THE UNIVERSITY OF EDINBURGH

The Status and Distribution of the Endemic Vascular Flora of Ascension Island

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Summary

An account of the expedition results relating to the endemic vascular flora of Ascension Island is presented. The status, distribution, and community structure of the ten endemic vascular plant species as recorded by the expedition is given. The expedition found some differences in the distributions of some species notably *Euphorbia origanoides* in comparison to previous studies. The expedition increased the population of *Sporobolus caespitosus* but this is due to under recording rather than population expansion. Based on our observations we propose up to date categories for the species using 1994 IUCN criteria (IUCN, 1994) *Oldenlandia adscensionis* (Extinct) *Sporobolus durus* (Extinct) *Dryopteris ascensionis* (Extinct) *Anogramma ascensionis* (Extinct/Critically Endangered D) *Marattia purpurascens* (Lower Risk/nt) *Asplenium ascensionis* Status: (Lower Risk/nt) *Xiphopteris ascensionense* (Lower Risk/nt) *Sporobolus caespitosus* Status: (Endangered C 2a) *Euphorbia origanoides* (Endangered B1+3cd) *Pteris adscensionis* (Critically Endangered C2a). Results of two way indicator species analysis (Hill, 1979) of the recorded quadrats for the endemic species are given, this together with observations made by the expedition indicate that available moisture may be an important factor in the endemic species distribution. Suggested areas for further study in relation to the conservation of these species are also presented.

Acknowledgements

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1. INTRODUCTION

Ascension Island, (7° 56'S, 14° 22'W), is situated in the South Atlantic Ocean to the west of the mid-Atlantic ridge and covers an area of 97 km². It is entirely volcanic (except some beach material); composed mainly of basaltic lava flows, the highest point being Green Mountain at 859m. The last volcanic activity took place 600 years ago and all craters are currently dormant. The island currently has a population of approximately 1150.

Approximately 25 species of vascular plants are thought to be indigenous to Ascension Island, of which ten are regarded as endemic (Cronk 1980). These ten species are; *Oldenlandia adscensionis* (DC.) Cronk, *Sporobolus durus* Brogn., *Sporobolus caespitosus* Kunth, *Euphorbia origanoides* L., *Dryopteris ascensionis* (Hook) O. Kuntze, *Pteris adscensionis* Swartz, *Asplenium ascensionis* S. Watson, *Xiphopteris ascensionense* (Hieronymus) Cronk, *Anogramma ascensionis* (W.J. Hooker) Diels and *Marattia purpurascens* De Vriese.

These endemic species largely fall into the category of neo-endemics or type three relict species (Cronk, 1980), suggesting they are the result of recent evolution after colonising the island, rather than species of great antiquity whose range has been reduced by extinction elsewhere. The estimated immigration rate for plant species to Ascension Island is thought to be in the region of one plant every 100,000 years (Cronk, 1992 and 1997). This low immigration rate led to a low diversity indigenous flora and would suggest a flora of low competitive ability.

A picture of this low diversity flora can be glimpsed through the early biological records with very few plants being recorded typically only 4 or 5 species in early visits (details can be obtained in Duffey 1964, but see also Packer 1997). However, this indigenous flora was not to remain intact. In the nineteenth century large-scale introductions of exotic plants commenced in an attempt to modify the climate. This has been disastrous for the indigenous plant communities of Ascension Island and to a greater degree the endemic flora, with at least two species thought to be extinct prior to 1998 and a reduction in the distribution of many indigenous plant communities (Cronk, 1980). The extinction and reduction in distribution of the indigenous flora are thought to be due to the poor competitive ability of the indigenous flora (Cronk, 1980), allowing rapid colonisation of the exotic vegetation.

Overview of physical environment

Ascension Island is volcanic in origin. Approximately 60 vents are present the largest being Green Mountain at 859 m. The island is relatively young in geological terms, however, no volcanic activity has been recorded since its discovery in 1502. 85% of the island is comprised of basalt and allied rocks, with rocks composed of trachyte constituting the remainder (Mitchell-Thome, 1970).

There are many cinder cones of scoria, a basaltic version of pumice. The scoria is either black, such as that observed on Green Mountain, or red where oxidisation has occurred, for example Sisters Peak. Weathered oxidised red scoria forms the substrate for many of the areas containing *Euphorbia origanoides*. Other commonly encountered substrates include basaltic lava flows where plants grow in the grey volcanic ash between blocky lava.

The relative youth of the island and the low rainfall have resulted in poorly developed soils. The andosol soils on Green Mountain exhibit high water absorption, however, as expected on an island of pedalogical youth, limited soil analysis has shown concentrations of ammonia, nitrate and phosphate to be very low (Kirk, unpublished, available on request).

The high porosity of the island's rocks leads to a substrate with a high infiltration capacity and only after exceptional rainfall is there any flow of water above ground. This can prove to be a destructive force, such as during the last major flooding event in April 1985. Many erosion gullies are visible on the steep slopes of Ascension indicating erosion due to water flow after these events. The only permanent body of water, named Dew Pond, is of anthropogenic origin and is sited on the peak of Green Mountain amongst the dense bamboo.

Meteorological data has been recorded at various locations on the island since the end of the nineteenth century. The average annual rainfall is given in Figure 1 for the years 1977 to 1997. A fuller discussion of the climate of Ascension can be found in Duffey (1964). Immediately prior to the expedition, the Island experienced a very dry period.

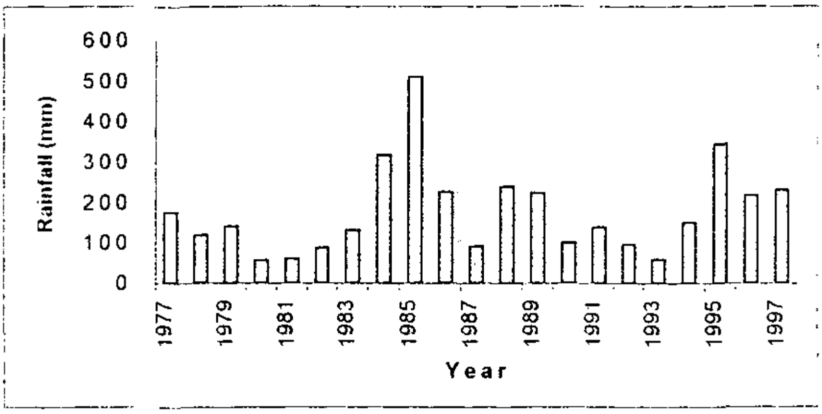


Figure 1: Average annual rainfall for Ascension Island from 1977 to 1997 from rain gauges located at the airhead and pan-am sites. Data provided by Ascension Meteorological office.

The altitudinal range of the island extends from sea level to the summit of Green Mountain at 859m. Although situated in the tropics the oceanic situation and influence of south-east trade winds (Duffey 1964) modify the climate. The climatic regime of the island largely mirrors the gradient in altitude, with low lying areas receiving little rain and higher temperatures except during periodic rainfall events, and the higher areas such as Green Mountain exhibiting the greatest rainfall and lowest temperatures. Green Mountain is often shrouded in mist and a high proportion of the rainfall is in the form of this occult deposition. Contrary to this pattern higher areas in the lava plains, for example Sisters Peak, remain very dry for much of the time. The low-lying lava plains exhibit the xeric conditions common to many desert habitats.

Ascension '98 expedition

Biological and ecological baseline information for many of the UK dependent territories remains incomplete including Ascension (Oldfield and Shepherd 1997). The continuation of the endemic vascular flora on Ascension is dependent on the generation of scientific data that can be used for the purpose of conservation management. However, knowledge of the ecology, population dynamics, nutrient requirements etc. of these species is lacking.

In 1998, six undergraduate ecology students from the University of Edinburgh undertook an expedition to Ascension Island, aiming to assess the current distribution of the endemic vascular flora. It had been over 20 years since the last assessment of these species (see Cronk, 1980 and Table1), therefore up to date information of the distribution of the endemic species was required.

Table 1 shows the history of botanical recording on Ascension Island prior to the expedition. Early botanical records recorded few species indicating a low diversity flora. Of the contributors mentioned, Duffey (1964), Cronk (1980) and Packer (1997) provide the best data on plant distribution. It should be noted that the majority of the visits provide casual botanical records collected on an ad hoc basis and few scientific studies have been conducted. Duffey (1964) and Cronk (1980) represent the most recent scientific surveys of the plant species on the island. Details of each of the visits in Table 1 can be found in Packer (1997).

Date	Contributor(s)	Date	Contributor(s)
1698	J. Cunninghame	1876	W.B. Hemsley
1752	P. Osbeck	1877	I.Gill
1754	Abbe de la Caille	1888	H.J. Gordon
1775	G. Forster	1889	J. Loomis and S. Watson
1825	R.P. Lesson	1904	N. Rudmose Brown
1828	J. Holman	1917	O.Stapf
1829	H.R. Brandreth	1922	H. Cronk
1829	A. Richard	1958	E. Duffey
1830	W.H.B. Webster	1967	J.E. Packer
1843	S.Fraser	1969	D.N. Stokes
1843	J. Hooker	1971	K. Hutchfield
1847	Wren	1976	Q.C.B. Cronk
1851	B. Seeman	1976	J.D. Price and P. James
1859	J.C. Bell	1981	Ascension Historical Society
1864	F.L. Barnard	1986	Q.C.B. Cronk
1865	T. Baines	1997	J. and L. Packer

Table1: Chronological history of the contributors to botanical work on Ascension Island. Details can be found in Packer (1997).

In addition to plant survey work, connections were made with residents of the island, in particular the Ascension Island

Heritage Society and the school at Two Boats. A plant fun day including aspects of the endemic flora was organised for younger children at Two Boats school. Guided walks around Green Mountain for the older children from the school and for adult residents were conducted, highlighting important information regarding the endemic plants. An evening slide show and talk were organised in conjunction with the Ascension Island Heritage Society and held at the Exiles Club in Georgetown coincident with articles written for the island's newspaper, The Islander. These events were well attended and indicate an interest in the endemic flora amongst the island's residents and we hope that in some way we have helped to raise awareness of the plight of the endemic flora of Ascension Island.

In contributing towards the conservation of the endemic species on the island, it is hoped that this report may provide the basis for a forum of discussion on the conservation of the endemic species and in so doing ensure the long-term persistence of these unique species.

2. OVERALL OBJECTIVE AND EXPEDITION AIMS

Overall Objective

The overall objective of the expedition was to investigate the status and spatial distribution of the endemic vascular flora of Ascension Island and in so doing contribute to their conservation. Achievement of this overall objective was sought by fulfilling the following expedition aims using the methods described below.

Expedition Aims

- To contribute to the conservation of the Ascension Island endemic vascular flora by providing up to date base line data on extant populations. This involved the generation of site specific data for each of the endemic species.
- To examine the structure of the communities in which the endemic species are found.
- To revise IUCN red data book categories for each of the endemic species using 1994 IUCN guidelines.
- To broaden the experience of all team members in expedition organisation, field survey techniques and data analysis with regard to taxa not encountered in the United Kingdom.

3. METHODS

The survey conducted between the 9th July and the 26th of August, encompassed the known historical sites of each of the endemic species as recorded by Duffey (1964) and Cronk (1980) but included sites brought to our attention by residents of the island and any areas of suitable habitat encountered. Populations were either mapped by hand to indicate the geographical extent of the population, or by a target note indicating geographical position where the extent of the population was too small to be mapped. Photographs of the endemic species and sites at which they are found were also taken.

Where a population was found the following parameters were recorded, although later modified depending on the extent and size of the population encountered (see below).

- Counts of individual plants of each endemic species.

- Written descriptions of each population in the form of a concise numbered target note, including details of the population size, all species present in the area, and any identifiable threats, such as grazing or invasive plant species. Each species recorded was assigned a DAFOR rating (Dominant, Abundant, Frequent, Occasional or Rare), allowing rapid coverage and assessment of the communities in which the endemic species were found.

- Percentage cover of the vegetation using quadrat sampling. Quadrats varied in size according to the situation encountered and were biased towards homogenous stands of vegetation containing endemic species; *Marattia purpurascens*, *Euphorbia origanoides* and *Pteris adscensionis* 2m, *Asplenium ascensionis* 1m, *Sporobolus caespitosus* and *Xiphopteris ascensionense* 0.5m. Within each homogenous stand five random quadrats were assessed. However, many areas were either too small to allow a random quadrat allocation or five quadrats and thus were sampled in their entirety.

- Classification of percentage cover data was done using two-way species indicator analysis (Hill, 1979), with cut points at 0, 2, 5, 15, and 33%.

In addition to survey work on the endemic species the following taxa were also assessed to a limited extent using the following methods:

- Populations of indigenous plants encountered were geo-referenced with a numbered target note as above.

- A collection of bryophytes and lichens was made and voucher specimens were deposited in the herbarium at the Royal Botanic Gardens, Edinburgh, UK.

- A collection of the Cyperaceae was made.

- A small ad hoc collection of marine shells was also made from various points around the island.

Plate 1: *Marattia purpurascens* photographed on Elliot's Path Green Mountain (c. Kirk 1998).

Plate 2: *Sporobolus caespitosus* on Elliot's Path Green Mountain (c. Kirk 1998).

Plate 3: *Xiphopteris ascensionense* on bamboo node at the summit of Green Mountain (c. Kirk 1998).

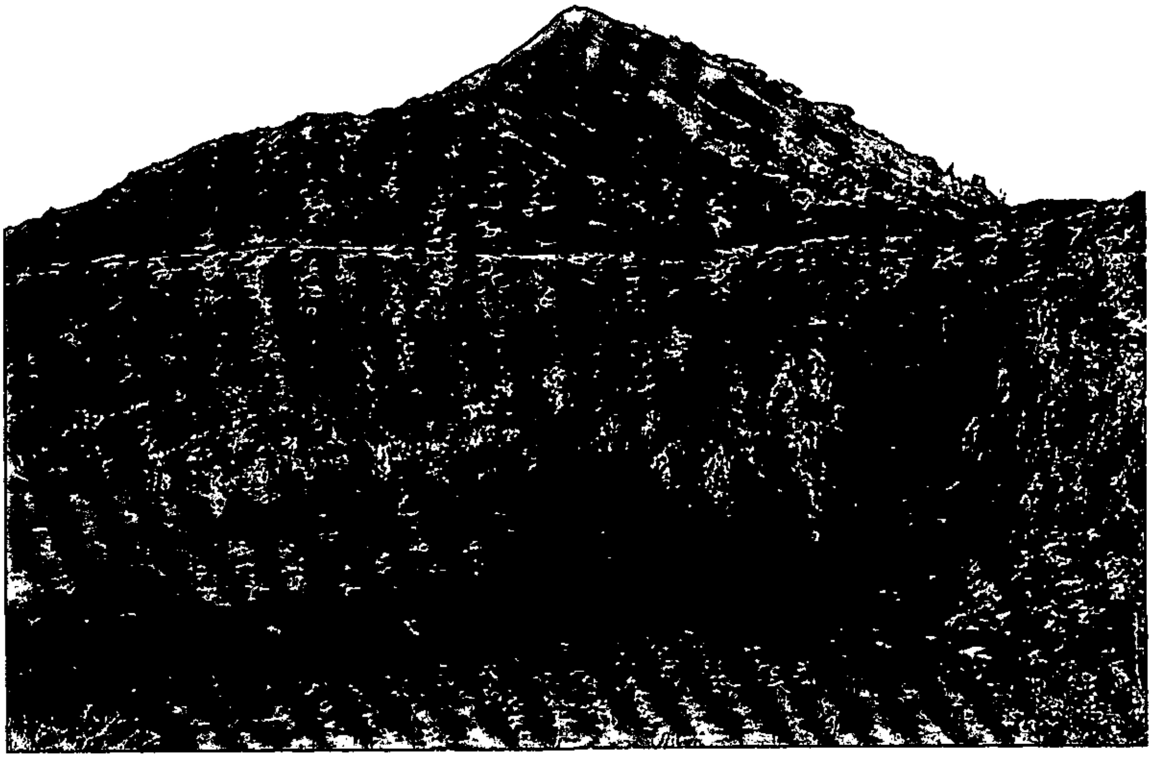


Plate 4: Cricket Valley with Green Mountain in the background. This indicates the general area of the largest *Pteris adscensionis* population (c. Kirk 1998).

Plate 5: Largest individual found of *Pteris adscensionis* photographed amongst the largest population in Cricket Valley (c. Robinson 1998).

Plates 6 and 7: *Asplenium ascensionis* photographed in Breakneck Valley (c. Kirk 1998).

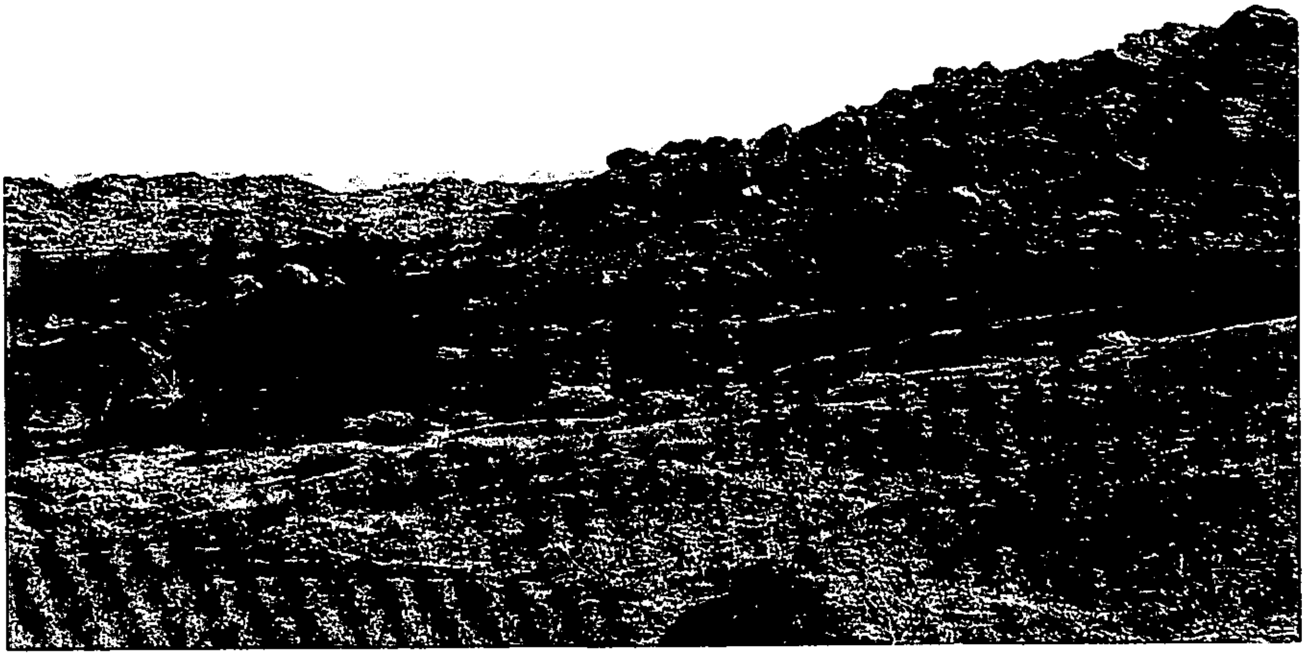


Plate 8: *Euphorbia origanoides* at Cotar Hill looking towards the sea with dead *Waltheria indica* in the foreground. Note the evenly spaced nature of the community (c. Kirk 1998).

Plate 9: *Euphorbia origanoides* at Mars Bay (c. Kirk 1998).

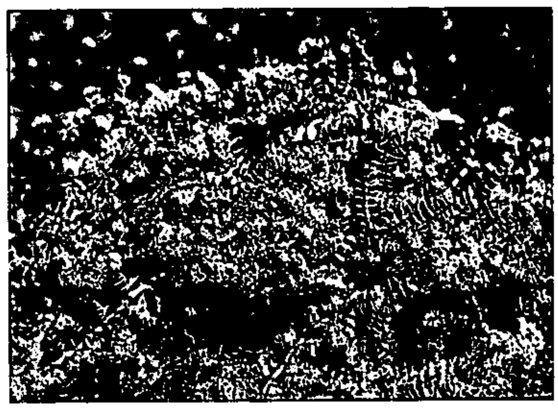


Plate 10: *Euphorbia origanoides,* note the oblique angle of leaves and domed shape believed to be adaptations to the xeric conditions (c. Kirk 1998).

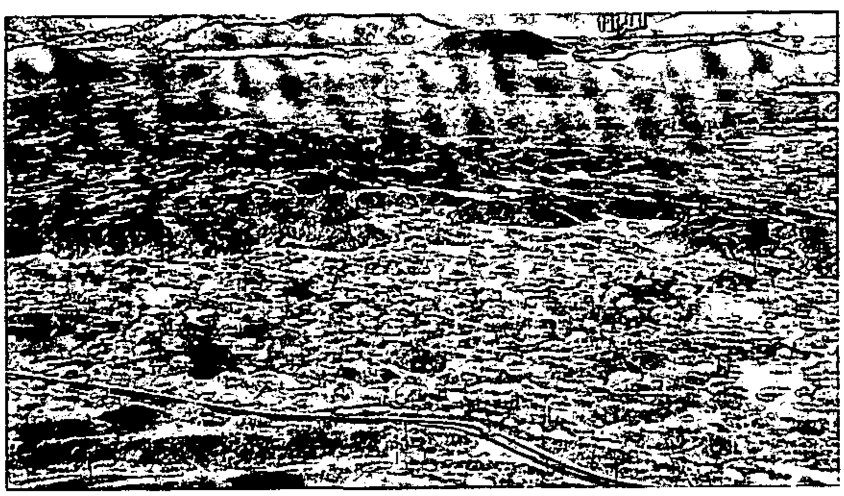


Plate 11: View looking north from Cross Hill showing scrub dominated by *Prosopis juliflora,* illustrating the potential threat to *Euphorbia origanoides* sites (c. Kirk 1998).

Plate 12: Bamboo thicket at the summit of Green Mountain, habitat for both *Marattia purpurascens* and *Xiphopteris ascensionense* (c. Kirk 1998).

Plate 13: The extent of *Alpinia zerumbet* on Green Mountain, viewed from the path to the summit (c. Kirk 1998).

4. RESULTS AND DISCUSSION

The following section details the distribution, habitat, and community structure of each of the endemic species as found by the expedition. The status, distribution, and community structure of the ten endemic vascular plant species is presented, using maps and observational notes. New red data book categories for the endemic species, using 1994 IUCN criteria (IUCN, 1994) are also proposed. Red data book categories for the endemic species were first proposed by Cronk (1980), and in updating the status of these species we propose new categories using 1994 IUCN criteria. The category appearing in bold print is that proposed by expedition members based on observations of the distributions and any apparent threats at the time of survey, following the guidelines of Oldfield *et al* (1998). Any categories shown in normal font and contained in brackets are those that the species qualifies for under the present guidelines, but have been judged inappropriate by the expedition members. A discussion of the conservation of the endemic species is presented, with areas considered to be of some importance to the survival of the endemic species.

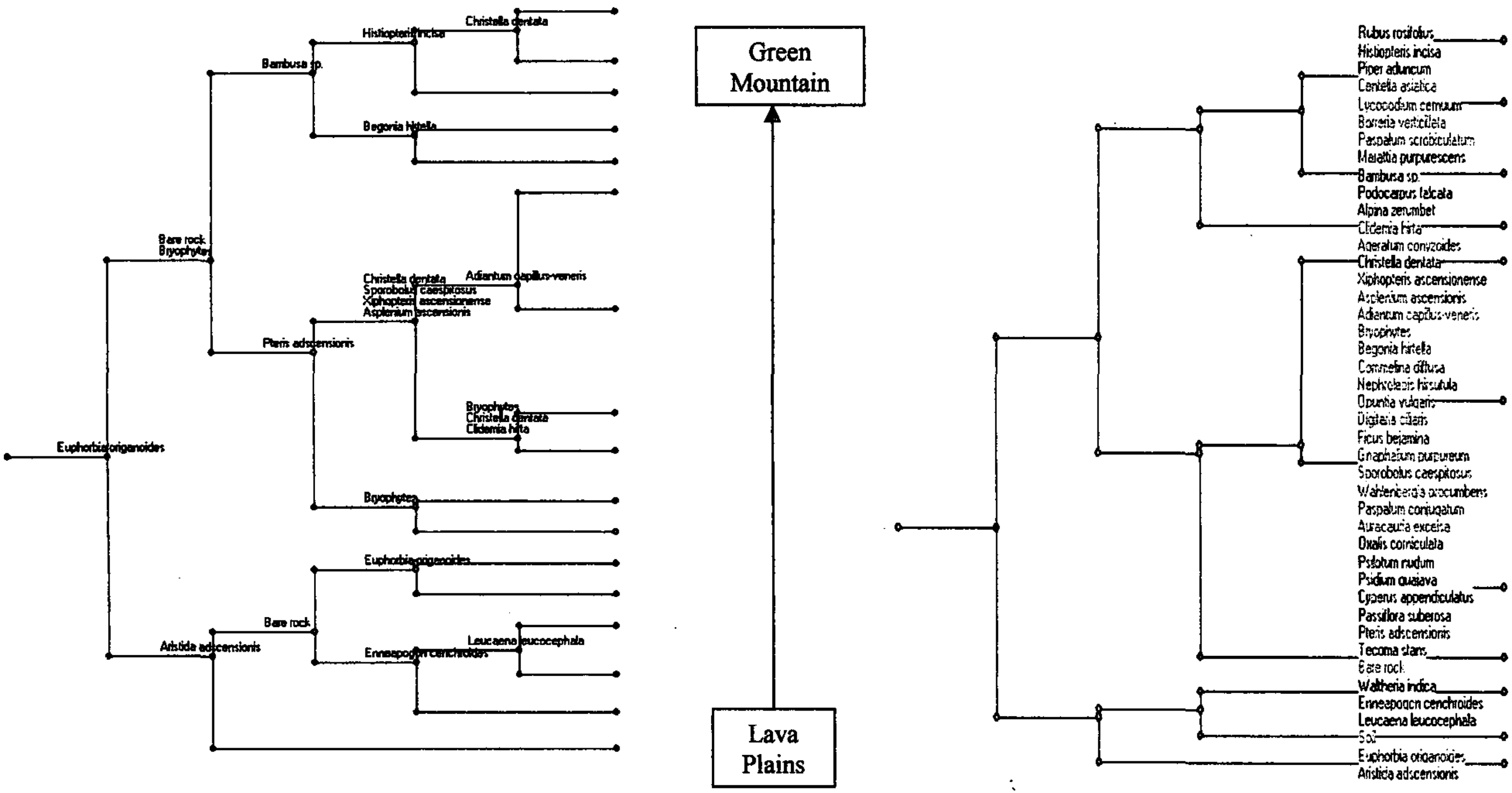
Results not presented in this section include, the distribution of the indigenous vascular plants encountered (detailed in Appendix 2), bryophytes identified to date (detailed in Appendix 4), and marine shells (detailed in Appendix 5).

Although the status of the Cyperaceae on Ascension Island was not assessed due to taxonomic uncertainties, a collection was made and is held by Alan Gray. It is hoped this may help to clear up taxonomic uncertainty in the future.

Community analysis of endemic species

Two way indicator species analysis (Twinspan) was devised by Hill (1979) and is a complex, divisive clustering method for vegetation classification. It allows the characterisation of community structure and the inference of ecological relationships. However, it must be noted that analysis of the output is subjective and relies on the experience of the observer in interpreting the results. It must also be remembered that sampling conducted by the expedition was biased towards areas with endemic species and as such does not reflect the entire suite of vegetation on the island. Tentative generalisations are thus made, and the community descriptions that follow rely as much on observation as on the Twinspan analysis. This analysis should be regarded as a first step to characterisation of the vegetation communities on Ascension and a more in depth analysis awaits further sampling.

The former range of the endemic species would appear to have been that of a patchy distribution of indigenous communities, such as the carpet of ferns reported by Hooker (1867) on Green Mountain and probably related to the availability of water. Today, the distribution of plant communities on Ascension also appears to be related to climatic variations but is characterised as much by the presence of introduced species as any indigenous species. Figures 2 (a) and (b) summarise the Twinspan analysis in relation to the quadrats sampled. These figures illustrate not only the relationship between site and species, but also indicate a gradation of vegetation from the lowland lava plains to the summit of Green Mountain. Although this is partly a reflection of sampling bias, it nevertheless indicates strong separation on ecological grounds. As discussed previously the climatic regime of Ascension Island reflects an altitudinal gradient. The analysis appears to offer support for the theory that available water may be the most important ecological factor in relation to the endemic plant distribution. This is most apparent in comparisons between the communities containing *Euphorbia origanoides* and those of *Marattia purpurascens* at the summit of Green Mountain (Figure 2). While the communities can be separated in accordance with the presence of endemic species, community relationships in-between the extremes of the summit of Green Mountain summit and the lava plains are less well defined, and further sampling is required to elucidate relationships between the vegetation communities of Ascension Island.



(a) (b)

Figure 2: (a) Dendrogram showing classification of samples. Species in the dendrogram indicate the indicator species as identified by Twinspan for that division. (b) Dendrogram showing classification of species. Species groupings in the dendrogram indicate vegetation similar in composition as identified by Twinspan. End divisions for both dendrograms show a gradation from quadrats sampled in the lava plains of the lowlands to those sampled in Green Mountain.

Status and Distribution of the endemic vascular flora of Ascension Island

1). *Oldenlandia adscensionis*

Status: **Extinct**

Distribution and reason for extinction: *O. adscensionis* was formerly found on Green Mountain on the northern and western slopes between 356m and 680m but has not been seen since Gordon found it in 1889 (Cronk, 1980). A sighting in 1985 (St. Helena Agriculture and Forestry Department, 1985) remains unconfirmed as no specimen was collected or photographed. No further reports have surfaced, therefore due to the lack of evidence for the persistence it is suggested that *O. adscensionis* should continue to be regarded as extinct. If specimens of this species are extant then they are likely to be ephemeral in nature and very susceptible to grazing mammals. The large-scale introductions of exotic plant species and browsing by goats are thought to have contributed to the demise of this species (Cronk, 1980).

2). *Sporobolus durus*

Status: **Extinct**

Distribution and reasons for extinction: No trace of this species was found after extensive searches of White Horse Hill, where it was last recorded in 1889 at 460m (Cronk, 1980). The introduced grass *Melinis minutiflora* P.Beauv. is now the dominant grass in this area and it is unlikely that *S. durus* could compete with this vigorous species. If any surviving specimens persist, they are likely to be in areas inaccessible to survey, for example, small ledges on cliff faces. Due to the inability to locate this species in the wild, *S. durus* should continue to be regarded as extinct. The introduction of species such as *M. minutiflora* are likely to be responsible for the reduction in the distribution of *S. durus* (Cronk, 1980).

3). *Dryopteris ascensionis*

Status: **Extinct** (Critically Endangered D)

Distribution and reason for extinction: *D. ascensionis* was formerly recorded from Green Mountain between 725m and 825m and is likely to have been a component of the 'carpet of ferns' reported by Hooker (1867). A reported sighting in 1975 (Cronk 1980) remains the last record of this species although no collection appears to have been made. Despite repeated searches the expedition could find no trace of this species, the last confirmed sighting therefore remains 1889. *D. ascensionis* is now regarded as extinct as it is thought unlikely that it remains extant. Certainly no trace of Hooker's 'carpet of ferns' remains. If populations of this species do persist, they are likely to be very small and declining. The large-scale introductions of exotic plant species have probably contributed to the reduction of the populations of this species.

4). *Anogramma ascensionis*

Status: **Extinct** (Critically Endangered D)

Distribution and reason for extinction: This small annual fern also grew on Green Mountain, between 365 m and 710 m. The last confirmed sighting was by Duffey in 1958 (Duffey, 1964). No specimens could be found after extensive searching in areas of known historical sites and suitable habitat. There is some hope that *A. ascensionis* may persist in some of the moist ravines, perhaps emerging after a period of rain. Fern gametophytes were present in many suitable habitat areas, however none of these were identified to species level. Due to the lack of evidence of persistence, it now seems appropriate to regard A. *ascensionis* as extinct. Introduced species are again likely to have contributed greatly to the decline of *A. ascensionis*, possibly shading out this small annual fern.

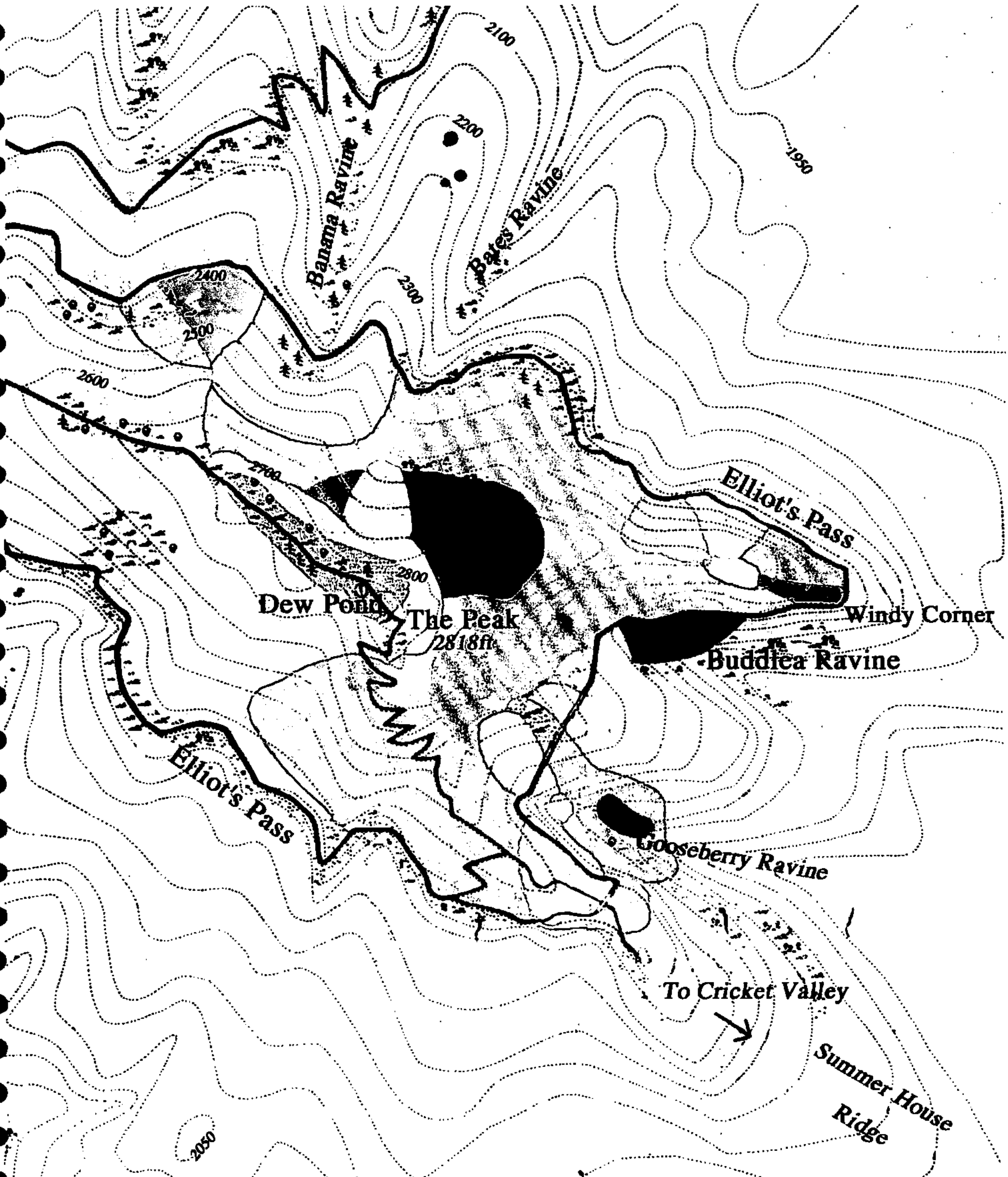


Figure 3: Map showing habitats of Green Mountain Peak area. This map indicates the distribution of *Marattia pupurascens* and *Sporobolus caespitosus* as recorded by the Ascension '98 Expedition. Areas shown are approximate and do not reflect the true population extent. For further populations identified, refer to target notes.

Key to Figure 3

Alpinia zerumbet

Psidium guajava

P. guajava, Buddleia madagascarensis, Lantana camara & Clenodendron fragrans.

P. guajava, B. madagascarensis & Vitex trifolia.

P. guajava & L. camara

P. guajava, B. madagascarensis & L. camara

Bambusa with Marattia purpurascens.

M. purpurascens & Histiopteris incisa.

M. purpurascens

Podocarpus elongata

Agave sisalana

Sporobolus caespitosus

Grass and Scrub: Melinis, Juniperus, Paspalum & Sporobolus africanus

Grass and Scrub: P. guajava, Borreria verticulata, P. scrobitulatum & Rubus spp.

Buddleia madagascarensis

5). *Marattia purpurascens* (Plate1)

Status: **Lower Risk/nt** (Vulnerable D2)

Distribution and community structure: Figure 3 (see also target notes, Appendix I) illustrates the distribution of *M. purpurascens* as found by the expedition. It can be seen that *M. purpurascens* was found on the weather side of Green Mountain growing in the open *Paspalum* grassland and amongst the dense stand of *Bambusa* sp. at the summit, from an altitude of approximately 700m to 859m. *M. purpurascens* is physically the largest of all the endemic species on Ascension and appears to be able to compete favourably with other exotic species, possessing a degree of phenotypic plasticity that may contribute to its survival (Cronk, 1980). This plasticity is evident when comparing individuals amongst the *Bambusa* sp. near the summit with those on the more open *Paspalum* grassland. The former tends to be smaller and darker, whereas the latter are lighter in colour and larger. Sampled specimens varied from 30 mm to 1850 mm in length, 50% with sporangia. Floristically the two areas appear very different, the *Bambusa* site at the summit (Plate 12) includes *Christella dentata* (Forssk) Holttum., and *Clidemia hirta* (L.) D.Don. as frequent associates, and *Piper aduncum* Mayc., *Podocarpus falcata* A.Cunn., *Alpinia zerumbet* (pers.) Burtt and Smith, and *Xiphopteris ascensionense* as casual associates. The *Paspalum* grassland on the weather side is dominated by *Paspalum scrobiculatum* L.. Other prominent species found here include *Lycopodium cernuum* Linn., *Histiopteris incisa* (Thunb.) J. E. Sm., (both indigenous), *Ageratum conyzoides* L., *Rubus rosifolius* J.Sm., *Clidemia hirta*, and *Centella asiatica* (L) Urban (for other species see target notes below). The two distinct communities containing *Marattia purpurascens* are characterised not only by their differing vegetation but also in topography and site microclimate. The weather side is steeper and more exposed, whilst the summit is possibly more humid, being sheltered from climatic effects of the trade winds and solar input by the dense bamboo stand. The weather side of the mountain appears to be the most diverse community of Ascension in terms of species richness, although this diversity is due to the inclusion of many introduced species. It is likely however, that this area has always been the most species rich area of Ascension due to the high level of available moisture.

Threats to the survival of *Marattia Purpurascens*: There do not appear to be any immediate threats to the persistence of *M. purpurascens*. Longer-term threats are more difficult to detect and only by implementing long term monitoring will they become apparent. The survival of *M. purpurascens* is dependent on its ability to compete with introduced vegetation. Certainly over the past twenty years no great changes in distribution are apparent, implying competitive ability. Some plants do appear to be grazed by sheep but this is not a widespread or common occurrence and does not appear to be contributing to mortality. Large-scale habitat destruction would be disastrous for the localised populations, however, this seems unlikely at present.

6). ***Sporobolus caespitosus*** (Plate 2)

Status: **Endangered C 2a**

Distribution and community structure: Figure 3 illustrates the distribution of *S. caespitosus* as found by the expedition. It can be seen that *S. caespitosus* is found between 730m and 760m on the weather side of Green Mountain (see target notes also). The expedition recorded an apparent population increase from 70 tufts (Cronk, 1980) to over 300 tufts in seven small sites. This apparent population expansion is more likely to be due to previous under recording rather than a true increase in population extent, as the majority of new recordings were in extremely inaccessible areas. Further finds should not be ruled out, although these are likely to be in extremely inaccessible areas not searched by the expedition. The former range of this species may have been greater than it is today and the introduction of exotic species, particularly *Melinis minutiflora* and *Sporobolus africanus* (Poir) Robyns and Tournay, are likely to have contributed to this reduction in distribution. Of the areas identified as containing *S. caespitosus*, the largest single study site had more than 250 individuals, highlighting the fact that other sites contain very few individuals. Specimens varied in height from 10 to 100 mm. Only one old inflorescence was found and most of the specimens examined were not in flower at the time of survey. *S. caespitosus* inhabits the vertical or near vertical cinder walls and sloping cinder banks of Green Mountain but always where very few other species are present, and seems to be adapted to the exposed conditions found at these sites (Cronk 1980). Competition for available water may be the most important factor for the plants that inhabit these areas. The loose community of plants can be characterised not only by *S. caespitosus* but probably more importantly by the bryophyte species and occasionally *Xiphopteris ascensionense*, although the specimens located here lack the luxuriance of specimens found amongst the *Bambusa* sp.. The vegetation found here may be the closest representation of indigenous plant communities left on Ascension, although the status, native or otherwise, of the bryophyte species requires further investigation. Bryophytes recorded here include *Calymperes erosum* Müll.Hal. det. L.T. Ellis, *Mastigophora diclados* (Brid.

ex Web.) Nees det R. Grolle, *Anastrophyllum piligerum* (Nees) Steph. det. R. Grolle, and as yet undetermined *Campylopus* sp. and *Bryum* sp.. Other species found within this community include the introduced *Begonia hirtella* Link., *Wahlenbergia procumbens* D.C., and as a casual associate *Oxalis corniculata* Linn.. The *S. caespitosus* and *Asplenium ascensionis* sites are in close proximity in some areas and may indicate similar ecological conditions. However, *S. caespitosus* sites are characterised by a more exposed situation than the more sheltered *A. ascensionis*.

Threats to the survival of *Sporobolus caespitosus:* The species poor community of *S. caespitosus* appears to be under pressure from the surrounding introduced vegetation. Of particular note are the grasses *Sporobolus africanus*, *Melinis minutiflora*, and *Paspalum conjugatum* Berguis, which may be capable of encroaching on endemic sites, especially windy corner on Elliot's Path. Monitoring may be necessary to identify if encroachment is occurring at these populations. Erosion of the loose volcanic substrate may also represent a threat contributing to local mortality, however, it is equally possible that disturbance may be a factor in the persistence of *S. caespitosus* by denying the stability required by introduced species.

7). *Xiphopteris ascensionense* (Plate 3)

Status: **Lower Risk/nt** (Vulnerable D2)

Distribution and community structure: *X. ascensionense* was found from around 700 m to the summit of Green Mountain (see Figure 3) and is also located in certain sites of the *S. caespitosus* community. The most luxuriant specimens were observed amongst bryophytes, on the nodes of *Bambusa* sp. at the summit of Green Mountain. Bryophyte species found here include *Microlejeunea ulicina* (Taylor) A.Evans det. R. Grolle, *Calymperes erosum* Müll.Hal. det. L.T. Ellis, and as yet undetermined *Campylopus* and *Riccardia* spp.. These smaller epiphytic communities would seem to be dependent on the continuation of the stand of *Bambusa* and the moisture that this attracts (Cronk, 1980). As such, this population would seem to be fairly stable as long as suitable conditions remain. The height of most of the epiphytic communities amongst the *Bambusa* made them difficult to survey (> 5 m). Fronds encountered ranged from 5 mm to 105 mm in length, with approximately 40% bearing sporangia.

Threats to the survival of *Xiphopteris ascensionense*: *X. ascensionense* appears to benefit from the increased humidity on the summit of Green Mountain (Cronk 1980). Gradual long-term changes may be more important than immediate threats, as none were perceived. Long-term threats may include encroachment of *Alpinia zerumbet* (Plate 13), which appears to have spread over recent years (D Henry, pers. com 1998). This is of some concern since *Xiphopteris ascensionense* does not appear to grow on or amongst *A. zerumbet*. Long-term monitoring of *A. zerumbet* may establish if encroachment is occurring. Rapid catastrophic changes could be equally disastrous for *X. ascensionense* such as changes or disappearance of the stand of bamboo. It is therefore advisable to determine the exact species of *Bambusa* and timing of planting given the reproductive biology of bamboo. This may help to make informed management decisions about this site to ensure long-term survival of *X. ascensionense*.

8). *Asplenium ascensionis* (Plate 6 and 7)

Status: **Lower Risk/nt** (qualifies for Vulnerable D2)

Distribution and community structure: This is perhaps the most widespread of all the endemic species. Although localised to the Green Mountain area, it can be the dominant species where it occurs. Figure 4 (see target notes also) illustrates the distribution of *A. ascensionis* as recorded during the survey. Our findings appear to concur with those of Cronk (1980) and *A. ascensionis* seems to be able to persist with introduced vegetation in species poor communities. Frond length varied from 10-400 mm, although the majority were less than 220 mm. Over 70% of the fronds sampled bore sporangia. However, *A. ascensionis* is no longer found as a component of the ground vegetation and few specimens attain the large size of Hookers collection (Cronk, 1980), and has therefore suffered reduction in distribution to some extent. The community structure and habitat are similar to that of *S. caespitosus* and both communities are found in close proximity. However, *A. ascensionis* inhabits stone as well as cinder walls and is found in more sheltered locations that are rarely completely exposed to solar radiation. Species commonly associated with *A. ascensionis* include *Christella dentata* (usually stunted) and *Adiantum capillus-veneris* L., both introduced species. Casual species found locally include *Opuntia* sp., *Centella asiatica*, *Rubus rosifolius*, *Ageratum conyzoides*, *Nephrolepis hirsutula* (Forsst.) Presl., and *Commelina nudiflora* Linn.. Available water is likely to be an important factor to the species that inhabit these rocky, near-vertical areas.

Threats to the survival of *Asplenium ascensionis*: *A. ascensionis* appears to persist well where present, being the dominant species in some areas. Changes in the distribution of *A. ascensionis* are likely to be spread over long time-periods. It is interesting to note the local abundance of *Adiantum capillus-veneris* in suitable habitat for *A. ascensionis*. An expansion of the introduced *A. capillus-veneris* may represent a threat to *A. ascensionis*, although mutual co-existence may also be conceivable. Long-term monitoring would allow the determination of *A. capillus-veneris* as a pervasive threat.

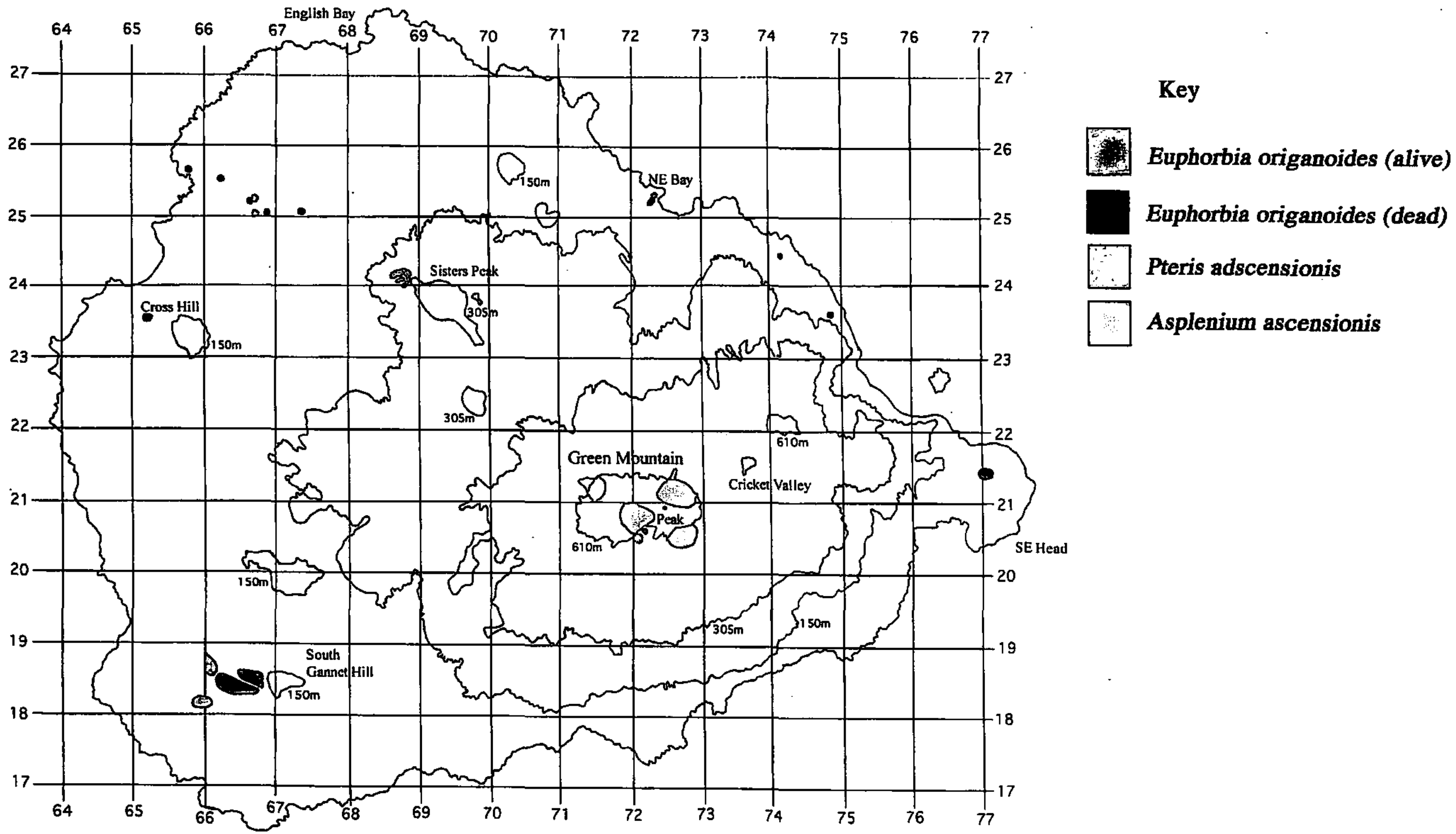


Figure 4: The distribution of *Asplenium ascensionis, Euphorbia origanoides* and *Pteris adscensionis* as recorded by the Ascension '98 Expedition. Areas shown are approximate and do not reflect the true population extent. For further populations identified, refer to target notes.

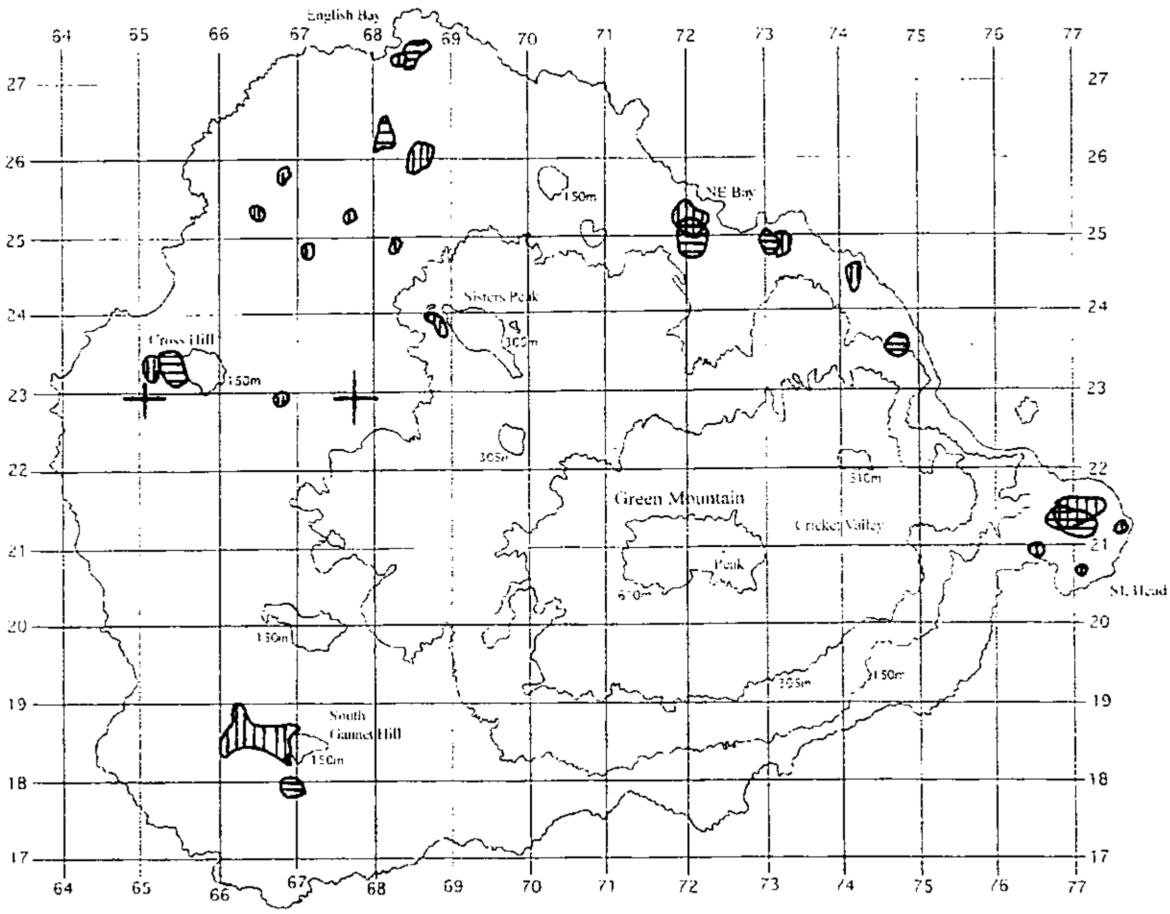


Figure 5: The distribution of *Euphorbia origanoides* as recorded by the Cronk (1980) (vertical hatching), Duffey (1964) (horizontal hatching), and Rudmose Brown (1904) (crosses) re-drawn from Cronk (1980).

9). *Euphorbia origanoides* (Plates 8, 9 and 10)

Status: **Endangered B1+3cd**

Distribution and community structure: *E. origanoides* is found on the dry lava plains of the island from almost sea level to 310 m. This species is characterised by inhabiting the most xeric areas of the island. The distribution of this species as recorded by the expedition is somewhat different from that found by Duffey (1964) and Cronk (1980). Figure 4 illustrates the distribution as found by the expedition. By comparison to Figure 5, the distribution as recorded by Duffey (1964) and Cronk (1980), it can be seen that there appears to be a reduction in its distribution. The reductions are most noticeable in the Cross Hill, English Bay, North-East Bay, and Letterbox (South-East Head) areas. The apparent loss of some sites is most probably due to the absence of rain prior to the expedition. Fluctuations in distribution seem to be characteristic of *E. origanoides*, for example, the colony found at Mars Bay by Duffey in 1958 was not recorded by Cronk (1980), although this colony was again recorded in 1998. The ephemeral nature of *E. origanoides* seems to be a result of intermittent precipitation, the rapid infiltration capacity of the substrate, and higher temperatures. Stochastic rainfall events would therefore appear to lead to the germination, flowering and seed set of *E. origanoides*. The reduced distribution of living plants is initially of some concern as this may be part of a prolonged decline. Nevertheless, as the observed number of seed shed was very high, and as seeds can be found in many areas where no living plants are present, such as Comfortless Cove, a resurgence in *E. origanoides* populations may result as favourable conditions return. Species associated with *E. origanoides* include the introduced *Waltheria indica* L., *Enneapogon cenchroides* (Roem. et Schult.) C. E. Hubbard, *Prosopis juliflora* (Sw.) D. C. and the indigenous *Aristida adscensionis* Linn. The appearance of these communities is characterised by evenly spaced, species poor vegetation restricted in distribution by available water. The Sisters Peak community differs from those found at Mars Bay/South Gannet Hill in being extremely species poor. This may be due to the more exposed nature of this area compared with the relatively sheltered conditions of Mars Bay/South Gannet Hill. Over 90% of the *E. origanoides* specimens encountered were in flower, ranging in height from 20 to 280 mm and up to 800 mm in diameter. Only smaller specimens had no flowers, indicating that continual flowering and seed set are characteristic of the species reproductive biology.

<u>Threats to the survival of *Euphorbia origanoides:*</u> Factors likely to be important to the survival of *E. origanoides* include the number of viable seeds produced, the number of viable seeds present in the seed bank, survival rate of seeds, seed dormancy characteristics and the duration between rain events. *E. origanoides* connection to intermittent rainfall events may indicate vulnerability if periods of drought are persistent. This may be more serious if other species have established in areas where *E. origanoides* was historically the dominant vegetation. The presence of *Prosopis juliflora* represents the most serious threat in this respect (Plate 11). This species can spread very rapidly and is very efficient at commanding available ground water with a root depth of over 10m. The distribution of *P. juliflora* at present in the *E. origanoides* areas is limited. This will undoubtedly increase, especially as sheep and donkeys provide efficient vectors for seed dispersal. Control of *P. juliflora* at these sites should be implemented immediately if the perceived threat to *E. origanoides* is to be prevented. Measures should be implemented to ensure that extinction of the island's populations, in a habitat where survival is already marginal, is not exacerbated by the absence of rain and presence of *P. juliflora*. Biological control as suggested by Fowler (1998) should be seen as an aid to the eradication of *P. juliflora* and

should be accompanied by physical removal of *P. juliflora* from *E. origanoides* areas.

Cronk (1980) states that the cottony-cushion scale *Icerya purchasi*, Mask., introduced via *Causarina equisetifolia* L., represented a threat to *E. origanoides*. Biological control, introduced in 1976, appears to have had some effect. However, there has been no consistent surveillance. Consequently *I. purchasi* must still be considered a potential threat to *E. origanoides* (Pickup, 1998).

10). *Pteris adscensionis* (Plate 5)

Status: **Critically Endangered C2a**

<u>Distribution and community structure:</u> The distribution of *Pteris adscensionis* has been drastically reduced, and it is now almost totally confined to Cricket Valley at 460 m (Plate4). A few small outlying individuals within Breakneck Valley at approximately 520 m present the only other populations on the island. These fragmented populations occupy areas climatically intermediate between the lava plains of *E. origanoides* and the summit of Green Mountain. Although *P. adscensionis* did once occupy the summit, this species has completely disappeared from the vegetation of this area. The expedition increased the recorded numbers of this species from around 20 (Cronk, 1980) to over 100 individuals; most likely due to previous under recording rather than an actual increase in population size. The largest single colony is located in Cricket Valley and consists of approximately 80 plants. This community is characterised by the presence of a *Psidium guajava* L. canopy, typical of the Cricket Valley area. The ground flora is rather sparse but important species include some bryophytes and a species of *Cyperus* yet to be determined, and *Clidemia hirta*. Other casual species associated with *P. adscensionis* include *Ageratum conyzoides*, *Opuntia* sp., *Passiflora suberosa* Linn., *Oxalis corniculata* and *Asplenium ascensionis*. In Breakneck Valley, individuals are found in the cracks of vertical scoria cliffs, with few other species present. Fronds encountered varied from 100 mm to 820 mm with the majority less than 520 mm, approximately 70% of these fronds bore sporangia.

<u>Threats to the survival of *Pteris adscensionis*:</u> The long-term survival of this species is in serious doubt with only small fragmented populations present. Population sizes have reached critical levels and it is probably the most threatened plant species on the island. Introduced taxa are the most immediate threat to this species and urgent action is required to ensure the

survival of the species. Genetic erosion must also be considered a longer term threat to this species survival.

5. CONSERVATION OF THE ENDEMIC VASCULAR FLORA OF ASCENSION ISLAND

The following section details areas of research and concern, which we consider important aspects for the conservation of the endemic species of Ascension Island. We begin by considering population genetics and options for genetic conservation. Specific conservation proposals are then considered and the section ends with specific action plan objectives and targets for each of the species. It is important to recognise that what is presented below represent conservation ideals. However, due to funding constraints, and logistic and practical considerations, it is unlikely that all proposals will be realised. It will therefore be for those who implement the proposals on the ground to separate proposals which are realistic, necessary, and achievable, from those which cannot be resourced. The following list, although not comprehensive, indicates the audience that should be sought with regard to the conservation of the endemic species of Ascension Island.

- Ascension Island Administration.
- Royal Air Force, Ascension.
- United States Air Force, Ascension.
- Cable and Wireless, Ascension.
- British Broadcasting Corporation, Ascension.
- Green Mountain Farm Manager.
- NGO's e.g. Flora and Fauna International and Bird Life.
- University Botany/Ecology departments e.g. University of Edinburgh, UK.
- Botanic Gardens such as Royal Botanic Garden Edinburgh and Kew, UK.
- South Atlantic Working Group.

Population Genetics

In considering the survival of small populations, it is necessary to discuss the genetic viability of the populations. Given that the populations of the endemic species are now small and fragmented, such consideration is increasingly important. Research should seek to elucidate the extent of genetic variability and exchange between and within populations.

The extent to which genetic diversity has changed amongst the surviving species is unknown at present since no genetic research has been conducted. If these populations are to remain viable then information on genetic diversity and genetic exchange is required to guide conservation, as any programme should seek to conserve all levels and patterns of genetic variation (Spencer, 1997). This information is necessary in attempting to avoid populations suffering from genetic drift, inbreeding depression or a reduction in heterozygosity.

Patterns of variation in plants depend on the breeding system, reproduction biology and life history of the plants; the history, size and degree of isolation of local populations; and natural selection (Kay and John, 1997). In chronically small populations lack of genetic variation may prevent adaptive responses to changes in abiotic or biotic environmental conditions and predispose the population to extinction (Ennos *et al*, 1997). Conservation measures implemented without first considering the genetic variation within species and between populations may be in vain. The endemic plants of Ascension are little studied and so research is necessary to guide the conservation management of the endemic species.

Options for genetic research

Two broad techniques may be useful in analysing the genetic variation of the Ascension Island endemics. Firstly, molecular techniques can rapidly give a means of assessing the genetic variation within and among populations. These methods can also be used to compare related species and clarify taxonomic relationships. Molecular techniques may be useful for analysing the evolutionary patterns of the Ascension endemics and taxonomic relationships with closely related species, for example from Africa. Secondly, quantitative genetic techniques can be used to determine the level of variation in adaptive characters. These are measured because there is a direct relationship between the level of genetic variation for adaptive characters and the ability of a population to respond to selection (Ennos *et al*, 1997). This technique relies on growing plants from different populations in a common environment, as the resulting phenotypic variation arises through genetic variation rather than from any environmental differences. We have already detailed that a few of the endemics no longer show the luxuriance of past specimens. Whether this is a result of decreased genetic variation or a response to changing environmental factors might be investigated using this technique. It may also highlight differences between populations, thus directing conservation action.

The fact remains that very little is known about the genetic variation of the Ascension endemic species, this should be considered at some stage during any conservation programme in order to ensure that the all levels of variation in adaptive characters are conserved and that finite resources are not wasted.

Conservation Proposals

The inherent aim of our expedition was to gather information on the endemic flora, providing both stimulus and reasoning for conservation action. The geographical location and botanical history of Ascension Island ensures that conservation practices on the island will always be required; the results presented here go some way to highlight areas where it is most necessary.

The main threat to the islands endemic flora is the high number and widespread and increasing distribution of exotic plants. The continuing decline of Ascension's endemic plants is exacerbated by poor competitive ability (Cronk 1980) resulting from evolution in species poor communities. The situation on Ascension Island is one of an increasingly competitive environment through the increases in distribution of exotic species. Adaptation to competition occurs over a very long time period (Usher, 1997). The island's endemic species have had little over 100 years to adapt to the introduction of many new vigorous species whose competitive adaptations have evolved elsewhere in more species rich environments. Introduced species often flourish on islands such as Ascension as they arrive in an environment free of natural enemies, termed the exaggeration of ecological release (Cronk and Fuller, 1995). For example, *Melinis minutiflora* seems to benefit from low levels of herbivory (Duffey, 1964), and its expansion has been to the detriment of *Sporobolus durus* and *Sporobolus caespitosus*. This and the small size of Ascension compounds the impact of exotic species. The small area of the island means that dispersal distance for propagules is reduced allowing rapid colonisation in any suitable area. This may be particularly pertinent in the case of *Prosopis juliflora*. The geographical location, area, lack of specialist plant herbivores and efficient mammal vectors for seed transport (*P. juliflora*) allows the expansion of exotic species and results in the decrease of the existing refugia for endemic plants. There is thus a strong emphasis on intervention in order to aid the endemic species of Ascension to persist. The exotic species represent a long term or pervasive threat (Cronk and Fuller, 1995), as they cannot now be removed from the island, however, without intervention the spread will continue. The following conservation proposals fall into two broad areas, *ex-situ* and *in-situ*, and are summarised as follows:

Ex-situ

- Continued research (e.g. genetics and taxonomy).
- Seed banks.
- Breeding programmes.

In-situ

- Plant breeding programmes.
- Plant, distribution, habitat, and community surveys.
- Education to raise awareness of conservation, scientific and local communities.
- Habitat and species inventory, mapping and monitoring (GIS).
- Active conservation measures e.g. removal of *P. juliflora*.

Ex-situ measures should only be used where the provision of *in-situ* measures is difficult or impossible to carry out. In cases where low level intervention and habitat management is not sufficient to safeguard the endemic populations, *ex-situ* measures can provide opportunities to conduct ecological experiments or to prevent deterioration in genetic stock (Fleming and Sydes, 1997). Small fragmented populations of rare plants, such as those of Ascension Island, are subjected to genetic processes that may well result in a loss of genetic variability and a subsequent decline in fitness of future generations (Fleming and Sydes, 1997). This decline in fitness means the populations are weakened and more susceptible to changing environments such as drought, or increased competition from advancing exotics. One possible way to minimise this and to safeguard populations is to develop breeding programmes for endemic species. Such a programme could allow manipulative experiments to be conducted such as quantitative genetic experiments. This information could then be used in a direct habitat management programme. Ideally, the breeding programmes should be situated on the island, as it would benefit from close proximity to any habitat management programmes and a more natural growing environment. This may not be possible but whether breeding programmes are initiated on Ascension or elsewhere, close co-operation with relevant botanic gardens should be sought.

Education

There is a need for increased awareness of the plight of the unique flora on Ascension Island. A greater understanding amongst all people on the island will provide them with reasoning for conservation work. Whilst we are aware of the transient nature of a large part of Ascension's population this should not be seen as reason not to empower people with information. There is a justifiable pride on the part of the islanders in any mention of the Green Turtles, a similar pride in the presence of endemic plants is not implausible. One simple way of increasing awareness would be to put in place a number of information boards near endemic sites drawing attention to their habitat and threats. As recognition of the plight of the endemic species is gained, the potential for the loss of these species through ignorance alone is diminished, and the opportunity for improved and continuous monitoring is enhanced.

The development of an endemic plant breeding programmes may also provide opportunities for education of both children and adults on the island. If local people can be encouraged to assist in the development, implementation and evaluation of the programme, it would provide them with a tangible experience of conservation and help to highlight the importance of their endemic flora.

Monitoring

Continuous and extensive monitoring of both flora and fauna is a basic requirement for any conservation programme, and whilst there have been occasional visits assessing the islands wildlife, these visits do not constitute a monitoring programme. Definition of what we consider monitoring to be is also important. We define monitoring as; *intermittent surveillance carried out in order to ascertain the extent of compliance with a* ***pre-determined standard,*** *or degree of deviation from an expected norm* (Hellawell, 1991). Surveillance is defined as repeated observations over time.

The standard for monitoring each species needs to be bound by limits of acceptable change, which once crossed, necessitate intervention. In the case of the Endemic flora of Ascension, the limits of acceptable change are defined as the population size and distribution as recorded by this expedition. These limits of acceptable change are rigid and do not incorporate any natural fluctuations in the population size or distribution. This is necessary at present because further reduction in population size is likely to result in extinction for many of the species, and because necessary ecological information on the occurrence or periodicity of naturally occurring fluctuations is currently unavailable. We should, therefore, err on the side of caution.

There is a strong need to establish continuous monitoring of particular species such as *E. origanoides* and *P. adscensionis* at least every 3 years, as these would appear to be most at risk. Monitoring should also be directed towards introduced species perceived as a threat, current or potential, to the endemic species. For instance, the gradual spread of *Alpinia zerumbet* into *Marattia purpurascens* sites should be recorded and action taken when and where required. Surveillance of the mammal populations in particular sheep and donkeys, may be useful in planning the maintenance of *E. origanoides* populations as the spread of *P. juliflora* is ultimately linked to the 'range' of these herbivores.

In an effort to encourage monitoring, seven permanent quadrats and fixed point photography sites have been set up to asses five different endemic plants (see Appendix 3). Three of these concern *Asplenium ascensionis*, and one each for *Sporobolus caespitosus*, *Marattia purpurascens*, *Pteris adscensionis* and *Euphorbia origanoidés*. Although this does not constitute a comprehensive monitoring programme, especially considering the definition of monitoring chosen, it may constitute a base from which such a monitoring programme could be implemented. The inability of this expedition to construct a comprehensive monitoring programme was partly due to time constraints as permanent quadrats were set up on the eve of departure.

Active measures regarding *Prosopis juliflora*

At present the invasive species *P. juliflora* poses a very real threat to *E. origanoides*. Whilst complete eradication of this species may no longer be possible, the threat to *E. origanoides* could be minimised by a combination of careful monitoring and direct action. Due to the changing nature of the distribution of *E. origanoides* populations, all potentially suitable sites and historical sites should be continually monitored and any *P. juliflora* plants should be eradicated from these areas, establishing a network of *P. juliflora* free zones. Re-invasion from other areas presents a continual threat, hence the need for continual monitoring. It may be prudent to implement the use of fencing to ensure that grazing mammals cannot transport seeds into these *P. juliflora* free zones. Biological control cannot be solely relied upon to eradicate *P. juliflora* since it is intended as a control technique of already established populations (Fowler, 1998). When necessary, individuals should be removed, the roots grubbed out and fallen seeds cleared from the area (Cronk & Fuller, 1995). These sites should then be re-surveyed intermittently to ensure that no *P. juliflora* plants re-sprout. (See also Fowler, 1998 and Pickup, 1998, for further measures).

Establishment of a Floral Database

Contemporary distribution data is necessary to guide any conservation programme necessitating the establishment of a comprehensive biological database incorporating the known distribution of all species on the island. This information, if continually up-dated, can help to guide monitoring programmes, aid future rationale and conservation decisions, as introductions of exotic species to the island are unlikely to cease. In the opinion of Given (1994), for critically threatened species in very small populations the spatial relationship of plants can be mapped; general notes should be taken on the condition, size classes, and reproduction, of individual plants and on physical and biological characteristics of the site. Photographs of the whole site habitat and selected individuals should also be standard procedure. A Geographical Information System (GIS), allows information of this type to be stored and retrieved in a comprehensive database and is useful in devising conservation prescriptions and guiding proposals. For example, it would be possible to highlight all known *E. origanoides* sites threatened by the presence of *P. juliflora*. This type of information can then be used to guide conservation management and keep *E. origanoides* sites free of *P. juliflora*. Therefore, it is recommended that a GIS database be established on Ascension Island to collate and disseminate information for conservation management.

6. CONCLUSIONS

- The endemic vascular flora of Ascension Island has undergone dramatic changes in the last century. These changes have mostly been negative.

- The most likely factor responsible for the decline of these species is the mass introduction of exotic plants.

- Of the ten endemic species four are believed extinct and of the six presently extant only two, *Marattia purpurascens* and *Xiphopteris ascensionense*, are considered under no immediate threat.

- Species most at threat of extinction are, *Pteris adscensionis* vulnerable because of small population size, and *Euphorbia origanoides* due to the spread of *Prosopis juliflora*.

- *Sporobolus caespitosus* and *Asplenium ascensionis* appear to be under less immediate threat of extinction but are vulnerable to long term changes and replacement by invasive exotic species.

- Unless direct action is taken to halt the current spread of the introduced species, continual decline of endemic populations seems likely.

The expedition objective was not only to investigate the endemic species, but also contribute to their conservation. In attempting to achieve this, and initiate a conservation programme aimed at preventing the extinction of the endemics, we present species action plan objectives and targets, in the next section.

7. SPECIES ACTION PLANS: OBJECTIVES AND TARGETS

The following objectives and targets are based on the findings of the expedition and as such represent ideals. However, they provide a basis from which species action plans can be developed for each of the endemic species. We have attempted to be as comprehensive as possible but inevitably some may feel that these are too comprehensive or that we have omitted vital aspects. It is hoped that these aspects and considerations will form the basis of future discussions on the conservation of the endemic species.

Species regarded as extinct are considered together as objectives and targets are the same. Although many targets and objectives are similar for all extant species, each one is considered separately.

1) Extinct Species: *Oldenlandia adscensionis, Sporobolus durus, Dryopteris adscensionis and Anogramma ascensionis.*

a) Main objective

- Establish if any individuals of these species are extant.

b) Main target

- Establish status of species beyond reasonable doubt within a period of 10 years.

c) Work objectives

- Survey suitable habitat areas for each of the above species particularly after periods of rain.

d) Work targets

- Conduct yearly surveys coincident with periods of rainfall in all suitable habitat areas for a period of 10 years.

2) *Marattia purpurascens*

a) Main Objectives

- Maintain and enhance the present populations of *M. purpurascens*.
- Ensure the long-term viability of the present and future populations.

b) Main Targets

- Maintain and enhance the present population size on the weather side and on the summit.
- Instigate scientific research within 10 years.

c) Work Objectives
- Instigate genetic research into the taxonomic status and the genetic variation of *M. purpurascens*.
- Instigate research into the ecology of *M. purpurascens* to guide management practice.
- Monitor present and future populations.
- Initiate research to identify feasibility of expanding present populations.
- Establish spore bank.
- Establish nursery to grow plants for future population expansion.
- Investigate taxonomy of *Bambusa* sp. on the summit.
- Monitor *Alpinia zerumbet* on the summit with a view to establishing if this species is expanding.

d) Work Targets
- Conduct feasibility survey and identify sites for population expansion within 5 years.
- Collect spores and establish spore bank from all extant populations within 1st year.
- Establish nursery and grow plants on as *in/ex situ* populations.
- Establish plants at population expansion sites by natural means and/or from nursery populations within 5 years.
- Monitor populations every year for 5 years to evaluate management.
- Instigate genetic research into the taxonomic status and the genetic variation of *M. purpurascens* within 10 years.
- Instigate research into the ecology of *M. purpurascens* to guide management practice within 10 years.
- Investigate taxonomy of *Bambusa* sp. on the summit within 5 years.
- Monitor *Alpinia zerumbet* on the summit every 3 years with a view to establish whether this species is expanding.

3) __Sporobolus caespitosus__

a) Main Objectives
- Maintain and enhance the present populations of *S. caespitosus*.
- Ensure the long-term viability of the present and future populations.

b) Main Targets
- Maintain and enhance present populations within 5 years.
- Instigate scientific research within 10 years.

c) Work Objectives

- Instigate genetic research into the taxonomic status and the genetic variation of *S. caespitosus*.
- Instigate research into the ecology of *S. caespitosus* to guide management practice.
- Monitor present and future populations.
- Initiate research to identify feasibility of expanding present populations.
- Establish seed bank.
- Establish nursery to grow plants for population expansion.

d) Work Targets

- Conduct feasibility survey and identify sites for population expansion within 5 years.
- Collect seeds and establish seed bank from all extant populations within 1st year.
- Establish nursery and grow plants on as *in/ex situ* populations within 5 years.
- Establish plants at population expansion sites by natural means and/or from nursery populations within 5 years.
- Monitor populations every year for 5 years to evaluate management.
- Instigate genetic research into the taxonomic status and the genetic variation of *S. caespitosus* within 10 years.
- Instigate research into the ecology of *S. caespitosus* to guide management practice within 10 years.

4) ***<u>Xiphopteris ascensionense</u>***

a) Main Objectives

- Maintain and enhance the present populations of *X. ascensionense*.
- Ensure the long-term viability of the present and future populations.

b) Main Targets

- Maintain and enhance present populations within 5 years.
- Instigate scientific research within 10 years.

c) Work Objectives

- Instigate genetic research into the taxonomic status and the genetic variation of *X. ascensionense*.
- Instigate research into the ecology of *X. ascensionense* to guide management practice.
- Monitor present and future populations.
- Initiate research to identify feasibility of expanding present populations.
- Establish spore bank.

- Establish nursery to grow plants for population expansion.
- Investigate taxonomy of *Bambusa* sp. on the summit.
- Monitor *Alpinia zerumbet* on the summit every 3 years with a view to establish whether this species is expanding.

d) Work Targets

- Conduct feasibility survey and identify sites for population expansion within 5 years.
- Collect spores and establish spore bank from all extant populations within 1st year.
- Establish nursery and grow plants on as *in/ex situ* populations within 5 years.
- Establish plants at population expansion sites by natural means and/or from nursery populations within 5 years.
- Monitor populations every year for 5 years to evaluate management.
- Instigate genetic research into the taxonomic status and the genetic variation of *X. ascensionense* within 10 years.
- Instigate research into the ecology of *X. ascensionense* to guide management practice within 10 years.
- Investigate taxonomy of *Bambusa* sp. on the summit within 5 years.
- Monitor *Alpinia zerumbet* on the summit with a view to establishing if the species is expanding every 3 years.

5) <u>Asplenium ascensionis</u>

a) Main Objectives

- Maintain the present populations of *A. ascensionis*.
- Ensure the long-term viability of the present and future populations.

b) Main Targets

- Maintain present population size and ensure no decrease in the next 5 years.
- Instigate scientific research within 10 years.

c) Work Objectives

- Instigate genetic research into the taxonomic status and the genetic variation of *A. ascensionis*.
- Instigate research into the ecology of *A. ascensionis* to guide management practice.
- Monitor present and future populations.
- Initiate research to identify feasibility of expanding present populations.
- Establish a spore bank.
- Establish nursery to grow plants to ensure conservation of present populations.

d) Work Targets

- Conduct feasibility survey and identify sites for population expansion within 5 years.
- Collect spores and establish spore bank from all extant populations within 1st year.
- Establish nursery and grow plants on as *in ex situ* populations within 5 years.
- Establish plants at population expansion sites by natural means and/or from nursery populations within 5 years.
- Monitor populations every year for 5 years to evaluate management.
- Instigate genetic research into the taxonomic status and the genetic variation of *A. ascensionis* within 10 years.
- Instigate research into the ecology of *A. ascensionis* to guide management practice within 10 years.

6) Euphorbia origanoides

a) Main Objectives

- Maintain and enhance the present populations of *E. origanoides*.
- Ensure the long-term viability of the present and future populations.

b) Main Targets

- Maintain and enhance present populations within 5 years.
- Instigate scientific research within 10 years.

c) Work Objectives

- Instigate genetic research into the taxonomic status and the genetic variation of *E. origanoides*.
- Instigate research into the ecology of *E. origanoides* to guide management practice.
- Monitor present and future populations.
- Initiate research to identify feasibility of expanding present populations.
- Establish a seed bank.
- Establish nursery to grow plants for population expansion.
- Establish *Prosopis juliflora* free zones to ensure the continuing survival of *E. origanoides*.

d) Work Targets

- Conduct feasibility survey and identify sites for population expansion within 5 years.
- Collect seeds and establish seed bank from all extant populations within 1st year.

- Establish nursery and grow plants on as *in/ex situ* populations within 5 years.
- Establish plants at population expansion sites by natural means and/or from nursery populations within 5 years.
- Monitor populations every year for 5 years to evaluate management.
- Instigate genetic research into the taxonomic status and the genetic variation of *E. origanoides* to guide management practice within 10 years.
- Instigate research into the ecology of *E. origanoides* to guide management practice within 10 years.
- Establish 5 *Prosopis juliflora* free zones to ensure the continuing survival of *E. origanoides* within 1 year expanding this to 10 free zones within 5 years. This may involve the use of fences to restrict the range of grazing mammals.

7) ***Pteris adscensionis***

a) Main Objectives
- Maintain and enhance the present populations of *P. adscensionis*.
- Ensure the long-term viability of the present and future populations.

b) Main Targets
- Maintain and enhance present populations within 5 years.
- Instigate scientific research within 10 years.

c) Work Objectives
- Instigate genetic research into the taxonomic status and the genetic variation of *P. adscensionis*.
- Instigate research into the ecology of *P. adscensionis* to guide management practice.
- Monitor present and future populations.
- Initiate research to identify the feasibility of expanding present populations.
- Establish a spore bank.
- Establish nursery to grow plants for population expansion.

d) Work Targets
- Conduct feasibility survey and identify sites for population expansion within 5 years.
- Collect spores and establish spore bank from all extant populations within 1st year.
- Establish nursery and grow plants on as *in/ex situ* populations within 5 years.
- Establish plants at population expansion sites by natural means and/or from nursery populations within 5 years.

- Monitor populations every year for 5 years to evaluate management.
- Instigate genetic research into the taxonomic status and the genetic variation of *P. adscensionis* within 10 years.
- Instigate research into the ecology of *P. adscensionis* to guide management practice within 10 years.

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9. APPENDIX 1: TARGET NOTES

The locations of the target notes are shown in Figure 7 and are identified using the following; **target note number, endemic species name, six figure grid reference, date, and altitude.**

1) Euphorbia origanoides **664 185 12.7.98 58m**
Near Wideawake Fairs on path to Mars Bay. Substrate dry ash and scoria. *Euphorbia origanoides* 50-60 clumps sporadic in distribution over a large area. Other species present include, frequent *Waltheria indica*, *Enneapogon cenchroides* occasional *Heliotropium* sp., and rare *Prosopis juliflora*. The *E. origanoides* also appeared to have many insects among the foliage.

2) Marattia purpurascens **726 208 13.7.98 762m**
Green Mountain, facing south west on the weather side. Amongst rank grasses and other shrubs, on a 60° slope frequent *Marattia purpurascens*. Other species include abundant *Paspalum scrobiculatum*, frequent *Clidemia hirta*, *Rubus rosifolius*, *Histiopteris incisa*, *Lycopodium cernuum*, and *Centella asiatica*. Bryophytes were rare on bare soil.
M. purpurascens showed some signs of being grazed where it could be reached from sheep tracks.

3) Marattia purpurascens **724 209 13.7.98 860m**
Xiphopteris ascensionense
Dew pond at the summit of Green Mountain occasional *Marattia purpurascens* (of a different habit and appearance, darker and smaller, than those on the weather side). Other species recorded include dominant *Bambusa* sp. frequent *Christella dentata*, occasional *Clidemia hirta* and *Alpinia zerumbet*. Also present was frequent *Xiphopteris ascensionense* as an epiphyte amongst the bryophytes on the nodes of the *Bambusa* sp.

4) Euphorbia origanoides **657 256 14.7.98 6m**
Small gorge near Comfortless Cove. Near five unmarked graves, occasional *Euphorbia origanoides*, 18, all dead on loose sandy soil, with large amounts of seed underneath the dead plants. Also present in the area were occasional *Enneapogon cenchroides*, and *Aristida adscensionis*, and rare scattered dead shrubs, possibly *Waltheria indica*. One healthy *Prosopis juliflora* bush 90 m from *E. origanoides* site. Rabbit droppings were also found in the vicinity.

***5) Xiphopteris ascensionense* 725 209 13.7.98 810m**
Weather side of Green Mountain. South west slope, frequent *Xiphopteris ascensionense* as an epiphyte amongst bryophytes on *Bambusa* sp. and *Vitex trifolia*. Other species in the field layer include frequent *Paspalum scrobiculatum*, *Clidemia hirta* and *Rubus rosifolius*.

***6) Asplenium ascensionis* 720 206 16.7.98 535m**
Breakneck Valley, on a shaded cliff face, in cracks and hollows from base of cliff to height of 8 m quite extensive clumps of *A. ascensionis*. Other species present on the cliff face included occasional *Christella dentata*, *Nephrolepis hirsutula*, *Begonia hirtella*, *Clidemia hirta*, *Ageratum conyzoides* and bryophytes; rare *Psidium guajava*, *Ficus* sp., *Opuntia* sp., *Psilotum nudum*. *Adiantum capillus-veneris*, and *Digitaria ciliaris*.

***7) Asplenium ascensionis* 721 207 16.7.98 535m**
Small rocky outcrop on path up Breakneck Valley, occasional *Asplenium ascensionis*, *Christella dentata*, *Clidemia hirta*, *Begonia hirtella*, rare *Nephrolepis hirsutula*, and *Plantago lanceolata*.

***8) Asplenium ascensionis* 720 207 16.7.98 580m**
Hollows of exposed cliff on Breakneck Valley path on either side of path occasional *Asplenium ascensionis* with frequent *Clidemia hirta*, occasional *Ageratum conyzoides*, *rare Centella asiatica*, and *Psilotum nudum*.

***9) Asplenium ascensionis* 718 208 16.7.98 610m**
Northern side of Breakneck Valley path, narrow gorge with caves at entrance, approx. 3 m high, with frequent *Asplenium ascensionis* over both sides of the rock face. Other species include occasional *Musa* sp., *Ageratum conyzoides*, *Christella dentata*, and *Begonia hirtella*.

***10) Euphorbia origanoides* 690 274 20.7.98 10m**
East of the BBC power station a few scattered dead specimens of *Euphorbia origanoides*, with some seed present. *Prosopis juliflora* also rare in the same area.

***11) Euphorbia origanoides* 666 185 20.7.98 60 -150m**
South Gannet Hill, steep slopes on ashy scoria of a small size, occasional *Euphorbia origanoides*. Other species in the same area include occasional *Waltheria indica*, *Leucaena leucocephala*, and rare *Argemone mexicana*. The *E. origanoides* plants to the south of the road were much healthier and more numerous than those to the north of the road.

12) Euphorbia origanoides **770 214 21.7.98 120m**
Letterbox, substrate extremely dry and wind-swept, loose gravel/scoria and fine dust underneath. Occasional dead *Euphorbia origanoides* no seed detected but may still be present. Species present included occasional *Waltheria indica, Cyperus* sp. and rare *Ageratum conyzoides*.

13) Euphorbia origanoides **689 240 22.7.98 320m**
Saddle to the north west of Sisters main peak. Substrate of a loose fine scoria and fine dust. Species present included occasional *Aristida adscensionis*, rare *Melinis minutiflora, Euphorbia origanoides* (4 small individuals) *Argemone mexicana*, and *Waltheria indica*.

14) Euphorbia origanoides **689 241 22.7.98 310m**
North north east of the main Sisters peak on the slope of secondary hump, with a substrate of loose scoria and fine dust, rare *Euphorbia origanoides*. All plants were young/small, 18 individuals. Other species in the vicinity include occasional *Aristida adscensionis* and *Waltheria indica*.

15) Euphorbia origanoides **687 241 22.7.98 305m**
North north east of Sisters main peak on loose scoria and fine dust on very end of buttress after Peak, rare *Euphorbia origanoides* (10 individuals counted). Motorcycle tyre tracks were seen close to plants.

16) Sporobolus caespitosus **725 211 23.7.98 730m**
Asplenium ascensionis
Elliot's Path on north-facing volcanic (loose) rock, occasional *Sporobolus caespitosus*. Other species on the vertical rock face include occasional *Begonia hirtella, Clidemia hirta, Borreria verticillata, Asplenium ascensionis, Ageratum conyzoides, Gnaphalium purpureum, Wahlenbergia procumbens, Paspalum conjugatum* and *Christella dentata*.

17) Asplenium ascensionis **726 209 23.7.98 760m**
Elliot's Path on a vertical rock cutting, abundant *Asplenium ascensionis* on the north facing side of cutting approximately 3.5 m deep. The rock is loosely held red volcanic porous material. Other species included occasional *Begonia hirtella*, and *Christella dentata*.

18) Sporobolus caespitosus **727 209 23.7.98 760m**
Xiphopteris ascensionense
Asplenium ascensionis
Windy Corner (see Figure 3) on Elliot's Path with a south-easterly aspect, occasional *Sporobolus caespitosus*, *Xiphopteris ascensionense*, and rare *Asplenium ascensionis*. Other species in the area include abundant *Sporobolus africanus*, frequent *Centella asiatica*, *Lycopodium cernuum*, *Begonia hirtella*, occasional *Psidium guajava*, *Plantago lanceolata*, *Borreria verticillata*, *Wahlenbergia procumbens*, *Paspalum conjugatum*, *Gnaphalium purpureum*, *Clidemia hirta*, and rare *Ageratum conyzoides*.

19) Asplenium ascensionis **723 208 23.7.98 730m**
South facing section of Elliot's Path on an exposed cliff face, occasional *Asplenium ascensionis*. Other species included occasional *Christella dentata*, *Begonia hirtella*, *Paspalum conjugatum*, *Wahlenbergia procumbens*, bryophytes, and rare *Ageratum conyzoides*.

20) Euphorbia origanoides **652 237 24.7.98 60m**
Near the bottom of Cross Hill facing Georgetown with a west north west aspect on small rocky outcrop of scree and loose scoria, rare *Euphorbia origanoides*, all dead, 8-10 individuals. Other species included occasional *Aristida adscensionis*, and *Enneapogon cenchroides*. Some *E. origanoides* seeds were present.

21) Euphorbia origanoides **661 188 24.7.98 90m**
Northern side of Cotar Hill on a 30° slope next to road to summit. On fine red scoria occasional *Euphorbia origanoides*, approximately 50 individuals. Associated species included rare *Waltheria indica*, *Heliotropium curavassium*, and dead *Enneapogon cenchroides*. Some *E. origanoides* were dying, but others were very healthy. Five more *E. origanoides* plants were found near the junction of the road to the dump approximately 15 m away from the road.

22) Euphorbia origanoides **660 183 24.7.98 85m**
Cotar Hill on a flat plain near fuel tanks, rare *Euphorbia origanoides* (all in flower), 6 clumps on eastern side of tanks and 30 on west side where the surface changes to larger scoria. Other species in the area include occasional *Waltheria indica*, rare *Leucaena leucocephala*, *Aristida adscensionis*, *Enneapogon cenchroides*, and an Asteraceae with large woody stem when mature.

23) Sporobolus caespitosus **728 209 26.7.98 700m**
Asplenium ascensionis

Approximately 20 clumps of *Sporobolus caespitosus* 10-15 m down from Elliot's path. Also nearby on rock occasional *Asplenium ascensionis*, on a 30° slope. Other species found in the vicinity included frequent *Psidium guajava*, *Christella dentata*, occasional *Sporobolus africanus*, *Rubus rosifolius*, *Wahlenbergia procumbens*, and *Begonia hirtella*.

24) Asplenium ascensionis **727 212 26.7.98 640m**

Rupert's path in a deep gorge with a large *Ficus Benjamin* tree at entrance, occasional *Asplenium ascensionis*. Other species in the same area included frequent *Adiantum capillus-veneris*, *Bryophyllum pinnatum* occasional *Begonia hirtella*, and *Psidium guajava*.

25) Sporobolus durus **740 222 29.7.98 595m**

Weather Post Hill site of previous records for *Sporobolus durus*. No *S. durus* present. The site must be considerably changed from when the species was last recorded (1889). Now showing signs of transition semi-natural woodland and grassland. Lee side mostly dominated by *Melinis minutiflora* (probably responsible for decline of *S. durus)* with frequent *Juniperus bermudiana*. Other species included occasional *Sporobolus africanus*, *Opuntia* sp., and *Psidium guajava*.

26) Pteris adscensionis **736 213 29.7.98 425m**

Cricket valley in a small crack in a vertical cliff face, *Pteris adscensionis*, one individual.

27) Pteris adscensionis **736 214 29.7.98 425m**

Cricket Valley on a vertical cliff face in a small crack, *Pteris adscensionis*, one individual. Other species included occasional *Ageratum conyzoides*, *Tecoma stans*, bryophytes were also frequent on the rocks.

28) Pteris adscensionis **736 215 29.7.98 425m**

Cricket Valley south east facing slope, vertical, on rocks above scree slope. *Pteris adscensionis* approx. five individuals, most were dried but a few green and healthy. Also two more plants further down on the eastern side of scree slope. Other species present were frequent *Psidium guajava*, lichens & bryophytes, occasional *Tecoma stans* and *Ageratum conyzoides*.

29) ***Pteris adscensionis*** **736 216 29.7.98 440m**
Asplenium ascensionis

On western side of a 40° slope of large boulder scree. *Pteris adscensionis* 5 plants, also some young emergent plants. Approx. 80% sporing. Other species present include occasional *Clidemia hirta, Tecoma stans, Nicotiana tabacum, Psidium guajava, Passiflora suberosa* and lichen. Another approx. 75 plants in a small gorge between two vertical cliff faces, facing south west on approx. 40° slope. Also present are occasional *Psidium guajava, Clidemia hirta, Ageratum conyzoides,* and *Cyperus* sp. Also rare *Asplenium ascensionis.*

30) ***Sporobolus caespitosus*** **727 206 3.8.98 700m**
Asplenium ascensionis

South east spur of Green Mountain on a 40° slope of volcanic rock *Sporobolus caespitosus*, eight plants. Other species present include frequent *Sporobolus africanus* and *Melinis minutiflora,* occasional *Clidemia hirta, Psidium guajava, Juniperus bermudiana, Ageratum conyzoides, Rubus rosifolius, Cyperus* sp., *Wahlenbergia procumbens, Begonia hirtella,* and *Oxalis corniculata,* with rare *Asplenium ascensionis.*

31) ***Euphorbia origanoides*** **730 250 27.7.98 30m**

North East Bay, south side. No *Euphorbia origanoides* present, but likely site once better conditions prevail. Species present include occasional *Prosopis juliflora, Heliotropium curavassium (dead) Waltheria indica (dead) Cyperus sp.,* and rare living *Heliotropium curavassium.*

32) ***Euphorbia origanoides*** **723 253 27.7.98 10m**

North East Bay, north end. On a flat topped lava flow. *Euphorbia origanoides* three live plants (two flowering) plus two more dead. Also further inland (100 m) five more dead. No seed was found. Species present include occasional *Aristida adscensionis* and rare *Waltheria indica (dead).*

33) ***Euphorbia origanoides*** **747 237 4.8.98 60m**

North of Spire Rock. Soil of dry, dusty clinker and sand. *Euphorbia origanoides several* dead specimens. Seed was found. Species present include occasional *Cyperus* sp.

34) ***Euphorbia origanoides*** **740 246 4.8.98 30m**

South west of Hummock Point on a dry watercourse gently sloping towards the sea. *Euphorbia origanoides*, 1 living (flowering), 1 dead. Seeds also present. Soil dusty with clinker and boulders. Species present include occasional *Cyperus* sp. and *Psidium guajava.*

35) ***Euphorbia origanoides*** **663 255 5.8.98 45m**
Southern side of Pyramid Point Road, south east of Pyramid Point area. Deep volcanic ash and clinker. *Euphorbia origanoides* (dead), seed present. Species present include occasional *Aristida adscensionis*.

36) ***Euphorbia origanoides*** **667 250 5.8.98 45m**
Southern side of Pyramid Point Road. South East of Pyramid Point area. On flat exposed area of volcanic ash amongst clinker. *Euphorbia origanoides* (dead), 1 living (in flower with signs of grazing). Seed present. Species present include occasional *Aristida adscensionis*.

37) ***Euphorbia origanoides*** **673 251 5.8.98 45m**
Northern side of Pyramid Point Road. *Euphorbia origanoides* (dead), seed present. Species present include occasional *Aristida* sp. *Enneapogon cenchroides* and *Prosopis juliflora*.

38) ***Euphorbia origanoides*** **666 253 5.8.98 45m**
At the edge of the northern side of Pyramid Point Road, on volcanic ash & clinker, *Euphorbia origanoides* 1 living plant (not in flower). Further N.E. more dead plants with seed present. Species present include occasional *Aristida* sp., *Enneapogon cenchroides* and *Prosopis juliflora*.

39) ***Asplenium ascensionis*** **715 211 25.7.98 725m**
Royal Marines Garrison building (abandoned) near water catchment on Green Mountain. *Asplenium ascensionis* found on dark, damp inside wall. Species present include dominant *Adiantum capillus-veneris*, occasional *Begonia hirtella* and *Christella dentata*.

40) ***Pteris adscensionis*** **720 205 6.8.98 520m**
Breakneck Valley, near roofed water tank. *Pteris adscensionis* found on volcanic cliff face. Two dead and eight living plants. Species present include occasional *Ageratum conyzoides*, *Clidemia hirta*, *Christella dentata*, *Opuntia* sp., *Nephrolepis hirsutula* and *Psidium guajava* (shading).

41) ***Asplenium ascensionis*** **719 208 6.8.98 565m**
Breakneck Valley. *Asplenium ascensionis* found on cliff face of narrow gorge off to east of path. Species present include *Oxalis corniculata*, *Ageratum conyzoides*, *Centella asiatica*, *Christella dentata*, *Clidemia hirta*, *Paspalum scrobiculatum* and *Psidium guajava* (shading). Frequent bryophytes and thalloid liverwort present.

42) Asplenium ascensionis **715 212 10.8.98 700m**
Entrance to main tunnel between Breakneck Valley and farm, at farm end, to a depth of 10 m into the tunnel. Species present include frequent *Asplenium ascensionis* and *Adiantum capillus-veneris*, with occasional *Christella dentata*.

43) Sporobolus caespitosus **723 211 13.8.98 745m**
Xiphopteris ascensionense
Elliot's Path near Banana Ravine. On vertical cinder rock face. Species present include frequent bryophytes with occasional *Sporobolus caespitosus*, *Christella dentata*, *Clidemia hirta*, *Centella asiatica*, *Ageratum conyzoides*, *Paspalum conjugatum*, *Sporobolus africanus*, *Borreria verticillata*, and rare *Oxalis corniculata*, *Wahlenbergia procumbens*, *Gnaphalium purpureum*, *Begonia hirtella*, and *Xiphopteris ascensionense*.

44) Asplenium ascensionis **725 211 13.8.98 745m**
Top of Banana Ravine, on Elliot's Path, in a small cave, occasional *Asplenium ascensionis* on cinder wall. Species present include frequent *Christella dentata*, *Adiantum capillus-veneris*, *Clidemia hirta* and *Begonia hirtella*.

45) Sporobolus caespitosus **724 211 13.8.98 745m**
Xiphopteris ascensionense
Elliot's Path near Bates Ravine. Approx. 12 plants of *Sporobolus caespitosus* found on cinder vertical wall. Species present include frequent bryophytes with occasional *Wahlenbergia procumbens*, *Christella dentata*, *Clidemia hirta* and *Xiphopteris ascensionense*, with rare *Rubus rosifolius*, *Begonia hirtella*, *Gnaphalium purpureum*, *Ageratum conyzoides* and *Oxalis corniculata*.

46) Sporobolus caespitosus **727 209 17.8.98 670m**
Spur below Elliot's Path near Windy Corner, five plants of *Sporobolus caespitosus* found on 80° slope of volcanic rock. Species present include occasional *Clidemia hirta*, *Centella asiatica*, *Psidium guajava*, *Sporobolus africanus* and *Juniperus bermudiana* with rare *Oxalis corniculata*.

47) Xiphopteris ascensionense **726 206 17.8.98 670m**
Asplenium ascensionis
Sporobolus caespitosus
South east spur of Green Mountain below Elliot's Path on vertical clinker rock. Rare *Xiphopteris ascensionense* and *Asplenium ascensionis* (which occurs sporadically down the spur in shaded spots). Species present include occasional *Centella asiatica, Ageratum conyzoides, Clidemia hirta, Begonia hirtella* and *Christella dentata.*
Also present at this site are one population of approx. 50 plants of *Sporobolus caespitosus* and another of approx. 15 plants over ridge towards Buddleia Ravine. Other associate species include occasional *Paspalum conjugatum, Christella dentata* and *Centella asiatica* with rare *Rubus rosifolius, Gnaphalium purpureum, Wahlenbergia procumbens* and *Oxalis corniculata.*

48) Asplenium ascensionis **714 211 22.8.98 670m**
Green Mountain Farm behind pig sties on vertical cinder cliff (scoria) approx. 5 plants of *Asplenium ascensionis.* Fronds up to 150 mm long. Species present include abundant *Adiantum capillus-veneris*, with occasional *Begonia hirtella.*

49) Pteris adscensionis **722 206 22.8.98 580m**
On vertical rocky outcrop north east of Breakneck Valley, 3 plants of *Pteris adscensionis*, totalling 17 fronds, none of which were sporing. Species present include occasional *Clidemia hirta, Plantago lanceolata, Borreria verticillata, Ageratum conyzoides, Psilotum nudum, Rubus rosifolius, Psidium guajava, Opuntia* sp. and lichens.

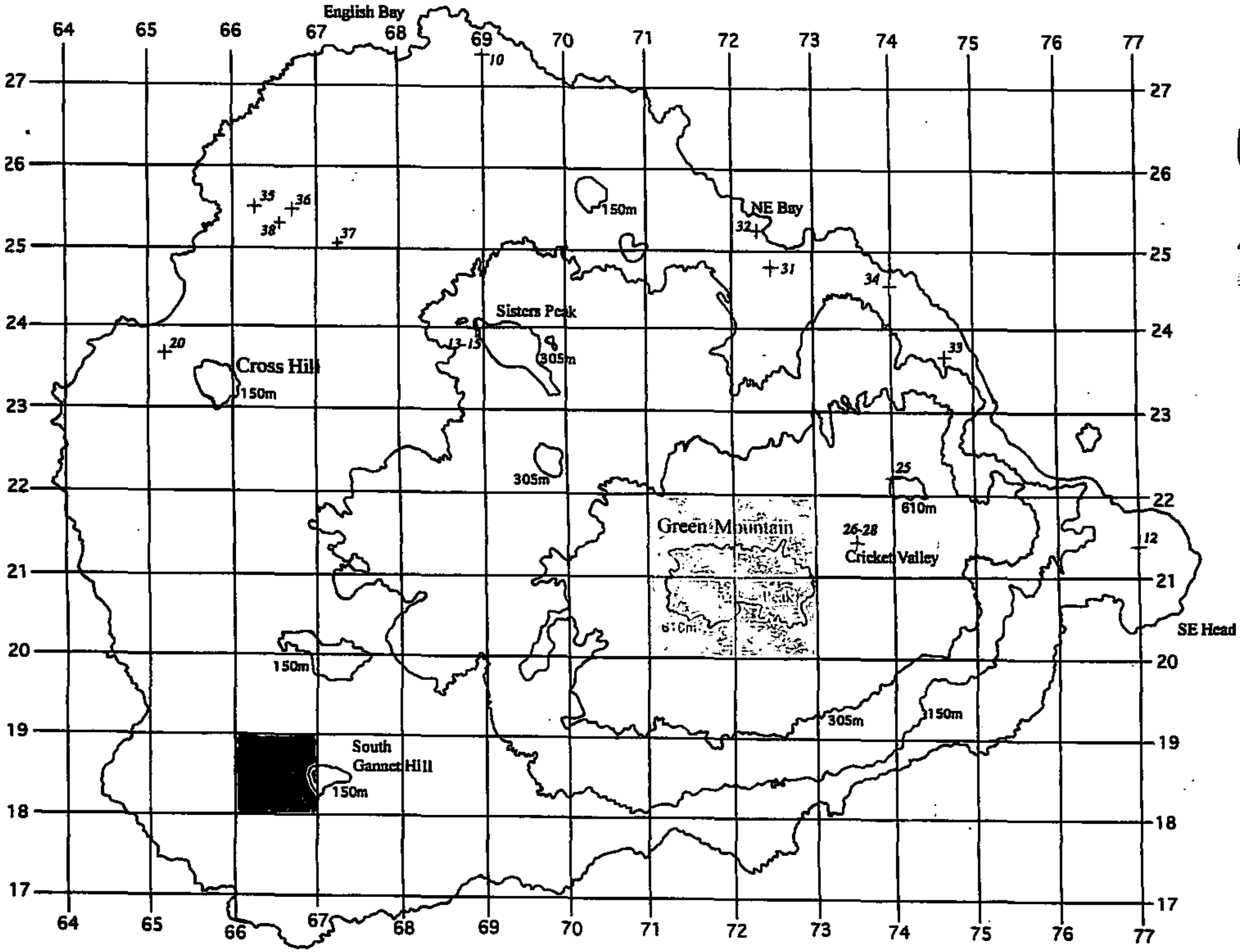
50) Pteris adscensionis **721 205 22.8.98 550m**
North east of Breakneck Valley in a small gorge of *Psidium guajava* and *Hippeastrum reginae*, 7 plants of *Pteris adscensionis* on vertical cinder cliff. Comprising 40 fronds of which 6 were sporing, ranging in size from 20-700 mm, the small plants being newly grown. Species present include abundant *Psidium guajava* and *Hippeastrum reginae* with occasional *Begonia hirtella, Opuntia* sp., *Ageratum conyzoides, Christella dentata*, and *Oxalis corniculata.*

51) Xiphopteris ascensionense **725 211 23.8.98 700m**
Elliot's Path between Banana Ravine and Bates Ravine. Frequent *Xiphopteris ascensionense* on vertical cinder cliff. Species present include occasional *Borreria verticillata, Sporobolus africanus, Christella dentata, Centella asiatica*, and *Paspalum conjugatum* with frequent bryophytes.

52) Sporobolus caespitosus **727 209 23.8.98 700m**
Elliot's Path on northern side of Windy Corner, 3 plants of *Sporobolus caespitosus*. Species present include frequent *Centella asiatica*, *Christella dentata* and *Paspalum scrobiculatum*, with occasional *Clidemia hirta* and *Wahlenbergia procumbens*.

53) Xiphopteris ascensionense **717 210 23.8.98 700m**
Near tunnel on Elliot's Path (approx. 5 m above path) occasional *Xiphopteris ascensionense* on a vertical cinder cliff. Species present include frequent bryophytes with occasional *Christella dentata*, *Oxalis corniculata*, *Paspalum conjugatum*, *Gnaphalium purpureum*, *Centella asiatica*, *Lycopodium cernuum* and *Wahlenbergia procumbens*.

54) Xiphopteris ascensionense **716 210 23.8.98 700 m**
Elliot's Path on a soil bank near path *Xiphopteris ascensionense*. Species present include occasional *Paspalum conjugatum*, *Ageratum conyzoides*, *Borreria verticillata* and bryophytes.



Key

+ Target note taken at this position

Largest populations of *Euphorbia origanoides* described in target notes 1, 11, 21 and 22.

Green Mountain area where the majority of target notes were taken. Within these grid squares target notes 2, 3, 5-9, 16-19, 23, 24, 30 and 39-54 are located.

Figure 7: Map showing the location of target notes and grid square containing the largest population of *Euphorbia origanoides*, as mapped by Ascension '98 Expedition.

10. APPENDIX 2:THE INDIGENOUS VASCULAR FLORA OF ASCENSION ISLAND

Although no comprehensive survey of the indigenous species was carried out on this expedition, notes were made where they were found. The absence of some species and the patchy distribution of others may have been due in part to the drought prior to our visit. The table below lists the indigenous species excluding endemics with notes on their distribution as found by the expedition.

Aristida ascensionis	An annual grass found in many areas of the island. Appeared frequently with *Ipomoea pes-caprae* (L.) and *Nephrolepis hirsutula*.
Blechnum australe	Not found
Cyperus appendiculatus, C. distans, C. haspan, C. brevifolia	The four indigenous sedges were not identified during the expedition although several species were collected. These are held by Alan Gray.
Digitaria ciliaris	One plant recorded with *Asplenium ascensionis* site (target note 6, appendix 1) in Breakneck Valley.
Euphorbia prostrata	Individuals found in dry areas all over the island. Sporadic distribution.
Hibiscus trionum	Not found (not recorded since 1699).
Histiopteris incisa	Very common on Green Mountain especially amongst *Marattia purpurascens* on the weather side. Freq. associates; *Clidemia hirta, Ageratum conyzoides, Centella asiatica, Christella dentata*.
Ipomoea pes-caprae	Common along the NASA Road, and around Two Boats Village. Small patch at the summit of Sister's Peak. Freq. associates; *Psidium guajava, A. ascensionis, L. camara*.
Lycopersicum esculentum	Not found.
Nephrolepis hirsutula	Occasional in rocky outcrops beside the NASA road, up to Middleton's Ridge and the Red Lion car park. Freq. associates: *Melinis minutiflora, A. ascensionis, I. pes-caprae, R. rosifolius, Adiantum capillus-veneris*.
Portulaca oleracea	Only four individuals found in varying habitats.
Ophioglossum vulgatum	Not found

As detailed above there have been many plant introductions on the island. It is likely that the indigenous plant distribution of at least some species has decreased as with endemic species. One of the most notable declines appears to be *Portulaca oleracea*, described in 1906 as forming "an almost continuos carpet" on areas where the Wideawake terns (*Sterna fuscata)* nest (Rudmose Brown, 1906). Nesting occurred over the duration of the project ruling out a detailed survey, but binocular investigation revealed this description no longer held during our visit. Although conservation of these species is not of primary importance given their wider distribution, the preservation of these species is important if indigenous vegetation on Ascension is to remain for future generations.

11. APPENDIX 3: MONITORING ENDEMICS PERMANENT QUADRATS AND FIXED POINT PHOTOGRAPHY

Six permanent quadrats and fixed point photography sites have been set up to monitor four different endemic plants. Three of are for *Asplenium ascensionis* and one each for *Sporobolus caespitosus*, *Marattia purpurascens* and *Pteris adscensionis*.

Elliot's Path

i) *Asplenium ascensionis* Grid Reference 718211
The quadrat is found inside the entrance to the tunnel nearest Breakneck Valley arriving from the farm side. The quadrat is 1m down from the red cross and 50cm either side of it. The fixed photographic site (FPS) is 2m away and directly opposite the quadrat.

ii) *Asplenium ascensionis* Grid Reference 727209
The quadrat is found on the face of narrow man made cutting through volcanic rock. The quadrat lies 50cm to the N, S E and W of the red cross. The FPS is marked by a metal post and is found opposite the site.

iii) *Sporobolus caespitosus* Grid Reference 727209?
This quadrat is found above Windy Corner on a rocky outcrop. The red cross marks the bottom left hand corner of the quadrat that is 3m vertical and 2m horizontal. There are two FPS's here, one is marked by the furthest away metal pole the other is 1m down from the pole nearest to the red cross

iv) *Marattia purpurascens* Grid Reference 726210?
This quadrat is found above the *Sporobolus caespitosus* site described above, follow the path up until you reach a metal pole, turn left and go down a small bank until you reach a second pole this is the FPS. The area to be photographed is marked by a third pole, it marks the bottom left hand corner of the site, and the area is all that can be seen through the camera from the FPS.

Breakneck Valley

i) *Asplenium ascensionis* Grid Reference 721204
This site is shortly after the Norfolk Island Pines at the base of Breakneck Valley approximately 50m behind the old cow shed. The quadrat is located on a rocky cliff shaded by a large fig tree. The red cross marks the top left hand corner of a 1m by 1m quadrat. The metal pole marks the FPS.

ii) *Pteris adscensionis* Grid Reference 721204
This site is in between the old cow shed and the *Asplenium* site described above. A metal pole marks the FPS and is located next to a *Psidium guajava* tree.

South Gannet Hill
i) *Euphorbia origanoides* 690 274
The site is located on the southern side of south Gannet hill on the lower slopes nearest the south west side of the population. A metal pole marks the FPS.

12. APPENDIX 4: ASCENSION ISLAND BRYOPHYTES, LICHENS AND LIVERWORTS

A collection of bryophytes, lichens and liverworts was made by the expedition and deposited in the herbarium at the Royal Botanic Gardens Edinburgh. Not all of these have been determined as yet. Species determined at present were identified by Riclef Grolle and Len Ellis at the request of David Long of the Royal Botanic Garden Edinburgh. We hope that a fuller account of the specimens collected will appear in the future. As no complete list exists for Ascension, it is hoped that this may contribute to the compilation of a comprehensive checklist.

Hepaticae

Species	Determiner	Location	Alt (m)
Anastrophyllum piligerum (Nees) Steph.	R. Grolle	Green Mountain. Epiphyte on bamboo node, on volcanic rock and by Elliot's Path.	810, 760 and 700
Frullania ericoides (Nees) Mont.	R. Grolle	On rock below Middleton's Ridge.	410
Isotachis aubertii (Schwägr.) Mitt.	R. Grolle	On vertical scoria, east facing, by Elliot's Path.	700
Lejeunea sp.	R. Grolle	On rock below Middleton's Ridge.	410
Lophocolea ascensionis Steph.	R. Grolle	On north facing rock and on tree branches and roots, Green Mountain.	760 and 700
Mastigophora diclados (Brid. ex Web.) Nees.	R. Grolle	On scoria cliff facing east on Elliot's Path.	700
Microlejeunea ulicina (Taylor) A.Evans.	R. Grolle	Epiphyte on bamboo node, SW facing, Green Mountain	810
Riccardia sp.	R. Grolle	Epiphyte on bamboo nodes, summit of Green Mountain.	860
Symphyogyna brasiliensis Nees & Mont.	R. Grolle	On soil amongst ginger and agave, east facing on Elliot's Path	730

Mosses

Species	Determiner	Location	Alt (m)
Bryum sp.		On SW facing rock, Elliot's Path.	730
Calymperes afzelii Sw.	L.T. Ellis	On a wall, Breakneck Valley	580
Calymperes erosum Müll.Hal.	L.T. Ellis	Epiphyte on bamboo node and on soil at Windy Corner, Elliot's Path	810 and 760
Campylopus sp.		Epiphyte on bamboo node, on soil at Windy Corner and on rock in Breakneck Valley.	810, 760 and 530
Racopilum sp.		On shaded wall Breakneck Valley.	520

13. APPENDIX 5: REPORT ON ASCENSION ISLAND MARINE SHELLS.

Identified by Dr William S. Penrice.

These shells were collected on the Island in 1998 on a casual basis and are unlikely to be representative of the molluscan fauna. These have been identified and some characteristics of their life histories outlined where possible. On the whole the shells were very well worn and cannot be used as reliable indicators of what is actually living there at this time. They are none the less of some considerable interest.

Cypraea spurca L. 1758
Cypraeidae, Atlantic Yellow Cowry
A single well worn specimen.
Under rocks at low tide, moderately common extending from Florida, Yucatan, West Indies, Brazil, Mediterranean, Angola. The subspecies would appear to be *C.s.acicularis* which is often treated as a separate species. This subspecies is found in the Americas (North Carolina south to Brazil).

Cypraea lurida L. 1758
Cypraeidae, Lurid Cowrie
Two well worn specimens
Frequent to common extending from the Mediterranean and Azores and the East Atlantic south to Gabon and St Helena.

Capulus incurvatus
Capulidae, Incurved Cap Shell
Two moderately worn specimens retaining red colouration.
Uncommon on rocks in the upper level of the infralittoral zone (immediately below the inter tidal zone) from North Carolina to Florida and Brazil.

Bursa pustulosa Reeve
Bursidae, a Frogshell
Single moderately worn specimen.
Uncommon, distribution is West African from Senegal, Gabon, Congo to Angola and West as far as St Helena and Ascension. It is likely this is of the variety *B.pustulosa* var *Jabik* which is known to occur on Ascension.

Strombus latus Gmelin
Strombidae, Bubonian Conch   syn S.bubonius
Single well worn specimen.
Common, distribution is West African from the Western Sahara south to Angola although it is known as a Quaternary fossil from

the Mediterranean. Not to be confused with *S. alatus* which is similar and essentially Caribbean.

Pisania pusio L. 1758

Buccinidae, Miniature Triton Trumpet

Single reasonably worn specimen

Common though apparently restricted to the Caribbean and south to Brazil (var *P.p.janeirensis*). It is common on or among corals in the infralittoral zone.

UNIDENTIFIED

4 very heavily eroded and beach washed specimens, the possibility that these are subfossils could not be ruled out.

Thais sp.

Thaidae, A Rock Shell

Single very heavily eroded specimen, reliable identification not possible.

Nerita sp.

Neritidae, a Nerite

Eight specimens, mostly in reasonable condition. Available literature does not allow an identification to be made.

Fissurella sp.

Fissurellidae, A keyhole limpet

Four specimens in reasonable condition.

Spondylus sp.

Spondylidae, A Thorny Oyster

Single well worn specimen with no spines etc. The condition of the specimen does not allow for a reliable identification.