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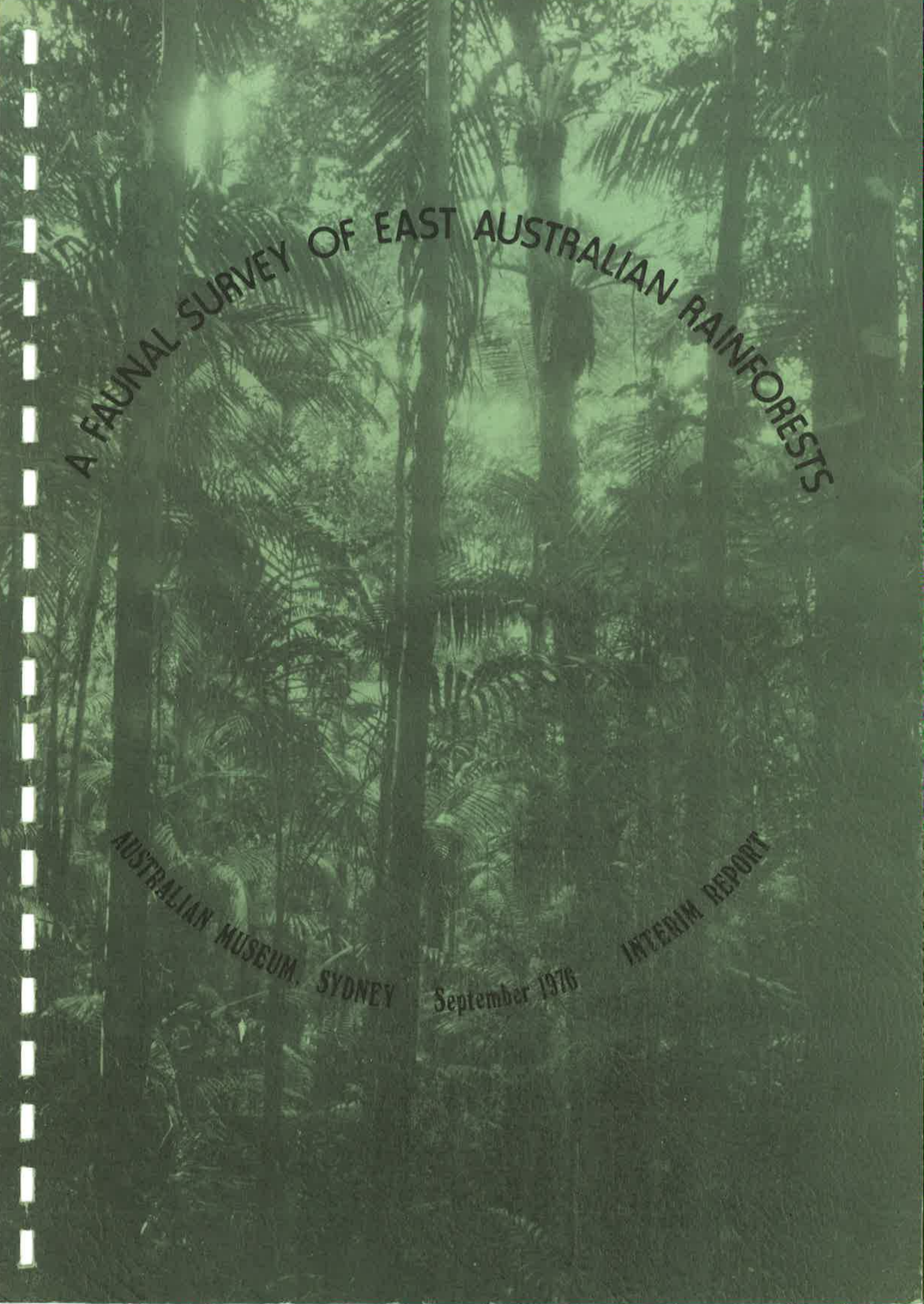

A FAUNAL SURVEY OF EAST AUSTRALIAN RAINFORESTS

AUSTRALIAN MUSEUM, SYDNEY September 1976 INTERIM REPORT

A FAUNAL SURVEY OF EAST AUSTRALIAN RAINFORESTS

Studies by the Australian Museum in mid-eastern and north-eastern Queensland and northern New South Wales

Edited by J. Broadbent & S. Clark

INTERIM REPORT

Contents

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General Introduction

Rainforest is one of the most important ecosystems found in Australia. It occurs patchily along the east coast and (as monsoonal forest) across the north of the continent. Rainforest itself is of very limited extent, covering some 1.8 million hectares - scarcely 0.24% of the total land surface (Miller, 1974). Since the arrival of European man widespread clearing has taken place. Baur (1957), for example, estimated that only 50% of the rainforests of New South Wales now remain, while Floyd (in Colley, 1975) recently put the figure at 10%. The patchy or "island" occurrence of rainforest has also been accentuated by man's activities. Apart from total clearance for agricultural purposes, rainforests are also selectively logged for timber, some 3.5% of timber production in 1972/73 being from this source. At the same time rainforests are a major source of inspiration, enjoyment and recreation for man and a rich store of biological information. The recreational value of rainforests can be gauged from the estimate that some 59,000 people visited Lamington Park alone during 1972 (Colley, 1975). The exceptional biological richness of rainforests is well exemplified by the fact that 81 (15%) of the 531 species of Australian land and freshwater birds are specific to or reach their greatest abundance in rainforest (Keast, 1959, 1961).

Botanical studies of east Australian rainforests have a long history, although they have been largely concerned with plant systematics until recently. It was not until the late 1950s that the first detailed classifications of east Australian rainforests became available, together with a better understanding of the environmental factors that determine their distribution. Two classifications were developed almost concurrently, one floristic (Baur, 1957) and the other structural/physiognomic (Webb, 1956, 1959). Baur limited his floristic classification to the rainforests of New South Wales. He recognised four main subformations (or leagues), which he referred to as tropical, subtropical, temperate and dry rainforests, and within these subformations he defined six alliances and some 18 associations. Briefly, his tropical rainforests were characterised especially by the Black and White Booyongs

PLATE 1 - Examples of structural characters of rainforest - vines

Heritiera (Argyrodendron) spp, Rosewood Dysoxylum fraseranum, and Silver Quandong Elaeocarpus grandis, the subtropical forests mostly by Coachwood Ceratopetalum apetalum, and the temperate forests by Negrohead Beech Nothofagus moorei. The dry rainforest associations were more diverse, but included the true dry rainforests (characterised by Yellow Tulip Drypetes australasica), the littoral rainforests (Cupaniopsis Cupaniopsis anacardioides) and the riverine rainforests (Black Bean Castanospermum australe). This classification, which has since been slightly modified (Baur, 1965), was used as the basis for site selection in northern NSW, although the sites were later identified in terms of Webb's structural and floristic classifications (see below).

Baur found that the distribution of the different rainforest alliances in NSW was determined by a complex interaction of several environmental factors. Not surprisingly he considered rainfall a major determinant of distribution, the main rainforest tracts in NSW being only in areas of high annual rainfall ($>$1400mm). Temperature was another important factor, with a major influence on the progressive replacement of tropical by subtropical rainforests in lowland areas from north to south in the state. A third important factor was soil nutrient status, particularly phosphorus content. Thus, high phosphorus levels were found to favour tropical rather than subtropical rainforest in northern NSW. Other environmental factors of lesser significance were wind and fire. However, it was the interaction of all these factors which determined the type of rainforest found at any one locality. Topography also had a demonstrable effect on rainforest distribution, through its influence on soil moisture and nutrient status as well as exposure.

To avoid confusion later, it should be noted now that Baur's first three subformations - tropical, subtropical and temperate - are referred to by Webb (1959) as subtropical, warm and cool temperate respectively, and it is these latter terms which will be used in the rest of this report.

Webb's (1959) classification is based on the structural/physiognomic characters of rainforest throughout east Australia. Initially he recognised 12 structural/physiognomic types, but this was later increased to twenty

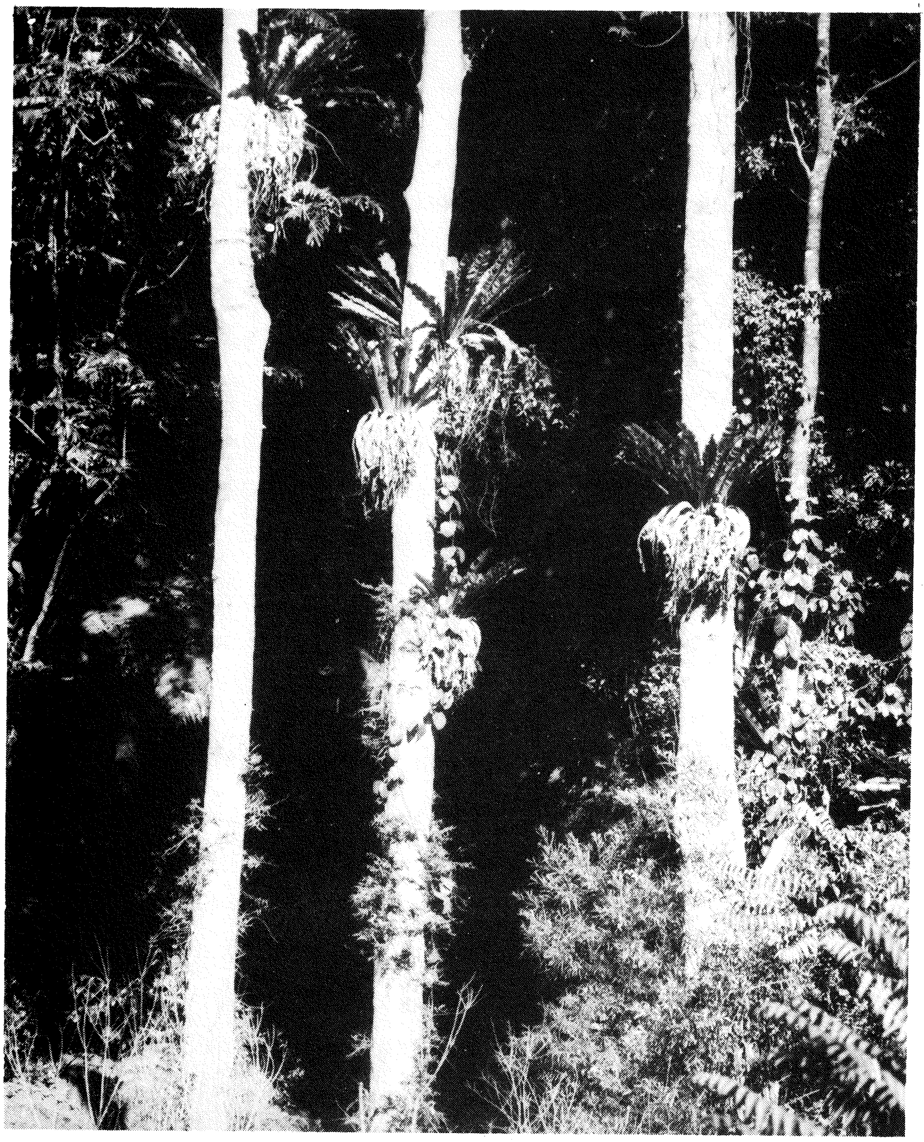


PLATE 2 - Examples of structural characters of rainforest - epiphytes

PLATE 3 - Examples of structural characters of rainforest - buttressing

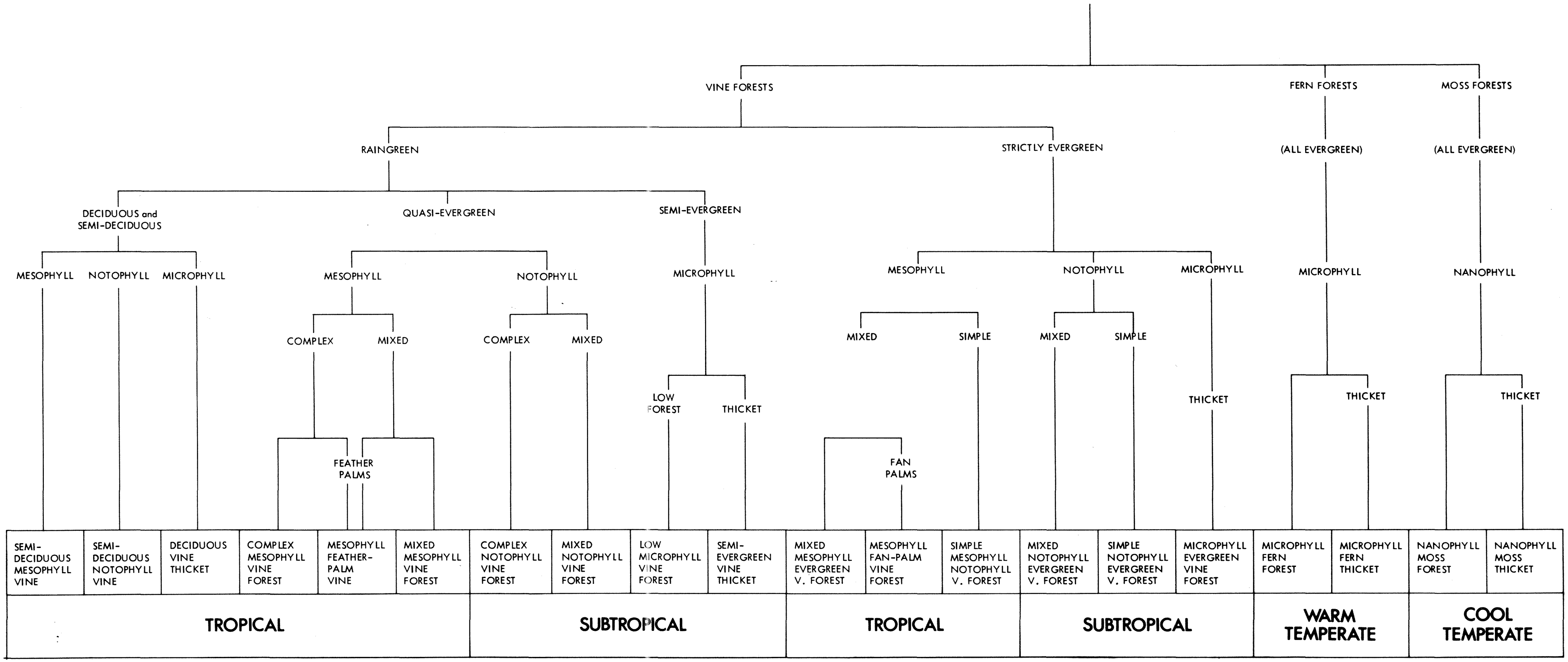
(Webb, 1968). As this classification provided the main basis for the present study, it is reproduced in Figure 1. It can be seen that the primary division is into vine, fern and moss forests - these corresponding to tropical/ subtropical, warm temperate (submontane) and cool temperate (montane) thermal regions respectively. Evergreen and raingreen (i.e. forests with one or more deciduous species during the dry season) forests are next distinguished. There is then a major division on leaf size, this in large part separating the tropical and subtropical rainforests. The former are characterised by a higher proportion of mesophyll than notophyll leaves, while the converse is true for the latter. Further separation is then made into simple, mixed and complex forests, these terms referring to the incidence of special life forms such as tree ferns, palms, strangler figs, buttresses, vines and epiphytes (see Plates 1-4).

Webb showed a high correlation of the structural types he had defined with certain climatic and edaphic factors. Considering individual structural features (e g deciduousness, leaf size, incidence of palms, tree ferns) he found a close relationship between their occurrence and such environmental factors as latitude, altitude, average annual rainfall and soil mineral status (broadly defined as eutrophic, mesotrophic and oligotrophic). As the latitudinal and altitudinal associations probably reflect a more basic interaction with temperature, it can be seen that both the structural/physiognomic and floristic classifications of Webb and Baur respectively can be interpreted in terms of the same environmental factors.

Apart from the major influence of climatic and edaphic factors on the nature of rainforest vegetation, Webb also considered fire to be important. This is most evident outside the main rainforest tracts where, because of fire, a seral stage in growth is frequently encountered rather than the stable climax vegetation. Webb speculated that the relative floristic poverty of the evergreen vine forest and fern forest types may be due to repeated fires and noted that vine forests on lower fertility soils could be irreversibly destroyed by fire under present-day climatic conditions.

A current development of some importance is the definition of a floristic classification for all east Australian rainforests (Everist & Webb, 1975).

Figure 1: A hierachical classification of the structural types of Australian rainforest vegetation, after Webb (1968)



Numerical analysis of 265 rainforest and monsoon forest sites with 1147 tree species has identified six primary floristic provinces, three of which are regarded as tropical (see Figure 2).

Zoological studies in east Australian rainforests also have a long history, but it was not until the comprehensive botanical classifications of these rainforests became available that systematic zoo-ecological studies began. These have been pioneered in the field of avian ecology, most particularly by Kikkawa and more recently, on rainforest pigeons especially, by Crome. Their studies are considered in more detail in the bird section of this report. Monteith (1975) has recently reviewed some of the ecological problems facing rainforest entomologists in Australia and is himself carrying out some broad ecological studies on selected groups of rainforest insects.

In view of the inadequacy of faunal information about a rare and interesting community, the Australian Biological Resources Study Interim Council made funds available to the Australian and Queensland Museums in June 1974 for a joint rainforest faunal survey. While the main emphasis of this survey was to improve the collections of the two museums for taxonomic purposes, it also provided an opportunity to obtain a better ecological understanding of the distribution of rainforest fauna. More precisely, it seemed of great importance to determine whether the fauna of structurally and floristically different rainforest types varied and, if so, how this variation could be related to changes in vegetation and the underlying physical environment. Such information would be most useful in determining priorities for reserving areas of rainforest and in devising appropriate management procedures once areas were reserved.

It was well beyond the resources of the survey to study all animal groups found within rainforest, hence an initial decision had to be made about which animals to study. Seven groups were finally chosen, mainly on the basis of the time and skills of those interested. These groups were birds, mammals, reptiles, amphibians, spiders, molluscs and flies. As will be seen from this report, five of these groups proved to be extremely useful in characterising different rainforests. They included both mobile and sedentary animals, a difference of considerable interest as an essentially 'island' situation was being studied.

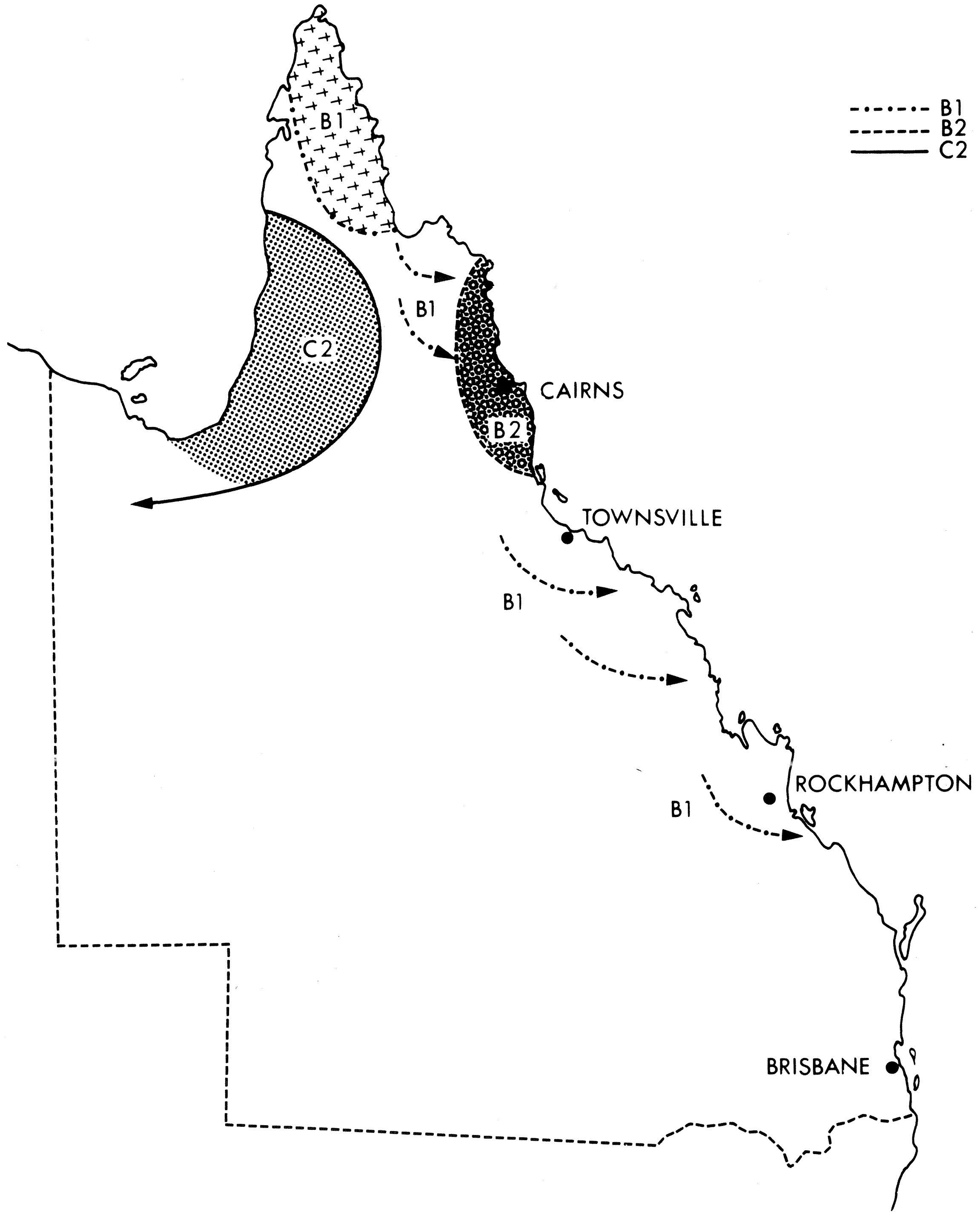


FIGURE 2 - Primary floristic provinces of tropical closed forests. B1 is tropical moist monsoonal; B2 is tropical seasonal humid; and C2 is tropical dry monsoonal (from Everist & Webb, 1975)

PLATE 4 - Examples of structural characters of rainforest - epicauliflory

It was thought from the beginning that the ecological value of the project would be enhanced if two procedures were observed. The first was to select sites which represented as broad a range as possible of the structural and floristic types recognised by botanists in east Australian rainforests. As has been mentioned already, Webb's (1968) structural classification of rainforest was used as the basis for this selection, because of its completeness and ease of use in the field. The sites thus chosen were then defined according to the floristic classification of Everist and Webb (1975). The second procedure was to use standardised study methods, so that faunal differences could be related with some confidence to characteristics of the sites involved without being confounded by variations in technique. These methods tended to suffer from two main limitations - firstly they were often inefficient as collecting methods, being chosen more for their ease of standardisation, and secondly they were often very selective, providing information on only a small part of the total representation of a particular animal group. Where possible these shortcomings were offset by encouraging fieldworkers to also make general collections at each site by methods of their own choice and by using more than one standardised method.

This report described the studies made so far. It should be clear that analyses of the results are still incomplete, so that discussion of these results is of a preliminary nature.

Study Sites

As noted already (page 12), sites were selected on the basis of both the structural/physiognomic classification of east Australian rain-forests by Webb (1968), in which twenty forest types are recognised, and the more recent floristic classification of Everist and Webb (1975) in which six primary floristic provinces are distinguished.

At the outset it was thought desirable that the sites selected should meet four criteria; they should be

a. in stands which were typical of the relevant vegetation types.

b. located in larger areas of the same vegetation type, to minimise edge or island effects.

c. undisturbed by man, e g through selective logging, grazing of domestic animals, tracks.

d. readily accessible.

In practice scarcely a third of the sites met all these criteria, while 10% satisfied only one criterion. Problems of access were greatest in north-eastern Queensland (especially Thornton Peak) while human disturbance, particularly from selective logging, was evident in over half the sites in northern NSW. What effect these limitations may have had on the results is unknown, but it is clear that much more effort and time than was originally envisaged must be given to site selection and location if criteria such as these are to be met.

Sites were mostly located during preliminary trips to each general study area. This was not possible in mid-eastern Queensland because of heavy rains, and here sites were located immediately prior to study. Once the general area for a particular site was known, a brief reconnaissance was made to ensure that visually at least there was some vegetational uniformity through the site. A centrepoint was then identified with coloured plastic tape and a large metal plate bearing the relevant site number, and a convenient access to this point was tagged.

Each site was defined as that area within 150 metres of the centre-

PLATE 5 - Complex mesophyll vine forest dominated by fan palms (Fritz Creek)

point, an area of just over 7 hectares.

Duplicate adjacent sites were located for each of the mid-eastern Queensland sites and those sites in north-eastern Queensland surveyed primarily by the Queensland Museum. This was considered necessary because these sites were surveyed for all animal groups at one time, and it was felt that this would lead to excessive disturbance if only one site was used. One such site was used for the study of spiders, reptiles and amphibians and the other for birds, mammals and molluscs. Duplication of sites was unnecessary for the Australian Museum sites in either north-eastern Queensland or northern NSW because surveys for the various animal groups at these sites were done at different times.

Information on the sites studied is given in Tables 1-3, while approximate site locations are given on the accompanying maps (Figures 3-6). Each museum undertook to study half the sites in mid-eastern and north-eastern Queensland while the Queensland Museum is studying sites in south-eastern Queensland (details not given here) and the Australian Museum those in northern NSW. The Queensland sites (Tables 1 and 2) are classified botanically in both structural/physiognomic and floristic terms (Webb, 1968; Everist & Webb, 1975), while those in NSW (Table 3) are also classified according to forest type (Baur, 1965). The moisture relations and soil nutrient status of the sites have been inferred from their structural type (see Webb, 1968).

The wide range of rainforest types encountered during the survey is illustrated by plates through the text.

TABLE 1: Information on mid-eastern Queensland sites

SITE		LOCATION		BOTANICAL CLASSIFICATION				
NAME	NUMBER	CO-ORDINATES	MAP REF. (R502 series)	STRUCTURAL TYPE	FLORISTIC PROVINCE	ALTITUDE (metres)	MOISTURE RELATIONS	SOIL NUTRIENT STATUS
BULBURIN	1	24°31'S 151°29'E	Monto 454948	CNVF	A1	540	Wet	Eutrophic
BULBURIN(AUSTRAL)	3	24°34'S 151°29'E	Monto 453944	LMVF	A1	580	Moist	Eutrophic/ Mesotrophic
EURIMBULA	4	24°11'S 151°50'E	Bundaberg 492990	MNEVF	B1	10	Wet	Mesotrophic
RUNDLE RANGE	5	23°39'S 150°59'E	Rockhampton 398056	SEVT	A1	30	Dry	Eutrophic/ Mesotrophic
CREDITON	7	21°13'S 148°34'E	Mackay 123348	CNVF	A1	920	Wet	Eutrophic
DALRYMPLE HEIGHTS	8	21°04'S 148°35'E	Mackay 125366	MNEVF	A1	1000	Wet	Mesotrophic
FINCH HATTON	9	21°04'S 148°38'E	Mackay 131364	CNVF	B1	180	Wet	Eutrophic
HOMEVALE	10	21°24'S 148°33'E	Mackay 123326	SEVT	C1	440	Dry	Eutrophic/ Mesotrophic
Mt DRYANDER	12	20°15'S 148°32'S	Proserpine 118465	SEVT	C1	120	Dry	Eutrophic/ Mesotrophic
BRANDY CREEK	13	20°21'S 148°43'E	Proserpine 140452	CNVF	B1	120	Wet	Eutrophic
Mt WILLIAM (lower slopes)	15	21°01'S 148°36'E	Mackay 127371	SNEVF	A1	1120	Wet	Oligotrophic
Mt WILLIAM (summit)	17	21°01'S 148°36'E	Mackay 127372	MEVT	A1	1259	Wet	Meso-enriched Oligotrophic

TABLE 2: Information on north-eastern Queensland sites

SITE		LOCATION		BOTANICAL CLASSIFICATION				
NAME	NUMBER	CO-ORDINATES	MAP REF. (R502 series)	STRUCTURAL TYPE	FLORISTIC PROVINCE	ALTITUDE (metres)	MOISTURE RELATIONS	SOIL NUTRIENT STATUS
TWELVE-MILE SCRUB	20	$15^{\circ}50'$S $145^{\circ}19'$E	Cooktown 322000	CMVF	B2	90	Wet	Eutrophic
HELENVALE	28	$15^{\circ}45'$S $145^{\circ}13'$E	Cooktown 309012	CMVF	n/a	150	Wet	Eutrophic
MOUNT FINLAY	29	$15^{\circ}50'$S $145^{\circ}20'$E	Cooktown 323001	MVF	B2	245	Wet	Mesotrophic
FRITZ CREEK	33	$15^{\circ}50'$S $145^{\circ}21'$E	Cooktown 325999	CMVF with dominant fan palms	n/a	30	Wet	Eutrophic
MOUNT COOK	34	$15^{\circ}30'$S $145^{\circ}15'$E	Cooktown 312042	SDMVF	B1	90	Moist	Eutrophic/ Mesotrophic
SHIPTON'S FLAT	36	$15^{\circ}48'$S $145^{\circ}15'$E	Cooktown 310005	CNVF	B1/B2	275	Wet	Eutrophic
SPEAR CREEK	37	$16^{\circ}42'$S $145^{\circ}24'$E	Mossman 330896	CNVF	B2	600	Wet	Eutrophic
THORNTON PEAK	39	$16^{\circ}11'$S $145^{\circ}22'$E	Mossman 326959	MVF	n/a	640	Wet	Mesotrophic
THORNTON PEAK	40	$16^{\circ}10'$S $145^{\circ}22'$E	Mossman 326960	SMVFF/SNVF	n/a	1020	Rainy wet	(Eutrophic/ (Mesotrophic/
THORNTON PEAK	41	$16^{\circ}10'$S $145^{\circ}22'$E	Mossman 327961	SMVFT	n/a	1260	Rainy wet	(enriched (Oligotrophic
THORNTON PEAK	42	$16^{\circ}13'$S $145^{\circ}22'$E	Mossman 325954	MVF	n/a	185	Wet	Mesotrophic

TABLE 3: Information on northern New South Wales sites

SITE		LOCATION		BOTANICAL CLASSIFICATION					
NAME	NUMBER	CO-ORDINATES	MAP REF. (R502 series)	STRUCTURAL TYPE	FLORISTIC PROVINCE	FOREST TYPE	ALTITUDE (metres)	MOISTURE RELATIONS	SOIL NUTRIENT STATUS
RED SCRUB	45	28°38'S 153°19'E	Tweed Heads 649448	CNVF	A1	White Booyong (_H. trifoliata_)	210	Wet	Eutrophic
WIANGARIE	46	28°23'S 153°06'E	Tweed Heads 626480	CNVF	A2	Booyong (_Heritiera_ spp.)	1000	Wet	Eutrophic
MARENGO	47	30°06'S 152°25'E	Dorrigo 549271	SNVF	A2	Coachwood-Crabapple (_Ceratopetalum_-_Schizomeria_)	1020	Wet	Enriched Oligotrophic
Mt BOSS	48	31°09'S 152°22'E	Hastings 547143	MFF	A2	Beech-Coachwood (_Nothofagus_-_Ceratopetalum_)	1050	Wet	Eutrophic/ Mesotrophic
BEAURY	50	28°27'S 152°24'E	*Warwick MP4150	CNVF	A2	Black Booyong (_H. actinophylla_)	810	Wet	Eutrophic
CHICHESTER	51	32°06'S 151°26'E	Singleton 444031	SNVF	A2	Crabapple-Sassafrass Corkwood-Silver Sycamore (_Schizomeria_-_Doryphora_-_Ackama_-_Cryptocarya_)	880	Wet	Enriched Oligotrophic
TERANIA CREEK	52	28°34'S 153°19'E	Tweed Heads 648458	NPVF	A1	Palm (_Archontophoenix cunninghamiana_)	340	Wet	Eutrophic
CHERRY TREE NORTH	53	28°54'S 152°45'E	*Warwick MP7603	SEVT	C1	Brush Kurrajong (_Brachychiton discolor_)	400	Dry	Eutrophic/ Mesotrophic
ILUKA	54	29°24'S 153°22'E	Maclean 651355	LMVF	A2	Cupaniopsis (_C. anacardiodes_)	3	Moist	Eutrophic/ Mesotrophic
KOREELAH CREEK	55	28°31'S 152°20'E	*Warwick MP3646	LMVF + _Araucaria_	C1	Hoop Pine (_Araucaria_-_Drypetes_)	530	Moist	Eutrophic/ Mesotrophic
NEW ENGLAND	56	30°30'S 152°24'E	Dorrigo 546224	MFF	A2	Negrohead Beech (_Nothofagus moorei_)	1300	Wet	Eutrophic/ Mesotrophic

* These references should be located on the Warwick map in the new metric series

FIGURE 3 - General location of study areas

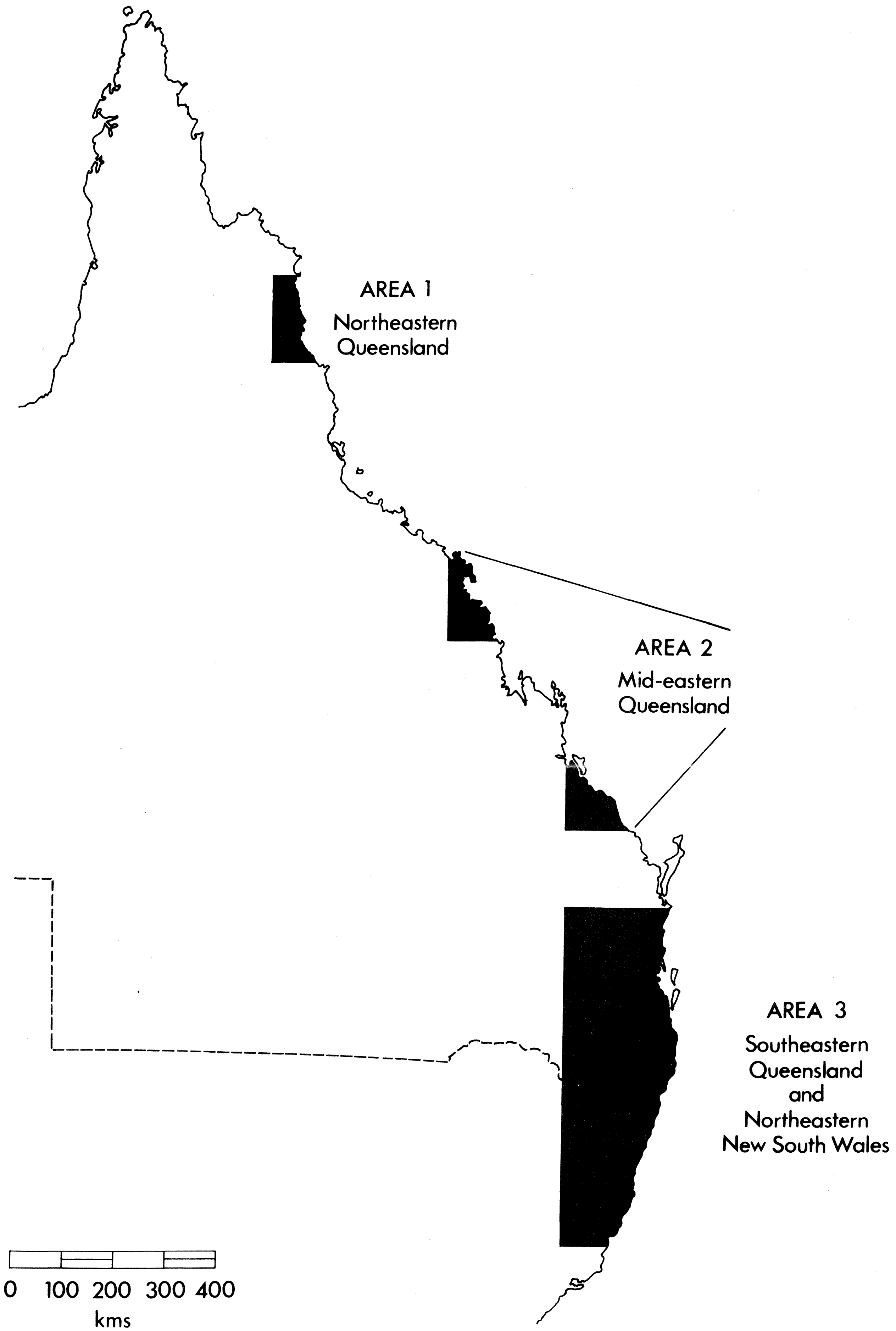


FIGURE 4 - Locations of mid-eastern Queensland sites

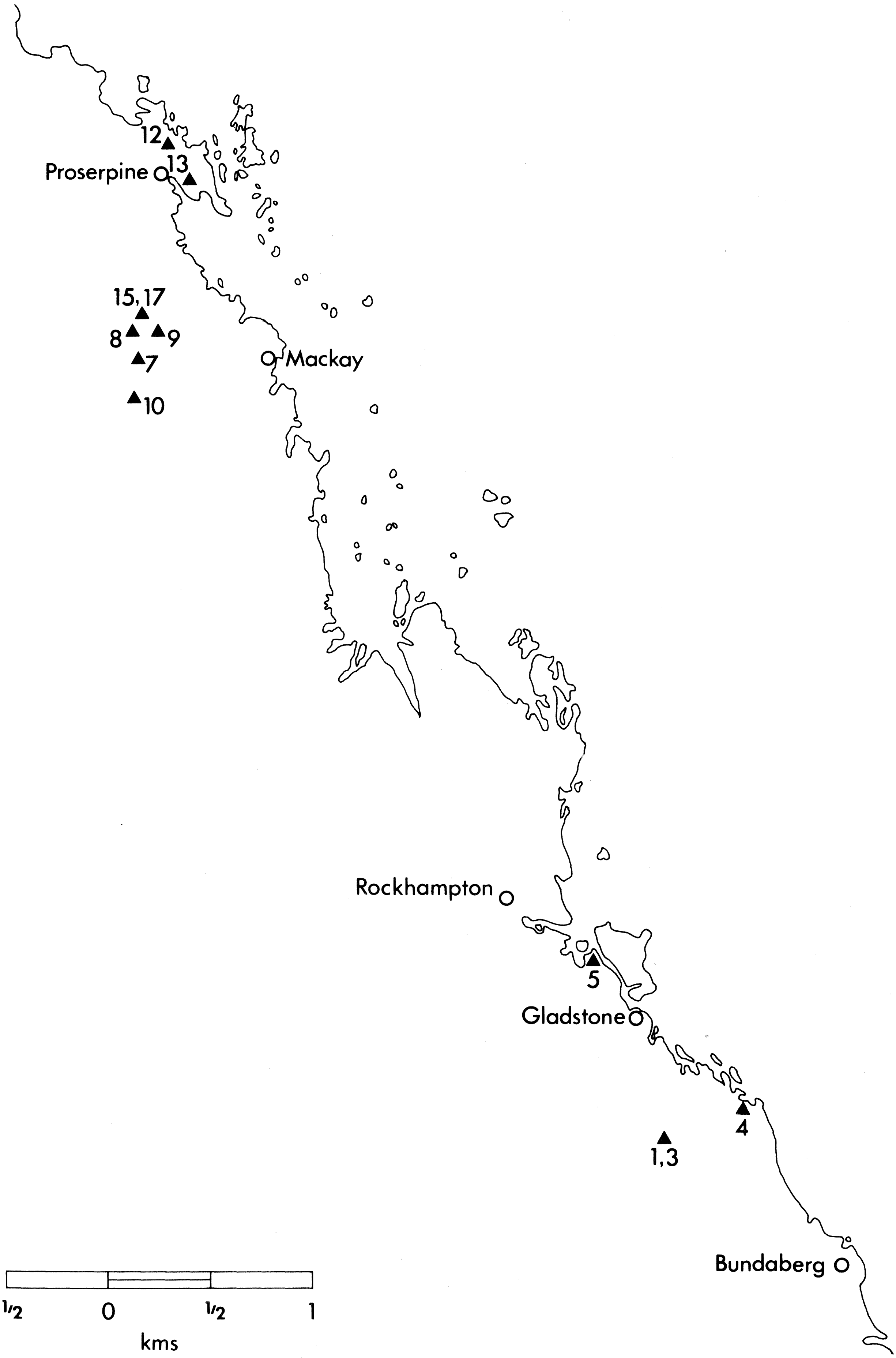


FIGURE 5 - Locations of north-eastern Queensland sites

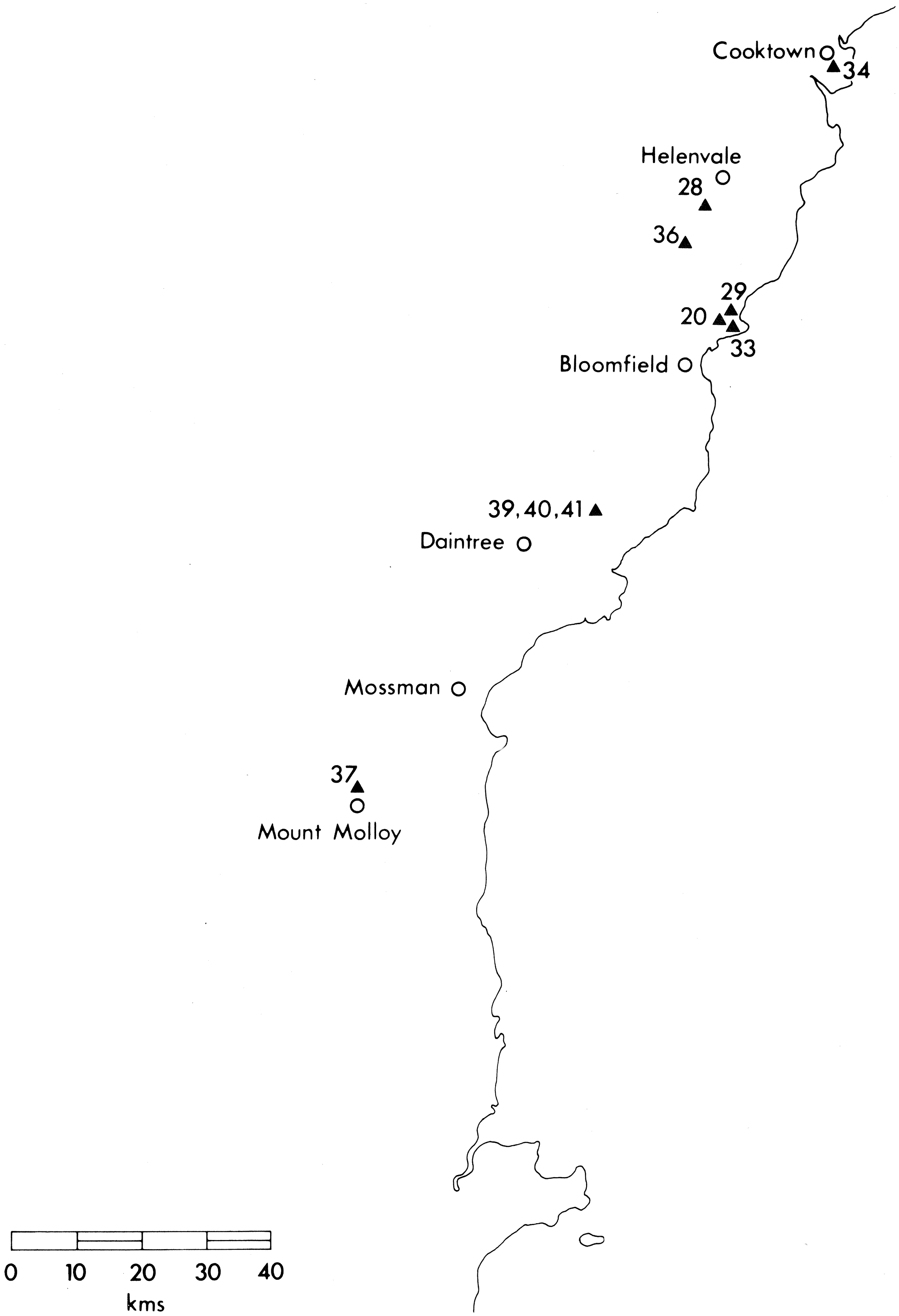
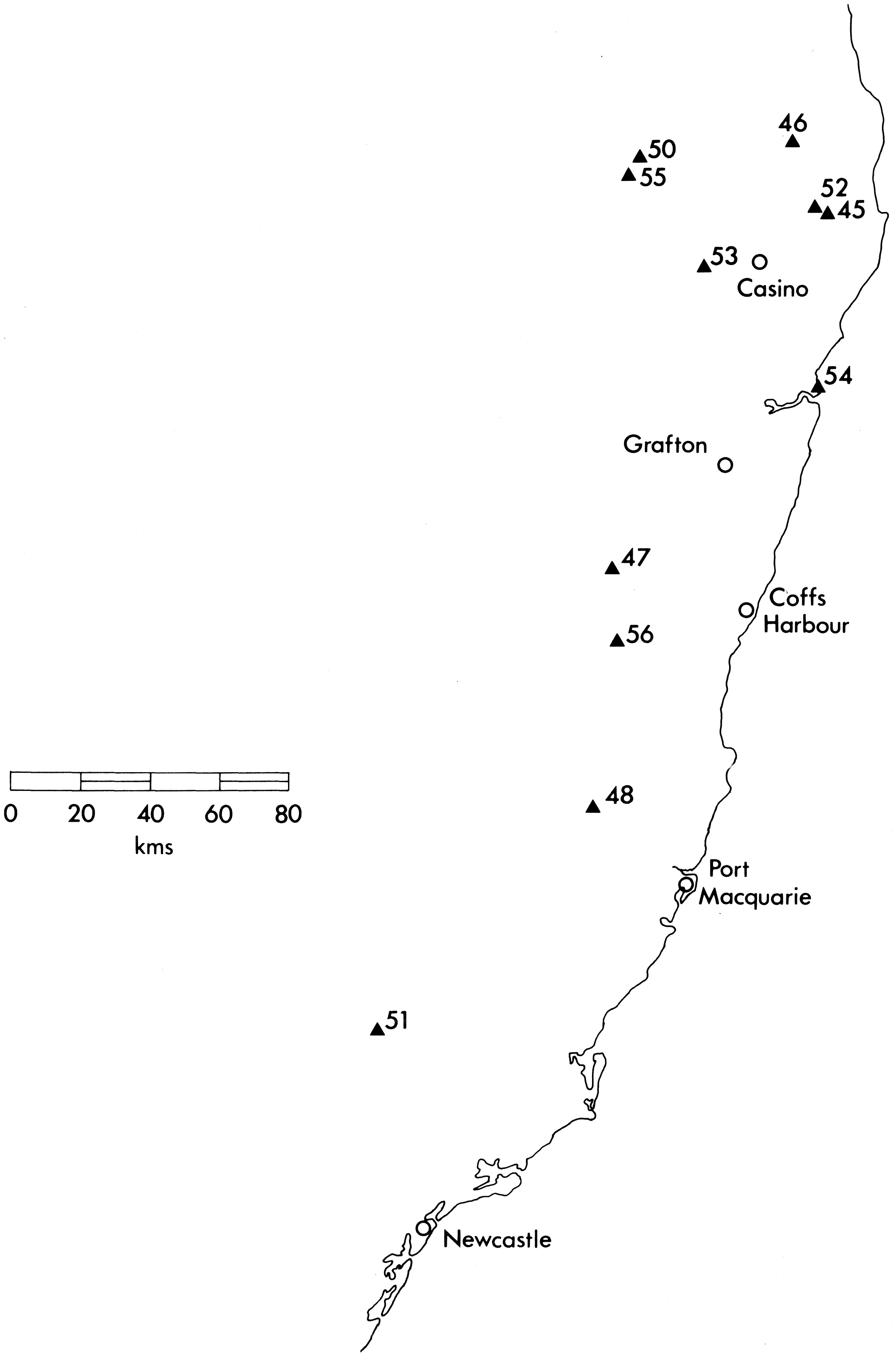


FIGURE 6 - Locations of northern NSW sites



Mammals

SUMMARY

The distribution of small mammals appears to be related to fine differences in the structure and type of vegetation rather than broad classifications. Preliminary results suggest that an increase in the density of vegetation at the lower levels will lead to an increase in the abundance of small mammals, and certain floristic components may also be important. The abundance and distribution of large mammals similarly could not be related to particular structural types of rainforest. The results do suggest though that species richness of the larger mammals is related to the size of available habitat, in this case rainforest, and that shooting may have led to some local extinction of macropods.

The problems of surveying mammals are discussed and the need for systematic sampling of both animals and habitat is stressed if relationships between mammal populations and vegetation type are to be established. Supplementary studies suggest that snap traps catch *Rattus* species more effectively than live traps (Fox & Posamentier, 1976), and that peanut butter mixture is more attractive than aniseed as a bait for *Rattus* species.

INTRODUCTION

Most surveys of mammals in Australia - whether in rainforests or other habitats - are still limited to providing species lists for different localities, with little or no habitat information. This point is well illustrated by previous studies on the mammals of east Australian rainforests. Tate (1953), for example, surveyed the mammals of Cape York Peninsula and Calaby (1966) conducted a survey of the upper Richmond and Clarence river

PLATE 6 - Complex notophyll vine forest (Finch Hatton)

districts of northern NSW, but neither provided significant habitat information on the species recorded. More recently Wood (1971) studied the ecology of Rattus fuscipes and Melomys cervinipes in rainforest, and showed how these two species apportion the available habitat. A general review of Australian rainforest mammals can be found in Winter (1973).

It seems clear that a detailed knowledge of both the habitat and spatial needs for viable populations is a primary requirement if areas are to be set aside for the survival of these animals. With this thought in mind, the present survey was designed to establish differences in both the types and abundance of species in different rainforest types. As has been mentioned earlier (page 12), a broad range of rainforest types was selected for the survey. It was anticipated that some of these may contain very few mammal species; however it is clearly only by systematic studies of this kind that the habitat requirements of individual species can be established.

Because of their elusiveness and rarity mammals proved to be one of the most difficult groups to survey in the time available. Recognition of this prior to the beginning of the survey led to the decision to concentrate on the small mammal fauna frequenting the ground, which could be recorded using standardised techniques. It was felt that the results of this trapping, augmented by less rigorously obtained records on the remaining mammal species, would provide information on the basis of which different types of rainforests could be compared and their relative status with respect to the mammal fauna thus ascertained. However standardised techniques were abandoned during the project due to lack of adequate staff; for this reason also the sites in New South Wales were not studied for mammals. Consequently the results of this part of the survey can be discussed only in broad terms.

Due to the author's interests three pilot studies were carried out in addition to the general survey, but during and in conjunction with that survey. These studies relate to trap response (Fox & Posamentier, 1976; Appendix 1) and habitat analyses with respect to small mammals. A large portion of the discussion is based on the results from these smaller studies, and consequently there is a heavy bias towards small mammals in this report.

METHODS

a) Small mammal trapping (standardised)

Seven study plots were located in each site, six containing snap traps and one with live traps (Figure 7). The plot with live traps was located at the centre of the study area. Live traps were placed along two lines (each 32m long) which bisected each other at right angles (Figure 8). The distance between traps was two metres and a large cage trap was set at the centre of the plot. The live traps used were 33cm 'Elliott' box traps. This resulted in 32 live traps for the plot plus one cage trap.

The centres of the remaining plots with snap traps were located along the compass bearings of 0^{o}, 60^{o}, 120^{o}, 180^{o}, $240^{o}$and 300^{o} at 100 metres from the centre point (Figure 7). Snap traps were placed along two lines (each 30 metres long) which bisected one another. The distance between traps was three metres. Again a large wire cage trap was set at the centre of each plot. This resulted in 20 snap traps per plot (Figure 9). Traps were baited with a compound mixture of peanut butter, oats and bacon fat, and were set for five nights (Brandy Creek was trapped for four nights only). This trapping method was used at all the mid-eastern Queensland sites.

b) General collecting (non-standardised)

The sites in north-eastern Queensland were trapped primarily along lines, using mostly snap traps but also live traps, 'Conibear' snap traps and cage traps. Varying numbers of traps were set for varying lengths of time. Traps were baited with peanut butter compound mixture, aniseed oil or meat, and generally checked every morning, reset and rebaited where necessary.

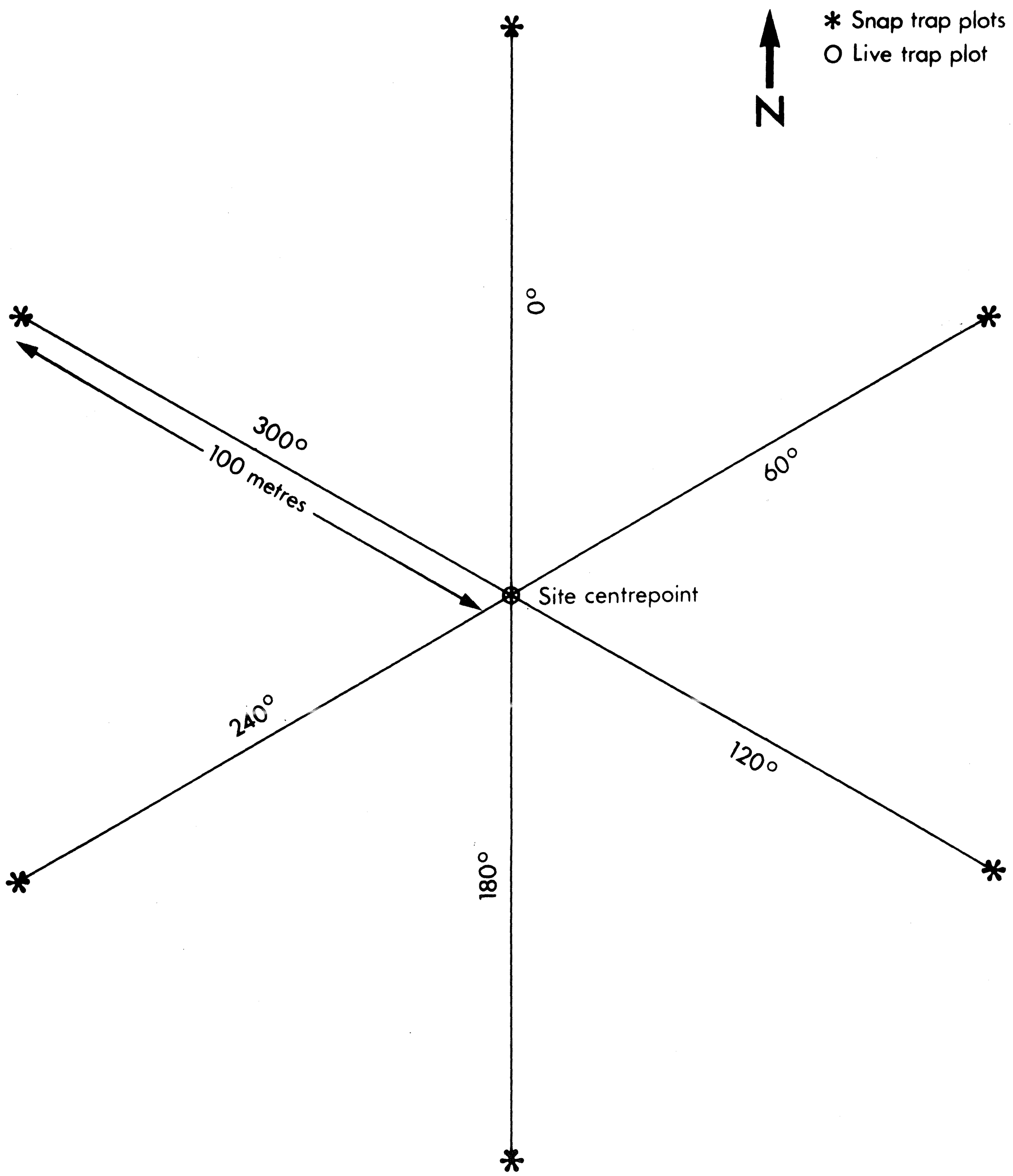


FIGURE 7 - General arrangement of live and snap trap plots within study area.

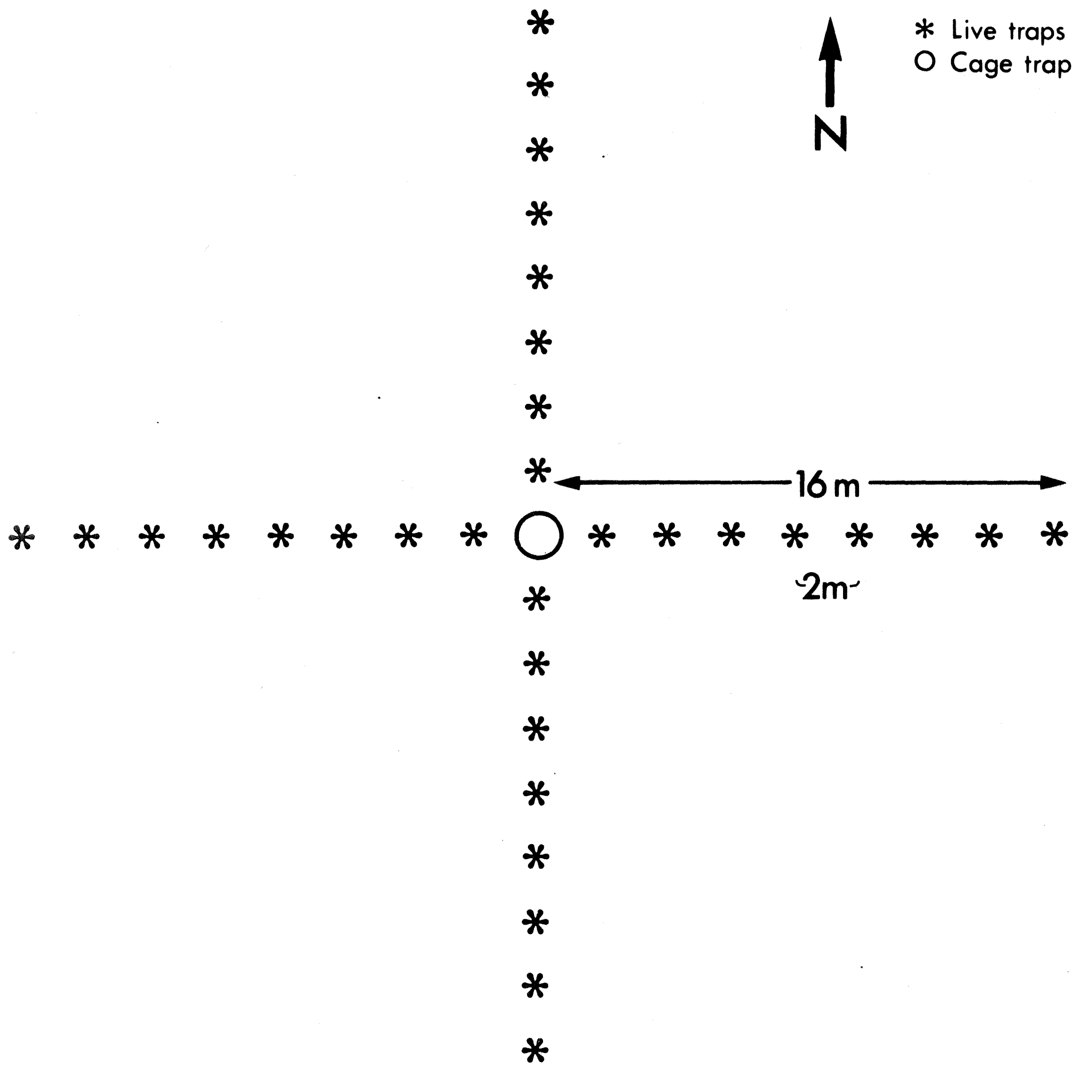


FIGURE 8 - Detail of live trap plot

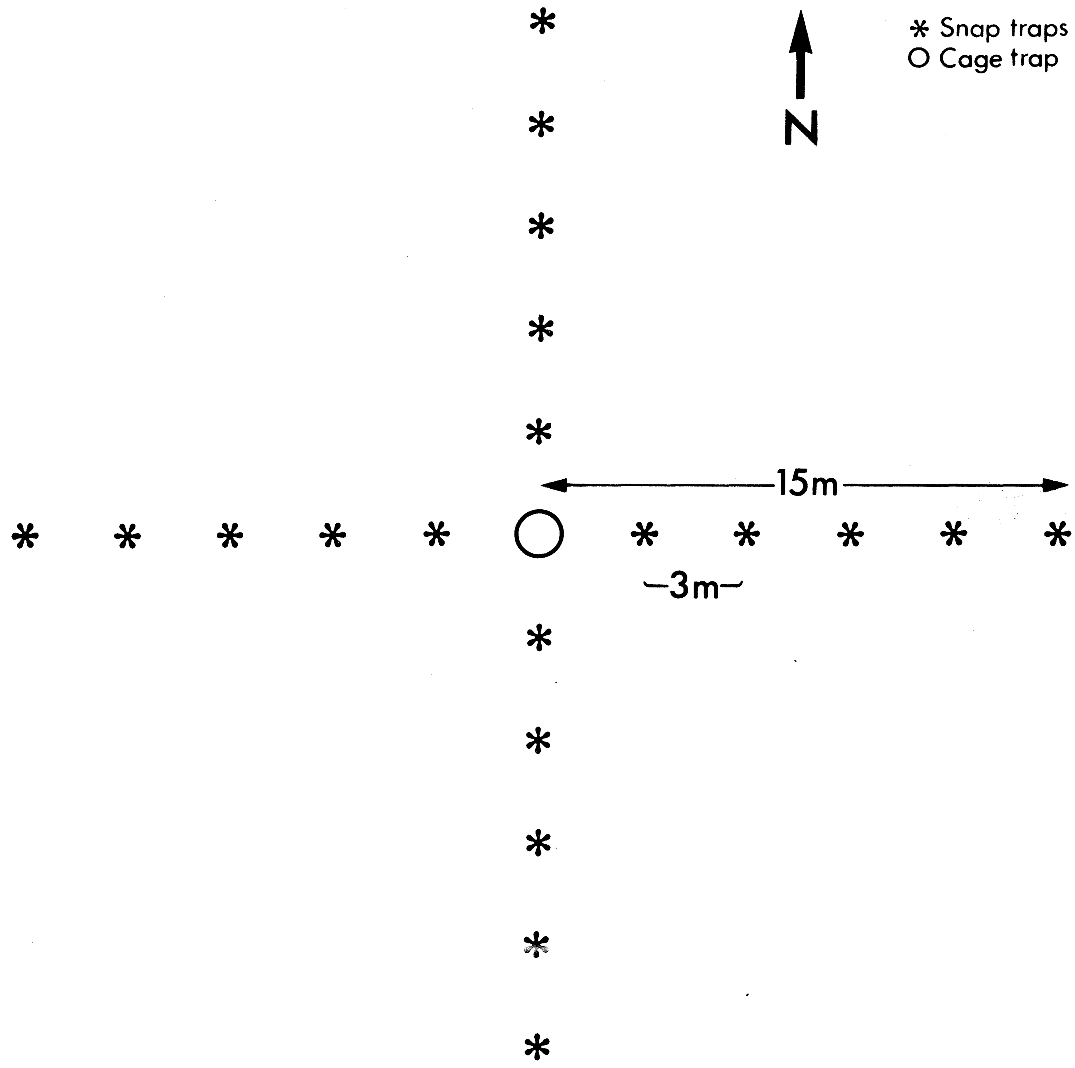


FIGURE 9 - Detail of a snap trap plot

Other records were obtained from spotlighting, occasional shooting, road kills, reports by locals, and mist netting for bats. While most of the records were from rainforests, some collecting was also carried out in other vegetation types.

c) Detailed habitat analysis

This experiment was carried out at the Thornton Peak sites as an exploratory study, to identify which factors might be relevant in describing small mammal habitat in rainforests and if indeed methods used elsewhere (see Posamentier, 1975) would be appropriate in rainforest. Sixteen points in each of the three study areas were sampled for mammals and habitat. Two traps, a live and a snap trap, were placed at each point, baited and checked each morning as described earlier. Trapping was conducted for 4 nights. Stations were never less than five metres and generally ten metres apart. At each point four habitat analyses were made, these were averaged for each point, and the sixteen means were summed to provide an index of each variable for each area. Each variable was estimated within a 20cm x 50cm frame. The following variables were measured:

*a) Percentage cover of leaf litter.

*b) Depth of leaf litter within frame, measured in centimetres to the nearest centimetre.

c) The size of leaf litter within the frame. This was subjectively estimated as: 1 - leaves mainly less than 7.5cm 2 - leaf sizes mixed 3 - leaves mainly 7.5cm or larger. The number of records in each category was recorded per site, so that three variables each representing a category were obtained.

d) Fronds - this was recorded only if present. Refers to any pinnate leaf-like structure, primarily palms, tree ferns and *Macrozamia* spp.

e) Vines - recorded in the same way as fronds.

f) Grasses - recorded as for fronds. Refers to plants with long leaf blades, essentially low monocots.

*g) Moss - cover of moss.

*h) Lichen - cover of lichen.

*i) Bare ground - exposed rock or bare soil.

*j) Vegetation 0-20cm - cover of all vegetation between the ground and 20cm.
*k) Vegetation 20-50cm - cover of all vegetation between 20-50cm.
*l) Vegetation 50-300cm - cover of all vegetation between 50-300cm.

The variables marked with an asterisk were estimated as a percentage within the quadrat frame using six cover classes (see Daubenmire, 1959). The remaining variables were either recorded as present only, or directly measured.

RESULTS AND DISCUSSION

a) General

Too few animals were recorded to relate mammal distribution to latitudinal/altitudinal criteria beyond the known geographical distribution limits of individual species. The most interesting distributional find was several specimens of a species of the *Melomys* '*levipes*' group, a species with Papuan affinities. This species was first recorded by Dr J. Winter at the same locality (Thornton Peak), and he is presently working on the status and taxonomy of these specimens. Also of interest was the netting of several specimens of the Ghost Bat *Macroderma gigas* at Helenvale, thus confirming the occurrence of this species in Cape York Peninsula (cf Dwyer, 1968).

Some variation is apparent in the total number of species recorded per site (Table 4). While this may be due in part to differing survey effort between sites, there does appear to be some relationship between the number of species recorded per site and the relative size of the rainforest tract in which the site was located. Thus none of the small tracts has a high number of species. It should be noted that from subjective estimation, areas with high species numbers also seemed to have larger populations of the species recorded. The greatest numbers of species were recorded at Bulburin and Austral. Nevertheless it must be pointed out that at these two sites more time was spent spotlighting and a larger area was covered than at any other site. Long roads along and through the rainforest,

TABLE 4: Results from general collecting

	Bulburin	Bulburin (Austral)	Eurimbula	Rundle Range	Crediton	Dalrymple Heights	Finch Hatton	Homevale	Mt Dryander	Brandy Creek	Mt William	Fritz Creek	Helenvale	Thornton Peak (39)	Thornton Peak (40)	Thornton Peak (41)
Thylogale thetis	+	+														
T. stigmatica	+	+										+	+			
Macropus rufogrieseus	(+)		(+)					(+)								
M. dorsalis	+	+						+								
Wallabia bicolor	+	+	+													
Macropus giganteus			(+)	(+)	(+)											
M. agilis													(+)			
M. parryi	?															
Dendrolagus sp.														+		
Potorous tridactylus	?															
Aepyprymnus rufescens								(+)								
Isoodon macrourus	+					+										
Perameles nasuta	+	+	?													+
Trichosurus vulpecula (dark)	+	(+)				+	+	+								
T. vulpecula (grey)	(+)		(+)			(+)		(+)								
T. caninus	+	+														
Pseudocheirus peregrinus	+	+				+					+					
Acrobates pygmeus							+				+					
Antechinus maculatus						+										
A. flavipes	+															
Dasyurus maculatus	?		?													
Tachyglossus aculeatus	?		(+)	(+)												
Ornithorhynchus anatinus					(+)											
Rattus leucopus														+	+	+
R. fuscipes	+	+	+											+	+	+
R. lutreolus			(+)													
R. tunneyi			(+)													
*R. rattus						+					+					
Melomys cervinipes	+	+	+		+	+	+		+	+	+	+				
M. 'levipes' group														+	+	
Uromys caudimaculatus														+		
Hydromys chrysogaster	+	+			+			(+)	+	+			+			
Nyctophylus timoriensis				+												
Nyctime robinsoni								+								
Rhinolophus megaphyllus	+															
Syconycteris australis			+				(+)			+	+					
Pteropus scapulatus													+			
Macroderma gigas													+			
*Vulpes vulpes			?			?										
*Sus scrofa						+										
*Felis catus						?		(+)								
Total No. of species**	12	10	3	0	2	6	3	1	2	2	4	2	2	3	3	3
Relative size of area***	L	L	S	S	M	L	L	S	L	L	L	L	L	L	L	L

* Introduced species ( ) Record outside rainforest ? Doubtful record

** Excluding bats, introduced species and unconfirmed records

*** Relative size of rainforest within which the study site was located:
L - large M - medium S - small

additional staff and the ability to use cars for spotlighting enabled a greater effort than elsewhere. In addition the camp site was situated on a clearing which was surrounded by rainforest. The clearing attracted animals from the forest and facilitated recording. A number of species were recorded in the clearing only; i.e. Isoodon macrourus, Parameles nasuta, Macropus dorsalis, and possibly M. parryi and Potorous tridactylus.

By contrast some areas were particularly poor; for example Rundle Range, Crediton and Homevale, and possible reasons for this will be discussed below. The reasons for the low records at the Thornton Peak sites cannot be explained at present. Dr J. Winter has observed a rat kangaroo Hypsiprymnodon moschatus on the peak and in the general area has seen a Herbert River ringtail possum Pseudocheirus herbertensis, although these species were not observed during the present survey.

The six sites visited by the author can be discussed with greater certainty as the subjective recording (ie spotlighting) and effects of differential effort can be considered. These six areas were: Austral, Eurimbula, Dalrymple Heights and the three Thornton Peak sites (39, 40 and 41). The lower number of species at Eurimbula is undoubtedly related to the small tract of available habitat. In addition the area was isolated by heavily grazed and/or burnt woodland. Austral on the other hand was situated in a large tract of rainforest, most of which was state forest and received relatively little ongoing interference by man. Dalrymple Heights was situated more or less at the edge of a large expanse of rainforest. Its species number was inbetween the two previously-mentioned sites. Local residents have informed us that macropods are present in the area, but none was observed during this survey. It appears that strong shooting pressure in the area may be responsible for the lack of sightings; shooting may have lowered populations to a point where certain species have become locally extinct in spite of suitable habitat.

b) Small mammal trapping and Thornton Peak habitat analysis

The abundance of small mammals in the sites surveyed seems unusually low (Table 5). However, low population densities and even small areas

TABLE 5: Results from standardised small mammal trapping

	Bulburin	Bulburin (Austral)	Eurimbula	Rundle Range	Crediton	Dalrymple Heights	Finch Hatton	Homevale	Mt Dryander	Brandy Creek	Mt William	Helenvale	Fritz Creek	Thornton Peak (39)	Thornton Peak (40)	Thornton Peak (41)
Melomys cervinipes	1	1	1		14	23	8		13	3	14		4			
Rattus fuscipes	2	4	1													
R. fuscipes/leucopus*														5	33	38
R. rattus**						1					1					
Melomys 'levipes' group														5	1	
Hydromys chrysogaster									1	1						
Antechinus flavipes	2															
Total trapnights	1920	795	1820	795	795	1496	795	795	795	636	795	144	217	206	182	198

* These two species were not separated in the field

** Introduced species

TABLE 6: Results of small mammal trapping and habitat analysis at the Thornton Peak sites

Variables	Site Number 39	40	41
Leaf litter cover	1001	1147	950
Leaf litter depth (cm)	60	41	37
Leaf litter size:			
small	8	16	23
medium	35	44	38
large	21	4	3
Rock cover	508	323	341
Vegetation cover:			
0-20cm	58	120	145
20-50cm	158	311	498
50-300cm	819	1236	1292
Fronds	18	57	59
Vines	19	22	24
Grass	16	14	11
Moss cover	82	74	119
Lichen cover	0	6	66
Number of small mammals trapped	7	26	26

Note: The habitat variable figures in this table are indices only, so that those for one variable cannot be compared directly with those for another.

entirely without animals are not unusual in Australia (Watts, 1974; Posamentier, 1975). Such results must be expected if standardised methods are used. While more subjective methods of recording small mammal populations - in which only areas where animals are likely to occur are surveyed - may be more productive, they are of little value if one wishes to determine the factors which affect the spatial distribution of a species over its broad geographical range (see Jones, 1963; Terman, 1961).

The results gained from the small mammal trapping were initially used to find associations with certain forest types. Computer analyses have thus far failed to produce meaningful results. This may well be due to the low number of sites studied in a standardised manner and/or the low numbers of individuals and species recorded at each of these sites. However, it is also possible that the structural features used in Webb's classification of rainforests are too general to explain small mammal distribution. As several studies have already shown that small mammal distribution is largely related to detailed structure of the vegetation (Batzli, 1968; Getz, 1961; Eadie, 1953; Posamentier, 1975) or to certain types of vegetation (Getz, 1961; Fleharty _et al._, 1969) a pilot small mammal trapping/habitat analysis study was conducted at each Thornton Peak site to investigate this possibility.

It can be seen (Table 6) that the two higher altitude sites (40 and 41) supported more small mammals, mainly _Rattus_ spp, than the lower site (39). The most obvious difference between these sites is the more open vegetation and larger amount of bare ground at the lower site. These same habitat factors also influence the distribution of _Rattus lutreolus_ in the coastal heath lands of New South Wales (Posamentier, 1975). The results suggest that a negative correlation may also exist between average leaflitter depth and small mammal distribution. In contrast leaf litter size and the amount of fronds present were both positively correlated with the number of small mammals trapped. The other variables recorded showed no obvious correlations with small mammal distribution.

PLATES 7 and 8 - Examples of sparse and dense ground vegetation cover in rainforests, a factor apparently important in the distribution of small mammals

These results suggest that small mammal distribution in eastern Australian rainforests is related to the detailed structure of the vegetation, especially near the ground (Plates 7 and 8). The fact that there was a correlation between fronds and small mammals indicates that animal distribution may also be related to certain floristic components of the vegetation. Subjective observations established that at Dalrymple Heights, another site with relatively high numbers of captures (Table 5), a large portion of the vegetation was made up of palms. It is possible that palms, or some other plants associated with palms, provided food preferred by the rodents of this biotope. Small mammals have been related to the locality of preferred foods elsewhere (Batzli & Pitelka, 1970).

c) Evaluation of methods

It may be helpful at this point to outline some recommendations based on our experience, for future surveys of a similar nature.

i) Large mammals: These mammals are difficult to sample quantitatively over short periods of time. Relative abundances have been estimated by spotlighting or by counting droppings. However the latter technique is time consuming and may be misleading. In view of these problems I would suggest that relative abundances be estimated in three classes, ie rare, common and abundant. A single operator can then adjust for differential efforts between areas, or through discussion between operators fairly realistically. Such estimates are likely to be very approximate unless the study area is visited several times. Some species - such as the larger possums, bandicoots and small macropods - can be trapped in medium-sized and large cage traps, and such traps should be used where possible.

ii) Bats: It appears that mist netting possibly augmented by shooting is the most efficient way to sample bats. In addition caves and other resting sites of bats may be sought for and recorded.

iii) Small mammals frequenting the ground: These animals are most suitable for comparative studies between habitats because they can be adequately sampled by standardised trapping techniques. Snap traps should be used as they are more effective than live traps (Fox & Posamentier, 1976).

Due to the low population densities found in this survey, it is suggested that use be made of a large number of small sized plots over a wide area, encompassing as many different habitats as possible, including minor variations. In addition it would be advisable to have two or more replicates per recognised habitat type (see also Posamentier, 1975).

Trapping for five nights by the methods employed in the present survey seems adequate. Several studies have shown that trapping between 3-5 nights using enough traps obtains a significant sample of the resident population (Burt, 1940; Tevis, 1956; Zejda, 1965; Goertz, 1964; Babinska & Bock, 1969; Radda et al., 1969; Rosenzweig & Winakur, 1969; French et al., 1971). Van Vleck (1968) marked a population of small mammals using live traps and found that 81% of the marked population was caught in the first three nights of snap trapping following live trapping. Pelikan et al. (1964) caught 80% of the population in the first three nights and Zejda & Holisova (1970) 71% in the first two nights, providing trap density was high enough. In Australia Recher and Posamentier (unpubl. data) trapping in dry sclerophyll forest in eastern Australia found a steep drop in unmarked animals on the fourth night of trapping. Trapshyness or new object response is generally overcome after two nights (Fox & Posamentier, 1976).

As animal numbers fluctuate over a twelve-month period due to breeding patterns and seasonal differences in trap response (Smirnov, 1967; Fitch, 1954; Grodsinsky et al., 1966), it would also be appropriate to visit every site twice, i e spring and late summer. Where this is not feasible, all sites should be sampled at about the same time of year to minimise the effects of season-related variables.

When the types of traps were chosen for this survey it was realised that not all species of small mammals would be trapped in them. An example of this is the record of a planigale Antechinus maculatus at Dalrymple Heights. This species was too small to be caught in the traps set, instead it was caught in a pit trap containing liquid which was set for spiders and

PLATE 9 - Semi-evergreen vine thicket (Homevale)

PLATE 10 - Complex notophyll vine forest (Wiangarie). Note the abundant epiphytes on tree trunks and walking stick palm in the foreground

reptiles. If sufficient staff and time are available other types of traps - such as smaller snap traps and pit traps - could certainly be incorporated into the trapping programme. However, the extra effort would probably be better spent in trapping more sites rather than the same sites more thoroughly.

One more point needs mentioning. As was indicated in the Queensland Museum interim report (Anon, 1976), fewer species of small mammals were recorded than are known from the general area. This is largely due to the fact that records for a given area are usually built up over many years; naturally it is impossible to record the same number of species on a single survey. In addition these records were derived from a number of vegetation types and not just one type of rainforest, as was the objective of the present survey.

APPENDIX 1: Relative effectiveness of a peanut butter compound and aniseed oil as baits in small mammal traps

An experiment looking at possible differential response to different baits was carried out at the three Thornton Peak sites (Nos 39, 40 and 41). At each of these sites several trapstations were located along one or more lines. Spacing between stations was generally about 10m but never less than 5m. Each station had one snap trap and one live trap placed close together. The two baits used were peanut butter compound and aniseed oil soaked into a pad of cottonwool. Bait type was alternated between stations. Traps were set for four nights, checked each morning and reset and rebaited where necessary.

As mentioned earlier two species of *Rattus* were caught here, but these were not separately identified in the field. Consequently the results refer to the total of small mammals caught including one or two species of *Melomys* (some juveniles of this genus have not yet been identified).

TABLE 9: Trapping results between baits

Site No.	No. Trapnights	No. animals captured using	
		aniseed	peanut butter
39	160	4	5
40	152	5	31
41	160	16	25
Totals	472	25	61

The results of this experiment are listed in Table 9, which clearly shows that more animals were caught on peanut butter. Peanut butter has been found to be a good allround bait for both rodents and shrews elsewhere (Buckner, 1957; Gottschlang, 1965; Gentry *et al.*, 1968; Patric, 1970). However some trapping by the Discoverers (Australian Museum) in the Blue Mountains, west of Sydney, using the same two baits found a 1:1 ratio between the two baits. They trapped <u>Antechinus stuarti</u>, a very inquisitive species. Clearly more experiments of this kind are required to establish whether the findings of this experiment apply to other biotopes, seasons and species as well.

Birds

INTRODUCTION

Keast (1959, 1961) estimated that 81 bird species - about 15% of the Australian land and freshwater avifauna - occur largely or solely in the continent's rainforests. The distribution of these species is well-known in general terms (e g Slater, 1970, 1974; Storr, 1973) although - as is clear from the present survey - much is still to be learnt of their detailed distribution.

Keast (1961) also provided a zoogeographical explanation for the contemporary distributional patterns of these species. He identified three major avifaunal zones in east Australian rainforests. The first, in Cape York, is notable for the high incidence of recent colonists from New Guinea (e g Palm Cockatoo Probosciger aterrimus, Red-sided Parrot Eclectus roratus, Yellow-billed Kingfisher Syma torotoro, White-faced Robin Eopsaltria leucops and Green-backed Honeyeater Glycichaera fallax). The closer resemblance of the Cape York forms of several species more widely distributed in Australia to their counterparts in New Guinea rather than those elsewhere in Australia similarly suggests a recent invasion from New Guinea (e g Wompoo Pigeon Megaloprepia magnifica assimilis, Spectacled Flycatcher Monarcha trivirgata albiventris).

The second zone, separated by some 250km of sclerophyll woodland, lies in the extensive rainforests of the Cairns/Atherton area. Here there are eight endemic species (including the Grey-headed Robin Heteromyias cinereifrons, Pied Flycatcher Arses kaupi, Macleay's Honeyeater Meliphaga macleayana and Golden Bowerbird Prionodura newtoniana) as well as several distinctive subspecies. Finally there are the rainforests of southern Queensland and northern New South Wales, in which only a third to a half of the true rainforest species occur - the number further decreasing with increasing latitude. Even here, though, there are several endemic species (e g Black-breasted Quail Turnix melanogaster, Albert Lyrebird Menura alberti, Rufous Scrub-bird Atrichornis rufescens, Paradise Riflebird Ptiloris paradiseus and Green Catbird Ailuroedus crassirostris) and sub-species (e g Olive Whistler Pachycephala olivacea macphersonianus, Fig

PLATE 11 - Low microphyll vine forest with emergent Hoop Pine
Araucaria cunninghamii (Austral)

Parrot Opopsitta diophthalma coxeni).

In seeking to interpret these distributional patterns, Keast suggested that the Cape York rainforests were once extensive enough to provide a corridor along which New Guinea species reached the rainforests of Cairns/Atherton. A drier climate then caused the contraction of these rainforests and thus isolated several of these species in the Cairns/ Atherton rainforests. More recently the Cape York rainforests have again expanded, allowing further colonization by New Guinean species. In contrast, he considered the Cairns/Atherton rainforests extensive enough to accommodate climatic change and thus act as a refuge for rainforest species in periods of a drier climate.

Kikkawa (1968) has since elaborated this interpretation. He found that the wet tropical lowland rainforests of the Cairns/Atherton area contained an avifauna quite distinct from that of the adjacent sclerophyll forests and woodlands. In contrast, he was unable to distinguish the avifauna of temperate and subtropical rainforests in northern NSW, either one from the other or from that of the adjacent wet sclerophyll forests. In interpreting these findings, Kikkawa considered that the refuge nature of the Cairns/Atherton rainforests has allowed a high level of adaptation to the rainforest habitat but that successful colonization of the southern tracts of rainforest has been largely limited to those species which have developed or retained adaptations favourable to wet formations in general. Rainforest species that were ecologically less tolerant would have had a more dramatic history of colonization, speciation and extinction as the rainforest patches expanded and shrank during past climatic cycles.

Whilst the distribution of birds through the east Australian rainforests is well-known and has been explained in zoogeographical terms, their ecology is still little understood. An early study was that of Harrison (1962) into the feeding niches of Australian rainforest species. He classified 117 species associated with rainforests according to their feeding niches. He found that the distribution of species between niches closely resembled that in Malayan rainforests, but with more aerial-feeding species.

Harrison's study has since been much extended by Kikkawa & Webb (1967), who sought to classify the rainforest avifauna according to niche occupation and then establish possible relationships between this classification and the structural/physiognomic classification of east Australian rainforest vegetation developed by Webb (1959, 1966). They defined nine major niches in rainforest, based on differences in food requirements, feeding zone and nesting site. While they obtained some correlation between niche occupation and rainforest structure/physiognomy, the latter classification was found to be limited in its predictive power. They concluded that the precise description of avian habitats in the tropics requires a knowledge of the quantitative floristic composition of the vegetation as well as its structure.

In recent years additional ecological information on the Australian rainforest avifauna has become available, firstly through the determination of altitudinal ranges for many rainforest species in Queensland (Gill, 1970; Storr, 1973) and more recently through detailed studies on the biology of selected species (Crome, 1975, 1976).

The present study was designed to determine relationships between the distribution of rainforest birds and both the structure and floristics of east Australian rainforests.

METHODS

The following methods were chosen with three criteria in mind. Firstly, that they should describe the avifauna of each study site sufficiently to permit the identification of any relationship between bird distribution and the structure or floristics of rainforests. Secondly, that they should provide quantitative estimates of species abundance within each study plot and, thirdly, that they should be defined well enough to be repeatable.

a. Spot censusing (standardised)

Essentially this method entails observation with binoculars for a set period at each of four predetermined points within the study site. The four points were located 130 metres from the centre point of the site along the compass bearings 45°, 135°, 225° and 315° - these bearings being chosen to minimise disturbance from sometimes concurrent mammal studies. All birds observed within 20 metres of a census point or at any height overhead were recorded. Calls were used to locate birds, but birds were not recorded on call alone. Observation at each census point was for one hour and censusing was usually done between 07.00 and 12.00 hr. Most points were censused on each of three days, giving a total census time/site of 12 hours. The exact time of day was noted for each census period. Censuses were made only in fair to good weather.

b. Mist netting (standardised)

Two net lines were located along the 45^{o} and 225^{o} bearings from the site centre point, each line starting about 50 metres from the centre point. Each net line consisted of five 12 x 3 metre (30mm mesh) nets set as far as possible in a straight line. Netting started at dawn and continued for six hours. Netting was done on each of three days, but only in fair to good weather. Each bird netted was identified and, in most cases, banded before release. Retrapped individuals were distinguished on the data sheets. Where possible, details of soft part colours, weight, body measurements and moult were also taken.

c. General observation (non-standardised)

All species observed within the site were noted and towards the end of the study period each observer separately assessed the relative abundance of these species - taking into account also his spot censusing and mist netting experiences and using the following terms:

Abundant - Species unusually numerous

Common - Species observed in reasonable numbers

Frequent - A few individuals usually, but not always, present

Occasional - Species observed 2-5 times during the entire observation period at the site

Rare - Species observed once only

Where observers' assessments for a particular species differed, an assessment was obtained by discussion.

The nomenclature of birds in this section follows Slater (1970, 1974).

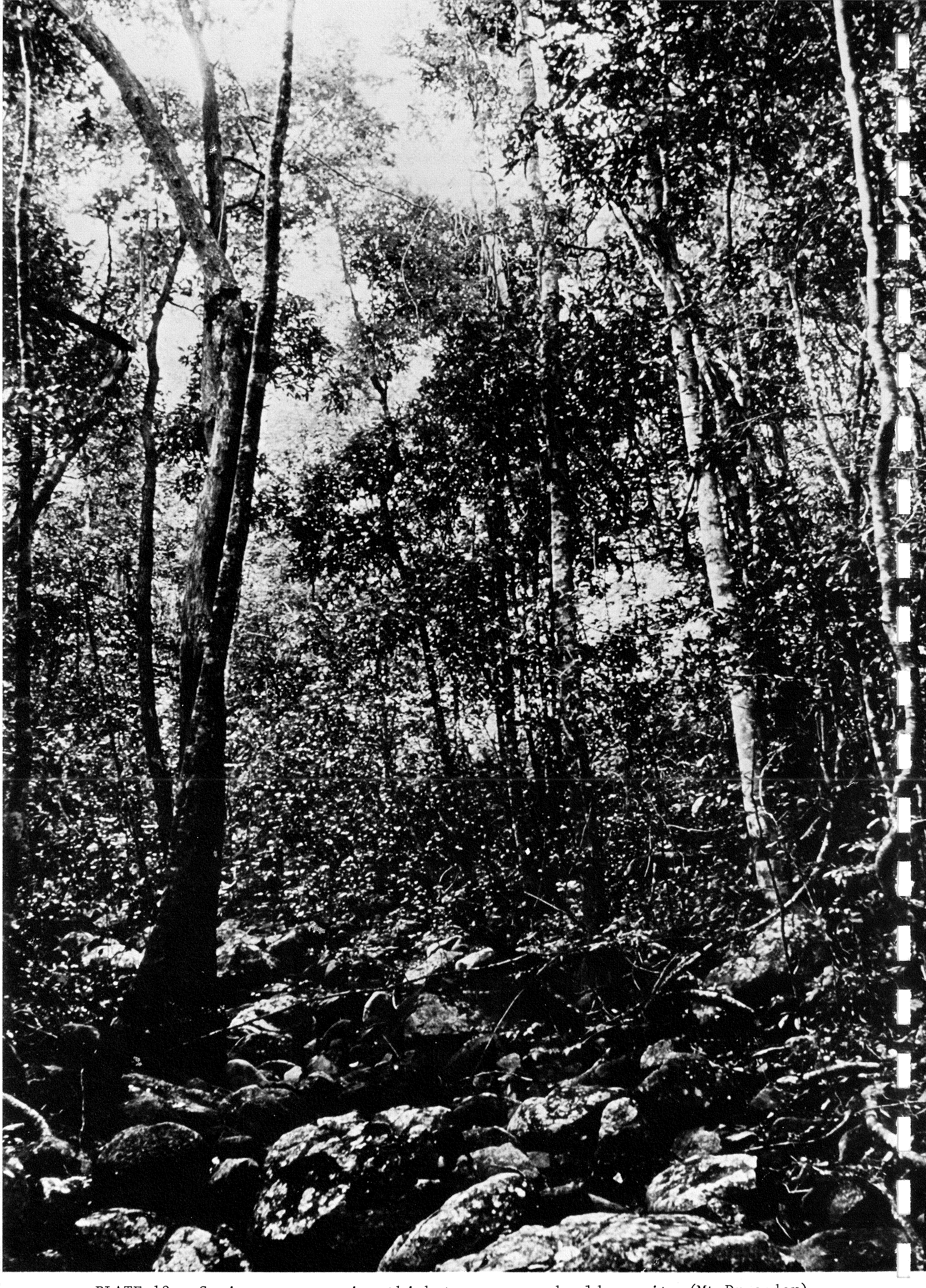


PLATE 12 - Semi-evergreen vine thicket on a very bouldery site (Mt Dryander)

RESULTS AND DISCUSSION

Fieldwork in mid-eastern Queensland was done between 20th March and 25th April 1975, in north-eastern Queensland between 3rd November and 10th December, and in northern New South Wales between 26th January and 9th February 1976 and 20/24th March 1976 (sites 47 and 56). For the most part the methods described above were followed. In some of the more rugged sites (e g nos 40, 41 and 56), however, the mist nets and census points were placed along bearings which were more convenient than those prescribed in the method. Also, bad weather limited spot censusing to two days at Bulburin (Austral) and both mist netting and spot censusing to two days at Mount Finlay and New England.

The results from the survey are summarized in Table 10. In all, 55 species were netted, 126 species observed during spot censusing and 146 species during general observation within the sites. When examined on a per site basis for those species largely dependent on rainforest, mist netting and spot censusing detected on average 30 and 80% respectively of the total number of such species recorded for each site. A detailed consideration of the methods, particularly in relation to future ecological surveys, will be made in the final report.

The survey provided new information on the distribution of several species. Immature White-tailed and Little Kingfishers (*Tanysiptera sylvia* and *Alcyone pusilius*) were collected at Eurimbula on the 25th and 28th March 1975 respectively. Condon (1975) records the former south to Mt Spec, near Ingham and some 750km north of Eurimbula, although E. Zillmann (pers. comm.) notes that this species has been observed at Point Vernon, Hervey Bay in recent times and was once "in the Bundaberg district judging from an old collection of the area". The Little Kingfisher is recorded by Condon (1975) south to Hinchinbrook Island, some 800km north of Eurimbula. It may well be that the White-tailed Kingfisher at least had undertaken a 'wrong-way' migration (cf Serventy, 1973).

The observation of Glossy Swiftlets (*Collocalia esculenta*) at Finch Hatton is also noteworthy (Boles & Barry, 1975). The birds were observed on 12th April 1975 close to a breeding colony of Grey Swiftlets. The Glossy Swiftlet has been recorded only twice in Australia, at Cape York and Iron Range, and this observation raises the interesting possibility that it may also occur at other breeding colonies of the Grey Swiftlet.

TABLE 10: Summary of results and species diversity measurements

Site No.	Locality	Spot censusing		Mist netting		Relative abundance (No. species)	Species diversity
		No. species	No. observations	No. species	No. individuals netted		
1	Bulburin	23	240	7	28	33	3.39
3	Bulburin(Austral)	16	88	15	58	37	3.27
4	Eurimbula	16	83	7	32	31	3.29
5	Rundle Range	25(17)	136(106)	12	38	41(33)	3.80(3.40)
7	Crediton	21	65	5	10	27	3.56
8	Dalrymple Heights	14	77	6	12	18	3.17
9	Finch Hatton	19	69	3	5	19	3.70
10	Homevale	33(24)	177(160)	8	21	42(26)	3.88(3.61)
12	Mt Dryander	19	123	9	17	23	3.64
13	Brandy Creek	22	122	10	29	26	3.61
15	Mt William	18	95	5	27	23	3.23
20	12-mile Scrub	33	487	8	23	34	3.94
28	Helenvale	28	575	3	4	33(26)	3.09
29	Mt Finlay	26	247	3	3	30	3.61
33	Fritz Creek	30	428	6	23	34	3.68
34	Mt Cook	28	317	10	28	32	3.23
36	Shipton's Flat	31	431	9	37	34	3.83
37	Spear Creek	29	313	13	47	38	3.77
39	Thornton Peak	25	119	9	20	32	3.89
40	Thornton Peak	17	118	9	26	26	3.20
41	Thornton Peak	12	74	8	37	21	2.95
45	Red Scrub	23	242	10	56	31	3.54
46	Wiangarie	27	377	9	25	31	3.15
47	Marengo	28	220	9	14	33	3.69
50	Beaury	32	291	16	82	39	3.78
53	Cherry Tree North	25	350	12	43	40	3.50
54	Iluka	30(25)	429(408)	12	59	36(30)	3.57(3.43)
55	Koreelah Creek	34	315	11	35	38	3.97
56	New England	14	55	7	12	18	2.71

Note: Figures in brackets are for the essentially rainforest species in those site avifaunas with several species not normally associated with rainforests.

The Little Scrubwren Sericornis beccarii was observed and netted at Mount Cook. It was also collected by the Queensland Museum on the Endeavour River, near Cooktown (Anon, 1976). These records confirm the occurrence of this species in the Cooktown area (McGill, 1970), although this population was not considered by Parker (1970). Two scrubwrens collected on Thornton Peak have been identified as the Atherton Scrubwren S. keri (R. Schodde, pers. comm.), extending the known range of this species northwards by some 130km.

It has been assumed in the following discussion that the patterns of bird distribution described are those which occur during the breeding season. However, fieldwork in mid-eastern Queensland and northern NSW was done late in the breeding season, so that some changes to these patterns may have already occurred through migration.

Although the concept of species diversity has been questioned (Hurlbert, 1971), this measurement has been so widely used that its application to the results of the present survey is probably worthwhile. Diversity measurements for each study site have been determined from the spot census results by means of the Shannon-Weaver Information Function (Table 10). For those sites in which there was a marked influence of dry sclerophyll species (Rundle Range, Homevale and Iluka) a diversity measurement for rainforest species alone is given in brackets. The data conform with some well-established trends in species diversity. Firstly, there was a decline in species diversity with increasing latitude. This was most marked between the lowland rainforests of north-east and mid-eastern Queensland (from about 3.9 to 3.6), the lowland rainforests of north NSW showing a similar diversity (3.5) to those of mid-east Queensland. Superimposed on this trend is that of decreasing diversity with altitude. This is well illustrated by the indices for Thornton Peak, which were 3.9 at 640m, 3.2 at 1020m and 2.9 at 1260m. It is of some interest that this trend seemed more complex in the northern NSW rainforests, there being a noticeable increase in species diversity at intermediate altitudes - to figures matching those obtained for north-eastern Queensland (e g 4.0 at Koreelah Creek) - followed by a marked decrease at higher altitudes. These sites are located in the overlap zone between the highland and lowland rainforest avifaunas of northern NSW, and this probably explains the high species diversity observed.

PLATE 13 - Bridled Honeyeater Meliphaga frenata, a bird of the highland rainforests of north Queensland south to Mackay (Thornton Peak)

PLATE 14 - An unusual nesting site - that of the White-tailed Kingfisher Tanysiptera sylvia in a termitarium (Fritz Creek)

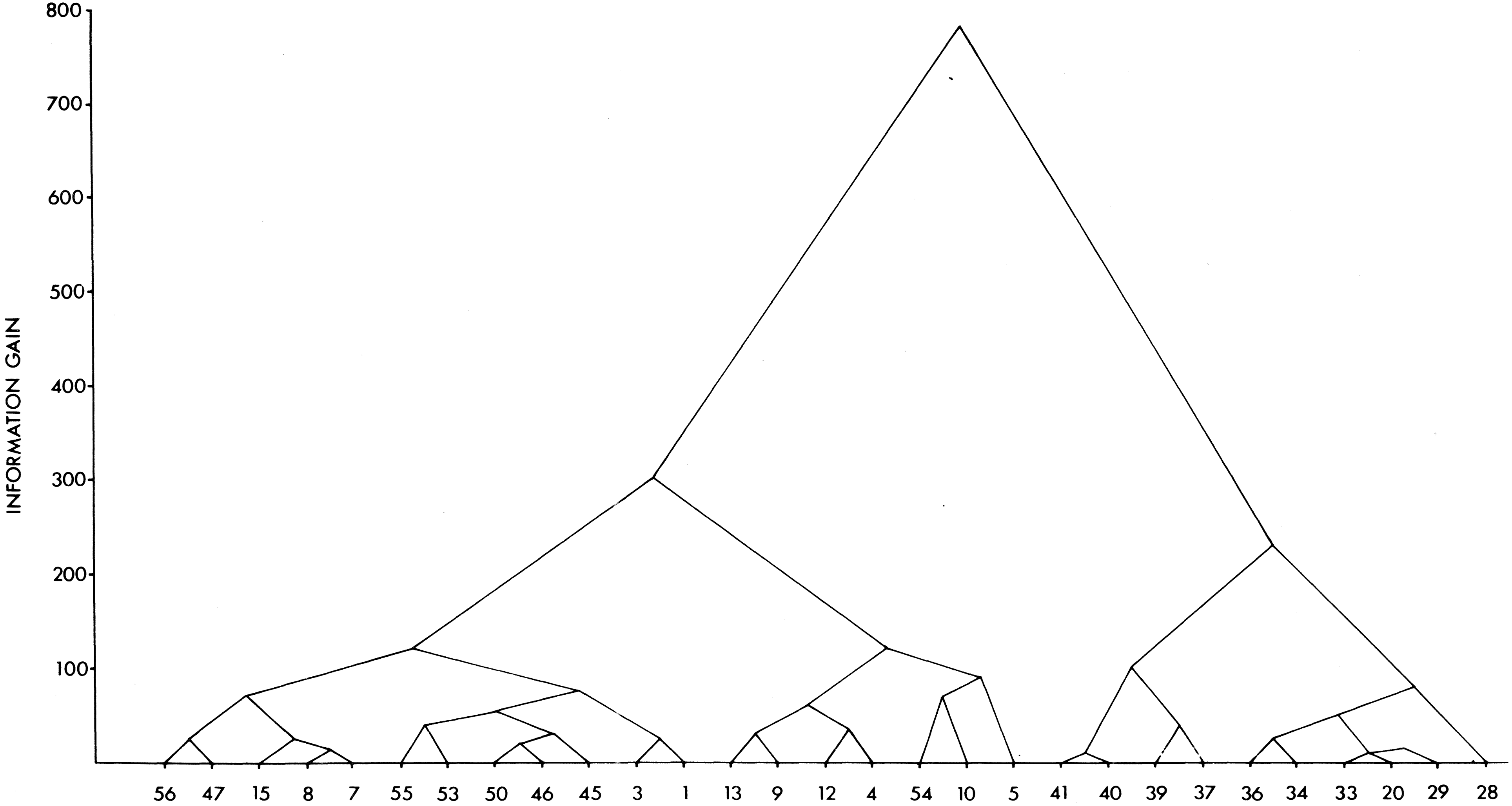


FIGURE 10 - Site classification based on relative abundance data

The results of the survey have so far been analysed with the polythetic agglomerative programmes MULTBET and CENPERC. MULTBET has been used to analyse the data qualitatively (presence/absence) and CENPERC to analyse the data quantitatively. Both programmes have been used normally and inversely. A normal analysis groups the sites on similarities and differences in species occurrence while an inverse analysis groups the species on the basis of similarities in site occurence. In these analyses the site associations have been similar, although not identical, regardless of whether the mist net, spot census or relative abundance results were used or whether these results were analysed quantitatively or qualitatively. An example of the site associations obtained is given in Figure 10, derived in this case from the relative abundance data. It can be seen that the main separation is into the north-eastern Queensland sites on the one hand and the mid-eastern Queensland and northern NSW sites on the other. The former separate readily into the highland ($>$ 600m) and lowland sites. Further division of the mid-eastern Queensland and northern NSW sites is less clear, but here too the division appears to be largely on altitude. This time three major site groups can be distinguished - the highland ($>$ 900m) and intermediate elevation (400-1000m) sites, which show a closer affinity to each other than to the more distinct lowland ($<$ 400m) sites.

The reasons for this classification of sites become apparent when the two-way table constructed from both normal and inverse analyses of the relative abundance data is considered (Table 11). The highland sites in north-eastern Queensland are found to be characterised by two main species groups. The first is composed largely of species from groups 7-9 in the table, species which are widely distributed in east Australia. They include the Top-knot Pigeon *Lopholaimus antarcticus*, White-headed Pigeon *Columba norfolciensis*, Brown Pigeon *Macropygia amboinensis*, Crimson Rosella *Platycercus elegans*, Brown Warbler *Gerygone mouki*, Yellow-throated Scrubwren *Sericornis citreogularis*, Grey Fantail *Rhipidura fuliginosa*, Golden Whistler *Pachycephala caledonica*, Eastern Whipbird *Psophodes olivaceus*, Eastern Spinebill *Acanthorhynchus tenuirostris*, Pied Currawong *Strepera graculina* and Satin Bowerbird *Ptilonorhynchus violaceus*. Many of these species appear more ecologically tolerant in the southern parts of their ranges, where they occur widely outside rainforest, but become increasingly restricted both to rainforest and to higher altitudes towards the northern limits of their ranges. Many are represented by distinct subspecies in the Queensland highlands,

TABLE 11: Groupings of rainforest species, obtained from normal and inverse analyses of the relative abundance results

(1 = rare, 2 = occasional, 3 = frequent, 4 = common, 5 = abundant)

Group No.	Species	56	47	15	8	7	55	53	50	46	45	3	1	13	9	12	4	54	10	5	41	40	39	37	36	34	33	20	29	28
	Albert Lyrebird									1																				
	Red-faced Lorilet						1																							
1	Olive-backed Oriole								1					2				1	3	3										
1	Southern Figbird															3	2	4	3	3										
1	Fairy Warbler													4	4	4	1		4	4										
1	White-eared Flycatcher											3		1		2	2	1												
	Superb Lyrebird	2	3																											
2	Yellow Oriole																						2			2				5
2	Northern Fantail																									2				
2	Papuan Frogmouth																									2				
3	Paradise Riflebird							1	1		2	2	2																	
3	Ground Thrush	2	1					2	2	1	1	1																		
3	Green Catbird		2				3		4	3	3	2	4																	
3	Southern Logrunner						2	2	3	2	4																			
3	Satin Bowerbird		3				1		3	2																				
4	Mountain Thornbill																				4	4	4							
4	Fernwren																				3	4	1	2						
4	Northern Logrunner																				3	2	2	2						
4	Tooth-billed Bowerbird																					3								
4	Grey-headed Robin																				4	3		2						

TABLE 11 (continued)

Group No.	Species	56	47	15	8	7	55	53	50	46	45	3	1	13	9	12	4	54	10	5	41	40	39	37	36	34	33	20	29	28
		Site number																												
4	Golden Bowerbird																				2	2								
	Bower Shrike Thrush																				3	3								
	Bridled Honeyeater		4	3	4																4	2	2							
	Topknot Pigeon	2			2					3											4	4	2							
	Pied Flycatcher																						1	3	2		2			
	Barred Cuckoo-shrike																	2					2		1					
	Brush Cuckoo						1																	1						
	Crested Hawk						1							2				1					1	1						
	Spotted Catbird																				3	4	4				3	3	4	
5	Grey Swiftlet																				4	3	4					3		2
	Little Bronze Cuckoo																										2	2		2
	Blue-faced Lorilet																										3	2	2	
	Torres Strait Pigeon																										5	4		
	Grey Whistler																					1		1			2	1	2	
	Victoria Riflebird																						2	2			3	3	3	
	Macleay Honeyeater																						1	1	3	4	4	3	3	
	Lesser Lewin Honeyeater																						3	4	4	5	4	4	4	3
6	Yellow Figbird																							2	2	2	2	2	3	4
	Black-throated Warbler																							1	2	2	3	3	2	2
	Graceful Honeyeater																							3	3		4	4	4	3
	White-tailed Kingfisher																1							2	4	3	4	4	2	
	Lemon-breasted Flycatcher																							2	3	2	2	2	2	

TABLE 11 (continued)

Group No.	Species	Site number																												
		56	47	15	8	7	55	53	50	46	45	3	1	13	9	12	4	54	10	5	41	40	39	37	36	34	33	20	29	28
6	Purple-crowned Pigeon													2								2	4	4	3	3	3	3	2	1
	Dusky Honeyeater													2			1		4				2	2	2	3	3	2	3	3
	Helmeted Friarbird																								2	3	2	3	3	4
	Shining Starling																								1	3	4	4	4	3
	Scrub Fowl																								4	3	3	3	2	3
	Black Butcherbird													2											3	2	3	3	3	3
	Boat-billed Flycatcher																								3	2	2	3	2	
7	Crimson Rosella	3	4		1	1	3		3	3											2	1								
	Yellow-throated Scrubwren	3	3				3		4	4	4											1		3						
	Eastern Spinebill	3	2	2	3	2		4	2	3								2	3		1	2	1							
	Mistletoe Bird	3	1				3	4	2	2	3							2			2	3	4	3	2	2	3	2	3	2
	Pale-yellow Robin		3					3	2		3							1		1			3	4	4		3	3	3	
	White-headed Pigeon								3	4	3								2			1	4	3			1			1
8	King Parrot		2	2		1	3	2	2	3		2	2		2															
	Regent Bowerbird			1				2	1	3	3	2	2		2			3												
	Eastern Whipbird			3		2	3	4	2	3	4	3	3				1	3			4	3								
	Red-crowned Pigeon					1	1	3	3		4	2	3				2			1						3				
	Noisy Pitta			1		1	2	2	3	2	2	2	2				2							4	2	4		1	3	
	Brush Turkey		2				3	2	2			1	3	2			1		2			1	1	1		2				
	Brown Pigeon		2			2		2	4	2	4	2	4	3			2				1	2	2	1		1				
9	Pied Currawong	2	3	2	4		2		3	2		3	2		2	4			4											
	Golden Whistler	2	3	2	3	4	3	4	3	3	3	2	4	2	3		2	4	4	4	3	2		2						
	White-browed Scrubwren	3	3	4	3	3	3	3	3	4	1	3	4	4	3	3		3	4	4										

TABLE 11 (continued)

Group No.	Species	56	47	15	8	7	55	53	50	46	45	3	1	13	9	12	4	54	10	5	41	40	39	37	36	34	33	20	29	28
		Site number.																												
9	Grey Fantail		1	1	2	2		2	2	2	3	2	4	3	4	2		3	3		4	1								
	Brown Thornbill	4	4	4	3	2	3	3	3	4	2	2			2			3	3											
	White-throated Tree-creeper	3	4	3	2	3	3	1	2	3	2	1			2			3												
	Grey Shrike Thrush		2	2	2	2	2	2	2	3	2	2						3	2											
	Northern Yellow Robin	3	2	4	2	4	3	4	4	3	4	4	5	4	2			4												
	Brown Warbler	2	4	4	4	2	4	4	4	4	4	2	4					3						4						
10	Sulphur-crested Cockatoo			3	3	2		3						4		3	3						4		2		2		4	3
	Wompoo Pigeon					2			3		2		3	4	2	2							3	3	3	3	3	4	4	2
	Scaly-breasted Lorikeet					2											3	3		4					2			1		3
	Spangled Drongo							1						2		4	3	2	4	3					2	3	3	3	3	4
	Green-winged Pigeon				2		4	4				2	4			3	2		3					2		3	1	2	2	3
	Varied Triller						2	3				2				3	2	3	4					2	3	2	4	4	3	2
11	Rainbow Lorikeet		2		3	2	2	2	2	2	2	3	3	2	2	2	4		4					3	4	4	2	2	2	5
	Silvereye		3	2	2		2	5	4	3	3	1	4			4		3	4	3			4	4	3	3	2	4	4	
	Large-billed Scrubwren	3	4	3	2	3	4	3	2	4	4	3	4	3	3		4	4			3	3	4	4	3	3	4	4	3	
	Spectacled Flycatcher						1	2			2	3	3	4	4	4	4	3	2	3		1	3	4	4	3	4	3	2	
	Rufous Shrike Thrush			2			2				1	3	3	4	4	4	3	3	4	4			4	4	4	4	4	4	4	
	Lewin Honeyeater	2	3			1	3	4	4	3	4	4	5	4	4	4	4	4	4	4			2	2						
	Rufous Fantail		1				4	4	3	3	3	3	2	4	4	3	4	3	4	5			1			2				
	Black-faced Flycatcher						3	4	3	3	4	1	2		3	2	2		4	4			2	3	2	2				

reaching as far south in some cases as the Eungella Ranges behind Mackay in mid-eastern Queensland.

The second group comprises most of those species in group 4, namely the Northern Logrunner Orthonyx spaldingi, Mountain Thornbill Acanthiza katherina, Fernwren Oreoscopus gutturalis, Grey-headed Robin Heteromyias cinereifrons, Bower's Shrike Thrush Colluricincla boweri, Bridled Honeyeater Meliphaga frenata, Tooth-billed Bower-bird Scenopoeetes dentirostris and Golden Bower-bird Prionodura newtoniana. The Atherton Scrubwren Sericornis keri (collected near the summit of Thornton Peak) also belongs to this group. These species occur only in the highland rainforests of the Cairns/Atherton area, except for the Bridled Honeyeater which extends south to the Eungella Ranges in mid-eastern Queensland.

The Spear Creek site occupies a somewhat intermediate position between the highlands and lowlands, having a limited representation of typically highland species like the Fernwren, Northern Logrunner, Grey-headed Robin, Pied Currawong and Golden Whistler but also a broad range of typically lowland species (see below).

While the species in the two groups just described are essentially highland birds in north-eastern Queensland, some do have lowland populations, especially in areas of high rainfall (for example, the Northern Logrunner and Eastern Whipbird - Storr, 1973).

The avian communities of lowland rainforest in north-eastern Queensland also seem to contain two main species groupings. The first is a large, very distinctive avifauna which is essentially restricted to the rainforests of north Queensland, although some species extend southwards into mid-eastern Queensland (notably the Dusky Honeyeater, Scrub Fowl, Black Butcherbird and Torres Strait Pigeon). Species in this group are confined to groups 5 and especially 6 in Table 11. They include the Pied Flycatcher Arses kaupi, Torres Strait Pigeon Myristicivora spilorrhoa, Grey Whistler Pachycephala griseiceps, Victoria Riflebird Ptiloris victoriae, Macleay Honeyeater Meliphaga macleayana, Lesser Lewin Honeyeater M. notata, Graceful Honeyeater M. gracilis, Yellow Figbird Sphecotheres flaviventris, Black-throated Warbler Gerygone palpebrosa, White-tailed Kingfisher Tanysiptera sylvia, Lemon-breasted Flycatcher Microeca flavigaster, Dusky Honeyeater Myzomela obscura, Helmeted Friarbird Philemon novaeguineae, Shining Starling Aplonis metallica, Scrub Fowl Megapodius freycinet, Black

PLATE 15 - Riverine gallery rainforest (Helenvale)

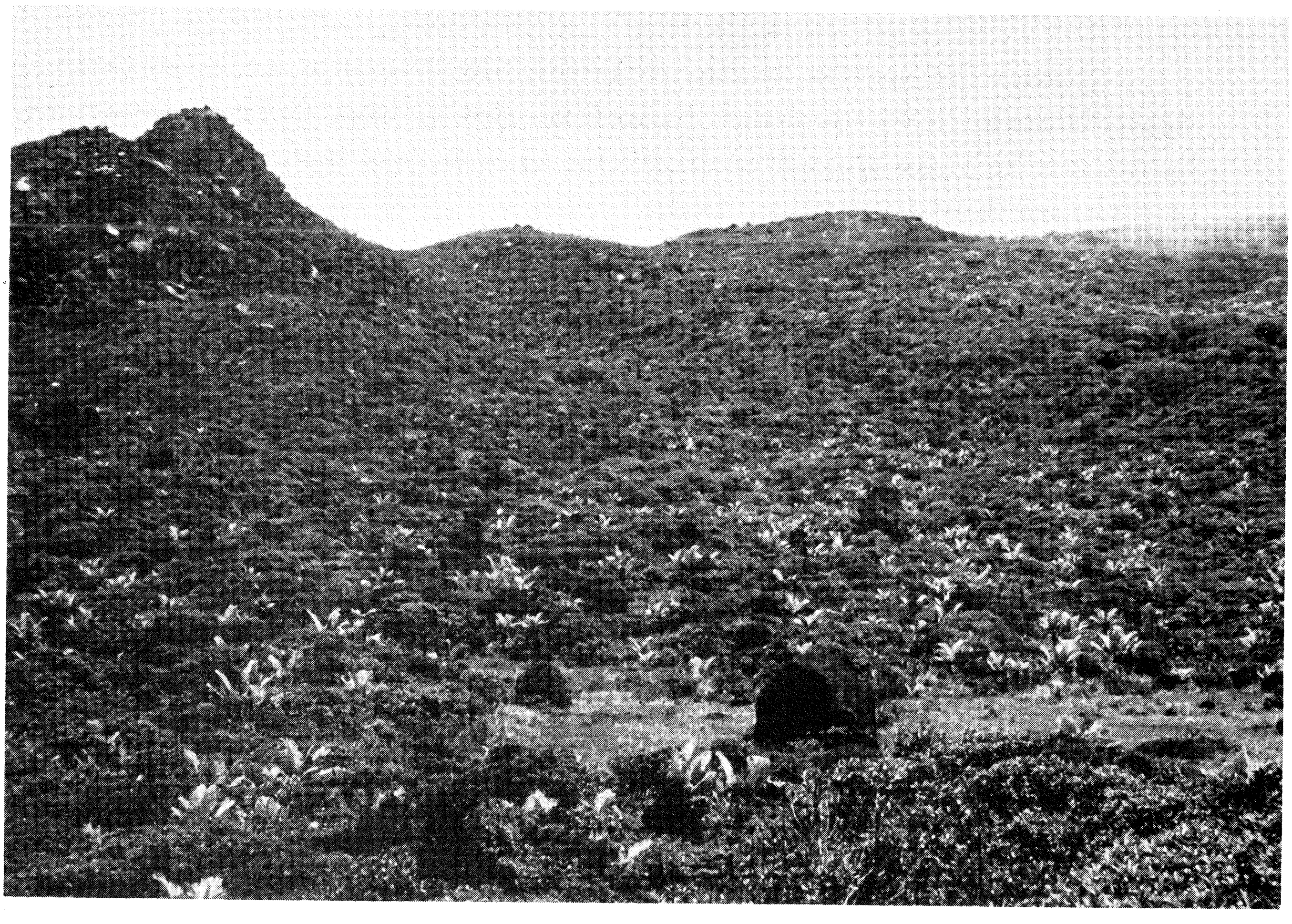


PLATE 16 - Simple microphyll vine fern thicket (summit of Thornton Peak)

Butcherbird *Cracticus quoyi*, Boat-billed Flycatcher *Machaerirhynchus flaviventer* and Blue-faced Lorilet *Opopsitta diophthalma macleayana*. The second major component of the lowland avifauna in north-eastern Queensland rainforests is composed mostly of species in groups 10 and 11 of the table. These species are widely distributed through lowland rainforests in east Australia, in many cases southwards into northern NSW but sometimes further south still. Members of this group include the Red-crowned Pigeon *Ptilinopus regina*, Wompoo Pigeon *Megaloprepia magnifica*, Spangled Drongo *Dicrurus bracteatus*, Green-winged Pigeon *Chalcophaps indica*, Varied Triller *Lalage leucomela*, Spectacled Flycatcher *Monarcha trivirgata*, Rufous Shrike Thrush *Colluricincla megarhyncha* and probably the Barred Cuckoo-shrike *Coracina lineata*. The Rainbow and Scaly-breasted Lorikeets (*Trichoglossus haematodus* and *T. chlorolepidotus*) were also commonly recorded from the lowland rainforest sites although they also occur widely in other habitats.

At this point it may be worth commenting briefly on the avifauna of the Helenvale site, an example of riverine gallery rainforest. Although the avifauna of this rainforest type is essentially lowland, it is impoverished. When considered together with the results from a supplementary site (Trevethan Creek) of the same rainforest type, the following lowland species were not recorded: Blue-faced Lorilet, Grey Whistler, Victoria Riflebird, Macleay Honeyeater, White-tailed Kingfisher, Lemon-breasted, Boat-billed, Pied and Spectacled Flycatchers, Silvereye, Large-billed Scrubwren and Rufous Shrike Thrush. On the other hand this rainforest type seems to be an important habitat for the Yellow Oriole *Oriolus flavocinctus*, Large-billed Warbler *Gerygone magnirostris* and possibly the Papuan Frogmouth *Podargus papuensis*.

Turning now to the avifauna of the mid-eastern Queensland and northern NSW rainforests, two species groupings can be distinguished - one highland and the other lowland - although the separation is less distinct than in north-eastern Queensland. The highland avifauna has many species in common with that in north-eastern Queensland, notably the Crimson Rosella, Satin Bowerbird, Topknot Pigeon, White-headed Pigeon, Pied Currawong, King Parrot, White-throated Treecreeper, Yellow-throated Scrubwren, Eastern Spinebill, Eastern Whipbird and Bridled Honeyeater. In addition, it contains several species with a more southern distribution, including the Rose Robin *Petroica rosea*, Albert Lyrebird *Menura alberti*, Superb Lyrebird *M. superba*, Paradise Riflebird *Ptiloris paradiseus*, Green Catbird *Ailuroedus crassirostris*, Southern Logrunner Orthonyx temminckii, Brown Thornbill Acanthiza pusilla, Regent Bowerbird Sericulus chrysocephalus, Grey Shrike Thrush Colluricincla harmonica and Northern Yellow Robin Eopsaltria chrysorrhoa.

In contrast, most of the species which constitute the lowland avifauna of mid-eastern Queensland and northern NSW also occur in the lowland rainforests of north-eastern Queensland, notably the Red-crowned Pigeon, Wompoo Pigeon, Scaly-breasted Lorikeet, Spangled Drongo, Green-winged Pigeon, Varied Triller, Spectacled Flycatcher, Rufous Shrike Thrush and Barred Cuckoo-shrike. Additionally, three other species which were present in north-eastern Queensland now appear as important members of this lowland avifauna - the Lewin Honeyeater Meliphage lewinii, Rufous Fantail Rhipidura rufifrons and Black-faced Flycatcher Monarcha melanopsis. Our limited experience suggests that these species occur infrequently and mostly at intermediate/low altitudes in north-eastern Queensland but are important members of the lowland rainforest avifauna in mid-eastern Queensland and northern NSW. There were five species/subspecies recorded only in the southern lowland rainforests, namely the Red-faced Lorilet Opopsitta diophthalma coxeni, Fairy Warbler Gerygone flavida, Olive-backed Oriole Oriolus sagittatus, Southern Figbird Sphecotheres vieilloti and White-eared Flycatcher Monarcha leucotis. The first two are closely related to the Blue-faced Lorilet and Black-throated Warbler of the northern rainforests.

Four other species which are usually associated with rainforests of south-eastern Queensland and northern NSW were not encountered during the present survey. These are the Black-breasted Quail Turnix melanogaster, Plumed Frogmouth Podargus plumiferus, Rufous Scrub-bird Atrichornis rufescens and Olive Whistler Pachycephala olivacea. The latter two species at least appear to prefer high altitude rainforests.

Although this discussion has so far been limited to considering the distribution of birds through east Australian rainforests during the breeding season, it may be worth concluding with some comments on the changes which occur towards the end of the breeding season. It is clear that two major movements of rainforest birds occur at this time - a large migration northwards coupled with an altitudinal migration towards the lowlands. Storr (1973) described annual latitudinal movements for almost a quarter of the species that occur in east Australian rainforests. He also provides some evidence of altitudinal movement for at least half those species that occur at higher altitudes in the northern rainforests. Clearly rainforest bird communities are far from static and it would be wrong to assess their conservational needs until these migratory patterns are better understood.

Reptiles and Amphibians

INTRODUCTION

Currently about 670 species of reptiles and amphibians are known from Australia. Of these some 20 species of reptiles (or 4% of the reptile fauna) and 25 species of amphibians (18% of the amphibian fauna) appear to be endemic to rainforest (viz. confined to rainforests, or dependent upon them to the extent that they only occur in other habitats provided these are directly associated with, or adjacent to, rainforest).

Rainforest reptiles and amphibians exhibit a marked decline in species number with increasing latitude (Figure 11), with the amphibians exhibiting a far greater rate of decline; one family and one important rainforest genus of frogs are entirely unrepresented in the southern rainforests. This latitudinal fall-off undoubtedly represents, in part at least, a limiting winter temperature effect on what is essentially a tropical, poikilothermal faunal element. To date it has not been correlated with floristic or structural differences in the rainforest itself.

This report describes briefly the results from a survey of eleven sites in mid-eastern Queensland, made between 15th March and 30th April 1975, and ten sites in north-eastern Queensland made during October/ November 1975 and July 1976. General collecting was carried out at each site and in adjacent rainforest, while a standardised sampling method was also used at most sites.

For convenience the nomenclature followed below is consistent with that of Cogger (1975).

METHODS

a) <u>Drift fence trapping</u> (standardised)

A drift fence in conjunction with pit and funnel traps - a method used successfully in more open habitats - appeared to be the only practicable

PLATE 17 - Complex notophyll vine forest dominated by feather palms (Crediton)

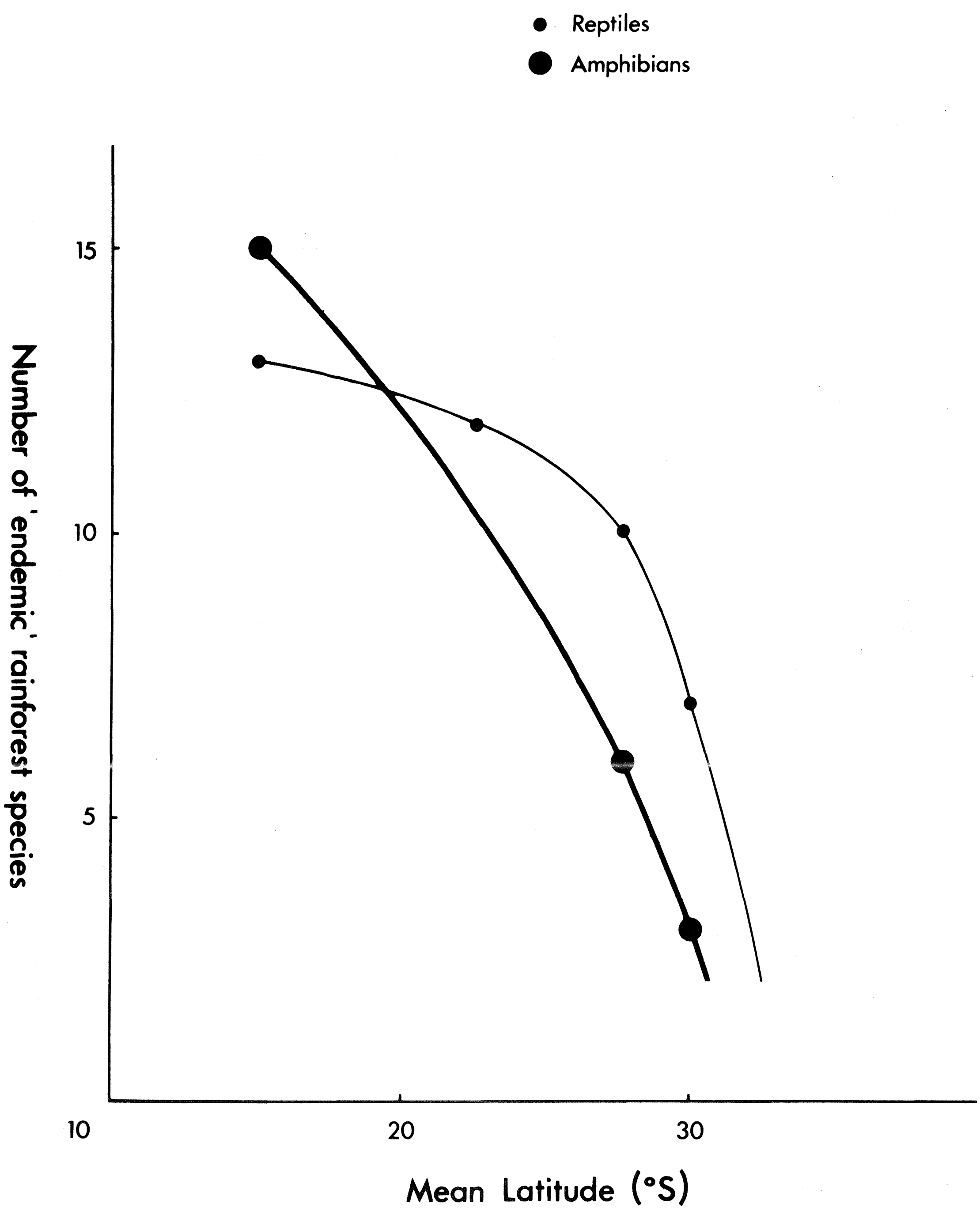


FIGURE 11 - Decline with latitude in the numbers of 'endemic' rainforest species of reptiles and amphibians

way in which to quantitatively sample each site within the time available. The fence consisted of two lengths of bitumenised paper, each 15m long and 45cm high, supported by wire stakes. One length was placed along the contour while the other bisected it at right angles, giving a cross with four 7.5m arms. Two funnel traps were placed at the end of each arm, one on each side of the fence, while pit traps were placed both at the intersection of the arms and halfway along each arm (see Anon (1976) for illustration). This provided a total drift fence length of 30m, with eight funnel and twelve pit traps. The pit traps used were half-gallon paint cans, and the funnel traps were of the type illustrated by Cogger (1975).

The drift fence was left in place for six days. The traps were initially examined four times daily, then each morning and evening as trapping success indicated, in the hope that information would be obtained on the diurnal and nocturnal movement of species across the slope.

b) General collecting (non-standardised)

General collecting was carried out in those parts of the site not occupied by the drift fence and in adjacent rainforest. Areas under logs, bark and rock were examined, and spotlighting undertaken at night, coupled with the opportunistic collection of animals active during the day.

An attempt was also made to assess the relative abundance of the herpetofauna on an arbitrary basis during the six days spent at each site, as described in the preliminary report of the Queensland Museum (Anon, 1976). This was aimed at comparing related taxa at different sites, and was not used to compare the densities of different taxa at the same site. However, snakes were at no time seen in sufficient numbers to confidently assess their relative abundance.

RESULTS AND DISCUSSION

Some modification of the standardised sampling method proved necessary in the field. A standardised position for the drift fences was not always possible due to the nature of the terrain. Natural obstructions, such as trees, roots and rocks also greatly affected the position and shape of the fences. The method provided fewer results than anticipated, possibly

PLATE 18 - Drift fences in use

PLATE 19 - Northern Barred Frog Mixophyes schevilli, a species restricted to the rainforests of north-eastern Queensland (Thornton Peak)

due to the low density of reptiles and amphibians in rainforest. However, as certain species were obtained only in this way, the fences partly justified the time and effort needed for their construction. A more detailed assessment of the method has been made elsewhere (Anon, 1976).

Of the 65 species of reptiles and amphibians collected during the survey from the sites and/or adjacent rainforest (Table 12), only 6 of the described species may be said to be endemic to rainforest. Tentatively, twelve new species and two new genera of reptiles and amphibians were obtained during the survey, comprising 4 frogs and 8 lizards. Half the new lizard species belong to the skink genus Leiolopisma (sensu lato), a group which is currently under review by several workers. The biogeographic affinities and habitat preferences of these undescribed species have yet to be assessed.

Study sites located within small tracts of rainforest sometimes contained herpetofaunal elements from adjacent unrelated floristic types. This was particularly noticeable in the low to medium altitude sites. In general the highland sites were situated in more extensive stands of rainforest. Many of the undescribed species were from the latter sites and are as yet unknown from other localities.

The results for the mid-eastern Queensland sites are given in more detail in Figures 12 and 13 and Tables 13 and 14. Figure 12 shows the site affinities obtained by a MULTBET (qualitative) analysis of the results from all collecting within the sites and/or adjacent rainforest, while Figure 13 shows a similar site classification from a CENPERC (quantitative) analysis of the standardised trapping results alone. Table 13 lists in systematic order those species obtained from all collecting within the study sites and/or adjacent rainforest, with their relative abundance at each site, while Table 14 groups those species collected by standardised trapping alone according to an inverse CENPERC analysis.

In considering possible relationships between the different rainforest types, the introduced Cane Toad Bufo marinus has been excluded from these analyses. The importance of this species, however, may lie in its potential as a direct competitor with the native fauna, upon much of which it may also prey. Covacevich & Archer (1975) have shown that death from mouthing or ingesting the cane toad occurs in a large number of native vertebrates; however, it has yet to be shown whether the cane toad

TABLE 12: Numbers of species collected during standardised and general collecting in the site and adjacent rainforest

	Standardised (site only)	Standardised and general (site only)	Standardised and general (site and/or adjacent rainforest)
Chelonians	0	0	1
Anurans	8	15	17
Lizards	11	27	35
Snakes	3	8	12
TOTAL	22	50	65

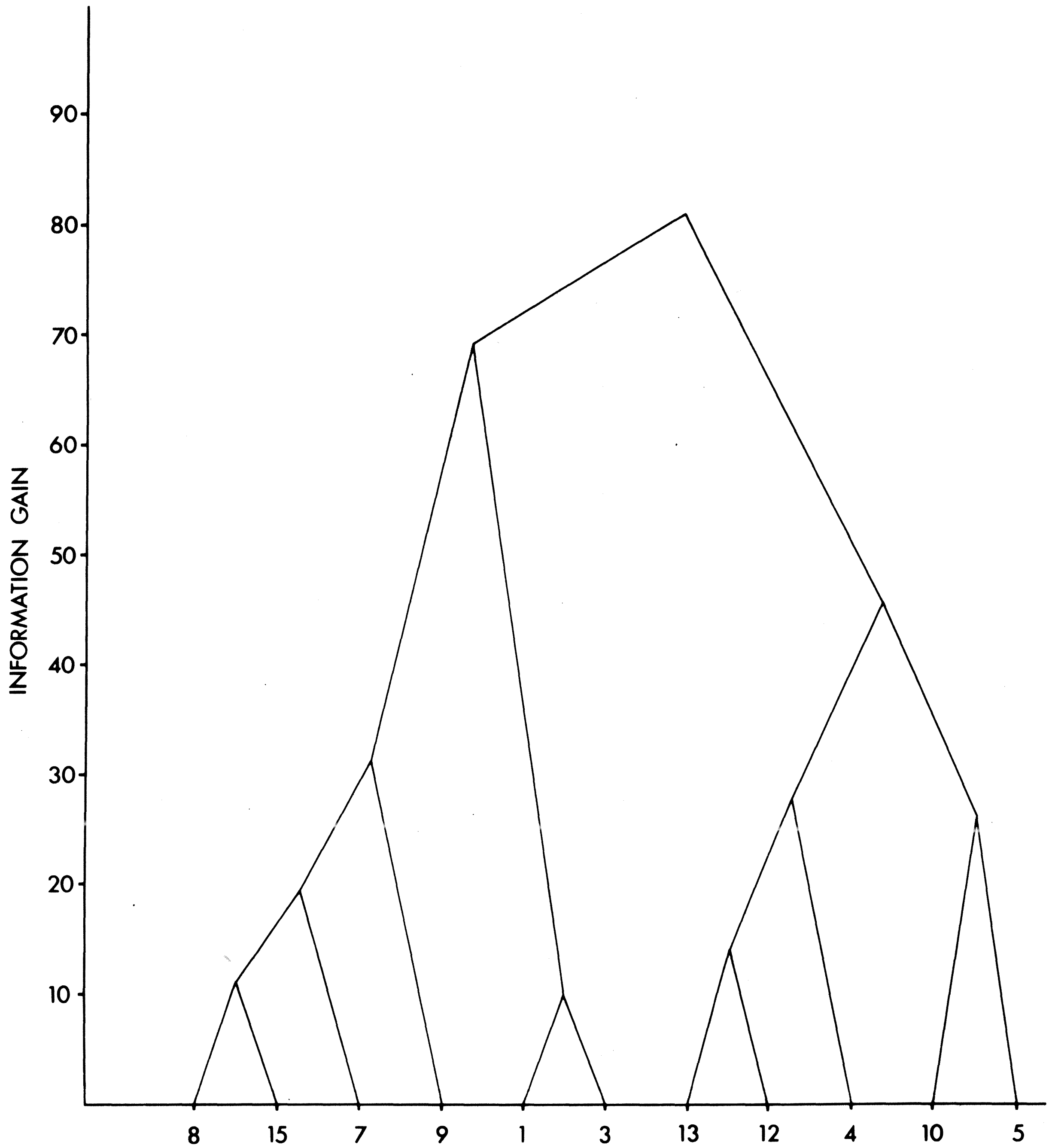


FIGURE 12 - Site classification based on presence/absence results from general and standardised collecting within the sites and adjacent rainforest (excluding Bufo marinus)

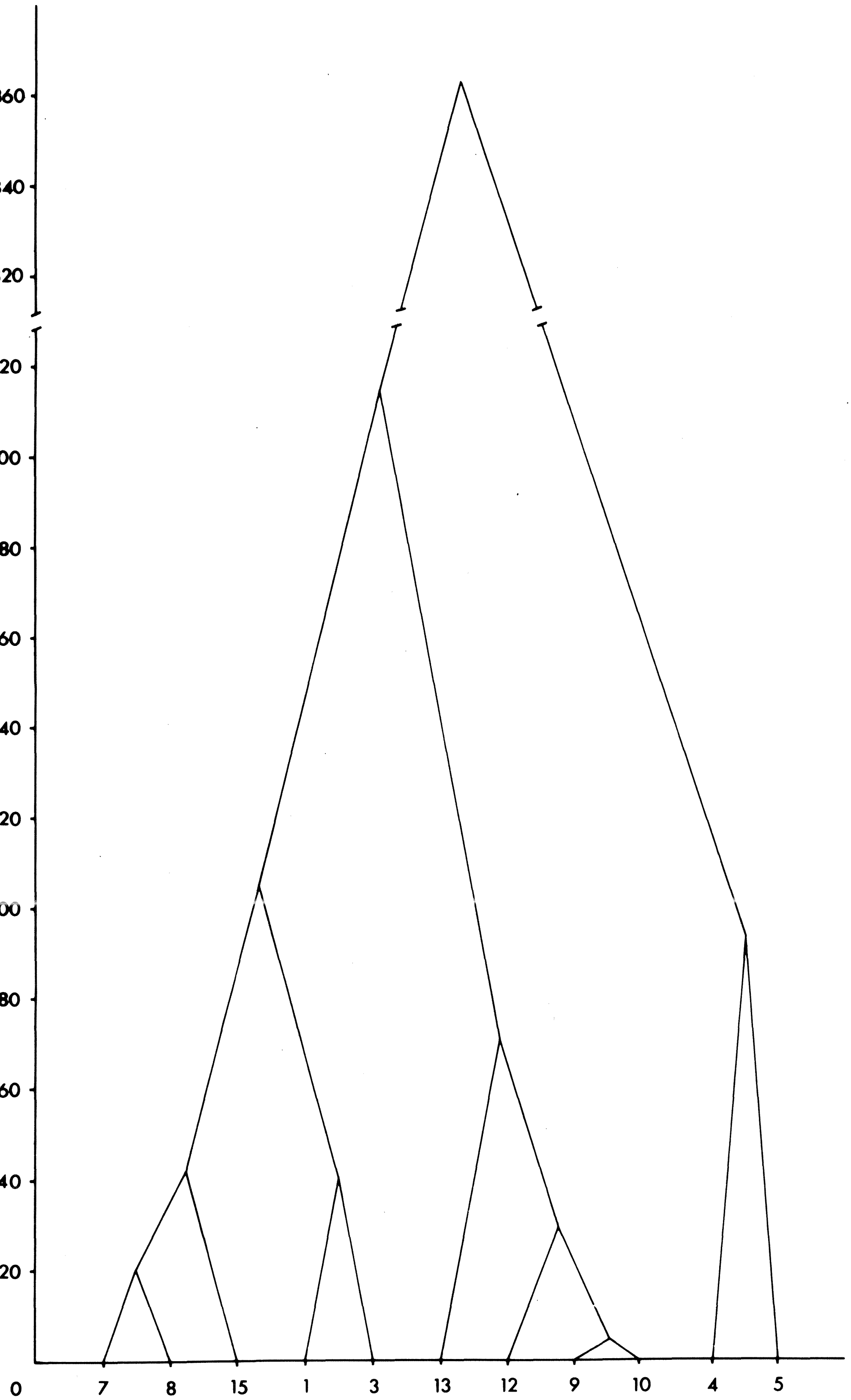


FIGURE 13 - Site classification based on quantitative results from standardised trapping within the sites (excluding <u>Bufo marinus</u>)

TABLE 13: Relative abundance of species collected by all methods within the sites and/or adjacent rainforest
(1 = present, 2 = scarce, 3 = common, 4 = abundant, 5 = very abundant)
*species collected within site.

	Site No.										
	1	3	4	5	7	8	9	10	12	13	15
LEPTODACTYLIDAE											
Adelotus brevis	3*	2*			1*						
Limnodynastes ornatus				1							
L. peronii	2*	2*	3*		4*	2*					1*
L. terraereginae			3*								
Mixophyes fasciolatus					5	3*	4				1*
Taudactylus eungellensis					5	5	5*				5
Uperoleia sp.			5*								
Pseudophryne sp.						2*					
Gen. nov.					5*						4*
HYLIDAE											
Litoria bicolor			5*								
L. caerulea		1*		4*		1					
L. chloris	2	1	1								
L. gracilenta			1								
L. lesueurii	5*	4*			5*	5	5*	5			2
L. nasuta	3	2	1*						1*	1	
Litoria sp.						1*					
BUFONIDAE											
Bufo marinus	5*	5*	5*	5*		1*	5*	3*	3*	5*	
CHELIDAE											
Elseya latisternum							1				
GEKKONIDAE											
Gehyra australis				3*							
Heteronotia binoei				5*				3	1		

TABLE 13 (continued)

	Site No. 1	3	4	5	7	8	9	10	12	13	15
GEKKONIDAE (Contd)											
Oedura lesueurii										2*	
O. tryoni			4*				3				
Phyllurus caudiannulatus	5*	4*									
P. caudiannulatus ssp(?)					5*	5*	4*				5*
P. salebrosus	3	1									
PYGOPODIDAE											
Lialis burtonis				2*							
AGAMIDAE											
Physignathus lesueurii					1						
VARANIDAE											
Varanus varius	3	3		3	1		1				
SCINCIDAE											
Anomalopus ophioscincus	4*	2*									
A. verreauxii	2	1									
Anomalopus sp(?)							1	2*			
Carlia burnetti				2				2			
C. mundivensis								5			
C. pectoralis				5*							
C. rhombiodalis							5*	5*	4*	5*	
C. schmeltzii				5*				4			
C. vivax								1*			
Ctenotus robustus			1*								
C. taeniolatus								1*			
Cryptoblepharus boutonii				2*				2			
Egernia frerei	2	2									
Leiolopisma challengeri							5*			4*	
L. delicata	5*	4*			5*		5*			5*	5*
Leiolopisma sp(Eurimbula)			5*								
Leiolopisma sp(Mt Dryander)									1*		

TABLE 13 (continued)

	Site No. 1	3	4	5	7	8	9	10	12	13	15
SCINCIDAE (Contd)											
Leiolopisma sp(Homevale)								1			
Leiolopisma sp(Mt William)											2*
Gen. nov.							5*			3*	
Sphenomorphus sp(Dalrymple Heights)						5*					4*
Sphenomorphus sp(Rundle Range)				4*							
S. quoyii	5*	4*					2				
S. scutirostrum	5*	3*			4*		5*				
S. tenuis	5	3*	4*	4			4*	3			
Tiliqua gerrardii	1		1*			1*			1*		
TYPHLOPIDAE											
Typhlina sp.		1									
BOIDAE											
Morelia spilotes	3	3								1*	
COLUBRIDAE											
Boiga irregularis	1	1*		2							
Dendrelaphis punctulatus	1		1*	3			1*				
ELAPIDAE											
Cacophis harriettae								1			
C. krefftii					1*		1				
C. squamulosus	1					2*	1*				1*
Cryptophis nigrescens	2*	2					1	1			1*
Demansia psammophis		1								1	
D. torquata								1	3		
Hemiaspis signata	1*										
Pseudechis porphyriacus	1*	1*				1*					1*

TABLE 14: Groupings of species obtained from normal and inverse CENPERC (quantitative) analysis of standardised trapping results

Species	No. individuals trapped at site 7	8	15	1	3	13	12	9	10	4	5
Litoria nasuta						1					
Demansia torquata						3					
Carlia rhombiodalis	1	1				3	1	1	1		
Leiolopisma challengeri							1	1			
Litoria lesueurii	1	3		2	6						
Phyllurus caudiannulatus					1						
Boiga irregularis					1						
Adelotus brevis				1							
Carlia vivax									1		
Leiolopisma delicata	3		2				3				
Phyllurus sp.	1	2	1								
Cacophis squamulosus		2									
Genus nov.			7								
Leiolopisma Mt William			1								
Litoria caerulea											1
Lialis burtoni											1
Sphenomorphus Rundle Range											4
Limnodynastes peronii				1	2					3	
Uperoleia sp.										3	
Leiolopisma Eurimbula										2	
Tiliqua gerrardii										1	

contributes to any significant mortality in wild populations of reptiles and amphibians. Exclusion of Bufo marinus had little effect on the site classifications obtained from qualitative analyses of the results. However in assessing the relative abundance results there were marked dissimilarities in the site groupings when the two sets of results - with and without Bufo - were compared. Most affected were the highland sites, where toads were either absent or had only been observed in recent years. This may be due to vegetation, altitudinal or physical factors, or any combination of these. Indeed, it may well be that low densities of Bufo at some sites are not simply the result of acclimatisation or recent colonisation, but represent unstable populations in marginal habitats. Such populations may not be self sustaining, and may depend on continuing recruitment from adjoining populations, especially those at lower altitudes.

As can be seen in Figure 12, the highland sites examined separate out clearly from the other sites. Sites 7, 8, and 15 are all between 920 and 1120m in altitude. Closely allied to these is site 9, of low/intermediate altitude. It was, however, geographically only a short distance (20km) from sites 7, 8 and 15, and one might therefore expect some faunal elements common to both sites. Similarly sites 1 and 3 were only separated by a few kilometres and were at 540 and 580m altitude respectively, and one would again expect them to group together on the presence of certain common faunal elements. Sites 4, 12 and 13, and sites 5 and 10 seem to separate on a geographical basis. Sites 12 and 13 are both at 120m altitude, and lie close to each other and the coast; site 4 was also distinctly coastal and only marginally above sea level. Despite marked differences in altitude (30 and 440m respectively) the grouping of sites 5 and 10 may be related to their common structural type, viz., semi-evergreen vine thicket.

A similar arrangement of sites 7, 8 and 15 and sites 1 and 3 is also found in Figure 13. The different groupings of the remaining sites when compared with Figure 12 may well result from the paucity of data.

The most frequently encountered reptiles and amphibians in rainforest, including the areas studied, are usually not the rainforest endemics, but rather wet sclerophyll or woodland species which have penetrated the rainforest by way of natural or man-made corridors, such as creeks, tracks or clearings, where the break in the canopy allows entry of sunlight and growth of herbs and shrubs, and also provides basking areas for diurnal

PLATE 20 - Red-eyed Frog Litoria chloris, a species widely distributed through rainforest and wet sclerophyll in eastern Australia. A nocturnal and arboreal species (Bulburin)

reptiles.

Sometimes, by use of these corridors, non-rainforest species were found deep within large tracts of rainforest, but are ecologically quite distinct (although not isolated) from the true rainforest species (e g *Pseudechis porphyriacus*, *Physignathus lesueurii*).

Another group of ecologically vagile species was also sometimes found in the rainforest, but its members are regarded only as marginal rainforest species, generally occurring more commonly in a variety of other mesic (or even xeric) habitats (e.g. *Ctenotus robustus*, *Varanus varius*).

Finally there were those species which although unable to fully utilize corridors to penetrate the rainforest, were often found in ecotonal areas adjacent to rainforest, ranging from naturally occurring eucalypt forests to man-made grasslands or orchards (e.g. *Ctenotus taeniolatus*, *Gehyra australis*).

Few of the reptiles confined to rainforest, and only a small proportion of the amphibians, belong to any of the older Australian faunal elements, but have been derived from a series of relatively recent invasions from New Guinea. The earliest of these invasions gave rise to a minor radiation of reptiles and amphibians in isolated tracts of rainforest along the eastern coast of Australia, although the effects of late Pleistocene/ Holocene faunal exchanges appear to be confined to Cape York Peninsula.

The species collected at both the Queensland and Australian Museum sites in north Queensland are listed in Appendix 1. Analyses of the results from this study area are now in progress.

APPENDIX 1: Amphibians and reptiles recorded from study sites and/or adjacent rainforest in north Queensland

LEPTODACTYLIDAE
Cophixalus sp.
Mixophyes schevilli
Nyctimistes vestigea
Sphenophryne fryi
S. pluvialis
S. robusta

HYLIDAE
Litoria chloris
L. gracilenta
L. fallax
L. infrafrenata
L. latopalmata
L. lesueurii
L. nasuta
L. nannotis
L. rheocolus
L. rothii
L. serrata

RANIDAE
Rana daemelii

BUFONIDAE
Bufo marinus

CHELIDAE
Elseya latisternum

GEKKONIDAE
Carphodactylus levis
Cyrtodactylus louisidensis
C. pelagicus
Gehyra sp.
Phyllurus cornutus
Oedura rhombifer
Oedura sp.

AGAMIDAE
Goniocephalus boydii
Physignathus lesueurii

VARANIDAE
Varanus timorensis
V. varius

SCINCIDAE
Carlia fusca
C. novaeguinae
C. rhomboidalis
Cryptoblepharus boutonii
Egernia frerei

SCINCIDAE (continued)

Leiolopisma challengeri

Leiolopisma sp.

Sphenomorphus tenuis

Sphenomorphus sp. 1

Sphenomorphus sp. 2

Tropidophorus queenslandae

TYPHLOPIDAE

Typhlina sp.

BOIDAE

Aspidites melanocephalus

Liasis amethystinus

COLUBRIDAE

Amphiesma mairii

Boiga irregularis

Dendrelaphis calligaster

D. punctulatus

Stegonotus cucullatus

ELAPIDAE

Demansia psammophis

Oxyuranus scutellatus

Pseudechis porphyriacus

Pseudonaja textilis

Spiders

INTRODUCTION

Rainforest spiders have been studied by several workers. Koch (1871), for example, described many rainforest species mainly from the families Salticidae, Araneidae and Thomisidae. W.J. Rainbow, a former Curator of Entomology at the Australian Museum, published several papers dealing with rainforest spiders (notably Rainbow, 1914, 1916a & b). Later contributions have been made by Forster (1959) and Main & Mascord (1970, 1974).

Nevertheless the spider fauna of Australian rainforests is still poorly known. The main objectives of the present study are to provide an inventory of rainforest species, to establish the extent and significance of differences in species composition in different types of rainforest and to define broad biogeographical patterns in the distribution of rainforest spiders.

METHODS

a. Pit fall traps (standardised)

This method mostly samples the more active segment of the ground dwelling fauna. Because of the short sampling time available (4 days, 5 nights) the pit traps were supplemented with tar paper drift fences. The traps consisted initially of 20 waxed cardboard cups (12cm mouth diameter) which could be transported easily in the field. Because of their lack of durability these were in part replaced by glass jars of a similar size. The drift fence was set up in a cross configuration with 7.5 metre arms and the traps let into the ground along the arms as shown in Figure 14. A formalin-propanol preservative solution was placed in the bottom of each pit trap. For practical reasons this method was used only in mid-eastern Queensland (see below).

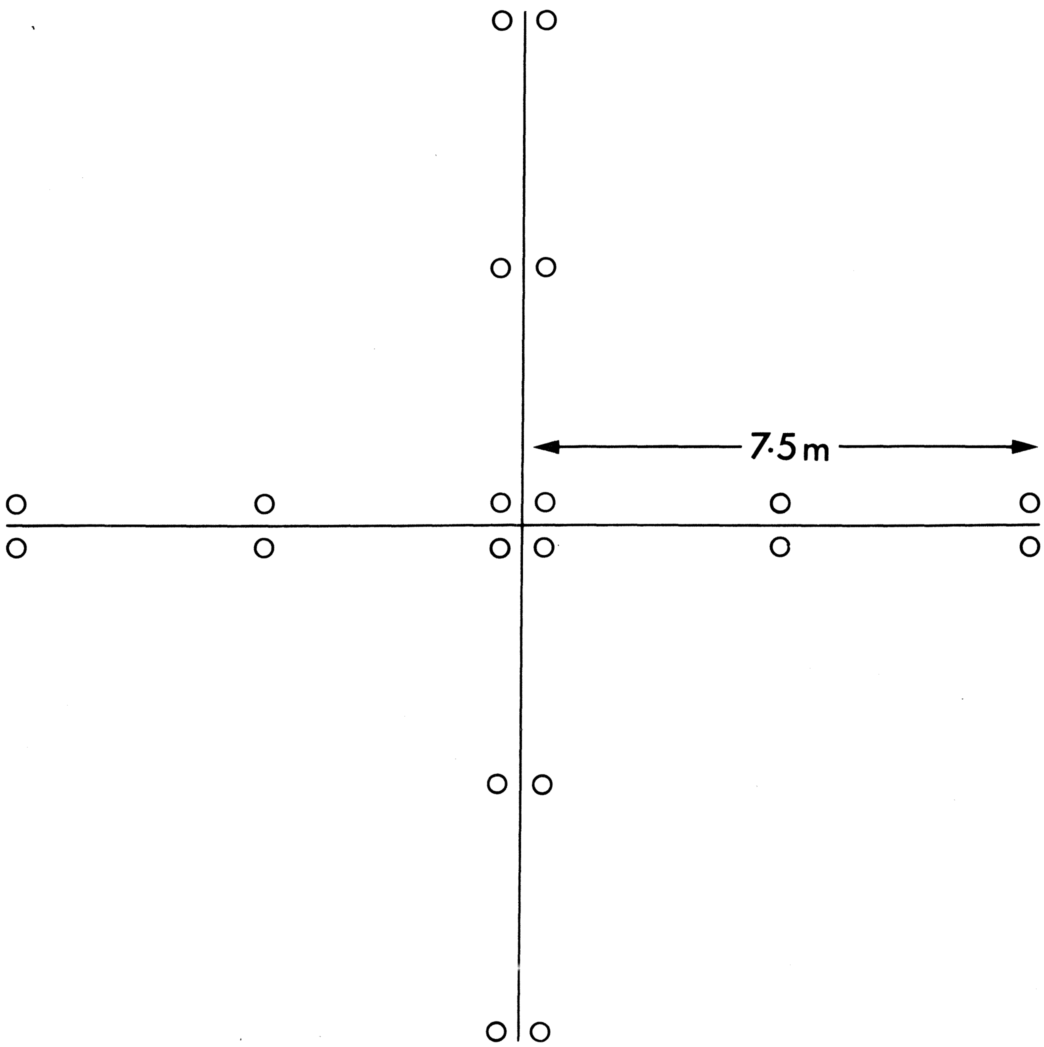


FIGURE 14 - Layout of standardised pitfall trapping method used in mid-east Queensland

b. Leaf Litter (standardised)

Leaf litter can be sampled both rapidly and repeatably. Samples were taken on a constant volume basis from well-developed litter deposits (a subjective assessment). The litter was collected by hand with the requirement that each subsampling plot (one handful) should be separated from any other plot by at least one metre. This was done to reduce potential bias associated with irregularities in the micro-distribution of the fauna and to ensure sample collection over a considerable area of each site. In this way 14 plastic bags (30 x 50cm) were filled with litter to a constant volume of about $0.02m^3$/site. The sample was usually taken in two halves both to spread the sorting load and to ensure that not more than half a day lapsed between sampling and sorting. The litter was sorted by hand. This simply involved placing a handful of litter at a time into a white tray and examining it piece by piece. All specimens observed were transferred to alcohol using forceps or brush. Sorting time varied from 12 to 18 hours per site sample.

c. General collecting (non-standardised)

Spiders (and other arachnids) were sampled from all accessible habitats by day and night. Various collecting methods were used including hand collecting, tray beating, net sweeping and pit fall trapping. These activities simply aimed at obtaining as many of the species present on each site as possible in the time available (2.5-3 days in mid-eastern Queensland; 1.5-2 days for the Australian Museum sites in north-eastern Queensland). The data obtained is not quantitatively comparable between sites but it provides the basis for the systematic work associated with this survey.

d. Detailed habitat analysis

Additional habitat information was taken at several of the north Queensland and north New South Wales sites, in the hope that this would help interpretation of differences in faunal composition between sites. The method was based on the canopy coverage method of Daubenmire (1959). At each site sixteen sampling stations were located within the study area, each station being 15 metres from its nearest neighbour. Four 20 x 50cm plots were defined at each station with a 20 x 50cm frame, and the following habitat variables were recorded: % vegetation cover at 0-20cm, 20-50cm, 50-300cm; % rock, root, moss and lichen; presence/absence of fronds, vines

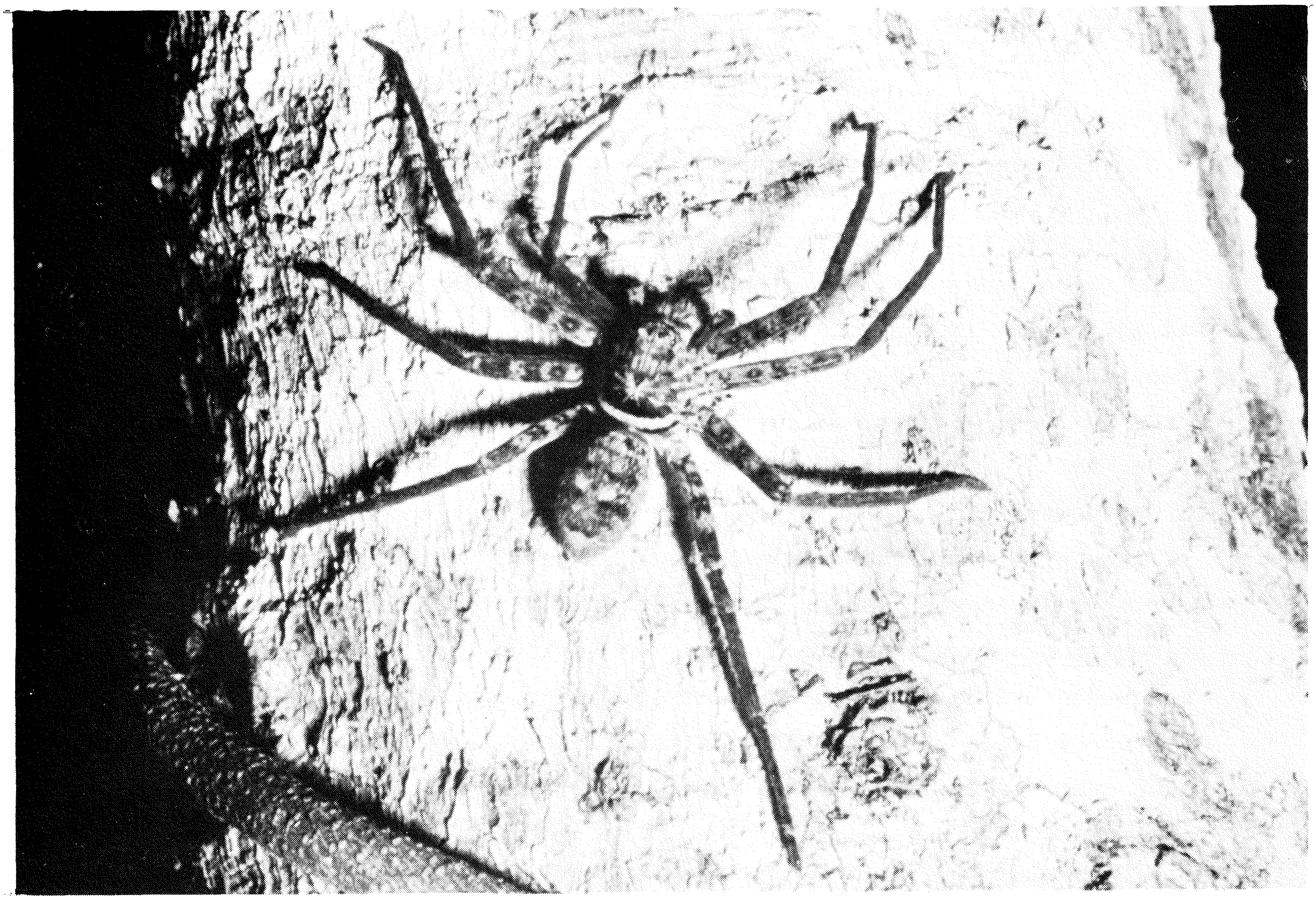


PLATE 21 - Heteropoda cervina, a common rainforest huntsman spider which forages on tree trunks at night (Dalrymple Heights)

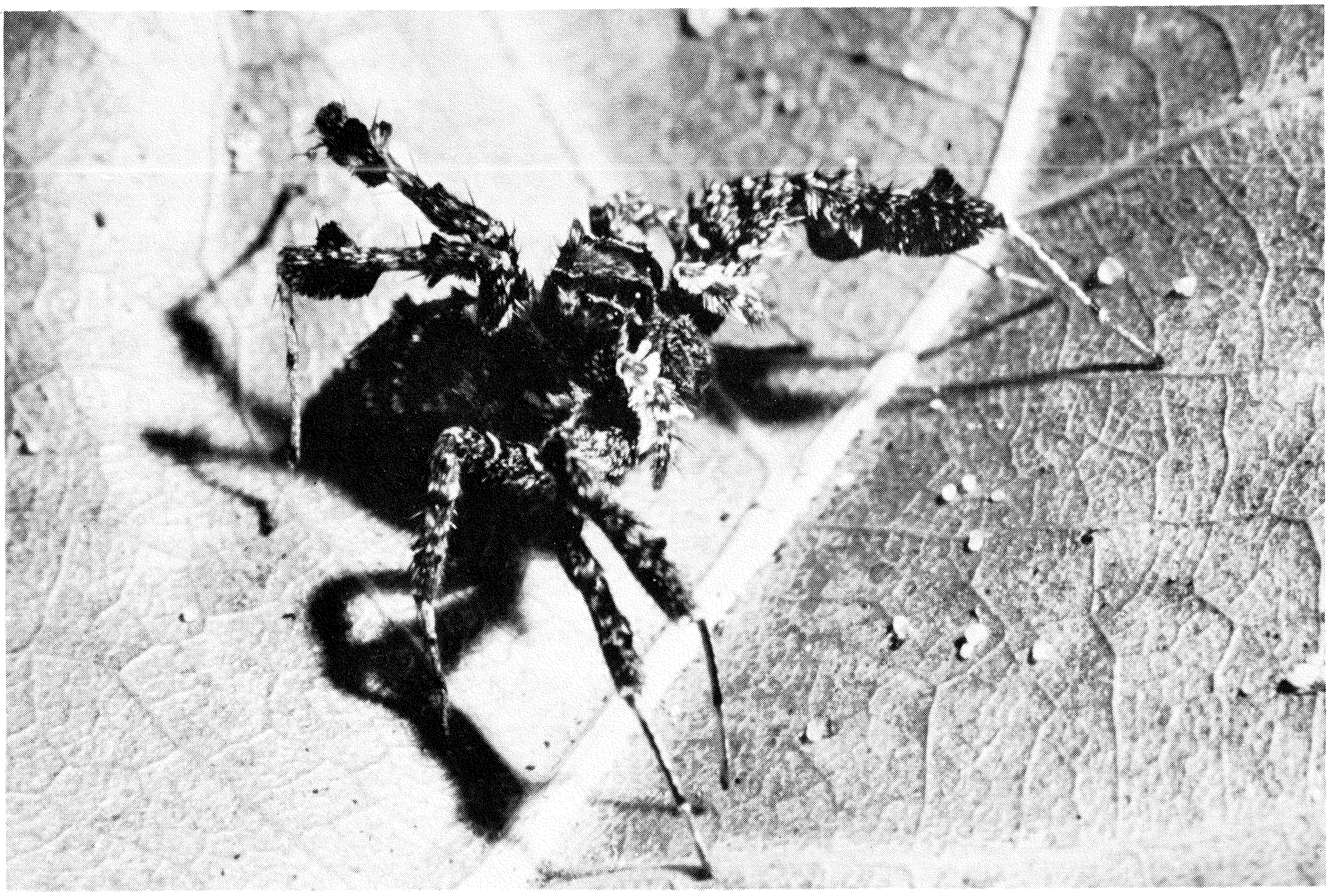


PLATE 22 - An unidentified salticid spider which occurs in the ground leaf litter and camouflages itself by large hair tufts on its body and legs (Fritz Creek)

and grasses. The combined plot data provides an environmental summary for each site.

RESULTS AND DISCUSSION

Fieldwork was completed as follows: mid-eastern Queensland, March-April, 1975; north-eastern Queensland, October-November, 1975; northern New South Wales, April-May, 1976. The results considered here are mostly from the standardised litter collections made in mid-eastern Queensland (all sites) and north-eastern Queensland (Australian Museum sites only). Full species lists for all the sites studied will be presented and discussed in the final report.

a. Preliminary evaluation of methods

The pit fall trapping method was quickly found to have several limitations as a standardised collecting method for short term survey work. The equipment takes a considerable time to set up (2-3 hours) and dismantle, while installation causes extensive local ground disturbance. Retrieval of specimens from the muddy preservative is time-consuming while the species catch was less than that obtained by sampling leaf litter. The success of the method also depends greatly on the activity patterns of ground-dwelling spiders and these may be quite variable between sites according to the time of sampling and environmental factors.

For these reasons pit fall trapping was discontinued as a standardised method after the mid-eastern Queensland sites had been studied. It was, however, retained in a simpler form as a general collecting method because of its ability to trap sporadically active species less amenable to other forms of collecting.

Two points can be made on the ground litter method. Firstly, the method tends to oversample the upper litter layers and undersample the lower layers. Provided this difference is maintained in sampling different sites it is of no consequence to the aims of a study such as the present one. It would, however, be a limitation to more fundamental studies on the spider fauna of ground litter and other methods, such as core sampling, might then be more appropriate. Secondly, some comment might be made on the use of hand sorting to separate spiders from the litter. Hand sorting is efficient for litter animals larger than two millimetre body

PLATE 23 - Mopsus penicillatus, a brilliantly coloured jumping spider which inhabits foliage (Fritz Creek)

length but other methods such as heat extraction are better for smaller organisms (Van der Drift, 1951). Litter spiders fall mainly into the 1-5mm size range so that any loss of data due to hand sorting would involve primarily juvenile specimens and some of the smaller adults. This is unlikely to affect comparative site analyses based on the presence or absence of species but may affect any such analyses based on quantitative results.

b. Mid-eastern Queensland

Litter sampling and pit fall trapping yielded a total of 201 species of spiders - 109 in litter samples and 92 from pit traps. Sampling yields at Finch Hatton (Site 9) and Dalrymple Heights (Site 8) were probably adversely affected by heavy rainfall during the sampling period.

The Multbet species presence/absence analysis for litter sampling is given in Figure 15. Table 15 summarises the site associations at an information level of 50 (X axis, Figure 15). Also listed are the gross environmental data available for each site plus the total species and 'site endemic' species counts. The species collected at each site are listed in Appendix 1 according to a Multbet inverse analysis of the leaf litter results.

A major differentiation of the litter fauna into two main site groupings is immediately obvious; those with wet and those with dry climatic regimes. This emphasises the importance of moisture in determining the distribution of litter spiders. The three dry sites (5, 10, 12) are all at low or medium altitudes. However, the wet sites show considerable altitudinal variation and they are clearly grouped faunistically into high (800-1200 metres), medium (400-800 metres) and low ($<$ 400 metres) altitude site groups.

Both species numbers and 'site endemicity' were highest at the dry sites. Eurimbula (Site 4), a distinctive and isolated rainforest developed on coastal sands, was the only site with a similarly high count of site endemics. Mt William (Site 15), a high altitude site, was easily the richest of the wet sites.

Although the dry rainforest sites are grouped together as being quite distinct faunistically from the wet sites they are also rather

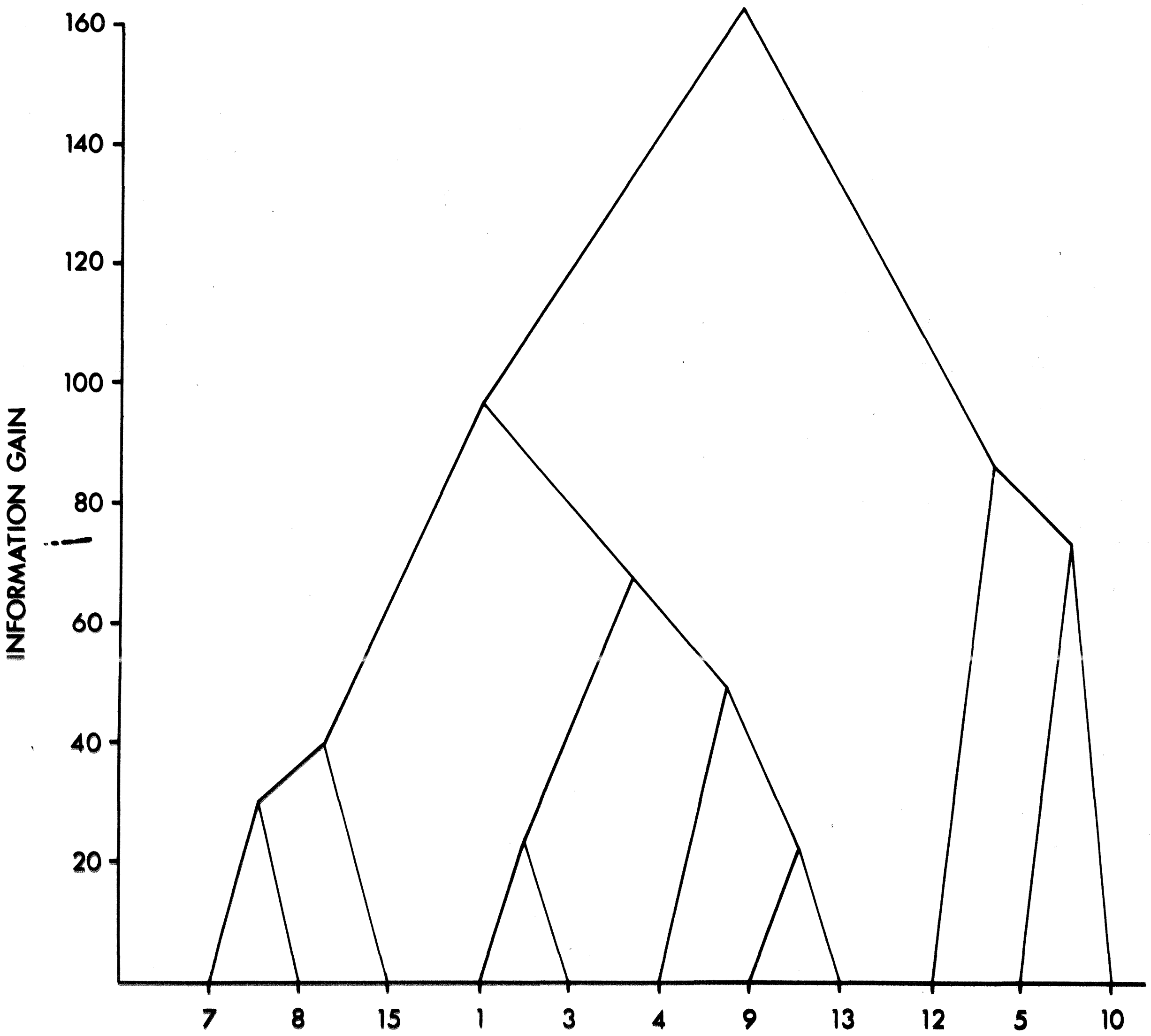


FIGURE 15 - Site classification based on presence/absence results from standardised litter sampling

TABLE 15: Litter spider species and environmental data for mid-eastern Queensland sites

Site No.	7	8*	15	1	3	4	9*	13	12	5	10
No. species	16	14	26	15	16	18	10	14	30	29	34
% Site endemics	25	30	46	47	56	72	30	50	74	83	65
Structural type	CNVF	MNEVF	SNEVF	CNVF	LMVF	LMEVF	CNVF	CNVF	SEVT	SEVT	SEVT
Floristic type	A1	A1	A1	A1	A1	B1	B1	B1	C1	A1	C1
Latitude	N	N	N	S	S	S	N	N	N	S	N
Moisture relations	WET	WET	WET	WET	MOIST	WET	WET	WET	DRY	DRY	DRY
Altitude	HIGH	HIGH	HIGH	MED.	MED.	LOW	LOW	LOW	LOW	LOW	MED.

* Rain affected sites = Primary Multbet site grouping - Secondary Multbet site groupings

dissimilar from each other. These differences are well reflected in the wide separation of the three dry sites in the ordination analysis (Figure 16). This analysis also suggests a moisture gradient in the site relationships with a secondary latitudinal trend for the wet sites discernable along axis 2. Geographical separation could be expected to be of some importance in the distribution of litter dwelling spiders because factors such as small size, low dispersal capability and habitat discontinuities tend to promote their localisation.

The particularly high species numbers recorded at the dry rainforest sites compared to the wet sites is surprising but may be due in part at least to the sampling technique used. Constant volume litter sampling means that litter-poor sites are more extensively sampled on an area basis than litter-rich sites. Consequently one could anticipate somewhat inflated species numbers from the litter-poor sites - in this case the drier sites. Even so, the disparity is so large (dry sites species average 31; wet sites species average 16) that the dry sites really may possess more species than the wet sites. The most likely explanation for this is an augmentation of species numbers by invading sclerophyll forest and woodland species. Unfortunately time did not permit comparative sampling of the sclerophyll forest areas adjoining these sites.

c. North-eastern Queensland

Only the standardised data for litter collections made at the Australian Museum sites is available for comment here. Four of these sites (42, 39, 40, 41) make an altitudinal gradient on Thornton Peak from 150 to 1260 metres. In addition two lowland sites (28, 33) were sampled. Helenvale (Site 28) consisted of a narrow belt (10-60 metres wide) of gallery rainforest along the Annan River. This 'riverine' rainforest was developed on coarse, sandy soil and surrounded by clear land or dry sclerophyll woodland. Cattle regularly passed through the area and litter disturbance was common. Fritz Creek (Site 33) was situated within a large block of relatively undisturbed complex rainforest dissected by meandering creeks.

Additional quantitative environmental data was obtained at each of these sites. These results along with the faunal sampling data are given in Table 16.

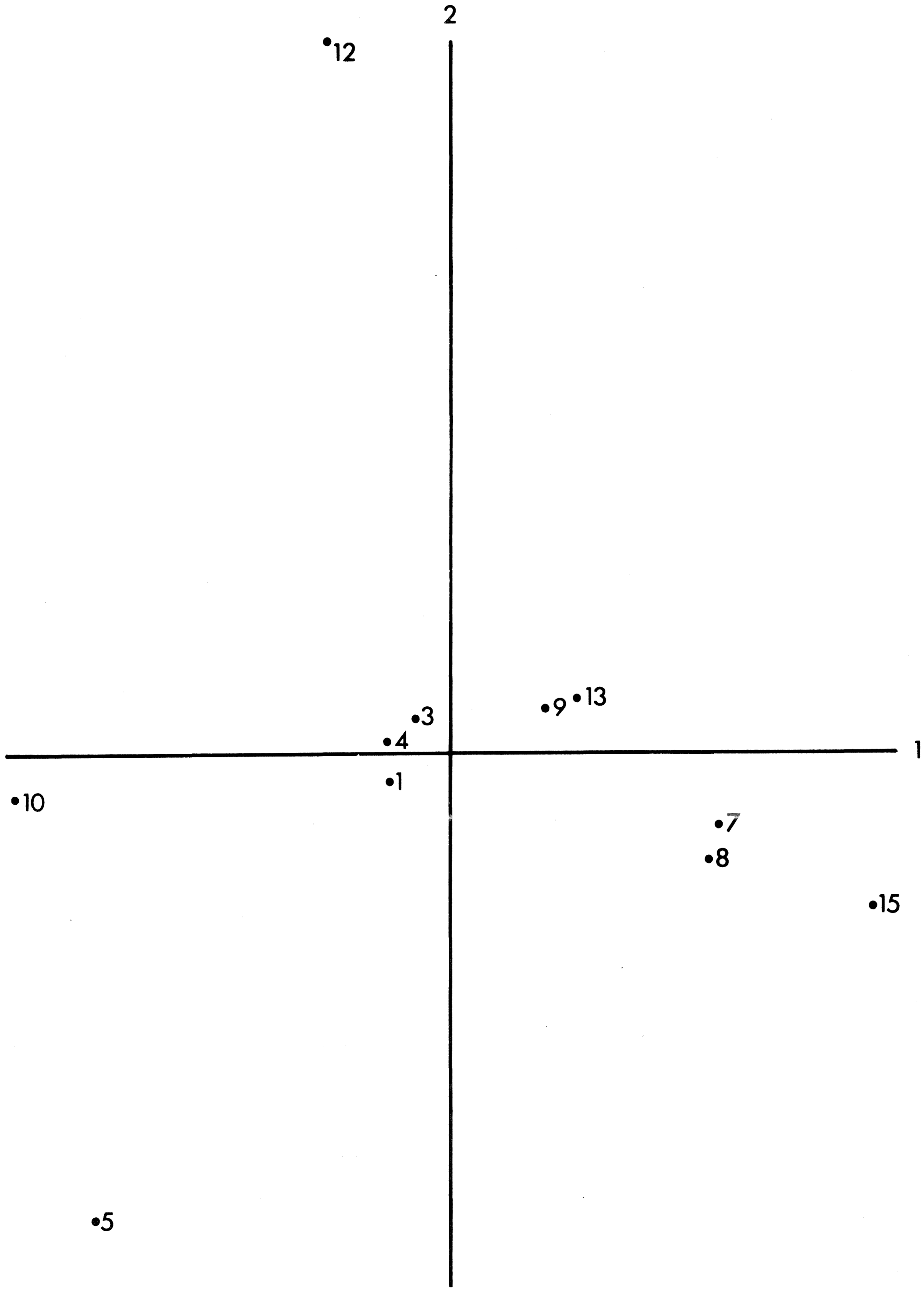


FIGURE 16 - GOWER ordination based on presence/absence results from standardised litter sampling

TABLE 16: Litter spider species and environmental data for the Australian Museum sites in north-eastern Queensland

Site No.	28	33	42	39	40	41
No. species	18	35	32	30	24	13
No. specimens	324	679	181	187	152	87
% site endemics	88	63	40	50	42	23
Altitude(metres)	150	30	240	640	1020	1260
Structural type	CMVF	CMVF	MVF	MVF	SMVFF/SNVF	SMVFT
Litter cover	1338	1450	1312	1001	1147	950
Litter depth	43.25	37.75	41	60	41	37
Litter size:						
small	1	3	2	8	16	23
medium	42	51	39	35	44	38
large	21	10	23	21	4	3
Vegetation cover						
0-20cm	93	74	44	58	120	145
20-50cm	104	165	133	158	311	498
50-300cm	363	333	800	819	1236	1292
Moss	-	20	1	82	74	119
Lichen	-	18	-	-	6	66
Rock	9	-	-	508	323	341
Fronds	1	24	55	18	57	59
Vine	-	21	26	19	22	24
Grass	5	5	1	16	14	11
Root	-	45		NOT NOTED		

As noted above the two lowland sites, Helenvale (28) and Fritz Creek (33) are very different environmentally and this is reflected in their species compositions. Helenvale yielded about half the number of species taken at Fritz Creek and they shared only four species in common. In terms of species composition Fritz Creek is more closely related to the lowest Thornton Peak site (42).

The ground litter at Helenvale, though quite dense, lies on river sand which dries out readily and does not allow the development of a moisture holding mulch layer in the lower litter levels (unlike Fritz Creek). The litter itself was very dry and completely lacking in moist-adapted invertebrates such as amphipods. Ground disturbance was common, 33 of the 64 litter plots examined being thus affected. In addition the site is apparently flooded periodically, a factor of considerable significance in this very restricted rainforest environment. Consequently, the low species count for Helenvale is not surprising. Nonetheless, its fauna is highly distinctive ('site endemicity' 88%) but certainly includes sclerophyll forest elements (e g Tharpyna diademata L.K., Scytodes tardigrada Thorell).

One feature peculiar to both the Helenvale and Fritz Creek sites is the occurrence of extremely high populations of certain species, so that the total number of individuals recorded at these two sites was 2-8 times greater than those recorded at the Thornton Peak sites (Table 16). For example, at Helenvale a single species of Coleosoma (Theridiidae) contributed 187 out of a site total of 324 specimens. At Fritz Creek three species dominated in a total of 679 specimens: Coleosoma sp. 162; and two cribellate amaurobiids with 189 and 122 specimens respectively. A probable explanation lies in the fact that both sites are liable to periodic flooding or ground waterlogging. This would have a catastrophic effect on the litter fauna, followed by a recolonisation process in which certain species were favoured so that their numbers built up enormously. Theridiid spiders would seem particularly well suited for this since the young could probably invade rapidly from adjacent areas by ballooning. The presence of large amounts of rainforest in the Fritz Creek area would assist in the maintenance of high species richness by comparison to the very restricted rainforest environment at Helenvale.

At the four Thornton Peak sites a total of 62 species was recorded from litter. Only 6 species were taken at all four sites. An obvious feature of these results is the decline in the numbers of species obtained with increasing altitude (Table 16). This is usually related to a reduction in environmental complexity with increasing climatic severity. The available environmental data suggests that the species decline may be correlated with a decrease in amount of ground litter cover and an increase in amount of rock at the higher sites. It is of interest to note that the anomalously low litter cover result for Site 39 is caused by the large amount of rock outcropping on this site. Despite this the species count remained high, probably because of the complex vertical litter environment provided by the accumulation of very deep litter around the rock outcrops.

Some data relating to altitudinal stratification on Thornton Peak are given in Table 17. The absence of theridiid spider records from the higher sites is interesting. The commonest genus, Achaearanea, is essentially a lowland group but one would expect other genera at higher altitudes. The amaurobiid spider, Ommatauxesis, has southern temperate zone relatives which may explain its commoner occurrence at the higher sites. However, relatives of the symphytognathid spider, Pseudanapis, are known from lowland rainforest in New Guinea.

c. Regional comparisons

The results so far obtained indicate that more than 60% of the spider species collected are undescribed. For the litter fauna alone the figure may be more than 80%.

Table 18 provides a preliminary comparison of family representation in the litter fauna. These results suggest that the families with the greatest specific representation overall are the Salticidae, Theridiidae, Linyphiidae and Oonopidae. Other significant families include the Thomisidae, Clubionidae, Gnaphosidae and Amaurobiidae. However, some of these groups show considerable differences in regional representation. The Salticidae and Amaurobiidae are better represented in north-eastern Queensland while the Theridiidae, Linyphiidae and Gnaphosidae seem more frequent in mid-eastern Queensland.

Among the less common groups the collection of relatively rare families such as the Hadrotarsidae and the Toxopidae primarily from mid-eastern Queensland is of interest. The toxopids are closely related to the

TABLE 17: Altitudinal stratification of some common groups of litter spiders on Thornton Peak

Group	Site No. (altitude in metres) 42(240)	39(640)	40(1020)	41(1260)
Theridiidae	+			
Telemidae	+	(+)		
Thomisidae	+	+		
Linyphiidae	+	+	(+)	
Ommatauxesis		+	+	+
Pseudanapis			+	+

(+) - single record

TABLE 18: Regional comparison of families of spiders recorded from ground litter

FAMILY	% total number species collected Mid-eastern Queensland	North-eastern Queensland
Salticidae	12	19
Theridiidae	12	6
Oonopidae	10	9
Linyphidae	10	6
Gnaphosidae	7	2
Clubionidae	7	6
Thomisidae	6	7
Zodariidae	4	2
Amaurobiidae	3	9
Symphytognathidae	3	4
Miturgidae	3	3
Toxopidae	3	1
Lycosidae	3	1
Sparassidae	2	7
Hahniidae	2	3
Araneidae	2	2
Dipluridae	2	1
Barychelidae	1	1
Ctenizidae	1	1
Oxyopidae	2	-
Hadrotarsidae	1	-
Ctenidae	1	-
Uloboridae	1	-
Nicodamidae	-	1
Scytodidae	-	1
?Telemidae	-	1
Pholcidae	-	2
Mimetidae	-	2

New Zealand genus Toxopsoides. In fact both of these families presently have a mainly southern temperate distribution (New South Wales, Tasmania, New Zealand).

Two other species with south temperate zone affinities were noted. An amaurobiid spider from Thornton Peak is placed here with the Tasmanian genus Ommatauxesis, while a theridiid, common in mid-eastern Queensland, has affinities with another Tasmanian genus, Trigonobothrys.

The north-eastern Queensland litter collections yielded some most unusual haplogyne spiders from the Thornton Peak sites. They have been provisionally placed with the family Telemidae, a northern hemisphere group.

APPENDIX 1: Spider species collected in mid-eastern Queensland by standardised leaf litter sampling, arranged into groups by a MULTBET inverse analysis

(+ indicates species present in site)

	Site number										
	7	8	15	1	3	4	9	13	12	5	10
Chenistonia sp.			+								
Oxyopes sp. B			+								
Miturgidae sp. A			+								
Sidyma sp. B			+								
Sidyma sp. E			+								
Sidyma sp. F			+								
Linyphiidae sp. I			+								
Linyphiidae sp. J			+								
Symphytognathidae sp. C			+								
Phoronicidae sp. B			+								
Theridiidae sp. A			+								
Theridiidae sp. B			+								
Encyocrypta sp. A		+					+				
Oonopinus sp. B	+										
Oonopidae sp. E							+				
Ariadna sp. B	+		+								
Trabea sp. A		+									
Lycosidae sp. B	+										
Amaurobiidae sp. C	+		+				+	+			
Amaurobiidae sp. D	+						+				
Hahniidae sp.		+									

	Site number										
	7	8	15	1	3	4	9	13	12	5	10
Uliodon sp. C	+	+	+								
Gen. nov. sp. B		+	+								
Gen. nov. sp. C	+										
Gnaphosidae sp. F							+				
Gnaphosidae sp. K	+	+					+				
Hetaerica sp. A		+	+								
Storena sp. C	+		+					+			
Pluridentata sp. C	+	+	+								
Salpesia villosa	+	+									
Unidentati sp. K							+				
Sidyma sp. C	+										
Laetesia sp. C	+		+					+			
Laetesia sp. G		+									
Linyphiidae sp. E		+	+								
Linyphiidae sp. K	+	+	+								
Mysmeninae sp. A		+	+								
Symphytognathidae sp. A	+	+	+								
Gamasomorpha sp. G								+			
Tetrablemma sp. A								+			
Ariadna sp. C								+			
Corinninae sp. E							+	+			
Corinninae sp. F								+			
Storena sp. B						+		+	+		
Pluridentati sp. D							+	+			
Unidentati sp. B								+	+		
Stephanopsis sp. A								+			
Mysmeninae sp. C								+			
Euryopinae sp. E								+			

	Site number										
	7	8	15	1	3	4	9	13	12	5	10
Lycosa ornatula						+					
Amaurobiidae sp. H						+					
Hahniidae sp. B						+					
Uliodon sp. B						+					
Ophisthoncus sp. A						+					
Salticidae sp. I						+					
Salticidae sp. J						+					
Tharpyna diademata						+					
Linyphiidae sp. B						+					
Linyphiidae sp. C						+					
Linyphiidae sp. D						+					
Sympytognathidae sp. B						+					
Achaearanea sp. A						+					
Gamasomorphinae sp. B											+
Gamasomorphinae sp. C											+
Gamasomorphinae sp. D											+
Oonopidae sp. C											+
Oonopidae sp. D											+
Oxyopes sp. D											+
Ctenidae sp. A											+
Venonia sp. A											+
Hahniidae sp. C											+
Gen. nov. sp. E											+
Lampona fasciata											+
Gnaphosidae sp. G											+
Gnaphosidae sp. L											+
Gnaphosidae sp. M											+
Corinninae sp. B											+

	Site number										
	7	8	15	1	3	4	9	13	12	5	10
Micariinae sp. B											+
Delena cancerides											+
Unidentati sp. G											+
Unidentati sp. H											+
Unidentati sp. J											+
Laetesia sp. F											+
Theridiidae sp. E											+

	7	8	15	1	3	4	9	13	12	5	10
Gamasomorpha sp. D			+				+		+		+
Gamasomorpha sp. F										+	+
Oonopidae sp. A									+		+
Oonopidae sp. B			+								+
Amaurobiidae sp. A				+						+	+
Echemus sp. B									+		+
Molycria sp. A						+					+
Storena striatipes										+	+
Muziris sp. A						+				+	+
Unidentati sp. E										+	+
Mysmeninae sp. B	+								+		+

	7	8	15	1	3	4	9	13	12	5	10
Aname sp. A					+						
Gamasomorpha sp. A					+	+					
Lycosidae sp. A					+						
Gnaphosidae sp. A					+						
Gnaphosidae sp. B					+						
Gnaphosidae sp. C					+						
Clubionidae sp. A					+				+		
Laetesia sp. B						+			+		

	Site number										
	7	8	15	1	3	4	9	13	12	5	10
Linyphiidae sp. A					+						
Euryopinae sp. B					+						
Cethegus sp. A				+							
Gamasomorpha sp. B				+							
Oonopinus sp. A				+							
Uliodon sp. A				+	+						
Gen. nov. sp. A				+	+						
Gnaphosidae sp. I				+							
Storena spirifera				+	+						+
Astia sp. A				+	+						
Myrmarachne sp. A				+	+						
Unidentati sp. A				+							
Sidyma sp. A				+	+						
Laetesia sp. A				+	+						
Linyphiidae sp. F				+							
Dipoena sp. A				+							
Conothele sp. A									+		
Encyocrypta sp. B									+		
Ariadna sp.									+		
Gmogala sp. A									+		
Oxyopes sp. A									+		
Amaurobiidae sp. B									+		
Gnaphosidae sp. H									+		
Chiracanthium sp. B									+		
Clubionidae sp. E									+		
Salticidae sp. O									+		

	Site number										
	7	8	15	1	3	4	9	13	12	5	10
Salticidae sp. P									+		
Sidyma sp. D									+		
Tharpyna sp. A									+		
Thomisidae sp. A									+		
Thomisidae sp. B									+		
Laetesia sp. E									+		
Linyphiidae sp. G									+		
Achaearanea sp. C									+		
Euryopis sp. A									+		
Euryopinae sp. D									+		
Phoronicidia sp. A									+		
Synotaxus sp. A									+		
Gamasomorpha sp. E										+	
Ariadna sp. A										+	
Oxyopes sp. C										+	
Trabea sp. B										+	
Miturga sp. A										+	
Gen. nov. sp. D										+	
Echemus sp. A										+	
Corinninae sp. A										+	
Micariinae sp. A										+	
Olios salacius										+	
Hetaerica sp. B										+	
Storena sp. D										+	
Unidentati sp. C										+	
Unidentati sp. D										+	
Unidentati sp. F										+	

	Site number										
	7	8	15	1	3	4	9	13	12	5	10
Tmarus sp. A										+	
Miagrammopes sp. A										+	
Laetesia sp. D										+	
Achaearanea sp. D										+	
Ariamnes sp. A										+	
Dipoena sp. B										+	
Moneta sp.										+	
Theridiidae sp. D										+	
Missulena sp. A										+	

Molluscs

INTRODUCTION

Current knowledge of rainforest molluscs has been derived largely from taxonomic studies on land molluscs in general. The first such study of significance was Cox's (1868) monograph on Australian land snails, later supplemented by the contributions of Hedley and especially Iredale (1937a, b; 1938). These works have provided the taxonomic basis for the present study.

METHODS

These can be considered under three headings:

a. General collecting (standardised)

2-3 collectors moved through the study area randomly for three man-hours, searching for and hand-picking both dead and alive snails. Searching was concentrated on the ground and associated habitats (logs, stones, litter etc).

In addition, one collector searched for 15 minutes for snails within reach on the foliage of standing plants while another spent the same time searching for snails on the trunks of standing trees. These collections were kept separate, from each other and from the main collection.

b. Leaf litter (standardised)

$0.02m^3$ of leaf litter was randomly collected by hand in the study area and transported back to the Australian Museum. Here the litter was dried and sifted through a 1cm aperture wire mesh screen to remove the coarser litter component. The latter was examined for snails before being discarded. The finer material was then sieved through 1.68mm and 500μ aperture wire mesh screens and the dust which passed through both sieves discarded. The fractions remaining on the sieves were separately hand-sorted for snails against a white background and

PLATE 24 - Some of the shells from a sample of leaf litter -
none exceeds 2mm in diameter

under a low-power lens.

c. Supplementary collecting (non-standardised)

Additional collecting was done at some sites but the material obtained was kept separate from the other collections.

RESULTS AND DISCUSSION

Results from the standardised collecting are given in Table 19. Identification is complete for all but two of the 24 families represented. For the other two families - the Punctidae and Camaenidae - only the mid-eastern Queensland collections have so far been identified.

The difficult and time-consuming nature of identification has so far precluded a detailed analysis and interpretation of the results. Nevertheless, some comments can be made on these results. 158 species and subspecies have so far been identified, of which 57(36%) and 6(4%) are previously undescribed species and subspecies respectively. Well over half of these 'new' species and subspecies were collected in mid-eastern Queensland. This area seems to have a particularly rich molluscan rainforest fauna, there being almost twice as many species (77) collected here as, for example, in north-eastern Queensland (41) (excluding species in the two partially analysed families).

Although a similar number of families were represented in the collections from each of the three main collecting zones, some families showed marked differences in occurrence between these zones. The Pupinidae, for example, seem to have tropical affinities - in rainforest at least - being unrecorded from northern NSW but represented by five and seven species respectively in mid-eastern and north-eastern Queensland. In contrast, the Patulidae were represented by one species only in north-eastern Queensland but by 26 and 21 species respectively in mid-eastern Queensland and northern NSW. The Acavidae and Phenacohelicidae may also have a more temperate distribution. Another family, the Megaspiridae, was represented only in the mid-eastern Queensland sites. While the results show several trends of interest, the full significance of these must await a thorough analysis of all the data collected.

Finally, it may be worth considering briefly an analysis of the results from mid-eastern Queensland made earlier in the project.

TABLE 19: Molluscs obtained by standardised collecting methods at all sites

Species	Site number 1	3	4	5	7	8	9	10	12	13	15	17	20	28	29	33	34	36	37	39	40	41	45	46	47	50	52	53	54	55	56
HELICINIDAE																															
Helicina gouldiana Forbes																	13					6								5	
H. draytonensis Pfeiffer	4	16		3	3	7																	1								
H. gladstonensis Cox				104		8		36	9	6																					
H. jana Cox											2				31																
Helicina sp. nov.										7																					
CYCLOPHORIDAE																															
Leptopoma nitidum (Sowerby)																	1	1													
PUPINIDAE																															
Ambipupina petterdi (Crosse)																	95														
Ambipupina sp. nov.																		10													
Dolopupina wilcoxi edna Iredale	15	2								1																					
Diplopupina sp. nov.					6																										
Necopupina simplex (Fulton)								4																							
Necopupina sp. nov 1																						3									
Necopupina sp. nov. 2															2					1											
"*Pupina*" *sp. nov.*																						12									
Signepupina macgillivrayi (Cox)									3	101																					
S. strangi (Pfeiffer)			113																												
Signepupina sp. nov.													9		5	13		2		1											
DIPLOMMATINIDAE																															
Diplommatina gowllandi (Brazier)																			41												

TABLE 19 (continued)

Species	Site number 1	3	4	5	7	8	9	10	12	13	15	17	20	28	29	33	34	36	37	39	40	41	45	46	47	50	52	53	54	55	56
RATHOUISIIDAE																															
<u>Prisma</u> <u>australe</u> (Heynemann)	2	4																													
<u>Prisma</u> <u>sp</u>. <u>nov</u>.										1																					
ATHORACOPHORIDAE																															
<u>Triboniophorus</u> <u>graeffei</u> Humbert	3	4			2																			1		1					3
<u>T</u>. <u>rosea</u> (Hedley)																						1									
ACHATINELLIDAE																															
<u>Tornatellinops</u> <u>pressus</u> Iredale				45																											
<u>T</u>. <u>jacksonensis</u> (Cox)	1	4		6													3									10		30	5	13	
<u>Elasmias</u> <u>wakefieldiae</u> (Cox)			1															15													
PUPILLIDAE																															
<u>Australbinula</u> <u>pediculus</u> <u>queenslandica</u> Pilsbry				2																											
<u>Cylindrovertilla</u> <u>fabreana</u> Crosse			50					254																							
<u>C</u>. <u>kingi</u> (Cox)			54																												
<u>Gastrocopta</u> <u>sp</u>. <u>nov</u>. 1				75																											
<u>Gastrocopta</u> <u>sp</u>. <u>nov</u>. 1, subsp.																												20	6	8	
<u>Gastrocopta</u> <u>sp</u>. <u>nov</u>. 2								3	2																						
<u>Glyptopupoides</u> <u>egregia</u> (Hedley & Musson)				2																											
<u>G</u>. <u>egregia</u> <u>ssp</u>. <u>nov</u>.																														3	
<u>Nesopupa</u> <u>sp</u>. <u>nov</u>. 1														14		1	2	1	1												
<u>Nesopupa</u> <u>sp</u>. <u>nov</u>. 2																1															
<u>Sominopupa</u> <u>scotti</u> <u>ssp</u>. <u>nov</u>.									1																						

TABLE 19 (continued)

Species	1	3	4	5	7	8	9	10	12	13	15	17	20	28	29	33	34	36	37	39	40	41	45	46	47	50	52	53	54	55	56
	Site number																														
PUPILLIDAE (continued)																															
"Acanthinula" sp. nov.													1																		
Imputegla porteri (Brazier)			1	11				3						1			9	2													
I. circumlita (Hedley)		1		6				7						2				2													
MEGASPIRIDAE																															
Coelocion australis (Forbes)	1								8																						
Coelocion sp. nov. 1	2				2	1																									
Coelocion sp. nov. 2												1																			
ACHATINIDAE																															
Opeas sp. 1	1	1	69	85			1	3						7																66	
Opeas sp. 2													1						2												
RHYTIDIDAE																															
Saladelos cf. urarensis (Cox)																							2	7		2		1			
Saladelos sp.													1				7														
Saladelos sp. nov.						5		1		1																					
Echotrida strangeoides strangeoides (Cox)	6	6																					4	2		2	2	2			
E. strangeoides ssp. nov.															2		3														
Rhytida(?) bullacea (Reeve)	2	4		14	10	2	1	4	1	7	1																				
R. (?) capillacea (Fer.)																							6					1			
Strangesta confusa (Pfeiffer)					1								1									2									
S. franklandiensis (Forbes)					1	1					1	1	1					1		1	1										
S. leichhardti (Cox)	3																														
S. sheridani (Brazier)													2							1	2	3	4	3		1	2	2			

TABLE 19 (continued)

Species	1	3	4	5	7	8	9	10	12	13	15	17	20	28	29	33	34	36	37	39	40	41	45	46	47	50	52	53	54	55	56
	Site number																														
ACAVIDAE																															
Pedinogyra hayii (Griffith & Pidgeon)	4	9																													
P. rotabilis (Reeve)																										4				1	
Hedleyella falconari (Gray)																							12	4		1	5				
Pandofella whitei (Hedley)					3	2	1																								
PATULIDAE																															
Gyrocochlea conferta ssp. nov.			115																												
G. eurythema ssp. nov.	1		20	44																									4		
G. intermedia (Odhner)										14																		5			
G. omicron (Pfeiffer)																											1				
G. recava (Hedley)						1	2																								
G. vinitincta (Cox)																							3				3				
Gyrocochlea sp. nov. 1				1																											
Gyrocochlea sp. nov. 2																								22							
Gyrocochlea sp. nov. 3	1						1																								
Gyrocochlea sp. nov. 4							1																								
Gyrocochlea sp. nov. 5																							7	1			2				
Gyrocochlea sp. nov. 6																								2		5		56		2	
Gyrocochlea sp. nov. 7																										64	4				
Gyrocochlea sp. nov. 8								14		18																					
Gyrocochlea sp. nov. 9	25	38																													
Gyrocochlea sp. nov. 10		2		1				1																							
Gyrocochlea sp. nov. 11							1		13																						

TABLE 19 (continued)

Species	Site number 1	3	4	5	7	8	9	10	12	13	15	17	20	28	29	33	34	36	37	39	40	41	45	46	47	50	52	53	54	55	56
PATULIDAE (continued)																															
Gyrocochlea sp. nov. 12									1																						
Gyrocochlea sp. nov. 13			4																												
Pernagera brazieri (Cox)					1			2																			3				
P. (?) *cinnamea* (Hedley)									11	25																					
P. planorbis (Hedley)																							5						44	2	
Pernagera sp. nov. 1	4	1																													
Pernagera sp. nov. 3																							8								
Pernagera sp. nov. 4																															1
Pernagera sp. nov. 5																							2								
Discocharopa concinna (Hedley)		2		5				1		1																			10	2	
Egilomen cochlidium (Cox)																												225		51	
Geminoropa sp. nov. 1									12	33																					
Geminoropa sp. nov. 2					6																										
Geminoropa sp. nov. 3											1	2																			
Geminoropa sp. nov. 4						1																									
Elsothera inusta (Cox)																							1								
Kannaropa sp. nov.	10	1																													
Obanella sp. nov. 1	3																														
Obanella sp. nov. 2																								7		4					
Obanella sp. nov. 3																							2			1					
Oreomava sp. nov.	18	9																													

TABLE 19 (continued)

	Site number																														
Species	1	3	4	5	7	8	9	10	12	13	15	17	20	28	29	33	34	36	37	39	40	41	45	46	47	50	52	53	54	55	56
PATULIDAE (continued)																															
Rhophodon consobrinus Hedley																							1								
R. peregrinus Hedley																										30					
Setomelea seticostata (Hedley)																							1	7		2	1				
Setomelea sp. nov.						8					17		6		7	39															
PHENACOHELICIDAE																															
Oreokera corticicola (Cox)																							12				1				
O. dorrigoensis Iredale																									1	3					
Oreokera sp. nov.	1	1																													
PUNCTIDAE																															
Paralaoma sp. nov. 1		3	2																												
Paralaoma sp. nov. 2		3	10																												
Iotula microcosmos (Cox)	1	1			2								- Punctidae from these stations still to be identified -																		
Excellaoma sp. nov.	3																														
Pasmaditta sp. nov.	10	9							1																						
VITRINIDAE																															
Zonitoides nitidus (Müller)																													7		
EUCONULIDAE																															
Sodaleta darnleyensis (Brazier)			12							5			10	27	2	16	16	8													
S. scandens (Cox)		1	107											12			15	19	53									3			
S. nepeanensis ssp. nov.																		55	5												
Sodaleta reedei (Brazier)																							1					5		6	

TABLE 19 (continued)

Species	Site number 1	3	4	5	7	8	9	10	12	13	15	17	20	28	29	33	34	36	37	39	40	41	45	46	47	50	52	53	54	55	56
EUCONULIDAE (continued)																															
S. barnardensis (Brazier)													20			1	4														
Turrisitala wildiana Iredale			47										3	5		16	15	147	136												
Eclipsena elleryi (Brazier)																3	6	61	30												
HEDLEYOCONCHIDAE																															
Hedleyoconcha delta (Pfeiffer)																								3		38		17		7	
MICROCYSTIDAE																															
Dendronitor rusticus (Pfeiffer)										2																					
D. responsivus (Hedley)		4	25	9		9		62	4	5	17																	6	6	2	
D. antiquua (Odhner)																	48														
Dendronitor sp. nov. 1					1	5			3	22		4																			
Dendronitor sp. nov. 2													8		25	27	3	27	1				2								
Microcystina sp. nov. 1			24										2	1	4	4		30	28												
Microcystina sp. nov. 2													1		2	3		11													
MACROCHLAMYDIDAE																															
Malandena sp. nov.																				6	13	45									
NITORIDAE																															
Nitor subrugatus (Reeve)																							18	31	2	30	6	321	226	152	
N. pundibundus (Cox)										2																					
Nitor sp. nov.																						3									
HELICARIONIDAE																															
Helicarion leopardina Iredale																															
Veracularion mastersi (Cox)																															20

TABLE 19 (continued)

Species	Site number 1	3	4	5	7	8	9	10	12	13	15	17	20	28	29	33	34	36	37	39	40	41	45	46	47	50	52	53	54	55	56
HELICARIONIDAE (continued)																															
Veracularion virens (Pfeiffer)					2																										
Veracularion sp. 1					24	20					11	11																			
Veracularion sp. 2	1	6																													
Veracularion sp. 3																						35									
Peloparion sp.									20	32																					
Mysticarion insuetus Iredale																										12				32	
M. leucospira (Pfeiffer)																											2				
Parmacochlea semoni (Martens)																								22							
P. smithi Simroth																			4	6											
P. fischeri Smith													56		25	28	4	3													
Parmacochlea sp.			10																												
CYSTOPELTIDAE																															
Cystopelta astra Iredale																								17			2				18
CAMAENIDAE																															
Sphaerospira frazeri (Griffith & Pidgeon)	5	3			14	14	1					2																			
Bentosites macleayi (Cox)								20																							
B. blomfieldi (Cox)			3	3																											
Varohadra rockhamptonensis (Cox)									17	39			- Camaenidae from these stations still to be identified -																		
V. lessoni (Pfeiffer)			22	118																											
V. yappoonensis (Beddome)			22																												
Austrochloritis fringilla Iredale					17	13	4	8																							
A. novocambrica (Gude)												1																			

TABLE 19 (continued)

Species	Site number 1	3	4	5	7	8	9	10	12	13	15	17	20	28	29	33	34	36	37	39	40	41	45	46	47	50	52	53	54	55	56
CAMAENIDAE (continued)																															
Calvigenia blackmani (Cox)				34				6	15	15	1																				
Calvigenia sp. nov.	2																														
Mussonea spinei (Cox)	14									22																					
Mussonea sp. nov.		12											- Camaenidae from these stations still to be identified -																		
Xanthomelon pachystylum magnidicum Iredale									5																						
X. p. saginatum Iredale				1																											

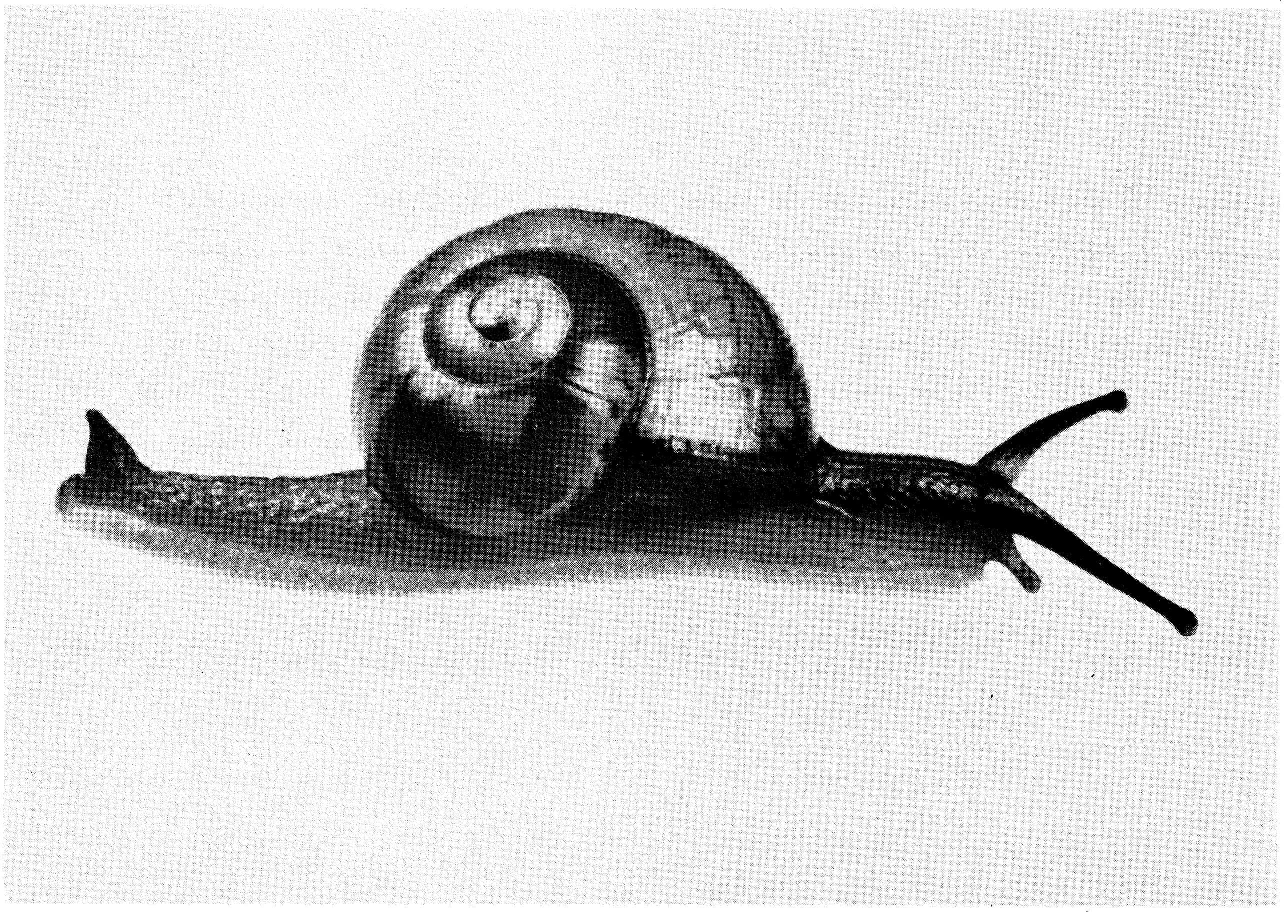


PLATE 25 - Possibly a new species of the Helicarionidae, this species differs from most other helicarions in having a more closely coiled shell and only rudimentary mantle flaps

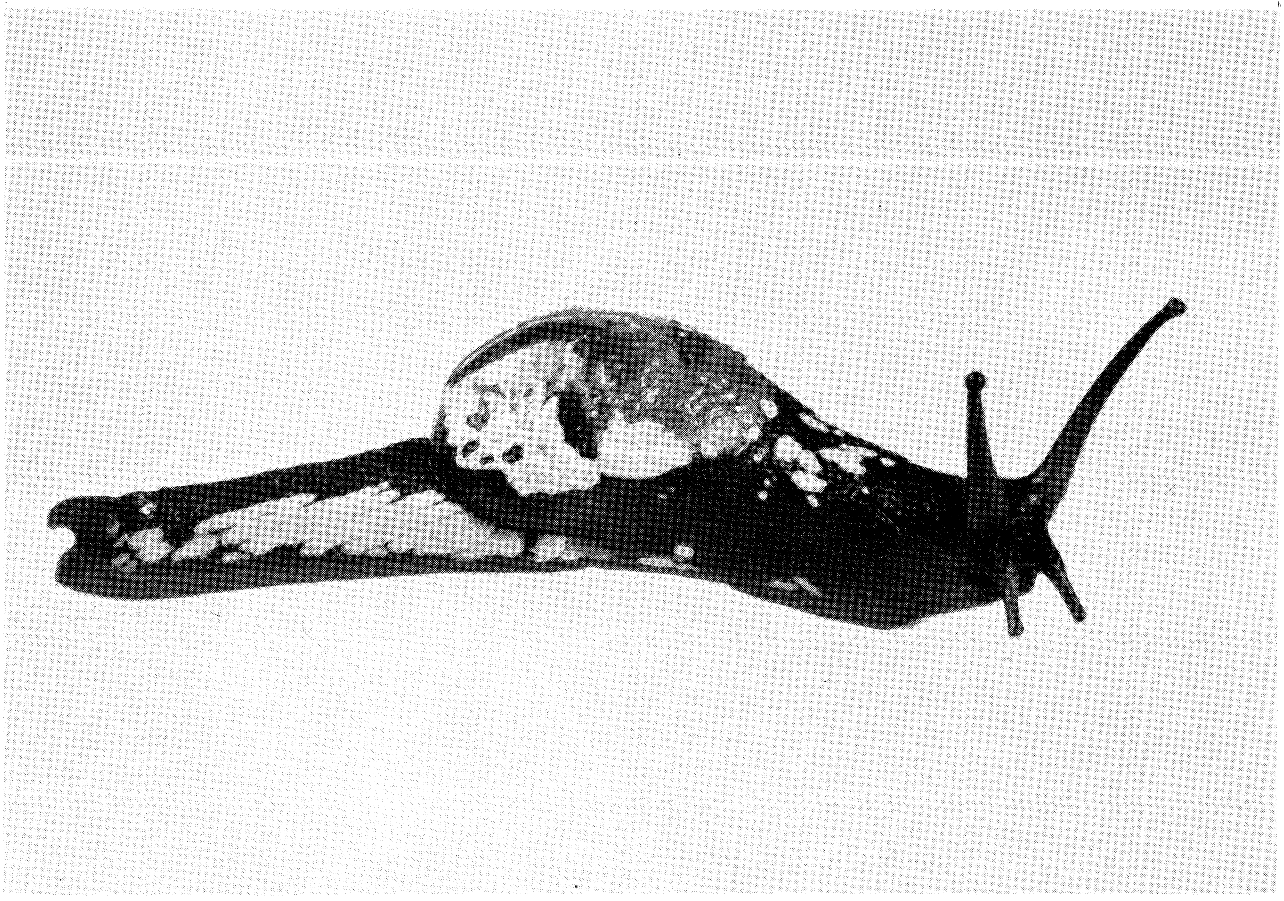


PLATE 26 - The protective coloration of this helicarion allows it to move in safety over the exposed surfaces of leaves unlike its more uniformly coloured congeners

Presence/absence data from standardised collecting at these sites were analysed by MULTBET and the resulting classification is given in Figure 17. It can be seen that the sites are largely separated on altitude. Thus sites 7, 8 and 15 are at 920m, 1000m and 1120m respectively; sites 1 and 3 at 540m and 580m; sites 9 and 10 at 180m and 440m; sites 12 and 13 at 120m; and sites 4 and 5 at 0 and 30m. The ordination of sites (Figure 18) gives further confirmation of an elevation gradient along axis 2. It would seem that, in common with the other animal groups studied, mollusc distribution shows a marked correlation with altitude or altitude-related factors.

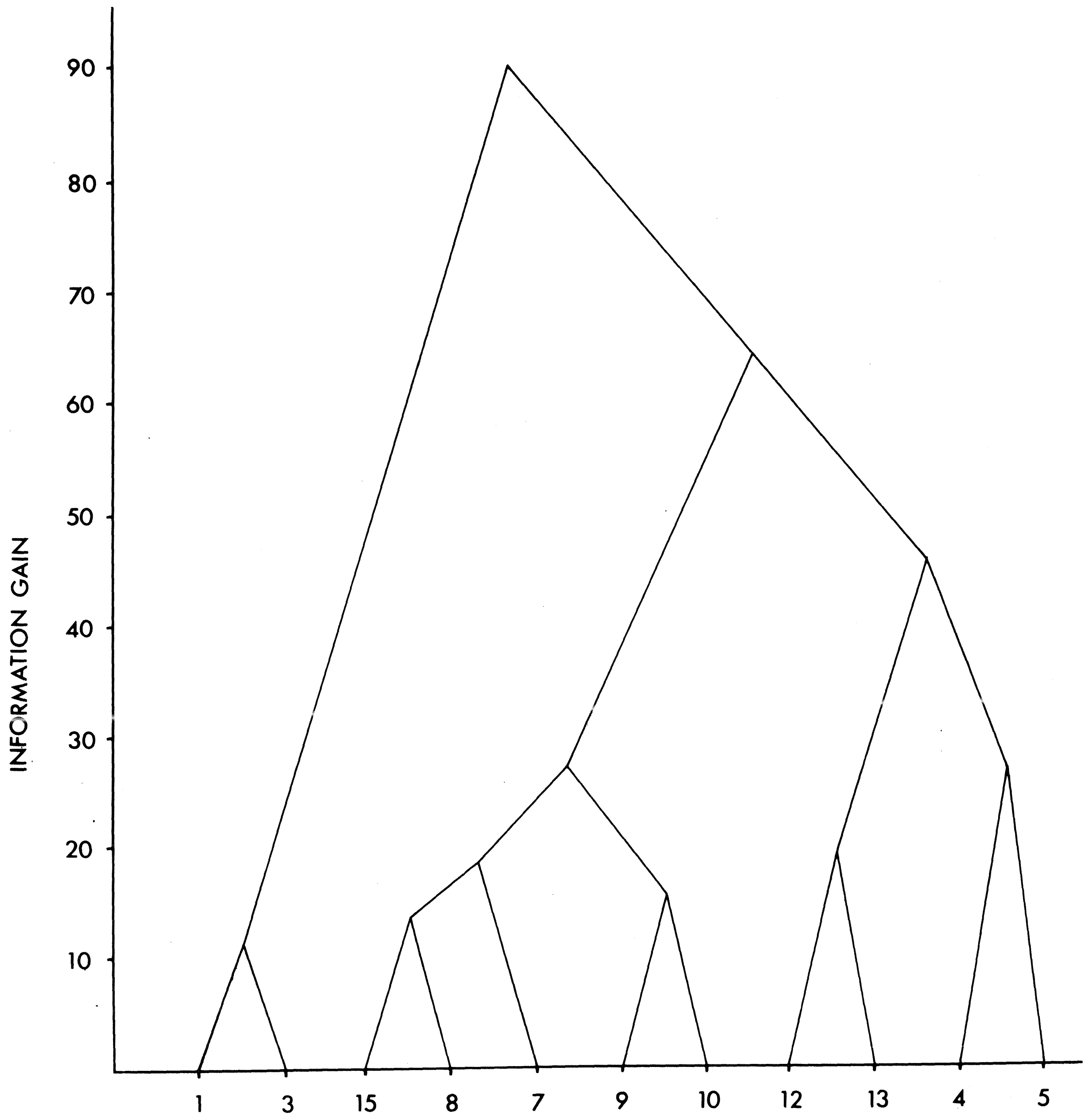


FIGURE 17 - Site classification based on presence/absence results from standardised general collecting and litter sampling

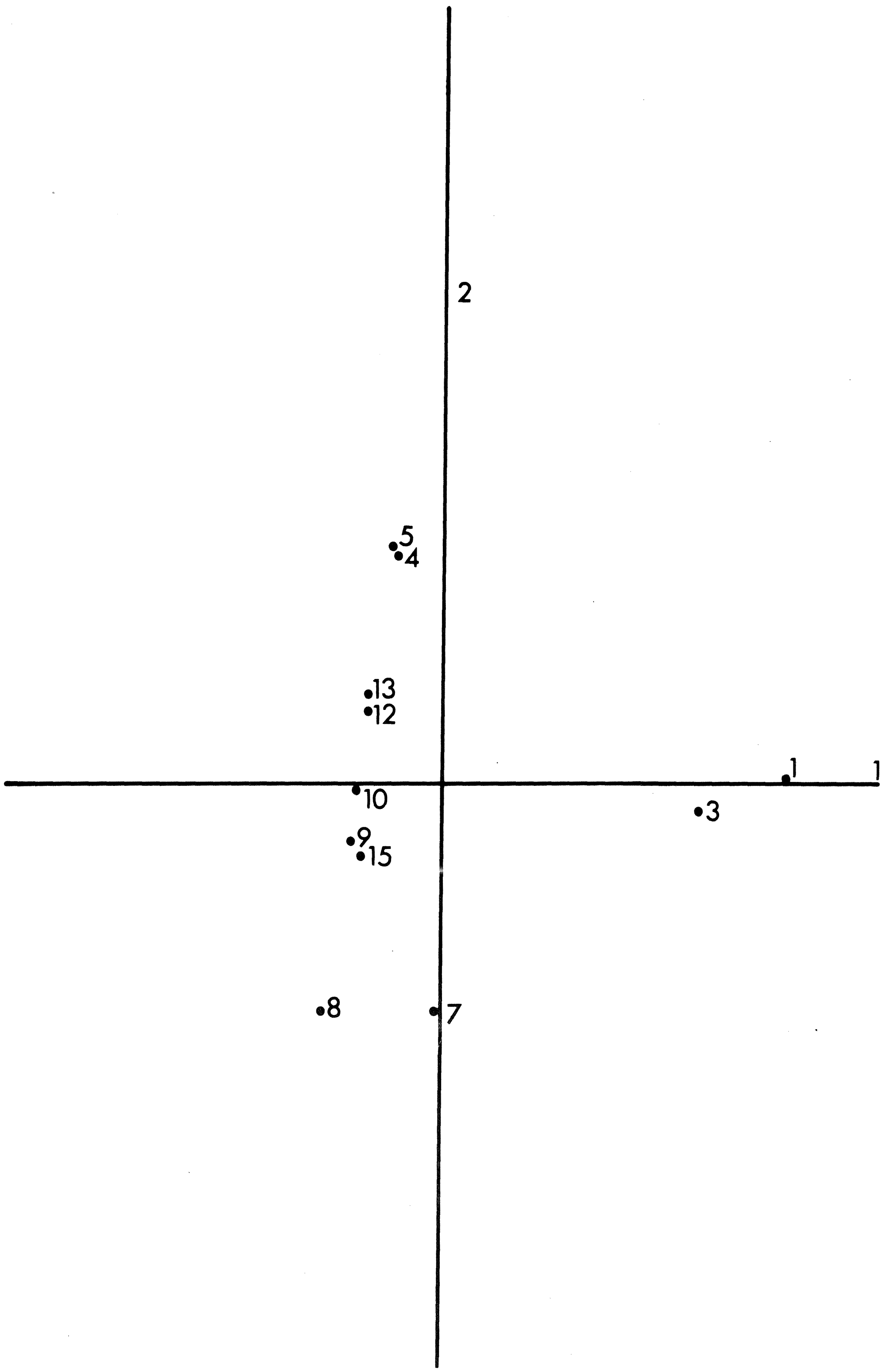


FIGURE 18 - GOWER ordination based on presence/absence results from standardised general collecting and litter sampling

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