Salt Marshes Plant Diversity of Coastal Zone in Albania

Julian Shehu, Alfred Mullaj, Alban Ibraliu
Department of Crop Production, Faculty of Agronomy and Environment, Agricultural University of Tirana, Albania

Abstract

The salt marshes of Albania comprise a narrow belt along the Adriatic and Ionian Seas, with a total length of 476 km from the north to south. They have long been the subject of a range of human activities causing habitat loss. Enclosure for agricultural use, ports and other infrastructure has reduced many salt marshes to a narrow fringe along estuary shores. Salt marshes are important for a range of interests. In particular they support a range of specialist plant communities and associated animals (especially breeding and wintering birds) and often have a high nature conservation interest. They rarely exist in isolation and form an integral part of many estuaries, other tidal inlets and bays.

The objectives of this study are flora and vegetation of salt marshes. In this study, on the basis of field surveys, is given a phytosociological classification of the Albanian salt marshes vegetation by the European standard methods of phytosociology (Zurich-Montpellier).

The salt marsh communities of Albania are poor in endemism and generally similar to relevant vegetation types elsewhere in the Mediterranean. The flora of coastal salt marshes is differentiated into levels according to the plants' individual tolerance of salinity and water table levels. Coastal salt marshes of Albania are offered a number of 62 taxa, extended in 16 diverse families. The most presented families are Chenopodiaceae 24 %, followed by Poaceae and Asteraceae with 11%, with dominating genera like: Arthrocnemum, Limonium, Puccinellia, Chenopodium, Plantago, Tamarix and Juncus. The representative species recorded were Arthrocnemum fruticosum, Halimione portulacoides, Halocnemum strobilaceum, Juncus acutus, J. maritimus, Limonium vulgare, Polypogon monspeliensis, Salicornia europaea, Suaeda maritima, and Tamarix dalmatica.

The most common salt marsh plant communities in coastal area of Albania are salt meadows dominated by glasswort (Salicornia europaea), pioneer marsh communities, perennial vegetation of marine saline mud's mainly composed of scrub such as Sarcocornia fruticosa, Sarcocornia perennis and belonging to the Sarcocornetea fruticosi class, tall rush salt marshes dominated by Juncus maritimus or J. acutus (Juncetalia maritime). Phytosociological analysis evidenced 16 associations, which belong to 4 classes, 5 orders and 6 alliances.

Key words: *plant salt marshes, flora and vegetation, Zosteretea Marinae, Arthrocnemetea; Juncetea maritimi; coastal vegetation; halophytes; phytosociological analysis.*

Introduction

On the coastal area of Albania, salt marshes are one of the most prevalent habitats, mainly around the coastline of Lagoons, in both sides near the deltas of many rivers and also in depressions behinds sand dunes and low-being alluvial plains. The most important areas in Albania are those around Viluni, Kune-Vain, Patok, Bishtaraka, Karavasta, Narta, Orikumi, Butrinti Lagoons and Buna, Drini, Mati, Ishmi, Erzeni, Shkumbini, Semani, Vjosa delta's rivers.

Salt marshes area is considered as one of the most important areas in Albania based on the high biodiversity values and the number of habitat found there. The biodiversity found in salt marshes is unique and highly adapted.

Salt marshes are populated by **halophytes**, plants that can live under saline conditions. Plant species diversity is low, since the flora must be tolerant of salt and anoxic mud substrate.

The plant communities' composition of salt marshes area is rather variable depending on the nature of the soil. The development from constantly submerged areas and ending in areas that are always above water level is marked by the increasing diversity which follows the arrival of a range of new species.

The salt marsh vegetation has been the object of scientific investigation of several recent phytosociological studies (Géhu & Biondi 1996; Géhu 1999; Poldini et al. 1999).

Coastal salt marshes rank among the systems with the highest productivity of any in the world. High productivity of salt marshes is just one reason we are protecting and restoring these valuable "liquid assets."

Materials and methods

A total of 33 phytosociological releve's were made in the period between 2004 and 2009. The vegetation releve's were made and elaborated according to the standard procedures of the Braun-Blanquet methods of phytosociology (Zurich-Montpellier). (Braun-Blanquet 1964). The standard keys for determination of plants and nomenclature of plant species were used (Tutin et al. 1964-1980, 1993; Paparisto et al. 1984-2000).

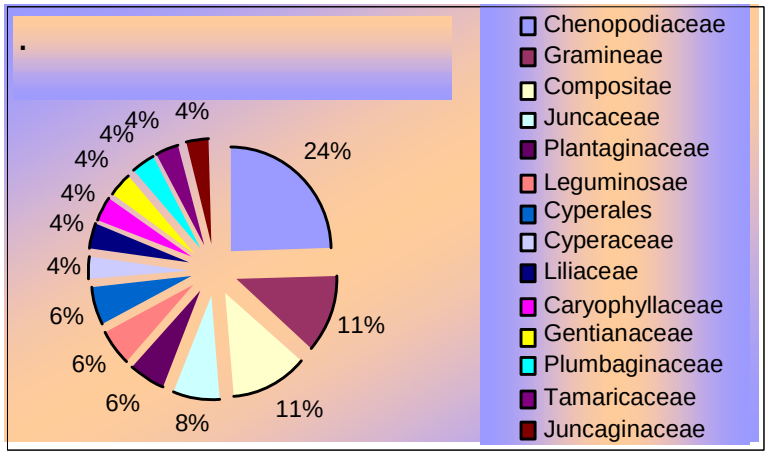
All releve´s available were collected and classified using numerical methods (TWINSPAN). A database was built of these releve´s using TURBOVEG (Hennekens 1996a). For syntaxonomic nomenclature of the higher levels of classification (class, order and alliance) we followed Rivas-Martinez et al. (1999). Species cover-abundance values we followed the Braun Blanquet scale. A structured table was produced by running TWINSPAN (Hill 1979). Some clearly heterogeneous releve´s were removed.

For each syntaxon the location where the releve´s have been made is listed. Attention is paid to ecological requirements and geographical distribution. The characteristic and differential species for each syntaxon are also described. Human impact and conservation of coastal communities is discussed.

Results and Discussion

1. Flora. Along the Albanian coast, some salt-marshes, sometimes very extended, are frequent. These are submerged in winter and dry (partly or totally) in summer. Around these salt-marshes there is developed and extended halophilous vegetation. Generally, this vegetation, mainly shrubby, presents a remarkable analogy with formations known in other marshy coastal areas of Europe

Salt-marshes are presented from a number of 62 species (Annex 1), extended in 16 different families. The most presented families are *Chenopodiaceae* 24 %, followed by *Graminae* and *Compositae* with 11% (Graph. 1). The dominant forms in this type of habitat are succulent plants.



Graph. 1 Family's richness (percentage) of flowering plant species of the Salt marshes

In these habitats, frequent floristical elements are: Mediterranean and Mediterranean-Atlantic (*Inula crithmoides*, *Parapholis filiformis*, *Centarium spicatum*, *Centarium tenuiflorum*, *Lotus preslii*, *Plantago coronopus, Limonium oleifolium*, *Parapholis incurve, Juncus subulatus*, *Triglochin bulbosum*); Borealo-Tropical and Circum Boreal (*Halimione portulacoides*, *Suaeda maritima*, *Salicornia europaea*, *Carex extensa*, *Juncus acutus*, *Juncus maritimus*: Paleo-Temperate (*Spergularia marina*, *Carex divisa*); Mediterranean-Irano-Turanian (*Arthrocnemum glaucum*, *Halocnemum strobilaceum, Frankenia pulverulenta*, *Hordeum marinum*; Cosmopolitan (*Polypogon monspeliensis, Ruppia cirrhosa.*

2. Habitat types and Syntaxonomic scheme of the studied vegetation:
Habitats pertaining to salt marsh vegetation of the studied area are recorded at a total of 10 localities

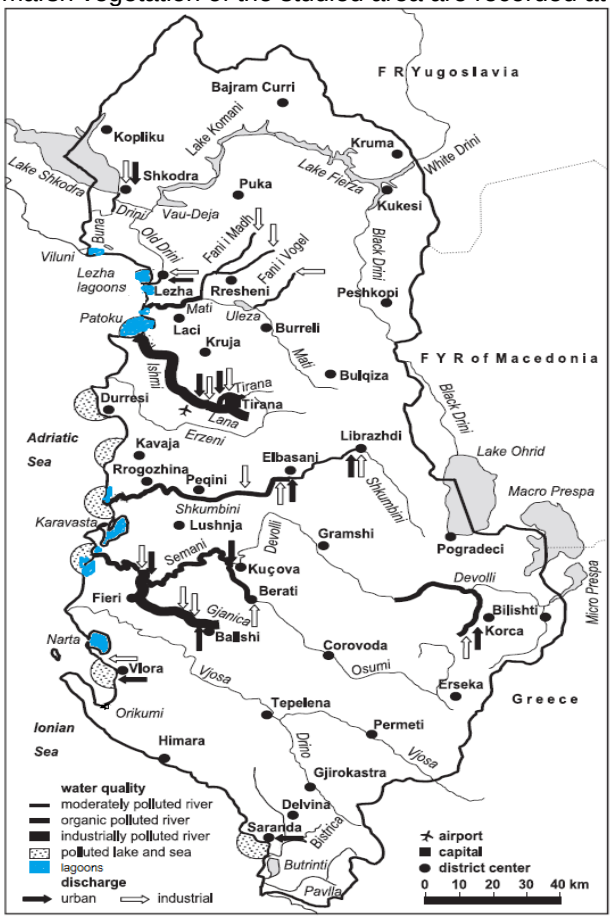


Fig.1. Map of lagoons of Albania

With regard to its floristic composition the studied vegetation can be classified within classes: Zosteretea Marinae, Ruppietea Maritimae, Thero-Salicornietea **,** Sarcocornietea Fruticosae and Juncetea maritimi. The performed numerical analysis supports such syntaxonomic division.

2.1 Sea grass beds of coastal lagoons
ZOSTERETEA MARINAE Pignatti 1953
Zosteretalia marinae Beguinot 1941 em. R.Tx. et Oberdorfer 1958
Zosterion marinae Christiansen 1934
Zosteretum noltii Harmsen 1936

RUPPIETEA MARITIMAE J.Tüxen 1960
RUPPIETALIA MARITIMAE J. Tüxen 1960
Ruppion maritimae Br.-Bl. 1931
Ruppietum cirrhosae Hocquette 1927

The seagrass beds are a common feature of shallower waters on firm sands, sandy muds and gravelly flats of the Albanian lagoons. Where seagrass beds occur, eelgrass (*Zostera noltii*) is the most dominant species. Eelgrass (*Zostera noltii)* communities are prominent, usually with very few other vascular species but often with abundant algae.
Zostera noltii forms stands with a cover of delicate trailing narrow leaves up to about 20 cm long. It often occurs in pure stands on mud/sand mixtures of a variety of consistencies from very soft to quite firm. *Z.*

noltii experiences considerable leaf loss in autumn and early winter through natural shedding, storm damage and wildfowl grazing, but plants towards the lower limit may remain winter-green.
In Europe the *Zosteretum noltii* is widespread in similar situations to those in Albania (Beeftink 1962, Géhu 1975).
In shallow areas whole prairies settle, dominated by the spiral tasselweed (*Ruppia cirrhosa*). Fluctuating algae populations of *Ulva rigida* (a variety of green seaweed) settle on soft, muddy substrata while the gut weed (*Enteromorpha* sp.) lives on harder (sandy) substrata. The seagrass beds have few species, but reach enormous quantities of biomass and in these communities live a large number of planktonic and benthonic animals. These plant communities cover important surfaces in the bottoms of the Albanian Lagoons. Such beds play an important role in influencing the shape and stability of the shoreline, regulating dissolved oxygen and filtering suspended matter. They can enhance the biodiversity of a lagoon by providing a physical refuge from predation and also serve as nursery and feeding habitats for a variety of organisms.

2.2 Salt-marshes plant communities

THERO-SALICORNIETEA (Pignatti 1953) R.Tx. in R.Tx. et Oberdorfer 1958
Thero-Salicornietalia Pignatti 1953 em. R.Tx. 1954 ex R.Tx. et Oberdorfer 1958
Thero-Salicornion strictae Br.-Bl. 1933 em. R.Tx. 1950 in Tx et Oberdorfer 1958
Salicornietum europaeae Warming 1906
Suaedetum maritimae (Conard 1935) Pignatti 1953

SARCOCORNIETEA FRUTICOSAE R.Tx. et Oberd. 1958
Sarcocornietalia fruticosae (Br.-Bl. 1931) R.Tx. et Oberd. 1958
Sarcocornion fruticosae Br.-Bl. 1931
Puccinellio festuciformis - Sarcocornietum fruticosae (Br.-Bl. 1928) Géhu 1976
Halimionetum portulacoidis (Kuhnholtz-Lordat 1927) Des Abbayes et Corillion 1949

Halocnemenion strobilacei Géhu et Costa in Géhu et al. 1984
Halocnemetum strobilacei Oberd. 1952 em. Géhu 1994
Limonion angustifolii Br.-Bl. (1933) 1934
Limonio-Artemisietum coerulescentis Horvatic (1933) 1934

JUNCETEA MARITIMI Br.-Bl. 1952 em. Beeft. 1965
Juncetalia maritimi Br.-Bl. 1931
Juncion maritimi Br.-Bl. 1931
Puccinellio festuciformis - Juncetum maritimi (Pign. 1966) Géhu et al.1984
Juncetum maritimo - acuti Horvatic 1934

Salt marshes are one of the most prevalent habitats around the coastline of Albanian Lagoons, near the deltas of the rivers and also in depressions behinds sand dunes and low-being alluvial plain. The biodiversity found in salt marshes is unique and highly adapted, able to survive high salt concentrations, periodical submersion, and low-nutrient conditions. Salt marshes are populated by halophytes, plants that can live under saline conditions. The flora of a salt marsh is differentiated into levels according to the plants' individual tolerance of salinity and water table levels. Under regular conditions it is possible to encounter the whole range of typical species by traveling from constantly submerged areas or lower marsh communities, moving on to areas subject to tidal movements, and ending in areas that are always above water level.
The most common salt marsh plant community in Coastal area of Albania is S*alicornietum europaeae,* dominated by glasswort (*Salicornia europaea*. Glasswort is often the first plants to take hold in a mudflat and begin its ecological succession into a salt marsh. Their shoots lift the main flow of the tide above the mud surface while their roots spread into the substrate and stabilize the sticky mud and carry oxygen into it so that other plants can establish themselves as well. Plants such as sea lavender (*Limonium vulgare*),

Spiny rush (*Juncus acutus*) and Sea rush (*Juncus maritimus)* grow once the mud has been vegetated by the pioneer species.
The *Salicornia europaea* (pioneer marsh communities) takes place in the space of just a few months between summer and early autumn. *Salicornia europaea* stands may form a distinct zone in the lower marsh. At some sites, particularly those on sandy substrates (Patok and Narta areas), patches of *Salicornia europaea* may be separated from the main marsh front by several hundred metres of bare flat.

At a number of sites, S*alicornietum europaeae* forms an open mosaic with *Suaedetum maritimae,* which is a species-poor community, generally open, though always dominated by *Suaeda maritima* the density of which is high, sometimes associated by *Salicornia europaea*, *Halimione portulacoides* and *Aster tripolium*. *Suaeda maritima* is an annual and it is tolerant of a wide range of soil types subject to various submersion regimes. Like the *Salicornietum europaeae*, its growth appears heavily dependent upon sediment nutrients, especially nitrogen, and it is particularly characteristic of open situations free of competition from established perennials.

Following this layer is a plant community of *Puccinellia festuciformis* and *Sarcocornia fruticosa* or association *Puccinellio festuciformis - Sarcocornietum fruticosae.* Stands of this association occur on the lower parts of salt-marshes covered by water for the greater part of a year, whose surface becomes dried-up and parched only at extremely hot temperatures. They develop on clayish and marshy soils, periodically or permanently flooded, showing a high rate of salinity. The association *Puccinellio festuciformis - Sarcocornietum fruticosae* is poor in species. This association is easily recognized and differs from a related ass. *Halocnemetum strobilacei* by the abundant presence of *Sarcocornia fruticosa*, which is a characteristic and dominant species of the association. The community reaches its optimum development during the summer.

The associations *Limonio-Artemisietum coerulescentis, Halimionetum portulacoidis* develops outside of the tidal zone, on less saline and moist soils, such as embankments and meadows. They represent perennial communities of the middle parts of salt-marshes, rarely inundated by spring tides, with more species compared to other communities within the class *Sarcocornietea Fruticosae*. The community reaches its optimum development by the end of the summer and at the beginning of autumn,

As the saltmarsh develops, the accumulation of new material raises the surface level of the new marsh in relation to the sea and this reduces the frequency and duration of tidal inundation. This enables species less tolerant of inundation to colonize, and more complex plant communities gradually develop.

The next stage is the development of the plant communities dominated by Spiny rush (*Juncus acutus*) and Sea rush (*Juncus maritimus*) that cover a large surface in this area. Ass. *Juncetum maritimo-acuti, Puccinellio festuciformis - Juncetum maritime* extends across the entire area of the Albanian coasts, usually closed swards on the silt and sand of coastal salt-marshes in the area of highly moist and marshy soils with sea and brackish water. Floristic composition of the both associations is very similar, mostly elements of halophilous vegetation of the class Sarcocornietea Fruticosae. The association reaches its optimum development in the summer.

The development of the saltmarshes in terms of plant species and communities is also accompanied by developments in the soil structure and microflora. These developments involve the establishment of populations of bacteria and fungi which are involved in biogeochemical processes controlling the breakdown of organic matter and the cycling of plant nutrients.

Conclusions

Salt marshes area is considered as one of the most important areas in Albania based on the high biodiversity values and the number of habitat found there. The biodiversity found in salt marshes is unique and highly adapted.
The flora of coastal salt marshes is differentiated into levels according to the plants' individual tolerance of salinity and water table levels. *Coastal salt marshes* of Albania are offered a number of 62 taxa, extended

in 16 diverse families. The most presented families are *Chenopodiaceae* 24 %, followed by *Poaceae* and *Asteraceae* with 11%.

Phytosociological analysis evidenced 11 associations, which belong to 5 classes, 5 orders and 7 alliances.

The most common salt marsh plant communities in coastal area of Albania are salt meadows dominated by glasswort (*Salicornia europaea*), pioneer marsh communities, perennial vegetation of marine saline mud's mainly composed of scrub such as Sarcocornia fruticosa, *Sarcocornia perennis* and belonging to the *Sarcocornetea fruticosi* class, tall rush salt marshes dominated by *Juncus maritimus* or *J. acutus* (*Juncetalia maritimi*).

The plant communities' composition of salt marshes area is rather variable depending on the nature of the soil. The development from constantly submerged areas and ending in areas that are always above water level is marked by the increasing diversity which follows the arrival of a range of new species.

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Annex 1: Salt marshes floristic richness of the Albanian Coastal area

Nr.	Latin name	Family name	Flowering time
1	*Anthrocnemum fruticosum* (L.)Maq	Chenopodiaceae	VII-IX
2	*Aeluropus littoralis* (Gouan) Parl	Gramineae	VI-VIII
3	*Artemisia coerulescens* L.	Compositae	VII-IX
4	*Arthrocemum glaucum* (Delile) Ung	Chenopodiaceae	VIII-X
5	*Arthrocemum perenne* (Miller) Moss	Chenopodiaceae	VII-VIII
6	*Asparagus maritimus* (L.)Miller-Gard	Liliaceae	V-VI
7	*Asphodelus aestivus* Brot	Liliaceae	III-V
8	*Aster squamatus* Sprengel	Compositae	VIII-XI
9	*Aster tripolium* L.	Compositae	VIII-IX
10	*Asteriscus aquaticus* (L.) Less	Compositae	IV-VIII
11	*Atriplex hastata* L.	Chenopodiaceae	VII-IX
12	*Carex extensa* Good	Cyperaceae	V-VI

13	*Centaurium erythraea* Rafn.	Gentianaceae	V-VIII
14	*Centaurium spicatum* (L.)Fritsch	Gentianaceae	V-IX
15	*Chenopodium glaucum* L.	Chenopodiaceae	VI-IX
16	*Chrypsis aculeata* (L.)Aiton	Gramineae	VII-IX
17	*Cynanchum acutum* (L.)Plian	Asclepidaceae	V-VII
18	*Elymus pycnanthus* Godron	Gramineae	V-VI
19	*Equisetum ramosissimum* Desf.	Equisetaceae	V-VI
20	*Frankenia pulverulenta* L.	Frankeniaceae	IV-VI
21	*Halimione portulacoides* (L.)Aellen	Chenopodiaceae	VII-X
22	*Halocnemum strobilaceum* (Pallas)	Chenopodiaceae	IX-X
23	*Inula crithmoides* L.	Compositae	VII-XI
24	*Juncus acutus* L.	Juncaceae	V-VII
25	*Juncus compressus* Jacq.	Juncaceae	VI-VII
26	*Juncus littoralis* C.A.Meyer	Juncaceae	V-VII
27	*Juncus maritimus* Lam.	Juncaceae	VI-VIII
28	*Lepidium ruderale* L.	Cruciferae	V-VIII
29	*Limonium oleifolium* Miller	Plumbaginaceae	VI-VIII
30	*Limonium vulgare* Miller	Plumbaginaceae	VI-IX
31	*Linum maritimum* L.	Linaceae	V-IX
32	*Lotus tenuis* Ëaldst. & Kit.	Leguminosae	IV-VI
33	*Lythrum salicaria* L.	Lythraceae	VI-IX
34	*Melilotus alba Medicus* Vorl.Churpf	Leguminosae	VII-IX
35	*Mentha pulegium* L.	Labiateae	V-IX
36	*Parapholis incurva* L.C.E.Hubbort	Gramineae	IV-VI
37	*Petrosimonia oppositifolia* Pallas	Chenopodiaceae	VI-VIII
38	*Phragmites australis* (Cav)Trin.ex	Gramineae	VI-X
39	*Plantago coronopus* L.	Plantaginaceae	V-VIII
40	*Plantago crassifolia* Forskal	Plantaginaceae	IV-IX
41	*Plantago maritima* L.	Plantaginaceae	IV-VIII
42	*Polypogon monspeliensis* (L.)Desf.	Gramineae	III-V
43	*Potentilla reptans* L.	Rosaceae	VI-VIII
44	*Rumex conglomeratus* Murray	Polygonaceae	VI-IX
45	*Saccharum ravennae* (L.)Murray	Gramineae	VII-X
46	*Sagina procumbens* L.	Carophyllaceae	III-VIII
47	*Salicornia europaea* L.	Chenopodiaceae	VII-X
48	*Salsola soda* L.	Chenopodiaceae	VIIVIII
49	*Samolus valerandi* L.	Primulaceae	VI-VIII
50	*Schoenus nigricans* L.	Cyperaceae	IV-VIII
51	*Scirpus holoschoenus* L	Cyperaceae	IV-VI
52	*Scirpus maritimus* L	Cyperaceae	VI-IX
53	*Sonchus maritimus* L.	Compositae	VI-IX
54	*Spergularia marina* L.	Carophyllaceae	III-IX
55	*Suaeda maritima* (L.)Dumort	Chenopodiaceae	VII-X
56	*Suaeda splendens* Pourret.Gren	Chenopodiaceae	VII-IX
57	*Suaeda vera* J.F.Gmelin	Chenopodiaceae	V-X
58	*Tamarix dalmatica* Baum.	Tamaricaceae	V-VI
59	*Tamarix hampeana* Boiss. & Heldr.	Tamaricaceae	IV-V
60	*Trifolium fragiferum* L.	Leguminosae	IV-VIII
61	*Triglochin bulbosa* L.	Juncaginaceae	IV-XI
62	*Triglochin maritima* L.	Juncaginaceae	IV-V