# Distribution patterns, weed incursions and origins of terrestrial flora at the Capricorn-Bunker Islands, Great Barrier Reef, Australia

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***Abstract***: A checklist of vascular plants of the 15 Capricorn-Bunker Islands (CBI) (lat 23° 11' to 24° 07'S; long 151° 43' to 152° 43'E) compiled from 2007/08 surveys, recorded 131 vascular plant species including 44 (34%) native and 87 (66%) naturalized species from 55 families and 104 genera. New native records include *Hernandia nymphaeifolia* and *Boerhavia* sp. (Bargara L.Pedley 5382). An increase of about 35 exotic species over 23 years was recorded indicating a weed incursion rate of 1.5 species per annum. *Cakile edentula* (13 islands) and *Solanum americanum* (12 islands) are the most widespread exotic weeds. The naturalised flora ranged from 5% at Erskine Island (low disturbance) to 68% at Lady Elliot Island (very high disturbance). *Achyranthes aspera, Argusia argentea* and *Pisonia grandis* are the only species found on all 15 islands. Six indigenous species are limited to one island: *Boerhavia* sp. (Bargara L.Pedley 5382), *Calophyllum inophyllum*, *Clerodendrum inerme*, *Hernandia nymphaeifolia*, *Stephania japonica* and *Ximenia americana*.

Patterns of plant distributions, diversity and origin are discussed. Eleven indigenous species reach their southern limit at the CBI, indicating connectivity with the Indo-Pacific region. PATN analyses using native flora generated two island groups. Tryon, Heron, North West, Masthead, Wilson, Wreck and Erskine Islands are the most closely related islands. Another group of related islands includes North Reef, Lady Musgrave, Fairfax Islands, Hoskyn and One Tree Islands. With the inclusion of the exotic flora, Lady Elliot Island separated into its own distinct group. Greater conservation management efforts are required to control and minimise the introduction of exotic weed species to islands with high human visitation.

Key words: coral cay, checklist, distribution, naturalised species.

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## Introduction

The 15 Capricorn and Bunker Islands (CBI) at the southern end of the Great Barrier Reef (GBR) represent the largest cluster of permanently vegetated coral cays in Australia and are recognised as a distinct geomorphic province within the Great Barrier Reef (Domm, 1971; Hopley, 1982; QPWS, 2000). The historic uses of the islands included guano mining, turtle canneries, fishing, campgrounds, resorts and lighthouses (QPWS, 2000; Daly & Griggs, 2006). The present uses include conservation (National Parks), tourism activities (island resorts, IR), maritime transport (lighthouses, LH), education and scientific research (research stations, RS), camping and fishing (QPWS, 2000). Fourteen of the fifteen CBI are administered as part of the Capricornia Cays National Park and Capricornia Cays National Park (Scientific) and managed by the Queensland Parks and Wildlife (QPW) division of the Department of Environment & Resource Management. Lady Elliot Island (IR) and North Reef Island (LH) are administered by the Great Barrier Reef Marine Park Authority (GBRMPA). Leases for private resorts and research stations are held for areas of Heron Island, Wilson Island, One Tree Island and Lady Elliot Island. The surrounding waters and reefs are within the Great Barrier Reef Marine Park, administered by the Commonwealth and the Great Barrier Reef Coast Marine Park, administered by the State. All the islands, waters and reefs are within the Great Barrier Reef World Heritage Area, administered by the Commonwealth and jointly managed by GBRMPA and QPW.

Relative to its offshore location, the flora and vegetation structure of the CBI is considered highly diverse and

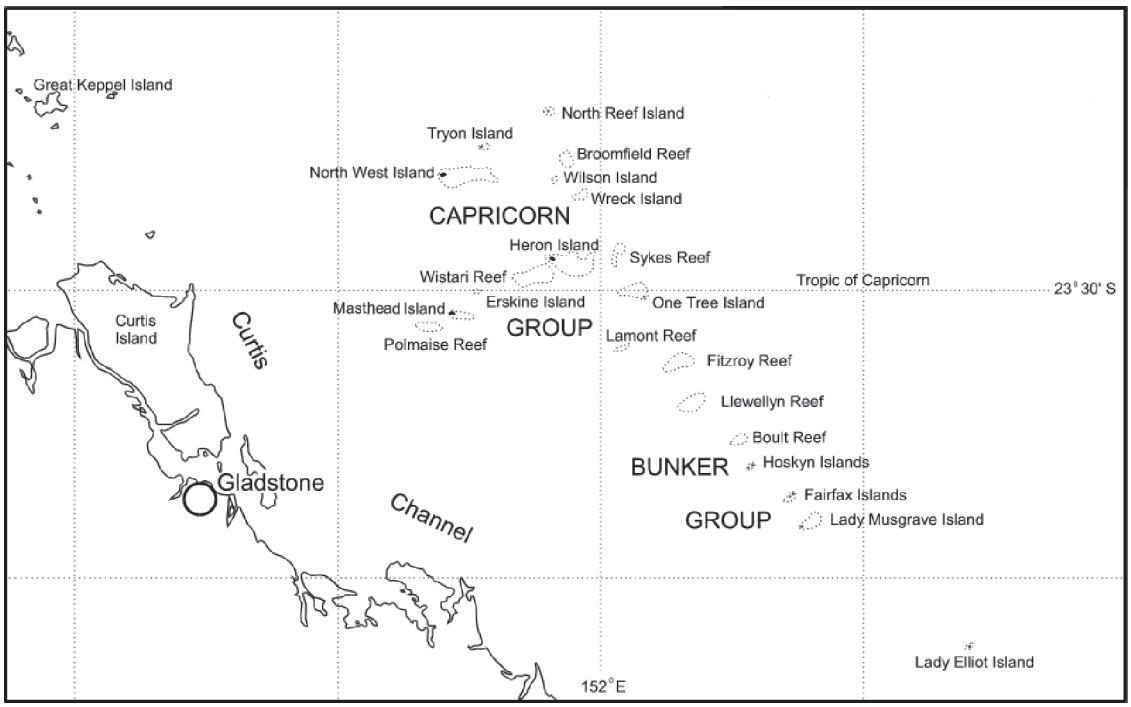


**Fig. 1.** Location of the Capricorn and Bunker Island groups (Capricornia Cays) in the southern Great Barrier Reef.

different from coral cays located in the northern Australian regions (Stoddart & Fosberg, 1991). The study area forms the southern geographic limit for 11 tropical Indo-Pacific plant species. The CBI also support the largest area of *Pisonia grandis* closed-forest, a rare rainforest community in Australia (Adam, 1994). According to Dyer *et al*. (2005), Hulsman (1984) and Stokes *et al*. (1997) the CBI are considered to be one of the richest areas for breeding seabirds on the GBR. Large populations of seabirds and marine turtles and a high plant diversity make the CBI a globally significant and critically important area for conservation (QPWS, 2000).

Field surveys of the terrestrial flora of the CBI have been published by Heatwole (1984b), Chaloupka & Domm (1985) and Walker (1991); however, no comprehensive flora inventory of the region has been completed in more than 20 years. Over the last eight years, Queensland Herbarium botanists have been visiting the CBI. The major aims of the paper are to:

(a) provide an accurate regional checklist of terrestrial vascular flora;
(b) highlight species distribution patterns;
(c) highlight trends in exotic flora;
(d) indicate origins of the regional flora including species of unresolved status;
(e) compare and contrast floras of individual cays within the study; and
(f) highlight some key changes in flora since earlier surveys.

## Methods

### *The study area*

Straddling the Tropic of Capricorn, and located 45–75 km offshore of the central Queensland coast, the Capricorn-Bunker Islands (lat 23° 11'–24° 07'S; long 151° 43'–152° 43'E) are the southernmost coral cays in Australia (Figure 1). The cays are composed of sand, shingle, or a mixture of the two (Flood, 1977). With the exception of shingle cays all of the CBI are located on the leeward margin of reef tops ranging in size from 1 km$^2$ to 28 km$^2$ (Mather & Bennett, 1993). The cays are between 4 ha and 105 ha in area with a total area of around 335 ha. These 'low isles' have a maximum elevation of a few metres (3–8 m).

The CBI experiences a dry maritime climate that is warmer and more tropical than the adjacent coastal mainland. Long-term data from Bureau of Meteorology weather stations on Lady Elliot Island (No. 039059, est. 1939) and Heron Island (No. 039122, est. 1956) show that the mean temperature ranges from 16.6–29.8º, with January the warmest month and July the coolest (BOM, 2008a). At Heron Island, the annual rainfall average is 1035 mm over 85 rain days, whereas Lady Elliot Island has recorded an average of 1134 mm over 101 rain days (BOM, 2008a). About 22% of annual rainfall at the two islands occurs during winter, with a minimal spring component. The wettest month is February (150 mm); September is the driest month (31 mm). Twenty-four cyclones have been recorded passing within 100 km of the CBI in the past 100 years (BOM, 2008b). Cyclones usually

occur during the months of January to March. During March to September south-easterly trade winds prevail, averaging 20–40 km/h (BOM, 2008a). From October to March, wind directions are stronger and more variable, with north-westerlies (monsoons) predominating, interspersed with calm periods (Flood, 1984).

*Data collection*

Thirteen of the 15 Capricorn-Bunker Islands were surveyed from August 2007 – September 2008 over five separate trips except the two Hoskyn Islands which the senior author(GNB) surveyed in May 2000. Broomfield cay, gazetted as part of the Capricornia Cays National Park was not surveyed during the current 2007/08 surveys, as the vegetation there is as ephemeral as the cay itself. Survey time varied from 2–3 hours at the smaller islands to more than 7 days at North West Island. A checklist of the flora for each island, including life forms, status and frequency data was compiled. The status categories used were 'indigenous to the CBI', 'native to the mainland' or 'exotic'. The frequency of each plant taxon was approximated as either 'abundant' (>25% cover), 'frequent' (6–25%), 'infrequent' (1–5%) or 'rare' (<1%) as per Batianoff and Burgess (1993). Cultivated species (e.g. in resort leases) that are not naturalised, were not included. Plants with unknown origins that are widely distributed in the Indo-Pacific region are assumed to be indigenous to the CBI.

Plant voucher specimens were collected for new species on each island, as well as species that had not been collected previously in the past ten years. Voucher specimens were incorporated into the Queensland Herbarium (BRI) collection. The BRI specimen database (HERBRECS, 2008) was utilised to verify dates and locations of previous botanical collections. Previous botanical reports for the CBI were critically examined. The similarity of plant compositions for each island was compared using the Bray-Curtis association analysis function in PATN (Belbin, 2004). The PATN analysis was used to determine dissimilarity between island floras. The categorical data used were based on the frequency of species found on each cay. Data were then classified using a hierarchical agglomerative polythetic clustering method based on a flexible unweighted pair-group averages method (Belbin, 2004).

Island disturbance was estimated as a percentage from 0–100% (least disturbed to most disturbed) based on past and present natural disturbances (sea turtle nesting, bird burrows, severe weather, cyclones, scale insect damage, etc.) as well as human activities (resorts, campgrounds, lighthouses, etc.). These rankings were determined from field knowledge and historical data provided by Heatwole (1984a) and QPWS (2000). A higher weighting was given to human disturbances.

## Results

*Flora checklist*

The combined regional flora of the 15 coral cays of the Capricorn-Bunker Islands (Appendix 1) contains 131 species, 55 families and 105 genera (Table 1). The flora is dominated by the dicotyledon species (99 spp., 76%); herbs are the most frequent life form (89 spp., 68%). The flora has a low number of species per higher taxa groups (2.5 spp. / family and 1.4 spp. /genus) when compared to the adjoining mainland (11 spp. /family and 2.5 spp. /genus) (Batianoff & Dillewaard, 1988). These patterns of low representation per family or genus, and the high frequency of herbs are reflected in both the indigenous and the naturalised flora. The families with the greatest number of species are Poaceae (20 spp., 15%), Asteraceae (10 spp., 8%), Brassicaceae (8 spp., 6%) and Euphorbiaceae (6 spp., 5%). The checklist includes 89 (68%) species of herbs, 21 (16%) species of trees/tall shrubs, 13 (10%) species of shrubs and eight (6%) species of vines.

**TABLE 1 Summary of major plant groups and life forms of the Capricorn-Bunker Islands**
* = exotic, % = percentage of total flora (native plus exotic), there are no ferns

| Plant groups | Totals | Dicots | Monocots | Conifers |
|---|---|---|---|---|
| Families | 55 (31n,38*) | 47 | 7 | 1 |
| Genera | 105(41n,70*) | 82 | 22 | 1 |
| Species/entities | 131 | 99 | 31 | 1 |
| Native to coral cays | 44 (34%) | 38 | 6 | 0 |
| Introduced from mainland | 10 (8%) | 6 | 3 | 1 |
| Exotic | 77 (59%) | 55 | 22 | 0 |
| Total naturalised | 87 (66%) | 61 | 25 | 1 |
| **Life forms** | | | | |
| Native Trees / tall shrubs | 14 (11%) | 13 | 1 | 0 |
| Naturalised Trees / tall shrubs | 7 (5%) | 6 | 0 | 1 |
| Native Shrubs | 4 (3%) | 4 | 0 | 0 |
| Naturalised Shrubs | 9 (7%) | 4 | 5 | 0 |
| Native Herbs – annual | 7 (5%) | 7 | 0 | 0 |
| Naturalised Herbs – annual | 47 (36%) | 37 | 10 | 0 |
| Natice Herbs – perennial | 14 (11%) | 9 | 5 | 0 |
| Naturalised Herbs – perennial | 21 (16%) | 11 | 10 | 0 |
| Native Vines | 5 (4%) | 5 | 0 | 0 |
| Naturalised Vines | 3 (2%) | 3 | 0 | 0 |

The indigenous flora of the CBI is 44 species (34%), 31 families and 41 genera. The naturalised flora has 87 species (66%), 38 families and 70 genera including 10 Australian species (8%) that are native to the adjacent mainland, but not indigenous to coral cays (Table 1). Native families with more than one species per family are: Poaceae (5 spp.), Nyctaginaceae (4 spp.), Aizoaceae (2 spp.), Boraginaceae (2 spp.), Convolvulaceae (2 spp.), Euphorbiaceae (2 spp.), Fabaceae (2 spp.) and Moraceae (2 spp.). Prominent naturalised families are: Poaceae (15 spp.), Asteraceae (9 spp.), Brassicaceae (7 spp.), Amaranthaceae (4 spp.), Euphorbiaceae (4 spp.), Agavaceae (3 spp.), Commelinaceae (3 spp.), Malvaceae (3 spp.) and Solanaceae (3 spp.). The indigenous flora life forms number 21 herb species, 14 trees/tall shrub species, five vine species and four shrub species. The naturalised flora life forms number 68 herbs, nine shrubs, seven tree/tall shrub species and three vine species.

*New floristic records*

Two new indigenous species for the Capricorn-Bunker Islands were recorded during the 2007/08 surveys-

- *Hernandia nymphaeifolia*, a small tree, recorded at North West Island as a new record for the Central Queensland region, and the southern limit of its occurrence in Australia. This tropical seashores species occurs throughout northern Australia, New Guinea, Fiji and the Melanesian region. Considered rare and vulnerable in the Northern Territory (Kerrigan & Cowie, 2006).
- *Boerhavia* sp. (Bargara L.Pedley 5382), an undescribed perennial herb recorded at Lady Elliot Island as a new record for coral cays. The species is widely distributed in tropical northern Australia, Central Queensland and New Guinea.

New records of naturalisations for the CBI included 6 exotic species* and one mainland native species#:

- **Amaranthus blitum* (creeping amaranth) recorded at One Tree Island, the first record for Central Queensland and for coral cays in Australia. This species has a relatively isolated and patchy distribution, limited to the Cape York region of north Queensland, and south east Queensland.
- **Calyptocarpus vialis* (creeping Cinderella weed) recorded at Heron Island. A weedy plant widespread along coastal areas of Queensland.
- **Catharanthus roseus* (pink periwinkle) recorded at Lady Elliot Island. An escapee from garden areas, originally from Madagascar, now spreading into areas of natural vegetation.
- **Cynodon nlemfuensis* var. *nlemfuensis* (Bermuda grass) recorded at Heron Island, widely naturalised in coastal and inland tropical and subtropical areas.

**TABLE 2 Plant species with northern and southern geographic limits at the Capricorn-Bunker Islands**
*Note:* New Caledonia information from Morat *et al*. (2001)

**Northern & Southern Limits**

***Abutilon albescens*** – Malvaceae: Shrub
Torres Strait to Lady Elliot Island (24º07'S, 152º 43'E) + Northern Territory, New Guinea, New Caledonia

***Boerhavia albiflora* var. *heronensis*** – Nyctaginaceae: Herb
This variety is endemic to the Capricorn-Bunker Islands. Southern limit: Lady Elliot Island (24º07'S, 152º43'E), northern limit: North West Island (23º12'S, 151º42'E)

***Chamaesyce atoto*** – Euphorbiaceae: Annual herb
Cook district to West Hoskyn Island (23º48'S, 152º17'E) + Northern Territory, New Guinea, New Caledonia

***Commicarpus insularum*** – Nyctaginaceae: Vine
Mainly Port Curtis, one record in North Kennedy district (19º58'S, 145º35'E). South to Hoskyn Island (23º48'S, 152º17'E)

***Cordia subcordata*** – Boraginaceae: Tree
Cook district to Masthead Island (23º32'S, 151º43'E) + New Guinea, Northern Territory, New Caledonia

***Hernandia nymphaeifolia*** – Hernandiaceae: Tree
Cook and North Kennedy districts. Previously, only as far south as Zoe Bay, Hinchinbrook Island (18º23'S, 146º19'E) + New Guinea, New Caledonia.

***Lepidium englerianum*** – Brassicaceae: Annual herb
Cook district to Fairfax Island (23º51'S, 152º22'E – Collected in 1927) + New Caledonia

***Pisonia grandis*** – Nyctaginaceae: Tree
Cook district to Lady Elliot Island (24º07'S, 152º43'E) + New Caledonia

***Stenotaphrum micranthum*** – Poaceae: Herb
Cook District to West Hoskyn Island (23º48'S, 152º17'E) + New Guinea

***Triumfetta procumbens*** – Sparrmanniaceae: Herb
Cook district to Lady Elliot Island (24º07'S, 152º43'E) + New Guinea, New Caledonia

***Trachymene cussonii*** – Apiaceae: Annual herb
Native to Vanuatu, New Caledonia and Australia, it is restricted to the Capricorn-Bunker Islands in Australia. Southern limit: Lady Elliot Island (24º07'S, 152º43'E). Northern limit: Tryon Island (23º15'S, 151º47'E) + Vanuatu and New Caledonia. Reviewed by Holland (1989).

- **Mirabilis jalapa* (four o'clock) recorded at Lady Elliot Island. Originally planted in the staff residential gardens, it has now escaped into *Casuarina* forest areas.
- **Plectranthus amboinicus* (soup mint) recorded at Lady Elliot Island. Planted as a spice herb in the staff gardens and is currently spreading along the western shores of the *Casuarina* forest.
- #*Terminalia arenicola* (brown damson) recorded at Lady Elliot Island. A tropical Australian mainland tree planted in garden areas and currently escaping into adjoining areas along the western shores.

Five previously reported species **Bromus catharticus*, *Cocos nucifera*, **Conyza canadensis* var. *canadensis*, **Digitaria didactyla* and **Polycarpon tetraphyllum* were not found during the 2007/08 surveys.

Five species have doubtful origin and status on the CBI: *Cocos nucifera, Lepidium englerianum, Plumbago zeylanica, Portulaca oleracea* and *Pseudognaphalium luteoalbum*. In this study, *L. englerianum, P. zeylanica* and *P. oleracea* are assigned an indigenous status. *Pseudognaphalium luteoalbum* is a mainland species which is naturalised in the CBI. The origins and status of *Cocos nucifera* are unresolved (see Discussion).

Eleven species (25%) of the coral cay native flora reach the southern limit of their Australian distribution at the Capricorn-Bunker Islands (Table 2). Two taxa are known in Australia only from the CBI (*Boerhavia albiflora* var. *heronensis* and *Trachymene cussonii*). Though a few plants of *Suriana maritima* have been found on the mainland at Rodds Peninsula National Park (now the most southern location for this species), the rest of the population is found in abundance at CBI.

*Rare species*

Appendix 1 documents the frequency of occurrence of species on each island. Very rare species, i.e. 1–3 individual indigenous plants found on only one location were: *Calophyllum inophyllum* (North West Island), *Clerodendrum inerme* (Masthead Island) and *Hernandia nymphaeifolia* (North West Island). Rare species, represented by a few individuals and found on one or two cays were *Stephania japonica* (Masthead Island), *Triumfetta procumbens* (Fairfax West Island and Lady Elliot Island) and *Ximenia americana* (Tryon Island). Other species with limited distributions include *Boerhavia* sp. (Bargara L.Pedley 5382, at Lady Elliot Island) and an annual herb *Salsola kali* at Erskine and Masthead Islands.

55 exotic species are found on only a single island (Appendix 1). Of these, 47 species are limited to Lady Elliot Island, but not all are considered rare there. **Lantana camara* was recorded as abundant and **Stenotaphrum secundatum*, **Eragrostis tenuifolia,* **Bryophyllum delagoense*, **B. pinnatum* and **Alternanthera pungens* were relatively frequent.

*Abundant species*

The ten most widely distributed indigenous plant species on the CBI (Table 3) include three species found on all 15 islands: *Pisonia grandis*, *Argusia argentea* and *Achyranthes aspera*. Eighty percent of indigenous species are either rare or infrequent compared to 98% of the exotic species that are rare or infrequent (Figure 2). The two most ubiquitous exotic species in the study areas are **Cakile edentula* (13 islands) and **Solanum americanum* (12 islands).

Total species richness (occurrences) ranged from 16 species at North Reef Island to 97 species at Lady Elliot Island (Table 4). Fairfax (East) Island had the lowest indigenous species richness (12 spp.) and Masthead Island had the highest (35 spp.). The number of exotic species recorded from each island varied from one species at Erskine to 76 species at Lady Elliot Island. The relationship between island area size and species richness (Figure 3) shows only a very weak trend for indigenous species richness and island areas.There was no relationship between the number of exotic species and the size of island areas (Figure 3)

**TABLE 3 Ten most frequent/abundant native species on Capricorn-Bunker Islands**

| Plant Taxa | No.of islands |
|---|---|
| *Achyranthes aspera* | 15 |
| *Argusia argentea* | 15 |
| *Pisonia grandis* | 15 |
| *Abutilon albescens* | 14 |
| *Boerhavia albiflora* var. *heronensis* | 14 |
| *Casuarina equisetifolia* subsp. *incana* | 14 |
| *Lepturus repens* | 14 |
| *Thuarea involuta* | 13 |
| *Ficus opposita* | 12 |
| *Pandanus tectorius* | 12 |

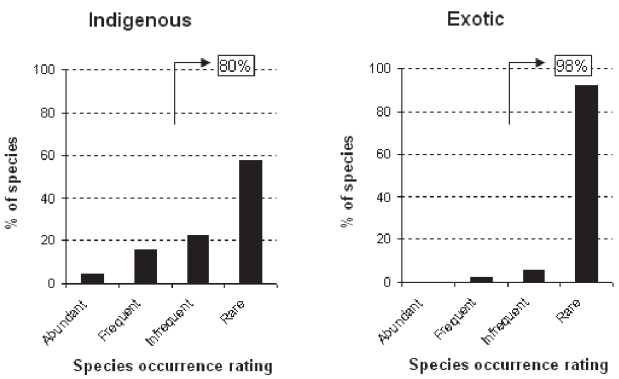


**Fig. 2.** Proportion of species making up each abundance category for native (n=44) and exotic (n=87) floras.

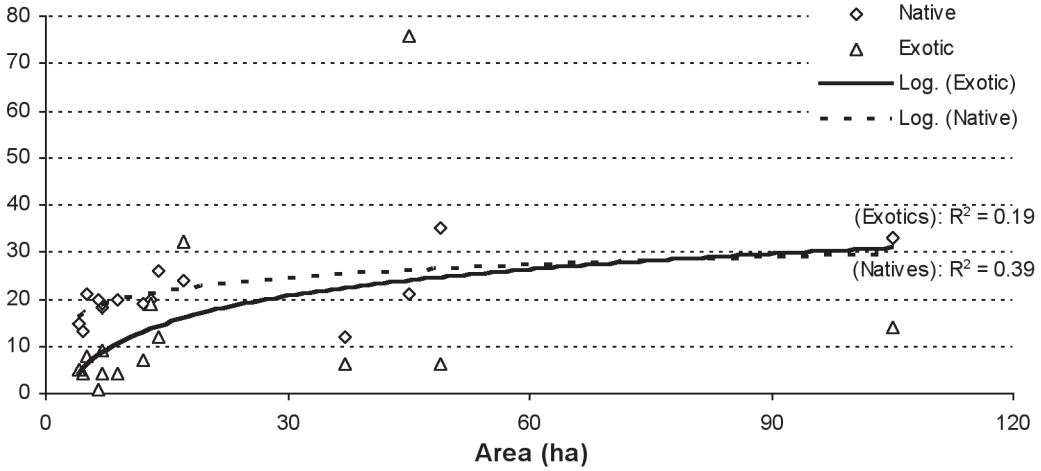


**Fig. 3.** Species richness area curve for native (n=44, R2 = 0.39) and exotic species (n=87, R2=0.19) for the Capricorn-Banker Islands. Each symbol represents an island.

**Table 4 Capricorn-Bunker Islands – island size, disturbance and species richness based on 2007/08 surveys**
Disturbance level estimates based on field observations and Heatwole *et al*. (1981), Heatwole (1984a), QPWS (2001) and Daly & Griggs (2006).
* = exotic to Australia and coral cays; # = native mainland species, exotic to coral cays

| Coral cay (area) | Disturbance level | Disturbance history | Total species |
|---|---|---|---|
| North Reef (4.5 ha) | 30% | Past – lighthouse/weather station; human inhabitants with planted gardens and storage sheds.<br>Current – low visitation; weather station and lighthouse. | 17<br>(4*) |
| Tryon 14ha) | 40% | Past – moderately high level of public camping.<br>Current – no camping; rehabilitation following 90% loss of *Pisonia* forest during 1ate 1990s. | 38<br>(11* + 1#) |
| North West (105 ha) | 50% | Past – guano / rock phosphate mining, feral chickens and cats.<br>Current – high levels of seasonal camping; three toilet blocks on island, house mice. | 47<br>(13* + 1#) |
| Wilson (7 ha) | 50% | Past – moderate level of visitation and camping.<br>Current – camping resort with a number of buildings. | 27<br>(9*) |
| Wreck (7 ha) | 25% | Past – low visitation, oil exploration one private residence in late 1960's, rats.<br>Current – low visitation, tenure restricts public access. | 23<br>(3* + 1#) |
| Heron (17 ha) | 60% | Past & Current – high visitation, > 10% of land supports buildings for research stations and resort. | 56<br>(31* + 1#) |
| Erskine (6.5 ha) | 20% | Past – low visitation.<br>Current – restricted low visitation. | 21<br>(1*) |
| Masthead (49 ha) | 30% | Past – moderately high camping.<br>Current – seasonal camping with no permanent buildings. | 41<br>(5* + 1#) |
| One Tree (5 ha) | 30% | Past – Australian museum leased reef in 1969, began building research station in 1971.<br>Current – research station operated by Sydney University. Tenure restricts public access | 29<br>(8*) |
| Hoskyn West (9 ha) | 20% | Past – moderate level of visitation.<br>Current – low visitation, tenure restricts public access. | 24<br>(4*) |
| Hoskyn East (4 ha) | 20% | Past – low visitation.<br>Current – low visitation, tenure restricts public access. | 20<br>(5*) |
| Fairfax West (12 ha) | 30% | Past – guano / rock phosphate mining, bombing-range, goats, rats. Current – low visitation, tenure restricts public access. | 26<br>(6* + 1#) |
| Fairfax East (37 ha) | 40% | Past – guano / rock phosphate mining, bombing range, goats, rats.<br>Current – low visitation, tenure restricts public access. | 18<br>(6*) |
| Lady Musgrave (13 ha) | 60% | Past – light tower, guano / rock phosphate mining, camping, high level of visitation, resort during 1930s, goats.<br>Current – high level of day visitation and camping, one toilet block and day visitor displays. | 39<br>(18* + 1#) |
| Lady Elliott (45 ha) | 90% | Past – lighthouse, high level of guano / rock phosphate mining, >90% of top soil removed, replanting in 1960s.<br>Current – high level of visitation, lighthouse, resort buildings and air strip; > 10% of the cay is used for human occupancy. | 97<br>(66* + 10#) |

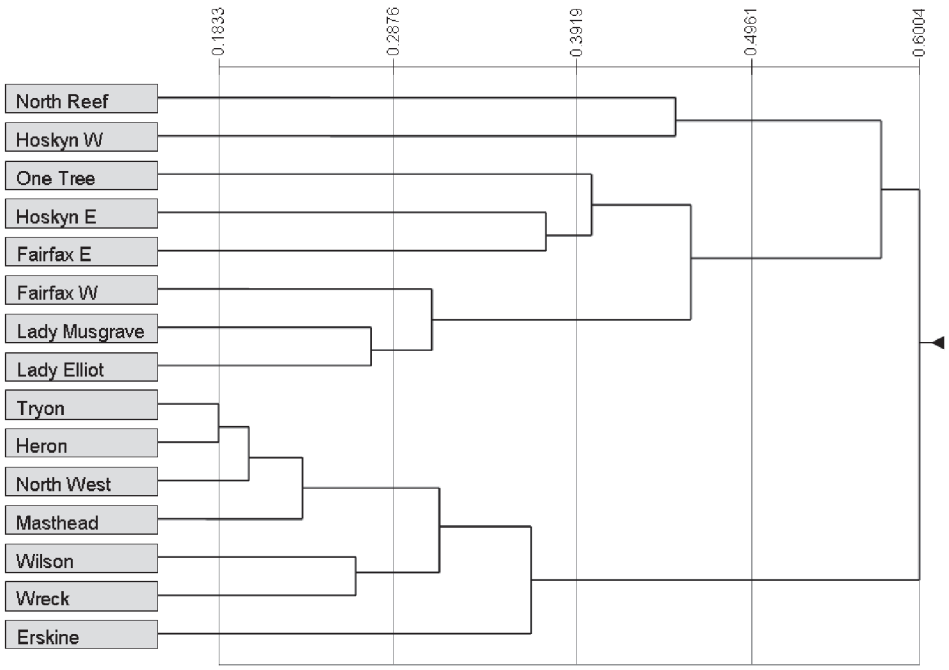


**Fig. 4.** Fusion dendrogram of the floristic association of native species on the Capricornia Cays based on Belbin's (2004) PATN analysis using plant presence and abundance data.

*Comparison of island floras*

Tryon, Heron, Masthead and North West Islands are the most closely related islands on the basis of the presence and abundance of indigenous species. (Figure 4). Other pairings of similar island floras include Wilson and Wreck Islands and Lady Musgrave and Lady Elliot Islands. The fusion dendrogram of indigenous species shows that the CBI can be more or less separated into two groups. The first group includes North Reef, One Tree, the Hoskyn Islands, the Fairfax Islands, Lady Musgrave and Lady Elliot. The second group includes Tryon, North West, Wilson, Wreck, Heron, Erskine and Masthead Islands.

The inclusion of the exotic flora does not substantially change the dendrogram, apart from Lady Elliot Island forming its own floristic group at the highest level. This reflects the sizeable human impact on the flora of this island.

The separation of islands into two distinct groups based in native flora species richness could be due to the closeness of islands to each other and/or the 'distal' and 'proximal' location relative from mainland. The southern CBI are closer to the edge of the continental shelf and could therefore by subject to higher exposure of wind and waves. The northern group are closer to the mainland, and more protected. The inclusion of North Reef Island in the southern group could be

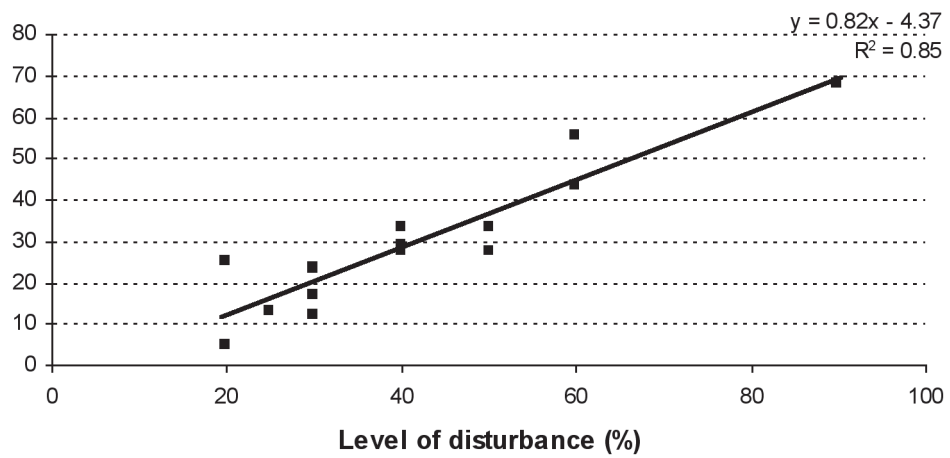


**Fig. 5.** Relationship between estimated disturbance levels at each island and the percentage of exotic species in its floristic composition.

due to the low number of indigenous species recorded from the island (13 spp.), and the comparatively low abundance of key species such as *Pisonia grandis*, which is rare on North Reef Island.

*Disturbance*

All cays are subject to some natural disturbances by wildlife and weather conditions. The level of human disturbance to each CBI ranges from very low to very high. Table 4 provides some of the known information of historic and current disturbances, as well as a percentage of overall disturbances for each island. The percentage of exotic species in each island's floras increased with increased levels of disturbance (Figure 5). Erskine, Wreck and the Hoskyn Islands with the lowest estimated disturbance level (around 20%), had an average of 14.9% exotic species (Figure 5). The islands that were estimated at about 30% disturbed (North Reef, Tryon, Masthead, One Tree and the Fairfax Islands) had an average of 24.8% exotic species. North West, Wilson, Heron and Lady Musgrave Islands were estimated to be around 60% disturbed and had an average of 31.2% exotic species. The naturalised non-indigenous species made up 78% of the flora of Lady Elliot Island, the most disturbed of all islands surveyed (90% disturbed) (Figure 5).

## Discussion

*Character of the flora*

The flora of Coral Sea cays, including the Capricorn-Bunker Islands, is a subset of the tropical flora found in the Indo-Pacific region (Batianoff *et al*. 2009). The connectivity of flora between distant islands is due to the South Equatorial Current, which reaches the Great Barrier Reef to the north of the study area, and the East Australian Current that operates southwards along the mainland coast (Wachenfeld *et al.,* 2007). Together with the seabirds inhabiting the CBI, these currents disperse coral cay plant propagules across very long distances (Batianoff *et al.,* 2009). As a result, the flora of the CBI has an affinity with islands elsewhere in the western Pacific Ocean as well as with the mainland of Australia (Batianoff & McDonald, 1980; Walker, 1991; QPWS, 2000). However according to Stoddart and Fosberg (1991), the southern and northern Australian coral cays floras are different from the neighbouring islands of Melanesia. For example Great Barrier Reef cay provinces do not have orchids or ferns as common species.

At the same time, the southern and northern coral cays are different from each other. The characters of the flora of the southern Great Barrier Reef cays are said to be 'Indo-Pacific' (Stoddart & Fosberg, 1991). The dominant *Pisonia* forests at the Capricorn-Bunker Islands define this region, whereas *Pisonia grandis* occurs infrequently on the northern cays (Walker, 1991). Other differences between the two regions are that the southern cays do not have mangroves, have fewer rock platform succulents, and have a much lower number of littoral rainforest species. The native flora of the northern cays has been estimated to be more similar to the Australian mainland and has a species richness several times greater than the flora of southern cays (Walker, 1991; Stoddart & Fosberg, 1991). We postulate that the wetter climate in the northern region and the closer proximity to the mainland provides for higher plant diversity. Avifauna and humans are other ecological factors likely to have contributed to the distinctiveness of the regions. The major disperser of fleshy fruited rainforest species, the Torresian Imperial Pigeon (*Ducula spilorrhoa* (Gray)), is seasonally abundant on most of the northern cays but is absent at the southern cays (Crome, 1975). Selective historic planting of useful medicinal and food plants by humans has also been suggested as occurring on the northern islands (Stoddart & Fosberg, 1991).

*Species richness*

The indigenous species richness at Capricorn-Bunker Islands is higher than the Caroline Atoll Group islands (10º00'S, 150º14'W, Republic of Kiribati, central Pacific Ocean) average of 18 species (Appendix 1). According to Kepler & Kepler (1994) the indigenous species richness of islands ranging in size from 4–70 ha in the Caroline Atoll Group rarely exceeded 18 species. The number of indigenous species is also much higher than the cays contained within the remote Coringa-Herald National Nature Reserve in the northern Coral Sea Islands Territory (Batianoff *et al.,* 2009).

The number of species present on any island is influenced by, among other things, its size and degree of remoteness (MacArthur & Wilson, 1967; Whittaker & Fernández-Palacios, 2007). However, in this study the relationship between island area and the number of native and naturalised species is very weak. MacArthur and Wilson (1967) also noted that the species-area curve does not increase beyond a certain critical size (the "small-island effect"). They suggested that species on islands below a certain size are highly unstable and may periodically extirpate, becoming locally extinct, a trend also reported by Heatwole (1984a) and Chaloupka and Domm (1985). It is apparent that species richness of the CBI is more influenced by other factors such as disturbance, than the size of the cays.

*Species of doubtful status*

The case of the status of coconut *Cocos nucifera* is particularly contentious. Early botanists and biogeographers frequently commented that coconuts in Australia were not commonly found, but at the same time many explorers believed that coconuts were indigenous to Australia (Macgillivray, 1852; Bentham, 1878). Du Puy and Telford (1993) state that coconuts are native to the Indo-Pacific Region including Australia. However Bostock & Holland (2007) class *C. nucifera* as an

introduced exotic to Queensland. The species does naturalise along the Queensland coast, but it is not invasive. Native-wild and/or cultivated coconuts were recorded at North Reef, Tryon, One Tree, North West, Wilson, Wreck, Heron, Hoskyn (West) and Lady Elliot Islands (Heatwole, 1984a). However, Chaloupka and Domm (1985) in their checklist omitted reporting any presence of coconuts on any of the CBI. Since the late 1980s all populations of coconuts found on cays administered by QPW have been removed and this species is no longer found growing in the CBI, except as cultivated *C. nucifera* populations on cays that are administered by the Commonwealth (North Reef and Lady Elliot Islands). The current coconut drift seed observed at CBI originates from cultivated and/or naturalised populations. These coconuts are therefore not indigenous to CBI and have not been included in the regional checklist of flora (Appendix 1).

*Lepidium englerianum* and *Portulaca oleracea* are listed as naturalised exotics in Queensland (Bostock & Holland, 2007). According to Batianoff (2001), *Lepidium englerianum* is an endemic species to coral cays. Field observations along the Great Barrier Reef indicate that *Lepidium englerianum* and *Portulaca oleracea* are widely distributed, and are part of the natural coral cay flora (Batianoff *et al*., 2009). *Plumbago zeylanica* is recognised as native to Australia (Bostock & Holland, 2007; Du Puy & Telford, 1993d). According to Ridley (1930), *P. zeylanica* has an African/Asian origin and was introduced into Australia during the early 1800s in contaminated imports. It is currently widespread across subtropical Africa, southern Asia, northern Australia and some Pacific Islands (Du Puy & Telford, 1993d). *Pseudognaphalium luteoalbum* is considered native to the mainland of Australia (Bostock & Holland, 2007). However, the status of this species is doubtful due to its complex taxonomy. Field observations show that this species' distribution and growth is indicative of a weedy plant species. As a result, it is considered exotic to the Capricorn-Bunker Islands.

*Temporal patterns & human impacts*

The dominance of the Capricorn-Bunker Islands flora by short-lived herbs (54 spp., 41%) indicates an adaptation to a dynamic local environment, with variable climate and disturbances. The high percentage of rare and infrequent species (80% indigenous, 98% exotic) in the current CBI flora compared to the mainland Sunshine Coast (62%), indicates that very few species have the potential for dominance (Batianoff & Burgess, 1993). The higher incidence of plant rarity on cays compared to mainland areas is to be expected. Heatwole (1976; 1984) and Batianoff (1999) stated that coral cay floras generally have very high species turnover. Many species may establish for limited duration, surviving for some time in very low numbers. The occurrence of mostly monospecific *Pisonia grandis*, *Argusia argentea*, *Casuarina equisetifolia* and *Scaevola taccada* canopies with little or no understorey and groundcover also limits potential establishment and spread of new plant species. The higher incidence of rarity in the exotic species compared to the indigenous species is most likely due to their recent establishment.

It is difficult to comment on temporal changes to regional flora of Capricorn-Bunker Islands, as most of the past regional studies used lists derived by compilation of anecdotal records spaced over long periods of time. However, we have examined two comprehensive studies and by removing some of the clearly erroneous records we are confident that we can use these data to report some of the changes that occurred over the last 23 years. Heatwole (1984) listed 85 species including 41 exotics (48%). Chaloupka and Domm (1985) recorded 85 species, including 46 exotics (54%). The current data indicate that numbers of exotic species have risen to 77 (59%). At the same time, *Bromus catharticus*, *Conyza canadensis* var. *canadensis*, *Digitaria didactyla* and *Polycarpon tetraphyllum* are no longer recorded. The increase of about 36 exotics over 24 years indicates a rate of 1.5 species per annum.

The number of native species over the last 23 years remains relatively static. However, changes have occurred locally at individual island level and some of the more common species of the mid 1980s surveys are no longer common or widespread. *Spinifex sericeus*, a perennial grass, is no longer recorded at North Reef, Tryon, Heron, One Tree, Hoskyn East, Hoskyn West, Lady Musgrave and Lady Elliot Islands. *Trachymene cussonii*, an annual herb, was common and abundant on most islands and now is recorded as infrequent and/or rare at Masthead, One Tree, Fairfax West and Lady Elliot Islands. *Ipomoea pes-caprae* subsp. *brasiliensis*, a perennial herb, is no longer recorded at North Reef, Tryon, North West, Wreck and Fairfax East Islands. *Chamaesyce atoto*, an annual herb, is no longer recorded at Wilson, Heron, One Tree, Hoskyn East, Fairfax East and Fairfax West and Lady Elliot Islands. *Tetragonia tetragonioides*, an annual herb, is now not recorded at North Reef, Heron, Hoskyn West and Fairfax West Islands. It is important to note that most of the above native species that are no longer recorded, are littoral/shore species. The population losses of these beach plants may simply indicate loss and/or erosion of sandy beaches at the CBI.

Olds *et al*. (2007) discusses the recent occurrence of drought in relation to scale insect outbreaks on *Pisonia grandis*. The *Pisonia grandis* forest on Tryon Island was almost completely devastated (88%) by an outbreak of the soft scale *Pulvinaria urbicola* (Cockerell) (Olds *et al*. 2007). The loss of this almost monospecific stand at Tryon Island has allowed the expansion of other species including weeds.

Chaloupka & Domm (1986) stated that human visitor numbers are highly correlated to the number of exotic species but Heatwole & Walker (1989) suggested that the nature of human activities rather than numbers alone was more critical. The high number of exotic species on Lady Elliot Island was contributed by human activities (Batianoff, 1998). In this

study we found the intensity of human disturbance is clearly shown to be the major factor contributing the high number of establishment and spread of exotic species, islands with a disturbance level less than 50 % recorded an average of 21% exotic species, while islands with high disturbance recorded 46 % exotic species. The exotic species at Lady Elliot Island (around 90% disturbed) make up 68 % of its flora but 47 species (36 %) of weeds are not present on any other Capricorn-Bunker Island. If Lady Elliot Island is excluded, exotic species for the region is reduced to 39 species, i.e. 30% of the total flora.

## Conclusions

Large populations of seabirds, high plant diversity, the presence of nesting marine turtles and large areas of *Pisonia grandis* closed-forests make Capricorn-Bunker Islands a globally significant and critically important area for conservation. The area as a southern limit for many Great Barrier Reef coral cay species in Australia and the tropical World, and includes some of the most characteristic species of the Indo-Pacific Oceanic region low island floras such as *Argusia argentea*, *Cordia subcordata*, *Lepidium englerianum* and *Pisonia grandis*.

Though the CBI flora contains 66 % exotic species, the great majority (98 %) are infrequent or rare, making efforts to manage them more achievable. The naturalised non-indigenous species at Lady Elliot Island make up 78% of its flora due to past efforts to revegetate the island after guano mining, and the residential activities of lighthouse keepers.

The current management plans for the Capricornia Cays National Park and Capricornia Cays National Park (Scientific) state that both conservation and recreational uses require efforts to maintain natural and economic values (QPWS, 2000).Efforts to eradicate key weed species at Heron Island and One Tree Island have shown that vigilance and proactive approach to conserving native biodiversity pays off. Comparisons with studies in the mid 1980s have shown the native flora of CBI is resilient. However the large increase in exotic plants requires active management.

Some quarantine measures and continued weed eradication programs are recommended for Lady Elliot Island and a management priority for the Capricornia Cays National Park and Capricornia Cays National Park (Scientific).

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## Appendix 1 Species recorded from the Capricorn-Bunker Islands – 2007/08

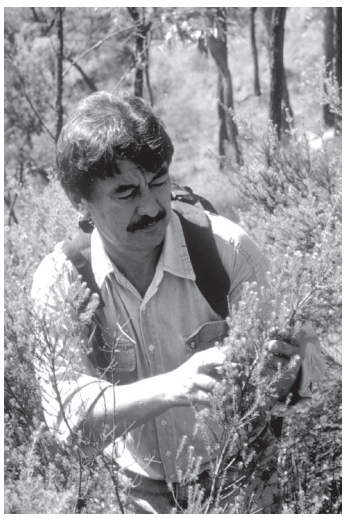
**Status:** * = exotic to Australia and coral cays; # = native mainland species, exotic to coral cays.
**Life form (LF):** T = tree (>5m tall); ST = small tree / tall shrub (2–5m); S = shrub (<2m); H = perennial herb; aH = annual herb; V = vine.
**Frequency:** A = abundant (>30% of sites); F = frequent (15–30% of sites); I = infrequent (1–15% of sites); R = rare (<1% of sites); VR = very rare (single occurrences).
**Coral cays:** 1 = North Reef; 2 = Tryon; 3 = North West; 4 = Wilson; 5 = Wreck; 6 = Heron; 7 = Erskine; 8 = Masthead; 9 = One Tree; 10 = Hoskyn West; 11 = Hoskyn East; 12 = Fairfax West; 13 = Fairfax East; 14 = Lady Musgrave; 15 = Lady Elliot.

| Species Name | Family | LF | Coral Cay | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| *Abutilon albescens* | Malvaceae | S | | F | F | I | I | I | I | I | A | X | I | A | A | A | A | 14 |
| **Acetosa vesicaria* | Polygonaceae | aH | | | | | | | | | | | | | | | R | 1 |
| *Achyranthes aspera* | Amaranthaceae | aH | I | I | I | I | I | R | I | I | F | X | I | I | F | I | F | 15 |
| **Agave americana* | Agavaceae | S | | | | | | | | | | | | | | | I | 1 |
| **Agave attenuata* | Agavaceae | S | | | | | | | | | | | | | | | R | 1 |
| **Agave sisalana* | Agavaceae | S | | | | | | | | | | | | | | | I | 1 |
| **Ageratum conyzoides* | Asteraceae | aH | | | | | | | | | | | | | | | I | 1 |
| **Aloe arborescens* | Asphodelaceae | S | | | | | | | | | | | | | | | I | 1 |
| **Aloe parvibracteata* | Asphodelaceae | S | | | | | | | | | | | | | | | I | 1 |
| **Alternanthera pungens* | Amaranthaceae | aH | | | | | | | | | | | | | | | F | 1 |
| **Amaranthus blitum* | Amaranthaceae | aH | | | | | | | | | R | | | | | | | 1 |
| **Amaranthus viridis* | Amaranthaceae | aH | | I | I | | | I | | | | | | | | I | I/F | 5 |
| #*Araucaria cunninghamii* var. *cunninghamii* | Araucariaceae | T | | | | | | | | | | | | | | | R | 1 |
| **Argemone ochroleuca* subsp. *ochroleuca* | Papaveraceae | aH | I | | | | | R | | | | | X | | R | R | I | 6 |
| *Argusia argentea* | Boraginaceae | ST | F | A | F | I | A | F | F | A | A | X | F | F | I | F | A | 15 |
| **Bidens pilosa* | Asteraceae | aH | R | I | | | | R | | | | X | I | R | F | F | I | 9 |
| *Boerhavia albiflora* var. *heronensis* | Nyctaginaceae | H | I | I | I | I | | I | I | I | F | F | I | I | A | I | A | 14 |
| *Boerhavia* sp. (Bargara L. Pedley 5382) | Nyctaginaceae | H | | | | | | | | | | | | | | | I | 1 |
| **Brassica napus* | Brassicaceae | aH | | | | | | | | | | | | | | | R | 1 |
| **Bryophyllum delagoense* | Crassulaceae | H | | | | | | | | | | | | | | | F | 1 |
| **Bryophyllum pinnatum* | Crassulaceae | H | | | | | | | | | | | | | | | F | 1 |
| *Caesalpinia bonduc* | Caesalpiniaceae | S | | | R | | | | | | | F | | R | | R | | 4 |
| **Cakile edentula* | Brassicaceae | aH | F | F | F | F | F | I | I | I | I | X | | F | | I | I | 13 |
| **Calophyllum inophyllum* | Clusiaceae | ST | | | VR | | | | | | | | | | | | | 1 |
| **Calyptocarpus vialis* | Asteraceae | aH | | | | | | I | | | | | | | | | | 1 |
| *Canavalia rosea* | Fabaceae | V | | | R | | | | | I | A | | I | I | R | I | A | 8 |
| **Capsella bursapastoris* | Brassicaceae | aH | | | | | | I | | | | | | | | | I | 2 |
| **Capsicum frutescens* | Solanaceae | H | | | | | | | | | | | | | | | I | 1 |
| **Carica papaya* | Caricaceae | ST | | | | | | | | | | | | | | | R | 1 |
| *Cassytha filiformis* | Lauraceae | V | I | I | I | | | I | I | I | | | | | | | | 6 |
| *Casuarina equisetifolia* subsp. *incana* | Casuarinaceae | T | F | F | F | F | I | F | | F | I | F | I | A | I | F | A | 14 |
| **Catharanthus roseus* | Apocynaceae | H | | | | | | | | | | | | | | | I | 1 |
| *Celtis paniculata* | Ulmaceae | T | | I | I | R | | I | I | F | | | | | | | | 6 |
| **Cenchrus echinatus* | Poaceae | aH | | F | I | I | I | I | | I | | | | | R | R | I | 9 |
| *Chamaesyce atoto* | Euphorbiaceae | aH | | R | I | | I/R | | I | I | | X | | | | | | 6 |
| **Chamaesyce hirta* | Euphorbiaceae | aH | | | R | | | R | | | | | | | | | I | 3 |
| **Chamaesyce hyssopifolia* | Euphorbiaceae | aH | | | | | | R | | | | | | | | | | 1 |
| **Chamaesyce prostrata* | Euphorbiaceae | aH | | | | | | I | | | R | | | | | R | F | 4 |
| **Chenopodium murale* | Chenopodiaceae | aH | | | | | | | | | | | | | | | R | 1 |
| **Chloris gayana* | Poaceae | H | | | | | | | | | | | | | | | I | 1 |
| #*Chloris ventricosa* | Poaceae | aH | | | | | | | | | | | | | | | R | 1 |
| **Citrullus lanatus* var. *lanatus* | Cucurbitaceae | aH | | | | | | | | | | | | | | R | | 1 |
| **Citrus* sp. | Rutaceae | ST | | | | | | | | | | | | | | R | | 1 |
| *Clerodendrum inerme* | Lamiaceae | S | | | | | | | | R | | | | | | | | 1 |
| **Commelina benghalensis* | Commelinaceae | H | | | | | | | | | | | | | | | I/R | 1 |
| *Commicarpus insularum* | Nyctaginaceae | V | | A/F | R | A | | | F | F | F | I | | | | | | 7 |
| **Conyza bonariensis* | Asteraceae | aH | | I | | | | I | | | | | | R | | I | | 4 |
| **Conyza sumatrensis* | Asteraceae | aH | | I | I | | | R | | | | | X | | | | F | 5 |

| Species Name | Family | LF | Coral Cay | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| *Cordia subcordata* | Boraginaceae | ST | | I | | I | | I | | I | | | | | | | | 4 |
| **Cyclospermum leptophyllum* | Apiaceae | aH | | | | | | R | | | | | | | | | I/R | 2 |
| **Cynodon dactylon* var. *dactylon* | Poaceae | H | | | | R | | I | | | | | | | | | F | 3 |
| **Cynodon nlemfuensis* var. *nlemfuensis* | Poaceae | H | | | | | | R | | | | | | | | | | 1 |
| *#Cyperus gracilis* | Cyperaceae | aH | | | | | | | | | | | | | | | I | 1 |
| *#Dentella repens* | Rubiaceae | aH | | | | | | | | | | | | | | | I | 1 |
| *#Digitaria bicornis* | Poaceae | aH | | | | | | | | | | | | | | | I | 1 |
| **Digitaria ciliaris* | Poaceae | aH | | I | | R | | I | | | R | | | | | R | F | 6 |
| **Eleusine indica* | Poaceae | aH | | F | I | I | | F | | | I | | | | | R | F | 7 |
| **Emilia sonchifolia* | Asteraceae | aH | | | | | | | | | | | | | | | I | 1 |
| **Eragrostis minor* | Poaceae | aH | | | | | | | | | | | | | | | I | 1 |
| **Eragrostis tenuifolia* | Poaceae | aH | | | | | | | | | | | | | | | F | 1 |
| **Euphorbia cyathophora* | Euphorbiaceae | aH | | F | | | | I | | | | | | | | | A | 3 |
| *Euphorbia tannensis* subsp. *tannensis* | Euphorbiaceae | aH | | I | I | I | I | I | I | I | | | | I | | I | I | 10 |
| *Ficus opposita* | Moraceae | ST | | I | I | I | I | I | F | F | | | X | F | I | I | I | 12 |
| *Ficus rubiginosa* | Moraceae | T | | I | I | | | | | | | | | | | | I | 3 |
| **Gomphrena celosioides* | Amaranthaceae | aH | | | | | | | | | | | | | | | I | 1 |
| *Hernandia nymphaeifolia* | Hernandiaceae | T | | | VR | | | | | | | | | | | | | 1 |
| *#Hibiscus tiliaceus* | Malvaceae | T | | | | | | | | | | | | | | | R | 1 |
| *#Hydrocotyle acutiloba* | Apiaceae | aH | | | | | | | | | | | | | | | I | 1 |
| **Hylocereus undatus* | Cactaceae | H | | | | | | | | | | | | | | | I | 1 |
| **Ipomoea cairica* | Convolvulaceae | V | | | | | | | | | | X | | | | | I | 2 |
| **Ipomoea indica* | Convolvulaceae | V | | | | | | | | | | | | | | I | I | 2 |
| *Ipomoea macrantha* | Convolvulaceae | V | | I | R | I | I/R | | | I | F | X | | | | R | R | 9 |
| *Ipomoea pes-caprae* subsp. *brasiliensis* | Convolvulaceae | H | | | | | | R | | I | I/R | | | R | | I | I | 6 |
| **Lantana camara* | Verbenaceae | S | | | | | | | | | | | | | | | A | 1 |
| **Lepidium didymum* | Brassicaceae | aH | | | I | | | R | | | I/R | | | | | R | I | 5 |
| *Lepidium englerianum* | Brassicaceae | aH | I | | I | | I | | | I | | I | | | | | | 5 |
| **Lepidium virginicum* | Brassicaceae | aH | | | | R | | R | | | | | | | | R | R | 4 |
| *Lepturus repens* | Poaceae | H | I | I | F | F | F | F | I | F | F | X | F | | I | F | F | 14 |
| **Malva parviflora* | Malvaceae | H | | | | | | | | | | | | | | | I | 1 |
| **Malvastrum coromandelianum* | Malvaceae | S | | | | | | R | | | | | | | | R | F | 3 |
| **Megathyrsus maximus* | Poaceae | H | | | | | R | R | | | | | | | | | I | 3 |
| **Mirabilis jalapa* | Nyctaginaceae | H | | | | | | | | | | | | | | | I | 1 |
| **Nerium oleander* | Apocynaceae | S | | | | | | | | | | | | | | | R | 1 |
| **Opuntia stricta* | Cactaceae | S | | | | | | | | I | | | | | | | R | 2 |
| **Oxalis corniculata* | Oxalidaceae | H | | | | | | | | | | | | | | | I | 1 |
| *Pandanus tectorius* | Pandanaceae | ST | I | F | I | A | F | F | | I/F | I | I | | I | | F | I/F | 12 |
| **Passiflora suberosa* | Passifloraceae | V | | | I/F | | | | | | | | | | | | F | 2 |
| *Pipturus argenteus* | Urticaceae | ST | | I | I | | | I | | I | | | | | | | | 4 |
| *Pisonia grandis* | Nyctaginaceae | T | R | I/F | A | A | A | A | F | A | F | F | F | A | I | A | I | 15 |
| **Plantago lanceolata* | Plantaginaceae | aH | | | | | | | | | | | | | | | I/F | 1 |
| **Plectranthus amboinicus* | Lamiaceae | H | | | | | | | | | | | | | | | I/F | 1 |
| *Plumbago zeylanica* | Plumbaginaceae | H | | | | | | | I/F | R | A | I | F | | | | | 5 |
| **Poa annua* | Poaceae | aH | | | | | | I | | | | | | | | I | | 2 |
| *Portulaca oleracea* | Portulacaceae | H | R | I | I/R | | I | F | | I | I | X | X | R | A | R | I | 13 |
| **Portulaca pilosa* subsp. *pilosa* | Portulacaceae | aH | | | | R | | R | | | | | | | | | I | 3 |
| *#Pseudognaphalium luteoalbum* | Asteraceae | aH | | I | I/F | | I/F | I | | I | | | | R | | I | I | 8 |
| *Salsola kali* | Chenopodiaceae | aH | | | | | | | R | I | | | | | | | | 2 |
| **Sansevieria trifasciata* | Dracaenaceae | H | | | | | | | | | | | | | | | I | 1 |
| *Scaevola taccada* | Goodeniaceae | ST | F | F | F | | I | F | F | F | R | X | X | R | | | | 11 |
| *#Schefflera actinophylla* | Araliaceae | T | | | | | | | | | | | | | | | I | 1 |
| **Senna pendula* var. *glabrata* | Caesalpiniaceae | ST | | | | | | | | | | | | | | | R | 1 |
| *Sesuvium portulacastrum* | Aizoaceae | H | | | R | | | | | I | I | | | | I | R | | 5 |
| **Sisymbrium irio* | Brassicaceae | aH | | | | | | I | | | | | | | | | | 1 |
| **Sisymbrium orientale* | Brassicaceae | aH | I | | F | | | R | | | | | | R | R | | I | 6 |

| Species Name | Family | LF | Coral Cay | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| **Solanum americanum* | Solanaceae | aH | | A | I | I | | I | | I | F | I | I | I | A | F | F | 12 |
| **Solanum lycopersicum* var. *cerasiforme* | Solanaceae | aH | | | R | | | R | | R | | | | | | | | 3 |
| **Sonchus oleraceus* | Asteraceae | aH | | I | R | R | | I | | | I | | X | I | F | I | I | 10 |
| *Sophora tomentosa* subsp. *australis* | Fabaceae | ST | | | R | | | R | | I/F | | | | | | | | 3 |
| **Sorghum bicolor* | Poaceae | aH | | | R | | | | | | | | | | | | | 1 |
| *Spinifex sericeus* | Poaceae | H | | | I/R | | | | I | I/F | | | | I | | | | 4 |
| *Sporobolus virginicus* | Poaceae | H | | F | I | F | F | F | F | I | | | | | | F | | 8 |
| **Stachytarpheta cayennensis* | Verbenaceae | aH | | | | | | | | | | | | | | | I | 1 |
| **Stellaria media* | Caryophyllaceae | aH | | | | | | | | | | | | | | | I | 1 |
| *Stenotaphrum micranthum* | Poaceae | H | | I | I | | | F | | F | F | X | X | I | | | | 8 |
| **Stenotaphrum secundatum* | Poaceae | H | | | | | | | | | | | | | | | F | 1 |
| *Stephania japonica* | Menispermaceae | V | | | | | | | | R | | | | | | | | 1 |
| *Suriana maritima* | Surianaceae | S | | | I | | F | I | | I | | X | | | | | | 5 |
| *#Terminalia arenicola* | Combretaceae | T | | | | | | | | | | | | | | | I | 1 |
| *Tetragonia tetragonioides* | Aizoaceae | aH | | | | | | | | | F | | I | | F | I | | 4 |
| *Thuarea involuta* | Poaceae | H | F | I/F | A | A | F | F | F | I | | X | X | F | | A | F | 13 |
| *Trachymene cussonii* | Apiaceae | aH | | | | | | | | R | I | | | F | | | R | 3 |
| **Tradescantia pallida* | Commelinaceae | H | | | | | | | | | | | | | | | I | 1 |
| **Tradescantia spathacea* | Commelinaceae | H | | | | | | | | | | | | | | | R | 1 |
| **Trianthema portulacastrum* | Aizoaceae | H | | | | | | R | | | | | | | | | I | 2 |
| *Tribulus cistoides* | Zygophyllaceae | H | | I | I | I | I | I | I | I | | | | | | R | F | 9 |
| **Tridax procumbens* | Asteraceae | aH | | | | | | | | | | | | | | | I | 1 |
| *Triumfetta procumbens* | Sparrmanniaceae | H | | | | | | | | | | | | R | | | R | 2 |
| **Urochloa subquadripara* | Poaceae | H | | | | | | R | | | | | | | | | F | 2 |
| *Wollastonia biflora* | Asteraceae | H | | F | F | F | F | F | I | I | A | X | | | | | I | 10 |
| *Ximenia americana* | Olacaceae | ST | | I/R | | | | | | | | | | | | | | 1 |
| **Zephyranthes candida* | Amaryllidaceae | H | | | | | | | | | | | | | | | R | 1 |
| Total species: 131 spp. | 32 families | – | 16 | 38 | 47 | 27 | 23 | 56 | 21 | 42 | 28 | 24 | 20 | 26 | 18 | 39 | 97 | – |
| Natives: 44 spp. | 31 families | – | 12 | 26 | 33 | 18 | 19 | 24 | 20 | 36 | 20 | 20 | 15 | 19 | 12 | 20 | 21 | – |
| Exotics (*): 77 spp. | 33 families | – | 4 | 11 | 13 | 9 | 3 | 31 | 1 | 5 | 8 | 4 | 5 | 6 | 6 | 18 | 66 | – |
| Mainland natives (#): 10 spp. | 10 families | – | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 10 | – |

# *Vale* George N. Batianoff
# (April 24, 1945 – February 20, 2009)



The botanical community and Queensland Herbarium have lost a passionate, creative and talented botanist with the passing of George Batianoff on the 20th February 2009 in the Wesley Hospital. George succumbed to the debilitating effects of motor neurone disease. George joined the Queensland Government in 1966 and had diverse ecological research interests which ranged from beaches and coastal vegetation, to a love of island vegetation and seabirds. He had a fascination of the unique flora of serpentine regions worldwide, and was an expert in the serpentine flora of central Queensland.

George published 100 scientific papers of which he was the primary author of 86. He had a diverse range of ecological research interests which ranged from beaches and coastal vegetation (22 papers), to a love of island vegetation (27 papers) and seabirds (4 papers). He had a fascination with the unique flora of serpentine regions worldwide, and was an expert in the serpentine flora of central Queensland (11 papers). His other quest was to document the impact of invasive plants on the environment and the development of appropriate management practices (18 papers). He was always driven towards real conservation outcomes from his work and his research on Mt Coolum on the Sunshine Coast lead to the unique flora of this area being protected as a National Park. George is honoured by having three Queensland coastal plants named after him; a shrub *Capparis batianoffii*, a herb *Plectranthus batianoffii* and a grass *Paspalum batianoffii*.

George was an enthusiastic advocate for the Queensland Herbarium and a champion of the value of voucher plant specimens (he lodged 20,000). George was a real character, a people person who enjoyed conversation, a clever joker and was always ready for a good laugh. He will be sorely missed.

*Dr John Neldner, Queensland Herbarium*