Botanica Marina Vol. 41, 1998, pp. 89–93

Biodiversity of Australian Marine Macroalgae – A Progress Report

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The biodiversity of Australian macroalgae is assessed by reference to species numbers recorded for the various biogeographical and political regions. The figures show a marked disparity between northern and southern Australia, with the former apparently depauperate as compared to the rich flora recorded from southern Australia. Whilst a reduction in species numbers is expected when comparing tropical to temperate regions, the situation in Australia is greatly exaggerated by relative levels of collecting and research effort. The completion of an Australia-wide macroalgal flora will be severely hampered until additional effort is directed towards these unexplored regions.

Introduction

Recent years have seen the promotion of biodiversity studies as essential to the future well-being of the planet. Recognition that human survival rests on our preservation of the diversity of the natural world is not new – but that it is now discussed in political as well as scientific arenas most certainly is. But what is biodiversity? Simply put, biodiversity is the variety of life – an uncomplicated definition for a complex subject. The study of biodiversity includes a wide range of scientific disciplines, from taxonomy and systematics, to conservation genetics and ecosystem ecology. Long-term conservation and prudent management of biodiversity depends upon a through knowledge of genetic, species and ecosystem diversity. Generally, the first step is to enumerate and document the species. The 'Systematics Agenda 2000', an ambitious program initiated by several international systematics societies (The American Society of Plant Taxonomists, the Society of Systematic Biologists, and the Willi Henning Society), has as its aim 'to discover, describe and classify the world's species'. It recognises three 'missions' integral to this endeavour.

1. *Discovering* biological diversity, through surveys, inventories, collections, and the description of species.
2. *Understanding* biological diversity, through phylogenetic studies, classification, and monographing.
3. *Managing* systematic knowledge, through the assembly of knowledge into databases and its availability via international information networks.

Once established, this information can then be applied, if appropriate, in the sustainable utilization of biological diversity.

These tasks, although interrelated, can only be completed sequentially. Without at least some progress in the 'discovery' phase, no further studies can proceed. Within this framework we will present a summary of the current level of knowledge regarding the biodiversity of the Australian marine macroalgae. Our results refer only to 'species diversity' or 'richness', which equates to the total number of species present in a given area (Silva 1992).

Biodiversity of Australian marine macroalgae:

Present situation

Australia, as is also true for many other countries, is primarily in the 'discovery' and 'understanding' phases of biodiversity studies in the macroalgae. Despite a long history of phycological studies (see Ducker 1979, 1988, 1990 for further information) and the recent publication of several excellent regional studies (e. g. Womersley 1984, 1987, 1994, 1996; Millar 1990; Cribb 1983; Price and Scott 1992), there remain large geographical and taxonomic gaps in our understanding of Australia's macroalgae. To illustrate the geographical disparity in macroalgal records, we have constructed a chart that gives the species numbers thus far recorded in each of the Australian biogeographical and political regions (Table I, Fig. 2). We have used the provinces as described by Womersley (1981) and have made a further division based on political boundaries (Fig. 1). We have incorporated the Great Barrier Reef province with the Solanderian province, as the distinctness of these regions has been questioned by several authors (e. g. Womersley 1981) and have separated the Maugean subprovince as 'Flindersian Victoria' and 'Flindersian Tasmania' (Fig. 2). Our purpose in presenting this data is not to attempt an accurate assessment of

Table I. Accepted names recorded for each of the regions and percentage of the Australia-wide total.

Region	Recorded Taxa	Percent of total
Queensland Dampierian	105	5.9
Queensland Solanderian	432	24.3
Queensland Peronian	252	14.2
New South Wales Peronian	468	26.3
Victoria Flindersian	638	35.9
Tasmania Flindersian	508	28.6
South Australia Flindersian	785	44.2
Western Australia Flindersian	667	37.6
Western Australia Dampierian	184	10.4
Northern Territory Dampierian	90	5.1

the diversity of the macroalgae, but to illustrate the level of completion of the discovery phase. The results are drawn directly from the 'Australian Marine Algal Name Index' (AMANI) a database of all the marine macroalgae recorded from Australia. This database is being prepared by the second author (RAC) with funding from the 'Australian Biological Resources Study' and is designed to be a precursor to the planned 'Algae of Australia', a multi-volume series that will eventually include descriptions of all algae found in Australia and Australian waters. At present the database is nearing completion, with perhaps only 5% of species yet to be catalogued. Table I gives the number of accepted species recorded for each region and the percentage of the Australia-wide total (1776). The percentages given in Figure 2, however, are the proportion of the total number of records entered into the database. Both representations clearly demonstrate a skewed division between northern and southern Australia, indicating either a particularly depauperate flora for the north, or a lack of collecting and research effort for the region. A number of authors have commented on the low diversity of marine algae in tropical as compared to cold and warm temperate regions (Lüning 1990, Bolton 1994), a pattern apparently at odds with most other groups of organisms. Whilst we acknowledge the rich southern Australian flora is likely to have a greater species diversity than that from the tropical north, we believe that the current disparity is exaggerated due to varying levels of research effort. For example, in the region extending from the North-West Cape in Western Australia to the Northern Territory/Western Australian border – a coastline several thousand kilometres in length – there have been only twenty eight species of algae recorded in the literature, included in a handful of publications (earlier publications catalogued by Lewis 1984, 1985, 1987; later works including Phillips *et al.* 1993; King and Puttock 1994; Withell *et al.* 1994; Huisman 1996; Kamiya *et al.* 1997). Over half of the recorded species are mangrove-associated epiphytes. Obviously this is not a 'real' evaluation of the north-west algal flora – even a conservative estimate of species numbers for a tropical region of that size would give a total of over 300. Womersley (1981) suggested that northern Australia might only support around 200 species, but this was regarded as a severe underestimate by King (pers. comm. cited in Bolton 1994). Comparisons between the algal flora of the Australian Dampierian Province and its relatively well-studied counterparts in Indonesia and the Philippines – regions reasonably likely to have similar algal floras – clearly demonstrate the paucity of knowledge regarding northern Australia (Table II). Likewise islands in the region (Table III) – the algal floras of Christmas and Cocos/Keeling Islands are virtually inknown. Thus the

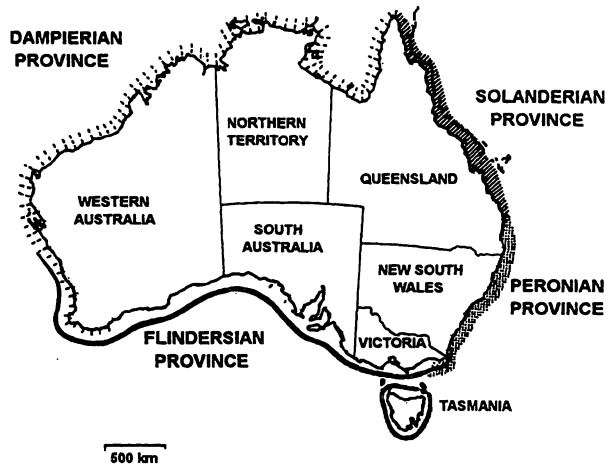

Fig. 1. Australian macroalgal biogeographic regions as used in this study (modified from Womersley 1981).

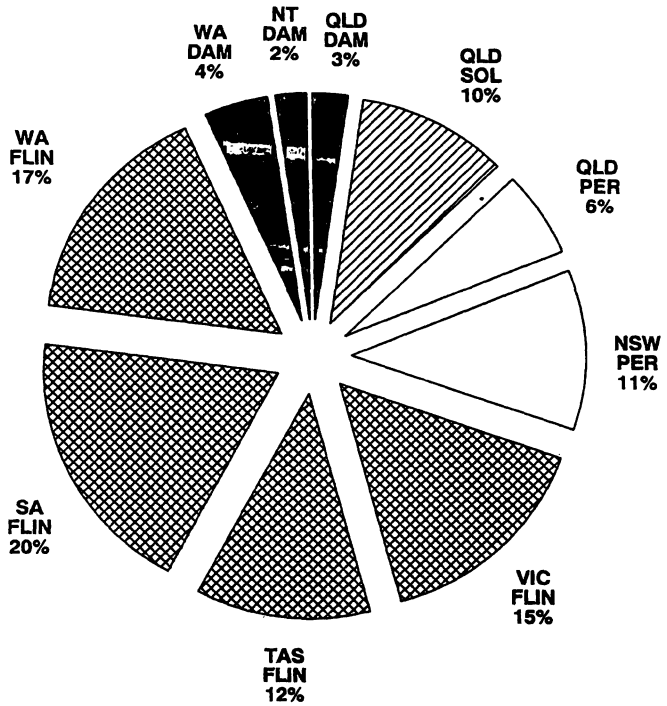

Fig. 2. Percentages of algal species recorded from the various biogeographical and political regions.

Table II. Comparison of taxa recorded from north-west Australia and nearby regions.

Region	Recorded Taxa	Sources
Philippines	911	Silva *et al.* 1987
Indonesia	452	Verheij & Prud'homme van Reine 1993
Dampierian	291	AMANI

Table III. Comparison of taxa recorded from islands adjacent to north-west Australia (Christmas and Cocos/Keeling Islands) and comparable islands in the west Pacific.

Island	Recorded Taxa	Sources
Rotuma	88	N'Yeurt 1996
Lord Howe	298	AMANI
Christmas	23	AMANI
Cocos/Keeling	6	AMANI

breakdown of species recorded from the various zones demonstrates an almost complete ignorance of certain regions of northern Australia, with the preponderance of studies dealing with southern Australia. A superficial survey of the major floristic literature reinforces this observation; southern Australia is well catered for with the publications of H. B. S. Womersley (1984, 1987, 1994, 1996) and before them Harvey's *Phycologia Australica* (1858, 1859, 1860, 1862, 1863). Publications dealing with northern and north-western Australian macroalgae are far fewer in number and invariably based on limited collections (e. g. Womersley 1958). This situation is well recognised by Australian phycologists – a recent workshop held to discuss plans for the 'Algae of Australia' project (Flora of Australia – Workshop Series. Algae, 8–10 June 1992) had, as one of its primary recommendations, the need to increase collecting effort in northern Australia.

Thus our knowledge of the algal flora ranges from good (the southern Australian flora, particularly once the remaining volumes of Bryan Womersley's flora are completed), to very poor (the north-west region). It is clear that we have great deal more exploratory and descriptive work to do before we can make any conclusions about the real biodiversity of the Australian macroalgae.

Predictions

Biodiversity lends itself to sweeping statements and what are apparently outlandish estimates. The *Global Biodiversity Assessment* (Watson *et al.* 1995) gives the number of described algal species as 40 000 and estimates that the total number is around 400 000. The total number of marine macroalgae recorded from Australia is in the order of 1800. Applying the same factor to the Australian macroalgae would therefore give a total of around 18 000. Of course, application of this factor implies that the undescribed species are spread evenly across the taxonomic groups and geographic regions, something that is patently not true. The marine macroalgae, by definition, constitute the more visible component of algal biodiversity. If the vast undescribed pool of algae does in fact exist, it is more likely to be drawn from the more cryptic groups – the marine nanoplankton, picoplankton and terrestrial algae are likely suspects.

Despite our poor state of knowledge regarding certain regions of Australia, it is unlikely that further study will increase the total number of macroalgal species by more that two-fold. Silva (1992) gives the total number of macroalgal species worldwide at around 6500 to 7000. Entwisle and Huisman (1998) estimated the total number of species of algae in Australia, including all taxonomic groups. Extracting the macroalgal component of their estimates gives a total of around 2000 species.

The future

Perhaps the single most important constraint on macroalgal biodiversity studies is the lack of suitably trained and employed phycologists. In Australia at present they number less than ten, with several of those employed on a part-time basis. Very few hold appointments in herbaria and the situation in universities is variable – in the latter there is often pressure to partake of greater 'resource' oriented research (read dollars). And the prospects for taxonomy are not encouraging. The trend away from basic research and the continual diminishing of the research dollar are hardly enticing to students contemplating a career in algal taxonomy. In Australia in the past twenty years there have been many students awarded doctoral degrees for research into marine macroalgal taxonomy, but at present only one of those holds a permanent position as a taxonomist. It is not surprising that those staff remaining at universities are less than enthusiastic about recommending taxonomy as a career. If we are to pursue the goal of an Australia-wide algal flora, there will need to be a substantial increase in both training and opportunities for phycologists.

The 'Australian Biological Resources Study', in its endeavours to publish the 'Algae of Australia', has supported, and is likely to continue to support, phycological floristic research, but it cannot be expected to be the saviour of the phycological community. Recent tightening of government expenditure has forced the redirection of research funds, and ABRS has had to reassess its involvement in phycological research. Whilst the enthusuasm for the 'Algae of Australia' project remains, financial constraints have slowed its progress and have added to the general disillusion-

ment felt by potential contributors. But what will cure this malaise? Unfortunately there does not appear to be an easy fix. In a perfect world algal taxonomists would hold positions in all herbaria and universities, they would conduct their research unfettered by financial constraints, and governments would recognise the inherent value of biodiversity studies. Obviously this is never going to be a reality. Perhaps the most valuable characteristics for future taxonomists will be perserverence and an enduring belief in the worth of their studies. Combine those with some innocent enthusiasm and we might yet see an Australia-wide algal flora.

Acknowledgements

Financial support to JMH and RAC was provided by the 'Australian Biological Resources Study'. Assoc. Professor Michael Borowitzka (Murdoch University) designed the database and is thanked for his support. Thanks also to Professor Margaret Clayton (Monash University) who convened the symposium and suggested the topic.

Accepted 7 October 1997

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