'WEEDS BY NATURE': THE PLANTS OF MACQUARIE ISLAND

Mark Fountain, Alan Macfadyen, Natalie Papworth and Jim Cane
Royal Tasmanian Botanical Gardens,
Queens Domain, Hobart, Tas. 7000

Abstract Subantarctic Macquarie Island is a small, very isolated island in the Southern Ocean 1500 km south-southeast of Tasmania. It is a relatively young landmass, emerging from the sea between 200,000 and 90,000 years ago, and like other subantarctic islands only has a small number (41 species) of flowering plants. All species on the island have travelled there by long distance dispersal, often showing biogeographical links to the other subantarctic islands and land masses to the west and north. Many could be characterised as obligate colonisers or 'weeds by nature' since they come from 'weedy' genera with cosmopolitan distributions such as *Galium, Epilobium, Cardamine* and *Stellaria.*

The island's soils are essentially skeletal at high altitude or highly organic loam or peat at low altitude. Their unstable nature coupled with the steep gradients, wind and water erosion, seismic activity and the effect of the island's multitudes of birds and animals creates a shifting mosaic of colonisation and succession. The cultivation and control of these species within the new Subantarctic Plant House at the Gardens will offer challenges.

INTRODUCTION

The scattered subantarctic islands share several physical features, among them remoteness from continental landmasses and adverse weather conditions associated with high latitudes. Of the plants which have colonised them a significant proportion are from families which contain many weed species, and it can be argued that it is this trait which has allowed them to become established.

BACKGROUND

Subantarctic Macquarie Island lies at latitude 54°30' S in the Southern Ocean, approximately 1500 km south - southeast of Tasmania. It is of recent origin, a narrow plateaued ridge, 34 km long, 5 km wide and 400 m at its highest point.

The island lies on the outer edge of an important oceanic boundary, the Antarctic Convergence, where cold waters from the south meet warm waters from the north. This produces a cool, moist and windy climate, in which the annual temperature varies little from the mean of 4.8°C, rain falls nearly every day but there is little persistent snow. Westerly winds predominate, frequently reach gale force for prolonged periods, and cloud covers the island for most of the year.

SOIL DYNAMICS

The key characteristic of Macquarie Island soil is that of instability, and the two factors of seismic activity and gravity interplay here. Earthquakes 6.2 on the Richter scale or stronger occur at least annually (Jones and McCue 1988), and are responsible for mass movement in the form of landslips typified in the ridgetop peatbeds (Selkirk *et al.* 1988). The steep slopes exposed to the constant rain and wind are susceptible to gradual downward movement, aided on a more local scale by freeze-thaw action and the effects of mammals and birds.

These physical events result in continual but irregular disruptions to the established plant communities and their replacement or regeneration, often in a well-recognized cycle which is also seen on other subantarctic islands (Heilbronn and Walton 1984). This disturbance exposes a fresh niche for plants with the ability to exploit it.

VEGETATION

Macquarie Island has evolved in isolation (Selkirk *et al.* 1990) thus all its flora and fauna has reached the island by long-distance oceanic dispersal. The remote and hostile nature of this habitat makes it unreceptive to all but a handful of pre-adapted species of vascular plants. Many traits associated with such plants are typical of weedy species. Historically weeds have had an elusive definition, usually derived from their adverse economic impact, but alternatively it may be based on other characteristics such as life cycle, adaptation or taxonomic nomenclature (Bridges 1995). Lack of a uniform definition leads to uncertainty for example *Cardamine corymbosa* Hook.f. is listed as a weed in the 'CSIRO Handbook of Australian Weeds' (Lazarides *et al.* 1997) but is classified as a native of Macquarie Island in 'Flora of Australia Volume 50' (George *et al.* 1993).

Typically, weeds share several attributes such as high fecundity, rapid growth and effective dispersal vectors which contribute to their effectiveness as colonisers and competitors. (Rats, rabbits and cockroaches all possess similar attributes). Rapid colonisation of disturbed ground is a common feature of many global weed species such as ragwort, (*Senecio jacobae*a L.) which utilises wind and animal transport of seed in addition to regeneration of broken crowns and roots. On Macquarie Island some of these traits can be seen in plants such as *Acaena magellanica* (Lam.) Vahl with its hooked fruit which is spread by animal vectors. This mode of dispersal has been reported in a kelp gull found near another subantarctic island with the fruit clinging to its breast feathers (Smith 1986 in Scott 1990). *A. magellanica* has a circumpolar distribution and has been dispersed to most of the subantarctic islands in an arc from South America to Macquarie Island. An additional weedy attribute is its ability to colonise disturbed drier ground such as bird colonies and seal wallows (Walton 1979).

A cohort of vascular plants from a small number of families has colonised most of the subantarctic islands, which share similar latitude but are separated by thousands of kilometres. Access to these islands is thought to have been wind or bird assisted, a route favoured by small seed size, which is a common feature of these established species. The primary colonisers faced several environmental problems including a gradient of soil nutrient levels and the low temperatures of the summer growing period. Only species with tolerance to this range of adversities have survived in sufficient numbers to establish successful communities.

Certain plant families are well recognised as containing a large number of weedy genera. Bridges (1995) lists 26 such families, 10 of which occur on Macquarie Island. Included in these are the Asteraceae, Onagraceae, Apiaceae, Brassicaceae, Rosaceae and Poaceae. Of the fourteen dicotyledonous and four monocotyledonous families on Macquarie Island most contain genera which in turn have high representation as weeds in Australia (Lazarides *et al.* 1997). *Juncus* (31 weed species), *Carex* (20), *Stellaria* (5), *Crassula* (13) and *Ranunculus* (12) are good examples. Other weed genera with a more cosmopolitan distribution with species on the island include *Epilobium* and *Cardamine.*

Successful colonisation requires not only that an initial foothold be established but that secondary, local spread should ensue. Bergstrom *et al*. (1997) have identified four basic growth patterns displayed by Macquarie Island plants and related them to their colonising ability. The first group, small herbs and grasses, have vegetative growth potential, rapid flowering and seed set with high germinability, all of which enable them to colonise bare ground. The self-fertilising, *Cardamine corymbosa*, for example is a primary coloniser of disturbed ground such as landslip surfaces. Other species exhibiting these traits are *Epilobium pedunculare* A.Cunn. and the introduced *Poa annua* L.

The second group of medium herbs and medium to large grasses, are the major contributors to biomass on the island, with the capacity for juvenile vegetative expansion and high seed germinability. Amongst this group are the monocots *Agrostis magellanica* Lam., *Luzula crinata* Hook.f. and *Poa foliosa* (Hook.f.) Hook.f. A large measure of the success of this group can be attributed to the use of tillering and stoloniferous growth in local expansion, a strategy which permits rapid spread.

The third group, typified by large herbs, has extensive storage tissue and vegetative growth, attributes which enable them to function as perennial stayers. While the megaherbs, *Stilbocarpa polaris* (Hombr. & Jacqinot ex Hook.f.) A.Gray and *Pleurophyllum hookeri* Buchan. cannot be described as weeds, their success on the island can be attributed to vigorous vegetative growth and a high level of tissue storage. *Stilbocarpa* is readily able to recolonise disturbed areas through rapid vegetative regrowth and fragmentation of rhizomes in much the same way as weeds such as couch grass, *Elytrigia repens* (L.) Nevski, does.

Lastly there is a group of plants which have no vegetative reproduction, very slow flowering and seed production levels but which can tolerate and colonise difficult sites. *Azorella macquariensis* Orch. is a poor competitor and only survives to populate extreme environments.

Interestingly two of the weed species which have arrived with human activity have fared differently. *Poa annua* has benefitted from the coexistence of the feral rabbit but has declined with the reduction of rabbit warrens. *Rumex crispus* L., well established as an agricultural problem elsewhere, has never had a population of more than two plants.

RTBG SUBANTARCTIC PLANT HOUSE

The Subantarctic Plant House is a teardrop shaped, solid walled, clear roofed display facility measuring 14 by 6 m. Standing 4 m high, it has high curving walls to maximise the opportunities for visual display combined with a separate steel framed external structure. Internally the structure will be cooled by piped cold water at ground level: air conditioning and misting systems will cool the atmosphere and the steel frame will support a shading system and external watering.

The temperature variation within the house will be several degrees above the equivalent on the island. Air movement in the building will be provided by fan-driven chiller units, and though this will supply ample airflow it will not provide the extremes experienced on the island. Trial cultivation has indicated that a high level of airflow is an important requirement for the successful growth of these plants. The island's constant high humidity will be maintained in the new structure by chiller units and a fogging system. Experience to date, growing the plants in refrigerated containers under artificial light, indicates that environmental conditions in the house will be suitable for successful growth.

PLANT COMMUNITIES IN CULTIVATION

Scale and dimensions within the house do not permit enough variation in the environmental conditions, therefore our approach will be a horticultural one. Over the past three years of trial cultivation the Gardens have developed a generic soil mix for all Macquarie Island plants which replicates many of the characteristics of the island's soil, in that it has good structure and high water holding capacity.

The composition of community plantings will be defined from the outset and maintained by weeding out unwanted species. Communities dominated by single species will be planted as such, but others for example, short tussock grasslands, mire and coastal vegetation will be composed of the major representative species. Each community will be defined and maintained as an entity by hand weeding to prevent contamination or encroachment of one community on another. It is unclear at present if the constant higher temperature in the house will affect the relative growth rate of the plants. For example the mixed communities of *Poa foliosa* and *Stilbocarpa polaris* on Macquarie Island may be maintained by environmental interactions which cannot be replicated in the house. It is possible that one species may outcompete the other. The spectrum of interactions may prove to be even broader in the herbfield communities, where the mixture of smaller monocots and herbaceous plants are controlled by edaphic and other microclimatic factors. Mosses and hepatics will be added as named provenanced collections become available.

These traits might also make cultivation problematic. In the face of rapid seed dispersal and high germinability it may be difficult to maintain community boundaries; interspecific growth rates may vary in the new environment and there may be competition-loss of preselected plant material.

It is the invasive properties of these plants, which have enabled them to so successfully colonise their hostile environment, that might make them a risk should they escape from their enclosure. Some species, thought to be too great a risk through their weed potential, have been excluded from the collection. For example, *Cardamine*, *Epilobium* and *Stellaria* showed increased growth rates and proved to be prolific seeders within the refrigerated storage containers. These species have been eradicated and will not be planted in the house.

There still remains the potential problem of seed transport. Seed movement may be minimised by maintaining a degree of separation between the visitors and the beds, and a duckboard walkway will reduce the opportunity for transfer on footwear.

SUMMARY

In this brief overview it is suggested that most of the established Macquarie Island species originate from families which have genera that show weedy traits. It is not implied that Macquarie Island plants are weeds in the conventional context, but that they display attributes found in many weed species which make them such successful colonisers of disturbed ground. An understanding of the factors controlling these communities, in conjunction with rigorous horticultural management and experimental cultivation will help to visually replicate Macquarie Island's flora. The Subanatarctic Plant House will be an effective instrument for the interpretation and research of Macquarie Island plants.

REFERENCES

Bergstrom, D.M., Selkirk, P.M., Keenan, H.M. and Wilson, M.E. (1997). Reproductive behaviour of ten flowering plant species on subantarctic Macquarie Island. *Opera Botanica* 132, 109-120.

Bridges, D.C. (1995). Ecology of weeds. In 'Handbook of weed management systems,' ed. A.E. Smith, pp. 19-34 (Marcel Dekker Inc, USA)

George, A.S., Orchard, A.E. and Hewson, H.J. (1993). 'Flora of Australia Volume 50' (AGPS Press, Canberra)

Heilbronn, T.D. and Walton, D.W.H. (1984). Plant colonisation of actively sorted stone stripes in the subantarctic. *Arctic and Alpine Research* 16(2), 161-172.

Jones, T.D. and McCue, K.F. (1988). Seismicity and tectonics of the Macquarie Ridge. *Papers and Proceedings of the Royal Society of Tasmania* 122(1), 51-57

Lazarides, M., Cowley, K. and Hohnen, P. (1997). 'CSIRO handbook of Australian weeds.' (CSIRO Publishing, Victoria).

Scott, J.J. (1990). Changes in vegetation on Heard Island 1947-1987. In 'Antarctic ecosystems: change and conservation,' eds K.R. Kerry and G. Hempel, pp. 61-76. (Springer-Verlagg, Berlin).

Selkirk, D.R., Selkirk, P.M., Bergstrom, D.M. and Adamson, D.A. (1988). Ridge top peats and paleolake deposits on Macquarie Island. *Papers and Proceedings of the Royal Society of Tasmania* 122(1), 83-90.

Selkirk, P.M., Seppelt, R.D. and Selkirk, D.R. (1990). 'Subantarctic Macquarie Island: environment and biology.' (Cambridge University Press, Cambridge).

Walton, D.W. (1979). Studies on *Acaeana* (Rosaceae) III. Flowering and hybridisation on South Georgia. *British Antarctic Survey Bulletin* 48, 1-13.