

**Sites:** 1; Ribeira da Madalena ca. Loreto; 2,3,4: between Paúl and Loreto; 5: stream south of Pico Ferreiro; 6: south of Pico Tapeiro

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#### XXXVI: The vegetation of Madeira: IV - Coastal Vegetation of Porto Santo Island (Archipelag of Madeira)

The littoral geomorphology of the Porto Santo Island is of paramount importance in the coastal phytocoenosis assemblage: the southern part of the island has an 8 km long sand beach with littoral sandstone platforms in its eastern extreme; sandstone or volcanic (mostly trachites) sea cliffs predominate in the rest of the island; in the northern part of the island, near the airport, there is an elevated dune (more than 150 m above sea level), related to an ancient island tilt. In the Porto Santo's beach and cliff ecosystems, we found four new associations. All of them are finicolous associations in the context of their alliances, with low floristic diversity and presided by small area endemics.

**1. *Senecio incrassati-Mesembryanthemum crystallini*** Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã associatio nova hoc loco [*typus*: table 1, relevé #3] –

it is a halonitrophylous succulent annual prostrate plant community associated with dune systems disturbed by trampling or by the input of nitrogen compounds, either of natural or artificial origin. It is very similar to the canarian *Mesembryanthemum cristalinum* and is characterized by the two nominal plants together with *M. nodiflorum* and *Beta procumbens*. The *Senecio incrassati - Mesembryanthemum cristalinum* is not exclusive of mobile substrata: was also observed in Ponta de S. Lourenço (Madeira) in compact soils (variant with *Aizoon canariensis*).

**Table 1** – *Senecio incrassati - Mesembryanthemum crystallini*

# of relevé	3	4	6	7
m.s.m.	ca. 2	ca.2	ca.3	ca.5
Area	4	4	16	12
Cover	60	60	90	70
<b>Characteristic combination</b>				
<i>Mesembryanthemum crystallinum</i>	4	4	3	2
<i>Senecio incrassatus</i>	1	1	2	+
<i>Beta procumbens</i>	1	2	3	1
<i>Mesembryanthemum nodiflorum</i>	.	.	.	4
<b>Characteristic of higher syntaxa</b>				
<i>Brachypodium distachyon</i>	.	.	+	.
<i>Bromus rigidus</i>	.	.	1	.
<i>Chenopodium murale</i>	.	.	+	.
<i>Asphodelus fistulosus</i>	.	.	1	.
<i>Emex spinosa</i>	.	.	1	1
<i>Euphorbia terracina</i>	.	.	+	.
<i>Lavatera cretica</i>	.	.	1	+
<i>Lolium rigidum</i>	.	.	2	.
<i>Medicago polymorpha</i>	.	.	1	.
<i>Scorpiurus muricatus</i>	.	.	.	+
<i>Sonchus tenerrimus</i>	.	.	+	.
<i>Spergularia marina</i>	.	.	+	.
<b>Companions</b>				
<i>Salsola kali</i>	+	+	.	.
<i>Hedypnois cretica</i>	.	.	1	.
<i>Cynodon dactylon</i>	.	.	+	.
<i>Cyperus rotundus</i>	.	.	+	.

Porto Santo, Vila Baleira: 3 and 4: near the harbour, 6, 7 fallow ground on sandy soil. Contact with Salsolo-Cakiletum.

[taxonomical nomenclature follows: PRESS & SHORT (1994) *Flora of Madeira*. BM. London. Sometimes names are shortened to the last infra-specific rank].

## 2. *Euphorbia paraliae*-*Lotetum glauci*

Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã associatio nova hoc loco [typus: table 2, relevé #9] –

this association stands mostly for the chamaephytic communities of secondary fixed "grey" dunes of southern Porto Santo and its dominated by the Madeira and Canaries Islands endemic *Lotus glaucus*. The *Euphorbia-Lotetum glauci* was also identified in the elevated dunes of northern Porto Santo [subass. *plantaginetosum maderensis*; typus subass. table 2, relevé #53] and in Ponta de S. Lourenço (Madeira).

**Table 2** - *Euphorbia paraliae*-*Lotetum glauci*

# of relevé	8	9	53	54	55	3	4
m.s.m.	ca. 2	ca. 2	ca. 40	ca. 40	ca. 40	140	145
Area	4	8	10	8	12	10	16
Cover	90	80	70	60	30	80	90
Slope	.	.	10	20	10	10	10
Aspect	.	.	W	W	W	E	SE
<b>Characteristic combination</b>							
<i>Crepis divaricata</i>	2	2	.	.	.	.	1
<i>Euphorbia paralias</i>	+	1	+	+	1	.	.
<i>Lotus glaucus</i>	3	4	2	2	2	3	4
<i>Polygonum maritimum</i>	+	1	+	1	1	2	1
<i>Lotus loweanus</i>	2	.	.	.	.	.	.
<i>Matthiola maderensis</i>	.	.	.	+	+	.	.
<i>Phyllis nobla</i>	.	.	1	1	+	.	.
<i>Plantago maderensis</i>	.	.	3	3	2	.	.
<i>Satureja thymoides</i>	.	.	+	+	.	.	.
<i>Senecio incrassatus</i>	.	+	+	1	+	2	+
<b>Companions</b>							
<i>Asphodelus fistulosus</i>	.	1	.	.	.	.	.
<i>Carpobrotus edulis</i>	.	.	+	.	+	.	.
<i>Cynodon dactylon</i>	2	.	.	.	.	.	.
<i>Euphorbia terracina</i>	.	1	.	.	+	.	.
<i>Hedypnois cretica</i>	1	1	.	.	.	+	1
<i>Lolium rigidum</i>	.	+	.	.	.	.	.
<i>Scorpiurus muricatus</i>	1	+	+	.	.	.	.
<i>Sonchus oleraceus</i>	+	+	.	.	.	.	+
<i>Calendula maderensis</i>	.	.	.	.	.	2	+

8. Porto Santo: Calheta. Secondary dune. Contact with *Euphorbia paralias*. Transitional facies to *Lotetum loweani*.

9. Porto Santo: Calheta. Secondary dune. Contact with *Euphorbia paralias*. Transitional facies to *Senecio-Mesembrianthemetum*.

53, 54, 55. Porto Santo: Fonte da Areia. Elevated dunes [subass. *plantaginetosum maderensis*].

3 and 4: Madeira, Ponta de S. Lourenço, Dunas da Piedade.

3. ***Polygono maritimi-Euphorbietum paraliae*** Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã associatio nova hoc loco [typus: table 3, relevé #15] – primary dune community. This species-poor community stands for one of the southernmost extremes of *Ammophiletea* vegetation in the Mediterranean Region. Although only higher rank characteristic taxa are present, the uniqueness of its biogeographical context allows recognizing it as an autonomous association. The absence of *Ammophila arenaria* subsp. *australis* is a noteworthy feature of the floristic combination.

**Table 3** - *Polygono maritimi-Euphorbietum paraliae*

# of relevé	10	13	15	16
m.s.m.	ca. 1	ca. 1	ca. 1	ca. 2
Area	6	8	3	2
Cover	20	15	60	50
<i>Polygonum maritimum</i>	2	1	2	.
<i>Euphorbia paralias</i>	1	2	3	3
<i>Calystegia soldanella</i>	.	.	.	3
<i>Plantago coronopus</i>	.	+	.	.
<i>Sonchus oleraceus</i>	.	.	+	.

10. Porto Santo: Calheta, beach. Primary (front) dune.

13, 15, 16. Porto Santo: a W da Calheta, beach. Primary (front) dune.

4. ***Lotetum loweani*** Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã associatio nova hoc loco – [typus: table 4 relevé #14] is a phytocoenosis only known from the Porto Santo's beach in elevated compact sandstone platforms. It is characterized by the Porto Santo endemics *Lotus loweanus*.

5. ***Limonietum pyramidati*** Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã associatio nova hoc loco [typus: table 5 relevé #51] - this

chasmophytic phytocoenosis is found under the influence of the sea salt spray in the Porto Santo's northern arenitic cliffs. The *Limonietum pyramidati* characteristic combination is constituted by a small number of species among of wich stands out the microendemic *Limonium pyramidatum* (Lowe) Brullo & Erben.

**Table 4** - *Lotetum loweani*

# of relevé	11	12	14
m.s.m.	ca. 5	ca. 5	ca. 5
Area	6	6	8
Cover	50	50	25
<b>Characteristic combination</b>			
<i>Lotus loweanus</i>	3	3	3
<i>Crithmum maritimum</i>	.	(+)	2
<i>Frankenia laevis</i>	1	+	.
<i>Senecio incrassatus</i>	1	.	.
<b>Companions</b>			
<i>Gastridium ventricosum</i>	1	+	.
<i>Euphorbia paralias</i>	.	.	+
<i>Hedypnois cretica</i>	.	.	+
<i>Mesembrianthemum crystallinum</i>	+	1	.
<i>Plantago coronopus</i>	.	+	.
<i>Polygonum maritimum</i>	.	+	.
<i>Sonchus tenerrimus</i>	+	.	.
<i>Sonchus oleraceus</i>	+	.	.

11. Porto Santo: Calheta. Flat sandstone platform, a cliff 4m high, with lime-rich evaporites.

12. Porto Santo: a W da Calheta. Flat sandstone platform. Partially covered by mobile sand.

14. Porto Santo: a W da Calheta. Flat sandstone platform. Partially covered by mobile sand.

6. ***Euphorbio paraliae-Lotion glauci*** Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã aliancia nova hoc loco - [typus aliancia: *Euphorbio paraliae-Lotion glauci* Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã ass. nova; characteristic species: *Lotus glaucus*, *Crepis divaricata*]. Moreover, we propose that the few *Crucianelletalia* [AMMOPHILETEA] communities of secondary dunes in the Canarian Sub-Region to be grouped in a particular alliance. *Nota bene*: Ecological affinities

with *PEGANO-SALSOLETEA* (*Forskaleo-Rumicetalia lunariae*) and *POPLYCARPO-TRAGANETEA MOQUINII* (*Traganion moquinii*) could be taken on account, but *Lotus glaucus* communities have their main phytosociological optimum in secondary dune systems].

**Table 5** – *Limonietum pyramidati*

# of relevé	50	51	52
m.s.m.	ca. 25	ca. 15	ca. 15
Area	4	10	15
Cover	20	10	40
Slope	15	30	30
Aspect	N	N	N
<b>Characteristic combination</b>			
<i>Crithmum maritimum</i>	2	1	1
<i>Limonium pyramidatum</i>	1	2	2
<i>Frankenia laevis</i>	3	1	2
<i>Crepis divaricata</i>	.	.	.
<i>Lotus glaucus</i>	1	.	.
<i>Matthiola maderensis</i>	.	.	1
<i>Senecio incrassatus</i>	+	+	+
<i>Tolpis suculenta</i>	.	+	+
<b>Companions</b>			
<i>Anagallis arvensis</i>	.	.	.
<i>Carpobrotus edulis</i>	.	.	3
<i>Herniaria cinerea</i>	+	.	.
<i>Leontodon taraxacoides</i>	+	.	.
<i>Melilotus indica</i>	+	1	+
<i>Mesembryanthemum nodiflorum</i>	.	.	+
<i>Mesembryanthemum crystallinum</i>	.	.	+
<i>Phagnalon hansenii</i>	+	.	.
<i>Plantago coronopus</i>	+	+	+
<i>Scorpiurus muricatus</i>	2	.	.
<i>Sonchus tenerrimus</i>	+	.	.
50, 51, 52: Porto Santo: Fonte da Areia, sea cliff.			

**Table 6** - *Salsolo kali-Cakiletum aegyptiacae*  
Costa & Mansanet 1981

# of relevé	5
m.s.m.	1
Area	4
Cover	30
<i>Cakile maritima</i>	2
<i>Salsola kali</i>	2

5. Porto Santo: Vila Baleira, beach  
Contact with *Senecio-Mesembryanthemum crystallini*.

[taxonomical nomenclature follows: PRESS & SHORT (1994) *Flora of Madeira*. BM. London; and also the checklist of taxa of RIVAS-MARTÍNEZ, DÍAZ, F. DEZ-GONZÁLEZ, IZCO, LOIDI, LOUSA & PENAS (2002) - *Itinera Geobotanica* 15(2) : 697-813. Sometimes names are shortened to the last infra-specific rank].

7. ***Salsolo kali* - *Cakiletum aegyptiacae*** Costa & Mansanet 1981 [table 6] The first band of terrestrial vascular vegetation, where tidal organic debris accumulate, is represented by this annual community.

#### Sintaxonomy

*STELLARIETEA MEDIAE* Tüxen, Lohmeyer & Preising ex von Rochow 1951

Chenopodio-Stellarienea Rivas Goday 1956

Chenopodietalia muralis Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936 em. Rivas-Martínez 1977

***Mesembryanthemion crystallini*** Rivas-Martínez, Wildpret, Del Arco, O. Rodríguez, Pérez de Paz, García Gallo, Acebes, T.E. Díaz & Fernández-González 1993

*Senecio incrassati-Mesembryanthemum cristallini* Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã & Lousã ass. nova

*CRITHMO-STATICETEA* Br.-Bl. in Br.-Bl., Roussine & Nègre 1952

Crithmo-Staticetalia Molinier 1934

***Helichryson obconico-devium*** Rivas-Martínez, Capelo, J.C. Costa, Lousã, Fontinha, Jardim & Sequeira 2002

*Lotetum loweani* Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã ass. nova

*Limonietum pyramidati* Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã ass. nova

*AMMOPHILETEA* Br.-Bl. & Tüxen ex Westhoff, Dijk & Passchier 1946

Ammophiletalia Br.-Bl. 1933

***Ammophilion australis*** Br.-Bl. 1921 corr.

Rivas-Martínez, Costa & Izco in Rivas-Martínez, Lousã. T.E. Díaz, Fernández-González & J.C. Costa 1990

*Polygono maritimi-Euphorbietum paraliae*

Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã ass. nova

Crucianelletalia Sissingh 1974

***Euphorbio paraliae-Lotion glauci*** Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã all. nova

*Euphorbio paraliae-Lotetum glauci* Jardim,

Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã ass. nova

*lotetosum glauci*

*plantaginetosum maderensis* Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã subass. nova.

CAKILETEA MARITIMAE Tüxen & Presing ex Br.-Bl. & Tüxen 1952

*Cakilion maritimae* Pignatti 1953

*Salsolo kali-Cakiletum aegyptiacae* Costa & Mansanet 1981

**Aknowledgment:** the authors would like to thank the most valuable support of the *Direcção Regional de Florestas da Secretaria Regional do Ambiente e Recursos Naturais da Região Autónoma da Madeira*.

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**XXXVII: The vegetation of Madeira: V - *Lino stricti-Stipetum capensis*, ass. nova and *Vicio costei-Echietum plantagini*, ass. nova, two new semi-nitrophylous associations from Porto-Santo Island (Archipelag of Madeira)**

Porto Santo is a deeply eroded oceanic island. The human uses of the territory led to a massive destruction of its primitive vegetation cover and its substitution by new types of vegetation constituted by plants adapted to the novel perturbation regimes introduced by human settlers. A vegetation cover once dominated by trees or shrubs that evolved isolated from herbivory during millions of years, was replaced since the XV century by herbaceous anthropogenic vegetation, dominated by neophytes, adapted to perturbation events imposed by mammal herbivores (goats and rabbits) and by dry-farming agriculture (mostly barley). Agriculture and grazing together with low climatic precipitation levels promoted subnitrophylous types of herbaceous vegetation. So, today's Porto Santo vegetation is largely dominated by two, yet undescribed, herbaceous subnitrophylous phytocoenosis: *Lino stricti-Stipetum capensis* and *Vicio costei-Echietum plantagini*.

1. ***Lino stricti-Stipetum capensis*** Jardim, Sequeira, Capelo, Aguiar, J.C. Costa, Espírito-Santo & Lousã associatio nova hoc loco [typus: table 1 relevé #17]. This is the most conspicuous vascular plant community in Porto Santo [it is also present on Ponta de São Lourenço (NE of Madeira Island ) and on dryer and warmer slopes of the southern Madeira]. It ranges from a basal infra-mediterranean semi-arid stage to the thermomediterranean dry inferior stage.