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A history of biogeographical regionalisation in Australia

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Abstract

The development of Australian biogeographical regionalisation since 1858 has been driven by colonial 19th-century exploration and by the late 20th-century biodiversity crisis. The intervening years reduced existing large scale regionalisation into smaller taxon specific areas of vegetation or endemism. However, large scale biotic biogeographical regionalisation was rediscovered during multi-disciplinary meetings and conferences, sparking short-term revivals which have ended in constant revisions at smaller and smaller taxonomic scales. In 1995 and 1998, the Interim Biogeographic Regionalisation for Australia and the Integrated Marine and Coastal Regionalisation of Australia, Australian Commonwealth funded initiatives in order to "identify appropriate regionalisations to assess and plan for the protection of biological diversity", have respectively replaced 140 years of Australian biogeographical regionalisation schemes. This paper looks at the rise and slow demise of biogeographical regionalisation in Australia in light of a fractured taxonomic biogeographical community.

Key words: biogeographical regionalisation, biogeography, classification, colonialism, systematics, taxonomy

Introduction

In Australasian lands so wide,
By meadows green, and forests' side,
Strange and uncouth forms we see,
Bounding over hill and lea.

Kangaroos are gaily leaping,
Wombats through their burrows creeping;
And in deep streams, near sunny rocks,
The duckbill - Nature's paradox.

Their graceful plumes the lyre-tails spread,
And the penguin sits on her chilly bed,
While black swans in flocks are streaming,
And cockatoos and parrots screaming.—Newton, 1845

The history of biogeographical regionalisation[1] is both complex and confusing and largely unknown by taxonomists, covering a period of geographical exploration and scientific discovery. The study of Australia's flora and fauna was a new and bewildering subject for early 19th-century naturalists, who started to recognise the immense diversity of life and the sudden break between Asian and Australasian biota. Moreover, the development of mapping techniques, quantitative ways to catalogue new species and the mapping of new terranes added to the growing demand for information and knowledge about Australia's biodiversity. "How much diversity was there and how could it be classified?" were two of the main questions asked during this period (1805–1906). With the advent of evolutionary biology, new ways to explain the distribution of organisms shifted from classification to dispersal

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pathways independent of geographical processes (Browne 1983; Camerini 1993). Plant (phyto-) and animal (zoo-) geography changed from a science of mapping distributions[2], migrations and classification, to one of determining species endemism, centres of origin and dispersal pathways[3] (Schmidt 1954; Nelson 1978). Viewed theoretically and methodologically, plant and animal geography of the mid-19th-century became a different subject by the turn of the 20th-century.

Bioregionalisation is a concept first explored by Augustin Pyramus de Candolle (Lamarck & Candolle, 1805), who drew the first biogeographical map indicating the composition of floras, their boundaries, and the geographical processes determining their distribution (Ebach & Goujet 2006). Candolle used abiotic factors such as elevation (i.e., temperature), soil composition and drainage to compare floras (or "habitations") across a wide variety of areas with different climates. While this practice brought a method to biogeography, it failed to accurate identify areas globally[4]. In 1858 Phillip Lutley Sclater, like Robert Brown and others before him, made the same observation in comparing zoogeographical regions, but a method was never fully explored nor realised until the end of the 20th-century (see Nelson 1978; Sclater 1858).

Alfred Russel Wallace (1896) was one of the few naturalists during the early period of evolutionary biology to attempt a regionalisation or classification of the world's biogeographical regions. Unlike Candolle (1820), Prichard (1836), Schmarda (1853) and Sclater (1858), Wallace looked at all biotic regions, combining both animal and plant geography and starting a biogeographical legacy that still survived the 20th-century in the phytogeographical regions of Good (1964) and Takhtajan (1986), with a flurry of revisions occurring in recent times (see Parenti & Ebach 2009).

While most continents underwent revision after revision of biogeographical regions[5], Australia has had only four periods in which continental plant and animal regionalisation were attempted. These four periods reflect the increasing knowledge of Australia's natural history, from the early naturalists (which 19th-century naturalist, Charles Hedley, wholeheartedly dismissed)[6], to the 2000s in which vast amounts of animal and plant distribution data are housed in digital databases (e.g., Atlas of Living Australia: http://www.ala.org.au/).

Australia's history of biogeographical regionalisation can be divided into what one might call the Colonial Period (1820–1910s), iconic for human expansion in the form of exploration and the first colonial surveys[7]; the Post-Federation Period (1920s–1940s), where the first national biological surveys, revisions of regionalisation and taxon specific studies took place; the Ecogeographical[8] Period (1950–1980s) signified by the first modern ecological analyses and increased knowledge of Australia's interior and, the Systematic Period (1980s–2000s) marked by the widescale use of numerical methods and attempts at comparing different areas (see Ladiges *et al.* 1991). Strangely, Australia's first and only attempt at a complete biotic regionalisation was undertaken by the Australian Government as late as the mid-1990s, and independently of concurrent biogeographical research. Since the establishment of the Interim Biogeographic Regionalisation for Australia (IBRA) in 1995 and the later Integrated Marine and Coastal Biogeographic Regionalisation of Australia (IMCRA) in 1998, some attempts have been made to revise the work using earlier regions (e.g., Waters *et al.* 2010, Millar 2007). Unlike research programs in South America, Europe and North America, Australia has lacked an active program in biogeographical regionalisation, despite its vast biological diversity, a large community of biodiversity researchers and large biological specimen databasing projects. A reason for this may be the demise of the Australian and New Zealand Association for the Advancement of Science (ANZAAS) Congress, the last being held in Adelaide in 1997 (Pockley 1997: 532)[9]. In addition to presenting the history of biogeographical regionalisation, a short socio-historical account of phyto- and zoogeography in Australia between the early 19th-century and the early 2000s will also be made.

Phytogeographical regionalisation between the Colonial and the Ecobiogeography Period.

Floras are invariably divided into climatic or ecological regions, reflecting the temperature, hydrology and soil types of a particular area, an idea fundamental in 19th-century regionalisation.

Although Augustin Pyramus de Candolle (1820) linked his floristic distributions to elevation and climate, an idea, however, that was abandoned by his son Alphonse in favour of species endemism (Nelson 1978). Regardless, A. P. de Candolle's regionalisation work did influence further regionalisation studies in the 19th and 20th-century, and specifically (for our purposes) in the work of naturalists working on Australian flora.

Probably the first phytogeographic classification of Australia was proposed by Ferdinand von Mueller 1858 in his 'Botanical Report on the North-Australian Expedition, under the command of A. C. Gregory, Esq[10].' While von Mueller's classification is that of vegetative types (rather than of floristic regions), it still relevant to the question of how a large continent such as Australia was thought of in terms of phytogeographic areas.

> "It would lead beyond the limits of this document to contemplate the botany of the country in its full details, but I may sketch the principal distinctive features of the vegetation, which in a comprehensive view can be divided into the following groups:
>
> 1. Plants of the dense coast forests.
> 2. Plants of the Brigalow scrub[11].
> 3. Plants of the open downs.
> 4. Plants of the desert.
> 5. Plants of the sandstone table-land.
> 6. Plants of the sea-coast.
> 7. Plants of the banks and valleys of rivers" (von Mueller 1858: 146).

Unlike the large-scale botanical regionalisation of de Candolle and zoogeographers such as Schmarda, von Mueller like many of his contemporaries, divided Australia into regions of vegetation (sensu "stations[12]") — that is, areas defined by environmental parameters other than latitudinal climatic barriers (see below). One reason for his doing this was that Australian vegetation varied substantially along a single latitudinal gradient, such as the Tropic of Capricorn. British naturalist Joseph Hooker saw no distinct geographical feature, instead deferring to a latitudinal gradient:

> "[t]here are no geographical or other features of the Australian continent which enable me to draw any natural boundary between temperate and tropical Australia. In selecting a botanical tropic of Capricorn, I hence have had recourse to the distribution of the plants themselves, and these must afford very vague data" (Hooker 1859: xxxviii).

The botanical observations for example, of explorer and politician Sir George Grey, north and south of Shark Bay in Western Australia as a potential geographical marker for the tropic of vegetation was rejected by Hooker,

> "The parallel of Sharks [sic] Bay, I have hence assumed to be north of the position of the tropic of vegetation [...] In determining what may be called the tropic of vegetation, regard must be had not only to the latitude and isothermal lines, but to the abundance of the vegetation and its character" (Hooker 1859: xxxviii).

Hooker however referred readers to von Mueller's seven regions, the latter "the banks of the northern rivers, which, however, seem scarcely to afford a peculiar vegetation" (Hooker 1859: xl).

In 1882, however, von Mueller didn't refer to his earlier vegetative designation. Rather:

> "The geographical limitations in this work coincide with the political boundaries of the colonial territories, except that the tropic of Capricorn eastward to the 188th degree separates what is here called Northern Australia (N.A.), from the South- and West-Australian extratropic possessions. Such geographic segregations are necessarily quite arbitrary, though they serve our present purpose of assigning to each of the colonial divisions of Australia its number of specified plants; the limitation is the same as that adopted in the Flora Australiensis, and as regards abbreviations also identical with the method of indications, chosen for the list of Australian trees in 1866" (von Mueller 1882: viii).[13]

The unambiguous latitudinal gradients used by Candolle to designate between areas such as the Neotropical and Nearctic, failed to distinguish between distinct biotic areas across Australia. However, it was Ralph Tate (1889: 315), an English-born naturalist, who was the first to divide the Australian flora into three regions:

"1. Euronotian (lit. south-east wind) dominant in the south and east parts of the Continent.
2. Autochthonian (lit. of the original race) restricted to the south-west corner of West Australia and approximately coinciding with the rain-fall limit of twenty inches[14].
3. Eremian[15] (lit. desert) dominant the dry region, which has its centre in the Lake Eyre Basin [...] It is bounded on the north and north-east by the Indo-Australian vegetation; on the east and south-east by the typical Euronotian Flora, and on the extreme south-west by the Autochthonian" (Tate 1889: 315).

Interestingly, Tate included two 'immigrant' elements, Oriental and Andean, as having representatives living in Australia. The latter was confined to the alpine areas of southeastern Australia and Tasmania[16]. Most important however was Tate's reference to von Mueller (1882),

> "To draw the species into physiographic and regional complexes must be the work of future periods, when climatic and geologic circumstances throughout Australia shall have become more extensively known" (von Mueller in Tate 1889: 312).

In Tate's Presidential address to the Australian and New Zealand Association for the Advancement of Science (ANZAAS) 'On the influence of physiographic changes in the distribution of life in Australia'. Tate continued:

> "I propose to make a beginning in the direction indicated by the foregoing citation, which of necessity concerns the geologist equally well as the botanist; believing, that however crude and imperfect our first efforts may be, they may nevertheless incite to further enquiry into all the circumstances involved and thereby advance to the attainment of our object more rapidly than if we permit the subject to be dormant until the said circumstances have been fully mastered independently" (Tate 1889: 312).

Tate emphasised the role of geology in natural history, a stark contrast to later 19th-century phytogeography, which was predominantly about physiological and adaptational processes. Regardless, Tate's regionalisation was most evident in its dependency on climate as the mechanism for the distribution of Australian flora (Fig. 1)[17].

Oscar Drude (1890) had a similar approach to that of von Muller. Ignoring Tate's regionalisation, he divided Australia's flora into 11 regions of vegetation, namely,

> "North Australian region, Tropical Forest region, Queensland evergreen Araucaria and Livistona Forest region, North Australian Tree Savannah and Bushland region, Northwest Australian Transition region, West Australian Desert Steppe, East Australian Desert and Grass Steppe, Southwest Xerotide and Proteaceae region, South Australian Eucalyptus Forests, South Australian Eucalyptus and Fern region, the Mountain and Snow region of the Australian Alps, the Tasmanian Conifers, Grasslands and Mountain forest region" (Drude 1890: 499–502, my translation).

Drude's division was dependent on vegetation types and micro-environments (e.g., Desert Steppes) rather than general climatic regions. Drude's regions of vegetation were more typical of late 19th-century vegetative provinces rather than floristic regionalisation, as further exploration and collection has given way to greater knowledge of environmental conditions and physiological adaptations of plants to each region. Early evolutionary thought such as adaption and selection also plays a role, although minor, in determining regions. Take for instance Ludwig Diels' volume on 'Die Pflanzenwelt von West-Australien', in Engler and Drude's 'Vegetation der Erde', in it Diels (1906) discusses the climate, ecology, geology and geomorphology of Western Australia as well as the systematics, physiological attributes and development of the plants themselves. However, unlike Drude (the series editor) Diels divides Australia into nine Formations of vegetation[18]:

> "1. Tropical Rainforest, 2. Subtropical Rainforest, 3. Sclerophyll Forest, 4. Savanna Forest, 5. River Woodlands, 6. Beach Forests and Bushland, 7. Savanna, 8a. Mulga Scrub, 8b. Sub-littoral Sclerophyll Bushland, 8c. Heathland, 8d. Mallee Scrub, 8e. Brigalow Scrub, 9. Desert" (Diels 1906: 3–26, my translation).

Diels went on to add three regions to signify the mountainous areas, namely 'Bellenden Ker Mountains' and the 'Southeastern Highlands', as well as three floristic elements, the Antarctic, Melanesian and Australian. He was, however, less convinced of rigid or well-defined regions of vegetation[19]:

> "The description of vegetation formations within the floral elements of Australia leads us to believe that Australian plant geography cannot simply be divided into eastern and western halves as it is presently assumed to be [...] When Drude, for example, defines eleven "regions of vegetation", I think he has gone too far because the distinction between these subdivisions start to fade [...] Three provinces of very uneven distributions are the primary divisions of the Australian floral kingdom: East Australia, Eremaea and southwest Australia" (Diels 1906: 38, my translation).

Although Diels' regions of vegetation were similar to Tate's Autochthonian, Euronotian, and Eremaen[20] regions, the former two terms were ignored (see below).

Between the Colonial, Post-Federation and Ecobiogeography Periods, phytogeographical regionalisation concentrated on local regions, particularly Western Australia (Gardner 1944; Gardener & Bennets 1956; Beard 1980), Northern Territory (Specht 1958) and New South Wales (Beadle 1948). The intervening period was marked by the 1939 Presidential Address at the ANZAAS Congress by Professor George Edward Nicholls, who gave a summary of biogeographical regionalisation of Australia,

> "Wallace long ago called attention to the distinctive characters of the Faunas and Floras of Eastern and Western margins of Australia, and Hooker insisted on the primitive nature of the botanical facies of the West. It is, however, to Tate that we owe the first attempt at an actual marking off of the Australian biogeographical region provinces. According to that author, there was to be recognised an ancient endemic flora, restricted now to a relatively small south-western corner of the continent and, believing that in this areas there persists an unchanged remnant of a flora of which all Australia had been the cradle, Tate proposed for it the name Autochthonian" (Nicholls 1933: 94).

Nicholls' address was the first regionalisation of both the Australian flora and fauna. Rather than redefining these areas, Nicholls (a zoogeographer) reconciled both floristic and faunistic distributions into Tate's zones[21], by systematically going through all animal groups found in Western Australia. Such an approach however required caution,

> "In an attempt at generalization from such a set of facts as have been brought together in this survey it behoves on to go cautiously. There are numerous pitfalls in the path of the zoogeographer. For all but the specialist, in any given group, the actual identity or distinctness of named forms is frequently in doubt; in different orders, genera may come to have widely different values. The supposed facts of present day (or recent) distribution may prove to be insecurely based, locality records for material collected, for example, in the early days of Australian colonies being frequently vague, often quite erroneous" (Nicholls 1933: 131).

Nicholls was very cautious indeed. He did not create any new regions himself, unlike practicing phytogeographers in the Ecogeographical period. However, this changed with perhaps the most influential phytogeographical work on regionalisation during the Ecogeographical Period.

Nancy Burbidge, botanist at the National Herbarium in the Australian Capital Territory, created a new and perhaps longer lasting biogeographical classification based solely on climate,

> "Treated broadly the continent can be divided into three main climatic zones and these are referred to here as the Tropical, Temperate, and Eremaean Zones [Fig. 2]. The boundaries between these Zones are not always sharp, owing to differing tolerances of characteristic genera but it is hoped that the data presented will serve to justify their delineation as phytogeographic units. Each of the Zones shows floristic characteristics related to geography and it is interesting to find that they correspond with the main features of the zoogeographic 'regions' recognized by Main, Lee, and Littlejohn (1958[22])" (Burbidge 1960: 78).

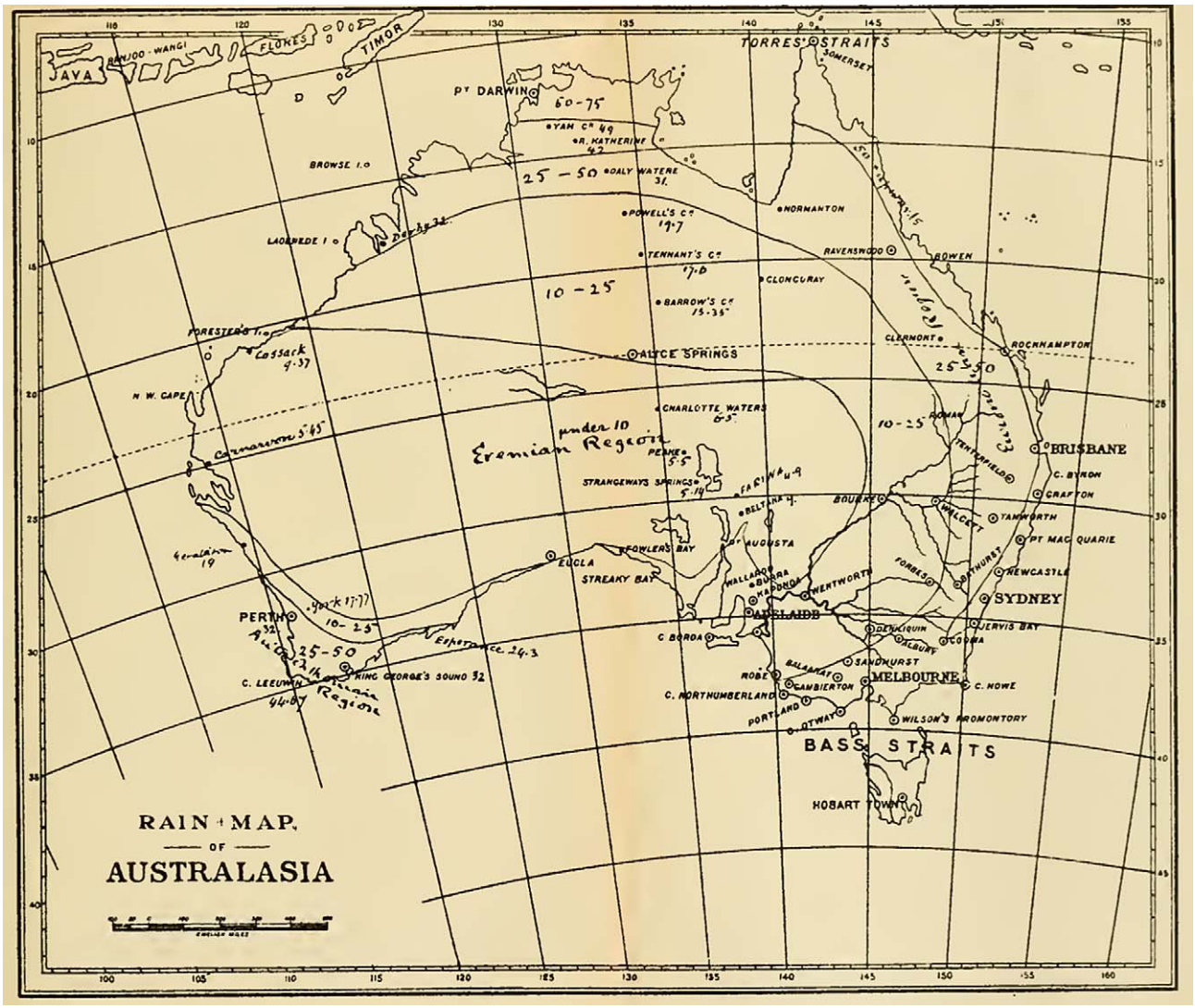


FIGURE 1. Tate's regions superimposed on a 'Rain Map of Australasia' (Tate, 1889, Plate XVIII).

Burbidge, like most contemporaries working on phyto- and zoogeography during the 1960s, rejected the idea of continental drift, focusing instead on explaining distribution patterns[23] in an Australia fixed to present day latitudes and longitudes (see Ladiges 1998). This meant compromising the three interzone areas and three 'focal areas' (see Fig. 3). In addition, Burbidge coined the McPherson–Macleay overlap zone and area of overlap between the temperate and sub-tropical regions,

> "Floristically the most interesting areas are the South-West Province of Western Australia as defined by Gardner (1944), Tasmania, and the MacPherson - Macleay [sic] Overlap" (Burbidge 1960: 79).

It is interesting to note that Burbidge included Tate's (1889) Eremean but ignored his Autochthonian Element as a separate zone (in favour of Gardener's South-West Province), rather synonymising it to the 'Australian Element'. This designation was strange as Tate referred to the Autochthonian Element as "restricted to the south-west corner of West Australia and approximately coinciding with the rain-fall limit of twenty inches[24]". Tate's Elements, like Burbidge's zones were both based on climate. So how were Burbidge's zones different from Tate's elements?

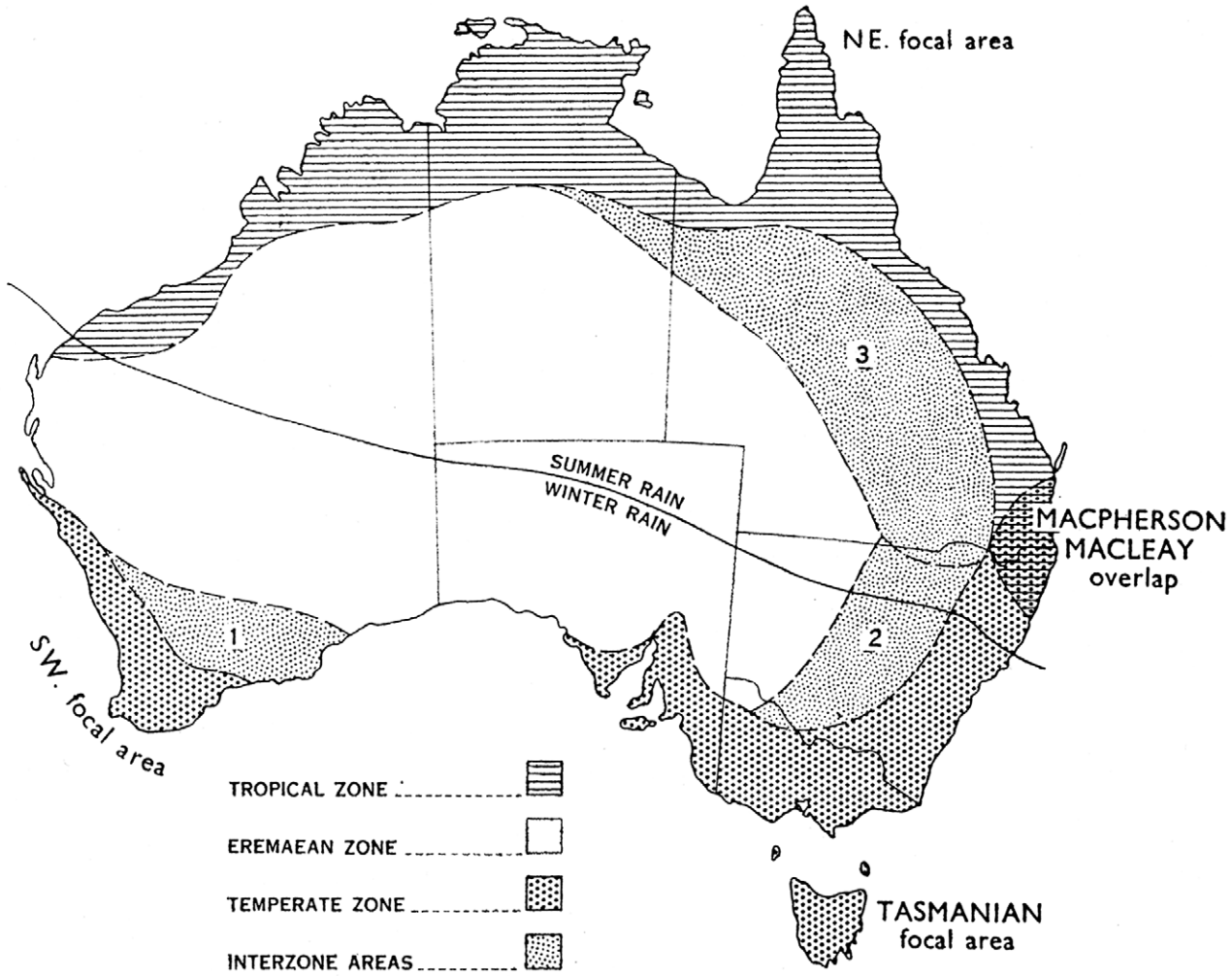


FIGURE 2. Burbidge's zones (Burbidge, 1960, fig. 1). Note the north-south and east-west division. [Reproduced with permission of CSIRO Publishing, Australia.]

It appears that Burbidge's provinces and zones were based on elements and climate respectively. Perhaps it is happenstance that both Tate's Autochthonian overlapped with Gardner's 'South-West Province', which is "distinguished floristically by the rich development of Australian and Antarctic Elements" (Gardner, 1944: xli) with Australian Elements having migrated in from the north and Antarctic Elements originating in the southern hemisphere. Given this, it is difficult to explain Burbidge's usage of the term 'Autochthonian' to signify Australian Elements. Tate referred to the 'Australian Element' as including the Autochthonian, Eremaen and Euronotian. Burbidge missed this earlier regionalisation in Tate's 1889 presidential address, referring rather to Tate (1890) in which the Autochthonian Element was never[25] mentioned. What is more, Main *et al.*'s similar usage of Tate's Autochthonian Element was also ignored, a classification that Burbidge compared to her own. Burbidge's own usage of 'Autochthonian' as 'Australian' indicates that she most likely did not know of Spencer's usage and Diel's objections to the term Autochthonian[26]. So why the term was used by Burbidge at all is puzzling[27].

Burbidge's one new area, the McPherson–Macleay Overlap Zone (MMOZ), still appeals to 21st century biogeographers (e.g., Colgan *et al.* 2009; Crisp *et al.* 2001; Ladiges *et al.* 2003). The overlapping nature of the MMOZ means that it does not fit into a formal regionalisation, much like the Mexican Transition Zone, which includes both Neotropical and Nearctic elements. The Mexican Transition Zone has not, however, stopped biogeographers from regionalising Mexico into discrete non-overlapping areas (see Escalante *et al.* 2007). But the MMOZ is problematic, in an analytical sense, because it is designated as a single discrete area (sensu Burbidge 1960), meaning that it is not unique within a formal classification and can share elements equally with two separate regions.

A large proportion of regionalisation was confined to either, Australian states and territories (e.g., Clarke 1926; Gardener & Bennetts 1956; Cameron 1935; Anderson 1947), or areas of vegetation (see Beard 1981). The last attempt at a major phytogeographic regionalisation of Australia within the Ecogeographical Period was made by Doing (1970a,b; see Beard 1981) before the popular works of Udvardy (1975) and Takhtajan (1986).

Henk Doing was a Dutch plant taxonomist based at the former University for Agriculture in Wageningen (presently the University of Wageningen), who had spent "5 memorable years with the C.S.I.R.O at Canberra". His "explorations of the Australian flora were guided during these years by Miss Dr. N. T. Burbidge, Mr. M. Gray and Dr. R. D. Hoogland" (Doing 1970b: 96). The achievement of Doing's work was to produce possibly the first comprehensive hierarchical classification of Australian flora: in his 'Botanical geographical map of the Australian Plant Kingdom', which he credited to "Williams' (1955) map of 'vegetative regions' of Australia than to any other map", though the map was based on a "mixed criteria of flora and vegetation" (Doing 1970b: 86). The 'Australian Kingdom' was divided into the Central Australian and the Eucalyptus sub-kingdoms[28] and seven regions (Desert, Mulga, Northern Savanna, Southeastern Savanna, Mallee, Eastern Forest and Southwestern Forest Regions). The regions together contained 21 Provinces, each identified by an endemic species (Fig. 3). Unfortunately Doing's map was ignored by most Australian phytogeographers, the only mention being in Barlow (1984) and Beard (1981), the latter who considered Doing's work as an advance on Burbidge, which, he asserted, broke down in places. Moreover: "[h]is nomenclature, boundaries, and the descriptions of vegetation of the provinces are open to objection and suggest both inadequate consultation of available sources and inadequate knowledge of the country by the author" (Beard 1981: 346).

Beard's objections reflected his own work, in which,

> "[t]he mapping thus established exact boundaries for the regions and later when the vegetation maps were published these boundaries were marked on them. For the most part they coincide with the boundaries of vegetation units and only rarely are drawn to cross open country. This method greatly reduces the element of subjectivity in the definition of regions which are normally quite clearly apparent from the map itself. It is not practicable to illustrate examples here, but those interested may refer to the published work: the map of 'Nullabor' (Beard, 1975) gives particularly clear cases" (Beard 1981: 348).

Doing (1970a,b) may have been an advance on Burbidge, but according to Beard's objections, so was Diels (1906). Burbidge's division of Australia into Tropical and Temperate zones smacked of the "little or no personal knowledge of the continent", which was lacking in Hedley's "earlier naturalists". Could Doing, rather than Burbidge, have produced the seminal work of Australia's phytogeographical regionalisation within the Ecogeographical Period? Certainly there were no further phytogeographical regionalisations during this period and none that covered the whole continent, other than vegetation maps (e.g. Carnahan 1976; see Beard 1981).

Zoogeographical regionalisation between the colonial and Ecobiogeography Periods

The zoogeographical regionalisation of Australia was started by the Reverend Julian Edmund Tenison-Woods (1878)[29], an English born priest and naturalist, who divided Australia into three provinces based on echini (sea urchins): "1. The N. Eastern. 2. The Eastern. 3. The Southern". However, "I do not deal with the Western fauna, for I know so little of it, that my remarks would posses no value" (Tenison-Woods 1878: 147)[30]. Tenison-Woods, never refers to this classification again, rather creating a new one in 1882, in which he divides Australia into seven zoogeographical sub-provinces:

> "A. the Neo-cambrian, or the south-eastern, including none of the south-coast; B, the Tasmanian, including Victoria; C, the Adelaidean, including the coast and watersheds of the colony of South Australia; D, the western, from the boundary of South Australia to Perth; E, the north-western, and taking in the western half of the north coast; F, the north-eastern, comprising the eastern half of the north coast and the northern half of the east coast [; G,] The Central, comprising all the inland waters and central regions[31]" (Tenison-Woods 1882: 48–49).

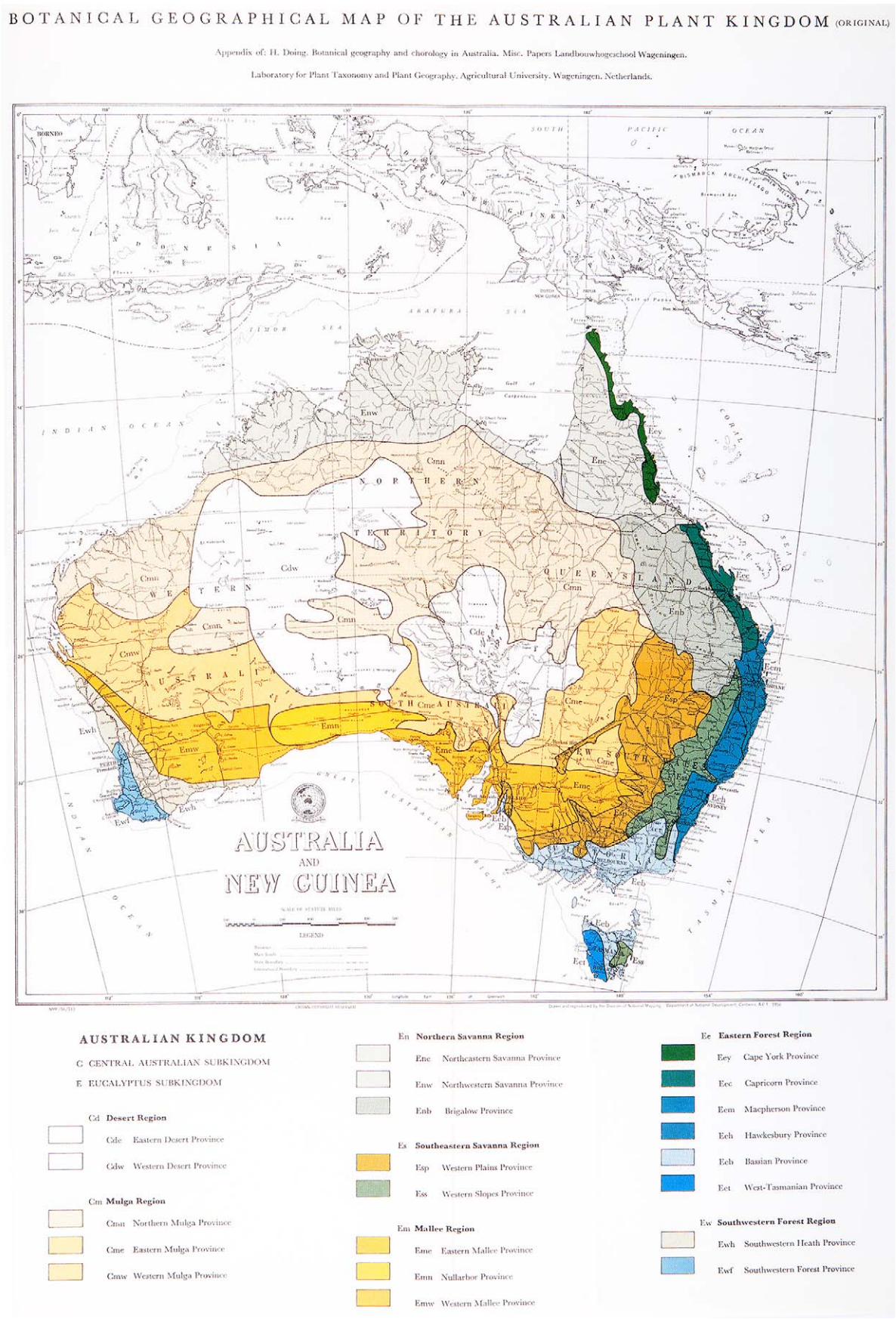
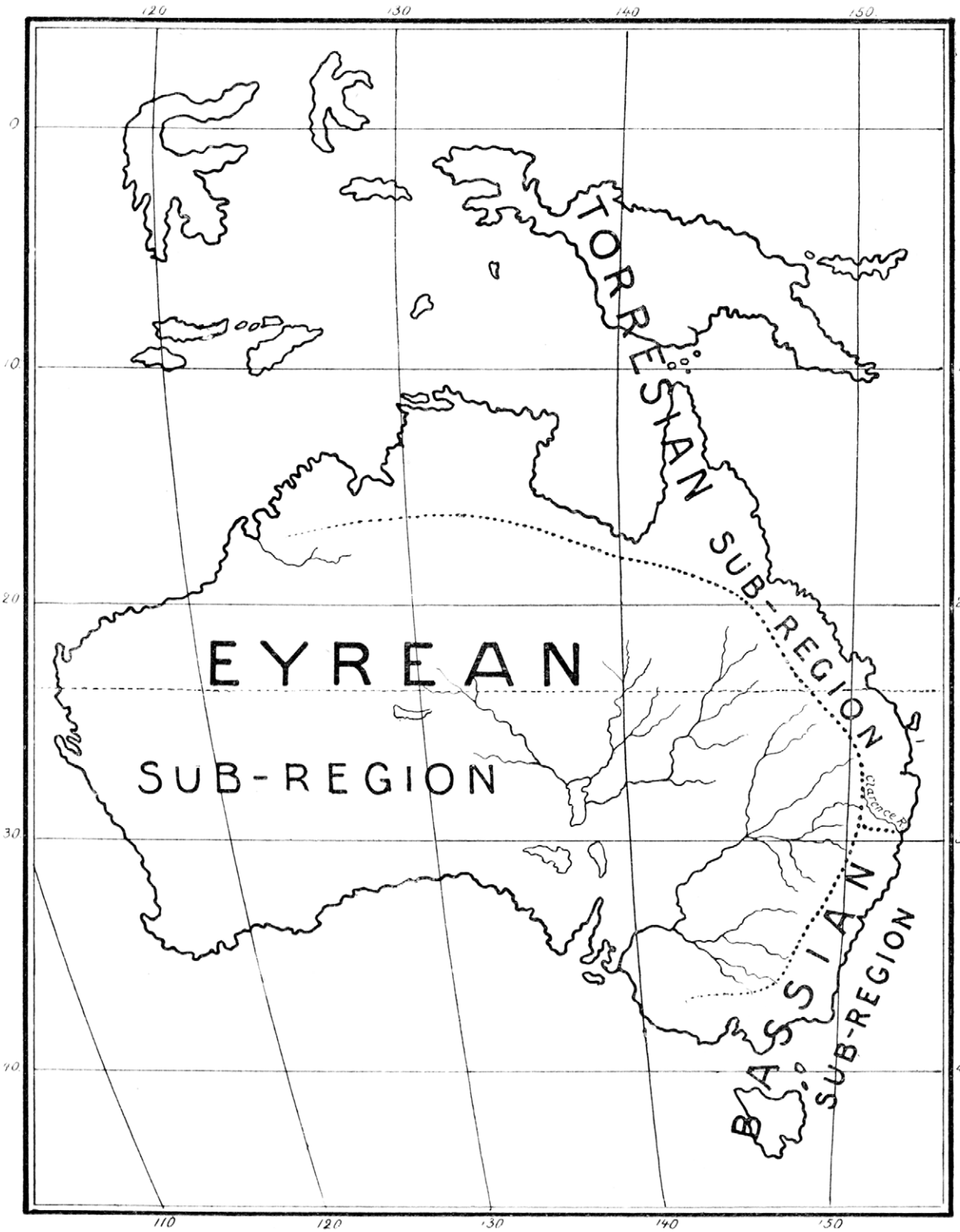


FIGURE 3. Doing's (1970) 'Botanical geographical map of the Australian Plant Kingdom', possibly the first hierarchical classification of Australia's flora. [Reproduced with permission of Wageningen University.]



FAUNAL SUB-REGIONS OF THE AUSTRALIAN REGION.

FIGURE 4. Spencer's (1896) 'Faunal sub-regions of the Australian region'.

Tenison-Woods believed that the sub-provinces, although intended for animals, also had representative forms in the flora. Unfortunately however Tenison-Woods does not follow either classification further, nor does he use any of

these terms in relation to animal distributions. The only other mention of regions occurs later in a 100 page study of Australian molluscs[32] in which he considers Australia a separate zoological region,

> "In the seas and in the rivers, in other departments of the Animal Kingdom multitudes of marvels meet us, all of so striking an anomalous kind, that Australia well deserves to be considered a Zoological region, singularly apart from the rest of the World [...] Australia is entitled to be considered as a true Molluscan province with peculiar features, and yet not separated in an extraordinary way from Molluscan provinces elsewhere. (p. 183)" (Tenison-Woods 1888: 106–107, 183).

In the same work, Tenison-Woods also refers to the "Australian Molluscan Province" which he divides into three Molluscan sub-Kingdoms: Marine Mollusca, Fresh-water Mollusca and Land Mollusca "[t]his division, which is of course not zoological, is more convenient for me, for reasons which will appear as we proceed" (Tenison-Woods 1888: 112–113). Why he created these sub-Kingdoms is not clear, other than eluding to that molluscan faunas change with changes in coastal habitat.

However, not much is said of Tenison-Woods Australian province and sub-provinces in the later zoological literature, probably because his "... scheme is neither natural nor well-defined, and has been overlooked by Tate, Spencer and other writers on Australian zoogeography" (Hedley 1904: 880)[33]. Tension-Woods classification is simply left hanging at the end of his essay - it is accompanied by no further explanation or map, nor are his these areas ever referred to again.

Rather, it was Charles Hedley, also an English born naturalist specialising in molluscs, who in accepting "[Tate's] two main biological divisions" created the first widely accepted zoogeographical classification. Hedley's areas included "... the Autochthonian, developed in west Australia, and the Euronotian, seated in eastern Australia and Tasmania; a subsidiary, less in value and derivable from both above, is the Eremian, or desert fauna and flora" (Hedley 1894: 444, original emphasis). This subdivision Hedley assured us was not the crude east–west divide of earlier naturalists,

> "[m]ost European writers who have touched on the zoo-geography of Australia have described the fauna and flora as falling into a temperate and a tropical division, which again subdivide into eastern and western sections. A little real experience proves these divisions to be quite artificial" (Hedley 1893: 189, also reiterated in Hedley, 1894: 444, see above).

Other than the Eremian, both the Authochthonian and Euronotian are extensions of the east–west divide. But Hedley may have been referring to much earlier attempts at regionalisation:

> "The discrimination of the various provinces into which the Australian fauna and flora group themselves has been frequently attempted. To the earlier naturalists, from a study of scanty material and with little or no personal knowledge of the continent, four divisions of east and west, temperate and tropical, seemed natural and sufficient" (Hedley 1894: 444).

Hedley's sentiment was reflected in part in Baldwin Spencer's contribution to the 'Report on the work of the Horn Expedition to Central Australia' in 1896, in which he divided the Australian region into three subregions: Torresian, Eyrean and Bassian (Spencer 1896: 196–199). Each sub-region was described in some detail and mapped (Fig. 4):

> "Torresian sub-region. This includes Papua and north and north-eastern Australia as far north as the Clarence River. On its north-western side it merges as might be expected to a certain extent into the western area [...] The Bassian sub-region. This includes the eastern and south-eastern coastal strip, lying between the coast line and the Dividing Range south of the Clarence River, and also Tasmania. On the mainland it naturally merges to a certain extent, where the dividing Ranges falls away at its western end, with the fauna of the interior but in the main it is strikingly dissimilar to this [...] The Eyrean sub-region. This includes the whole of the interior, southern and western part of the continent, the coastal region on the east and south-east separating it from the Torresian subregion in the north-east and the Bassian sub-region in the south-east" (Spencer 1896: 196–199).

The new regionalisation of Spencer was essentially a reworking of Tate's classification with Hedley's modifications. The Papuan and Eurotonian regions were relabelled as Torresian[34] and Bassian (after Bass Strait) respectively and, the Eremian and the Autochthonian (also known as Hesperontian)[35] were both replaced by Eyrean (after Lake Eyre). Spencer however did not specify exactly what it was that separated the Eyrean from "Torresian subregion in the north-east and the Bassian sub-region in the south-east".

While Spencer seemingly carved the names of Australian terrestrial areas in stone, Hedley (1904) was the first zoogeographer to classify Australia's marine areas, dividing the Australian coastline into four sub-regions (Fig. 5):

> "The marine fauna which extends from Melbourne along the south coast of Australia, and which was early elaborated in the neighbourhood of Adelaide by the researches first of G. F. Angas, and then of R. Tate, I now propose to distinguish as the Adelaidean Fauna[36]. The marine fauna of the east coast of Tasmania, Gippsland, and New South Wales I propose to call the Peronian Fauna, in allusion to the famous French naturalist who sacrificed his life to his work on Australian zoology [...] To these names I might take this opportunity of adding the Damperian for the marine fauna which extends from Torres Straits to Houtman's Abrolhos; and the Solanderian for the marine fauna of the Queensland coast from Moreton Bay to Torres Strait" (Hedley 1904: 880).

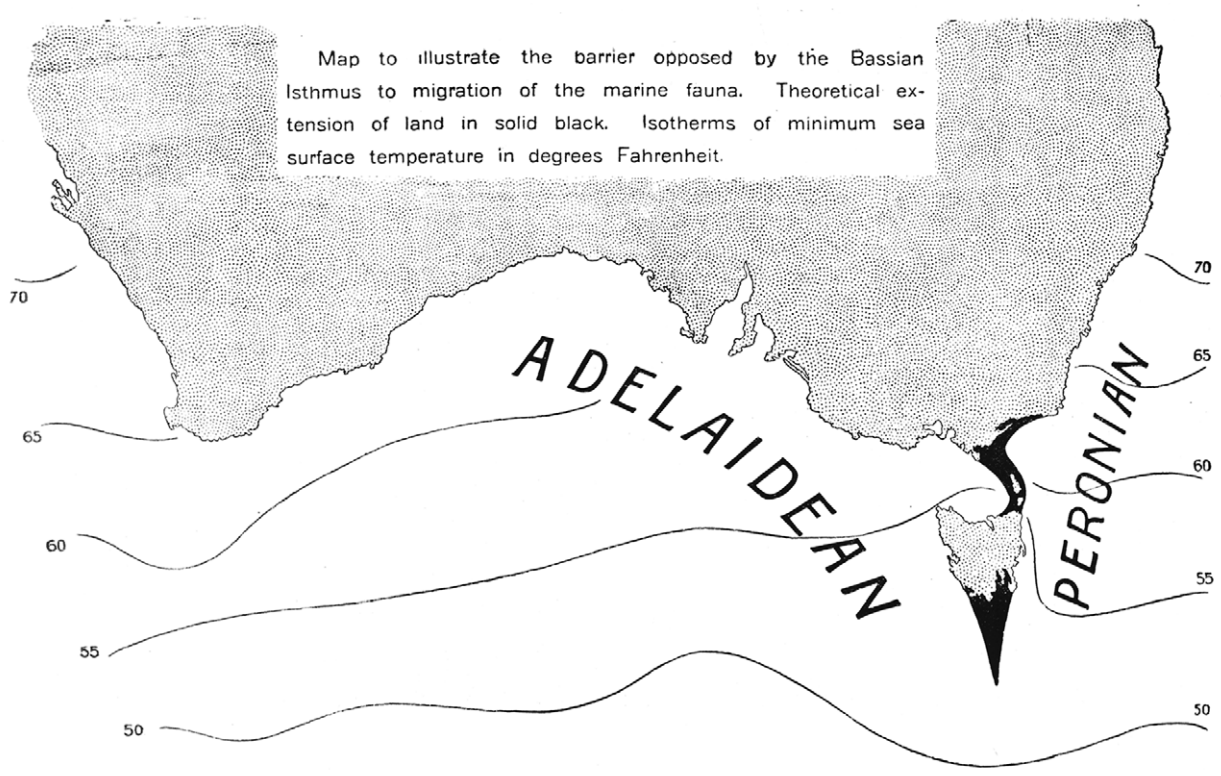


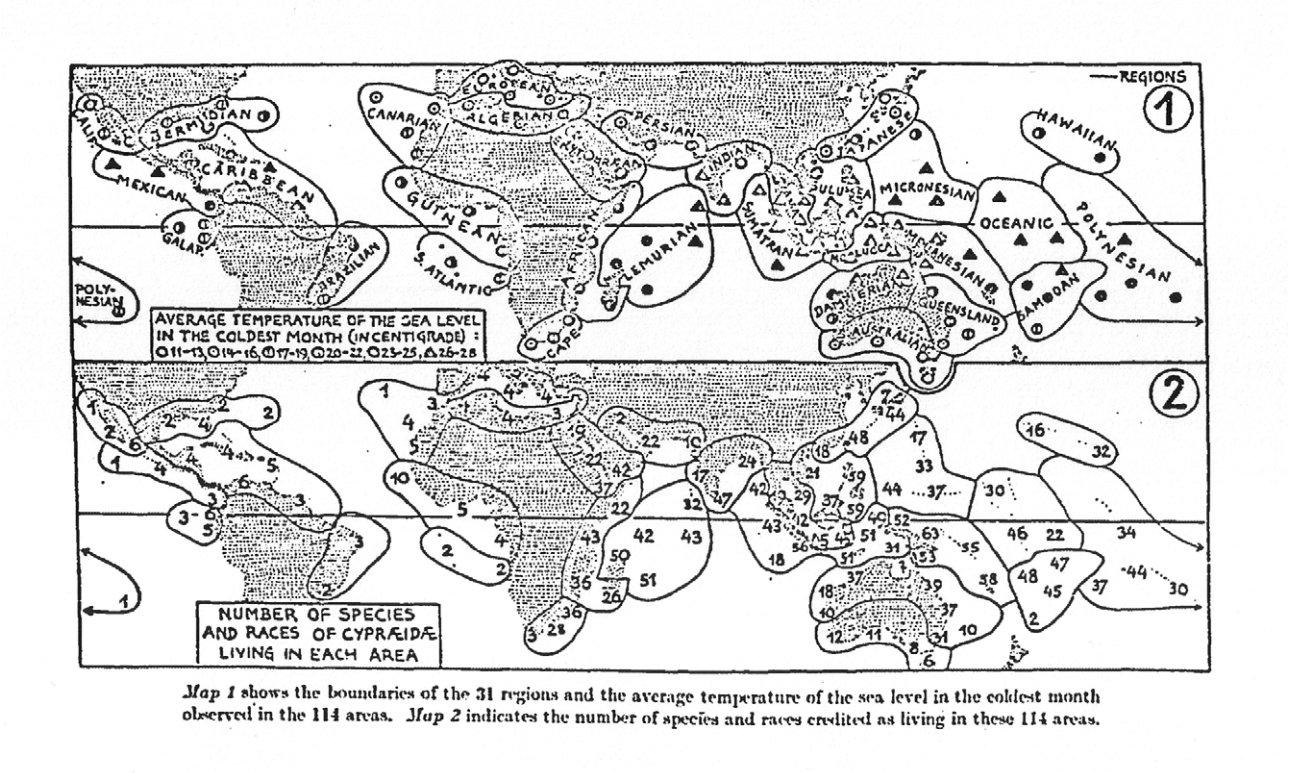
FIGURE 5. The Adelaidean and Peronian marine regions of Hedley (1904).

These regions were adopted and used primarily in the Australian molluscan community, an area to which Hedley contributed (see Walker 1981, Smith 1984).

Outside the country, distinct Australian marine regions were not recognised. For example, in Edmond Perrier's 'Étude sur la répartition géographique de astérides', four regions are recognised: Indo-Pacific, Indian, Sino-Japanese and Australian, while "... we do not know anything about the Austral and the Antarctic regions, which undoubtedly have their own special fauna" (Perrier, 1878: 108, my translation). Within Ortman's chapter on 'Die marien theirgeographischen regionen', Australia was placed in the Indo-Pacific region, denoted as "sehr einheitlich" ("very homogeneous" Ortmann 1896: 60). Ekman (1935) divided the southern marine regions of Australasia and northern Australasia into 'warm-antiboreal (south Australian [and] New Zealand)' and 'tropical Australian' respectively.

In their 'Prodrome of a Monograph on living Cypraeedae' (Schilder & Schilder 1938–39) produced a detailed world map of 114 marine areas of living cowries delineated by region (later modified by Powell 1957, Fig. 6)[37]. The classification was hierarchical, 'areas' being classified into 'regions', which were classified into 'provinces'.

Most of the Australian landmass and coastal areas were located in the ‘Damperian’ and ‘South Australian’ Regions, both being classified within the Central Indo-Pacific Province, with the ‘Queensland’ region, belonging to the Pacific province. The Damperian Region was united,



Map 1 shows the boundaries of the 31 regions and the average temperature of the sea level in the coldest month observed in the 114 areas. *Map 2* indicates the number of species and races credited as living in these 114 areas.

FIGURE 6. The regions of Schilder and Schilder (1939: p. 223). “Map 1 shows the boundaries of the 31 regions and the average temperature of the sea level in the coldest month observed in the 114 areas. Map 2. indicates the number of species and races credited as living in these 114 areas” (Schilder and Schilder 1939, p. 223, original italics). [Reproduced with permission of Oxford University Press.]

> “... with N.W. Australia, as we do not know any sufficient population of Cypraeidae from the Gulf of Carpentaria. Damp. C = *N.W. Australia from Port Essington to C. Jauhert, Rowley Shoals; 28°/26°C [...] Damp. W = **Port Walcott to Exmouth Gulf, Dampier Archipeligo; 25°/23°C [...] Damp. S= **West Australia from Sharks Bay to Geraldton; 22°/20°C. The South Australian Region includes, “S. Aust. W = S.W. Australia from Swan River to Esperance; 18/10°C [...] S. Aust. C. = South Australia from Eyre to the boundary of Victoria; 16°/14°C [...] S. Aust. E = Victoria from Portland to Montague I. (Southern New South Wales); 15°/13°C [...] S. Aust. S = King I., Flinders I., Tasmania ; 13°/l 1°C”. The Queensland region includes “Quee. S = New South Wales from Ulladulla to Port Macquarie; 19/16°C [...] Quee. E = *Lord Howe I., Middleton Reef, Norfolk I.; 21/18°C [...] Quee. C = *Southern Queensland from Macleay River to Hervey Bay; 22/19°C. [...] Quee. N = *Queensland from Port Curtis to C. Bedford; 24/21°C” (Schilder & Schilder 1939: 212–214[38]).

Within Schilder and Schilder’s classification there was only one reference made to Hedley’s earlier, and possibly only, marine classification. In their ‘Footnote 124’, Hedley was cited along with Iredale in reference to ‘Queensland’—a term Hedley never used to describe a region. It is difficult to determine why Schilder and Schilder decided to cite Hedley while at the same time omitting his Solanderian marine fauna, which extends from Moreton Bay to Torres Strait (the latter area being grouped in the Melanesian region).

Hedley, Tate and Spencer’s contributions were perhaps the only regionalisations of zoogeographic sub-regions in the Colonial Period. This is a far cry from the detailed vegetation maps and floristics of 19th-century botanists, who by 1896 had several revisions (see above). Revisions to existing zoogeographic regionalisations continued into the 20th-century. In the Post-Federation Period, T. G. Sloane, Thomas Iredale and Whitley were most active in

revising Hedley and Spencer's sub-regions[39]. However, during this period we see the greatest diversification of areas based on individual taxa. Iredale & May (1916) working on chiton distribution, designated the east coast of Tasmania the Maugean Region as a separate area "from the Peronian Region, which we restrict to the east coast of Australia from Bass' Straits [sic] to Caloundra, Queensland" (Iredale & May 1916:[40] 117). Iredale's (1929) work on molluscan and bird distributions added the "Kimberleys and Tasmania as sub-divisions of the Torresian and Basssian zones respectively" (Keast 1959: 130-131). Later Knott (1952) revised the marine regions according to ascidian distributions, extending the Maugean to Sydney[41], and finally adding the missing southwestern region, which "... corresponds to Iredale's (1937) Autochthonian Faunula in the Leeuwinian area, and an appropriate name for the marine region would be Baudinian (if there were sufficient evidence from other phyla that the fauna is distinctive) (Kott 1952: 323-324, original italics, Fig. 7). Like the terrestrial regions, further subdivisions and revision occurred based on individual taxa. A short review by Straughan (1967) on marine serpulidae, reveals how complicated these divisions and sub-divisions were:

> "Endean (1957) from an examination of the shallow water echinoderm fauna also supports this division calling the Great Barrier Reef area the Solanderian Province, but groups the fauna of Queensland mainland waters with that of the Damperian Province (tropical coast west of Torres St.) in a single Tropical province. Womersely (1959) also combines the tropical Queensland coast with the Damperian Province, retaining the Great Barrier Reef as a separate province. Knox (1963) lists three Australian tropical-subtropical provinces: (1) Damperian province, (2) Solanderian province (Queensland mainland north of 25°S), (3) Great Barrier Reef province" (Straughan 1967: 253–254)[42].

Iredale and Whitley (1938) continued subdividing each of the terrestrial sub-regions creating Australia's 'fluvifaunula' or freshwater regions in the Post-Federation[43] Period. Unlike most terrestrial sub-regions, Iredale and Whitley's fluvifaunula included New Guinea, which they categorised into 10 fluvifaunula: Leichhardtian, Greyian, Vlaminghian, Sturtian, Mitchellian, Lessonian, Tobinian, Krefftian, Jardinean and the "not strictly Australian" Gaimardian. A later revision by McMichael & Hiscock (1958), includes the Riechian, namely the southern part of New Guinea formerly referred to by (Iredale & Whitley 1938) as the Leichhardtian, "[w]e feel that this fluvifaunula is sufficiently distinct to warrant a separate name and propose to call it the Riechian fluvifaunula, in honour of Dr. E. Riech who pioneered the study of distribution of freshwater molluscs in this region" (McMichael & Hiscock 1958: 489, Fig. 8). Brian Smith (1984) used Iredale's 'Faunal areas and regions of Australia' (Iredale 1937: 289) extending the Oxleyan region further south and creating overlaps zones between all abutting regions. Walker's (1981) revision of Australia's fluvifaunal was possibly the last mention of these areas in the freshwater literature.

Faunal revisions of the Ecogeographical Period slowly dispensed with 19th-century faunal divisions. Those that remained were tucked away in field guides (i.e., Serventy & Whittell 1962), or discussed as region from which modern classification were derived (Walker, 1981). Although Main *et al.* (1958) summarised the work of Tate and Spencer (in light of amphibian distribution), reverting back to Spencer's Torresian, Eyrean and Bassian regions, many were contesting these areas (see Littlejohn 1981). For example, while Spencer's regions worked for three genera of frogs, it required modification for birds (Serventy & Whittell 1951) and reptiles and amphibians (Horton 1973). Moore (1961 summarised in Horton 1973 and Littlejohn 1981), was clearly dissatisfied with imprecise definitions and set out to define zoogeographical regions as, (1) having precise boundaries (2) a differently marked fauna, which is (3) characteristic of the region and should (4) at one time have been isolated. Horton however was not satisfied,

> "[t]he approach of Moore with his four criteria for recognizing subregions is arbitrary and unworkable. It results in a 'pigeonholding' [sic] approach to subregions, and gives no information about the nature of the subregions and their relationship to evolution within a region. It is a static approach which results in a static zoogeography. Modern zoogeography must have the same relationship to evolution as does modern taxonomy" (Horton 1973: 195).

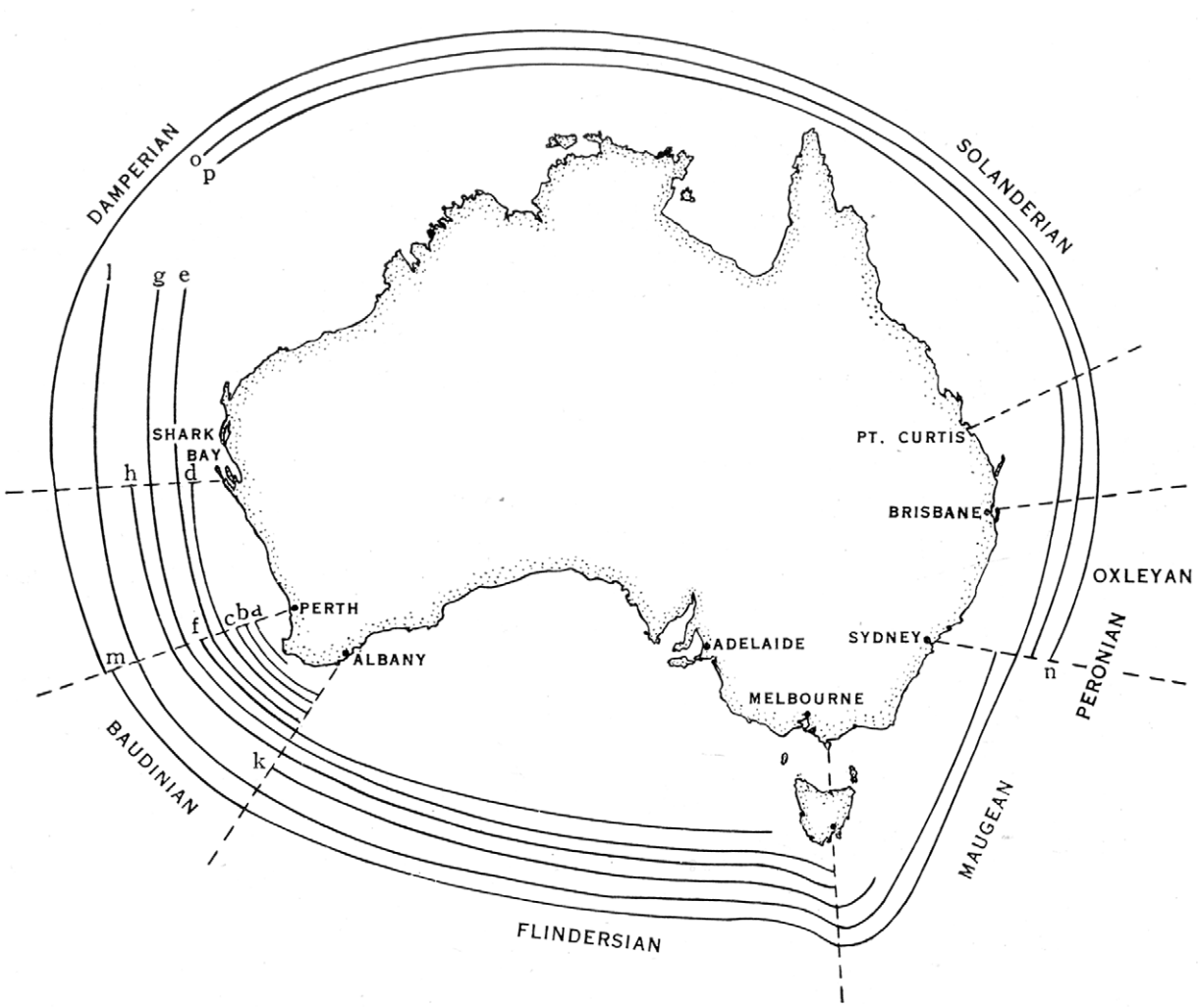


FIGURE 7. "Range of distribution of western, northern, and southern species and marine regions" (Kott 1952 fig. 182). [Reproduced with permission of CSIRO Publishing, Australia.]

During the same time, Doing (1970a,b) created the most ambitious phytogeographic regionalisation of Australia, something which only happened infrequently in zoogeography. The most ambitious zoogeographical regionalisations that of Sloane (1906, 1915), who divided up Australia into 10 "entomological districts", based on caribid[44] beetles, Campbell's (1943) 12 zones based on bird distributions and, Pianka's (1969a,b) 13 subregions of the Australian desert using lizard distribution in relation to vegetation and soil types (Fig. 9). Sloane and Campbell were both unique as they divided up the former Eyrean into interior zones, rather than areas that extend out to a coastline. Keast noted that "a considerable generalisation is necessary to get the bulk of reptiles to fit" (Keast 1959: 131) into the various regionalisations of the Post-Federation Period. In particular, he rejected Sloane and Campbell's zones as insignificant "from the reptile viewpoint" (Keast 1959: 132). Pianka's subregions however are based on lizard distributions that closely reflect the detailed phtyogeographical regionalisation of Doing (1970a,b)[45]. Contrary to Keast, Pianka's subregions were very specific (rather than general to fit most reptiles), even though "[t]he boundaries between these subregions are sometimes difficult to pin-point, but in other cases maybe quite sharp" (Pianka 1969a: 1013). Here we return to Horton's criticism, namely that these areas involved "a 'pigeonholding' [sic] approach to subregions, and [gave] no information about the nature of the subregions and their relationship to evolution within a region". The answer, he suggested, was to look at taxon-specific distributions. This way, areas are defined on endemism, on the evolutionary processes responsible for speciation and on the effects of geographical barriers on individual species.

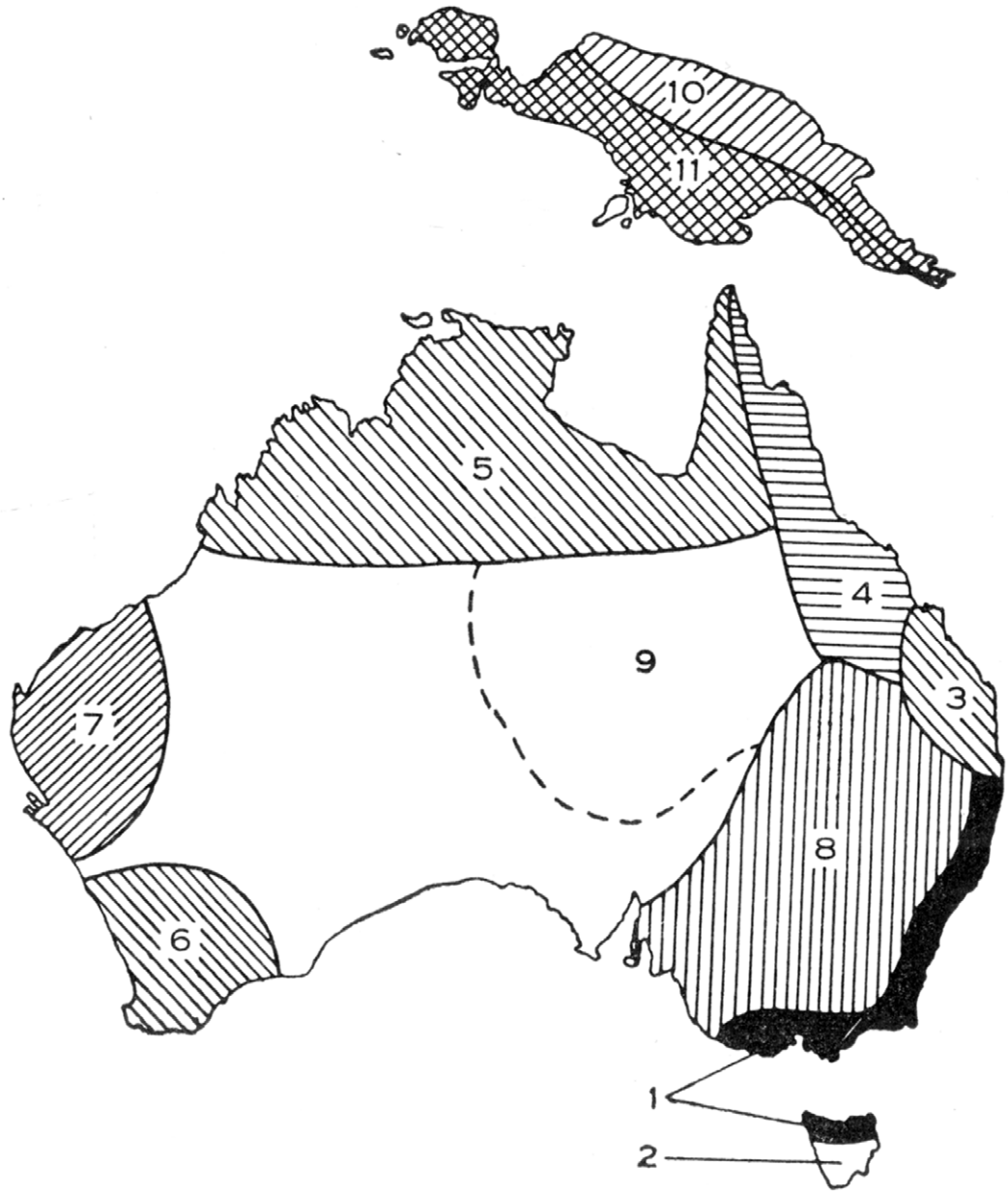


FIGURE 8. "The fluvifaunal provinces of Australasia (modified from Iredale and Whitley 1938).1. Lessonian; 2. Tobinian; 3. Krefftian; 4. Jardinian; 5. Leichhardtian; 6. Vlaminghian; 7. Greyian; 8. Xitchellian; 9. Sturtian; 10. Gaimardian; 11. Riechian" (McMichael & Hiscock 1958, fig. 17). [Reproduced with permission of CSIRO Publishing, Australia.]

The downside to taxon-specific regionalisation was the ability to fit all known distributions. This led to either wholesale rejection of new areas or sub-divisions, or major revisions. A classic example was provided by the regions of Smith (1984), in which Hedley's (1904) marine regions appeared as the faunal regions' native land mollusc fauna. Although Smith's revision, like those of Key (1959) and others during the Ecogeographical Period, retained Spencer's original regions, they did not stabilise the classification. "Any consideration of Australian biogeography", wrote Key, "must take into account of the climatic history of continent" (Key 1959: 208). Fluctuations in climate were the only destabilising factor in pre-plate-tectonic biogeographic classification:

> "It is obvious that, so far as the Spencer scheme is concerned, [...] whilst the sub-regions may also be centres of origin of faunal elements they are maintained to at least some extent, as recognisable units, by also having a climatic and vegetation basis" (Keast 1959: 132).

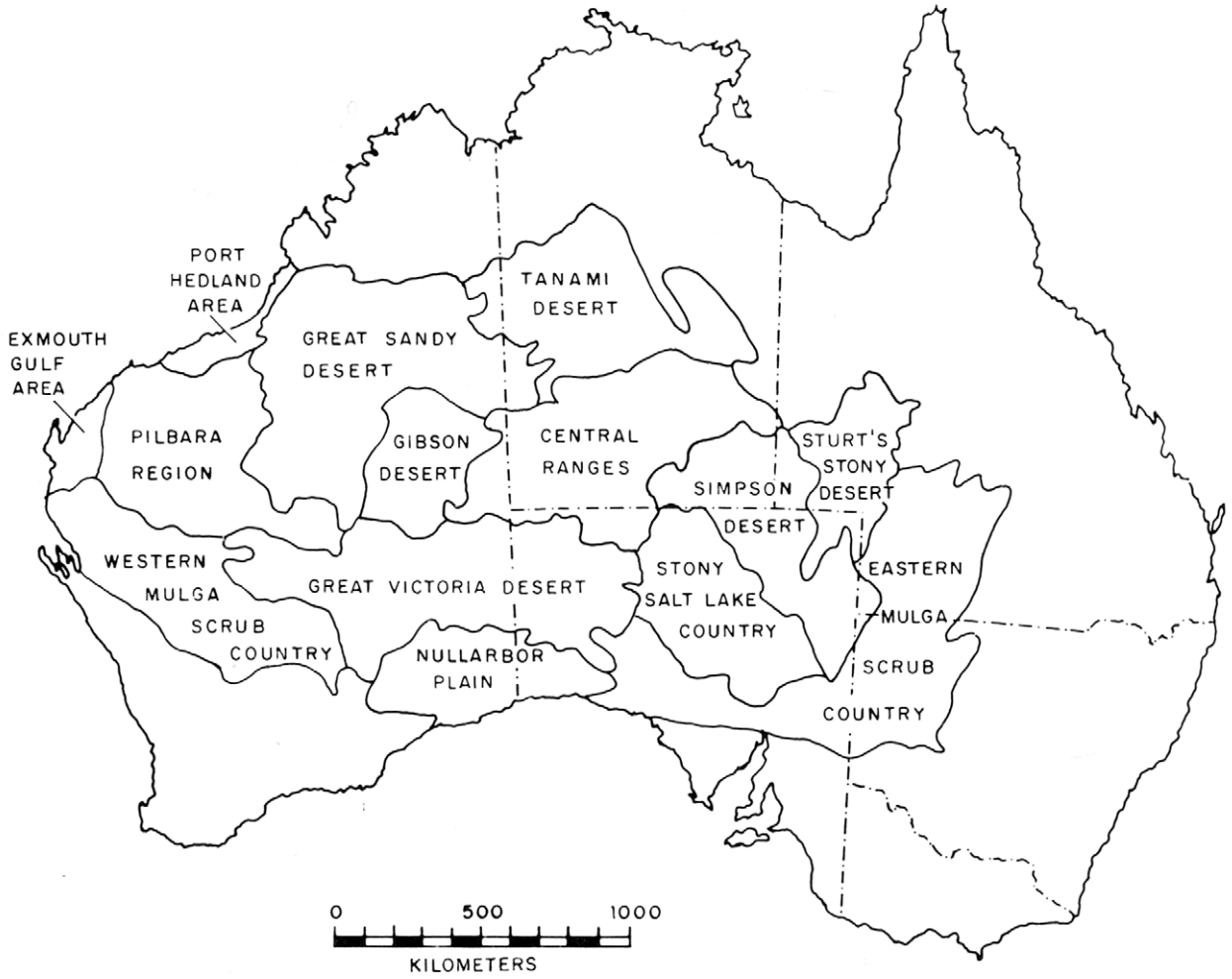


FIGURE 9. "The approximate boundaries of the various subregions of the Australian desert, based upon a variety of sources" (Pianka 1969b, fig. 1). [Reproduced with permission of Ecological Society of America.]

It seems that virtually all abiotic factors and the taxon's ability to move within or around it, somehow affect distribution and our ability to classify regions. Horton's objections, however, seem relevant at this point, namely: "[m]odern zoogeography must have the same relationship to evolution as does modern taxonomy". Regardless, these variations are rarely taken into account when creating taxonomies. So why should climate, geography and dispersion affect regionalisation?

Like taxonomy, biogeographical regionalisation lacks a method - rather it is the biogeographer who creates the regions. Given this and the above discussion, the history of zoogeography can be summarised quite simply as a profusion of terms and regionalisations over time, each referring to individual taxic distributions over smaller and smaller areas. The general biotic regionalisations of Nicholl's simply remain buried under all these newer areas. In a brief review of land snail biogeography, Bishop despaired at regionalisation:

> "My feeling is that the faunal province approach contains too many covert assumptions and has outlived its usefulness. It is not an empirically sufficient description of the real world [...] The map of zoogeographical provinces presented by McMichael & Iredale (1959) corresponds so closely to patterns of temperature and rainfall, that I entirely agree with Stephenson & Stephenson (1971) who, in discussing marine biogeographical regions, stated: 'A profusion of terms that are mainly meaningless to the general reader will serve to confound, rather than to clarify, his understanding of the relations of Australasia to ecologically similar regions'" (Bishop 1981: 925, 943).

The despairing comments of Key, Keast and Bishop, however, harked back to George Gaylord Simpson who remarked:

> "... most of the historical zoogeographic studies of the recent [Australian] fauna have been either so general as to lack significant detail or so partial and confined to particular groups and areas as to give an inadequate grasp of the whole" (Simpson 1961: 431).

The increase in smaller, or taxonomically specific regions, generated numerous conflicting regions that lead evolutionary biologist Emst Mayr to note that it,

> "... has become evident in recent years that there is much difference between phytogeographic and zoogeographic classifications. The major floristic regions coincide fairly well with the major climatic regions. The major zoogeographic regions, on the other hand, indicate primarily the extent of formerly (or currently) isolated land areas [...] A comparison of phytogeographic and zoogeographic maps indicates that it is impractical at the present time to construct biogeographic maps, that is, maps that intend to illustrate simultaneously the distribution of plants and of animals" (Mayr 1944: 12).

The zoogeographers of the Ecogeographical Period were becoming taxon specific, that is, putting major biogeographical regionalisation on hold while concentrating on individual distribution patterns. Cogger & Heatwole (1981) attempted to "quantify available data on reptilian distribution in order to determine whether recently-acquired evidence call[ed] for revision of traditional views on reptilian geography in Australia" (Cogger & Heatwole 1981: 1333). Their 'herpetogeography' described the dispersion and centres of origin of existing faunistic regions, rather than a new or revised area classification. Australian zoologists, it appears, were still unable to create "maps that intend to illustrate simultaneously the distribution of plants and of animals" (Mayr 1944: 12).

The Systematic Period

The taxon-specific classifications from the Ecogeographical Period were almost entirely replaced by a single publication in an edited volume titled 'Austral Biogeography' (Ladiges *et al.* 1991). In it, Joel Cracraft, an ornithologist from the American Museum of Natural History, unwittingly and single handedly wiped the slate clean with his avian endemic areas (Cracraft 1991; see fig. 10). What made Cracraft's areas unique is that they appealed to a wide taxonomic audience. For instance, they feature as endemic flora areas in Volume 1 of the second edition of the 'Flora Australia' series, a widely used compendium for floristic studies in Australia. The cross-pollination between ornithology and botany resulted in traditional regions (Bassian, Eremaen and Eyrean etc.) being used less in the botanical[46] literature in favour of 'areas of endemism' (see Turner 1996; Crisp & Weston 1995; Crisp *et al.* 1995, 1999). While such terms vary, the principle remains the same: an area can be defined by its vegetation type, endemicity and so on. However, the overall result is that the biogeographer ends up with a classification of these areas that can be mapped. The preferred usage of one set of terms and areas over another has the effect of diluting a common area classification, that is a biogeographical regionalisation. For example, Cracraft's areas of endemism have been modified throughout the botanical literature. Crisp *et al.* (1995) modified Cracraft's regions by adding 'New Guinea', splitting his 'Southeastern forest' into 'Southeastern New South Wales' and 'Victoria', and splitting his "Eastern Queensland" into "McPherson-Macleay' and a smaller 'Eastern Queensland' (Crisp *et al.* 1999: 337, caption in fig. 76).

Crisp *et al.* (1999) have been careful to note that the gaps between these areas "occur because areas of endemism represent coincident sets of range restricted species, and ignore widespread species (and minor areas of endemism) that occur in the gaps" (Crisp *et al.* p. 337, caption in fig. 76). This is beside the point. Biotic areas like the Bassian, Eremaen and Eyrean for example, were never considered to be biotic in this sense. The term 'biota' termed by Leonard Stejneger (1901) as a "term to include both flora and fauna which will not only designate the total of animal and plant life of a given region or period, but also any treatise upon the animals and plants of any geographical area or geological period (Stejneger 1901: 89). Bassian, Eremaen and Eyrean are terms that were coined and in use before Stejneger's biota. They merely referred to regions that included 'elements', which is synonymous (in its use) to the present-day areas of endemism (Parenti & Ebach 2009). The use and revision of

Cracraft's areas to designate floral and faunistic elements, areas of endemism and so on, represents a change in biogeographical regionalisation from a descriptive or numerical division to a hypothesis of range based on the overlap of particular taxa. For instance, Barlow's regionalisation of 33 botanical regions illustrates the "geographical distributions of plant taxa, for arrangement of specimens in herbaria" (Barlow 1984: 195). While Barlow acknowledges that each state herbarium uses its own regionalisation[47] for

> "... the coding of label data for generating computer data bases of herbarium accessions", there is "no practical division of Australia as a whole into botanical regions. Most taxonomic revisions produced in Australia now treat genera or families on an Australia-wide basis, sometimes (but not always) with reference to the individual botanical regions accepted within each state. However some difficulties arise when state botanical regions are combined for use on a continental scale. Firstly, the combined number of regions is impractically high at 69 (which includes Victoria and Tasmania each scored as a single region). Secondly, the boundaries of the regions do not conform at state borders. Thirdly, the state regions themselves are based on different criteria, so that regions in different states are hardly comparable as to shape or composition" (Barlow 1984: 195).

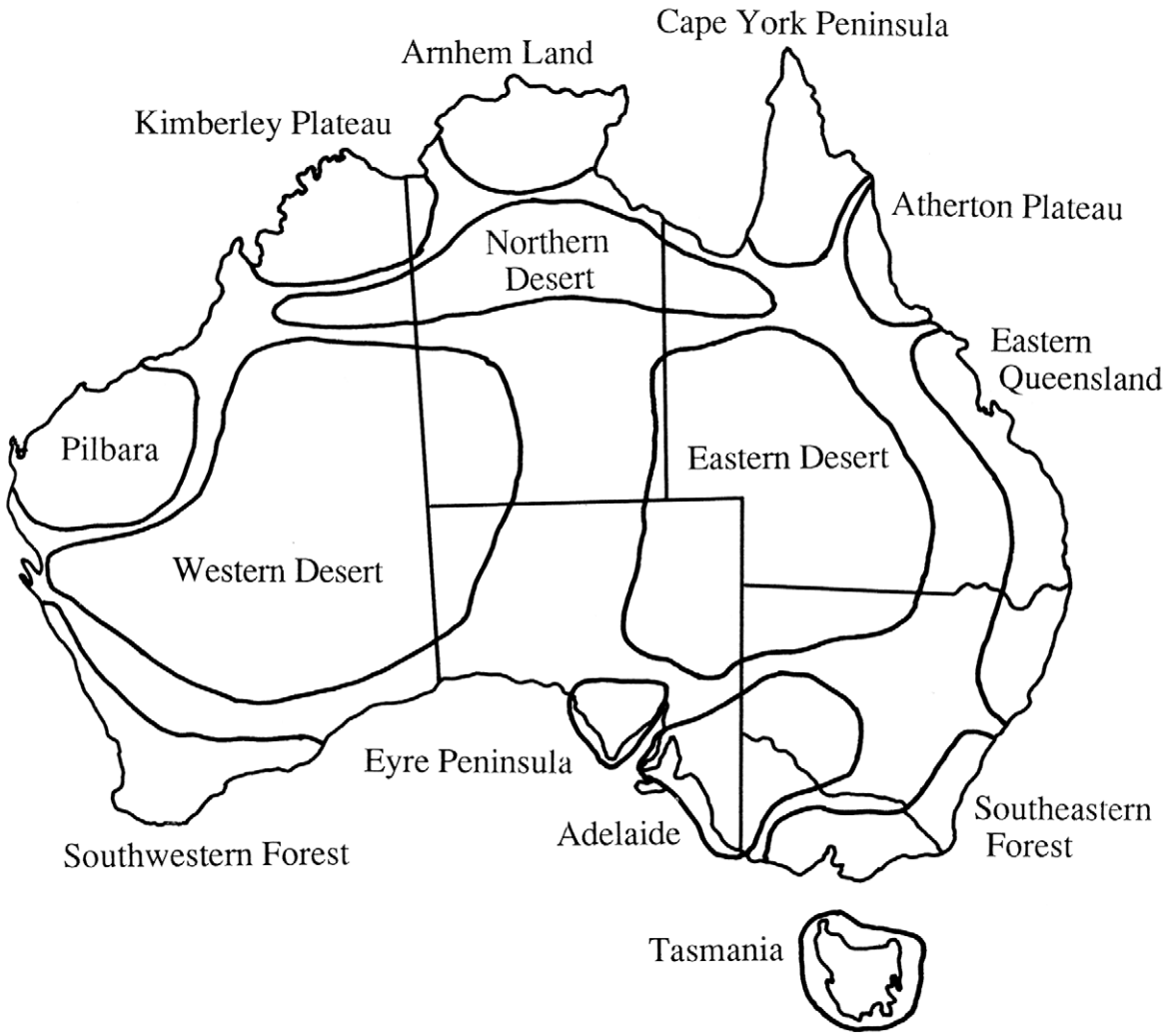


FIGURE 10. The avian endemic areas of Cracraft (1991). [Reproduced with permission of CSIRO Publishing, Australia.]

Effectively what Barlow means is that coding of taxa at a national level elevates the problem of multiple conflicting classifications. Unlike regionalisations produced by botanists like Beard (1980), Barlow's regions are arbitrary:

> "It may well be useful for a variety of purposes to divide the Australian continent into a convenient number of botanical or other regions defined by lines of latitude and longitude, but such divisions should not masquerade as ecological regions (Beard 1985: 381)".

What Beard means is that Barlow's regions are not 'natural regions'[48] as they are based on grid system rather than on actual ecological or geographical features or processes that are used in his own regionalisation of Western Australia. In Barlow's defence, his regions were a proposal, not one to replace "Beard's excellent hierarchical phytogeographic analysis for Western Australia (Barlow 1985: 387)". Furthermore, Barlow's now revised 1985 regions were to "represent an attempt to find closest agreement, within the grid cell framework, with natural regions defined or conceived through other studies [...] Although it is intended that the regions be used in describing plant species' distributions, it is felt that the term 'natural regions' may be preferable to 'botanical regions'. The regions are defined on criteria which are not all botanical, and they are potentially suitable for describing distributions other than those of plant species" (Barlow 1985: 388).

Barlow's comment is interesting as the prevailing attitude toward natural classification was that it is taxon specific, like the revised biotic elements of Schodde (1989) and the botanical endemic areas of Crisp *et al.* (1995)[49]. A similar attempt at regionalisation by Blakers *et al.* (1984) for bird distributions using grids rather than natural regions, shows a trend toward a quantitative approach to delimitating areas, especially for use in databases. The 'Australian Zoological Catalogue', for instance, derives its areas for all known animal taxa from "[s]tates, standard drainage divisions, coastal zones with the 200m bathymetric contour, and the 200 nautical mile Australian fishing zones" (Wells 1998: caption text map 1). One explanation is that the 'Australian Zoological Catalogue' "... was conceived as a concise, computer database consisting of current taxonomic and biological knowledge of the Australian fauna" (Wells 1998: ix[50]). Such a format elevates any revision or alternate interpretation of areas (a necessity for a functional database), it is equally arbitrary as using geopolitical areas.

In 1995, however, without any reference to past biogeographical studies, the Interim Biogeographic Regionalisation for Australia (IBRA; Thackway & Cresswell 1995) was published by the Australian Department of Environment and Heritage, Canberra (Fig. 11):

> "The Interim Biogeographic Regionalisation for Australia (IBRA) was developed in 1993–94 under the coordination of Environment Australia by the States and Territories as a basis for developing priorities for the Commonwealth in funding additions to the reserve system under the National Reserve System Cooperative Program. This regionalisation built upon previous work by the Commonwealth, States and Territories to identify appropriate regionalisations to assess and plan for the protection of biological diversity [...] IBRA regions represent a landscape based approach to classifying the land surface. Specialist ecological knowledge, combined with regional and continental scale data on climate, geomorphology, landform, lithology and characteristic flora and fauna were interpreted to describe these patterns [...] The resulting integrated regions were ascribed the term biogeographic regions. The developers of the IBRA acknowledged, given the paucity of biophysical data in some parts of the continent, that new information through time would modify our understanding of the regions, hence the term interim was used in the title of the IBRA (Enviroment Australia 2000: 4).

The rationale for IBRA resulted from a previous classification of 130 areas "defined by nature conservation agencies across their respective jurisdictions". This means that IBRA is completely autonomous and independent of history of Australian biogeographical regionalisation, being created "by compiling the best available data and information about each State and Territory including specialist field knowledge, published resource and environmental reports, and biogeographic regionalisations for each State and Territory, as well as continental data sets" (Environment Australia 2000: 5), rather than previous biogeographical work. Erecting a whole new regionalisation without reference to any previous biogeographical regionalisation may appear to be postmodernist. However, from the "outset, the developers of the IBRA agreed on a conceptual process model as the basis for understanding and explaining ecological patterns and processes. Namely, it is the physical processes which drive ecological processes, which in turn are responsible for driving the observed patterns of biological productivity and the associated patterns of biodiversity" (Environment Australia 2000: 5). This aim is significant as IBRA had an aim in mind, as a conceptual process model. Originally, biogeographical regionalisations were in place to explain

the distributions of taxa, their migrations, centres of diversification and so on. IBRAs aims differed, but resulted in producing a similar result - a classification of areas. Like the classifications of the 'Australian National Herbarium's Centre for Australian National Biodiversity Research' and 'Australian Zoological Catalogue', IBRA is also based on existing landform data[51]. This bears similarity to Barlow's regionalisation, who offered a functional classification for use in databasing herbarium specimens, not identifying and mapping areas of diversification.

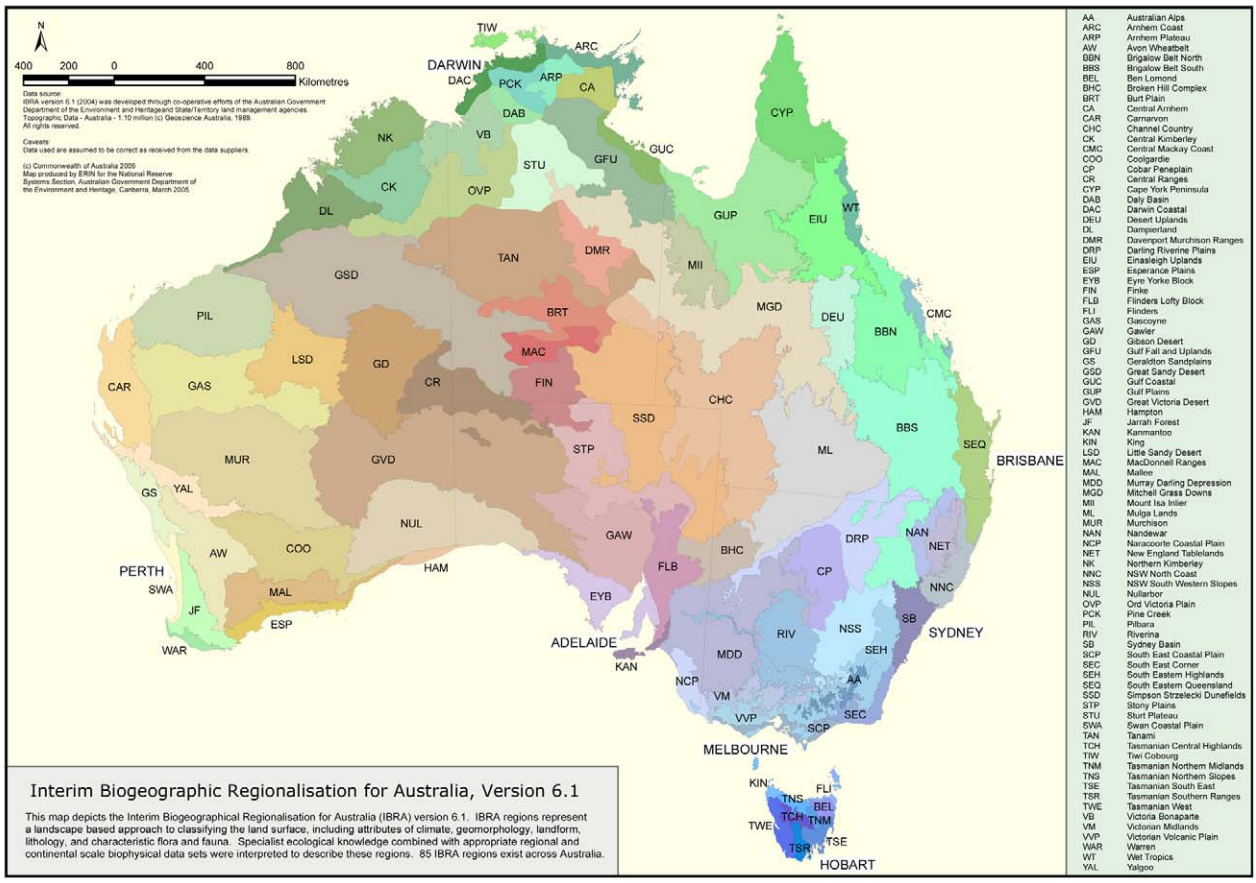


FIGURE 11. Interim Biogeographic Regionalisation for Australia Version 6.1 (IBRA, 1995). [Reproduced with permission of Australian Government].

The 'Interim Marine and Coastal Regionalisation for Australia Technical Group' has a similar history to IBRA (Fig. 12):

> "IMCRA has been developed through the collaborative efforts of State, Northern Territory and Commonwealth marine management and research agencies. Work began in 1992 with the Commonwealth Government providing support for the development of a range of biogeographic projects in the States and Northern Territory. In 1995 work began on the development of regionalisation projects for Commonwealth waters" (IMCRA Technical Group 1998: viii).

Like IBRA, IMCRA had a purpose, namely conservation management:

> "Importantly, the scale and extent to which different human activities affect either biodiversity and/or ecological processes and the extent to which these human activities or impacts can be managed, determines both the scale and nature of management and monitoring required, and hence defines the framework for ecosystem management. As such, biogeographical regions or bioregions provide the boundaries and framework for biodiversity or conservation management and the integrated, multiple-use management of other specific human activities or uses, such as fisheries, mining and tourism" (IMCRA Technical Group 1998: 3).

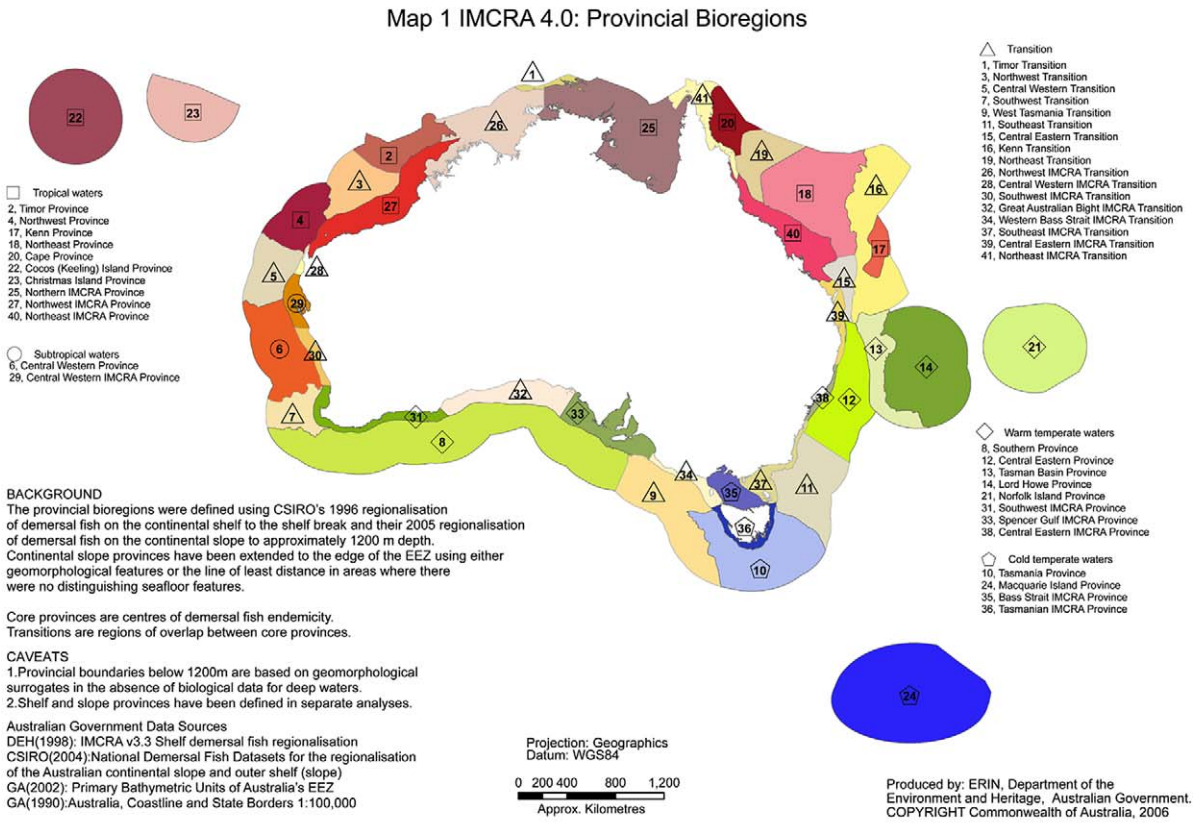


FIGURE 12. Interim Marine and Coastal Regionalisation for Australia version 4 (IMCRA). [Reproduced with permission Of Australian Government].

Therefore it is unsurprising that IMCRA does not rely or refer to previous biogeographical studies. So why refer to biogeography at all, particularly biogeographical regionalisation?

One might suppose the purpose of biogeographical regionalisation is to catalogue the biotic wealth of a nation in number of taxa, ecosystems or both (e.g., vegetation), whether it be for exploitation or conservation. In a sense, the job of Brown, von Mueller, Spencer and Diels is no different from that of Thackway, Cresswell and the IMCRA Technical Group. One may ask whether the scholarly aspects of biogeographical regionalisation, such as natural regions, endemism, elements and so on is a result of practical biological survey rather than that of primary scholarly pursuits?

Biogeographical regionalisation, exploration and conservation

This section will attempt to show that early on, the primary purpose of biogeographical classification was to provide stable geographical units to measure the biotic wealth of Australia. During the Colonial Period much of the Australian landscape was unknown, meaning that there were potential areas for exploitation, resulting in surveys and land claims. By 1800 the inhabited east and south east of Australia was known as Terra Australis (or New South Wales), while "... in a vague kind of way, the Dutch claim to the western portion of Australia was recognized [...] New South Wales is fixed at 135 deg. E. longitude, a position approximating to the boundary of New Holland as fixed by the Dutch" while "earlier in the [19th] century, the French evidently considered that they had a well-founded claim, both to the discovery and possession of the south coast" (Favenc 1888,: 33). However, "[t]he claims of the English have no fixed boundaries; they seem desirous of confounding the whole of New Holland under the modern name which they have given to the east coast" (Malte Brun in Favenc 1888: 33).

Once claimed, a territory would need to be occupied and defended and, without any knowledge of the natural resources most areas remained unclaimed until a survey via an exploratory group was undertaken. The result, the exploration boom of the 1800s, led to large rewards for newly found fertile territory. For example, Gregory Blaxland, William Wentworth and William Lawson, who managed to cross the Blue Mountains west of Sydney in 1813, were granted "one thousand acres each of the country they explored" (Field in Richards 1979: 47). George Caley was one of Joseph Banks' team (along with Robert Brown and Matthew Flinders) sent to New South Wales "to gather botanical specimens for Banks and Kew Gardens, and to search for articles 'advantageous to Manufacture and Commerce" (Currey 1966: ix). In fact, Banks' intentions were quiet clear:

> "It is impossible to conceive that such a vast body of land as large as Europe does not produce vast rivers capable of being navigated into the heart of the interior; or, if properly investigated, that such a country, situated in a most fruitful climate, should not produce some native raw material of importance to a manufacturing country as England is" (Banks to the Colonial Office, May 15th 1798, in Currey 1966: 1).

Explorers engaged on larger expeditions brought with them naturalists (mainly botanists and mineralogists) collecting on behalf of non-Australian institutions like British herbaria and museums or to survey the biotic wealth of the Australian continent. For instance, Robert Brown, naturalist to Matthew Flinders' voyage to Australia on board the HMS Investigator, collected along the South Australian coast, a territory to whom the French had a "well-founded claim". Flinders was quite clear in the expedition's intentions:

> "The establishment, in 1788, of a British colony on the easternmost, and last discovered, of these new regions, had added that degree of interest to the question of their continuity, which a mother country takes in favour, even, of her outcast children, to know the form, extent, and general nature of the land, where they may be placed. The question had, therefore, ceased to be one in which geography was alone concerned: it claimed the paternal consideration of the father of all his people, and the interests of the national commerce seconded the call for investigation" (Flinders 1814: i).

The HMS Investigator also had the job of collecting objects for the purposes of recording the colonies biotic and mineral wealth. Apart from Robert Brown, the "scientific staff was completed by an astronomer, John Crossley, and a miner, John Allen" (Ferrar 1984: 97). In addition there were three botanical collections:

> "As HMS Investigator sails through what would become Australian waters several rather separate collections of materials accumulate. Here I point to three plant collections. The first is the collection Brown will hand over to the British Museum. This will satisfy his employer, the State, and he will get his salary. These objects will fit in with the established categories at Kew Gardens, they will disturb them a little and provoke all sorts of interest among those who wish to find plants that might be useful for the newly developing imperial plantation economy. This collection will add to the well deserved reputation of Kew Gardens and the British botanical establishment [...] There is another collection on HMS Investigator, that of Peter Good the expedition gardener [...] Good hoped that his collection of seeds would enable him to become an entrepreneur in England's booming gardening market. Here Peter Good works a whole/ parts version of generalizing. The vague whole 'commercial plants' enable his entrepreneurial collecting—selecting this likely seedling for its attractive colour for client gardens, or that promising seed pod on the basis of the possibility that these plants might become plantation crops" (Verran 2009: 176).

It appears that the scientific crew, as well as the institutions that sent them, had an economic interest in scientific expeditions. The naturalist may be working to exploit new territories, but at the same time this provides he or she with the opportunity for scholarly research. The third collection onboard the HMS Investigator was Brown's own private collection, on which he "will sort in new ways, he will dissect and experiment with plant bits and come up with experimental criteria. He will use these to re-assemble criteria in such a way as to profoundly challenge established understandings of what plants, and living things are and how they might be ordered" (Verran 2009: 176).

19th-century plant geography seemingly was riding on the back of colonialism, for instance, Brown and von Mueller's botanical research was underwritten by the British Government. The same is true of present day research. Rather than colonialism, Australia's biogeographical research is fuelled by conservation and the biodiver-

sity crisis as biotic resources are under threat from climate change, agriculture and fishing. Government and industry funding into assessing this threat via the 'Commonwealth Scientific and Industrial Research Organisation', 'Australian Biological Resources Study' (ABRS), IBRA, IMCRA, and the databases used by the 'National Herbarium and the Flora of Australia' and the 'Zoological Catalogue', also supports taxonomic, systematic and biogeographical research. The model of underwriting an economic/environmental issue that also happens to funds scholarly research has not changed since the days of Joseph Banks and the HMS Investigator. What is puzzling, however, is how the resulting large-scale biogeographical regionalisations, once proposed, almost immediately diverged into various taxon-based area classifications without further discussion.

The appearance of IBRA and IMCRA in 1995 is ironic. The adoption of a new set of endemic areas by Australian botanists and the drive away from zoogeographical regionalisation, marks another historical repetition of the Post-Federation Period. In the early 20th-century, as we have seen, Spencer (a zoologist) adopted Tate's botanical regions, while fluvial zoologists are slowly revising zoological regions to suit their own organisms. In other words, Spencer sought to regionalise while latter malacologists like Hedley and ichthyologists like Whitley, looked for smaller taxon-specific endemic areas. The former generalises many distributions into a larger regionalisation, while the latter specialises, creating endemic areas for individual groups. This cycle of specialisation versus generalisation has prevented the development of a single map that depicts biodiversity in Australia. However, the question is what causes these cycles to occur in the first place?

Advocates for the biogeographical regionalisation of Australia like Tate, Hedley, Nicholls and later Cracraft, Weston and Crisp, all had one common factor. They interacted outside their own taxonomic fields: Tate, Hedley, Nicholls were past Presidents of the Australian and New Zealand Association for the Advancement of Science (ANZAAS), who discussed regionalisation within their presidential addresses. Cracraft, Weston and Crisp attended the Willi Hennig Society Meeting in Canberra in 1990 and possibly others, possibly leading Crisp *et al.* (1999) to note that:

> "[d]uring the last 20 years, major symposia and multi-authored books have brought together the common threads in floral and faunal biogeography in Australia. These vary in geographic focus from regions within Australia to the whole Southern Hemisphere, e.g., the arid zone (Barker & Greenslade 1982), Australia and New Guinea (Keast 1981), the alpine region (Barlow, 1986), the wet tropics (Kitching 1988), the Southern Hemisphere (Ladiges & Humphries 1991; Hill 1993), the monsoon tropics (papers in Aust. Syst. Bot. 9(2), 1996) and the Pacific (Keast & Miller 1996). A diversity of approaches is seen in these and other recent literature" (Crisp *et al.* 1999: 330).

Given the literature of the time, Crisp *et al.*'s statement is unconvincing. These major symposia and multi-authored volumes at different regional levels explain why Australian biogeography lacks a clearly defined regionalisation. It might also help to explain why no attempts were made for a unified regionalisation for all taxonomic groups, like that of Tate or Nicholls, in large edited volumes on Australian biogeography, ecology and taxonomy. These include the three volume 'Ecological Biogeography' (Keast, 1981), 'Evolution and Biogeography of Australasian Vertebrates' (Merrick *et al.*, 2007), 'Vertebrate zoogeography and evolution in Australasia' (Archer and Clayton, 1983) and, the second edition of the 'Flora of Australia Volume 1' (1995), with the exception of Cracraft (1991) and Crisp *et al.* (1999). Furthermore, those attempts that tried to create unified regions were either geopolitically based (e.g., Beard and Sprenger 1984) or artificial (e.g., Barlow 1984). Marine regions, however, are in better stead. The regions proposed by Hedley and later refined by Kott (1952) and Straughan (1967) are still in use today for most marine organisms (including algae) (see Waters *et al.* 2010; Millar 2007, Jeffrey *et al.* 1990).

The main reason is that terrestrial and freshwater biogeography has become increasingly localised and taxonomically focused, meeting in taxonomic-theme based conferences[52]. The arrival of IBRA has led to renewed interest in terrestrial and freshwater Australian biogeographical regionalisation, but only marginally.

Conclusion

Richard Schodde in the Australian Systematic Botany Society's 'Nancy T. Burbidge Memorial Lecture', has commented as follows:

> "After all this, do you have a sense of deja vu? In the middle of this century, plant and animal geographers presented a combined picture of the origin and radiation of Australia's higher order biota with all the hallmarks of finality. Now, only a few decades later, we are proposing another, almost diametrically opposed view with a similar certainty. This carries a three point cautionary message, of which I know Nancy Burbidge would have approved:
>
> First, biogeographic reconstructions such as we have examined today are no more or less than best-fit hypotheses for the data available. They stand only by continuing testing.
>
> Secondly, as many sets of evidence as possible should be enjoined to resolve biogeographies, not just present distribution patterns or the fossil record but phylogeny, biotechnology and evolutionary ecology as well, and anything else that might help. And let us not forget the service that morphology has and will still render us.
>
> Thirdly and finally, a sound biogeography can only come from a sound taxonomy. Without it, biogeographic constructions, like other endeavours in biology extending to conservation ecology and the breeding of economic crops, are built on foundations of clay and will eventually crumble" (Schodde, 1989: 11).

Ironically, in 1989 biogeographical regionalisation was crumbling for the reasons that Schodde carefully noted. Biogeographical regionalisation is available for testing by any method and, like any taxonomy, it varies. Revising a taxonomy from one version to another is a natural progression. However, like any natural taxonomy it needs to incorporate more than just one taxon. Biogeographical regionalisation is a large project that requires the involvement of wider expertise and knowledge than can be found in any one person. Perhaps this is why Doing (1970a,b) thought that the establishment of a 'Flora Australiana' project and the "establishment of posts for research and teaching at Australian universities and herbaria and extensive description, classification and mapping of Australian vegetation" was an urgent priority (Doing 1970b: 95). In the case of IBRA and IMCRA, however, this has been done without the expertise or knowledge of past biogeographical regionalisation.

Presently IMCRA and IBRA have yet to be adopted by the wider biogeographical community. Considering that regionalisation from the biogeographical community has rarely been adopted for longer than a generation, it seems hard to imagine that a classification based predominantly on abiotic patterns would appeal to a predominantly biological field – but future meetings or symposia that incorporate a wider community could resolve this issue provided that it is directly addressed.

> *Australia, n. A country lying in the South Sea, whose industrial and commercial development has been unspeakably retarded by an unfortunate dispute among geographers as to whether it is a continent or an island — Bierce (2000).*

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Endnotes

1. Biogeographical regionalisation (a.k.a bioregionalisation) herein refers to the study of determining and classifying the vegetative regions, floristic and faunistic elements, as well as biotic and endemic areas.
2. "The partition of the world into faunal regions, defined as corresponding with a considerable uniformity and distinctiveness of the animal life of each area in question, was the major pre-occupation of animal geography for more than fifty years, from about the year 1850 to the end of the century" (Schmidt 1954: 322).
3. The review "Wallace's Geographical Distribution of Animals" by Anon (1877) demonstrates the transition of biogeography based on geographical process like climate to more intrinsic biological or evolutionary mechanisms, "It is written as it should mainly be, in the light of the recent uniformitarian views in geology and the theory of evolution, though with occasional disregard of zoogeographical laws laid down by Humboldt, Brown, Schouw, Schmarda, Decandolle, Agassiz, Dana, and others whose names are not even mentioned in the work before us, no historical sketch of the subject being presented, an omission of considerable importance [...] The grand merit of the work, and one which will give a substantial foundation to the author's fame as a biologist, aside from his authorship, simultaneous with Darwin, of the doctrine of natural selection, is the endeavour to account, from a more extended range of study than any previous author, for the present diversity of life on the different continents by a study of the fossil forms and of past geological changes. He discards the older notions of certain authors, as Humboldt, Schouw, and others, that the distribution of life over the globe is due primarily to difference is in temperature and to physical barriers" Anon (1877: 232–233).
4. Unlike his contemporaries Augustin Pyramus Candolle and Alexander von Humboldt, Brown saw the usefulness of relating areas based on their taxa rather than on abiotic elements like elevation, soil type and climate. "The geography of plants being as yet in its infancy, the smallest addition to our knowledge of a subject which promises to become of considerable importance, will probably be received with indulgence; and in this persuasion I venture to make the following observations on the order before us. In the first place, it is remarkable that the Proteaceae are almost entirely confined to the southern hemisphere. This observation originated with Mr. Dryander, and the few exceptions hitherto known to it, occur considerably within the tropic. The fact is the more deserving of notice, as their diffusion is very extensive in the southern hemisphere, not merely in latitude and longitude, but also in elevation; for they are not only found to exist in all the great southern continents, but seem to be generally, though very unequally, spread over their different regions: they have been observed also in the larger islands of New Zealand and New Caledonia; but hitherto neither in any of the lesser ones, nor in Madagascar. As in America, they have been found in Terra del Fuego, in Chili, Peru, and even Guiana, it is reasonable to conclude that the intermediate regions are not entirely destitute of them. But with respect to this continent, it may be observed, that the number of species seems to be comparatively small, their organization but little varied; and further, that they have a much greater affinity with those of New Holland than of Africa" (Brown 1810: 9–10).

   Almost 50 years on, Hooker as a practitioner of the geography of plants (phtyogeography herein) overlooks the biological relevance of Wallace's claims, namely a new non-geographical mechanism to explain distribution. Rather Hooker sees the geographical in Wallace's claims, a divide between the Malayan and Australian province: "P.S. At a meeting of the Linnaean Society, held on the 3rd of November, and after the printing of this essay was completed, I heard an admirable paper read on the Geographical Distribution of Animals in the Malayan, New Guinea, and Australian continents and islands, by Mr. Alfred Wallace, who is still indefatigably investigating the zoology of those countries. The total absence of information as to the vegetation of New Guinea precludes my attempting any botanical corroboration of one of Mr. Wallace's most striking facts, viz. the complete difference between the zoology of Celebes and Borneo. These countries are separated by the Straits of Macassar, which are very deep, and the former belongs to the Australian zoological province, but the latter to the Malayan. The Straits of Lombok, to the south of those of Macassar, again, are, though only sixteen miles broad, also very deep, and separate in that latitude the Malayan from the Australian zoological province" (Hooker 1859: cxxviii).
5. For a summary of Latin American regionalisation see Morrone (2009: 176–181) and Fittkau et al. (1969); North America see Merriam (1892), Heilprin (1887), Dice (1943) and Haigmeier (1966); Papua New Guinea see Mayr (1944) and Gressitt (1982); South-east Asia see Schilder and Schilder (1939) and Southern Africa see Werger (1978).
6. "To the earlier naturalists, from a study of scanty material and with little or no personal knowledge of the continent, four divisions of east and west, temperate and tropical, seemed natural and sufficient" (Hedley 1894: 444).
7. This includes both European explorers and naturalists either at bequest by the colonial Governors or sent here by British collectors, gardens, herbaria or museums. For example German naturalist Ludwig Diels was invited to survey the Western Australian flora by the then first Premier John Forrest (Diels 1906: vi). Fellow German Ferdinand von Mueller was appointed government botanist in 1853 by the Lieutenant-Governor Charles La Trobe and, botanist to the North Australian Exploring Expedition (Morris 1974). George Caley, also a naturalist, was sent to New South Wales by Joseph Banks, who asked "to be supplied with specimens of such plants as you may find for myself and seeds for the Kew Gardens" (Banks to Caley November 16, 1798, in Currey 1966: 20). Only later in the Colonial Period do Australian based naturalists start making an impact, in particular English-born naturalists Charles Hedley and Ralph Tate.
8. Julian Huxley who first coined the term 'ecogeography' in English, never defined it clearly but wrote: "The tendency for eco-geographical differences within a continuous continental area to introduce partial discontinuities into a single specific population is of great evolutionary importance since, [...] species thus partially isolated into subspecies possess the highest degree of evolutionary plasticity and potentiality" (Huxley 1939: 416). The use of ecogeography has dwindled in recent decades (however see Suchantke [2001] for another use). We defer to the Oxford English Dictionary, 'Ecogeography' "the

combined study of the ecology and geographical distribution of organisms; (also) the geographical distribution of an organism in relation to its ecology" (OED, Third edition, March 2008; online version June 2011. <http://www.oed.com/view/Entry/59377>; accessed 28 July 2011. An entry for this word was first included in Oxford English Dictionary second edition, 1989).

9. Australian biogeographical regionalisation had its home in ANZAAS, at which Tate, Hedley and Nicholls presented their Presidential addresses on Australian biogeography. By 1997, the number of specialist conferences, held by ANZAAS drew to a close, due to higher cost and lower numbers. The result, fewer multidisciplinary meetings at which biogeographers from different taxonomic backgrounds could meet. A report on the online WiseNet laments the decision: "There were 187 people registered for the Congress [1996] - a far cry from the 2000-odd who used to turn up in the 1970s-80s. What has gone wrong? Chairman Bruce McKellar in his report of the Congress in the ANZAAS journal Search says the Congress was a success, that the science reported was topical, controversial and mostly well presented. Indeed I agree that the program was good, but how do we measure success? Why did so few attend, and why so few also at the Congresses in Newcastle in 1995 and in Geelong in 1994? [...] Has ANZAAS made a mistake by charging 'user-pays' registration fees and by holding its Congress in a hotel/conference centre? [...] I believe that many people who might be interested in ANZAAS are put off by such amounts; only those who can charge them to their employer or a 'slush fund' consider such fees normal. Historically, Congresses were held on university campuses, and host universities were proud to be involved in their organisation. Not so, it seems, in Canberra, for reasons that are not clear. [...] Scientists and fellow travellers have for years been predicting the demise of ANZAAS, but it persists. Its congresses have excellent programs, despite recent poor attendance records. [...] Universities are less willing in the existing economic climate, to commit resources and to second staff to give time to organising such events as these" (Temple 1997).
10. The seven volume 'Flora Australiensis' prepared by George Bentham between 1863–1878 is considered to be the most complete compendium of Australian flora for almost a century, did not have a section on botanical or vegetation elements or regions. Regardless, "Flora Australiensis, still a classic, was the first to cover any large continental area and one of the very few entirely written by one author. It represents a prodigious intellectual effort never equalled" (Burbidge 1969). Tate (1890) however seems to have mixed feelings about Bentham's weighty tome. Tate's 'Handbook of the flora of extratropical South Australia containing the flowering plants and ferns' "... is intended for those who have mastered the elements of botany and who wish to be acquainted, as rapidly and readily as may be, with the name and systematic position of any our of Native Plants. It is purposely kept brief, and, though too abridged to serve as a sole source of information, yet it is issued to meet the need of a handy work of reference, since the Flora Australiensis is too bulky and too expensive" (Tate 1890: v).
11. Tenison-Woods (1883: 572) was correct to believe that it was German born explorer Friedrich Wilhelm Ludwig Leichhardt who introduced the term "Bigalow" into the English language: "The Bricklow Acacia, which seems to be identical with the Rose-wood Acacia of Morteon Bay" (Leichhardt 1847: 4).
12. Vegetational provinces are based on the physiological and climatic features common to smaller "stations", whereas floristic regionalisation are based on the taxonomic composition and general climatic features of larger areas or "habitations". The former gave way to ecology while the latter to biogeography (see Nelson 1978).
13. The designation of geopolitical boundaries continues to this day, with many plant and animal distributions conflicting with those from other states (see Barlow 1984 and below).
14. Interestingly, in Tate's Rain Map of Australasia (Fig. 1) the Autochthonian is found within isocline of 25–90 inches. The next isocline 10–25, does not indicate exactly where the Autochthonian element ends.
15. Burbidge noted that "[t]he term was originally defined by Tate (1890) for a portion of northern South Australia and was spelt "Eremia". It was redefined under the current spelling by Diels (1906) and was further discussed by Gardner (1944)" Burbidge (1960: 79). Nicholls (1933) however ignores Diels and uses Tate's original spelling.
16. This apparent misunderstanding (i.e., that alpine plants in Australia are not native) may well, however, have had some truth about about it. Recent research suggests a strong link between Australian alpine and Andean flora (Moreira-Munoz 2009).
17. Tate's regions are superimposed onto a 'Rain Map of Australasia' (Tate 1889: Plate XVIII), once again emphasising the role of climate in Australian regionalisation.
18. Diels's 'Schematic explanation concerning the vegetation map of Australia' is divided unnumbered differently "Tropical Rainforest, Temperate Rainforest Sclerophyll Forest, Savanna Forest, Savanna, Mulga Scrub, Brigalow Scrub, Mallee Scrub or Heathland, Desert" (Diels 1906: 26, my translation). Differences between the vegetation types in Diels's map and accompanying text was noted by Beard, "A curious feature of the map and its key is that they seem out of accord with the treatment of the vegetation of Western Australia itself in the text of the book. The introductory chapter, which is a general introduction to the plant world of Australia, discusses in detail the eight formations recognized on the map using the same terminology, but the later chapters dealing with the South-west and Eremaean Provinces use quite a different classification" (Beard 1981: 441).
19. It is important to state here that a floristic element is type of flora with a similar distribution (e.g., Melanesian) whereas a vegetation type is a group of plants that are unique to a particular type of environment (e.g., riparian).
20. Diels refined the term 'Eremian' to 'Eremaea' (see Burbidge 1960).
21. Nicholls, like Diels, disapproved of Tate's term Autochthonian and replaced it with a new term 'Hesperonotian', "The name Autochthonian is not, however, altogether suitable, having certain implications with are, I believe, not warranted. Diels notes that he, likewise, refrains from the use of this term because there are attached to it certain genetic meanings which he could not accept. I propose, therefore, to use for this Region the term 'Hesperonotian' and for a less well-defined

borderland, overlapping the Eremian and agreeing fairly closely with Prescott's Sclerophyll Woodland and Scrub, I shall employ 'Mesohesperian'" (Nicholls 1933: 94).

22. These regions were proposed originally by Spencer (1896; see below), with the exception of the southwest of Australia, a region proposed by Nicholls (1933; see also Main *et al.* 1958: 228–229). Main *et al.* continue "Serventy and Whittell (1951: 46) modified Spencer's terminoloy [sic] and spoke of Bassian and Eyrian faunas. Serventy and Whittell note that the southwest (i.e. Nicholls' Hesperonotian region) contains both Eyrian [sic] and true Bassian elements and speculate as to which is the "true autochthonian" (Main *et al.* 1958: 229). In fact Spencer originally used the terms Eyrean and Bassian. Main *et al.* (1958) may have confused Nicholls terminology with Spencer's.
23. In particular see Fell (1962), Mayr (1952) and Axelrod (1963).
24. The various positions of the south-west boundary are summarised in Beard (2001: fig. 3).
25. The Autochthonian is vaguely referred as the 'extreme south-west': "The Euronotian Flora which is dominant in the more humid parts of temperate Australia, excepting the extreme south-west" (Tate 1890: 204).
26. Diels dismissed of the term 'Autochthonian' because: "it attaches itself to certain genetic concepts, which I am unable to make myself. Namely, Tate assumes that the autochthonous element is the oldest component of the whole Australian Flora. Originating on the continent, autochthonous element separated during the Cretaceous, establishing itself in the southeast, in which Eremaea became heavily modified, while the southwest remained unchanged." (Diels 1906: 375, my translation).
27. One explanation may be that Burbidge was referring to the term rather than to its definition. 'Autochthonian' derives from 'Autochthon' meaning indigenous. To most phyto- and zoogeographers of the Ecogeographicial Period, the Australian region is unique. In its usage however, 'Autochthonian' refers to primarily to south-west Australia.
28. "The latter being more or less identical with the 'Eremaean Region' of most Australian authors—is new in its present form" (Doing 1970b: 87).
29. In 1875, Tenison-Woods proposed that "[t]here can be no doubt that Tasmania unites features in her natural history which is characteristic of distinct provinces in Australia. If we take the eastern half of the Continent, we may divide it into three portions, viz. : The coast region, characterized by a genial humid climate, with a vegetation in the temperate regions which is almost tropical in luxuriance, and generally Asiatic in facies, which is more decided as we approach northward: (Tenison-Woods 1875: 42, original emphasis).
30. Tenison-Woods continues to describe each area: "The Southern has a peculiar fauna which possesses what are called the truly Australian genera [...] The Eastern has a few peculiar forms [...] The North-Eastern province seems entirely a derived fauna, in which the E. Australian, Indian and Pacific species meet [...] The N. Eastern province includes the species of Darnely Island and Torres Straits, with say Rockhampton for its centre. The Eastern province would include the East coast from Cape Byron to Cape Howe including E. Tasmania. The Northern provinces would extend from Cape Howe to Port Lincoln, west of Spencer's Gulf. These provinces are only meant to be some-what roughly estimated, but they correspond with what I have noticed as to the Molluscan fauna" (Tenison-Woods 1878: 147–148).
31. Tenison-Woods considered the north-western and western divisions "arbitrary, as of these regions so little is known" (Tenison-Woods 1882: 49 footnote).
32. In the same year (1888) Tenison-Woods was the recipient of the prestigious Clarke Medal, awarded by the Royal Society of New South Wales for his 'On the anatomy and life history of Mollusca peculiar to Australia' (Borchardt, 1976). Other medalist include George Bentham (1879), Baron Ferdinand von Mueller (1883), Joseph Dalton Hooker (1885), Ralph Tate (1893), Walter Baldwin Spencer (1923), Charles Hedley (1925), Edward de Courcy Clarke (1954), Tom Iredale (1959), Charles Austin Gardner (1961), Gilbert Percy Whitley (1970), Nancy Tyson Burbidge (1971), Noel Charles William Beadle (1982) all of whom have made a significant contribution to Australian biogeography (Royal Society of New South Wales: http://nsw.royalsoc.org.au/awards/clarke_medal.htm accessed 28 March, 2012).
33. Given that Hedley (1894) created three new areas after 1882, one wonders whether Hedley himself should be included as having overlooked the scheme of Tenison-Woods.
34. Spencer rejected Hedley's term of Papuan in favour of Torresian "as being less liable to lead to confusion and as suggestive of the position of the old land connection which gave rise to the faunal affinity of its now separated northern and southern parts" (Spencer 1896: 197). Spencer also describes the Torresian, something that Hedley never did with his term the 'Papuan', "[the] fauna and flora developed on the coasts of Queensland and New South Wales would best be described as Papuan. Indeed, so distinct is this latter, that a separation of Australian life in Papuan and non-Papuan seems to the writer to be the primary divisions into which fall the Australian fauna and flora" (Hedley 1894: 445). Also, "[l]ate in the Tertiary Epoch, as I read the record, Torres Straits, now only a few fathoms deep, was upheaved, and across this bridge there poured into Australia a stream of Papuan life. Between the coastal range and the sea as far as the tropics the irruption flowed in undiminished strength; on reaching the border of N.S.W. the cooler climate diminished its vigour, and at the Clarence River, N.S.W., with few exceptions, it found its southern limit. Within this area grow side by side, like oil and water touching yet not commingling, two distinct vegetations, the dense Papuan jungle called "Scrub" by the Queenslanders, which has usurped every rich volcanic upland and every fat alluvial plain, and the lightly timbered "Forest" of acacias and eucalypts confined to the inferior soils" (Hedley 1893: 190–191).
35. "We find no great Autochthonian region occupying the western and south-western part of the continent [...] there is no evidence pointing to the fact that in the case of the most important groups of Australian animals—the Monotremes and Marsupials—the old western part of the continent has any claim to the title Autochthonian" (Spencer 1896: 176–177; also see Eaton 1900: 29; Main et al. 1958: 228).

36. Hedley noted the use of the term ‘Adelaidean’ by Julian Tenison-Woods (1882): “His scheme is neither natural nor well-defined, and has been overlooked by Tate, Spencer and other writers on Australian zoogeography. The meaning I attach to 'Adelaidean' is not that of Tenison-Woods" (Hedley 1904: 880). The Adelaidean was replaced by the Flindersian by Cotton (1930).
37. In Schilder’s (1956) later work, ‘Lehrbuch der Allgemeinen Zoogeographie’, which attempts to regionalise all terrestrial animals, Australia is divided into nine terrestrial regions, “1 Inneraustralien, 2 Nord-Terrt., Arnhemld., 3 Queensland, 4, New South Wales, 5 Victoria, 6 Tasmania, 7 Südaustralien, 8 Eucla - Geraldton, 9 Sharksbay - Windham [sic]” (Schilder 1956: 87). Given their vast Prodrome, it seems puzzling as to why Franz Schilder didn’t include marine regions into his world classification.
38. One point of interest however is the close similarity between Schilder and Schilder’s area ‘Queensland S’, extending from the Macleay River to Hervey Bay, to that of Burbidge’s later terrestrial McPherson-Macleay overlap zone[25]. Both areas would abut and have exactly the same the northern and southern extents.
39. The Post-Federation Period is expertly summarised by Nicholls (1933) and Keast (1959).
40. Later revised by Ashby (1926) and Bennett & Pope (1953).
41. Kott (1952) divides the Peronian into the Oxleyan and Maugean marine sub-regions.
42. Straughan also used Whitely’s (1932) term, Banksian, “... a province which may be continuous with the Damperian, embracing he mainland coast and islands between 10°S and 25°S” (Straughan 1967: 254).
43. Günther (1880: 2) was possibly to first to unwittingly classify Australian marine regions, namely into the ‘Temperate Zone of the South Pacific’ and ‘Tropical Zone of the Indo-Pacific’. Unfortunately neither of these zones are justified or explained further. Rather they are used to break up the text into the areas in which fish were collected during the Challenger Expedition between 1873 - 1876.
44. Sloane 1915 map was an improvement on his previous attempt (Sloane 1905, map on p. 2). Interestingly, Sloane emphasised the “view that such faunal districts are better suited than any political division for use of biologists to show the distribution of genera and species [...] It is much desired that workers in different groups should use the same set of faunal districts, and it is not to be supposed that a system of districts which will command itself generally to zoologists can be evolved without much study and research” (Sloane 1915: 148, map on p. 147). Sadly, this is no longer the view among zoogeographers today.
45. Pianka was unusual for zoogeographers of his time in that he used existing geographical areas such as the Great Sandy Desert, Nullabor Plain, Great Victoria Desert, Pilbra region, rather than existing zoogeographical areas. Interestingly, he used two phytogeographic regions proposed by Diels (1904), namely, ‘Mulga scrub country’ and ‘Mulga scrub’. Although Doing’s phytogeographical regions included several geographical regions (i.e, Nullabor), they do contain areas of vegetation, for example ‘western Mallee province’, ‘Brigalow’, ‘Eastern forest region’ etc.
46. Presently, the term ‘Bassian’ is used to describe the bird *Zoothera lunulata* or the Bassian Thrush, which ironically occurs along the entire length of eastern Australian coast, formerly Tate’s Euronotian region.
47. State regionalisations include New South Wales (Harden 1990), Northern Territory (Chippendale 1972), Queensland (Henderson 1974), South Australia (Jessop & Toelken 1986), Tasmania (Orchard 1988), Victoria (Conn 1993) and Western Australia (Beard 1980). The Australian National Herbarium’s Centre for Australian National Biodiversity Research (CANBR) provides areas for the Australian Capital Territory and the Oceanic Islands (see Halasz http://www.anbg.gov.au/cpbr/anhsir/anhsir-manual/botanical-districts.html accessed November 2, 2011). The accumulation of areas used by state herbaria is practical rather than in ignorance of Barlow’s scheme. To adopt any new scheme, there would need to be a complete revision of databases found in eight or so herbaria.
48. In response to Barlow (1984), Beard stated “that if we are going to use natural ecological regions they must be allowed to have their correct natural boundaries. A natural region ceases to be such if it is dissected or has adjacent areas lumped with it” (Beard 1985: 384). Natural regions, as opposed to arbitrary regions, are based on assumed ecological, biotic or climate areas that are defined by history and process, rather than ad hoc divisions, like grids or geopolitical areas.
49. Richard Scodde, in presentation at the Nancy T. Burbidge Memorial Lecture in 1989, was possibly the last person to revise the increasingly forgotten biotic elements, “[a]ll that I have had to do here to conventional schemes of southern Bassian, northern Torresian and central Eyrean or Eremaean biotas is to separate the Malesian or Irian rainforest biota and the old Australian Tertiary or Tumbunan rainforest biota out from the Torresian eucalypt element, and, on top of that, to superimpose arrowed lines showing the directions of adaptive radiation [...] The word Tumbunan, incidentally, comes from the Melanesian pidgin word Tumbuna, meaning ancestor” (Scodde, 1989, http://www.anbg.gov.au/asbs/newsletter/burbidge-1989.html).
50. “An objective of the Australian Biological Resources Study is to stimulate research and publications on the taxonomy and distribution of Australian fauna [Australian Zoological Catalogue] and flora [Flora of Australia]” (Wells in Calder 1998: ix).
51. The baseline data for Victoria is a refinement of the 1:500,000 scale land systems and geomorphic units; for Tasmania it is the 1:500,000 scale Nature Conservation Regions; for NSW and ACT were “derived by expert assessment of available information on the distribution of geological, geomorphological and biological elements. The environmental regions developed by Morgan and Terrey (1992) were used as a regionalisation of the environment west of the Great Dividing Range”; South Australia the 1:500,000 scale Environments of South Australia; Western Australia is a modification of Beard (1980); Northern Territory “included land system mapping developed by CSIRO and the CCNT, vegetation mapping, environmental domains and biogeographic domains. Map regions were reclassified and aggregated to reflect affini-

ties with those of adjacent States and Territories by grouping regions with similar geology, landform, soils and vegetation" and; Queensland the "1:500,000 scale land system mapping, 1:2,500,000 scale, Biogeographic Regions and a number of other resource and environmental reports" (Environment Australia 2000: 6, table 1).

52. For instance, Australian biogeographical regionalisation (traditionally revised by malacologists and botanists) was not discussed at two prominent conferences, the XVIII International Botanical Congress held in Melbourne, 2011 and, the World Congress of Malacology held in Perth, 2004, despite attracting thousands of people, many of whom are biogeographers. However, regionalisation of other areas, such as Europe and Latin America were discussed at the Botanical Congress.

References

Anderson, R.H. (1947) The trees of New South Wales. NSW Government Printer, Sydney, 453 pp.

Axelrod, D.I. (1963) Fossil floras suggest stable, not drifting continents. *Journal of Geophysical Research*, 68, 3257–3263.

Anon (1877) Wallace's Geographical Distribution of Animals Source. *The American Naturalist*, 11, 232–238.

Archer, M. & Clayton, G. (1984) Vertebrate zoogeography and evolution in Australasia. Hesperian, Perth, pp. 1203.

Ashby, E. (1926). The regional distribution of Australian chitons (Polyplacophora). *Reports of the Australian and New Zealand Association for the Advancement of Science*, 17, 366–393.

Barker, W.R & Greenslade, P.J.M. (1982) Evolution of the flora and fauna of arid Australia. Peacock, Adelaide, 392 pp.

Barlow, B.A. (1984) Proposal for delineation of botanical regions in Australia. *Brunonia*, 7, 195–201.

Beard, J.S. (1985) Comment on Barlow's Proposal for Delineation of Botanical Regions in Australia. *Brunonia*, 8, 381–385.

Beard, J.S. (1981) The history of the phytogeographic region concept in Australia. In: Keast, A. (Ed.). Ecological biogeography of Australia. Dr W. Junk Publishers, The Hague, pp. 335–375.

Beard, J.S. (1980) A new phytogeographic map of Western Australia. *Research Notes of the Western Australian Herbarium*, 3, 36–58.

Beard, J.S. (2001) A historic vegetation map of Australia. *Austral Ecology*, 26, 441–443.

Beard, J.S. & Sprenger, B.S. (1984) Geographical data from the Vegetation Survey of Western Australia, with map of aeolian landforms 1:3 000 000. Vegetation Survey of Western Australia Occasional paper No. 2. Vegmap Publications, Applecross, Western Australia, 62pp.

Beadle, N.C.W. (1948) The Vegetation and Pastures of Western New South Wales. Government Printer, Sydney, 281 pp.

Bennett, I. & Pope, E.C. (1953) Intertidal zonation of the exposed rocky shores of Victoria, together with a rearrangement of the biogeographical provinces of temperate Australian shores. *Australian Journal of Marine and Freshwater Research*, 4, 105–59.

Bierce, A. (2000) The Unabridged Devil's Dictionary. University of Georgia Press, Athens, 440 pp.

Bishop, M.J. (1981) The biogeography and evolution of Australian land snails. In: Keast, A. (Ed.). Ecological biogeography of Australia. Dr W. Junk Publishers, The Hague, pp. 923–954.

Blakers, M., Davies, S.J.J.F. & Reilly, P.N. (1984) The Atlas of Australian Birds. Melbourne University Press, Melbourne, 738 pp.

Borchardt, D.H. (1976). Tenison-Woods, Julian Edmund (1832–1889). Australian Dictionary of Biography, National Centre of Biography, Australian National University, http://adb.anu.edu.au/biography/tenison-woods-julian-edmund-4700/text7787, accessed 28 March 2012.

Browne, J. (1983) The secular ark: Studies in the history of biogeography. Yale University Press, New Haven, Connecticut, 273 pp.

Burbidge, N. (1960) The phytogeography of the Australian region. *Australian Journal of Botany*, 8, 75–211.

Burbidge, N.T. (1969) Bentham, George (1800–1884). Australian Dictionary of Biography, National Centre of Biography, Australian National University, http://adb.anu.edu.au/biography/bentham-george-2979/text4345, accessed 26 July 2011.

Camerini, J.R. (1993) Evolution, biogeography, and maps: An early history of Wallace's Line. *Isis*, 84, 700–727.

Cameron, L.M. (1935) The Regional Distribution of Vegetation in New South Wales. *Australian Geographer*, 2, 18–32.

Campbell, G. (1943) Australian faunal regions. *Emu*, 42, 242–245.

Carnahan, J.A. (1976) Natural vegetation. Atlas of Australian Resources, Second Series. Department of National Resources, Canberra, 36 pp.

de Candolle, A.P. (1820) Essai élélmentare de géographie botanique. *Dictionnaire des sciences naturelles*, 18, 1–64.

Clarke, E. de C. (1926). Natural Regions in Western Australia. *Journal and Proceedings of the Royal Society of Western Australia*, 12, 117–132.

Chippendale, G. (1972) Checklist of Northern Territory Plants. *Proceedings of the Linnean Society of New South Wales*, 96, 207–267.

Conn, B.J. (1993) Natural regions and vegetation of Victoria. In: Foreman, D.B. & Walsh, N.G. (Eds.). Flora of Victoria Volume 1, Inkata Press, Melbourne, pp. 79–158.

Cracraft, J. (1991) Patterns of diversification within continental biotas: hierarchical congruence among the areas of endemism of Australian vertebrates. *Australian Systematic Botany*, 4, 211–227.

Crisp, M.D. & Weston, P.H. (1995) Mirbelieae. In: Doyle, J.J. & Crisp, M.D. (Eds.). Advances in Legume Systematics, Part 7. Royal Botanic Gardens, Kew, pp. 245–282.

Crisp, M.D., Linder, H.P. & Weston, P.H. (1995) Cladistic biogeography of plants in Australia and New Guinea: congruent pattern reveals two endemic tropical tracks. *Systematic Biology*, 44, 457–473.
Crisp, M.D., West, J.G. & Linder, H.P. (1999) Biogeography of the terrestrial flora. In: Orchard, A.E. & Thompson, H.S. (Eds.). Flora of Australia, Volume 1. Second Edition. CSIRO, Melbourne, pp. 321–367.
Cogger, H.G. & Heatwole, H. (1981) The Australian reptiles: Origins, biogeography, distribution patterns and island evolution. In: Keast, A. (Ed.). Ecological biogeography of Australia. Dr W. Junk Publishers, The Hague, pp. 1331–1374.
Colgan, D.J, O'Meally, D. & Sadlier, R.A. (2009) Phylogeographic patterns in reptiles on the New England Tablelands at the south-western boundary of the McPherson Macleay Overlap. *Australian Journal of Zoology*, 57, 317–328.
Cotton, B.C. (1930) Fissurellidae from the "Flindersian" region, Southern Australia. No. 1. *Records of the South Australian Museum*, 4, 212–222.
Currey, J.E.B. (1966) Reflection on the colony of New South Wales: George Caley explorer and natural history collector for Sir Joseph Banks. Lansdowne Press, Melbourne, 239pp.
Dice, L.R. (1943) The biotic provinces of North America. University Michigan Press, Ann Arbor, 78 pp.
Diels, L. (1906) Die Pflanzenwelt von West-Australien südlich des Wendekreises. In: Engler, A. & Drude, O. (Eds.). Vegetation der Erde VII. W. Engelmann, Leipzig, pp. 1–413.
Doing, H. (1970a) Botanical Geography and Chorology in Australia. *Mededelingen van de botanische tuinen en het Belmonte Arboretum der Landbouwhogeschool te Wageningen*, 13, 81–89.
Doing, H. (1970b) Botanical Geography and Chorology in Australia. *Belmontia* (Miscelanous Papers No. 6), 13, 81–88.
Drude, O. (1890) Handbuch der Pflanzengeographie. J. Engelhorn Verlag, Stuttgart, 582 pp.
Eaton, E.H. (1900) The Zoology of the Horn Expedition. *The American Naturalist*, 34, 25–31.
Ebach, M.C. & Goujet, D.F. (2006) The first biogeographical map. *Journal of Biogeography*, 33, 1–9.
Ekman, S. (1953) Zoogeography of the sea. Sidgwick and Jackson, London, 417 pp.
Endean, R. (1957) The biogeography of Queensland shallow-water echinoderm fauna (excluding Crinoidea), with a rearrangement of the faunistic provinces of tropical Australia. *Australian Journal of Marine and Freshwater Research*, 8, 233–73.
Environment Australia (2000) Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and development of Version 5.1: Summary Report. Environment Australia, Canberra, 36 pp.
Escalante, T., Rodríguez, G., Cao, N., Ebach, M.C. & Morrone, J.J. (2007) Cladistic biogeographic analysis suggests a Caribbean diversification prior to the Great American Biotic Interchange and the Mexican Transition Zone. *Naturwissenschaften*, 94, 561–565.
Favenc, E. (1888) The History of Australian Exploration from 1788 to 1888. Turner and Henderson, Sydney, 474 pp.
Fell, H.B. (1962) West-wind drift dispersal of echinoderms in the southern hemisphere. *Nature*, 193, 759–761.
Ferrar, A.N. (1984) The graphical records of Matthew Flinder's Voyage to Terra Australis. Journal of Navigation, 37, 94–103.
Flinders, M. (1814). A Voyage to Terra Australis. G. & W. Nicol, London, 613 pp.
Fittkau, E.J., Iilies, E.J.J., Klinge, H., Schwabe, G.H. & Sioli, H. (1969) Biogeography and ecology in South America. Dr. W. Junk Publishers, The Hague, 516 pp.
Gardner, C.A. (1944) The vegetation of Western Australia with special reference to the climate and soils. *Journal of the Royal Society of Western Australia*, 28, 11–87.
Gardner, C.A. & Bennetts, H.W. (1956) The Toxic Plants of Western Australia. West Australian Newspapers Ltd, Perth, 253 pp.
Good, R. (1964) The Geography of flowering plants. Longman, London, 518 pp.
Gressitt, J.L. (1982) Biogeography and ecology of New Guinea. Dr. W. Junk Publishers, The Hague, 983 pp.
Günther, A.C.L.G. (1880) Report on the shore fishes procured during the voyage of H. M. S. Challenger in the years 1873–1876. *Report on the scientific results of the voyage of H. M. S. Challenger during the years 1873–76 (Zoology)*, 22, 1–82.
Hagmeier, E. (1966) A numerical analysis of the distribution patterns of North American mammals. *Systematic Zoology*, 13, 125–155.
Harden, G.J. (1990) Flora of New South Wales, Volume 1. New South Wales University Press, Kensington, New South Wales, 601 pp.
Hedley, C. (1893) On the Relation of the Fauna and Flora of Australia to Those of New Zealand. *Natural Science*, 3, 187–191.
Hedley, C. (1894) The Faunal Regions of Australia. *Reports of the Australian Association for the Advancement of Science*, 5, 444– 446.
Hedley, C. (1904) The effect of the Bassian isthmus upon the existing marine fauna: a study in ancient geography. *Proceedings of the Linnean Society of New South Wales*, 28, 876–883.
Heilprin, A. (1887) The Geographical and Geological Distribution of Animals. Kegan Paul, London, 435 pp.
Henderson, R.J.F. (1974) Solanum nigrum L. (Solanaceae) and related species in Australia. *Contributions from the Queensland Herbarium*, 16, 1–78.
Hill, R.S. (1993) Program and abstracts, Southern Temperate Ecosystems, Origin and Diversification: Hobart, Tasmania, January 18th–22nd. The Connection, Hobart, 109 pp.
Hooker, J.D. (1859) The Flora of Australia, its [sic] origin, affinities, and distribution; being an introductory essay to the Flora of Tasmania. Lovell Reeve, London, cxxviii pp.
Horton, D. (1973) The concept of zoogeographic subregions. *Systematic Zoology*, 22, 191–195.
Huxley, J.S. (1939) Ecology and Taxonomic Differentiation. *Journal of Ecology*, 27, 408–420.

Interim Marine and Coastal Regionalisation for Australia Technical Group (1998) Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments Version 3.3. Environment Australia, Commonwealth Department of the Environment. Canberra, 102 pp.
Iredale, T. (1929) The avifaunal districts of Australia. From Report of the Hobart Meeting, 1928, Australian Association for the Advancement of Science, pp. 244–245.
Iredale, T. (1937) A basic list of the land Mollusca of Australia. *Australian Zoologist* 8, 287–333.
Iredale, T. & May, W.L. (1916) Misnamed Tasmanian chitons. *Proceedings of the Malacological Society of London*, 12, 94–117.
Iredale, T. & Whitley, G.P. (1938) The fluvifauna of Australia. *South Australian Naturalist*, 18, 64–68.
Jeffrey, S.W., Rochford, D.J. & Cresswell, G.R. (1990) Oceanography of the Australasian Region. In: Clayton, M.N. & King, R.J. (Eds.). Biology of Marine Plants. Longman Cheshire, Melbourne, pp. 243–265
Jessop, J.P. & Toelken, H.R. (1986) Flora of South Australia. South Australian Government Printing Division, Adelaide, 2248 pp.
Keast, A. (1959) Australian birds: their zoogeography and adaptations to an arid continent. In: Keast, A., Crocker, R.L. & Christian, C.S. (Eds.). Biogeography and Ecology in Australia. Dr. W. Junk Publishers, The Hague, pp. 89–114.
Keast, A. & Miller, S.E. (1996) The origin and evolution of the Pacific island Biotas, New Guinea to Eastern Polynesia: Patterns and Processes. SPB Academic publishing, Amsterdam, 531 pp.
Kitching, R. (1988) The Ecology of Australia's wet tropics: proceedings of a symposium held at the University of Queensland, Brisbane August 25–27, 1986. Surrey Beatty, Chipping Norton, 326 pp.
Key, K.H.L. (1959) The ecology and biogeography of Australian grasshoppers and locusts. In: Keast, A., Crocker, R.L. & Christian, C.S. (Eds.). Biogeography and Ecology in Australia. Dr. W. Junk Publishers, The Hague, pp. 192–210.
Kott, P. (1952) The Ascidians of Australia. I. Stolidobranchiata Lahille and Phlebobranchiata Lahille. *Australian Journal of Marine and Freshwater Research*, 3, 205–334.
Knox, G.A. (1963). The biogeography and intertidal ecology of the Australasian coasts. *Annual Review of Oceanography and Marine Biology*, 1, 341–404.
Ladiges, P.Y. (1998) Biogeography after Burbidge. *Australian Systematic Botany*, 11, 231–242.
Ladiges, P.Y., Humphries, C.J. & Martinelli, L.W. (1991) Austral biogeography. CSIRO, Melbourne, 227 pp.
Ladiges, P.Y., Udovicic & Nelson, G. (2003) Australian biogeographic connections and the phylogeny of large genera in the plant family Myrtaceae. *Journal of Biogeography*, 30, 989–998.
Lamarck, J.B.P.A.D.M.D. & A.P.D. Candolle. 1805. Flore française, ou descriptions succinctes de toutes les plantes qui croissent naturellement en France: Disposées selon une nouvelle méthode d'analyse, et précédées par un exposé des principes élémentaires de la botanique Tome 2. Desray, Paris, 940 pp.
Leichhardt, L. (1847) Journal of an overland expedition in Australia from Moreton Bay to Port Essington, a distance of upwards of 3000 miles, during the years 1844 – 1845. T & W Boone, London, 554 pp.
Littlejohn, M.J. (1981) The amphibia of mesic Southern Australia: A zoogeographic perspective. In: Keast, A. (Ed.). Ecological biogeography of Australia. Dr W. Junk Publishers, The Hague, pp. 1303–1330.
Main, A.R., Lee, A.K. & Littlejohn. M.J. (1958) Evolution in Three Genera of Australian Frogs. *Evolution*, 12, 224–233.
Mayr, E. (1944) Wallace's line in the light of recent zoogeographic studies. *Quarterly Review of Biology*, 19, 1–14.
Mayr, E. (1952) The problem of land connections across the South Atlantic, with special reference to the Mesozoic. *Bulletin of the American Museum of Natural History*, 99, 79–258.
Merriam, C.H. (1892) The geographical distribution of life in North America with special reference to the Mammalia. *Proceedings of the Biological Society of Washington*, 7, 1–64.
Merrick, J.R., Archer, M., Hickey, G. & Lee, M. (2007) Evolution and Zoogeography of Australasian Vertebrates. Australian Scientific Publishing Pty Ltd, Sydney, pp. 942.
McMichael, D.F. & Hiscock, I.D. (1958) A monograph of the freshwater mussels (Mollusca: Pelecypoda) of the Australian region. *Australian Journal of Marine and Freshwater Research*, 9, 372–508.
McMichael D.F., & Iredale, T. (1959). The land and freshwater Mollusca of Australia. In: Keast, A., Crocker, R.L. & Christian, C.S. (Eds.). Biogeography and Ecology in Australia. Dr. W. Junk Publishers, The Hague, pp. 224–245.
Millar, A.J.K. (2007) The Flindersian and Peronian Provinces. In: McCarthy, P.M. & Orchard, A.E. (Eds.). Algae of Australia: Introduction. Australian Biological Resources Study, CSIRO Publishing, Collingwood, Victoria, Australia, pp. 554–559.
Morgan, G. & Terrey, J. (1992) Nature Conservation in Western New South Wales. A report prepared by Landwater Management for the National Parks Association of NSW Inc., Sydney, 138pp.
Moore, J.A. (1961) The Frogs of Eastern New South Wales. *Bulletin of the American Museum of Natural History*, 121, 149–386.
Moreira-Muñoz, A. (2011) Plant Geography of Chile. Springer, Dordrecht, 343pp.
Morris, D. (1974). Mueller, Sir Ferdinand Jakob Heinrich von (1825–1896). Australian Dictionary of Biography, National Centre of Biography, Australian National University, http://adb.anu.edu.au/biography/mueller-sir-ferdinand-jakob-heinrich-von-4266/text6893, accessed 12 October 2011.
Mueller, F. von (1858) Botanical report on the North-Australian Expedition, under the command of A. C. Gregory, Esq. *Journal of the Proceedings of the Linnean*, 2, 137–63.
Mueller, F., von (1882) Systematic census of Australian plants. McCarron, Bird & Co., Melbourne.

Nelson, G.J. (1978) From Candolle to Croizat: Comments on the history of biogeography. *Journal of the History of Biology*, 11, 296–305.
Newton, J.H. (1845) Animal topography: or, the geographical distribution of animals, illustrated in familiar verse with descriptive notes, and accompanied by a zoological map of the world. William Spooner, London, 99 pp.
Nicholls, G.E. (1933) The Composition and Biogeographical Relations of the Fauna of Western Australia. *Reports of the Australian Association for the Advancement of Science*, 21, 93–138.
Orchard, A.E. (1988) A natural regions map for Tasmania. *Proceedings of the Royal Society of Tasmania*, 122, 47–51.
Ortmann, A.E. (1896) Grundzüge der marinen Tiergeographie. Gustav Fischer Verlag, Jena, 96 pp.
Parenti, L.R. & Ebach, M.C. (2009) Comparative Biogeography: Discovering and Classifying Biogeographical Patterns of a Dynamic Earth. University of California Press, Berkeley, 295 pp.
Perrier, E. (1878) Étude sur la répartition géographique de astérides. *Nouvelles Archives du Museum d'historie Naturelle*, 2, 1–108.
Pianka, E.R. (1969a) Habitat specificity, speciation, and species density in Australian desert lizards. *Ecology*, 50, 498–502.
Pianka, E.R. (1969b) Sympatry of desert lizards (Ctenotus) in Western Australia. *Ecology*, 50, 1012–1030.
Pockley, P. (1997) Cash-strapped ANZAAS is set for closure. *Nature*, 389, 532.
Powell, A.W.B. (1957) Marine provinces of the Indo-West Pacific. *Proceedings of the Eighth Pacific Science Congress of the Pacific Science Association*, 3, 359–370.
Prichard, J.C. (1836) Researches into the physical history of mankind, Third Edition. Sherwood, Gilbert and Piper, London, 376 pp.
Richards, J.A. (1979) Blaxland-Lawson-Wentworth. Blubber Head Press, Hobart, 222 pp.
Schilder, F.A. (1956) Lehrbuch der allegemeinen zoogeographie. Gustav Fischer Verlag, Jena, 150 pp.
Schilder, F.A. & Schilder, M. (1938) Prodome of a monograph on living Cypraeidae. *Proceedings of the Malacological Society of London*, 23, 119–180.
Schilder, F.A. & Schilder, M. (1939) Prodome of a monograph on living Cypraeidae. *Proceedings of the Malacological Society of London*, 23, 181–252.
Schmidt, K.P. (1954) Faunal Realms, Regions, and Provinces. *The Quarterly Review of Biology*, 29, 322–331
Schmarda, L.K. (1853) Die Geographische Verbreitung der Thiere. Carl Gerold and Son Verlag, Vienna, 642 pp.
Schodde, R. (1989) Origins, radiations, and sifting in the Australasian biota - Changing concepts from new data and old. *Australian Systematic Botany Newsletter*, 60, 2–11.
Sclater, P.L. (1858) On the general geographical distribution of the members of the class Aves. *Journal of the Proceedings of the Linnean Society (Zoology)*, 2, 130–145.
Serventy, D.L. & Whittell, H.M. (1951) A handbook of the birds of Western Australia. University of Western Australia Press, Perth, 384 pp.
Serventy, D.L. & Whittell, H.M. (1962) Birds of Western Australia, Third Edition. Perth, Paterson Brokensha, 427 pp.
Simpson, G.G. (1961) Historical Zoogeography of Australian Mammals. *Evolution*, 15, 431–446.
Sloane, T.G. (1905) Australian Carabidae. Check-list. Part i. Subfamily Carabinae. *Supplement to the Proceedings of the Linnean Society of New South Wales (Part i)*, 30, 1–18.
Sloane, T.G. (1915) On the faunal subregions of Australia. *Proceedings of the Royal Society of Victoria*, 28, 139–48.
Specht, R.L. (1958) Geographical relationships of the flora of Arnhem Land. In: Specht, R.L. & Mountford, C.P. (Eds.). Records of the American-Australian Scientific Expedition to Arnhem Land, Volume 3, Botany and Plant Ecology. Melbourne University Press, Melbourne, pp. 415–478.
Spencer, W.B. (1896) Report on the work of the Horn Scientific Expedition to Central Australia: Part I - Introduction, narrative, summary of results, supplement to zoological Report, map. Melville, Mullen & Slade, Melbourne, 220 pp.
Smith, B.J. (1984) Regional endemism of the south-eastern Australian land mollusc fauna. In: Solem, A. & van Bruggen, A.C. (Eds.). World-wide snails: biogeographical studies on non-marine Mollusca. Backhuys Publishers, Leiden, pp. 178–188.
Stejneger, L. (1901) Scharff's history of the European fauna. *The American Naturalist*, 35, 87–116.
Straughan, D. (1967) Marine Serpulidae (Annelida: Polychaeta) of eastern Queensland and New South Wales. *Australian Journal of Zoology*, 15, 201–261.
Suchantke, A. (2001) Eco-Geography. Lindisfarne Press, Great Barrington Massachusetts, 250 pp.
Takhtajan, A. (1986) Floristic regions of the world. University of California Press, Berkeley, 522 pp.
Tate, R. (1889) On the influence of physiological changes in the distribution of life in Australia, Report of the First Meeting of the Australian Association for the Advancement of Science, pp. 312–326.
Tate, R. (1890) A handbook of the flora of extratropical South Australia, containing the flowering plants and ferns. The Eduction Department, Adelaide, Australia, 303 pp.
Temple, D. (1997) 1996 ANZAAS Congress. WISENET Journal, 43, http://www.wisenet-australia.org/issue43/anzaas.htm. Accessed on 21 March 2012.
Tenison-Woods, J.E. (1875) Notes on the physical and zoological relations between Australia and Tasmania. *Papers and Proceedings of the Royal Society of Tasmania*, 29, 42–52.
Tenison-Woods, J.E. (1878) The echini of Australia. *The Proceedings of the Linnean Society of New South Wales*, 2, 145–176.
Tenison-Woods, J.E. (1882) On the natural history of New South Wales: an essay. Thomas Richards, Government Printers, Sydney, 50 pp.

Tenison-Woods, J.E. (1883) Botanical notes on Queensland, No. V. The Forest or Scrubs. *Journal and Proceedings of the Royal Society of New South Wales*, 7, 565–585.
Tenison-Woods, J.E. (1888) On the anatomy and life history of Mollusca peculiar to Australia. *Journal and Proceedings of the Royal Society of New South Wales*, 22, 106–186.
Thackway, R. & Cresswell, I.D. (1995) An Interim Biogeographic Regionalisation for Australia: a Framework for Establishing the National System of Reserves, Version 4.0. Australian Nature Conservation Agency, Canberra, 36 pp.
Turner, H. (1996) Sapindaceae and the biogeography of eastern Australia. *Australian Systematic Botany*, 8, 133–167.
Udvardy, M.D.F. (1975) A Classification of the Biogeographical Provinces of the World. IUCN Occasional Paper (No. 18). International Union for Conservation of Nature and Natural Resources, Morges, Switzerland, 49 pp.
Verran, H. (2009) Natural Resource Management's "Nature" and its Politics. *Communication, Politics, and Culture*, 42, 3–18.
Walker, K.F. (1981) The distribution of freshwater mussels (Mollusca: Pelecypoda) in the Australian zoogeographic region. In: Keast, A. (Ed.). Ecological biogeography of Australia. Dr W. Junk Publishers, The Hague, pp. 1231–1250.
Wallace, A.R. (1876) The geographical distribution of animals; with a study of the relations of living and extinct faunas as elucidating the past changes of the Earth's surface. Macmillan, London, 503 pp.
Waters, J.M., Wernberg, T., Connell, S.D., Thomsen, M.S., Zuccarello, G.C. & Kraft G.T. (2010) Australia's marine biogeography revisited: Back to the future? *Austral Ecology*, 35, 988–992.
Wells, A. (1998) Zoological Catalogue of Australia, Volume 29.6. CSIRO Publishing, Melbourne, 264 pp.
Werger, M.J.A. (1978) Biogeography and Ecology of Southern Africa. Dr W Junk Publishers, The Hague, 1439 pp.
Whitley, G. (1932) Marine zoogeographical regions of Australia. *Australian Naturalist*, 8, 166–67.
Williams, R.J. (1955) Vegetation regions. Atlas of Australian Resources, Canberra, 23 pp.
Womersley, H.B.S. (1960) The marine algae of Australia. *Botanical Review*, 25, 545–614.