

RESEARCH ARTICLE

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Coastal salt-marshes in Albania¹JULIAN SHEHU, ¹ALMA IMERI, ¹RUDINA KOCI, ²ALFRED MULLAJ,¹Agricultural university of Tirana, Department of Plant Production,²Faculty of Natural Sciences, Department of Biology**Abstract**

The salt marshes of Albania comprise a narrow belt along the Adriatic and Ionian Seas. They have 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. 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%. 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 [4]. 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*), halo-psammophile meadows mainly dominated by *Plantago crassifolia*, *Saccharum ravennae*, *Scirpus holoschoenus* (*Plantaginion crassifoliae*), [4, 5]. 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 [7]. 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."

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, in both sides near the deltas of many rivers and also in depressions behind sand dunes and low-lying alluvial plains. 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, [10].

Materials and methods

A total of 33 phytosociological relevés were made in the period between 2009 and 2012. The vegetation relevés 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; Papanicolaou et al. 1984-2000). 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. For each syntaxon the location where the relevés 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 [2, 3] 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.

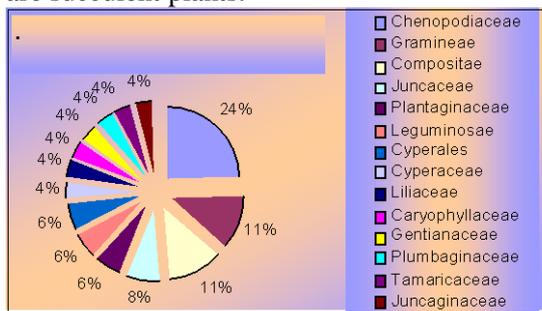


Figure. 1 Family's richness (percentage) of flowering plant species of the Salt marshes

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*).

Floristic composition the studied vegetation can be classified within classes:

1. Zosteretea - Marinae,

2. Ruppieteae - Maritimae,
3. Thero - Salicornietea,
4. Sarcocornietea – Fruticosae,
5. Juncetea – Maritimi,

The performed of syntaxonomic division.

- Sea grass beds of coastal lagoons
 ZOSTERETEAE MARINAE Pignatti 1953
 Zosteretalia marinae Beguinot 1941 em. R.Tx. et Oberdorfer 1958
 Zosterion marinae Christiansen 1934
 Zosteretum noltii Harmsen 1936
 RUPPIETEAE MARITIMAE J. Tüxen 1960
 RUPPIETALIA MARITIMAE J. Tüxen 1960
 Ruppion maritimae Br.-Bl. 1931
 Ruppium cirrhosae Hocquette 1927

The seagrass beds are a common feature of shallower waters on firm sands, sandy muds and gravelly flats. 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 [11]. *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.

Salt-marshes plant communities

- KL. 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 europaea Warming 1906

Suaedetum maritimae (Conard 1935) Pignatti 1953

Kl. **ARTHROCNETEA** Br.-Bl. et Tx. 1943 corr. Bol. 1957

* Rend. *Arthrocnemetalia fruticosi* Br.-Bl. 1931 corr. Bol. 1957

+ Al. *Arthrocnemion fruticosi* Br.-Bl. 1931 em. Riv. Mart. et al. 1980

Asoc. **Puccinellio festuciformis-Arthrocnemum fruticosi** (Br.-Bl. 1928) Géhu 1976 (= *Salicornietum fruticosae* Br.-Bl. 1928)

* Rend. *Limonietalia* Br.-Bl. & O. Bolòs 1957

+ Al. *Limonion angustifolii* Br.-Bl. (1933) 1934

Asoc. **Limonio-Artemisietum coerulescentis** Horvatic (1933) 1934

Kl. **JUNCETEA MARITIMI** Br.-Bl. 1952 em. Beeftink 1965

* Rend. *Juncetalia maritimi* Br.-Bl. 1931

+ Al. *Juncion maritimi* Br.-Bl. 1931

Asoc. *Juncetum maritimo-acuti* Horvatic 1934

+ Al. *Plantaginion crassifoliae* Br.-Bl. in Br.-Bl., Roussine & Nègre 1952

Asoc. **Eriantho-Schoenetum nigricantis** (Pignatti 1953) Géhu in Géhu et al. 1984

Asoc. **Holoschoenetum romani** Tchou 1948



Figure 4. Asociacioni *Holoschoenetum vulgaris* Br.-Bl. ex Tchou 1948

Salt marshes are one of the most prevalent habitats around the coastline of Albania, near the deltas of the rivers and also in depressions behind sand dunes and low-lying 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 *Salicornietum 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, *Salicornietum europaeae* forms an open mosaic with *Suaedetum maritimae*, which is a species-poor community, generally open, though always dominated by *Suaeda maritima* the



Figure 2. Asoc. *Limonio-Artemisietum coerulescentis* Horvatic (1933- 1934)



Figure 3. Asoc. *Eriantho-Schoenetum nigricantis* (Pignatti 1953) (Géhu et al. 1984) in the depression of dunes dunave ranore

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. *Halocnemum 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 [6, 12].

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 *Sarcocornietea 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. 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."

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