

Plant Formations in the Azorean BioProvince

Peter Martin Rhind

Azorean Rocky Coastal Vegetation

The most common coastal habitat in the Azores is exposed lava (mainly andesitic cliffs and sharp basaltic rocks) with some of the older areas now subject to considerable coastal erosion. In places the exposure is extremely intense. On the north-facing Cachorro coastline on Pico Island, for example, storms with strong winds and high waves can occur all year round with waves often reaching 7 m in height and washing upslope for 20 m or more. Such places are often devoid of vegetation. Also at Cachorro the geological structure of the pahoehoe basaltic lavas often give rise to almost flat coastal platforms that are difficult for plants to colonize, but in fissures the endemic *Spergularia azorica* (Caryophyllaceae) often forms the pioneer zone of maritime vascular plants together with *Asplenium marinum* and species of *Atriplex* - a second zone is often characterized by the endemic grass *Festuca petraea* (Poaceae). Even in less exposed situations the vegetation is usually sparse with percentage cover often below 30% but species diversity increases. *Asplenium marinum*, *Crithmum maritimum* and *Solidago sempervirens* are usually the most conspicuous species but endemic taxa in addition to the ones mentioned above such as *Azorina vidalii* (Campanulaceae), *Corema album* subsp. *azorica* (Empetraceae) and *Euphorbia azorica* (Euphorbiaceae) may also be present. Where the coastal belt is quite wide there can be a degree of structural diversity with shrubs and various sized herbaceous species. Very steep coastal, rocky slopes are difficult to survey but are known to be important for a number of rare endemic species. On Terceira Island, for example, these may support the Azorean endemics *Euphorbia stygiana* (Euphorbiaceae) and *Lactuca watsoniana* (Asteraceae) and the Macaronesian endemics *Diphasium madeirense* (Lycopodiaceae) and *Smilax canariensis* (Smilacaceae). Landward of the coastal fringe, maritime grassland dominated by either *Cynodon dactylon* or the endemic *Agrostis azorica* (Poaceae) is often one of the main vegetation types.

Azorean Coastal Shrublands

These formations represent the most landward belt of coastal zonation and represent a transition to non-maritime vegetation. Three types are recognized in the central islands - *Erica azorica* shrubland, *Myrica faya* shrubland and mixed shrubland. In the first of these the endemic *Erica azorica* (Ericaceae) can, in places, form almost monospecific stands especially in areas subject to strong ocean winds. In these situations this sparse community can reach heights of up to 1.5 m and is typically without stratification. *Myrica faya* formations are also typically poor in both floristic and structural diversity. They occur in less exposed situations, usually on poor substrata such as recent lava and where freshwater availability is low during summer periods. In more favourable areas, in terms of shelter and hydrology more complex, mixed communities occur. These are characterized by species such as *Myrica faya*, *Myrsine africana*, *Pittosporum undulatum* and the endemic *Erica azorica* (Ericaceae) and *Juniperus brevifolia* (Cupressaceae). The bushy undergrowth may include *Crithmum maritimum*, *Silene vulgaris* ssp. *marina* and the endemic *Corema album* subsp. *azoricum* (Empetraceae), while herbaceous elements may comprise the endemic *Carex hochstetteriana* (Cyperaceae), *Daucus carota* ssp. *azorica* (Apiaceae) and *Festuca petraea* (Poaceae). However, these rich coastal shrublands are becoming increasingly rare.

Azorean Dunes and Shingle Vegetation

Extensive dune systems, such as in the bay at Praia da Vitória (Terceira Island) are rare in the Azores. Most are just small sandy beaches with scattered stands of *Salsola kali*.

However, the scattered shingle beaches support several endemics including *Euphorbia azorica* (Euphorbiaceae) and *Spergularia azorica* (Caryophyllaceae).

Azorean Grasslands

Four endemic grassland formations occur in the Azores - *Holcus rigidus* grassland, *Festuca petraea* grassland, *Festuca jubata* grassland and *Deschampsia foliosa* grassland. Grassland dominated by the endemic *Holcus rigidus* (Poaceae) is confined to lower mountain slopes and can be found, for example, at the base of Rocha of Juncal (Terceira), Caldeira of St Bárbara (Terceira) and Caldeira of Faial (Faial). The most extensive area is in the Caldeira of St Bárbara. In wetter areas associated species include *Eleocharis multicaulis*, *Juncus effusus*, *Mentha aquatica*, *Sphagnum palustris* and the endemic *Tolpis azorica* (Asteraceae). In areas of better drainage a greater diversity of species can be found and typically include *Blechnum spicant*, *Holcus lanatus*, *Poa trivialis*, *Pteridium aquilinum* and the endemic *Agrostis gracillaxa* (Poaceae) and *Erica azorica* (Ericaceae). There may also be a number of rare endemic species like *Lactuca watsoniana* (Asteraceae), *Leontodon rigen* (Asteraceae), and *Pericallis malvifolia* (Asteraceae). Grassland dominated by the endemic *Festuca petraea* (Poaceae) is a coastal formation that has already been referred to under the coastal section, whereas grassland dominated by the endemic *Festuca jubata* (Poaceae) is a mountain formation. These two species rarely come into contact the exception being on the islands of Corvo and Flores where there are extensive transitions from coastal to mountain grasslands. In mountain grassland *Festuca jubata* often forms regular cushions and is thought to have a soil fixation function. Associated species typically include *Centaureum scilloides*, *Holcus lanatus*, *Poa trivialis*, *Selaginella kraussiana* and the endemic *Lysimachia azorica* (Myrsinaceae). Grassland dominated by the endemic *Deschampsia foliosa* (Poaceae) is confined to the summits of the highest mountains and above the altitudinal limit of trees. It is adapted to extreme climatic conditions of low temperatures and strong winds. These grasslands are usually made up of a series of *Deschampsia* cushions and the few associated species such as *Centaureum scilloides*, *Holcus rigidus* and *Selaginella kraussiana*. Several bryophytes often use *Deschampsia* cushions for shelter.

Azorean Wetlands

Wetlands including areas of standing water are of great ecological importance in the Azores. Large oligotrophic lakes, mainly caldera lakes, are a major feature of the landscape and some of these are incredibly deep. Lagoa da Caldeira Negra (Flores), for example, has a depth of about 108 m. Small lagoons are also numerous and these often support bottom dwelling and marginal communities characterised by species such as *Callitriche stagnalis*, *Cyperus alternifolius*, *C. longus*, *Eleocharis multicaulis*, *E. palustris*, *Juncus articulatus*, *Littorella uniflora* and the endemic *Isoetes azorica* (Isoetaceae). In other wetland areas where permanent saturation occurs other wetland species like *Galium palustre*, *Hydrocotyle vulgaris*, *Juncus effusus*, *Osmunda regalis*, *Rumex conglomeratus* and the endemic *Dryopteris azorica* (Dryopteridaceae) and *Lysimachia azorica* (Myrsinaceae) may be encountered.

Azorean Laurel Forest

These broad-leaved evergreen forest, are largely dominated by *Laurus azorica* (a Macaronesian endemic) and *Myrica faya* and are considered to be the natural climax vegetation up to an altitude of about 600m. Similar laurel forests can be found in Madeira and the Canaries, and all are thought to be the relicts of vegetation that was once widespread in southern Europe before climatic cooling during the Pleistocene. These macaronesian forests are rich in endemics. On the Azores they include *Ilex perado* subsp. *azorica* (Aquifoliaceae) and *Notelaea azorica* (Oleaceae) among the trees, *Euphorbia*

stygiana (Euphorbiaceae), *Picconia azorica* (Oleaceae), *Prunus lusitanica* ssp. *azorica* (Rosaceae), *Rubus hochstetterorum* (Rosaceae), *Vaccinium cylindraceum* (Ericaceae), *Viburnum tinus* var. *subcordatum* (Adoxaceae) among the shrubs and *Hypericum foliosum* (Hypericaceae), *Rubia peregrina* var. *azorica* (Rubiaceae), *Sanicula azorica* (Apiaceae), *Senecio malvaefolius* (Asteraceae), *Lactuca watsoniana* (Asteraceae) and *Selaginella azorica* in the field layer. In the central islands three sub formations are recognized – mesic forest, humid forest and hyper-humid forest. In mesic forest the environmental conditions are characterized by moderate winds, high levels of precipitation and low humidity, and usually have high levels of floristic diversity. Among the trees there is typically a high level of codominance. In addition to *Laurus azorica* include *Myrica faya* and the endemic *Frangula azorica* (Rhamnaceae) and *Picconia azorica* (Oleaceae). The herbaceous layer is usually dominated by pteridophytes like *Diplazium caudatum* and the endemic *Dryopteris azorica* and *D. crispifolia* (Dryopteridaceae). Other herbaceous elements may include the endemic *Bellis azorica* (Asteraceae), *Platanthera azorica* and *P. micrantha* (Orchidaceae). Humid laurel forests have elevated levels of both floristic and structural diversity and as implied occur in areas of high atmospheric humidity and rainfall, and usually have a degree of soil saturation at certain parts of the year. In addition the *Laurus azorica* they are typically dominated by the endemic *Erica azorica* (Ericaceae), *Frangula azorica* (Rhamnaceae) and *Ilex perado* subsp. *azorica* (Aquifoliaceae). Ferns again dominate the herbaceous layer with species such as *Diplazium caudatum*, *Dryopteris affinis*, *Pteris incompleta* and the endemic *Dryopteris azorica* (Dryopteridaceae). Hyper-humid laurel forests occur at high altitudes where human intervention has been less pronounced and as a consequence these now represent the commonest form of laurel forest in the Azores. Both strong humid winds and high levels of precipitation characterize the environment of these upland areas. In floristic terms, one of the main differences between these and other laurel forest is the absence of *Erica azorica*, which is replaced by its upland counterpart the endemic *Vaccinium cylindraceum* (Ericaceae). They also tend to have a less complex vertical structure but a more complex horizontal structure with many hummocks and hollow. Many of the low-lying areas are permanently saturated making germination difficult. Nevertheless, the herbaceous ground layer is well developed particularly with species such as *Culcita macrocarpa* and the endemic *Dryopteris azorica*, but the filmy fern *Trichomanes speciosum* may also be common.

Azorean Fayal Forest

Forest dominated by *Myrica faya* (fayal) mostly develops on recently developed lava soils rich in potassium. The local climate also has to be moderate with reduced exposure, moderate temperatures and good amounts of precipitation. They tend to have a simple structure but the endemic tree *Picconia azorica* (Oleaceae) is often a conspicuous component. At ground level the herbaceous layer typically includes the endemic *Carex hochstetteriana* (Cyperaceae) and *Polypodium azoricum* (Polypodiaceae).

Azorean Cloud Forest (*Ilex* Forest)

Forest dominated by the endemic *Ilex perado* subsp. *azorica* (Aquifoliaceae), also known as cloud forest is, as implied, confined to areas of almost permanent cloud cover and extremely high humidity. This occurs at altitudes of between 700-900 m usually on north-facing slopes. These forests also tend to be associated with acidic lavas, and as such the forest floor is often composed of peat, which is more or less permanently saturated. At ground level there is also a degree of horizontal structure with various hummocks and hollows with varying degrees of wetness. *Ilex perado* usually emerges above a canopy dominated by the endemic *Juniperus brevifolia* (Cupressaceae) and *Vaccinium cylindraceum* (Ericaceae). The herbaceous ground layer is largely dominated by

pteridophytes like *Culcita macrocarpa*, *Dryopteris aemula* and *Trichomanes speciosum*, and as with all cloud forests, the epiphytic flora is well developed with species such as the filmy fern *Hymenophyllum tunbrigense* and the Macaronesian endemic *Elaphoglossum semicylindraceum* (Elaphoglossaceae).

Azorean Juniper Forest

Forest dominated by the endemic *Juniperus brevifolia* (Cupressaceae) is confined to areas of extreme wetness and strong winds and typically occurs on exposed mountaintops. In the central islands two types are recognized – juniper forest and juniper forested peat land. In the former there is usually a continuous and fairly uniform layer of juniper often with a three-tiered structure comprising a canopy up to 4.5 m high, a shrub layer and a herbaceous layer. However, these forests are often so dense that little can grow on the darkened forest floor. The epiphytic flora, on the other hand, is often well developed and includes a distinctive epiphytic bryo-community that can completely envelop juniper branches. In the case of juniper forest on peat bog, the juniper trees form a sparse canopy while *Sphagnum* and other bog mosses dominate the underlying peat. On Terceira, there is also forest co dominated by *Juniperus brevifolia* and the endemic *Ilex parado* ssp. *azorica* (Aquifoliaceae). Associated species here include *Culcita macrocarpa*, *Laurus azorica*, *Myrsine africana* and the endemic *Vaccinium cylindraceum* (Ericaceae).

Azorean Erica woodland

Above about 600m the laurel forest peters out and is replaced by woodland mainly composed of the endemic *Erica azorica* (Ericaceae) which can grow to a height of about 6m. The endemic *Juniper brevifolia* (Cupressaceae) is also common in this zone. The shrub layer typically includes *Hedera canariensis* and *Myrsine africana*, while endemics such as *Bellis azorica* (Asteraceae) and *Lysimachis azorica* (Myrsinaceae) can be found in the field layer. In places, these woodlands have been converted to grazing pasture but surprisingly these areas can still support up to 14 endemics including *Carex azorica* (Cyperaceae) and *Doboecia azorica* (Ericaceae).

Azorean Upland Calluna Heath

In the zones above 1500m *Calluna vulgaris* becomes the dominant heathland species although patches of endemic *Doboecia azorica* (Ericaceae) may also occur, while the summit rocks include arctic-alpine bryophytes, particularly *Gymnomitrium adustum* and *Racomitrium lanuginosum*.

Azorean Shrublands

Shrublands are scattered throughout the islands and may be dense or open or in some cases have emergent trees. The shrubs can be low growing like *Calluna vulgaris*, *Thymus caespititius* and the endemic *Doboecia azorica* (Ericaceae) or semi-arborescent such as *Myrica faya*, *Laurus azorica* and *Juniperus brevifolia*. Several types have been described. *Erica* mixed shrubland occurs on acid gravel slopes and is dominated by the endemic *Erica azorica* (Ericaceae) together with the endemic *Juniperus brevifolia* (Cupressaceae). These are open communities interspersed with scattered grasslands with species such as the endemic *Holcus rigidus* and *Festuca petraeae* (Poaceae), together with *Huperzia selago*, *Lycopodium cernuum* and the endemic *Tolpis azorica* (Asteraceae). *Euphorbia* shrublands dominated by the endemic *Euphorbia stygiana* (Euphorbiaceae) are usually small, scattered communities often associated with some form of disturbance. They are mostly seen on mountain slopes or deposits associated with slopes. Lajido shrublands are associated with so-called lajido formations – a term used on Pico Island to describe flat basaltic compact lavas where root penetration is almost impossible. The species that manage to colonise these areas are mainly found in fissures and typically include *Calluna*

vulgaris, *Laurus azorica*, *Myrsine africana*, *Thymus caespititius* and the endemic *Erica azorica* and *Daboecia azorica* (Ericaceae). Volcanic sand shrubland is also distinctive but mainly confined to just three locations – Graciosa (Pico Timão), Cabeco do Fogo (Faial) and the ‘sand mountain’ (Pico). Typical species include *Thymus caespititius*, the endemic *Corema album* subsp. *azoricum* (Empetraceae) and *Daboecia azorica* (Ericaceae), together with herbaceous taxa like *Centaureum scilloides*, the endemic orchid *Plantanthera micrantha* (Orchidaceae), and the moss *Racomitrium lanuginosum*.

Further information required.

References

Balgooy, Van. M. M. J. 1969. A study of the diversity of island floras. *Blumea*, 17: 139-178.

Carine, M. A. & Schaefer, H. 2010. The Azores diversity enigma: why are there so few Azorean endemic flowering plants and why are they so widespread? *Journal of Biogeography*, 37: 77-89.

Dias, E., Elias, Rui, B. & Nunes, V. 2004. Vegetation mapping and nature conservation: a case study in Terceira Island (Azores). *Biodiversity and Conservation*, 13: 1519-1539.

Dias, E., Mendes, C., Melio, C., Pereira, D. & Elias, R. 2005. Azores central Islands vegetation and flora guide. *Quercetea*, 7: 123-173.

Gabriel, R. & Bates, J. W. 2005. Bryophyte community composition and habitat specificity in the natural forests of Terceira, Azores. *Plant Ecology*, 177: 125-144.

Godman, F. D. C. 2005. *Natural History of the Azores or Western Islands*. An unabridged facsimile of the edition published in 1870 by John van Voorst, London. Elibron Classics series.

Haggar, J. P. 1988. The structure, composition and status of the cloud forests of Pico Island in the Azores. *Biological Conservation*, 46: 7-22.

Haggar, J. P., Westgarth-Smith, A. R. & Penman, D. 1989. Threatened flora and forest in the Azores. *Oryx*, 23: 155-160.

Humphries, C. J. 1979. Endemism and Evolution in Macaronesia. In: *Plants and Islands*. Ed. D. Bramwell. Academic Press.

Rodríguez-Sánchez, F. & Arroyo, J. 2008. Reconstructing the demise of Tethyan plants: climate-driven range dynamics of *Laurus* since the Pliocene. *Global Ecology and Biogeography*, 17: 685-695.

Schäfer, H. 2005. *Flora of the Azores. A Field Guide*. Margraf Publishers.

Sjogren, E. 1993. Dry coastal ecosystems of Madeira and the Azores. In: *Ecosystems of the World 2B Dry Coastal Ecosystems Africa, America, Asia and Oceania*. Ed. Eddy van der Marel. Elsevier.

Sunding, P. 1979. Origins of the Macaronesian Flora. In: *Plants and Islands*. Ed. D, Bramwell. Academic Press.

Tutin, T. G. 1953. The vegetation of the Azores. *Journal of Ecology*, 41: 53-61.

Tutin, T. G. & Warburg, E. F. 1932. Contributions from the University Herbarium Cambridge - notes on the flora of the Azores. *The Journal of Botany*, 70: 38-46.