CONSERVATION OF ISLAND PLANT POPULATIONS AND COMMUNITIES

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1. Introduction

1.1 Islands and Plant Diversity

Because of their isolation and small size, most islands, particularly oceanic ones, are often low in biological diversity in comparison with continental areas. Paradoxically, such low biological diversity is often of considerable interest because it contains unique components. Endemic taxa may be thought of either as *paleoendemics*, which are remnants of basal lineages that have been extirpated elsewhere but find refuge on islands, or as *neoendemics*, which are the products of more recent speciation by vicariance and radiation of more-derived lineages that may still occur elsewhere.

Island or island group	**Native species**	**Endemic Species**	**Percent endemic**	**Threatened endemics**	**Percent of endemics threatened**
Ascension	25	11	44.0	9	81.8
Azores	600	55	9.2	23	41.8
Canary Islands	1022	460	45.0	?	?

Cape Verde	224	65	29.0	45	69.2
Galapagos	543	229	42.2	135	59.0
Hawaiian group	970	883	91.0	~353	40.0
Henderson	63	9	14.3	2	22.2
Ireland	900	0	0.0	0	0.0
Juan Fernandez	147	118	80.3	93	78.8
Madeira	760	131	17.2	86	65.6
Mauritius	900	300	33.3	?	?
New Caledonia	3250	2474	76.1	146	5.9
New Zealand	2000	~1620	81.0	~132	8.1
Norfolk	174	48	27.6	45	93.8
Oeno atoll	16	1	6.3	1	100.0
Pitcairn	81	10	12.3	8	80.0
Rodrigues	145	40	27.6	36	90.0
Socotra	815	260	31.9	?	?
St. Helena	60	49	81.7	42	85.7
Tristan/Gough Group	74	28	37.8	?	?

Table 1. Numbers of higher plant species, endemic higher plants and threatened endemic plant species for various islands and island groups. [Data from various sources]

Figure 1. Atlantic blanket bog in western Ireland, a vegetation type strongly dependent on oceanicity. Oceanicity is a key factor in the development of island biodiversity. Islands often contain unique components of biological diversity, but, as in the case of

Ireland, this need not always be at the level of endemic species.

Species richness of island biotas generally increases with age, island size, proximity to a source, and proximity to the tropical zone. The effect of island size is probably due to a combination of habitat diversity and area available for colonization (*see The Equilibrium Theory of Insular Biogeography*). Table 1 gives some examples of island floras, together with their species richness, levels of endemism, and the percentage of the endemics that are threatened with extinction. The ancient continental islands of New Zealand and New Caledonia have greater species richness than do the other oceanic islands in Table 1, yet the percentage of threatened endemics is very much higher for oceanic islands; this is especially true of human-inhabited islands. Notice also that Ireland, a temperate continental island of relatively recent isolation, completely lacks endemic higher plants; tropical, oceanic Mauritius has a similar-sized flora to Ireland but with about 33% endemism. However, Ireland contains important plant communities absent from, or poorly represented, elsewhere (Figure 1). Conservation of biological diversity needs to be considered at other levels of organization than merely species richness and endemism.

1.2 The Hierarchy of Biological Diversity

Biological diversity can be thought of as a hierarchical system of variation. Landscapes are typically the highest level of organization of biodiversity. A landscape such as a mountain range may contain several habitat types, possibly including ridges, cliffs, streams and valley bottoms. These habitats may differ in their biotic communities due to different soil types, exposure, aspect and other factors. Communities are built up of assemblages of species of plants and animals, the composition of which will differ among communities. There may also be variation among similar communities, particularly among islands, due to chance dispersal and establishment. The species themselves are generally organized into populations, which are local groups of individuals that exchange genes among themselves to a greater extent than they do with other populations. There may be considerable variation among populations of a given taxon due to different selection pressures operating in different environments, and to restricted gene flow among populations. Even within a population, there is often considerable variation among its constituent individuals. Some of this variation may be environmentally induced. This is particularly true of plants that are generally rooted in one location and must either cope with whatever biotic, edaphic and climatic micro-environments that are present, or simply die. Some clonal species are, however, able to spread into other biotic, edaphic or micro-climatic environments, and the modules (ramets) of their clonal growth may take on very different characteristics in different environments. Other aspects of the variation among individuals may be genetically determined through differences in DNA base sequence altering the function of structural genes. Variation in base sequence of noncoding regions of the genome is also important, particularly as the study of these regions offers valuable methods of determining patterns of genetic variation.

It should be obvious then that “biodiversity” is not an easily defined parameter, and should really be thought of as the diversity of all biological entities, and the organization of, and interactions between, components of this diversity in the broadest possible sense. The above discussion of spatial diversity is, of course, only part of the picture. Individual genotypes die and are replaced with other, slightly different genotypes. Community structure changes partly through succession following colonization and partly in response to ever-changing climatic, biotic and edaphic environments. The landscape itself changes over geological time. Thus, there also is a temporal aspect to biological variation.

Because of spatial, temporal and biological isolation, islands often contain unique components of biological diversity, particularly at and below the species level. Table 1 indicates that even very remote and small islands may contain species found nowhere else; the same is surely true for combinations of alleles.

1.3 Why Conserve Island Plant Diversity?

The occurrence of paleoendemics on many island groups suggests a certain level of stability of island biodiversity. In summing up an immense treatise on Pacific island vegetation types, Dieter Mueller-Dombois suggested that many islands may be remarkably resilient. Yet islands also contain some of the most ravaged ecosystems known, largely due to the disproportionate effect of one component of biodiversity: *Homo sapiens* and its associates. Island biodiversity is often under severe threat, and frequently the smaller the island and more specialized its biota, the greater the threat (see also Table 1).

Plants are the main primary producers of terrestrial ecosystems, utilizing radiant energy to convert carbon dioxide to utilizable sugars. The survival of assemblages of many other organisms is dependent on the sustained functioning of those plants. Plants also provide the basis of a human life-support system. Plant communities cover most terrestrial surfaces, are involved in pedogenic processes, and help prevent soil erosion. They are likely to be essential to hydrological functioning, particularly on high islands. The plant species themselves provide essential human resources such as shelter, construction materials, clothing, medicines, and food; many species also have great value in religious and cultural contexts. These are important reasons to conserve island plant diversity.

An additional and somewhat more esoteric reason to conserve island plant and animal species and entire communities is the valuable scientific insights island populations can offer into the processes of dispersal, colonization, evolution, and, unfortunately, extinction. Island ecosystems are frequently less speciose than their continental counterparts, and it is possible that detailed investigation of ecosystem functioning in simpler island communities may provide a valuable insight into more complex systems elsewhere. Study of island biodiversity has been instrumental in developing many concepts in biology, most notably in conservation biology and evolutionary theory; it is no coincidence that both Darwin and Wallace arrived at similar views on evolution by natural selection after extensive study of island biota (*see The Dawn of the Modern Era*).

2. The Threats to Island Plants and their Communities

Threats can be simply classified into two main categories, *deterministic* and *stochastic*. Deterministic threats reduce populations by the direct effects of particular actions. Stochastic threats are different in that they are the effects of chance. Such random effects are more pronounced in small populations.

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Biographical Sketch

Steve Waldren is the Curator/Administrator of Trinity College Botanic Garden, University of Dublin, Ireland. His research interests include ecophysiology and genecology of wetland plants, conservation biology of threatened plant populations in Ireland and in South Pacific Islands, molecular biogeography and the origins of insular floras, and the links between ethnobotany and practical conservation. He participated in the 1991 Sir Peter Scott Commemorative Expedition to the Pitcairn Islands, and returned to Pitcairn in 1991 to undertake a vegetation and floristic survey of the island. He has traveled widely, including visits to Indonesia and Vietnam while acting as a consultant on conservation projects.