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Establishment of a network of plant micro-reserves on the Municipality of Funchal (Madeira, Portugal)

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With 13 figures and 3 tables

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ABSTRACT: This paper summarizes the results of a project developed at Funchal City Hall. The objectives were to obtain an inventory and cartography of the areas of natural or semi-natural vegetation cover, in order to propose a network of micro-reserves of the local flora and vegetation (PMRs). The main objective was, therefore, to preserve the sites of ecological interest that still remain on the limits of the municipality of Funchal below 350 m *a.s.l.*

Keywords: European Habitats Directive, plant micro-reserves, Funchal.

RESUMO: Este artigo resume os resultados de um projeto desenvolvido na Câmara Municipal do Funchal. Os objetivos foram obter um inventário e cartografar as áreas de cobertura vegetal natural ou seminatural, a fim de propor uma rede de micro-reservas da flora e vegetação locais (MRF). O principal objetivo foi, portanto, de conservar os locais de interesse ecológico que ainda permanecem nos limites do concelho do Funchal abaixo de 350 m de altitude.

Palavras-chave: Diretiva Habitats da Comunidade Europeia, micro-reservas de flora, Funchal.

INTRODUCTION

The islands that make up the archipelago of Madeira (Madeira, Porto Santo, Desertas and Selvagens) are located about 900 km from mainland Portugal and 600 km from the coast of Morocco. The island of Madeira (32° 38' and 32° 52' N and 16° 39' and 17° 16' W) (PRADA, 2007) has 737 km² (58 km long and 23 km wide) and a maximum altitude of 1861 m, the Pico Ruivo. The municipality of Funchal, on the south coast of Madeira Island, occupies an area of 7630 ha.

Forest habitats existing in Madeira, which are included in the Annex I, of the Habitats Directive, are detailed in Table 1, according to the Decree-Law no. 140/99 of the 24th of April (CAPELO *et al.*, 2007). Note that the endemic Macaronesian heaths, the Macaronesian laurel forests and endemic forests with *Juniperus* spp. are priority habitats and therefore require strict protective measures.

Table 1 – List of forest or scrub habitats and their code according to Habitat Directive.

Type	Code	Designation	Plant communities and their phytosociological correspondence
Temperate heath and scrub	4050	*Endemic macaronesian heaths	High altitude heath (<i>Polysticho falcinelli-Ericetum arboreae</i>) and secondary heath vegetation (<i>Vaccinio padifoli-Ericetum madericolae</i>)
Thermo-Mediterranean and pre-steppe bush	5330	Thermo-Mediterranean and pre-desert scrub	Scrub community of Madeiran tree-spurge (<i>Euphorbietum piscatoriae</i>)
Mediterranean sclerophyllous forests	9320	<i>Olea</i> and <i>Ceratonia</i> forests	Microforest of Madeiran oleaster (<i>Mayteno umbellatae-Oleetum maderensis</i>)
Mediterranean sclerophyllous forests	9360	*Macaronesian Laurel Forests (<i>Laurus</i> , <i>Ocotea</i>)	Laurisilva forests (<i>Clethro arboreae-Ocoteetum foetentis</i> , <i>Semele androgyna-Apollonietum barbujanae</i> and <i>Diplazio caudatae-Perseetum indicae</i>); microforests of <i>Sideroxylon mirmulans</i> (<i>Helichryso melaleuci-Sideroxyletum marmulanae</i>); riverine vegetation; caulirosetted phanerophyte communities
Mediterranean and Macaronesian mountainous coniferous forests	9560	*Endemic forests with <i>Juniperus</i> spp.	Phoenician Juniper and Madeiran Juniper communities

* Priority habitats

In the municipality of Funchal, that spreads from 0 to 1818 m, are present, potentially, all described communities; up to 350 m, the microforest of Madeiran oleaster, the microforest of *Sideroxylon mirmulans* R. Br. and the Canary Laurel forest (*Semele androgyna-Apollonietum barbujanae*) represent the climatophyllous communities. Although most of these habitats are occupied by agricultural and urban areas, several small landscape relicts are known to exist (PAZ *et al.*, 2013).

Besides the above communities, there are other endemic and indigenous vegetation series in the area of Funchal, forming rich and diverse mosaics that is

important to protect and preserve, like the riparian woods of *Salix canariensis* Ch.P.Sm. ex Link (*Scrophulario hirtae-Salicetum canariensis*), dominated by *Salix canariensis* and the *Musschiaetum aureae*, a rupicolous community dominated by *Musschia aurea* (L.f) Dumort., accompanied by plants such as *Andryala crithmifolia* Aiton, *Aeonium glandulosum* (Aiton) Webb & Berthel., *Aeonium glutinosum* (Aiton) Webb & Berthel., *Sinapidendron angustifolium* (DC.) Lowe, *Helichrysum monizii* Lowe and *Erysimum maderense* Polatschek (COSTA *et al.*, 2004).

All these communities are rich in endemic species and lack of protection by their very weak representation in protected areas of the archipelago (Natural Park of Madeira and the Natura 2000 Network).

METHODOLOGY

In the initial phase of this work the conclusions in the report of 2008 on micro-reserves in the municipality of Funchal (PAZ *et al.*, 2008) were reviewed in order to select the areas to revisit. These were: *Garajau*, *Pináculo*, *Chão da Loba* and *Ribeira dos Socorridos*. Due to the existing vegetation and the presence of priority species the areas of *Ribeira de Gonçalo Aires*, *Lazareto* and *São João* were again surveyed; a new site was added – *Cancela* (Fig. 1 and Table 2).

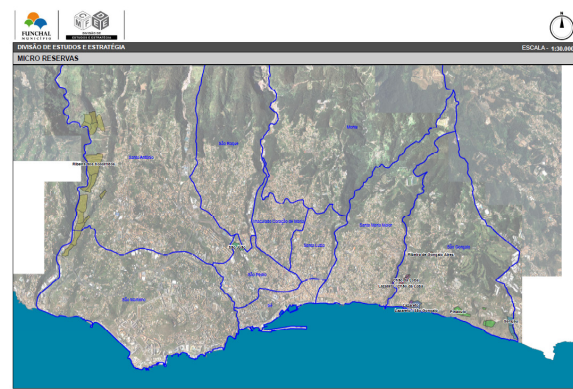


Fig. 1 – Distribution of the surveyed areas in the Municipality of Funchal.

Sinphytosociological inventories were used for landscape description using the vegetation model proposed by CAPELO *et al.* (2004). This initial approach was complemented by floristic and phytosociological inventories. The data obtained allowed a qualitative and

semi quantitative evaluation of floristic and ecological diversity, endemism, as well as the listing of each site's species and habitats included in the Habitats Directive and Bern Convention. For each site several other landscape features were registered including: constructions, trails, roads, threats (e.g. trash deposition, evidence of recent fires, etc.).

Table 2 – Number of sinphytosociological and phytosociological inventories.

Code	Natural area	Number of sinphytosociological inventories	Number of phytosociological inventories
D	Chão da Loba	3	1
F	Garajau	3	0
G	Lazareto - São Gonçalo	3	1
H	Pináculo	6	1
M	Ribeira de São João	1	0
Soc	Ribeira dos Socorridos	15	3
P	Ribeira de Gonçalo Aires	1	2
C	Cancela	1	1
Total		33	9

The ranking parameters of sinphytosociological inventories were the native tree cover rate, the presence of endemic *taxa* (Macaronesian or Madeiran) and, within these, how many are protected by the Habitats Directive. To calculate the Natural Areas Protection Index (IPEN), the following formula was used: $IPEN = 2ICAA + IPEDH$, where ICAA is the Coverage Ratio of Arboreal Indigenous species (sum of the coverage percentages of *Mayteno umbellatae-Oleatum maderensis*, *Semele androgynae-Apollonietum barbujanae* and *Scrophulario hirtae-Salicetum canariensis* communities) and IPEDH is the Presence of Species of the Habitats Directive Index.

In the case of phytosociological surveys the different areas studied were prioritized taking into account three factors: the number of Madeiran and Macaronesian endemisms present, number of protected *taxa* (either by the Bern Convention and the Habitats Directive) and the native tree cover rate *versus* the exotic tree cover rate.

OUTCOME AND CONCLUSIONS

A total of 58 Macaronesian endemic *taxa* and 36 Madeira exclusive endemisms could be found, revealing a remarkable richness (PRESS *et al.*, 1994). Nine *taxa* are included in the Habitats Directive, two being priority *taxa* (*Chamaemeles coriacea* Lindl. and *Convolvulus massonii* F. Dietr.), which are also included in the Bern Convention,

together with *Musschia aurea* (JARDIM *et al.*, 2008).

In the valleys of *Ribeira dos Socorridos* (Fig. 2), *Ribeira de São João* (Fig. 3), *Ribeira de Gonçalo Aires* (Fig. 4) and *Chão da Loba* are some groves belonging to the community *Semele androgynae-Apollonietum barbujanae*, being the only priority forest habitat, protected by the Habitats Directive, found throughout the execution of this study. The highest percentage of this community found in the areas under study was 30% in *Ribeira de São João* and *Ribeira de Gonçalo Aires* (Table 3), followed by Soc4 plot, of the *Ribeira dos Socorridos*, with 25%.

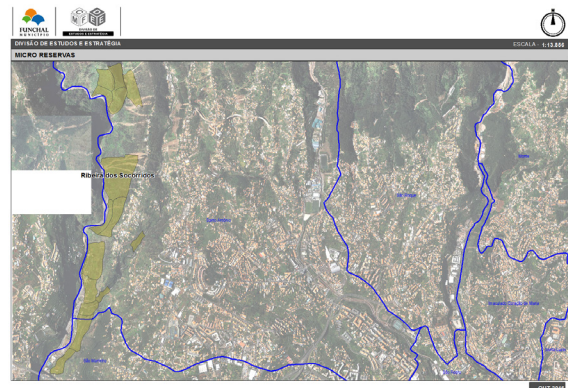


Fig. 2 – Ribeira dos Socorridos.



Fig. 3 – Ribeira de São João.

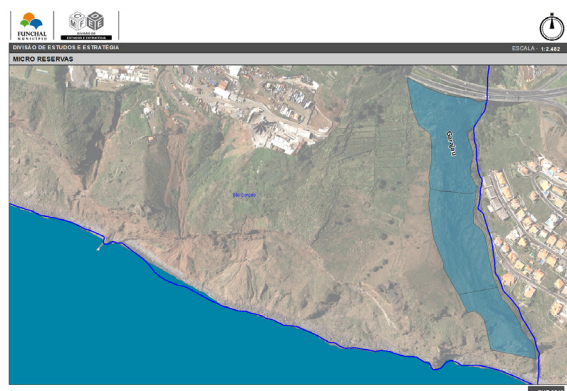


Fig. 4 – Ribeira de Gonçalo Aires.

Table 3 – Synphytosociological inventories higher values.

Parameter	Plots
<i>Euphorbietum piscatoriae</i>	F1
<i>Mayteno umbellatae-Oleetum maderensis</i>	D11
<i>Semele androgynae-Apollonietum barbujanae</i>	M1; P1
<i>Scrophulario hirtae-Salicetum canariensis</i>	Soc4
Native arboreal coverage	Soc4
Number of protected species	H4
IPEN	D11; Soc4

The other forest habitats of the Habitats Directive and associated communities identified in the inventories are the *Euphorbietum piscatoriae* (scrub community of Madeiran tree-spurge) and the *Mayteno umbellatae – Oleetum maderensis* (microforest of Madeiran oleaster). The *Euphorbietum piscatoriae* has the highest coverage rate in the F1 portion of **Garajau**, with 62% (the three plots of **Garajau** – Fig. 5 – have a coverage of *Euphorbietum piscatoriae* ranging from 40% to 62% in 2016, values that are only matched by some plots of **Pináculo**) and the *Mayteno umbellatae – Oleetum maderensis* community has a maximum of 40% in the D11 portion of **Chão da Loba** (Table 3).

**Fig. 5** – Garajau.

In addition to forest habitats were also identified other habitats included in the Habitats Directive: *Myrto communis – Hypericetum canariensis* (DH 9360), *Artemisio argenteae – Genistetum tenerae* (DH 5330), *Scrophulario hirtae – Salicetum canariensis* (DH 9360), *Sedo nudi – Aeonietum glutinosae* (DH 1250), and *Musschiaetum aureae* (DH 1250) – Fig. 6. In vertical zones of waterfalls and walls of trickling water or weak and laminar stream, there is the *Deschampsietum argenteae*, a madicolous Madeiran endemic community, dominated by the Madeiran

endemism *Deschampsia argentea* (Lowe) Lowe.

After calculating the Natural Areas Protection Index (IPEN), it was observed that the plots with the highest value are in **Ribeira dos Socorridos** (Soc4), an area that also has the largest spot of *Scrophulario hirtae – Salicetum canariensis*, and **Chão da Loba** (D11) with IPEN = 11. Next are the H4 portion of **Pináculo**, **Ribeira de Gonçalo Aires** (P1) and Soc3, Soc7, Soc8, Soc12 and Soc13 plots of **Ribeira dos Socorridos**, with IPEN = 7. IPEN, being an index that value forest areas, depreciates all plots with vertical slopes where forests cannot occur and where soil conditions allow only the existence of rupicolous vegetation like *Musschiaetum aureae* (Fig. 6), or, in paraclimax situation, communities of *Euphorbietum piscatoriae*.

**Fig. 6** – *Musschiaetum aureae* in Pináculo.

From the ranking of phytosociological inventories it is detected that the portion with the largest number of endemic species is in **Pináculo** (H3A), with 7 taxa, followed by the valley of **Ribeira dos Socorridos** (Soc1A) and **Ribeira de Gonçalo Aires** (P1A), with 4 endemics.

When the protected rate is concerned, several plots have the presence of one of the protected species: D11A portion of **Chão da Loba**, G3A of **Lazareto**, H3A of **Pináculo**, P1A of **Ribeira de Gonçalo Aires** and Soc1A and Soc7A of **Ribeira dos Socorridos**.

As to the native tree coverage of the different areas, it was verified that, the phytosociological inventory, where a higher percentage was obtained, was held in place P1B of **Ribeira de Gonçalo Aires**, with 65% coverage. The second highest was 60%, belonging to the site D11A, in the area of **Chão da Loba**. All other values are much lower (8% in area G3A of **Lazareto**), which shows the absence of large native tree spots within the project perimeter, with rather small clumps in more inaccessible places, far from human action.

The inventories carried out in the valley of *Ribeira dos Socorridos* showed that this area has great floristic interest (higher *taxa* protected concentration by each type of inventory, the presence of a priority forest habitat in 9 of 15 sinphytosociological inventories performed, presence of riparian community of *Salix canariensis* (*Scrophulario hirtae* – *Salicetum canariensis*) (Fig. 7), the largest native tree cover by sinphytosociological inventory and the plot with higher IPEN: Soc4.



Fig. 7 – *Scrophulario hirtae* – *Salicetum canariensis* in Ribeira dos Socorridos.

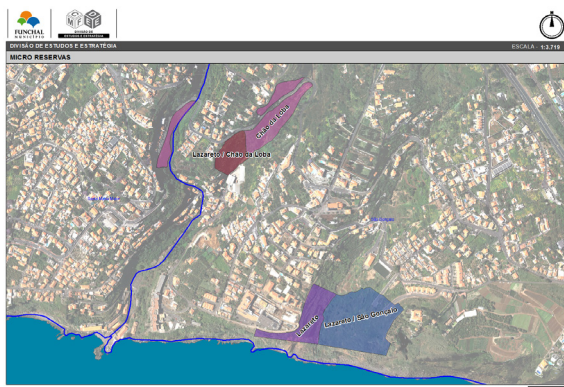


Fig. 8 – Lazareto-São Gonçalo and Chão da Loba.



Fig. 9 – Ribeira de São João.

The *Lazareto* area (Fig. 8), besides having in its floristic catalogue, the presence of *Chamaemeles coriacea*, a priority species of Habitat Directive, also has the presence of *Rumex simpliciflorus* Murb. var. *maderensis* (Murb.) Samuelson, a Madeiran endemism classified as “very rare” by JARDIM & FRANCISCO (2000).

The area under study in *Chão da Loba* (Fig. 8), consisting in two valleys, exhibits the plot with the highest percentage of Macaronesian endemic tree cover, both in sinphytosociological level as in phytosociological level. This value corresponds to a grove of *Olea maderensis* (Lowe) Rivas Mart. & Del Arco (*Mayteno umbellatae* – *Oleetum maderensis* community) disposed in the valley head, where the insolation is highest and humidity lowest. The valley floor is occupied by specimens of *Apollonias barbujana* (Cav) Bornm. and *Laurus novocanariensis* Rivas Mart., Lousã, Fern. Prieto, E. Días, J. C. Costa & C. Aguiar (*Semele androgynae* – *Apollonietum barbujanae* community) in an edapho – hygrophilous situation (with higher humidity and lower temperature).

The Canary laurel forest community (*Semele androgynae* – *Apollonietum barbujanae*), priority habitat of the Habitats Directive (the only priority habitat found during the inventory), has its maximum in the areas of *Ribeira de São João* (Fig. 9) and *Ribeira de Gonçalo Aires* (Fig. 10).



Fig. 10 – Ribeira de Gonçalo Aires.

The *Pináculo* (Fig. 11), Site of Community Importance (SCI) of the Natura 2000 Network, is the only protected space in the study area and it was the space where the largest number of *taxa* protected by sinphytosociological inventory was found.

Inventoried areas are located in stream valleys and cliffs, orographic protections that prevented their destruction by human activities, taking refuge there

examples of native vegetation that disappeared from the remaining space through the agricultural and urban development (Fig. 12). These areas need protection because, increasingly, the pressure on them is intensified, either by nearby buildings, trash and debris dumped in these areas and competition with alien species.

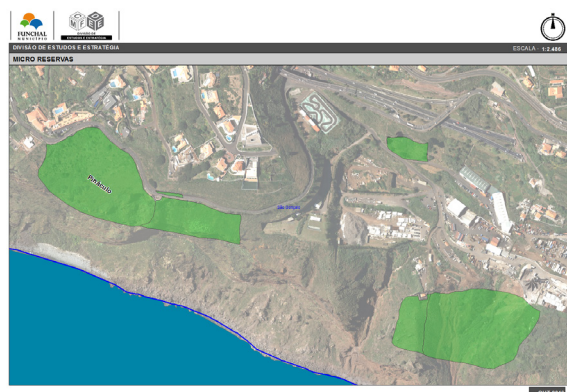


Fig. 11 – Pináculo.



Fig. 12 – Occupation of Ribeira dos Socorridos valley.



Fig. 13 – Area that suffered a landslide.

In addition to these threats, there are other factors (natural or anthropogenic) that may affect the existing *taxa* in these areas, such as landslides (Fig. 13) and droughts (MARTIN *et al.*, 2008).

The quality of these different sites can be improved through various interventions: establishment of trails and security areas, space cleaning, eradication of invasive species, introduction and reintroduction and reinforcement of native *taxa*. The implementation of these measures will contribute to the maintenance of natural flora diversity and these areas should be included in a PMR network (LAGUNA, 2001; LAGUNA *et al.*, 2004) and preserved from increasing pressures.

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