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GARDENING AS ENVIRONMENTALISM: A WET-DRY TROPICAL PERSPECTIVE.

by

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This paper is the text of a talk given by Dr R W (Dick) Braithwaite in July 1992 as one of the State Library's series of "Under the Banyan Tree" lunchtime entertainments.

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GARDENING AS ENVIRONMENTALISM: A WET-DRY TROPICAL PERSPECTIVE.

by

R.W. Braithwaite

ABSTRACT

Most of us spend between a half and two-thirds of our time at home. Our gardens are thus an important part of our personal environment. This is particularly so with the outdoor living of the tropics which results from the absence of cold weather. National parks remain the art galleries of nature and serve a crucial role in their unparalleled ability to replenish the soul with the experiences of beauty and complexity of nature they offer. However, the home and garden environment can also teach us much about nature and shape our development as people. It has the advantage of being convenient to our busy lives. The responsibility for maximising this is both a personal and community one. It is not costly to create a more ecological environment. However, we all need to think and learn about the options much more. This paper is written in the spirit of an unfinished voyage of discovery. It attempts to consider the elements of a more environmentally friendly and fulfilling, aesthetic garden. Personal taste will always mean a healthy diversity in the ways the various elements are combined.

INTRODUCTION

A garden should satisfy human needs. It teaches yet at the same time relaxes. For some it is primarily an outdoor living room, for others a collection of objects and for others still, a place of personal expression. It should be aesthetic, interesting, and serene. We water, fertilise and prune and generally manipulate a set of plants to produce this living artefact. It is a link between the artificial world of humans and the natural world, the space between opposites. The garden has long served as a way of thinking about nature and about culture and about how each influences the other. The history of the concept of nature and its opposites is complex but it always remains a central philosophical issue (Seddon 1991). The garden is nature under control. However, a garden should also capture key elements of the natural environment, the essence of local ecosystems. The garden is a landscape idealised and transformed by design. It should characterise the ideals and values of our time. This means it should contribute to a community sense of place, rather than contribute to the homogenisation of the world. The garden should help those who experience it feel at one with nature and provide a sense of continuity with bush experiences. As the immediate context of our house, it is the environment we spend much
of our time in. Consequently it is an important influence on the sort of people we become. In the wet-dry tropics, where the windows are usually open and much time is spent outside, this must be particularly true.

As an experience, being in the garden is important. Smells, sounds and feelings are paramount and are accessible daily if you take the time. It can be a spontaneous diversion from routine. It is also a place of ritual. The processes of growth, reproduction, senescence and decay are acted out by many players operating on a range of time scales, from the brief cycle of the small annuals to the decades and centuries of large trees. The act of gardening, the working in the garden is another ritual. The work is important but may often be merely the punctuation between long spells of thinking and imagining.

Gardening can be an endless object of study. Jennifer Owen (1991) identified every plant and animal species that visited her small plot in Leicester, England, for 15 years (1,782 animal and 433 plant species). This project illustrates what a vast amount of natural history can be done in a suburban garden. While nature reserves in England number 85,000 acres, gardens occupy over a million acres, a twelvefold difference (Owen & Owen 1975). Most of these are urban gardens. Gardens have a potential for nature conservation and enhancement that has only begun to be explored. This is especially important ecologically as garden acreage is increasing worldwide while natural areas are declining (Dawson 1990).

Gardens and gardening can be a stimulus to creativity. For example, the development of the atomic absorption spectrometer, regarded as the most significant advance in chemical analysis this century, is linked with gardening. It was mainly the work of a Melbourne based physicist, Dr. Alan Walsh, who solved the century-old scientific problem in a flash of inspiration while working in his garden one Sunday morning in 1952. He realised that the way to detect the presence of metallic elements was not by the amount of energy emitted during vaporisation but by the amount of energy absorbed. He ran inside, rang his colleague John Shelton and shouted down the telephone: "We've been measuring the wrong bloody thing!". By morning tea the following day they had conducted the first successful experiment in atomic absorption spectroscopy, a discovery that has earned Australia at least $150 million in exports (Coomber 1991).

The economic importance of gardening can also be represented more directly. In Australia, plant nurseries turned over $600 million a year a decade ago (Pont 1982). A growth industry during economically hard times, surely this signifies the growing psychological importance of gardening.

Much effort is now going into restoration of rural land. The importance of remnants of bush in agricultural land is now well recognised and being studied scientifically (e.g. Saunders et al. 1989). There is much that can, and is being done by some farmers and other rural dwellers (e.g. Breckwoldt 1983, Buchanan 1989). The descriptions of the efforts of such people in a wide variety of contexts are inspiring reading (e.g. Johnson & Don 1990). As a community, we now need to look at small home gardens much more than we have. After all, about 85% of Australia's population lives in urban areas.
Environmentalism has many definitions (Pepper 1989), but here it is used in the sense of "concern for the well-being of the environment". Gardening is different from most environmental issues in that it is not the opposite of development. It is intrinsically developmental but of a particularly sensitive type. It generates economic activity. People spend part of their disposable income on enhancing their gardens. However, it does add value to property, perhaps a return of about 300% on landscaping outlay (W. Redman, pers. comm.). It does not seem to threaten economic activity by precluding development. Hence it can be examined in a way that is relatively free of the added complexity which results from the lobbying of vested interests.

THE WET-DRY TROPICS

In the past, visiting naturalists have been appalled by the lack of interest in the Territory's fauna and flora by the denizens of the "town named after the world's greatest naturalist" (Barrett 1941). It is taking us a long time to come to terms with the environment of north-western Australia. The climate of the region is an extreme annual alternation between an intense monsoonal wet period of about four months when eighty percent of the rain falls and an extremely dry period coinciding with the southern winter and spring. Apart from a slight drop in June-July, temperatures remain constant seasonally, totally invalidating the traditional European concepts of summer, autumn, winter and spring. More environmentally apt festivals than the mid winter one at Christmas and the spring one at Easter, for north-western Australia, would be the depths of the dry season around September and the "renewal of life" arrival of the monsoon around November-December (as it is in southern Asia, Zimmermann 1987). The local Aborigines generally recognised six seasons of around two months each. Elsewhere I have described the common sounds, smells and sights of these six seasons (Braithwaite & Estbergs 1988). We need also to think of our garden in terms of these six seasons.

A GLOBAL CONTEXT

Brown and Braithwaite (1993) divide the lands of the world into three: agro-urban lands, nature reserves, and the semi-natural matrix. In terms of the ecological functioning of the world, most of our gardens are found in the 11% of the land which is devoted to human residence and the production of carbohydrates to eat (agro-urban lands). The gathering of a wide variety of natural and some exotic resources for human use mainly occurs in the semi-natural areas which occupy more than 85% of the land surface. The conservation of plant and animal species and maintenance of ecological function also largely occurs in the semi-natural matrix plus the precious 3% which is dedicated to nature reserves globally. Even all the gardens put together are likely to be unimportant in terms of what they do for flora and fauna conservation directly. Their importance is what they can do for us. The aim of this article is to try to identify ways in which we can maximise this process.

Gardens can also contribute to conservation of the world's resources. The shade offered by a well-treed garden can greatly contribute to the cooling of the house and hence to the
comfort of the occupants. A rainforest patch may be on the western side of the house where it might use more water but certainly contributes to the cooling of the house. Water efficiency can be improved by directing water from the laundry into the garden. It was also found that during Cyclone Tracy, which destroyed 90% of Darwin in 1974, houses with well-treed gardens suffered less damage during the violent storm (Stocker 1976).

The composting of food scraps, garden clippings, etc., allows the fertilisation of garden soil without expense. A well balanced fauna in the garden is likely to eliminate or diminish the need for chemical pesticides and is also a cost saving.

WHAT IS A GARDEN?

The Oxford Shorter English Dictionary states that a garden is "an enclosed piece of ground devoted to the cultivation of flowers, fruit and vegetables...".

The making of gardens is one of the oldest human activities and even in very early times was transformed from a purely utilitarian activity into one in which art and science were united (Joyce 1989). However, such a unification is anathema to some. For example, Fukuoka (1987) argues that the most important factors responsible for man's loss of his native aesthetic sense and of the understanding inherent to man are the human intellect and what we call reason. Now for an even more extreme view: "I have strong antipathy to everything connected with gardens, gardening and gardeners....Gardening seems to me a kind of admission of defeat...Man was made for better things than pruning rose trees. The state of mind of a confirmed gardener seems to me as reprehensible as that of the confirmed alcoholic. Both have capitulated to the world. Both have become lotus-eaters and drifters" (Wilson 1963).

Gardening is a task which is never complete. "A gardener's work is never at an end; it begins with the year, and continues to the next: he prepares the ground, and then sows it; after that he plants and then gathers the fruits..." (Evelyn 1706).

Gardens are a product of their culture which is a product of both history and environment. The first Englishman known to write about gardens, Alexander of Neckham (born 1157), wrote "...the garden should be adorned with roses and lilies..." (Strong 1991). This description also fits the most important parts of the garden of my mother during my childhood in Ipswich in the 1950s and that of her father in Sydney some years earlier.

"A primrose from England" is the title of a lithograph by Edward Hopley published in 1856. The caption explains, "a primrose had been taken to Australia in a covered glass case, and when it arrived there in full bloom, the sensation it excited as a reminiscence of the 'Fatherland' was so great, that it was necessary to protect it with a guard". A large and diverse number of people was united in their common yearning for England (Dixon 1989). Identification with the land of a particular region frequently focuses on particular species of plants and animals. Some like the roses were adopted by royal dynasties and became political symbols throughout much of English history. It seems reasonable that as we stop
seeing ourselves as British, we shall increasingly adopt Australian symbols. Similarly, it is appropriate that we adopt local symbols in our garden. Our garden should look like it is in Darwin, not in Cairns, Madagascar or West Africa, and certainly not in Los Angeles or England. It should, to at least a recognisable extent, represent local Australian ecosystems. Clearly, gardens embrace a wide variety of different things for different people. My argument is that a garden diverse in local species, a wildlife garden, can be artificial and attractive, and is the most appropriate one for the wellbeing of the gardener and the world.

GARDENING AS A FINE ART

The late nineteenth century French artist Henri Rousseau had a marvellous sense of composition. He painted many pictures of the tropics, even though he had never been there. His inspiration came from seeing the plant and animal species in a Parisian zoo and botanic gardens (Werner 1958). The mixtures of colours and variety of leaf shapes suggesting diversity, the use of people and animals to create mood, be it serenity, violence or mystery, are all elements of the paintings. For me they manage to capture the essence of the tropics, in the way I think a garden in the tropics should.

Others have suggested particular gardens are the horticultural manifestation of the work of a particular poet. For example, the superb design of the Melbourne Botanic Gardens was developed by W.R. Guilfoyle, building on the magnificent set of plants collected by Baron F. Von Mueller. V.J.Pyers (1953) has suggested that of all the influences from the great eighteenth century English landscape tradition, "the basic principles laid down by Pope have been the framework upon which Guilfoyle designed his garden ". He quotes from an epistle written to the Earl of Burlington by Alexander Pope:

In all let nature never be forgot
But treat the Goddess like a modest fair,
Nor over-dress nor leave her wholly bare;
Let not each beauty everywhere be spy’d
Where half the skill is decently to hide.
He gains all points who pleasantly confounds
Surprises, varies and conceals the bounds.

and in explanation, states that Pope was putting into poetic form, those ideas, with various modifications and qualifications, which were to be the basis of English landscape for the remainder of the century (Pescott 1974). Much of the writing about gardens would be classified as literature and writing about the fine arts. It has also been in the domain of horticulture, but rarely that of ecologists.
SOME FASHIONS WITH AUSTRALIAN GARDENS

A primrose from England

In the England of the sixteenth century, gardens were rather different from today. They were populated with a much more limited range of species. Textural variation resulting from variety of leaf shapes and shades produced much of the aesthetic. Such Elizabethan gardens may still be seen at Hever Castle in Kent. With the advent of empire, many colourful plants were introduced to England from around the temperate and Mediterranean world. Changes to less formal design were concurrently occurring in the eighteenth century in England. The plants from sunny lands around the Mediterranean were accommodated by building walls in gardens to create warmer, sunnier microclimates. The beautiful garden of New College, Oxford is an example of the aesthetic, complex riot of colour of the more modern English garden. The changing fashions of English gardens reflected the changing culture of England. So too should Australia's gardens reflect the changing culture we find ourselves in.

As almost a quarter of Australia's population was born overseas, it would be surprising if there were not strong influences from a diverse set of origins which were part of the cultural baggage brought to this country. This is likely to always remain so. However, it is a tradition which appears to fade quickly within a generation and this is no bad thing.

A tropical garden

For Europeans, the tropics have held a strong fascination since at least the early nineteenth century. The development of greenhouses which allowed the growth of tropical plants in the temperate capitals of Europe, and the Wardian case to transport living plants, brought the tropics within reach of many. Apart from some modest royal gardens in places like India and Thailand, there was little "gardening for aesthetics" tradition indigenous to the tropics (Warren 1991). It was the European tradition which engendered tropical botanic gardens, the first being Pamplemousses established on Mauritius in 1735. Within the following century, an extensive network was set up throughout the colonial world of the tropics. They were established initially to test out plant species for economic purposes (Warren 1991). Indeed, this is how the devastating shrub Mimosa pigtia first came to Darwin last century (Miller & Lonsdale 1987).

The colonial past of most of the tropics has ensured the translocation of many hardy and attractive plants from all regions. Consequently, many of the plants of tropical gardens are common throughout the world's tropics. This can be seen by comparing handbooks of tropical plants. Most of the hundred or so species usually featured are the same whether the book was published in London, New York, Amsterdam or Sydney. Many of these plants certainly have become strongly associated with the image of the tropics. However, exclusive use of them in a garden precludes a distinctive local appearance. Partial use of these readily available plants obviously evokes tropicality but still leaves room for a local flavour. Such a tropical garden in the wet-dry tropics of Darwin requires much reticulated water to maintain. In essence, you are creating a patch of rainforest/ creekline vegetation in a region where the climate does not allow it, except in small localised pockets where water accumulates in the landscape. The NT Power & Water Authority estimates that
Plate 1. The garden outside the study of the famous naturalist Charles Darwin at Down House, Downe, Kent, England. This study was where he wrote almost all of his massive contribution to science and knowledge. What contribution did the delightful ambience of his garden play in his creativity?

Plate 2. The Botanic Gardens at Pamplemousses on Mauritius. This was the first tropical gardens and was established in 1735. The idea quickly spread throughout the tropics and facilitated the rapid spread of exotic plants.
approximately half the water provided to the city is used in a landscaping situation: for private gardens, sporting fields, public landscaping, etc. This is equivalent to 200kL volume annually per person or 200 sq.m. of irrigated land per person (Jackson 1992).

Lawn

This has become the symbol of the ultimate taming of nature and human behaviour (Riley 1990). The well-manicured lawn seems to be an ideal of people of the West. One idea is that lawn is a cultural outgrowth of the pastures on which aristocrats grazed their horses (Fukuoka 1987). Perhaps it represents a state of luxury, of being able to afford to set aside land from growing crops. Grass has formed an important part of European gardens since the Middle Ages, although the medieval ideal was a meadow spangled with flowers (Owen 1991). Apparently, the popularity of bowls in the sixteenth century led to the close cropping and the development of suitable grasses. Precise cutting became possible after the invention of the cylinder or reel mower by Edward Budding in 1830 (Owen 1991).

Lawns are labour-intensive and not very interesting. The unpleasant sound of the two- or four-stroke power mower is amongst the worst aspects of suburbia. Owen (1991) suggests that the lawn is so different from the rest of the garden and so sharply delimited from it physically and functionally, that it is best regarded as a separate ecosystem. It can be extremely rich in a limited range of resources. Falk (1976) has found that food utilisation per unit area of temperate lawn by suburban birds, at 46 Cal/sq.m/yr, greatly exceeded food utilisation by birds in natural grassland (1.01-2.33 Cal/sq.m/yr). Leaving the cuttings to decompose on the lawn is better for the lawn and may obviate the need for fertilisers. Falk (1976) calculated that 63 kg dry weight of living and dead material was removed from a 110 sq.m Californian lawn by raking and mowing in the course of a year. This contained the equivalent of 3300 g of nitrogen, 960 g phosphorus and 1850 g of potassium. Keeping a lawn "reasonably attractive" required 1865 calories per square metre per year, more than twice that required to grow maize.

The lower the lawn is kept cropped the greater the use of water as rooting depth tends to decrease. When you water, add enough water to wet the whole root zone to field capacity. Light frequent watering encourages shallow rooting, reduces drought resistance, increases evaporation and therefore water use. With mowing, watering and fertilizing, the aim is not maximum growth. The aim should be acceptable appearance with minimum work and minimum use of water and fertilizer (Handreck 1986).

No matter how efficiently managed, lawns as the dominant feature of a garden are extravagant. However, they are kind but stimulating to tender feet, and an important part of the diversity of a wildlife garden providing they are kept quite small.

Palms

For people of a European culture, these distinctive plants seem to symbolise the interesting and relaxing tropics. It is also a symbol of jungle, the antithesis of lawn. However, a garden can too often become a sterile world made up of disjunctive natural objects where
a high value is placed on order, efficiency, cleanliness, and segregation. By pursuing such values, gardeners unknowingly reduce the habitats of the natural creatures like birds and butterflies they often want to attract. A tidy garden of palms and grass is a too often seen example of this.

Natives

The 1960s saw the popularisation of the Australian native garden - eucalypts, wattles, banksias, minute-leaved sclerophyllous shrubs, etc. It was more than a fashion. It was an important statement of national identity. Jock Marshall returned to Australia after years in England to take up the Foundation Chair in Zoology at Monash University. He turned the grounds into native gardens, tricking gardeners into removing fine stands of exotic trees with fictitious diseases.

Front yard, backyard

A generation ago the Australian front yard was generally highly manicured, rather European and for public display. It was nature but in the English tradition. In contrast, the backyard was more rural and useful. It was where edible things were grown and where the children played. Fiske et al. (1987) suggest that this coexistence of both kinds of gardens on the one suburban plot was a sign of the shallowness of the commitment to English values embodied in the front garden, as well as the lack of confidence in the values less consciously articulated in the backyard. They argue that the dramatic reversal of attitudes towards Australian plants with the fading of empire is underlaid by the idea that Europe is culture and Australia is nature; the shift towards Australianness is justified by reading it as a shift towards the natural.

THE INGREDIENTS OF A DARWIN ECOLOGICAL GARDEN

Shade

There seem to be few differences between the personal values attached to their gardens by Norwegians and Californians. However, Norwegians place greatest value on sun in their garden, while Californians rate shade as the most valued part of their garden (Francis 1990). In Darwin, shade is what is attractive. However, total shade is ecologically uninteresting and harbours mosquitoes. Partial shade should be the goal. Dappled light, morning sun, afternoon sun are all part of the spatial variety that allows a wide variety of plants to co-occur and produces interest and surprise.

Local plants

There is an enormous variety of local plants available from the Darwin region and northwestern Australia in general (Brennan 1986, Brock 1988, Clark & Traynor 1987, Cousins
1989, Harmer 1974, Hearne 1975, Miller & Ratcliffe 1990, Petheram & Kok 1983, Wightman & Andrews 1989, White 1988); other less germane books covering adjacent regions include Erickson et al 1979, Jones 1984, Williams 1984 a & b. The easiest way of obtaining plants for your garden is to purchase them from a plant nursery which has large stocks of native plants. Others prefer the cheaper, more time-consuming but more satisfying method of collecting seed from unreserved bush (collecting from National Parks is illegal). The methods of breaking seed dormancy and raising plants from seed may be found in various books (e.g. Wrigley & Fagg 1979). Untreated seed from the bush may also be distributed into the garden to add little time bombs of surprise for the future (A.Press pers.comm. 1992).

A knowledge of traditional Aboriginal usage of the plants can also enrich the pleasure of your garden (e.g. Anon. 1988, Levitt 1981, Wightman & Smith 1989). Indeed, Aboriginal usage has shaped our landscape and is just as relevant to any resident’s relationship with their land of choice as is a study of the history of the countryside such as in Oliver Rackham’s (1986) fascinating scholarly work to English people.

Aromatic plants

All senses should be considered when developing a garden. Fragrances of a garden should be considered, particularly where you sit and spend time. In the Top End with our small population and lack of industrial development, we have little air pollution. Consequently we are able to pamper our battered sense of smell much more satisfactorily than in most places. Wrigley and Fagg (1990) list many aromatic plants which are suitable to the local situation.

Rocks

According to the Japanese, the principal boulders of a landscape garden are supposed to suggest the mountains, hills and rocks of natural scenery. They should appear as if natural forces placed them in position. Rocks and stones are combined in pairs of contrast. So as to create an impression of stability and repose, no stone should be utilised which is larger at the top than the base. In Japan, great value is set on stones of good shape, proportion and colour. Numerous terms are used for rocks, according to geological origin, shape and position or usage in a garden (Conder 1964). These and other rules are a reasonable guide.

In my garden, I use rocks as borders to garden beds and paths. I collect them from many places, but most are local (Pietsch 1983). Care should be taken to not to degrade natural areas. Each rock is individually chosen for its aesthetic qualities. I spend considerable time arranging them according to the most pleasing mixture of shapes, sizes, textures and colours. The sun catches the facets of the rocks in different ways through the day. Being wet changes their appearances again. Such rocks also provide living places for small animals like small skinks which can grace their appearance.
Curves

With each step a curve makes the vista change. Curves are essential to maximise the variety of experiences one can encompass in a garden. The precise size and shape of the curve can require much thought.

Mulching

Covering any bare soil with matter such as hay, wood chips from garden trimming, paper or other vegetable material adds organic matter to the soil improving its structure, slows the evaporation rate and improves water use efficiency (Handreck 1979). It also can be used to suppress undesired plant species.

Water

Without this no garden is truly complete (Strong 1991). In Sir George Sitwell’s words, "I have left almost to the last the magic of water, an element which owing to its changefulness of form and mood and colour and to the vast range of its effects is ever the principle source of landscape beauty, and has like music a mysterious influence over the mind. It was, perhaps, of this that Wagner was thinking when he wrote that music is like a power of nature which men perceive but do not understand" (Sitwell 1949). It is pleasing that swimming pools and spas are now being designed to fit into the landscape much more than in the past. However, we still have a long way to go in presenting water in the most aesthetic and mood-creating ways.

Local aquatic plants and animals might also become part of water features. However, one would need to experiment and attempt to develop an ecological system which kept mosquito larvae in check.

Habitat for wildlife

While we are unlikely to save any endangered species by what we do in our garden, we do make an unequivocal statement about our sensitivity and our relationship with the environment. Those who have taken a bulldozed block and developed a garden will recognise the changes which take place as the newly planted vegetation develops. It is with sadness that one recognises that as the dust diminishes and structural complexity of the vegetation increases, so do elements of the original fauna disappear. In my street, the reptile fauna of the 1970s, the Bluetongues, the Frilled Lizards, the Black Whip Snakes, the Bynoe’s Geckoes (Gow 1977, Braithwaite et al. 1990, Homer 1992) have disappeared. In spite of your best efforts to seek the high road to biodiversity you lose species. You end up with lots of Rainbow Skinks Carlia ruficauda and Carlia aracilis, the glossy Sphenomorphus Skinks Sphenomorphus isolepis and some Sphenomorphus douglasi, the occasional arboreal Snake-eyed Skink, and numbers of the charming but exotic Asian House Gecko Hemidactylus frenatus. Even though 16 species of frogs are found within 50 km of the centre of Darwin (Tyler & Davies 1986), frogs disappear from home gardens more quickly than other groups, presumably because of their requirement for standing
water for breeding. Eventually even the long-lived and delightful Green Tree Frog *Litoria caerulea* disappears. On the other hand, bird diversity increases as floristic and structural complexity increases; the Rufous-banded Honeyeaters begin breeding. You are delighted: it is a milestone. However, you are creating a rainforest/creekline vegetation type of environment and this is one which is a minority environment in the Top End. It is a habitat type of low diversity for most groups of species, trees being the obvious exception (Braithwaite 1990).

Obviously, a key thing is to create a diversity of habitat types in your garden. All of one thing, whatever it is, is unlikely to be the best goal. The maintenance of a diversity of habitats is likely to be the way. One part of the garden is recognised as rainforest, another as something else. The truth is that the original habitat, eucalypt savanna, is the habitat type which creates greatest diversity. In other words, the richest garden is one of a range of habitats, rather than one attempting to maximise diversity by pursuing a single goal such as a simulation of rainforest.

**Birds**

Apart from a few domestic pigeons, Darwin has a completely native avifauna. This is unusual. Most places in Australia have their suburbs dominated by exotic sparrows, starlings, mynas, blackbirds and the like. What we have in Darwin is very much worth hanging on to.

In their compilation on the common birds of Darwin, Thompson & Goodfellow (1987) list 91 species. While these are birds commonly found, they are mainly found in the diminishing area of bush within the area. The dozens of species regularly or occasionally observed in well vegetated Darwin gardens are dependent on the remaining bush areas. Very few species actually breed in suburbia and most of those individuals are probably taken by domestic cats. The main breeding species seems to be the Rufous-banded Honeyeater in the northern suburbs. While some breeding by figbirds is recorded in the CBD (Thompson & Goodfellow 1987). Double-bar finches, White-gaped Honeyeaters, Torrssian Imperial Fruit-doves, Bar-shouldered Doves and even Brahminy Kites have been recorded breeding in Darwin backyards (J.A.Estbergs, pers. comm. 1992). Other species may breed but not many and not often. Nonetheless, the number of birds is quite impressive when compared with the 48 species from gardens in Singapore (Ward 1968). Darwin is more like studies from Nigeria with 102 species recorded, including many savanna species (Elgood & Sibley 1964). Few rainforest birds adapt to gardens, so cleared rainforest as at Singapore sustains few birds species. In fact, some garden species were eventually acquired from the savanna areas of Thailand to the north.

Both a lower bird diversity and a greater proportional occurrence of introduced species have been reported in association with the following urban properties: greater "urbanisation" or density of built structures, smaller distance to the city centre, fewer years since initial development, less vegetation cover, less structurally diverse vegetation, lower spatial patchiness of vegetation, and less native vegetation (Catterall et al. 1989 inter alia). On the other hand, the distance from large forest areas does not seem to be important.
Granivorous species, like finches, doves and some pigeons, may be enticed into a garden by a regular supply of mixed seeds. Although a nice planting of mixed native grasses is not difficult to setup, like many garden arrangements it does seem to need more knowledge than I have to maintain satisfactorily for any time.

For frugivorous and nectarivorous species, particular species of plants provide food. The Australian flora is not characterised by specific pollinators; many species of animals can do the job (Braithwaite 1990). Therefore native flora generally is attractive to native nectarivorous birds. Species of grevillea (e.g. G. pteridifolia) and eucalypts (e.g. E. phoenicia) seem most attractive. Others are important in that they add variety of appearance for our aesthetic benefit (Umbrella Tree Schefflera actinophylla). Local species commonly used by bird species are listed in Figure 3 of Brooker, Braithwaite & Estbergs 1990).

Much of the Australian flora attractive to nectarivorous birds is woody fruited and while attractive to cockatoos does not provide food for soft-fruit eating birds like some pigeons, orioles, etc. For them, Ficus spp. and many palms are good providers.

Contrary to expectation, the generalised nature of the relationships between Australian plants and their animal pollinators and seed dispersers does not prove true for exotic plants. The Traveller’s Tree is a plant from Madagascar which now is found throughout the tropics of the world. While Flying-foxes feed on its vertebrate-adapted flowers on occasion, only rarely do native birds feed on its nectar or on the brilliant blue arils on its seeds (Calley, Braithwaite & Ladd 1993).

It is possible to predict which plant species are attractive to animals of certain kinds. For example, wattles whose seeds are bird-dispersed have large and colourful arils (edible appendages to less edible seed) displayed in curly seed pods, while ant-dispersed wattles have arils which are small and white and in straight seed pods (Davidson & Morton 1984). For example, Noske (1990) has recorded ten species of native birds feeding on the colourful arils of a popular tree of Darwin gardens, the Black Wattle Acacia auriculiformis.

Further, different sets of plant characteristics are associated with attracting pollinators of different sorts. For example, butterfly-attracting flowers are typically vividly coloured, weakly but agreeably odoured, and produce ample nectar well hidden in narrow erect tubes with a flat narrow rim during the day (Faegri & van der Phil 1971).

Most birds use a high horizontal branch with a good view but with vegetative cover nearby. They sit there and call, and sometimes mate. Providing trees with such branches can be very rewarding.

Water is attractive to many birds but particularly to granivorous and nectarivorous ones. Many of them depend on it while other species use it if it is there.

There are books which provide more information on artificial feeders and other techniques for attracting birds into the garden (e.g. Salter 1977, Adams 1980, Pizzey 1988, Hutchison 1990).
Aviary Birds

Captive birds entice those that are free to come into your garden. This is the basis of the large bird markets in Kuala Lumpur and Bangkok. Wealthy Asians hoist caged birds into the treetops in order to create a more pleasant ambience for their gardens. Not only do the caged birds like Hill Mynas call beautifully from the trees but they draw in other species. In Darwin, a small aviary of finches seemingly provides confidence to pigeons, doves and honeyeaters, as well as free finches, to come into your garden adding to the sights and sounds in a most enchanting way.

Poisons

The use of poisons in the domestic garden appears to mirror that of society in general: it is often done in ignorance and far too much is used. Persistent pesticides are used when biodegradable ones would suffice. Our society is negligent in the lack of control of this. Places overseas today lament the pollution of their groundwater for decades into the future with unpredictable complex impacts on human and animal health. Further, the use of herbicides seems without justification in the suburban garden. It is being used to tidy areas which could easily be done by hand. When I protested to a neighbour about his use of herbicides, he subsequently volunteered that he usually felt ill after doing it. Obviously, pesticides affect the quality of life of suburban wildlife both through loss of prey and accumulation of pesticides in their body tissues (Carson 1958, Van den Bosch 1978).

Termites

A high proportion of Australian vertebrates use tree hollows. At Kakadu, one fifth of bird and amphibian species, half the mammal and a quarter of the reptile species use hollows for some purpose (Braithwaite 1985). In Kakadu, eucalypt forests have about 60% of trees greater than 20cm in diameter with a hollow trunk. The hollows start when trees are less than 10 cm. but become larger and more common with the passing years. The hollowing is done by termites but normally is quite benign (Braithwaite loc.cit.). Thus large old eucalypts are particularly valuable as wildlife habitat. Too frequently such trees are felled in the mistaken belief that because they have termites the trees are sick and in danger of falling.

Butterflies

Most of the species of organisms in the world are insects and other invertebrates. While some are pests, many serve important ecological functions. They are food to many of the vertebrate species we find attractive. They contribute to soil fertility. They decompose the leaves. They pollinate the flowers. A major group of invertebrate pollinators is the butterflies. They certainly add an extra dimension to the sense of beauty and serenity of a garden. A recent book from southern Australia provides guidance on what to plant to attract butterflies (Clyne 1991). The list of species is surprising, with an abundant representation of what are normally regarded as weedy species.
Dogs and cats

These animals presumably create a sense of menace for potential prey in the garden. We have a responsibility to consider their role in our garden. They have long been close associates of humans. Dogs were used for hunting, but frequently were a public nuisance because of their large numbers and infrequent employment as working dogs. Cats, long tolerated as predators of rodent pests, were only widely accepted and loved as domestic pets from the seventeenth century (Thomas 1984). In contemporary Australia, more than a third of households keep at least one cat (Paton 1991). In Darwin, an estimated 58% of households have a dog (Darwin City Council, pers comm. 1992). The impact of cats on native wildlife, mammals, birds, reptiles, amphibians, and insects is substantial (Potter 1991), while that of dogs is generally regarded as of little consequence except where they go feral and exist like dingoes (L.Corbett, pers.comm. 1992). Certainly, a pack of **dogs** using bushland at Cranbourne on the edge of Melbourne ate native bandicoots and swamp rats. However, it is cats that seem to be the major problem. Estimates of density of suburban cats vary greatly. From recent surveys in suburban Adelaide, Paton (1991) has estimated that based on a density of two cats per hectare, domestic cats take 10-20 birds per hectare per year. This compares with typical bird densities of 10-30 birds per hectare. Honeyeaters, the group most responsible for pollination of garden plants, were found to be the most frequently taken group. Not all domestic cats took wildlife but based on responses from owners 50-60% of domestic cats collected birds, 50-60% caught mammals, and a little over 30% collected reptiles. The wearing of bells seemed to make little difference, the same proportions of cats with bells taking wildlife as those without. So cats have a major impact on suburban wildlife. What is more there is fine line between domestic and feral cats around the margins of cities, with domestic cats contributing to the feral population. This would be a particular problem in Darwin's vast rural sector.

Just as dingoes are reputed to control the numbers of foxes and cats in the bush, dogs control the use of people's gardens by cats. As dogs appear to have relatively little impact on suburban wildlife and cats are the one domestic animal that do not respect human property boundaries, it is suggested that having a dog (but no cats) may be the most effective means of protecting wildlife using your property from neighbourhood cats. However, it should be pointed out that a study conducted by the South Australian Environment Protection Council showed concern about noise from dogs was second only to concern about traffic noise.

Exotic rats and mice

Mice (Mus musculus) turn up in people's houses from time to time. They also frequently associate with aviaries. Recent studies in the United States show that mice in suburbia are frequently associated with dog ownership but not that of cat or of compost heaps (A.E.M.Baker, pers. comm. 1992). Perhaps dogs generally keep out cats which would normally control the mice.

The black rat (Rattus rattus) is a frequent denizen of well vegetated Darwin gardens. From what we can tell they do little harm. They appear to eat the fruit of palms and other tropical trees (E.Howard, pers.comm. 1992).
Flying-foxes

The large bats which visit our tropical gardens are rather special (Thomson 1989). They are very social and probably quite intelligent, apparently being more closely related to primates than to bats (Pettigrew 1986). Apart from their charm, they serve as very important pollinators and seed dispersers for native plants. The fruit they take from your garden may be denied from them by picking it a little earlier.

Responsibility for plant pests

As attractive as some exotic plants are, particular species have a great potential to invade the bush and threaten its integrity. Humphries et al. (1991) have produced an excellent overview of plant invaders on a continental scale. They identify a number of exotic plants with a high potential to become weed pests in the bush. Major threats grown in northern gardens include African Tulip Tree (Spathodia campanulata), Captain Cook Tree (Thevetia peruviana), Rubber Vine (Crytostegia grandiflora), Lantana (Lantana camara), Blue Thunbergia (Thunbergia grandiflora), Asparagus Fern (Protasparagus spp.), Agave (Agave spp.), Camphor Laurel (Cinnamomum camphora), Morning Glory (Ipomoea spp.), Leucaena (Leucaena leucocephala) and Pond Apple (Annona glabra). Cowie & Werner (1987) have produced a list for the Kakadu region that has recently been updated with a graded assessment of risk (Brock & Cowie 1992). Wider availability of such reports is clearly in the public interest. The planting of such species must be unwise in situations where there is high risk of escape into bushland.

Composting

Household waste such as lawn clippings, pruning refuse, domestic peelings, food scraps, spoilt food, paper in small quantities, dog faeces and virtually any other organic refuse can be converted into compost which can be used to improve the quality of the soil. Compost bins may be bought or made and routinely used by any household (Handreck 1978).

Seating

Every garden needs seats upon which to linger. A variety of places is needed. They may be garden furniture, rocks, stumps, old railway sleepers, or patches of lawn. Spas are of course an extremely pleasant place to relax and enjoy the garden. Places are needed to match the comfort of the time of day but mostly to allow the appreciation of different parts of the garden.

A GARDEN OF VARIETY

A set of garden types is the way of accommodating the greatest range of plants. Plant to provide a variety of degrees of shade, from full sun to full shade. Watering requirements
will consequently vary according to the species requirements and site conditions. This variety enriches the challenge of creation and the experience of the garden. Clearly the variety of a large botanic gardens cannot be recreated in precisely the same way on a suburban block. The scale is vastly different. The fine scale and delicate use of space of Balinese gardens should be an inspiration to all.

The ecological literature tells us that the development of such variety is also a key to maintaining a variety of wildlife. The number of animal species is greater where plant species diversity is greater (e.g. Murdoch, Evans & Peterson 1972, Braithwaite, Winter, Taylor & Parker 1985). Animal diversity is also greater where there is leafy vegetation at a wide range of heights from ground level to treetops (e.g. MacArthur and MacArthur 1961, Murdoch et al. 1972). Further, it is greater where a number of different plant communities are arranged in close proximity (e.g. Root 1973, Braithwaite 1990, Braithwaite & Estbergs 1993). Such medleys of microhabitats also create lots of areas of community overlap or ecotones and these are also associated with high diversity (e.g. Taylor, Friend & Dudzinski 1984).

Such a complexity of relationships as comes with such high diversity systems leads to low stability (Begon, Harper and Townsend 1986), the populations of individual species of plants and animals fluctuate through time. This is part of what makes a garden interesting. It can be the actions of the gardener which maintain this high diversity of plants. Owen (1991) suggests that gardens left alone would become a simpler community with fewer species. I suspect that in many situations in Darwin this may not be the case. However, whatever the case, in a complex garden, many would-be animal pests are likely to be kept in check by the large range of predators present.

In short, the richest and most interesting gardens are those with a great variety of species, representing a great range of sizes and types, and arranged into different microhabitats. The enhanced diversity possible in a garden is greatly assisted by the high natural diversity of Australian heathlands, rainforests and savannas. The uniqueness or endemicity of the Australian biota (Braithwaite 1990), should also easily lead to a very characteristic appearance to Australian gardens, including those in Darwin.

QUALITY OF LIFE IN DARWIN

For some, this seems to be a year-round warm climate, lots of open space and an informal lifestyle. These things are important but there is more. Until recent times, a major problem for city dwellers in Europe was the smell. It was a stench that went with disease, aggravating distress and associated with a poor quality of life. Responses were planter boxes, pot pourri, perfume, snuff and houses in the country. Today, by contrast, a major problem of urban life is noise. In 1989, I remember sitting on North Head of Sydney and watching and hearing the city come to work one weekday morning. In a few minutes around eight o’clock, the tranquillity of North Head was perturbed by the noise of the nearby city. In Darwin, many houses are designed around open windows and electric fans for cooling. Consequences of this are the sound of birds in the garden that is effectively part of the environment of the house. Also the fragrance of garden plants penetrates the house. In most cities the sounds are excluded in a manner similar to the way noxious
Plate 3. Diversity, light and shade, curves and a place to sit and observe: all desirable elements of an aesthetic ecological garden. Such a garden is a complex mosaic of open space and shade, of tall and low vegetation, forming an intricately structured and patchy environment which represents habitat to a contrived diversity of plants in a continuous state of flux.

Plate 4. Elements of a Darwin garden symbolic of local ecosystems: native plant species from the region.
smells were: a sealed-off microclimate was created with the walls of the dwelling. For the inhabitants, this creates a life largely devoid of nature, except for indoor plants. In Darwin, using air conditioners for cooling has the same effect. Unfortunately, for those who choose that option it creates a more limited view of what constitutes important ingredients of the quality of life we can enjoy in Darwin.

The fragility of what we have is easy to overlook. Many cities have areas which cannot be developed and serve as refuges for fauna and flora allowing them to persist in the city. For example, Brisbane has areas of hills and creeks and Sydney has rocky areas. Darwin is made vulnerable by its flatness. The refuges that exist are the result of human land-use decisions (e.g. the airport area) and are thus prone.

As Recher (1972) wrote with respect to Sydney, "We do ...an injustice by not devoting more resources (land primarily) to the perpetuation of wildlife within the city and immediate suburbs. The return in recreation and relaxation should more than compensate for the cost."

A COMMUNITY APPROACH

Anne Spirn (1984) argues that humankind has opposed culture to nature with disastrous results and that in order to correct our historical failings, we must subsume culture into nature, or train ourselves to deny culture’s existence as a separate entity.

What someone does on a quarter acre suburban block may have considerable impact on them but little impact on the survival of species in the urban/suburban environment. For most species of animals, an individual may require the resources of several home gardens to survive. Further, it needs the companionship of others of its kind in order to survive. Hence reasonably extensive areas of suitably maintained suburbia are needed to maintain populations of many bird species. The greater the number of people who plan a more ecological garden, the more successful will any individual be.

There is clearly an important role for local government in penalising some of the undesirable behaviour and encouraging the desirable by residents. They have a role in providing advice. So many people come into our community with no experience of the wet-dry tropics. Currently these newcomers take their advice wherever they happen to find it. As Cocks (1992) points out, local governments have often been more effective than State governments in enforcing environmental measures concerning noxious weed and animal pest control. They have a much greater role to play in nature conservation.

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