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# A fine-grained analysis of the macropod motif in the rock art of the Sydney region, Australia

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***Abstract***

*The purpose of this study is to determine whether a fine-grained analysis of variation in the macropod motif across the Sydney region demonstrates similar or different patterns when compared with previous stylistic studies of the area. Here we discuss the figurative representation of the macropod motif. We discuss the syntax of the rock art using concepts of conventions, language and symbols to interpret macropod stylistic representation. We show how a fine-grained assessment of both frequencies of design elements and measurements of shape complements previous regional stylistic studies by demonstrating how stylistic regions are multilayered and not definite. The paper suggests new stylistic zones that future work can test, and demonstrates that these zones do not correspond simply with one widely used reconstruction of language distributions.*

## Introduction

In the Sydney Basin of New South Wales (NSW), Australia, rock art occurs in two distinct media in two types of locations: petroglyphs on sandstone in open locations, and pictographs within sandstone shelters and overhangs (e.g. McDonald 2008). There are more than 5000 recorded rock art sites for the region in the NSW Aboriginal Heritage Information Management System; however, due to the swift loss of Aboriginal life and lifeways post-1788, there are few ethnographic or historical studies explaining the reasons for the art or the meanings of the motifs.

This is a major reason for avoiding an approach that seeks to use projections of what the makers might have thought about the images. Instead, we favour one that concentrates on the way in which the images were produced. Our position on this is that, whether or not the makers intended images to look like an animal or a particular aspect of an animal, a fine-grained analysis can reveal something about the patterns behind 'what the images look like'. The simple example here is derived from images called 'anthropomorphs'. The name of the image class acknowledges that the images look like images of people. A comparison of, for example, Wandjinas from the Kimberley (Donaldson 2007), northwest central Queensland anthropomorphs from south and west of Cloncurry (Davidson et al. 2005) and Quinkan figures from Cape York Peninsula (Cole and Watchman 2005) shows that there are many different ways of making images that look like people. Some of these images may look like people but have been made to represent something else. Assigning images to an image class can conceal similarities between individual images in particular classes (as has been shown for the Wandjinas and earlier Gwion Gwion images in the Kimberley) and, in the worst of cases, can combine images that are quite unalike (June Ross pers. comm.), making statistical analysis problematic (Cole and David 1990). An analysis that defines the way images were composed is an essential precursor to any other analysis, particularly one which seeks to consider interpretations of those images that might be based on understandings of image production derived from other cultural contexts.

Traditional social interaction for peoples of the Sydney region cannot be assessed accurately from the available literature, and has been augmented by ethnographic information from other language groups with other symbolic systems in other regions in Australia (Attenbrow 2010; Collins 1798; Hiatt 1968; Lawrence 1968; McDonald 2008). Nevertheless, there are claims that variation in rock art played a major role in defining possible boundaries and communication between regions (McDonald 1994). Early rock art observers (e.g. Campbell 1899; Carroll 1888; Mathews 1893) and more recent researchers (e.g. Bursill 1993; Maynard 1976; McDonald 1994; McMah 1965; Officer 1984; Smith 1983; Tasire 2008) record variation in one of two ways that we define here as coarse-grained or fine-grained (following Officer 1992).

Coarse-grained information includes the image's location in the landscape, the techniques used to create it, its motif class (which is defined by the overall motif form, such as a macropod), its size and, if a pictograph, the colour(s) used.

In contrast, fine-grained studies focus on the motif form's attributes as they are defined by the properties of the design elements (such as dimensions, relative angles of parts of the image and other attributes of shape). Both coarse- and fine-grained analyses have provided insights into stylistic patterning and demonstrate that variations in the Sydney region are a result of both environmental stimuli and cultural choices. Overall, the visual imagery demonstrates a regional consistency in style, with patterned spatial and stylistic variations that can be attributed to cultural signaling.

The most comprehensive regional analysis hitherto is that by McDonald (1994, 2008). Focusing on Capell's (1970) conjectural reconstruction of language areas at the time of contact, McDonald analysed thematic variation between images in those language areas using motif class, image location, technique, quantity and pigment colour. In her analysis petroglyphs and pictographs exhibited stylistic variation and, in most parts of the region, this variation was clinal. The variation was explained in terms of defined language areas, with identifiable variation across drainage basins indicating the likely range of smaller social groups (McDonald 1994:145).

The age of rock art in the Sydney region has been addressed using the general characteristics of the art and it is widely agreed that the two components are both relatively recent and roughly contemporaneous. It can be argued that the majority of the Sydney basin art dates to within the last 3000 years (McDonald 1994:124). This allows us to assess stylistic conventions of the whole body of the art, with the proviso that any variations could result from time differences, if, for example, different styles were found in all parts of the region.

The research reported here was designed to determine if fine-grained analysis focusing on motif form could complement our regional understanding of Aboriginal visual representation. To test this, we examined metric and non-metric design features of the macropod motif—chosen because of the abundance of images in the local record—and placed the variation in the context of spatial distributions independent of the supposed language areas. We describe our method for a fine-grained classification of macropod form and confirm that such an approach allows for the identification of regional stylistic conventions in the rock art of the Sydney Basin and permits an independent stylistic evaluation of pre-contact symbolic images that can be compared with the conjectured language areas at contact.

## Background

The study area is located on the southeast coast of Australia in the Sydney Basin and covers approximately 15,000 square km (Figure 1). The Hawkesbury Sandstone, which extends from Newcastle in the north to Wollongong in the south, and from the eastern coast to the Blue Mountains, defines both the study area and the contexts for rock art. The area includes a large portion of the catchment areas of Mangrove and Mooney Mooney Creeks, and the Macdonald, Hawkesbury-Nepean, Colo and Georges River systems.

European colonisation from 1788 onwards caused a drastic cultural upheaval for the Aboriginal peoples of the region, and a catastrophic depopulation by way of direct violence or, in 1789, a smallpox epidemic (Attenbrow 2010:21). Written accounts by early colonists did not record much detail about local Indigenous people, with authors such as Hunter (1793), Collins (1798) and Threlkeld (1892) providing only scant information about these groups after the substantial effects of colonial impact. These records indicate the use of different languages in the region, but contain conflicting reports about where members of the various language groups may have interacted in the landscape. Aboriginal language groups and social interactions in the Sydney region cannot be assessed accurately from the available literature.

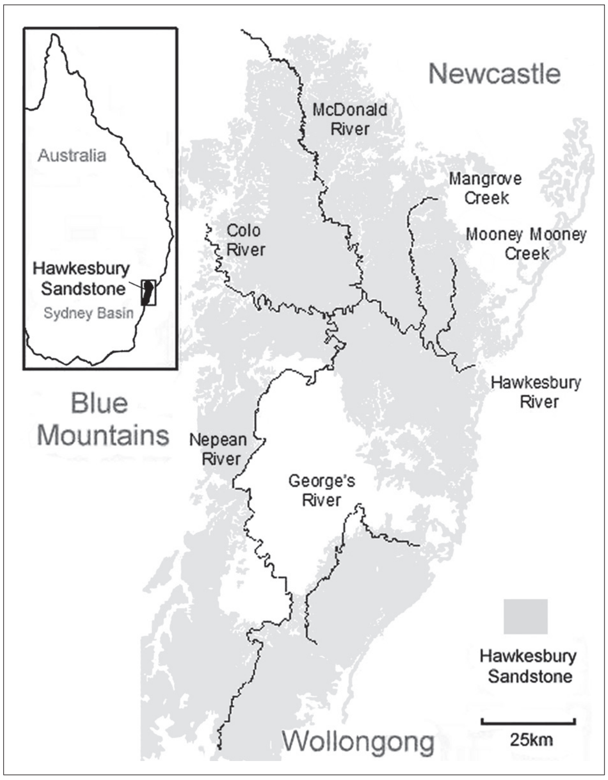


**Figure 1** Study area defined by the geology of the Hawkesbury Sandstone.

Early written accounts from the Sydney region record macropods as having been important to daily subsistence and cultural life. Macropod bones and teeth were used as fishing barbs and hunting spears, young girls were seen wearing waistbands made from kangaroo fur twisted into a thread and kangaroo tail sinew was used to tie cloaks together. Faunal assemblages from both coastal and hinterland archaeological excavations further indicate that various macropods were utilised as year-round food resources across the region (Attenbrow 2010:70–74).

## Macropod Characteristics and Variation

The macropods referred to in written accounts and represented in the rock art are classified into two families: the small Potoroidae, comprising potoroos and bettongs, and the generally larger Macropodidae, comprising kangaroos, pademelons, rock wallabies, wallabies and wallaroos (Strahan 1983:175–176). There are nine species from these two groups currently found in the Sydney region and a further two have been identified from excavations (Attenbrow 2010:72–73). The semitechnical term 'macropod' (from the Greek for long footed) is used here to refer to any species or visual depiction characteristic of a member of either the Potoroidae or Macropodidae families.

Generally speaking, macropods are characterised by large

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hind limbs, long feet, arms shorter than the hind limbs, ears and an extended tail (Figure 2). With respect to their identification in rock art, McMah (1965:96) defined a minimum shape requirement to recognise a macropod: an arched back, snout, ears, limbs on one side (as seen in profile), the front legs shorter than the back and a long tail. Nevertheless, variations on this characteristic form occur, and it is these variations that are the basis of our analysis.

**Figure 2** *Macropus giganteus* (Richardson 2012:140).

In our initial visual assessment it was clear there were varied representations: motifs that were clearly a macropod according to our template differed in details of shape and the specifics of representation of particular body parts. Some included clear naturalistic characteristics, such as the correct number of digits, but also included non-natural marks, such as circles and lines across the body. It was these differences that led us to adopt four stylistic categories developed by Pigeaud (2007) in his analysis of the components of design element variation in Palaeolithic images of horses: naturalistic, perceptual, schematic and intentional (Figure 3). *Naturalistic variation* refers to variations in size, shape, marking or movement and may reveal the species, and/or whether the animal is moving or stationary. In our analysis naturalistic variation was defined as when macropod attributes were recognisable within the normal range of macropod characteristics. *Perceptual variation* results from a peculiarity in the producer's way of representing a living animal as an image. This peculiarity diminishes or increases the size of body parts, a process that is typified by the almost universal misrepresentation of the proportions in human images among untrained artists (e.g. <www.portrait-artist.org/misc/proportion.html>). As such, these variations do not necessarily contain cultural information, although, as we will show, they may do so if there is variation in styles between different communities. *Schematic variation* refers to characteristics that are simplified but that still allow for recognition, such as the conventions for identification of a macropod defined by McMah (1965). The simplification of characteristics includes (1) an outline of a head, (2) the arm shorter than the leg and (3) an extended tail. These three characteristics allowed images to be recognised despite a lack of other detail. *Intended variation* occurs through the use of characteristics that are not necessarily related to those visible on a living macropod. There are intentional markings on macropods that highlighted possible stylistic representation; however, it was Pigeaud's approach, where variation in proportions based on anatomy were found to be attributed to style, that instigated the approach of our fine-grained analysis. Thus, in our case intended variation was measured through the motifs associated with macropods in rock art, for example, stripes, spots or boomerangs.

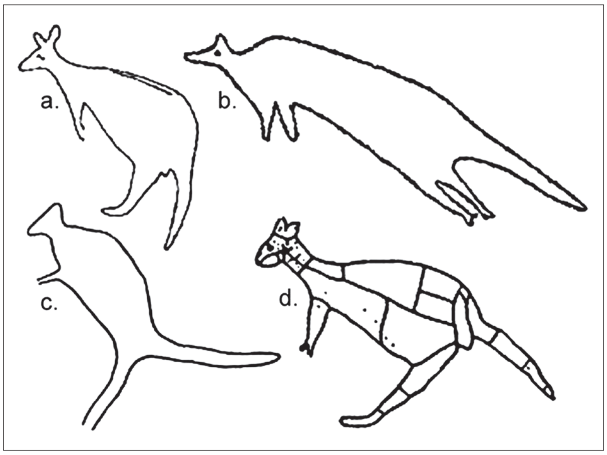



**Figure 3** Examples of stylistic categories: (a) naturalistic; (b) perceptual; (c) schematic; (d) intended.

## Style, Conventions and Semiotics

Questions about style in rock art were once more widely discussed than they have been recently (e.g. Conkey and Hastorf 1993; Ucko 1977), and questions of style in stone artefacts were common in the 1980s (e.g. Sackett 1977, 1982, 1985; Wiessner 1983, 1985, 1991). The discussions of the 1980s have had little lasting impact. The reasons for this are complex, but the retreat from discussions of style came at about the same time as the first direct radiocarbon dates on European cave art (Valladas et al. 1992) and the first chemical analyses (Clottes 1993; Lorblanchet 1990). Not only did these studies seem to move the study of rock art away from questions of the interpretation of the content of the art, but they were followed by the dating of Chauvet Cave, in which the direct radiocarbon dating of the images demonstrated an age quite different from that estimated by looking at the stylistic conventions thought to characterise the images (see the recent summary in Clottes and Geneste 2012).

The absence of recent discussion has led to a lack of clarity of thought, which in turn has contributed to a perception that such studies are not sufficiently scientific to contribute to mainstream archaeology. We argue that, even in the case of analysis of dates or chemical composition, stylistic comparisons are necessary to extend the particular scientific analysis of an image in a defined style to other images in the same style. Conventions accessed through a fine-grained analysis of style should contribute to making such extensions more reliable.

Conventions are identified by the repetition of characteristics (Davidson 2003:964; Schapiro 1953), as Schapiro (1953, quoted in Brandl 1977:222) noted:

> … conventions are a system of forms produced by an individual or group represented by the constant elements, qualities and expression of the art. Conventions are a system of forms with a quality and meaningful expression through which the individual's personality and group outlook are visible, they define the manifestation of the culture as a whole and, are a visible sign of its unity.

Stylistic conventions were identified by Conkey (1980) in her study of marked bones in the Upper Palaeolithic of northern Spain, which she argued were similar to language in that they were signs of a readable code (Conkey 1989). In a study of linguistic signs, Peirce (1985:5) defined a sign as 'something which stands to somebody for something in some respect or capacity'. Simplifying Peirce's semiotic scheme allows for the recognition of three types of signs: icon, index and symbol. Adopting this scheme, we explore what might be interpreted from conventions in the representation of macropods in Sydney rock art. An *iconic sign* 'represents its object mainly by its similarity' (Pierce 1985:10); the macropod motif is iconic in that it has a similarity between some aspects of its form and the animal it is intended to portray. *Indexical signs* refer to objects by the 'association of an action' (Pierce 1985:13); the macropod motif is an indexical sign of the action of the individual who created the art, since the indexicality of the sign refers to a producer, or producers, rather than to the animal represented. A *symbolic sign* refers to its object 'by virtue of [an] idea' (Pierce 1985:18); symbols may be arbitrarily related to the things they stand for, but most importantly, the image of a macropod as a symbolic sign can represent multiple meanings not necessarily having any direct connection to the animal itself because of a convention within the society that produced it. As an example, since 1944, the image of the flying kangaroo has been symbolic of the airline Qantas.

Sackett (1982) argued that some conventions derive from shared practices learned as new producers acquired their skills, calling such practices 'isochrestic behaviour'. This process results in the repetition of patterns as a result of the constraints of common functional requirements and from learning common practices. The patterning derived from this behaviour need not carry a message, though an observer, such as an archaeologist, may well take this as an indexical sign of the community of shared practices. On other occasions, conventions emerge via what we might call 'active behaviour', approximating a concept developed by Wobst (1977) and used by Wiessner (1983), such that the producers self-consciously produce material culture so as to distinguish either themselves or their beliefs from others. Therefore, patterning can be both indexical from the isochrestic nature of the behaviour, and symbolic through attachment of meaning by active behaviour.

It seems relatively unlikely that all repeated patterns in macropod images would be 'merely' isochrestic, because, unlike the case where people learn skills to make functional objects, the skills required for rock art production are not constrained, except in relation to the need to be able to produce a recognisable form. Hence, as macropod images present some of the properties of the living animal they are iconic, but, through conventions about what is or is not represented, they can come to have both an indexical quality for the society's conventions of representation and probably a symbolic meaning with cultural connotations. This symbolic meaning would have been passed on between generations of producers, but in most cases it is no longer known.

## Methods

The macropod images in this assessment were obtained in 2007 from the NSW Aboriginal Heritage Information Management System (AHIMS), where descriptive information and drawn images are available for more than 5000 rock art sites in the Sydney region. The approximate quantity of macropod rock art images recorded on AHIMS at the time of this assessment was 1335 (McDonald 1994:99, 792); however, only 580 image records were accompanied by photos or drawings (385 engraved and 195 painted), as most were only recorded descriptively after 1985. Although engraved and painted images have often been analysed separately because of the technical and contextual differences (e.g. McDonald 1994; Smith 1983), there is a common vocabulary between them in many regions, as Ross (2002) has shown in Central Australia. Our analysis focuses on image design elements before considering the contextual and technical differences.

An initial visual assessment determined the anatomical design elements that can be said to characterise the macropod motif in the Sydney Basin. Anatomical design elements were defined from the physical parts of the animal most represented. These were arm, leg, ear, eye, mouth, genitalia, paw, foot, digits, tail, stripes on tail and orientation (Figure 4a). A range of associated motifs were recorded as stripe, spot, boomerang, spear, grinding groove, fish, shield, circular, half circular, anthropomorph, quadruped, joey, eel, trident, snake and other. A feature described as 'twisted perspective' (Stanbury and Clegg 1990:123) was noted on some images. This occurs, for example, in images where two eyes are visible although the head is in profile, when two arms and/or two legs are seen on a macropod in profile, or when digits are shown in varying quantities on arms or feet in a twisted perspective. We originally included the ears as an aspect of twisted perspective but, after examining multiple macropod photographs, two ears can usually be seen regardless of the position of the head and thus are not considered here to be an indicator of twisted perspective.

Anatomical design elements indicated that the back, head, ear, arm, leg and tail of macropod images were diverse in form. Subjective categories for the shapes for each design element were defined (Figure 4b) as:

- Back: circular, oval, elongated or tear drop;
- Head: blunt, curved, pointed, long or short;
- Ear: round, curved, pointed, short or pronged comb;
- Arm: straight same, straight narrow, curved same and curved narrow; and,
- Leg and tail: straight same, straight narrow, bent same, bent narrow, curved same and curved narrow.

The Adobe Photoshop® measurement tool (which allows length and angle to be measured simultaneously in any direction from an individual pivot point), was used to obtain measurements from which ratios and angles were derived. Where possible, an initial datum line (Figure 5) was created from datum points at the base of the neck (P1) and the dorsal base of the tail (P15), and was set horizontally on the page with the head facing left, rotating the image if necessary to provide consistency in datum point locations and measurements. As shown in Figure 5, a total of 19 datum points were utilised to create 13 length and eight angle measurements. Lengths were measured from one datum point to the other. Angles were measured from the initial datum point used for the length measurement. The measurement tool gives the angle of any line measured relative to the horizontal datum line: anything below the horizontal is given a negative value measured clockwise from the horizontal, and anything above is given a positive value measured anticlockwise from the horizontal.

Based on the completeness of the back and the presence or absence of the previously defined design elements, the following five data subsets were identified:

1. All (n=580), comprising the full set of images extracted from AHIMS;

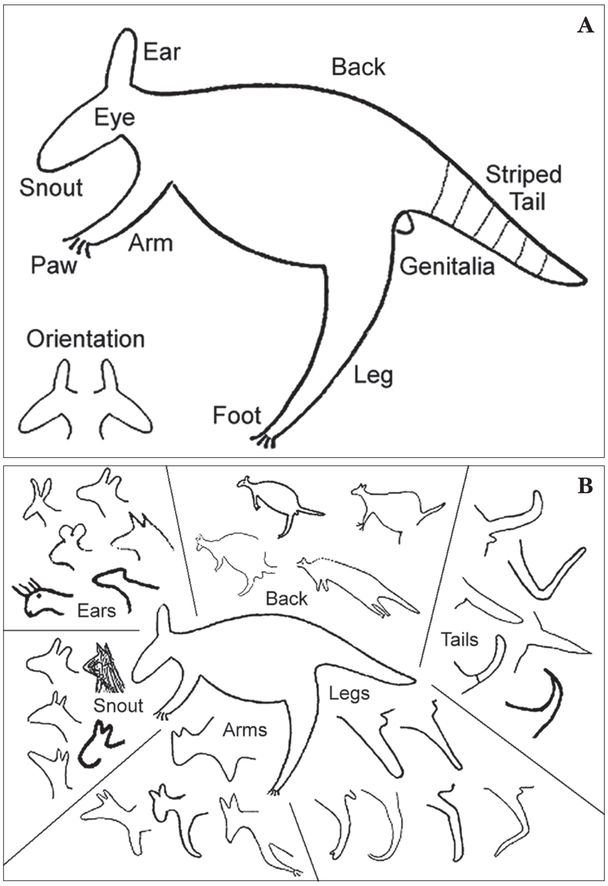


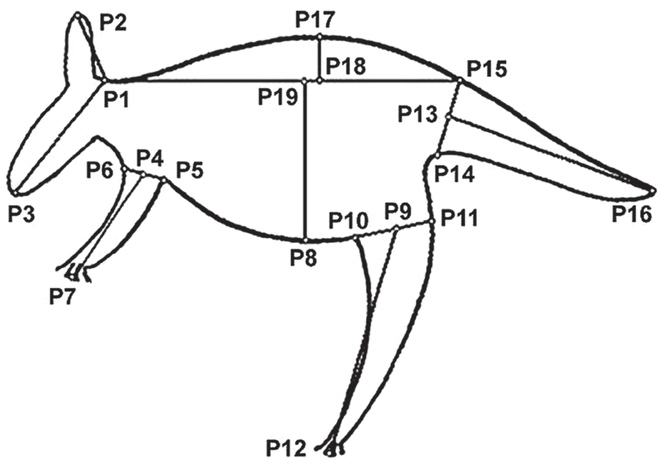

**Figure 4** (a) Macropod anatomical design elements; (b) Variation in macropod design elements derived from visual assessment.

2. Complete (n=300), comprising images with all six attributes of arm, leg, ear, snout, back and tail;
3. Partial (n=135), comprising images with a datum line but missing attributes specified for Complete;
4. Incomplete (n=86), comprising images without a datum line; and,
5. Non-measurable (n=59), comprising images with a datum line but unclear measurement points.

The qualitative analysis utilised data subset 1 (All, or 580 images), assessing all design elements on all of the images. The quantitative analysis utilised data subset 2 (Complete, or 300 images), assessing ratio and angle variation in images that showed the same characteristics of image form. The other images in subsets 3–5 did not contribute to the analysis described here.

Our method for obtaining length and angle measurements were derived from Clegg's (1978) strategy for zoological identification, which incorporated the size and proportion of animals, with our approach expanding upon an earlier study of macropod forms north of the Hawkesbury River by Smith (1983). The angle measurements (Table 1) were taken so as to define the orientation of body appendages. For example, the 'angle of tail' was defined by the measurement from the tip of the tail (P16) to the base of the tail (P13); the result was an angle that demonstrated whether the tip of the tail was lower or higher than the base.

Ratios were derived from Rosenfeld (1982), where the division of one length measurement by another created eight ratios describing the shape of distinct body sections, independent of the size of the image (Table 1). Importantly, the use of ratios allows for the inclusion of images that do not include scales and allows for comparisons where the size of the image varies from location to location. For example, head shape was defined by ear length (P1 to P2, using the points indicated on Figure 5) divided by snout length (P1 to P3), the result being a ratio that numerically represented the macropod head shape, ranging from short ears with a long snout, to long ears with a short snout. Body shape and direction, displayed by the ratio and angle indices, were plotted as frequency distributions for each index. The variations in frequency distributions were fairly consistent, with the majority of values clustered around the mean. This is a result of the fact that representation is predominantly iconic. Thus, in order to identify those aspects of variation that are not principally due to the perceptual variation of the artists, we chose to consider the variation at the extremes of the ranges represented.




| Point | Description |
|---|---|
| P1 | Base of back of head / top of neck |
| P2 | Tip of rear ear |
| P3 | Tip of snout |
| P4 | Centre of width of upper arm |
| P5 | Arm meets chest |
| P6 | End for line drawn from P5 through P4 |
| P7 | End of paw |
| P8 | Lowest point of belly between point P5 and P10 |
| P9 | Centre of width of upper leg |
| P10 | Leg meets belly |
| P11 | End for line drawn from P10 through P9 |
| P12 | End of foot |
| P13 | Centre of width in base of tail |
| P14 | Base of tail ventral side |
| P15 | Base of tail dorsal side |
| P16 | End of tail |
| P17 | Highest point of back between point P1 and P15 |
| P18 | Point along back perpendicular to P17 |
| P19 | Point along back length perpendicular to P8 |

**Figure 5** Datum points and measurement descriptions.

| Measurement Description | Direction | Angle ID | Ratio ID | Ratio Description | Divisions |
|---|---|---|---|---|---|
| Ear length | P2 to P1 | A1 | R1 | Head | Ear length / snout length |
| Snout length | P3 to P1 | A2 | R2 | Arm | Arm width / arm length |
| Arm width | P5 to P6 | A3 | R3 | Leg | Leg width / leg length |
| Arm length | P7 to P4 | A4 | R4 | Tail | Tail width / tail length |
| Leg width | P10 to P11 | A5 | R5 | Back1 | Back height / back length |
| Leg length | P12 to P9 | A6 | R6 | Back2 | Upper back length / lower back length |
| Tail width | P14 to P15 | A7 | R7 | Belly1 | Back height / belly width |
| Tail length | P16 to P13 | A8 | R8 | Belly2 | Back length / belly width |
| Back height | P18 to P17 | | | | |
| Upper back length | P1 to P18 | | | | |
| Lower back length | P18 to P15 | | | | |
| Belly width | P19 to P8 | | | | |

**Table 1** Names and definitions for measurements, angles and ratios.

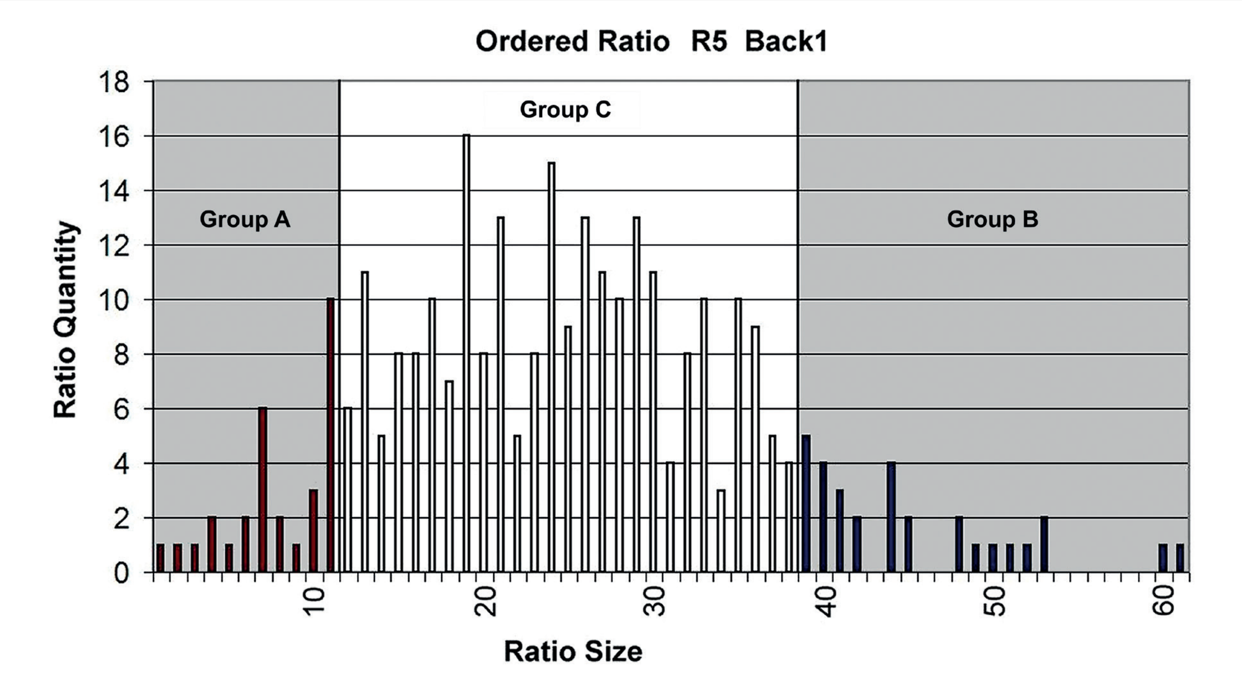



**Figure 6** Frequency distributions for ratio R5-Back (from Complete 300 images).

To do this, we used the following procedure:

1. For the spreadsheet of any three sets of index values (Ri, Rii and Riii), we sorted one column of values (Ri) from highest to lowest;
2. We identified three groups of images, A, B and C, such that Group A contained the 10% lowest values (30 in this sample) of the sorted (ordered) index, and Group B the 10% highest values (shown in Figure 6 and Table 2). Group C was not considered further in this analysis on the grounds that these values represented the core variation common to the whole sample; and,
3. For each set of images in Groups A and B we plotted the corresponding values of Rii and Riii as a scatterplot.

Finally, all image data were entered into Microsoft Access®, including spatial location extracted from AHIMS, and then transferred to ArcGIS to display the spatial location of each image in order to identify regional distributions.

| AHIMS Site ID | Ordered Index | Corresponding Indices | |
|---|---|---|---|
| | R5 Back1 | R7 Belly1 | R8 Belly2 |
| 45-3-0324 | 0.015 | 0.059 | 4.000 |
| 45-6-0613 | 0.022 | 0.042 | 1.875 |
| 52-2-0168 | 0.029 | 0.056 | 1.944 |
| 45-3-0324 | 0.041 | 0.171 | 4.171 |
| 52-2-0168 | 0.042 | 0.082 | 1.967 |
| 45-3-0404 | 0.047 | 0.172 | 3.655 |
| 45-2-0035 | 0.057 | 0.119 | 2.071 |
| 45-2-0269 | 0.062 | 0.172 | 2.793 |
| 52-2-0794 | 0.067 | 0.098 | 1.471 |
| 52-2-0218 | 0.068 | 0.086 | 1.257 |

**Table 2** Example of Ordered Index and Corresponding Indices using the ten lowest results for the Ordered Index R5.

## Results

### Quantitative Analysis

A scatterplot of corresponding frequencies for Groups A and B was created, with two results identified. For example, we used ratio R5 and defined the Ordered Index from Group A, and then identified the values of R7 and R8 for the images in Group A as the Corresponding Indices (Table 2). The same process was repeated for the Group B decile values (not shown in a table). A scatterplot was then produced with the two series of corresponding values from Groups A and B, with R7 on the x-axis and R8 on the y-axis.

The result was a clear separation of the two groups as shown in Figure 7a, which suggests (in this instance) that back shapes were related to belly shapes. After repeating this process for different angles and ratios, a second pattern of results was seen in which there was no separation between the two groups (Figure 7b). In the example, there was almost complete overlap of the ratios representing Head (R1) and Arm (R2) shape, whatever the shape of the back. The separation indicated images that were formally significantly different. The spatial locations of these image groups were then analysed.

The indices based on the extreme ratio and angle variations revealed distinctive separations in five scatterplots: ratios R5 Back1, R7 Belly1, R8 Belly2 and angles A3 Arm Width and A4 Arm Length. Images showing at least two of R5, R7 or R8 and images showing A3 and A4 were combined and plotted spatially.

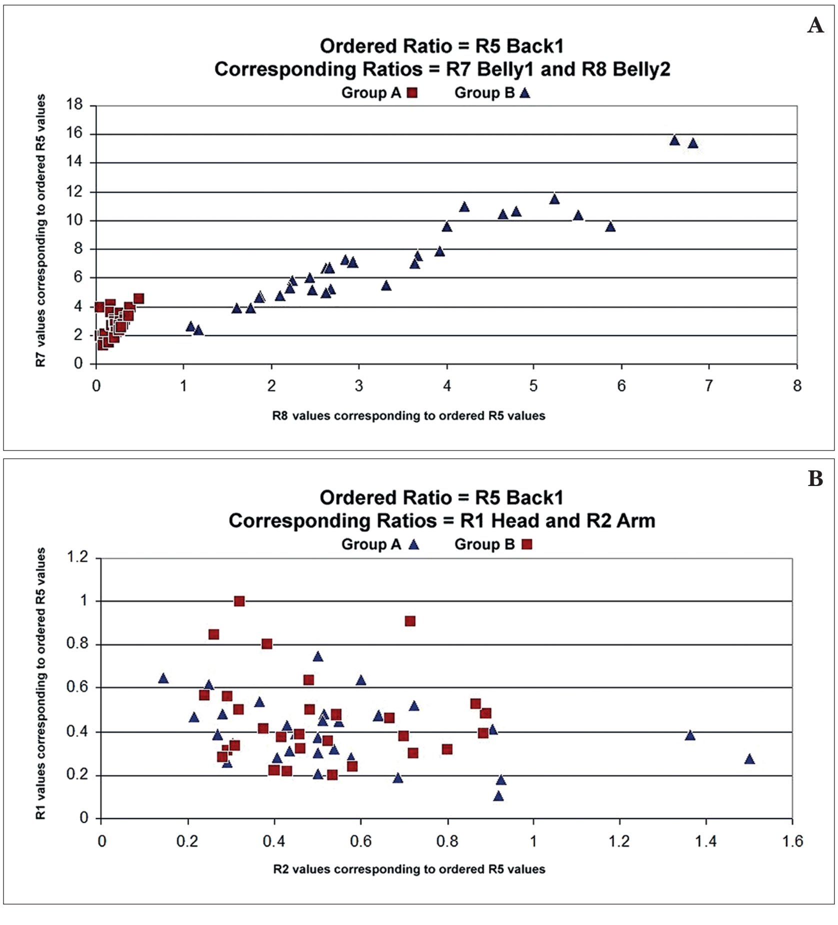



**Figure 7** (a) Separation of corresponding indices; (b) No separation of corresponding indices.

When the R5 images were mapped, Group A (anomalous images in the lowest 10% of the sample) was found mostly south of the Hawkesbury River, with greater numbers south of the Georges River. Group B (anomalous images in the highest 10% of the sample) was located predominantly north of the Hawkesbury River, east of Mangrove Creek (Figure 8).

The locations of these images show that a greater quantity of images south of the Hawkesbury River have a small back and a large belly, and an arm angled away from the belly (Group A). North of the Hawkesbury River, images show a large curvature of the back and a small belly, and an arm angled close to the belly.

### Qualitative Analysis

Images described as macropod on the AHIMS database show an extended tail and one or more other characteristic anatomical attributes which allow for motif identification, such as ears, snout, an arched back, limbs on one side (as seen in profile) or front legs shorter than the back. Design elements that can be said to characterise the macropod motif in the Sydney region are one arm (71%), one leg (68%), two ears (65%) and no eyes (72%) (Table 3); however, only 17% are found to show all four combined in the one image.

Characteristics that occur less frequently are genitalia (30%), mouth (6%), paw (11%) (if they have paw digits there are usually four), foot (9%), (if they have foot digits there are usually two), and a striped tail (6%). There are 10% more macropods orientated to the right (55%) than to the left (45%). Associated motifs, which we would identify as intended variations in Pigeaud's classification, are usually stripes (19%) or spots (10%). There are 38% in total that can be said to be in a twisted perspective: 114 show two arms and 113 show two legs, and when combined they are found on 87 images. Eighty images show two eyes, with 77 of these being on macropods with one arm and one leg.

When these quantities were plotted they displayed spatially discrete groupings across the region. The spatial distribution of the anatomical design elements and body shape led to some clear visual repetition. From these we created five subregions (Figure 9a): west of Mangrove Creek and east of the Macdonald River (NW); east of Mangrove Creek (NE); west of the Macdonald River and south of the Hawkesbury River to around Berowra Creek (CW); the coastal area south of the Hawkesbury River to Port Jackson and the Parramatta River (CE); and south of the Georges River (S).

There was a clear separation at the Georges River, where the convention of one arm and one leg (n=367) on the same image is only found in the north. There were also minor quantities of one arm and two legs (n=8), two arm and one leg (n=5), and two arms and two legs (n=6). South of the Georges River macropods mostly show two

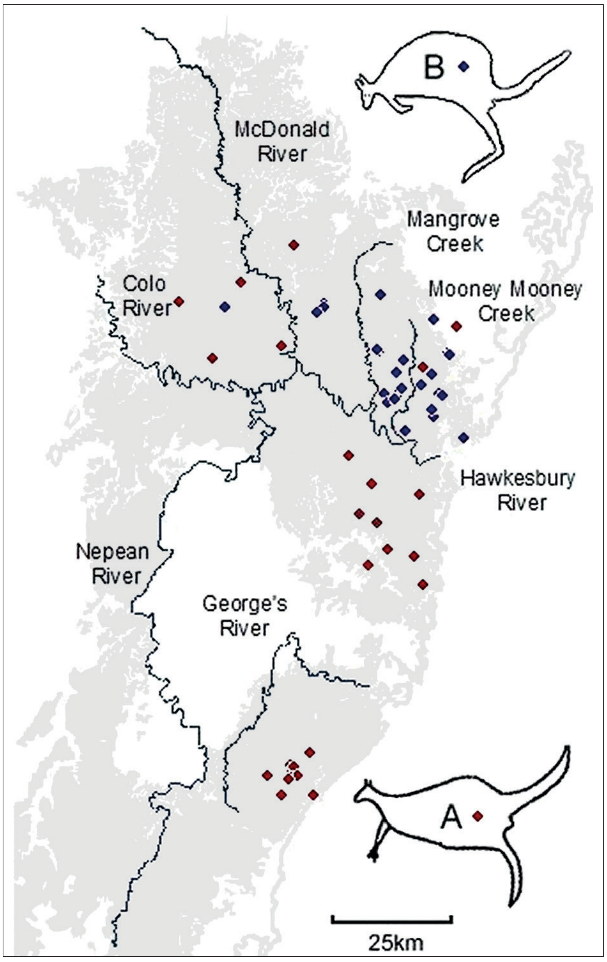



**Figure 8** Distribution of body shape characteristics from Groups A and B.

arms and two legs (n=80). There were also small quantities of one arm and two legs (n=15), and two arms and one leg (n=9).

The characteristics of ears and eyes were slightly more diverse in representation (Table 3). North of the Hawkesbury River images tend to show two ears and either have no eyes, or have one or two eyes. In contrast, south of the Hawkesbury River three subregional differences were found: west of the Nepean River images show two ears and no eyes; east of the Nepean River inland images tend to show one or two ears and no eyes; along the coast images show one ear and no eyes or one eye. Below the Georges River images tend to show two ears and no eyes.

When different combinations of all four arm, leg, ear and eye design elements were tested on individual macropod images, five groupings were found to fall fairly consistently within three regions (Figure 9b). North of the Hawkesbury River 49 of 53 images (92%) show one arm, one leg, two ears and two eyes, and 50 of 69 images (72%) show one arm, one leg, two ears and no eyes. South of the Hawkesbury River, along the coast, 29 of 53 images (55%) show one arm, one leg, one ear and no eye, and 13 of 17 images (76%) show one arm, one leg, one ear and one eye. South of the Georges River 44 of 46 images (96%) show two arms, two legs, two ears and no eyes.

Chi-squared analysis of 2x2 contingency tables comparing the different regions of the study area produced several patterns of result[1]. Considering the orientation of images, for example, showed that there were differences in frequencies

| Attributes | | Subregional Quantities | | | | |
|---|---|---|---|---|---|---|
| | | NW | NE | CW | CE | S |
| Arm | One | 101 | 126 | 102 | 72 | 13 |
| | Two | 4 | 4 | 0 | 9 | 97 |
| Leg | One | 98 | 122 | 47 | 119 | 6 |
| | Two | 3 | 3 | 4 | 9 | 95 |
| Ear | One | 12 | 30 | 18 | 95 | 7 |
| | Two | 93 | 103 | 36 | 30 | 114 |
| Eye | Zero | 70 | 86 | 37 | 93 | 131 |
| | One | 14 | 17 | 12 | 34 | 2 |
| | Two | 31 | 37 | 8 | 8 | 0 |
| Orientation | Left | 41 | 85 | 20 | 73 | 43 |
| | Right | 77 | 53 | 36 | 62 | 90 |
| Mouth | Yes | 14 | 11 | 5 | 5 | 0 |
| | No | 103 | 128 | 51 | 130 | 133 |
| Paw | Yes | 14 | 23 | 8 | 8 | 6 |
| | No | 103 | 115 | 48 | 127 | 128 |
| Foot | Yes | 8 | 14 | 5 | 9 | 19 |
| | No | 108 | 125 | 51 | 126 | 115 |
| Striped Tail | Yes | 8 | 12 | 7 | 7 | 1 |
| | No | 108 | 127 | 49 | 128 | 133 |
| Genitals | Yes | 31 | 53 | 22 | 51 | 16 |
| | No | 86 | 86 | 34 | 84 | 117 |
| Body Shape | Group A | 1 | 3 | 6 | 6 | 14 |
| | Group B | 3 | 33 | 1 | 2 | 1 |
| Arm Leg Ear Eye (ALEE) | 1A1L1E0E | 3 | 14 | 7 | 29 | 0 |
| | 1A1L1E1E | 1 | 0 | 3 | 13 | 0 |
| | 1A1L1E2E | 1 | 1 | 1 | 4 | 0 |
| | 1A1L2E0E | 18 | 32 | 9 | 10 | 0 |
| | 1A1L2E1E | 9 | 12 | 4 | 0 | 0 |
| | 1A1L2E2E | 23 | 26 | 7 | 3 | 0 |
| | 2A2L2E0E | 0 | 1 | 0 | 1 | 44 |

**Table 3** Design element quantities for each state in each region.

of right- and left-facing images from region to region. Thus, left-facing images were more abundant in the NE and the CE regions—the two coastal regions in the northern part of the study area (Table 4a); all other regions had more right-facing images. These differences are significant in five of the ten comparisons (Table 4b). Looking at these results, the CE region groups with the NE region.

Turning to the images with different numbers of ears, two ears are more abundant in all regions except the CE, so that it does not group with any of the other regions. And looking at the question of whether one or two arms are represented, the Southern region alone has substantial representation of two arms, such that the CE region groups with all of the other regions except the Southern.

The outcome of this analysis is that each region groups differently according to the design element considered. This should not be a surprise, because several factors would have contributed to the decisions about how to represent the animals, perhaps at different times. But this variation

[1] We only considered results which showed highly significant ($p<0.01$) or very highly significant ($p<0.001$) differences.

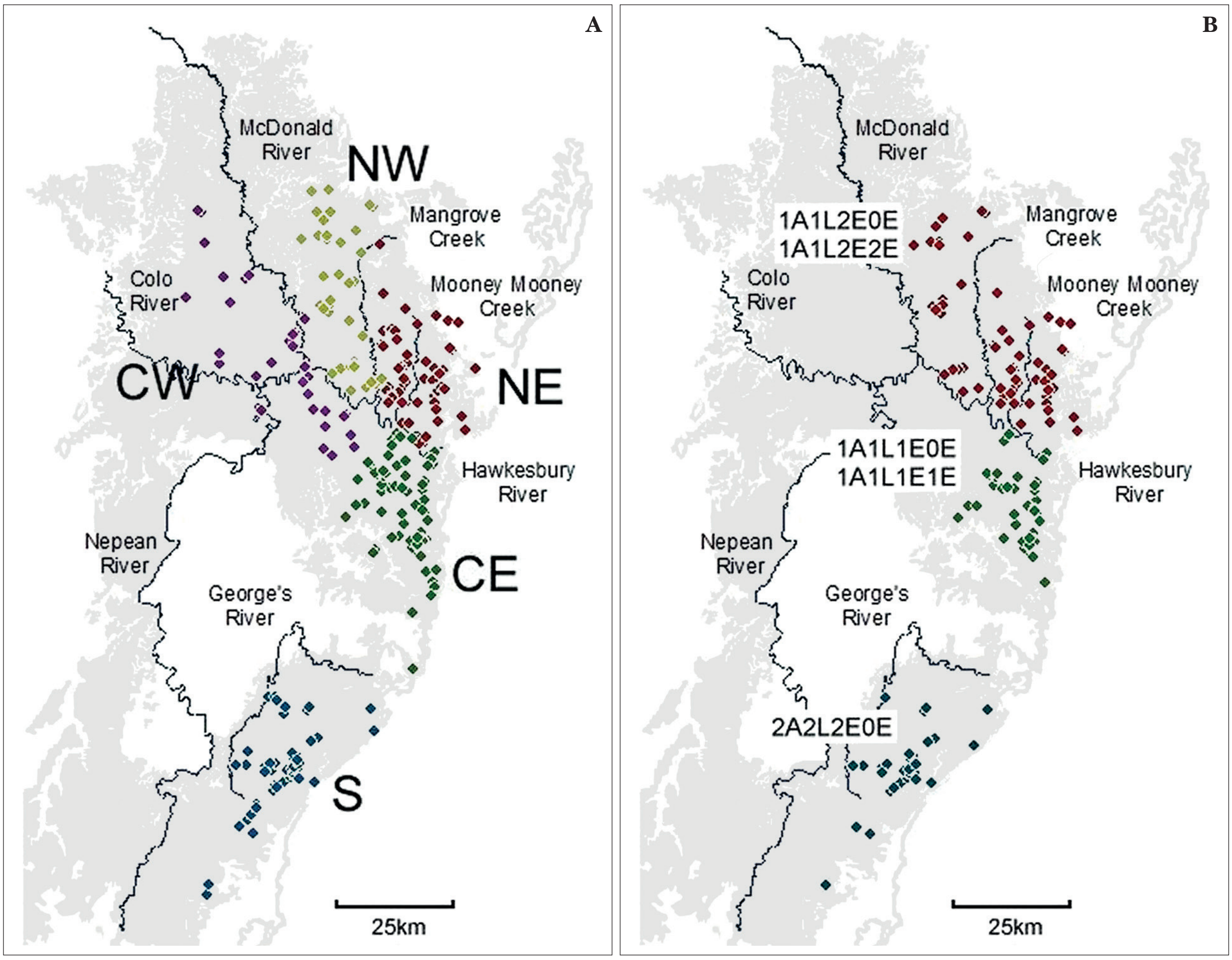



**Figure 9** (a) Five subregions defined from 2x2 chi-squared tests; (b) Groupings of arm, leg, ear and eye (ALEE) combinations on individual images.

contributes to the distinctive stylistic character of the regions.

Considered together, the variation can be subdivided in different ways (Figure 10). The fundamental subdivision is between North (A) and South (B). It may be that this is further complicated by the predominance of painted images in the south, but that should be investigated in further research.

Within A, the Central East (M) and the North East (L) are distinct for some groupings of variables and similar for other groupings when they constitute subdivision R. The North West region sometimes groups with the North East to constitute subdivision Q, and sometimes with the Central West to constitute subdivision P. These relationships are shown in Figure 10, and the constituent design elements are summarised in Table 5.

The most striking result is the fundamental subdivision between North (A) and South (B) of the Georges River. North of the Georges River the significant frequencies of one arm, one leg, and the presence of a mouth, genitals and a striped tail contrast to south of the Georges River, with significant frequencies of two arms, two legs and the absence of a mouth, genitals and a striped tail.

## Discussion and Conclusion

The Sydney region contains a large corpus of rock art considered to be a single regional style. Motifs have been studied at the regional and subregional level utilising coarse-grained and fine-grained methods, demonstrating internal stylistic variation. However, until now, macropod images have not been studied across the entire region at such a fine-grained level.

For this analysis, we have described the variable characteristics in the macropod images of the Sydney region and placed them into distinct categories of style: naturalistic, perceptual, schematic and intended. In our analysis repeated macropod characteristics were found to be primarily produced either in naturalistic style defined by quantitative attributes or perceptual style defined by qualitative attributes. Spatial analysis then revealed that variation in characteristic locations displayed bounded groupings, which, because of the repetitive bounding, we interpret as indicating stylistic markers.

The stylistic features we discuss here were produced by isochrestic choices, as well as active behaviour on the part of the art producers. For example, ears can be considered a part of naturalistic variation, for, when viewing a live macropod either one or two ears are visible. In the images analysed some portrayed both ears, while others portrayed only one. While it would be possible to have a convention whereby this and other differences could be used to distinguish between different species given their ecological requirements and consequent geographic distributions, we argue that the spatial patterning in the preference for depicting macropods with either one or two ears is best explained as caused by stylistic differences between these geographic spaces.

| Regions Tested | Variable Frequency | | Chi-squared Result | Significance |
|---|---|---|---|---|
| | Right | Left | | |
| NE | 53 | 85 | 18.55 | Very highly significant |
| NW | 77 | 41 | | |
| NE | 53 | 85 | 1.58 | Not significant |
| CE | 62 | 73 | | |

**Table 4a** Chi-squared analysis example for image orientations, showing NE and NW have very highly significant difference, and NE and CE have no significant difference.

As another example, the distinctive body shape of the oversized rump is considered perceptual variation. When these distinctive images were found to be spatially discrete in their distributions, we identified their characteristics as likely indicating stylistic variation. It might be possible that variation in metrical characteristics represents shape variation in different species, gaits or postures, but, as with the aforementioned ear example, it is very unlikely, for example, that this difference would be used to distinguish different species, or that being stationary is represented in one region and movement in another. The most parsimonious explanation is that some perceptual variation was shared by a group of producers. Even if our logic is wrong, the patterning apparent in spatially discrete regions both qualitatively and quantitatively was created by cultural choices, and, as a result, created a convention that we would call stylistic.

Finally, we can consider whether the spatial distributions of fine-grained stylistic features of macropod images are comparable to Capell's (1970) linguistic groups. First, north of the Hawkesbury and Macdonald Rivers, Capell claimed that a language boundary between the Guringai and the Darkingung existed at Mooney Mooney Creek. We found stylistic markers in body shape that crossed this suggested boundary, with greater numbers shown to extend to Mangrove Creek. We also found that the grouped design elements of arm, leg, ear and eye link Capell's Guringai and Darkingung groups from the coast to the McDonald River. Second, Capell identified the Guringai as one coastal group found both north and south of Broken Bay. Our Body Shape Group B was found in the north but not in the south, and the area is separated by two ears and two eyes in the

| Regions | NE | CW | CE | S | Design Elements |
|---|---|---|---|---|---|
| NW | Orientation | | Orientation | | Orientation |
| | | Ear | Ear | | Ear |
| | | | Eye | | Eye |
| | | | | Arm | Arm |
| | | | | Leg | Leg |
| | | | | | Mouth |
| | | | | Genitals | Genitals |
| | | | | | Paw |
| | | | | | Foot |
| | | | | | Tail |
| | | | | Hump | Hump |
| NE | | Orientation | | Orientation | Orientation |
| | | | Ear | Ear | Ear |
| | | | Eye | | Eye |
| | | | | Arm | Arm |
| | | | | Leg | Leg |
| | | | Mouth | | Mouth |
| | | | | Genitals | Genitals |
| | | | Paw | Paw | Paw |
| | | | Foot | | Foot |
| | | | | | Tail |
| | | Hump | Hump | Hump | Hump |
| CW | | | | | Orientation |
| | | | Ear | Ear | Ear |
| | | | | | Eye |
| | | | | | Arm |
| | | | | Leg | Leg |
| | | | Mouth | | Mouth |
| | | | | Genitals | Genitals |
| | | | Paw | Paw | Paw |
| | | | | | Foot |
| | | | | | Tail |
| | | | | | Hump |
| CE | | | | Orientation | Orientation |
| | | | | Ear | Ear |
| | | | | | Eye |
| | | | | Arm | Arm |
| | | | | Leg | Leg |
| | | | | | Mouth |
| | | | | Genitals | Genitals |
| | | | | | Paw |
| | | | | | Foot |
| | | | | | Tail |
| | | | | | Hump |

**Table 4b** Table of highly significant (p<0.01) results of chi-squared analysis.

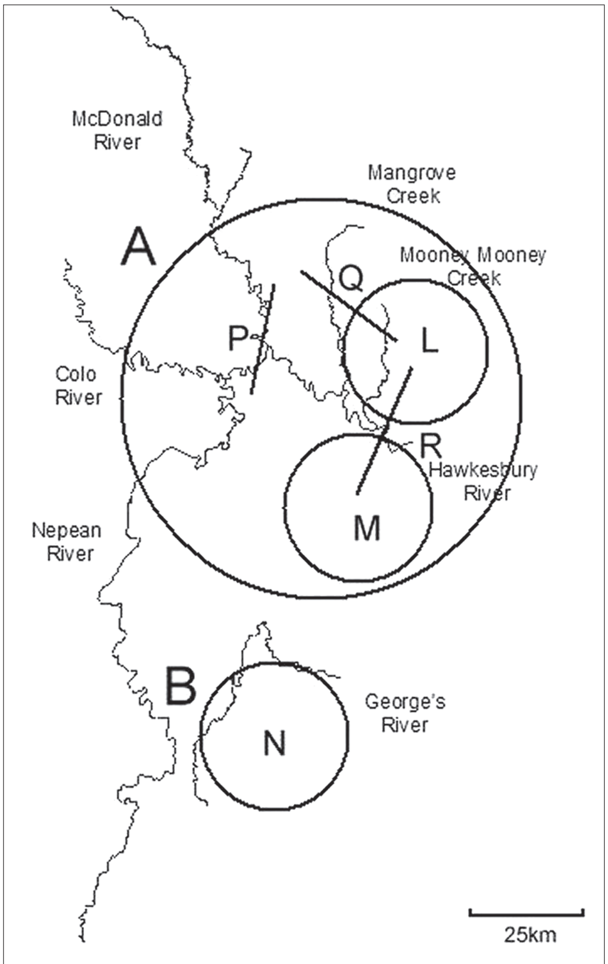



**Figure 10** Significant design element distributions grouped into stylistic regions.

| Region | Significant Design Elements |
|---|---|
| A | Arm 1, Leg 1, Mouth, Genitals, Striped Tail |
| B | Arm 2, Leg 2, Mouth No, Genitals No, Striped Tail No |

| | |
|---|---|
| L | Body Shape Group B, 1A1L1E0E, 1A1L1E1E, Paw |
| M | Ear 1, Eye 0 and 1, Paw No, |
| N | Body Shape Group A, 2A2L2E2E, Orientation Right, Ear 2, Eye 0, Paw No, |
| P | Orientation Right |
| Q | 1A1L2E0E, 1A1L2E2E, Ear 2, Eye 0 and 2, |
| R | Orientation Left |

**Table 5** Significant design element distribution grouped into the stylistic regions shown on Figure 10.

north and one ear and one eye in the south. However, the coastal area of the Guringai is grouped by the orientation of the macropods which look left or inland.

Our analysis confirms that macropod images show conventions that do not conform to boundaries suggested by Capell's linguistic research. Important questions are raised by these results, such as: are the linguistic boundaries identified by Capell really consistent with the available evidence?; do visual representations reflect a change in boundaries that occurred due to the colonisation process?; does the visual content relate to any language group distribution?; do attempts to fit art into predefined boundaries contribute to the understanding of multilayered patterns of cultural interaction?; and, finally, how can fine-grained studies be integrated with coarse-grained to uncover multilayered stylistic areas in other situations?

The purpose of this study was to determine if a fine-grained analysis of the macropod motif across the Sydney region would demonstrate similarities or differences when compared to previous studies of the area. By discussing the figurative representation of the macropod motif and how we ascertained an assessment at the fine-grained level, we demonstrate how stylistic representation is represented by naturalistic and perceptual characteristics of the macropod form. This fine-grained assessment ultimately complements previous regional stylistic studies, in that it reveals multilayered stylistic markers in the Sydney Basin. The methods we have outlined should allow further detail of stylistic distributions to be investigated.

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