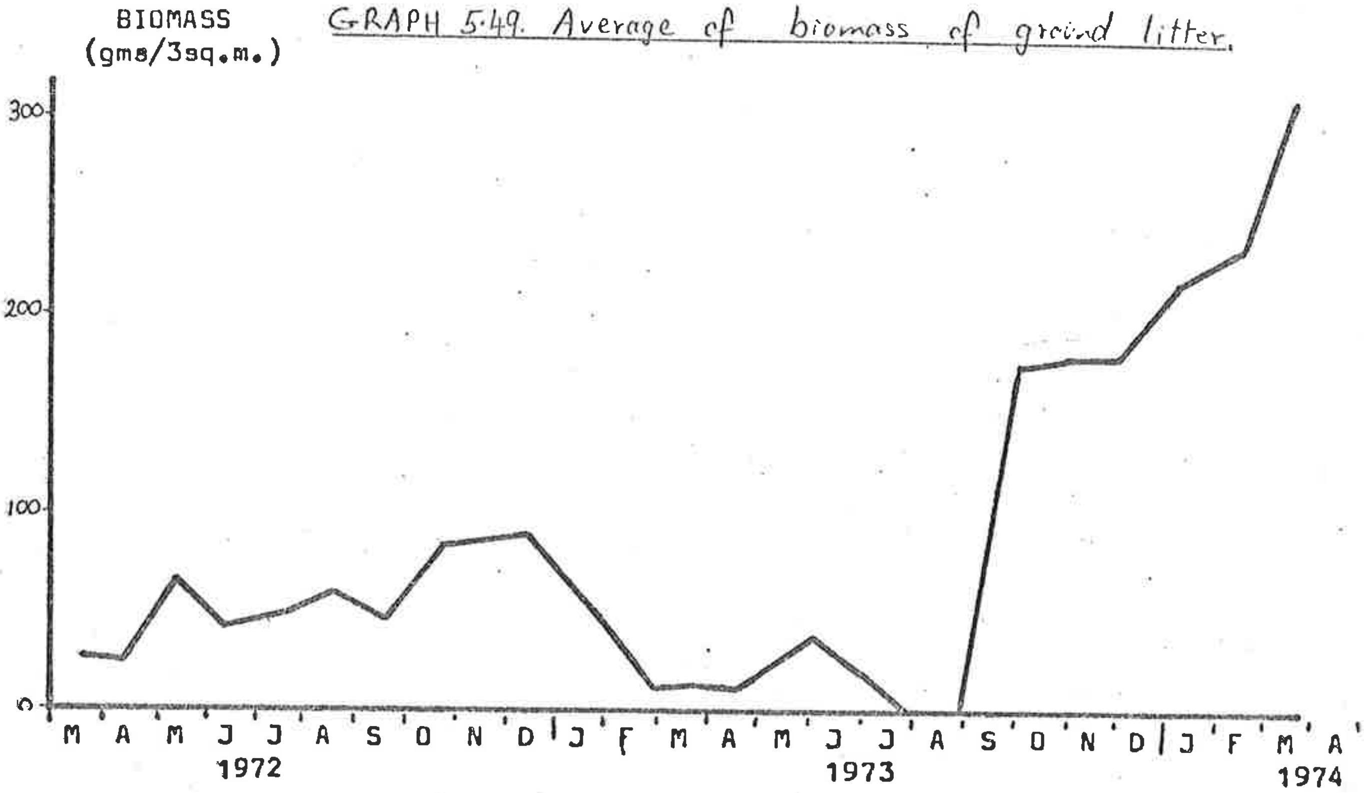
Total Vegetation (Appendix 5.16)

Graph 5.53 shows the biomass trend for all living species combined. It is of interest to note the close opposite relationship between this graph and the ground litter biomass. (Graph 5.54.) Where the amount of living material decreases the ground litter increased (in 8 out of the 10 such changes), and where there was an increase in the amount of living material, ground litter decreased (in 8 out of the 12 such changes).

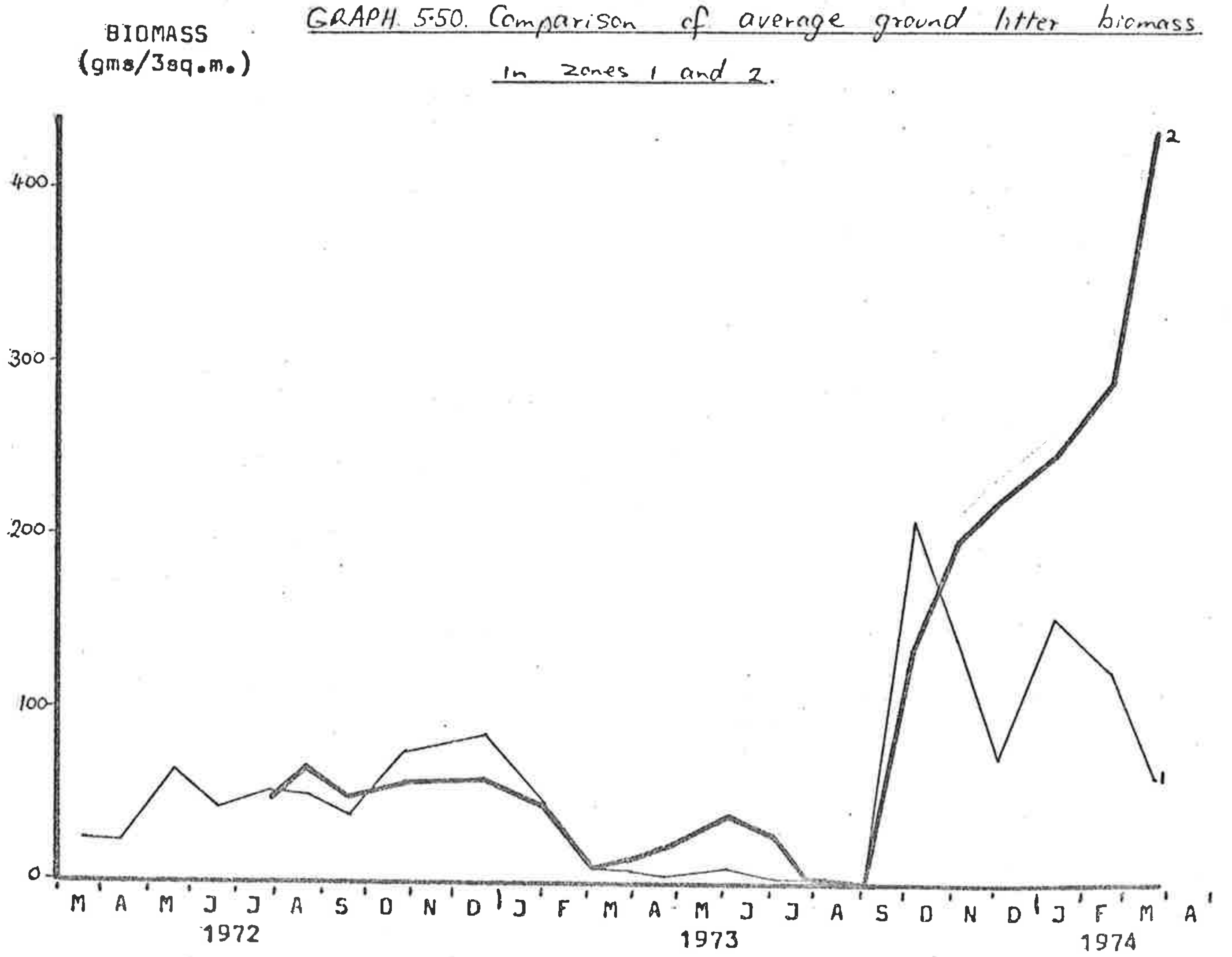
Comparison with the rainfall graphs shows, as expected from the fore-going species comparisons, little positive relationship between total quadrat biomass changes and any of these graphs. Obviously the dynamics of the situation are extremely complex and rainfall is but one factor to have an influence.

Similarly, soil moisture bears little relationship. Graph 5.55, of the total biomass of all plant

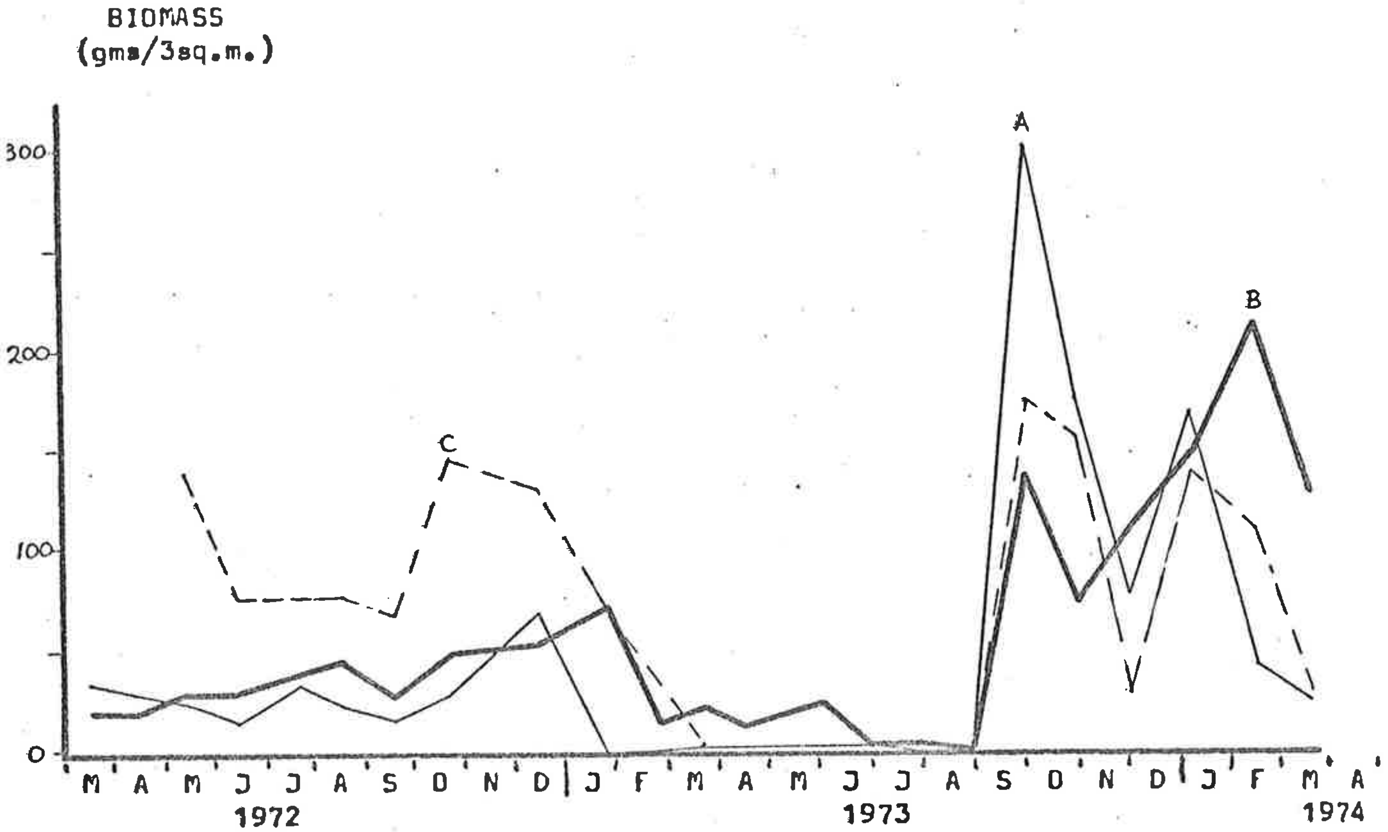
GRAPH 5.49. Average of biomass of ground litter.



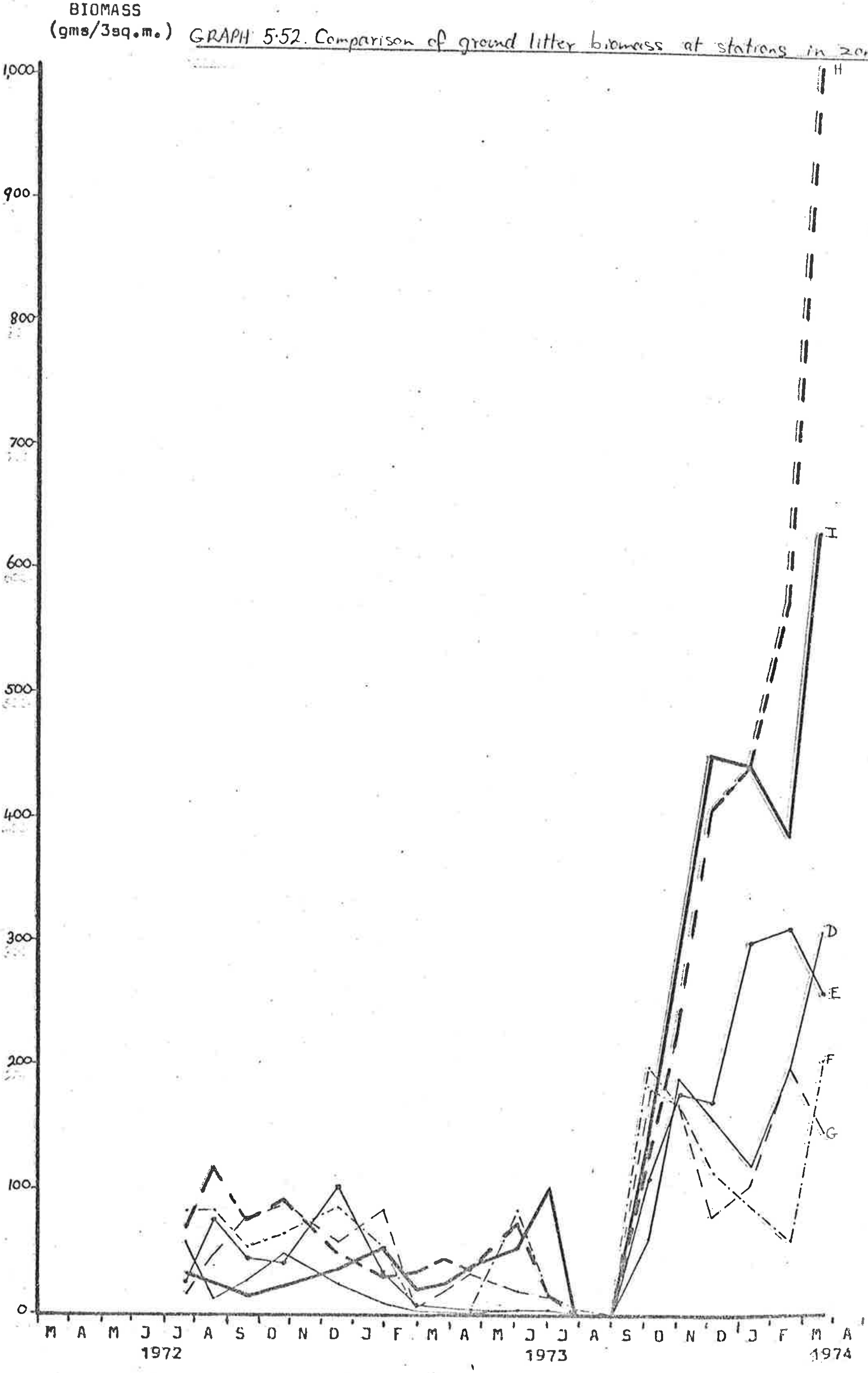
GRAPH 5.50. Comparison of average ground litter biomass in zones 1 and 2.



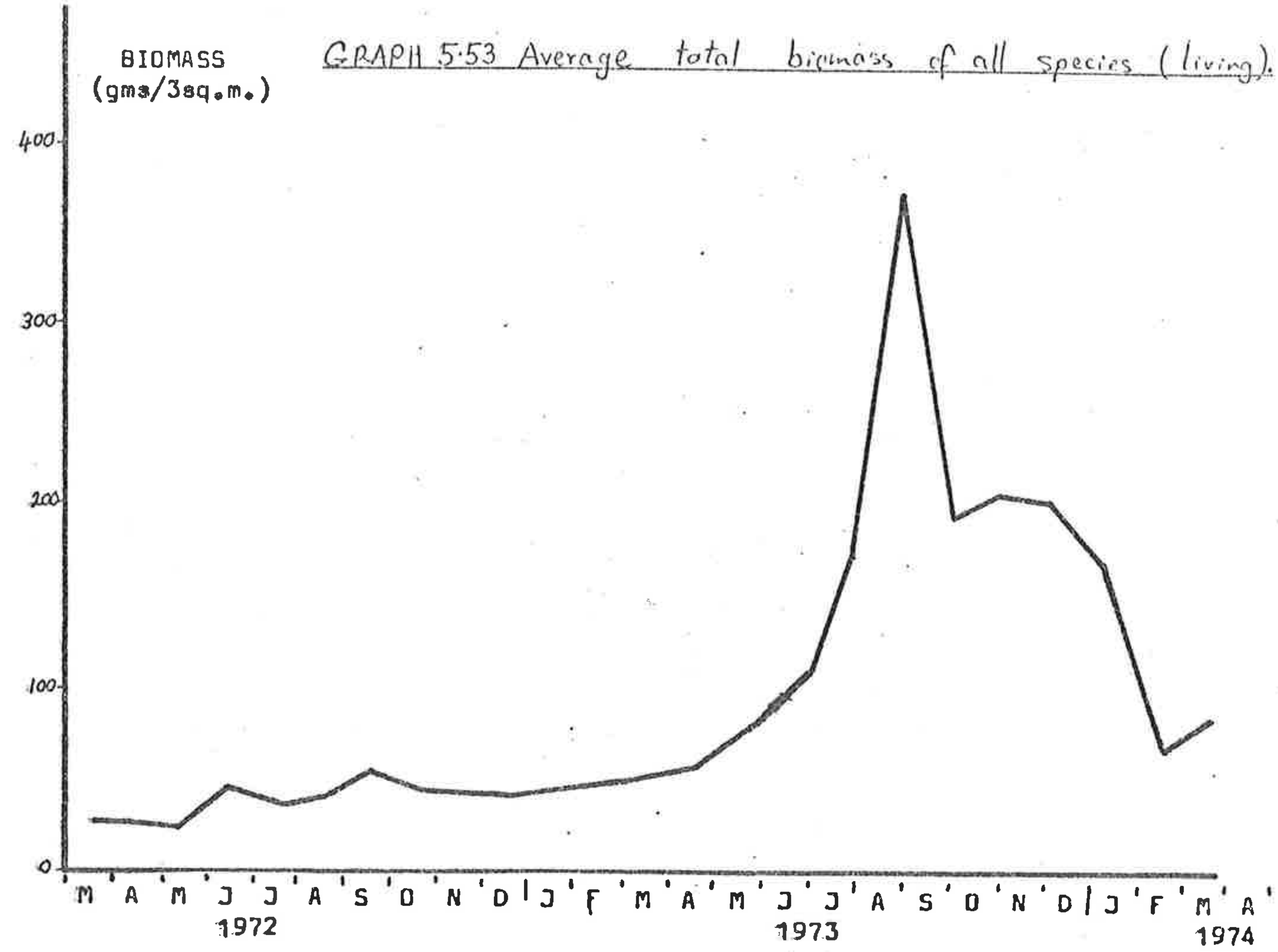
GRAPH 5.51. Comparison of ground litter biomass at stations in zone 1



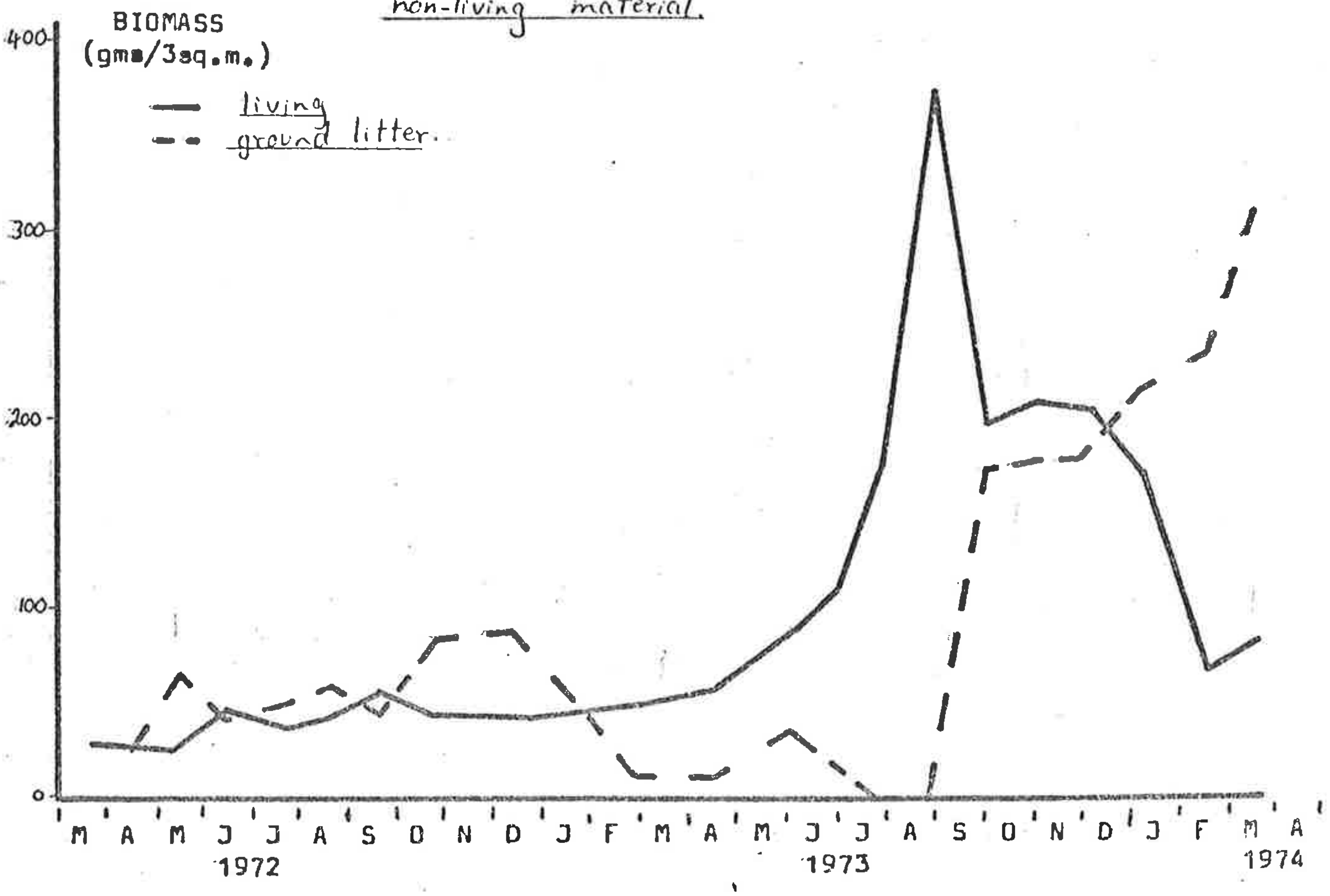
GRAPH 5·52. Comparison of ground litter biomass at stations in zone 2.



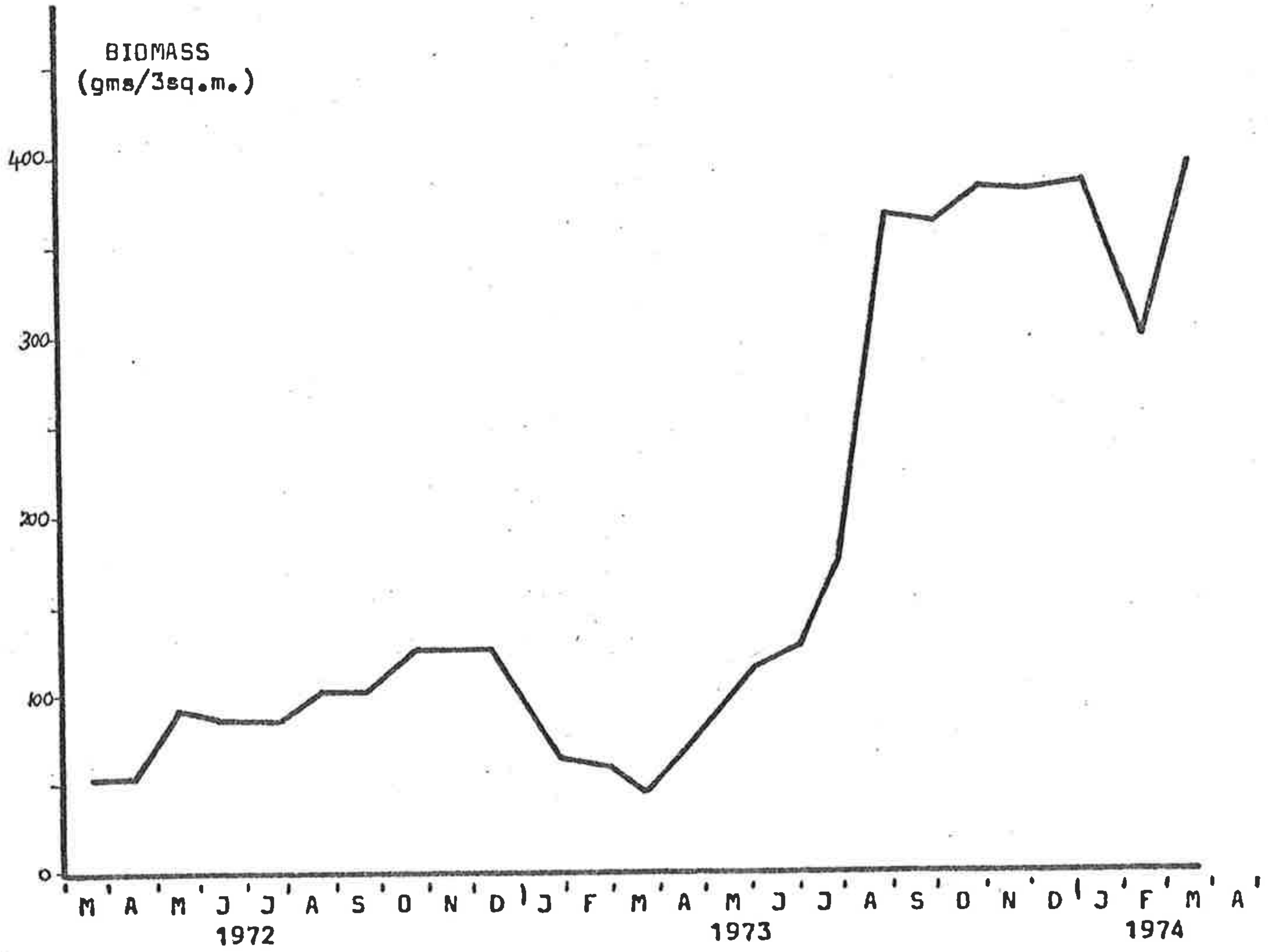
GRAPH 5·53 Average total biomass of all species (living).



GRAPH 5·54 Comparison of average total biomass of living and non-living material.



GRAPH 5·15. Average total biomass of all species (including ground litter).



matter collected, shows very distinctly the almost four-fold increase in plant material from the driest season recorded on the property and the wettest up to that time.

2. RADIAL TRAVERSES

As outlined in Chapter 2, six radiating transects were set up from the centre of each warren. They were labelled, and at each visit the visual interface between grazed and ungrazed was noted. The data appears in Table 5.2. By plotting these data on transects, maps were drawn to approximate the area of completely grazed pasture, and changes occurring from month to month. This is shown in Map 5.1 (Zone 1) and Map 5.2 (Zone 2).

Both maps indicate movement of the interface in and out from the warren from month to month. Presumably, the amount of movement, and direction of movement, are related primarily to the amount of pasture available and the number of wombats feeding from month to month.

The warren in Zone 1 appears to have been far more active than that in Zone 2 especially during the last five months of the study. This is borne out by the following evidence:

(i) the greater distances eaten out by the wombats (as seen from the Table and Maps)

(ii) more recordings of an obvious interface (13 for Zone 1 versus 8 for Zone 2). However, Graph 5.8 of *Stipa* biomass shows that from August 1973 to December 1973 there was far more feed available in Zone 2 than Zone 1 so that any wombat grazing effect would be difficult to detect anyway. (This is shown by the lack of data in these months.)

It is interesting and not unexpected, to note the

TABLE 5.2

Distance eaten out from warren (metres)

Zone 1 | Zone 2

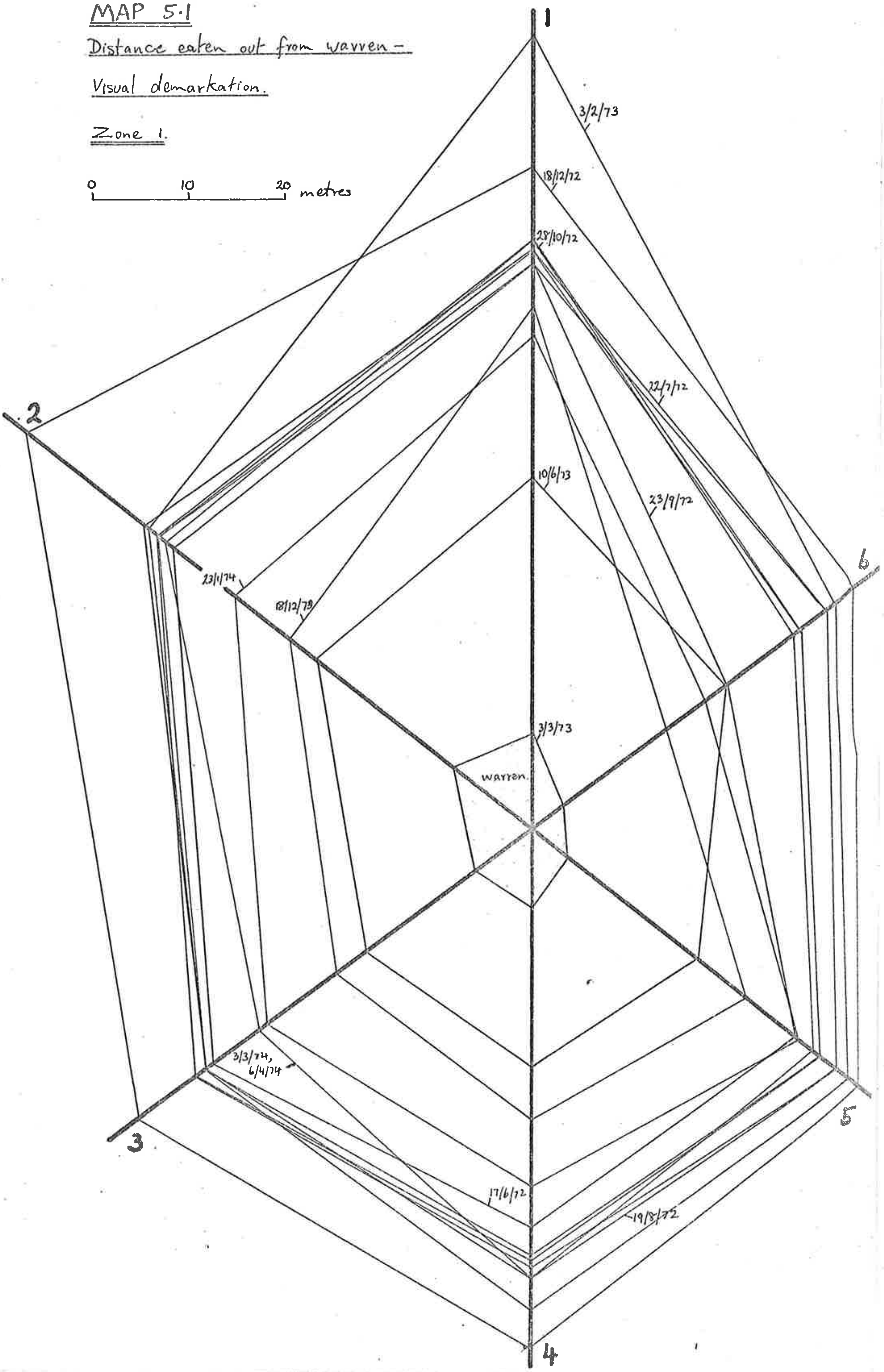
	Transect number								Transect number						
DATE	1	2	3	4	5	6	$\bar{x}$		1	2	3	4	5	6	$\bar{x}$
17/6/72	60	51	42	44	38	35	45·0								
22/7/72	60	49	43	46	40	38	46·0		28	30	35	25	10	11	23·2
19/8/72	59	49	42	47	40	38	45·8		10	11	13	12	11	13	11·7
23/9/72	59	47	41	42	35	25	41·5		6	7	5	7	5	7	6·2
28/10/72	61	49	43	45	38	35	45·2		7	9	6	8	7	9	7·7
18/12/72	68	66	50	54	43	42	53·8		11	9	8	5	6	5	7·3
3/2/73	82	50	42	50	42	39	67·8		5	7	5	5	5	7	5·7
3/3/73	10	10	7	8	5	4	7·3		5	7	5	5	5	7	5·7
1/4/73	0	0	0	0	0	0	0		0	0	0	0	0	0	0
25/4/73	0	0	0	0	0	0	0		0	0	0	0	0	0	0
10/6/73	36	28	21	25	22	27	26·5		28	10	21	32	25	28	24·0
8/7/73	0	0	0	0	0	0	0		0	0	0	0	0	0	0
5/8/73	0	0	0	0	0	0	0		0	0	0	0	0	0	0
9/9/73	0	0	0	0	0	0	0		0	0	0	0	0	0	0
13/10/73	0	0	0	0	0	0	0		0	0	0	0	0	0	0
11/11/73	0	0	0	0	0	0	0		0	0	0	0	0	0	0
18/12/73	49	32	25	30	28	17	30·2		0	0	0	0	0	0	0
23/1/74	51	39	34	37	35	22	36·3		0	0	0	0	0	0	0
3/3/74	61	48	35	42	37	34	42·8		0	0	0	0	0	0	0
6/4/74	61	50	35	42	38	35	43·5		0	0	0	0	0	0	0

MAP 5.1

Distance eaten out from warren –

Visual demarkation.

Zone 1.

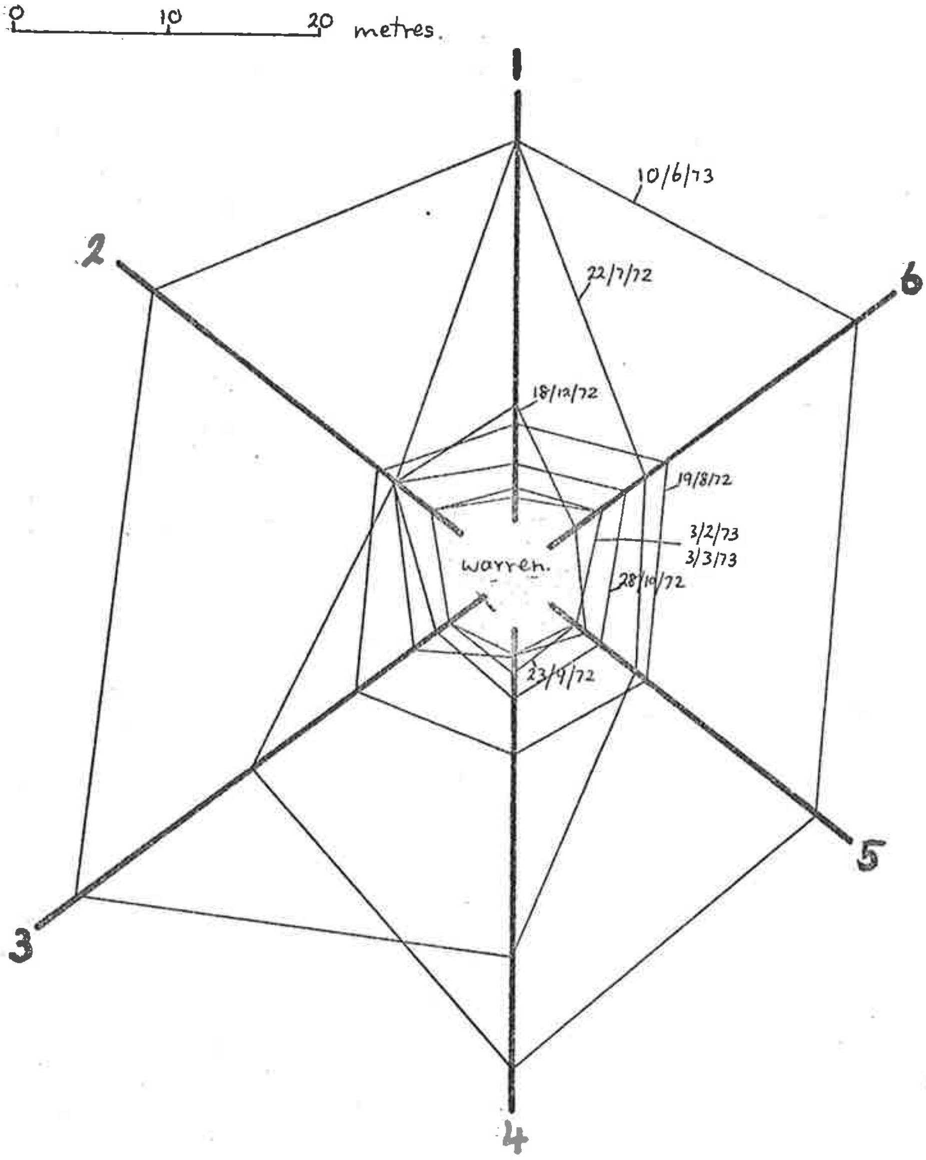


MAP 5·2

Distance eaten out from warren-

Visual demarkation.

Zone 2.



concentric patterns that have occurred. However, *Stipa* biomass increases generally as one goes further from the warren (Refer to Appendix 5.4 and Section 5.1(b)), and although wombats appear to graze in a circular pattern radiating outward from the warren, and tend to denude this area methodically there must be some grazing further out. This undoubtedly complicates the picture, and any interface is only but an indication of feeding behaviour.

It should be apparent that once an area is grazed out (as occurs nearer the warrens), it takes a longer time to regenerate than pasture further out from the warren. For a meaningful comparison of denuded area with pasture availability, then, average biomass must be calculated from quadrats within the grazed zone. Thus Table 5.3 compares the *Stipa* biomass with the mean distance eaten out. (The average of stations A and C, and D and E are averaged, respectively.)

One would expect that as pasture decreased the interface would move out, and as it became more plentiful the interface would move in. The first seven months of recording for Zone 1 and the first four and last six months of Zone 2 are in keeping with this, but the other times show a distinct difference from the expected. Obviously the situation is not as uncomplicated as one might expect.

Had it been possible to maintain a count on the wombats, monitor their movements to and from the burrows and observe their feeding, this data could be better compared with the seasonal vegetational changes that occurred.

3. PHOTOPOINTS

(a) Stereo pairs

Another source of information about the changes in the vegetation are the photopoints located within permanent

TABLE 5·3.

Stipa biomass compared with mean distance eaten out from warrens in zones 1 and 2.

	ZONE 1		ZONE 2	
Date	$\bar{x}$ (m)	biomass (gm/3 sq.m)	$\bar{x}$ (m.)	biomass (gm/3 sq.m.)
17/6/72	45	12·9		
22/7/72	46	12·9	23	41·5
19/8/72	46	18·6	12	44·5
23/9/72	42	26·0	6	47·5
28/10/72	45	19·5	8	18·0
18/12/72	54	2·6	7	16·5
3/2/73	68	+	6	9·5
3/3/73	7	+	6	5·0
1/4/73	0	+	0	5·5
25/4/73	0	+	0	5·0
10/6/73	27	+	24	9·0
8/7/73	0	5·1	0	4·5
5/8/73	0	1·3	0	7·0
9/9/73	0	11·1	0	17·0
13/10/73	0	19·0	0	63·0
11/11/73	0	46·2	0	169·0
18/12/73	30	36·5	0	149·5
23/1/74	36	69·4	0	129·5
3/3/74	43	77·9	0	55·0
6/4/74	44	45·0	0	107·0

quadrats, exclosing wombats. As stated in Chapter 2 photopoints were established within five permanent quadrats. The partially stereo-photographs that were obtained supplement the sampling data and leave a visual record of the seasonal effects. Of the large number of stereo-pairs obtained, four have been selected that are representative of the kinds of changes that occurred during the present study, and also represent crucial stages in these changes. The remaining photographs are housed at the Botany Department, University of Adelaide.

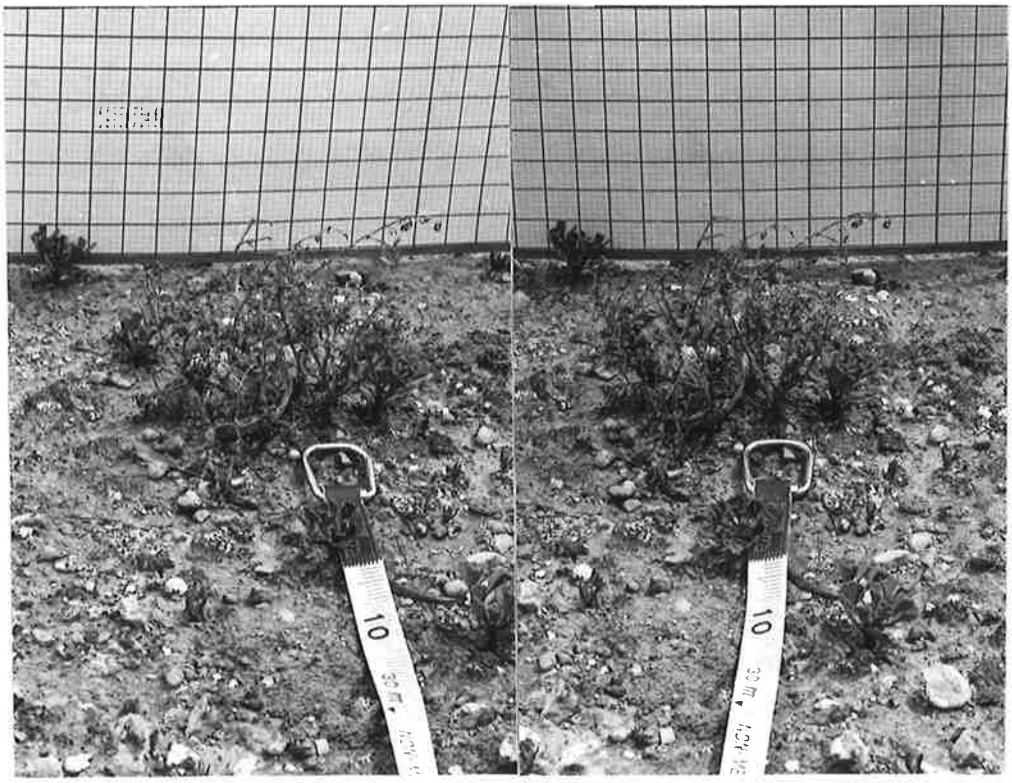
Consider the series of photographs Plates 5.1 to 5.4 taken from Station A on 14/5/72, 3/3/73, 13/10/73 and 3/3/74 respectively. Using stereo-glasses it can be seen that vast changes have occurred during the study period. The detailed changes are shown in Table 5.4, where the complexity of the situation again shows itself with a number of young, thriving *Zygophyllum* plants at 3/3/73, yet no living plants at 3/3/74, 12 months later. This difference appears to be as a result of rainfall. From Graph 5.3 ("effective" rain) it appears that the growth period giving rise to the large *Zygophyllum* plant at 14/5/72 occurred as a result of significant March rains. In January of 1973 rains again seem to have initiated germination of *Zygophyllum*, *Stipa*, *Helipterum* and *Erodium*. Comparison with the soil moisture graphs (5.4a, 5.5a) suggests that although the surface moisture had dropped to about 2%, the soil at 10 cm. depth increased in moisture content to about 9%, apparently enough for the root system to gather.

By 13/10/73, and after heavy falls in August-September, the vegetation reached maturity, and although soil

(14/5/72) Plate 5.1

Stereo-pairs, Station A.

(3/3/73) Plate 5.2



(13/10/73) Plate 5·3

Stereo-pairs, Station A.

(3/3/74) Plate 5·4

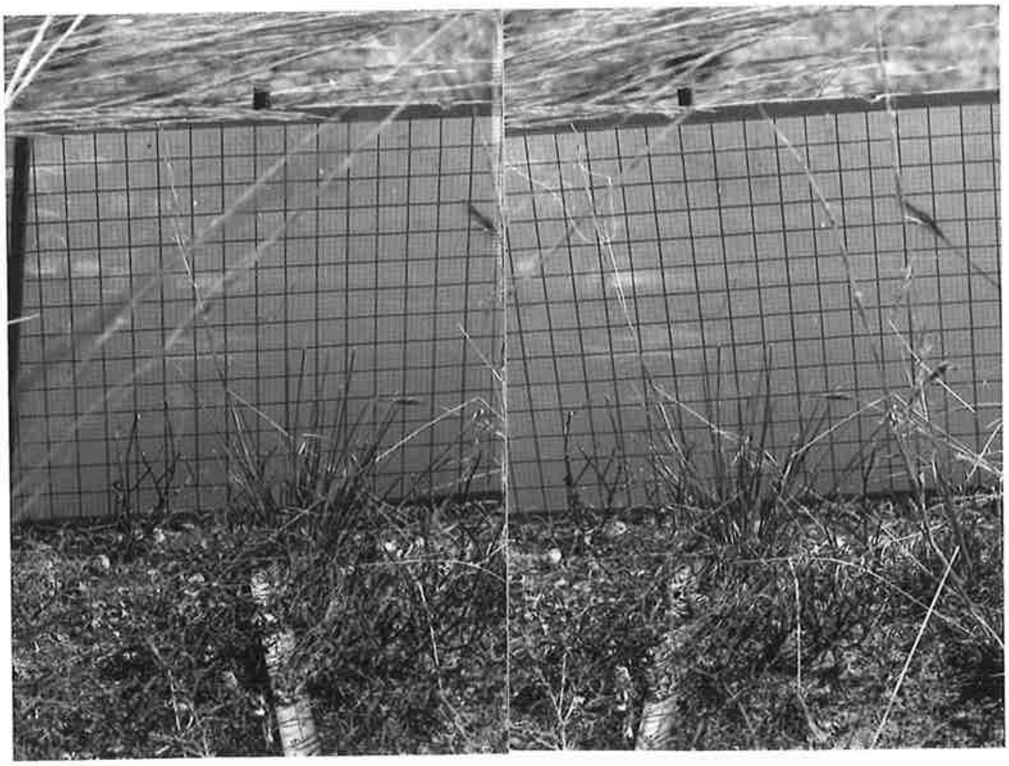


TABLE 5.4 PHOTOPOINT CHANGES (STATION A.)

	14/5/72	3/3/73	13/10/73	3/3/74
Zygophyllum	1 mature plant; fruits opened; dying off	dead 5 new plants; approx. 13,27, 30,20,15 leaf stages	all mature; large; fruit mature	dead
Stipa		1 plant; small	3 plants; grown larger; mature	dead, base had grown larger
Helipterum		12 plants; + other forbs; 6-10 leaf stage	large; flowering	dead
Erodium		2 plants; 8 leaf stage	dead	
Danthonia		a few plants; sprouting	(obscured)	dead
Lichens	small area covered	Larger area covered	(obscured)	small amount covered
Ground litter	small amount; *Erodium* seeds, *Stipa*	large *Zygophyllum* plant	more litter; *Erodium* seeds, *Stipa*	large amount; *Stipa*, *Zygophyllum*, *Erodium* *Danthonia*. *Helipterum*.

moisture at the 10 cm. level is still about 9%, the plants are dying off. It thus appears that seasonal changes and/or life-cycle of these flora species is more important than water availability (at this time). At 3/3/74, all is dead. Even the heavy rains in November-December-January have had no effect. The soil moisture at the 10 cm. depth has remained fairly constant yet no new growth seems to have occurred. A very similar situation occurred 12 months earlier, yet there has not been the same response. This is obviously a frustrating situation and one which would be very difficult to explain. Future detailed studies may reveal more of the intricate interaction of the many factors that are operating in this semi-arid pasture system.

Finally, comparison with Graph 5.54 of living and non-living biomass, shows that the photographs are sensible choices that illustrate the trends, and parallel the changing average biomasses found by the quadrat analysis.

(b) Other Photographs

Plate 5.5 was taken on 16/4/72 at Station A, when the permanently enclosed quadrat (at right) was set up. (The quadrat at left was replaced with the more mobile "weldmesh" the following month.) The vegetation is very sparse.

Plate 5.6, taken on 18/12/73, near the end of the research programme, is of the same quadrat. A number of features can be seen here:

- 3 permanent photopoint pegs (to support the graph paper for the taking of Plates 5.1-4)
- wombat activity as shown by the egesta material in

Plate 5.5 Permanent quadrat at Station A (16/4/72).

Plate 5.6 The same quadrat at 18/12/73.

the clear area by the star droppers

- the grazed-ungrazed interface in the middle distance. (This shows the *Stipa* has been eaten out, leaving mainly *Bassia* near the warren.)
- the effects of excluding wombats after 20 months, as shown by the large, mature *Stipa* inside the quadrat compared with outside the exclosure.
- Station C enclosure is at top left.

Plate 5.7, also taken on 18/12/73, is of the area nearer Station C. The change in pasture is very noticeable, and the demarcation line fairly easy to see.

4. VEGETATION IN PROTECTED AND UNPROTECTED QUADRATS

As stated earlier, an attempt was made to measure the effect of wombat grazing around the warren. By measuring the change in the vegetation within the enclosed quadrat, an estimate of change without wombat effect could be made. By measuring the change in the vegetation in the "open" quadrat, an estimate of change with wombat effect could be made. A comparison would give a first objective account of wombat activity.

It has been shown from biomass analysis that in general, as one moves out from the warrens, pasture biomass increases. Radial traverses have indicated a concentric grazing pattern from the warren that changes with pasture availability (and probably wombat numbers). Photographs have shown that over the period of the present study significant plant matter has accumulated in quadrats that have been exclosed to wombats, compared with the area outside these exclosures.

The raw data was analysed and biomass extracted. Table 5.5 shows the *Stipa nitida* biomass at Station B. As

Plate 5·7 Permanent quadrat at Station C, 18/12/73.
(Taken from warren)

TABLE 5·5

STATION B

SPECIES NO. 4

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Biomass (gms/3sqm) dry wt.	36·4	25·2	10·6	112·7	56·0	101·5	91·5	86·5	60·0	32·5	6·6	7·2	3·2	2·2	t	96·8	72·2	91·5	241	121	422	157	133·5
	36·4	25·2	11·3	65·5	86·5	75·5	69·0	71·5	17	2·6	6·6	·1	1·9	2·6	t	87·8	44·3	39·2	241	151	298	46·5	267·5
		24·7	6·7	74·5	33·9	89·4	76·0	74	24·8	1·9	1·4	1·0	·7	2·3	t	68·7	28	42·0	241	161	420	97	
"open" changing in proportion	36·4	·69) 25·2	·46) 11·7	9·8) 114	1·2) 133	2·2) 296	·77) 229	1·1) 216	·23) 49·6	·19) 5·2	5·3) 18·1	·06) 1·29	1·9) 2·45	3·7) 9·1	–	92·3	·64) 59·1	1·4) 82·7	5·7) 471	·51) 315	1·85) 583	·11) 64·2	2·8) 180
"closed" relative to "open."	36·4	·69) 25·2	·43) 10·6	10·6) 117	·85) 97	1·17) 156	1·22) 361	1·25) 286	·84) 182	1·91) 94·6	2·6) 13·5	1·1) 19·9	32) 41·3	1·84) 4·5	–	92·3	·32) 75·5	2·1) 124	6·1) 505	·50) 235	2·6) 820	·53) 309	2·9) 186

grasshoppers

very dry in appearance

grasshoppers

note 1) Proportional changes in brackets
2) start at 36·4gm/3sqm on 18/3/72
3) start at 92·3gm/3sqm. on 5/8/73.

stated in chapter 2, for valid comparison, a previously "open" quadrat was enclosed each month so that no cumulative effects over long periods of time would affect the comparison. Similarly, because the starting biomass of "open" and "closed" quadrats at any one visit were not the same, a method had to be employed, to make a realistic comparison. The following procedure was used :

The proportional change in each situation is obtained by dividing the score for that visit by the corresponding score for the same quadrat from the previous visit. For example, for the change between the "open" quadrats between 17/6/72 and 22/7/72, the proportional change is given by the latest biomass divided by the previous, i.e. 86.5 ÷ 74.5 = 1.2. (A value greater than 1 means an increase in biomass; a value of less than 1 means a decrease, and a value of 1 means no change.) Thus Table 5.5 starts with the arbitrary value of 36.4 grms/3 sq.m. (the average of the 2 "open" scores at 18/3/72) and using the proportional change fractions each time, a biomass value can be found, i.e.

18/3/72		36.4 grms.
16/4/72	36.4 x .69	25.2 grms.
14/5/72	25.2 x .46	11.7 grms.
17/6/72	11.7 x 9.8	114 grms.

etc.

The biomasses obtained are not the actual biomasses that occurred, but progressive proportional values produced for comparison; they are artifacts of the method used.

To enable the change in "closed" quadrats to be validly compared, the same starting values must be used. In this analysis the "closed" changes are shown relative to the "open" values, i.e.

18/3/72		36.4 grms.
16/4/72	36.4 x .69	25.2 grms.
14/5/72	25.2 x .42	10.6 grms.
17/6/72	11.7 x 10.0	117 grms.

etc.

The processed data for *Stipa* at Station B are shown in Graph 5.56. A sign of wombat feeding would occur where the "open" value drops significantly compared with the "closed" value, or there is a significant increase in the "closed" value above the "open" value. Two such significant situations occur, From August to September 1972, and December 1973-January 1974, and are asterisked on the graph.

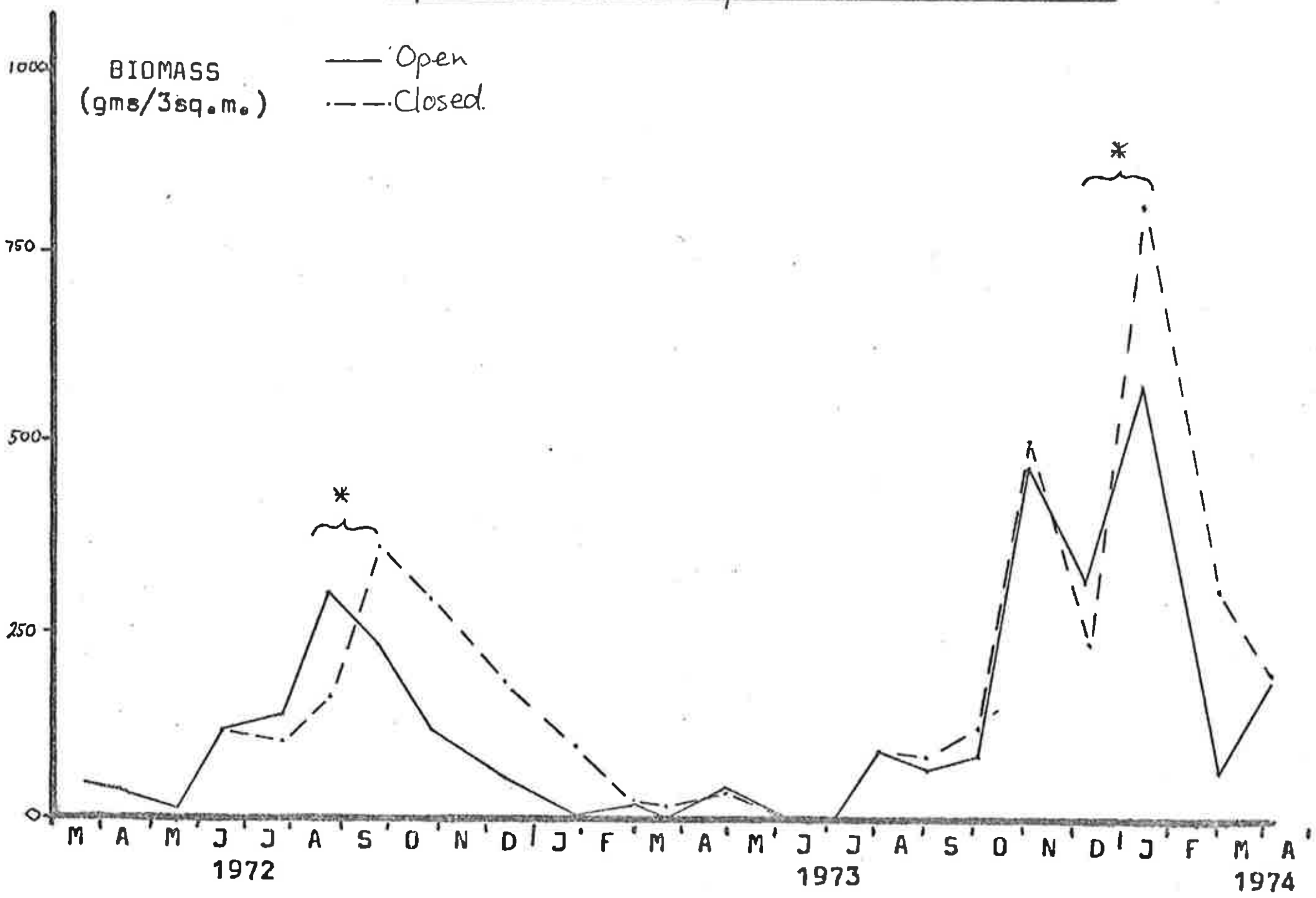
Although the "closed" graph stays above the "open" graph in most months, on 3 occasions the opposite occurred.

The data for the other stations can be found in Appendix 5.17. They show a similar trend. Some idea of the cumulative picture can be obtained by adding the "closed" values for each visit, and subtracting the "open" values. The following results :

Station A	insufficient data	
B	+ 797	grms/3 sq.m.
C	+ 119	"
D	- 3758	"
E	+ 1185	"
F	+ 28	"
G	+ 2630	"
H	+ 278	"
I	+ 38	"

Although the absolute values are not significant because of the arbitrary starting values, the sign is significant. At only one station was the value negative. (It was also

GRAPH 5·56 Proportional comparison of biomasses of *Stipa nitida* in Open and Closed quadrats at station B.



apparent that other factors affected the vegetation close in to the warren, suggesting that the values for Stations A and D are not representative anyway.)

Similarly, if it is assumed that differences between any two quadrats measured at the same station at the same time will tend to even themselves out over the programme period, then an absolute value can be found, as well as the sign. The relevant data was extracted from Appendix 5.I Consider each zone in turn :

(a) Zone 1

Because stations are set up at 10 m., 40 m. and 100 m. distances from the warren, it has been assumed that Station A approximates the average biomass turnover from 0-24 metres from the warren. Station C from 25-70 m., and Station B from 70-100 m. (There are a number of assumptions here, none of which can be verified in the present study, but the picture is the best that can be shown.) The results are :

Station A cumulative difference + 153 grm/3 sq.m. over 24 months.

Station B cumulative difference + 195 grm/3 sq.m. over 24 months.

Station C cumulative difference + 120 grm/3 sq.m. over 24 months.

Computing the average biomass in a circle of 100 m. radius about the warren gives an average loss of *Stipa* due to wombats of 70.6 kg./month.

(b) Zone 2

Similarly the raw data is :

Station D -334 grm/3 sq.m. over 22 months

Station E +223 grm/3 sq.m. over 22 months

Station F +351 grm/3 sq.m. over 22 months
Station G +225 grm/3 sq.m. over 22 months
Station H -141 grm/3 sq.m. over 22 months
Station I +599 grm/3 sq.m. over 22 months

Again it is assumed that the value at Station D represents 0-15 m. feeding distance from the warren, E represents 15-25 m., F (25-35 m.), G (35-45 m.), H (45-60 m.), I (60-100 m.). The average loss of *Stipa* that can be attributed to wombats is 191 kg/month in a circle of 100 m. radius from the warren.

It can be seen that although a figure of something like 61 kg/hectare (approx. 190 kg. in 100 m. radius-circle) was obtained, this value is likely to be an underestimate for a number of reasons :

(i) Low numbers of samples obtained. The data for Zone 1 do not correspond very well with that of similar stations of Zone 2.

(ii) Complex vegetation-soil-season-rainfall relationship giving rise to more pasture accumulating outside exclosures than inside at Stations D and H, especially since these are widely separated geographically. Comparison with the earlier "proportional change" discussion showed a negative cumulative value of "closed" minus "open" for Station D only.

(iii) It has been assumed that wombats prefer the green shoots of *Stipa* and leave the dried pasture; the data used is only for living material. Egesta cuticle analysis showed one kind of *Stipa* cuticle only. Carefully controlled laboratory tests would need to be carried out to determine any difference between fragments from living and dead spear grass in the egesta material.

(iv) It has also been assumed from the very small amounts of other herbage cuticle fragments in the egesta material that *Stipa* is the main dietary component. Perhaps less of other species cuticles remain after digestion. However, during pasture growth periods noticeably denser *Erodium*, *Zygophyllum* and *Bassia* plants occurred within 5-8 metres of the warren, and appeared untouched by wombats. (See Plate 3·10.)

(v) It was not possible, in the present study, to know how many wombats were present from time to time, and because wombats are known to move around from warren to warren (R.Wells; pers. comms.), this number could vary quite considerably.

(vi) It was stated earlier that the enclosed quadrats excluded larger animals, but this did not preclude birds and insects. At two times a large number of locusts were observed. There seemed to be a greater concentration on the *Stipa* that was enclosed suggesting they preferred new grass that would occur here rather than outside the enclosure. The significance of this observation cannot be determined.

(vii) The texture and depth of soil around warrens is very different from the undisturbed soil further away. This has influenced the luxuriance of the species sampled, especially *Zygophyllum* and *Bassia* which are denser and larger in size, and probably compete effectively with *Stipa*.

(viii) As stated earlier, it appears that once grazed, *Stipa* rootstock takes an appreciably longer time to develop new shoots than does relatively ungrazed pasture. Thus growth rate for the one species will change with distance from the warren, and therefore affect the cumulative values of biomass differences between grazed and ungrazed areas.

In summary it can be argued that there has been a wombat-grazing effect, too subtle to be significant from month to month, but more obvious in the accumulated results. Photographs of the same enclosures taken at different times, and stereo-pairs are undoubtable proof of a grazing effect. However, in order to obtain a quantitative influence on pasture, a much finer and more detailed approach than the one used here would have to be employed, and consideration made of a broader range of influences acting on the warren ecosystem.

5. WOMBAT BEHAVIOUR

Discussion of the warren and its surrounding vegetation would not be complete without a brief mention of the wombat itself. A number of photographs, taken at different times, can be used to give an idea of the behaviour of this mainly nocturnal mammal.

Warrens can be found in various places on the Reserve - on the open grassland areas (as in the present study) Plate 5.8, in the limestone areas of clearings in the *Geijera*-mallee, in bluebush country, and even in claypans.

Plate 5.9 shows a burrow opening soon after rain. Very little rain falls, and what does, soaks into the ground quickly, keeping the burrow dry. When moisture does penetrate deeper, the wombat kicks the damp soil out as

Plate 5.8
Warrens in open grassland

Plate 5.9
Burrow opening.

pellets.

Wombats show certain behavioural patterns associated with defecation and urination. The egesta pellets (Plate 5.10) tend to be deposited in special places like the one in Plate 5.11, where pellets of different ages can be seen, and where a hollow has been scratched out. The star dropper has had soil piled against it. It is not unusual to find a wallow as in Plate 5.12 where wombats can bask in the sun. Perhaps the rock acts as a backscratcher or as a wind-break. Other wallows can be found at the end of a distinct path, (Plates 5.13, 5.14), not far from a warren, and near fallen logs.

* * *

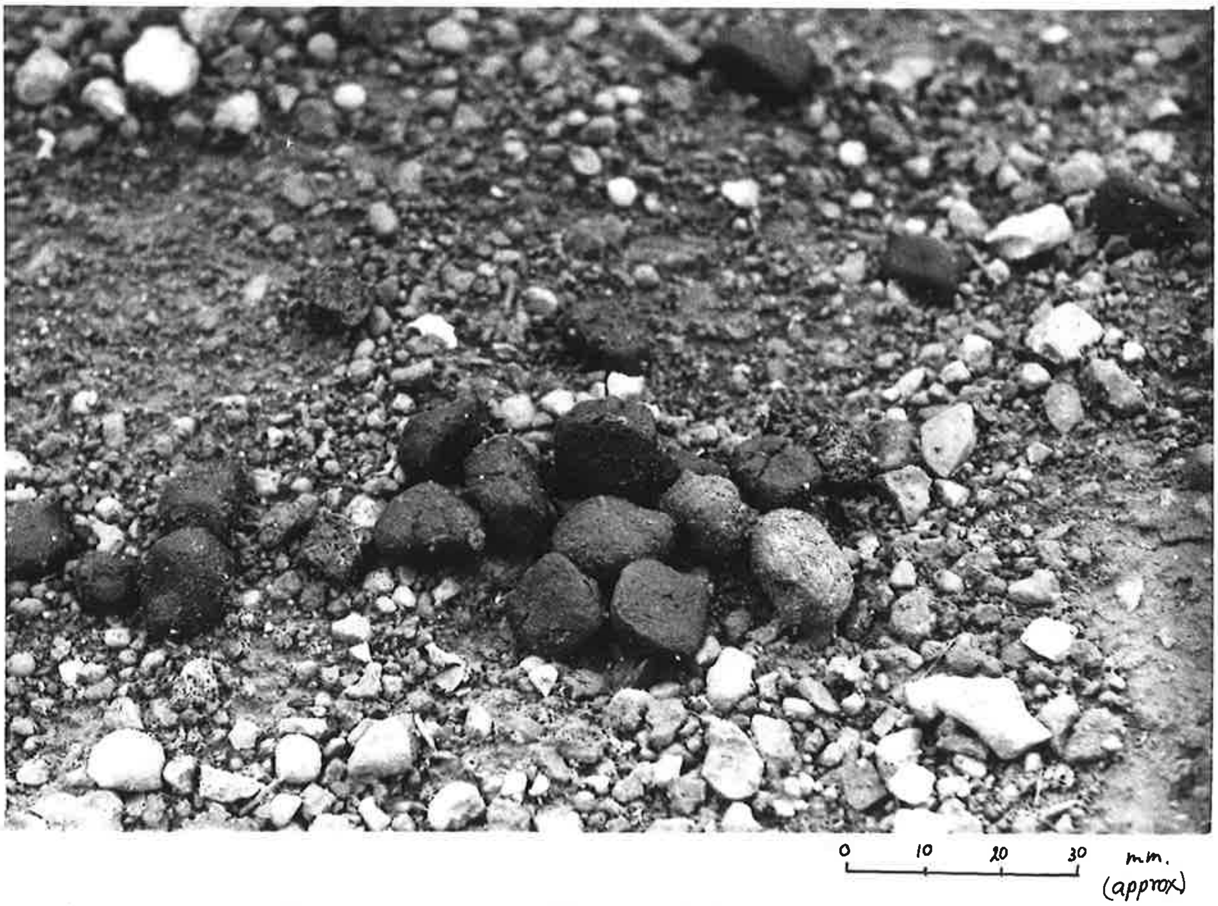


Plate 5.10 Egesta pellets.

Plate 5.11 Wombat wallow, Station A permanent quadrat.

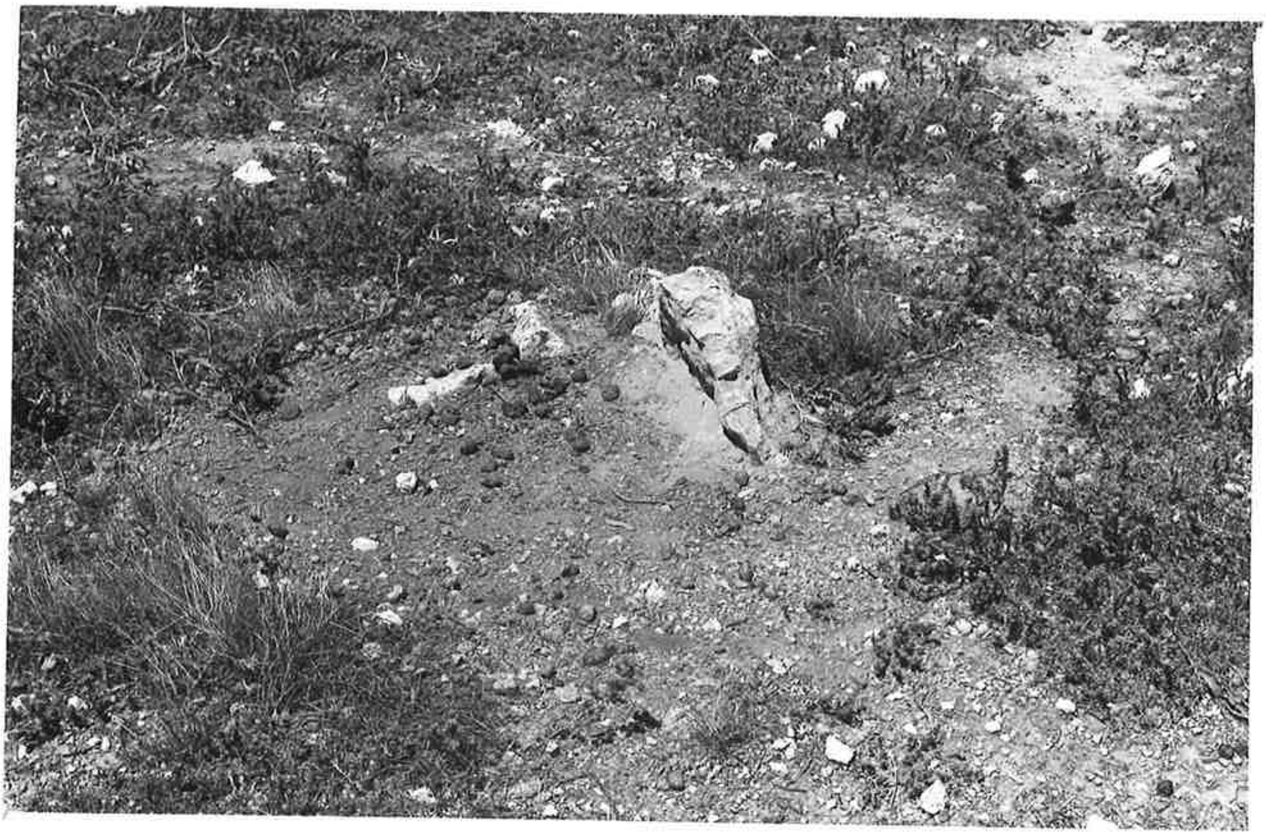
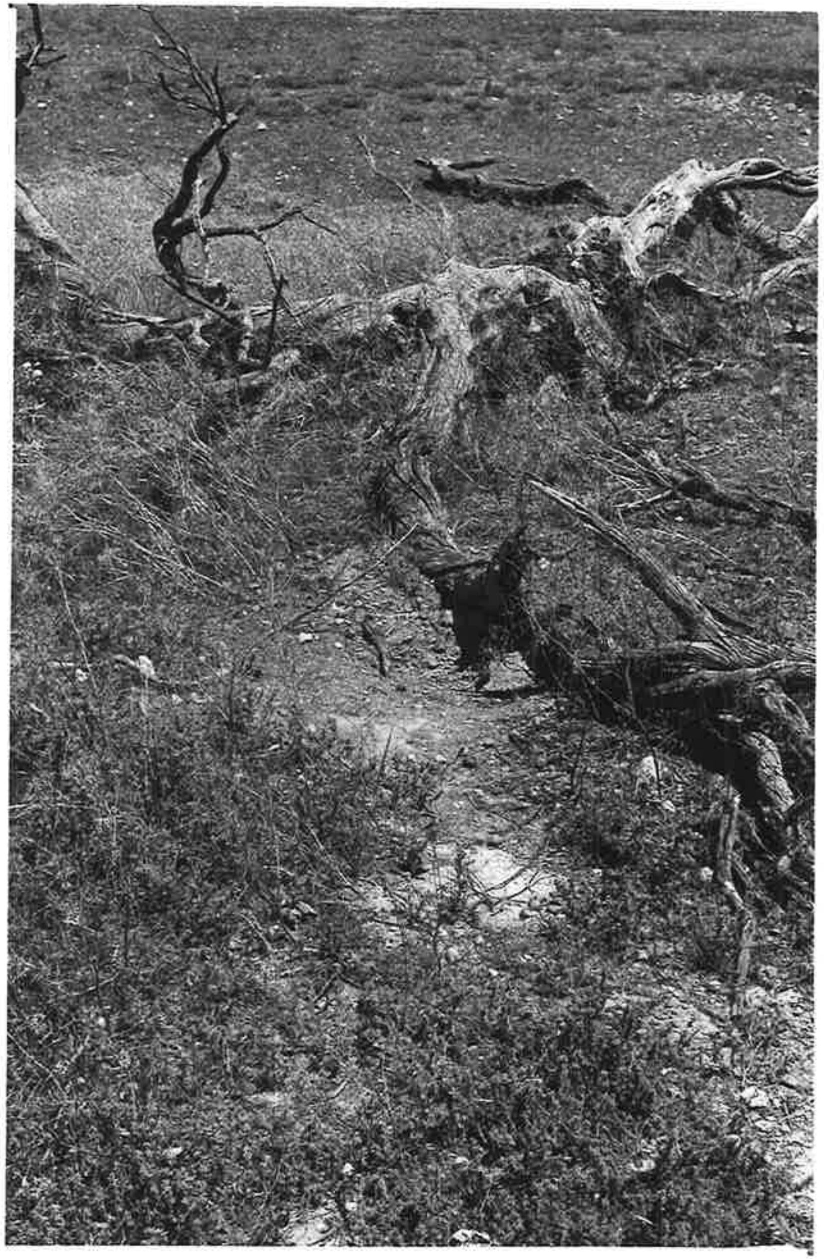


Plate 5.12 Wombat wallow.

Plate 5.13
Wombat
tracks.

Plate 5.14
Wombat
wallow.



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CHAPTER 6

RETROSPECTIVE INTERPRETATION AND INFERENCES

Of the issues dealt with in this thesis the grazing interaction between the wombats and their food supply probably will be of the greatest interest to most readers. Therefore it will be treated first in this chapter, which attempts to extract and itemise the essential conclusions and generalisations from the study.

1. *Demonstration and analysis of the wombat grazing effect about typical active warrens* on the Brookfield Zoological Society's Reserve *depends upon very fine-scale observations at short range from the warren.*
2. *Thus using the most sensitive techniques available* (cross-fence biomass comparisons extending into the very focus of the warren, and nose-to-the-ground detail) *no detectable grazing effect was ever found beyond 70 m. from the warren.*
3. *Demonstration and analysis has to be accomplished against a complicated background of change due to other factors of which some are not apparent to the casual observer.*
   (i) There is much variation in the soil properties from place to place around each warren. The following factors influence this particular habitat and must be taken into account :
      (a) soil texture
      (b) soil structure
      (c) water-holding capacity
      (d) microtopography and drainage
      (e) mineral makeup
      (f) mineral concentrations
      (g) depth of soil
      (h) shape of underlying limestone.

   Considering the soil moisture distribution at 0 cm. (Graph 5.4a) and 10 cm. (Graph 5.5a) depths, in the table below for only two occasions, it can be seen there are large differences in both the proportion of the change with depth, and the direction of the change.

19/8/72				3/2/73			
Zone	0 cm.	10 cm.	% change	Zone	0 cm.	10 cm.	% change
A	2.9	14.2	+ 79.6	A	18.2	5.4	-237.0
B	25	14.4	- 73.6	B	.8	.3	-166.7
C	9.7	1.4	-592.8	C	18.2	5.1	-256.9
D	-	16.8	-	D	17.7	11.7	- 51.3
E	25.5	17.6	- 44.9	E	18.2	5.4	-237.0
H	13.8	10.7	- 29.0	H	3.6	3.8	+ 5.3

This is not consistent with a relatively homogeneous set of soil conditions at any time.

Further evidence can be seen when some plants which were quite green and actively growing occurred within centimetres of others of similar size that were dried off.

(ii) Seasonal changes in diurnal temperatures and daily temperature ranges, rainfall distribution pattern and length of day and night obviously have an effect on the fauna and flora. The effects of these changes are modified by episodic climatic changes and other factors such as locusts which give rise to dramatic shifts in the growth dynamics of the flora.

4. *The use of shifting exclosures was the first application of its sort in non-cultivated South Australian grassland, was successful, and is worth the attention of others concerned with similar problems.* The size of the samples taken could only be improved by the addition of more manpower and/or time, but I suspect it would only marginally improve the accuracy of the data. Because the same people carried out the same techniques in each quadrat for the duration of the programme, any failing in an individual's technique would tend to be included in all data of the same kind. This particularly applies to the hand specimen method which could be open to criticism. However, as stated on p.17, there was very good agreement in 93% of the estimates between the two independent

estimates.

5. *Wombats eat the grass component of the flora and do not deliberately ingest the remaining species.*
   - (i) No evidence for grazing other species was found at any time. All plants observed appeared to be free from wombat grazing except *Stipa* and the occasional *Schismus*. Even around the warren itself where there was a high density of *Bassia*, *Zygophyllum* and *Erodium* (which was quite luxurious at times), no parts of these plants appeared pruned.
   - (ii) At any station there was no significant difference between the exclosed and enclosed biomass of *Bassia*, *Zygophyllum* and *Erodium*.
   - (iii) Initial faecal analysis produced a large quantity of *Stipa* cuticle compared with other species which were probably ingested accidentally.

6. *Once grazed Stipa rootstock takes an appreciably longer time to develop new shoots than does relatively ungrazed pasture; the degree of grazing has a non-uniform effect on regrowth.*

In closed quadrats closer to the warren the starting biomass is low, because grazing is heavier here, and there are fewer viable plants remaining. In his article "Measurement of the Primary Production of Arid Zone Plant Communities",(pp. 53-59 IBP Handbook No. 6; Methods for the Measurement of the Primary Production of Grassland, ed. C.Milner, R.E.Hughes, 1968;) R.O. Slatyer suggests that "under uniform environmental conditions the biomass will increase from low levels when leaf area alone may be limiting photosynthesis through a period of most rapid growth which may be determined largely by the genetic characteristics of the species, to a stage of declining growth rates as senescence or specific environmental factors becomes limiting". It is not unlikely that close grazing at this distance would cause some damage to the plants and growth rate would be further depressed, at least in the initial stages.

In quadrats further from the warren the starting biomass is greater, and the initial growth rate will be higher leading to a higher final biomass being reached in a shorter time. Both situations are modelled in graphs 6.1 and 6.2.

The present data are consistent with this model :

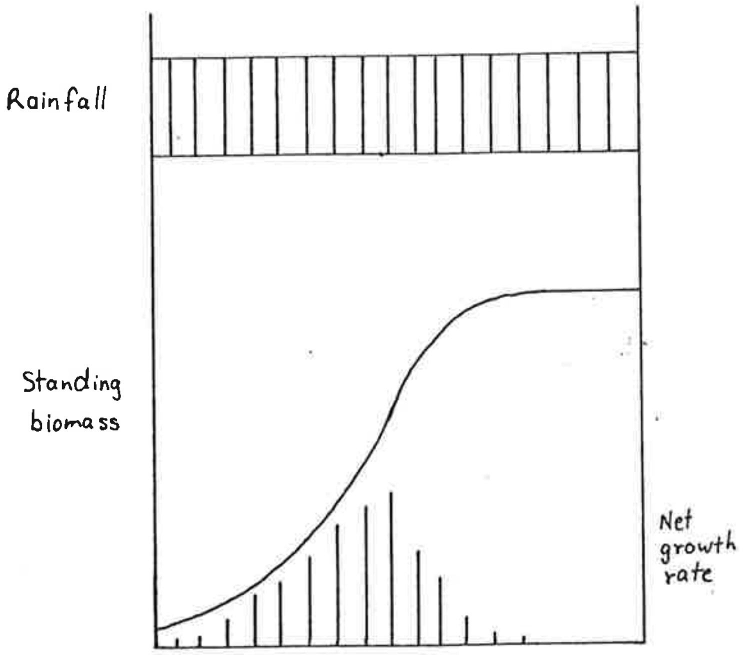
(i) From Graph 5.10 (Comparison of *Stipa nitida* biomass at stations in Zone 1) it can be seen that at Station A *Stipa* biomass starts each major growth period from a lower level than C, and C starts lower than B. Similarly the amount of biomass at the height of each season is least at A and greatest at B.

Further, from the slopes of the three graphs in Graph 5.10 which represent growth rate, there is a corresponding increase in rate of addition of biomass from inner to outer stations.

From Graph 5.10 (Comparison of *Stipa nitida* biomass at stations in Zone 2) it can be seen that a similar trend occurs between the inner stations D and E, and the outer stations H and I. (This point is expanded below).

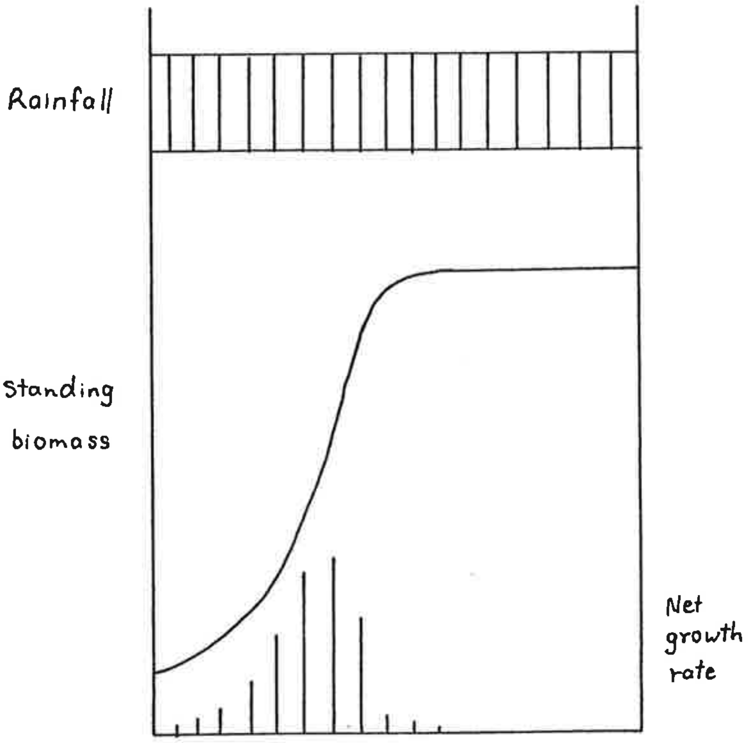
(ii) No such trends appear for the species *Erodium* (Graphs 5.15, 5.16), *Zygophyllum* (Graphs 5.26, 5.27), *Euphorbia* (Graphs 5.38, 5.39) and *Helipterum* (Graphs 5.43, 5.44).

In recording data for wombat grazing effect at stations closer to the warren only about one month's growth on heavily grazed *Stipa* was obtained. One would not expect a significant difference between biomasses inside and outside of an enclosed quadrat. Similarly at some distance from the warren, where there is no evidence of grazing, no significant difference will occur. Graphs 6.3 and 6.4 strongly support this inference and show plots of biomass inside and outside of the shifting enclosures for Stations D and B respectively (see App. 5.1). Station D represents areas close to



GRAPH 6·1
Stations near warren.

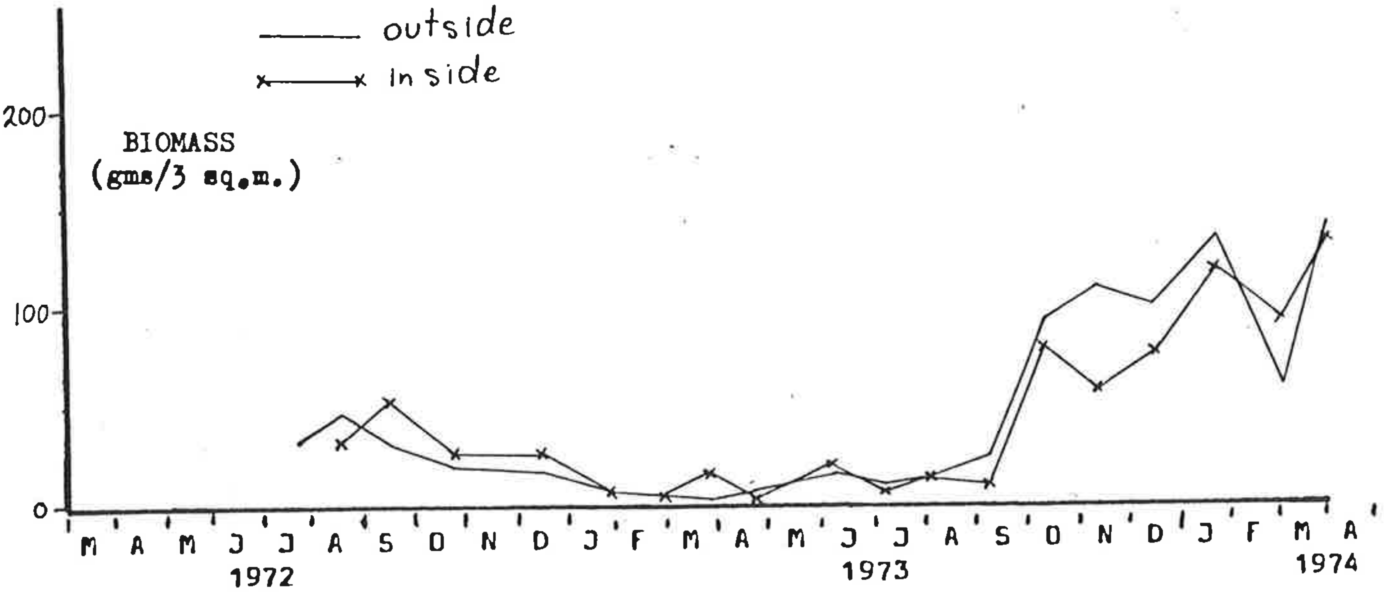
Schematic representation of annual dry matter increments (net growth rates) and total standing dry matter of annual plants such as *Stipa*.



GRAPH 6·2
Stations distant from warren.

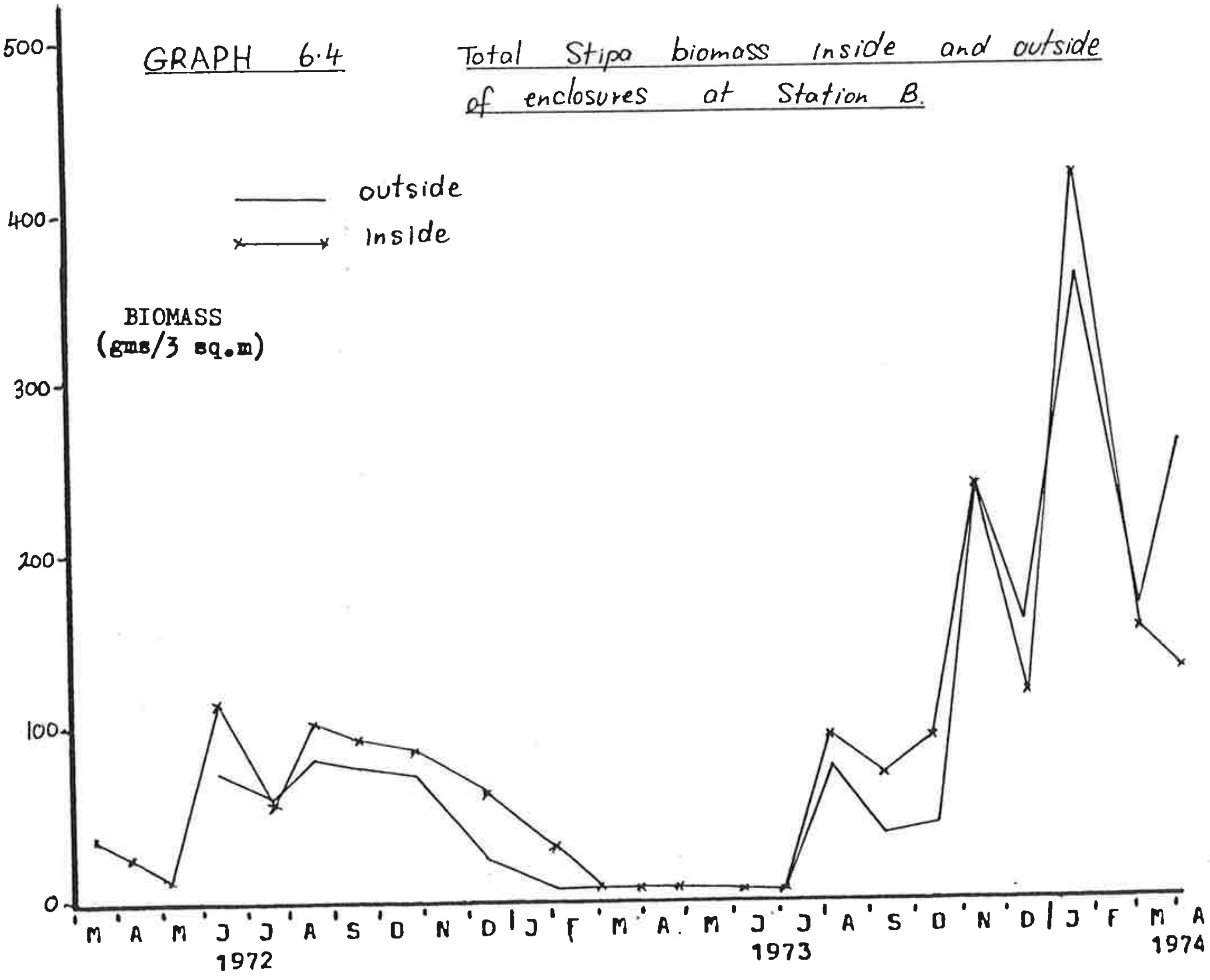
GRAPH 6·3

Total *Stipa* biomass inside and outside of enclosures at Station D.



GRAPH 6·4

Total *Stipa* biomass inside and outside of enclosures at Station B.



a warren and Station B represents those further out. There is no station that truly represents the interzone throughout the study period.

Two areas of data need to be considered in the light of Point 6.

(i) The seemingly remarkable differences between photopoint data and actual biomass data can now be easily explained. In the permanently enclosed quadrats the *Stipa* growth in the first season allowed the pruned plants to become re-established, and new plants to germinate and also become established. After the second main growth season recorded, these quadrats developed to the extent that they were indistinguishable from the quadrats at 70 m. or beyond. This is not inconsistent with the biomass data.

(ii) The second area of evidence that does not at first seem compatible with the biomass data is seen in the radial traverses. The data of Table 5.2 as expressed in Maps 5.1 and 5.2 show distinct radial patterns of grazing. This is further supported by the photographic evidence exemplified by Plates 5.5 - 5.7.

However, as intimated on p.68, once eaten out, the areas around a warren will tend to remain in that state. Regeneration will be slower, and grazing will continue to remove the small amounts of *Stipa* produced. Therefore what appears to be a devastating grazing effect is in fact a reflection of the maintenance of rather small compounded grazing effects on *Stipa* growth.

What seems important is not the inner area that is almost denuded of vegetation, nor the outer area that is relatively untouched by wombats, but the border area. It is here that the vegetation changes due to wombats would be greatest and most significant. It is this region that future researchers would do well to consider. Not only will the biomass changes here be a most obvious reflection of wombat activity, but the changing extent of the grazed zone as measured by the visual method employed in this study would probably be the simplest indicator of wombat activity for population management purposes.

Quadrats would best be established in this region rather than at set intervals as in the present study. Because the grazed-ungrazed demarkation line moved in and out from time to time through different station areas (notably Stations C, D, E and F), the present data cannot be used to indicate the importance of this region.

8. *Episodic environmental effects are a major factor in considering plant growth dynamics.*

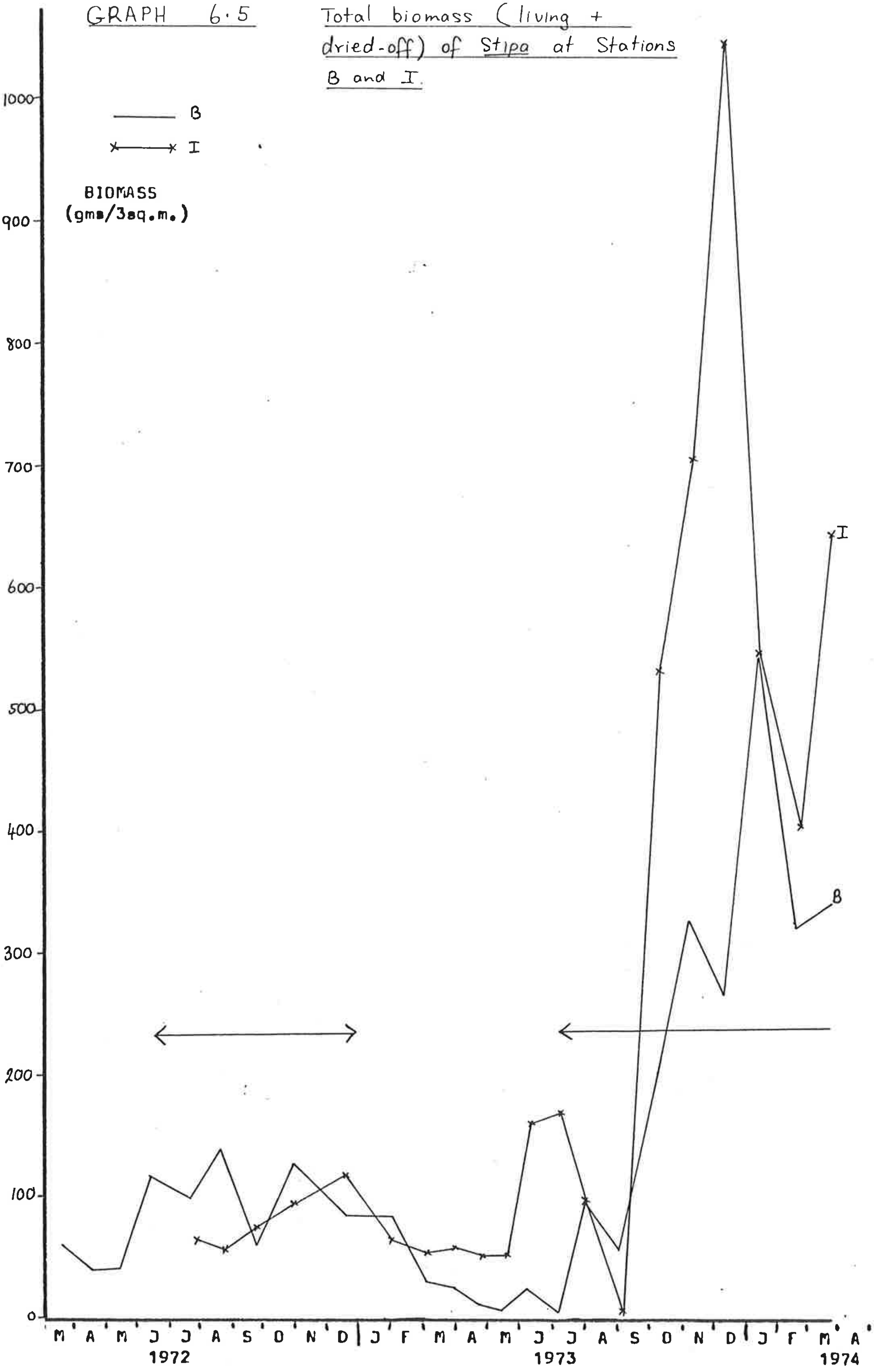
The total biomasses of *Stipa* (living and dried off) for Stations B and I, furthest from the warren and sharing no wombat grazing effect, are displayed in Graph 6.5. The growth and die-back periods are marked. There is a striking similarity with Slatyer's model (Graph 6.6) and the size of the variations from Graph 6.2 suggests that the episodic effects need to be investigated very closely indeed.

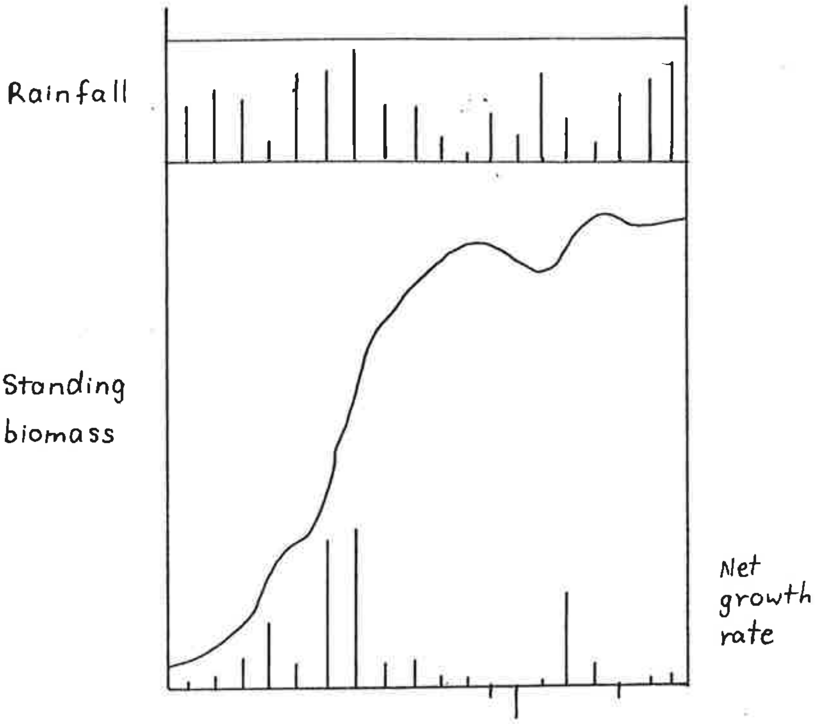
Further, by averaging the biomass of all stations (Graph 6.7) we achieve a graph that closely resembles Graph 6.2. This is remarkable in the light of the data for Stations B and I, and suggests that

9. *the episodic effects are quite different at the microhabitat level; some quadrats show a change in biomass while others nearby show a quite different change both in the quantity of Stipa and also the direction of the change.*

10. *Rainfall is not of prime importance in triggering growth of Stipa. Photoperiodic or seasonal temperature responses are much more likely alternatives.* These could be investigated by future researchers.

GRAPH 6·5 Total biomass (living + dried-off) of *Stipa* at Stations B and I.





GRAPH 6·6

Schematic representation of annual dry matter increments (net growth rates) and total standing dry matter of annual plants such as Stipa.

The evidence is as follows:

(i) From Graph 5.8 it can be seen that growth occurred in June - July of each year although not preceded by any increase in rainfall, and indeed not much rain at all (see Graphs 5.1 - 5.3).

(ii) From Graphs 5.1 - 5.3 (rainfall), 5.7 (average biomass of *Stipa*) and 5.12 (moisture content of *Stipa*), it can be seen that in May - June 1972 and again in March - April 1973, plant moisture was high yet there was no corresponding increase in biomass at this time.

11. *The amount of moisture in Stipa plants does not appear to bear much relationship with the biomass.* One might think that an increase in moisture would lead to a state conducive of activity, including growth, yet the March - April 1973 moisture was greater than the June - July 1973 content but the corresponding biomasses did not show the same trend.

    Even the moisture distribution pattern (Graph 5.12) shows that at the height of growth plant moisture varied from 20% to 43% in September 1972, and from 32% to 59% in October 1973. Even plants with a moisture content of about 10% appeared quite healthy.

12. *Growth of Stipa is promoted by significant August-September rains.* Some August 1972 rain led to an increase in the biomass and significant September 1973 rain led to a greater increase in the biomass.

13. *Rain in December-February has little effect on growth of Stipa and only serves to prolong the drying-off process.* Significant rain in January 1973 and in February 1974 was not able to stop the drying-off of the plants. In fact the plant moisture content decreased significantly despite rain after September, in both seasons studied.

14. *Stipa reaches a particular stage of maturity and dries off completely.*

Because closely grazed *Stipa* takes longer to recover it would be expected to mature later.

(i) This lag in growth is reflected in Graph 5.10 by the maximum biomass of *Stipa* after the 1972 and 1973 seasons occurring later at Station C than at Station B. Similarly in Zone 2 (Graph 5.11), D (and to some extent E) lags H and I. It can also be seen that at G a similar trend to that at D occurs in the 1973 season. The station G area sampled was particularly well grazed in July - August 1973 and thus started the growth season in about the same condition as plants at D.

(ii) From Graph 5.11 H and I *Stipa* biomass decreased to zero by March 1974, and from Graph 5.52, H and I ground litter biomass increased significantly beyond that of any other station in Zone 2. *Stipa* made up almost all of the biomass. Thus it appears that once *Stipa* had reached a particular stage of maturity, it dried off, but until a suitable stage of maturity occurred, senescence was prolonged.

(iii) From Graph 5.8 (Comparison of average biomass of *Stipa nitida* in Zones 1 and 2), Zone 1 biomass in August 1973 dropped, while Zone 2 biomass increased rapidly. This set-back at the beginning of the growth period led to a lag in the regrowth and also in the timing of maximum biomass.

Thus these similar trends between stations within each zone, as well as the trends between zones are illustrated in the data, all being consistent with the inference.

The wombat is relatively unobtrusive on its environment on the large scale but very effective on the immediate warren locality. Thus it appears that the limiter of the wombat population is not the available food. Even after the sheep were removed the amount of available food increased and yet there did not appear to be any increase in wombat activity.

The second thing to be considered will be the vegetation survey and analysis.

15. *The use of trail bikes in vegetation sampling is recommended in open woodland areas such as at Blanchetown.* Not only is it quicker than by foot, but fallen trees are no obstacle. By relating information from stop sites with the large aerial photograph a high degree of accuracy was obtained; the transects as shown in Map 2.3 are almost linear and stops were almost equidistant from each other on any particular route from the base line A-B.

16. *Five distinct community types exist on the Reserve.*

This is surprising in the light of the individual distribution maps and also the visual observations, and reaffirms the value of both statistical analyses and the concept of the vegetation community. One would hardly be likely to associate the tree *Myoporum* with the small forb *Erodium*, let alone *Zygophyllum* with *Bassia* from visual observations alone.

The independent associations are reflected by the very significant polarisation of species interactions into two large and one smaller nodes at χ greater than 50 as can be seen in Tables 4.4 and 4.5. What amplifies the importance of these interactions is the level of significance of the positive and negative associations of these species. At $\chi = 50$ which is usually accepted as significant, 19 of the species show interaction with others and 7 of the species have an incredible χ interaction greater than 90 which is highly significant.

Table 4.7 shows the 4 x 3 matrix which gives rise to a possible 12 community types, yet only 5 are represented, the remaining 7 not even occurring in small numbers, or even at all for some ratings.

Stipa species were observed in all parts of the Reserve, and thus the Mapping Units should also include these species. For simplicity one can consider Map 4.5 to be of a *Stipa* woodland community incorporating these five sub-communities.

1. *Stipa* - *Myoporum*/*Erodium* - *Geijera*
2. *Stipa* - *Myoporum*/*Erodium* - *Bassia*/*Zygophyllum* - *Geijera* interzone
3. *Stipa* - *Zygophyllum*/*Bassia* - *Geijera*
4. *Stipa* - *Myoporum*/*Erodium* - *Maireana*
5. *Stipa* - *Myoporum*/*Erodium*

Further, the other species with significant association with these five community types fall into distinct categories too. Thus 19 of the 30 species analysed occur in a particular community type with a frequency of an arbitrary four-times (or better) the frequency in any other community type. Obviously some unobtrusive but dramatic factors are producing these relationships; future investigators may wish to study this aspect.

17. *The topography and soil are not of prime importance in determining the distribution of the majority of taxa.* Of greatest interest is the obvious complementarity of the *Geijera linearifolia* distribution (Map 3.1) with *Maireana sedifolia* (Map 3.2). There is no apparent reason for this to occur as markedly as it does. The topography is no different. Future analysis of the soil may reveal some difference which allows one but not the other to survive. Perhaps one plant (or both) produces a chemical substance (e.g. hormone) which inhibits germination of the other. The distribution of *Myoporum* appears very haphazard, as does that of the *Eucalypts*. From the many fallen logs and secondary regrowth

18. it is obvious that *the area under study is grossly disclimactical and woodcutters and sheep-grazers in the past have brought this situation about.* As indicated on p.37, certain species that were

favoured by sheep are restricted to less accessable parts of the Reserve. For reasons that are not apparent, quite overt effects attributable to man can be seen in the distributions of *Zygophyllum* species. *Zygophyllum apiculatum* (Map 3.5) and *Zygophyllum aurantiacum* (Map 3.14) occur in the northern sector, but *Zygophyllum ovatum* (Map 3.6) only, appears in the southern sector. The east-west track seems to act as a demarking line suggesting a man-caused distribution pattern. Perhaps at some time sheep may have been forced to eat out the missing species through lack of preferred food in each area, leading to complete removal. Further investigation could be made concerning the historical aspects, as well as the annual growth periodicity of each species to throw further light on this situation.

19. *Some species are well suited to the modified conditions of micro-habitats on the Reserve.*

    (i) *Triodia irritans* is well adapted to the sandy soil conditions that occur along part of the north-south ridge.

    (ii) Claypans, with their specialised soil conditions allow *Centipeda* sp.,*Ajuga* sp. and *Reseda* sp., among others to flourish where other species cannot.

    (iii) The earth mounds of the warrens provide conditions of soil texture and structure, depth and therefore water-holding capacity that allow denser populations of *Zygophyllum* sp., *Erodium* sp. and *Bassia* sp. to thrive. This can be likened to the success of *Nicotiana glauca, Salso la kali* and various species of the family cruciferae in disturbed soil conditions.

During the period from when the data collection ended (1974) up to the present (1979) massive regrowth of bluebush and the appearance of new plants around the perimeter have occurred. Young trees and shrubs have sprouted, and species that sheep preferred have begun to re-inhabit the property. The Reserve is in a state of very rapid flora pattern changes.

With the abundance of feed one would expect the perimeters of warrens to be extended, grazed haloes to increase in size and the number of warrens to increase. None of these has occurred, but present studies indicate that the population has increased markedly. Our understanding of the intricate relationships that are occurring is only just beginning.

Having the opportunity to take into account such changes over a number of years has proven invaluable in writing this thesis and situations such as this should perhaps be the rule rather than the exception.

APPENDIX 1·1

Rainfall Data for the Reserve.

APPENDIX 1·1

YEAR 1963 RAINFALL (MM.)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1	2·0				1·3	1·5							1
2													2
3							10·4						3
4						6·4							4
5						·8							5
6													6
7						15·4							7
8						1·3							8
9													9
10		4·1											10
11					19·1		3·8						11
12		5·1											12
13	6·4				2·5			4·3					13
14					14·2	17·0							14
15					2·8			6·4					15
16								1·3					16
17													17
18						5·8	17·8						18
19													19
20							6·4						20
21										7·6			21
22													22
23													23
24													24
25				21·6	3·8			10·2					25
26								2·5		6·4			26
27				22·1				3·8		7·6			27
28				10·2	22·9				5·1	8·9			28
29				5·1	3·0					12·7			29
30					3·8								30
31					6·4								31
Totals													Totals

YEAR 1964 RAINFALL (MM.)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1					6·1								1
2		5·1											2
3													3
4	19·1				4·8								4
5													5
6		18·5		16·0									6
7										10·2			7
8									2·5				8
9													9
10									30·5				10
11									2·5				11
12						9·1							12
13							7·6						13
14													14
15													15
16													16
17											20·8		17
18							2·5						18
19													19
20				34·6									20
21													21
22												25·4	22
23								22·9					23
24												12·7	24
25													25
26									34·8				26
27								4·1	7·6				27
28													28
29					4·6								29
30													30
31								5·1					31
Totals													Totals

APPENDIX 1·1

YEAR 1965 RAINFALL (M.M.)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1													1
2							5·1						2
3													3
4													4
5									22·9		7·6		5
6													6
7							11·4						7
8					20·3								8
9									6·4				9
10													10
11								18·3					11
12													12
13													13
14													14
15								5·6					15
16								10·2					16
17													17
18													18
19								5·6					19
20													20
21						25·4							21
22													22
23													23
24							3·8				3·8		24
25													25
26													26
27													27
28													28
29													29
30													30
31													31
Totals													Totals

YEAR 1966 RAINFALL (M.M.)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1												11·4	1
2												12·7	2
3					14·2							5·8	3
4							3·0					15·2	4
5													5
6													6
7													7
8													8
9							3·0						9
10													10
11													11
12						5·6			8·9				12
13		21·3				7·6						12·7	13
14						3·6							14
15		7·6											15
16									3·0				16
17													17
18													18
19													19
20													20
21									4·6				21
22													22
23						8·4							23
24													24
25													25
26							12·7						26
27							6·4						27
28													28
29													29
30											12·7		30
31					4·1								31
Totals													Totals

APPENDIX 1·1

YEAR 1968 RAINFALL (M.M.)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1													1
2	7·6												2
3												5·6	3
4								38·1					4
5													5
6											8·4		6
7													7
8								8·4					8
9													9
10									4·1	5·1			10
11													11
12													12
13													13
14								2·8					14
15						8·6							15
16													16
17							3·8						17
18													18
19	22·9	78·7		11·3									19
20		18·3											20
21	2·5				12·7								21
22						10·9						10·4	22
23													23
24		3·8			7·6								24
25													25
26						8·4							26
27													27
28				10·4									28
29				2·0									29
30													30
31													31
Totals													Totals

YEAR 1969 RAINFALL (M.M.)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1					1·8							15·5	1
2									3·8			·5	2
3													3
4							7·1	3·3					4
5						2·3					6·1		5
6													6
7								5·6	3·0				7
8									·5				8
9		51·3				·5							9
10		6·1											10
11					·8		1·3						11
12			5·1	·3			11·7						12
13			7·4	·3	1·8				7·9				13
14				13·5									14
15	4·6				10·9				6·4				15
16													16
17									·5				17
18			·3			3·0							18
19				1·3					2·0			·5	19
20					1·5	·8						2·5	20
21					1·8		5·8						21
22		6·4					2·5		5·1				22
23								1·5	1·3			·3	23
24			15·0										24
25	2·5												25
26													26
27													27
28								1·5					28
29					9·4								29
30								2·8					30
31					1·8								31
Totals													Totals

APPENDIX 1·1

YEAR 1970 RAINFALL (MM)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1	6·6												1
2	2·3					1·0		4·1					2
3						·3							3
4					·5	1·3			2·5				4
5			2·8										5
6				1·3									6
7					4·5								7
8													8
9							·5						9
10				1·8	2·3	2·8	1·0		·5			6·6	10
11							2·0	1·8			32·3	8·6	11
12							·8	1·0	8·9				12
13						1·5		·8	·3				13
14									·3				14
15						1·0		1·8			5·6		15
16					4·3								16
17													17
18					·5		·5						18
19			1·3	1·5			1·0			10·4			19
20				2·0									20
21				4·6		·8			2·3				21
22								1·8	6·9				22
23									·3				23
24									1·0				24
25				1·0				·5					25
26				6·6					·5				26
27				·3				5·1	30·0				27
28									5·6				28
29									·8				29
30					5·1	3·3							30
31													31
Totals													Totals

YEAR 1971 RAINFALL (MM)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1			5·3		1·0			·3		·8			1
2						6·9		2·5					2
3					·5				2·0				3
4									8·6		9·4		4
5					·5								5
6													6
7											7·1	1·0	7
8					·5	19·1					·3		8
9			·5										9
10								3·0				6·4	10
11						·5		1·5					11
12												·5	12
13													13
14								8·9					14
15			10·9	8·9		·5	·5	2·3	1·0	1·3			15
16							6·1		3·3				16
17				3·3							2·3		17
18				·8					·5		5·3		18
19				3·6		·8							19
20		2·3		·5	10·4				·8				20
21								2·3	·5		1·0	·3	21
22						2·8	7·1		1·0				22
23			3·0					1·3					23
24				·5		2·0	·3	2·5					24
25								1·0	4·1				25
26			4·1						·5				26
27				6·6				·8		1·8			27
28							·3	2·5					28
29					·3	·5		2·5			3·3		29
30						·3							30
31							·8						31
Totals													Totals

APPENDIX 1·1

YEAR 1972 RAINFALL (MM)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1								·3					1
2								1·8			4·3		2
3							1·8				2·0		3
4							1·8				4·6		4
5								·3					5
6	2·3						1·5						6
7	7·1						1·8		2·5				7
8				3·6			3·3		·5				8
9					2·3						·5		9
10							5·3	1·3					10
11	12·2						·3	1·0					11
12	7·1						1·5						12
13									·3				13
14													14
15		9·4						5·6		3·0			15
16		2·8					1·5	5·3		4·3			16
17		·8			1·3								17
18	·8												18
19								5·6					19
20							1·0						20
21		3·6											21
22				·8									22
23				·8									23
24				·3									24
25				·3									25
26						·5						1·8	26
27													27
28													28
29						2·0		·3					29
30						3·3							30
31		21·8								1·0			31
Totals													Totals

YEAR 1973 RAINFALL (MM)

Date	J	F	M	A	M	J	J	A	S	O	N	D	Date
1					2·3	·5			4·6				1
2						·3			·3				2
3						·5			·5		1·5	·5	3
4		5·8				1·0		·8	1·0		1·5		4
5		26·9						3·8	2·8				5
6		72·4											6
7								1·0					7
8													8
9					2·3	1·8		·5		1·8			9
10						3·0			·8				10
11						17·0				6·1			11
12			·8			3·6			2·0				12
13								·5					13
14							23·1	·3					14
15				6·1	1·3	2·4						34·8	15
16							15·2						16
17													17
18				12·7									18
19			2·5	·8		·6	1·0						19
20						1·3	·8			42·7			20
21						2·0				39·4			21
22				·5						·8			22
23					1·3				3·8				23
24					1·3				4·0				24
25				1·0	·3					15·2			25
26				2·0	·3			2·3					26
27	4·1		6·4					50·8		·5			27
28	12·7		3·6								27·7		28
29	·5		9·7		4·3								29
30												5·8	30
31										7·1			31
Totals													Totals

APPENDIX 3·1

Density distribution data for 6 prominent flora species.

APPENDIX 3·1.

Quodrat Number ↓

SPECIES NUMBER → (See Table 3.1 for species names)

	1	3	10	19	49	50
1					1	3
2	3				1	3
3	3				1	3
4	3				1	3
5	3				1	
6				3	1	
7		3	1	2	1	
8		2			1	
9		3			1	
10	3	3			1	3
11	3	3		3	1	3
12	2	3			1	3
13	2				1	3
14	3	3			1	
15		3			1	
16					1	
17		3		1	1	
18					1	
19					2	1
20	1	2			1	
21	3	3			1	
22	3	3			1	
23	3	3			1	
24	3	3			1	
25		3		1	2	
26		3		1	3	
27				2		
28					3	
29	2	3	1		3	1
30			1		3	3
31	3	2	1		1	
32		2			2	
33		3		1	2	
34		3		1	2	
35		3		1	2	
36		3		1	2	
37		3		1	2	
38		3		1	2	
39	2	3			1	2
40	3	2			2	2
41	3	3			1	2
42		2	1	3	2	
43		2		1	3	
44		2		1	3	
45		2		1	3	
46		2		1	3	
47		2		1	3	
48		2		1	3	
49	2	2			3	1
50		2			1	
51					1	
52		2		2		
53		3		1	3	
54				1	3	
55		2		1	2	
56		2		2	2	
57		2		3	3	
58		2	1	2	3	
59		2		2	2	
60	2				2	
61		3			3	
62		2			3	
63		2			3	
64		2		2	3	
65		2		2	3	
66	3	2		2	3	
67		3			2	
68		2			3	
69		2			3	
70					2	
71					2	
72	3	3			2	
73	3	2			1	
74		2		3	3	
75		3			2	
76		3			3	
77		3			2	
78		2			3	
79		2		3	2	
80	3	2			3	
81	2	2			3	
82	3	2			3	
83	3	2			3	
84	2	3			2	2
85	2	2			1	
86		2			1	
87	3	2			2	
88		2			3	
89						
90		2	1		3	
91		3	2		3	
92	3	2	2		3	
93	3	2			2	
94	2	2	3		2	
95	3	2	3		2	
96	2	3			2	
97			3		2	
98					2	
99		2			3	
100		2			3	

	1	3	10	19	49	50
101 ↓		1				
2		3			2	
3		3			3	
4	3	3	3		3	
5	2	2			3	
6		3			3	
7	3	2			3	
8	2	2			2	
9	2	3	3		3	
10	1	3			3	
11	2				3	
12	2	3			2	
13	2		3		1	
14	2				3	
15	2	1			2	
16	2	1			2	
17	3	3			2	
18		3			3	
19	3	2			3	
20	2	2			3	
21	2	2			3	
22	2	2			3	
23	2	3	2		2	
24	1	3	3		3	
25	2	2	3		2	
26	2		3		3	
27	2	2			2	3
28		2	3		2	
29	2	2			3	
30	3	2			3	
31		3			3	
32	2	3			3	
33	3	2			3	
34	2	2			2	
35	2	1			2	
36	3	2	3		3	
37	2	2	3		3	
38	2	3	3		3	
39	2	3			3	
40	3	3	3		2	
41	2	3	3		2	
42	3	3	2		3	
43	2	3	2		2	
44	3	2			3	
45	2	2			3	
46	2	2			2	
47	2	2	3		2	
48	2	2	3		2	
49	2	2	3		3	
50	2	2	2		3	
51	1	3	3		3	
52	2	3	3		2	
53	2	1	3		3	
54	2	2			3	
55	2	2	3		2	
56	1	2	3		3	
57	1	2	3		3	
58	3				2	
59			3		1	
60	2	2	3		3	
61	2	2	3		3	
62	1	2	3		3	
63	2	2	3		3	
64	2	1	3		3	
65	2		3		3	
66	1	2	3		3	
67	1	3	1			
68	1	2	2		3	
69	2	1	3		3	
70	3		3		3	
71					3	
72	2		2		3	
73	2		2		2	3
74	2	3			2	
75	1		2		3	
76	1	2	1		3	
77	1	1	3		3	
78	1	2	3		3	
79	1	1	1		3	
80	2		3		3	
81	1		3		3	
82	1	2	1		3	
83	2				3	
84	2				3	
85	3		3		2	3
86	3		3		3	
87	1	2	2		3	
88	1		1		3	3
89	2				3	3
90	2		3		3	
91	2		3		3	
92	1	2	1		3	
93	1	2	2		3	
94	1	2	2		3	
95	1		2		2	
96	2		3		3	3
97	2		3		2	3
98	2		2		3	
99	3				2	
200	2	2	3		3	

	1	3	10	19	49	50
201 ↓	3	3	3		3	
2	3	2	3		3	
3	2	2	3		3	
4	3	2			3	
5	2	2			3	
6	2	2	2		3	
7	1	2	2		3	
8	1		3		2	1
9	2				3	2
10	2	2				
11	1				3	
12	2				3	
13	2	2				
14	1	3				
15	2	3				
16	3	3				
17	1	2				
18	1	2				
19	1		2		3	
20	1		3			
21	3				1	1
22	2				1	1
23	2				1	1
24	1	3				
25	1					
26	1					
27	1		3			
28	2	2	3			
29	1					
30	1	3	2			1
31	2				1	
32	1					1
33	1					1
34	1					
35	1					1
36	3					
37	3	3				1
38	2					1
39	3					1
40	3					1
41	3			1		
42	2	1				1
43	2					1
44	2					1
45	2					1
46	3					1
47	2			3		2
48	2		1			
49	3		2			3
50	3		3			
51	2		1			3
52	3					3
53	3		1			1
54	2	2				2
55	2				1	2
56	3					2
57	2					2
58	2					2
59	2	1	1			1
60	1	2	2			
61	3	2	3			
62	2	3				2
63	3					2
64	2					2
65	1	3				
66	2	1			1	1
67		1		2		
68	3	1		1		2
69	2					
70	2	3				1
71	3					3
72	1					
73	3					1
74	2					1
75	2	1	2			
76		1	3			
77	2	2	2			
78	3	2				
79	3	2	3		1	
80	2	1	3			
81	1	2	2			
82	3					2
83	3					1
84	3	3		1		3
85	2	3		1		

1 highest density.
2 medium density.
3 low density.
no score (4) - absent.

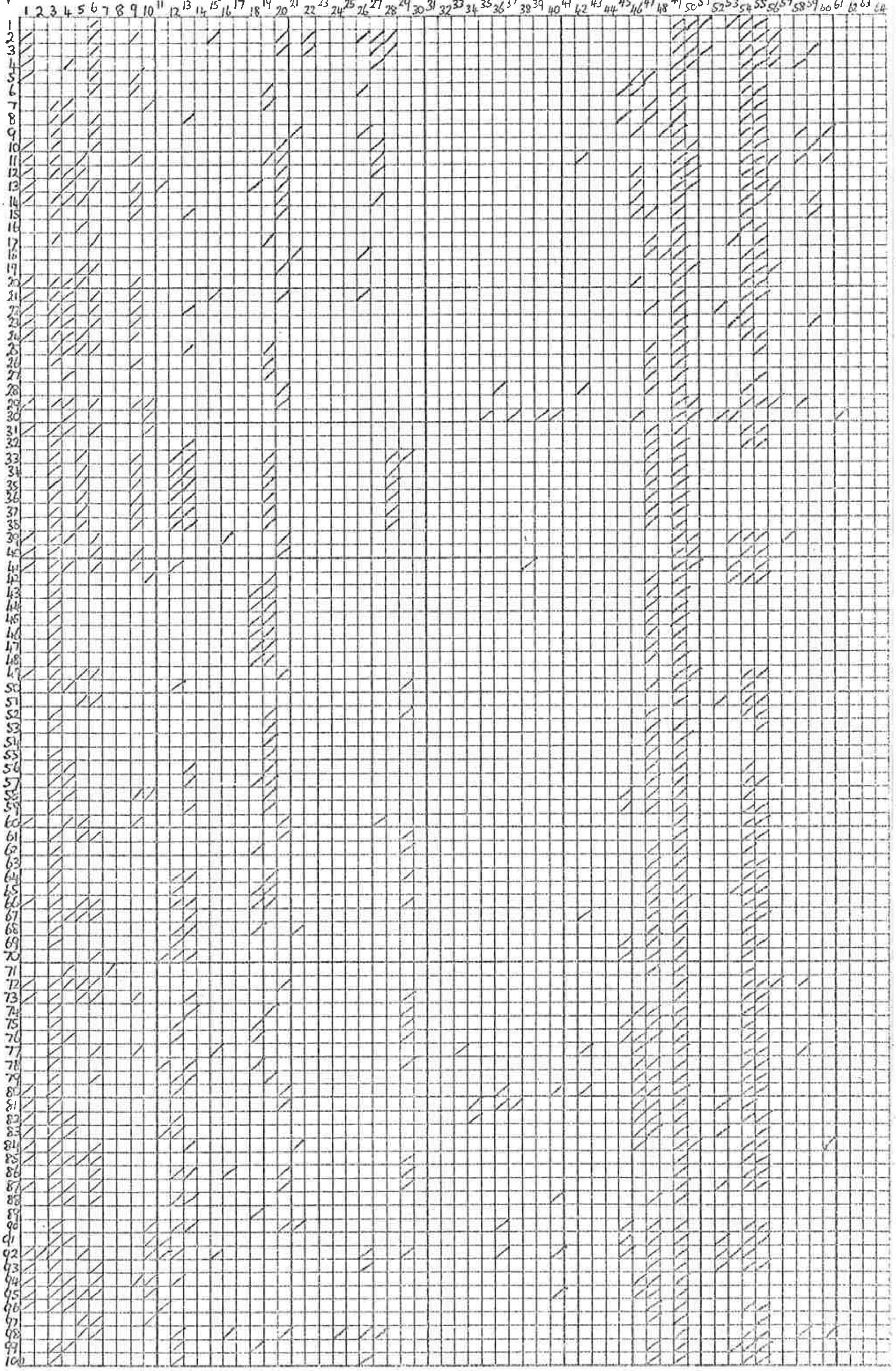
APPENDIX 3.2

Incidence Data for the Distribution of 64 Flora Species.

APPENDIX 3.2

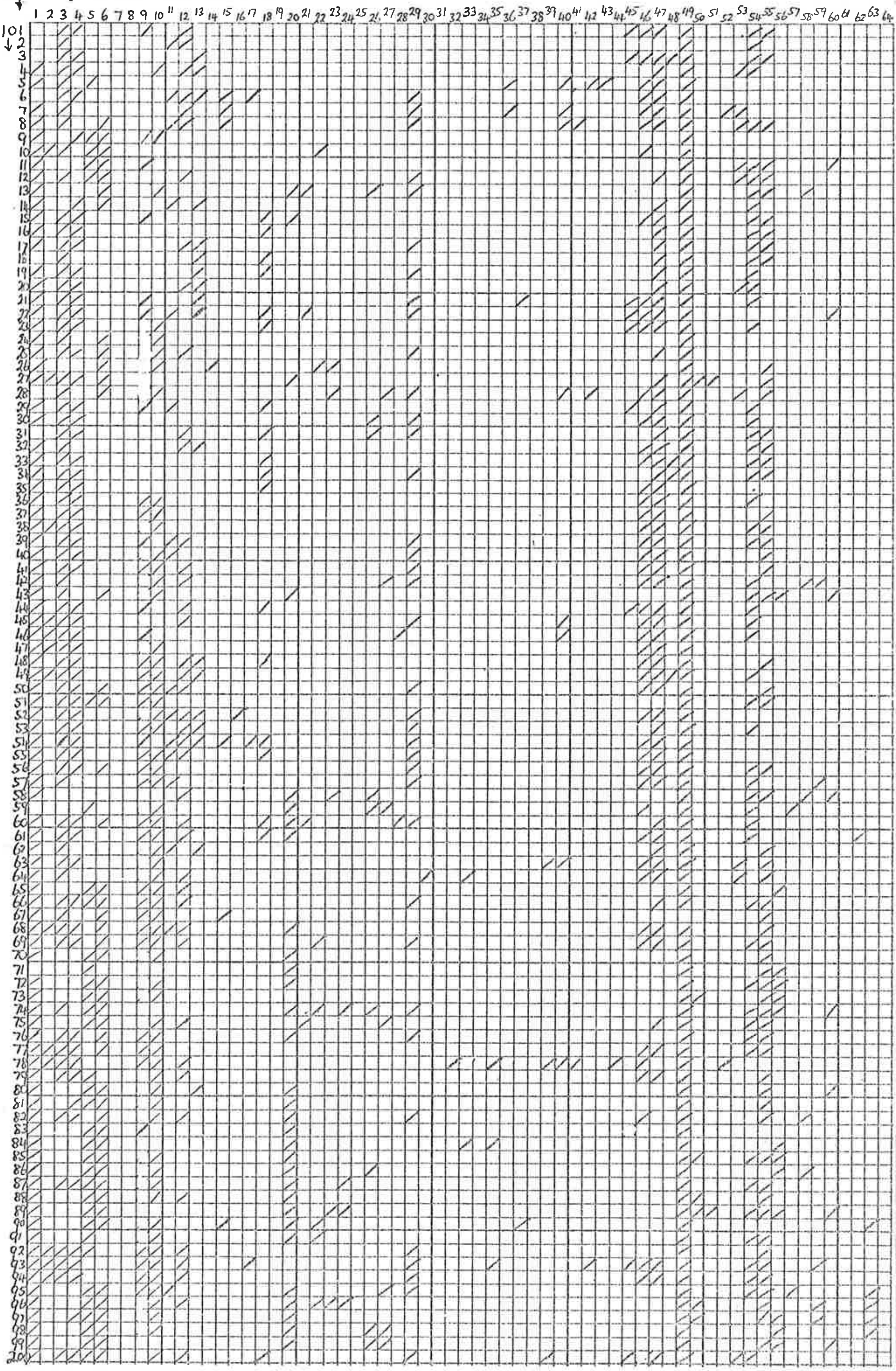
Quadrat Number

SPECIES NUMBER → (See Table 3.1 for species names.)



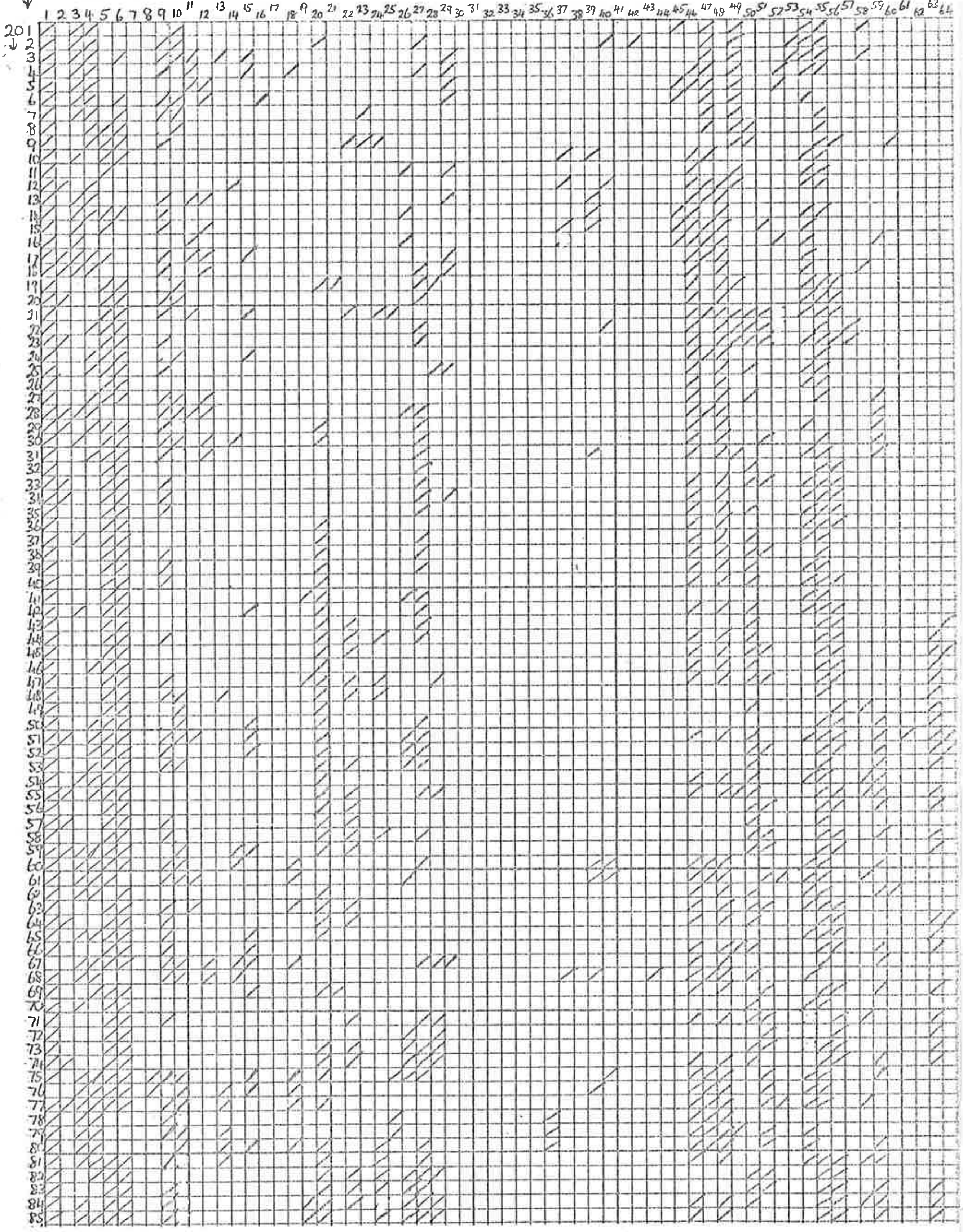
Quadrat Number ↓

SPECIES NUMBER ⟶



Quadrat Number

SPECIES NUMBER →



APPENDIX 4·1

Computer printout of Incidence Data for 37 flora species.

APPENDIX 4/

```
DATA CARDS READ ARE AS FOLLOWS:

QUADRAT   SPECIES
 IDENT
    1     0000010000000000000000000111011000010
    2     1000010100000101011100000110011100000
    3     1000010000000101001100000111011100000
    4     1001010000000000000100000110011111000
    5     1000010100000000000000001110001000000
    6     0001010100001100010000010100011000000
    7     0010000100010000000000001100011000000
    8     0011010000010000000000001100011000000
    9     0010010000000010010000010100011010000
   10     1010010000000100001000000110011001000
   11     1010100100001100001000100110011110000
   12     1011100000001000010000101100110000000
   13     1001010101000100000000010110011100000
   14     1011100100000010001000010100011001000
   15     0010000100010100000000011100010001000
   16     0000100000000000000000000100011000000
   17     0010010000001000000000001100001000010
   18     0000000000000010010000001100011000000
   19     0000110000000100000000000110011100000
   20     1011100100000000000000010100011000000
   21     1011010100000100010000000100011000000
   22     1011010100010000000000001100110000010
   23     1011010100000000000000000100010001000
   24     1011100100000000000000000100011000000
   25     0011110000011000000000001100001000000
   26     0010000100001000000000001100000000000
   27     0001000000001000000000001000001000000
   28     0000000000000100000010101100010000000
   29     1011010110000100000000000110011110000
   30     0001000010000000000000001011010000010
   31     1011010010000000000000001100011000000
   32     0010000000010000000000001100011000000
   33     0010100100111000000100001100000000100
   34     0010100100111000000100001100000000000
   35     0010100100111000000100001100000000000
   36     0010100100111000000100001100000000000
   37     0010100100111000000100001100000000000
   38     0010100100111000000100001100000000000
   39     1011010000000100000000000110011000011
   40     1010010100000100000000000110011000000
   41     1011010100100000000000001100010000010
   42     0010000100010000000000001100011000010
   43     0010000000001000000000001100000000000
   44     0010000000001000000000001100000000000
   45     0010000000001000000000001100000000000
   46     0010000000001000000000001100000000000
   47     0010000000001000000000001100000000000
   48     0010000000001000000000001100000000000
   49     1010110000001000000000001100110000000
   50     0011000000100000000000001100010000100
   51     0000110000000000000000000100111000000
   52     0010000000001000000000001000011000100
   53     0010000000001000000000001100010000000
   54     0000000000001000000000001100000000000
```

```
DATA CARDS READ ARE AS FOLLOWS:

QUADRAT   SPECIES
 IDENT
   55     0010000000001000000000001100000000000
   56     0011000000011000000000001100010000000
   57     0011000000011000000000001100011000000
   58     0011000110001000000000001100010000000
   59     0010000000011000000000001100011000000
   60     1001100100000100001000000100011000000
   61     0010110000000100000000000100011000100
   62     0010000000000000000000001100010000100
   63     0010000000000000000000001100011000000
   64     0010000000111000000000001100011000100
   65     0010000000101000000000001100011000010
   66     1010110000111000000000001100011000100
   67     0011110000010000000000101100011000000
   68     0010000000110010000000001100010000000
   69     0010000000100000000000001100011000000
   70     0000010001110000000000001100010000000
   71     0001001000000000000000001100010000000
   72     1011110000000100000000000100011110000
   73     1010110100010000000000000100011000100
   74     0010000000110000000000011100011000100
   75     0010000000100000000000001100010000100
   76     0011000000100000000000011100011000100
   77     0010010100000000000000110100011010000
   78     0010000001010000000000011100011000100
   79     0010010000111000000000011100011000000
   80     1010000000100100000010111100011000000
   81     1010000000000100000010011100110000000
   82     1011000001000000000000011100011000000
   83     1011000001100000000000011100101000000
   84     1010010000010010000000010110011000000
   85     1011110000000000000000000100011000100
   86     0010010000110100000000000100011000100
   87     1011010000000100000000000100111000100
   88     0011010000110000000000001100000000000
   89     0000000000000000000000000000000000000
   90     0010000010110110000010001100011000000
   91     0011000110000000000000001100111000000
   92     1110100011100000010010001100110000110
   93     1010010000000000010000001100111000000
   94     1011010110100000000000011100000000000
   95     1011110010000000000000011100000000000
   96     1011000010000000000000001100011000000
   97     0001100100000000000000001100001000000
   98     0000110000100100011000000100011010000
   99     0011000001000000000000001100011000010
  100     0010000000100000010000001100011000000
  101     0011001001000000000000001100001100000
  102     0010000001100000100000001000100000000
  103     0011000000010000000000011100011000000
  104     1011000010110000000000001100010000010
  105     1010100000000000000000101111000000000
  106     0011000001110000000000011100000000100
  107     1010000001000000000010011100100000110
  108     1010010001100000000000101110001100110
  109     1001110110000000000000000100000000000
```

```
DATA CARDS READ ARE AS FOLLOWS:

QUADRAT   SPECIES
 IDENT
  110     1110110000000001000000010100000000000
  111     1000110100000000000000000100011000010
  112     1010110000100000000000001100011000110
  113     1000010010000110010000000100011010100
  114     1001010010100000000000001100011000000
  115     1011000100000100000000011100011000000
  116     1011000000000000000000001100011000000
  117     1011000000110000000000001100011000100
  118     0010000000100000000000001100011000000
  119     1011000000100000000000001100011000100
  120     1011000001100000000000001100011000010
  121     1011000100010000000000011100011000100
  122     1011000101010010000000011100000000100
  123     1011000100000000000000011100011000000
  124     1010010010000000000000000100000000000
  125     1011010010100000000000001100000000100
  126     1000010010000001000000000100001000000
  127     1111010000000100000000011100011000000
  128     0010010010000000001000111100101000110
  129     0011000101000000000000001100011000000
  130     1011000000000000010000011100011000100
  131     0011000000100000100000001100111000100
  132     1010000001100000000000011100011000000
  133     1011000000000000000000011100011000000
  134     1011000000000000000000001100011000100
  135     1011000000000000000000011100001000000
  136     1011001100000000000000011100011000000
  137     1011001100000000000000011100011000000
  138     1111000100000000000000011100011000000
  139     1011000101100000000000011100011000100
  140     1011000011000000000000011100011000100
  141     1011000110100000000000011100011000100
  142     1010000010100000010000111000110111100
  143     1010010010000100000000000100011100000
  144     1011001001000000000000011100011000000
  145     1111000000100000000000011100111000100
  146     1111001000000000000100011100011000000
  147     1111000100000000000000011100001000000
  148     1011001101100000000000011100011000000
  149     1111001101100000000000011100011000000
  150     1011010111110000000000011100011000100
  151     1011110110000000000000000100011000000
  152     1011000111100000000000011100011000100
  153     1011000110110000000000001100011000100
  154     1011000101110000000000011100110000100
  155     1011000111110000000000011100011000100
  156     1011010110000000000000011100011000100
  157     1010010111000000000000011100011001100
  158     1000010000100100010000000100011010000
  159     0000110010000100011000010100011000001
  160     1011010110100110000100001100111000100
  161     1011001101001000000000011100011000000
  162     1010000011010000000000001100011000000
  163     1011000010000000000000011100101000010
  164     1010000010100000000000011100101000010
```

```
DATA CARDS READ ARE AS FOLLOWS:

QUADRAT  SPECIES
 IDENT
  165    1000110110100000000000000100000100000
  166    1011110110100000000000001100011000100
  167    1010010110000000000000000000001000000
  168    1111010111100100000000011100001000000
  169    1011010110100001000000011100011000100
  170    1000110010000100000000000100001000000
  171    0000100000000100000000000100001100000
  172    1000110010000100000000000100011100000
  173    1000110010000000000000000110001100000
  174    1010110000000101010000000100011100100
  175    1000110010100010001000001100011000000
  176    1011010110000100000000000100011000100
  177    1111010110000000000000011100011000000
  178    1111001101000000000001010100100000000
  179    1011100010100000000000011100001000000
  180    1000110010010100000000000100001000000
  181    1001110010000100000000000100001000000
  182    1011010010100100000000010100001010100
  183    1000110100000100000000000100000000000
  184    1000110000000100000000000100000100000
  185    1000110010000100000000000110011100000
  186    1000110010000100010000000100000110000
  187    1011110010000100000000000100011000000
  188    1000110010100100000000000110001000000
  189    1000110000000100000000000111011100000
  190    1000110010000101000000000100000000000
  191    1000100010000101000000000100011000000
  192    1111100110100000000000000100001000100
  193    1111000110100000000000111100011001100
  194    1111000110100000000000011100011000100
  195    1000110111000100001000000100011000101
  196    1000110010100101000000000110001001000
  197    1001110010000100000000000110001101000
  198    1000110010000100011000000100000100000
  199    1000110000000100011000000100001100000
  200    1011110010100000000000001100010000110
  201    1011000010000000000000001100011010000
  202    1011000110000100001000101100011000010
  203    1011010111010000000000001100011010110
  204    1011000101000000010000011100111000100
  205    1011000001100000000000011100100000100
  206    1011010110100000000000001100010000100
  207    1011010110000000000000001100001000000
  208    1001110010000000000000001110001000000
  209    1001110100000001000000000110001100000
  210    1010110000000000000000011000011000000
  211    1000100000000000010000101000011000100
  212    1101000000000000000000011100011000000
  213    1011000101100000000000011000000000100
  214    1011110100000000010000010000011000000
  215    1010100100100000000000011001010000000
  216    1010000001000000100000011000110001000
  217    1111100101100000000000011000010000100
  218    1111000100100000010000100000010010100
  219    1000110010000110001100010100011100000
```

```
DATA CARDS READ ARE AS FOLLOWS:

QUADRAT  SPECIES
 IDENT
  220    1100110110000000001000010000011100000
  221    1000110101000001100000011111011100000
  222    1001110000000000001000010111001000001
  223    1100110100000000001000010111011100001
  224    1001110010000000000000011000001000000
  225    1001110100000000001000010010011000100
  226    1000110000000000000000010000011000000
  227    1001110110100000000000010010001001000
  228    1111000111100000011000110000000001000
  229    1101110100000100001000010000011001000
  230    101011011*100100001000010001001001000
  231    1001110100100000001000010100011001000
  232    1000110000000000001000000010001100000
  233    1100110100000000001000010011011100000
  234    1100110100000000001000010000011100100
  235    1000110100000000001000010010011100000
  236    1000110000010000000000010000011100000
  237    1010110000000100001000010010011000000
  238    1000110100000100001000010011001000000
  239    1000110100000100001000010010011000000
  240    1000110100000100000000010010011100000
  241    1000110000001100011000000000011000000
  242    1010110000000100001000010010011100000
  243    1000110000000101001000000010001100000
  244    1000110100000101001000010010001100000
  245    1000110000000101000000010011001100000
  246    1001110000000100000000010010001100000
  247    1000110100001101000100010011001100000
  248    1000110110010101000000000000000000000
  249    1000110010000100000000010000011000000
  250    1001110010000100001000000000001101000
  251    1101110111000100011000010010011101000
  252    1001110100000100011000000011001101000
  253    1001110110000101011000000010001001000
  254    1011110000000100000000010010011011000
  255    1101110000000101001100010110001111000
  256    1000110000000101000000000011001101000
  257    1100110100000101000000000010001000000
  258    1000110100000101001000000011001101000
  259    1111110010000101000000000011001100000
  260    1011110110000000001000011000011001000
  261    1011000111000000010000011001111010000
  262    1011110000000100000000010010011001000
  263    1000110101000100000000010011011100000
  264    1100110100000101000000010010001100000
  265    1011110100000101000000000000011100000
  266    1000110100000000000000010110001101000
  267    0011110110100000001100010000001001100
  268    1011000110100000000000011010010000000
  269    1001110000000110000000010001001101000
  270    1010110000000000000000010011000000000
  271    1000110100000001001100010011000110000
  272    1000110000000000010100000010001000000
  273    1000110000000101011100000011001100000
  274    1100110000000101011100010010001101000
```

```
DATA CARDS READ ARE AS FOLLOWS:

QUADRAT  SPECIES
 IDENT
  275    1011110110000100111000011001011001000
  276    0011110010010000000000011001011000000
  277    1111110110010100000000011001111010000
  278    1011000100000000100010011000000000000
  279    1011000110010000100010011101010000000
  280    1011000010010100001010011001010001000
  281    1011110110010100001000010000011111000
  282    1001110000000101011100000110011000000
  283    1000110100000101011000000011001101000
  284    1010110100001101011100010010001111000
  285    1011110100001100011100010000001101000
```

APPENDIX 5·1

Data from quadrats at stations in zones 1 and 2

- wet and dry weights.
- sample sizes.
- plant numbers.

PREAMBLE TO APPENDIX 5.1

KEY TO READING DATA (Raw quadrat data.)

1. A fraction indicates the proportion of the quadrat sampled, e.g. x 1/5)
2. The figures in brackets are the fresh (wet) weight and dry weight respectively of the species in each quadrat.

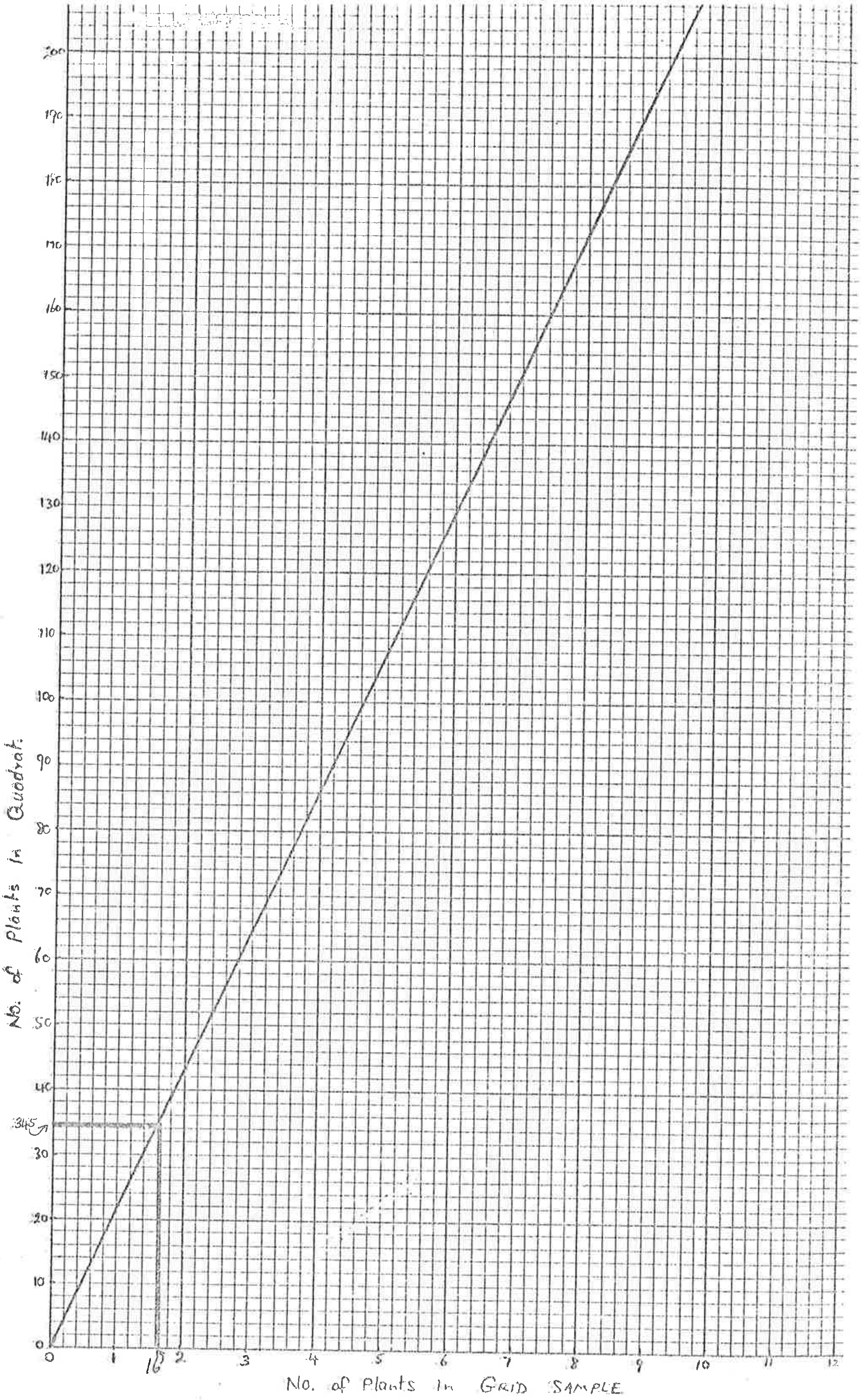
   e,g, (85.4/36.0) means the fresh weight per 3 sq.m. is 85.4 grm. and the dry weight is 36.0 grm/3 sq.m.
3. The number of plants in a sample is given the prefix "S" e.g. S17.
4. The number of plants in a quadrat is given the suffix "P" e.g. 38P.

   This is obtained in either of two ways (or both for comparison where time allowed). The first is based on actual counting, or the sample being visually a true representation of the quadrat total, and extrapolating accordingly. The second is based on a grid sampling device and was used when large numbers, and/or irregularly spaced, and/or very small plants occurred and/or there was obvious per-random variation in sizes of plants. A 300 mm. x 250 mm. metal rectangle was further divided into a large number of smaller rectangles that allowed for accurate counts to be made.

   In most cases that the grid was used, three samples were taken that gave as true a representation of the quadrat as possible. The average was obtained and by referring to the accompanying Table, the approximate number of plants was obtained.

   e,g, grid 26, 7, 15 16 345P means that 3 samples yielded 26, 7 and 15 plants respectively. The average of 16 was referred to the conversion graph and 345 plants was recorded for the quadrat (see graph).

NOTE: 5. Species 2 and 11 (*Helipterum spp.*) were indistinguishable for most of the visits, hence their occurring together in earlier visits, and separate later.


200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
345
30
20
10
0
No. of Plants in Quadrat
0
1
16
2
3
4
5
6
7
8
9
10
11
12
No. of Plants in GRID SAMPLE

A1

Species number	OPEN (Wet/Dry)	OPEN (Wet/Dry) 18/3/72	CLOSED (Wet/Dry) 16/4/72
1		(-/49.3gm) mostly *Erodium*	(-/31.6)
2		(-/4.4)	(-/.8)
3		1 plant. (-ve)	
4.		(2.2/1.2)	6 plants shooting only
5		1 plant (-ve)	
6		5 plants (green shoots only)	
7		(8.2/3.5) green-coloured	(5.2/2.3) red.
8		(25.0/5.7) green.	(1.3/6.8)
9		(2.5/1.1)	(2.3/1.3)
10		(-/13.0)	(-/2.0)
11			(-/.3)
12			
13			

A2

Species Number	OPEN (Wet/Dry) 18/3/72	OPEN (Wet/Dry) 16/4/72	CLOSED (Wet/Dry) 14/5/72
1	(-/19.3) mostly *Erodium*	(-/15.8)	(-/16.5) complete harvest.
2	(-/.35)	(-/.4)	-ve
3			
4.	(1.5/.7)	8 small plants (+ve)	14 shooting
5	1 plant (+ve)		
6	10 shooting	none shooting	3 shooting
7	(12.2/4.8)	(4.9/2.2)	(4.8/3.4) 22 plants. harvest.
8	(7.4/1.7) 2 live, 2 dead plants	(5.6/3.4)	(3.11/2.2) 1 live, 1 dead harvest.
9	(2.5/.8)	(2.7/1.6)	(1.6/1.0) 2 plants harvest.
10	(-/.9)	(-/.3)	(-/.6) harvest
11	(-/.7)	(-/.2)	(-/1.1) harvest.
12			
13			

A3

Species number	OPEN (wet/Dry) 16/4/72	OPEN (wet/Dry) 14/5/72	CLOSED (wet/Dry) 18/6/72
1	(—/42·6)	(—/44·4)	(—/8·2)
2	(—/1·0)	(—/·64)	(—/2·3)
3			
4	5 shooting (-ve)	5 shooting (-ve)	7 shooting (-ve)
5			
6			1 shooting (-ve)
7	(·03/·1)	(·2/·2) 3 plants	(·2/·1) 2 plants
8	(19·1/11·5)	(11·0/10·2) 3 plants	(7·9/7·3) 3 plants
9	(52·2/30·6)	(40·8/33·5) 21 plants	(32·9/24·0)
10	(—/1·3)	(—/·7)	(—/1·8)
11	(—/·4)	(—/·9)	(—/1·2)
12			
13			

A4

Species Number	OPEN (wet/Dry) 14/5/72	OPEN (wet/Dry) 18/6/72	CLOSED (wet/Dry) 27/7/72
1	(—/5·4)	(—/5·9)	(—/16·5) harvest
2	(—/·2)	+ve	+ve
3			
4	7 shooting (+ve)		+ve
5			many small 2-4 leaf stage. +ve
6			10 plants (+ve)
7	(·7/·4) 4 plants	(·3/·2)	
8	(5·9/2·8) 1 green 2 dry	(5·5/4·8)	(4·8/4·3) + many small 2-4 leaf stages; harvest
9	(12·2/9·0) 6 plants	(10·9/8·0)	(12·8/8·4)
10	(—/·5)	(—/·6)	+ve
11	(—/·8)	(—/·8)	+ve
12			
13			

As

Species number	OPEN (wet/Dry) 18/6/72	OPEN (wet/Dry) 22/7/72	CLOSED (wet/Dry) 19/8/72
1	(–/23.7)	(–/51.5)	(52.5/44.9) harvest
2	(–/.9)	+ve	
3		+ve 1 plant.	
4	(1.5/.6)	(1.5/.6)	(1.5/.6) harvest
5		+ve ∞ 2-4 leaf stages	(9.6/2.4)
6		(4.0/2.1) 15 plants	(7.9/4.4) harvest
7	(1.3/.7)	+ve 2 live, 1 dead.	
8	(4.1/3.6)	∞ 2-4 leaf stages + 3 old dead. (+ve)	
9	(16.8/12.3).	(11.2/5.8) 7 plants.	(23.7/12.0)' harvest.
10	(–/.3)	+ve	
11	(–/.8)	+ve.	
12			
13			

A6

Species Number	OPEN (wet/Dry) 22/7/72	OPEN (wet/Dry) 19/8/72	CLOSED (wet/Dry) 23/9/72
1	(–/13.6)	+ve	(4.0/4.0)
2			
3			
4			(.5/.40) 8 plants.
5	∞ 2-4 leaf stages (+ve)		
6	(.5/1.5) 15 plants shooting	(5.8/2.5)	(7.1/4.3) flowering 20 plants.
7	(2.9/.8) 13 plants	(1.6/.8)	(9.7/4.5) 15 plants.
8	(+ve) ∞ 2-4 leaf stages	+ve	
9			
10			
11			
12			
13			(.3/.2) 2 plants

⑬ a new grass (grey leaf)

A7

Species number	OPEN (Wet/Dry) 17/8/72	OPEN (Wet/Dry) 23/9/72	CLOSED (Wet/Dry) 28/10/72
1	(52·2/45·6)	(26·0/25·0)	x1) (15·2/14·5)
2			
3			
4	(31·8/16·8)	(19·0/15·0) 264 plants	x1) (14·3/8·7)
5			
6	(7·2/3·6)	(2·2/1·7) 17p. flowering.	x1) (1·3/1·1) 12p. (dead)
7		+ve	x1) (2·0/1·0)
8			
9			
10			
11		+ve	
12			
13			

∞ grasshoppers.

A8

Species Number	OPEN (Wet/Dry) 23/9/72	OPEN (Wet/Dry) 28/10/72	CLOSED (Wet/Dry) 18/12/72.
1	x1) (8·0/7·8)	x1) (6·4/6·2)	x1) (12·8/12·4) v. dry
2			
3			
4	(3·5/2·0)		x1) (·6/·5)
5	(9·8/4·8)		
6	(4·0/1·5) 13p. flowering		
7	+ve	(1·9/·9) 9 plants	x1) (1·1/·7) 8p.
8			
9	(22·5/12·8) 8p.	(25·7/9·0) 10p.	x1) (18·7/13·0) 8p.
10			
11			
12			
13			

∞ grasshoppers.

A9

Species number	OPEN (wet/Dry) 28/10/72	OPEN (wet/Dry) 18/12/72	CLOSED (wet/Dry) 3/2/73
1	(×½) (57·8/56·0)	(×1/5) (143·5/142·0) v dry	×1) (49·4/47·4)
2			
3			
4			
5			
6			
7			
8			
9	(177·5/58·0) 22p.	(170·8/106·8) 27p.	×1) (96·6/72·0)
10			
11			
12			
13			
	∞ grasshoppers.		v. dry.

A10

Species Number	OPEN (wet/Dry) 18/12/72	OPEN (wet/Dry) 3/2/73	CLOSED (wet/Dry) 3/3/73
1	+ve.		
2			
3			
4			
5			×1) (18·4/7·5) 311 p.
6			×1) (·88/·55) 4p.
7	1 plant.		×1) (·69/·18) 2p.
8			×1) (21·2/3·7) 81p.
9	(15·4/10·4) 10p.	(16·0/11·2) 10p.	×1) (49·2/27·3) 10p.
10			
11			
12			
13			
	v. dry.	v. dry.	>4" rain, but no grass — only *Erodium* + *Zygophyllum*.

A11

Species number	OPEN (wet/Dry) 3/2/73	OPEN (wet/Dry) 3/3/73	CLOSED (wet/Dry) 1/4/73
1			
2			
3			
4	+ve 1p.	+ve 1p.	x1) +ve 2p.
5		(6·3/2·6) 107p.	x1) (9·3/4·3) 167p.
6	+ve 1p.	+ve 1p.	x1) (·6/·4) 5p.
7	+ve 2p.	(5·0/·1) 4p	x1) (5·1/·1) 18p.
8		(16·8/2·9) 64p.	x1) (29·4/·4) 80p.
9	+ve 1p.	+ve 1p. (v green lush)	x1) (1·9/1·2) 2p.
10			
11			
12			
13			

v. dry

>4" rain but no grass.

A12

Species Number	OPEN (wet/Dry) 3/3/73	OPEN (wet/Dry) 1/4/73	CLOSED (wet/Dry) 25/4/73
1		+ve	+ve.
2			
3			
4	+ve 1p.	+ve 1p.	+ve 2p.
5	(11·2/4·6) 190p.	× 1/5) (25·5/13·5) 560p. ~~[illegible]~~	x1) (34·5/16·6) 514p.
6	+ve 2p	+ve 4p.	x1) (2·5/1·7) 4p
7	+ve 6p.	(2·8/1·2) 34^+p.	x1) (4·0/1·7) 49p.
8	(18·3/3·2) 70p.	x1/5) (73·0/11·0) 81p, S17,	x1) (188/29·0) 90p.
9	+ve 1p (spindly)	+ve 1p.	x1) (2·7/·9) 2p.
10			
11			
12			
13			

>4" rain.

A13

Species number	OPEN (wet/Dry) 1/4/73	OPEN (wet/Dry) 25/4/73	CLOSED (wet/Dry) 10/6/7
1	+ve	+ve	+ve.
2			
3			
4	+ve, 4p.	+ve 2p.	+ve
5	x1/5) (33.5/9.0) S65	(14.9/7.2) 222p.	x1) (66.0/33.1), 412p.
6		(1.8/1.3) 3p.	+ve
7	(2.5/1.0) 30p	(2.7/1.1) 33p	x1) (4.3/2.8) 42p.
8	x1/5) (77/10.2), 37p, S8	(57.5/9.4) 28p.	x1) ~~119~~(191.9/56.4) 34p
9	+ve 1p.		
10			
11			
12			
13			

A14

Species Number	OPEN (wet/Dry) 25/4/73	OPEN (wet/Dry) 10/6/73	CLOSED (wet/Dry) 8/7/73
1		+ve	+ve
2			x1/5) grid 5, 7, 28 ≈ 13 ⇒ 28 (26.0/9.0) S101
3			
4		+ve	
5	1/5) (34.5/14.5) S131	x1/5) grid 20, 20, 11 ≈ 17 ⇒ 360p. (51.0/25.0), S97	x1/5) grid 33, 34, 27 ≈ 31 ⇒ 1 (140/61), S149
6			
7		x1/5) (.9/.6) S6, 19p.	+ve 12p.
8	+ve 4p. (small)	+ve 5p.	
9		+ve.	
10			
11			included in $\boxed{2}$
12			
13			

A15

Species number	OPEN (Wet/Dry) 10/6/73	OPEN (Wet/Dry) 8/7/73	CLOSED (Wet/Dry) 5/8/73
1	+ve	+ve	+ve
2		(16·1/5·6) grid 14,5,6≈8→173p	(89·0/21·6) grid 44,31,5≈27.
3			
4	+ve		+ve (flowering)
5	×1/5) grid 13,14,36≈21→450p. (49/28) S100.	(82/36) grid 15,24,16≈18→3[illegible]p	×1/5) grid 24,27,15≈22→ (298/111·5) S123
6	+ve		+ve 3p
7	×1/5) (1·9/1·2) 37p	+ve 8p.	+ve 13p
8	×1/5) (34·0/10·0) S9, 48p.	×1/5) (55·5/10·8) S21, 24p.	×1) (62·6/12·0) 28p
9	(4·9/2·6) 6p.	+ve 3p.	+ve 12p
10			+ve
11		included in [2]	included in [2] (both flowering)
12			
13			

V. green all over.

A16

Species Number	OPEN (Wet/Dry) 8/7/73	OPEN (Wet/Dry) 5/8/73	CLOSED (Wet/Dry) 9/9/73
1	+ve.		
2	(18·1/6·3) grid 5,21,1≈9→194p.	grid 23,31,32≈25→ (82·6/20·0)	grid 12,22,28≈21→450p. (256/71)
3			
4		+ve 14p.	grid 1,4,4≈3→65p. (16·3/6·8)
5	grid 21,24,12≈19→407p. (86/32·4)	grid 32,14,24≈23→ (310/116·5)	grid 22,12,7≈14→300p. (187/48)
6			
7	+ve 6p.	+ve 1p.	
8		+ve	×1) (8·4/3·2)
9	(2·9/1·0) 1 large, 2 small p.	+ve 3p.	
10		+ve	
11	included in [2]	included in [2], both flowering	(224/62) grid 7,7,9≈8→172p.
12			
13			

Species number

A17	OPEN (wet/Dry) 5/8/73	OPEN (wet/Dry) 9/9/73	CLOSED (wet/Dry) 13/10/73
1			×1/5) (352/235·5)
2	grid 45, 21, 20 ≈ 29 → (96·0/23·2)	grid 9, 14, 4 ≈ 9 → 195 (111/30·8)	
3			
4	+ve 2p.	grid 0, 0, 1 ≈ ½ → 11p. (2·8/1·2)	×1) (14·5/7·5) 27p.
5	grid 9, 24, 24 ≈ 19 (95·6/96·1)	grid 15, 5, 11 ≈ 10 → 216p. (35/34·5)	
6	+ve 4p.		
7	+ve 5p		
8	+ve 9p.	+ve 14 small p.	×1) (98·1/23·2) 12p.
9	(20·0/3·9) 9p.		×1) (56·1/24·1) 118p.
10	+ve		×1) (6·9/2·7) 14p.
11	included in [2] both flowering.	grid 22, 19, 7 ≈ 16 → 342p (441/123).	
12			
13			

Species Number

A18	OPEN (wet/Dry) 9/9/73	OPEN (wet/Dry) 13/10/73	CLOSED (wet/Dry) 11/11/73
1		×½)(700/470)	×1/5) (–/570)
2	grid 7, 24, 12 ≈ 14 → 300p. (171/47·5)		
3			
4	grid 2, 3, 0 ≈ 2 → 43p. (10·8/4·5)	+ve.	×1/5) (67·5/28·5) S24, 116p.
5	grid 19, 28, 32 ≈ 26 → 580p. (368/92·8)		
6		+ve 5p.	
7			
8	(280/59) S8, 23p.	(301/81) 20p.	
9	+ve ∞p.	+ve ∞p.	×1/5) (307·5/119·0) S51, 255p.
10		(23/9) 5p.	
11	grid 10, 26, 9 ≈ 15 → 321p. (446/115)		
12			
13			

A19

Species number	OPEN (wet/Dry) 13/10/73	OPEN (wet/Dry) 11/11/73	CLOSED (wet/Dry) 18/12/73
1	$\times\frac{1}{5}$)(232/141)	$\times\frac{1}{5}$) (−/185.5)	$\times\frac{1}{3}$) (−/120)
2			
3			
4	+ve.	$\times\frac{1}{5}$)(10.5/4.5) S18, 51p	$\times 1$) (38.6/21.9), 65p,
5			
6			
7			
8	(149.9/44.5), 19p,		
9	+ve ∞p, v.small.	$\times\frac{1}{5}$)(240/100) S35, 175p.	$\times\frac{1}{3}$)(251.7/146.7)
10	(6.8/2.6), 13p		
11			
12			
13			

A20

Species Number	OPEN (wet/Dry) 11/11/73	OPEN (wet/Dry) 18/12/73	CLOSED (wet/Dry) 23/1/74
1	(−/190)	(−/40)	$\times\frac{1}{4}$) (−/172)
2			
3			
4	(12/5.2), 62p	(19/11) 27p.	$\times\frac{1}{13}$) (17.8/10.1)
5			
6			+ve
7			
8			
9	(240/100) approx.	(62.9/36.7)	$\times\frac{1}{4}$) (147/76) mostly dying off.
10			
11			
12			
13			

Species number		OPEN (wet/Dry) 18/12/73	OPEN (wet/Dsy) 23/1/74	CLOSED (wet/Dry) 3/3/74
A21	1	(–/120)	$\times\frac{1}{4}$) (–/170)	$\times\frac{1}{2}$) (–/76)
	2			
	3		+ve 3p.	
	4	(19/11) 71p.	$\times\frac{1}{6}$) (8·2/4·7)	$\times 1$) (48·2/26·4) 30p.
	5			
	6		+ve	
	7			
	8			
	9	(189/110)	$\times\frac{1}{6}$) (220/114) mostly dying off	$\times 1$) (136·0/13·6) ∞p.
	10			
	11			
	12			
	13			

Species Number		OPEN (wet/Dry)	OPEN (wet/Dry)	CLOSED (wet/Dry)
A22	1	(–/170)	(–/57)	$\times\frac{1}{3}$) +ve.
	2			
	3	+ve 3p.		
	4	$\times\frac{1}{6}$) (8·2/4·7)	$\times\frac{1}{4}$) (24·8/18·4) S9, 36p.	$\times\frac{1}{3}$) (68·1/46·2) S14, 42p.
	5			
	6	+ve		
	7			+ve 4p.
	8			
	9	$\times\frac{1}{6}$) (220/114)	(119/55·7)	$\frac{1}{3}$) (84·3/54·3) S24, 72p
	10			
	11			
	12			
	13			

Species number

		OPEN (wet/Dry) 3/3/74	OPEN (wet/Dry) 6/4/74	CLOSED (wet/Dry)
A23	1	x1) (–/27.4)	x$\frac{1}{3}$) (29.7/25.8)	
	2			
	3			
	4	x$\frac{1}{2}$) (3.7/2.9) S4, 10p	x$\frac{1}{3}$) (14.1/8.4), S7, 21p.	
	5			
	6			
	7			
	8			
	9	x1) (21.5/8.5)	+ve (dead)	
	10			
	11			
	12			
	13			

Species Number

		OPEN (wet/Dry)	OPEN (wet/Dry) 8/3/72	CLOSED (wet/Dry) 16/4/72
B1	1		(–/19.8)	(–/19.8)
	2		(–/1.1)	+ve
	3			
	4		(57.5/36.4)	(30.8/25.2)
	5			
	6			
	7			
	8		+ve 4 chrids dead.	
	9			
	10		+ve	(–/.7)
	11		(–/2.23)	(–/2.1)
	12			
	13			

	Species number	OPEN (wet/Dry) 18/3/72	OPEN (wet/Dry) 6/4/72	CLOSED (wet/Dry) 14/5/72
B2	1	(–/19·8)	(–/19·8)	(–/36·7)
	2	(–/1·1)	+ve	
	3			
	4	(57·5/36·4)	(30·8/25·2)	(21·5/10·6)
	5			
	6			
	7			
	8			
	9			
	10	+ve	(–/·7)	(–/·9) harvest
	11	(–/2·2)	(–/2·1)	(4·0) harvest
	12			
	13			

	Species Number	OPEN (wet/Dry) 16/4/72	OPEN (wet/Dry) 14/5/72	CLOSED (wet/Dry) 17/6/72
B3	1	(–/19·6)	(–/36·1)	(–/22·5)
	2	+ve	+ve	+ve
	3			
	4	(28·4/24·7)	(20·7/11·3)	(13/11)
	5			
	6			
	7			
	8	+ve	+ve	+ve (all dead & dry)
	9	+ve	+ve.	+ve (v. little still green)
	10	(–/·7)	(–/·9)	(–/3·3)
	11	(–/2·1)	(–/8·8)	(–/2·5)
	12			
	13			

	Species number	OPEN (wet/Dry) 14/5/72	OPEN (wet/Dry) 17/6/72	CLOSED (wet/Dry) 22/7/72
B4	1	(—/20·2)	(—/30·6)	(A)(42·8/38·0)
	2	+ve	+ve	
	3			
	4	(11·3/6·7)	?	(70·3/56·0)
	5	+ve (dead)	+ve (dead)	+ve ∞p, small.
	6			
	7			
	8	+ve (dead)	+ve (dead)	+ve ∞p, small 2-4 leaf.
	9	+ve 2 live	+ve 2 live	+ve 1 live, 1 dead
	10	+ve	(—/1·1)	+ve
	11	(—/2·8)	(—/2·0)	+ve
	12			
	13			

	Species Number	OPEN (wet/Dry) 17/6/72	OPEN (wet/Dry) 22/7/72	CLOSED (wet/Dry) 19/8/72
B5	1	(—/38·8)	(31·5/28·5)	(68·0/45·0)
	2	(—/1·1)	+ve	
	3			
	4	(81·9/76·5)	(107·5/86·5)	(162·5/101·5)
	5		+ve ∞p, 2-4 leaf stage	(·3/·1) flowered. ∞p all 4-6 leaf stage
	6		+ve 5p. shooting	(A)(·3/·1) 4p
	7			
	8	+ve (dead)	+ve ∞p, 2-4 leaf.	+ve. V. few, v small.
	9	+ve	+ve	+ve.
	10	(—/3·0)	+ve.	
	11	(—/1·1)	+ve.	
	12			
	13			

B6

Species number

	OPEN (Wet/Dry) 22/7/72	OPEN (Wet/Dry) 19/8/72	CLOSED (Wet/Dry) 23/9/72
1	(58.2/52.8)	(55.0/40.5)	(52.5/50.0)
2			
3			
4	(45.0/33.9)	(115.0/75.5)	(127.0/91.5)
5	+ve ∞, 2-4 leaf.		(12.5/.95)
6		(3.0/1.0)	+ve 2p
7			
8	+ve ∞, 2-4 leaf.		
9			+ve
10			
11			
12			
13			

B7

Species Number

	OPEN (Wet/Dry) 19/8/72	OPEN (Wet/Dry) 23/9/72	CLOSED (Wet/Dry) 28/10/72
1	(72.6/55.2)	(33.0/31.3)	+1/5)(52.0/50.0)
2			
3			
4	(136.8/89.4)	(96.5/69.0)	+1/5)(104/86.5)
5			
6			
7		+ve	
8			
9		+ve	+ve
10			
11			
12			
13			

grasshoppers

B8

Species number	OPEN (Wet/Dry) 23/9/72	OPEN (Wet/Dry) 28/10/72	CLOSED (Wet/Dry) 18/12/72
1	(57.0 / 54.0)	$\times\frac{1}{5}$) (44/42)	$\times\frac{1}{5}$)(39.5/39.5) v.dry
2			
3			
4	(103/76)	$\times\frac{1}{5}$) (88.5/71.5)	$\times\frac{1}{5}$)(69.5/60.0) S146
5			
6	(8.0/6.0)	+ve	
7	(5/.5)		
8			
9	+ve		
10			
11			
12			
13			
		grasshoppers	v. dry.

B9

Species Number	OPEN (Wet/Dry) 28/10/72	OPEN (Wet/Dry) 18/12/72	CLOSED (Wet/Dry) 3/2/73
1	$\times\frac{1}{5}$) (69.5/56.5)	$\times\frac{1}{5}$) (50.0/49.5) v.dry	$\times\frac{1}{3}$)(71.4/69.0)
2			
3			
4	$\times\frac{1}{5}$)(77.0/74.0)	$\times\frac{1}{5}$)(19.8/17.0) S98, 380p.	$\times\frac{1}{3}$) (37.0/32.5) S91, 248p.
5			
6			
7			
8			
9			
10			
11			
12			
13			
	grasshoppers	v. dry	v dry

Species number

B10	OPEN (wet/Dry) 18/12/72	OPEN (wet/Dry) 3/2/73	CLOSED (wet/Dry) 3/3/73
1	$\times\frac{1}{5}$)(74·5/74·5) v dry	$\times\frac{1}{5}$)(66·0/~~[illegible]~~ 65·0)	$\times\frac{1}{3}$) 13·5/12·3
2			
3			+ve
4	$\times\frac{1}{5}$)(28·7/24·8) S90, 337p.	$\times\frac{1}{5}$)(3·4/2·6) S19, 44p.	$\times\frac{1}{3}$)(9·9/6·6) S12, 43p.
5			$\times\frac{1}{3}$)(41·6/14·0) S86, 439p.
6	+ve 5p		+ve
7			+ve
8			$\times\frac{1}{3}$)(90/55·5), S26, 164p.
9	+ve 1p.		$\times$1) (1·8/·6) 1p.
10			
11			
12			
13			
	v.dry.	v.dry	>4" rain.

Species Number

B11	OPEN (wet/Dry) 3/2/73	OPEN (wet/Dry) 3/3/73	CLOSED (wet/Dry) 1/4/73
1	$\times\frac{1}{5}$) (96·0/94·5)	$\times\frac{1}{5}$) (13·5/12·3)	$\times\frac{1}{3}$) (15·0/14·1)
2			
3			
4	$\times\frac{1}{5}$) (2·8/1·9) S7.	(9·9/6·6) 42p.	$\times\frac{1}{3}$) (11·1/7·2) 26p.
5		(41·6/14·0)	Grid 10·5, 50, 41 ≈ 65 ⇒ 40p. (7·1/2·9)
6		+ve 5p.	
7		+ve	+ve 2p. small
8		(107/66) 195p.	$\times\frac{1}{3}$) (95·9/25·5) S72, 216p.
9		+ve.	
10			
11			
12			
13			
	v.dry.	>4" rain.	

Species number

		OPEN (wet/Dry) 3/3/73	OPEN (wet/Dry) 1/4/73	CLOSED (wet/Dry) 25/4/73
B12	1	$\times\frac{1}{5}$) (19·0/17·0)	$\times\frac{1}{5}$) (20·5/19·5)	$\times\frac{1}{2}$ (12·4/11·6)
	2			
	3			
	4	$\times\frac{1}{5}$) (2·7/1·4) S11, 34p.	$\times\frac{1}{5}$)(1·3/·1), S26, 22p	$\times 1$) (6·2/3·2) 62p
	5	(41·6/14·0)	$\times\frac{1}{5}$) (18·5/7·5), S23, 365p	$\times\frac{1}{4}$) (29·1/12·4), S106, 424p.
	6	+ve		
	7	+ve	+ve 1p, small	
	8	$\times\frac{1}{5}$) (56·6/7·3) S62, 252p.	$\times\frac{1}{5}$) (19·2/25·5) S48, 228p.	$\times\frac{1}{2}$) (17·3/26·0) S135, 220p.
	9	+ve		
	10			
	11			
	12			
	13			

>4" rain

Species Number

		OPEN (wet/Dry) 1/4/73	OPEN (wet/Dry) 25/4/73	CLOSED (wet/Dry) 10/6/73
B13	1	$\times\frac{1}{5}$) (36·0/33·5)	(36/28) ?	$\times 1$) (35·6/25·2)
	2			
	3			
	4	$\times\frac{1}{5}$) (2·0/1·0) S18, 46p.	$\times 1$) (3·3/1·9) 34p	$\times 1$) (3·9/2·2) 138p.
	5	grid 44, 42, 52 ≈ 46p (5·0/2·0) 99p.	(4·2/1·9)	$\times 1$) (3·5/1·8) 61p.
	6			
	7	+ve 2p.	+ve	$\times 1$) (·43/·20) 7p.
	8	$\times\frac{1}{5}$) (16·9/22·3), S76, 265p.	$\times\frac{1}{2}$) (74·0/45·2) S55, 117p.	$\times 1$) (19·0/5·2) 44p
	9			
	10			
	11			
	12			
	13			

B14

Species number	OPEN (wet/Dry) 25/4/73	OPEN (wet/Dry) 10/6/73	CLOSED (wet/Dry) 8/7/73
1	+ve	×1) (35·6/25·2)	+ve
2			×1) (18·1/5·7), 65p.
3			
4	×1/5) (1·2/·7) S5, 7p.	(4·6/2·6), 163p	+ve. 5p. v. small
5	×1/5) (3·3/1·9) S43, 264p.	×1/5) (3·5/1·9) S32, 75p	×1) (9·9/5·2) 57p
6			
7		+ve 6p.	+ve 11p.
8	×1/5) (20·5/2·8), S22, 112p.	×1/5) (69·0/18·1) S31, 79p.	×1) (150·6/26·7) 92p
9			
10			
11			included in [2]
12			
13			

B15

Species Number	OPEN (wet/Dry) 10/6/73	OPEN (wet/Dry) 8/7/73	CLOSED (wet/Dry) 5/8/73
1	×1) (35·6/25·2)	+ve	+ve
2		grid 10, 5, 1 ≃5 ⇒ 109p. (30·5/9·5)	×1/5) grid 7, 0, 7 ≃5 ⇒ (16·5/14·0) S29.
3			
4	(4·2/2·3) 147p	+ve 5p v. small	grid ≃55 ⇒ 1180p (208·6/76·8) S44
5	×1/5) (9·0/9·9), S23, 102p.	grid 12, 20, 5 ≃12 ⇒ 260p. (45·2/23·7)	×1/5) grid 32, 12, 63, 17 ⇒ (113·0/82·5) S67
6		+ve 5p	×1) (12·6/7·0) 13p.
7	(·4/·2) 7p.	+ve 6p.	×1) (·6/·2) 10p
8	×1/5) (156/38·5), S50, 138p.	(254/44·7) 154p.	×1/5) (477·8/83·0) S87, 161p
9			
10			+ve.
11		included in [2].	included in [2] both flowering.
12			
13			

B16	OPEN (Wet/Dry) 8/7/73	OPEN (Wet/Dry) 5/8/73	CLOSED (Wet/Dry) 9/9/73
1	+ve	+ve	
2	grid 1,1,2≈1.3 ⇒ 29p. (8.2/2.5)	grid 1,3,3,≈2 ⇒ 43p. (6.6/1.6)	grid 3,4,5≈4 ⇒ 86p. (32.3/10.8)
3			
4	+ve ∞p.	grid 49,58,44≈50, (190/87.8)	grid 48,40,35≈41 ⇒ 881p. (136/72.2)
5	grid 21,24,11≈15 ⇒ 330p. (57.3/30.0)	grid 24,22,14≈20 (164.2/44.6)	grid 19,24,6≈19 ⇒ 408p. (300/95.5)
6		+ve.	
7	+ve 9p.	+ve 14p.	
8	(100/17.7) 61p.	(198/34.3) 72p.	(212.3/47.4) 55p.
9			
10		+ve	(15.1/3.7) 5p.
11	included in [2]	included w[2] both flowering.	+ve
12			
13			

Species number

B17	OPEN (Wet/Dry) 5/8/73	OPEN (Wet/Dry) 9/9/73	CLOSED (Wet/Dry) 13/10/73
1			×1/5) (119/95)
2	grid 8,14,5≈9 (29.7/7.2)	grid 10,9,4≈8 ⇒ 172p. (64.5/24.5)	
3			
4	grid 47,42,27≈39 (148/65.7)	grid 25,30,21≈25 ⇒ 540p. (83/44.3)	×1/5) (175.0/91.5) Siss, 449p.
5	grid 23,53,41≈39 (259/74.6)	grid 16,9,19≈15 ⇒ 321p. (236/74.8)	
6			
7	+ve 5p.		
8	(296/46.7) 98p.	(333/74) 86p.	×1) (114/38.8) 63p
9	+ve 1p.		
10	+ve	(33.2/8.1) 11p.	×1) (1.3/.4) 3p.
11	included in [2] both flowering	+ve grid 2,1,0≈1	
12			
13			×1) (153.8/64.5) 17p Gnephosis acrocarpha

Species Number

B18	Species number	OPEN (wet/Dry) 9/9/73	OPEN (wet/Dry) 13/10/73	CLOSED (wet/Dry) 1/11/73
	1		(120/100)	×1/5) (–/76)
	2	grid 8,4,225 → 108p. (40.5/13.5)		
	3			
	4	grid 26,7,15≈16 → 342p. (52.5/28)	(75/39.2) 332p	×1/5) 400/240.5 , S154
	5	grid 13,21,15≈16 → 342p. (252/79.9)		
	6			
	7			
	8	(286/63.6) 74p.	(121/44.3) 67p	
	9		tue 3p	×1) (40.2/1.2) 3p.
	10	(33.2/8.1), 11p.	(3.6/1.1) 8p.	
	11	tue		
	12			
	13		(118/49.3) 13p.	×1) (132.7/60.9) 13p.

Gnephosis sciorophora

B19	Species Number	OPEN (wet/Dry) 3/10/73	OPEN (wet/Dry) 11/11/73	CLOSED (wet/Dry) 18/12/73
	1	×1/5) (374/220.5)	(–/76) ?	(–/129.4)
	2			
	3			
	4	(81/42) 36p.	(400/241) ?	(166.9/120.8)
	5			
	6			
	7			
	8	(74/25.2) 41p.		
	9		(12.6/3.6) 9p.	tue 3p.
	10	(2.7/.8) 2p.		
	11			
	12			
	13	(54.4/22.7) 6p.	(23/12.1) 3p.	

Gnephosis sciorophora

B20

Species number	OPEN (Wet/Dry) 11/11/23	OPEN (Wet/Dry) 18/12/23	CLOSED (Wet/Dry) 23/1/24
1	(–/76)	×$\frac{1}{5}$) (–/103.5)	(–/150)
2			
3			
4	(400/241)	×$\frac{1}{5}$) (222.5/161) S216	grid 42, 39, ≃41 (592/422)
5			
6			
7			
8			
9			
10			
11			
12			
13	(26/24) 6p.		

↖ Gnephosis scirrophora

B21

Species Number	OPEN (Wet/Dry)	OPEN (Wet/Dry)	CLOSED (Wet/Dry)
1	×$\frac{1}{5}$) (–/103.5)	×$\frac{1}{10}$) (–/151)	×$\frac{1}{5}$) (–/204.5)
2			
3			
4	×$\frac{1}{5}$) (222.5/161)	×$\frac{1}{10}$) grid 27, 31, ≃29 (419/298) S114	×$\frac{1}{5}$) (192.5/156.5) S109
5			
6			
7			
8			
9			
10			
11			
12			
13			

		OPEN (Wet/Dry) 23/1/74	OPEN (Wet/Dry) 3/3/74	CLOSED (Wet/Dry) 6/4/74
B22	1	(—/150)	$\times\frac{1}{5}$) (—/263.5)	$\times\frac{1}{5}$) (102.5/99.5)
	2			
	3			
	4	(590/420)	$\times\frac{1}{5}$) (48.0/46.5) S97,	$\times\frac{1}{5}$) (234.5/133.5), S100
	5			
	6			
Species number	7			
	8			
	9			
	10			
	11			
	12			
	13			

		OPEN (Wet/Dry) 3/3/74	OPEN (Wet/Dry) 6/4/74	CLOSED (Wet/Dry)
B23	1	$\times\frac{1}{5}$) (—/176.5)	$\times\frac{1}{5}$) (207/163)	
	2			
	3			
	4	$\times\frac{1}{5}$) (120.5/97.0) S43	$\times\frac{1}{5}$) (418/267.5) S147	
	5			
	6			
	7			
Species Number	8			
	9			
	10			
	11			
	12			
	13			

	Species number	OPEN (wet/Dry)	OPEN (wet/Dry) 14/5/72	CLOSED (wet/Dry) 17/6/72
C_3	1		(–/193·1)	(–/102·2)
	2		(–/15·5)	(–/4·1)
	3			
	4		(4·5/2·3)	(13·4/12·2)
	5			
	6			
	7			
	8			
	9			
	10		(–/·6)	(–/·6)
	11		(–/1·3)	(–/1·3)
	12			
	13			

	Species Number	OPEN (wet/Dry) 14/5/72	OPEN (wet/Dry) 17/6/72	CLOSED (wet/Dry) 22/7/72
C_4	1	(–/92·9)	(–/91·8)	(93·8/85·0) harvest
	2	(–/7·3)	(–/2·1)	+ve
	3			
	4	(2·2/1·2)	(11·3/10·3)	(33·8/29·5) harvest
	5			+ve sp 2-4 leaf.
	6			+ve 1 p.
	7			
	8			+ve sp. 2-4 leaf
	9			
	10	(–/3·1)	(–/3·0)	+ve
	11	(–/·4)	(–/3·3)	+ve
	12			
	13			

	Species number	OPEN (wet/Dry) 17/6/72	OPEN (wet/Dry) 22/7/72	CLOSED (wet/Dry) 19/8/72
C5	1	(–/67.5)	(93.0/89.0)	(145.8/124.8)
	2	(–/2.2)	+ve	
	3			
	4	(43.4/40.6)	(33.8/29.5)	(81.6/49.2)
	5		+ve ∞p. 2-4-leaf	(15.0/4.8)
	6		+ve. 1p.	(.4/.1), 2p. harvest
	7		+ve 2p.	
	8	+ve 1 dead p.	+ve ∞p. 2-4-leaf	
	9	+ve	+ve	(1.6/.5), 6p. harvest
	10	+ve	+ve	
	11	(–/.6)	+ve	
	12			
	13			

	Species Number	OPEN (wet/Dry) 22/7/72	OPEN (wet/Dry) 19/8/72	CLOSED (wet/Dry) 23/9/72
C6	1	(75.0/71.0)	(120.0/100.8)	(29/28)
	2			
	3			
	4	(30.1/21.5)	(42.2/30.0)	(90/60) 534p.
	5	+ve ∞p. 2-4-leaf	(13.2/3.6) ∞ 4-6-leaf	
	6	+ve 2p.	(1.2/.6) 1p.	+ve 3p.
	7	+ve 4p.		+ve 2p.
	8	+ve ∞ 2-4-leaf		
	9	+ve	(1.2/.2)	(1.6/.65) 4p.
	10			
	11			(1.2/.55)
	12			
	13			

C7

Species number

	OPEN (wet/Dry) 17/8/72	OPEN (wet/Dry) 23/9/72	CLOSED (wet/Dry) 28/10/72
1	(68.4/58.2)	(59.5/56.5)	×1) (74.8/72.2)
2			
3			
4	(44.4/27.6)	(71.3/48.0) 483p.	×1) (17.8/13.9)
5			
6			
7		(3.0/1.5) 63p.	
8			
9			
10			
11			
12			
13			

grasshoppers.

C8

Species Number

	OPEN (wet/Dry) 23/9/72	OPEN (wet/Dry) 28/10/72	CLOSED (wet/Dry) 18/12/72
1	(87.5/83.0)	×1/5) (134/131.5)	×1/5) (128.7/128.7) v. dry
2			
3			
4	(55.5/39.0) 583p.	×1/5) (28.0/21.5)	×1/5) (21.0/18.5), 593, 379p.
5			
6	×1/5) (3.8/2.0) 517, 37p.	indistinguishable from 4.	
7			
8			
9	tue 2p.		
10			
11			
12			
13			

grasshoppers.

	Species number	OPEN (wet/Dry) 28/10/72	OPEN (wet/Dry) 18/12/72	CLOSED (wet/Dry) 3/2/73
C9	1	$\times\frac{1}{5}$)(166.5/163.5)	$\times\frac{1}{5}$)(82.5/82.5) v. dry	$\times\frac{1}{2}$) (75.4/74.0)
	2			
	3			
	4	$\times\frac{1}{5}$) (22.5/17.5) S71, 264p.	$\times\frac{1}{5}$) (3.8/3.8) S42, 230p.	$\times\frac{1}{2}$) (5.0/4.6) S29, 35p
	5			
	6	indistinguishable from 4.		
	7	+ve	+ve	
	8			
	9			
	10			
	11			
	12			
	13			

grasshoppers.

v. dry

	Species Number	OPEN (wet/Dry) 18/12/72	OPEN (wet/Dry) 3/2/72	CLOSED (wet/Dry) 3/3/72
C10	1	$\times\frac{1}{5}$)(183.0/182.5) v. dry.	$\times\frac{1}{4}$)(84/82.4)	$\times\frac{1}{4}$)(30.0/26.8)
	2			
	3			
	4	$\times\frac{1}{5}$)(1.4/1.4), S24, 142p.	+ve 15p	$\times1$) (3.8/2.0), 39p.
	5			$\times\frac{1}{4}$) (32.4/12.8), S146
	6			
	7	+ve 10p. (v. poor)	(1.6/.9) 12p.	$\times1$) (5.9/1.8) 8p.
	8			$\times\frac{1}{4}$)(24.0/3.0), S24, 81p.
	9			
	10			
	11			
	12			
	13			

v. dry

Species number

		OPEN (wet/Dry) 3/2/73	OPEN (wet/Dry) 3/3/73	CLOSED (wet/Dry) 1/4/73
C11	1	×1/3) (53.7/52.8)	×1/6) (25.8/23.4)	×1) (20.7/19.9)
	2			
	3			
	4	+ve 1p.	+ve 1p	*1) (.4/.3) 6p. gall 77, 46, 19 ≈ 47 → 1100p.
	5			(15.8/7.1) , 519,
	6			
	7			+ve
	8		+ve 6p.	×1) (2.6/.3) 18p.
	9			+ve 1p.
	10			
	11			
	12			
	13			

v. dry

Species Number

		OPEN (wet/Dry) 3/3/73	OPEN (wet/Dry) 1/4/73	CLOSED (wet/Dry) 25/4/73
C12	1	+ve		
	2			
	3			
	4			
	5	+ve 6p.	+ve 2p.	+ve. 4p + ∞ 2-leaf stage.
	6			+ve. ∞, v. small.
	7			
	8			
	9			
	10			
	11			
	12			
	13			

C13

Species number	OPEN (Wet/Dry) 1/4/73	OPEN (Wet/Dry) 25/4/73	CLOSED (Wet/Dry) 10/6/73
1	$\times\frac{1}{5}$) (5.0/5.0)		$\times 1$) (41.4/16.6)
2			
3			
4	$\times\frac{1}{2}$) (.8/.3) S24, 14p.	+ve 4p.	+ve.
5	$\times\frac{1}{5}$) grid 33,74,103 ≈ 70 → 1515p (23.5/10.5), S120	$\times\frac{1}{5}$) grid 44,71,76 ≈ 64 → 1380p (57.5/24.5) S151	+ve.
6	$\times\frac{1}{2}$) (1.5/1.2) S4, 9p.	$\times\frac{1}{3}$) (1.6/1.2). S4, 10p.	$\times 1$) (5.0/3.5), 7p.
7	(4.4/3.1) 18p.	+ve 23p.	$\times 1$) (1.6/.8) 27p.
8	$\times\frac{1}{5}$) (167.5/19.0) S30, 130p.	$\times\frac{1}{7}$) (352.8/29.6) S17, 122p.	$\times 1$) (112.0/40.9) 77p.
9	+ve 1p.	+ve 1p.	(2.4/1.3) 1p.
10			
11			
12			
13			

C14

Species Number	OPEN (Wet/Dry) 25/4/73	OPEN (Wet/Dry) 10/6/73	CLOSED (Wet/Dry) 8/7/73
1	+ve.	+ve	+ve
2			$\times\frac{1}{5}$) grid 7,2,5 ≈ 2.7 (14.0/4.5) S56
3			
4		+ve	$\times 1$) (9.9/4.5) 198p.
5	$\times\frac{1}{5}$) grid 72,95,77 ≈ 81. (82.5/38.0) S235	$\times\frac{1}{5}$) grid 63,76,69 ≈ 69. (200.5/98.0) S350	$\times\frac{1}{5}$) grid 86,66,77 ≈ 76 (196/88) S259
6	+ve		
7		(.6/.2) 11p.	
8	(9.0/1.5) 5p.	(5.8/2.1) 4p.	$\times 1$) (1.6/.3) 1p.
9	+ve 1p.		
10			
11			included in [2]
12			
13			

Species number

		OPEN (Wet/Dry) 10/6/73	OPEN (Wet/Dry) 8/7/73	CLOSED (Wet/Dry) 5/8/73
C15	1	+ve	+ve.	
	2		grid 14, 42, 21 ≃ 26 → 56p. (135/43.4)	grid 130, 63, 79 ≃ 91 → 2000p. (300/73)
	3			
	4	+ve	(9.7/4.41), 178p.	(13.1/6.1) grid 8, 10, 2≃72 150p
	5	$\times\frac{1}{5}$) grid 59, 67, 66 ≃ 64. (53.5/26.5) S16,	grid 17, 38, 28 ≃ 28. (72/32.4)	$\times\frac{1}{5}$) grid 42, 42, 25 ≃ 36. (283.5/85.5)
	6		(38.1/22.5), S6, 20p.	×1) (23.0/10.7)
	7	(2.5/.8), S14, 49p.	+ve	+ve 2p.
	8	(252/45) S7, 64p.	(355/60), S12, 52p	$\times\frac{1}{5}$)(560/86) S13, 265p
	9			
	10			+ve.
	11		included in [2]	included in [2]. both flowering
	12			
	13			

Species Number

		OPEN (Wet/Dry) 8/7/73	OPEN (Wet/Dry) 5/8/73	CLOSED (Wet/Dry) 9/9/73
C16	1	+ve.		
	2	(62/20) grid 14, 10, 13 ≃ 12	grid 18, 17, 28 ≃ 21 (69.3/16.8)	grid 10, 22, 36 ≃ 23 → 495p. (282 ~~455~~/78.1)
	3			
	4	(2.8/5.8) 256p.	(4.1/1.9) 47p.	grid 15, 41, 26 ≃ 27 → 580p. (14.5/6.1)
	5	grid 41, 49, 76 ≃ 55. (142/63.6)	grid 49, 44, 49 ≃ 47. (372/112)	grid 70, 40, 40 ≃ 50 → 1080p (675/173)
	6			
	7	+ve 4p.	+ve 6p	
	8	(136/23.2) 20p.	(181/27.8) 21p.	(58.5/10.9), 11p.
	9	+ve 1p, small		
	10		+ve.	
	11	included in [2]	included in [2]	grid 0, 4, 2 ≃ 2 → 43p (56/15.5)
	12			
	13			

C17

Species number

	OPEN (wet/Dry) 5/8/73	OPEN (wet/Dry) 9/9/73	CLOSED (wet/Dry) 13/10/73
1			×$\frac{1}{5}$) (230/182.5)
2	grid 6,32,15 ≈18 (59.4/14.4)	grid 3,4,5 ≈ 4 → 86p. (48.9/13.6)	
3			
4	(6.6/3.1) 76p	grid 15,6,5 ≈ 9 → 195p. (48.8/20.5)	×$\frac{1}{5}$) (78/40) S70, 254p
5	grid 61,63,47 ≈ 57 (450/136)	grid 35, 44, 21 ≈ 33 → 708p. 442/113)	
6	(16.7/7.8) 21p		
7	+ve 3p.		
8	(17.2/2.6) 2p	+ve 1p	+ve 1p
9	+ve 4p	+ve 4p.	×1) (24.2/9.7) 4p.
10	+ve		(1.3/.4) 3p
11	included in $\boxed{2}$	grid 9,5,9 ≈ 8 → 172 (224/162).	
12			
13			

C18

Species Number

	OPEN (wet/Dry) 9/9/73	OPEN (wet/Dry) 13/10/73	CLOSED (wet/Dry) 1/11/73
1		×$\frac{1}{5}$) (230/180)	×$\frac{1}{5}$) (198.5/39.7)
2	grid 17,60,32 ≈ 36 → 760p. (432/120)		
3			
4	grid 5, 2, 18 ≈ 8 → 172p. (43/18.1)	×$\frac{1}{5}$) (80/40)	×$\frac{1}{5}$) (207.5/113.0) S134
5	grid 20, 19, 32 ≈ 24 → 529p. (325/83.3)		
6		+ve 1p.	
7			
8		+ve 3p.	
9		(39.4/17.6) 6p.	×1) (81.2/24.7) 26p.
10		(1.8/.5) 4p	
11	grid 2,5,6 ≈ 4 → 86p. (112/30.9)		
12			
13			

C19

Species number

	OPEN (Wet/Dry) $^{13/10/73}$	OPEN (Wet/Dry) $^{11/11/73}$	CLOSED (Wet/Dry) $^{18/12/73}$
1	$\times\frac{1}{5}$) 230/180.	$\times\frac{1}{5}$ (–/116.5)	$\times\frac{1}{5}$) (–/63.5)
2			
3			
4	(65.7/33.6), 213p	$\times\frac{1}{5}$) (117.5/65.0)	$\times\frac{1}{5}$) (89/53), 584
5			
6	+ve 2p.		
7			
8	+ve 1p.		
9		+ve 6p.	+ve 2p
10	(3.6/1.1) 8p.		
11			
12			
13	+ve 1p.		

C20

Species Number

	OPEN (Wet/Dry) $^{11/11/73}$	OPEN (Wet/Dry) $^{18/12/73}$	CLOSED (Wet/Dry) $^{23/1/74}$
1	$\times\frac{1}{5}$) (–/200)	$\times\frac{1}{5}$) (–/29.0)	$\times\frac{1}{10}$ (/–14.3)
2			
3			
4	$\times\frac{1}{5}$) (208/810)	$\times\frac{1}{5}$) (104.5/62.0) 52p	$\times\frac{1}{5}$) (170/110) 570
5			
6			
7			
8			
9		+ve 16p, v.small.	
10			
11			
12			
13			

o. grasshoppers.

	Species number	OPEN (wet/Dry) 18/12/73	OPEN (wet/Dry) 23/1/74	CLOSED (wet/Dry) 3/3/74
C21	1	×1/5)(−/29.0)	(−/140)	×1/5) (−/120)
	2			
	3			
	4	×1/5) (104.5/62.0) S52	(200/134)	×1/5)(164.5/128.5) S48.
	5			
	6			
	7			
	8			
	9	tre, 16 v. small p.		
	10			
	11			
	12			
	13			

∞ grasshoppers

	Species Number	OPEN (wet/Dry) 23/1/74	OPEN (wet/Dry) 3/3/74	CLOSED (wet/Dry) 6/4/74
C22	1	(−/140)	×1/5)(−/165)	×1/5)(374/95)
	2			
	3			
	4	(200/134)	×1/5) (166/124.5) 54p.	×1/5)(129/68.7) 34p.
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			

C23

Species number

	OPEN (wet/Dry) 3/3/74	OPEN (wet/Dry) 6/4/74	CLOSED (wet/Dry)
1	$\times\frac{1}{5}$) (—/61·0)	$\times\frac{1}{5}$) (264/28·5)	
2			
3			
4	$\times\frac{1}{5}$) (169/165·5), S54	$\times\frac{1}{5}$) (117/72·5), S33	
5			
6			
7			
8			
9			
10			
11			
12			
13			

D5

Species Number

	OPEN (wet/Dry)	OPEN (wet/Dry) 22/7/72	CLOSED (wet/Dry) 19/8/72.
1		(60·5/57·0)	(97·2/88·2)
2			
3			
4		(46·0/29·5), 247p.	$\times\frac{1}{6}$) (45·0/34·2) S46, 253p.
5		∞ 2-4 leaf., +ve	
6		(3·7/2·2). 37p	$\times\frac{1}{6}$) (6·2/6·0) S9, 153p.
7		(1·6/·3) ,. 6p	+ve 7p.
8		+ve ∞ 2-4 leaf.	
9			+ve 6p., small.
10			
11			
12			
13			

D6 Species number	OPEN (Wet/Dry) 22/7/72	OPEN (Wet/Dry) 19/8/72	CLOSED (Wet/Dry) 23/9/72
1	(63.5/60.0)	(24.0/21.0)	(15.6/15.0)
2			
3			
4	(44.5/31.5), 233p	(61.5/39.5) S54, 170p.	(76.5/52.8), 266p
5	tue ∞ 2-4-leaf		
6	(4.0/2.5) 48p.	(25.5/17.5), S4, 50p.	(17.1/14.4), 47p.
7			tue 1p.
8	tue ; ∞ 2-4-leaf.		
9	(1.0/.3) ; 1p	tue. 2p.	(2.2/.9)' 3p.
10			
11			
12			
13			

∞ grasshoppers.

D7 Species Number	OPEN (Wet/Dry) 19/8/72	OPEN (Wet/Dry) 23/9/72	CLOSED (Wet/Dry) 28/10/72
1	(4.5/3.5)	(45.5/45.0)	×$\frac{1}{5}$) (53.5/52.5)
2			
3			
4	(79.0/51.5) S57, 284p.	(52.0/36.5), 257p.	×$\frac{1}{5}$) (34.0/26.5)
5			
6	(3.9/2.4) S8, 66p.	(1.5/1.0) 32p.	indistingt. from $\boxed{4}$.
7			
8			
9			
10			
11			
12			
13			
		grasshoppers	grasshoppers

Species number

D8	OPEN (wet/Dry) 23/9/72	OPEN (wet/Dry) 28/10/72	CLOSED (wet/Dry) 18/12/72
1	(11.0/11.0)	$\times\frac{1}{3}$)(68.4/67.5)	×1) (27.0/27.0)
2			
3			
4	$\times\frac{1}{5}$)(28.9 / 21.3) ? S81 198p.	(38.1/31.2) 144p.	×1) 26.1/26.1) 177p.
5			
6	$\times\frac{1}{5}$)(.9/.7) S10 17p.	indistinguishable from 4	
7			
8			
9	fue 1p.	fue 1p(sickly)	
10			
11			
12			
13			

grasshoppers grasshoppers v. dry.

Species Number

D9	OPEN (wet/Dry) 28/10/72	OPEN (wet/Dry) 18/12/72	CLOSED (wet/Dry)
1	$\times\frac{1}{5}$) (28.0/27.5)	$\times\frac{1}{5}$) (52.5/51.5)	×1) (3.0/2.9)
2			
3			
4	$\times\frac{1}{5}$) (12.5/9.5) S28 127p.	$\times\frac{1}{3}$)(28.0/23.5) S24, 106p.	×1) (12.4/10.1), 65p.
5			
6	indistinguishable from 4		
7	fue 1p.	fue 1p.	
8			
9			
10			
11			
12			
13			

grasshoppers v. dry

	Species number	OPEN (wet/Dry) 18/12/72	OPEN (wet/Dry) 3/2/73	CLOSED (wet/Dry) 3/3/73
D10	1	—	×1) (3.0/2.9)	–
	2			
	3			
	4	(10.4/8.2) 40p.	(3.1/2.5) 17p.	×1) (11.9/7.2) 34p.
	5			×1) (9.6/4.6) 141p.
	6			×1) (6.8/6.2) 18p.
	7	(2.9/1.4) 7p.	fine 1p.	×1) (.95/.33) 9p.
	8			×1) (9.6/1.4) 31p.
	9			
	10			
	11			
	12			
	13			
		v dry	v. dry	

	Species Number	OPEN (wet/Dry) 3/2/73	OPEN (wet/Dry) 3/3/73	CLOSED (wet/Dry) 1/4/73
D11	1	$\times\frac{1}{5}$) (19.5/12.0)	fine	fine
	2			
	3			
	4	$\times\frac{1}{5}$) (12.4/18.8)? S18, 32p.	(14.4/8.7) 41p.	×1) (18.2/12.8) 82p.
	5		grill 7, 16, 31×18 → 395p. (20.8/10.0)	$\times\frac{1}{5}$)(16.0/7.5) S62, 248p.
	6		(1.5/1.4) 4p.	×1) (1.3/1.0) 10p.
	7		(.3/.01) 3p.	×1) (1.8/.7) 5p.
	8		(39.8/6.1) 134p.	×1) (70.2/21.2) 117p.
	9		fine 1p.	
	10			
	11			
	12			
	13			

v. dry
(collected in the rain)

		OPEN (Wet/Dry) 3/3/73	OPEN (Wet/Dry) 1/4/73	CLOSED (Wet/Dry) 25/4/73
D12	1		tne.	
	2			
	3			
	4	(4·6/2·88) , 13p	$\times\frac{1}{3}$) 2·7/1·8) S5, 15p.	$\times 1$) (3·0/1·7) 3p
	5	grid 37, 36, 19 ≈ 31 ⇒ 665p (35·9/17·2)	$\times\frac{1}{5}$) (18·5/7·5) S97, 273p.	$\times\frac{1}{3}$) (39·9/18·6) S128 313p.
Species number	6	(2·3/2·1) 5p.	$\times\frac{1}{2}$) (3·0/2·0) S5, 9p.	$\times 1$) (8·2/6·1) 17p.
	7	(·4/·1) 4p.	tne 2p.	$\times 1$) (1·3/·6) 41p.
	8	(17/2·1) 51p.	(37·0/11·0) 64p.	$\times\frac{1}{3}$ (410/56) S12, 62p
	9	tne 3p.	tne	$\times 1$) (20·1/10·3) 2p.
	10			
	11			
	12			
	13			

		OPEN (Wet/Dry) 1/4/73	OPEN (Wet/Dry) 25/4/73	CLOSED (Wet/Dry) 10/6/73
D13	1	tne		tne.
	2			
	3			
	4	$\times\frac{1}{3}$) (5·6/3·9) S23 25p.	$\times\frac{1}{4\cdot3}$) (15/8·7) S17, 36p	$\times 1$) (29·2/18·2). 21p
	5	$\times\frac{1}{3}$) (4·1/1·9) S30, 89p.	$\times\frac{1}{4\cdot3}$) (29·7/11·2), S38, 92p	$\times 1$) (16·3/8·5) 76p
	6		tne	$\times 1$) (9·0/6·5) 9p.
Species Number	7	tne.	(3·4/1·6) S21, 47p.	$\times 1$) (6·1/3·5) 68p.
	8	tne	$\times\frac{1}{4\cdot3}$) (182/26) S11 31p.	$\times 1$) (533·9/98·6) 33p.
	9		(111/49) 8p.	$\times 1$) (122·6/48·6) 51p.
	10			
	11			
	12			
	13			

	Species number	OPEN (wet/Dry) 25/4/73	OPEN (wet/Dry) 10/6/73	CLOSED (wet/Dry) 8/7/73
D4	1		+ve	+ve
	2			×1) (52.4/10.6) 300p.
	3			
	4	×1/5) (3.9/20.4) S5, 15p.	(23.4/14.6) 16p.	×1) (12.9/6.8) 39p.
	5	×1/5) (68.0/28.5) S65, 296p.	(26.8/14.0) 125p.	×1) (69.8/33.6) 285p.
	6	+ve	(7/5.4) 7p.	×1) (14.9/11.3) 12p.
	7	(1.2/.5) S17, 19p.	(2.5/1.6) 25p.	×1) +ve 3p (small)
	8	(61/9) 12p.	(146/26.9) 9p.	×1) (313.3/28.2)
	9	(94/46) 10p	×1/3) (40.9/16.2)	×1) (112.8/37.9), 29p
	10			
	11			included in [2]
	12			
	13			

	Species Number	OPEN (Wet/Dry) 10/6/73	OPEN (Wet/Dry) 8/7/73	CLOSED (Wet/Dry) 5/8/73
D15	1	+ve	+ve	
	2		×1/5) grid 60, 30, 15 ≈ 35 → 75p (40.2/8.1) S46	×1/4) grid 17, 33, 37 ≈ 30 (184.0/49.6) S184
	3			
	4	(29.4/18.3), 22p	(17.9/9.4) 54p.	×1/2) (26.1/11.6) S29, 43p.
	5	×1/5) (68.0/29.5) S27, 154p.	(20.6/9.9) 84p.	×1/2) grid 37, 10, 17 ≈ 20 (252/72) S165, 435p.
	6	(17/12.2) 17p	(16.1/12.1) 13p	×1) (22.6/12.1) 15p.
	7	3.2/1.9) 36p	+ve 5p	×1) (.3/.1) 2p.
	8	(308/56.8) 19p.	×1/5) (494/126) S8, 26p	×1/2) (1470/217) S13, 22p
	9	×1/3) (41/16)	(×1/7.2) (81.6/43.1) 15p.	×1) (120.4/38.9)
	10			+ve
	11		included in [2]	included in [2] both flowering
	12			
	13			

D16

Species number	OPEN (wet/Dry) 8/7/73	OPEN (wet/Dry) 5/8/73	CLOSED (wet/Dry) 9/9/73
1	+ve		
2	grid 42,13≈28 → 610p. (32·1/16·5)	grid 58,38,13≈36 → 770p (221/59·4)	grid 41,12,37≈30 → 647p. (65/52·9)
3			
4	(26·8/14·2) 81p.	(35·7/15·9) , 59p	grid 13,8,3 → 38p. (18·4/8·1)
5	(28·9/13·9) 118p.	grid 26,3,9≈13 → 290p. ((164/146·8)	grid 21,4,11≈12 → 260p. (1015/220)
6	(13·7/10·5) 11p	(111·4/59·7) 74p.	(23·9/11·7) 16p
7	+ve 6p.		
8	(494/126) 26p.	(1530/227) 23p.	×½) (124·1/21)
9	(8·5/4·5) 2p.	(21·3/4·3) 5p.	×1) (35·2/8·9) 3p.
10		+ve	×1) (21·2/4·5) 8p.
11	included in $\boxed{2}$	included in $\boxed{2}$	grid 3,15,33≈17 → 365p. (112/32·8)
12			
13			

D17

Species Number	OPEN (wet/Dry) 5/8/73	OPEN (wet/Dry) 9/9/73	CLOSED (wet/Dry) 13/10/73
1			×⅕) (295/186·5)
2	grid 11,53,122≈59 (362/97·4)	grid 1,15,46≈21 → 450p. (115/36·8)	
3			
4	(14·6/6·5) 24p	grid 2,4,13≈6 → 12p. (61·5/27·1)	×⅕) (132/75·5) S11, 406p.
5	grid 1,16,36≈18 → 390p. (227/64·8)	grid 33,12,2≈16 → 342p. (336/290)	
6	(84·4/45·3) 56p.	(3/1·5) 2p.	×1) (6·5/3·7) 9p
7			
8	(570/78) S14, 31p.	(57/10)	×1). (390·1/142·4) 23p.
9		+ve 3p. small	×1) (4·8/1·9) 18p
10	+ve	(5·3/1·1) 2p.	×1) (4·8/2·0) 4p.
11	included in $\boxed{2}$.	grid 8,29,27≈21 → 450p (138/40·5)	
12			
13			

	Species number	OPEN (wet/Dry) 9/9/73	OPEN (wet/Dry) 13/10/73	CLOSED (wet/Dry) 11/11/73
D18	1		$\times\frac{1}{3}$) (89·4/52·2)	$\times\frac{1}{2}$) (–/158·4)
	2	grid 0,0,2≈1 → 22p. (5·6/1·8)		
	3			
	4	grid 1,2,11≈5 → 108p. (52·3/23)	$\times\frac{1}{3}$) (220·5/115·2) S75, 125p	$\times\frac{1}{2}$) (94/55·6) S70.
	5	(215/46·7) 55p	~~(3/1·5)~~ ~~3p~~.	
	6	(3/1·5) 2p.	(23·1/13·3) 7p.	
	7			
	8	$\times\frac{1}{2}$) (20·7/3·5)	(24·6/6·4) 5p.	
	9	+ve 2p.	(1·9/·7) 7p.	$\times 1$) (7·5/2·8) 9p.
	10	(5·3/1·1) 2p.	(15·6/6·5) 13p.	
	11	grid 7,11,16≈11 → 240p. (73·5/21·6)		
	12			
	13			

	Species Number	OPEN (wet/Dry) 13/10/73	OPEN (wet/Dry) 11/11/73	CLOSED (wet/Dry) 18/12/73
D19	1	$\times\frac{1}{5}$) (110·5/72·5)	$\times\frac{1}{3}$) (–/100·2)	$\times\frac{1}{2}$) (–/122)
	2			
	3			
	4	$\times\frac{1}{5}$) (112·5/63·0) S92, 264p.	$\times\frac{1}{3}$) (117/73·5) S105, 265p.	$\times\frac{1}{2}$) (107·4/74·4) S130
	5			
	6	(36·1/21·7) 11p		
	7	+ve		
	8	(90·5/25·1) 25p		
	9	(2·1/·8) 8p.	+ve 9p.	$\times 1$) (17·5/7·8) 20p
	10	(26·4/11·0) 22p		
	11			
	12			
	13			

	Species number	OPEN (wet/Dry) 11/11/73	OPEN (wet/Dry) 18/12/73	CLOSED (wet/Dry) 23/1/74
D20	1	×1/5) (—/280)	×1/3) (—/156)	×1/4) —/119·6)
	2			
	3			
	4	×1/5) (243·5/136) S_{64}p.	×1/3) (144/97·5) S_{144}	(156/114) S_{70}; 273p.
	5			
	6			
	7			
	8			
	9	fne 2p.	(3.5/1.5) 4p.	
	10			
	11			
	12			
	13			

∞ grasshoppers.

	Species Number	OPEN (wet/Dry) 18/12/73	OPEN (wet/Dry) 23/1/74	CLOSED (wet/Dry) 3/3/74
D21	1	×1/3) (—/156)	(—/120)	×1/5) (—/107·5)
	2			
	3			
	4	×1/3) (144/98)	(206/150) S_{70} 360p	×1/5) (—/88·5) S_{53}
	5			
	6			
	7			fne 1p (large green)
	8			
	9			
	10			
	11			
	12			
	13			

∞ grasshoppers

Species number

		OPEN (wet/Dry) 23/1/74	OPEN (wet/Dry) 3/3/74	CLOSED (wet/Dry) 6/4/74
D22	1	(—/120)	$\times\frac{1}{5}$) (—/108)	(184/154)
	2			
	3			
	4	(153/112) S_{70}, 268p	(109/77)	(180/130)
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			

∞ grasshoppers

Species Number

		OPEN (wet/Dry) 3/3/74	OPEN (wet/Dry) 6/4/74	CLOSED (wet/Dry)
D23	1	$\times\frac{1}{5}$) (--/293)	$\times\frac{1}{5}$)(369/308)	
	2			
	3			
	4	$\times\frac{1}{5}$)(57·0/43·5) S_{15}.	$\times\frac{1}{5}$) 180/129 S_{27}	
	5			
	6			
	7	fue 1p large green.	fue	
	8			
	9			
	10			
	11			
	12			
	13			

Species number

		OPEN (Wet/Dry)	OPEN (Wet/Dry) 22/7/72	CLOSED (Wet/Dry) 19/8/72.
E5	1		(10.65/9.45)	(90.0/43.0)
	2			
	3			
	4		(105.7/65.8) 319p.	(83.0/43.0) S82, 293p.
	5		+ve ∞ 2-4-leaf	
	6			+ve 5p.
	7			
	8		+ve ∞ 2-4-leaf.	
	9			
	10			
	11			
	12			
	13			

Species Number

		OPEN (Wet/Dry) 22/7/72	OPEN (Wet/Dry) 19/8/72	CLOSED (Wet/Dry) 23/9/72.
E6	1	(46.3/42.5)	(224.4/115.2) ?(or $\frac{22.4}{11.5}$)?.	(30.5/29.4)
	2			
	3			
	4	(54.9/38.0) 222p.	(42.6/19.2)	(60.2/41.6)
	5	+ve ∞ 2-4-leaf		
	6	+ve 7p.	(1.8/.6) S2, 12p.	(.6/.4) 7p
	7		+ve 2p.	(1.1/.6) 22p.
	8	+ve ∞ 2-4-leaf.		
	9		+ve 2p.	(1.3/.5) 3p.
	10			
	11			
	12			
	13			

E7 Species number	OPEN (Wet/Dry) 19/8/72	OPEN (Wet/Dry) 23/9/72	CLOSED (Wet/Dry) 28/10/72
1	(64.0/40.5)	(68.8/66.7)	(74.6/72.2)
2			
3			
4	(124.5/67.0) S63, 280p.	126/85 22p	×$\frac{1}{3}$) (73.2/57.6) S120, 205p.
5			
6	~~tve~~ tve S4, 5p.	tve 5p.	including from 4.
7			
8			
9			
10			
11			
12			
13			

∞ grasshoppers

E8 Species Number	OPEN (Wet/Dry) 23/9/72	OPEN (Wet/Dry) 28/10/72	CLOSED (Wet/Dry) 18/12/72.
1	×$\frac{1}{5}$)(21.0/20.5)	×$\frac{1}{3}$)(51.0/45.6)	×1) (53.0/51.8)
2			
3			
4	(78.5/53.0) S60, 214p.	×$\frac{1}{3}$) (23.1/18.6) S86, 215p.	×1)(62.2/51.8) 191p.
5			
6	tve 1p.	including. from [4]	
7			
8			
9			
10			
11			
12			
13			

∞ grasshoppers

	Species number	OPEN (Wet/Dry) 28/10/72	OPEN (Wet/Dry) 18/12/72	CLOSED (Wet/Dry) 3/2/73
Eq	1	(29.5/29.0)	×1/5)(47.5/47.5)	×D(10.6/10.5)
	2			
	3			
	4	×1/5)(18.5/14.0) S36, 136p.	×1/5)(14.0/11.5) 83p.	×D(12.7/10.5) 59p.
	5			
	6			
	7	(1.3/.3) 8p		
	8			
	9	fue 5p.		
	10			
	11			
	12			
	13			

∞ grasshoppers. v. dry.

	Species Number	OPEN (Wet/Dry) 18/12/72	OPEN (Wet/Dry) 3/2/73	CLOSED (Wet/Dry) 3/3/73
E10	1	×1/5)(158.5/156.0)	×1/5)(31.0/30.0)	×D(10.6/9.9)
	2			
	3			
	4	×1/5) (27.0/23.0) S26, 131p.	×1/5)(16.5/14.5) S6, 31p	×1)(19.8/14.7) 47p
	5			×1)(4.2/1.9) S5.3, 90p.
	6			
	7			
	8			×1)(.6/.1) 3p.
	9			
	10			
	11			
	12			
	13			

v. dry.

	Species number	OPEN (wet/Dry) 3/2/73	OPEN (wet/Dry) 3/3/73	CLOSED (wet/Dry) 1/4/73
E11	1	$\times\frac{1}{5}$) (38.5/35.0)	(11/10) of/nce.	$\times 1$)(31.5/29.4)
	2			
	3			
	4	$\times\frac{1}{5}$) (2.3/1.07) S3, 18p.	(7.6/5.7) 18p.	$\times\frac{1}{3}$) (7.6/13.5) S5, 17p.
	5		Grid 101,197×149→8200p (118/53.4)	$\times\frac{1}{5}$) (27.5/12.5) S242 1210p.
	6			+ve.
	7			(.01/+ve) 3p.
	8			(.02/+ve) 1p
	9			+ve
	10			
	11			
	12			
	13			

v. dry

	Species Number	OPEN (wet/Dry) 3/3/73	OPEN (wet/Dry) 1/4/73	CLOSED (wet/Dry) 25/4/73
E12	1	+ve.	$\times\frac{1}{5}$)(8.5/8.5)	+ve
	2			
	3			
	4	(3.0/2.2) 7p.	$\times\frac{1}{5}$) (18.2/14.0) 18p	$\times 1$)(5.2/3.6) 4p
	5	grid 65,83,130≈93p. (74/33.4) 2000p.	$\times\frac{1}{5}$)(76.5/28.5)	$\times\frac{1}{2}$)(117.4/37.2) 30p
	6			
	7			
	8	(15.0/1.3) 76p.	$\times\frac{1}{5}$) (167/24) S66, 121p (+v. logs, plant)	$\times 1$)(189.8/27.6) 86p
	9			
	10			
	11			
	12			
	13			

Species number

		OPEN (wet/Dry) 1/4/73	OPEN (wet/Dry) 25/4/73	CLOSED (wet/Dry) 10/6/73
E13	1	+ve	+ve	+ve
	2			
	3			
	4	$\times\frac{1}{2}$) (2.6/1.6) S6, 11p.	(10.0/7.5) 10p.	×1) (7.7/4.7) 44p
	5	$\times\frac{1}{5}$) (15.0/6.5)	grid 17, 28, 57 ≃ 34 ↓ 730p (66/30)	×1) grid ≃ 32 → 680p. (67.2/48.3)
	6		+ve 6p	+ve.
	7		+ve 10p	×1) (1.63/.93) 43p.
	8	$\times\frac{1}{5}$) (48.5/6.6) S6, 35p.	(48.5/7.2) 40p.	×1) (124.3/24.2) 42p
	9			
	10			
	11			
	12			
	13			

Species Number

		OPEN (wet/Dry) 25/4/73	OPEN (wet/Dry) 10/6/73	CLOSED (wet/Dry) 8/7/73
E14	1		+ve	+ve
	2			48/20
	3			
	4	(8.0/6.0) S4, 7p.	(2.8/1.7) 16p.	×1) (17.9/9.2) 210p
	5	grid 23, 6, 23 ≃ 38 ⇒ 720p. $\times\frac{1}{5}$) (74/33.5)	grid 12, 18, 47 ≃ 26 ⇒ 560p. (54.7/39.3)	$\times\frac{1}{2}$) grid 12, 45, 43 ≃ 33 → 710p (89.6/33.2)
	6	+ve 1p.		
	7	+ve 6p.	+ve 8p.	+ve.
	8	$\times\frac{1}{5}$) (56/8.2) S4, 46p.	(60.0/31.0), 54p	×1) (226.6/34.6), 65p.
	9	+ve 1p large	(31.7/13.1) 3p.	×1) 57.0/22.0
	10			
	11			included in $\boxed{2}$
	12			
	13			

E15

Species number

	OPEN (Wet/Dry) 10/6/73	OPEN (Wet/Dry) 8/7/73	CLOSED (Wet/Dry) 5/8/73
1	tue	tue.	
2		(48/20)	~~1.20~~ grid 101,60≈80 ×1/5) (223.5/68.0) 5420
3			
4	(1.4/.9) 8p.	(1.6/.8) 19p.	×1)(4.8/2.2) 21p
5	grid 11,15,98≈41→,899p (101.4/66.1) 72 laguenes	grid 4,12,60≈25)→ 540p. (21.5/65)	×1)(245.8/62.9). 714p
6			
7	tue 4p	tue.	
8	(36.0/5.7)	(232.5/34.5) 3p	×1) 431/61.3) 4p
9	(25.3^+/10.5^+) ∞p.	(48^+/25.6^+) ∞p.	×1)(163.8^+/44.0^+) ∞p.
10			tue
11		included in [2]	included in [2]
12			
13			

E16.

Species Number

	OPEN (Wet/Dry) 8/7/73	OPEN (Wet/Dry) 5/8/73	CLOSED (Wet/Dry) 9/9/73
1	tue.		
2	×1/5) grid 28,83,6≈39 (47.5/20) 5201	grid 70,102,23≈65. (182/55.3)	grid 3,2,0.2→43p. (8.4/3)
3			
4	(2.2/1.1) 26p.	(8.2/3.8) 36p.	grid 2,3,1≈2→43p (7.7/3.9)
5	grid 7,17,37≈20→430p. (17.0/5.0)	grid 4,6,47≈19→410p. (139/35.8)	grid 4,14,20≈13→280p (109.2/23.8)
6			
7	tue.		
8	tue 2p		tue.
9			tue 1p
10		tue	(26.7/5.6) 10p.
11	included in [2]	included in [2]	grid 8,73,27≈60→1292 (183/61.8)
12			
13			

E17

Species number

	OPEN (wet/Dry) 5/8/73	OPEN (wet/Dry) 9/9/73	CLOSED (wet/Dry) 13/10/73
1			×1/5) (280/172)
2	grid 34, 60, 71 ≃ 55 (154/46·8)	grid 9, 4, 2 ≃ 5 → 108p. (210/7·6)	
3			
4	(6·4/2·9) 28p.	grid 1, 3, 2 ≃ 2 → 43p. (7·7/3·9)	×1/5) (66·5/37·0) S31, 85p.
5	×1/5) grid 47, 31, 26 ≃ 35 → 750p. (258/66·3)	grid 11, 23, 23 ≃ 19 → 408p (1590/347)	
6			fne 2p.
7			
8	(97·0/12·5) S, 5p	(12·9/2·1) 5p.	×1) (9·1/2·9) 2p.
9		fne 1p.	×1) (1·3/·6)
10	fne	(26·7/5·6) 10p.	(19·2/8·00) 16p.
11	included in [12]	grid 47, 44, 30 ≃ 40 → 861p. (122/41·2)	
12			
13			

E18

Species Number

	OPEN (wet/Dry) 9/9/73	OPEN (wet/Dry) 13/10/73	CLOSED (wet/Dry) 11/11/73
1		×1/5) (280/170)	×1/3) (–/122·7)
2	grid 28, 10 ≃ 7 → 152p. (29·6/10·6)		
3			
4	grid 0, 4, 17 ≃ 7 → 152p. (27·3/13·7)	(93/52) 119p.	×1/3) (199·8/117·6) S107 215p
5	grid 3, 26, 20 ≃ 16 → 340p 1336/290		
6			
7			
8			
9		fne 1p.	×1) (2·0/·8) 2p
10	(47·9/10·1) 8p.	(24/10) 20p	
11	grid 51, 50, 30 ≃ 44 → 945p. (134/45·5)		
12			
13			

E19.

Species number	OPEN (wet/Dry) 13/10/73	OPEN (wet/Dry) 11/11/73	CLOSED (wet/Dry) 18/12/73
1	$\times\frac{1}{5}$)(85·7/51·1)	$\times\frac{1}{3}$) —/123)	$\times\frac{1}{2}$(—/176·0)
2			
3			
4	(38·3/ 21·4) 49p.	$\times\frac{1}{3}$)(134·1/69·6) S46, 96p.	$\times\frac{1}{2}$)(122·4/65·7) S30 90p
5			
6	tue 6p.		
7			
8			
9			
10	(21·6/9·0) 18p.		
11			
12			
13			

E20

Species Number	OPEN (wet/Dry) 11/11/73	OPEN (wet/Dry) 18/12/73	CLOSED (wet/Dry) 23/1/74
1	$\times\frac{1}{5}$) (—/231·5)	$\times\frac{1}{5}$)(—/211·3)	$\times\frac{1}{6}$) (—/234)
2			
3			
4·	$\times\frac{1}{5}$) (663·5/395·5) S167	$\times\frac{1}{5}$)(329·5/224·0) S147	$\times\frac{1}{6}$) (236/185)
5			
6			
7			
8			
9		tue 3p	
10			
11			
12			
13			

→ grasshoppers.

Species number

		OPEN (wet/Dry) 18/12/73	OPEN (wet/Dry) 23/1/74	CLOSED (wet/Dry) 3/3/74.
E21	1	×$\frac{1}{5}$) (—/132)	×$\frac{1}{5}$)(—/150)	×$\frac{1}{5}$)(—/153)
	2			
	3			
	4	×$\frac{1}{5}$)(306/178) S81	×$\frac{1}{5}$) (184/126)	×$\frac{1}{5}$) (215/157.5) S36.
	5			
	6			
	7			tve 1p largegreen.
	8			
	9	tve 4p.		
	10			
	11			
	12			
	13			

∞ grasshoppers

Species Number

		OPEN (wet/Dry) 23/1/74	OPEN (wet/Dry) 3/3/74	CLOSED (wet/Dry) 6/4/74.
E22	1	(—/450)	×$\frac{1}{5}$) (—/257)	×$\frac{1}{3}$) (166.5/141.9)
	2			
	3			
	4	(180/130)	×$\frac{1}{5}$) (91.0/69.5) S18.	×$\frac{1}{3}$) (170/100) S37.
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			

∞ grasshoppers

E23

Species number	OPEN (Wet/Dry) 3/3/74	OPEN (Wet/Dry) 6/4/74	CLOSED (Wet/Dry)
1	×$\frac{1}{5}$) (–/366)	×$\frac{1}{3}$)(305/257)	
2			
3			
4	×$\frac{1}{5}$) (39.5/30.5) S17	×$\frac{1}{3}$) (135/85) S46.	
5			
6			
7			
8			
9			
10			
11			
12			
13			

F5

Species Number	OPEN (Wet/Dry) ~~22/7/72~~	OPEN (Wet/Dry) 22/7/72	CLOSED (Wet/Dry) 19/8/72
1		(83.6/77.6)	(75.0/63.0)
2			
3			
4		(50.5/36.0) 199p.	(35.7/20.2) S58, 202p
5		+ve. ∞2-4 leaf.	
6			
7			
8		+ve ∞2-4 leaf	
9			
10			
11			
12			
13			

	Species number	OPEN (wet/Dry)^22/7/72	OPEN (wet/Dry)^19/8/72	CLOSED (wet/Dry)^23/9/72
F6	1	(100/91)	(137·0/81·5)	(62·6/60·4)
	2			
	3			
	4	(31·0/26·0) 211p.	(35/20) S22 84p	x½) (19/13·5) S16 81p
	5	pre c 2-4-leaf	pre	pre.
	6			
	7			pre 1p.
	8	pre c 2-4-leaf		
	9			pre 1p
	10			
	11			
	12			
	13			

	Species Number	OPEN (wet/Dry)^19/8/72	OPEN (wet/Dry)^23/9/72	CLOSED (wet/Dry)^28/10/72
F7	1	(100/87·5)	(63·0/61·5)	x1) (43·7/42·9) harvest.
	2			
	3			
	4	(11·7/7·5) S7 48p.	(6·5/4·5) S34 51p.	x1) (14·1/11·0) 39p.
	5			
	6		(·4/·2) S12 41p.	indistinguishable from [4]
	7			
	8			
	9			
	10			
	11			
	12			
	13			

grasshoppers.

F8 Species number	OPEN (wet/Dry) 23/9/72	OPEN (wet/Dry) 28/10/72	CLOSED (wet/Dry) 18/12/72
1	(49.5/48.0)	(60.5/59.5)	×1)(51.2/40.4)
2			
3			
4	(99.5/65.5) 204p.	$\times\frac{1}{5}$)(52.5/40.0) S29, 150p.	×1)(80.0/67.2) 184p.
5			
6	+ve	indisting. from [4].	
7		+ve 4p.	
8			
9			
10			
11			
12			
13			

grasshoppers

F9 Species Number	OPEN (wet/Dry) 28/10/72	OPEN (wet/Dry) 18/12/72	CLOSED (wet/Dry) 3/2/73
1	(77.5/71.5)	$\times\frac{1}{5}$)(87.5/86.5)	$\times\frac{1}{2}$)(19.2/19.0)
2			
3			
4	$\times\frac{1}{5}$)(58/46.5) S29, 258p.	$\times\frac{1}{5}$)(51.0/32.0) S43, 210p.	$\times\frac{1}{2}$)(30.2/27.6) S53, 104p.
5			
6	indisting from [4]		
7	+ve 4p.		×1)(1.8/.7) 3p.
8			
9			
10			
11			
12			
13			

grasshoppers

v. dry

F10

Species number

	OPEN (wet/Dry) 18/12/72	OPEN (wet/Dry) 3/2/73	CLOSED (wet/Dry) 3/3/73
1	×$\frac{1}{5}$) (85.0/84.5)	×$\frac{1}{5}$) (79.5/78.5)	×1) (24.6/22.7)
2			
3			
4	×$\frac{1}{5}$) (74.5/62.0) S46, 183p.	×$\frac{1}{5}$) (4/3) S2 10p	×1) (3.0/2.4) 25p. gm0| 123, 155, 90 ≈ 123 ⇒ 365p.
5			(97.5/44)
6			
7			
8			
9			
10			
11			
12			
13			

v. dry.

F11

Species Number

	OPEN (wet/Dry) 3/2/73	OPEN (wet/Dry) 3/3/73	CLOSED (wet/Dry) 1/4/73
1	×$\frac{1}{5}$) (27.0/26.5)	(12.3/11.4)	×1) (14.01/13.4)
2			
3			
4	×$\frac{1}{5}$) (24.9/21.9) S13, 38p.	(3.8/3.0) 33p. gm0| 154, 135, 73 ≈ 121 ⇒ 360p	×1) (8.0/5.3) 1p.
5		(71/43.4)	×$\frac{1}{5}$) (24/10)
6			
7			
8		(.4/.03) 2p	×1) (1.2/.1) 3p
9			
10			
11			
12			the 1p. large.
13			

v. dry.

Species number

F12	OPEN (wet/Dry) 3/3/73	OPEN (wet/Dry) 1/4/73	CLOSED (wet/Dry) 25/4/7
1		+ve.	
2			
3			
4	(·9/·7) 9p	$\times\frac{1}{5}$) (4·2/3·0) S2, 13p	×1) (7·3/4·4) 20p
5	grid 104, 36, 135 × 92 → 2000p. (73/33)	$\times\frac{1}{5}$) (23·5/10·0) S45, 225p	$\times\frac{1}{3}$) (69·9/30·9) S260, 622p
6	+ve 12p.	$\times\frac{1}{10}$) (6/4) S1, 11p	×1) (4·0/2·8) 13p
7			+ve
8	(3·6/·3) 18p.	$\times\frac{1}{5}$) (37/6) S11, 20p	×1) (5·4/2·1) 29p
9	+ve 1p large.	×1) (4·0/1·6) 1p.	×1) (58·0/9·41) 1p
10			
11			
12		+ve 1p large	
13			

Species Number

F13	OPEN (wet/Dry) 1/4/73	OPEN (wet/Dry) 25/4/73	CLOSED (wet/Dry) 10/6/73
1	+ve		+ve
2			
3			
4	×1) (4·5/3·2) S6 5p.	$\times\frac{1}{5}$) (21·0/14·5) S12	×1) (16·8/10·7) 12p
5	$\times\frac{1}{5}$) (30/14·5) S149, 745p	$\times\frac{1}{5}$) grid 64, 105, 60 × 76 → 1645p. (28·5/15·5)	grid 36, 97, 48 × 60 → 12957p (16·7/8·9)
6		+ve.	
7			(·8/·5) 22p
8	$\times\frac{1}{5}$) (11·0/1·5) S11, 19p	$\times\frac{1}{5}$) (27/4) S29	×1) (32·2/6·5) 21p
9			
10			
11			
12			
13			

F17

Species number	OPEN (wet/Dry)$^{25/4/73}$	OPEN (wet/Dry)$^{10/6/73}$	CLOSED (wet/Dry)$^{8/7/73}$
1		(101/85)	$\times 1$) (18·6/16·9)
2			grid 42,29,35≈35 (95·6/35)
3			
4	$\times\frac{1}{5}$) (21/14·5) S12	(20/15)	$\times 1$) (37·2/25·3) 28p
5	$\times\frac{1}{5}$) grid 48,48,54≈50→1090p. (21/12) S184	grid 88,61,112≈87→1900p. (24·2/12·9)	grid 32,26,31≈30→645p. (132/57·5)
6	tre		
7	tre		tre 12p.
8	$\times\frac{1}{5}$) (25/4) S29	(9·2/2·6) 18p	$\times 1$) (36·8/6·1) 23p
9			
10			
11			included in [2].
12			
13			

F15

Species Number	OPEN (wet/Dry)$^{10/6/73}$	OPEN (wet/Dry)$^{8/7/73}$	CLOSED (wet/Dry)$^{5/8/73}$
1	$\times\frac{1}{5}$) (100·5/84·5)	(19/17)	tre
2		grid 13,12,11≈12. (29·4/12)	$\times\frac{1}{5}$) grid 118,37,105≈87 (136/38) S300
3			
4	$\times\frac{1}{5}$) (27·0/20) 59	(41·2/28·0) 31p.	$\times 1$) (42·6/21·1) 116p
5	$\times\frac{1}{5}$) grid 39,18≈27→590p. (7·5/4) S28,	grid 3,40,12≈15→320p. (66·3/28·8)	$\times\frac{1}{5}$) grid 4,74,7≈28→600p (106/39) S71?
6			
7		tre 14p.	
8	(16·4/4·6) S33, 27p.	(45·0/7·4) 28p	$\times 1$) (70·7/10·6) 39p
9			
10			tre
11		included in [2]	included in [2].
12			
13			

F16

Species number

	OPEN (wet/Dry) 8/7/73	OPEN (wet/Dry) 5/8/73	CLOSED (wet/Dry) 9/9/73
1	(12·2/11·2)	fine.	
2	×1/5) grid 10,11,10≃10 (24·5/10) S100	grid 73,15,24≃37. (57·8/16·2)	grid 16,4,2≃7→152p. (29·6/10·6)
3			
4	(25·2/17·2) 19p.	(85·3/12·6) 87p	grid 19,5,1≃8→172p (135/63·5)
5	×1/5) grid 6,5,7≃6→129p. (26·5/11·5)	grid 9,10,9≃10→220p. (37·8/13·9)	fine
6			fine
7	fine 9p.		fine
8	×1/5)(96·6/17·1) S10, 42p	(62/10·9) 48p	×1/5)(293·5/47·0)
9			
10		fine	(14·5/3·2) 6p
11	included in [2]	included in [2]	grid 46,19,32≃32→686p. (97/32·8)
12			
13			

F17

Species Number

	OPEN (wet/Dry) 5/8/73	OPEN (wet/Dry) 9/9/73	CLOSED (wet/Dry) 13/10/73
1	fine.		×1/3)(427·5/236·5)
2	grid 50,28,81≃63. (88·5/22·5)	grid 16,10,20≃15→321p (69·5/22·5)	
3			
4	(13·4/6·6) 46p	grid 11,5,4≃7→152p. (119/56·1)	×1/5)(215/118) S50, 186p
5	grid 17,1,0≃6→129p. (92·7/8·4)	grid 9,0,1≃3→65p. (254/55·2)	
6		fine.	
7		fine	
8	(88·7/13·3) 49p.	×1/7)(410·9/68·6)	×1)(274·3/100·9) 47p
9	fine. 2p	fine 3p	fine ~~2p~~
10	fine	(21·8/4·8) ,9p	×1) (16·7/7·0) 17p
11	included in [2]	grid 33,19,29≃27→581p (82·4/27·8)	
12			
13			×1). 48·4/18·0 3p.

F18

Species number	OPEN (wet/Dry) 9/9/73	OPEN (wet/Dry) 13/10/73	CLOSED (wet/Dry) 11/11/73
1		×$\frac{1}{5}$) (420/240)	×$\frac{1}{5}$) (–/296)
2	grid 73, 3, 69 ≈ 48 ⇒ 1039p. (203/72.6)		
3			
4	grid 17, 13, 14 ≈ 15 ⇒ 321p. (251/118.5)	×$\frac{1}{2}$) (313/171) S135	×$\frac{1}{3}$) (623.5/378) S127
5	+ve		
6		+ve 3p.	
7			
8	×$\frac{1}{3}$) (176.1/29.4)	(82/32.4) 14p.	
9			×1) (1.4/.4)' 1p.
10	(16.9/3.7) 7p.	(12.8/5.3) 13p.	
11	grid 177, 21, 102 ≈ 83 ⇒ 1798p. (255/86.2)		
12			
13		(135/74.3) 15p.	

F19

Species Number	OPEN (wet/Dry) 13/10/73	OPEN (wet/Dry) 11/11/73	CLOSED (wet/Dry) 18/12/73
1	×$\frac{1}{5}$) (300.5/157.0)	×$\frac{1}{3}$) (–/125.4)	×$\frac{1}{3}$) (–/190.2)
2			
3			
4	(135/74.3) 117p.	×$\frac{1}{3}$) (291.6/173.4) S114	×$\frac{1}{3}$) (258.9/159.0) S60.
5			
6			
7			
8	760/200 S14 53p.		
9	+ve 4p.	+ve 9p.	×1) (29.4/15.7) 51p. (includes B. zebra)
10	(15.7/6.6) 16p.		
11			
12			
13	(210/78) 13p.		

		OPEN (wet/Dry) 11/11/73	OPEN (wet/Dry) 18/12/73	CLOSED (wet/Dry) 23/1/74
F20	1	$\times\frac{1}{5}$) (—/219.5)	$\times\frac{1}{3}$) (—/107.4)	$\times\frac{1}{10}$) (—/186)
	2			
	3			
	4	$\times\frac{1}{5}$) (534/405) S130	$\times\frac{1}{3}$) (242.7/176.1)	$\times\frac{1}{10}$) (411/331) S28.
	5			
Species number	6			
	7			
	8			
	9	fme 13p	fme 3p	
	10			
	11			
	12			
	13			

grasshoppers.

		OPEN (wet/Dry) 18/12/73	OPEN (wet/Dry) 23/1/74	CLOSED (wet/Dry) 3/3/74
F21	1	$\times\frac{1}{5}$) (—/120.5)	$\times\frac{1}{5}$) (—/142.5)	$\times\frac{1}{5}$) (—/68.5)
	2			
	3			
	4	$\times\frac{1}{5}$) (100/60.5) S79	$\times\frac{1}{5}$) (125/124) S79	$\times\frac{1}{5}$) (98.0/78.0) S47.
	5			
	6			
Species Number	7			
	8			
	9	fme 3p		
	10			
	11			
	12			
	13			

grasshoppers.

	Species number	OPEN (wet/Dry) 23/1/74	OPEN (wet/Dry) 3/3/74	CLOSED (wet/Dry) 6/4/74
F22	1	$\times\frac{1}{5}$) (–/29.5)	$\times\frac{1}{5}$) (–/26.0)	$\times\frac{1}{5}$) (212/167)
	2			
	3			
	4	$\times\frac{1}{5}$) (105.5/75.0)	$\times\frac{1}{5}$) (73/57.5) S_{39}	$\times\frac{1}{5}$) (72.5/13.5) S_{9}
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			

grasshoppers

	Species Number	OPEN (wet/Dry) 3/3/74	OPEN (wet/Dry) 6/4/74	CLOSED (wet/Dry)
F23	1	$\times\frac{1}{5}$) (–/93)	$\times\frac{1}{5}$) (247/207)	
	2			
	3			
	4	$\times\frac{1}{5}$) (160/118) S_{27}	$\times\frac{1}{5}$) (287/180) S_{35}	
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			

Species number

		OPEN (Wet/Dry)	OPEN (Wet/Dry) 22/7/72	CLOSED (Wet/Dry) 19/8/72
G5	1		(5.7/5.0)	(36.0/31.2)
	2			
	3			
	4		(68.2/48.6) 198p.	(61.8/40.2) 547,125p
	5		tre ∞ 2-4 leaf	
	6		tre 1p.	
	7			
	8		tre ∞ 2-4 leaf.	
	9			tre 1p.
	10			
	11			
	12			
	13			

Species Number

		OPEN (Wet/Dry) 22/7/72	OPEN (Wet/Dry) 19/8/72	CLOSED (Wet/Dry) 23/9/72
G6	1	(35.0/23.5)	(40/36)	(25.8/25.0)
	2			
	3			
	4	(45.2/32.7) 93p.	(95.5/59.5) ?	(52.5/32.7) 150p
	5	tre ∞ 2-4 leaf		
	6		tre 1p	
	7			
	8	tre ∞ 2-4 leaf.		
	9		tre 1p.	(6.8/2.8) 3p.
	10			
	11			
	12			
	13			

	Species number	OPEN (wet/Dry) 19/8/72	OPEN (wet/Dry) 23/9/72	CLOSED (wet/Dry) 28/10/72
G7	1	(69.0/58.5)	(106/103)	(101.5/100.0)
	2			
	3			
	4	(41.0/27.5) S59, 231p.	(63/42) 335p.	+1/5) (69.5/56.0) S46, 270p
	5			
	6	tre 2p	tre	tre
	7			
	8			
	9	tre 1p.		
	10			
	11			
	12			
	13			

grasshoppers

	Species Number	OPEN (wet/Dry) 23/9/72	OPEN (wet/Dry) 28/10/72	CLOSED (wet/Dry) 18/12/72.
G8	1	(61.0/58.5)	(89.5/88.5)	+1/5) (109.0/107.0)
	2			
	3			
	4	(84.5/55.0) 409p.	+1/5 (82.5/66.5) S53, 313p.	+1/5) (47.0/39.5) S41, 201p.
	5			
	6	tre.	tre.	
	7			
	8			
	9			
	10			
	11			
	12			
	13			

grasshoppers

G9

Species number

	OPEN (wet/Dry) 28/10/72	OPEN (wet/Dry) 18/12/72	CLOSED (wet/Dry) 3/2/73
1	(87.0/85.5)	×1/5)(42.0/42.0)	×1)(126/79.2)
2			
3			
4	×1/5) (65/52) S46, 142p.	×1/5) (12.5/11.0) S15 122p.	×1)(13.3/9.6) 18p
5			
6			
7	fine		
8			
9	(1.2/.7). 1p.		
10			
11			
12			
13			

grasshopper

v. dry. (collected in the rain)

G10

Species Number

	OPEN (wet/Dry) 18/12/72	OPEN (wet/Dry) 3/2/73	CLOSED (wet/Dry) 3/3/73
1	×1/5)(80.5/79.5)	×1/5)(134.5/84.0)	×1) (34.6/32.08)
2			
3			
4	×1/3) (64.5/54.5) S56, 172p.	×1/5) (16.8/12.0) S6, 23p.	(11.9/9.1) 17p
5			(93.7/42.3) 9.01 135/101=1187 260p.
6			
7			
8			(.90/.21) 13p.
9			
10			
11			
12			
13			

v. dry ([illegible] the rain)

Species number

		OPEN (Wet/Dry) 3/2/73	OPEN (Wet/Dry) 3/3/73	CLOSED (Wet/Dry) 1/4/73
G11	1	$\times\frac{1}{5}$)(129·5/81·0)	$\times\frac{1}{5}$)^2(10·8/10·0)	$\times\frac{1}{3}$)(19·5/18·0)
	2			
	3			
	4	$\times\frac{1}{5}$)(186/135) S_{27}, 202p.	(128/91·0) S_{21}, 163p	$\times\frac{1}{3}$)(13·5/5·1) S_{124}
	5		grid 67, 73270 → 1520p (56/25)	$\times\frac{1}{3}$)(99·6/73·5) S_{56}, 168p
	6			
	7			
	8		(8·9/1·9) S_{57} 46p	$\times\frac{1}{3}$)(18·6/15·6) S_{25}, 235p
	9			
	10			
	11			
	12			
	13			

v. dry (collected in the rain)

Species Number

		OPEN (Wet/Dry) 3/3/73	OPEN (Wet/Dry) 1/4/73	CLOSED (Wet/Dry) 25/4/73
G12	1		$\times\frac{1}{4}$)(14·8/14·0)	$\times 1$)(8·8/8·3)
	2			
	3			
	4	(78·6/57·6) S_{32}, 186p.	$\times\frac{1}{4}$)(14·4/10·2) S_{103}	$\times\frac{1}{2}$)(115·4/83·0) S_{121}, 245p.
	5	grid 74,63 × 69 → 1490p. (54/25)	$\times\frac{1}{4}$) (57·6/43·2) S_{40}, 160p	$\times\frac{1}{2}$) (21·2/10·8) S_{14}
	6			
	7		few	few
	8	(2·4/·2) S_1 10p	$\times\frac{1}{4}$)(5·6/·8) S_6,	$\times 1$) (13·1, 1·9) 28p
	9		few 1p.	
	10			
	11			
	12			
	13			

Species number

G13	OPEN (Wet/Dry) 1/4/73	OPEN (Wet/Dry) 25/4/73	CLOSED (Wet/Dry) 10/6/73
1	×$\frac{1}{5}$) (23.0/22.5)	×$\frac{1}{5}$) (41.5/39.5)	tre
2			
3			
4	×$\frac{1}{5}$) (5.5/2.5) S23	(32/26) S23, 52p.	×1) (103.1/70.4) 177p
5	(9.0/14.5) ? 42p v.small	(39/20) S118, 296p.	×1) (4.8/2.6) 54p.
6		tre	
7		tre.	
8	(–/0.4)	(8.5/1.0) S2, 9p.	×1) (12.6/2.6) 9p.
9	tre. 1p (small)		
10			
11			
12			
13			

raining

Species Number

G14	OPEN (Wet/Dry) 25/4/73	OPEN (Wet/Dry) 10/6/73	CLOSED (Wet/Dry) 8/7/73
1	×$\frac{1}{5}$) (29.5/27.5)	×$\frac{1}{3}$) (51.0/37.5)	×1) (7.6/7.2)
2			×1) (15.9/5.8) 87p
3			
4	(38/26) S25, 69p.	(70/47) S55, 87p	×1) (62.8/33.8) 187p
5	×$\frac{1}{5}$) (58.5/26.0) S25, 202p.	(7.0/3.8) S36, 62p	×1) (27.1/14.7) 156p.
6	tre.		
7		×$\frac{1}{3}$) (9.5/1.4) S21, 43p.	×1) (1.2/.6) 34p
8	×$\frac{1}{5}$) (108.0/15.5) S6, 35p.	(56.8/11.6) S25, 26p	×1) (252.0/41.4) 27p
9		tre. 2p.	
10			
11			included in (2)
12			
13			

raining

		OPEN (wet/Dry) 10/6/73	OPEN (wet/Dry) 8/7/73	CLOSED (wet/Dry) 5/8/73
G15	1	+ve	+ve.	
	2		grid 49, 3, 13 ≃ 22 (3/1)	grid 89, 46, 30 ≃ 55 (92.5/24.3)
	3			
	4	×$\frac{1}{4}$) (13/9) S30, 84p (obvious grazing)	(44/23.5) 130p.	×$\frac{1}{2}$) (32.9/15.4) S24 112p
	5		grid 14, 11 ≃ 13 → 286p (39/17.2)	
Species number	6	(6.4/4.4) S8, 17p.	+ve 22p.	×$\frac{1}{2}$) (37.6/24.9) S19, 28p
	7	(.8/.5) 22p.	(1.3/.6) 36p.	×1) (2.2/1.3) 27p
	8	(72/17.7) S37, 99p.	×$\frac{1}{3}$) (31.3/5.4) S17, 51p.	×$\frac{1}{2}$) (322/34.5) S122, 182p.
	9	(86.5/39.5) 18p	+ve 23p (1 small)	×1) (262.2/71.5) 37p
	10		+ve 3p.	+ve
	11		included in [2]	included in [2]
	12			
	13			

raining.

		OPEN (wet/Dry) 8/7/73	OPEN (wet/Dry) 5/8/73	CLOSED (wet/Dry) 9/9/73
G16	1	×$\frac{1}{5}$) (34.5/32.5)		
	2	×$\frac{1}{5}$) (9/3) S49 grid 102, 19 ≃ 60.	grid 39, 29, 56 ≃ 41 (69/18.2)	grid 15, 9, 9 ≃ 11 → 240p (46.8/16.8)
	3			
	4	×(5/3.2) S40, 72p.	(23.2/12.3) 56p.	grid 8, 20, 7 ≃ 12 → 260p. (242/169.3)
	5	×$\frac{1}{5}$) (102.0/45.0) S128 grid 37, 31 ≃ 34 → 730p	grid 58, 27, 32 ≃ 39 → 840p (331.5/102.5)	grid 3, 14, 27 ≃ 21 → 450p (490/136)
	6			
Species Number	7	(.3/.1) 9p.	(.6/.4) 8p	
	8	(78/12.6) S9, 16p.	(188/28) 12p.	×1) (337.9/60.2)
	9	+ve 2p	+ve 8p	×1) (23.8/5.2)
	10		+ve.	
	11	included in [2]	included in [2]	grid 29, 22, 26 = 26 → 580p. (79.5/26)
	12			
	13			

G17

Species number	OPEN (Wet/Dry) 5/8/73	OPEN (Wet/Dry) 9/9/73	CLOSED (Wet/Dry) 13/10/73
1			$\times\frac{1}{5}$) (251.5/185)
2	$\times\frac{1}{5}$) grid 45,21,35 ≈ ~~35p.~~ 35 59/15.5	grid 7,10,19 ≈ 12 → 260p. (50.8/18.2)	
3			
4	$\times\frac{1}{5}$) (16.2/8.6) S41, 39p.	grid 16,9,13 ≈ 13 → 280p. (260/117.9)	$\times\frac{1}{5}$) S69, 322p. (272.5/146.0)
5	$\times\frac{1}{5}$) grid 56,35,26 ≈ 39 → 840p. (331.5/122.5)	grid 29,17,10 ≈ 19 → 408p (443/123.5)	
6			
7	(.9/.5) 11p.	few	few.
8	(79.9/11.9) 15p.	$\times\frac{1}{3}$) (58.8/16.8)	$\times1$) (121.9/32.5) 7p.
9	few 2p.		$\times1$) (38.3/11.1) 30p
10	few		
11	included in [2]	grid 19,23,31 ≈ 26 → 580p (79.5/26)	
12			
13			

G18

Species Number	OPEN (Wet/Dry) 9/9/73	OPEN (Wet/Dry) 13/10/73	CLOSED (Wet/Dry) 11/11/73
1		$\times\frac{1}{5}$) (250/185)	$\times\frac{1}{5}$) (—/202.5)
2	grid 8,11,31 ≈ 17 → 365p. (71/25.5)		
3			
4	grid 18,17,15 ≈ 17 → 365p (339/153.5)	$\times\frac{1}{2}$) (334/179) S197	$\times\frac{1}{5}$) (554.0/306.0) S113
5	(746/208) grid 26,54,16 ≈ 32.		
6			
7			
8	(165.8/23.8)	(146.3/39.0) 12p.	
9		few 7p	$\times1$) (10.4/2.6) 11p
10			
11	grid 34,46,39 ≈ 40 → 866p (122/41.2)		
12			
13			

	Species number	OPEN (Wet/Dry) 13/10/73	OPEN (Wet/Dry) 11/11/73	CLOSED (Wet/Dry) 18/12/73
G19	1	×1/5) (252/185)	×1/5) (—/203)	×1/2) (—/132)
	2			
	3			
	4	×1/2) (158/84.5) 93p.	(333/184)	×1/2) (156/104.8) S206
	5			
	6			
	7			
	8	(73.5/27.3) 12p		
	9			
	10			
	11			
	12			
	13			

	Species Number	OPEN (Wet/Dry) 11/11/73	OPEN (Wet/Dry) 18/12/73	CLOSED (Wet/Dry) 23/1/74
G20	1	×1/5) (—/134.5)	×1/5) (—/45.5)	×1/6) (—/61.8)
	2			
	3			
	4	×1/5) (249/146) S85	×1/5) (98.5/67.0) S50	×1/6) (157/118) S66
	5			
	6			
	7			
	8			
	9		fue 1p.	
	10			
	11			
	12			
	13			

grasshoppers.

G21

Species number

	OPEN (wet/Dry) 18/12/73	OPEN (wet/Dry) 23/1/74	CLOSED (wet/Dry) 3/3/74
1	$\times\frac{1}{5}$) (–/115·5)	(–/52)	$\times\frac{1}{5}$) (–/68·5)
2			
3			
4	$\times\frac{1}{5}$) (206.5/145·5) S46	(139.5/125·4)	$\times\frac{1}{5}$) (175/147) S46
5			
6			
7			
8			
9			
10			
11			
12			
13			

grasshoppers

G22

Species Number

	OPEN (wet/Dry) 23/1/74	OPEN (wet/Dry) 3/3/74	CLOSED (wet/Dry) 6/4/74
1	$\times\frac{1}{5}$) (–/157)	$\times\frac{1}{5}$) (–/210)	$\times\frac{1}{3}$) (298/238)
2			
3			
4	$\times\frac{1}{5}$) (186/141)	$\times\frac{1}{5}$) (156/130) S40	$\times\frac{1}{3}$) (291/189) S32
5			
6			
7			
8			
9			
10			
11			
12			
13			

grasshoppers

Species number

		OPEN (wet/Dry) 3/3/74	OPEN (wet/Dry) 16/4/74	CLOSED (wet/Dry)
G23	1	$\times\frac{1}{5}$) (–/191)	$\times\frac{1}{3}$) (200/146)	
	2			
	3			
	4	$\times\frac{1}{5}$) (80·5 /66) S26	$\times\frac{1}{3}$) (85·2/58·8) S_{23}	
	5			
	6			
	7	+ve 1p larger		
	8			
	9			
	10			
	11			
	12			
	13			

Species Number

		OPEN (wet/Dry)	OPEN (wet/Dry) 22/7/72	CLOSED (wet/Dry) 19/8/72
H5	1		(109·0/101·0)	(103·5/95·5)
	2			
	3			
	4		(57·0/38·0) 161p	(45·0/32·5) S33, 19p
	5		+ve @ 2-4 leaf	
	6			
	7			
	8		+ve @ 2-4 leaf.	
	9		+ve	(19·5/9·5) 12p
	10			
	11			
	12			
	13			

H6

Species number	OPEN (wet/Dry) 22/7/72	OPEN (wet/Dry) 19/8/72	CLOSED (wet/Dry) 23/9/72
1	(44.0/41.0)	(179.5/168.0)	(100/94)
2			
3			
4	(48.5/34.5) 135p	(87.0/55.0)	(165.2/108.0) 259p
5	+ve ∞ 2-4 leaf		
6	+ve 4p.	+ve 26p.	
7			
8	+ve ∞ 2-4 leaf		
9	+ve 7p.	(276/7.8)?	(34.0/14.2)
10			
11			
12			
13			

H7

Species Number	OPEN (wet/Dry) 19/8/72	OPEN (wet/Dry) 23/9/72	CLOSED (wet/Dry) 28/10/72
1	(111/102)	(93.8/89.5)	(114.0/109.6)
2			
3			
4	7½) (62.0/69.5) S73 300p.	(175.0/123.0) 208p.	(116/94) S66, 228p
5			
6	+ve 2p.		
7			
8			
9		+ve 2p.	
10			
11			
12			
13			

grasshoppers.

Species number

		OPEN (wet/Dry) 23/9/72	OPEN (wet/Dry) 28/10/72	CLOSED (wet/Dry) 18/12/72
H8	1	(44.0/42.0)	(52.5/51.0)	$\times\frac{1}{2}$) (59.2/59.2)
	2			
	3			
	4	(184.0/124.5) 239p.	$\times\frac{1}{5}$) (68.0/55.5) S33, 254p	$\times\frac{1}{2}$) (97.0/83.6) S25, 247p.
	5			
	6			
	7			
	8			
	9	me.		
	10			
	11			
	12			
	13			

grasshoppers.

Species Number

		OPEN (Wet/Dry) 28/10/72	OPEN (Wet/Dry) 18/12/72	CLOSED (Wet/Dry) 3/2/73
Hg	1	(89/86.5)	$\times\frac{1}{5}$) (43.5/43.5)	$\times\frac{1}{3}$) (61.8/58.8)
	2			
	3			
	4	$\times\frac{1}{5}$) (69/54.5) S42 255p	$\times\frac{1}{5}$) (76.5/70.0) S43, 194p.	$\times\frac{1}{3}$) (33.3/29.4) S28, 89p.
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			

grasshoppers.

v. dry

H10

Species number	OPEN (wet/Dry) 18/12/72	OPEN (wet/Dry) 3/2/73	CLOSED (wet/Dry) 3/3/73
1	$\times\frac{1}{5}$) (41.5/41.5)	$\times\frac{1}{5}$) (31.0/29.5)	$\times\frac{1}{2}$) (19.8/17.6)
2			
3			
4	$\times\frac{1}{5}$) (85.0/83.0) S60 254p.	$\times\frac{1}{5}$) (73.2/63.0) S23, 145p.	$\times\frac{1}{2}$) (95.8/66.8) S26, 161p.
5			
6			
7			
8			(5.2/.8) S17, 33p.
9	+ve 1p.		
10			
11			
12			
13			

v. dry

H11

Species Number	OPEN (wet/Dry) 3/2/73	OPEN (wet/Dry) 3/3/73	CLOSED (wet/Dry) 1/4/73
1	$\times\frac{1}{5}$) (5.0/4.5)	$\times\frac{1}{5}$) (45/41.5)	$\times\frac{1}{3}$) (34.2/32.1)
2			
3			
4	$\times\frac{1}{5}$) (55/50) S26, 106p.	$\times\frac{1}{4}$) (82.4/58.0) S32, 104p.	$\times\frac{1}{3}$) (76.5/52.8) S45, 145p.
5		grid 84,84,=85 → 185°p. (47.5/30.5)	$\times\frac{1}{3}$) (18.6/9.9) S36.
6			
7		+ve 1p (small)	
8		(6.5/.8) S16.	×1) (49.8/6.9) 57p.
9			
10			
11			
12			
13			

v. dry

	Species number	OPEN (wet/Dry) 3/3/23	OPEN (wet/Dry) 1/4/73	CLOSED (wet/Dry) 25/4/73
H12	1	×$\frac{1}{5}$)(45/42)	×$\frac{1}{5}$)(54.5/50.5)	×$\frac{1}{3}$)(34.2/32.0)
	2			
	3			
	4	×$\frac{1}{5}$)(84.6/61.2) S11, 70p.	×$\frac{1}{6}$)(49.2/33.6) S11, 64p.	(56/47) S17 43p
	5	grid 145, 119≈132⇒2830p. (105/47.4)	×$\frac{1}{10}$)(41/16) S109	grid 97, 103, 58≈86→187p ×$\frac{1}{4}$)(66.0/31.6) S249.
	6			
	7	tne 1p. (v large)		tne.
	8	(17.7/2.5) S17 70p	×$\frac{1}{10}$)(61/9) S9, 87p	
	9		tne 2p.	
	10			
	11			
	12			
	13			

	Species Number	OPEN (wet/Dry) 1/4/73	OPEN (wet/Dry) 25/4/73	CLOSED (wet/Dry) 10/6/73.
H13	1	×$\frac{1}{5}$)(55/51)?	×$\frac{1}{5}$)(34/32)	×$\frac{1}{3}$)(85/72)
	2			
	3			
	4	×$\frac{1}{5}$)(24.5/16.0) S21, 104p.	×$\frac{1}{5}$)(72/55) 92p.	×1)(63.3×42.9) 99p.
	5	tne.	grid 78, 121, 77≈92⇒200p ×$\frac{1}{4}$)(71.0/33.7)	×1)(30.2/5.1) 120p.
	6			
	7			grid 34, 41, 84≈53 ×1)(3.1/1.6) S118p.
	8	×$\frac{1}{6}$)(132.6/17.4) S14, 89p.	×$\frac{1}{5}$)(180/23) 102p	×1)(354/65.4) 82p
	9			
	10			
	11			
	12			
	13			

H14

Species number

	OPEN (Wet/Dry) 25/4/73	OPEN (Wet/Dry) 10/6/73	CLOSED (Wet/Dry) 8/7/73
1	$\times\frac{1}{5}$) (42.0/40.0)	(84/70)	×1) (19.9/18.1)
2			grid ≃ 5. ×1) (6.3/2.2) 79p
3			
4	$\times\frac{1}{5}$) (72/55) S27, 92p.	(150/111) 134p	×1) (154.5/103.2) 138p.
5	grid 70,71,61 ≃ 67 → 145p $\times\frac{1}{5}$) (58.5/27.5) S156	grid 48,26,57 ≃ 42 → 90p (32.1/17.9)	grid 27 → 152p. ×1) (37.9/18.5) 125p.
6			
7		tve 9p.	
8	$\times\frac{1}{5}$) (180/23) S24, 102p.	(166/30) 82p.	×1) (353.6/55.5) 90p
9			
10			
11			included in $\boxed{2}$
12			
13			

H15

Species Number

	OPEN (Wet/Dry) 10/6/73	OPEN (Wet/Dry) 8/7/73	CLOSED (Wet/Dry) 5/8/73
1	$\times\frac{1}{3}$) (84.9/72.3)	(20/18)	
2		grid 2,5,4 ≃ 4 (408/105)	grid 11,6,0 ≃ 6 $\times\frac{1}{5}$) (67/18) S48
3			
4	(215/158) S47, 192p.	(177/117) 147p.	$\times\frac{1}{5}$) (292/172) S35, 146p
5	grid 36,37,97 ≃ 57 → 1230p $\times\frac{1}{3}$) (43.5/24.3)	grid 10,40 ≃ 19 → 410p. (103/50)	grid 53,26,21 ≃ 33p. $\times\frac{1}{5}$) (781/165) 718p
6			
7	tve 31p.	tve 6p	
8	(111/20.5) S37, 55p	(177/27.8) 46p	×1) (506.7/71.7) 57p
9		tve 1p.	tve 1p.
10			tve
11		included in $\boxed{2}$	included in $\boxed{2}$
12			
13			

H16

Species number	OPEN (wet/Dry) 5/7/73	OPEN (wet/Dry) 5/8/73	CLOSED (wet/Dry) 9/9/73
1	(20/18)		
2	grid 11, 5, 4 ≃ 7 (7.7/3.3)	grid 6, 19, 8 ≃ 11 (23/33)	grid 7, 8 ≃ 8 → 172p. (49/15.5)
3			
4	×1/5) (1444/495.5) S36, 120p	(126/74) 63p	grid 16, 24 ≃ 20 → 430p. (1078/510)
5	grid 35, 17, 9 ≃ 20 → 430p. (108/50.6)	grid 11, 37, 26 ≃ 26 → 56p (630/130)	grid 7, 17, ≃ 12 → 260p. (161/46)
6			
7	tre 11p		
8	(omitted)	(258/36.4) 29p	(omitted)
9			
10		tre	
11	included in [2]	included in [2]	grid 22, 4, ≃ 13 → 280p. (274/77)
12			
13			

H17

Species Number	OPEN (wet/Dry) 5/8/73	OPEN (wet/Dry) 9/9/73	CLOSED (wet/Dry) 13/10/73
1			×1/5) (205.5/125.5)
2	(257/69) grid 17, 16, 36 ≃ 23	grid 5, 17 ≃ 11 → 240p (68.4/21.6)	
3			
4	(230/135) 115p.	grid 12, 23 ≃ 18 → 390p. (975/463)	×1/5) (506/295.5) S61, 250p
5	grid 41, 7, 11 ≃ 20 → 430p. (474/100)	grid 33, 13 ≃ 23 → 495p. (307/87.4)	
6			
7			
8	(680/41.7) S17, 91p.	? (omitted)	×1) (281.1/72.4) 24p
9	tre 3p.		
10	tre	tre	tre 4p.
11	included in [2].	grid 16, 34 ≃ 25 → 540p. (528/148.5)	
12			
13			

	Species number	OPEN (wet/Dry) 9/9/73	OPEN (wet/Dry) 13/10/73	CLOSED (wet/Dry) 11/11/73
H18	1		$\times\frac{1}{5}$) (206/126)	$\times\frac{1}{5}$)(–/153.5)
	2	grid 2,2 ≈ 2 → 43p. (12.2/3.9)		
	3			
	4	grid 12,12 ≈ 12 → 260p. ×(650/308)	$\times\frac{1}{5}$) (506/296)	$\times\frac{1}{5}$) (649.5/401.0)
	5	grid 59,33 ≈ 46 → 990p. (614/175)		
	6			
	7			
	8		+ve	
	9		+ve	$(63.3^+/24.6^+)$ 84^+p
	10		+ve 1p.	
	11	grid 16,49 ≈ 33 → 710p. (694/195)		
	12			
	13			

	Species Number	OPEN (wet/Dry) 13/10/73	OPEN (wet/Dry) 11/11/73	CLOSED (wet/Dry) 18/12/73
H19	1	$\times\frac{1}{5}$) ?	(–/250)	$\times\frac{1}{2}$) (–/614)
	2			
	3			
	4	$\times\frac{1}{5}$) (1047/635) 573	(840/520)	(414/304)
	5			
	6			
	7			
	8			
	9	1p.	∞p. v.small	∞p. v.small
	10	6p.		
	11			
	12			
	13			

H20

Species number

	OPEN (wet/Dry) 11/11/73	OPEN (wet/Dry) 18/12/73	CLOSED (wet/Dry)$^{23/1/74}$
1	$+\frac{1}{5}$) (−/250)	$+\frac{1}{5}$) (−/307)	$+\frac{1}{10}$) (−/438)
2			
3			
4	$+\frac{1}{5}$) (838/520) S_{130}	$+\frac{1}{5}$) (828/608.5) S_{31}	$+\frac{1}{10}$) (349/292) S_{17}
5			
6			
7			
8			
9	∞ plants. v. small.	14p.	
10			
11			
12			
13			

locusts.

H21

Species Number

	OPEN (wet/Dry) 18/12/73	OPEN (wet/Dry)$^{23/1/74}$	CLOSED (wet/Dry)$^{3/3/74}$
1	(−/307)	(−/440)	$+\frac{1}{5}$) (−/606)
2			
3			
4	(828/609)	(350/290)	
5			
6			
7			
8			
9			
10			
11			
12			
13			

grasshoppers.

H_{22}

Species number

	OPEN (wet/Dry) 23/1/74	OPEN (wet/Dry) 3/3/74	CLOSED (wet/Dry) 6/4/
1	(–/440)	(–/733)	$+\frac{1}{5}$) (1253·5/1023·5)
2			
3			
4	(350/290)		
5			
6			
7			
8			
9			
10			
11			
12			
13			

locusts

H_{23}

Species Number

	OPEN (Wet/Dry) 3/3/74	OPEN (Wet/Dry) 6/4/74	CLOSED (Wet/Dry)
1	$+\frac{1}{5}$) (–/388)	$+\frac{1}{5}$) (1294/1103)	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			

Species number

		OPEN (wet/Dry)	OPEN (wet/Dry) 22/7/72	CLOSED (wet/Dry) 19/8/7
I5	1		(58.0/53.0)	(79.5/71.5)
	2			
	3			
	4		(71.3/49.7) 286p	(75.5/47.0) 291p
	5		∞ p. (2-4 leaf)	
	6		7p. shooting.	(5.0/.5) 18p
	7			
	8		∞ p. 2-4-leaf)	
	9			
	10			
	11			
	12			
	13			

Species Number

		OPEN (Wet/Dry) 22/7/72	OPEN (Wet/Dry) 19/8/72	CLOSED (Wet/Dry) 23/9/7
I6	1	(16.5/15.0)	(28.5/24.5)	(13.7/12.3)
	2			
	3			
	4	(34.5/23.9) 212p.	(27.0/17.5)	(45.9/29.8) 248p
	5	∞ p. (2-4-leaf)		
	6	13p shooting	(3.5/2.0) 33p	(8.6/5.6) 65p
	7		3p.	+ve
	8	∞ (2-4-leaf)		
	9			
	10			
	11			
	12		(10.5/5.0) 99p.	(13.3/8.3) 96p
	13			

I7

Species number

	OPEN (wet/Dry) 19/8/72	OPEN (wet/Dry) 23/9/72	CLOSED (wet/Dry) 28/10/72
1	(28.5 / 25.0)	(22.0/20.3)	(30.9/28.8)
2			
3			
4	(66.5 / 44.5) 267p.	(72.5 / 49.3) 451p	(49/41) S156 353p indistinguishable from 6. *
5			
6	3p	5p (.1/.07)	*
7			
8			
9	1p.		
10			
11			
12	(5.5/2.5) 29p.	(4.6/3.0) 38p	
13			

~~grasshoppers~~ grasshoppers

I8

Species Number

	OPEN (wet/Dry) 23/9/72	OPEN (wet/Dry) 28/10/72	CLOSED (wet/Dry) 18/12/72
1	(9.0 / 8.5)	$\times\frac{1}{5}$) (17.0/16.5)	$\times\frac{1}{3}$) (39.0/ 39.0)
2			
3			
4	(117/84) 332p.	indisting. from 6 * (96 / 77.2) 51S, 340p.	$\times\frac{1}{3}$)(101.6/90.3) S117 310p
5			
6	(.25/.15) 2p.	*	
7			
8			
9			
10			
11			
12	(.9/.3) 3p.		
13			

grasshoppers

Species Number

I9		OPEN (wet/Dry) 28/10/72	OPEN (wet/Dry) 18/12/72	CLOSED (wet/Dry) 3/2/73
	1	×1/5) (21/19.5)	×1/5) (33.0/33.0)	×1/2) (55.4/53.4)
	2			
	3			
	4	initiating. from 6.* ×1/5) (78.5/65.5) S59 365p	×1/5) (83.0/73.5) S56 286p	×1/2) (15.4/13.8) S18, 37p
	5			
	6	*		
	7			
	8			
	9			
	10			
	11			
	12			
	13			

grasshoppers. v. dry

Species Number

I_{10}		OPEN (wet/Dry) 18/12/72	OPEN (wet/Dry) 3/2/73	CLOSED (wet/Dry) 3/3/73
	1	×1/5) (41.5/40.5)	×1/5) (61.0/60.0)	×1) (42.9/39.4)
	2			
	3			
	4	×1/5) (80/69.5) S89, 326p.	×1/5) (5.1/4.6) S2, 12p.	×1) (22.7/18.0) 16p.
	5			grid 153, 88 ≈ 12 ⇒ 2600p (3/1) S52.
	6			
	7			
	8			×1) (·8/·7) · 5p.
	9			
	10			
	11			
	12			
	13			

v. dry.

	Species number	OPEN (Wet/Dry) 3/2/73	OPEN (Wet/Dry) 3/3/73	CLOSED (Wet/Dry) 1/4/73
I11	1	$\times\frac{1}{5}$) (51.5/48.5)	+ve	$\times\frac{1}{2}$) (38.4/36.0)
	2			
	3			
	4	$\times\frac{1}{5}$) (25.5/21.5) S23, 112p	$\times\frac{1}{5}$) (34/24.4) S27, 108p	$\times\frac{1}{2}$) (91/53) S81, 162p
	5		grid 111,29,17 ≈ 52 ⇒ 1120p. (1.3/.4)	$\times\frac{1}{4}$) (8.8/4.0) S101, 404p
	6			
	7			
	8		$\times\frac{1}{5}$) (1.5/.2) S6, 8p.	$\times1$) (8.4/1.3) 21p.
	9			
	10			
	11			
	12			
	13			

	Species Number	OPEN (Wet/Dry) 3/3/73	OPEN (Wet/Dry) 1/4/73	CLOSED (Wet/Dry) 25/4/73
I12	1	$\times\frac{1}{5}$) (26.5/24.0)	$\times\frac{1}{4}$) (15.6/14.8)	$\times\frac{1}{2}$) (28/26)
	2			
	3			
	4	$\times\frac{1}{5}$) (102.5/80.5) S36, 176p	$\times\frac{1}{4}$) (76.4/5.2) S31, 131p	$\times\frac{1}{2}$) (107.8/77.8) S79, 149p
	5	grid 61,65 ≈ 63 → 136p. (1.6/.5)	$\times\frac{1}{4}$) (8.8/4.0) S101, 404p	grid 53,80,113 ≈ 82 → 177p (51.6/30.0)
	6			
	7			+ve
	8	$\times\frac{1}{5}$) (3.2/1.0) S5, 32p	$\times\frac{1}{4}$) (8.2/1.2) S22, 29p	$\times1$) (29.9/4.7) 38p
	9			
	10			
	11			
	12			
	13			

I13

Species number	OPEN (wet/Dry) 1/4/73	OPEN (wet/Dry) 25/4/73	CLOSED (wet/Dry) 10/6/73
1	$\times\frac{1}{5}$)(22.0/20.0)	$\times\frac{1}{3}$)(28.8/25.8)	$\times\frac{1}{2}$)(71.4/60.0)
2			
3			
4	$\times\frac{1}{5}$) (64/48) S_{40} 101p.	$\times\frac{1}{3}$) 73.2/51.0) S_{17} 74p.	$\times\frac{1}{2}$)(116/76.8) S_{38} 96p
5	(8/2)	grid 88, 97, 78 ≈ 88 → 1905p $\times\frac{1}{2}$)(55.2/32.2) S_{57}.	$\times 1$) (7.9/4.4) 105p
6			
7		+ve	$\times 1$)(2.9/1.8) 52p
8	$\times\frac{1}{5}$) (56.5/8.3) S_{14}, 89p.	$\times\frac{1}{3}$) (89/16.3) S_9, 64p.	$\times 1$)(92.1/18.3) 70p
9	1p. +ve.	1p. +ve	1p. (2.6/1.0)
10			
11			
12			
13			

I14

Species Number	OPEN (wet/Dry) 25/4/73	OPEN (wet/Dry) 10/6/73	CLOSED (wet/Dry) 8/7/73
1	$\times\frac{1}{5}$) (60.0/57.5)	$\times\frac{1}{3}$) (45.3/37.2)	$\times 1$) (22.5/21.0)
2			grid 11, 6, 14 ≈ 10 (12.6/4.4)
3			
4	$\times\frac{1}{5}$) (66.5/45) S_8 95p.	$\times\frac{1}{3}$) (250.5/169.5) S_{32}, 119p.	S_{220} 541p. $\times\frac{1}{2}$)(151.8/93.0)
5	grid 141, 102, 138 ≈ 94 → 2030p. (59.1/33.6)	grid 72, 23, 32 ≈ 42 → 900p. $\times\frac{1}{3}$)(27.0/13.1) S_{97}	grid 56, 8, 28 ≈ 31 → 660p (168/82)
6			
7		(11.6/.7) 29p	6p. +ve
8	$\times\frac{1}{5}$) (11.2/1.4) S_2, 9p	$\times\frac{1}{3}$) (7.7/1.6) S_4, 11p	$\times 1$) (39.0/6.1) 17p
9			
10			
11			[included in 2]
12			
13			

Species number

		OPEN (Wet/Dry) 10/6/73	OPEN (Wet/Dry) 8/7/73	CLOSED (Wet/Dry) 5/8/73
I15	1	×1/5)(82.5/67.5)	×1/5)(149.5/143.0)	—
	2		grid 66,8,24 ≈ 33 ⇒ (41.6/14.5)	grid 193,71,210 ≈ 158. ×1/5)(151.5/38.5) S372
	3			
	4	×1/5) (82/56.5) S21, 81p	×1/5)(88.8/40.6) 91p	×1/5)(235/111) S26, 140p
	5	grid 16,48,64 ≈ 42 ⇒ 900p (27/13.1) 3	grid 15,40,24 ≈ 26 ⇒ 56p (141/69)	S247 1050p ⇐ ×1/5) 230/144) 72.5 grid 23,93,29 ≈ 49
	6			
	7	(4.9/3.0) 86p	6p twe	×1) (.6/.3) 15p
	8	×1/5)(92.0/18.6) S26, 52p	×1/5)(170/28) 56p	(610/90) S30, 66p
	9	(642/250.2) 4p	(347.4/123.6) 3p	×1) v.small (542.7/185.4)
	10			twe
	11		[included in 2]	[included in 2]
	12			
	13			

Species Number

		OPEN (Wet/Dry) 8/7/73	OPEN (Wet/Dry) 5/8/73	CLOSED (Wet/Dry) 9/9/73
I16	1	×1/5)(149.5/143.0)	—	—
	2	grid 10,15,24 ≈ 16 (20.2/7.0)	grid 26,23,72 ≈ 40 (38.5/9.8)	grid 59,12,13 ≈ 28 ⇒ 605p (202/66.5)
	3			
	4	S37 132p ×1/5) (99.5/59.0)	(162/76) 96p	grid 9,16,13 ≈ 13 → 280p (298/139)
	5	grid 27,14,58 ≈ 33 → 710p (179/82)	grid 52,55,32 ≈ 46 ⇒ 990p (217/68.5)	grid 13,20,15 ≈ 16 → 342p (176/53.8)
	6			
	7	3p twe	(.4/.2) 11p	
	8	×1/5)(94/15.5) S14, 31p	(359/53.2) 39p	×1) (161.1/34) 39p
	9	4p twl		
	10		twe	
	11	[included in 2]	[included in 2]	grid 29,16,10 ≈ 18 ⇒ 390p (462/410)
	12			
	13			

I17

Species number	OPEN (wet/Dry) 5/8/73	OPEN (wet/Dry) 9/9/73	CLOSED (wet/Dry) 3/10/73
1			$\times\frac{1}{5}$) (554/313)
2	grid 105, 54, 114 ≈ 91 (88/22.2)	grid 23, 24, 72 ≈ 40 ⇒ 861p. (287/94.5)	
3			
4	(170/80) 101p.	grid 14, 12, 9 ≈ 12 ⇒ 260p. (276/129)	$\times\frac{1}{5}$) (820.5/457.5)
5	grid 47, 27, 15 ≈ 30 ⇒ 645p (142/44.7)	grid 3, 4, 32 ≈ 13 ⇒ 280p. (144/44)	
6			
7	(.5/.3) 13p		
8	(267/39.6) 29p.	?) (228.6/43.2) S29	$\times$1) (298.1/84.6) 29p
9			
10	+ve		
11	[included in 2]	grid 49, 60, 38 ≈ 49 ⇒ <u>105p</u>. (125/113)	
12			
13			

I18

Species Number	OPEN (wet/Dry) 9/9/73	OPEN (wet/Dry) 13/10/73	CLOSED (wet/Dry) 11/11/73
1		$\times\frac{1}{5}$) (−/55.1)	$\times\frac{1}{5}$) (−/244)
2	grid 1, 8, 16 ≈ 8 ⇒ 172p. (57/18.9)		
3			
4	grid 43, 27, 38 ≈ 36 ⇒ 770p. (820/408)	$\times\frac{1}{5}$) (600/353) S155	$\times\frac{1}{5}$ (694.5/389.0) S169.
5	grid 9, 10, 12 ≈ 7 ⇒ 151p. (77.5/12.2)		
6			
7			
8	(165.1/31.2) 30p	(166.1/59.3) 30p	
9			
10		6p +ve	
11	grid 11, 14, 30 ≈ 18 ⇒ 390p. (462/410)		
12			
13			

I19

Species number	OPEN (wet/Dry) 13/10/73	OPEN (wet/Dry) 11/11/73	CLOSED (wet/Dry) 18/12/73
1	(—/55)	(—/244)	×$\frac{1}{5}$) (—/450)
2			
3			
4	(600/350)	(558/311.2)	×$\frac{1}{5}$) (818/556) 5172
5			
6			
7			
8	(652/186) 53p.		
9			1p. tue'
10			
11			
12			
13			

I20

Species Number	OPEN (wet/Dry) 11/11/73	OPEN (wet/Dry) 18/12/73	CLOSED (wet/Dry) 23/1/74
1	(—/244)	(—/450)	(—/444)
2			
3			
4	(695 / 390)	(818/556)	(114·5 /89·5)
5			
6			
7			
8			
9			
10			
11			
12			
13			

locusts

	Species number	OPEN (wet/Dry) 18/12/73	OPEN (wet/Dry) 23/1/74	CLOSED (wet/Dry) 3/3/74
I_{21}	1	(—/450)	(—/440)	+$\frac{1}{5}$) (—/521)
	2			
	3			
	4	(818/586)	(115/90)	+ve
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			

locusts

	Species Number	OPEN (wet/Dry) 23/1/74	OPEN (wet/Dry) 3/3/74	CLOSED (wet/Dry) 6/4/74
I_{22}	1	(—/440)	(—/520)	+$\frac{1}{5}$) (704/531)
	2			
	3			
	4	(115/90)	+ve	
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			

locusts.

Species number

		OPEN (wet/Dry) 3/3/74	OPEN (wet/Dry) 6/4/74	CLOSED (wet/Dry)
I23	1	$\times\frac{1}{5}$) (—/115)	$\times\frac{1}{5}$) (898/229)	
	2			
	3			
	4	$\times\frac{1}{5}$) (—/7.0) S18	$\times\frac{1}{5}$)(50.5/28.5) S7	
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			

APPENDICES 5.2 – 5.16

Analysis of Raw Data.

5.2 Rainfall table (taken from App. 1.1)
5.3 Soil water.
5.4 Stipa nitida biomass
5.5 " " water content
5.6 " " plant numbers
5.7 Erodium cygnorum biomass
5.8 " " water content
5.9 " " plant numbers
5.10 Zygophyllum ovatum biomass
5.11 " " water content
5.12 " " plant numbers
5.13 Euphorbia drummondii biomass, water content, plant numbers & Bassia patenticuspis data.
5.14 Helipterum spp. biomass, water content, plant numbers.
5.15 Ground litter biomass.
5.16 Total vegetation

Appendix 5·2

RAINFALL (mm)

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Since previous visit	38·3	3·6	4·3	1·3	25·7	21·1	9·1	7·4	12·4	19·1	105·2	22·9	20·6	17·0	31·8	44·7	69·1	18·6	108·7	63·0	82·6	100·0	31·0
Rain in previous 1 week.	0	3·6	2·3	0	<16·7	13·2	·4	7·4	0	17·3	0	22·1	20·6	8·4	0	·8	62·2	7·9	10·2	35·3	76·7	0	31·0
Rain in previous 2 weeks.	1·6	3·6	2·3	0	2·6	10·9	·4	0	0	17·2	0	19·6	14·0	3·3	0	·8	9·1	7·9	3·2	35·0	0	0	26·2
"Effective" rain.	38·3	3·6	4·3	1·3	24·6	10·7	3·6	7·4	0	17·2	+	22·9	19·6	11·2	31·8	40·1	58·4	9·7	103·6	28·2	82·6	3·3	28·7

App. 5.3 SOIL MOISTURE (%)	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	13/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
0cm. depth.																							
A				1.9	3.8	2.9	1.2	2.9	.4	18.2	1.4	6.4	6.3	3.2	1.9	15.6	13.6	2.0	.6	4.2	.37	.79	13.8
B				2.1	3.8	25	1.9	.9	.2	.76	1.6	5.9	—	.8	4.0	21	8.9	2.1	1	1.6	.97	.52	18
C				1.9	3.7	9.7	1.5	1	0	18.2	1.3	4.6	—	.5	2.3	—	9.1	2.2	1.6	—	.37	.81	16.3
A-C average				2	4	13	1	2	+	12	1	6	6	2	3	18	11	2	1	3	+	1	16
D					2.3	—	—	1	0	17.7	1.1	—	—	15	2	14.2	9.1	1.7	.6	2.6	2	.7	18
E					2.5	25.5	1.7	1.2	.5	18.2	1.7	—	7.1	13.4	3.9	17.7	7.5	2.1	1.7	4.5	4.8	1.4	17.4
H					5.7	13.8	1.7	1.2	0	3.6	1.2	—	5.9	17.9	2.1	19.9	21.8	4	.2	5.5	3.8	.9	21.6
D-I average.					4	20	2	1	+	13	1		7	15	3	17	13	3	1	4	3	1	19
✻ A-I ave. (0cm depth)				2.0	3.6	15.4	1.6	1.4	.2	12.8	1.4	5.6	6.4	8.5	2.7	17.7	11.7	2.3	1.3	3.7	1.9	.9	17.5
10 cm depth																							
A				4.5	9.5	14.2	7.9	4.4	1.5	5.4	7.8	11.1	8.2	5.1	4.6	11.3	12.9	6.5	17.1	10.8	9.9	4.8	17
B				3.3	9.2	14.4	7.1	2.2	2.2	.3	5.9	28.9	—	7.7	6.8	19.4	13.4	7.6	5.2	10.6	9.8	5.8	18
C				4.7	8.7	1.4	6.3	4.1	2.1	5.1	6.6	12.4	—	6.9	8.0	12.1	10.9	9.7	8.7	—	8.4	17	19
A-C ave.				4	9	10	7	4	2	4	7	17	8	7	6	14	12	8	10	11	9	9	18
D					6.8	16.8	—	5.3	.2	11.7	5.1	—	—	6.3	7.5	13.1	9.7	34.8	5.7	7.8	10.8	7.9	16.4
E					6.8	17.6	5.7	6.4	1.8	5.4	8.3	—	8.1	7.1	8.6	18.4	12.5	6.7	5.6	10.9	12.6	8.7	14
H					8.3	10.7	7.2	5	.5	3.8	6.3	—	9.2	6.8	7.2	16.6	17.3	8.9	7.9	11.4	11	4.2	15.8
D-I ave					7	15	6	6	1	7	7		9	7	8	16	13	17	6	10	11	7	15
✻ A-I ave. (10cm depth)				4.2	8.2	12.5	6.8	4.6	1.4	5.3	6.7	17.5	8.5	6.7	7.1	15.2	12.8	12.4	8.4	10.3	10.4	8.1	16.7

App. 5.4

STATIONS A-C

SPECIES NO. 4

Biomass (gms/3sqm) dry wt.

STATIONS D-I

	10/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	23/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	1/4
Ave A	1	+	T	·3	·3	8·4	8·5			+	T	+	+	+		+	2·9	+	4·9	11	4·7	10·7	3·4
B	36·4	25	9·5	84·2	58·8	88·8	79	77·3	34	12	4·9	2·8	1·9	2·4	+	84·1	48·2	57·6	241	141	380	100	200
C			1·8	25·5	25·5	28·8	43·5	19·5	2·6	+	+	·2	+	+	5·1	2·5	19·3	36·8	87·5	62	134	145	72·5
A-C average	19	13	4	37	28	42	44	32	12	4	2	1	1	1	2	29	23	31	39	71	173	85	94
Ave D					31	46	29	20	16	11	6	3	6	17	8	11	25	89	105	98	131	60	129
E					52	43	66	16	17	8	4	8	4	1	1	3	9	37	233	201	128	50	55
F					31	5	35	43	47	13	2	3	15	18	23	10	87	123	289	118	100	88	160
G					41	44	49	59	33	·74	74	5	26	28	13	11	136	132	165	106	123	98	59
H					36	52	119	68	79	47	62	34	52	104	105	127	427	466	460	457	791	—	—
I					37	36	54	81	78	13	41	35	58	101	64	89	225	387	363	556	90	+	—
D-I average					38	38	59	45	45	28	32	14	27	45	36	42	152	206	269	256	144	50	76
A-I average	19	13	4	37	35	39	54	40	34	20	22	10	18	30	24	38	109	148	192	194	154	61	82

App. 5.5

STATIONS A-I

SPECIES NO. 4

% water.

	13/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	23/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
A-C	46 53 36	22 18 13	51 46 41 49 45	60 12 7 10 9 7	60 20 19 24 13 29	60 49 31 35 34 38 39	20 21 43 28 29 26 32	39 12 16 4 22	17 14 12	12 23 32 8	60 33 48 47	36 92 50 25 63	48 43 42	43 45	54	53 54	58 57 51 47 58	48 49 51	58 57 44 46 45	43 42 28 40 41	43 29 35 33	45 26 22 21 3 22 19 2	32 40 43 36 39 47
A-Cave.	45	15.5	46	17	28	42	28	20	14	19	47	53	44	44	54	54	54	49	49	39	35	20	38
					36 29 24 31 16 29 28 33 29 30 31	24 36 35 48 55 46 44 36 35 37 33 28 37 31 38 55 33	30 31 26 24 32 29 31 34 38 33 35 30 32 28	22 18 24 20 22 24 19 20 18 16	0 16 17 18 15 16 37 17 16 12 15 14 9 2 11 18 13	19 17 12 26 9 25 12 28 29 27 12 14 9 7 10 16	40 39 26 27 20 21 22 23 29 27 31 30 28 21	30 33 23 38 34 29 62 50 54 31 32 35 43 93 25	43 42 39 31 25 40 31 28 19 32 16 24 28 30 32	38 39 36 25 26 32 33 31 26 27 34 32 31	47 49 50 32 46 36 33 34 39 41	55 54 51 53 48 47 41 53	56 49 50 53 55 52 53 50	43 44 48 45 44 59 32 46 42 39 44 41	41 44 37 48 40 41 45 24 45 41 39 38 44	31 30 46 42 32 39 27 40 32 30 33 27 32	27 22 31 28 19 29 25 24 16 17 22	29 15 26 24 23 20 21 25 16 17 18	28 41 37 44 47 35 31 44
D-I ave.					28	~~28~~ 37	~~37~~ 32	~~32~~ 20	~~20~~ 15	~~15~~ 16	~~16~~ 27	~~22~~ 41	~~44~~ 31	~~31~~ 31	~~34~~ 41	~~47~~ 50	~~54~~ 53	~~53~~ 44	~~44~~ 43	~~43~~ 34	~~34~~ 26	~~28~~ 21	39
A-I ave	45	15.5	46	17	28	38	31	20	15	17	32	44	33	33	42	51	53	45	44	35	27	21	39

App. 5·6

STATIONS A-I

SPECIES NO. 4

Ave. no. of plants. /30gm.

	10/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	1/4
		6	14	7	247	253	8	264	730	248	311	2	2	138	∞	14	65	27	116	65	880	30	42
		8	5		233	170	264	144	380	41	43	26	62	163	∝	2	11	449	51	27	620	36	21
		5	7		319	284	534	127	337	35	42	22	34	147	∞	1180	43	332	62	71	350	10	500
					222	393	483	205	379	35	34	46	7	4	198	1080	881	360	770	1080	273	545	200
					199	280	583	215	230	15	39	6	∞	21	178	840	540	254	670	420	360	425	190
					211	202	266	136	142	65	6	2	4	16	256	150	342	213	140	260	268	215	165
					198	84	257	39	177	17	34	14	3	22	39	47	580	406	268	260	402	240	135
					93	48	198	150	106	32	41	82	36	44	54	76	195	125	320	432	280	270	111
					166	125	158	258	40	59	13	15	15	16	81	43	172	264	215	90	280	265	138
					135	231	212	270	191	31	47	25	14	88	210	59	38	85	96	735	395	75	45
					286	197	214	313	83	18	18	17	10	12	19	24	127	119	835	465	396	180	175
					212	300	81	142	131	104	7	18	7	45	26	21	108	49	635	180	170	90	96
						291	51	228	184	10	25	11	20	177	28	36	43	186	342	395		85	69
						267	204	254	210	38	33	1	60	87	31	28	152	270	650	412		225	0
							150	255	183	18	9	13	245	84	19	146	172	117	565	250		195	0
							335	353	201	23	17	5	52	99	187	87	152	322	425	230		135	0
							409	340	122	282	163	372	69	134	130	46	321	394	650	155		230	35
							259	365	172	59	186	412	43	192	72	112	260	93	845	860		200	0
							208		247	145	161	365	92	96	138	56	280	250				130	0
							239		194	106	104	145	149	119	147	39	365	365				0	
							248		254	37	70	64	74	81	120	146	430	525				0	
							451		310	12	16	104	95		541	63	390					90	
							332		286	112	108	162			91	115	260					0	
									326		176	131			132	140	280					0	
												101				96	260						
																101	770						
A-I ave		6	9	7	210	223	262	225	234	62	68	86	49	81	112	147	278	288	425	351	389	150	102

App. 5·7

STATION A-I

SPECIES NO. 5.

	10/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
A-C (average)	+	+	+ + 0	0 + 0	·1 + +	0 + 1·8	2·4 ·3 0	0 0 0	0 0 0	0 0 0	3·6 14 +	11·3 4·1 5·3	10·9 5·4 31·3	26·5 4·5 62·3	36·7 19·6 48	106·3 50·6 124	63·7 83·3 98·2	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
	~~+~~	~~+~~	~~+~~	~~0~~	~~+~~	~~·2~~	~~2·7~~	~~0~~	~~0~~	~~0~~	~~18~~	~~21~~	~~47~~	~~93~~	~~104~~								
	+	+	+	0	+	1	1	0	0	0	6	7	16	31	35,	94	82	0	0	0	0	0	0
Biomass. (gms/3sqm) dry wt. DI(average)				0		0	0	0	0	0	530 43 38 25 39 1	177 18 12 29 9 3	194 32 15 23 31 32	22 53 9 2 16 9	12 6 20 31 35 79	56 51 11 103 132 462	168 319 28 166 103 37	0	0	0	0	0	0
				0	0	0	0	0	0	0	29	14	27	19	31	69	137	0	0	0	0	0	0
A-II (average)	+	+	+	0	0	0	0	0	0	0	20	12	22	23	32	77	118	0	0	0	0	0	0

eliminate as atypical.

App. 5.8

STATION A-I

SPECIES NO. 5

		18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
%water.	A-C						75 68 72	51 50				59 66 60	54. 47 73 59 60 55	52 57 58 55 42 57 54	50 51 43 49 46 53 51 50	56 60 57 47 48 55 54	63 62 71 73 68 70	74 75 68 74						
	ave.						72	51.				62	58	54	50	54	68	73						
	D-I											52·1 55 59 55 53 55 67 69	53 54 54 63 73 58 52 26 24 47 61 55 75	53 58 68 55 56 46 43 49 56 52 42 43	48 57 28 35 47 46 83 44 52	52 63 70 56 57 46 56 51 53 51	72 66 74 63 70 79 68	78 72 69 84						
	ave											58	53·4	53·5	44·5	55·5	70	76						
A-I average							72	51				59	55	54	47	55	69	74						

App. 5.9

STATION A-I

SPECIES NO. 5

		10/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
no. plants/ 3sqm.	A-C	1	3	5 ∞ 0	0 ∞ 0	∞ ∞ ∞	∞ ∞	∞ 0	0 0 0	0 0 0	0 0 0	203 439 197	264 201 872	464 344 1051	407 79 957	487 216 2942	460 547 1007	365 357 769	0 0	0	0	0	0	0
	ave	1	3	5^+	+	+	+	+	0	0	0	279	446	620	481	1215	671	498	0	0	0	0	0	0
	D-I					∞ ∞ ∞	0 0 +	0 0 +	0	0	0	400 1763 2825 1870 2340 1693	200 1000 398 123 519 404	234 493 1119 175 1773 1902	118 707 1262 39 767 553	162 673 365 389 331 643	370 628 316 569 547 895	219 343 22 515 582 258	0	0	0	0	0	0
	ave.					+	+	+	0	0	0	1815	441	949	574	427	556	323						
A-I average.		1	3	5^+	+	+	+	+	0	0	0	1303	442	839	543	690	594	381	0	0	0	0	0	0

App. 5.10

STATION A-I

SPECIES NO. 8.

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
A-C	3.7 +	7.5 0	6.5 +	4.2 + +	+ + +	+ +					3.1 42.9 +	10.6 24.4 9.5	4.7 25 15.6	5 20.6 23.6	5.4 29.7 41.6	+ 54.7 15.2	29.5 61.7 +	62.8 35.1 +					
ave.	1.9+	3.8	3.3+	1.4+	+	+					15.5+	15	15	16.4	25.6	23.3+	30.4	32.6+					
Biomass (gms / 3.09m) dry wt. D-I				0 0 0 0 0 0	+ + + + + +						4.1 .7 .2 1.1 1.4 .6	5.5 15.3 1.1 .4 11.1 3.6	17.5 7.7 4 12 15.3 7.5	41.9 18.4 3.6 14.7 37 12.8	126 17.3 12.3 9 41.1 16.5	153 6.3 12.1 20 49.9 60.9	6.8 1.1 49 20.3 36.1	15.8 0 116.2 33.2 24.1 110	+				
ave				0	+						1.3	7.8	10.7	15.7	37.1	27.4	22.7	49.9	+				
A-I average	1.9+	3.8	3.3+	+	+	+	0	0	0	0	6	10	12	16	33	26	26	44	+	0	0	0	0

App. 5.11

STATION A-I

SPECIES NO. 8

	18/3 1972	16/4	14/5	11/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	4/4
	77 91	40 39	29 7 54	8 13 12	10						83 38 87 88	99 85 87 12 84	85 84 84 39 86 92 83	71 73 74 75 63 64 82	81 82 81 83	81 83 85	62 79 78 81	76 73 70 64 66					
	84	40	30	11	10						59	62	78	72	82	83	75	70					
% water											85 88 83 91 93 92 77 79 92 85 88 86 13 87 69	70 8 86 88 92 84 86 85 86 87 85 88	86 85 61 85 84 86 88 85 87 84 82 88	82 81 83 80 72 79 75 82 80 79	91 75 85 81 84 82 84 83 84 85 84 83	85 86 87 85 89 85 86 85	83 84 84 83 82 81 86 79 81	64 74 73 68 63 61 74 73 62 74 72 65					
											81	79	83	79	83	86	83	70					
											75.0	74.0	81.5	76	83	85	80	70					

App. 5.12

STATION A-I

SPECIES NO. 8

no. plants/ 3sq m.

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
A-C	4 4		3 +	3 + 1	∞ ∞ ∞	+					72 204 29	66 236 49	41 150 42	29 87 48	8 102 24	12 110 29	12 72 4	11 57 2					
ave.	4	0	2+	1	+	+	0	0	0	0	102	117	78	55	45	50	29	25	0	0	0	0	0
D-I											72 26 10 25 52 15	60 49 14 83 78 46	35 57 29 24 68 37	20 48 22 45 73 44	26 23 31 22 68 26	25 3 43 70 50 45	2 33	18 1 38 10 8 37					
ave											35	55	42	42	33	39	18	19	0	0	0	0	0
A-I ave.	4	0	2+	1	+	+	0	0	0	0	57	76	54	46	37	43	25	21	0	0	0	0	0

App. 5·13

STATIONS A–I

SPECIES NO. 7

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
	4·2	1·2	·3	·5 0	·4 + 0 ·2	·4 0 0 +	+ ·2 ·8 + ·3	·5 + + ·2	+ + 0 ·7	+ ·4 +	+ + + ·1	1·1 + 1·6 + +	·6 + + + + + + 1·1	·9 ·1 ·5 1·8 ·5 1·0 + 1·8	+ + + + + ·4 + + +	+ ·1 + ·3 ·5	+ + +					+ +	+ +
Biomass (gms / 3.09m) dry wt.	·21	·6	·15	·17	·07	·04	·14	·08	·08	·04	·01	·3	·19	·73	·04	·1	+	0	0	0	0	+	+
% water	57·3 60·6	55·7 55·1 66·7	29·7 42·8	46·6 50 33·3	72·4 81·2	50	53·6 50 61·5	50 52·6 76·9 51·7	36·4	43·7 61·1	73·9 98 69·5 65·2 66·6 75	98 57·1 96 29·5 61·1	57·4 57·2 53·8 52·9 58·3	34·8 33·3 36·8 53·4 50 66·7 68 37·9 93·9 38·7 51·7 44 32·5 43·7 42·6 36 40·6 36 40·6	96·5 50 53·8 66·6	66·6 50 40 40·9 33·3 44·4 66·6							
average	59	59	36	43	77	50	55	58	36	52	75	68	56	48	67	49							

App. 5·13 cont.

STATIONS A–I

SPECIES NO. 7.

	10/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
no. plants/ 3 sq m.			10	2	5 2 2	0 1 1 2	5 22 + + 1 +	1 + 3 3 +	1 3 3	1 4 1 +	4 3 1 5	27 2 6 + 2	27 0 8 + + + 5 36	23 7 29 53 53 22 7 18 43	8 9 1 4 6 26 12 + 5	7 10 4 13 15 1	+ +	+ +	⊕			+ + 1	1 +
average	0	0	5·0	·7	1·0	·5	3·1	·8	·8	·7	1·4	4·2	8·5	28·6	8·0	5·6	+	+	0	0	0	·1	·1

App 5·13

App. 5.13 cont.

STATIONS A-I

SPECIES NO. 9

	10/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
	1	16.1 +	21.3 +	10.2 + +	20.9 + + .2 +	+ .1 + + + 5.8 +	6.4 + + + .2 3.7	34 + + + .4	59 + +	5.6	+ .2 + + .8	+ + + .8 + + +	+ 48 + + + +	1.3 16.1 11.8 20 125.1	.5 + 23.8 12.8 + + 62	20.0 + + 2.2 + + +	+ + + + +	+ 8.0 .8 + + + + +	100 1.6 + + + 8.2	74 + + 1.5 + + + +	114	32.3	+
Biomass average (gms/3.sq.m) dry wt.	1	8.1	10.7	3.4	.3	.7	1.1	4.2	6.6	.6	.1	.1	5.3	17.4	11+	.5	+	1.1	12.2	8.4	13	3.6	+
% water.	56 68	44 41 40	38 17 26	27 27	34 48 70	49 69 83 59 57 72	43 56 59 62 59 58	65 67 42	31 37 33	26 31	45 67 45	37 60	67 49 56 51 84	47 46 60 61 59 54 62 61	66 66 47 48 57 47 35	80 67 81 73 66	75 78	57 55 60 66 63 53	61 58 48 72 70 63 60 75 61	42 55 57 47	48	53 61	36
average	62	42	27	27	51	63	56	58	34	29	52	49	61	56	52	73	77	58	64	50	48	57	36
no. plants/ 3.sq.m. (over 2cm long)			10	0	3 1 2	3 1 1 6 +	3 1 1 + 1 2	11 + 2 +	15 +	6	4 1 + +	1 + + + 1 + +	1 7 + + + + 1	3 27 ∞ 7 2	2 15 ∞ 8 + 2	8 6 ∞ + 16 1 ∞	∞ 3 1 +	∞ 118 1 ∞ 12 + +	215? 7 1 8 4 ∞	8 2 19 + ∞ +		∞	72?
average			3.3	0	.7	1.2	.9	1.4	1.7	.7	.6	.2	1	4.9	3.4	4.4	.5	3.4	3.0	4.1	0	0	+

App. 5·14

STATIONS A-I

SPECIES NOS 2+11 Combined.

	15/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Biomass (gms/3sqm) dry wt.	2·08 3·3	1·0 2·1	1·2 5·2 12·3	2·0 2·2 4·5	+ + +		+								7·0 5·9 22·3 11·7 20 19 3·3 2·4 8·6	21·6 4·3 34·7 68·8 56·7 27·2 16·3 40 23·5	149·8 15·3 106·7 62·1 56·6 84·2 51·2 153·6 371						
av.	3·1	1·6	6·2	2·9	+	0	0	0	0	0	0	0	0	0	11·1	32·6	116·7	0	0	0	0	0	0
no. plants/3sqm.		no data available													553 840 1007 617 115 420 60 225 300	897 445 1337 240 257 2003 115 690 940	726 1134 1527 962 662 841 140 310 630						
average						0	0	0	0	0	0	0	0	0	460	847	770	0	0	0	0	0	0
% water.															34·6 31·5 32·1 20 33·3 41·7 40·9 36·5 34·9 39·0	24·2 27·0 30·4 27·9 26·3 26·9 25·4 24·3 ~~[illegible]~~	33·3 22·7 32·0 35·9 29·4 33·8 31·6 28·2 33·0.						
average															34·5	26·6	31·7						

App. 5.15

STATIONS A–I

SPECIES NO. 1

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
AC	34 20	29 20	25 31 143	15 31 80	33 40 80	23 47 80	16 30 70	31 50 148	71 54 133	0 76 68	0 14 12	+ 22 3	+ 13 +	+ 25 +	+ + +	0 + 0	0 0 0	310 140 180	190 75 160	80 112 29	170 150 140	40 215 113	26 130 29
ave.	27	25	66	42	51	50	39	76	86	48	9	9	5	9	+	+	0	210	142	74	153	123	62
Biomass (gms / 3 sq m) dry wt. DI					60 26 84 15 71 34	12 78 85 48 122 41	28 44 55 81 75 14	48 39 66 89 83 22	26 102 86 61 48 37	8 33 53 83 31 54	+ 5 6 5 34 21	+ 4 + 19 45 24	0 + 0 34 35 37	+ + 85 19 72 55	+ + 14 16 18 102	0 0 + 0 0 0	0 0 0 0 0 0	62 111 200 185 126 141	190 178 173 169 230 244	156 172 115 81 409 450	120 300 87 105 438 440	201 312 60 201 576 385	308 257 207 146 104 630
ave.					48	64	49.5	58	60	44	11.5	15	18	38.5	25	+	0	137.5	197	220.5	248	289	435
A–I average	27	25	66	42	49	60	46	82	86	45	11	13	13	28	17	0	0	173	179	178	217	234	311

App. 5.16

STATION A-I	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Ave. total biomass of all species. (gms/3.sq.m)	25	27	24	44	35	40	55	44	41	21	48	32	57	86	111	174	370	193	204	202	167	65	82
Ave. biomass of ground litter. (gms/3 sq m.)	27	25	66	42	49	60	46	82	86	45	11	13	13	28	17	0	0	173	179	178	217	234	311
Ave. total of all organic material (gms/3 sq m.)	52	52	90	86	84	100	101	126	127	66	59	45	70	114	128	174	370	366	383	380	384	299	393

APPENDIX 5.17

Biomass changes in "Open" vs. "Closed" quadrats — proportional comparison.

APPENDIX 5·17

STATION A

SPECIES NO. 4

Biomass
(gms / 3.09m)
dry wt.

18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
1·2	+																					
·7	+	+																				
	+	+	+																			
		+	—	+																		
			·6	·6	·6																	
				—	—	·4																
					16·8	15·0	8·7															
						2·0	—	·5														
							—	—	—													
								—	—	—												
									+	+	+											
										+	+	+										
											+	+	+									
												—	+	—								
													+	—	+							
														—	+	6·8						
															+	1·2	7·5					
																4·5	+	28·5				
																	+	4·5	21·9			
																		5·2	11	10·1		
																			11	4·7	26·4	
																				4·7	18·4	46·2
																					2·9	8·4

App. 5.17 cont.

STATION C

SPECIES NO. 4

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Biomass (gms / 3.09m dry wt.			2·3 1·2	12·2 10·3 40·6	29·5 29·5 21·5	49·2 30·0 27·6	60 48 39	13·9 21·5 17·5	18·5 3·8 1·4	4·6 + +	2·0 + +	·3 + ·3	+ + 0	+ + +	4·5 4·4 5·8	6·1 1·9 3·1	61 20·5 18·1	40 40 33·6	113 65 110	53 62 62	110 134 134	128·5 124·5 165·5	68·7 72·5
OPEN, changing in proportion			1·8	(8·6) 15·5	(·73) 11·3	(1·4) 16·2	(1·74) 28·2	(·55) 15·5	(·22) 3·4	+	+	+	0	+	5·1	(·33) 1·7	(6·6) 11·1	(2·2) 24·4	(1·94) 47·3	(·56) 26·5	(2·16) 57·2	(·93) 53·2	(·54) 23·4
CLOSED, relative to open.			1·8	(5·3) 9·5	(2·87) 14·5	(1·66) 18·8	(2·0) 32·4	(·29) 8·2	(·86) 13·3	(1·21) 4·1	+	+	0	+	5·1	(1·37) 7·1	(3·2) 54·4	(1·95) 21·6	(2·82) 68·8	(·82) 38·8	(1·77) 46·9	(·94) 53·8	(·55) 29·3

App. 5.17 cont.

STATION D

SPECIES NO. 4.

	10/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Biomass (gms/3sqm) dry wt.					29·5 31·5	34·2 39·5 51·5	52·8 36·5 21·3	26·5 31·2 9·5	26·1 23·5 8·2	10·1 2·5 18·8	7·2 8·7 2·8	12·8 1·8 3·9	1·7 8·7 2·4	18·2 14·6 18·3	6·8 9·4 14·2	11·6 15·9 6·5	8·1 27·1 23	75·5 115·2 63	55·6 73·5 136	74·4 97·5 98	114 150 112	88·5 77 43·5	130 129
OPEN, Changing in proportion					31	1·25) 38·9	·71) 27·5	1·46) 40·2	2·48) 100	·31) 31	·46) 14·2	·64) 9·1	2·23) 20·3	6·1) 124	·51) 63	1·12) 70·5	4·16) 294	5·0) 1470	1·16) 1700	·72) 1222	1·53) ·1889	·69) 1294	2·96) 3825
CLOSED, relative to OPEN					31	1·2) 37·2	1·3) 50·5	·73) 20·0	·84) 33·8	·43) 43	2·9) 89·9	1·47) 20·9	·95) 8·6	1·98) 40·2	·47) 57	1·24) 78·1	·51) 36	2·74) 806	·48) 705·6	1·01) 1717	1·17) 1430	·59) 1115	1·69) 2187

App. 5.17 cont.

STATION E SPECIES NO. 4	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Biomass (gms / 3.0qm dry wt.)					65.8 38.0	43.0 19.2 67.0	41.6 85 53	57.6 18.6 14.0	51.8 11.5 23	10.5 14.5 1.7	14.7 5.7 2.2	13.5 14.0 2.2	3.6 1.6 6	7.5 1.7 .9	9.2 .8 1.1	2.2 3.8 2.9	3.9 3.9 13.7	37 52 21.4	118 69.6 396	65.7 224 178	185 126 130	158 69.5 30.5	100 85
OPEN, changing in proportion					51.9	.5) 26	1.27) 33	.35) 11.5	.82) 9.47	.63) 5.96	3.35) 20	6.38) 127	.73) 93	.27) 25	.89) 22.4	3.45) 77	1.34) 107	3.8) 407	3.25) 1320	.57) 753	.71) 536	.53) 294	2.8) 793
CLOSED, relative to OPEN.					51.9	.65) 33.7	2.17) 56.4	.68) 22.4	2.75) 30.8	.91) 8.6	1.01) 6.0	2.37) 47.4	.26) 32.6	4.7) 437	5.4) 135	2.5) 61.6	1.02) 78.5	9.5) 617	2.27) 924	.94) 1241	.82) 618	1.26) 675	1.44) 409

App 5.17 Cont.

STATION F

SPECIES NO. 4.

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Biomass (gms/3sqm dry wt.)					36.0 26	20.2 20 7.5	13.5 4.5 65.5	11 40 46.5	67.2 32 6.2	27.6 3 21.9	2.4 3.0 .7	5.3 3 3.2	4.4 14.5 14.5	10.7 15 20	25.3 28 17.2	21.1 12.6 6.6	63.5 56 118.5	118 171 74.3	378 173.4 405	159 176.1 60.5	331 124 75	78 57.5 118	13.5 18.0
OPEN, changing in proportion					31	.77) 23.9	.60) 14.3	.61) 8.75	.69) 6.05	.049) .296	.137) .041	4.28) .174	4.53) .79	1.03) .81	1.4) 1.14	.73) .83	8.5) 7.0	1.44) 10.1	2.32) 23.4	.43) 10.1	2.05) 20.6	.77) 15.9	1.53) 24.3
CLOSED, relative to OPEN.					31	.56) 17.4	.68) 16.3	2.45) 35	1.18) 14.7	.86) 5.2	.8) .237	1.77) .073	1.47) .256	.74) .58	1.69) 1.37	.75) .86	5.04) 4.2	2.1) 14.7	2.21) 22.3	.93) 21.5	1.98) 20.0	.63) 13.0	.234) 3.7

App. 5.17 cont.

STATION G

SPECIES NO. 4

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Biomass (gms / 3.09m dry wt.)					48.6 32.7	40.2 59.5 27.5	32.7 42 55	56.0 66.5 52	39.5 11.0 54.5	9.6 12.0 135	9.1 91.2 57.6	5.1 7.2 2.5	83 26 26	70.4 47 9	33.8 23.5 3.2	15.4 12.3 8.6	109.3 117.9 153.5	185 179 84.5	306 184 146	105 67 145.5	118 105.4 141	147 130 66	189 58.8
OPEN changing in proportion					40.7	1.82) 714	1.53) 113	1.21) 136.7	.21) 28.7	.22) 6.3	.67) 4.2	.13) .55	10.4) 5.7	1.91) 10.9	2.6) 28.3	3.54) 109	13.7) 14900	1.16) 1730	2.17) 3760	.46) 1730	.72) 1250	.92) 1150	.89) 1024
CLOSED, relative to OPEN					40.7	.83) 33.8	.55) 40.7	1.34) 151.4	.60) 82.0	.87) 25.0	.76) 4.8	.06) .25	11.5) 6.3	2.7) 15.4	.72) 2.18	.66) 18.7	8.9) 970	1.6) 2384	1.1) 2941	.57) 2143	1.76) 3045	1.44) 1750	1.45) 1668

STATION H

SPECIES NO. 4

	18/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	5/3	6/4
Biomass (gms/3.09m) dry wt.					38 34.5	32.5 55 69.5	108 123 124.5	94 55.5 54.5	83.6 70 83	29.4 63 50	66.8 58 61.2	52.8 33.6 16	47 55 55	142.9 111 158	103.2 117 95.5	172 714 135	510 463 308	295.5 296 635	401 520 520	304 609 609	292 290 290	0 0 0	0 0
OPEN, changing in proportion					36.3	1.6) 58	1.77) 103	.44) 45.3	1.29) 58.5	.76) 44.5	1.16) 51.5	.55) 28.4	3.44) 97.6	2.0) 195	.74) 145	.77) 111.5	3.43) 372.5	.96) 357	.82) 293	1.17) 343	.48) 164	0) 0	0) 0
CLOSED, relative to OPEN.					36.3	.85) 30.9	1.96) 113.7	.77) 79	1.5) 68.0	.42) 24.6	1.06) 47.2	.91) 46.9	1.14) 39.8	.78) 76.1	.93) 181.4	1.47) 213.2	6.9) 769.4	.64) 238.4	1.36) 485.5	.58) 169.9	.42) 164	0) 0	0) 0

App 5.17 cont.

STATION I

SPECIES NO. 4

	19/3 1972	16/4	14/5	17/6	22/7	19/8	23/9	28/10	18/12	3/2 1973	3/3	1/4	25/4	10/6	8/7	5/8	9/9	13/10	11/11	18/12	23/1 1974	3/3	6/4
Biomass (gms / 3.09m) dry wt.					49·7 23·9	47·0 17·5 44·5	29·8 49·3 84	41 77·2 65·5	90·3 73·5 69·5	13·8 4·6 21·5	18·0 24·4 80·5	53 5·2 48	77·8 51·0 45	76·8 169·5 56·5	93 40·6 59·0	111 76 80	139 129 408	457·5 353 350	389 311·2 390	556 556 556	89·5 90 90	+ + 7·0	– – 28·5
OPEN. changing in proportion					36·8	·73) 26·8	1·1) 29·5	·92) 27·1	1·1) 29·8	·07) 2·08	1·1) 2·3	·06) ·14	1·01) ·15	3·8) ·58	·72) ·42	1·2) ·54	1·4) ·87	·87) ·75	·89) ·67	1·4) ·94	·16) ·15	·9) 0	4·1) 0
CLOSED. relative to OPEN.					36·8	·95) 35·0	1·7) 45·6	·83) 24·5	1·17) 31·7	·19) 5·7	3·9) 8·1	2·1) 4·8	15·0) 2·1	1·5) ·23	·55) ·32	2·7) 1·13	1·8) ·97	3·6) 3·1	1·1) ·83	1·8) 1·2	·16) ·15	·00) 0	0) 0