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ASBS SYMPOSIUM AND FORUM, 1989

INTRODUCTION

On 28-30 June, the Society held a Symposium entitled *'Plant Systematics in the Age of Molecular Biology'*, followed by a Forum on *'Gondwanan Elements in the Australian Flora'*, at Women's College, Sydney University. Both events were highly successful thanks to the organising committee of Barbara Briggs, Roger Carolin, Tony Brown and Chris Quinn.

In the Symposium, several speakers brought us news of exciting developments in a rapidly expanding field. Papers from local authors impressed upon us the amount of molecular systematics being done in Australia, and its high quality. It was apparent to me that molecular biologists are still coming to grips with an issue that has concerned systematists for a long time: getting the data is only half the problem; the other half how to analyse and interpret it.

The papers presented at the Symposium will appear in a special issue of *'Australian Systematic Botany'* next year. For the benefit of Society members who could not attend, we reproduce in this *'Newsletter'* the full text of Roger Carolin's introductory address, *'Molecules and Systematic Botany'*, which brings an entertaining historical perspective to the subject, as well as Bryan Barlow's concluding *'Synthesis and Prospect'*, which is all the more impressive because it was composed 'on the run'. These two papers will appear in a combined form in *'Aust. Syst. Bot.'*

A significant event during these meetings was the presentation of the *Nancy Burbidge Memorial Lecture*. The invited speaker, Richard Schodde, provided an outstanding introduction to the Forum on Gondwanan Flora with his overview of the historical biogeography of the Australian region, entitled *'Origins, Radiations and Sifting in the Australasian Biota - Changing Concepts from new Data and Old'*. In keeping with the Society's tradition, we reproduce his talk here.

Papers from the Forum on Gondwanan Flora

will not be published collectively, so we are reprinting the abstracts here.

In conjunction with the Symposium and Forum, the Society held its General Meeting where among things, a new Council was elected. Reports from the General Meeting appear later in this *'Newsletter'*. Ed. ☺

SNIPPETS FROM THE MEETINGS

'Roger Carolin was offering us moral leadership'
Barbara Briggs

'Cladistics: the art of being wrong with confidence'
David Penny quoting Willi Hennig

'Dahlgren's anastomosing bubble bath of recombination'
Adrian Gibbs

'Continental drift took the ground from beneath it [dispersalist biogeography]'
Dick Schodde

'Behind the cryptic Darlingtonian phrases [of Sid James] there was a masterly exposition'
Bryan Barlow

'New Zealand was virtually discarded, an island waif with faunal flotsam and jetsam that had washed up on it over time'
Dick Schodde

NANCY BURBIDGE MEMORIAL LECTURE, 1989**Origins, Radiations and Sifting in the Australasian Biota
- Changing Concepts from New Data and Old**

Richard Schodde
CSIRO, Division of Wildlife and Ecology

It is a very great pleasure for me to be here today to give the Nancy Burbidge Memorial Lecture, for three different reasons. First, and foremost, it allows me to honour my friend and colleague, Nancy Burbidge, and pay homage to her tireless productivity. We were not only fellow travellers in plant systematics and biogeography in the 10 years that I worked at the National Herbarium in Canberra, but also active members in the local National Parks Association after hours - at least Nancy was active. Secondly, it gives me a chance to remeet and mix it with old friends that I have seen little of since I moved from systematic botany to ornithology and the curatorship of the Australian National Wildlife Collection 18 years ago. And thirdly, it allows me to share with you the zoological side of the dramatic changes that have taken place in our understanding of the origins and evolutionary radiation of Australia's biota over the last 20-30 years.

To appreciate the extent of the changes, it may help to recapitulate the earlier views of biotic origins in Australia and the reasons for them. For the flora, Nancy Burbidge's own great summary in 1960 of the phytogeography of the Australian region was the apotheosis of a

conventional interpretation that had continued from the time of J.D. Hooker. This interpretation, as I'm sure you are all aware, saw the Australian flora as comprising three principal elements: first, an old autochthonous element of scleromorphic proteads, myrtles, epacrids, and many other families that make Australia's landscape so different from the rest of the world; secondly, an Antarctic element of cool temperate myrtle beech-podocarp rainforest and alpine vegetation in extreme south-east Australia and Tasmania; and thirdly, an Indo-Malayan element, comprising the tropical and subtropical rainforests of the north and east coasts. Both Antarctic and Indo-Malayan elements were perceived as recent immigrants, the Antarctic from somewhere in the south and the Indo-Malayan from the Eurasian tropics via New Guinea.

In this broad context, the New Guinean flora was almost entirely Indo-Malayan, according to the analyses of van Steenis; even its alpine flora was derived from east Asian sources. New Zealand's, by contrast, was prevaillingly Antarctic.

What of the fauna? In this lecture I shall confine myself to the land vertebrates - for two

The '*Nancy Burbidge Memorial Lecture*' is held regularly in conjunction with the Society's General Meeting to commemorate this outstanding Australian botanist of the post-war era.

Our invited speaker for 1989 was Richard Schodde, who currently curates the wildlife collection at the CSIRO Division of Wildlife and Ecology in Canberra. Dick's connection with plants has been far closer than his present position may indicate. He started his career as a botanist in Adelaide, where he revised *Millotia* (Asteraceae) for his Honours Science degree under Hansjoerg Eichler. From there, he joined the CSIRO Division of Land Research for whom he made extensive collections of plants in Papua-New Guinea. He revised Pittosporaceae in Papuasias, then returned to Adelaide to complete a Ph. D. on the systematics of the Atherospermataceae. After returning to CSIRO in Canberra, he eventually found his present post with the Wildlife Division, where he made a profession of his long-standing interest in birds. Dick has become an authority on bird systematics and has written and edited several monographic books including the *Readers Digest Complete Book of Australian Birds*.

reasons. First, I am far more familiar with them. And secondly, most invertebrate phyla and classes are still so poorly known taxonomically that biogeographic conclusions of any significance are difficult to reach. The vertebrate faunas of Australia, New Guinea and New Zealand all include frogs, reptiles, birds and mammals, although New Zealand's complement is far more sketchy than those of the other two.

Sharing some 370 species roughly equally between them, Australia's and New Guinea's amphibian faunas are distinctive rather than diverse by world standards. They have no salamanders or sirens, only frogs, and of them they share only 4 of the world's 23 or so families. One family comprises the austral frogs, Myobatrachidae, which are endemic to the region, dominate in Australia, just reach southern New Guinea and have as their nearest relatives the leptodactylid frogs of South America. Another comprises the hylid tree frogs in the form of an endemic regional off-shoot of this nearly cosmopolitan family; its species are the second most abundant in both Australia and New Guinea. The third family, Microhylidae, is particularly diverse in lower and mid-montane New Guinea, and has outliers in the Atherton bloc rainforests of north-east Queensland; elsewhere it is generally pan-tropic. The last family, Ranidae, comprises the true frogs and is cosmopolitan, with greatest diversity in Eurasia. Its 21 species in New Guinea and one in north Australia are members of two genera that are widespread in Eurasia and the Pacific. New Zealand has only three species of frogs, all members of a primitive endemic family, Leiopelmatidae, which is related not to any other Australasian family but to relictual ascaphids in north-west America.

Why, you might wonder, am I going into such detail about the distributions of so insignificant a group of animals. The reason is simple. Amphibians are intolerant of salt water, and cannot fly over physical barriers or travel far; among vertebrates they are one of the best indicators of past geographical connections among terrestrial biota. Fresh-water turtles and tortoises are too. They are missing from New Zealand and only a handful survive in Australia and New Guinea. Those that do reveal a pattern repeated again and again in land reptiles, birds and mammals. Three families are involved. One, the pitted-shell turtles, is represented by an

endemic species that is the families' sole survivor from Mesozoic times. Another, widespread in Afro-Asia, is represented by a single Malesian species that just reaches New Guinea. The third, comprising 20 species shared between Australia and New Guinea, occurs elsewhere only in South America and belongs to a suborder of side-necked tortoises found today only on the southern continents and Madagascar.

Land reptiles are far more diverse in Australia and New Guinea, both lands sharing about 910 species; Australia is decidedly the richer with some 680, reflecting the opportunities for evolutionary radiation in its warm arid zone. Five of the world's 16 families of lizards are represented on both lands, plus five of the 11 families of snakes; legless lizards, geckos, dragons, goannas, skinks, blind snakes, pythons, file snakes, and solid-toothed and front-fanged snakes. Only one family, the small one of the legless lizards, is endemic; and the closest extra-continental relatives of it and the other families all range through the Malesian archipelago and Afro-Asia. What is not so obvious is a pattern of bicentric distribution between the families. Either they are centred in Afro-Asia and reach Australo-Papua on a comparatively small scale. Such are the gekkonine geckos, skinks, pythons, blind snakes and solid-toothed snakes, which just trickle in. Or, like legless lizards, diplodactylid geckos, dragons, goannas and highly venomous front-fanged snakes, they are centred in Australo-Papua and radiate through Afro-Asia in a more limited way. Coincidentally, the closest family relatives of the dragons and goannas are the American iguanas and Gila Monsters, respectively. New Zealand's reptile fauna is as extraordinary as it is almost non-existent, comprising just 11 primitive endemic diplodactylid geckos, 18 skinks derived from Australian stocks, and the Tuatara, the world's single living rynchoccephalian dinosaur.

With about 980 land and freshwater species, the Australian and New Guinean bird fauna is very rich and third only to those in South America and Africa. I have grouped the Australo-Papuan bird faunas together because their dominant families - parrots and cockatoos, frogmouths, wood kingfishers, honeyeaters, acanthizid warblers, and thick-head flycatchers - are shared by and centred in the region. At the present imperfect state of knowledge, no major

New Guinean families are missing from Australia; even birds-of-paradise are here. And the only three Australian families missing from New Guinea - the plains wanderers, lyrebirds and primitive scrub-birds - are found nowhere else either. Outside the region, the relationships of the many orders and families of Australo-Papuan birds lie numerically with Eurasia. Among non-passerines - that is, all the orders of birds that do not sing - most of the Australo-Papuan wading birds, ducks, fowls, birds-of-prey, rails, pigeons, and nocturnal birds are outlying members of groups more diverse in Eurasia. Most passerines or songbirds, moreover, such as the Australo-Papuan robins, flycatchers, wrens, warblers, thrushes and babblers, resemble, in their morphology, the robins, warblers and flycatchers etc. of Eurasia. The one further point that I would like to draw to your attention here, once more, is the sniff of a bicentric pattern of distribution in the non-passerine orders. Again and again it crops up, in the hawks, Magpie-geese, mould-bulling hens, stiff-tailed ducks, plains wanderers, and parrots. Genera in these orders that are endemic to Australo-Papua are either obscure in their intercontinental relationships or have links with vicariant groups in South America.

What of the New Zealand land and freshwater bird fauna? Birds are that island's most diverse group of vertebrates, yet, with only about 80 species, they are a depauperate and patchy mix of a few very old endemics with no close relatives - the kiwis and moas, nestorine parrots and rifleman wrens - plus equally few endemic genera and families derived from Australo-Papuan stocks - the kakariki parrots, mohouine warblers and callaeatid crowshrikes. Added to them is a considerably greater number of contemporary Australian species that have evidently been blown across the Tasman Sea to colonise the islands.

The New Zealand mammal fauna is so depauperate that it can be virtually discounted: no egg-laying monotremes, no marsupials, and no placental mammals are present other than two insectivorous bats. One of the bats is closely related to species in Australia and New Caledonia, and the other, curiously, represents an endemic family related to the cosmopolitan mastiff bats. The Australian and New Guinean mammal faunas, although considerably richer with some 350 species between them, are still

poor and patchy by world standards. Yet they include the egg-laying monotremes and groups of marsupials found nowhere else. Both monotremes (two echidnas) and marsupials occur in New Guinea as well as Australia, although not with such diversity. The only two groups of placental mammals in the region - rodents and bats - are also shared by both land masses and are moderately rich in species and genera. Here again is that division in distribution patterns, one set directed towards Eurasia, the other to South America. Both groups of placental mammals in Australo-Papua are but two of the many groups of placentals found throughout the rest of the world; and both, moreover, are members of families that are more diverse in Eurasia. The monotremes, however, have no extant relatives anywhere while the marsupials, rich in diversity and endemism, are represented outside only by the didelphid opossums in South America.

How did vertebrate zoogeographers up to the 1960's interpret these patterns? Led by Bernard Rensch, George Gaylord Simpson, Ernst Mayr and P.J. Darlington, they first grouped the Australian and New Guinean faunas together as one major element among the world's faunas. Their common yet distinctive mix of frogs, side-necked turtles, snakes, birds, marsupials and rodents compelled this - and rightly so. New Zealand was virtually discarded, an island waif with faunal flotsam and jetsam that had washed up on it over time and had evolved divergently in its own way.

Secondly, and this is the important point, the zoogeographers played the numbers game. Reptiles and birds were the dominant groups in the fauna, and their members had prevailing links with Eurasia. Bats and murid rodents, which together roughly equal the marsupials in numbers of species, were also Eurasian; and so too the ranid frogs. If they could reach antipodean Australia-New Guinea from Asia, as they probably did, so could the rest. Out of this developed a theory of dispersal to explain the origin of Australasian vertebrates. It rested on two particular circumstances and one principle. The two circumstances were, first, the patterns of distribution that I have described; and, secondly, the steady state of the earth's crust, its continents and archipelagos in supposedly fixed position. Over Tertiary time, the Indonesian archipelago had served as the stepping stones

for one wave of animals after another dispersing into Australia from the Afro-Asian cradle of vertebrate evolution. Those that came first diverged farthest - the austral frogs, side-necked turtles, emus and parrots, and monotremes and marsupials. And those that came last, presumably within the last million or two years, changed least. Among them were (and are) the ranid frogs, solid-toothed snakes, single species of Eurasian larks, pipits, thrushes and sunbirds, and the true rats, and many insectivorous bats.

The principle that contributed to this theory was one of competitive succession. According to it, more primitive less competitive groups were constantly being pushed out and replaced by more advanced and successful groups in the Afro-Asian evolutionary cradle. This was used to dismiss the one great distributional anomaly: the uniquely shared occurrence of the side-necked turtles, marsupials and flightless ratite birds on the tips of the southern continents. Competition had consigned them to refuges in the antipodes. Similarities in form between the ratites, marsupials and others on the different southern continents, moreover, were often explained also not by common ancestry but by evolutionary convergence through occupation of equivalent niches.

As far as Australia was concerned, immigration was by two pathways. One, via the Lesser Sundas to the north-west, was older and led to the development of endemic groups such as the austral frogs, diplodactyline geckos, honeyeaters and marsupials in the old autochthonous Australian flora, perhaps coevally. The other, via New Guinea to the north, was newer, perhaps Plio-Pleistocene in age, and had led to the ingress of rainforest taxa down the east coast, along with the Indo-Malayan elements of the flora. The scenarios pieced together for the origin of Australia's phanerogam flora and vertebrate fauna matched closely and gained from mutual support. Within Australia, late Tertiary climates zoned the biota concentrically, creating a tropical or Torresian province across the north, a temperate or Bassian province around the south, and an Eremaean or Eyrean province in the centre. Again the phytogeographers and vertebrate zoogeographers agreed. Both old autochthonous and Indo-Malayan rainforest elements were included, undistinguished, in the tropical Torresian province.

What a comfortable theory it was, fitting the systematic and biogeographic ideas of the day like a hand in a glove. The only biogeographer to challenge it seriously was the Queensland botanist, D.A. Herbert. With rare insight he claimed that Australia's rainforests were not new but old and that elements of the autochthonous flora had evolved out of them by processes of ecological sifting. Leo Croizat also challenged the theory, as he challenged everything, in his world view - but I don't want to get sidetracked into his *Genorheitron*. Vertebrate zoogeographers, however, found little to question and were content to leave the running to dispersalists like Mayr, Darlington and their disciple Allen Keast. Cladism and its biogeographic sister, vicariance, had not yet taken root; and the implications of vicariance in the global distribution of marsupials, parrots, side-necked tortoises and austral frogs went unremarked. Australia was still seen as something of a biotic vacuum, a bottomless cup waiting to be filled with everything that Eurasia could pour into it. The idea that Australia might have also had a vertebrate fauna, as well as a flora, as old as any in the world and had contributed colonists from its shores to Eurasia in reverse was barely considered. To be sure, Mayr had pointed out that an Australian cuckoo-shrike here and a whistler there had established itself in South-East Asia; but to think that whole groups of Eurasian vertebrates, such as its front-fanged snakes and song bird families, could have stemmed from Australian ancestors was thinking the unthinkable.

How much it was all to change and how soon. Literally overnight, continental drift took the ground from beneath it. The shifting position of the earth's continental plates through time, by whatever process, turned from fiction to fact in the 1960's and early 1970's. When Australia was supposed to be getting its first stocks of Eurasian vertebrates and perhaps angiosperms in later Cretaceous to early Tertiary times, some 120-60 million years ago, it was nowhere near its present position but several thousands of kilometres south beside Antarctica. It was, as is now well known, a fragment of the vast southern supercontinent Gondwana which was positioned just north of the south pole in late Palaeozoic and Mesozoic times. Separating Gondwana from the ancestral Eurasian continent, Laurasia, was the Tethys Sea, a barrier that seems to have

been much wider and more effective than the island-dotted Indonesian seas today. Gondwana began breaking up about 120 million years ago, beginning with the rifting of Africa and South America and the splitting off of India. New Zealand broke away next from east Gondwana 80-85 million years ago, followed by South America from west Gondwana early in the Tertiary at 60-70 million years. Last to split were the final remnants, Australia and Antarctica, some 50-60 million years ago. Australia remained close to Antarctica for several million years before finally commencing its northward drift to its present position about 40-45 million years ago, into the Oligocene.

New Guinea began to form then on, along the northern edge of the Australian continental plate, developing in two parts. One part was the northern rim of the Australian plate itself and the other a string of islands off the north-east coast, away from Laurasia. The islands and mainland only came together towards the end of the Tertiary, throwing up the mighty central cordilleras there in Plio-Pleistocene times and giving New Guinea its present form.

This knowledge affected the Eurasian immigrant theory for vertebrates in two ways. First, it drew attention to a possible Gondwanan origin for such primitive - and so presumably ancient - groups as the austral frogs, side-necked turtles, ratite birds and parrots, and the monotremes and marsupials. A common ancestry could now be entertained for their vicariant stocks isolated on the southern continents. These appeared to form a thin faunal base in Australia, over which a dominant immigrant Eurasian facies had later been imprinted. Secondly, the position of Australia so far south at the beginning of supposed Eurasian vertebrate invasions led the proponents of invasion to speculate that the Asian stocks had arrived later and had radiated faster than had been thought. Australia, it was realised, could hardly have been a biotic vacuum for such a long time in its early history; it must have had a Gondwanan fauna. The *apparent* dearth of such a fauna, particularly in birds and reptiles, was explained away by the ghost of competition past on a continental scale: all but a few of the Gondwanan animals had been out-competed and obliterated by the immigrant Eurasian stocks.

Vertebrate zoogeography was still holding on

to dispersalistic theory to explain the origin of the Australasian fauna. Indeed, it pervades Australian biogeographic thinking into the 1980's. Pick up any modern text and you will see bird geographers and reptile geographers talking about antarctic dispersal routes into Australia via Gondwana and Indo-Malayan dispersal routes in via Indonesia. Even current phytogeographic treatises talk about Australia receiving its first stocks of angiosperms by north-west land bridges from Laurasia in the Cretaceous. The point I want to make here, and I can't stress it enough, is that whatever biotic elements Australia received before its break from Antarctica in the early Tertiary it inherited from Gondwana. If angiosperms did come into the region from the north in the Cretaceous, they came to Gondwana, perhaps even the Australian-sector of Gondwana; but not to Australia as such. This point needs absorbing in Australian biogeographic thinking. The concept of dispersal routes, as it is being used today in Australasian biogeography, is all too often misused, confusing the difference between vicariance and dispersal at continental level, and the different contributions that both - and I stress both - have made to shaping the distribution patterns of plants and animals in the world today.

So much for presumptions, what of the evidence? Enter the Australasian fossil record. For plants it is moderately good through the Tertiary, the critical period for the radiation of the flora; and, thanks to the palaeopalynologists, moderately well-worked over the last 20-30 years. It reveals that from the late Cretaceous to some 20-18 million years ago in the Miocene, Australia, New Zealand and what there was of New Guinea were clothed in temperate to subtropical rainforests little different in floristic composition from the temperate and subtropical rainforests of east Australia, montane New Guinea and New Zealand today. *Nothofagus* forests of tropical *brassii* and temperate *fusca* were widespread and so too the podocarps, laurels and myrtles. These forests today hold many primitive angiosperms - the Winteraceae, ancestral Proteaceae, and all the palaeopolyploid families of that great order Laurales - and they range from montane New Guinea and New Caledonia through east Australia and New Zealand to Chile in South America. According to traditional

phytogeographic theory, these forests made up much of the newer immigrant Antarctic and Indo-Malayan elements in the Australasian flora. Where was the supposedly old autochthonous scleromorphic element? According to the fossil record, *Eucalyptus*, one of its most characteristic components, does not appear until Oligocene times, some 35-40 million years ago. So, as Bryan Barlow has recently pointed out, the original pan-Australian phanerogam flora from the Cretaceous to mid Tertiary times - the flora that would have fed and sheltered the original stocks of Australasian vertebrates - was a Gondwanan, not autochthonous scleromorphic one. The scleromorphic flora came later.

The fossil record for the fauna is much patchier and more poorly worked. In New Guinea found deposits only go back to the upper Tertiary 6 million years ago. In New Zealand, there are random early Tertiary deposits of marine vertebrates, then only one massive 'window' in the Quaternary, within the last million or so years. It comprises members of today's fauna plus the Moas. Australia is better served with two such 'windows on the past', one in the Pleistocene and the other, most fortuitously, in the middle Tertiary, from the late Oligocene to mid Miocene. Both windows have been worked actively over the last 20 years, work that is continuing today. The Pleistocene window reveals a massive fauna, larger and more diverse than today's, but still comprising the same groups of vertebrates - side-necked tortoises, giant goannas, diprotodonts, marsupial lions, giant kangaroos, a great radiation of ratite birds, giant mound-building fowls, eagles, and a rich flamingo fauna in the Lake Eyre basin. Flamingos today are centred in the southern continents of Africa and South America. These mega-elements of Australia's fauna were finally exterminated only about 15-18,000 years ago, at what seems to have been the combined hands of the last arid glacial epoch and aboriginal man.

The mid Tertiary window is even more informative. It comprises, once more, the same basic elements as Australia's vertebrate fauna does today, except they are more primitive in form. There are even platypusses with teeth; but there are no Eurasian rats or bats. The passerine or songbird component is still more interesting and is being worked out by Walter Boles at the Australian Museum. It includes lyrebirds and logrunners, one of which is virtually

undistinguishable from a species found today in both montane New Guinea and central east coastal Australia. These birds are inhabitants of cool subtropical rainforests of the type dominated by Antarctic beech, laurels and myrtles; and their fossils are the oldest of any songbird yet found in the world.

While the fossil record may provide good clues to the origin and radiation of Australasia's biota, it can never, on its own, provide final answers. It is too patchy stratigraphically, too limited geographically and too biased against the less easily preserved organisms. The connections indicated by the fossil record between the Gondwanan rainforests and their faunas in montane New Guinea and Australia had, however, already been picked up in analyses of the Australasian bird and mammals faunas by John Calaby and myself in the early 1970's. We found that the birds and mammals of the montane New Guinean rainforests had their closest affinities not with those in the tropical rainforests of lowland New Guinea and Cape York Peninsula, but with others further south in Australia, from the Atherton Tablelands southwards. This was not a pattern of immigrant dispersal of Indo-Malayan elements into Australia, but one of vicariance. And so we interpreted the faunas of these forests as old, relictual and ancestral to the bird and mammal faunas that had radiated in Australia's scleromorphic flora.

But if current palaeontological and geographical evidence seem to be bringing together a picture of a prevaillingly Gondwanan origin for the Australasian biota, they have so far failed to resolve at least two critical anomalies. One of these is in birds. If the Australasian bird fauna arose in Gondwana one might expect it to have close ties with the South American. Apart from a few groups of non-passerines, it doesn't; its passerines, in particular, do not. Passerines or songbirds are the most prolific order of birds on earth. Over half the world's birds are passerines, and they comprise over half the bird species in Australasia and South America. They are distinguished from other birds by free plantar tendons in the feet, which allows them to grip perches involuntarily, and by the structure and musculature of their syringes or voice boxes, which allows them to sing and defend territories by throwing their voices about instead of fighting. This has contributed to their success.

South America's songbird fauna is dominated by a raft of endemic and sub-endemic families with unspecialised voice boxes. Australia's, by contrast, is dominated by families with conventional voice boxes and which otherwise resemble the songbirds of Afro-Asia.

In the absence of a complete fossil record, finer tuning of these anomalies in birds is only possible through a finer tuning of phylogenetic links, something that comparative morphology has not been able to achieve after 200 years of research in this the most studied group of organisms in the world. New sets of characters were needed. Enter molecular genetics and the U.S. ornithologist Charles G. Sibley. No doubt you have all heard at this meeting of how molecular genetics has become the new whizz-bang technology for systematic biology. And I expect that buzz acronyms like PCR, RFLP, ribosomal DNA, DNA fingerprinting, and DNA hybridisation have been echoing in the corridors. Today there is a wide and growing range of molecular and biochemical techniques - all good and with different values and virtues - for attacking different kinds of taxonomic and phylogenetic problems. When Sibley began assaying blood proteins in birds in the 1950's, however, there was little else. He didn't get far with blood proteins, then switched to egg-white proteins in the 1960's, and at the IOC in Canberra in 1974 presented results which suggested that Australia's divergent families of songbirds were all more closely related to one another than to their look-alikes in Eurasia. Ernst Mayr likened the results to reading tea-leaves in a cup, and so everyone forgot about them. Sibley went home to be fined for holding birds eggs illegally and switched attention to DNA-DNA hybridisation for salvation.

DNA-DNA hybridisation is a black box/cook book technology in which single stranded DNA of one organism is bound with single copy strands of another and then heated until they dissociate. The temperature of dissociation gives a measure of the genetic relatedness between the two organisms across the entire nuclear genome. Sibley published his DNA hybridisation phylogenies for the world's songbirds in the mid 1980's. They indicated three primary assemblages. One was the morphologically primitive group centred in South America. Another was the honeyeater-scrub wren assemblage of Australia and New Guinea,

linked to which were cuckoo-shrikes, birds-of-paradise, robins, monarch flycatchers and crow-shrikes also centred in the same region. And last was the thrush-warbler-lark-finch assemblage of Eurasia and North America. It was a sensational result. Overnight, the Australo-Papuan songbirds found themselves landed with a marsupial-like radiation. Ernst Mayr eulogised that Sibley had scaled the ice wall. Had Sibley made it at last? Oh no. He turned his attention to the ape and man, stirred up a predictable hornet's nest, and, if you've been following it in *'Science'*, you'll know he's under fire for using an unsatisfactory constant in his measures of dissociation and for discarding data points that didn't fit as they should. It is all too easy to forget, through this flack, that Sibley has been the greatest pioneer yet in the use of biotechnology for systematic biology.

Sibley's results in songbirds needed testing, either by re-runs of DNA-DNA hybridisation or, preferably, with other, independent molecular and biochemical evidence. This is now coming from work in which I am collaborating with Dr Peter Baverstock of the Northern Rivers College of Advanced Education and with Dr Les Christidis at the Museum of Victoria. Baverstock is using an immunological technique called microcomplement fixation and Christidis protein electrophoresis. The first is a rather approximate black box technology; and the second is limited by the number of characters or proteins that can be screened, abetted by the possibility of convergence in their allelic states at the level of familial comparisons. Whatever the shortcomings of these techniques, however, their results, except on several minor points, are broadly consistent with the radiations indicated by DNA-DNA hybridisation. The diverse Australo-Papuan-centred songbird families, although closer as a group to Eurasian than South American songbirds, were nevertheless allied still more closely to one another. Thus the Australasian flycatchers are not related to Eurasian flycatchers but to Australian butcherbirds and cuckoo-shrikes; and the Australian wrens and warblers are not related to their namesakes in Eurasia, but to the Australasian honeyeaters and robins. These results reveal the similarities in form between Australasian and Eurasian songbirds as superficial convergences that have arisen in adaptation to the same sorts of niches and the

same ways of life.

More than that, and this is important, the electrophoretic data indicate that the genetic distances between the Australasian songbird families are greater than those between the Eurasian. If genetic distance is time-related, as I believe it is even if we don't yet have an accurately calibrated molecular clock, then this means that the Australasian songbird families are older than those in Eurasia. Think of its implications. If the Australasian and Eurasian songbird groups are monophyletic - and there is considerable morphological and molecular evidence indicating that they are - then the Eurasian groups are derived from the Australian, in reverse to the traditional view. Carry this concept on to the supposedly Eurasian reptiles centred in Australia - the diplodactyline geckos, goannas and dragons - and suddenly the entire Australasian land vertebrate fauna begins to take on a prevailing Gondwanan aspect. In this scenario, the world's songbirds are Gondwanan and on that supercontinent diverged into eastern and western groups; the western group, primitive with an unspecialised voice box, was inherited by South America; and the eastern group with a specialised voice box was inherited by Australia. From there it colonised Eurasia later.

From all this data - old morphological and new palaeontological and molecular - a broad new picture emerges of the origin and radiation of Australasia's phanerogam flora and vertebrate fauna. Australia and New Zealand inherited from Gondwana a prevailing cool temperate to subtropical rainforest biota, one dominated by podocarps, antarctic beeches, laurels, myrtles, proteads, Cunoniads, elaeocarps and Winteraceae among plants, and dare I add, monimiads and even Pittosporums. The vertebrate fauna included the primitive myobatrachid and leiopelmatid frogs, side-necked land turtles, the range of land reptiles now centred in both lands, plus ratite birds, parrots, many other non-passerines, and the ancestral specialised songbirds. Breaking away first, New Zealand may have missed out on monotremes and marsupials; and being small and at times broken, it had much less space for diversification than Australia. Its biota was probably never particularly rich, but it probably also changed rather little under a moderately constant climate on its northward drift through

the Tertiary. Man and the Plio-Pleistocene glacials brought moderate extinction in recent times but proximity to Australia then allowed wind-blown colonisation by a range of Australian bird stocks and several bats.

Australia itself had also inherited a rather diverse waterbird fauna, including flamingos, on lakes across its central Artesian basin. From the later Miocene on, however, climate became progressively drier, beginning about 17-18 million years ago. The aquatic fauna dwindled and the rainforest biotas retreated to the wetter periphery of the continent. This gave the impetus for the radiation of the scleromorphic flora, the ancestral elements of which had evidently developed endemically from harder rainforest stocks and now diversified to replace the retreating rainforest. Elements of the land fauna radiated with it, derived from ancestral Gondwanan rainforest stocks.

Climatic deterioration peaked in the dry and cold glacial oscillations of the Plio-Pleistocene, when, fortuitously, the present Great Dividing Range and central cordilleras of New Guinea reached their greatest rain-catching height. New Guinea by this time had reached its present form and fronted broadly along the northern edge of Australia; its last connection was severed only 11,000 years ago by the flooding of Torres Strait. The Tertiary rainforest biotas completed their retreat to refugial pockets in the Great Dividing Range and to subtropical and temperate levels in montane New Guinea, in reverse to the traditional view of their advent in Australia. As Michael Archer has pointed out in his compendium of *Vertebrate Zoogeography and Evolution in Australia*, a walk up a New Guinea mountain is like a walk back through time. In the New Guinea mountains, the Australian biota became intermingled with the Malesian rainforest flora, a flora which completely dominates the lower altitudes on that island and on east Cape York Peninsula. Curiously, the vertebrate fauna of the Malesian forests in New Guinea is almost completely Australian; it is the other significant anomaly that I referred to earlier and it has yet to be explained.

The coincidence of increasing aridity with the approach of Australia and its fringing islands to Asia at the end of the Tertiary developed Australia's arid zone biota and made space for Eurasian immigrants. The exotic nature of Australia's chenopod flora and northern

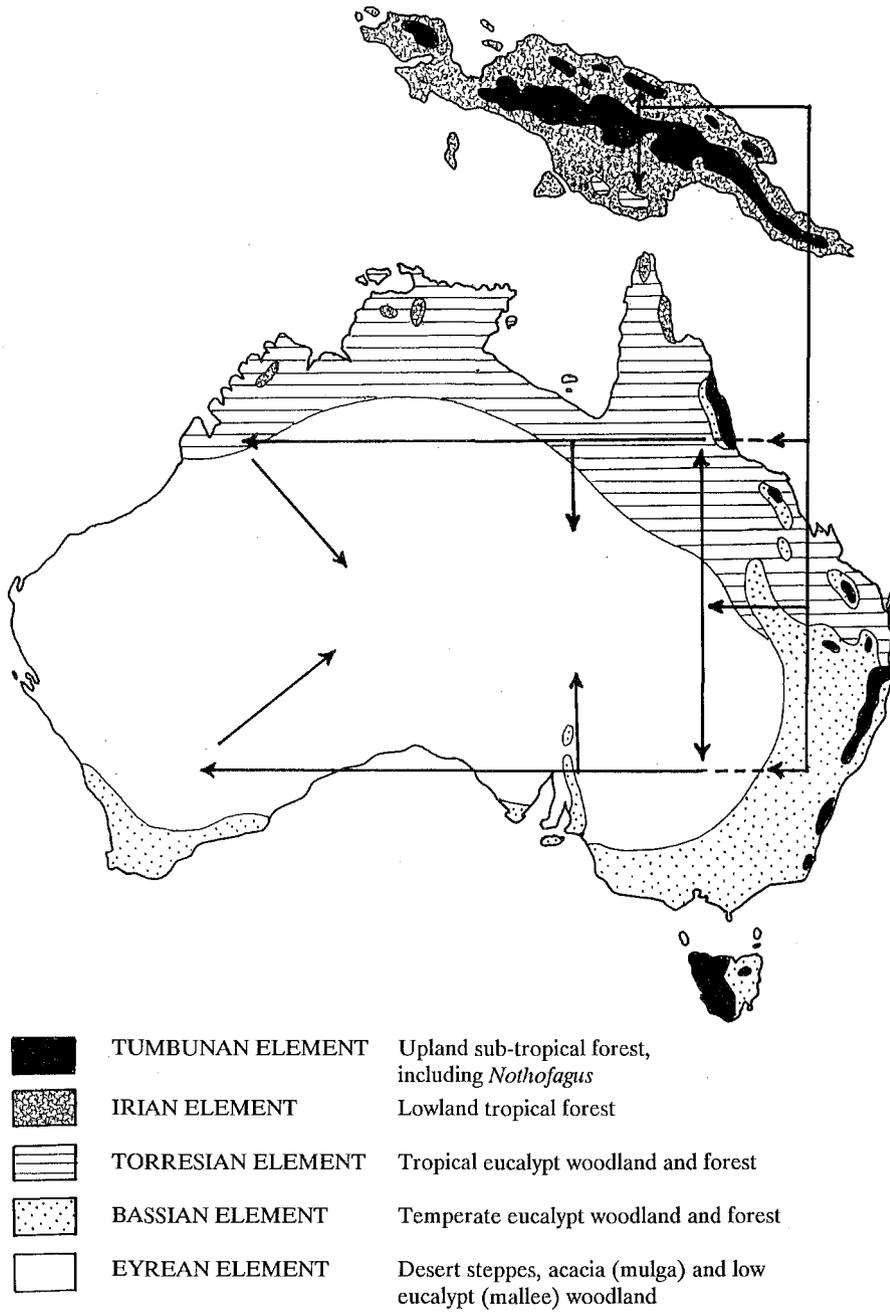


Figure 1. Australasian biotic regions

Australian savannahs is well documented; and they have provided niches for radiation not so much in Australian bird families as in Eurasian sylviid warblers. Except for reptiles, the arid zone biota, covering some 70% of Australia today, is the poorest of all in vertebrates. If the old rainforest biota was the reservoir for adaptive colonisation of the arid zone, and the scleromorphic biota the plumbing and taps to feed it, the arid zone has behaved like a sink, its plug pulled more-or-less by every dry glacial cycle during the Plio-Pleistocene.

These scenarios can be encapsulated by minor but significant modifications to the traditional concepts of Australian biotic elements. For the broad patterns of distribution have not changed, even if the interpretation of their origin has. All 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 (Fig. 1). The word Tumbunan, incidentally, comes from the Melanesian pidgin word *Tumbuna*, meaning ancestor.

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. ©

PLANT SYSTEMATICS IN THE AGE OF MOLECULAR BIOLOGY

Molecules and Systematics

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In the middle of the last century the city of Manchester was a great centre of philosophical endeavour. It didn't attract the brilliant galaxies of temperamental talent that flocked to the Universities of London, Paris and Munich but rather the solid, and nevertheless imaginative, non-conforming Protestants for which the north of England is famous.

Indeed, had we been there about this time of year 145 years ago, we would have witnessed a most remarkable funeral of one of these solid unassuming men who had shunned the spotlight of human adulation but was nevertheless

thoroughly exposed to it upon his death. Forty thousand Mancunians of all degrees shuffled past his catafalque and a hundred carriages followed the coffin to the cemetery. Possibly the biggest funeral Manchester will have ever seen.

It may surprise you to know this man was no politician or general or prince but a humble Quaker chemist - John Dalton. And John Dalton's fame rests on a theory, the basic idea of which he had snatched from that marvellous grab bag of concepts passed on to us over two millennia by an even more remarkable person - Democritus. The theory is the atomic theory of

matter and it was the start of what we are doing here today.

Chemicals, of course, have always had a serious impact upon the systematization of our knowledge of plants. Indeed during medieval times chemicals were probably the most important property of plants used in arranging them into a systematic order - their medicinal properties are, after all, the result of the action of chemicals on our bodies.

But perception of chemicals as such is difficult and even more difficult to convey to someone else; precise reference is difficult without instruments which will catalogue differences objectively. For scientific classification to be satisfactory, accurate perceptions and accurate communication of information was essential. The emphasis on chemicals had to be down-played. It was Caesalpini who emphasized the features that could be observed correctly and thus diverted systematics into a morphological basis.

Indeed it is difficult to see what one could do with chemicals in systematics before Dalton.

The materialist reductionists of mid-Victorian times, of course, considered that these atoms and compound atoms, or molecules as they came to be called, were what determined the characteristics of organisms. The colours of flowers are chemically determined, the physiology of organisms are chemically mediated etc. Maybe a bit of 'vital force' was necessary now and then but that was a point for discussion. Thus the presence or absence of various chemical compounds became incorporated into the systematic corpus. Eventually, indeed, morphological attributes could be dispensed with. Just as the structure of a crystal was determined by its atomic constitution, the structure of an organism was determined by its molecular constitution. It is this idea which is so much to the forefront now but let us not forget that it has been a persistent theme on the fringes of biology for 100 years.

But the presence or absence of a particular compound is not enough. Systematics should have escaped from the data storage-retrieval era in the time of Aristotle. For it was he who taught us that systematic arrangement was a way to derive new hypotheses and to predict unknown but discoverable facts. If we are concerned with deriving new hypotheses about the history of variation we need to arrange these chemicals in

a logical order.

Of course the logical way to deal with these chemicals is to arrange them in the same sequence as the biosynthetic pathway to which they belong. In their investigation of the iridoid compounds, Jensen, Nielsen and Dahlgren attempted this. And this actually gives us a putative evolutionary sequence since biosynthetic pathways are, in a sense, Markovian pathways: one compound must necessarily precede another because the former is the substrate for the production of the latter. It was the chemicals along these pathways that determined the characteristics of the organism. Lignin, for instance, couldn't be developed until the pathway to aromatic amino acids was established. Thus, with these chemicals we have a more satisfactory way of relating the binary states of these chemical characters.

Nevertheless, most of the chemicals which are used in systematic arrangements are the result of reactions along the final twigs of the biosynthetic pathways and even by the turn of the century researchers realized that the chemicals they were examining were not the controlling units. They needed to seek something even closer to the ultimate control of variation. They were not only interested in how satisfactorily to arrange variation. The great hypothesis resulting from that approach had been synthesized by Darwin. They were now interested in what caused the variation between organisms, and the corollary to that, what caused progeny to resemble their parents and, following on from these questions, how new species were formed.

During the latter part of the last century there gradually developed a conviction that it was the nucleus that was the determining influence. Nageli and his friend Mendel came within an ace of developing the chromosome theory of inheritance in the mid years of the last century but their scientific caution caused them to stall. Otherwise we might have been holding this symposium 50 years ago! It was not until 1911 that T.H. Morgan set the chromosome theory of inheritance well on its way.

Now, at last, the evolutionary systematist had a basic paradigm upon which to work. The chromosomes consisted of strings of genes which determined the characteristics of the organism. Now, all we needed to do was to find the individual genes which caused the significant

variation, enumerate them, compare them and thus obtain a definitive classification. Unfortunately this approach was only possible when organisms could produce offspring. Mendelian analysis, the basis for the recognition of genes, was only useful at the level of the specific boundary or within it.

Nevertheless, there might be other ways in which one might get at a genic comparison between uncrossable taxa. At that stage everyone was convinced that genes were proteins. The constituent amino acids might be the actual conveyors of the bits of information but the chromosome was really a protein. These were the only natural compounds which occurred in all living organisms known at the time, which were considered to be complex enough to carry a code for initiating the host of other compounds found in organisms.

It was, then, only necessary to characterize these proteins in an organism in such a way as to quantitatively distinguish them from different proteins in another organism and we would have a very sensitive way of judging relationships between taxa. There was, of course, a way of doing that which had been developed in bacteriological laboratories where different strains of, for example, *Salmonella* were distinguished and compared with great accuracy by serological methods.

From about 1913 to the early 1930s, at the University of Königsberg in East Prussia, Mez and his collaborators set about characterizing the proteins of the Plant Kingdom using serology. Some of the methods which they used would make your hair curl and have present day Animal Liberationists hammering at the doors of the University waving bazookas. Mez was certain his methods were examining the hereditary material - the chromatin in the nucleus. And he produced an incredible branching sequence, with constant updating, to

illustrate the systematic arrangement which resulted from these researches. This 'Stammbau', as he called it, was patented, a step which incidentally must have tempted many others since, apparently to prevent rival researchers in Berlin from criticizing it in the pungent way to which Berliners are accustomed.

This was the first avowed attempt to characterize and compare the ultimate determinants of the characteristics of plants and to use the results in a classification.

Sad to relate, not only was the paradigm incorrect but the technology was defective. The work was lost in one of those vituperative exchanges which occasionally disfigure the face of science.

For some time people were still convinced that proteins were the ultimate touchstone for investigating variation. Indeed, when in 1943 Avery demonstrated that proteins were not, in fact, the basis for the gene and that DNA, until then considered to be mere packing around the essential protein molecules, was implicated, few people believed it. But at last we were on the right tack and with the cracking of the genetic code surely a definitive systematics was possible?

That each DNA triplet coded for a particular amino acid, and that the order of these triplets implied the order for the amino acids in the proteins, meant that the DNA could be precisely defined in terms of the proteins of an organism. And thus differences between organisms in their DNA could be determined by differences in the properties and constitution of the proteins.

Thus, the simplified paradigm which connects the three different levels of molecular organization consists of DNA mediating the production of enzymes, which in their turn take part in reactions to produce the so-called micromolecules of the biosynthetic pathways.

ASBS SYMPOSIUM AND FORUM - PROGRAM BOOKLET

Some copies of this booklet, which includes all abstracts from the meeting, are still available. They may be obtained by sending a stamped addressed envelope for return (because of postal complications this offer applies only within Australia). Postage is 80 cents and the envelope should be at least 22 x 16 cm (e.g. large enough to take a copy of ASBS Newsletter) and sent to:

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Now, small changes may occur in some of the triplet code to alter the sequence of amino acids in the enzyme without affecting its function. These changes may produce differences in the distribution of charge and thus differences in the migration rate of the enzyme along an electrical gradient. This is the basis for electrophoretic differentiation of slightly different molecules. In sexual reproducing organisms, different forms of a particular enzyme may occur in the same organism - produced by different alleles, that is slightly different DNA sequences. In themselves these may only be treated in a phenetic way between individuals, or a statistical way, between populations. The vast majority are co-dominant and diploid heterozygotes show both enzyme configurations (allozymes) produced by the two allelic loci enabling accurate population analyses to be undertaken.

These enzyme configurations can also be useful in providing historical information. If a duplication occurs involving a certain allele then three loci will be operating in the population, and the presence of this extra locus can be regarded as a synapomorphy. The distribution of allozymes may also give us a clue as to the putative parents of polyploids. And, even more interesting, they may adjudicate between alternative hypotheses of polyploidy or aneuploidy advanced for some unusual chromosome numbers. It would be intriguing to apply this method to some of Smith-White's suggestions with regard to cytological evolution in Rutaceae and Epacridaceae, although the length of time involved here may be a complication.

Unfortunately, not every change in DNA, and therefore in amino acid, sequence is reflected in changes in the reaction to electrical current. Thus differences in protein (enzyme) configurations between organisms do not necessarily reflect their total genetic difference.

Amino acid sequencing of proteins is a more satisfactory way of characterizing enzymes. It is, however, a trifle expensive.

In general, then, these differences in a particular enzyme can be best used to investigate problems of population biology which in their turn relate to the problems of speciation and species integrity which interest the systematist.

DNA sequencing, I suppose, is the touchstone that all the systematic reductionists

have been seeking. Unfortunately, the paradigm needs further adjustment since the proteins do not exactly reflect the DNA sequencing on the chromosome, at least in the eukaryotes with which we are most concerned here. There are large regions of DNA, both within the 'gene' and outside it, which do not appear to contribute directly towards the other properties of the organism. Proteins (enzymes), then, still give us a reflected but distorted, picture of the real situation.

Having recognized these problems in the eukaryotic genome we have one further feature to bring in. Boveri, Morgan and the other originators of the chromosomal theory of inheritance were not exactly right when they suggested that the nucleus was the sole conveyor of genetic information in the plant cell. There are two other sites that also carry such information, that is the plastid and the mitochondrion. Their DNA sequences are somewhat simpler to follow since they are based upon the prokaryotic ancestors of these organelles with a simpler battery of encodings than eukaryotes.

But let us not forget that we are interested in the history of variation. To repeat: systematics is not just a data storage-retrieval system; we are asking it to infer historic, evolutionary sequences. How can the DNA and amino acid sequences do this?

Some years ago I gave a talk entitled '*Mitchell's Theorem*' which attempted to set out the principles of cladistics - a method used to develop evolutionary hypotheses. Mitchell's theorem can hardly apply in the case of the DNA sequence. Indeed it is only by altering the definition of words that it can be made to apply in the case of many morphological attributes. We cannot assume that a particular purine or pyrimidine at a particular site indicates a synapomorphy, and how do we polarize them? Nor can we assume that each triplet of a codon has a single origin; that is only a little less absurd. The probability of such changes occurring is relatively high. But a particular linear sequence of triplets, and therefore of amino acids in the derived proteins, has lower probability of occurring independently. Nevertheless, even at this level the frequency of parallel substitutions appears to be high and is estimated at 40% for cytochrome and >30% for plastocyanin in plants.

Unlike morphological characters, we can be fairly sure about the homologies. The same enzymes in different organisms are homologous, whereas apparently similar morphological structures may be produced by different developmental pathways. So in many respects the DNA or amino acid sequence 'characters' can be treated in the same way as morphological features.

We might even think in terms of the subordination of characters. Certain sequences are more conservative than others, that is do not vary so much as others over a range of taxa. For instance the DNA in the chloroplast appears to be rather conservative. It still raises all the old arguments about the subordination of characters.

So, having discovered the ultimate genetic determinant, and having established particular DNA sequences, we are still confronted with an analytical problem. Do we use Parsimony, Minimum Genetic Distance or Maximum Likelihood as a principle for the analysis which will develop evolutionary hypotheses and classifications? What models of molecular evolution will we accept: a regular molecular clock; the Neutral Selection Hypothesis, etc.? On this will depend the parameters we provide for the analysis.

The optimistic concepts of the early geneticists and of Mez and his associates that the enumeration of the genes would objectively formulate the definitive systematics is not realized. Theory-based judgements are necessary at several points along the line, as indeed they always are. Strict objectivity is again unattainable.

We thus have several points of attack on the history of variation:

1. The DNA sequence
 - a. That of the nucleus
 - b. That of the plastid
 - c. That of the mitochondrion
2. The amino acid sequence of the derived proteins
3. Characterization of the physical characteristics of the derived protein
4. The reactions of the proteins with the vertebrate immune system (serology)
5. The biosynthetic sequence of chemicals and therefore of the proteins (enzymes) which produce them
6. The developmental sequence of organs
7. The final characteristics of the organs of the organism.

The first four are concerned with macromolecules the fifth with so-called micromolecules. It is the macromolecules which we are going to examine in this series of talks and I would invite you consider the problems that arise in their use in Systematics as you listen to the various treatments. For example there is still a problem in the recognition of convergent character states, parallel changes of character states, loss of characters etc. These have to be solved satisfactorily before macromolecules can contribute to an evolutionary systematics. How, in fact, have they been solved? And what do macromolecular characters give us that morphological features do not?

Macromolecules will have a remarkable impact on systematic biology and the interpretation of the history of variation but only if we recognize where problems in their use exist and only if we take steps to solve those problems. ©

Roger Carolin recently retired after a long tenure as Associate Professor in Plant Biology at the University of Sydney. He has trained and inspired some of Australia's best young taxonomists. A short biography of Roger will appear in the next issue of the 'Newsletter'.

PLANT SYSTEMATICS IN THE AGE OF MOLECULAR BIOLOGY

Synthesis and Prospect

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Introduction

It was originally planned that this paper would be published as part of the proceedings of the 1989 ASBS Symposium. It seemed to me, however, that the *real* knowledge would be found in the original papers, that themes would become evident as the symposium proceeded, and that there would be little need to rehearse them in a synthesis. As a compromise, it was agreed that a verbal summary would be presented at the Symposium, but that it would not be committed to posterity in the Proceedings. At the Symposium Organizers' request, my concluding remarks are reproduced here.

In my view, the Symposium itself was outstanding. It allowed us to come to grips with many of the issues of contemporary systematics, and for most of us must have been an education and an inspiration.

Some General Observations

One great thing that molecular biology has brought to plant systematics is a new vigour. There has been no alternative but to find ways to manage and integrate tangible and intangible data. This has led us to objective and sometimes abstract processes for analysing and interpreting data. It is interesting to contemplate where plant systematics would be if we hadn't entered the age of molecular biology at the same time as we entered the age of computers.

It is clear that systematic methodology has developed as a true science. Molecular biology and the need for strategies for objective data management have been the driving forces. As systematists we have gained much from these changes, but have also contributed greatly to

biological science. As Mike Clegg very fairly pointed out, the new era in data generation has required new intellectual input from the systematist.

Roger Carolin's elegant introduction to the Symposium drew attention to the need to maintain the fundamental systematic methodology as our data input diversifies. The need to sustain the *predictive* power of systematics in the way we process molecular data remains. We still have the same problems in handling molecular data as we do with morphological data. What is a homology and what is not? How do we choose from the alternative strategies for processing our data into hypotheses? Whilst we can consider the possibility of defining an organism by its molecular structure alone, how do we give taxonomic status to data from the DNA which is not reflected directly in the external form?

The Symposium Papers

Mike Clegg, of the University of California at Riverside, presented the keynote address. As a general account for those, like me, who are not molecular biologists, it was a *superb* crash course in DNA sequencing and the technology of today. His outline was very well enhanced by the Symposium's final paper, by Ross Crozier, which further developed the applications of mitochondrial DNA restriction and sequencing.

My own systematics research began with attempts to count chromosomes which were mostly seen in sticky metaphase clumps. We then dreamed of a technology which would somehow allow us to probe and separate them. To see a chromosome clearly and measure it seemed to be a great leap forward. As Mike Clegg has shown us, we can now sequence a gene in a few days, and the taxonomist is facing

an enormous amplification in the amount of data being generated. Perhaps our biggest problem is finding the methodology, and the resources, to manage the data.

Tony Brown presented himself as an electrophoreticist practising the 'technique of yesterday'. This obviously isn't the case, as allozyme data have important applications, and in terms of cost/benefit are likely to provide a continuing basis for taxonomic decision making. The papers by Tony Brown himself, and those by Hwang Yee, Gavin Moran, John Conran and Dave Coates all showed the value of the method in certain areas, especially at or near the species level, and as a device to define the genetic structure of populations.

One common theme in these papers was the importance of combining the allozyme data set with, or comparing it with, data from other sources, including morphology, rather than using it in isolation. In particular, it often seems that allozyme data can point to genetic differences which can lead us back to a closer look at our morphological data to see if we have missed something. This highlights what has always been an important procedural basis for taxonomy. As a Ph.D. student working on *Casuarina* I found karyological variation but no correlated morphological variation, and my Ph.D. examiner, Ledyard Stebbins, encouraged me to look a little harder at the variations in external form.

One aspect of the use of allozyme data touched upon by Hwang Lee was the question of what is the unit character state, and perhaps what is the unit of selection and response. The issue of the locus versus the band as the unit character has not been laid to rest in this symposium.

Even as a student, Sid James was a great admirer of the legendary C.D. Darlington, and as his experience grows his style becomes more and more Darlingtonian. However behind the cryptic Darlingtonian phrases there was a masterly exposition, and although molecular biology was rarely mentioned, the message was clear. In assembling and analysing molecular data we should not lose sight of the patterns and processes of change in natural populations. These should remain as a framework for our interpretation, and the rules for adaptive change which Sid James laid down *have* be obeyed, even by allozymes and DNA molecules.

The exciting potential applications of pulsed field electrophoresis were outlined by Barbara Howlett. In part the technology bridges the gap between conventional karyology through light microscopy and the now conventional molecular methods. On the one hand we can study karyotypes and make chromosome number determinations, and on the other we can apply some of the molecular techniques to the recovered DNA. The technology has obvious applications for 'difficult' genomes, for example in fungi, and it may have an important role in the future in contributing to a biological approach to the management of root diseases.

Another approach which in a sense bridges the gap between molecular analysis and the light microscope is that used by Donald Colgan in the study of gene duplications. There are now many more techniques available to identify duplications, and because of the ways in which they arise they can be good indicators of monophyly, especially at higher taxonomic levels.

The Symposium covered a broad range of topics in DNA sequencing and data analysis. Adrian Gibbs presented a cautionary tale which highlighted the variation in the level of conservation along the DNA molecule, and the derivation of different parts of the molecule from different sources, thus raising some doubts about the value of dendrograms based on segments of DNA rather than all of it. The observations on promiscuous mitochondrial and chloroplast DNA in the nucleus, and the need to allow for this in sequence work, were revisited in the contributions of David Penny and Peter Baverstock. Following these observations, another possibility for acquiring data for higher level systematics was raised by Jeremy Timmis, who has linked these changes in nuclear DNA with the probability of the endosymbiotic origin of the organelles concerned. In particular, he raised the possibility that the *extent* of the move of organelle DNA to the nucleus can be used as a character in itself, and he correlated the information on the use of fragments and sequence data in chloroplast and mitochondrial DNA.

Cyril Appleby presented an outstanding account of molecular conservation *par excellence*. It was outstanding because the painstaking sequence work on haemoglobin genes was qualified by careful consideration of

taxonomic distribution, adaptive value, and geologic age. This work provides a model to be remembered when we deliberate the taxonomic importance of rare chemical compounds in distantly related plants, and it is a rare contribution from molecular biology to ideas on the physiological conditions under which higher life forms evolved on earth.

In a Symposium such as this, cladistics and its methodologies are an inevitable discussion area. David Penny referred to a Pandora's box of cladistic problems, and his own presentation and that of Judy West opened the box widely. Many of the areas of debate surrounding cladistic methodologies and their relevance were raised.

As in the classical myth, Hope stayed in Pandora's box when all of the evils, including Cladistics, got out. Those of us who are not practising cladists can take heart that the science is healthy and progressing, and aware of its conceptual problems and weaknesses, and working to overcome them. We were reminded of the need for good models to cope with masses of new sequence data. We were reminded that the quality of our data is at least as important as the quality of our analysis. How we sample is emerging as a highly sensitive area. We were also reminded of the importance of how we code data and conserve information, especially by Gavin Moran.

The universal nature of sequence data was highlighted by David Penny and later by Peter Baverstock. Peter Martin and Peter Baverstock presented some hands-on examples of analysis of sequence data which provide some important provisional models of phyletic relationship. However their examples reaffirmed the ultimate need to reconcile sequence analyses with other data, as well as the need for ways of handling ever larger data sets. Julie Dowd heralded a new phase in higher category classification research in seeking to complement the earlier protein sequence analyses with RNA sequence work. This should lead to valuable comparisons between the RNA and protein sequence data, and to refinement of the phylogenetic trees through integration of the RNA data.

In contrast to the use of sequence analysis at higher taxonomic levels, as discussed in several earlier papers, Jeff Doyle presented a very elegant study of the use of chloroplast DNA restriction studies and nuclear ribosomal DNA to

address problems at a low taxonomic level. He clearly showed the value of molecular biology in resolving the taxonomic difficulty in *Glycine*. The study had all the ingredients which earlier discussion indicated were needed in a comprehensive and reliable treatment. These include incorporation and accounting for data from other sources, including crossability, morphology and karyology, and also the great importance of high quality and adequate sampling. *Glycine* is emerging as a classical example of a group in which molecular analysis has sent us back to the drawing boards in terms of descriptive taxonomy, and has led, or is leading us, to a much more robust taxonomic treatment.

Jeff Doyle was careful to distinguish between his chloroplast tree and a phylogenetic tree, as was Ross Crozier with respect to gene and species trees. Ross Crozier also emphasized, again, the importance of good sampling in generating sequence data.

Rudi Appels explored another approach to macromolecular systematics, in which probes may be used to analyze the repeat sequence structure at loci such as the nucleolar organizer and the ribosome, as an alternative to complete sequence data to identify relationships between taxa. This approach is applicable at a range of taxonomic levels, and is clearly important at the intermediate level where taxonomists traditionally have problems, for example in determining rank or relationship at or near the level of genus.

Prospects

Plant systematics is clearly in an exponential growth phase as far as data accumulation and procedural methodology are concerned. Its practitioners seem to be conscious of the pitfalls and seeking to avoid them. We are conscious of the need to accommodate the classical data and hypotheses in generating new ones. If we reject earlier hypotheses we understand that we know why we do it. There is every reason to be optimistic as far as the future prospects of plant systematics are concerned.

Perhaps owing to the social and economic climate of the times, it seems more and more that producing a systematic treatment or hypothesis can not be regarded as an end in

itself. Its value comes in application by a user. Speakers in this Symposium referred to conservation and vegetation management, and to plant genetic resources management as justification for their systematic research. Our users are more diverse than we at first think, and must be seen to include politicians, students, naturalists and tourists.

We are rapidly entering a time of high quality taxonomic decision-making, based on high quality data and analysis, and of more targetted work. This will give systematics a much higher standing in the natural sciences than it has had in recent years, and will be perceived as the key to good environmental management in the broad community interest. ©

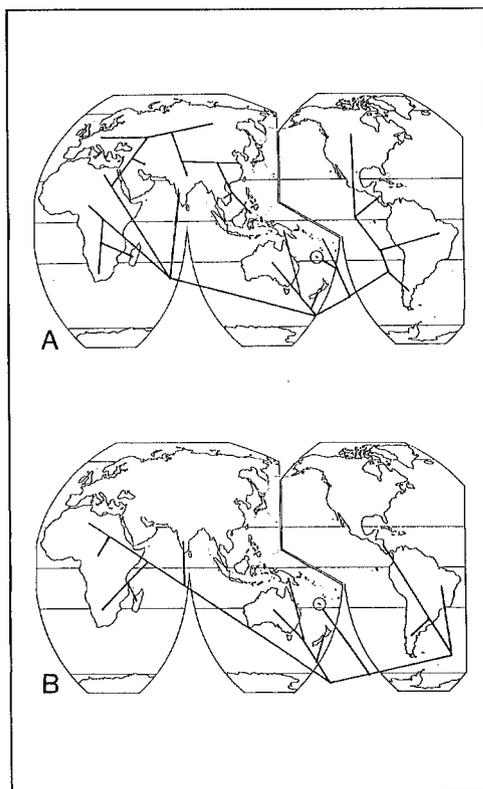
GONDWANAN ELEMENTS IN THE AUSTRALIAN FLORA: ABSTRACTS

Gondwanan affinities and evolution within the Liliiflorae

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The Liliiflorae (excluding the 'orchids') comprise c. 52 families within five orders. These taxa show marked distribution patterns at the family and subfamily levels world-wide, and many of the families have Gondwanan distributions. If these families are treated as characters to describe regional floras, these regions can be clustered using the patterns of 'lily' distribution. As each character is monophyletic (assuming the taxonomy is correct), the joint occurrence of a taxon in two regions must indicate either a dispersal or a vicariance event. The data for 20 regions and for the 11 of these which comprised Gondwana were subjected to parsimony analysis on PAUP. This was in order to cluster the floras using minimal numbers of changes to move from one flora to another.

The results both at (A) world and (B) Gondwanan levels showed clear Gondwanan assemblages, corresponding well to the break-up sequence of the supercontinent. At the world level, the floras of North Africa and Central America probably grouped with adjacent Laurasian regions as a result of dispersal events which occurred when the regions came into contact. The cladograms, combined with the large numbers of primitive Gondwanan endemic families, could be possible evidence for an early origin and radiation of the group in Gondwana. ©



Pittosporaceae - an old east Gondwanan family?

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The recent discovery in Western Australia of two new species which did not fit into recognised genera prompted a cladistic analysis of the family (one of the new species has subsequently been described as a monotypic new genus, *Bentleya*). Five families suggested by previous authors to be related to Pittosporaceae were included as outgroups. These were the Araliaceae, Byblidaceae, Escalloniaceae, Rutaceae and Tremandraceae. Characters included in the analysis were mostly morphological.

The results were equivocal because the set of most parsimonious trees was very large; nevertheless some conclusions can be drawn:

- Monophyly of the family is confirmed.
- *Citriobatus* is most closely related to a subgroup of *Pittosporum* and should be included within it.
- *Rhytidosporum* does not belong in *Billardiera* and should be re-segregated from it.
- *Billardiera* as currently defined appears to be polyphyletic. Either four genera (including *Bentleya*) could be sunk into it, or the genus could be divided. Since this is the least resolved part of the consensus cladogram, more work is needed before major taxonomic conclusions can be drawn.
- *Bentleya* and the other new species from Western Australia, although superficially very different, are sister taxa within the *Billardiera* complex. Thus, the second species could either be included within *Bentleya*, or described as a monotypic new genus. It is proposed to follow the former course.

Pittosporaceae are widespread in the

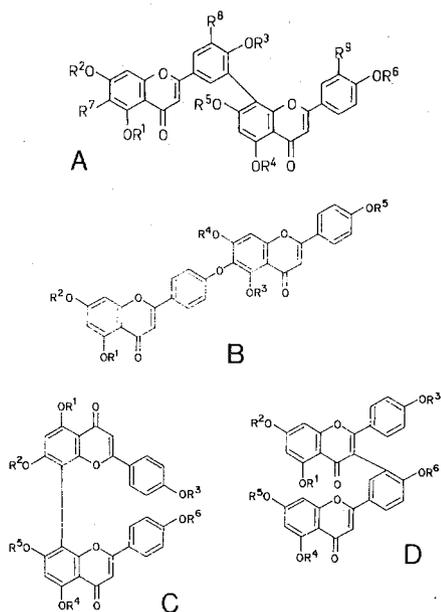
fragments of Gondwana (Africa, Madagascar, India-China, Malesia, Australia, New Caledonia and New Zealand), and in the Pacific, but absent from South America, which perhaps indicates an origin in east Gondwana. Nevertheless, most genera are restricted to Australia. Moreover, *Bursaria*, which is endemic in Australia, appears to be the sister-taxon of the rest of the family, which includes the widespread genus *Pittosporum*. This is not in accord with current vicariance biogeography models, under which Australian taxa are expected to be more closely related to each other than to taxa on other continents. ©

Affinities of southern Cupressaceae

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The presently accepted intrafamilial classification of the Cupressaceae *sensu stricto* (Li, 1953) recognises a basic division between northern and southern elements. Li based his separation on the degree of overlap of the scales in the female cone (imbricate/valvate), although his interpretation of this character is difficult to follow. Recent advocates of a merger between this family and the Taxodiaceae to form the Cupressaceae *sensu lato* (Eckenwalder, 1975; Hart, 1987; Price, 1989) have continued to recognise this separation within the Cupressaceae *sensu stricto*, the southern elements in particular being considered by Hart to form a monophyletic group. However, the extensive literature reviews of existing data by both Eckenwalder and Hart indicate that there are few existing characters that have been systematically scored, and that an expansion of the data base is clearly needed before any reassessment of affinities can be made.

A survey of leaf biflavonoids in representatives of all genera has been completed. The distribution of biflavonoid series based on different interflavonyl links appears to be a significant data source in the taxonomy of the family. Differences in the degree of methylation of the leaf biflavonoids also appear to provide useful characters. Out-group comparisons indicate the plesiomorphic condition to be a complex mixture of



Examples of the different interflavonyl links of the major biflavonyl series found in the family

amentoflavone (A) and hinokiflavone (B) derivatives in which di- and trimethylethers are conspicuous constituents; presence of cupressuflavone (C), taiwanilaflavone (D) and 2,3-dihydro derivatives of amentoflavone and hinokiflavone, and absence of hinokiflavone are derived states, as also is a biflavone fraction in which the major constituents are unmethylated, and di- and trimethylethers are absent.

A survey of leaf and wood anatomy carried out under light and scanning electron microscopy has allowed traditional characters derived from wood anatomy to be re-evaluated. The morphology of the vested layer of tracheids has been investigated systematically for the first time, and has revealed some striking variations. Transfusion tracheids in the leaf provide some new characters. A strikingly different sequence of differentiation of the protoxylem has been distinguished within the leaf trace of Cupressaceae *sensu stricto*.

The impact of these data on our understanding of relationships within the family is discussed, with special emphasis on the southern members. The present subfamily

arrangement is clearly artificial, some southern genera showing stronger affinities to northern genera than to other southern genera. Significant changes are also required in the tribal divisions. ©

Classification of Australian Casuarinaceae using allozyme evidence

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Seedlings of 36 casuarina species were tested for four enzymes (peroxidase, superoxide dismutase, leucine aminopeptidase and tyrosinase). Two dendrograms (Euclidean Distance and Correlation Coefficient; UPGMA), two projections of Principal Coordinate Analysis, a Minimum Spanning Tree and a Wagner consensus cladogram were produced. *Casuarina pinaster* and another three affiliated species which are possibly relics from S.W. Western Australia form the most distinct group in the section *Cryptostomae*. Either *C. glauca* or *C. pusilla* appears to be the most derived, and the *C. pinaster* group the least. The *C. distyla* group were found not to be as homogeneous as previously thought. The present results do not support Johnson's division of the *Cryptostomae* into genera *Allocasuarina* and *Casuarina* s. str. ©

A molecular evolutionary clock

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This contribution is based on the paper of Martin and Dowd (1988; *Taxon* 37: 364-377). The species compared are descendants of others putatively separated by continental drift and are from Winteraceae and *Nothofagus* (Australia, New Zealand and South America), *Solanum* (Australia and Africa) and Proteaceae (all four land masses). Differences between taxa have been obtained from sequences of the N-terminal forty amino acids of the small subunit of rubisco; inferred nucleotide differences (*ind*)

have been derived after conversion of amino acid sequences using the genetic code in a parsimonious fashion. Times of separation have been derived from the literature on plate tectonics for one set and of biogeography for an alternative set. Altogether there are 42 comparisons, 15 for Africa-Australia, 12 for New Zealand-Australia and 15 for South America-Australia. With either set of times, the data are compatible with a linear regression line that passes through the origin, the latter suggesting that we could ignore the possibility of differences existing before separation. The variance about the regression line has been estimated using 49 comparisons between major taxa, each involving between 16 and 165 measurements of *ind*. For each of the 49 comparisons the mean and variance has been calculated and then, using an iterative weighted least squares method, the relationship between mean and variance has been derived. Thus, when a mean value has been calculated for a particular time, the variance can be derived and then the 95% confidence limits. For each set of times, a regression has been calculated and a botanical criterion (the inferred time of monocot-dicot separation) has been used to discriminate in favour of the biogeographical set which has final separations between Australia and Africa at 80Ma, Australia-New Zealand at 60Ma and Australia-South America at 38Ma. The variance about the regression is such that the 'clock' is not very accurate but it is possible to discern those disjunctions which fall below the lower 95% confidence limit and are therefore likely to be the result of long range dispersal more recent than continental separation. The clock suggests a Jurassic origin for the angiosperms. ©

Gondwanan grasses in the Australian flora

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All the currently recognised major groups of the Poaceae (the grass family) with the exception of the poides, are postulated to have

had a Gondwanan origin. There is no hard evidence for this belief, the fossil record of the family being extremely poor and giving little assistance in the study of palaeogeography and evolution of taxa. The evolution of the major groups and in some cases genera and species of grasses is reviewed in relation to Gondwanic events, both generally and in relation to Australia, in the light of studies from biogeography, plate tectonics, numerical methods and cytogeography. ©

Transpacific cladistic patterns in the Proteaceae and Elaeocarpaceae

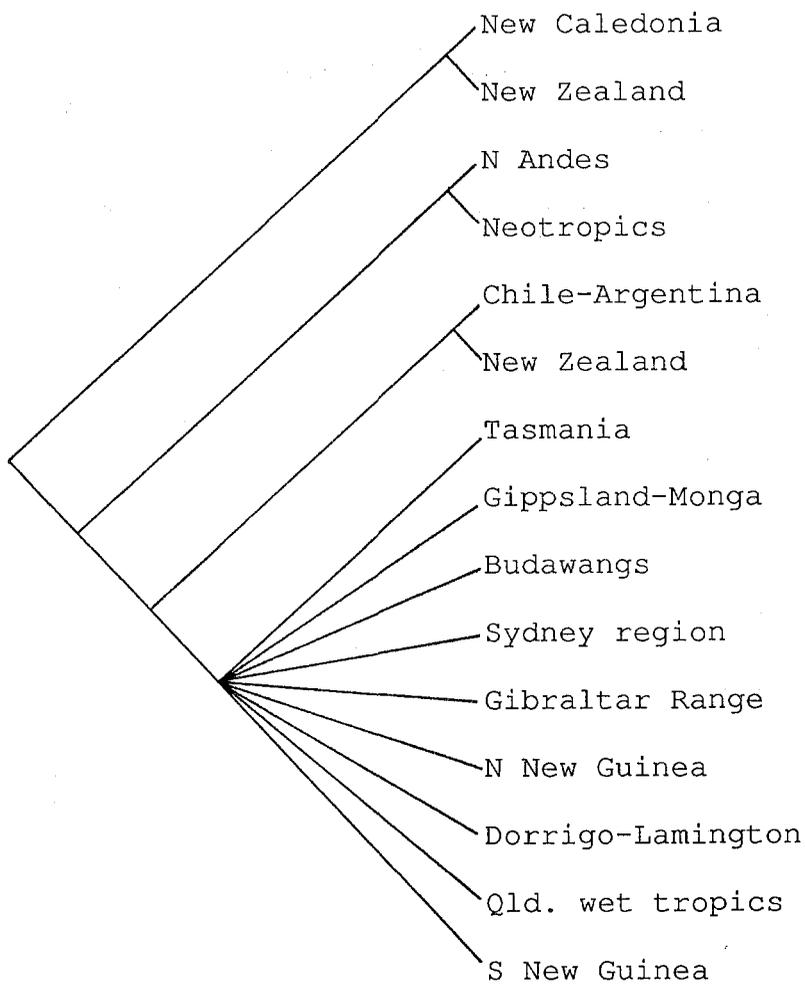
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The Proteaceae are often said to be a 'relic Gondwanic group' because they are vicariously distributed over several southern continental blocks. Eleven different taxa in the family show such distributions and these are mostly presumed to have resulted from fragmentation of ancestral taxa by continental drift. Hypotheses of this sort may be tested using techniques of cladistic biogeography. These methods analyse cladograms of two or more taxa that have overlapping distributions. The end-product of such an analysis is one or more 'general area-cladograms', hypotheses of the cladistic relationships between whole biotas. General area-cladograms should be congruent with the history of geological/geographical 'vicariance events'.

I have produced (with M.D. Crisp) a well-corroborated cladogram for the subtribe Embothriinae (Proteaceae). Less well-corroborated cladograms for the subtribes Lomatiinae, Gevuiniinae, Persooniinae, and Knightiinae, as well as Coode's cladogram for *Vallea* and *Aristotelia* (Elaeocarpaceae) combine with it to yield the general area-cladogram opposite.

This pattern is mostly consistent with conventional geological theories of earth history. The different groups are incongruent with each other in the relationships that they specify for continental land masses (such as New Zealand) that are known to have a complex geological history. ©



*General area-cladogram of the Pacific region
based upon subtribes of the Proteaceae and genera of the Elaeocarpaceae*

ARTICLES

AN HENNIGIAN ANALYSIS OF THE EUKARYOTAE

David Morrison and Michael Crisp
Institute of Banksia Studies

Introduction

During the recent ASBS Symposium on '*Plant Systematics in the Age of Molecular Biology*', the participants were treated to a feast of hypotheses concerning the phylogenetic history of various plant groups. Most of these hypotheses were generated by use of the cladistic technique developed by Hennig (1950, 1966), which searches for shared derived character states. However, only one of these talks lends itself to the sort of **bold** hypothesis generation-and-testing for which the '*Institute of Banksia Studies*' wishes to become famous.

The Background

This particular talk was presented late on the first day (always a good time for a bold hypothesis) by Cyril Appleby from CSIRO in Canberra, on behalf of himself, Elizabeth Dennis and Jim Peacock. His talk concerned a study of haemoglobin in plants, which is a strange enough concept on its own. However, it has long been known (well, since 1982 anyway) that the nitrogen-fixing root nodules of legumes contain a haemoglobin, called leghaemoglobin, which has essentially the same gene structure as vertebrate haemoglobin. Cyril and his co-workers have extended these studies to other plants, and have found haemoglobin with similar gene structures in the roots of *Parasponia* and *Trema* (Ulmaceae), and *Casuarina* (Casuarinaceae). This work led them to speculate about haemoglobin evolution and also about the earliest stages of plant evolution' (Appleby et al. 1989).

Well, we enjoy this sort of speculation ourselves, and it seems to us that Cyril did not go far enough in speculating about the early evolution of plants. It is only the very boldest hypotheses that are worth pursuing, and, as one of us has noted before (Morrison 1989), we

believe that taxonomists should be in the very forefront of scientific speculation.

The Hypothesis

Cyril's data (as presented at the Symposium) are summarised in Table 1. Cyril and his colleagues concluded from this that the haemoglobin genes 'originated by vertical descent from a proto-organism (whose genes had introns) common to animals and plants' (Appleby et al. 1989). The word 'vertical' here means gene inheritance from parent to offspring, as opposed to 'horizontal' gene transfer from a root-inhabiting animal to the plants. So, they are postulating an origin of the haemoglobin gene in a common ancestor, rather than repeated transmission of the gene from animals to extant plants, as was originally supposed. In order to generate this new hypothesis, they had to conclude that vertebrates have lost an intron in the gene, and they also had to anticipate that monocotyledonous plants will prove to have haemoglobin genes. Unfortunately, these are both *ad hoc* hypotheses, unsupported by direct

Table 1. Distribution and characteristics of haemoglobin in eukaryotes.

Taxonomic group	Presence of haemoglobin	Presence of introns in gene
Insects	yes	no
Vertebrates	yes	yes (2)
Dicotyledons	yes	yes (3)
Monocotyledons	-	-

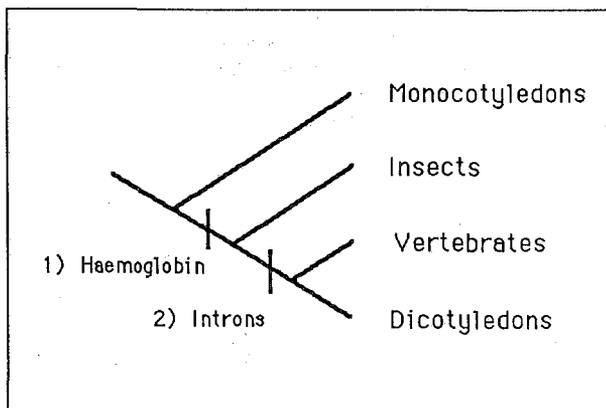


Fig. 1. Proposed phylogeny of eukaryotes

evidence. Being younger and bolder, we would like to propose a much more provocative hypothesis, which has at least as much explanatory power as that proposed by Appleby et al. (1989).

Our hypothesis is summarised in Fig. 1. We propose that the presence of haemoglobin genes is the apomorphic (derived) state, while the presence of introns in the gene is a further derivation.

Our hypothesis specifically suggests that the class Liliopsida (monocotyledons) are the sister group to much of the rest of the superkingdom Eukaryotae, rather than being a specialised offshoot of the class Magnoliopsida (dicotyledons) as is more usually suggested (see Dahlgren et al. 1985). In particular, the phylum Uniramia (insects) and subphylum Vertebrata (vertebrates) share haemoglobin with the dicotyledons and are therefore more closely related to them than are the monocotyledons, which apparently have none. The relationships of the rest of the eukaryotes are not specified by our hypothesis.

We would like to call this hypothesis the *Crisp Hypothesis*, mainly because no self-respecting scientist would propose a soggy hypothesis, but partly because it was first proposed by Dr Crisp.

The Supporting Evidence

This hypothesis is, as usual, truly scientific (*sensu* Popper 1968), as it accounts for all of the known data at least as well as do the competing hypotheses, and it is in principle testable. In true

Hennigian style, to test our cladogram we must search for other characters that support the proposed synapomorphies. We believe that there are a number of characters that corroborate our hypothesis.

Firstly, let's consider the matter of *mery*. We all know that monocotyledons are trimerous, while dicotyledons are tetramerous or pentamerous. In addition, it seems to us that vertebrates also have tetramerous limbs (although zoologists call them tetrapods), and we know well that insects in this respect are hexamerous or even worse. If we accept the following ordered transformation series for the

character states of *mery*:

tri- → tetra-, penta- → hexa-, octa-merous, etc.,

then we have a corroboration of character 1 (and also a neat autapomorphy for insects).

Next, consider venation. Monocotyledons have parallel venation in their leaves, while dicots have reticulate venation. Furthermore, vertebrates have reticulate venation throughout their bodies, while insects have it in their wings. It only requires a reversal in the usually-accepted polarity of the character states, and we have another corroboration of character 1.

Furthermore, the vascular bundles of monocotyledons are scattered throughout the tissues (called polystely), as they also are in insects. However, dicotyledons have their bundles in a ring around the pith (dictyostely), while vertebrates have theirs in rings around their bones. If scattered vascular tissue is the plesiomorphic (ancestral) state, then we have a corroboration of character 2.

Now, let's examine secondary growth. Dicotyledons have a functioning cambium, while monocots don't. More to the point, we know a number of people (vertebrates) who can only politely be referred to as exhibiting secondary growth around the midriff (including, alas, Dr Morrison). Alternatively, secondary growth is responsible for woodiness, and, as anyone who has taught at a university will tell you, students (also vertebrates) are prone to exhibiting woodiness in a certain part of their upper anatomy. Pursuing the same line of thought,

secondary growth produces bark, and some vertebrates are also known to bark. Insects, on the other hand, do not usually show much evidence of secondary growth. Consequently, if secondary growth is the apomorphous condition, we have another corroboration of character 2.

Finally, we can investigate the matter of wings. Monocotyledons, naturally, do not have wings, at least not under our definition of wings. On the other hand, many insects and vertebrates most definitely do. Similarly, many dicotyledons also have wings. Consider, for example, the Goodeniaceae and Fabaceae, which have them as part of their flowers, and the Casuarinaceae, which have them on their fruits. So, the presence of wings being apomorphous, we have another corroboration of character 1.

Discussion

At this stage we feel that our hypothesis is not only crisp, but well and truly toasted. We have at least three synapomorphies at each dichotomy in our cladogram, and a Consistency Index of 1.00. As those of you who were at the Symposium will realise, this is a truly remarkable achievement, especially when dealing with morphological characters. In some ways it is even more remarkable, because we are dealing with plants, which have characters that Norman Platnick (pers. comm.) has claimed 'a zoologist wouldn't spit on'. Perhaps Norman, being a zoologist, lacks credibility in this. However, there are also botanists who claim to have hard evidence that plant characters are inferior to animal characters, being shot through with homoplasy (Syvanen et al. 1989). These people should be dealt with.

With considerable reluctance, however, we are prepared to admit that we don't really have a good reason for rooting our tree below the monocotyledons. Rooting the tree below the dicotyledons, for example, would restore the polarity traditionally accepted for the venation character. Nevertheless, we are certain that there is no rooting-point possible that will show the monocots and dicots as each other's closest relatives. Biologists are simply going to have to accept that higher plants are a paraphyletic group that gave rise to the animals.

There are, of course, very significant consequences from this conclusion. For

example, if plants are not a real group, then Botany is not a real profession. Or, at least, not unless it includes Zoology as well. This is another strong reason for establishing a combined Systematics Society (see Crisp 1988).

There are a number of other things that can be inferred from our analysis. Firstly, those of you who question our assessment of the homologies and polarities involved in our reasoning, can only be described as preferring soggy hypotheses (rather than the over-cooked one we have here). Finally, this sort of well-corroborated research is a good example of the Hennigian precept that David Penny introduced us to at the Symposium from his authoritative new translation of Hennig (1950). Cladistics is indeed *'the art of being wrong, with confidence'*.

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A SIMPLE PLANT PRESS

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The Press

The plant press outlined here has several advantages over standard wire presses. These include its speed of use, light weight and its simple and inexpensive construction.

Pressure to press specimens is supplied by the velcrose straps. Experience has shown this to be effective, quick to use and relatively long lasting. The press is suited to contain a bundle of specimens up to 20 cm deep, though on occasions we have used much deeper bundles. It is intended for day use only, and has only one fold of paper per specimen without cardboard or blotting material between specimens. Specimens are transferred to an appropriate 'drying' press at the end of each day.

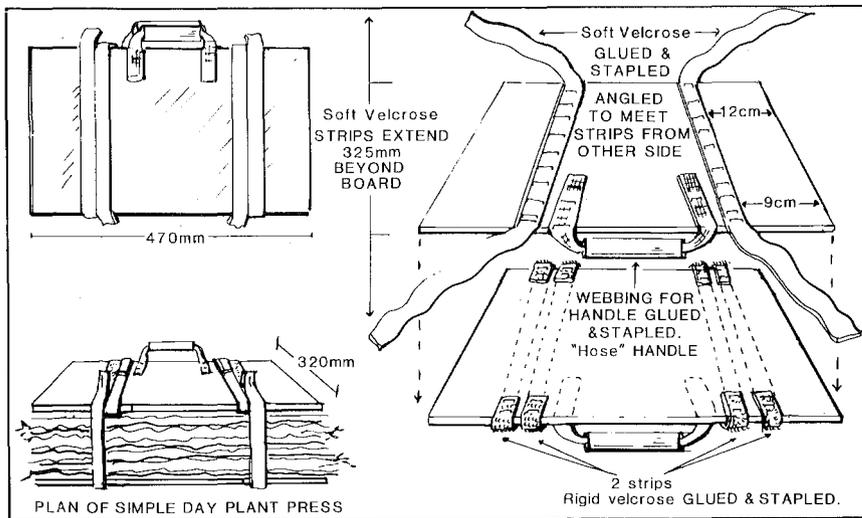
This style of press has been in use at DNA for about four years. The first part of the press to wear is the velcrose straps, and these have been replaced on our original presses.

Materials (for one press)

Wood - 3 ply (4-6mm drop): 2 @ 470 x 320 x 4-6 mm; velcrose - 25 mm wide: 4 @ 320 mm = 1.280 m; webbing - 25 mm wide: 2 @ 400 mm = 800 mm; hose - standard garden hose: 2 @ 150 mm = 300 mm. Also required: glue, paint, staples, staple gun and sandpaper.

Construction

The method of construction is depicted below. It is best to overlap the rigid velcrose onto the inside of the plywood, this prevents the velcrose peeling back after use. Glue should be used in quantity on both the handles and velcrose. It is best to smooth the protruding staples back on the inside of the wood to prevent scratching. Painting the plywood restricts water entering and rotting the timber; plywood edges should be sanded back to a smooth surface to prevent chipping. ©



FAST PCOA PROJECTIONS WITH PATN AND LASER PRINTER

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After completing a PCoA (principal coordinate analysis) or similar ordination such as multidimensional scaling from a package such as PATN (Belbin, 1987), the next task, done reluctantly or not, is to spend usually several hours redrawing the output to a standard suitable for publication. Although projections are supplied by most computer packages, their quality is generally poor, especially when linked to a dot-matrix printer. This is very time consuming and inefficient by comparison with using a computer from which suitable plots can be done in about 10 minutes.

To carry out our plotting method, access is needed to an MS-DOS (IBM-compatible) personal computer with FORTRAN compiler and the graphics package SCD (also called NCAR) of McArthur (1983), plus a laser printer with support for graphics. An output file from PATN (for example M45.PCA, below) can be used as the data file for our FORTRAN program (PCA.FOR) which reads and then range-standardises (Gower 1971) the entries for all OTUs against each eigenvector. The standardised vector values are multiplied by a 'resolution parameter' and the expanded values used as the ordinates for plotting. SCD allows 1000 divisions for each of the X and Y axes; thus the resolution parameter is 1000 (some marginal space is optionally reserved for lettering and/or axis lines). On an IBM PC there are two parameters: 720 for the X axis and 348 for the Y axis. PCA.FOR also reads in codes for OTU symbols on the projection from a pre-established file (see Fig. 1 and example below using M45.COD).

PCA.FOR has been divided into two parts here for ease of use. PCA1.FOR extracts and standardises the data in M45.PCA, creating M45.DAT. PCA2.FOR reads and expands the data in M45.DAT (for 3 vectors only), chooses the vectors specified in advance and plots the projections. PCA2.FOR needs re-programming when using the IBM PC graphics. The

programming for multidimensional scaling and PCA is virtually identical to that for PCoA. We have also developed programs for drawing Minimum Spanning Trees, dendrograms and zymograms which we hope to detail in the near future.

For further information about these programs, including the source code itself, please contact the authors.

Example

This is an output file (M45.PCA) from PATN.

28-JUL-89 08:52:24 PCA m45

<u>LABEL</u>	<u>VECTORS 1 → 3</u>			
ACU (1)	-0.2622	0.0267	0.0498	
AC1 (2)	-0.2549	0.1231	-0.0064	
AC2 (3)	-0.1977	-0.0415	0.1542	
CAM (4)	-0.1746	0.0590	0.1033	
CO1 (5)	-0.2427	0.1940	0.0436	
CO2 (6)	-0.1973	-0.0797	0.1457	
CRI (7)	0.1941	-0.0134	0.1623	
CUN (8)	0.1585	0.0880	0.0711	
DCA (9)	-0.0356	-0.1775	0.0893	
DCU (10)	0.0501	-0.1770	-0.0321	
DIE (11)	-0.0168	-0.0049	0.0868	
DI1 (12)	0.0085	0.0009	-0.1476	
:	:	:	:	:
:	:	:	:	:

After running the above through PCA1.FOR, an output file (M45.DAT) is created as follows:

0.0000	0.5040	0.2810	1
0.0690	0.6661	0.4263	2
0.2933	0.2447	0.7403	3
0.2775	0.5564	0.5755	4
0.0482	0.8376	0.5970	5
0.2287	0.1626	0.5896	6
0.9584	0.3071	0.8216	7

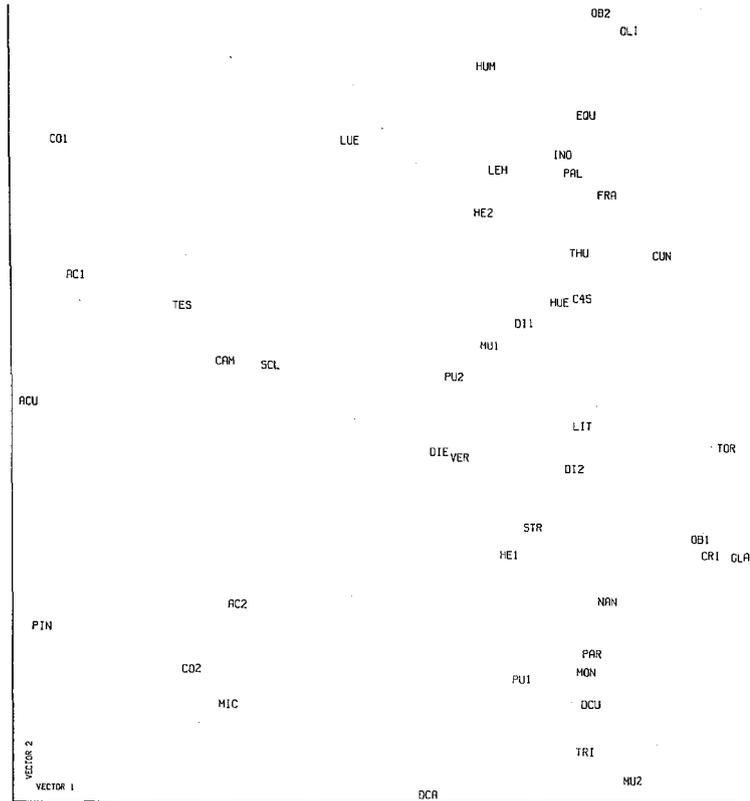


Fig. 1. Sample projection of first two vectors from M45 data

0.8927	0.6914	0.6507	8	DCA
0.5601	0.0000	0.4184	9	DCU
0.7877	0.1158	0.1983	10	DIE
0.5711	0.4406	0.5775	11	D11
0.6983	0.6060	0.0241	12	:
:	:	:	:	:
:	:	:	:	:

A pre-established file for OTU codes (M45.COD) is also needed in the following form:

- ACU
- AC1
- AC2
- CAM
- CO1
- CO2
- CRI
- CUN

References

Belbin, L. (1987). 'Pattern Analysis Package'. (CSIRO, Canberra).
 Gower, J.C. (1971). A general coefficient of similarity and some of its properties. *Biometrics* 27: 857-74.
 McArthur, G.R. (1983). 'An Introduction to the SCD Graphics System'. (Scientific Computing Division, National Center for Atmospheric Research, Boulder, Colorado). ☺

AUSTRALIAN SYSTEMATIC BOTANY SOCIETY INC. - BUSINESS**MINUTES OF THE 12TH GENERAL MEETING
SYDNEY, WEDNESDAY 28TH JUNE 1989**

The meeting opened at 5.15 p.m.

1. Attendance

The President, Dr Barbara Briggs, welcomed the 32 members to the 12th General Meeting.

2. Apologies

B. Barnsley, J. Bruhl, S. Jacobs, L. Jessup, S. Prober, B. Symon and E. Watson.

**3. Minutes of 11th General Meeting
held in Melbourne on 25 May 1988**

The minutes of the previous Council Meeting (25 May 1988) were published in the *Aust. Syst. Bot. Soc. Newsletter* 56: 19-28 (1988). The minutes were accepted [moved L. Johnson; seconded D. Foreman. Carried].

4. President's Report

The main activities of the Society will be reported later in this meeting under the relevant agenda items, so I will not detail them.

The General Meeting last year asked the Council to take an active role in drawing attention to the needs of systematic botany for adequate funding and for the significance of this field of science to be recognised. Letters stressing these matters have been sent to several Ministers, the Prime Minister, the Australian Research Council and to other relevant committees.

The *Australian Systematic Botany Society Newsletter* has continued to be among the main tangible benefits of membership for botanists throughout Australia. Recent issues have shown an excellent standard of quality and interest and I would like to convey the thanks of all ASBS members to both the Editor, Barbara Barnsley and the Associate Editor, Michael Crisp, on their fine achievement with the Newsletter.

A major aspect of the Society has been the activity of local chapters and I am sure that I speak for all of you in expressing our thanks to local conveners for their effective work.

In relation to the present Symposium, Council has accepted the recommendation of the Organising Committee that we seek to publish the papers in *Australian Systematic Botany*, with the prospect that extra copies be run on for sale as a book. The journal has agreed to this in principle, subject to its conditions of acceptability of individual papers. ASBS will not expect to receive profits from this, but there is no capital cost to the Society. The publication will give worthwhile publicity to ASBS, as well as presenting important and interesting work.

All Council Members have made active and important contributions to the work of the Society, but especially the Secretary, Barry Conn and the Treasurer, Don Foreman. I would thank all members of the Society, and particularly Council Members, for their support during the year.

5. Treasurer's Report

The Treasurer, Don Foreman, presented the following audited Report for the calendar year of 1988 (1 Jan. - 31 Dec.) and the following unaudited summary for the period of 1 Jan. - 26 Jun. 1989.

Membership of the Society

There are 337 members resident in Australia and 33 members overseas.

Income

The Society's main source of income continues to be subscriptions from members. This yielded \$5763.35 for the year ended 31 December 1988. Interest from Term Deposits and the cheque

account amounted to \$1956.30. Other income came from sale of 'Flora and Fauna of Alpine Australasia' (\$228.58) and 'Evolution of the Flora and Fauna of Arid Australia' (\$105.70) and the sale of one 'Aust. Syst. Bot. Soc. Newsletter' (\$3.50). As at 31 December 1988, the Australian Systematic Botany Society had assets of \$5828.05 at the Bank and \$15670.87 on Deposit.

Subscriptions

Late payment of subscriptions continues to be a problem. As of 26 June 1989, a total of 120 people had not paid their 1989 subscriptions, of which 14 had not paid their 1988 subscriptions. The introduction of the subscription year date that appears at the bottom of the 'Newsletter' address sticky label appears to be frequently overlooked. Regular reminders also appear in the 'Newsletter'.

Expenses

Production costs associated with the 'Newsletter' continue to be our major expense, totalling \$6691.87 for 1988, this included the costs associated with 'Newsletter' No. 53 that had the Boden Conference papers in it. It should be noted that this expense was not covered by subscriptions for the same period.

History Symposium

The final Balance sheet from Bloomsbury Services for the History Symposium issued 24 October 1988 showed:

Total Income	\$22097.00
Total Expenditure	<u>16710.01</u>
Net Profit.....	<u>5386.99</u>

However, from this needs to be deducted the following amounts:

Overseas speaker's expenses ...	1006.00
Printing costs	<u>680.62</u>
Total Expenses.....	<u>1686.62</u>

The Symposium was supported by the following:

Aust. Syst. Bot. Soc. Inc.	2500.00
Ansett (towards printing)	600.00
Royal Botanic Gardens, Sydney ..	200.00

Maud Gibson Trust	<u>1500.00</u>
Total Support.....	<u>4800.00</u>

The Symposium made a profit of \$3700.37, with a return of \$1200.37 to the Society.

The Bank statements and other records are presented and should be regarded as part of the Society's records.

CSIRO Journals

Several members now take advantage of the offer made by CSIRO to obtain journals at a reduced rate through the Society. The Society gets no financial gain from the exercise and costs to the Society are minimal.

Federation of Australian Science and Technology Societies

The Society's subscription to FASTS for the 1988/1989 financial year (\$1085.00) appears on the Summary for 1989. Subscription rate to FASTS is \$3.50 per member per year. We presently subscribe on the basis of 310 members.

Recommendation

Discount rate for early payment of subscriptions should be discontinued. This would allow us to hold standard rates at the present level of \$20.00 per annum.

A decision on the membership subscription rate was deferred until point 9 (see below).

Copies of the report, together with a statement of the Society's Assets and Liabilities were distributed to the members of the General Meeting. A copy of the audited summary has been given to the Public Officer (M. Crisp) to be lodged with the A.C.T. Corporate Affairs Commission.

It was moved, D. Foreman, seconded R. Henderson, that the report as presented be accepted. [Carried].

The meeting discussed the problems caused by unfinancial members. L. Johnson felt that a more prominent marker could be placed on the 'Newsletter' envelope to inform members of their financial status. B. Briggs pointed out that this

matter was currently being considered by Council. J. Thompson noted that it was difficult to remember if one had paid the subscription towards the end of the year. B. Briggs pointed out that the year in which a member was financial was printed on the address label of the 'Newsletter'. It was hoped that members would get used to this system. She also pointed out that Council planned to send an explanatory note to unfinancial members, instead of the 'Newsletter', once they were unfinancial for a period of six months. E. Canning agreed that a six month period was sufficient for unfinancial members to pay their subscriptions. B. Briggs concluded that those involved in the collection of subscriptions should develop general systems to promote prompt payment of subscriptions. J. West added that chapter conveners should encourage prompt payment.

R. Henderson asked if there had been any funds from the 'Tropical Symposium'. B. Briggs replied that nothing had been received, but Council will investigate as we believe that the Society is entitled to some return on its investment. She added that there will be no further financial investment required from the Society into the current Symposium. The \$3,000.00 donation from the Society had been used to help meet the travel expenses of some of the invited speakers.

B. Briggs expressed her thanks to D. Foreman for the competent way that he has managed the finances of the Society. [Supported by the Meeting].

6. Newsletter Editor's Report

The following Newsletter Editor's Report was presented by Mike Crisp on behalf of Barbara Barnsley.

Already I have been editor of the 'Aust. Syst. Bot. Soc. Newsletter' for six issues and feel that with the very able assistance and considerable support of Michael Crisp, some patience and a crash course in Microsoft Word, that the experience has been very worthwhile for me and I hope the Society in general. There are always some problems such as material arriving at the last minute, or a panic because not much has arrived yet, and the knowledge that there is so much happening out there that we miss. So I would like to urge you all to please drop us a

line about what is happening in your area, i.e. the Chapter Conveners could give us more information on meetings, career moves, retirements and unfortunately, the inevitable obituaries. In short, what we would like is current news and views of interest to the Society's members. If it is at all possible, we would appreciate your contribution as an unformatted word processor or ASCII file on an MS-DOS or Macintosh diskette, plus a printed copy. As there are many technical journals in which to publish taxonomic manuscripts, botanical checklists and similar material we feel that the 'Newsletter' is not the place to publish these.

There are many members who do not have a complete set of the 'Newsletter' and who may wish to add to their set so I would like to mention that I hold more copies of numbers 26-59, excluding nos. 29 and 31, and would be happy to send them to you if requested, with payment to the Treasurer.

It should be noted that the 'Newsletter' also accepts advertisements and this is a little-used facility that could well be of more use to members, botanic gardens and other institutions. We should perhaps look at the current rate of \$30.00 per full page.

'Newsletter' No. 59 has recently been distributed and in all 370 copies were sent out. We shall have to consider printing more than 400 copies as we do at the moment.

Mike Crisp asked if the membership wanted taxonomic manuscripts in the 'Newsletter'. It was agreed that present policy should be maintained.

B. Briggs thanked the editors for the excellent standard of the 'Newsletter'. [Supported by the Meeting].

7. Flora of Central Australia

B. Briggs reported that A.H. & A.W. Reed Pty Ltd has informed the Society that they wish to remainder their stock of the 'Flora of Central Australia' and that they are not interested in publishing a new edition of this Flora. This announcement has been conveyed to the membership via the Newsletter 58: 21 (1989).

8. Botanical History Symposium - Publication of Proceedings

B. Conn reported that all papers have been received and edited, except for some minor corrections. Brown Prior Anderson Pty Ltd (BPA) has been accepted as the printer. The Society, The Maud M. Gibson Trust (Royal Botanic Gardens and National Herbarium of Victoria) and private investors have jointly invested in the publication of the Proceedings. The Society has agreed to invest \$8,000.00 in the project. All parties will receive a pro-rata return on their investment. It is hoped that the manuscripts will be with the printer by the end of July, so that the book will be published by the end of the year. Council is currently investigating the possibility of obtaining an underwriter for the project.

B. Briggs proposed a vote of thanks to Dr L. Martinelli and CSIRO editorial staff for the sound publishing advice that they freely gave to P. Short (editor of the History Symposium publication). [Supported by the Meeting].

9. Membership Subscription Rate

D. Foreman pointed out that many members continue to pay at the discount rate of \$16.00 after 31 March. There also continued to be a large number of people, about one third of the membership, who were unfinancial. Both have meant a considerable financial burden to the Society. He informed the Meeting that Council recommends that the annual subscription be set at \$20.00 (\$12.00 for Students), without a discount for early payment. Moved J. West, seconded P. Gadek. Carried (not unanimously).

J. Thompson suggested that a late fee could be used to prompt members to pay on time. L. Johnson supported this proposal. P. Heyligers suggested that a discount for paying several years in advance might be a way of encouraging prompt payment of subscriptions. M. Crisp explained that it was important to simplify the payment procedures because the Treasurer's task was already very demanding.

It was proposed that an administration fee of \$5.00 should be charged to members who do not pay by the 31 March. [Moved R. Filson, seconded P. Heyligers. Not Carried.]

10. Research Grants Proposal

Judy West spoke to a proposal that the Society should establish a Research Fund. She and Helen Hewson had previously sent this proposal to Council and had recently published it in the *Newsletter* 59: 6-7 (1989). They believe that this would be an excellent way to promote the role of the Society to support botanical systematic research in Australia. She proposed that the Society would invest some of their funds initially and the interest would be used to award grants. This would not affect the Society's current activities. The Fund would be established with an initial investment of \$5,000.00, but that grants would not be issued until the capital was increased, for example to \$10,000.00. A scheme of 'Supporting Membership' could be introduced. Such members who voluntarily choose to be a Supporting Member would pay an additional \$10.00 per annum compared to ordinary members. This \$10.00 would go to the Research Fund. The Society would request tax-deductibility status for the Research Fund. The Fund would be run by a committee that would report to Council. The Committee would consist of two Councillors and three financial members who were not currently on Council.

P. Ladiges suggested that the Research Fund should finance student projects because it is difficult to obtain funds for these projects. B. Briggs added that it should not be limited to students.

R. Henderson asked if the grants would only be available to members. B. Briggs said that a decision had not been made, but it would probably only be for members.

R. Carolin raised some doubts concerning the lack of funds to establish such a fund. Furthermore, he felt that a great deal of time would be required to raise the money because corporate support was difficult to obtain.

H. Hewson stated that it will be necessary to get corporate support because the traditional sources of funding have less money available for grants.

L. Johnson pointed at that the corporate sector was being asked to supply more and more financial support for various activities. Therefore, it could prove difficult to attract such support.

C. Quinn suggested that the Society did not have much time to spend on fund raising. He

felt that the interests of the Society could be better served by maintaining and improving its current activities.

The meeting agreed (not unanimously) that the Society should investigate the pros and cons of establishing a Research Fund.

H. Hewson moved that we ask Council to set up a subcommittee to investigate the appropriateness of establishing a Research Fund. [Seconded P. Ladiges. Carried (not unanimously)].

11. Biological Council of Australia

B. Briggs reported that Professor A.J. Wicken (University of NSW) wrote to her (14 March 1989) concerning the establishment of a Biological Council of Australia. She replied that the Society would possibly be interested in being a member of such a Council, but that we are concerned about the possible increase in costs to the Society's members. [The Meeting agreed to proceed as suggested by Council].

12. Future activities

a. Symposia

Judy West proposed that a biogeographic symposium be combined with the Ninth Willi Hennig meeting in Canberra during August 1990. [Agreed].

L. Johnson suggested that the Society could financially support students to attend this proposed symposium. B. Briggs pointed out that some students had taken advantage of the reduced registration fees offered for the current symposium.

13. F.A.S.T.S.

B. Briggs stated that letters requesting an increase in Government funding for scientific research in Australia, particularly in biological sciences, were sent to the appropriate Federal Ministers. The Hon. J.S. Dawkins (Minister for Employment, Education and Training) responded positively and also referred our letter to Professor Aitkin, Chairperson of the Australian Research Council. The Hon. G. Richardson (Minister for the Arts, Sport, the Environment, Tourism and Territories) referred the matter to the Hon. J.S. Dawkins, but he brought our letter

to the attention of the ABRS Advisory Committee.

Mr Dawkins' Office replied to our concern over the membership of the National Board of Employment, Education and Training. They pointed out that six of the ten members of the ARC have been drawn from the natural sciences and engineering. However, it would appear that Prof. A. Clarke (Univ. of Melbourne) is the only member representing the biological sciences.

B. Briggs pointed out that FASTS has raised the general profile of science such that many groups now seek the views of our Society. She proposed that the Society should continue to support FASTS [Agreed].

14. Any other Business

None.

15. Announcement of Incoming Council

The Returning Officer (B. Conn) announced the newly elected Council of the Society for the coming term. No ballot was necessary as only one nomination was received for each position on the Council.

President	Judy West
Vice-President	Mike Crisp
Secretary	Barry Conn
Treasurer	Don Foreman
Councillors	Gordon Guymor Jocelyn Powell

J. West proposed a vote of thanks to Barbara Briggs for her two terms as President and for her part in the organization of the current symposium. Warmly supported by the Meeting. H. Hewson moved a vote of thanks to the outgoing Council. [Supported by the Meeting].

Meeting closed 7.00 p.m.

Barry J. Conn (Secretary)

☺

SUMMARY OF TREASURERS REPORT FOR THE FINANCIAL YEAR ENDED 31ST DECEMBER 1988

Credit for 1988	
Carried Forward 31/12/1987.....	\$19372.08
At Bank.....	2187.38
On Deposit.....	17184.70
Interest	
Term Deposits.....	1363.16
On Account.....	106.97
Accrued.....	486.17
Subscriptions.....	5763.35
Transfer from Term Deposit.....	2000.00
Subscriptions for CSIRO Journals.....	2475.00
(NB includes \$115.00 late payments from 1987)	
Sale of Alpine Symposium Proceedings....	228.58
Sale of Newsletter Number 54.....	3.50
Sale of 'Evolution of Flora and Fauna in Arid Australia'.....	<u>105.70</u>
Income for 1988.....	<u>12532.43</u>
Carried Forward.....	19372.08
Total Credit for 1988.....	<u>31904.51</u>
Debit for 1988	
Typing of Newsletters.....	\$844.45
Newsletter 52.....	80.00
Newsletter 53.....	371.40
Newsletter 54.....	144.00
Newsletter 55.....	154.25
Newsletter 56.....	94.80
Printing of Newsletters.....	4955.00
Newsletter 52.....	555.00
Newsletter 53.....	2190.00
Newsletter 54.....	580.00
Newsletter 55.....	650.00
Newsletter 56.....	980.00
Printing of Envelopes.....	210.00
Postage of Newsletters.....	682.42
Newsletter 52.....	110.24
Newsletter 53.....	147.67
Newsletter 54.....	*121.28
*Receipt was for \$121.38	
Newsletter 55.....	*172.23
*includes \$40.00 registration fee	
Newsletter 56.....	131.00
Bank Charges.....	15.51
FDT.....	9.45
FID.....	6.06
Miscellaneous.....	11.00
Returned cheque.....	5.00
Overseas cheque.....	6.00
Audit Fees for 1986-87, R. Quick.....	330.00
Stafleu and Cowan Presentation, L. Haegi.....	220.00
D. Foreman (Expenses).....	116.25
Postage.....	49.95
Postage & Receipt Bks.....	66.30
History Symposium (Charles Nelson).....	1000.00
L. Haegi (Expenses, Postage, Paper).....	20.96
Taken from Term Deposit.....	<u>2000.00</u>
Total Debit for 1988.....	<u>10405.59</u>
At Bank at 31 December 1988.....	5828.05
On Deposit*.....	<u>15670.87</u>
Balance at 31st December 1988.....	<u>31904.51</u>
*On Deposit \$17184.70 at 31st December 1987	
Less.....2000.00 transf. to cheque account	
Add..... <u>486.17</u> accrued interest	
Balance..... <u>15670.87</u>	
Audit Report	
We report to the members of the Australian Systematic Botany Society Incorporated that we have examined (where possible) the vouchers, receipts and books of the Society from which these statements are prepared, relating to the year ended December 31, 1988.	
Apart from the above we report that the statements comprising receipts and payments which have been drawn up in accordance with the Historical Cost Convention, in our opinion present fairly the affairs of the Society at that date.	
A.R. Quick & Associates	
Certified Practising Accountants	
(signed) A.R. Quick - A.A.S.A., C.P.A.	
Dated 20th June, 1989	☺

IMPORTANT NOTICE

NO NEWSLETTER FOR UNFINANCIAL MEMBERS

If you have read the minutes of the General Meeting on the preceding pages, you will know that the Society has a problem because many members are late in paying their subscriptions.

*Council met after the General Meeting and, recognising that under the Constitution, subscriptions must be paid in advance i.e. they become **overdue** for the current year from **January 1st**, came to the following decisions:*

- 1. A reminder notice about the next year's subscriptions will appear (as usual) in the 'Newsletter' each December.*
- 2. Each March, the 'Newsletter' will contain a warning to unfinancial members.*
- 3. In June and September, unfinancial members will be sent a 'Newsletter' envelope containing an explanatory letter but no 'Newsletter'.*
- 4. No further 'Newsletters' will be sent to these members until they are fully financial.*

SUBSCRIPTION RATES

The new subscription rate for 1990 will be \$20 standard, \$12 for students.

There will be no discount for early payment.

REPORTS**NEWS FROM THE NATIONAL HERBARIUM OF VICTORIA (MEL)****The Herbarium Extension**

Work commenced on the extension to the herbarium building in mid-July 1987 with the building programme scheduled for completion by late September, 1988. During the planning stage there was a clear indication from the architect that there would be two phases to the project. The extension would be completed first and the collections, with the exception of those that occupied the area required for a mechanical plant room, would be moved from their existing location into the extension, and then the existing herbarium building would be refurbished. Regrettably this was not the way that events unfolded.

For a few months all building activity was confined to the Western Lawn of the Royal Botanic Gardens but towards the end of 1987 the normal operations of the herbarium were affected. About half of the collections from the Foreign Room upstairs in the old building were relocated in the hall downstairs to make way for a mechanical plant room. Moving the collections involved a considerable amount of detailed planning but the task was accomplished on schedule with the timely assistance of some vacation students and the participation of all members of staff. Relief at having finished this task was short-lived. Within a few weeks we were notified that because the new mechanical and fire prevention services were common to both the extension and the existing building, the renovations required to the existing building were so extensive that we would have to move nearly all of the collections and vacate the building ourselves.

By the end of May 1988 nearly all of the plant collections had either been relocated to the hall downstairs or accommodated in buildings scattered on the nearby Observatory Reserve. Over half of the library collections were boxed up and placed in storage. The collections and

books remaining upstairs were wrapped carefully in heavy duty polythene sheeting to protect them from dust and moisture. All herbarium staff formerly accommodated in the herbarium sought refuge in a prefabricated building on the Observatory Reserve. So, by the end of May 1988, the library collections were completely inaccessible, the cryptogams and material of a number of flowering plant families were inaccessible, and access to much of the remaining material was difficult. As this state of affairs was only to last for about four months we felt that we would not be inconvenienced too greatly. Little were we to know of the frustrations, irritations and delays that awaited us. Initial optimism turned to dismay as the work dragged on. The project is now almost a year behind schedule. This has had tremendous implications for the staff and the collections.

As the extension was part of the Bicentennial Commemorative Programme, the extension had to be opened during 1988. Consequently, the extension was opened officially on 20th November 1988 by His Excellency the Governor General of Australia, The Right Honourable Sir Ninian Stephen. This pleasant function was marred only by the knowledge that the extension was not nearly finished. On 21st November the front doors of the building remained closed to allow the builder to continue work.

After numerous frustrating delays, including a month lost when the electrician walked off the job until moneys outstanding were paid, we were finally given partial occupation of the building on 19th April, 1989. Installation of the new library shelving commenced the following day. After a year without any library facilities, the library collections were safely ensconced in their new accommodation and available for use by early June. The fact that the photocopying machine is in another building almost four hundred metres away is considered a mere trifle!

Installation of the new herbarium cupboards

started a week after the library shelving was in place. The cupboards were to have taken between four and six weeks to install but this proved to be an entirely unrealistic estimate. The various components had been in storage for so long and moved so often while in storage that much damage had been sustained. Many of the shelves and other components had to be repaired and repainted. It was ten weeks before the first few cupboards were completed and handed over to us. At the time of writing (early July 1989) it is over eleven weeks since a start was made on the cupboards and less than twenty five percent of the cupboards are finished.

At the beginning of this year plans were made by the Friends of the Royal Botanic Gardens Inc. to celebrate the completion of building activities by staging an exhibition of Celia Rosser's Banksia paintings in the herbarium hall in mid-July. At the time it seemed inconceivable that the specimens would still be stored in the hall in June. However, the innumerable delays in the building programme and in the installation of the new cupboards resulted in just such an eventuality. As there was no prospect at this late stage of cancelling the exhibition, there was no alternative but to move all of the specimens from the cupboards in the hall and store them elsewhere so that the cupboards could be removed in readiness for the exhibition. The only storage area available for the specimens from the hall was on the floor of the identifications room and there they sit in a huge pile. Wall to wall specimens almost two metres high and, of course, quite inaccessible! It is ironic. The extension was built to afford the collections appropriate protection and yet they are temporarily more vulnerable than they have ever been.

At the time of writing there is still no clear indication of when all of the collections will be finally moved in to the extension and the routine of the herbarium will return to some form of normality. We hope that it will be achieved by the end of September. The builder still has to attend to several matters but we expect them to be finished in a few months.

Despite all of the problems of the last two years, or maybe because of them, we are all looking forward to finally moving in to the new accommodation and being able to concentrate on some botany.

Staff

Dr Patrick McCarthy joined the staff early in April as lichenologist to replace Rex Filson who retired on 6th April, 1988. Pat studied at the National University of Ireland, where he undertook an ecological community study of maritime lichens for a Ph.D. He has had a particular interest in the lichens of limestone areas for the last six years. His current interests are in the family Verrucariaceae and other saxicolous pyrenocarpous lichens. It would appear that the Verrucariaceae in Australia have been largely ignored. Pat's first one-day field trip to Gippsland yielded six new records of pyrenocarpous lichens for Australia, among which were two undescribed species.

Ian Clarke joined the staff as Technical Officer in late January replacing Margaret Corrick who retired in October, 1987. Ian joined us from the Botany School, University of Melbourne where, among other things, he was responsible for the herbarium. Ian is well known as joint author of '*Name that Flower*', a guide to the identification of flowering plants.

J.H. Ross

©

ABRS REPORT

A.S. George has attended and chaired the '*Workshop on Large Floras*' at Leiden. Meanwhile an official launch of four ABRS publications took place at Taronga Zoo, Sydney, on 30th June. Senator Richardson launched the publications: '*Fauna of Australia Vol. 1B*', '*Zoological Catalogue Vol. 7*', '*Flora of Australia, Vol. 3*' and '*Australian Flora and Fauna Series No. 10*'. The latter is the '*Catalogue of Mosses of Australia and its External Territories*' by Heinar Streimann and Judith Curnow. The Fauna section are proud to announce that '*Fauna of Australia 1B*' has won the Whitley Medal for the Best Book on Natural History of Australian Animals. It is presented by the Royal Zoological Society of New South Wales.

Helen Hewson

©

AUSTRALIAN BOTANICAL LIAISON OFFICER

Time to ring out the old year and ring in the new. Terry Macfarlane has arrived at Kew to take over from me as ABLO and the settling-in procedure has started.

The last few months have been busy for me. During June and July, I visited various herbaria: Copenhagen, Lund, Paris, Geneva, Florence and Cambridge. Botanists planning visits to European herbaria should note that inexpensive accommodation is often available within the institutions. For example, the Conservatoire et Jardin Botaniques in Geneva has two motel-type rooms, while the Botanischer Garten und Bot. Museum in Berlin-Dahlem has several rooms available in their students' *Wirtschaftshof*. Limited cooking facilities are often available with such rooms. It is advisable to request a booking several months in advance, and to ask what is not included (at both G and B, one has to provide one's own towels).

One botanical feature of general interest to Australian botanists, particularly in light of FI's decision not to lend types any more, was the extent of G's holdings of Labillardiere material. Of 16 Labillardiere types in Cyperaceae and Polygonaceae that I examined in Webb's herbarium in FI, all but two were represented by apparent duplicates in herbaria that I have visited, as follows: G (12 types), P (9), BRI (6 fragments), TCD (5), L (1), CGE (1), MEL (1). Labillardiere and/or Webb apparently distributed material liberally to people such as A. Richard, Desfontaine, Harvey, de Candolle, M.-E. Moricand dit Stefano, Delessert, Palisot de Beauvois, Ventenat, and Boissier. One type is represented in G by six sheets originally in the herbaria of the last six men listed! Thus, I would suggest that, if one cannot examine personally a type in FI-Webb, the next best thing will be to request a black and white photograph from FI and request a loan from G and/or P of any type material held in those herbaria. My sample may, of course, not be representative for all families. Can anyone comment further on holdings of duplicate types for other families?

My time in Europe was nicely ended by a visit to Leiden for the '*Flora Malesiana*' symposium (20-25 August) in honour of Prof. van Steenis. What he would have thought of this is rather

open to debate, since he was quoted by former colleagues as referring contemptuously to conferences and to those attending them as 'conference apes'. However, everyone agreed by the end of the week that he would probably have approved of this first '*Flora Malesiana*' symposium, which brought together over 200 botanists to discuss the Malesian flora and its origins and distribution patterns - as much out of lecture hours as in. The herbarium was open to workers 9 am to 10 pm most days (including the weekend). The Rijksherbarium staff made a typically thorough organisational job of all aspects, culminating in a splendid buffet banquet, at which an original song was very ably sung by Peter Baas and Diedel Kornet.

It is hoped that a second '*Flora Malesiana*' meeting will be held in Indonesia in 3-4 years.

The symposium was followed by a two-day workshop to discuss (in a smaller group) the rate of progress of the *Flora* and ways of improving it - Rob Geesink estimated that it would take over two centuries to complete the *Flora* at the current rate! I did not attend the workshop but I hope that an account of it will be prepared by one of the participants.

Next week, David Galloway (BM) is organising a lichen conference at BM, and the following week there is to be a two-day meeting here at Kew, 14-15 September, to present scientific results of last year's Kimberley Expedition. Various Australian botanists and zoologists will be participating, including Bryan Simon, Surrey Jacobs, Terry and myself.

Karen Wilson ☺

Karen Wilson has departed from Kew. The new ABLO is Terry Macfarlane. You can contact him at:

**Royal Botanic Gardens
Kew, Richmond
Surrey TW9 3AB
ENGLAND**

(Tel) 01 940 1171/4
(Fax) 01 948 1197

REVIEWS



Flora
THE ART OF
BOTANY

EXHIBITION

22 JUNE TO 31 OCTOBER 1989

NATIONAL LIBRARY OF AUSTRALIA

in association with

Australian National Herbarium CSIRO

On the 22nd June, Neville Wran, Chairman of CSIRO, opened the exhibition, '*FLORA. The Art of Botany*'. It was prepared by the National Library of Australia in association with the Australian National Herbarium, CSIRO.

A collection of original paintings by Adam Forster has been donated to the National Library. The Library chose to bring these to the public in conjunction with prints by some of our early artists, notably Sydney Parkinson¹ and Ferdinand Bauer². The effect is to present a glimpse of Australian botanical art across the face of more than 200 years. The exhibition has depth brought to it by the presentation of some early history of collecting, notably that of Joseph Banks, Daniel Solander and Robert Brown. This is brought to life with a few herbarium specimens collected by these botanists. Specimens and prints of particular plants are presented side by side. The whole is highlighted with a floral arrangement of some of our more spectacular native plants - xerophytic plants which lend themselves to a fresh and drying arrangement.

Adam Forster (1850-1928) is not prominent and well known to the botanical community as are Parkinson and Bauer. However, if you are familiar with '*Wild Flowers of Australia*' by Thistle Y. Harris³ you will 'know' his work. In that book

his work appears to be very ordinary. However, he has been done a gross injustice by the publisher. His original paintings are fresh, alive and much more accurate and detailed than presented in '*Wild Flowers of Australia*'. Forster's work is not as intense as that of the famous early artists, but the contrast of style and technique serve to enhance each, not to detract from either.

Congratulations to the National Library and the Australian National Herbarium. So go and have a look if you get the opportunity.

Helen Hewson

©

-
1. from '*Banks' Florilegium*'.
 2. most are from '*The Australian Flower Paintings of Ferdinand Bauer*'.
 3. Angus & Robertson, Sydney, first published 1938, later revised with several editions and reprints.

Plants of the arid shrublands of Western Australia. By A.A. Mitchell and D.G. Wilcox; photographs by E. Laidlaw. *University of Western Australia Press with the Western Australian Department of Agriculture, 1989. 325 pp. \$28.00.*

The book opens with a page defining the pastoral area, a few notes on how to use the book, some pages on range management, a brief comment on indicator species, on the assessment of range conditions, on range management objectives and some suggestions on recording change in range conditions; all this in 15 pages with a generous amount of white space.

Next follows the treatment of about 140 species each of which has a plain language description, a few lines on habitat distribution, forage value and indicator value. In addition there is a shaded map of distribution in Western Australia facing a page of colour plates mostly of a general view and close-up of each species. The species are grouped into four sections based on growth forms: annual herbs, grasses, small shrubs and large shrubs and trees. The book ends with separate indexes to common and scientific names.

The general presentation is attractive and the photographs are generally adequate but as there are no keys, identification is achieved solely by matching specimens with the photos.

The book has been designed for use by pastoralists but it will undoubtedly be added to the stock of references used by plant lovers in and near the region.

The plants selected are considered important in the area covered, but 140 is a very small percentage of the several thousand that must occur in the region. The user is given no indication of how large any particular genus may be or where confusion is likely to occur. For example, five *Sclerolaena* are discussed but something like 26 occur in the area. The treatment is a little better for *Maireana* where 16 out of approximately 36 are discussed, but only 24 *Acacia* in one of the richest areas of speciation in Australia. Some warning to the user or reference to substantial treatments would have helped. We do have '*Flora of Australia*' vol. 4, after all, for the chenopods.

It is unfortunate that the authors limit

distribution data to Western Australia when in fact many species extend to eastern States. It would not have been difficult to add 'extending to N.T.' or 'widespread in arid Australia' or similar comment.

Likewise, quite a number of the maps are misleading and imply a species is confined to Western Australia: e.g. *Atriplex nummularia*, *Maireana aphylla*, *Acacia cyperophylla* all of which are, in fact, far more widely spread.

If you do get the identity correct then the paragraphs on forage value and indicator value may be useful.

A few wrong identifications were noted: on p. 128 *Cassia sturtii* is densely pubescent and is not the species illustrated; on p. 298 the treatment of *Gastrolobium laytonii* includes a mis-labelled photograph of *G. brevipes* (per M.D. Crisp).

This book does perform a useful function in encouraging property managers to do their own monitoring for which every encouragement and aid is to be supported.

An attractive start but a second edition could be much improved.

D.E. Symon

☺

Pioneer, Priest and Botanist - Benedetto Scortechini. By Patrick J. Tynan. *Paperback: 183 pp., 1989. Price \$15.00 posted. Available from Fr. P.J. Tynan, P.O. Box 196, Nerang, Qld, 4211 or The Church Archivists Society, P.O. Box 756, Toowoomba, Qld, 4350.*

On being asked to review this little book, I was delighted to see another biography of an amateur botanist and botanical collector in print, whose name had been familiar for many years. A quick glance through the book showed it to be well researched, with references cited at the end of each chapter. There are many illustrations scattered throughout the publication to add interest, and their sources are listed at the beginning. On reading the book I was, however, disappointed. It is a wonderful book for the local historian: well written, full of an almost overwhelming amount of detailed and painstakingly researched background material of life during those pioneer days, and as such a valuable addition to historical research. But

Scortechini is a figure who appears only fleetingly now and then, tantalizing because he always remains just out of focus. Perhaps it is not the author's fault other than that he chose for his subject for a biography someone about whom almost no source material survives, and then tries to compensate for the paucity of biographical data with an over-abundance of extraneous background information. Thus, instead of highlighting Scortechini as the central figure, he is engulfed and lost sight of. Only the final two chapters give proper prominence to Scortechini.

H. Tryon published a good obituary of Scortechini in *Proc. Roy. Soc. Queensland* for 1881, Vol. 4, p. 2-8. It contained information additional to the present book, which is of particular interest to botanists. It also included extracts from Scortechini letters, which apparently no longer exist.

The present publication reprints four botanical papers by Scortechini as Appendices 1-4, which were published initially in *Proc. Linn. Soc. N.S.W.*, but this fact emerges only in the text and no full references are provided. Appendix 5 comprises a list of identifiable graves in the Tallebudgera Catholic Cemetery, which seems to have little direct relevance to Scortechini. Appendix 6 contains papers concerning McGoldrich, who made an attempt on Scortechini's life. *The Australasian Chemist and Druggist* is repeatedly cited as *'Australian Chemical and Drug Papers'*. Ferdinand von Mueller is referred to as 'Von Mueller' and indexed as 'Von Mueller, Frederick'. But these are minor irritations.

To a botanist this book presents little that is new. To anyone interested in the local history or the history of the Catholic parishes of that part of southeast Queensland it will be a goldmine.

Mrs D. Sinkora

National Herbarium of Victoria

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NOTICES

APINMAP

Asian Pacific Information Network on Medicinal and Aromatic Plants

Recent years have seen renewed interest being taken by the wider community in exploring 'alternatives'. Many of these quests, especially those involving lifestyles, are written off by the cynic as being 'alternatives to work' but not all can be dismissed in such a cavalier fashion. In the case of pharmaceuticals, there has been considerable concern expressed about the extensive use of expensive, synthetic, laboratory-based chemicals with neither adequate testing nor sufficient monitoring after commercial production. A positive result of this concern is increased research into the utilisation of natural compounds by people living in more direct contact with the natural environment than is possible for those people living in urban areas and/or with greater dependence upon industrial substitutes.

In the 1970s chemists established, in the Southeast Asian-Western Pacific area, a network to benefit workers in the field of natural chemistry, the Regional Network for the Chemistry of Natural Products (RNCNP). This network is sponsored by UNESCO. As the field of chemistry of natural products is extremely large, covering foods, pharmaceuticals, industrial compounds, cosmetics etc., several specialist networks have been established under the general umbrella of RNCNP. One of these is the Network for the Chemistry of Biologically Important Natural Products (NCBNP). Another, relating specifically to plants, is the Asian Pacific Information Network on Medicinal and Aromatic Plants (APINMAP). This network exists to promote information exchange in the field of medicinal and aromatic plants. Presently there are eleven participating countries in the network: Australia, People's Republic of China, India, Republic of Korea, Nepal, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand, and Socialist Republic of Vietnam. APINMAP has its headquarters in the Philippines and a national centre (or node) in each member state. The

Australian national node is located in Sydney and supervised by the Chairwoman of the Australian APINMAP National Coordinating Committee, Dr Helen Jarvis.

APINMAP was established formally in 1987 and, like RNCNP, is sponsored by UNESCO. It will be working towards achieving its objectives by:

- * Making available, and using to the maximum extent possible, information in the field of medicinal and aromatic plants, this information being either acquired from abroad or generated by research and development activities in the region.
- * Assisting in the development or strengthening of specialised information services and information handling capacities of member states.
- * Providing guidance in the development of information products and services appropriate to various target user communities of the network.
- * Promoting resource sharing activities and services.
- * Providing linkages to other regional and international networks or services in the fields of medicinal and aromatic plants and chemistry of natural products.

Data will be collected in three main areas: organisations and individuals conducting research on medicinal and aromatic plants; bibliographies of published and unpublished literature on these plants; and information on the plants themselves, their biology (in the widest possible sense) and their utilisation by man. The relatives of useful plants will be included also, where the information is available, as these plants may have value either in improvement programs or as potential alternative sources of the compounds. APINMAP is planning to use computers as much as possible to maintain the databases. Initially, the institutions/individuals (or referral) and bibliographic databases will be set up. Once these are established work on the plant database will commence. The three databases will be integrated so that relevant data can be drawn from all three in response to a single enquiry. Progress with the Australian input necessarily will be limited in the early years as, to date, no funding for staff is available. The development of the Australian section will

depend largely upon the goodwill and commitment of the Australian National Coordinating Committee.

One of the perceived benefits to researchers from the APINMAP databases is that contact with other researchers can be expedited, paving the way for collaboration in joint research investigations and/or in obtaining plant material for study. Several Australian scientists already are working directly on medicinal and/or aromatic plants for pharmaceutical and related purposes. But there are many more whose work is indirect. Commonly these people are systematists. Some are morphologists, others geneticists, and others again may actually be chemotaxonomists. Whatever your specialist field, if you are researching taxa which are known to contain chemicals of economic value (in either the positive or the negative sense), and would like to have your institution and/or self listed in the referral database, please contact the undermentioned (who is a member of the National Coordinating Committee).

Lyn Craven

Australian National Herbarium
CSIRO Division of Plant Industry
GPO Box 1600
Canberra, ACT 2601
Phone: (062) 465919 or 465924



SEABOP

A New Network of South East Asian Taxonomists

In South East Asia there are a number of networks which have been established to assist and develop chemical studies on medicinal and aromatic plants. One of the most successful is the Network for the Chemistry of Biologically Important Natural Products (NCBNP). This network is funded through Australian International Development Assistance Bureau support to the International Development Program of Australian Universities and Colleges.

In May 1988 I was asked by the NCBNP to examine a number of herbaria in South East Asia. As well, I was asked to make a study of the problems confronting taxonomists working in the various countries of the region.

The need for this survey arose because of an increased demand for taxonomic knowledge of medicinal and aromatic plants as well as the general interest which is now evident in most countries in the documentation of floras for conservation and management. As with most other countries, funding for taxonomic research and the amount of university training offered in taxonomy has declined in recent years.

For some time the chemists working on South East Asian plant material have experienced difficulties in identifying even their adequate plant specimens. Phytochemists have also experienced difficulty in re-collecting named taxa reported in the literature. This latter problem has caused many phytochemists to recognise the value of voucher material stored in well curated herbaria.

After visiting a number of herbaria a report was submitted to NCBNP. The report concluded that there was general support in South East Asia for the formation of a co-operative network. It was suggested that a number of taxonomists could be invited to a meeting to discuss herbarium curation, taxonomic research needs and ways of addressing the decline in tertiary teaching of taxonomy. It was proposed that a number of South East Asian taxonomists should be invited to meet to discuss the possible role of a new network and to form one if it concluded that a viable network could develop and promote taxonomic research in the region.

The report was enthusiastically received by the NCBNP and the concept was further developed by UNESCO in Paris.

In January 1989 at the Sixth Asian Symposium on Medicinal Plants and Spices, held in Bandung, Indonesia, the Director General of UNESCO announced a new interdisciplinary program called BOTANY 2000. A number of taxonomists from Indonesia, Malaysia, Thailand and the Philippines had been invited by NCBNP to this meeting in Bandung and I organised and chaired a meeting to discuss problems confronting taxonomy in South East Asia. At this meeting it was unanimously decided that a network, the South East Asian Botanical Program, SEABOP, should be formed. Dr Domingo Madulid of the Philippines National Herbarium, Manila was elected Chairman and I was elected Secretary.

The official recognition of SEABOP as part of the BOTANY 2000 program is an agenda item for

the forthcoming UNESCO general conference to be held in Paris in October 1989. The resolution, asking for recognition as a program is to be presented by the Philippines and hopefully supported by other countries in the region. If UNESCO recognition is obtained, SEABOP plans to initially support taxonomic activities in Burma, Thailand, Cambodia, Laos, Vietnam, Yunnan province of China, Malaysia, Indonesia, Philippines and Papua New Guinea.

It is intended that the network will seek funds for a number of projects, many of which could involve Australian taxonomists. It is hoped that SEABOP will be able to obtain funding for taxonomic studies on taxa common to Australia and South East Asia, dormant and active South East Asian regional Flora programs as well as new flora writing projects covering small geographic areas.

If you are interested in the aims of SEABOP I would be pleased to send further information and keep you informed of developments should we receive official recognition as a UNESCO network.

Neville Marchant

Western Australian Herbarium
Dept of Conservation and Land Management
PO Box 104, COMO 6152

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FOR SALE

**BACK ISSUES OF THE PROCEEDINGS OF
THE LINNEAN SOCIETY OF NSW**

Back issues of most volumes are available including some rare, leatherbound copies of early volumes. The *'Proceedings'* contain papers in all branches of Natural History. Much of the *'Transactions of the Entomological Society of NSW'* is available also.

**For further information, contact the Secretary,
Linnean Society of NSW, PO Box 457, Milsons
Point, 2061.**

**Telephone (02) 929 0253 (office open Tuesdays
only).**

**PUBLICATION DATES OF
AUSTRALIAN SYSTEMATIC BOTANY**

The publication date of the *Australian Systematic Botany* journal, volume 1, parts 3 & 4, is incorrectly stated as 1988. As Secretary of the Society, I have drawn our concern to the attention of the Managing Editor and have urged him to ensure that the correct publication dates are provided for all CSIRO journals and, in particular, for *Australian Systematic Botany*.

Correct publication dates for the first four issues are:

Volume 1, Number 1	20 June 1988
Volume 1, Number 2	22 September 1988
Volume 1, Number 3	21 April 1989
Volume 1, Number 4	7 June 1989

Barry J. Conn

**A BIBLIOGRAPHY OF RECENT
LITERATURE ON BANKSIA**

The July/August issue of *The Victorian Naturalist*, Vol. 106, No. 4, contains a bibliography entitled *The Biology and Ecology of Banksia L.f. A Bibliography of Recent Literature* by A.K. Cavanagh. A total of 97 recent books and papers relating to aspects of *Banksia* taxonomy, reproductive biology and ecology are referenced.

**CSIRO AUSTRALIAN JOURNALS OF
SCIENTIFIC RESEARCH**

Prices for 1990

I have been advised by the Manager of CSIRO Publications that the following prices will apply for the various Journals listed below.

JOURNAL	AUST /NZ \$Aust	CONCESS- ION \$Aust	BACK ISSUES \$Aust
<i>A J Agric Res</i>	145	70	30
<i>A J Bot</i>	140	70	30
<i>A J Chemistry</i>	350	170	30
<i>A J Exp Agric</i>	140	70	30
<i>A J Marine & Freshw</i>	145	70	30
<i>A J Physics</i>	195	70	30
<i>A J Soil Res</i>	130	50	30
<i>A J Zool</i>	145	70	30
<i>A Syst Bot</i>	100	50	30
<i>A Wildl Res</i>	130	50	30
<i>Invertebr Tax</i>	220	110	30
<i>Repro, Fert & Devel</i>	120	60	30

I would be grateful if members wanting to order these Journals at the Concessionary Prices could forward their orders and payment (**Cheques to be made payable to ASBS Inc.**) to me no later than November 17th 1989.

LATE ORDERS WILL NOT BE ACCEPTED.

Dr D.B. Foreman
Treasurer ASBS

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AUSTRALIAN FLORA FOUNDATION INC.

RESEARCH GRANTS - 1990

Applications for grants to support scientific projects on the biology or cultivation of Australian plants are now invited from research workers in Australia. Projects may aim to increase our basic understanding of native plants or to solve practical problems associated with their cultivation. The *'Foundation'* is particularly interested in receiving proposals for research into mycorrhiza and the propagation and cultivation of *Conospermum* spp. Other proposals, however, will be considered on their merits.

Preliminary applications for grants for 1990 should be submitted to the Secretary by October

30th, 1989. These should consist of a brief statement, 300-400 words in length, outlining the project. Please indicate the research institute to which you will be attached whilst the project will be in progress.

The Directors will invite a selection of these preliminary applicants to submit more detailed proposals. Offers for funding during 1990 will be made on the basis of these detailed proposals in February 1990.

OFFER OF LIVING MATERIAL FOR RESEARCH

The *'Australian Flora Foundation'* would like to assist researchers who need to obtain living material of Australian plants for their work. The *'Foundation'*, through its contacts in *'The Society for Growing Australian Plants'*, can often obtain numbers of plants of various species and cultivars which it may donate to research projects as part of the grant program of the *'Foundation'*. The exact native source of the material cannot always be guaranteed since it will be mostly nursery stock, but even this material may be useful in more general studies.

If you think that the *'Foundation'* may be able to assist your project by supplying plants, send a brief statement to the Secretary stating: (i) the nature of the project, (ii) the species or cultivars you need, (iii) the number of plants you need, and (iv) when you need them. Please remember that we need plenty of notice to have any hope of successfully fulfilling requests. If we are able to help, you would be expected to supply a short report which would be made available to our members.

The *'Australian Flora Foundation'* was established in 1981 with the aim of fostering scientific research on the biology and conservation of Australian plants. Since establishment, the *'Foundation'* has built up a modest research fund and a number of projects have been funded. In 1990 further small grants (\$1000-\$2000) will be made.

PRESIDENT:

Assoc. Prof. Roger Carolin
Botany Building A12
University of Sydney
NSW 2006

SECRETARY/TREASURER:

Ms. Janice Hughes
28 Buderim Avenue
Kareela
NSW 2232

Roger Carolin
PRESIDENT

AUSTRALIAN SYSTEMATIC BOTANY SOCIETY PUBLICATIONS

EVOLUTION OF THE FLORA AND FAUNA OF ARID AUSTRALIA

Edited by W.R. Barker & P.M. Greenslade. ASBS & ANZAAS, 1982. Price \$20.

This collection of more than 40 papers will interest all concerned with Australia's dry inland or the evolutionary history of its flora and fauna. It is of value to those studying arid lands and evolution in general. Six sections cover: ecological and historical background; ecological and reproductive adaptations in plants; vertebrate animals; invertebrate animals; individual plant groups; concluding remarks.

FLORA AND FAUNA OF ALPINE AUSTRALASIA: AGES AND ORIGINS

Edited by Bryan A. Barlow. ASBS & CSIRO, 1986. Price \$21.

The alpine environments of Australia, New Guinea and New Zealand differ from each other in terms of topography, genesis, climate and biota. They also contrast strongly with alpine habitats in the northern hemisphere. Paleoclimatology, paleobotany, biogeography, ecology and plant and animal systematics have been used here to give an understanding of the bihistorical relationships of these isolated islands of alpine terrain in the southern hemisphere.

SYSTEMATIC STATUS OF LARGE FLOWERING PLANT GENERA

ASBS Newsletter no. 53, edited by Helen Hewson. December 1987. Price \$5.

This *Newsletter* issue includes the Reports from the February 1986 Boden Conference on *The Systematic Status of Large Flowering Plant Genera*. Reports cover the genus concept; the role of cladistics in generic delimitation; geographic range and the genus concept; the value of chemical characters, pollination syndromes, and breeding systems as generic determinants; generic concepts in various taxa: Asteraceae, Chenopodiaceae, Epacridaceae, *Cassia*, *Acacia* and the eucalypts.

AUSTRALIAN SYSTEMATIC BOTANY SOCIETY NEWSLETTER

Back issues of the *Newsletter* are available from number 26 (March 1981) onwards, excluding nos 29 and 31. Here is the chance to complete your set. Cover prices are \$3.50 (nos 26-59, excluding 53) and \$5.00 (nos 53 and 60 onwards).

ORDER FORM

To: Helen Thompson
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 Canberra, ACT 2601, AUSTRALIA

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The Society

The Society is an incorporated association of over 300 people with professional or amateur interest in Botany. The aim of the Society is to promote the study of plant systematics.

Membership

Membership is open to all those interested in plant systematics and entitles the member to attend general and chapter meetings and to receive the '*Newsletter*'. Any person may become a member by forwarding the annual subscription to the Treasurer. Subscriptions become due on the 1st January.

The Newsletter

The '*Newsletter*' appears quarterly and keeps members informed of Society events and news, and provides a vehicle for debate and discussion. In addition original articles, notes and letters (not exceeding ten pages in length) will be considered. Contributions should be sent to the Editor at the address given below, preferably as an unformatted word-processor or ASCII file on an MS-DOS or Macintosh diskette accompanied by a printed copy, or as two typed copies with double-spacing. All items incorporated in the '*Newsletter*' will be duly acknowledged. Authors alone are responsible for the views expressed.

Notes

The deadline for contributions is the last day of February, May, August and November.

ASBS Annual Membership is \$20 (Aust); students (full-time) \$12. Please make your cheque out to *ASBS Inc* and remit to the Treasurer.

Advertising space is available for products or services of interest to ASBS members. Current rate is \$100 per full page, \$50 per half page or less. Contact the '*Newsletter*' Editor for further information.

All address changes should be sent to the Treasurer.

This Issue

Mike Crisp edited this issue while Barbara Barnsley was away enjoying warmer climes. Thanks go to Ian Telford for assistance.

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