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Analysis of vegetation diversity in relation to the geomorphological characteristics in the Salento coasts (Apulia - Italy)

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Abstract
We here present a phytosociological study of the plant biodiversity of the coastal environments of an area of the Italian peninsula (the Salento peninsula – Apulia), in relation to the variations of the geomorphological characteristics. In particular, the low sandy coast environments were examined, with an analysis of the populations making up the vegetation successions of the xeroseres and hygroseres, the sandy coasts plated on hard calcarenitic rocks, the low calcarenitic cliffs and the limestone cliffs. This study has allowed the recognition of a high number of plant communities that are in chain contact on the same geomorphological context, and that determine the psammophilous, halophilous and subhalophilous chain successions characterizing the different coastal plant landscapes. This knowledge on succession will be important in the reconstruction of the coastal environments that have been strongly degraded by the human impact.

Key words: Apulia, coastal vegetation, geomorphology, Italy, Mediterranean vegetation, phytosociology.

Riassunto
Analisi della diversità vegetazionale in relazione alle caratteristiche geomorfologiche delle coste del Salento (Puglia, Italia). Viene presentato lo studio fitosociologico della biodiversità vegetale degli ambienti costieri di un settore meridionale della penisola italiana (Salento, Puglia) in relazione con la variazione delle caratteristiche geomorfologiche. In particolare, le analisi delle comunità delle coste basse sabbiose evidenziano due successioni ecologiche distinte in xeroserie e idroserie. Lo studio ha permesso di riconoscere un numero elevato di comunità vegetali che sono in contatto catenale nell'ambito dello stesso contesto geomorfologico e che determinano le successioni psammofile, alofile e sub alofile caratterizzanti i diversi paesaggi vegetali costieri. La conoscenza delle successioni risulta essere importante nella ricostruzione degli ambienti costieri che sono attualmente fortemente degradati a causa dell'impatto antropico.

Parole chiave: fitosociologia, geomorfologia, Italia, Puglia, vegetazione costiera, vegetazione mediterranea.

Introduction

The aim of the present study is to provide a contribution towards the better understanding of the phytocoenosis that have colonised the coastal areas, and to evaluate their levels of biodiversity in relation to the geomorphological characteristics.

The study area is located in Apulia, the region of the Italian peninsula that has the most extensive coastline (784 km; 487 miles). Several studies have previously contributed to the phytosociological knowledge of the Apulian coast, which is indispensable for the definition of the plant communities that form the coastal plant landscape; these include Lorenzoni and collaborators (1980, 1984), Caniglia *et al.* (1978, 1984), Géhu *et al.* (1984), Géhu & Biondi (1988), Corbetta *et al.* (1989), and Taffetani & Biondi (1992).

The territory that is the object of the present study is in a large part in the Salento area, with extensions along the Adriatic Sea to the north along the Brindisi coast and along the southern Bari coasts up to Polignano a Mare, and extensions towards the west along the arc of the Ionic Sea to Ginosa Marina. The coastal areas under investigation are made up of stretches of low sandy coast alternating with rocky areas with cliffs of various heights and lithological natures.

The lithotypes that make up the rocky coastal stretches are of different origins and geological natures, and go from tuff to calcarenite. This is interspersed with calcareous formations that are themselves of various origins and compositions, and dolomitic limestone and organogenic detritic limestone. As indicated in Fig. 1, these rocky formations alternate with stretches of low sandy coast that reach their greatest extent along the Ionian coast.

On the basis of the bioclimatic classification proposed by Rivas-Martinez *et al.* (1999), all of the examined climatic stations belong to the Mediterranean Bioclimate, with a pluviseasonal-oceanic bioclimate. With respect to the bioclimatic belt, and as can be seen in Tab. 1, the stations of Otranto, Gallipoli, Taranto and Brindisi belong to the upper thermomediterranean thermotype, while the stations of Bari Palese and Marina di Ginosa are to be referred to the low mesomediterranean thermotype.

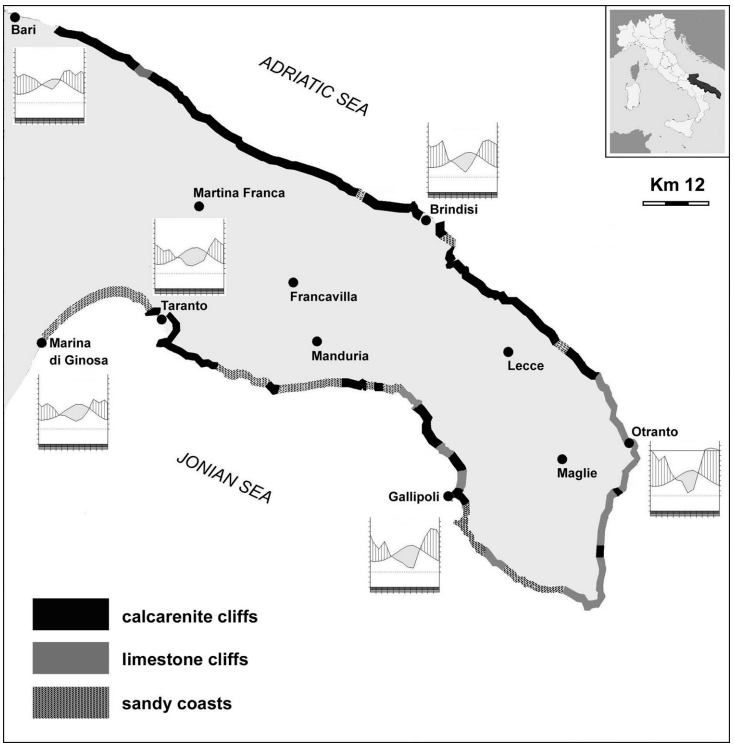


Fig. 1 - Alternation of rock formations along the Salento coasts

Materials and Methods

This study was carried out in accordance with the phytosociological method of the sigmatista school of Zurich-Montpellier that was later integrated (Tüxen 1978, Géhu & Rivas-Martìnez 1981, Biondi 1994, Rivas-Martìnez 1987, Géhu 1988, Theurillat 1992), with particular attention paid to the choice of the minimum surface of the communities and its uniformity. The relevés were made along a linear transect from the coast-line up to the inland areas.

The elaborations made for the classification of the phytosociological relevés were carried out according to cluster analysis methods (Anderberg 1973, Westhoff & van der Maarel 1978) using the Matedit programme.

For the arrangement of the plant associations in the upper hierarchic levels (see the syntaxonomic listing) the scheme proposed by Rivas-Martinez *et al*. (2002) for the Iberian Peninsula was mainly followed. For the identification of the plants, the Flora d'Italia (Pignatti 1982) and Flora Europaea (Tutin *et al*., 1993) were followed, and for the genus *Limonium*, the revision of Brullo (1988) was used.

Tab. 1 - Bioclimatic classification (on the basis of Rivas-Martinez *et al.* (1999) classification)

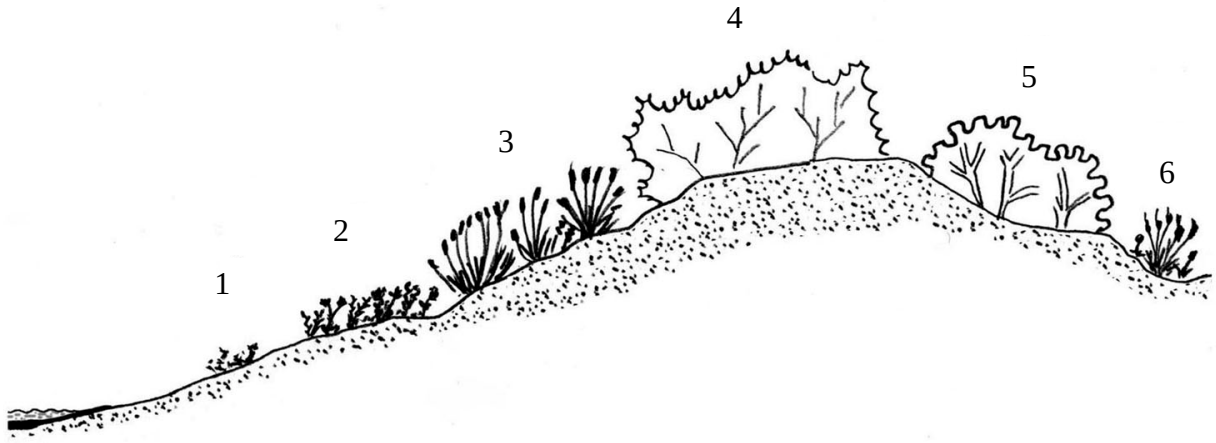
Station	Macrobioclimate	Bioclimate	Bioclimatic belt	
			thermotype horizons	*ombrotype horizons*
Bari Palese	Mediterranean	Pluviseasonal-oceanic	low mesomediterranean	low subhumid
Brindisi	Mediterranean	Pluviseasonal-oceanic	upper thermomediterranean	upper dry
Otranto	Mediterranean	Pluviseasonal-oceanic	upper thermomediterranean	low subhumid
Gallipoli	Mediterranean	Pluviseasonal-oceanic	upper thermomediterranean	upper dry
Taranto	Mediterranean	Pluviseasonal-oceanic	upper thermomediterranean	low dry
Marina di Ginosa	Mediterranean	Pluviseasonal-oceanic	low mesomediterranean	low dry

Vegetation: results and discussion

The low sandy coast (Fig. 2a-2b)

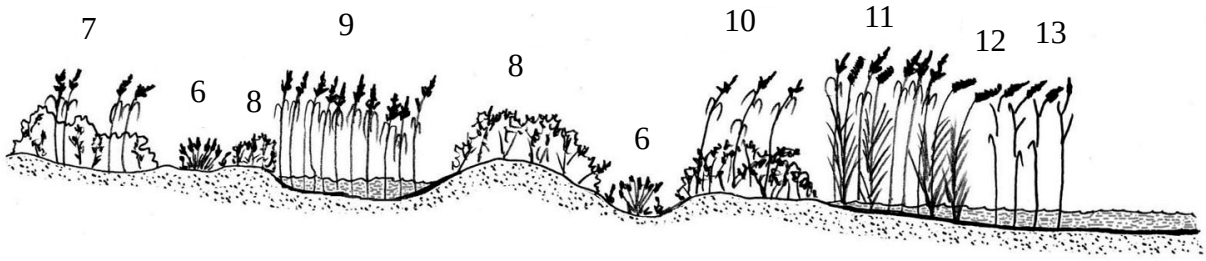
The sandy coasts that are largely exploited as holiday beaches are characterised by the presence of psammophilous plant communities that constitute a more or less complete chain succession. The transects in the Fig. 2a and 2b show the phytocoenotic succession that has developed from the aphytic zone (not colonised by vascular plants) to the humid zone behind the dunes. In particular, Fig. 2a describes the vegetation succession in the xeroseres: from the annual vegetation to the maquis of the fixed dunes while Fig. 2b shows the hydroseres of the retrodunal wet area. This complete succession has been found in a stretch of coast limited by Torre Specchia and San Foca and San Cataldo, while fragments of the same can be found in other areas that have been altered by human disturbance.

After the aphytic zone, which frequently has organic



a) xeroseres

Fig. 2a - Low sandy coasts. Distribution of the plant communities along a transect starting from the line coast, crossing the dunes and coming to the retrodunal salt area. 1. *Salsolo kali-Cakiletum maritimae*, 2. *Echinophoro spinosae-Elymetum farcti*, 3. *Echinophoro spinosae-Ammophiletum arenariae*, 4. *Asparago acutifolii-Juniperetum macrocarpae*, 5. *Phyllirea media* shrubbery, 6. *Schoeno nigricantis-Plantaginetum crassifoliae*



b) hydroseres

Fig. 2b - 6. *Schoeno nigricantis-Plantaginetum crassifoliae*, 7. *Soncho maritimi-Cladietum marisci myrtetosum communis*, 8. *Rubo ulmifolii-Myrtetum communis*, 9. *Soncho maritimi-Cladietum marisci*, 10. *Rubo ulmifolii-Myrtetum communis cladietosum marisci*, 11. *Schoeno nigricantis-Erianthetum ravennae cladietosum marisci*, 12. *Schoeno nigricantis-Erianthetum ravennae*, 13. *Phragmitetum communis*

and waste material deposited by the sea, there follows the annual alo-nitrophilous vegetation of the *Cakiletea maritimae* class with the *Salsolo kali-Cakiletum maritimae* association. With the formation of the first embryonal dunes, the vegetation of *Elymus farctus* of the *Echinophoro spinosae-Elymetum farcti* association develops, sometimes mixed with the *Sporoboletum arenarii* association that colonizes the base of the dunes in areas that are subjected to aeolian deflation and the entry of sea water (Tab. 2).

There are then the white dunes that are occupied by the *Echinophoro spinosae-Ammophiletum arundinaceae* association (Tab. 2) that is partly stabilised on the slope of the dune facing the sea, and for the completion of the psammophilious series there is the *Asparago acutifolii-Juniperetum macrocarpae* association (Tab. 3).

The land-facing slopes of the dunes provide a home for the low, very dense shrubbery of *Phyllirea media* that comes before a very large retrodunal depression in which it is possible to individuate the gradient of salinity of the water. This gradient gradually reduces towards the inland areas because of the entry of fresh water,

Tab. 2 - *Ammophiletea* Br.-Bl. & Tüxen ex Westhoff, Dijk & Passchier 1946

Rel. n.	1	2	3	4	5	6	7	8	P
Area in m²	10	30	8	20	40	30	30	30	r
Coverage in %	90	70	70	60	100	90	90	85	e
									s.
Echinophoro spinosae-Elymetum farcti Géhu 1987									
Agropyron junceum (L.) Beauv.	3.4	2.3	1.2	1.2	.	.	+	.	5
Echinophora spinosa L.	1.2	2.3	.	1.1	.	.	.	.	3
Sporoboletum arenarii Arènes 1924									
Sporobolus pungens (Schreber) Kunth	2.3	+	3.4	3.3	+	.	+	+.2	7
Echinophoro spinosae-Ammophiletum arundinaceae Géhu, Rivas-Martinez, & R. Tuxen 1972 in Géhu *et al.* 1984									
Ammophila arenaria (L.) Link subsp. arundinacea H. Lindb. fil.	.	.	.	.	5.5	5.5	4.4	4.5	4
Echinophora spinosa L.	.	.	.	.	2.2	1.2	1.2	2.3	4
Charact. species of the upper units									
Eryngium maritimum L.	1.2	1.2	+	1.1	1.2	+	.	1.2	7
Pancratium maritimum L.	+	2.2	.	.	+	.	1.1	1.2	5
Euphorbia paralias L.	.	.	.	.	2.2	2.3	+.2	2.2	4
Calystegia soldanella (L.) R. Br.	1.2	1.2	+	1.2	.	+	+	1.2	7
Lotus creticus	+	.	.	+	1.2	.	1.2	+.2	5
Cyperus kalli (Forsskal) Murb.	.	.	.	.	.	1.1	1.2	1.2	3
Otanthus maritimus (L.) Hoffmgg. et Link	1.3	.	.	.	.	.	+	2.2	3
Medicago marina L.	.	2.3	.	+	.	.	.	.	2
Other species									
Cakile maritima Scop.	.	.	+.2	+	.	.	.	.	2
Matthiola sinuata (L.) R. Br.	.	.	.	.	+.2	.	+	.	2
Reichardia picroides (L.) Roth var. maritima	+.2	.	.	.	.	.	+	.	2
Reichardia picroides (L.) Roth	.	.	.	.	1.1	.	.	.	1
Chondrilla juncea L.	.	.	.	.	.	1.1	.	.	1
Juniperus oxycedrus L. ssp. macrocarpa (S. et S.) Ball	.	.	.	.	.	+	.	.	1
Euphorbia terracina L.	.	.	.	.	.	+	.	.	1
Scabiosa rutifolia Vahl	.	.	.	.	.	+	.	.	1

Tab. 3 - *Asparago acutifolii-Juniperetum macrocarpae* (R. et R. Molinier 1955)
De Bolos 1962 razza tipo Géhu, Costa & Biondi 1990

Rel. n.	1	2	3	4	5	6	7	8	P
Altitude	0	0	0	0	0	0	0	0	r
Exposure	SW	-	-	-	-	-	-		e
Area in m²	100	200	200	200	200	300	200	200	s.
Coverage in %	100	100	100	100	100	100	100	100	
Juniperus oxycedrus L. ssp. macrocarpa (S. et S.) Ball	5.5	4.5	4.5	4.4	4.4	4.4	5.5	5.5	8
Charact. species of the upper units									
Phillyrea media L.	.	3.3	3.4	2.2	2.3	2.3	2.3	2.3	7
Rubia peregrina L.	1.2	1.2	.	1.2	1.2	2.2	2.3	.	6
Smilax aspera L.	1.2	4.4	2.2	+	.	2.3	1.2	.	6
Lonicera implexa Aiton	1.2	1.2	.	+	.	1.2	1.2	1.2	6
Pistacia lentiscus L.	1.2	2.3	.	.	+.2	1.2	2.3	.	5
Asparagus acutifolius L.	.	+	+	1.1	.	1.1	+	.	5
Pinus halepensis Miller	.	.	.	2.3	3.3	3.3	2.3	.	4
Prasium majus L.	+.2	1.2	.	.	.	.	2.2	.	3
Rhamnus alaternus L.	2.3	.	.	.	.	2.2	2.3	.	3
Quercus calliprinos Webb cfr.	.	2.2	.	.	.	+	.	.	2
Daphne gnidium L.	.	+	.	.	.	.	+	.	2
Myrtus communis L.	.	2.2	.	.	.	.	.	.	1
Calicotome infesta (C. Presl) Guss.	1.2	.	.	.	.	.	.	.	1
Phillyrea angustifolia L.	1.2	.	.	.	.	.	.	.	1
Ruscus aculeatus L.	.	1.2	.	.	.	.	.	.	1
Other species									
Agropyron junceum (L.) Beauv.	+.2	+.2	1.2	+.2	1.2	.	.	.	5
Cistus creticus L. ssp. creticus	.	.	.	1.2	+.2	1.2	1.2	.	4
Ammophila littoralis (Beauv.) Rothm.	.	1.2	.	+.2	1.2	.	.	1.2	4
Calystegia soldanella (L.) R. Br.	.	.	.	+.2	+.2	.	.	+	3
Sporobolus pungens (Schreber) Kunth	.	+	+.2	.	.	.	.	.	2
Pancratium maritimum L.	1.2	.	.	.	.	.	1.2	.	2
Carpobrotus acinaciformis (L.) L. Bolus	.	.	1.2	.	.	.	1.2	.	2
Cyperus kalli (Forsskal) Murb.	.	.	.	.	1.1	.	.	+	2
Cistus salvifolius L.	.	.	.	.	.	+.2	.	.	1
Osyris alba L.	.	1.2	.	.	.	.	.	.	1
Rosmarinus officinalis L.	.	.	.	.	.	1.2	.	.	1
Acacia saligna auct., non (Labill.) Wendl. fil.	.	.	.	.	.	.	1.2	.	1
Echinophora spinosa L.	.	.	.	+.2	.	.	.	.	1
Helichrysum italicum (Roth) Don	.	+	.	.	.	.	.	.	1
Rubus ulmifolius Schott	.	.	.	.	.	.	.	+	1
Holoschoenus romanus (L.) Fritsch	.	.	.	.	.	.	.	+	1

and therefore this is covered by various typologies of hygrophilous vegetation.

In Fig. 3 the dendrogram of the relevés concerning the retrodunal vegetation is shown, where it is possible to distinguish five principal clusters corresponding to the associations which are hereafter described.

The flat and slightly depressed retrodunal zone, which is flooded for long periods, is occupied by the Mediterranean subhalophilous *Soncho maritimi-Cladietum marisci* association (Tab. 4) - group 2 of the dendrogram- that with the new *myrtetosum communis* subassociation (rel. typus n. 5 of Tab. 4) - group 3- represents the connecting element with the *Phyllirea* shrubbery.

The retrodunal grassland has an undulating morphology, with the higher zones covered only for brief periods by the surface water and occupied by myrtle and bramble shrubbery of the *Rubo ulmifolii-Myrtetum communis* association (Tab. 5) - group 4 - recently described for Northern Sardinia (Biondi & Bagella, 2005) of which is here described the typicum subassociation *rubetosum ulmifolii* - group 4a - and the new *cladietosum marisci* subassociation (rel. typus n. 4 of Tab. 5) - group 4b - representing the element of change towards the dense halotolerant communities of *Erianthus ravennae* of the *Schoeno nigricantis-Erianthetum ravennae* association (Tab. 7) - group 5.

The microdepressions with superficial sand and silt are colonised by the *Schoeno nigricantis-Plantaginetum crassifoliae* association (Tab. 6) - grour 1 - while the *Schoeno nigricantis-Erianthetum ravennae* association is followed by the freshwater communities of the *Phragmitetum communis* association.

Erianthus ravennae is a Mediterranean-Turanian element, in Italy spread throughout the peninsular and the island coasts. It is a tall grass that can reach 4 m, and it presents a particular growth, as indicated by Braun-Blanquet & O. de Bolos (1957). Indeed, through the formation of strong tufts this plant withstands the floods, and through its strong vertical rhizome, the silting up. When the basal leaf rosette is buried by the sand, it decays, and some fibrous lateral roots form on the node, while on the surface a new leaf rosette is formed. This strategy allows the plant to withstand the repeated silting up over time, and in the same way, to remain in the sand.

The *Schoeno-Erianthetum ravennae* association was originally described by Pignatti (1952, 1953) for the eastern Venetian plain. It was also later found by Géhu *et al*. (1984) in some sites of the lagoon of Venice and at the mouth of River Sangro in the Abruzzo Region, and again by Vagge & Biondi (1999) along the coasts of northern Tuscany. Thus, the sites found in Apulia extend the Italian distribution area of the association.

It is very interesting to note the presence of *Ipomea sagittata* in these environments, an amphiatlantic and subtropical element, rare in its Italian distribution area, which appears to be disjointed (southern Latium, western Sicily, southern Apulia); it is included in the Red National List (Conti *et al*., 1997) as an entity in danger of extinction in the Italian territory. This deals with a rhizome geophyte that blooms in summer (from June to September), becoming very gaudy in this period. In Apulia the species is considered rare and present only in some coastal sites of Salento (Bianco *et al*., 1986).

The coastal tract between Torre Specchia and San Cataldo, where these sub-halophile retrodunal environments are most spread and best conserved, represents a new site of the distribution of this entity. This presence constitutes a further element for the conservation and the protection of these ecosystems.

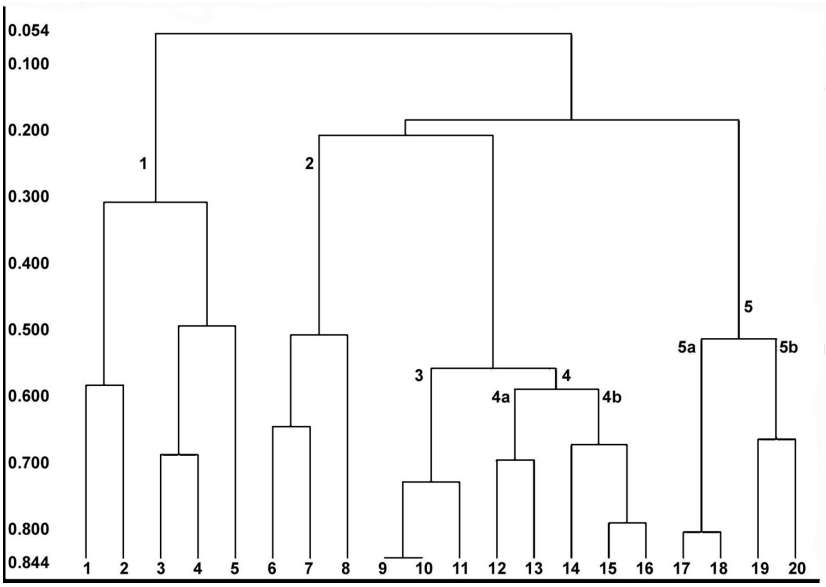


Fig 3 - Dendrogram of the retrodunal vegetation. 1. *Schoeno nigricantis-Plantaginetum crassifoliae*, 2. *Soncho maritimi-Cladietum marisci*, 3. *Soncho maritimi-Cladietum marisci myrtetosum communis*, 4. *Rubo ulmifolii-Myrtetum communis* (4a. typicum, 4b. *cladietosum marisci*), 5. *Schoeno nigricantis-Erianthetum ravennae* (5a. typicum, 5b. *cladietosum marisci*)

Tab. 4 - *Soncho maritimi-Cladietum marisci* (Br.-Bl. & Bolos 1957) Cirujano 1980
myrtetosum communis subass. nov. (rel. 4-6)

Rel. n.	1	2	3	4	5*	6	Pres.
Area in m²	30	80	20	100	100	100	
Coverage in %	100	100	100	50	100	100	
Charact. species of the association							
Cladium mariscus (L.) Pohl	5.5	5.5	4.4	2.2	1.2	1.1	6
Sonchus maritimus L.	1.2	.	2.2	1.2	+	+	5
Diff. species of the subassociation							
Myrtus communis L.	.	.	.	5.5	4.5	5.5	3
Erianthus ravennae (L.) Beauv.	.	.	.	2.2	1.2	+.2	3
Charact. species uf the upper units							
Phragmites australis (Cav.) Trin.	+.0	1.2	.	.	.	1.1	3
Carex hispida Willd.	.	.	1.2	.	.	+.2	2
Mentha aquatica L.	+	.	1.2	.	.	.	2
Other species							
Ipomoea sagittata Poiret	1.1	2.2	1.2	1.2	1.2	1.2	6
Inula viscosa (L.) Aiton	.	+	3.3	1.2	2.3	2.2	5
Schoenus nigricans L.	.	.	+.2	1.2	1.2	+.2	4
Juncus maritimus Lam.	2.3	.	+	.	.	.	2
Calystegia sepium (L.) R.Br.	.	1.2	.	.	.	+.2	2
Juncus acutus L.	.	.	1.2	.	.	.	1
Samolus valerandi L.	.	.	.	.	.	1.2	1
Cirsium creticum (Lam.) D'Urv. ssp. creticum	.	.	+	.	.	.	1
Phillyrea media L.	.	.	.	+.2	.	.	1
Rubia peregrina L.	.	.	.	+	.	.	1
Rubus ulmifolius Schott	.	.	.	.	.	1.2	1
Linum maritimum L.	.	.	.	+	.	.	1

Tab. 5 - *Rubo ulmifolii-Myrtetum comminis* Biondi & Bagella 2005
cladietosum marisci subass. nov. (rel. 3-5)

Rel. n.	1	2	3	4*	5	Pres.
Area in m²	100	70	40	60	150	
Coverage in %	100	100	100	100	100	
Charact. and diff. species of the association						
Myrtus communis L.	5.5	5.5	4.5	5.5	5.5	5
Rubus ulmifolius Schott	2.2	2.2	1.2	1.2	1.2	5
Ipomoea sagittata Poiret	.	1.2	+	1.1	+	4
Inula viscosa (L.) Aiton	+	1.2	.	1.2	.	3
Diff. species of the subassociation						
Cladium mariscus (L.) Pohl	.	+	2.3	2.2	1.2	4
Chract. specie of the upper units						
Phillyrea media L.	.	1.2	1.2	1.2	+	4
Pistacia lentiscus L.	1.2	+.2	.	+	1.2	4
Rubia peregrina L.	.	.	2.3	1.2	1.2	3
Lonicera implexa Aiton	.	.	1.2	+	+	3
Daphne gnidium L.	.	.	.	+	.	1
Other species						
Schoenus nigricans L.	1.2	+	+.2	1.2	1.2	5
Phragmites australis (Cav.) Trin.	.	+	.	1.1	+	3
Holoschoenus romanus (L.) Fritsch	+.2	.	.	+.2	.	2
Gladiolus palustris Gaudin	.	.	.	+	+	2
Sonchus maritimus L.	.	.	.	+	.	1
Calystegia sepium (L.) R.Br.	.	+.2	.	.	.	1
Plantago maritima L.	.	.	.	+	.	1
Spartina juncea (Michx.) Willd.	.	.	2.2	.	.	1
Carex extensa Good.	+	.	.	.	.	1
Juncus maritimus Lam.	.	.	.	.	+	1
Elytrigia atherica (Link) Kerguélen ex Carr.-Mart.	.	+	.	.	.	1
Vitis vinifera L.	.	1.2	.	.	.	1
Pteridium aquilinum (L.) Kuhn	.	.	.	.	+	1

Tab. 6 - *Schoeno nigricantis-Plantaginetum crassifoliae* Br.-Bl. in Br.-Bl., Roussine & Nègre 1952

Rel. n.	1	2	3	4	5	P
Area in m²	15	40	20	10	10	r
Coverage in %	100	100	80	80	80	e
						s.
Charact. and diff. species of the association						
Plantago crassifolia Forsskal	4.5	4.5	5.5	4.5	3.4	5
Schoenus nigricans L.	3.4	3.4	.	.	.	2
Limonium virgatum (Willd.) Fourr.	.	.	1.2	2.2	2.2	3
Charact. species of the upper units						
Limonium narbonense Mill.	.	+	1.2	2.2	.	3
Sonchus maritimus L.	2.3	.	.	.	.	1
Spartina juncea (Michx.) Willd.	.	.	.	.	1.2	1
Juncus acutus L.	.	.	1.2	.	.	1
Other species						
Inula viscosa (L.) Aiton	1.2	+	.	.	.	2
Sporobolus pungens (Schreber) Kunth	.	.	.	+.2	+	2
Inula crithmoides L.	.	2.3	.	.	.	1
Halimione portulacoides (L.) Aellen	.	.	.	+	.	1
Phragmites australis (Cav.) Trin.	.	+.0	.	.	.	1
Polypogon monspeliensis (L.) Desf.	.	+	.	.	.	1
Elytrigia atherica (Link) Kerguélen ex Carr.-Mart.	.	.	.	+	.	1
Limonium japygicum (Groves) Pign.	.	.	.	.	2.3	1
Cladium mariscus (L.) Pohl	1.2	.	.	.	.	1
Ipomoea sagittata Poiret	1.2	.	.	.	.	1
Carex hispida Willd.	+	.	.	.	.	1
Lotus creticus L.	.	.	.	+	.	1
Plantago coronopus L.	.	.	.	+	.	1
Phleum phleoides (L.) Karsten	.	.	.	.	1.2	1
Lagurus ovatus L.	.	.	+	.	.	1
Smilax aspera L.	.	.	.	+	.	1

The rocky coast

THE CALCARENITE CLIFFS (Fig. 4)

For long stretches along the Brindisi coast and particularly in Salento, the rocky coast is made up of low calcarenite cliffs of various compositions. These are characterised by superficial karst microforms of great phytosociological interest.

These are small circular holes with flat bottoms, called “corrosion basins” by geologists, that are a few tens of centimetres deep, or less, and of variable diameters from a few centimetres to a few metres. These basins form because of the corrosive actions of the salt water that stagnates there in certain periods and that upon evaporating, leaves copious quantities of salt on the bottom of the basin. Here, there grow different communities of halophilous plants, according to the composition of the rocks.

In some sectors, the coastal platform is made up of dark plio-Pleiostocene calcarenites that are easily broken and because of erosion they leave quite a lot of fine sand and silt. The first strip, close to the coastline, is often reached by the sea and is therefore rich in salt and is not colonised by vascular vegetation (aphytic). Immediately behind this first strip, there are the basins that are always constantly in contact with the sea, from which they receive a continuous spray of salt water that causes the formation of a thin layer of permanent salt. These are home to dense pioneering communities of *Arthrocnemum macrostachyum* (Tab. 8).

Further inland of this strip, and because of the presence at the bottom of the basin of sandy-silt deposits from the erosion of the rocks, there is the new *Limonio virgati-Arthrocnemetum macrostachyi* association (rel.

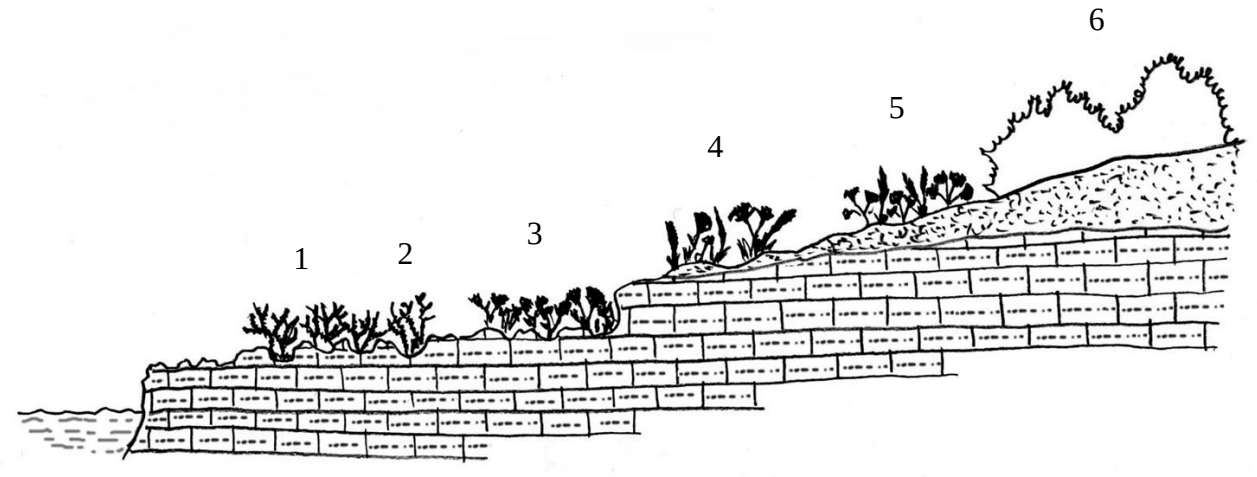


Fig. 4 - Cliffs of calcarenite. Distribution of the plant communities from the coast line to the sand dunes plated on the rock platform. 1. *Arthrocnemum macrostachyum* community, 2. *Limonio virgati-Arthrocnemetum macrostachyi*, 3. *Limonietum japygici*, 4. *Limonio virgati-Sporoboletum arenarii*, 5. *Echinophoro spinosae-Elymetum farcti*, 6. *Asparago acutifolii-Juniperetum macrocarpae* subass. *juniperetosum turbinatae*

Tab. 7 - *Schoeno nigricantis-Erianthetum ravennae* Pignatti 1953 *cladietosum marisci* subass. nov. (rel. 3-4)

Rel. n.	1	2	3*	4	P
Area in m²	50	50	100	60	r
Coverage in %	100	100	100	100	e
					s.
Charact. species of the association					
Erianthus ravennae (L.) Beauv.	5.5	5.5	5.5	5.5	4
Schoenus nigricans L.	.	.	+	1.2	2
Diff. species of the *cladietosum marisci* subassociation					
Cladium mariscus (L.) Pohl	+	.	1.1	1.2	3
Mentha aquatica L.	.	.	1.2	+.2	2
Lythrum salicaria L.	.	.	1.1	+	2
Carex hispida Willd.	.	.	+	.	1
Charact. species of the upper units					
Inula viscosa (L.) Aiton	1.2	1.1	1.2	1.2	4
Juncus acutus L.	2.2	1.2	.	+.2	3
Sonchus maritimus L.	+	.	1.2	1.2	3
Pulicaria dysenterica (L.) Bernh.	.	+	1.2	+	3
Agrostis alba	.	.	.	+	1
Other species					
Ipomoea sagittata Poiret	1.2	+.2	1.2	+.2	4
Phragmites australis (Cav.) Trin.	1.2	1.1	.	1.2	3
Cirsium creticum (Lam.) D'Urv. ssp. creticum	.	+	+	1.2	3
Myrtus communis L.	.	+	.	+.2	2
Centaurium erythraea Rafn	.	.	+	+	2
Samolus valerandi L.	.	.	+	+	2
Lotus tenuis W. et K.	.	.	2.2	1.2	2
Calystegia sepium (L.) R.Br.	.	+	.	.	1
Dorycnium rectum (L.) Ser.	.	.	.	3.3	1

typus n. 10 of Tab. 9), characterised by the presence of species that are linked to the *Crithmo-Limonietea* (with the new *crithmetosum maritimi* subassociation, rel. typus n. 12 of Tab. 9) and *Frankenietea pulverulentae* classes (Tab. 9).

The next strip is still influenced by the action of the sea. As it is also situated near to stretches of active cliffs that are occupied by the chamaephytic vegetation of the *Crithmo-Limonietea* class (*Limonietum japigyci*), this strip receives the seeds from this vegetation, which is also able to colonise the corrosion basins. The *Limonietum japygici* association, characterised by *Limonium japigycum*, a species endemic to the southern coast of Apulia, indeed forms dense low-spreading formations that colonise the cracks in the rocks and, when present, the corrosion basins (Tab. 10).

In some cases, it is possible to find the new *capparidetosum spinosae* subassociation (rel. typus n. 2 of Tab. 11), characterised by *Capparis spinosa* (Tab. 11).

In particular conditions where there are small accumulations of sand on the rocks, which forms microdunes, there is a community of *Sporobolus arenarius* and *Limonium virgatum*, which can be referred to the new *Limonio virgati-Sporoboletum arenarii* association (Tab. 12, rel. typus n. 2).

There follows the psammophilous series, typical of this sector.

The limestone cliffs (Fig. 5)

Where the cliffs are made of more compact and harder organogenic limestone from the Cretaceous and the Paleocene-Oligocene, as happens in Porto Badisco, this produces coarser debri that has a very limited sand content. The corrosion basins are produced by the sea even in these kinds of substrata, although they are very different in comparison with the previous basins as they are occupied by pebbly material. This provides conditions for the growth of vegetation belonging to the new *Crithmo maritimi-Inuletum crithmoidis* association (Tab. 13, rel. typus n. 1), while in the parts of the sheer cliffs over the sea, the cracks in the rocks are colonised by the *Limonietum japigyci* association.

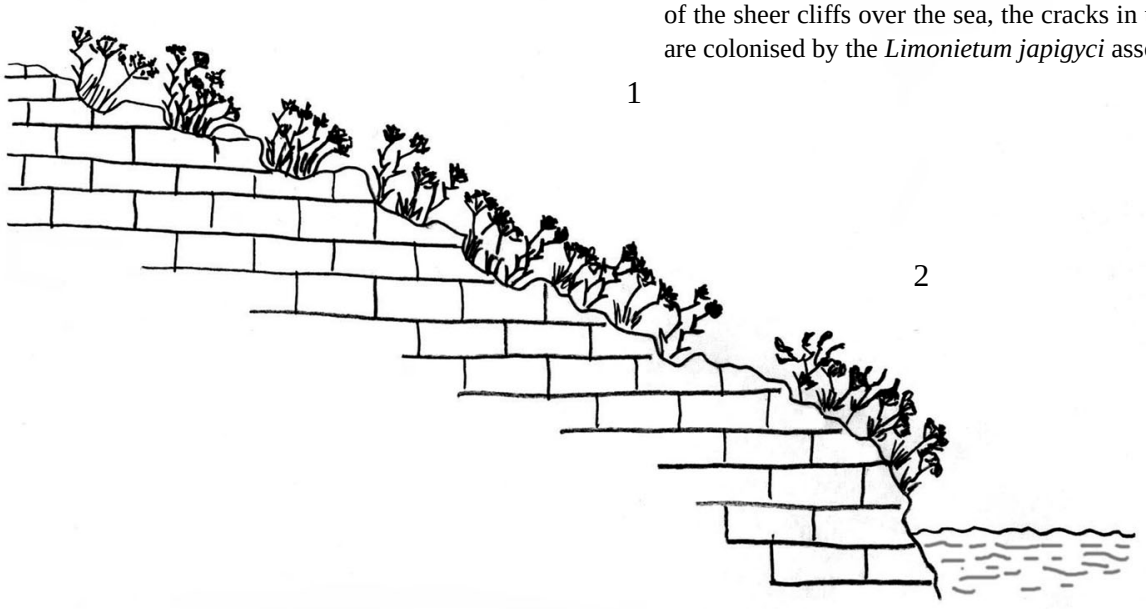


Fig. 5 - Cliffs of limestone. Distribution of the plant communities: 1. *Limonietum japygici*, 2. *Crithmo maritimi-Inuletum crithmoidis*

Tab. 8 - *Arthrocnemum macrostachyum* community

Rel. n.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	P
Altitude (m a.s.l.)	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	r
Area in m²	30	40	100	40	30	10	20	20	20	20	20	40	10-12	40	15	10-15	15	10	e
Coverage in %	60/90	100	95	30/45	40/80	70/90	100	100	90	100	95	90	85	80	90	60	60/80	90	s.
Arthrocnemum macrostachyum (Moric.) C. Koch	4.5	5.5	5.5	3.3	4.4	3.4	5.5	5.5	5.5	5.5	5.5	5.5	4.5	4.5	4.5	3.4	4.5	4.5	18
Charact. species of the upper units																			
Limonium narbonense Miller	.	.	.	.	.	1.2	+	+	1.2	2.3	2.2	+.2	.	.	.	.	.	.	7
Inula crithmoides L.	.	.	.	.	+.2	.	.	.	+	2.3	.	.	.	.	.	.	.	.	3
Arthrocnemum fruticosum (L.) Moq.	.	.	.	.	.	.	.	.	+.2	1.2	.	.	.	.	.	.	.	.	2
Halimione portulacoides (L.) Aellen	.	.	.	.	.	.	1.2	.	.	.	.	.	.	1.2	.	.	.	.	2
Juncus acutus L.	.	.	.	.	.	.	1.2	1.2	.	.	.	.	.	.	.	.	.	.	2
Arthrocnemum fruticosum (L.) Moq. var. deflexa	.	1.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Triglochim barellieri Loisel.	.	.	.	.	.	.	.	.	.	.	.	1.1	.	.	.	.	.	.	1
Suaeda vera Forssk. ex J.F. Gmel.	.	1.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Other species																			
Crithmum maritimum L.	.	.	.	.	.	3.4	.	.	.	.	.	.	+.2	2.2	2.2	1.2	(+.2)	+.2	7
Limonium japygicum (Groves) Pign.	1.2	.	.	.	2.2	.	.	.	.	.	.	.	1.2	+.2	.	.	.	1.2	5
Suaeda maritima (L.) Dumort.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.3	+	.	.	3.3	3
Juncus maritimus Lam.	.	+.2	.	.	.	.	.	.	1.2	+	.	.	.	.	.	.	.	.	3
Agropyron elongatum (Host) Beauv.	.	.	.	.	.	.	.	.	.	1.1	.	.	.	.	.	.	.	.	1
Aster tripolium L.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

Tab. 9 - *Limonio virgati-Arthrocnemetum macrostachyi* ass. nov.
crithmetosum maritimi subass. nov. (rel. 12-15)

Rel. n.	1	2	3	4	5	6	7	8	9	10*	11	12°	13	14	15	P
Rel. n.	57	58	61	62	196	64	117	74	200	213	216	45	46	55	194	r
Altitude	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	e
Area in m²	60	50	20	40	20	20-30	20	7	20	40	80	50	60	40	10	s.
Coverage in %	20/40	60/80	50/60	70/90	40/80	10/30	90	70	20/60	100	95	50/80	50/85-90	40-50/80-90	40/70	
Charact. species of the association																
Arthrocnemum macrostachyum (Moric.) C. Koch	2.3	4.5	4.4	4.5	4.4	2.2	4.5	3.4	3.4	5.5	5.5	4.5	5.5	5.5	2.3	15
Limonium virgatum (Willd.) Fourr.	1.2	3.3	2.2	2.2	1.2	1.2	1.1	+.2	1.2	+.2	1.1	2.2	2.2	2.2	1.2	15
Diff. specie of the subassociation																
Frankenia laevis L.	.	+.2	1.2	+	+.2	.	.	.	.	.	.	1.2	+	.	1.2	7
Crithmum maritimum L.	.	.	.	.	.	.	.	.	.	.	.	1.2	2.2	1.2	2.3	4
Charact. specie of the upper units																
Halimione portulacoides (L.) Aellen	.	2.3	.	3.4	3.4	.	+.2	.	.	.	.	r	.	+	1.2	7
Inula crithmoides L.	.	1.2	.	+	.	.	.	.	.	2.3	.	.	.	1.2	.	4
Limonium narbonense Miller	.	.	.	.	.	.	.	.	.	1.2	+.2	.	.	.	.	2
Juncus acutus L.	.	.	.	.	.	.	.	.	.	2.2	.	.	.	.	.	1
Other species																
Sporobolus pungens (Schreber) Kunth	.	+	.	.	.	.	.	3.3	.	.	.	.	.	.	.	2
Puccinellia festuciformis (Host) Parl.	.	.	.	.	.	.	.	.	.	.	2.2	.	.	.	.	1
Limonium japygicum (Groves) Pign.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.3	1
Suaeda maritima (L.) Dumort.	.	.	.	.	.	.	2.3	.	.	.	.	.	.	.	.	1
Juncus maritimus Lam.	.	.	.	.	.	.	.	.	.	1.2	.	.	.	.	.	1
Juncus subulatus Forsskal	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1
Suaeda splendens (Pourret) G. et G.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1

Tab. 10 - *Limonietum japygici* Curti & Lorenzoni 1968

Rel. n.	1	2	3	4	5	6	7	P
Altitude	-	-	-	-	-	-	-	r
Area in m²	10	5	20	10	8	15	20	e
Coverage in %	60	50	70/90	40	70	50	60	s.
Charact. species of the association								
Limonium japygicum (Groves) Pign.	3.3	1.2	2.3	2.2	2.3	2.2	3.3	7
Charact. species of the upper units								
Crithmum maritimum L.	2.3	2.2	4.4	2.3	3.3	2.3	2.2	7
Lotus cytisoides L.	.	.	+	.	.	.	.	1
Other species								
Plantago coronopus L.	.	.	1.2	.	.	1.2	1.2	3
Arthrocnemum macrostachyum (Moric.) C. Koch	.	1.1	.	.	.	+.2	.	2

Tab. 11 - *Limonietum japygici* Curti & Lorenzoni 1968 *capparidetosum spinosae* subass. nov.

Rel. n.	1	2*	3	P
Area in m²	20	50	50	r
Coverage in %	80	80	60	e
				s.
Charact. species of the association				
Limonium japygicum (Groves) Pign.	1.2	2.3	2.3	3
Diff. species of the subassociation				
Capparis spinosa L.	3.3	3.4	+	3
Charact. species of the upper units				
Crithmum maritimum L.	3.4	4.4	3.4	3
Reichardia picroides (L.) Roth	+.2	1.1	.	2
Lotus cytisoides L.	+.2	.	.	1
Other species				
Agropyron pungens (Pers.) R. et S.	1.1	.	.	1
Plantago coronopus L.	.	1.1	.	1
Beta vulgaris L. ssp. maritima (L.) Arcang.	+	.	.	1
Suaeda maritima (L.) Dumort.	.	+.2	.	1
Allium ampeloprasum L.	.	1.1	.	1
Asparagus acutifolius L.	+	.	.	1
Thymelaea hirsuta (L.) Endl.	+	.	.	1

Tab. 12 - *Limonio virgati-Sporoboletum arenarii* ass. nov.

Rel. n.	1	2*	3	4	P
Area in m²	8	20	20	40	r
Coverage in %	80	80	75	70	e
					s.
Charact. and diff. species of the association					
Sporobolus pungens (Schreber) Kunth	3.4	3.3	4.5	4.4	4
Limonium virgatum (Willd.) Fourr.	3.4	4.4	3.4	+	4
Frankenia laevis L.	.	+.2	1.2	.	2
Limonium japygicum (Groves) Pign.	.	.	+.2	.	1
Charact. species of the upper units					
Agropyron junceum (L.) Beauv.	1.2	2.2	2.2	1.2	4
Pancratium maritimum L.	.	1.2	1.2	.	2
Lotus cytisoides L.	.	.	+.2	2.2	2
Other species					
Plantago coronopus L.	+	1.1	2.2	1.2	4
Salsola kali L.	.	+	+	.	2
Parapholis incurva (L.) Hubbard	.	.	1.2	.	1

Tab. 13 - *Crithmo maritimi-Inuletum crithmoidis* ass. nov.

Rel. n.	1*	2	3	4	5	6	7	8	9	10	11	12	P
Area in m²	40	70	10	15	30	30	5	10	10	20	30	15	r
Coverage in %	50/90	80	80	90	100	80	80	80	95	70	40/80	40/60	e
													s.
Charact. species of the association													
Inula crithmoides L.	4.4	3.3	3.3	3.3	2.3	4.4	4.5	4.4	4.5	2.3	4.4	3.3	12
Crithmum maritimum L.	3.3	+.2	4.4	4.4	4.4	2.3	2.3	3.4	2.3	3.4	3.3	2.2	12
Charact. species of the upper units													
Limonium virgatum (Willd.) Fourr.	1.2	3.3	+.2	1.2	+.2	.	.	.	.	.	.	.	5
Lotus cytisoides L.	.	.	.	.	.	1.2	.	.	.	1.2	1.2	.	3
Limonium japygicum (Groves) Pign.	.	.	.	.	.	.	.	.	.	.	.	2.3	1
Other spcies													
Agropyron pungens (Pers.) R. et S.	1.2	1.2	+.2	3.3	+.2	.	.	.	2.2	.	.	.	6
Arthrocnemum macrostachyum (Moric.) C. Koch	+	+	+.2	.	.	.	.	.	2.3	.	.	1.2	5
Reichardia picroides (L.) Roth	.	.	.	+	.	1.1	.	.	.	+	+.2	.	4
Salsola soda L.	.	.	.	.	+	.	+	1.2	.	.	.	.	3
Sporobolus pungens (Schreber) Kunth	1.2	1.2	.	.	.	.	.	.	.	.	.	.	2
Beta vulgaris L. ssp. maritima (L.) Arcang.	.	.	.	.	.	1.1	.	.	.	.	1.2	.	2
Atriplex latifolia Wahlenb.	.	.	.	.	.	.	+	.	.	.	+	.	2
Frankenia laevis L.	.	1.2	.	.	.	.	.	.	.	.	.	.	1
Parapholis incurva (L.) Hubbard	.	+.2	.	.	.	.	.	.	.	.	.	.	1
Cynodon dactylon (L.) Pers.	+	.	.	.	.	.	.	.	.	.	.	.	1
Suaeda splendens (Pourret) G. et G.	.	+	.	.	.	.	.	.	.	.	.	.	1
Daucus carota L.	.	.	.	.	.	+	.	.	.	.	.	.	1
Eryngium maritimum L.	.	.	.	.	.	+	.	.	.	.	.	.	1
Suaeda vera J.F. Gmelin	.	.	.	.	.	.	.	.	1.2	.	.	.	1
Silene vulgaris (Moench) Garcke	.	.	.	.	.	.	.	.	+	.	.	.	1
Plantago maritima L.	.	.	.	.	.	.	.	.	.	.	.	2.3	1

Conclusions

On the basis of this study, it has been possible to describe the psammophilous, halophilous and subhalophilous successions that have developed along the different coastal typologies and different substrata of the areas under investigation according to the salt gradient that diminishes gradually towards the inland areas. Thus, it has also been possible to evaluate the great ecological and phytocoenotic biodiversity of the coast and its state of conservation. With the excessive exploitation for holiday beaches or for the construction of the associated facilities, the changes are great in some cases, and the ecosystems are therefore compromised, particularly in the areas characterised by the low sandy coast. In other cases, it was possible to observe a reasonable conservation of the environments. These should thus be protected from excessive and uncontrolled use, with the aim of preserving the more interesting and delicate ecosystems, which include, in particular, the retrodunal systems.

Sintaxonomic listing

CAKILETEA MARITIMAE Tüxen & Preising ex Br.-Bl. & Tüxen 1952
Cakiletalia integrifoliae Tüxen ex Oberdorfer 1949 corr. Rivas-Martínez, Costa & Loidi 1992
Cakilion maritimae Pignatti 1953
Salsolo kali-Cakiletum aegyptiacae Costa & Mansanet 1981

AMMOPHILETEA Br.-Bl. & Tüxen ex Westhoff, Dijk & Passchier 1946
Ammophiletalia Br.-Bl. 1933
Ammophilion australis Br.-Bl. 1921 corr. Rivas-Martinez, Costa & Izco in Rivas-Martinez, Lousa, T.E. Diaz, Fernandez-Gonzalez & J.C. Costa 1990
Ammophilenion australis
Echinophoro spinosae-Ammophiletum arundinaceae Géhu, Rivas-Martinez, & R. Tüxen 1972 in Géhu *et al*. 1984
Agropyro-Minuartion peploidis Tüxen in Br.-Bl. & Tüxen 1952
Agropyro-Minuartienion peploidis
Echinophoro spinosae-Elymetum farcti Géhu 1987 ril. 123-85
Sporobolion arenarii (Géhu & Géhu-Franck ex Géhu & Biondi 1994) Rivas-Martinez & Canto 2002
Sporoboletum arenarii Arènes 1924
Limonio virgati-Sporoboletum arenarii ass. nova

SARCOCORNIETEA FRUTICOSAE Br.-Bl. & Tüxen ex A. & O. Bolos 195
Sarcocornietalia fruticosae Br.-Bl. 1933
Arthrocnemion macrostachyi Rivas-Martinez & Costa 1984
Arthrocnemum macrostachyium community
Arthrocnemum macrostachyium and *Limonium virgatum* community

CRITHMO-LIMONIETEA Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
Crithmo-Limonietalia Molinier 1934
Crithmo-Limonion Molinier 1934
Limonietum japygici Curti & Lorenzoni 1968
capparidetosum spinosae subass. nova
Crithmo maritimi-Inuletum crithmoidis ass. nova

JUNCETEA MARITIMI Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
Juncetalia maritimi Br.-Bl. ex Horvatic 1934
Plantaginion crassifoliae Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
Schoeno nigricantis-Plantaginetum crassifoliae Br.-Bl. in Br.-Bl., Roussine & Nègre 1952

PHRAGMITO-MAGNOCARICETEA Klika in Klika & Novák 1941
Phragmitetalia Koch 1926
Phragmition communis Koch 1926
Phragmitenion communis

Phragmitetum communis (All. 1921) Pignatti 1953
Magnocaricetalia Pignatti 1954
Magnocaricion elatae Koch 1926
Soncho maritimi-Cladietum marisci (Br.-Bl. & O. Bolòs 1958) Cirujano 1980
myrtetosum communis subass. nova

Molinio-*Arrhenatheretea* Tüxen 1937
Holoschoenetalia vulgaris Br.-Bl. ex Tchou 1948
Molinio-Holoschoenion vulgaris Br.-Bl. ex Tchou 1948
Schoeno nigricantis-Erianthetum ravennae Pignatti 1953
cladietosum marisci subass. nova hoc loco

Quercetea ilicis Br.-Bl. ex A. & O. Bolòs 1950
Pistacio lentisci-Rhamnetalia alaterni Rivas-Martínez 1975
Juniperion turbinatae Rivas-Martínez 1975 corr. 1987
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Appendix

Locality and date of relevés

Tab. 2 - *Ammophiletea*
Rel. 1: north to Torre Specchia (19 August 2002); rel. 2: Marina di Ginosa, (3 September 2001); rel. 3: north to Torre Specchia (19 August 2002); rel. 4: Marina di Ginosa (3 September 2001); rel. 5: Lido Morelli (31 August 2001); rel. 6: Pantanaggianni (9 September 2001); rel. 7: north to Torre Specchia (19 August 2002); rel. 8: Marina d'Ugento (25 September 2002).

Tab. 3 - *Asparago acutifolii-Juniperetum macrocarpae*
Rel. 1: Torre Guaceto (29 September 2001); rel. 2: Pantanaggianni (2 September 2001); rel. 3: Castellaneta Marina (Taranto) (3 September 2001); rel. 4: Marina di Ginosa (3 September 2001); rel. 5: Marina di Ginosa (3 September 2001); rel. 6: Marina di Ginosa (3 September 2001); rel. 7: Foce di Lenne (3 September 2001); rel. 8: north to Torre Specchia (19 August 2002).

Tab. 4 - *Soncho maritimi-Cladietum marisci*
rel. 1-6: after San Foca, near the channel (22 August 2002).

Tab. 5 - *Rubo ulmifolii-Myrtetum comminis*
Rel. 1: between San Foca and San Cataldo (22 August 2002); rel. 2: Le Cesine (22 August 2002); rel. 3: north to Torre Specchia (19 August 2002); rel. 4: north to Torre Specchia (19 August 2002); rel. 5: after San Foca (22 August 2002).

Tab. 6 - *Schoeno nigricantis-Plantaginetum crassifoliae*
Rel. 1: a nord di Torre Specchia, depressioni retrodunali (circondate dal mirteto) (19 August 2002); rel. 2: Serricella, near Torre Lapillo ; rel. 3: near Torre Colimena, in the resort "la vecchia salina" (26 August 2002); rel. 4: near Torre Colimena, in the resort "la vecchia salina" (26 August 2002); rel. 5: Frigole Basin (19 August 2002).

Tab. 7 - *Schoeno nigricantis-Erianthetum ravennae*
Rel. 1-4: after San Foca (22 August 2002);

Tab. 8 - *Arthrocnemum machrostachyum* community
Rel. 1: Tricase Porto (21 August 2002); rel. 2: near Torre Colimena, in the resort "la vecchia salina" (26 August 2002); rel. 3: Riva degli Angeli (26 August 2002); rel. 4: Palude del Capitano (31 August 2002); rel. 5: Palude del Capitano (31 August 2002); rel. 6: Tricase Porto (21 August 2002); rel. 7: between Torre Canne and Lido Morelli, (6 September 2001); rel. 8: between Torre Canne and Lido Morelli, (6 September 2001); rel. 9: Frigole basin (19 August 2002); rel. 10: Frigole basin (19 August 2002); rel. 11: near Torre Colimena, in the resort "la vecchia salina" (26 August 2002); rel. 12: near Torre Colimena, in the resort "la vecchia salina" (26 August 2002); rel. 13: Polignano a mare, (29 August 2001); rel. 14: Polignano a mare (29 August 2001); rel. 15: Polignano a mare (29 August 2001); rel. 16: Pantanaggianni, (2 September 2001); rel. 17: S. Pietro Island, in the resort "Punta la Forca", (8 September 2001); rel. 18: S. Pietro Island, in the resort Punta la Forca, (8 September 2001).

Tab. 9 - *Arthrocnemum macrostachyum* and *Limonium virgatum* community
Rel. 1: Losciale (1 September 2001); rel. 2: Losciale (1 September 2001); rel. 3: Losciale (1 September 2001); rel. 4: Losciale (1 September 2001); rel. 5: Gallipoli in the resort "Lido delle conchiglie" (26 August 2002); rel. 6: Cala dei Ginepri (1 September 2001); rel. 7: S. Pietro Island, in the resort "Punta Dogana"(8 September 2001); rel. 8: Costa Merlata (2 September 2001); rel. 9: S. Pietro in Bevagna (26 August 2002); rel. 10: near Torre Colimena, in the resort "la vecchia salina" (26 August 2002); rel. 11: Riva degli Angeli (26 August 2002); rel. 12: Forcatella (31 August 2001); rel. 13: Forcatella (31 August 2001); rel. 14: Losciale (1 September 2001); rel. 15: Gallipoli, Lido delle conchiglie (26 August 2002).

Tab. 10 - *Limonietum japygici*
Rel. 1: S. Pietro Island, in the resort "Punta la Forca", (8 September 2001); rel. 2 S. Pietro Island, in the resort "Punta la Forca", (8 September 2001); rel. 3: Tricase Porto (21 August 2002); rel. 4: Capitolo (31 August 2001); rel. 5: Capitolo (31 August 2001); rel. 6: Pantanaggianni (2 September 2001); rel. 7: Pantanaggianni (2 September 2001).

Tab. 11 - *Limonietum japygici* subass. *capparidetosum spinosae*
Rel. 1-3: . Pietro Island, in the resort "Punta la Forca" (8 September 2001).

Tab. 12 - *Limonio virgati-Sporoboletum arenarii*
Rel. 1-3: Costa Merlata (2 September 2001); rel. 4: S. Pietro in Bevagna (26 August 2002).

Tab. 13 - *Crithmo maritimi-Inuletum crithmoidis*
Rel. 1: Torre a Mare (1 September 2001); rel. 2: Losciale (1 September 2001); rel. 3: Torre Canne Nord (31 August 2001); rel. 4: Torre a Mare (1 September 2001); rel. 5: Torre a Mare (1 September 2001); rel. 6: Pietro Island, in the resort "Punta la Forca" (8 September 2001); rel. 7: Torre Canne Nord (31 August 2001); rel. 8: Forcatella (31 August 2001); rel. 9: Porto Badisco (28 August 2002); rel. 10: Pietro Island, in the resort "Punta la Forca" (8 September 2001); rel. 11: Porto Badisco (28 August 2002).