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THE HALOPHYTIC VEGETATION IN SOUTH-EAST BULGARIA AND ALONG THE BLACK SEA COAST

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Abstract

The paper presents results of a syntaxonomic analysis of the herbaceous phytocoenoses on the salt steppes, meadows and marshes in Southeastern Bulgaria, and along the Southern Black Sea Coast. The halophytic vegetation is distributed mostly in the Tundzha Lowland and the large salt lakes along the Black Sea Coast, where the saline soils occupy large territories. Most syntaxa identified in the paper are well-known and widespread in Central and Eastern Europe (*Salicornietum prostratae, Suaedetum maritimae, Juncetum maritimae* etc.), but there are also some specific vegetation types, which are presented by endemic associations as *Petrosimonio brachiatae-Puccinellietum convolutae, Bupleuro tenuissimae-Camphorosmetum monspeliacae.* The most widespread one is *Diantho pallidiflori-Puccinellietum convolutae.* It demonstrates a big variation in the appearance and the dominant structure of the described phytocoenoses. The comparision of the Bulgarian halophytic vegetation with other places in Europe shows its similarities with these vegetation types distributed in the Eastern Mediterranean and Central and Eastern Europe.

Key words: Halophytic vegetation, syntaxonomy, saline habitats, NATURA 2000, Bulgaria.

Izvleček

V članku so predstavljeni rezultati sintaksonomske analize zeliščnih fitocenoz slanih step, travišč in močvirij v jugovzhodni Bolgariji in ob južni črnomorski obali. Halofitska vegetacija je najbolj pogosta v nižini Tundzha in v velikih slanih jezerih ob obali Črnega morja, kjer slana tla zavzemajo velika območja. Večina obravnavanih sintaksonov je dobro znanih in splošno razširjenih v srednji in vzhodni Evropi (*Salicornietum prostratae, Suaedetum maritimae, Juncetum maritimae* itd.), nekaj pa je posebnih vegetacijskih tipov, ki jih predstavljajo endemične asociacije *Petrosimonio brachiatae-Puccinellietum convolutae, Bupleuro tenuissimae-Camphorosmetum monspeliacae.* Najbolj razširjena je združba, ki jo uvrščamo v asociacijo *Diantho pallidiflori-Puccinellietum convolutae,* za katero je značilna velika variabilnost v videzu in dominantni strukturi. Primerjava halofitske vegetacije iz Bolgarije je pokazala podobnosti z vegetacijskimi tipi, razširjenimi v vzhodnem Sredozemlju ter srednji in vzhodni Evropi.

Ključne besede: halofitska vegetacija, sintaksonomija, slanišča, NATURA 2000, Bolgarija.

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INTRODUCTION

The halophytic vegetation in Bulgaria is scarcely distributed, because its occurrence depends on the local edaphic conditions and some specific soil types. The climate and relief conditions in Bulgaria do not presuppose development of saline soils (Figure 1). According to Ninov (2002) the most widespread saline soil types in Bulgaria are Solonchaks and Solonetz, which are mostly of a secondary origin – on the places of former Fluvisols, Histosols and other soils of swampy and meadow areas. The main factor causing the formation of these soils is considered to be the water drainage. The two saline soil types mentioned above often coexist as a result of their mixed processes of origin. The salinization in Bulgaria is mostly of sulfate-chloride type. Ninov (1998) assessed the correlation between the main soil types and the vegetation and identified 7 main dominants in the vegetation on saline soils – *Puccinellia convoluta, Aeluropus littoralis, Salicornia europaea, Artemisia santonicum, Crypsis aculeata, Crypsis alopecuroides* and *Cynodon dactylon.*

The most typical regions for the halophytic vegetations are those with the optimal distribution of salt soils. They are scattered along the coast of the Black Sea and especially the big salt lakes – Atanasovsko, Mandra-Poda, Beloslav and Pomorie. The other region is the Valley of the Tundzha River and some of its small tributaries – Blatnica, Mochurica etc., and the Sazliika River – a tributary of the Maritza River. There are also some small territories with halophytic vegetation in North and Southwest Bulgaria.

Relatively detailed investigation of the halophytic vegetation in these regions was carried out only by means of the dominant method (Ganchev et al. 1971). In the cited work the halophytic vegetation has been classified by the authors in two main groups – Euhalophytic (the formations and the associations of *Salicornia europaea, Suaeda maritima, Salsola soda, Puccinellia convoluta, Aeluropus littoralis, Crypsis aculeata, Statice latifolia, Camphorosma monspeliaca, C. annua*) and non-typical Halophytic (the association and formations of *Hordeum hystrix, Juncus gerardii, Polypogon monspeliensis, Atriplex*

Figure 1: Typical saline soils. **Slika 1**: Tipična slana tla.

hastata, Agropyron elongatum, Puccinellia distans, Juncus maritimus, Rottboellia digitata).

There are some data about this type of vegetation in the works of Yordanov (1931), Stoyanoff (1941) and Stefanoff (1943). Although they are mainly florisrtic studies, they contain information about the main vegetation types in Bulgaria including the halophytic vegetation. Ganchev & Kochev (1962) described some halohytic communities from the Central Danubian plain by applying the dominant method. The same communities were included also in the big inventory of pastures and meadows in Bulgaria (Bondev et al. 1964). The distribution of halophytic vegetation was shown also on the map of the vegetation of Bulgaria (after the dominant method) of Bondev (1991).

The aim of this investigation is to describe and to classify the Bulgarian halophytic vegetation in the regions of their optimal distribution, according to the methodology of the Zurich-Montpellier school of phytosociology. Other purposes of the work are to analyse the relationships of the Bulgarian halophytic communities with those, which are distributed in the neighbouring territories; their contemporary status and some problems of their conservation.

METHODS

Study area

The study was performed in two regions of Bulgaria. The first region included the territory of the valleys of Tundzha and Lower Maritza rivers as well as some of their smaller tributaries. The area falls into the Thracian plain and Tundzha hilly region. The relief includes lowlands and plain areas in the river valleys, characterized predominantly by salty soils (mostly Solonetz type), which have been formed as a result of the high levels of underground waters and the strong evaporation during the long hot summers. Many of these lowlands are flooded by the spring waters of Tundzha and Maritza Rivers and their tributaries (Figure 2).

The second region was the Black Sea coast – mostly the larger hyper-saline lakes – Pomorie and Atanossovsko lakes, and only a few parts of the Beloslav Lake (Varna district – Northern Black Sea coast).

The climate in these parts of Bulgaria is of transitional type – Continental-Mediterranean (Transitional continental to Continental Mediterranean). There are some small differences concerning the Black Sea coast, where the temperature amplitude is lower than that of the inner part of the country and the air humidity is higher, due to the sea breeze. There is a short humid period (especially in winter) and a long dry summer, but near the sea the temperature fluctuations are lower and the rainfalls are higher (Velev 1990).

Sampling methods

The phytocoenological relevés were described by R. Tzonev, Ch. Gussev and P. Zhelev during the summer of 2006; and three relevés were made by R. Tzonev and T. Lysenko during the summer of 2008, applying the methods of the sigmatic school (Braun-Blanquet 1964, Westhoff & Maarel 1978). A total of 125 phytocoenotic relevés were made, of which 22 were rejected during the process of data analysis. Three relevés, which belong to the association *Camphorosmetum annuae*, were added in the tables during the finalization of this work. The expanded scale of Braun-Blanquet for abundance/dominance (Barkman et al. 1964) was used. All phytocoenological relevés of the Bulgarian halophytic communities were accumulated in the database established with the aid of the TURBOVEG software package (Hennekens & Schaminée 2001) and then processed with the MEGATAB visual editor for phytosociological tables (Hennekens 1996) [with the program TWINSPAN (Hill 1979) included], which is intended for hierarchical classification. TWINSPAN is a divisive polythetic program, which made a two-way analysis of the relevés on the basis of the indicator species. The final block-diagonal table classified the relevés into 21 groups. The final tables were manually re-arranged and 12 groups remained, which are homogeneous and represent the associations or communities without syntaxonomic rank.

Nomenclature

The taxonomic nomenclature used in the paper was according to Delipavlov et al. (2003), and the syntaxonomic nomenclature followed Borhidi (2003), Dierßen (1996), Rodwell et al. (2002), Sanda et al. (1999), Pop (2002), SynBioSys Europe (http://www.synbiosys.alterra.nl/eu).

New syntaxa were described according to the rules of the International Code of Phytosociological Nomenclature (ICPN; Weber et al. 2000).

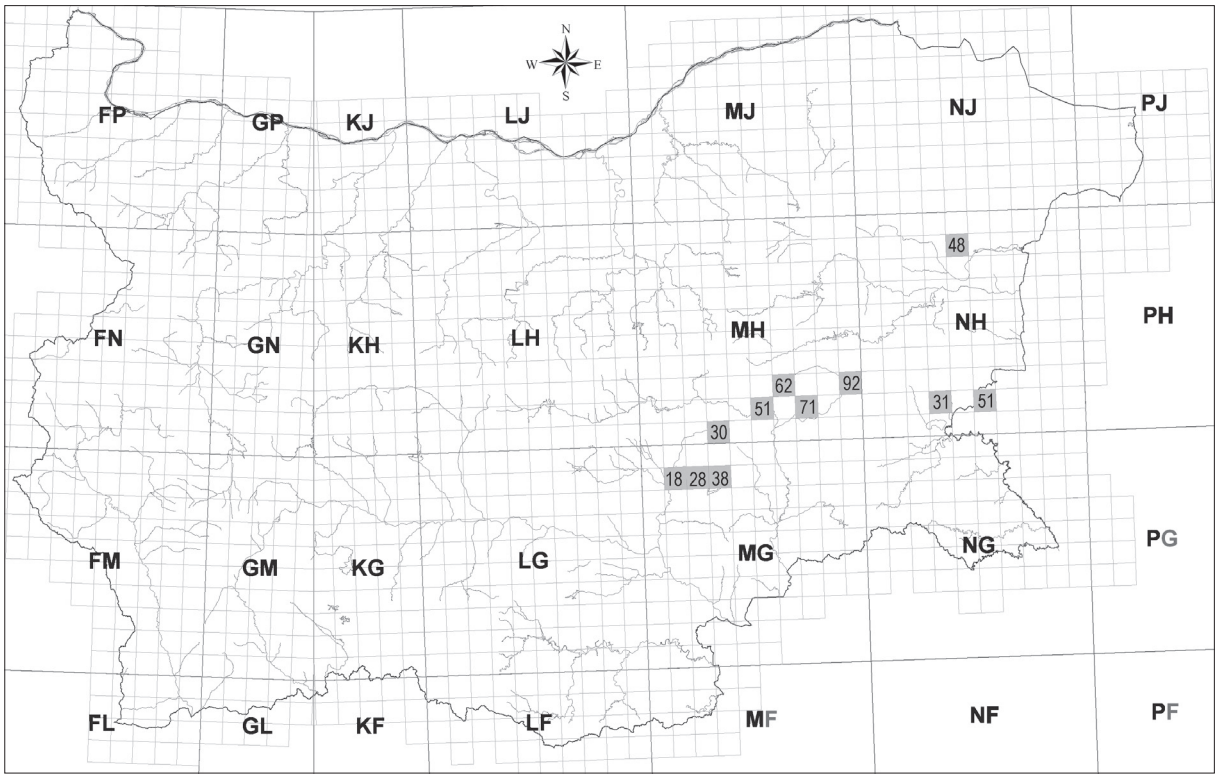

Figure 2: Map of localities with a 10 × 10 km UTM grid of the investigated halophytic communities.

- Devnya town, the quarter of Povelyanovo (Varna district) – NH48;
- Pomoriisko Ezero Lake (Burgas District) – NH51;
- North from Atanasovsko ezero Rezerve – Rudnik village (Burgas district) – NH31
- Between the southern and northern part of Atanasovsko Ezero Lake – locality "Ezika" (Burgas district) – NH31;
- Sigmen village (Burgas district) – MH92;
- Trapoklovo village (Sliven district) – MH62
- Bikovo village (Sliven district) – MH30
- Zhelyu Voivoda village (Sliven district) – MH51
- Blatec village (Sliven district) – MH62
- Atolovo village (Yambol district) – MH71
- Radnevo town (Stara Zagora district) – MG18
- Kunevo village (Stara Zagora district) – MG38
- Radetzki village (Stara Zagora district) – MG28

Slika 2: Karta lokacij proučevanih halofitskih združb z UTM mrežo 10 × 10 km.

- mesto Devnya, četrt Povelyanovo (okrožje Varna) – NH48;
- jezero Pomoriisko Ezero (okrožje Burgas) – NH51;
- severno od rezervata Atanasovsko ezero– vas Rudnik (okrožje Burgas) – NH31
- med južnim in severnim delom jezera Atanasovsko Ezero– lokacija "Ezika" (okrožje Burgas) – NH31;
- vas Sigmen (okrožje Burgas) – MH92;
- vas Trapoklovo (okrožje Sliven) – MH62
- vas Bikovo (okrožje Sliven) – MH30
- vas Zhelyu Voivoda (okrožje Sliven) – MH51
- vas Blatec (okrožje Sliven) – MH62
- vas Atolovo (okrožje Yambol) – MH71
- mesto Radnevo (okrožje Stara Zagora) – MG18
- vas Kunevo (okrožje Stara Zagora) – MG38
- vas Radetzki (okrožje Stara Zagora) – MG28

Results and discussion

According to our observations, the halophytic vegetation in Bulgaria is subdivided into two main types. The first one – whose communities are dominated by facultative halophytes, such as *Cynodon dactylon, Juncus gerardii, Trifolium fragiferum* subsp. *bonannii, Cerastium dubium, Myosurus minimus,* and *Mentha pulegium*, belongs to the class *Plantaginetea majoris*. Of this group, Tzonev (in press) identified in Bulgaria the association *Trifolio fragiferi–Cynodontetum* Br.-Bl. & Bolòs 1958 in some former floodplains of the Danube (Belene and Tutrakan), but there are some additional observations, which demonstrate that it is widespread in the river lowlands and along the big rivers, especially the Danube and some of its tributaries – Osam, Jantra, and Vit. The floristic structure of the communities of this association is rich in synanthropic plant species.

The second group of communities belongs to the typical halophytic classes *Thero-Salicornietea, Juncetea maritimae,* and *Festuco-Puccinellietea*. They are rich in obligate halophytes as *Salicornia europaea, Suaeda maritima, Camphorosma monspeliaca, Bassia hirsuta, Crypsis aculeata, Aster tripolium, Artemisia santonicum* etc. The typical halophytic communities are very rare in the inner part of Northern Bulgaria. Some phytocoenoses were described by Tzonev (2002) from the Karaboaz Floodplain (Pleven district) and the Valley of the Studena River (Veliko Tarnovo district), including the associations *Salicornietum prostratae, Hordeetum hystricis* and *Limonietum bulgaricum*.

After the TWINSPAN analysis of the halophytic vegetation in Southeast Bulgaria and the Black Sea Coast, and the processing of the obtained 21 groups, the following syntaxa were established:

Class *Thero-Salicornietea* Tx. in Tx. et Obertd. 1958
Order *Thero-Salicornietalia* Pignatti 1953
Alliance *Thero-Salicornion* Br.-Bl. 1933
Association *Salicornietum prostratae* Soó (1947) 1964
Association *Suaedetum maritimae* Soó 1927
Association *Suaedo-Bassietum hirsutae* Br.-Bl. 1928
Class *Juncetea maritimae* Br.-Bl. in Br.-Bl. et al. 1952
Order *Juncetalia maritimae* Br.-Bl. ex Horvatić 1934
Alliance *Juncion maritimae* Br.-Bl. ex Horvatić 1934
Association *Juncetum maritimi* (Rübel 1930) Pignatti 1953
Class *Isoëto-Nanojuncetea* Br.-Bl. et Tx. ex Br.-Bl. et al. 1952
Order *Crypsidetalia aculeatae* Vicherek 1973
Alliance *Cypero-Spergularion salinae* Slavnic 948
Association *Crypsidetum aculeatae* Wenzel 1934 em. Mucina 1993
Association *Heleochloetum alopecuroidis* Rapaics et Ubriszy 1948
Class *Festuco-Puccinellietea* Soó 1968
Order *Puccinellietalia* Soó 1947
Alliance *Puccinellion limosae* Soó 1933
Association *Diantho pallidiflori-Puccinellietum convolutae* ass. nova hoc loco, holotypus relevé No. 4, Table 3
Association *Aeluropetum littoralis* (Prodan 1939) Şerbănescu 1965
Association *Bupleuro tenuissimae-Camphorosmetum monspeliacae* ass. nova hoc loco, holotypus relevé No. 41, Table 4
Association *Camsphorosmetum annuae* Rapaics ex Soó 1933
Association *Petrosimono brachyatae-Puccinellietum convolutae* ass. nova hoc loco, holotypus relevé No. 62, Table 2
Artemisia santonicum comm.

Ass. *Salicornietum prostratae* Soó (1947) 1964

This association (Table 1) was described for the first time in Bulgaria by Tzonev (2002). It occurs in the Central Danubian Plain, it isolated and the only one in the inner part of the country. It is localised in the biggest former floodplain of the Danube – Karaboaz. It should be noted that this locality does not have connections with the remaining, relatively numerous localities of *Salicornia prostrata* and respectively with its association along the Black Sea coast (see Ganchev et al. 1971). Its origin probably derives from the localities along the Danube in Romania, Serbia (Banat) and Hungary (Hungarian Puszta), since there is a high similarity between the characteristics of these localities and those of the Bulgaria.

The presented relevés in this study belong to the coastal localities of the species and the syntaxon. The relevés were done in the following localities – the two big hyper-saline lakes along the Bulgarian Black Sea coast – Atanassovsko and Pomorisko – as well as in the westernmost part of Beloslav Lake (the quarter Povelyanovo of Devnya town) and Varna Lake (Kazashko locality).

There were only a few localities (Ganchev et al. 1971) that were not included in our study: Chengene skele Bay the mouth of Ropotamo River, the

region of Mandra-Poda and the small localities along Vaya Lake. The northernmost two localities are on the shore of Balchik Touzla (a small hyper-saline lagoon near the town of Balchik) and Shablenska Touzla Lake (Dobrich district).

The phytocoenoses (Figure 3) of the association's optimum are situated on the drying bottoms of the hyper-saline Black Sea Lakes – especially Pomoriisko and Atanassovsko. The water bodies are 0.20–0.40 m deep; the salinity is normally near 50–60 ‰. These bottoms are covered by muddy-clay and in some places by muddy-sandy substrates. When the bottoms dry, they are covered by big colonies of Cyanophyta as *Lyngbya* spp., *Phormidium* spp., *Rhzioclonium* spp., *Spirulina* spp., *Microcoleus chtonoplastes* etc. They stay on the dry bottoms as a thick cracked crust. The coenoses dominated by *Salicornia europaea* (V), are temporary ones. The seasonal optimum of their development is the end of the summer and the beginning of the autumn. They are typical monocoenoses, with other species participating like *Suaeda maritima* (IV), *Aster tripolium* (III), and *Puccinellia convolut* (IV).

Ass. *Suaedetum maritimae* Soó 1927

Suaeda maritima participates as a species, in many different halophytic communities. But the relevés belonging to the association *Suaedetum maritimae* (Table 1) were recorded only in the northern vicinities of Atanassovsko Lake. The soils are of Meadow's Solonetz (*Mollic Solonetz*) types that are flooded in the spring and in the beginning of the summer. The underground waters are very rich in sodium-sulfate salts. The phytocoenoses of the association develop on large, very dry at the end of the summer, bare, very salty spots. The dominant species – *Suaeda maritima* is accompanied by *Puccinellia convoluta, Artemisia santonicum, Cynodon dactylon,* and *Spergularia media.* The total cover is relatively high – 90–100 %.

The mono-dominant communities of *Suaeda maritima* were characterized as having limited distribution in Bulgaria by Ganchev et al. (1971). Only two phytocoenoses with the total size of 12 decares were described near Radnevo (Stara Zagora district) and Pomorie (Burgas district).

Figure 3: The association *Salicornietum europea*e and *Juncetum maritimae* in Atanassovsko Lake near Burgas.
Slika 3: Asociaciji *Salicornietum europea*e in *Juncetum maritimae* ob jezeru Atanassovsko v bližini Burgasa.

The new association *Suadetem maritimae balcanicum* was described by Micevski (1965) from Macedonia (former Yugoslavia). He noticed that the same syntaxon was distributed also in Bulgaria. Micevski (1965) described the new association only on the basis of 6 relevés with 4 species. According to article 34 of ICPN this association is invalid, because it was characterized only by the geographical epithet *balcanicum*. Of the two species with diagnostic importance – *Puccinellia convoluta* and *Hordeum marinum* (however, not indicated explicitly by the author) – only the first one was presented in the Bulgarian phytocoenoses. Also, *Cynodon dactylon* and *Spergularia media* participated in the described Bulgarian communities of *Suaeda maritima*, which were richer in species than the Macedonian ones. The association mentioned by Micevski (1965) *Suaedetum pannonicae* Wend. 1973 from Vojvodina (Serbia) was later considered by Dajić (1996) as a subassociation of the association *Puccinellietum limosae*. More realistic is the second possible suggestion of Micevski (1965), to accept one large association *Suaedetum maritimae* (poor in species) with a range of distribution connecting the Balkan Peninsula and Central Europe. We accepted this possible decision, but the question about the different subspecies of *Suaeda maritima* on the Balkan Peninsula – *Suaeda maritima* subsp. *maritima*, and Central Europe (including Serbia) – *Suaeda maritima* subsp. *pannonica* is still open. Probably, this taxonomical difference could have some syntaxonomical treatment in the future.

Ass. *Suaedo-Bassietum hirsutae* Br.-Bl. 1928

This association (Table 1) is considered to be distributed in the Mediterranean region (Braun-Blanquet 1951), but according to Pott (1997) it is widespread in the Continental as well as in the Mediterranean coastal regions of Europe. This nitrophilous syntaxon is mentioned for the Black Sea coast for the first time by Ţopa (1939) and after that by Géhu et al. (1994). It is known also from the coastal zone of Greece (Babalonas et al. 1995). It is localized in the basins of Atanassovsko and Pomoiisko Lakes

Figure 4: The association *Suaedo-Bassietum hirsutae* in Pomoriisko Lake (Burgas District).
Slika 4: Asociacija *Suaedo-Bassietum hirsutae* ob jezeru Pomoriisko (okrožje Burgas).

in Bulgaria. The phytocoenoses (Figure 4) inhabit mostly the peripheries of the lakes, with big deposits of *Bivalvia* shells, with the most common species *Cardium edule*, rarely – *Syndesmya (Abra) ovata*. These deposits are very rich in nitrogen, which is important for *Bassia hirsuta*, a nitrophilous species. The other common species are *Suaeda maritima* and *Salicornia europaea*. Rare species are *Puccinellia convoluta, Limonium gmelinii, Aster tripolium*.

Kaligarič & Škornik (2006) emphasized the disputable affinity of this association to the higher syntaxa ranks (some authors as Biondi (1998) included it in *Cakiletea*, not in *Thero-Salicornietea)*, but they assigned it to *Salicornion patulae* of *Thero-Salicornietea*.

Ass. *Juncetum maritimi* (Rübel 1930) Pignatti 1953

The phytocoenoses (Table 2, Figure 3) of this syntaxon were described in the southern part of Atanassovsko Lake (near the road Burgas – Nessebar) and the westernmost part of Beloslav Lake (near the town of Devnya). Kochev & Yordanov (1981) found phytocoenoses dominated by *Juncus maritimus* in the following places – Varna Lake (Kazashko village) and Dourankoulak Lake (both in Varna district); Chengene skele Bay, Mandra Lake (Kraimorie village), Karaach Marsh, near Sozopol and the mouth of the Ropotamo River (all in Burgas district). The total area was estimated to about 5 ha. Our relevés were recorded in shallow (0.1–0.2 m) salt water on the peripheries of the hyper-saline lakes. The cover of the communities was about 90–100 %. The height of the layer of *Juncus maritimus* was 0.9-1 m. Plants belonging to different ecological groups participated in the floristic structure of the coenoses: halophytes, such as *Salicornia europaea, Suaeda maritima* and *Puccinellia convoluta*, and some hydrophytes like *Phragmites australis*.

Ass. *Crypsidetum aculeatae* Wenzel 1934 em. Mucina 1993

This association (Table 2) belongs to the vegetation of the dry bottoms of the water bodies of different size. The phytocoenoses of *Crypsis aculeata* (Figure 5) were recorded near the villages of Radetski (Stara Zagora district), Blatec (Sliven dis-

Figure 5: The association *Crypsidetum aculeatae* in the locality near Blatec village (Sliven District).
Slika 5: Asociacija *Crypsidetum aculeatae* blizu vasi Blatec (okrožje Sliven).

trict) and Rudnik (northwards from Atanassovsko Lake – Burgas district). These phytocoenoses cover small areas on the bottom of drying temporary pools. The cover varies between 30 to 80% and species composition is relatively poor. Besides the main species, other grasses are *Puccinellia convoluta, Echinochloa crus-galli* and *Cynodon dactylon*. Other halophytes participating in the community are *Suaeda maritima, Limonium vulgare, Atriplex tatarica* and some others.

We can suppose that this association has wider distribution in the country. Ganchev et al. (1971) have pointed out the following places where *Crypsis aculeata* plays a dominant role in some phytocoenoses, such as Karaboaz Floodplain (Pleven district), the town of Aitos and Atanassovsko Lake (Burgas district), and the village of Marikostinovo (Blagoevgrad district). The species and its phytocoenoses had a wider distribution along the Danube in the past, when the river flooded the floodplains and many small pools dried after the river retraction. Such phytocoenoses were described in the marshes of Belene (Persina) island by Stoyanoff (1948).

This association has been mentioned for Bulgaria by Vicherek (1973), but without any detailed data or relevés. Micevski (1965) described a new association *Crypsidetum aculeatae balcanicum* from Ovče polje (today in FYROM). The presented 7 relevés contained only 9 species with wide distribution in Europe and did not prove any geographical specificities of the syntaxon. Because of the poor species composition and the clear ecological differentiation of the communities described in the present study, we accepted that the Bulgarian communities belong to the same association as in Central Europe and Romania.

Ass. *Heleochloetum alopecuroidis* Rapaics et Ubriszy 1948

This syntaxon (Table 2) is very similar to the previous one. The communities (Figure 6) described were near the villages of Rudnik (Burgas district) and Blatec (Sliven district). These pioneer communities occupy the drying bottoms of temporary pools, and their maximum development is soon after the receding of waters. The cover varies between 50 and 90 %. The phytocoenoses had poor species composition. Other species, often participating in

Figure 6: The association *Heleochloetum alopecuroidis* in the locality near Radecki village (Stara Zagora District).
Slika 6: Asociacija *Heleochloetum alopecuroidis* v bližini vasi Radecki village (okrožje Stara Zagora).

the communities, were *Puccinellia convoluta, Echinochloa crus-galli* and *Cynodon dactylon.*

Ganchev et al. (1971) reported about 30 dka occupied by communities dominated by *Crypsis alopecuroides* from the vicinities of the villages of Roza (Yambol district) and Mladovo (Sliven district). The dominant species is common along the Danube, but its communities there have different ecological peculiarities. They develop a belt in the middle and the upper part of the riverbank, which is flooded every year. The species composition of the communities is also different – it is not a typical halophytic one, but is rich in annual hygrophytes like *Dichostylis michelianus, Cyperus fuscus, Eleocharis acicularis, Gnaphalium uliginosum* and some others. Although the publication records are scanty, we have enough information to conclude that they belong to another alliance *Nanocyperion flavescentis* Koch 1926 – and probably to the association *Dichostylido-Heleochloetum alopecuroidis* (Timar 1950) Pietsch 1973.

Ass. *Diantho pallidiflori-Puccinellietum convolutae* ass. nova hoc loco, holotypus relevé No. 4, Table 3

This is the main syntaxon in the interior part of Southeast Bulgaria. The association (Table 3) is a very polymorphic one. The phytocoenoses (Figure 7) depend on the soil type and on the level of the underground waters. They determine the cover, species richness, and the dominant role of the species, especially the grasses such as *Elymus elongatus, Puccinellia convoluta* and *Cynodon dactylon.*

These communities occur on Solonetz soils. Most of them are of secondary origin from other saline types – Eutric Gleyosols, Gleyic Vertisols, and Fluvisols (Ninov 2002). The total cover of the phytocoenoses varied between 20 and 100 %, but was usually high – 80–90 %. Depending on the soil peculiarities, different species could form different sub-layers, which determine different facies of the association. The most important factor is the soil

Figure 7: The association *Diantho-Puccinillietum convolutae* in the locality near Atolovo village (Yambol District).
Slika 7: Asociacija *Diantho-Puccinillietum convolutae* pri vasi Atolovo (okrožje Yambol).

moisture. The wettest soils are near the small rivers or on the places of former marshes. They had the appearance of wet meadows. Such communities were established near the town of Radnevo, the villages of Sigmen (former Sigmen Marsh) and Radetski (respectively Stara Zagora and Burgas district). They had taller layers (1–1.20 m) dominated by *Elymus elongatus*.

The most constant grass species was *Cynodon dactylon*, which participated in all phytocoenoses, but its cover depended on the presence/absence of a higher sub-layer. The high constancy of *Cynodon dactylon* in different types of halophytic communities is specific for Southeast Europe (see Micevski 1965, Ţopa 1939), but because of its wide ecological flexibility it does not play a diagnostic role in the association. There were some phytoceonoses whose appearance was determined by plant species different from grasses. These were three communities from the village of Trapoklovo (Sliven district) and Atolovo (Yambol district), which was dominated by *Artemisia santonicum* and one phytocoenosis from Radnevo (Stara Zagora district) dominated by *Juncus gerardii*. One community from Radnevo was dominated by *Chrysopogon gryllus* and it demonstrated the advanced processes of xerophytisation. The phytocoenoses near the villages of Trapaoklovo and Atolovo had a more "steppe" (dominance of short grasses) appearance than the others.

In spite of the different appearance and dominant structure, this polymorphic group could not be divided into different sub-associations or even variants. These seemingly different groups are only different facies, whose appearance depends mainly on the soil conditions. The diagnostic species group included the following taxa: *Puccinellia convoluta* (IV), *Elymus elongatus* (III), *Polygonum pulchellum* (III), *Limonium vulgare* subsp. *serotinum* (II), *Dianthus campestris* subsp. *pallidiflorus* (II), *Scilla autumnalis, Centaurium spicatum* (II). These species characterize the geographic region of the origin and the distribution of this association. Southeast Bulgaria falls into the transitional zone between the Continental and the Mediterranean climatic types. The Mediterranean influence is demonstrated by the participation of species distributed in the Mediterranean region, like *Scilla autumnalis, Polygonum pulchellum, Centaurium spicatum*. These species do not play a diagnostic role in the syntaxa distributed in Central Europe southwards to Romania (see Borhidi 2003, Donit et al. 1992, Donit et al. 2005 etc.). The species *Scilla autumnalis* even does not occur to the North of Stara Planina Mts. The most specific group of diagnostic species included *Limonium vulgare* subsp. *serotinum* and *Dianthus campestris* subsp. *pallidiflorus*. They are endemics mostly for Southeast Europe. *Dianthus campestris* subsp. *pallidiflorus* is distributed in South Bulgaria (and probably North Greece) and the Crimean Peninsula, southeastern part of Russia and South Ukraine (Jalas & Suominen, eds. 1988). Its localities in Bulgaria are isolated and this species is associated with the halophytic habitats. There are also other examples revealing the importance of isolated saline terrains for the processes of endemic speciation. Other endemic species on saline terrains are some *Limonium* species – *Limonium asterotrichum* in South Bulgaria or *Limonium bulgaricum* in North Bulgaria. The diagnostic grass species, like *Elymus elongatus* and *Puccinellia convolute*, have different diagnostic values. *Elymus elongatus* is more flexible and participates in different types of communities, most of them not on saline soils. The described associations with equal names *Agropyretum (Elymetum) elongati* in neighbouring Romania (Şerbănescu 1965) and Greece (Babalonas & Papastergiadou 1990) are different. The Romanian syntaxon belongs to the salt steppe vegetation (without any Mediterranean species), but the Greek communities have some hygrophytic and mesophytic species, such as *Oenathe silaifolia, Carex divisa, Daucus guttatus* and *Holoschoenus vulgaris*. Other associations, where *Elymus elongatus* is a constant and diagnostic species, were described along the whole Mediterranean coast, but they are more typical for the coastal salt marshes with a sandy bottom. For example, the associations *Hainardio-Elymetum elongati* (Croatia) and *Agropyro elongati-Inuletum crithmoidis* (Spain) are included in *Juncetea maritimi* (see Horvatić 1934, Alcaraz et al. 1986). There are data for both ecological types of the communities dominated by *Elymus elongatus* and in Bulgaria. Ganchev et al. (1971) described different localities with occurrence of these communities. Species compositions of the communities near Sozopol, Ropotamo River, Balchik, Ravadinovo, Cape Atiya, were more similar to the coastal (maritime) type, while those near the villages of Atolovo, Gorno Aleksandrovo and the town of Radnevo belonged to the type probably presented in the association *Diantho pallidiflori-Puccinellietum convolutae*.

One of the most constant grass species in this group of relevés – *Puccinellia convoluta* – played also a very specific diagnostic role in the communities. The species did not have diagnostic importance for the halophytic syntaxa, described in other Southeast and Central European countries: Romania (Ivan et al. 1993, Donită et al. 2005), Hungary (Borhidi

2003), Austria (Mucina 1993) in contrast to *Puccinellia limosa* and *P. distans*. The species increases its phytosociologal importance in the halophytic vegetation in South Europe. The association *Puccinillietum convolutae* described in FYROM by Micevski (1965) had very poor species composition and the relevés were not similar to the Bulgarian ones. Micevski (1965) emphasized the increasing phytocoenological importance of this species (common along the Mediterranean coast) in the southern part of Europe. There are several syntaxa with high constancy of *Puccinellia convoluta*, described by different authors (Braun-Blanquet 1952, Géhu 1976, Géhu et al. 1984, 1992) in the coastal regions of France and Italy. However, they belong to the Mediterranean class of semi-scrubby halophytic communities of *Salicornietea fruticosae*, that do not occur in Bulgaria.

The high phytocoenological importance of *Puccinellia convoluta* has been emphasized by Ganchev et al. (1971). Different communities dominated by this species or with co-dominants, such as *Puccinellia distans, Hordeum hystrix, Crypsis aculeata, Suaeda maritima, Camphorosma monspeliaca, C. anna, Limonium bulgaricum*, cover hundred hectares on the salt places in Veliko Turnovo, Sliven, Yambol, Burgas and Plovdiv districts. They are widespread in the interior part of the country as well as in the coastal zone. Their patterns of distribution are opposite to the communities of *Puccinellia distans*, covering smaller areas mostly in the coastal territories.

Other species, which have the constancy of two or more than two in the Bulgarian groups of phytocoenoses, are not so typical. They are wide-spread halophytes like *Camphorosma monspeliaca* (II), *Hordeum hystrix* (II), *Spergularia marina* (II), *Lotus tenuis* (II), *Bupleurum tenuissimum* (II), *Atriplex tatarica* (II), *Lactuca saligna* (II); or ruderals or semi-ruderals as *Cichorium intybus* (II), *Plantago lanceolata* (III), *Achillea millefolium* (II) and *Eryngium campestre* (II). The specificity of this new Bulgarian association is determined by its particular species composition, ecological peculiarities and physiognomy.

Ass. *Aeluropetum littoralis* (Prodan 1939) Şerbănescu 1965

The species *Aeluropus littoralis* was evaluated as "vulnerable" in Bulgaria by the project "Red Lists of Plants in Bulgaria". It has scattered localities only along the Black Sea coast. The presented relevés (Table 2) were recorded in different parts of Atanassovsko Lake. There are some data (Ganchev et al. 1971) about the communities dominated by *Aeluropus littoralis* near Pomorie and Atiya Bay (Burgas district) and Durankulak Lake (Dobrich district).

The described communities were distributed in the hyper-saline lakes on the higher and drier zones in the periphery of the salt basins. The soil type was Solonchaks. These communities are very close to the neighboring phytocoenoses of *Thero-Salicornion* (mostly *Salicornietum prostratae*), but occupy the places whose drying takes more time. The communities were with high coverage (near 100 %) and poor floristic composition. Other species participating in their composition were mostly of alliance *Thero-Salicornion* – *Suaeda maritima, Salicornia europaea,* but included also *Puccinellia convoluta, Aster tripolium* and some others. Ganchev et al. (1971) mentioned the possibility of using these communities as pasturelands, but their economical importance is low, because of the limited areas occupied by them.

Aeluropus littoralis is widespread mostly in the coastal territories of the Mediterranean and the Black Sea Coasts. There are several associations described in different countries, where the species has a great diagnostic role. Most of them have richer species diversity than the Bulgarian one. The most numerous are the associations from the Danube Delta and Azov Sea: *Aeluropo-Salicornietum* Krausch 1965; *Aeluropo-Puccinellietum limosae* Popescu et Sanda 1975, *Limonio-Aeluropetum littoralis* Sanda et Popescu 1992, *Tripolio vulgaris-Aeluropetum littoralis* Dubyna et Neuhäuslová 2000.

The closest to the Bulgarian group of phytocoenoses is the Romanian association (from the Danube Delta) – *Aeluropetum littoralis* (Prodan 1939) Şerbănescu 1965. The differences between the two groups (the presence of *Puccinellia convoluta* in the Bulgarian phytocoenoses) are not sufficient for distinguishing a new association. The association *Aeluropetum littoralis* (Prodan 1939) Şerbănescu 1965 was revised by Pop (2002) and it was given the status of a new subassociation *aeluropetosum* in the association *Halimiono pedunculatae-Aeluropetum littoralis* Géhu et al. 1994. However, Pop (2002) did not determine the subassociation *typicum* (but only *aeluropetosum* and *halimionietosum* – the second one probably is the typicum), which makes his subassociation invalid because it contradicts Art.5 of the Code. Additionally, Pop (2002) used *Aeluropus littoralis*, which is a diagnostic species for the association, as a differential species for the subassociation. Also, Géhu et al. (1994) did not analize

the Romanian syntaxa published to that date (described in the same region – Danube Delta) with a high diagnostic role of *Aeluropus littoralis*, and from the analysis of Pop (2002) we understand that they are identical. The assocation *Aeluropetum littoralis* described by Babalonas (1979) from Greece has the same name as the one described by Şerbănescu (1965). In this case, the revision of Babalonas et al. (1995), which treated the association *Limonio-Aeluropetum littoralis* (Bab. 1979) Géhu et al. 1979 as a synonym of the association *Aeluropetum littoralis* Babalonas 1979, is not correct. The Bulgarian phytocoenoses are more similiar to the Romanian group of phytocoenoses than to the Greek ones, the latter being the more Mediterranean ones.

An other disputable issue is the affiliation of the communities dominated by *Aeluropus littoralis* along the Black Sea coast to syntaxa of ranks higher than the association level. The described associations in Spain (*Aeluropo littoralis-Puccinellietum fasciculatae* (Rivas Goday 1955) Rivas Mart. et Costa 1976. emend. Rivas Mart. 1984; *Aeluropo-Juncetum subulati* Cirujano 1981) or Italy (*Puccinellio festuciformis-Aeluropetum littoralis* (Corb. 68) Géhu et Costa in Géhu et al. 1984, *Aeluropo-Limonietum cercinensis* Barbagallo, Brullo et Furnari 1991, *Aeluropo-Sarcocornietum alpini* Brullo in Brullo, Santis et Furnari 1991) belong to the class *Juncetea maritimi*. Géhu et al. (1994) included in this class also the association *Halimiono-Aeluropetum littoralis* from the Black Sea coast of Romania. Dubyna et Neuhäuslová (2000) accepted the concept of the association *Tripolio vulgaris-Aeluropetum* belonging to the order *Artemisio santonici-Limonietalia gmelinii* Golub & V. Solomakha 1988, alliance *Salicornio-Puccinellion* Mirkin in Golub & Solomakha 1987. In fact, there is not a big difference in the species compositon of the communities of *Aeluropus littoralis* described in Bulgaria (present study), Romania (Şerbănescu 1965, Géhu et al. 1994, Pop 2002) and Ukraine (Dubyna & Neuhäuslová 2000). Probably future revisions will clarify the syntaxomical relations of these communities on the western coast of the Black Sea.

Ass. *Bupleuro tenuissimae-Camphorosmetum monspeliacae* ass. nova hoc loco, holotypus relevé No. 41, Table 4

The communities with significant participation of *Camphorosma monspeliaca* have wide distribution in Bulgaria, but the ecological peculiarities of the species in North and South Bulgaria differ. The northern populations of *Camphorosma monspeliaca* participate in the floristic composition of the petrophytic steppes. Tzonev (2002) described a new association *Hedysaro bulgaricum-Camphorosmetum monspeliacae* from a small region of the Middle Danubian plain (the municipalities of Levski and Svishtov). These phytocoenoses occupy steep slopes (mostly with southern exposition) on the basis of opened Cretaceous clay marls, which are rich in different iron oxides with reddish colour. These oxides are salty and this fact determines the participation of some halophytes like *Camphorosma monspeliaca* and *Artemisia santonicum,* which have the dominant role. However, the species composition is richer due to the typical Pontic steppe species, often with endemic subspecies, such as *Hedysarum grandiflorum* subsp. *bulgaricum*, *Genista sessilifolia* subsp. *trifoliata*, *Thesium simplex* subsp. *moesiacum, Centaurea thracica*, *Ephedra distachya, Tanacetum millefolium*, *Agropyron cristatum*, *Aster oleifolius*, and *Astragalus corniculatus*. Tzonev et al. (2006) described another syntaxon with *Camphorosma monspeliaca*, namely the subassociation *camphorosmetosum monspeliacae* of the association *Alysso caliacrae-Artemisietum lerchianae* Tzonev et al. (2006) from the locality of "Chirakman", near the town of Kavarna (Black Sea coast). The second group of communites occupies similar places as in the Middle Danubian plain – steep slopes above the sea, on Sarmatian marls with some oxides. They are rather rich in steppe species like *Agropyron cristatum, Aster oleifolius, Astragalus vesicarius, Cephalaria uralensis*, but the halophytes are limited only to the two dominants – *Artemisia lerchiana* and *Camphorosma monspeliaca*.

In South Bulgaria, *Camphorosma monspeliaca* is a typical halophytic species in the valleys of the small rivers on typical Solonetz soils. These valleys are flooded in spring and early summer, but dry out afterwards. The described phytocoenoses (Figure 8) were near the villages of Blatec, Zhelyu Voivoda and Trapoklovo (Sliven disitrict), Bikovo and Atolovo (Yambol district), Sigmen and Rudnik (Burgas district). Ganchev et al. (1971) described communities of *Camphorosma monspeliaca* also in other places: the villages of Radinovo and Kostievo (Plovdiv district), Dragodanovo, Novoselec, Kovachevo, Omarchevo, Konyovo and Mladovo (Sliven district), Opalchenec (Stara Zagora district) and near the towns of Aitos, Nova Zagora and Straldzha.

The level of salinization of the ground was high and there were white salt concretions of different size – often 4–5 cm. The phytocoenoses of this asso-

Figure 8: The association *Bupleuro-Camphorosmetum monspeliacae* in the locality near Zhelyu vojvoda village (Sliven District).
Slika 8: Asociacija *Bupleuro-Camphorosmetum monspeliacae* pri vasi Zhelyu vojvoda (okrožje Sliven).

ciation were open and their cover was mostly about 60–70 %. The main species – *Camphorosma monspeliaca* formed small micro-eminences rising several centimetres above the neighboring flat ground. The size of these micro-eminences was about 0.5–1 m^2. The other more frequent species are *Cynodon dactylon* (IV), *Puccinellia convoluta* (IV), *Bupleurum tenuissimum* (III), *Plantago lanceolata* (II) and *Polygonum pulchellum* (II).

This association (Table 4) was very close to *Diantho pallidiflorii-Puccinellietum convolutae*. This fact was proven by the high constancy of *Puccinellia convoluta* and *Cynodon dactylon*, as well as by the participation of a high number of diagnostic species from the above mentioned association – *Polygonum pulchellum* (II), *Dianthus campestris* subsp. *pallidiflorus* (I), *Scilla autumnalis* (I), *Limonium vulgare* subsp. *serotinum* (I) and *Elymus elongatus* (I). A particular feature is the higher constancy of *Bupleurum tenuissimum* (III). This taxon is widespread in saline communities all over Europe, but is of no diagnostic importance. For example, this species participates with low constancy (I) in some halophytic associations in Romania (Ivan et al. 1993). Borhidi (2003) mentioned the species only in the association *Limonio gmelinii-Artemisietum santonici* and it is presented in the association *Camophorosmetum monspeliacae* of Micevski (1965) with constancy I. The higher presence of *Bupleurum tenuissimum* in the Bulgarian phytocoenoses demonstrates their more continental origin and climatic influence in comparison to the Macedonian ones. The species participates in the composition of association *Diantho pallidiflori-Puccinellietum convolutae* with constancy II (22 %), lower than in *Bupleuro tenuissimae–Camphorosmetum monspeliacae* (III – 41 %). This higher presence is determined by some ecological differences. The second syntaxon has lower cover and lower participation of grasses (*Poacaeae*), which allows for the higher presence of species different from grasses, like *Bupleurum tenuissimum*.

We can conclude that the two syntaxa are very similar and their differences depend on the degree of drying and the level of the underground waters in the driest summer period. The association *Diantho pallidiflori-Puccinellietum convolutae* covers areas that are less saline and the soil moisture is appropriate for development of more "meadow-like" communities. The phytocoenoses of *Bupleuro-Camphorosmetum monspeliacae* are more open, the

terrains are subjected to a stronger summer drying and the concentration of salts in the soils reaches its highest values compared to all other communities. They have a more expressed "semi-desert" appearance and their geographical isolation is demonstrated by the participation of some endemic species and subspecies. There are also transitional types between these two associations.

The communities with a high diagnostic role of *Camphorosma monspeliaca* are distributed in South Europe – mostly in the Mediterranean region. Most similar to the Bulgarian syntaxa are the associations *Camphorosmetum monspeliacae balcanicum* Micevski 1965 (FYROM) and *Camphorosmetum monspeliacae* (Ţopa 1939) Şerbănescu 1965 (Romania). Both associations have floristic differences that derive from their geographical distribution. The Romanian association is poor in Mediterranean and endemic taxa, while the Macedonian association compared to the Bulgarian one is richer in such taxa. Similarities between these associations are the high presence of *Cynodon dactylon, Puccinellia convoluta* and *Bupleurum tenuissimum*, but with constancy I. There are many species that do not occur in the Bulgarian group of relevés, like *Plantago coronopus* (V), *Matricaria chamomila* subsp. *salina* (V), *Bromus japonicus* (IV), *Trigonella monspeliaca* (IV) and *Stratonostoc commune* (IV). Micevski (1965) named the association in Macedonia (FYROM) only as *Camphorosmetum monspeliacae,* in spite of the two diagnostic species identified – *Camphorosma monspeliaca* and *Plantago coronopus*. He noted that his association is a synonym of *Camphorsometum pilosae* Ţopa 1939 subass. *Nostocetosum commune* Bacar 1957, despite the differences exhibited at the association level. According to the ICPN (Weber et al. 2000), this association is now invalid. Micevski (1965) did not observe the rule of priority, because the association was already named by Ţopa (1939), even though as *Camphorosmetum pilosae* (*Camphorosma monspeliaca* v. *pilosa*). The association of Ţopa (1939) was validated in the same year by Şerbănescu(1965). The Romanian phytocoenoses described in the northern periphery of the range of *Camphorosma monspeliaca* showed a more typical Central European composition (see Ţopa 1939) than the Bulgarian association. The ecological plasticity of *Camphorosma monspeliaca* is demonstrated by the described associations in different vegetation types in the Mediterranean region. For example, *Camphorosma monspeliaca* is a diagnostic and constant (including dominant) species in the coastal marshes (*Juncetea maritimi, Puccinellion caespitosae*) in Spain (Ladero et al. 1984), coastal garriges (*Rosmarinetea officinalis*) in France (Molinier 1934), and in different vegetation types in Italy (Biondi et al. 1990, 2001) etc. These communities are substantially different from the Bulgarian syntaxa.

Ass. *Camphorosmetum annuae* Rapaics ex Soó 1933

The association is presented from 5 relevés only from the vicinities of Blatec village (Sliven district). Is spite of the wider distribution of the species, which was indicated by Yordanov & Kuzmanov (1966) and which includes the regions of Burgas, Nessebur, Ajtos, Karnobat, Sliven, Plovdiv, Nova Zagora, Yambol; the phytocoenoses with a dominant role of *Camphorosma annua*, were established by Ganchev et al. (1971) only from the villages of Mladovo and Atolovo (Yambol district).

The phytocoenoses of the association occupy the furrows of the terrain, which are flooded until the beginning of the summer. The soils are typical Solonchaks and the salt concentration is high. These communities are a pioneer succesional stage of the communities of *Camphorosma monspeliaca* and both form a complex, but *Camphorosma monspeliaca* occupies the small elevations of the terrain. The communities of *Camphorosma annua* have open cover (50–70%) and very poor floristic composition. Only *Puccinellia convoluta* and *Cynodon dactylon* participate in these communities.

The poor floristic composition (only 2 species) characterizes the association *Camphorosmetum annuae balcanicum*, which has been descibed by Micevski (1965) from the territory of former Yugoslavia. The high presence of *Puccinellia convoluta* can not be the reason for the describtion of a new association. In spite of some differences, the Bulgarian phytocoenoses must be assigned to the existing association *Camphorosmetum annuae*, as was done for the communities of *Camphorosma annua* in Romania by the Romanian authors (Ţopa 1939, Sanda et al. 1999, Pop 2002 etc.).

Ass. *Petrosimono brachiatae-Puccinillietum convolutae* ass. nova hoc loco, holotypus relevé No. 2, Table 2

The described communities (Figure 9) of the association (Table 2) are situated in the Pomoriisko Lake. The phytocoenoses were in the second suc-

Figure 9: The association *Petrosimonio brachiatae-Puccinillietum convolutae* in Pomoriisko Lake (Burgas District).
Slika 9: Asociacija *Petrosimonio brachiatae-Puccinillietum convolutae* ob jezeru Pomoriisko (okrožje Burgas).

cession stage of the drying of hyper-saline basins. The association *Salicornietum prostratae* develop on the wetter places. They surround the concentric belts of the communities of *Petrosimonia brachiata* and *Puccinellia convoluta*. These communities are more open (50–60 % cover) than the neighboring ones of *Salicornietum prostratae* and occupy very hard, dry salty mud. The coenoses are poor in species, with the obvious dominant role of the diagnostic species – *Petrosimonia brachiata* and *Puccinellia convoluta*.

Petrosimonia brachiata has very limited distribution in Bulgaria (Southern Black Sea coast, only in Atanassovsko and Pomoriisko Lakes) and here is the northwesternmost part of the species range. It was evaluated as critically endangered in the "Red List of Bulgarian Plants". The main part of its range is in the saline steppes and deserts in Southern Russia to Kazakhstan, Anatolian Plateau to Iran, where different associations with its participation have been described (Zohary 1973, Golub & Mirkin 1986, Korotkov et al. 1991, Vural et al. 1999). Most of these syntaxa belong to different classes and include semi-desert species that do not occur on the Balkan Peninsula. The specificity of the phytocoenoses of *Petrosimonia brachiata* in Bulgaria distinguishes the new association.

Artemisia santonicum comm.

These communities (Table 5) are of secondary origin, because they have been described on the dikes of the salt-pans of Pomorie (Pomoriisko Lake) and Burgas (Atanassovsko Lake). The dikes are 1.5–2 m high and were constructed by relatively large stones at the beginning of the 20th century. The phytocoenoses have a high cover – 70–100 %. The first sub-layer – 1–1.3 m high – is formed by *Artemisia santonicum*, which is an obvious dominant. The other species with constancy higher than I are *Puccinellia convoluta* (III), *Elymus elongatus* (II), *Melilotus officinalis* (II), *Atriplex tatarica* (II), *Bromus arvensis* (II). This species composition demonstrates a

secondary origin of these communities, determining their semi-ruderal appearance. Evidently, the dominant species covered these artificial constructions because they provide appropriate ecological conditions. The dikes have been used as pastures for cattle and domestic pigs for a long time. The pasture activities resulted in dunging the dikes and the regulation of vegetation development there. The animals (especially pigs) graze actively on the wormwood, thus regulating its population. The main reason for the preference of the wormwood by the animals is the anthihelmintic drug "santonin". Massive grazing by wild animals (deer, wild boar) of the wormwood in its natural locality can be observed near the mouth of Ropotamo river. After the establishment of the Atanassovsko Lake reserve and Pomoriisko Lake protected area the grazing of domestic animals stopped. This is the reason for the secondary increase of the wormwood populations on the dikes and the formation of monodominant communities with a high cover.

These semi-ruderal communities are not similar to other steppe communities of *Artemisia santonicum* that are widespread in the steppes and semi-deserts of Central, Southeast Europe, Russia, Ukraine, Kazakhstan and Asia Minor. The latter communities have a high species diversity and belong to different syntaxa of the halophytic vegetation (Korotkov et al. 1991, Ivan et al. 1993, Borhidi 2003, Donit et al. 2005). An indirect evidence of the origin of the Bulgarian phytocoenoses is the lack of any communities with dominant species *Artemisia santonicum* described in Ganchev et al. (1971). It indicates the period of secondary origin of the communities after the 1980s. These semi-ruderal communities are not similar to the described natural syntaxa with diagnostic species *Artemisia santonicum*, including the association *Artemisietum santonici* Soó 1947, and their syntaxonomical rank and position could be clarified after further investigations.

CONCLUSIONS

The halophytic vegetation has a limited distribution on the territory of Bulgaria. All together 11 associations and 1 community, belonging to 4 classes, 4 orders and 4 alliances were described as a result of the present study. Most of them are recorded for the first time in Bulgaria. However, they do not cover the whole diversity of the halophytic vegetation in the country, and further studies can provide more detailed information. For example, Vicherek (1973) proposed for Bulgaria the association *Heleochloetum schoenoidis* Ţopa 1939. In 2000, the communities of *Heleochloa schoenoides* were found on the bottom of drying small marshes in Karaboaz Floodplain of Danube River, Pleven district (Tzonev, unpubl.), and probably they belong to the same association.

The affiliation of the Bulgarian communities, especially of *Festuco-Puccinellietea*, to syntaxa higher than association appears to be the most complicated question. The current species composition of the halophytic vegetation is a result of the transitional position of Bulgaria between the continental and Mediterranean climate types. The Bulgarian phytocoenoses are similar and at the same time different, when compared with the typical Mediterranean (in Greece, Italy, Spain), and the typical Continental (in Romania, Hungary, Austria, Ukraine, Russia) syntaxa. These peculiarities of the halophytic vegetation of the Central part of the Balkan Penisula were outlined by Micevski (1965), who proposed to include the communities in a new alliance *Puccinellion convolutae* Micevski 1965. This new alliance was accepted by Babalonas & Papastergiadou (1990) for North Greece, too. The investigation of the Bulgarian halophytic communities of *Festuco-Puccinellietea* did not confirm their affiliation to the alliance *Puccinellion convolutae*. In spite of some evident differences, they should be classified to *Puccinellion limosae*, and the differences will be enough to designate probably a new sub-alliance in *Puccinellion limosae* rather than a new alliance. The preliminary studies on the grasslands in Bulgaria by Meshinev et al. (2005) placed the described halophytic communities in *Puccinellion limosae* as well. Most of the diagnostic species proposed by Micevski (1965) for *Puccinellion convolutae*, have a wide range of distribution, and some of them, like *Camphorosma annua, C. monspeliaca, Limonium gmelinii, Scorzonera laciniata* (syn. *Podospermum canum*), *Nostoc commune* participate in halophytic communities not only in Mediterranean parts of Europe, but also in Central Europe. This alliance was not accepted by Rodwell et al. (2002) in their overview of the vegetation of Europe at the alliance level. The revision of Golub et al. (2005) rejected the alliance *Puccinellion convolutae*, because of the unjustified unification of communities with different ecological origin and peculiarities. Additionally, most of the associations (excluding *Camphorosmetum monspeliacae* and *Hordeo-Trifolietum parviflorum*) described by Micevski (1965) are based on

an insufficient number of relevés and species, and moreover, they are named by using a geographical epithet. In this sense, they are not valid according to the rules of ICPN (Weber et al. 2000) and need further validation.

Also, Golub et al. (2005) only on the basis of the works of Micevski (1965) from FYROM and Korzhenevsky & Klyukin (1991) from Crimea, mechanically unified the halophytic communities on the Balkan Peninsula and Crimea in a new order *Puccinellio festuciformis–Camphorosmetalia monspeliacae* Golub et Karpov in Golub et al. (2005). The diagnosis of this order is characterized insufficiently on the basis of the geographic distribution only. The diagnostic species, like *Camphorosma monspeliaca* and *Scorzonera laciniata* are widespread and can not characterize the syntaxa localized on the Crimean and the Balkan Peninsulas. The alliance *Plantagini coronopodo-Camphorosmion monspeliacae* Golub et Karpov 2005 in Golub et al. (2005) is treated as a synonym of *Puccinellion convolutae* Micevski 1965. However, it should be noted that the diagnostic species selected by Golub et al. (2005) are very disputable. For example, *Bromus japonicus* was not established in the communities of Bulgaria, and *Petrosimonia brachiata* is distributed on the Balkans only along the Southern Bulgarian Black Sea coast and in some places in Northern Greece. *Lepidium ruderale, Crepis setosa* and *Veronica arvensis* are ruderal species, and *Crepis tectorum, Cynodon dactylon* and *Trifolium resupinatum* are not halophytes. Therefore, the alliance does not have ecological specificity, because only the combination of diagnostic species and the geographical criteria was used for its delineation. The differences between the Bulgarian and Crimean (see Korzhenevsky & Klyukin 1991) halophytic syntaxa are larger than their similarities.

Problematic are also the described syntaxa of *Aeluropus littoralis* on the Balkan Peninsula (see Pop 2002, Babalonas et al. 1995 etc.). Only further, more complete phytocoenological investigations could reveal their syntaxomic relationships and their affiliation to syntaxa higher than association.

The lack of information (small number of relevés and small investigated territories) about the halophytic vegetation on the Balkan Peninsula at the moment does not provide evidence to draw some general conclusions about the affiliation of the halophytic communities to the syntaxa with ranks higher than association. Therefore, we accepted the existing syntaxa of higher rank and searched for some differences only at association level.

The halophytic vegetation of Bulgaria has been subjected to significant human impact. The main threats are the changes in the regime of water bodies (rivers, wetlands) that affected the neighboring halophytic communities. The construction of new hotels and the tourist invasion on the Black Sea coast are other serious threats. The "Thrace" highway was projected to pass through such communities in the region of the town of Kermen. There are some negative changes observed in the halophytic vegetation, which were detected after the comparison with the previous work of Ganchev et al. (1971). For example, some dominants in the halophytic communities, described in Ganchev et al. (1971), like *Camphorosma annua* were found to be very limited in these communities in 2006. Some very rare phytocoenoses, like those of *Cressa cretica* are probably extinct. Many places with halophytic vegetation known from the past were not confirmed during our investigation.

Despite the human degradation, the fragments of halophytic vegetation that have survived are of special importance because of the participation of many rare and threatened species (listed in the Red Data Book of Bulgaria (Velchev 1984) and in the Red Lists of Plants in Bulgaria), including some Balkan endemics. Such species are *Aegilops lorentii, Dianthus campestris* subsp. *pallidiflorus, Halimione pedunculata, H. portulacoides, Petrosimonia brachiata, Frankenia pulverulenta, Limonium bulgaricum, L. latifolium, L. asterotrichum, L. gmelinii, L. vulgare* subsp. *serotinum, Cressa cretica, Plantago tenuiflora, Plantago cornutii, Taraxacum bessarabicum.* This fact increases their value for the conservation of the biodiversity in Bulgaria and Europe. All halophytic syntaxa in Bulgaria are represented in the Directive 92/43/EEC by the following habitats: 1310 *Salicornia* and other annuals colonising mud and sand; 1340 Inland salt meadows (priority) and 1530 Pannonic salt steppes and salt marshes (priority).

The results of our work could be used for the classification of the natural habitats and for the purposes of the European ecological network NATURA 2000 in Bulgaria, and for the conservation of the unique diversity of Bulgarian halophytic vegetation.

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Table 1: Table of the associations of class *Thero-Salicornietea.*
Tabela 1: Tabela asociacij razreda *Thero-Salicornietea.*

Name of syntaxa	***Salicornietum prostratae***																				***Suaedetum maritimae***				***Suaedo-Bassietum hirsutae***						
Number of relevé	124	62	69	74	78	79	80	82	91	92	105	106	108	116	117	118	120	122	125	**C**	99	100	101		67	85	86	87	109	110	**C**
Area of releve (sq. m)	**10**	**4**	**4**	**4**	**25**	**16**	**4**	**16**	**16**	**100**	**25**	**16**	**100**	**4**	**4**	**100**	**4**	**9**	**4**	**o**	**25**	**25**	**25**		**6**	**4**	**8**	**4**	**6**	**16**	**o**
Cover (%)	**90**	**95**	**80**	**70**	**60**	**85**	**85**	**75**	**80**	**85**	**85**	**95**	**85**	**80**	**80**	**90**	**70**	**80**	**60**	**n**	**95**	**100**	**90**		**85**	**90**	**90**	**80**	**90**	**85**	**n**
																				s											**s**
Diagnostic species of the association *Salicornietum prostratae* (and *Thero-Salicornion*, *Thero-Salicornietalia*, *Thero-Salicornietea*)																				**t**											**t**
Salicornia europaea	2b	3	3	3	4	5	5	4	4	5	4	5	4	3	4	4	4	3	3	**95**	.	.	+	**1**	3	3	2b	3	2a	2b	**100**
Diagnostic species of association *Suaedetum maritimae* (and *Thero-Salicornion*, *Thero-Salicornietalia*, *Thero-Salicornietea*)																															
Suaeda maritima	.	3	3	1	.	.	+	2a	.	+	.	+	.	3	2a	2b	.	3	+	**62**	4	5	3	**3**	3	2a	2a	.	2b	1	**83**
Diagnostic species of the association *Suaedo-Bassietum hirsutae* (and *Thero-Salicornietea*)																															
Bassia hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.		1	2b	3	2b	4	3	**100**
Accompanying taxa																															
Artemisia santonicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	+	.	**1**	.	.	.	.	.	.	
Aster tripolium	.	+	+	2b	.	+	+	.	+	.	.	.	.	.	2a	+	2a	2a	.	**57**	.	.	.		.	+	.	.	.	+	**33**
Juncus maritimus	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.		.	.	.	.	.	1	**17**
Puccinellia convoluta	4	+	.	+	.	.	.	+	.	.	1	2a	.	1	+	2a	1	2a	2a	**67**	2a	2a	3	**3**	2b	1	.	.	.	2a	**50**
Cynodon dactylon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		+	+	1	**3**	.	.	.	.	.	.	
Eryngium campestre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	+	.	**1**	.	.	.	.	.	.	
Bolboschoenus maritimis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**5**	.	.	.		.	.	.	.	.	.	
Phragmites australis	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	**10**	.	.	.		.	.	.	.	.	.	
Atriplex hastata	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**5**	.	.	.		.	.	.	.	.	.	
Melilotus officinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.		+	.	.	.	.	.	**17**
Limonium gmelinii	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	**5**	.	.	.		.	.	.	.	.	+	**17**
Spergularia media	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		2a	2a	1	**3**	.	.	.	.	.	.	
Elymus farctus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.		+	.	.	.	.	.	**17**
Kochia scoparia	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	**5**	.	.	.		.	.	.	.	.	.	
Polypogon monspeliensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	**5**	.	.	.		.	.	.	.	.	.	
Puccinellia limosa	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	**5**	.	.	.		.	.	.	.	.	.	

Localities and dates of the releves: 124, 116, 117, 118, 120, 122, 125 – Devnya town, Povelyanovo quarter – 12.09.06; 62, 67, 69, 78, 79, 80, 82 – Pomoriisko ezero Lake – 10.09.06; 85, 86, 87, 91, 92 – Atanasovsko ezero Reserve – 10.09.06; 105, 106, 108, 109, 110 – southern part of Atanassovsko ezero Lake – 10.09.06; 99, 100, 101– northern part of Atanassovsko ezero Lake, near Rudnik village – 10.09.06

Table 2: Table of the associations *Juncetum maritimae, Petrosimonio brachiatae-Puccinellietum, Aeluropetum littoralis, Crypsidetum aculeatae, Heleochloetum alopecuroides convolutae.*

Table 2: Tabela asociacij *Juncetum maritimae, Petrosimonio brachiatae-Puccinellietum, Aeluropetum littoralis, Crypsidetum aculeatae, Heleochloetum alopecuroides convolutae.*

	Petrosimonio brachiatae-Puccinellietum convolutae													*Heleochloetum alopecuroides*									
	Juncetum maritimae							*Aeluropetum litoralis*						*Crypsidetum aculeatae*									
Number	109	112	120	91	92	106		59	62	64	69a			12	100	33	35		40	98	31		
Area of relevé (sq. m)	25	100	100	16	16	16		2	2	4	10			10	2	10	4		16	4	25		
Cover (%)	100	100	95	100	100	90		30	50	60	50			30	80	30	60		80	90	50		
Diagnostic taxa of association *Juncetum maritimi*																							
Juncus maritimus	4	5	5	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diagnostic taxa of association *Aeluropetum littoralis* (and *Juncetea maritimi*)																							
Aeluropus littoralis	.	.	.	.	4	3	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diagnostic taxa of association *Petrosimonio brachiatae-Puccinellietum convolutae* ass. nova																							
Petrosimonia brachiata (Dt of *Festuco-Puccinellietea*)	.	.	.	.	.	.	.	.	3	2b	4	3	4	.	.	.	.	.	.	.	.	.	.
Puccinellia convoluta	+	.	.	1	.	2a	1	2	+	2a	1	+	4	+	2a	2a	.	3	+	+	1	3	
Artemisia santonicum (Dt of *Festuco-Puccinellietea*)	2a	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aster tripolium (Dt of *Juncetea maritimi*)	.	+	+	2	1	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diagnostic taxa of association *Crypsidetum aculeatae* (and *Crypsietea aculeatae*)																							
Crypsis aculeata	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	4	4	4	.	.	.	.	
Diagnostic taxa of association *Heleochloetum alopecuroidis* (and *Crypsietea aculeatae*)																							
Crypsis alopecuroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2b	.	.	1	4	3	4	3	
Diagnostic species of higher units *Juncetea maritimi, Juncetalia maritimi, Juncion maritimi*																							
Bolboschoenus maritimis	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	+	2	.	.	.	.	
Limonium vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.	.	
Diagnostic species of higher units *Festuco-Puccinellietea, Puccinellietalia, Puccinellion limosae*																							
Puccinellia limosa	.	.	.	.	.	.	.	.	+	.	.	1		.	.	.	.	.	.	.	.	.	
Taraxacum bessarabicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	1	.	.	.	.	
Accompanying taxa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Salicornia europaea	+	2a	+	3	.	2a	3	2	1	2a	.	.	2	.	.	.	.	.	.	.	.	.	
Cynodon dactylon	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2a	.	.	2	.	1	1	2	
Suaeda maritima	2a	.	.	1	2b	3	+	3	.	2b	.	.	1	.	.	.	.	.	.	.	.	.	
Polygonum pulchellum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2a	.	.	2	.	+	.	1	
Atriplex tatarica	.	.	.	.	+	.	.	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	
Hordeum hystrix	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	
Phragmites australis	.	1	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Echinochloa crus-galli	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	+	2	.	+	+	2	
Puccinellia distans	.	.	2a	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Lepidium ruderale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	2	
Juncus gerardii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	
Scorzonera laciniata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	

Localities and dates of the releves: 109, 112, 106 – Atanassovsko Ezero Lake (southern part) (Burgas district) – 10.09.06; 120 – Devnya town, Povelyanovo quarter (Varna district) – 12.09.06; 91, 92 – Atanassovsko Ezero Reserve – 10.09.06; 59, 62, 64, 69a – Pomoriisko Ezero Lake – 10.09.06; 12 – Radetski village (Stara Zagora district) – 8.09.06; 100, 98 – Rudnik village (north from Atanassovsko ezero) – 10.09.06; 31, 33, 35, 40 – Blatec village (Sliven district) – 9.09.06

Table 3: Association *Diantho pallidiflori-Puccinellietum convolutae* ass. nova.
Tabela 3: Asociacija *Diantho pallidiflori-Puccinellietum convolutae* ass. nova.

Number of relevé	1	2	3	4	5	6	7	8	10	11	13	14	17	45	46	48	50	54	57	58	95	55	101	**C**
Area of releve (sq. m)	25	25	25	25	25	10	25	25	25	25	25	25	25	16	16	9	9	25	25	25	25	25	25	**o**
Cover (%)	90	100	100	95	100	50	100	95	60	60	70	90	100	80	75	40	20	80	85	80	90	85	100	**n**
																								s
Diagnostic species of the association *Diantho pallidiflori-Puccinellietum convolutae* ass. nova																								**t**
Puccinellia convoluta	1	1	4	2a	1	.	1	2a	1	4	.	.	.	+	+	1	2a	2b	2a	1	.	2a	.	IV
Elymus elongatus	1	3	.	.	.	.	.	4	4	.	4	5	5	.	.	.	.	2b	1	3	2b	5	3	III
Polygonum pulchellum	2b	2a	2a	2b	.	.	2b	2a	2b	1	.	.	.	.	.	1	.	1	.	2b	+	+	.	III
Limonium vulgare subsp. serotinum	3	2a	1	3	.	.	+	1	+	.	.	.	.	.	.	.	1	.	+	.	+	.	.	II
Dianthus campestris ssp. pallidiflorus	2a	2a	2b	2a	.	.	2a	.	.	.	.	.	+	.	.	.	.	2a	.	+	2a	.	.	II
Scilla autumnalis	.	+	.	2a	.	.	1	+	.	.	.	.	+	.	.	.	.	.	.	.	1	.	.	II
Centaurium spicatum	.	.	.	.	+	2a	.	+	2b	.	+	.	.	.	.	.	.	.	.	.	.	.	.	II
Diagnostic species of higher units *Festuco-Puccinellietea, Puccinellietalia, Puccinellion limosae*																								
Lotus tenuis	.	.	1	.	.	1	.	+	1	.	.	+	.	.	.	.	.	1	.	1	.	.	1	II
Artemisia santonicum	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	3	.	.	+	.	2a	.	.	II
Juncus gerardii	.	.	.	.	.	4	.	.	.	.	2a	+	.	.	.	.	.	.	.	.	.	+	2a	II
Camphorosma monspeliaca	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	2a	2a	.	.	.	II
Crypsis aculeata	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	+	2a	2b	.	.	.	I
Accompanying taxa																								
Cynodon dactylon	4	4	3	4	2b	2a	3	3	3	2a	2b	3	2a	1	2b	1	+	3	4	2a	3	+	2a	V
Plantago lanceolata	2a	2a	2a	1	.	.	2a	1	+	.	.	.	.	1	1	.	.	+	+	+	.	.	.	III
Hordeum hystrix	.	.	+	.	.	.	.	.	+	2a	.	2a	.	.	.	1	.	2a	2a	+	.	.	.	II
Cichoryum inthybus	.	1	1	2a	+	.	.	+	2a	.	.	+	.	.	.	.	.	.	.	+	.	.	.	II
Lactuca saligna	+	.	.	.	.	.	.	+	+	.	+	.	.	.	+	.	.	.	1	1	.	.	.	II
Taeniatherum caput-medusae	1	1	1	.	.	+	2a	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	II
Atriplex tatarica	.	.	.	.	.	.	.	.	+	2b	1	.	.	.	.	2a	.	+	.	.	.	1	.	II
Bupleurum tenuissimum	.	.	.	2b	.	.	.	.	+	.	.	.	.	.	.	+	.	1	.	.	2a	.	.	II
Eryngium campestre	+	.	.	+	+	.	1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	II
Spergularia marina	.	.	.	.	.	.	.	.	.	2a	+	+	.	.	.	2a	+	.	.	.	.	.	.	II
Achillea millefolium gr.	.	1	1	.	.	.	1	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Bromus tectorum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	+	.	.	.	I
Centaurea calcitrapa	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	I
Pyrus communis	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Verbascum blattaria	.	+	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Scorzonera laciniata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	I
Allium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	I
Plantago major var. *uliginosum*	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Xanthium strumarium	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Aster tripolium	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Suaeda maritima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
Atriplex hastata	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Bromus arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Mentha pulegium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
Portulaca oleracea	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Pulicaria dysenterica	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Conyza canadensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Elymus farctus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	I

Lolium perenne	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Teucrium scordium	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Trifolium fragiferum ssp. *bonannii*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Verbena officinalis	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Carex sp.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Centaurea solstitialis	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Cephalaria transilvanica	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Chrysopogon gryllus	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Colchicum autumnale	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Crepis setosa ssp. *rhoedifolia*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
Cirsium vulgare	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Dichantium ischaemum	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Filago vulgaris	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Herniaria hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Inula britanica	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Nigella arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
Phleum arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
Salvia virgata	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Trifolium campestre	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Localities and dates of the releves: 1 ,2, 3, 4, 5, 6, 7, 8, 10 – Radnevo town (Stara Zagora district) – 8.09.06; 11, 13, 14 – Radetski village (Stara Zagora district) – 8.09.06; 17 – Kunevo village (Stara Zagora district) – 8.09.06; 45, 46 – Trapoklovo village (Sliven district) – 9.09.06; 48, 50 Atolovo village (Yambol district) – 9.09.06; 54, 55, 57, 58 – Sigmen village (Burgas district) – 9.09.06; 95, 101 – Rudnik village (north from Atanassovsko ezero Reserve) – 10.09.06.

Table 4: The associations *Bupleuro-Camphorosmetum monspeliacae* and *Camphorosmetum annuae.*
Table 4: Asociaciji *Bupleuro-Camphorosmetum monspeliacae* in *Camphorosmetum annuae.*

Number of relevé	20	21	22	23	24	25	26	28	30	36	37	39	41*	42	43	51	52	53	56	94		32	34	130	131	132
Area of relevé (sq. m)	20	40	10	25	25	4	4	4	4	2	16	4	4	16	16	4	16	25	25	25		16	16	4	9	4
Cover (%)	70	25	80	70	60	60	70	70	70	90	50	70	90	80	70	70	80	90	70	60		60	80	70	60	50
Diagnostic taxa of the association																										
Camphorosma monspeliaca	4	4	4	4	4	3	4	2b	2b	3	3	3	3	4	3	3	3	3	3	3	V	.	.	.	.	.
Puccinellia convoluta	.	.	.	.	2a	3	+	3	2a	2a	2a	.	1	2b	2b	2a	3	2b	3	.	IV	1	+	2	2	1
Cynodon dactylon	.	.	1	+	1	2a	.	+	1	2b	2a	2a	2b	2a	2a	2a	2a	2a	2b	2b	V	.	.	1	.	.
Bupleurum tenuissimum	+	.	.	+	.	+	.	.	.	+	.	+	1	.	.	.	.	1	+	+	III	.	.	.	.	.
Camphorosma annua	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	5	4	4	4
Diagnostic species of higher units *Festuco-Puccinellietea, Puccinellietalia, Puccinellion limosae*																										
Taraxacum bessarabicum	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	+	.	.	I	.	.	.	.	.
Puccinellia limosa	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Crypsis aculeata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I	1	.	.	.	.
Pholiurus panonnicus	2a	.	.	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Plantago cornuti	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Accompanying taxa																										
Plantago lanceolata	2a	.	.	.	.	+	.	.	+	1	.	1	1	.	.	.	.	1	+	.	II	.	.	.	.	.
Polygonum pulchellum	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	2a	+	.	II	.	.	.	.	.
Elymus elongatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	2a	+	I	.	.	.	.	.
Atriplex tatarica	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Hordeum hystrix	.	.	.	.	.	.	+	.	2a	.	.	.	.	.	+	.	.	.	2a	.	I	.	.	.	.	.
Limonium vulgare ssp. *serotinum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	I	.	.	.	.	.
Dianthus campestris ssp. *pallidiflorus*	.	.	.	.	.	.	.	.	.	2a	.	.	+	.	.	.	.	.	.	.	I	.	.	.	.	.
Eryngium campestre	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	I	.	.	.	.	.
Scilla autumnalis	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Spergularia marina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	I	.	.	.	.	.
Taeniatherum caput-medusae	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Atriplex hastata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	I	.	.	.	.	.
Bromus tectorum	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	I	.	.	.	.	.
Puccinellia distans	1	2a	+	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Achillea millefolium gr.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Lepidium ruderale	.	.	.	.	2a	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Bromus arvensis	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Scorzonera laciniata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	I	.	.	.	.	.
Allium sp.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I	.	.	.	.	.
Polygonum arenastrum	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Bromus scoparius	.	.	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Portulaca oleracea	.	.	.	.	.	+	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Heliotropium supinum	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Lolium perenne	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Centaurea diffusa	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I	.	.	.	.	.
Gypsophila muralis	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Hypochaeris maculata	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Lepidium campestre	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.
Tragus racemosus	.	.	.	.	.	.	.	.	.	.	.	.	2b	.	.	.	.	.	.	.	I	.	.	.	.	.

Localities and dates of the releves: 20, 21, 22, 23, 24 – Bikovo village (Sliven district), 8.09.06; 25, 26, 28, 30 – Zhelyu voivoda village (Sliven district), 9.09.06; 32, 34, 36, 37, 39, 41, 42 – Blatec village (Sliven district), 9.09.06; 130, 131, 132 – Blatec village (Sliven district), 4.09.2008; 43 – Trapoklovo village (Sliven district), 9.09.06; 51, 52 – Atolovo village (Yambol district), 9.09.06; 53, 56 – Sigmen village (Burgas district), 9.09.06; 94 – north from Atanassovsko ezero Reserve – 10.09.06 (Burgas district)

Table 5: Communities of *Artemisia santonicum.*
Tabela 5: Združbe z vrsto *Artemisia santonicum.*

Number of relevé	66	68	70	74	80	84	85	88	103	107	C
Area of relevé (sq. m)	4	16	25	16	16	4	4	16	25	25	o
Cover (%)	85	85	70	90	85	90	80	80	100	100	n
											s
Dominant species (Dt *Festuco-Puccinellietea*)											t
Artemisia santonicum	4	3	4	5	5	5	5	4	5	4	V
Diagnostic species of higher units *Festuco-Puccinellietea, Puccinellietalia, Puccinellion limosae*											
Petrosimonia brachiata	.	2b	.	2a	.	.	.	.	.	.	I
	.	.	.	.	.	.	.	.	.	.	
Accompanying taxa	.	.	.	.	.	.	.	.	.	.	
Puccinellia convoluta	.	3	.	.	+	.	2a	1	1	2b	III
Elymus elongatus	.	.	.	.	.	1	.	.	2a	2a	II
Atriplex tatarica	+	.	+	+	.	.	.	.	.	.	II
Melilotus officinalis	2a	.	2a	2a	2a	.	.	.	.	.	II
Bromus arvensis	.	.	1	+	.	.	.	.	+	+	II
Salicornia europaea	.	.	.	.	.	.	.	.	1	.	I
Polygonum pulchellum	.	+	.	.	.	.	.	.	.	.	I
Lactuca saligna	.	+	.	.	.	.	.	.	.	.	I
Phragmites australis	.	.	.	.	+	.	.	1	.	.	I
Salsola soda	.	1	.	.	.	.	.	.	+	.	I
Cerastium dubium	.	.	.	+	.	.	.	.	.	.	I
Lepidium perfoliatum	.	.	.	+	.	.	.	.	.	.	I
Tortula sp.	1	.	.	.	.	.	.	.	.	.	I

Localities and dates of the releves: 66, 68, 70, 74, 80 – Pomoriisko ezero Lake – 10.09.06; 84, 85, 88 – Atanasovsko ezero Reserve – 10.09.06; 103, 107 – Atanassovsko ezero (southern part) Lake – 10.09.06