THE 1984 CHILLAGOE SURVEYS

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The results of a systematic archaeological survey at Chillagoe (north Queensland) are presented. Observations are made concerning site location and the effects of ground visibility on site patterning. This paper concludes with a working model of site patterning at Chillagoe during recent prehistory.

Introduction

This paper reports on systematic site surveys undertaken at Chillagoe in mid-1984. The surveys were undertaken as part of a broader project aimed at obtaining information on settlement-subsistence systems in the region (David 1987). In particular, they aimed at recovering information about archaeological site characteristics, including, environmental context, in order that a site locational model for the later stages of Aboriginal prehistory in the Chillagoe region might be generated. This paper presents the data gathered during this research and concludes with a site locational model.

The Chillagoe Region

Chillagoe is located c.140km west of Cairns, north Queensland (Fig. 1). It lies along the western slopes of the Great Dividing Range, immediately northwest of the Atherton Tablelands. Chillagoe is renowned for its limestone karst towers, many of which possess deep caves of palaeontological importance. The towers of the limestone belt stretch from near the Walsh River in the north to Almaden in the south. The maximum width of the limestone belt is 11km.

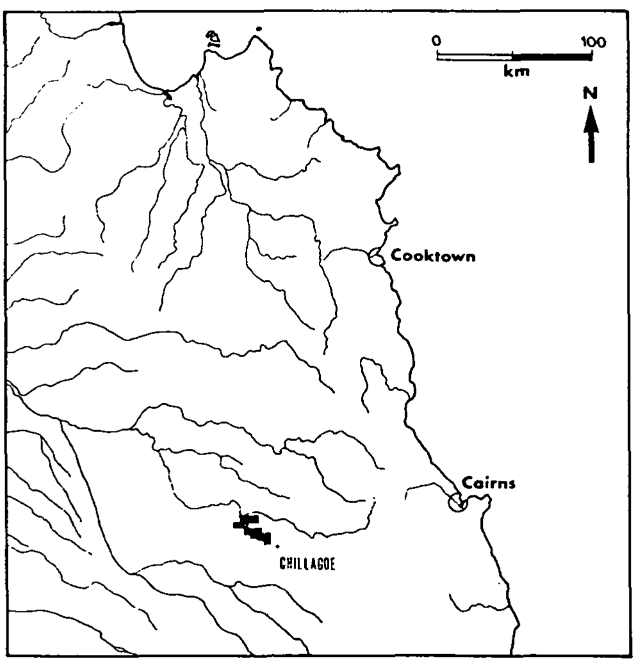

Figure 1. Map of north Queensland, showing locations of Chillagoe and the study region.

Rainfall around Chillagoe is greatly influenced by the interaction of seasonal monsoons and southeasterly Trade Winds. As a result, the region is characterised by a marked wet season (November-April), followed by a period of very little rain (May-October). There is an annual mean of 65 days and 800-900mm of rainfall at Chillagoe, with the wet season months of December-March receiving c.90% of the annual rainfall between them (Fig. 2). This marked wet-dry season dichotomy is thus likely to be an important factor for settlement-subsistence practices in Chillagoe prehistory.

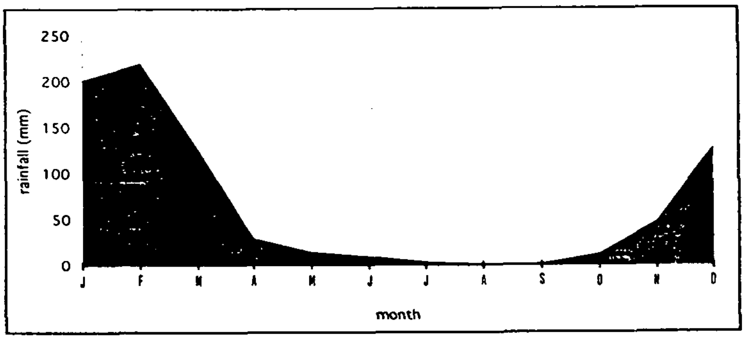

Figure 2. Mean annual rainfall, Chillagoe.

The Survey Region

An area measuring 20km (north-south) x 17km (east-west) maximum dimensions was chosen for systematic archaeological surveys to the immediate north of the township of Chillagoe (Fig. 3). The survey region covers 145km^2, centring on co-ordinates 144^0 22'E and 17^0 3'S. This region is bounded to the north by the Walsh River, to the south and west by the Sentinel Ranges, and to the east by Bungabilly Creek. The reasons for choosing this area was systematically to sample the northern parts of the Chillagoe limestone belt, thus offering a data base with which to compare and contrast archaeological results emanating from the southern parts of the limestone belt (Walkunder Arch Cave, Campbell [1982]).

At the time this survey was undertaken, the only archaeological results from the Chillagoe region came from excavations in an un-named (and as yet un-analysed) rockshelter by Wright (1971) and Walkunder Arch Cave (Birkett 1983, Campbell 1982, David 1983). Since then, our understanding of the prehistory of the region has increased through the works of Campbell (e.g. 1984), Mardaga-Campbell (1986), David (e.g. 1987, 1991, 1994) and others (e.g. Lamb 1993) (see Fig. 1). In spite of this, no systematic archaeological surveys have yet been published for the region, and no settlement-subsistence modelling has yet been attempted. This paper is an attempt to fill this gap.

For the purposes of this work, the study region was sub-divided into four land units, differentiated on the basis of: 1. topography; 2. near-surface lithologies and edaphic conditions; 3. drainage characteristics; and 4. vegetation. The four land units are: Plains, Hills, the Riverine Zone and Limestone Karst Towers (Table 1; Fig. 3).

Table 1. Land Units.

	Topography	Lithology	Drainage	Vegetation
plains	flat plains	Quaternary alluvials	very poor	savanna woodland (dry sclerophyll
hills	undulating slopes	chert, greywacke, quartzite, siltstone, conglomerate, some granite	good	savanna woodland (dry sclerophyll)
riverine	flat lands	Quaternary alluvials	very poor	vine thickets, dry & wet sclerophyll
karst	sloping pediments, limestone karst towers	limestone towers	very good	microphyll vine thickets

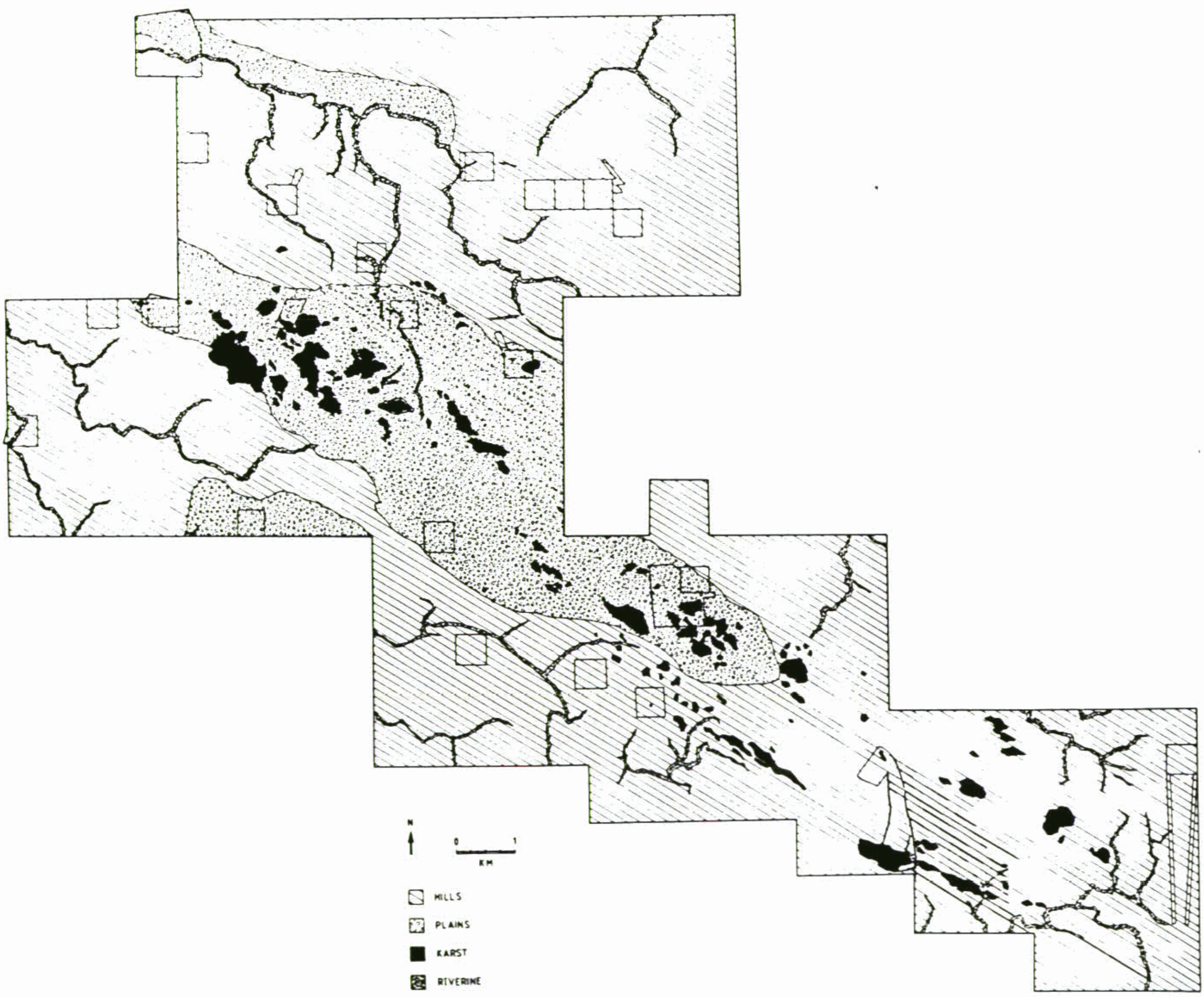

Figure 3. Survey region, showing the four land units and the surveyed areas.

The Plains

The Plains cover 35km², or 24% of the study area. The predominant plant species are *Eucalyptus leptophleba*, *E. cullenii*, *E. dichromophloia*, *Heteropogon contortus* and *Themeda australis*. The Plains contain 17 edible plant taxa, including tubers, seeds and nuts, sweet flowers, shoots and fruits (Table 2). Surface sediments consist of Quaternary alluvial deposits, with slope gradients of <2^0 resulting in poor drainage, especially during the wet season. Although the Plains were usually easily differentiated from other land units in the field and on aerial photographs, at times they graded into the surrounding Hills (Fig. 4).

Table 2. Edible plants growing on the Plains. √ = present, ? = probably present.

Plant Resource	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
TUBERS												
Acacia bidwillii	√	√	√	√	√	√	√	√	√	√	√	√
Cayratia trifolia		√	√	√	√	√	√	√	√			
Boehavia diffusa				√	√	√	√	√	√	√		
Ipomea eriocarpa				√	√	√	√	√	√	√		
Tribulus sp.				?	?							
SEEDS & NUTS												
Acacia bidwillii								√	√	√	√	
Hakea arborescens	?											?
SWEET FLOWERS												
Melaleuca sp.						√	√	√	√	√	√	
Hakea arborescens				√	√	√	√	√	√			
Heteropogon sp.			√	√	√							
FOLIAGE & SHOOTS												
Acacia bidwillii	√	√	√	√	√	√	√	√	√	√	√	√
FRUITS												
Cymbidium calycalatum	?	?	?	?	?	?	?	?	?	?	?	?
Grewia retusifolia			√	√	√							
Santalum lanceolatum									√	√	√	
Terminalia platyptera											√	√

Figure 4. The Plains.

The Hills

The Hills cover 99km², or 68% of the study region, including most of the undulating lands (Fig. 5). Slope gradients range from *c*.2° to 20°, and altitudes range from 440m ASL in the east to 240m in the west. The most common plants are *Eucalyptus cullenii*, *E. dichromophloia*, *Erythrophloeum chlorostachys*, *Heteropogon contortus* and *Themeda australis*. Edible plants include 24 taxa, including tubers, seeds and nuts, sweet flowers and fruits (Table 3). Drainage in the Hills ranges from poor at lower topographic levels to very good on the upper slopes.

The Hills are predominantly of the Lower Devonian Mt. Garnet and Chillagoe Formations, consisting of cherts, greywackes, quartzites, siltstones and conglomerates. In the southwestern portions of the study area, granites and quartzites of the Precambrian Dargalong Metamorphics are also found. This latter Formation is separated from the eastern Chillagoe Formation by the Palmerville Fault Line (de Keyser & Wolff 1964).

Table 3. Edible plants growing on the Hills. √ = present, ? = probably present.

Plant Resource	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
TUBERS												
Brachychiton paradoxus	√	√	√	√	√	√	√	√	√	√	√	√
Acacia bidwillii	?	?	?	?	?	?	?	?	?	?	?	?
Cochlospermum sp.	?	?	?	?	?	?	?	?	?	?	?	?
Cayratia trifolia		√	√	√	√	√	√	√	√			
Boehavia diffusa				√	√	√	√	√	√	√		
SEEDS & NUTS												
Brachychiton paradoxus			√	√	√	√	√	√	√	√		
Acacia bidwillii								√	√	√		
Crotalaria sp.			?	?	?							
SWEET FLOWERS												
Grevillea glauca								?	?			
Grevillea mimosoides								?	?			
Grevillea parallela								√	√			
Grevillea polystachya								?	?			
Persoonia faleata									√	√	√	
FRUITS												
Cymbidium calycalatum	?	?	?	?	?	?	?	?	?	?	?	?
Grewia retusifolia			√	√	√							
Capparis canescens						√	√	√				
Cayratia trifolia		√	√	√								
Exocarpus latifolius	?	?	?	?	?	?	?	?	?	?	?	?
Gardenia ochreata						√	?	?				
Persoonia faleata	√	√	√								√	√
Petalostigma pubescens					√	√	√					
Planchonella sp.								√	√	√		
Planchonia careya									√	√	√	
Pouteria sericea				√	√							

The Riverine Zone

The study area is drained by a dentritic system of mainly temporary creeks and rivers. The major waterway is the Walsh River to the immediate north of the study region, which carries waters from the major creeks westward to the Gulf of Carpentaria. Although most of the creeks and rivers dry up completely during the dry season, permanent springs occur, albeit sporadically.

The Riverine Zone forms a narrow belt along most water courses, varying in width from 10m to 100m (Fig. 6). It accounts for 7km² (5%) of the study region. The vegetation of the Riverine Zone is often distinct from that of the surrounding Plains and Hills, and include *Tristania grandiflora*, *Melaleuca bracteata*, *M. argentia* and *Pandanus* spp.. Fifteen edible plant species are known from the Riverine Zone, including edible fungi, seeds and nuts, sweet flowers, foliage and shoots and fruits (Table 4).

Figure 5. The Hills.

Figure 6. The Riverine Zone.

Table 4. Edible plants growing in the Riverine Zone. √ = present, ? = probably present.

Plant Resource	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
FUNGI												
Spp. unknown	√	√	√								√	√
SEEDS & NUTS												
Canarium australianum	√	√	√	√	√					√	√	√
Pandanus sp.	√							√	√	√	√	√
SWEET FLOWERS												
Melaleuca sp.								√	√	√		
Melaleuca argentia						√	√	√	√	√	√	
Melaleuca sp.				√								
Melaleuca sp.								√	√	√		
Melaleuca sp.	√	√	√									√
FOLIAGE & SHOOTS												
Portulaca sp.	?	?	?	?	?	?	?	?	?	?	?	?
FRUITS												
Canarium australianum	√	√	√	√	√					√	√	√
Ficus opposita										√	√	√
Ficus racemosa										?	?	?
Morinda oliefera	√	√										
Syzigium eucalyptoides	√											√
Terminalia platyphylla											√	√

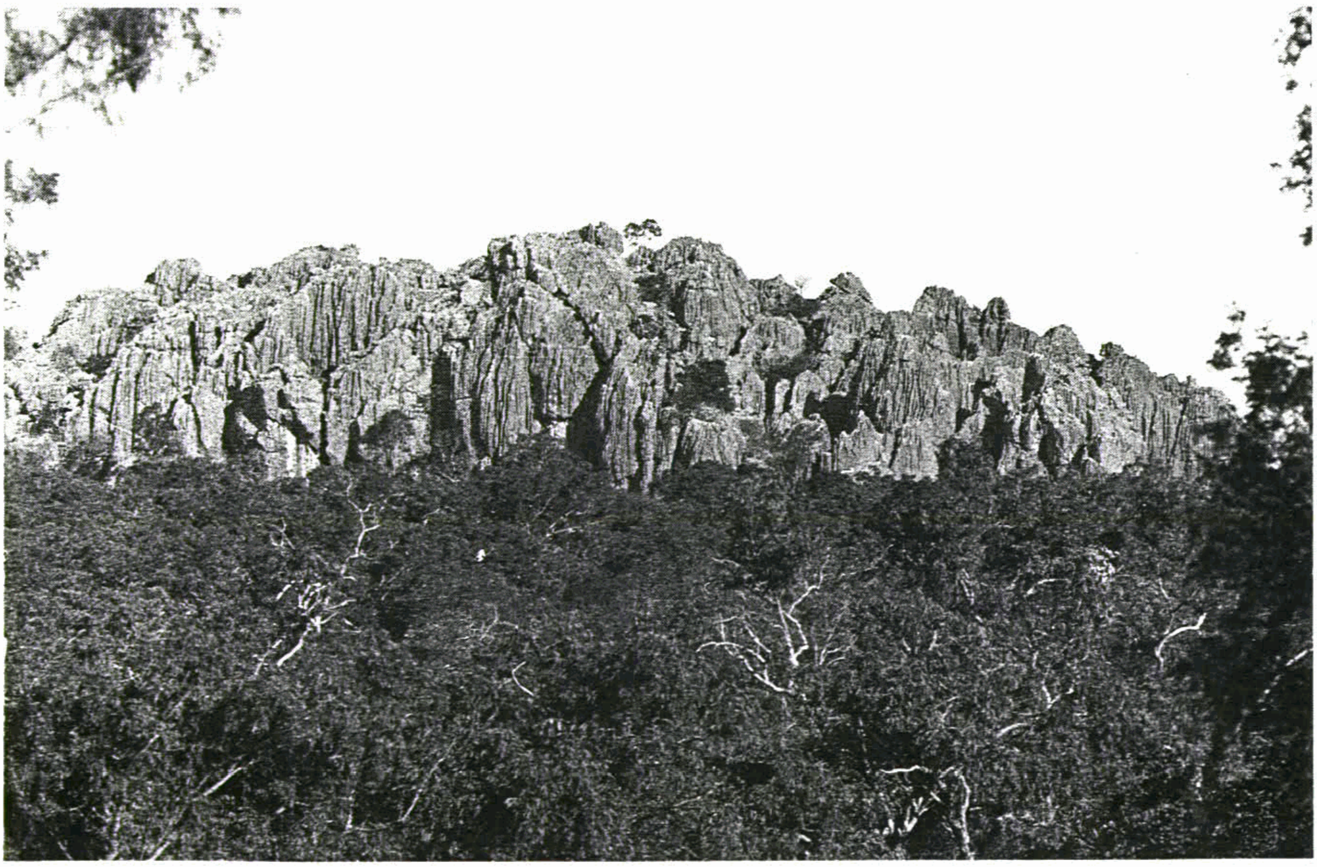

Figure 7. The Limestone Zone.

The Limestone Karst Towers

More than any other land unit, the Limestone Karst Towers (hereafter called the Limestone Zone) set the Chillagoe region apart from the surrounding landscape (Fig. 7). These are massive Lower Devonian-Upper Silurian fossiliferous reef-limestone outcrops which have been uplifted above the surrounding landscape. They rise up to 100m above the Plains, and are mostly devoid of vegetation except on their surrounding pediments where microphyll vine thickets abound. Caves and rockshelters are common throughout this land unit. While *Brachychiton* spp., *Ficus* spp. and *Lysiphyllum hookeri* predominate, the limestone pediments support a rich diversity of edible fruiting plants (Table 5). It boasts 15 known taxa of edible tubers, eight of seeds and nuts, two of sweet flowers, four of edible shoots and foliage, 41 edible fruit species as well as an unknown quantity of edible fungi. Of these, it is the fruit that make this land unit stand apart from the Plains, Hills and Riverine Zone. Some of these fruits are available year-round, although most are restricted to the wet season.

Limestone Karst Towers account for $4km^2$ (3%) of the study region.

Table 5. Edible plants growing on the Limestone Karst Towers. √ = present, ? = probably present.

Plant Resource	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
FUNGI												
Spp. unknown	√	√	√									
SEEDS & NUTS												
Canarium australianum	√	√	√	√	√					√	√	√
Brachychiton australe								√	√	√		
Acacia bidwillii								√	√	√		
Brachychiton sp.								√	√	√		
Crotalaria sp.		?	?	?								
Crotalaria sp.		?	?	?								
Hibiscus miraukensis			√	√								
Portulaca sp.		√	√	√								
SWEET FLOWERS												
Grevillea polystachya								?	?			
Lysiphyllum hookeri									√	√	√	
FOLIAGE & SHOOTS												
Cissus sp.	√	√	√	√	√	√	√	√	√	√	√	√
Dodonea platyptera	√	√	√	√	√	√	√	√	√	√	√	√
Erythrina vespertilio	√	√	√	√	√	√	√	√	√	√	√	√
Ficus platypoda										√	√	√
TUBERS												
Amplocissus acetosus								√	√	√		
Amplocissus sp.								√	√	√		
Brachychiton australe	?	?	?	?	?	?	?	?	?	?	?	?
Acacia bidwillii	?	?	?	?	?	?	?	?	?	?	?	?
Brachychiton sp.	?	?	?	?	?	?	?	?	?	?	?	?
Cayratia grandifolia		?	?	?	?	?						
Cayratia trifolia		√	√	√	√	√	√	√	√			
Cissus opaca												
Cissus sp.												
Cochlospermum sp.	?	?	?	?	?	?	?	?	?	?	?	?
Erythrina vespertilio	√	√	√	√	√	√	√	√	√	√	√	√
Ipomea sp.				√	√	√	√	√	√	√		
Portulaca lutea			?	?	?							
Portulaca napiformis			?	?	?							
Vigna canescens				√	√							
FRUITS												
Amplocissus acetosus						√	√	√	√	√	√	
Amplocissus sp.						√	√	√	√	√	√	
Antidesma parviflorum				√	?	?						
Canarium australianum	√	√	√	√	√					√	√	√

Capparis canescens						√	√	√				
Capparis lassiantha						√	√	√				
Carissa ovata				√	√	√	√	√	√	√		
Cayratia grandifolia		?	?	?								
Cayratia trifolia		√	√	√								
Cissus hastata						√	√	√	√	√	√	
Cissus sp.						√	√	√	√	√	√	
Citriobutus spinescens			√	√	√							
Celtis paniculata		√	√	√								
Clerodendrum tomentosum												
Dendroanide moroides						√	√	√				
Drypetes australisica	√	√	√	√								
Ficus copiosa	?									?	?	?
Ficus infectora	?									?	?	?
Ficus obliqua var *obliqua*	?									?	?	?
Ficus obliqua var *petiolaris*	?									?	?	?
Ficus opposita										√	√	√
Ficus platypoda										√	√	√
Ficus racemosa								√	√	√		
Ficus virens	?									?	?	?
Ficus virens var *sublanceolata*	?									?	?	?
Grewia retusifolia			√	√	√							
Hibiscus miraukensis	?	?	√	√							?	?
Hibiscus sp.	?	?	?	?							?	?
Marsdenia sp.	√	√	√									
Passiflora foetida	√	√	√	√	√	√	√				√	√
Planchonella myrisinoides								?	?	?		
Planchonella cotinifolia								?	?	?		
Planchonella pohlmaniana								√	√	√		
Planchonia careya									√	√	√	
Pouteria sericea				√	√							
Solanum ellipticum					√	√	√	√	√			
Syzigium eucalyptoides	√											√
Terminalia chillagoensis											√	√
Terminalia platyphylla											√	√
Terminalia platyptera											√	√

The Surveys

All surveys employed a three-person team.. In all cases, surveying was undertaken by spreading out over a 125m-wide corridor, parrallel corridors being surveyed to completely survey larger areas. Each person thus covered a width of 40m (see David 1984 for further details).

Two separate survey strategies were undertaken — random non-stratified surveys and non-random stratified surveys. The results of each are presented separately below.

The Random Non-Stratified Surveys

A grid of 500 x 500m quadrats was superimposed over the study region in order to undertake probabilistic (random) surveys. The research area contained 580 quadrats ($145km^2$) (see Fig. 3). Each quadrat was allocated a number, and 20 of them were randomly selected for systematic surveying by picking their numbers out of a hat. Although the surveys were not stratified, all of the land units were sampled. The sampled areas total $5km^2$ as listed in Table 6.

The Non-Random Stratified Surveys

Non-random (systematic) surveys were also undertaken in five selected limestone tower karsts in addition to those surveyed during the random surveys. Small areas of Plains, Hills and the Riverine Zone were also selectively surveyed, in particular the shores of the Walsh River in the extreme northwestern corner of the survey region (see Fig. 3). The total area selectively surveyed is $3.9km^2$.

Table 6. **Areas surveyed and contributions of each land unit to the total study area.**

	Random Survey	Non-Random Survey	Total Surveyed	Km^2 in Study Area	% of Land Unit Surveyed
plains	$1.500km^2$	$1.500km^2$	$3.000km^2$	35.00	8.6
hills	$3.250km^2$	$1.750km^2$	$5.000km^2$	99.00	5.1
riverine	$0.125km^2$	$0.250km^2$	$0.375km^2$	7.25	5.2
karst	$0.125km^2$	$0.375km^2$	$0.500km^2$	3.75	13.3
TOTAL	$5.000km^2$	$3.875km^2$	$8.875km^2$	145.00	6.1

The Effects of Ground Visibility

Given that each of the four land units contained distinct vegetation communities, the ground visibility of each was assessed to determine its effects on site recovery. Visibility here refers to our ability to see the ground surface; that is, the proportion of the ground surface that is not obscured by vegetation. A series of visibility ratings was recorded for all areas surveyed, enabling a quantification of recovery rates relative to visibility to be made (Fig. 8). These visibility ratings were assessed in two ways; 1, by estimating the mean ground visibility (in percentages) of the areas surveyed, and 2, by estimating the mean ground visibility of each site. A continuous commentary was noted on the ground visibility of the surveyed area (e.g. 0-300m, mean visiblity = 70%; 300-310m visibility = 80%; etc.). Running notes were also made of local environmental conditions and topography. In this manner, mean ground visibility was made available for both sites and for areas immediately surrounding them.

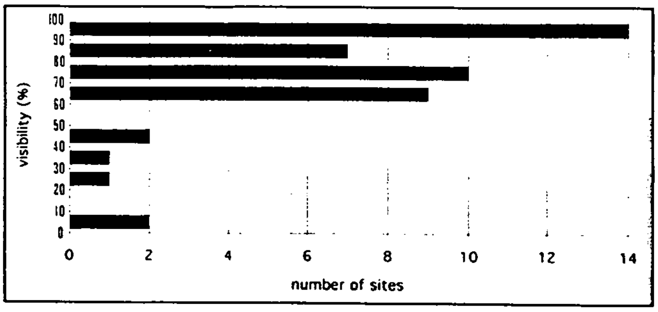

Figure 8. Number of sites recorded by 10% ground visibility intervals.

Site recovery increased dramatically above the 60% visibility mark; below which recovery rates were very low. However, areas of low (<60%) visibility covered only $1.75km^2$ of the surveyed area, giving a recovery rate of 3.4 open sites/km^2. Visibility was ≥60% over most of the surveyed area ($7.125km^2$), with a mean recovery rate in high visibility areas of 5.6 open sites/km^2. Thus, recovery in high visibility areas was 1.7 times that of low visibility areas (Table 7). We now need to determine whether or not this will significantly affect the distribution of the sites recorded for the purposes of this study.

Two sets of criteria are used in the following analysis of the survey data: land units and topographic features. The effects of ground visibility on site recovery are now assessed with these criteria in mind.

Table 7. Site discovery relative to ground visibility.

	Surveyed Area	Number of Open Sites	Site Density
high visibility areas	$7.125km^2$	40	5.6/km^2
low visibility areas	$1.750km^2$	6	3.4/km^2
TOTAL	$8.875km^2$	46	5.2/km^2

Table 8 presents the mean ground visibility of each of the four land units surveyed. Mean visibility is similar in each case, ranging from 62.0% (Riverine Zone) to 65.0% (Limestone Karst). Similarly, the mean ground visibility of ridge tops, slopes, flat areas and creek beds are similar, ranging from 62.0% (flat areas) to 67.9% (ridge tops) (Fig. 9). On this basis, ground visibility is assumed not to have significantly affected the differential recovery of archaeological sites in the region. It is also to be noted that:

1. Four of the six sites recorded in low visibility conditions were single artefacts (CM15, 17, 18, 24). One site consisted of three artefacts (CM13). If visibility was a critical factor, we could have expected larger sites to have been preferentially recorded. That this was not the case indicates that areas of low visibility were accurately sampled, even though they may not have been sampled as accurately as areas of greater ground visibility.
2. There is no positive correlation between visibility levels and site discovery rates by environmental zone, implying that site locations should be explained by other causes.
3. 80% of the surveyed areas were of high visibility, and 87% of sites came from these areas. While a discrepancy is apparent, it is not large.

Table 8. Mean visibility ratings and site densities (open sites) by land unit.

	Mean Visibility	Site Density
plains	64.0%	5.7/km^2
hills	62.5%	3.6/km^2
riverine	62.0%	16.0/km^2
karst	65.0%	2.0/km^2

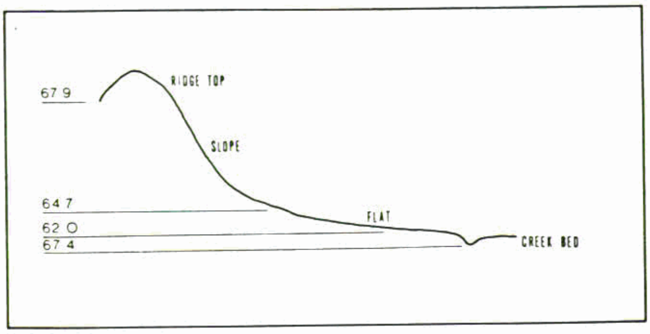

Figure 9. Mean ground visibility ratings, by topographic levels.

The above factors indicate that differential ground visibility is unlikely to account for the site patterning observed and reported in this paper.

The Archaeological Sites

All of the open sites recorded are surface or near-surface sites. Given the recent nature of most of the surface sediments (especially alluvial sediments near creeks and rivers), the site patterns observed are assumed to pertain to late Holocene times (M. Erceg, Elders Resources geologist, pers. comm. 1984). It is noted in this context that the only artefact *types* recovered are a single burren adze, two waisted axes and one possible elouera. As nothing is known of lithic technologies from the region, a relative chronology could not be formulated around the stone artefact assemblages.

Site Types

Sites are here identified as any evidence for human presence, be it in the form of a single artefact, surface scatter, structure, or painted or modified surface. Two sites are differentiated if they occur more than 25m apart. This arbitrary measure was used for recording purposes. Single artefacts were recorded as sites as there is no reason why such locations cannot be a locus of human activity.

Four site types were identified during the surveys: quarries, open artefact scatters, rockshelters and caves. Table 9 lists the numbers of sites identified from each land unit.

Table 9. Sites recovered in each land unit. *CM46-52 has been counted here as a single site, as this near-surface riverine site occurs as a series of adjacent exposures (<25m apart) that were recorded separately.

	Quarry	Open Artefact Scatter	Rock-shelter	Cave
plains	-	17	-	-
hills	1	18	-	-
riverine	1	4*	-	-
karst	-	1	5	3

Quarries

Two quarries were recorded (sites CM11 & 41). These consisted of major stone outcrops. Site CM41 is a medium-grained, white quartzite block outcrop spread over an area of *c*.250 x 200m (Fig. 10). The quartzite blocks have been extensively flaked (as evidenced by negative flake scars), although few flakes were found. Other (non-local) raw materials also occurred at site CM41; this site is therefore treated as both a quarry and an open artefact scatter.

Figure 10. The quarry site, CM41.

Site CM11 occurs as an extensive deposit of large water-rolled pebbles, many of which have been flaked. CM11 is the largest site recorded in this study. It lies along the southern shores of the Walsh River, near a permanent waterhole. Stone artefacts at this site are estimated to number in the thousands. This is the only open site that was not entirely surface collected during this survey (CM41 was entirely collected except for the outcropping blocks). Like CM41, it was classified as both a quarry and an open stone artefact scatter as artefacts of foreign raw materials (two waisted axes) were found at the site.

It is to be noted that small pebbles (≤5cm long) are abundant throughout the region, and indeed appear to have been flaked at many sites. The abundance of such raw materials in the region means that nearly *every* open artefact scatter recorded so far is a potential quarry, in the sense that raw materials are readily available at the site itself. I have thus identified a quarry only where stone raw materials occur as a distinct outcrop, and where this outcrop has been demonstrably exploited.

Open Artefact Scatters

Open stone artefact scatters range from single artefacts to large scatters of thousands of artefacts. Of the 46 open sites recorded, only four sites had more than 15 stone artefacts, and only one of these more than 56 artefacts. With the exception of quarries, no other types of open sites were found.

Rockshelters and Caves

Caves and rockshelters were differentiated during the surveys as the two possess different formal characteristics. Rockshelters were identified as relatively shallow overhangs where rock outcrops meet the surrounding plains or pediments. Caves were deeper intrusions into the limestone outcrops, at times extending for hundreds of metres or even kilometres into the rock outcrops (Fig. 11). No cultural material has yet been recorded in any parts of caves where sunlight does not reach.

It is also noted that members of the local Wagaman Aboriginal community were hesitant about approaching deep caves in the recent past as they are considered the abode of local Dreaming beings (David 1984). This reluctance was not evident for rockshelters.

Analysis of the Open Sites

The stone artefacts from the open sites (including the quarries) were differentiated into four categories:

1. *Primary flake*, being an unmodified stone flake or flaked piece. All artefacts were examined under 10x magnification for evidence of use-wear and retouch. Primary flakes are here assumed to be waste bi-products of tool manufacture.
2. *Modified flake*, being any stone flake or flaked piece exhibiting use-wear and/or retouch. Modified flakes are deemed to have functioned as tools.
3. *Chopper*, being either a) a core with heavy edge modification (e.g. Hayden 1979), or b) an axe-head (Fig. 12a). Choppers are here assumed to have been probably used as wood-working implements.
4. *Core*, being a stone artefact from which a flake has been struck, possessing both negative flake scars and one or more striking platform, and exhibiting no positive flake scar (i.e. bulb of percussion) (Fig. 12b). A core's function is here assumed to be the manufacture of stone tools.

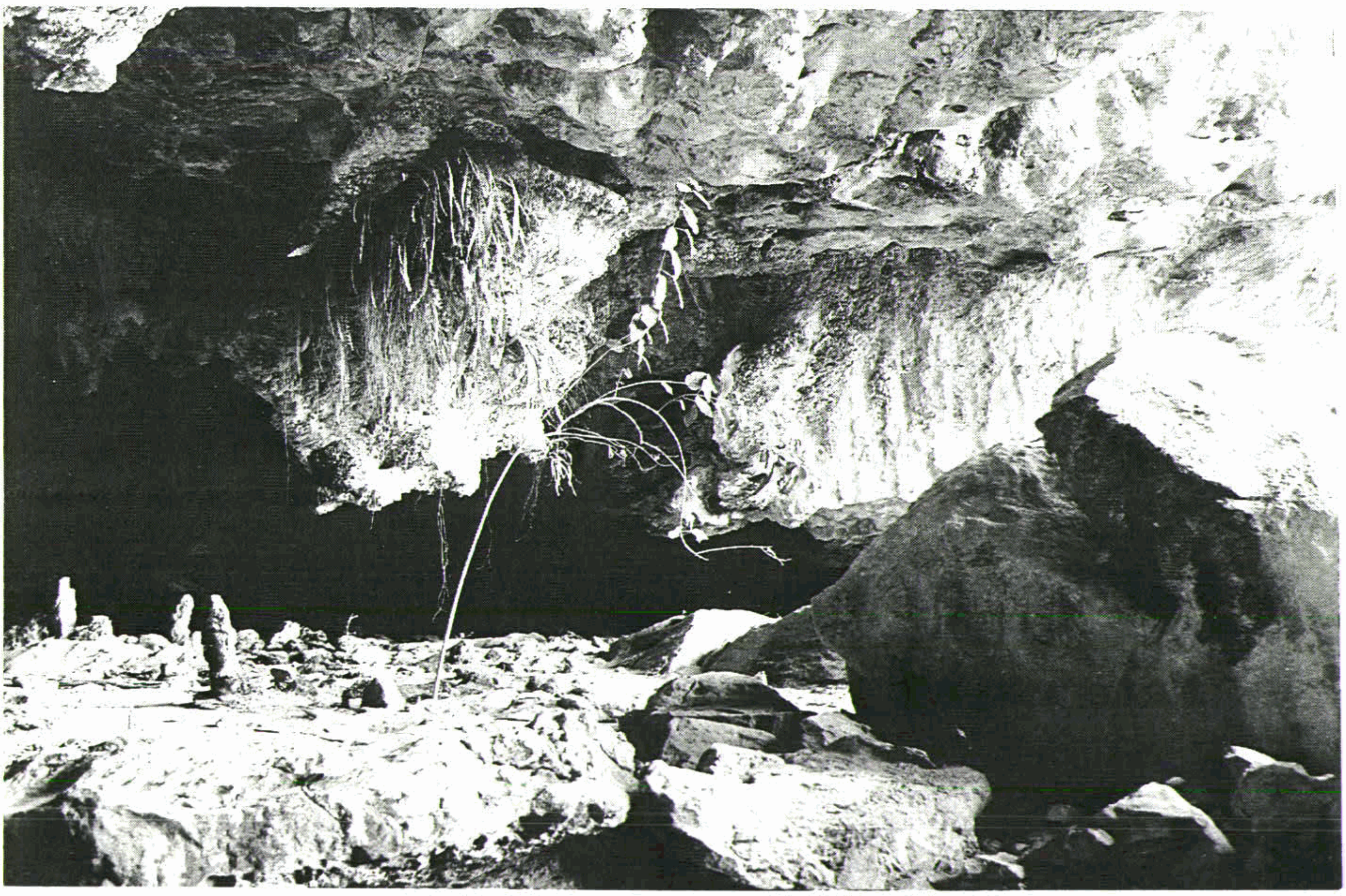

Figure 11. Fern Cave, CM26.

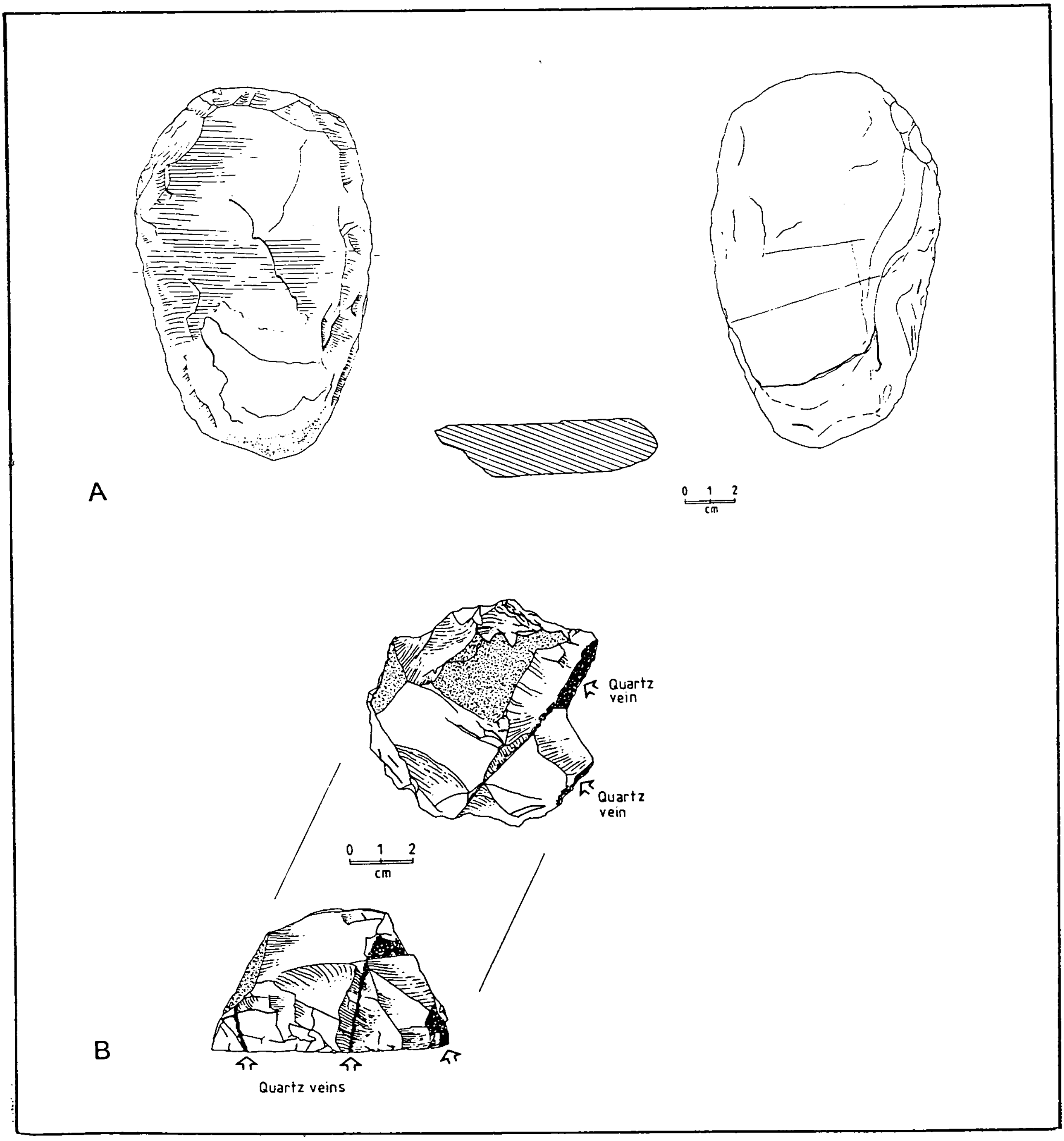

Figure 12a. Axe blank. Figure 12b Core.

In the absence of detailed analyses of edge wear and residue, the presence and combination of the above categories are used to compare and contrast activities in the open sites at a gross level. A comparative analysis is undertaken using multidimensional scaling (MDS) and Average Linkage Cluster Analysis, and take into account both the absolute numbers of artefacts in each site as well as the proportions of the four broad artefact 'types' (Table 10).

Table 10. Distribution of artefacts by open site. Site CM11 is note included as it was not totally collected.

Site (cm)	Primary Flakes	Modified Flakes	Cores	Choppers
1	3	1	1	-
5	45	9	2	-
6	1	1	1	-
7	32	6	2	-
8	5	4	1	-
9	-	2	1	-
12	8	-	3	-
13	1	2	-	-
14	1	1	-	1
15	2	1	1	-
16	1	-	-	-
17	-	1	-	-
18	-	1	-	-
19	5	5	-	-
20		4	-	-
21	1	2	-	-
22	-	2	-	-
23	2	-	-	-
24	-	1	-	-
25	5	1	-	-
27	1	-	-	-
28	-	1	-	-
29	1	-	-	-
30	7	4	2	-
31	6	1	1	-
32	2	1	-	-
33	1	3	1	-
34	4	-	-	-
35	-	-	1	-
36	-	1	-	-
37	1	-	1	-
38	2	1	-	-
39	1	-	-	-
40	2	1	-	-
41	-	1	4	2
42	6	5	-	-
44	3	1	-	-
45	-	1	-	-
46	1	3	1	-
47	2	1	-	-
48	2	2	-	-
49	-	3	-	-
50	1	2	2	-
51	1	2	1	-
52	2	1	1	-

Both the MDS and the Cluster Analysis (dendrogram not shown here) reveal a relatively unclustered distribution of sites — that is, the sites cannot be differentiated into separate groups on the basis of the artefact categories employed (Fig. 13). Rather, a functional cline is indicated between sites, assuming the lithic categories and absolute numbers to be valid criteria for the measurement of gross functions as outlined above (in particular stone- and wood-working). The majority of sites are small, and appear to have witnessed a limited amount of stone and/or wood working activity. The implication is that they are mostly ephemeral sites of short duration, and that people did not return to those particular places for camping purposes once the sites were abandoned (although they may have returned to local areas). Site CM11 (which was not included in the MDS or Cluster Analysis) is likely to be an exception given its large size and abundance of stone artefacts and raw materials. The results of the multivariate statistics may also indicate that open sites may not be readily diffentiated into distinct, more or less specialised functional types in this region. Having said this, it is nevertheless interesting to note that site CM41 (the quarry) stands out as being somewhat different from the other sites.

Open Sites and Environments

Tables 11 and 12 list a number of site attributes by land unit. Site densities range from two open sites/km^2 (Limestone Zone) to 16 sites/km^2 (Riverine Zone). The following analyses are aimed at investigating if these differences are associated with other parameters, such as differences in site sizes by land unit. My aim here is to investigate the patterning of site characteristics across the four land units.

If each open site is a single-event phenomenon, as appears to be the case, the relative sizes of sites across the landscape may inform us, in general terms, about the nature of land use. In particular, it may offer hints about the sizes and permanency of settlements in each land unit. Most of the open sites indeed appear to be single-event sites, as most are small in extent, spatially well defined, and possess a small number of stone artefacts. Furthermore, with the exception of sites CM11 and CM41, few (if any) of the sites possess characteristics that differentiate them from the surrounding landscape.

It is assumed as a *general* rule that the longer a group stays in one place, the more stone artefacts will be deposited on the ground. Likewise, the greater the number of people, the more likely that artefacts will be deposited. It is stressed, however, that these generalisations are made to generate a *model* of settlement-subsistence systems for the region. This model will then need to be independently tested and refined.

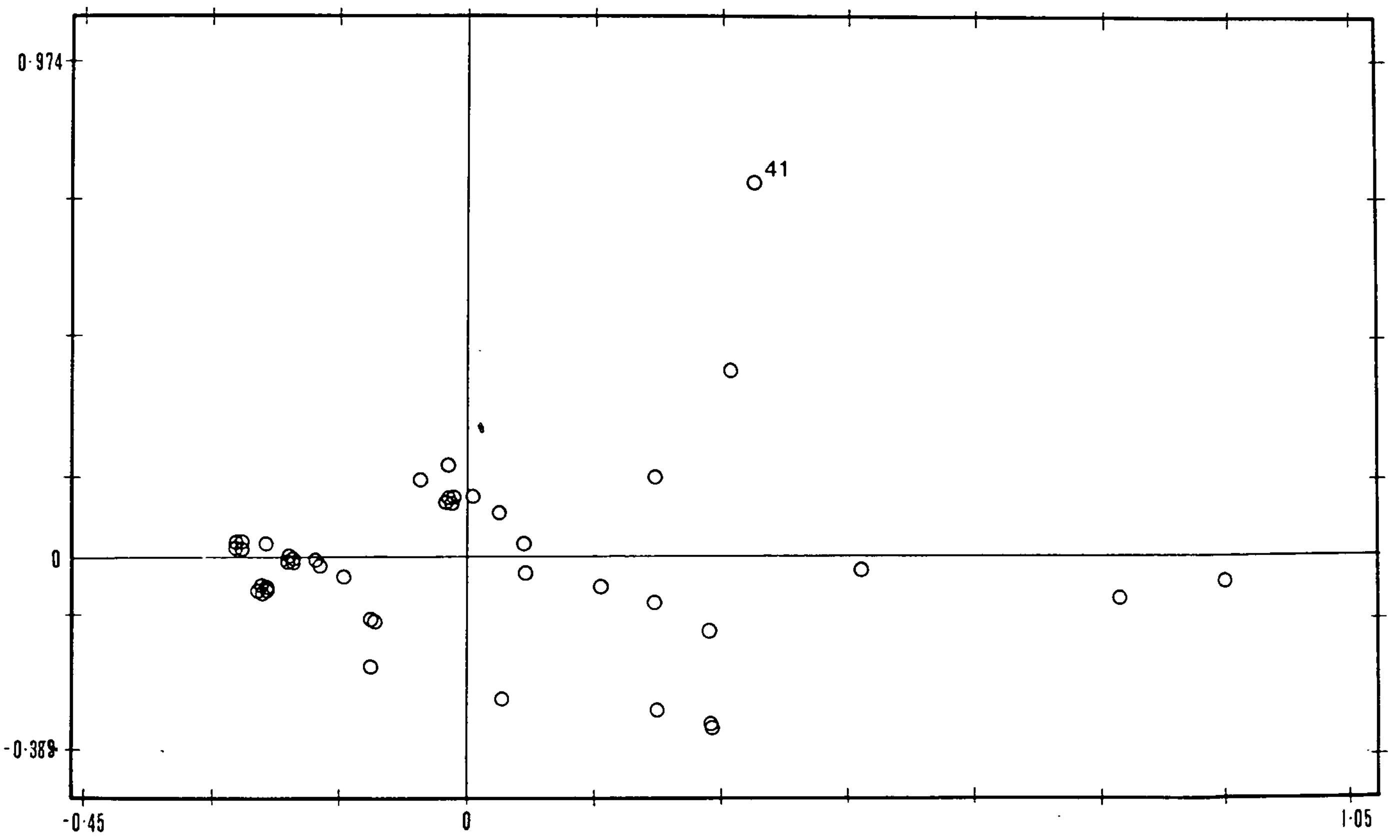

Figure 13. MDS 'map' showing statistical relationship of each site, based on stone artefact characteristics.

Table 11. Site characteristics, by land unit. *CM41 is excluded; **CM46-52 is counted as a single site and CM11 is excluded. Note that the Limestone Karst Tower unit consists of a single site only. It should therefore be used with caution.

	Mean Area Per Site (m^2)	Size Range (m^2)	Mean Site Density (Sites/ km^2)	Mean # of Lithics Per Site	Range for Number of Lithics	Total Number of Open Sites	Mean Core+ Primary Flake: Modif. Flake+ Chopper Ratio
plains	569	1-2500	5.7	8.8	1-56	17	1:0.3
hills*	687	1-9000	3.6	4.3	1-13	18	1:0.7
river**	1284	375-50,000	12.0	21.0	4-48	10	1:0.2
karst	50	50	2.0	4.0	4	1	1:0.3

Table 12. Mean artefact numbers per site.

	Primary Flakes	Modified Flakes	Cores	Choppers
plains	6.2	1.8	0.8	0.1
hills	2.1	1.6	0.5	0.1
riverine	13.0	3.0	1.7	0.0
karst	3.0	1.0	0.0	0.0

Results

The trends identified above show that sites in the Riverine Zone are more common (by a factor of two- to six-fold), tend to be larger (about twice the size, on average), and contain two- to five-times more stone artefacts than in sites located in other land units. The Riverine Zone also contains the greatest proportions of stone manufacturing debris (cores + primary flakes) relative to used tools (modified flakes + choppers), indicating that stone manufacture may have been focused in the Riverine Zone. On the other hand, the Hills contain the lowest amount of debris per implement, indicating that stone tool *use* rather than *manufacture* was predominant there (relative to other land units). This pattern may indicate the predominance of transient camps in the Hills, where curated technologies were used. More permanent camps may have been located along creeks and rivers. Camps along creeks may have been larger, their greater permanence allowing more time for maintenance and manufacturing activities. It may be relevent to note that this scenario is consistent with the Hills being the poorest resource zone in the region, and the Riverine Zone one of the richest; this applies to both water and food.

Seasonality and Resource Availability

I will attempt to model seasonality of site use following two procedures:

1. The Chillagoe region undergoes marked seasonal variation in the availability of surface water. As noted above, the dry season sees a drying-out of most of the creeks and rivers. Many of these waterways have rocky beds, making the digging of wells extremely difficult and unlikely. Consequently, it is assumed that sites adjacent to temporary water sources were likely to have been used at times when surface water was available - that is, sometime between November and April. Temporary water sources are here defined as those that dry up during the early stages of the dry season.
2. Following this logic, sites located near permanent water sources may have been occupied at any time during the year, unless these sites are situated in a position where they would be inundated during the wet season. In such cases (sites located in low-lying areas near creeks), I will assume that dry season occupation is indicated.

The Plains

Seventeen open sites were found in the Plains (Table 13). Of these, 14 were situated near temporary water sources, suggesting occupation during the wet season. However, many of these were in low-lying areas, implying that they were probably not occupied at the peak of the wet season when the surrounding landscape would have been boggy. All in all, there is evidence for both early and/or late wet (CM1, 5-9, 28, 45) and dry (CM12-16, 37-40) season occupation. There is no evidence for occupation during the peak of the wet season in the flat lands of the Plains, although this does not mean that the Plains were not used. There is a considerably greater number of artefacts per site in the early and late wet season sites than there are in the dry season sites (Table 14). The implication is that dry season sites in the Plains are more ephemeral, perhaps involving smaller groups of people, than those of the early and/or late wet season. I will return to this point shortly.

The Hills

Open sites in the Hills occur both near temporary and permanent water sources. Sites CM17, 25 and 27 are situated in contexts where they would be inundated or drenched during the wet season, although the total absence of water in their vicinity implies their use when water was available (early or late wet season). Sites CM18-24, 29 and 41 are on elevated areas away from permanent water sources, implying their wet season use. Sites CM30-33 and 35-36 occur on elevated areas near permanent water, indicating that they may have been used either during the dry or the wet season (seasonality is ambiguous). There are no major differences in the numbers of stone artefacts in sites of different seasons, although the wet season sites tend to have slightly more artefacts than those of the early or late wet (Table 15). Interestingly, there are no large sites in the Hills, indicating that this land unit may not have been relied upon for large residential camps, nor for camps of fairly long duration.

The Riverine Zone

Only four open sites were recorded from the Riverine Zone (including site CM46-52, which I am treating as a single site for reasons outlined above). Sites CM11, 34 and 42 are likely to be predominantly dry season sites, given their proximity to permanent water and their likelihood of at least partial inundation during the wet season. The seasonality of site CM46-52 is ambiguous, given its geographical setting.

It is clear from Table 16 that the Riverine Zone sites tend to exhibit more stone artefacts than sites from other land units. The Riverine Zone was used during the dry season, possibly for relatively large camps and/or camps of relatively long duration around standing waterholes. Unlike in other land units, there is evidence in sites CM11 and 46-52 that people may have returned to such places many times over the years. Therefore, dry seasons in particular may have involved a return to limited numbers of water sources, whereas no such returns are evident for the wet season in either the Plains, Hills or Riverine Zone.

The Limestone Zone

Only one open site was recorded from the Limestone Zone (CM44, with four stone artefacts), although 12 other sites are located within a short distance of this land unit. Site CM44 is located on well-drained ground near a temporary water source, indicating that it may have been used during the wet season. Little can be said of occupation of this zone given the small sample size.

Table 13. Site locational data, open sites.

Site (cm)	Land Unit	Metres to Tempor. Water	Metres to Perman. Water	Metres to Stone Raw Material	Metres to Karst Tower	Topography
1	Plains	75	>1000	75	100	flats
5	Plains	100	>1000	0	50	flats
6	Plains	200	>1000	150	10	flats
7	Plains	10	>1000	0	50	flats
8	Plains	10	>1000	0	20	flats
9	Plains	10	>1000	0	5	flats
11	Riverine	50	50	0	>1000	flats
12	Plains	100	350	0	>1000	flats
13	Plains	100	350	0	>1000	flats
14	Plains	5	500	0	>1000	flats
15	Plains	60	750	0	>1000	flats
16	Plains	2	1000	0	>1000	flats
17	Hills	15	>1000	10	>1000	flats
18	Hills	70	>1000	0	>1000	ridge-top
19	Hills	25	>1000	0	>1000	ridge-top
20	Hills	5	>1000	0	>1000	ridge-top
21	Hills	30	>1000	20	>1000	ridge-top
22	Hills	120	>1000	0	>1000	ridge-top
23	Hills	20	>1000	0	>1000	ridge-top
24	Hills	60	>1000	50	500	slope
25	Hills	2	>1000	0	500	flats
27	Hills	2	>1000	0	300	creek-bed
28	Plains	150	>1000	0	300	flats
29	Hills	50	>1000	0	>1000	slope
30	Hills	15	15	15	>1000	slope
31	Hills	15	15	15	>1000	slope
32	Hills	5	5	5	>1000	slope
33	Hills	2	2	2	>1000	slope
34	Riverine	5	5	5	>1000	flats
35	Hills	150	150	150	120	slope
36	Hills	25	25	25	>1000	slope
37	Plains	50	50	50	>1000	flats
38	Plains	120	120	120	>1000	flats
39	Plains	160	160	160	>1000	flats
40	Plains	130	130	130	>1000	flats
41	Hills	20	>1000	0	>1000	slope
42	Riverine	5	5	0	>1000	flats
44	Karst	200	>1000	200	0	flats
45	Plains	120	>1000	120	120	flats
46	Riverine	80	80	0	>1000	slope
47	Riverine	120	120	0	>1000	ridge-top
48	Riverine	100	100	0	>1000	ridge-top
49	Riverine	150	150	0	>1000	ridge-top
50	Riverine	100	100	0	>1000	ridge-top
51	Riverine	80	80	0	>1000	ridge-top
52	Riverine	10	10	0	>1000	ridge-top

Table 14. Mean numbers of artefacts per site by season, the Plains land unit.

	Mean Number of Lithics Per Site
early &/or late wet season	14.9
dry season	3.4

Table 15. Mean numbers of artefacts per site by season, the Hills land unit.

	Mean Number of Lithics Per Site
early &/or late wet season	2.7
wet season	4.2
indeterminate wet or dry season	5.2

Table 16. Mean numbers of artefacts per site by season, the Riverine Zone land unit.

	Mean Number of Lithics Per Site
dry season	>100
indeterminate wet or dry season	48

Discussion

Site patterning in the Chillagoe region indicates that the largest open sites of the late Holocene occur near water courses, and that they were probably used and re-used during the dry season. All other sites are small and appear to have been ephemeral, with stone artefact production not being particularly intensive at those sites. The Plains appear to have been used for camping purposes throughout the year, with the possible exception of the peak of the wet season, when widespread rainfall created boggy conditions. The Hills were used throughout the wet season, their importance for site location decreasing during the dry season. The Riverine Zone was particularly important during the dry season, especially where permanent water sources occurred.

Interestingly, 12 of the 21 (57%) purported early-to-late wet season sites are located within 1km of the Limestone Zone; none of the eight dry season sites is thus located. The implication is that the Limestone Zone may have been an important site locational determinant during the wet season. This pattern is consistent with the ability of the Limestone Zone to offer shelter from rainfall, as well as shade in the heat of the wet season (when high temperatures average 35^{o}C, some 10^{o}C above the dry season mean). It is also consistent with the seasonal pattern of resource availability in the various land units (see below).

The above spatial and seasonal site distributions indicate that while each land unit may have been used to some degree throughout the year, the Riverine Zone may have acted as a residential focus during the dry season, and the Limestone Zone as a similar focus during the wet. Most sites were small and of short duration, although some larger, seasonal aggregations took place near waterholes during the dry season and/or during the first or last stages of the wet. During the dry season populations lived mainly in small, ephemeral groups on the Plains and at times in more permanent camps on the Riverine Zone. The latter may have been re-used annually. There is little evidence for camping in the Hills during the dry season. This patterning is consistent with the availability of plant food resources in the various land units, with tubers (especially *Boehavia diffusa*, *Cayratia trifolia*, *Ipomea eriocarpa* and *Tribulus* sp.) being abundant in the Plains and fish being concentrated in waterholes of the Riverine Zone during the dry season.

The peak of the wet season, on the other hand, was probably not a time when large groups of people came together in central places. The wet season witnessed a focus of camps away from the Riverine Zone to the Limestone Zone (where some 22 species of edible fruits became available at the beginning of the wet), although again most, if not all, land units were used to some extent. The size and/or duration of camps on the Plains may have increased at the beginning and the end of the wet season, but not during periods of high rainfall. This increase coincided in time with a change in the availability of local plant resources, from tubers to fruits (in particular *Grewia retusifolia* and *Santalum lanceolatum* in the Plains, with a coincident increased availability of fruits in the Limestone Zone), although this is not to suggest that the changing availability of plant resources was the principle cause for changing settlement patterns. Again, most camps were small and ephemeral, although it is possible that rockshelters and the entrances of caves may have been used more intensively at this time.

Conclusion

The above model of settlement patterning in the Chillagoe region during relatively recent prehistoric times is necessarily coarse-grained, given the nature of the evidence at hand. Nevertheless, it has been possible to generate a number of hypothesis which now need testing. A number of lines of enquiry could be used with this aim in mind, including: 1. historical and ethnographic evidence; 2. seasonality indicators from faunal and vegetation remains in archaeological sites (e.g. brush turkey egg shells); and 3. the presence of seasonally-specific plant residues on stone artefact edges (e.g. starch grains of seasonal tubers). Once the above model has been tested and refined, the *dynamics* of settlement-subsistence systems through time in Chillagoe prehistory will be able to be investigated.

At this stage, an interesting contrast appears to have existed between the 'recent' settlement systems noted above and those of the last glacial maximum (*c.*22,000BP-17,000BP), with the latter involving an apparent narrowing of resource catchment areas, accompanied by a greater reliance and increased permanency of settlements near permanent waterholes (cf. David 1994, Lamb in press). It is only with further research in both open and sheltered sites, in all land units, that these patterns can be further explored.

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