Biotechnology & Biotechnological Equipment

ISSN: 1310-2818 (Print) 1314-3530 (Online) Journal homepage: https://www.tandfonline.com/loi/tbeq20

Distribution of Xerohalophytic Vegetation Along the Seaward and Landward Zone in South-Adriatic Sandy Beach (Montenegro)

A. Mijović, Z. Popović, B. Karadžić, M. Mijatović & S. Perišić

To cite this article: A. Mijović, Z. Popović, B. Karadžić, M. Mijatović & S. Perišić (2006) Distribution of Xerohalophytic Vegetation Along the Seaward and Landward Zone in South-Adriatic Sandy Beach (Montenegro), Biotechnology & Biotechnological Equipment, 20:1, 30-35, DOI: 10.1080/13102818.2006.10817300

To link to this article: https://doi.org/10.1080/13102818.2006.10817300

DISTRIBUTION OF XEROHALOPHYTIC VEGETATION ALONG THE SEAWARD AND LANDWARD ZONE IN SOUTH-ADRIATIC SANDY BEACH (MONTENEGRO)

A. Mijović, Z. Popović, B. Karadžić, M. Mijatović, S. Perišić
Institute for Biological Research "Siniša Stanković", Department of Ecology, Belgrade, Serbia and Montenegro

ABSTRACT

The objective of this research was to analyze the distribution of two typical widespread xerohalophytic associations in sandy and sandy-shingle beaches of Montenegrin foreland: Cakilo-Xanthietum italici (Beg. 1941) Pign.1953 and Echinophoro-Elymetum farcti GÉHU 1988. Intense human activity generally affects the processes of vegetation degradation in this habitat type. The Velika plaža beach near Ulcinj is one of the few relatively undamaged sand beaches, in floristic and vegetational sense. Major environmental gradient in this habitat is the decrease in moisture and salinity from seaward to landward zone. This site's conditions model the prominent zonation of coastal plant species and distribution patterns of plants and plant communities.

Introduction

Extreme environmental conditions in the foreland zone cause a specific vegetation type that is very poor in floristic composition – xerohalophytic vegetation. Plants of this vegetation type posses numerous ecological adaptations for resolving the problems of chemical and physical drought, as well as of injurious effects of the high chloride concentration and low percentage of humus particles in soil. By accumulating NaCl, halophytes increase the osmotic pressure of their cellular sap, which results in an increased xeromorphism of recruitment. Halophytic xerophytes can be included either into the group of preferring or the group of suffering halophytes (1).

Rocky coasts prevail on the Montenegrin foreland, so that the vegetation of swamp sites, as well as the vegetation of sandy and shingle coasts is relatively slightly present. As on all similar touristically attractive coasts, these habitats are particularly endangered in this part of Adriatic. Vegetation of Montenegrin foreland includes classes CAKILETEA MARITIMAE Tx. et Prsg. 1950 and AMMOPHILETEA Br.-Bl. & Tüxen ex Westhoff, Dijk & Passchier 1946 (2). Plant communities belonging to the Cakiletea maritimae class are present on narrow shingle beaches, while on broad sandy coasts these plant communities develop outlying belt of psammophytic vegetation. Plant communities of Ammophiletea class are commonly present on sandy coasts where the process of dune formation has already begun, resulting in a decrease of chloride concentration in the dune formation zone. Communities of these two classes can be distributed in a more or less mosaic pattern, depending on a terrain configuration (2, 3). Set aside the detailed classical studies of xerohalophytic flora and vegetation of Montenegrin foreland (e.g. 4, 5, 6), recent investigations are dealing with this problem in a relatively lesser extent (2, 7, 8, 9, 10, 11). In this study, we investigated the distribution of

xerohalophytic species that constitute the characteristic plant communities on broad sandy beaches of the Adriatic coast.

Materials and Methods

This research has been performed at the Velika plaža beach near Ulcinj, the most southern point of the Montenegrin coast. It is the largest beach in this part of South Adriatic (approximately 11.5 km in length), extending into Albanian foreland south from delta of Bojana River**.** Investigation within the characteristic xerohalophytic vegetation belt on this beach has been carried out during the vegetational season 2002. A combined abundance and cover scale was used, as proposed by Westhof and van der Maarel (12). In addition, census data were sampled within three strip transects perpendicular to the shoreline at the study site. For data analysis we used Statistica for Windows program. The City-block (Manhattan) distance analysis was applied to present the differences in floristic composition among the transects.

Results and Discussion

Psammophytic vegetation of the Velika plaža beach is built up of two belts. The first one is made of xerohalophytic plant communities belonging to the Cakiletea and Ammophiletea classes, interchanging each other along the salinity and moisture gradients, landwards; these are the associations *Cakilo-Xanthietum italici* (Beg. 1941) Pign.1953, and *Echinophoro-Elymetum farcti* GÉHU 1988. The second belt of xeropsammophytic vegetation comprised of plant groups under the class Thero-Brachypodietea Br.-Bl.1947, is not directly influenced by the seawater (3), which is a specific feature of Eastern Adriatic coast.

As shown in **Fig. 1a-c**, the vegetation of this particular site can be divided into three zones. In the first zone (up to 20-30 m wide), the vegetation is almost missing due to the overwash effects and strong chemical influence of the seawater, as well as the anthropogenic pressure. Only the individuals of *Salsola kali* L., *Cakile maritima* Scop.

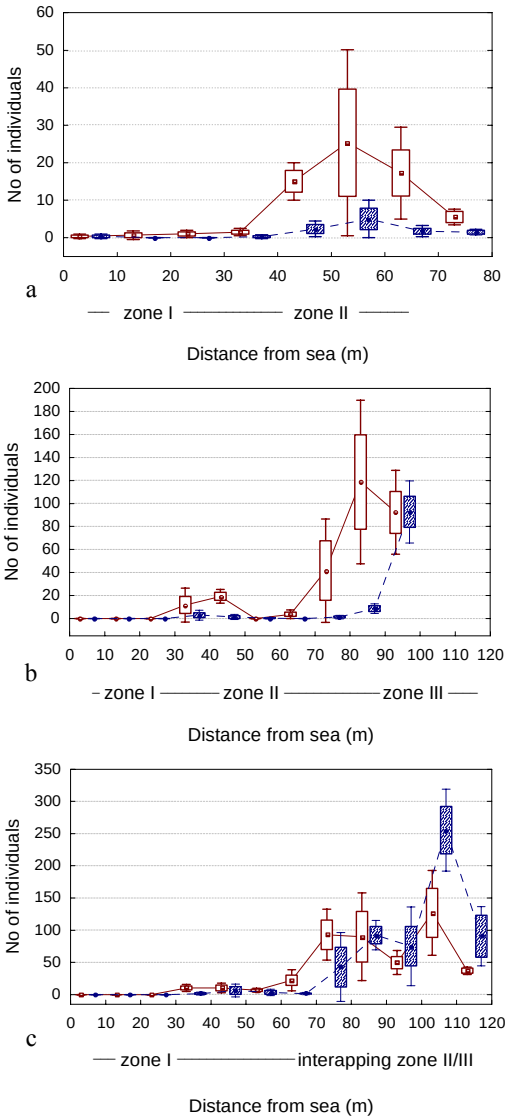

Fig. 1. Distribution and number of species from Cakiletea class (empty squares) and species from Ammophiletea class (filled squares) from seaward to landward zone. a. in the belt zone of *Cakilo-Xanthietum* ass. b. typical transect aligned perpendicular to the shoreline, including embryo dunes in landward zone. c. along the interdune transect, where zone II and zone III overlapping occurs.

TABLE 1

***Cakilo-Xanhtietum italici* (Beg. 1941) Pign.1953. Relevés 1-5 are from typical zone of *Cakilo-Xanhtietum* ass., and relevé 6 is from interdune depression.**

Distance form sea (m)	30	30	50	50	60	80	
Size of relevé (m^2)	25	25	25	36	36	50	
Coverage (%)	10	15	20	30	35	35	
Charact. species of ass.							
Cakile maritima Scop.	2	2	2	2	1	1	V
Xanthium italicum Mor.	3	5	5	5	7	7	V
Charact. species of Cakiletea class							
Salsola kali L.	1	1	1	-	1	1	V
Euphorbia peplis L.	1	-	2	1	-	1	IV
Polygonum maritimum L.	-	-	1	1	2	-	III
Species from Ammophiletea class							
Agropyron junceum (L.) P.Beauv.	-	-	1	3	3	5	IV
Eryngium maritimum L.	-	1	1	1	-	2	IV
Echinophora spinosa L.	1	-	-	-	1	2	III
Euphorbia paralias L.	-	-	-	-	1	1	II
Others							
Lagurus ovatus L.	-	-	-	-	1	1	II
Cuscuta sp. L.	-	-	3	-	-	3	II
Inula crithmoides L.	-	-	-	1	-	-	I

and *Xanthium italicum* Mor. can be observed in this zone.

The next zone, where the species from the Cakiletea maritimae class are dominant, is characterized by still remarkable sand salinity and by variable width depending on the terrain configuration. Pioneer association *Cakilo-Xanthietum italici* builds up this characteristic vegetational belt that is very poor in a floristic composition and has a small coverage, with dominant presence of annuals (**Table 1**).

With increasing distance from the sea, sand emersion occurs, simultaneously with the gradual decrease of salinity and moisture in soil. Such conditions are favorable for the development of species from Ammophiletea class, so that *Echinophoro-Elymetum farcti* ass. in the zone 3 continues farther beyond the belt of *Cakilo-Xanthietum italici* ass. Beside the dominant species *Elymus farctus* (Viv.) Runemark ex Melderis, also frequent in this association are *Echinophora spinosa* L. and *Eryngium maritimum* L. (**Table 2**). Inter-dune areas are overlapping patches of the *Cakilo-Xanthietum italici* and *Echinophoro-Elymetum farcti* communities in this zone (Fig. 1c).

Differences among transects based on floristic composition of studied associations are presented on tree-clustering diagram (**Fig. 2**).

Salt spray and seawater inundations are known to be very important factors in the strandline species distribution. Barbour and DeJong (13) have observed a strong correlation between the position of particular species in the zonation of strandline plants and their tolerance. Results presented in figures show that species are obviously distributed along the gradient of sand salinity and moisture. The pioneer community *Cakilo-Xanthietum italici* occupies the lowest and the most saline areas of the site studied. Salisbury (14) has defined such beach zone as the area of plants – pioneers of dunes, i.e. the zone where annuals with extensive root systems predominate (*Cakile maritima*, *Salsola kali*, *Xanthium italicum*). Generally, seasonal and irregular variations in distribution of these species in zone I are influenced by oscillations of wave action, but landwards dispersion (zone II and especially zone III) is mainly due to the wind

TABLE 2

Association *Ecinophoro-Elymetum farcti* GÉHU 1988

Distance from sea (m)	50	50	70	80	80	90	90	100	120	
Size of relevé (m^2)	36	50	50	36	100	36	50	50	100	
Coverage (%)	40	40	45	40	40	50	60	65	60	
Characteristic species of ass.										
Agropyron junceum (L.) P.Beauv.	5	5	5	7	7	7	8	8	8	V
Echinophora spinosa L.	-	-	2	-	2	5	2	2	2	IV
Species from Ammophiletea cl.										
Eryngium maritimum L.	2	2	1	3	3	3	2	1	-	V
Euphorbia paralias L.	-	-	-	-	1	2	-	1	1	III
Medicago marina L.	-	-	1	-	2	-	2	-	1	III
Ammophila arenaria (L.) Link.	-	-	-	-	-	-	-	5	5	II
Pancratium maritimum L.	-	-	-	-	1	-	1	-	-	II
Calystegia soldanella (L.) R.Br.	-	-	-	-	-	-	1	1	-	II
Pseudorlaya pumila (L.) Grande	-	-	-	-	1	-	-	1	-	II
Lagurus ovatus L.	-	-	-	-	1	1	-	1	-	II
Species from Cakiletea class										
Xanthium italicum Mor.	5	5	7	5	5	5	3	5	3	V
Cakile maritima Scop.	1	2	-	1	-	-	-	-	-	II
Polygonum maritimum L.	-	-	2	-	1	-	-	-	-	II
Atriplex hastata L.	-	-	-	1	-	1	-	-	-	II
Euphorbia peplis L.	-	1	-	-	-	-	-	-	-	I
Others										
Parapholis incurva (L.) C.E.Hubb.	-	-	-	-	1	1	-	-	-	II
Aegilops ovata L.	-	-	-	-	1	-	-	1	-	II
Vulpia ciliata Dumort.	-	-	-	-	1	1	-	-	-	II
Schoenus nigricans L.	-	-	-	-	1	-	-	1	1	II
Bromus tectorum L.	-	-	-	-	1	-	1	-	-	II
Juncus maritimus Lam.	-	-	-	-	-	1	-	-	3	II
Inula crithmoides L.	-	-	-	1	1	-	-	-	-	II
Cuscuta sp. L.	-	3	3	-	-	1	-	-	-	II
Reichardia picroides (L.) Roth.	-	-	-	-	-	-	1	-	-	I
Blackstonia perfoliata (L.) Huds.	-	-	-	-	-	-	-	-	1	I

action. Van der Valk (15) concluded that the sand movement and salinity are the most important factors influencing the distribution of plant species on sandy beaches. The relatively unstable floristic composition of *Cakilo-Xanthietum italici* ass. (typical for pioneer associations) is accompanied with its ability to overlap with the next association, especially in the further landward zone. So, certain differences within the transect III (Fig. 2) are mainly due to terrain configuration.

The pioneer associations of the same type, with similar distribution, populate the sandy beaches along the Mediterranean coasts. *Cakilo-Xanthietum italici* ass. is widely distributed on the coasts of Western Adriatic (16, 17), as well as on the coasts of Tirrenian Sea (18). This community is present as well as on sandy and sandy-shingle beaches in Eastern Adriatic, also in Montenegrin foreland, but it is mostly degraded by extremely strong anthropogenic influence. Low abundance of the species *Cakile maritima* is specific feature of this association in Velika Plaža of Ulcinj. Since the similar type of coasts prolongs further southwards from this beach, Xhulaj and Mullaj (19) described the same association in Narta region, Albania. In addition, a community *Salsola kali – Xanthium strumarium* Oberd. et Tx. 1950, floristically

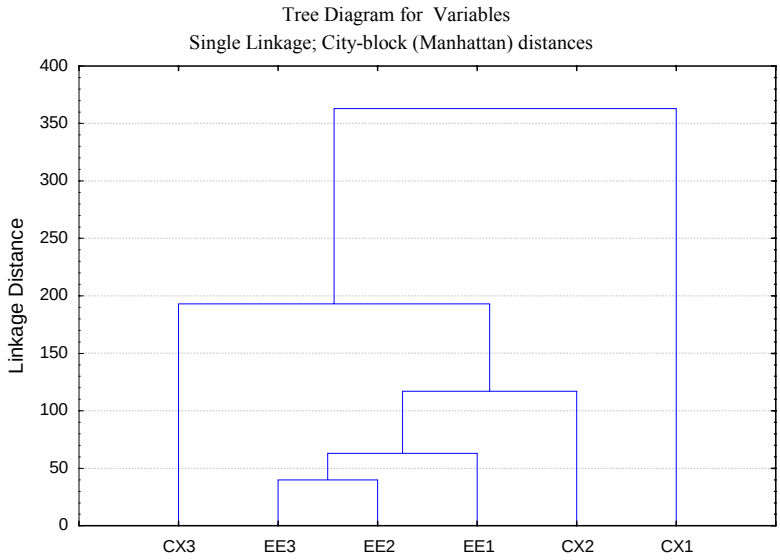

Fig. 2. Tree-clustering diagram presents the degree of similarity among transects based on floristic compostion. CX1 *Cakilo-Xanthietum italici* ass. in transect 1; CX2 *Cakilo-Xanthietum italici* ass. in transect 2; CX3 *Cakilo-Xanthietum italici* ass. in transect 3; *Echinophoro-Elymetum fracti* ass. in transect 1; *Echinophoro-Elymetum fracti* ass. in transect 2; *Echinophoro-Elymetum fracti* ass. in transect 3.

composed very similar to *Cakilo-Xanthietum italici* community from Velika plaža of Ulcinj, is found on W. Peloponnesos coasts, as described by Lavrantiades (20). Besides the abovementioned causes, distribution of these species from seaward to landward zone is also caused by the width of the beach, as on the narrow sandy beaches there are not conditions for fully development of the associations with perennial species.

On the Velika plaza beach, successive stages of developing *Echinophoro-Elymetum farcti* community are distributed in different beach areas that are more distant from the sea, but with relatively similar species composition in all transects. The tussocks of *Elymus farctus* constitute the main agents of the dune evolution (14), since its habitus "immobilizes" sand movements and consequently accumulates sand in the landward area. The significant decrease of sand salinity in this zone is indicated by the presence of *Ammophila arenaria* (L.) Link. (14). As stated earlier (14, 21), this species plays an important role in the development and stabilization of sand dune systems on European coasts. The zone of *Ammophila arenaria* can only be present on broader beaches and does never occur on relatively narrow beaches (22).

The only representative of Ammophiletea class on the Eastern Adriatic coast is *Echinophoro-Elymetum farcti* ass., which is distributed at all greater sandy coasts on Croatian and Montenegrin foreland (3, 22). Apart from dominant species *Elymus farctus* (Viv.) Runemark ex Melderis, the greatest physiognomical and coenological importance have the perennials from the Ammophiletea class – especially *Echinophora spinosa*, *Eryngium maritimum* and *Euphorbia paralias*. Generally, due to their low competitive ability comparing to psammophytic perennials, participation of annuals in *Echinophoro-Elymetum farcti* zone is infirmed (23, 24, 25). However, because of increased content of chlorides in inter-dune areas, the competitive pressure of perennials decreases, so these areas pre-

sent the transitional patches of the *Cakilo-Xanthietum italici* and *Echinophoro-Elymetum fracti* ass in this zone. As presented in phytocoenological relevés and transects, *Xanthium italicum* is the only annual that is quite abundant in this zone. Significantly greater vegetation covering and dominant participation of perennials in this community indicates to its greater ecological and coenological stability compared to *Cakilo-Xanthietum italici* ass. This fact is the reflection of site conditions in *Echinophoro-Elymetum fracti* zone – firstly of lower sand salinity levels, but also of lesser human impact.

Conclusions

Xerohalophytic vegetation of Velika plaža is built up out of two plant communities that are influenced by decreasing impact of seawater and thus characteristically zonated.

General distribution of species belonging to the Cakiletea and Ammophiletea classes can be presented through three vegetation zones. Because of strong physicochemical influence of seawater and human impact, only the individual annuals of pioneer *Cakilo-Xanthietum italici* ass. are present in the first zone. In the next zone, with degree of the still remarkable sand salinity, species from the *Cakilo-Xanthietum italici* ass. are prevalent. Third vegetation zone is characterized by decreased sand salinity and moisture, so that species from the *Echinophoro-Elymetum farcti* ass. develop this vegetation belt. The distribution of these two associations is more or less overlapping, depending on the terrain configuration.

Acknowledgements

This study was supported by the Ministry of Science, Technology and Development of the Republic of Serbia, Grant #1565.

REFERENCES

1. **Tsopa E.** (1939) Sigma, **70,** 1-22.
2. **Mijović A., Stevanović V.** (1988) Phytocoenological characteristics of vegetation of Southern-Montenegrian forecast, IV Congress of Ecologists of Yugoslavia, Ohrid, 344-345.
3. **Horvatić S.** (1974) Contribution to study of psamophytic vegetation of Eastern-Adriatic forecast, IV Congress of Biologists of Yugoslavia, Sarajevo, 39-40.
4. **Beck-Mannagetta G.** (1901) Vegetationsverhältnisse der Illyrischen Länder, (A. Engler, O. Drude, Eds.), Die Vegetation der Erde, Leiptzig, **4,** 1-534.
5. **Adamović L.** (1913) Contribution to flora of Montenegro, Document of Yugoslav Academy of Sciences and Arts (JANU), **135,** 1-96.
6. **Rohlèna J.** (1942) Cospectus Florae Montenegrinae, Presilia, **20-21,** 1-506.
7. **Blečić V., Lakušić R.** (1976) Prodromus of plant associations of Montenegro. Glasnik republičkog zavoda za zaštitu prirode i prirodnjačkog muzeja u Titogradu, **9,** 57-98.
8. **Pulević V.** (1973) Contribution to flora of Montenegro. Glasnik republičkog zavoda za zaštitu prirode i prirodnjačkog muzeja u Titogradu, **6,** 77-83.
9. **Pulević V.** (1976) On some new and rare plants in the flora of Montenegro, Glasnik republičkog zavoda za zaštitu prirode i prirodnjačkog muzeja u Titogradu, **9,** 99-102.
10. **Pulević V.** (1982) Protection of flora and vegetation in Montenegro, Macedonian Academy of Sciences and Arts (MANU), **1**, 109-124.
11. **Janković M.M., Stevanović V.** (1983) Contribution to study of marshy vegetation of Boka Kotorska, Povremena izdanja muzeja grada Šibenika, **10,** 377-396.
12. **Westhoff V., Van Der Maarel E.** (1973) The Braun-Blanquet approach. In: Handbook of Vegetation Sci., (R.H. Whittaker, Ed.), **5**, 616-726.
13. **Barbour M.G., DeJong T.M.** (1977) Bulletin of the Torrey Botanical Club, **104,** 29-34.
14. **Salisbury E.J.** (1952) Downs and Dunes. Bell, London.
15. **Van der Valk A.G.** (1974) Canadian Journal of Botany, **52,** 1057-1073.
16. **Pignatti S.** (1959) Bollettino del Muzeo Civico di Storia Naturale di Venezia, **12,** 61-142.
17. **Caniglia G.** (1982) Bollettino del Muzeo Civico di Storia Naturale di Venezia, **33,** 37-61.
18. **Arigoni P.V., Nardi E., Raffaelli M.** (1985) La vegetazione del parko naturale della Maremma (Toscana). Università degli studi di Firenze – Dipartimento di Biologia Vegetale, Firenze, Italy.
19. **Xhulaj M., Mullaj A.** (2002) Diagnosis report of the Narta area. Flora and vegetation. Retrieved from: http://www.medwetcoast.com/IMG/albsdnartareport_flora-2.doc.
20. **Lavrantiades G.J.** (1964) Vegetatio, **12(3-4),** 223-287.
21. **Ranwell D.S.** (1972) Ecology of Salt Marshes and Sand Dunes, Chapman and Hall London.
22. **Alegro A., Biljaković M., Bogdanović S. Boršić I.** (2004) Biologia, Bratislava, **59/4**, 435-445.
23. **Keddy P.A.** (1981) Journal of Ecology, **69,** 615-630.
24. **Ehrenfeld J.G.** (1990) Reviews in Aquatic Science, **2,** 437-480.
25. **Maun M.A.** (1994) Vegetatio, **111,** 59-70.