The Palaeogeographic Significance of Local Endemism in Tasmanian Higher Plants

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There are seven centres of local higher plant endemism in Tasmania. The locations of the strongest of these centres are consonant with current ideas relating to the Quaternary environmental history of the state.

The concept of equiformal ranges (Hulten, 1937) suggests that groups of species with generally similar geographically restricted distributions are likely to occur in environments that may have been more widespread in the past. For example, the distributions of alpine species, except for any very recently evolved, must have repeatedly expanded and contracted in response to recurring glacial cycles. During interglacial periods they would have equiformal recessive ranges (Daubenmire, 1975) and at the onset of glacial periods they would exhibit equiformal progressive ranges (Hulten, 1937). Over a cycle of glaciation they would exhibit equiformal oscillating ranges (Kirkpatrick and Brown, 1984). It should be possible on this basis to use present-day distributional evidence to test theories of past environmental change.

While undertaking the mapping of the distribution of all Tasmanian endemic higher plant taxa (Brown *et al.*, 1983) and a numerical analysis of the endemic flora (Kirkpatrick and Brown, 1984) we became aware of the high degree of geographic restriction of many taxa. The present paper attempts to determine whether these restricted endemics exhibit patterns of equiformal ranges and to examine their possible palaeogeographic significance.

To determine the distribution of restricted endemics we used the 10 × 10km grid records in Brown *et al.* (1983), defined a geographically restricted species as one with both a north-south and east-west extent of no more than 100km (cf. Leigh *et al.*, 1981) and counted the number of restricted species in each grid square. Endemic subspecies (but not varieties) were included in the analysis.

A chi-square test of the goodness of fit to a Poisson series showed that the distributions of the restricted endemics are highly contagious ($\chi^2 = 460.8$, $p < 0.001$) i.e. there is a pattern of clumps or centres of local endemism. In proceeding to identify these centres, we modified our scoring of species to allow for the variation in the degree of genetic isolation of the taxa. A weighting system was used in which 1 = subspecies or species which has been observed to intergrade or hybridise with other species, 2 = species with morphologically similar Tasmanian relations and not observed to hybridise or intergrade with any other species, 3 = species with no morphologically similar Tasmanian relatives and not observed to hybridise or intergrade with any other species.

The analyses showed that 59 of the 300 endemic taxa had restricted distributions, and revealed seven centres of local endemism, which contained all but 11 of the geographically restricted taxa (Table 1, Figure 1). The species with no morphologically similar relatives were largely confined to centres 1 and 3. Four of the centres of endemism seem consonant with presently held theories of environmental change since the last Interglacial. Centre 1 is the southernmost part of the perhumid west of the state, where restricted endemics occur from sea-level to the highest peaks. The temperature drop and intensification of the westerlies widely suggested for Tasmania during the Last Glacial (Macphail, 1979; Bowden, 1983) could conceivably have extended the cool, moist and maritime environment now experienced in this area well to the north, and the drop in sea-level would have compensated for any loss of habitat to glaciers. The species in centre 3 (Table 1) have subalpine and/or alpine

FIGURE 1

Centres of local endemism (numbered) and the distributions of local endemics outside these centres. Grid squares containing more than two local endemic taxa are marked by a medium sized dot. Grid squares containing more than two local endemic taxa and with these taxa having *in toto* a score greater than 5 using the weighting described in the text are marked by a large dot. The distributions of those local endemics that do not occur at least partly within a centre of local endemism are shown by crosses.

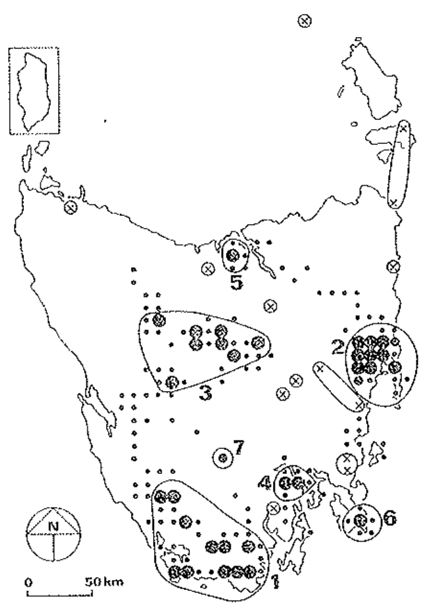

TABLE 1

Occurrence of restricted endemic taxa in geographic centres 1-7 (see Figure 1). Authorities for taxa are those given in Brown *et al.* (1983).

Centre 1	*Centrolepis* sp. *nova*, *Epacris stuartii*, *Gaimardia* sp. *nova*, *Geum talbotianum*, *Haemodorum distichophyllum*, *Lomatia tasmanica*, *Milligania johnstonii*, *Senecio papillosus*, *Senecio primulifolius*, *Sprengelia distichophylla*, *Trochocarpa disticha*.
Centre 2	*Acacia pataczekii*, *Epacris barbata*, *Eucalyptus barberi*, *Euphrasia collina* ssp. *deflexifolia*, *Helichrysum lycopodioides*, *Lasiopetalum micrantheum*, *Melaleuca pustulata*, *Pultenaea selaginoides*, *Spyridium microphyllum*.
Centre 3	*Capsella tasmanica*, *Centrolepis muscoides*, *Cyathodes nitida*, *Eucalyptus archeri*, *Euphrasia gibbsae* ssp. *microdonta*, *Gunnera cordifolia*, *Isolepis* sp. *nova*, *Milligania longifolia*, *Oreomyrrhis gunnii*, *Pimelea pygmaea*, *Ranunculus concinnus*, *Scirpus tasmanicus*.
Centre 4	*Caladenia atkinsonii*, *Eucalyptus morrisbyi*, *Eucalyptus risdonii*, *Euphrasia gibbsiae* ssp. *wellingtonensis*, *Monotoca linifolia*, *Prasophyllum concinnum*, *Senecio brunonis*.
Centre 5	*Epacris virgata*, *Pimelea filiformis*, *Tetratheca gunnii*.
Centre 6	*Epacris marginata*, *Euphrasia phragmostoma*, *Euphrasia semipicta*.
Centre 7	*Euphrasia gibbsiae* ssp. *pulvinestris*, *Schoenus pygmaeus*, *Viola hederacea* ssp. *curtisiae*.
Ungrouped	*Caladenia longii*, *Centrolepis pulvinata*, *Deyeuxia lawrencei*, *Helichrysum selaginoides*, *Helichrysum spiceri*, *Odixia achlaena*, *Phebalium daviesii*, *Prasophyllum truncatum*, *Pratia irrigua*, *Schoenus absconditus*, *Stackhousia gunnii*.

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distributions, but are confined to those relatively few places in the Tasmanian high country where soils are deep and largely free of rocks (Kirkpatrick, 1983). The depression of temperatures during the Last Glacial would have vastly extended the area with low summer temperatures and deep rock-free soils.

Geomorphic and palynological evidence has strongly suggested that effective rainfall during the Last Glacial was less in eastern Tasmania than at present (Sigleo and Colhoun, 1981; Bowden, 1983). The centre of local endemism at Great Oyster Bay (2, Figure 1) supports this suggestion, as it occupies the presently driest part of the east coast. Centre 4, at Hobart, also supports this suggestion, as the alpine area of Mt Wellington receives the least rainfall of any mountain in the state and the eastern shore of the Derwent is a strong local rainshadow. Nevertheless, the observed concentration of local endemics at Hobart may be partly attributable to its concentration of botanical collectors and taxonomists, especially in regard to the eucalypts and orchids.

The influence of relative density of collecting on the distribution of local endemics can also be imputed in the cases of the Tasman centre (6) and Mount Field (7). In the case of the Tasman Peninsula, the combination of a relatively fertile substrate, a high-energy coastal environment and high rainfall may not have been more extensive in the past than at present. The Tasman local endemics have not differentiated far from their local relatives, two of the three species involved being only recently described (Barker, 1982) in a genus characterised by local endemics. The three Mount Field taxa are also recently recognised, two at the subspecific level. Two of these taxa are likely to be found much more widely as collectors become accustomed to their differentiation.

The remaining centre of local endemism (5) is strongly associated with the ultramafic rocks of the Dazzler Range. The species involved may have evolved before the Last Glacial. If they did so they presumably occupied the same geological habitat during the cold and continental conditions that prevailed when Bass Strait was dry land. Thus, they could be expected to be able to tolerate much lower temperatures than prevail at present.

The patterns of local endemism in Tasmania are largely consistent with present perceptions of the Tasmanian environment during the Last Glacial and offer the opportunity for experimental verification of past climatic conditions in the case of the Dazzler Range endemics.

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Minimum Age for Desert Varnish in the Broken Hill Area, NSW: A Preliminary Estimate

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A manganese-rich varnish appears on fine-grained sandstone to the north of Broken Hill. Aboriginal rock engravings in the area have varnish coatings apparently similar to those on adjacent rock surfaces; in the absence of varnish redistribution, it is assumed that the period of varnishing postdated the engravings. A radiocarbon date of 7090 ± 310 years bp (SUA 2011) was obtained for calcium carbonate which partly encased a varnished stone. A conservative, corrected age for the carbonate would suggest a minimum of 5290 years for the engravings.

Desert varnish in the Eight Mile Creek area 80kms north of Broken Hill appears as a thin, shiny, dark reddish-brown to mainly black coating on the upper surfaces of many outcrops and loose stones. Aboriginal carvings frequently appear on the more extensive varnished surfaces, most carvings having varnish coatings apparently similar to their adjacent rock surfaces. Because of these similarities, it is assumed that a phase of varnishing occurred either during or after the period when engraving took place. This note provides an estimate of the minimum age of varnish which, although a preliminary result based on one sample, is of interest in the absence of reported dates for varnish in Australia and the importance of varnish as an age indicator for aboriginal rock art.

Anthropologists generally believe that varnished carvings indicate considerable, if indefinite, age (for example, Mountford and Edwards, 1963; Mountford, 1971; Bard *et al.*, 1978; Butzer *et al.*, 1979). At the Eight Mile Creek site, assessment of rock art technique (pecking or indirect percussion) and motif (predominantly representations of tracks and nonfigurative designs) has led to the carvings being designated 'Panaramitee Style', for which minimum ages of 5000 to 7000 years have been proposed (Maynard, 1979). A typology of these engravings is being developed by Clegg (1982) for comparing this rock art with that at other nearby sites. Apart from the date reported here, no age has been established for varnish or engravings at the Eight Mile Creek site.

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FIGURE 1

Location of carbonate-coated stone in relation to varnished and engraved rock surfaces within a portion of the EightMile Creek site: based on a map (approximate only) provided by J. Clegg, University of Sydney, who made tracings of engravings on all individual mapped outcrops.