Notas do Herbário da Estação Florestal Nacional (LISFA): Fasc. XXIV

∫2. *De Vegetatio Lusitana Notae*- V

10. Perennial vegetation of coastal sand-dunes in northern Portugal

Introduction

Coastal areas of Northern Portugal are dominated by sand-dune systems with a remarkable floristical and phytocoenotic diversity, which is mostly due to the (bio) climatic transitional situation.

Recent studies on these coastal dunes by Lomba (M.Sc. thesis, Univ. Porto, 2003), Silva (M.Sc. thesis, Univ. Porto, 2006) and Lomba et al. (Journal of Coastal Research, in press) have shown that:

i) Though the number of floristic endemics is comparatively lower than in neighbour mediterranean areas, most vegetation types are endemic, particularly in interior dunes;

ii) There is a gradual southwards replacement of Atlantic species and vegetation types by Mediterranean elements;

iii) Due to the non-coincident nature of most floristic and phytocoenotic changes (cf. Table I), territorial phytogeography is complex, both in its causal processes (climate, geology) and in its spatial expression.

In this short note, we provide a brief overview of coastal sand-dune perennial vegetation in Northern Portugal and describe three new, previously unreported syntaxa.

Overview of vegetation types and regional phytogeography

According to geomorphology and vegetation, dunes in Northern Portugal can be divided in two major types: mobile dunes (including embryonic dunes and foredunes) and interior (or secondary) dunes.

In mobile dunes, strong local environmental gradients tend to obscure biogeographical patterns, so no more than one perennial vegetation type occurs in both embryonic dunes (*Euphorbio-Elytrigietum boreo-atlanticae*)

and foredunes (*Othantho-Ammophiletum australis*).

On the contrary, interior dunes include a wide variety of perennial vegetation types. In dry habitats, as many as six associations can be found (Table I): i) nanochamaephytic vegetation (*Ammophiletea: Iberidetum procumbentis*), ii) perennial acidophilous grasslands (*Koelerio-Corynephoretea: Jasiono-Corynephoretum maritimi* and *Sedo-Corynephoretum maritimi*), iii) dwarf shrublands (*Calluno-Ulicetea: Ulicetum latebracteato-minoris*; *Cisto-Lavanduletea: Stauracantho-Corematetum albi*). The distribution of these six associations tends to exhibit a clear phytogeographic pattern, with Furadouro (Ovar) as a transitional area between the extreme North (Galaico-Português sector) and the dune-systems located along (and south of) the Aveiro Lagoon (Divisório Português sector). Vegetation of dune slacks is of less phytogeographical value, since only silver-willow (*Salix arenaria*) thickets (*Rhamno-Prunetea: Holoschoeno-Salicetum arenariae*) and brown-headed club-rush (*Holoschoenus australis*) formations (*Molinio-Arrhenatheretea: Holoschoeno-Juncetum acuti*) occur throughout the area.

New vegetation types

i) *Sedo sediformis-Corynephoretum maritimi* as. nova hoc loco (syntype: Table II, relevé n. 7)

Mediterranean acidophilous perennial grasslands predominated by *Corynephorus canescens* var. *maritimus*. Regarding the miniensian association *Jasiono sabulariae-Corynephoretum maritimi*, these coastal-lusitanean grasslands are well differentiated by the mediterranean taxa *Sedum sediforme* (co-dominant), *Cyperus capitatus* and *Antirrhinum* majus subsp. *cirrhigerum*.

ii) *Iberidetum procumbentis sedetosum sediformis* subas. nova hoc loco (syntype: Table III, relevé n. 6)

This southern form of the Northwest Iberian nanochamaephyte-dominated association *Iberidetum procumbentis* is endemic to the coastal-lusitanean dunes between Furadouro (Ovar) and Figueira da Foz, and is well discriminated from the typical form of the association (*iberidetosum procumbentis*) by the mediterranean taxa *Sedum sediforme, Antirrhinum majus subsp. cirrhigerum* and *Corema album*.

iii) *Ulicetum latebracteato-minoris cistetosum salviifolii* subas. nova hoc loco (syntype: Table IV, relevé n. 5)

Miniensian gorselands predominated by Ulex europaeus subsp. latebracteatus. When colonising coastal sand-dunes, these formations exhibit floristic peculiarities which discriminate them from the typical inland *Ulicetum latebracteato-minoris*: i) the occurrence of the mediterranean thermophilous shrubs *Cistus salvifolius* (co-dominant) and *Daphne gnidium*; ii) the rarity of *Ulex minor* and of most *Ericaceae*; and iii) the regular occurrence of sand-dune taxa like *Corynephorus canescens* var. *maritimus*, *Pancratium maritimum* and *Carex arenaria*.

Syntaxonomic scheme (perennial sand-dune vegetation in Northern Portugal)

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
Ammophilenion australis Rivas-Martínez & Géhu *in* Rivas-Martínez, Costa, Castroviejo & E. Valdês 1980 *nom. mut. propos.* Rivas-Martínez *et al.* 2002

Otantho maritimi-Ammophiletum australis Géhu & Tüxen 1975 *corr.* Fernández Prieto & T.E. Díaz 1991
Honckenyo peploidis-Elytrigion boreoatlanticae Tüxen *in* Br.-Bl. & Tüxen *nom.mut. propos.* Rivas-Martínez *et al.* 2002
Elytrigienion boreoatlanticae Rivas-Martínez & Géhu in Rivas-Martínez, Costa, Castroviejo & E. Valdês 1980 *nom. mut. propos.* Rivas-Martínez *et al.* 2002
Euphorbio paraliae-Elytrigietum boreoatlanticae Tüxen in Br.-Bl. & Tüxen 1952 *nom. mut. propos.* Rivas-Martínez *et al.* 2002
Crucianelletalia maritimae Sissingh 1974
Helichrysion picardii (Rivas-Martínez, Costa & Izco in Rivas-Martínez, Lousã, T. E. Díaz, Fernández-González & J.C. Costa 1990) *ex* Rivas-Martínez, Fernández-González & Loidi 1999
Iberidetum procumbentis Bellot 1996
sedetosum sediformis *subas. nova hoc loco*

CALLUNO-ULICETEA Br.-Bl. & Tüxen ex Klika & Hadač 1944
Ulicetalia minoris Quantin 1935
Daboecion cantabricae (P. Dupont ex Rivas-Martínez 1979) Rivas-Martínez, Fernández-González & Loidi 1999
Ulicetum latebracteato-minoris *(Br.-Bl., P. Silva & Rozeira 1964) Rivas-Martínez 1979*
cistetosum salviifolii *subas. nova hoc loco*

CISTO-LAVANDULETEA Br.-Bl. in Br.-Bl., Molinier & Wagner 1940
Stauracantho genistoidis-Halimietalia commutati Rivas-Martínez, Lousã, T.E. Díaz, Fernández-González & J.C. Costa 1990
Coremation albi Rothmaler 1954
Stauracantho genistoidis-Coremetum albi *Br.-Bl.,* P. Silva & Rozeira 1964

CYTISETEA SCOPARIO-STRIATI Rivas-Martínez 1974
Cytisetalia scopario-striati Rivas-Martínez 1974
Ulici europaei-Cytision striati Rivas-Martínez, Báscones, Díaz, Fernandez-González & Loidi 1991
Ulici latebracteati-Cytisetum striati Rivas-Martínez *ex* J.C. Costa, Izco, Lousã, Aguiar & Capelo *in* J.C. Costa, Capelo, Lousã, Antunes, Aguiar, Izco & Ladero 2000
cytisetosum grandiflori J.C. Costa, J. Honrado & J. Izco in J.C. Costa, Aguiar, Capelo, Lousã, Antunes, J. Honrado, J. Izco & Ladero 2003

KOELERIO-CORYNEPHORETEA Klika in Klika & Novák 1941
Corynephoretalia canescentis Klika 1934
Koelerion arenariae Tüxen 1937 nom. mut. propos. Rivas-Martínez *et al.* 2002
Jasiono sabulariae-Corynephoretum maritimi A. Lomba, P. Alves & J. Honrado (in press)
Sedo sediformis-Corynephoretum maritimi *as. nova hoc loco*

MOLINIO-ARRHENATHERETEA Tüxen 1937
Holoschoenetalia Br.-Bl. ex Tchou 1948
Molinio-Holoschoenion vulgaris Br.-Bl. ex Tchou 1948
Brizo-Holoschoenenion (Rivas Goday 1964) Rivas-Martínez in Rivas-Martínez, Costa, Castroviejo & E. Valdés 1980
Holoschoeno-Juncetum acuti Rivas-Martínez & Costa in Rivas-Martínez, Costa, Castroviejo & E. Valdés 1980

RHAMNO-PRUNETEA Rivas Goday & Borja ex Tüxen 1962
Salicetalia arenariae Preising & Weber in Weber 1999
Holoschoeno australis-Salicion arenariae Neto, J.C. Costa, Capelo & J. Honrado 2004
Holoschoeno australis-Salicetum arenariae M.J. Martins & Penas *ex.* J.C. Costa, Neto, Capelo & Lousã 2002

Nomenclature

Scientific names of plant taxa are mostly according to Castroviejo *et al.* (Flora Iberica, 1986-2003) as far as issued, and Franco and Franco & Rocha Afonso (Nova Flora de Portugal, 1971-2003) for other groups. Syntaxonomic nomenclature for higher groups and phytogeographic units are according to Rivas-Martínez *et al.* (*Itinera Geobotanica* 15, 2002).

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Table I - Overview of perennial sand-dune vegetation types of dry habitats occurring in selected dune systems along Northern Portugal (adapted from Silva 2006)

<table>
<tr><th rowspan="2">Site (Northern Portugal)</th><th colspan="5">Vegetation type</th></tr>
<tr><th>Ammophiletea of embryonic dunes</th><th>Ammophiletea of foredunes (primary dunes)</th><th>Ammophiletea of interior (secondary) dunes</th><th>Acidophilous grasslands (Corynephoretea) of interior dunes</th><th>Dwarf shrublands (Calluno-Ulicetea, Cisto-Lavanduletea)</th></tr>
<tr><td>Apúlia</td><td rowspan="6">Euphorbio paraliae-Agropyretum junceiformis</td><td rowspan="5">Otantho maritimi-Ammophiletum australis</td><td>Iberidetum procumbentis iberidetosum procumbentis</td><td rowspan="2">Jasiono sabulariae-Corynephoretum maritimi</td><td>Ulicetum latebracteato-minoris cistetosum salviifolii</td></tr>
<tr><td>Furadouro</td><td rowspan="5">Iberidetum procumbentis sedetosum sediformis</td><td rowspan="5">Stauracantho genistoidis-Corematetum albi</td></tr>
<tr><td>Torreira</td><td rowspan="4">Sedo sediformis-Corynephoretum maritimi</td></tr>
<tr><td>S. Jacinto</td></tr>
<tr><td>Mira/Quiaios</td></tr>
<tr><td>Cova Gala</td><td>Loto cretici-Ammophiletum australis</td></tr>
</table>

Table II - *Sedo sediformis-Corynephoretum maritimi* as. nova.

Relevé n.	1	4	2	3	5	6	7	8	9	10	11	
N. of taxa	5	6	6	6	7	7	**8**	9	10	11	11	
Characteristic and differential taxa												
Corynephorus maritimus	2	3	3	3	2	2	**3**	2	2	3	2	**11**
Sedum sediforme	1	1	2	2	2	1	**2**	1	1	1	1	**11**
Herniaria robusta	.	+	1	+	1	+	**+**	1	+	1	1	**10**
Antirrhinum cirrhigerum	.	+	+	.	.	.	**1**	+	1	+	+	**7**
Cyperus capitatus	1	.	.	1	1	+	**1**	.	2	1	.	**7**
Malcolmia littorea	.	.	.	.	.	.	**.**	.	+	1	.	**2**
Paronychia argentea	.	.	.	.	.	.	**.**	1	.	.	1	**2**
Carex arenaria	.	.	.	.	.	.	**.**	.	1	.	.	**1**
Linaria decumbens	.	.	.	.	.	.	**.**	.	.	.	+	**1**
Companion taxa												
Vulpia alopecuros	.	1	.	1	+	1	**1**	2	1	1	1	**9**
Lagurus ovatus	.	.	.	1	+	.	**+**	1	.	+	.	**5**
Erodium bipinnatum	+	.	.	.	+	+	**+**	.	.	.	.	**4**
Silene niceensis	.	.	+	.	.	.	**.**	+	.	+	+	**4**
Xolantha guttata	.	+	.	.	.	.	**.**	1	.	.	1	**3**
Pancratium maritimum	.	.	+	.	.	.	**.**	.	+	.	.	**2**
Seseli tortuosum	.	.	.	.	.	.	**.**	.	+	1	.	**2**
Aetheorhiza bulbosa	.	.	.	.		.	**.**	.	.	+	.	**1**
Calystegia soldanella	+	.	.	.	.	.	**.**	.	.	.	.	**1**
Euphorbia portlandica	.	.	.	.	.	.	**.**	.	.	.	+	**1**
Plantago coronopus	.		.	.	.	+	**.**	.	.	.	.	**1**
Reichardia gaditana	.	.	.	.	.	.	**.**	.	.	.	+	**1**

Sites:
Rel. 1: MIRA: north of Praia de Mira, 29TNE1779.
Rel. 2: FIGUEIRA DA FOZ: Cova Gala, 29TNE1141.
Rels. 3,4: JACCO1 AVEIRO: S. Jacinto, 29TNF2202.
Rels. 5,6: MIRA: north of Praia de Mira, 29TNE1779.
Rel. 7: AVEIRO: S. Jacinto, 29TNF2202.
Rels. 8,11: FIGUEIRA DA FOZ: Cova Gala, 29TNE1141.
Rels. 9,10: MURTOSA, Torreira, 29TNF2412.

Table III - *Iberidetum procumbentis sedetosum sediformis* subas. nova.

Relevé n.	1	2	3	5	4	6	7	8	9	10	11	
N. of taxa	8	11	12	13	13	**14**	14	16	18	18	19	
Characteristic taxa												
Ammophila arundinacea	1	+	1	1	+	**+**	1	1	3	1	1	**11**
Helichrysum picardii	2	2	2	3	2	**2**	3	2	2	2	2	**11**
Crucianella maritima	4	3	3	1	3	**2**	1	2	.	2	1	**10**
Pancratium maritimum	+	.	+	+	.	**.**	+	+	+	+	1	**8**
Artemisia crithmifolia	.	.	.	2	+	**.**	2	2	3	2	3	**7**
Medicago marina	.	.	1	1	1	**.**	2	.	1	1	1	**7**
Silene niceensis		1	.	.	+	**1**	+	.	1	+	+	**7**
Seseli tortuosum	.	.	2	.	2	**+**	.	.	2	1	1	**6**
Anagallis microphylla	+	.	.	+	+	**.**	.	.	+	+	.	**5**
Calystegia soldanella	.	+	+	.		**+**	+	.	.	.	+	**5**
Aetheorhiza bulbosa	.	.	.	.	.	**.**	.	.	2	1	.	**2**
Elytrigia boreo-atlantica		.	.	+	.	**.**	.	+	.	.	.	**2**
Eryngium maritimum	.	+	.	+	.	**.**	.	.	.	.	.	**2**
Iberis procumbens	.	1	.	.	.	**1**	.	.	.	.	.	**2**
Otanthus maritimus	.	+	.	.	+	**.**	.	.	.	.	.	**2**
Reichardia gaditana	.	.	.	.	.	**.**	+	+	.	.	.	**2**
Scrophularia frustescens	.	.	+	.	+	**.**	.	.	.	.	.	**2**
Differential taxa												
Sedum sediforme	2	1	1	1	2	**2**	1	1	2	1	1	**11**
Corema album	.	+	1	.	1	**+**	.	1	1	.	.	**6**
Antirrhinum cirrhigerum	.	1	.	.	.	**+**	.	+	.	1	+	**5**
Verbascum litigiosum	.	.	+	.	+	**.**	.	.	.	.	.	**2**
Companion taxa												
Vulpia alopecuros	+	.	.	1	.	**.**	+	1	1	+	1	**7**
Corynephorus maritimus	+	.	+	1	.	**.**	1	.	.	1	1	**6**
Herniaria robusta	.	.	.	+	.	**+**	.	.	.	1	+	**4**
Erodium bipinnatum	.	.	.	.	.	**.**	+	.	.	.	+	**2**
Jasione sabularia	.	.		.	.	**.**	.	.	1	+	.	**2**
Lagurus ovatus	.	.	.	.	.	**+**	.	.	.	.	+	**2**
Linaria decumbens	.	.	.	.	.	**+**	.	+	.	.	.	**2**
Malcolmia littorea	.	.	.	.	.	**.**	.	.	.	+	+	**2**
Plantago coronopus	.	.	.	.	.	**.**	.	.	2	+	.	**2**
Silene littorea	.	.	.	.	.	**+**	+	.	.	.	.	**2**
Carex arenaria	.	.	.	.	.	**.**	.	.	1	.	.	**1**
Cistus salviifolius	.	.	.		.	**.**	.	1	.	.	.	**1**

Table III – Cont.

Relevé n.	1	2	3	5	4	6	7	8	9	10	11	
N. of taxa	8	11	12	13	13	**14**	14	16	18	18	19	
Companion taxa												
Cyperus capitatus	.	.	.	.	.	.	.	1	.	.	.	**1**
Evax ramosissima	.	.	.	.	.	.	.	.	2	.	.	**1**
Hypochoeris radicata	.	.		.	.	.	.	.	1	.	.	**1**
Paronychia argentea	.	.	.	.	.	.	.	+	.	.	.	**1**
Polycarpon diphyllum	.	.	.	.	.	.	.	.	.	.	+	**1**
Sedum album	.	.	.	.	.	.		+	.	.	.	**1**
Senecio gallicus	.	.	.	.	.	.	.	.	.	.	+	**1**
Trifolium arvense	.	.		.	.	.	.	.	+		.	**1**

Sites:
Rel. 1: MIRA: south of Praia de Mira, 29TNE1677.
Rels. 2,6: AVEIRO: S. Jacinto, 29TNF2202.
Rels. 3,5: FIGUEIRA DA FOZ: Praia de Quiaios, 29TNE0952.
Rels. 4,7: MIRA: north of Praia de Mira, 29TNE1779.
Rels. 8: FIGUEIRA DA FOZ: Cova Gala, 29TNE1141.
Rels. 9: OVAR: Furadouro, 29TNF2723.
Rels. 10,11: MURTOSA, Torreira, 29TNF2412.

Table IV - *Ulicetum latebracteato-minoris cistetosum salviifolii* subas. nova.

Relevé n.	1	2	3	4	**5**	6	
N. of taxa	8	8	9	10	13	14	
Characteristic taxa							
Ulex latebracteatus	4	5	4	3	**4**	4	6
Ulex minor	1	.	1	.	.	.	2
Cistus psilosepalus	.	2	.	.	.	.	1
Cuscuta kotschyii	.	.	1	.	.	.	1
Differential taxa							
Cistus salviifolius	3	2	3	4	**3**	4	6
Carex arenaria	1	1	.	.	+	+	4
Daphne gnidium	.	.	2	1	**1**	+	4
Corynephorus maritimus	.	.	.	+	+	+	3
Pancratium maritimum	.	.	.	+	+	+	3
Ammophila arundinacea	.	.	.	+	+	.	2
Seseli tortuosum	.	.	.	+	+	.	2
Euphorbia portlandica	.	.	.	.	.	+	1
Helichrysum picardii	.	.	.	.	.	+	1
Myrtus communis	.	.	.	.	.	+	1
Companion taxa							
Quercus suber	.	.	1	+	**1**	+	4
Quercus robur	1	1	1	.	.	.	3
Rubus ulmifolius	.	2	.	.	+	+	3
Brachypodium rupestre	2	2	.	.	.	.	2

Table IV – Cont.

Relevé n.	1	2	3	4	**5**	6	
N. of taxa	8	8	9	10	13	14	
Companion taxa							
Briza maxima	.	.	1		+		2
Crataegus monogyna	.	.	.	+	.	+	2
Dactylis lusitanica	1	.	2	.	.		2
Leontodon taraxacoides	.	.	.	.	+	+	2
Scirpoides holoschoenus	.	.	.	+	.	+	2
Carpobrotus edulis	1	.	.	.	.	.	1
Lagurus ovatus	.	.	.	.	+	.	1
Pteridium aquilinum	.	2	.	.	.	.	1

Sites:
Rels. 1-3: VILA DO CONDE: Árvore, 29TNF2275.
Rels. 4-6: ESPOSENDE: Apúlia, 29TNF1991.