THE PLANT COMMUNITY *SECALI SYLVESTRI – ALYSSETUM BORZAEANI* (BORZA 1931) MORARIU 1959 IN ROMANIA AND BULGARIA

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Abstract: *Secali sylvestri-Alyssetum borzaeani* (Borza 1931) Morariu 1959 is one of the most rare psammophilous plant communities which grow on the western coast of the Black Sea. It was reported and described for the first time on the southern coast of Romania, in the natural reserve "Marine sand dunes of Agigea", which is a small Nature 2000 site located 15 kilometers south from Constanta town. Subsequently, the plant community has been noticed by different authors on the maritime sandbanks Lupilor and Saele (Istria) within the Danube Delta Biosphere Reserve. Recently, this plant association has been observed on the northern coast of Bulgaria, on the beach "Anna Maria", very close to the border with Romania. Here, *Secali sylvestri-Alyssetum borzaeani* occupies large surfaces on the embryonic and shifting sand dunes. In May and in the beginning of June, *Alyssum borzaeanum* accompanied by *Secale sylvestre* and other plant species give the dominant note of the landscape on the beach "Anna Maria". In spite of that, the plant community *Secali sylvestri-Alyssetum borzaeani* has not been mentioned in the last paper regarding classification of vegetation from Bulgaria - Syntaxa according to the Braun-Blanquet approach in Bulgaria.
Keywords: shifting sand dunes, plant community, *Alyssum borzaeanum*, *Secale sylvestre*.

AIMS AND BACKGROUND

On the basis of the field surveys carried out in Romania and Bulgaria in the period 2013-2015, the plant association *Secali sylvestri-Alyssetum borzaeani* has been described and a table of the association was accomplished. Phytocoenoses within the natural reserve "Marine

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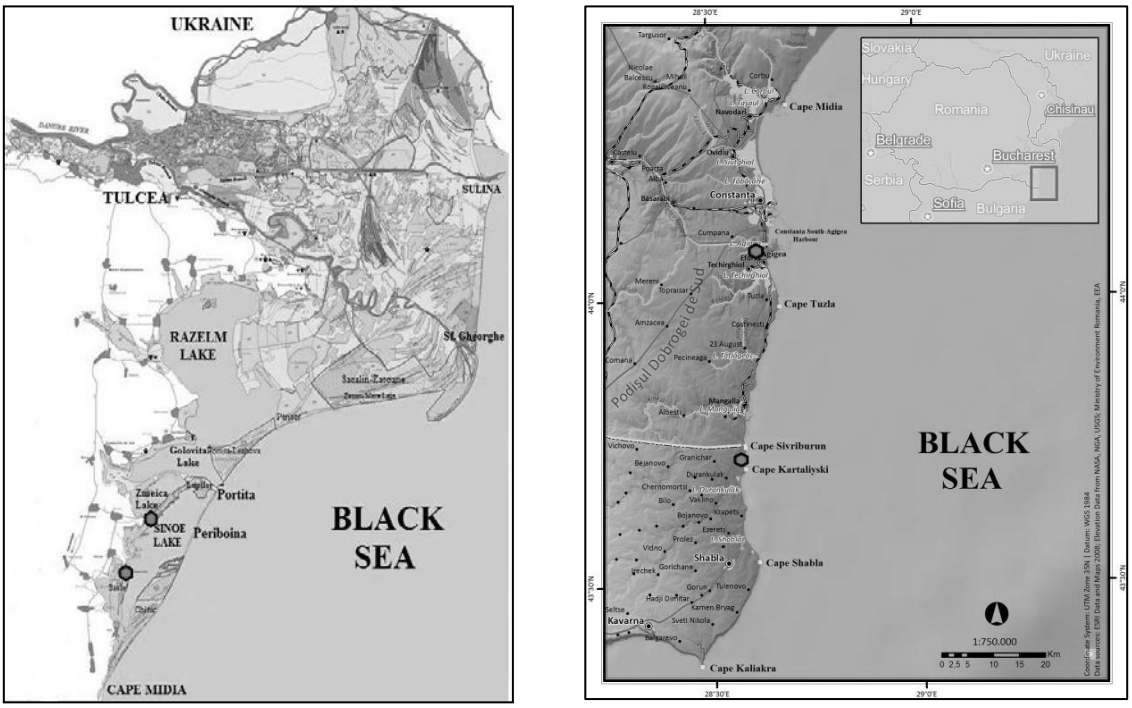
sand dunes of Agigea" (Romania) and from the beach "Anna Maria" (Durankulak, Bulgaria) have been compared in the aim of highlight the main characteristics of the association. Detailed considerations regarding floristic composition, coenotic structure, distribution, conservation status and proposed conservation measures for the phytocoenoses from Romania and Bulgaria will be specified in the paper.

Sea coasts are one of the most complex and at the same time, one of the fragile ecosystems, continuous influenced by the wind and the sea[1]. The coastline represent an environment with a high selectivity where the plants and the plant communities are adapted to the dryness and mobility of the sands, the lack of nutrients, the strong winds and the strong irradiation[2]. The coastal vegetation is highly specialized and strictly correlated with the microclimate and substrate condition.

Starting from the shoreline, the whole coastal system is spread along the gradient of the intensity of the wind, from the embryonic shifting dunes, representing the first stages of the dune construction, continuing with the fixed coastal dunes with herbaceous vegetation and further with coastal dune scrubs or with moist or wet dune slacks[2].



Figs. 1-2. Spreading area of the association *Secali sylvestri-Alyssetum borzaeani* in Danube Delta Biosphere Reserve (left) and on the western coast of the Black Sea (right)

Secali sylvestri-Alyssetum borzaeani (Borza 1931) Morariu 1959 is one of the most rare psammophilous plant communities which occur only in a few points of the western coast of

the Black Sea, in the frame of the habitat 2110 – Embryonic shifting dunes[3]. It was reported and described for the first time on the southern coast of Romania, in the natural reserve Marine sand dunes of Agigea[4], a small Natura 2000 site located 15 kilometers south from Constanta town (Fig. 1). Subsequently, this plant community has been noticed on the maritime sandbanks Lupilor and Saele (Istria) within the Danube Delta Biosphere Reserve[5, 6]. The maritime sandbanks Lupilor and Saele (Fig. 1) belong to the Razelm-Sinoe Lagoon complex (known as southern Delta) and they are large sand strips formed 1000-1500 years ago in the Halmyris bay (former bay of the Black Sea) as a consequence of the silt and sand deposits brought by the Danube and the marine streams.

Recently, the plant association has been identified on the northern coast of Bulgaria, on the beach "Anna Maria" (Fig. 2), one of the most isolated beaches of northern Bulgaria, situated very close to the border with Romania.

EXPERIMENTAL

Observations concerning association *Secali sylvestri-Alyssetum borzaeani* (Borza 1931) Morariu 1959 have been carried out between years 2013 and 2015 on the Black Sea coast of Romania and Bulgaria. Phytocoenoses within Agigea were compared with those from the northern Black Sea coast of Bulgaria. Field observations and phytosociological relevés have been done in accordance with the methodology of Braun-Blanquet's phytosociological school. Coenotaxonomic affiliation of this plant community is according to the book "Phytocoenoses of Romania"[6]. Nomenclature of the species from the floristic composition of the plant community is in concordance with Flora Europaea[7] and „Vascular Plants of Romania"[8].

RESULTS AND DISCUSSION

Alyssum borzaeanum, the main recognized plant of the association is an euxinic species which has a very limited and scattered distribution along the Black Sea coast, in Romania, Bulgaria, Ukraine[9] and in North-Western Turkey[10]. It is currently known only in three locations in Romania (in Marine Sand Dunes Reserve of Agigea[4], on the sandbanks Lupilor[11] and Saele[5] (near Histria ancient fortress) and in Bulgaria only on the beach "Anna Maria" at Durankulak. *Alyssum borzaeanum* is included as Critically endangered in Red Book of Vascular Plants of Romania[12] and as Endangered species in Red Data Book of the Republic of Bulgaria[13]. It has been included in the Annex I of the Bern Convention[14] since 1998.

Another characteristic species of the association is *Secale sylvestre* which is very common on the sand dunes in the coastal area of Romania and Bulgaria.

On the maritime sandbanks Lupilor and Saele, *Alyssum borzaeanum* occupy shifting sand dunes in inland areas, former sea shores. Large surfaces occupied by *Alyssum borzaeanum* occur in the western part of the Lupilor sandbank, close to the channel 2 which connecting the lakes Zmeica and Sinoe.

Because *Secale sylvestre* is missing on Lupilor sandbank, these phytocoenoses are not typical and could be included in a new sub-association called *Secali sylvestri-Alyssetum borzaeani* (Borza 1931) Morariu 1959 *alyssetosum borzaeani* subass. nova. Mentioning of the plant community *Secali sylvestri-Alyssetum borzaeani* on Saele sandbank[5] is doubtful because only a small local population with *Alyssum borzaeanum* has been observed on the sand dunes in the proximity of Histria ancient fortress.

In the protected site "Marine sand dunes of Agigea", *Secali sylvestri-Alyssetum borzaeani* is well represented on the shifting sand dunes in the north-west side of the natural reserve. Typical phytocoenoses of the association were recorded for the first time within this protected site. Different variant of this plant community have been published later such as a facies with *Astragalus varius*[15] or a variant with *Cynanchum acutum*[16]. The conservation status of this plant community is favourable here due to some effective management measures in the dune habitats area. The measures consist mainly of removing the invasive species and of some opportunistic steppe plant species.

In Bulgaria, the plant association has been noticed on the mobile and shifting sand dunes in the northern zone of the beach "Anna Maria", in a less accessible area due to vecinity with the Romanian border and because the lack the access roads. *Alyssum borzaeanum* develops plant communities with *Secale sylvestre* on the shifting sand dunes (Figs. 3-4) and plant communities with *Ephedra distachya*[17] on the stabilized sand dunes, especially at the base of the sea cliff. In May and in the beginning of June, phytocoenoses with *Alyssum borzaeanum*, accompanied by *Secale sylvestre* and other species, give the dominant note of the landscape on the beach "Anna Maria". In spite of that, the plant community *Secali sylvestri-Alyssetum borzaeani* has not been mentioned in the last paper regarding classification of vegetation from Bulgaria - Syntaxa according to the Braun-Blanquet approach in Bulgaria[18]. The conservation status of the plant community is favourable on the beach „Anna Maria" due to the low accessibility of the humans in the coastal area from the border vicinity.

In the phytocoenoses from Romania (Table 1, releves 1-11) the number of plant species (46 taxa) is almost similar with that noticed in Bulgaria where 43 taxa have been recorded (Table 1, releves 12-19). In the natural reserve "Marine sand dunes of Agigea", both *Alyssum borzaeanum* and *Secale sylvestre* have high abundance-dominance indices compared with other species from floristic composition of the association (Table 1). In the phytocoenoses from Bulgaria, the occurrence and the abundance-dominance index of *Secale sylvestre* are lower than in Romania. The species belonging to the alliances *Scabiosion ucrainicae* Boșcaiu 1975 and *Festucion vaginatae* Soó 1929 have high occurence in the relevés of this plant community (Table 1). Therefore, from coenotaxonomic point of view, the association *Secali sylvestri-Alyssetum borzaeani* belongs to the alliance *Scabiosion ucrainicae* Boşcaiu 1975 and to the order *Festucetalia vaginatae* Soó 1957.

Figs. 3-4. Phytocoenoses with *Alyssum borzaeanum* and *Secale sylvestre* on the sand dunes of "Anna Maria" beach (Durankulak)

Fifteen threatened plant species according to the Red Book of Vascular Plants of Romania[12] and Red Data Book of the Republic of Bulgaria[13] were recorded in the phytocoenoses of the plant association (Table 1). Many rare plants which belonging to the orders *Cakiletea maritimae* R. Tx et Preising 1950 and *Ammophiletea* Br.-Bl. et R Tx. 1943 grow only on the sand beaches and on the sand dunes from the seashore proximity such as on the beach "Anna Maria". Presently, the natural reserve "Marine sand dunes of Agigea" is located at approximately 300 meters away from the sea, because between the protected area and the seashore were built in the communist period some facilities of the harbour Constanta South-Agigea (buildings, access roads, a bridge, a parking).

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CONCLUSIONS

Typical phytocoenoses of the plant association *Secali sylvestri-Alyssetum borzaeani* can be considered only in the natural reserve “Marine sand dunes of Agigea” and on the beach “Anna Maria” in Bulgaria.

As *Secale sylvestre* is absent on the Lupilor sandbank, the phytocoenoses with *Alyssum borzaeanum* could be included in a new sub-association named *Secali sylvestri-Alyssetum borzaeani* (Borza 1931) Morariu 1959 *alyssetosum borzaeani* subass nova.

The plant species belonging to the alliances *Scabiosion ucrainicae* Boșcaiu 1975 and *Festucion vaginatae* Soó 1929 have a high occurrence in the floristic composition of this psammophilous plant community.

The plant association *Secali sylvestri-Alyssetum borzaeani* must to be included in the next paper regarding classification of vegetation from Bulgaria.

Putting under protection of the Bulgarian coastal areas with *Alyssum borzaeanum* and *Secale sylvestre* is strongly recommended for a better conservation of this rare plant community.

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Table 1. **Association table of *Secali sylvestri-Alyssetum borzaeani* (Borza 1931) Morariu 1959**

Relevé number	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**	**R12**	**R13**	**R14**	**R15**	**R16**	**R17**	**R18**	**R19**	**K**
Area (m2)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Cover (%)	70	70	70	60	60	70	70	50	70	60	60	80	60	60	60	70	70	70	80	
Number of taxa	17	18	14	17	17	17	19	19	17	15	16	19	13	15	13	20	17	15	12	
Characteristic taxa of the association																				
Alyssum borzaeanum	3	3	3	3	1	3	2	2	3	3	3	4	3	3	3	3	3	3	4	V
Secale sylvestre	2	2	2	1	2	2	3	1	2	1	1	-	1	+	1	+	1	2	+	V
Festucetalia vaginatae, Scabiosion ucrainicae																				
Centaurea arenaria subsp. *borystenica*	+	+	+	+	1	+	+	+	1	+	1	+	-	+	1	+	+	+	1	V
Alyssum hirsutum	1	1	1	+	1	1	1	+	1	1	+	+	-	-	+	+	-	-	-	IV
Silene thymifolia	-	-	-	-	-	-	1	1	-	-	-	1	2	-	1	1	2	+	1	III
Carex colchica	+	+	1	-	+	-	+	+	-	+	-	-	-	-	-	-	-	-	-	II
Ephedra distachya	-	-	-	1	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	I
Syrenia montana	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	I
Cynanchum acutum	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	I
Festucion vaginatae +Bassio laniflorae-Bromion tectorum																				
Astragalus varius	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1	+	+	V
Euphorbia segueriana	+	1	-	1	+	+	-	+	+	1	+	1	-	-	-	+	+	-	1	IV
Silene exaltata	-	+	-	-	-	+	+	+	+	-	+	+	-	-	+	-	-	+	-	III
Silene conica	+	-	+	-	-	-	+	-	+	+	-	-	-	+	-	+	-	+	-	III
Festuca beckeri subsp. *arenicola*	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	+	1	+	II
Erysimum diffusum	-	-	+	-	+	-	-	-	-	-	-	+	-	-	-	+	-	-	-	II
Corispermum nitidum	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	+	-	I
Stachys maritima	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	I
Peucedanum arenarium	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	I
Artemisia campestris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	I
Echinops ritro subsp. *ruthenicus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	I
Festucetalia valesiacae + Festucion rupicolae																				
Medicago falcata	-	+	-	-	+	-	+	+	+	+	-	+	+	-	+	+	+	+	+	IV
Stachys atherocalyx	+	+	+	+	-	1	1	+	+	+	-	+	-	-	-	-	-	-	-	III
Linaria genistifolia	+	+	-	-	+	-	+	-	+	-	+	+	-	-	-	+	-	+	+	III
Anchusa officinalis subsp. *procera*	-	-	-	+	+	-	+	-	-	-	+	-	+	+	+	-	-	-	-	II
Seseli tortuosum	+	-	+	-	-	-	-	-	-	+	-	+	-	-	-	+	-	-	-	II
Salvia aethiopis	-	-	-	+	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	II

Cerastium brachypetalum	+	-	1	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	II
Medicago minima	-	-	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	I
Sideritis montana	-	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	I
Marrubium peregrinum	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	I
Xeranthemum annuum	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	I
Vincetoxicum hirundinaria	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	I
Chondrilla juncea	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	I
Cionura erecta	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	I
Cerastium pumilum	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Bromus squarrosus	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	I
Achillea setacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	I
Papaver dubium	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Reseda lutea	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	I
Ammophiletea																				
Leymus racemosus subsp. *sabulosus*	+	+	-	-	-	-	+	-	-	-	-	+	+	+	+	+	+	+	-	III
Elymus farctus subsp. *bessarabicus*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	1	+	-	II
Ammophila arenaria subsp. *arundinacea*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	I
Eryngium maritimum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	I
Cakiletalia maritimae																				
Convolvulus persicus	-	+		-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	I
Crambe maritima	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	I
Salsola kali subsp. *ruthenica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	I
Lactuca tatarica	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	I
Cakile maritima subsp. *euxina*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	I
Sisymbrietalia, Sisymbrion																				
Bromus tectorum	1	1	+	1	2	1	+	1	1	1	1	-	1	-	+	+	+	1	-	V
Papaver rhoeas	+	+	-	+	+	+	+	+	-	-	-	-	-	-	-	-	+	-	-	III
Tragopogon dubius	-	-	-	+	-	+	-	+	+	-	-	-	-	-	-	-	+	-	-	II
Xanthium italicum	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	I
Secalietea, Secalietalia																				
Senecio vernalis	+	+	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	II
Crepis foetida subsp. *rhoeadifolia*	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	I
Erodium cicutarium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	I
Other species																				

Aristolochia clematitis	-	-	-	-	-	-	-	-	-	-	-	-	2	+	+	-	-	-	-	I
Ailanthus altissima (juveniles)	-	-	-	-	-	+	-	-	-	-	1	-	-	-	-	-	-	-	-	I
Polytrichum piliferum	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	I
Syntrichia ruralis	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	I
Asparagus pseudoscaber	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	I
Camelina microcarpa	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Carduus nutans	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Evonymus europaeus	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Crataegus monogyna	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Sisymbrium orientale	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	I
Bromus hordeaceus	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Erophila verna	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I
Phragmites australis	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	I

Relevés number and dates: Marine Sand Dunes of Agigea, Romania - R1-4 (12.05.2013); R5-7 (22.05.2014); R8-11 (18.05.2015); "Anna Maria" beach, Bulgaria - R12-15 (29.05.2014); R16-19 (14.05.2015);