

ASS. *ELEOCHARITETUM PALUSTRIS* SCHENNIKOW 1919 IN CROATIA

ZVJEZDANA STANČIĆ

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The association *Eleocharitetum palustris* is a marshland community that has been insufficiently investigated in Europe as a whole. In this paper 22 relevés from Croatia are presented. The association is characterized by its dominant species, *Eleocharis palustris* and poor floristic composition. The stands develop in very wet habitats alongside the banks of freshwater marshes and in shallow microdepressions of terrain. Habitats are flooded for most of the year. The community is also adapted to grazing, trampling and mowing. A comparison of the stands from the continental and Mediterranean parts of the country shows a higher species richness in the stands in continental Croatia. Based on the differences in floristic composition, the association was divided into two geographic variants: continental and Mediterranean. A comparison of *Eleocharitetum palustris* from Croatia and some other European countries shows similar species composition and mostly the same common plant taxa.

Key words: *Eleocharis palustris*, *Phragmito-Magnocaricetea*, marshland vegetation, Croatia

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Asocijacija *Eleocharitetum palustris* je vrlo slabo istražena močvarna zajednica u čitavoj Europi. U ovome radu su prikazane 22 fitocenološke snimke iz Hrvatske. Asocijaciju karakterizira dominantna vrsta *Eleocharis palustris* i siromašan florni sastav. Sastojine se razvijaju na vrlo vlažnim staništima uzduž obala slatkovodnih močvara i u plitkim mikrodepresijama terena. Staništa su poplavljena veći dio godine. Zajednica je dobro prilagođena paši, gaženju i košnji. Usporedba sastojina iz kontinentalnog i mediteranskog dijela zemlje pokazuje veći broj vrsta u sastojinama iz kontinentalne Hrvatske. Na osnovi razlika u flornom sastavu, asocijacija je podijeljena u dvije geografske varijante: kontinentalnu i mediteransku. Usporedba asocijacije *Eleocharitetum palustris* iz Hrvatske i nekih europskih zemalja pokazuje sličan sastav vrsta i uglavnom iste česte biljne svojte.

Ključne riječi: *Eleocharis palustris*, *Phragmito-Magnocaricetea*, močvarna vegetacija, Hrvatska

INTRODUCTION

Eleocharitetum palustris is marshland community of low growth with *Eleocharis palustris* as dominant and character species, the stands of which mostly grow in periodically flooded places.

The association *Eleocharitetum palustris* Schennikow 1919 is also known under the following synonyms: the *Eleocharis palustris* community Schennikov 1919, *Eleocharitetum palustris* Schennikow 1919, *Eleocharitetum palustris* Ubrizsy 1948, *Eleocharidetum palustris* Lakušić et Pavlović 1976.

So far, the community has been poorly investigated in Croatia (STANČIĆ, 2007) and indeed in Europe as a whole (PHILIPPI, 1998). In this paper, the association *Eleocharitetum palustris* is dealt with in detail. The first record of the association in Croatia was made by REGULA-BEVILACQUA (1978). Relevés of the association were also found by HULINA (1971), VODVARKA (1990) and BARIŠIĆ (1999), but they were assigned to various marshland communities (STANČIĆ, 2007).

In Europe, the association is distributed in the following countries: in Austria (BALÁTOVÁ-TULÁČKOVÁ *et al.*, 1993), Czech Republic (HEJNÝ & HUSÁK, 1978; MORAVEC *et al.*, 1995), Denmark (LAWESSON, 2004), Germany (MIERWALD, 1988; PHILIPPI, 1998; POTT, 1995; RENNWALD, 2000; SCHUBERT *et al.*, 2001), Great Britain (RODWELL, 1995), Greece (DIMOPOULOS *et al.*, 2005), Hungary (UBRIZSY, 1948; BORHIDI, 2003), Italy (POLDINI, 1989), Montenegro (BLEČIĆ & LAKUŠIĆ, 1976; LAKUŠIĆ & PAVLOVIĆ, 1976), Poland (MATUSZKIEWICZ, 2007), Serbia (CINCOVIĆ, 1955), Slovakia (HEJNÝ, 1960; OTAHELOVÁ & HUSÁK, 1985; OTAHELOVÁ, 1996; OTAHELOVÁ *et al.*, 2001; HRIVNÁK, 2003), Slovenia (MARTINČIĆ & LESKOVAR, 2002), and in Northern Europe (DIERBEN, 1996). Formations of *Eleocharis palustris* are known from Bulgaria (KOČEV & JORDANOV, 1981). The association is also noted in Asia: in Mongolia (HILBIG, 1995) and western Siberia (TARAN, 2000; KIPRIYANOVA, 2005).

Eleocharitetum palustris has been recorded in habitats such as: marshland (MERTZ, 2002), periodically inundated pastures (MIERWALD, 1988), shallow depressions (OTAHELOVÁ & HUSÁK, 1985), eutrophic gravel pits (BALÁTOVÁ-TULÁČKOVÁ *et al.*, 1993), bathing places (MERTZ, 2002), man-made canals (MERTZ, 2002) and similar places. According to the literature (BALÁTOVÁ-TULÁČKOVÁ *et al.*, 1993; PHILIPPI, 1998; MERTZ, 2002), the ecological conditions for the association's habitats are as follows: wet places with a high level of underground water, areas with considerable oscillations of the water level, long-term floodwater, a depth of water up to 50 cm, a soil rich in nutrients and calcium carbonate.

Since the association *Eleocharitetum palustris* has been poorly investigated, the aims of this paper are: (1) to do a phytosociological analysis of the community, (2) to show its distribution in Croatia, (3) to describe the ecological conditions in the habitat, (4) to identify the differences between stands in the continental and Mediterranean parts of the country, (5) to compare species composition of the community from Croatia and several other European countries, and (6) to analyse the community from the aspect of nature conservation.

METHODS

The field research was carried out during the last few years. The relevés were done in accordance with the Zürich-Montpellier methodology (BRAUN-BLANQUET,

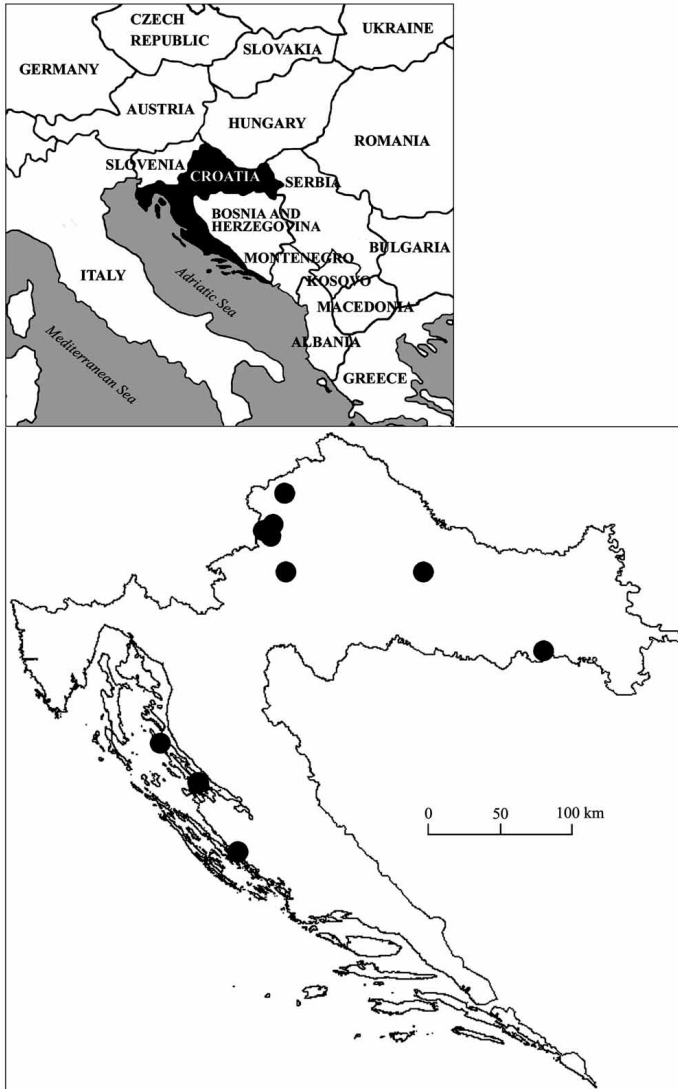


Fig. 1. Distribution map of the association *Eleocharitetum palustris* Schennikov 1919 in Croatia.

1964). The abundance of plant species was estimated using the old Braun-Blanquet scale (+, 1, 2, 3, 4, 5), which is taken as the standard in Croatia (HORVAT, 1949).

The floristic composition of the community from Croatia is shown in the analytical table (Tab. 1), in which species are sorted into groups according to their phytosociological affinity. The geographic distribution is presented in the map (Fig. 1). Relevé localities are listed in the Appendix.

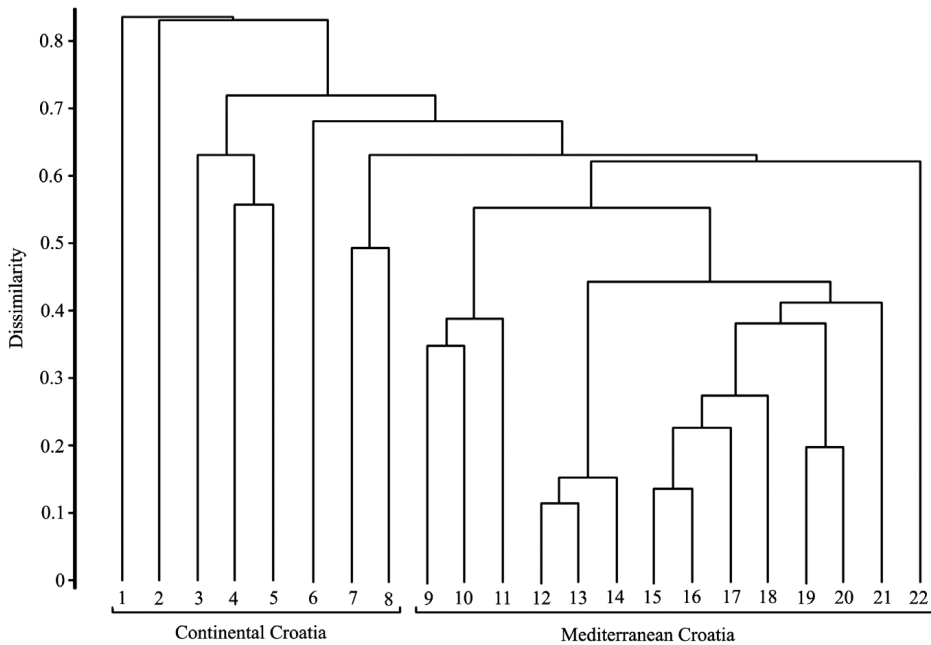


Fig. 2. Dendrogram of the association *Eleocharitetum palustris* Schennikov 1919 compiled from 22 relevés from Croatia. The relevés have been given the same numbers as in the analytical table and appendix.

For the purpose of the investigation of the community structure, the relevés were classified by numerical methods. The average linkage method (UPGMA) and similarity ratio distance coefficient in the SYN-TAX 2000 programs (PODANI, 2001) were applied. The result of analysis is shown in a dendrogram (Fig. 2).

Each of the groups (variants) obtained in classification is characterized with the fidelity values of species (Tab. 1). Statistical fidelity is a measure of species concentration in vegetation units, and therefore it is useful for detection of diagnostic values of particular species (CHYTRÝ *et al.*, 2002; TICHÝ & HOLT, 2006). Fidelity values were calculated on the basis of 22 relevés using presence/absence data in the JUICE program (TICHÝ & HOLT, 2006) and expressed as phi coefficients (Tab. 1).

Differences in species composition between continental and Mediterranean variants of the association *Eleocharitetum palustris* were examined through the analysis of biodiversity (Fig. 3). Biodiversity has two components: species richness and equitability. Species richness represents the number of taxa per community area, while equitability (expressed using the Shannon-Wiener index) shows how equally the species are represented in the community (LEPŠ, 2005). Differences in species richness and equitability were also tested by t-value.

The species composition of the community in Croatia was compared with that of the community in several other European countries, mostly in the vicinity (Tab. 2).

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------------------|---|--|---|---|--|--|--|--|---|---|---|---|---|--|--|--|--|--|--|--|--|--|--|---|---|---|---|--|--|--|--|------|
| <i>Athaea officinalis</i> | | | | | | | | | | | | | | | | | | | | | | | | 3 | + | | | | | | | 34.6 |
| <i>Bryophyta coll.</i> | + | | 4 | 3 | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | 48 |
| <i>Calystegia sepium</i> | | | | | | | | | 1 | | | | | | | | | | | | | | | | | 3 | + | | | | | 34.6 |
| <i>Carex otrubae</i> | 1 | | | | | | | | | + | | | | | | | | | | | | | | | | 3 | | | | | | 24.3 |
| <i>Elymus pycnanthus</i> (NT) | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | 34.6 |
| <i>Oenanthe fistulosa</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Paspalum paspalodes</i> (N) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Polypogon monspeliensis</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Ranunculus repens</i> | 1 | | | | | | | | | | + | 1 | | | | | | | | | | | | | | | | | | | | |
| <i>Rorippa sylvestris</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Ajuga reptans</i> | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Baldellia ranunculooides</i> (CR) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Epipactum atrorhense</i> | + | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| <i>Juncus compressus</i> | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Leucium aestivum</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Ranunculus aquatilis</i> agg. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Ranunculus flammula</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Scirpus holoschoenus</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Scirpus sylvaticus</i> | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Trifolium</i> sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Utricularia vulgaris</i> agg. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Species in only one relevé (companions): relevé 1: *Centaurea jacea* s. l. - +; *Juncus inflexus* - +; *Plantago major* s. l. - +; *Taraxacum officinale* agg. - +; relevé 2: *Yemisia scutellata* - 2; *Glechoma hederacea* - 1; relevé 4: *Epilobium* sp. - +; relevé 5: *Potentilla erecta* - +; relevé 6: *Amorpha fruticosa* (N) - +; *Bidens tripartita* - +; *Juncus gerardi* - +; relevé 7: *Carex panicea* (VD) - 1; *Lysimachia vulgaris* - +; relevé 8: *Rumex crispus* - +; relevé 9: *Mercurialis perennis* - +; *Lythrum portulacastrum* (VD) - +; relevé 11: *Oenanthe silaifolia* - +; relevé 13: *Ranunculus neopolitanus* - +; relevé 17: *Lobelia spicata* - +; relevé 21: *Euphorbia palustris* - +; *Ranunculus* sp. - +; relevé 22: *Cynodon dactylon* - 2; *Ranunculus sardous* - 1.

The data set contains threatened plant species and neophytes. The threat of the species was classified according to NIKOLIĆ & TOPIĆ (2005); the status of the neophytes was determined with the help of HORVATIĆ (1949) and PYŠEK *et al.* (2002).

The names of plant communities, and their syntaxonomic positions, have been adjusted with PHILIPPI (1998) and BALÁTOVÁ-TULÁČKOVÁ *et al.* (1993). Full Latin names, with the names of authors and the year of the first valid description, are mentioned at least once in the text.

The plant species nomenclature follows Flora Europaea (TUTIN *et al.*, 1968–1980, 1993).

RESULTS

In accordance with PHILIPPI (1998), it is accepted that the marshland association *Eleocharitetum palustris* Schennikow 1919 is affiliated to the alliance *Magnocaricion elatae* W. Koch 1926, to the order *Phragmitetalia* W. Koch 1926, and to the class *Phragmito-Magnocaricetea* Klika in Klika et Novák 1941.

The association *Eleocharitetum palustris* has been presented with 22 relevés and 86 taxa from Croatia (Tab. 1), 17 relevés of which were sampled from the author's own field research, while five relevés were taken from the available literature: one from

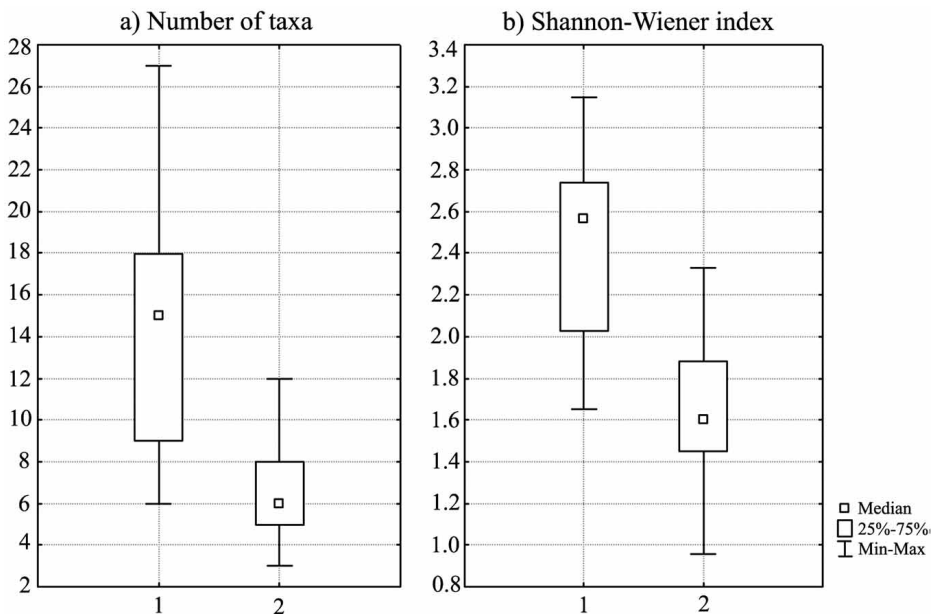


Fig. 3. Box-plots: a) comparison of species richness between continental (1) and Mediterranean (2) Croatia expressed by number of taxa per relevé; b) comparison of taxa diversity between continental (1) and Mediterranean (2) Croatia by the Shannon-Wiener index.

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|----------------------------------|--|---|---|--|---|---|--|--|--|---|--|---|---|---|---|--|---|
| <i>Potamogeton pectinatus</i> | | | | | | 1 | | | | 2 | | 1 | | | 2 | | 5 |
| <i>Rorippa amphibia</i> | | | | | | | | | | | | | | | 5 | | 5 |
| <i>Typha angustifolia</i> | | | 1 | | | | | | | | | 3 | | 1 | | | 5 |
| <i>Utricularia vulgaris</i> agg. | | | 2 | | | | | | | | | 2 | | 1 | | | 5 |
| <i>Calystegia sepium</i> | | | 3 | | | | | | | | | | | 1 | | | 4 |
| <i>Juncus articulatus</i> | | 1 | 3 | | | | | | | | | | | | | | 4 |
| <i>Lycopus europaeus</i> | | | | | 1 | | | | | | | | | 3 | | | 4 |
| <i>Myosotis scorpioides</i> agg. | | 3 | | | | | | | | | | | | | 1 | | 4 |
| <i>Oenanthe aquatica</i> | | | | | | | | | | | | | | | 4 | | 4 |
| <i>Phalaris arundinacea</i> | | | | | | | | | | | | | | 2 | 2 | | 4 |
| <i>Ranunculus aquatilis</i> agg. | | 2 | | | | | | | | | | | | 1 | 1 | | 4 |
| <i>Ranunculus sardous</i> | | 1 | | | 2 | | | | | | | 1 | | | | | 4 |
| <i>Rumex maritimus</i> | | | | | | | | | | | | | | 4 | | | 4 |
| <i>Typha latifolia</i> | | | | | 1 | | | | | | | 2 | | 1 | | | 4 |
| <i>Veronica scutellata</i> | | 1 | | | | | | | | | | | | 2 | 1 | | 4 |
| <i>Alisma gramineum</i> | | | | | | | | | | | | | 3 | | | | 3 |
| <i>Alopecurus aequalis</i> | | | | | | | | | | | | 1 | 2 | | | | 3 |
| <i>Alopecurus pratensis</i> | | 2 | | | | | | | | | | 1 | | | | | 3 |
| <i>Althaea officinalis</i> | | | 3 | | | | | | | | | | | | | | 3 |
| <i>Bryophyta</i> coll. | | 3 | | | | | | | | | | | | | | | 3 |
| <i>Carex acuta</i> | | | | | | | | | | | | | | 1 | 2 | | 3 |
| <i>Carex otrubae</i> | | 2 | 1 | | | | | | | | | | | | | | 3 |
| <i>Cirsium arvense</i> | | | | | | | | | | | | 1 | 1 | 1 | 1 | | 3 |
| <i>Echinochloa crus-galli</i> | | | | | | | | | | | | 2 | 1 | | | | 3 |
| <i>Eleocharis acicularis</i> | | | | | | | | | | | | 2 | | 1 | | | 3 |
| <i>Elymus pycnanthus</i> | | | 3 | | | | | | | | | | | | | | 3 |
| <i>Equisetum palustre</i> | | 2 | | | | | | | | | | | | 1 | | | 3 |
| <i>Euphorbia palustris</i> | | | | | 1 | | | | | | | | | 1 | | | 3 |
| <i>Iris pseudacorus</i> | | 1 | | | | | | | | | | | | 1 | 1 | | 3 |
| <i>Juncus effusus</i> | | 1 | | | | | | | | | | | | 2 | | | 3 |

| | | | | | | | | | | |
|--|---|---|---|---|--|--|---|---|---|---|
| <i>Mentha pulegium</i> | | 1 | | | | | 1 | | | 2 |
| <i>Myriophyllum spicatum</i> | | | 1 | | | | 1 | | | 2 |
| <i>Najas minor</i> | | | | | | | | 2 | | 2 |
| <i>Oryza sativa</i> | | | | | | | | 2 | | 2 |
| <i>Phragmites australis</i> | | | | 1 | | | | | 1 | 2 |
| <i>Plantago major</i> s. l. | 1 | | | | | | | | 1 | 2 |
| <i>Potamogeton crispus</i> | | | | | | | | | 2 | 2 |
| <i>Potamogeton gramineus</i> | | | | | | | | | 2 | 2 |
| <i>Ranunculus acris</i> | 2 | | | | | | | | | 2 |
| <i>Rumex hydrolapathum</i> | | | | | | | | | | 2 |
| <i>Salvinia natans</i> | | | | | | | | | 2 | 2 |
| <i>Scirpus holoschoenus</i> | | 2 | | | | | | | | 2 |
| <i>Scirpus sylvaticus</i> | 2 | | | | | | | | | 2 |
| <i>Sparganium erectum</i> | | | | | | | | | 1 | 2 |
| <i>Spirodela polyrrhiza</i> | | | | | | | | | | 2 |
| <i>Taraxacum palustre</i> agg. | 2 | | | | | | | | | 2 |
| <i>Trifolium hybridum</i> | 2 | | | | | | | | | 2 |
| <i>Trifolium</i> sp. | | 2 | | | | | | | | 2 |
| <i>Veronica anagallis-aquatica</i> | | | 1 | | | | | | 1 | 2 |
| <i>Zannichellia palustris</i> | | | | | | | | | 2 | 2 |
| Species in only one relevé | | | | | | | | | | |
| Croatia - inland part: <i>Amorpha fruticosa</i> , <i>Carex distans</i> , <i>C. panicea</i> , <i>C. vesicaria</i> , <i>Centaura jacea</i> s. l., <i>Epilobium</i> sp., <i>Festuca pratensis</i> s. l., <i>Gaudinia fragilis</i> , <i>Holcus lanatus</i> , <i>Juncus inflexus</i> , <i>Plantago lanceolata</i> , <i>Poa trivialis</i> , <i>Potentilla erecta</i> , <i>Senecio paludosus</i> , <i>Taraxacum officinale</i> agg., <i>Trifolium pratense</i> , <i>Valeriana dioica</i> . | | | | | | | | | | |
| Croatia - Mediterranean part: <i>Cynodon dactylon</i> , <i>Lotus corniculatus</i> , <i>Lycium portula</i> , <i>Oenanthe silaifolia</i> , <i>Potamogeton trichoides</i> , <i>Ranunculus neapolitanus</i> , <i>Ranunculus</i> sp. | | | | | | | | | | |
| Serbia: <i>Pseudolysimachion longifolium</i> , <i>Stachys palustris</i> . | | | | | | | | | | |
| Montenegro: <i>Najas marina</i> , <i>Nymphoides peltata</i> , <i>Potamogeton</i> sp., <i>Vallisneria spiralis</i> . | | | | | | | | | | |
| Hungary: <i>Atriplex patula</i> , <i>Bidens cernua</i> , <i>Chenopodium urticum</i> , <i>Cyperus glomeratus</i> , <i>Elatine</i> sp., <i>Elatine triandra</i> , <i>Epilobium tetragonum</i> subsp. <i>lanzi</i> , <i>Eragrostis minor</i> , <i>Hibiscus trionium</i> , <i>Lindernia procumbens</i> , <i>Lycopus exaltatus</i> , <i>Polygonum articulare</i> , <i>Potamogeton lucens</i> , <i>Pseudoglyphium luteoalbum</i> , <i>Pulicaria vulgaris</i> , <i>Rumex stenophyllus</i> , <i>Trifolium repens</i> , <i>Trifolium repens</i> , <i>Trifolium repens</i> . | | | | | | | | | | |
| Slovakia - I: <i>Alopecurus geniculatus</i> , <i>Bidens frondosa</i> , <i>Carex melanostachya</i> , <i>C. riparia</i> , <i>Cirsium canum</i> , <i>Elytorgia repens</i> , <i>Potentilla anserina</i> , <i>Ranunculus sceleratus</i> , <i>Symphitium officinale</i> . | | | | | | | | | | |
| Slovakia - II: <i>Aster novi-belgii</i> , <i>Callitriche</i> sp., <i>Plantago media</i> , <i>Potamogeton pusillus</i> , <i>Sagittaria sagittifolia</i> , <i>Salix triandra</i> , <i>Scirpus lacustris</i> , <i>Sium latifolium</i> . | | | | | | | | | | |

HULINA (1971), two from REGULA-BEVILACQUA (1978), one from VODVARKA (1990), and one from BARIŠIĆ (1999).

Concerning the distribution, the association is recorded at seven localities in inland Croatia and at three localities in Mediterranean Croatia (Fig. 1), at some localities with more than one relevé. In continental Croatia the association occupies mostly small areas of several square metres. By contrast, in the Mediterranean part of the country, a continuous elongated stand of several hundred square metres was found in Velo Blato on the island of Pag, and many discontinuous stands of several tens of square metres in the area around Vransko Lake near Pakoštane.

In the floristic composition of *Eleocharitetum palustris* from Croatia (Tab. 1), the character species of the association, *Eleocharis palustris*, is dominant in all the relevés. The character species of the class *Phragmito-Magnocaricetea* are found in small number and with small cover values. Represented among them with the highest frequencies are: *Galium palustre*, *Mentha aquatica*, and in Mediterranean Croatia, *Scirpus maritimus*. In relevés from inland Croatia there grow species typical of meadow vegetation of the order *Molinietalia* W. Koch 1926, and the class *Molinio-Arrhenatheretea* Tx. 1937 em. Tx. et Prsg. 1951. The most common are: *Myosotis scorpioides* agg. and *Cardamine pratensis* agg. The group of companions encompasses the largest number of species (Tab. 1), and represented with the highest frequencies are: *Agrostis stolonifera*, *Lythrum salicaria*, *Carex hirta*, and in Mediterranean Croatia, *Chara* sp. In general, the main characteristic of this association is a poor floristic composition and predominance of *Eleocharis palustris*, followed by *Agrostis stolonifera*, while the other species are mainly represented with the lower frequencies.

The results of the numerical classification presented in the dendrogram (Fig. 2) show that relevés from continental Croatia are grouped on the left-hand side, and relevés from Mediterranean Croatia on the right-hand side. Relevés are divided into two groups, which are assumed in this paper to be two geographic variants: continental and Mediterranean (Tab. 1). The continental variant shows high fidelity values for the species *Alisma plantago-aquatica*, *Lythrum salicaria* and *Lysimachia nummularia*. The Mediterranean variant shows high fidelity values for the species *Scirpus maritimus* and *Agrostis stolonifera*. Furthermore, relevés from the continental part of Croatia show more species in the floristic composition than relevés from Mediterranean Croatia. Species richness, i.e. the number of taxa, in continental Croatia ranges between 6 and 27 per relevé with a median of 15, and in Mediterranean Croatia between 3 and 12 with a median of 6 (Fig. 3a). Taxa diversity, expressed by the Shannon-Wiener index, shows similar trends (Fig. 3b). Statistical significance was obtained as follows: for number of taxa, t -value = 4.0266 and p = 0.000661, and for Shannon-Wiener index t = 4.2016 and p = 0.000439. In other words, differences between relevés of continental and Mediterranean variants are statistically significant.

Species composition of *Eleocharitetum palustris* from Croatia was compared with species compositions of the same community from the following countries (Tab. 2): Italy (POLDINI, 1989), Serbia (CINCOVIĆ, 1955), Montenegro (LAKUŠIĆ & PAVLOVIĆ, 1976), Hungary (UBRIZSY, 1948), and Slovakia (OTAHELOVÁ, 1996; HRIVNÁK, 2003). In the synoptic table, in total, 50 relevés and 166 plant taxa are included. The plant spe-



Fig. 4. Association *Eleocharitetum palustris* Schennikow 1919 in a habitat of the Ornithological Reserve within the Vransko Lake Nature Park on 10/06/2006.

cies with the highest frequencies in all the areas compared are: *Eleocharis palustris*, followed by *Agrostis stolonifera*, *Alisma lanceolatum*, *Lythrum salicaria*, *Gratiola officinalis*.

Physiognomically, this is sparsely structured vegetation with a height of about 30 (40) cm (Fig. 4). The recorded habitats are: surfaces along the banks of freshwater marshes, shallow depressions within pastures, meadows and even forest, and Mediterranean pastures close to bodies of water. They are exposed to long-term flooding, and to occasional grazing, mowing and trampling.

With regard to threatened taxa, in the floristic composition of the association, six species from the list of the Red Book of Vascular Flora of Croatia (NIKOLIĆ & TOPIĆ, 2005) are recorded: one critically endangered species (*Baldellia ranunculoides*), four vulnerable species (*Carex panicea*, *C. vesicaria*, *Glyceria plicata*, *Lythrum portula*), and one nearly threatened (*Elymus pycnanthus*). Two neophytes (*Paspalum paspalodes*, *Amorpha fruticosa*) have been recorded.

DISCUSSION

The association *Eleocharitetum palustris* is rarely recorded in vegetation studies and probably, in many cases, has also been overlooked. Based on the wide distribution area of the species *Eleocharis palustris* (SCHULTZE-MOTEL, 1980; WALTERS, 1980), the community has a potentially large range, and new localities of the community can be expected in future investigations.

The stands from inland and Mediterranean Croatia show obvious floristic differences and they are therefore divided at the level of geographic variants (Tab. 1). The differences are most probably caused by different types of management, climate, soil and underlying bedrock. However, in spite of the stated groupings, all relevés are considered as constituting the same association, due to common character species and ecological conditions such as high level of moisture and disturbance in the habitat.

The comparison of *Eleocharitetum palustris* from Croatia and several other European countries in the synoptic table (Tab. 2) shows a more or less similar species composition with a dominance of plants of very wet habitats.

The species *Eleocharis palustris* is a very variable taxon with the occurrence of polyploidy and hybridization (WALTERS, 1980). Due to morphological similarity, specimens within the *Eleocharis palustris* agg. could be misidentified. In this paper, the records of *Eleocharis palustris* in relevés from the literature have been taken in accordance with their original quotation as *sensu stricto* taxon; but, because of possible errors, they have been marked in brackets as *Eleocharis palustris* agg. (Tab. 1, 2). However, the ecological demands of closely related species of *Eleocharis palustris* agg. could differ. Therefore it is possible that the pertinent plant communities are also different in their ecological features. More detailed future investigations should consider the separation of communities at the level of aggregate (*Eleocharis palustris* agg.), species (*Eleocharis palustris* s. str., *E. mamilata*, *E. austriaca*, and others) and even subspecies (*Eleocharis palustris* subsp. *palustris* and *E. palustris* subsp. *vulgaris*). In Croatia, from the *Eleocharis palustris* agg. only three species are known (*E. austriaca*, *E. palustris* s. str. and *E. uniglumis*) (ILJANIĆ & TOPIĆ, 2000; <http://hirc.botanic.hr/fcd/>), but on the basis of distribution area one might expect the other species from the aggregate (WALTERS, 1980; GREGOR, 2003) as well as two subspecies: *Eleocharis palustris* subsp. *palustris* and *E. palustris* subsp. *vulgaris* (WALTERS, 1980).

In this paper, the association *Eleocharitetum palustris* is assigned to higher syntaxonomic categories in accordance with PHILIPPI (1998), as stated above. The investigations of GRÜTTNER (1990) also support the affiliation of the association *Eleocharitetum palustris* to the alliance *Magnocaricion elatae*. In the literature, however, various views are recorded. DIERBEN (1983) puts the association within the alliance *Phragmition* W. Koch 1926. BALÁTOVÁ-TULÁČKOVÁ *et al.* (1993) include the association in the alliance *Magnocaricion elatae* and the sub-alliance *Caricion gracilis* (Neuhäusl 1959) Oberd. *et al.* 1967. SCHUBERT *et al.* (2001) classify the association within the alliance *Eleocharito-Sagittarion sagittifoliae* Passarge 1964. Some botanists (e.g. HEJNÝ & HUSÁK, 1978; MORAVEC *et al.*, 1995; OTAHELOVÁ *et al.*, 2001) subordinate *Eleocharitetum palustris* to the alliance *Oenanthion aquaticae* Hejný ex Neuhäusel 1959, although this syntaxon was not validly published, and could be considered as a synonym of *Eleocharito-Sagittarion sagittifoliae* Passarge 1964. Consequently, this problem indicates the need for further phytosociological and ecological research in the wider region and with a large amount of data.

Besides *Eleocharitetum palustris*, in the phytosociological literature several closely related associations with considerable *Eleocharis palustris* cover values are known. For example, the association *Alismato-Eleocharitetum* Máthé & Kovács M. 1967 has

been recorded in Hungary (KOVÁCS & MÁTHÉ, 1967). The association *Eleocharito palustri-Hippuridetum vulgaris* Passarge 1955 is known in Austria (BALÁTOVÁ-TULÁČKOVÁ *et al.*, 1993), Germany (SCHUBERT *et al.*, 2001), Hungary (BORHIDI, 2003) and Netherlands (WEEDA *et al.*, 2000). In Spain and Portugal, MOLINA (1996) and RIVAS-MARTÍNEZ *et al.* (2001) have noted the following associations: *Acrocladio cuspidati-Eleocharitetum palustris* O. Bolòs & Vigo in O. Bolòs 1967, *Glycerio declinatae-Eleocharitetum palustris* Rivas-Martínez & Costa in Rivas-Martínez, Costa, Castroviejo & E. Valdés 1980, *Glycerio spicatae-Eleocharitetum palustris* J.A. Molina, Galán de Mera & Sardinero in J.A. Molina 1996, *Oenantho globulosae-Eleocharitetum palustris* O. Bolòs 1996.

The species *Eleocharis palustris* has a wide ecological range, and also grows in the composition of other marshland communities of the class *Phragmito-Magnocaricetea* (STANČIĆ, 2007), and in wet meadows of the order *Molinietalia* (OBERDORFER, 2001).

Concerning the ecological conditions, the dominant species *Eleocharis palustris* is resistant to trampling, grazing and mowing (KRAUSCH, 1996), but not to shade (MERTZ, 2002). It is a perennial that spreads with stolons; therefore the association *Eleocharitetum palustris* is very successful in colonising bare patches in the vegetation cover. It develops in many cases as a pioneer community (BALÁTOVÁ-TULÁČKOVÁ *et al.*, 1993; PHILIPPI, 1998) or in habitats with a high level of disturbance. Damage of plant cover can be caused by grazing, flooding, mowing, and artificial removal of surface-layer soil with vegetation. The pioneering character of the community is also confirmed by the presence of other species which spread quickly on disturbed surfaces (OBERDORFER, 2001) (Tab. 1), among them the most common being *Agrostis stolonifera*, *Mentha aquatica*, *Carex hirta*, *Juncus articulatus*, *Lysimachia nummularia* and *Potentilla reptans*.

From the nature conservation aspect, the community is not threatened, because of its distribution and the wide range of the character and dominant species. Nevertheless, all types of marshland and wetland vegetation could be considered as threatened to some extent (ANONYMOUS, 1992; MARTINIĆ, 2000). In the Croatian coastal area some stands of *Eleocharitetum palustris* represent habitats for the critically endangered species *Baldellia ranunculoides*, and they should be especially protected. However, for the preservation of the community, it is necessary to maintain the aquatic regime in the habitat and the traditional extensive form of sheep grazing in Mediterranean Croatia and mowing in inland Croatia.

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SAŽETAK

As. *Eleocharitetum palustris* Schennikow 1919 u Hrvatskoj

Z. Stančić

Asocijacija *Eleocharitetum palustris* je vrlo slabo istražena močvarna zajednica kako na području Europe tako i u Hrvatskoj. Sintaksonomski, uvrštena je u svezu *Magnocaricion elatae*, u red *Phragmitetalia* i razred *Phragmito-Magnocaricetea*.

U ovome radu sakupljene su 22 fitocenološke snimke s područja Hrvatske i poblizje analizirane. U flornom sastavu obično raste mali broj vrsta. Pored vrste *Eleocharis palustris* koja je karakteristična i dominantna vrsta, pokrovnim vrijednostima slijedi *Agrostis stolonifera*, dok su ostale vrste uglavnom slabije zastupljene. Fizionomski, to su niske sastojine, do 30–40 cm visine, i rijetke strukture. Najčešća staništa su obale slatkovodnih močvara, mikrodepresije terena unutar livada, te pašnjaci u mediteranskom dijelu Hrvatske. Zajednica se razvija na vrlo vlažnim mjestima koja su poplavljena veći dio godine. U kontinentalnoj Hrvatskoj zajednica je uglavnom izložena košnji, a u Mediteranu ispaši ovaca.

Usporedba sastojina iz kontinentalnog i mediteranskog dijela Hrvatske pokazuje da postoje razlike u sastavu i broju vrsta, na osnovi čega su u ovome radu opisane dvije geografske varijante. Kontinentalnu varijantu odlikuje veći broj vrsta, znatan udio vrsta vlažnih travnjaka reda *Molinietalia*, te visoke vrijednosti vezanosti vrsta: *Alisma plantago-aquatica*, *Lythrum salicaria* i *Lysimachia nummularia*. Mediteransku varijantu odlikuje vrlo siromašan florni sastav i visoke vrijednosti vezanosti vrsta: *Scirpus maritimus* i *Agrostis stolonifera*.

Usporedba snimaka iz Hrvatske, Italije, Srbije, Crne Gore, Mađarske i Slovačke pokazuje vrlo sličan sastav vrsta i iste česte vrste.

S aspekta zaštite prirode zajednica *Eleocharitetum palustris* nije ugrožena. Međutim, u mediteranskom dijelu Hrvatske postoje malobrojne sastojine u kojima raste kritično ugrožena vrsta, *Baldellia ranunculoides*, i takva staništa bi trebalo posebno zaštititi. Za očuvanje spomenutih sastojina neophodno je zadržati potreban vodni režim na staništu i tradicionalni ekstenzivni način ispaše ovaca.

Appendix

The list of relevé localities:

Relevé 1: close to Bobovec; Gauß-Krüger coordinates: 5558684, 5088793; date: 18/05/2001; author: Stančić; **relevé 2:** Kukavičeva jama, terrain depression in forest Mačkor Gaj; date: 11/06/1968; author: HULINA (1971); **relevé 3:** fishpond Končanica near Daruvar, stand on the bottom of fishpond which dried up during summer; date: 1989; author: VODVARKA (1990); **relevé 4:** Strahinščica, Sv. Jakov; date: 30/05/1974; author: REGULA-BEVILACQUA (1978); **relevé 5:** Strahinščica, Sv. Jakov; depth of water: 25 cm; date: 30/05/1974; author: REGULA-BEVILACQUA (1978); **relevé 6:** Gajna, near Slavonski Brod, depression of terrain in pasture; depth of water: 0 cm; date: 17/07/1999; author: BARIŠIĆ (1999); **relevé 7:** the Krapina river valley, Veliko Trgovišće-Žeinci; Gauß-Krüger coordinates: 5565589, 5093317; depth of water: 0 cm; date: 05/05/2006; author: Stančić; **relevé 8:** the Krapina river valley, Pojatno-Bistra; Gauß-Krüger coordinates: 5563821, 5085603; depth of water: 0 cm; date: 13/05/2006; author: Stančić; **relevé 9:** island of Pag, Novalja-Lun, along the bank of the marshland; Gauß-Krüger coordinates: 5486444, 4940861; depth of water: 0–20 cm; date: 19/06/2004; author: Stančić; **relevé 10:** Vransko Lake, Ornithological Reserve, Vrbiće-Lateralni kanal; Gauß-Krüger coordinates: 5543645, 4866617; depth

of water: 0 cm; date: 11/06/2006; author: Stančić; **relevé 11:** Vransko Lake, Ornithological Reserve, near ornithological station; Gauß-Krüger coordinates: 5541723, 4866034; depth of water: 15 cm; date: 09/06/2006; author: Stančić; **relevé 12:** island of Pag, Velo Blato; Gauß-Krüger coordinates: 5513149, 4912713; depth of water: 0–5 cm; date: 21/06/2004; author: Stančić; **relevé 13:** island of Pag, Velo Blato; Gauß-Krüger coordinates: 5513284, 4912614; depth of water: 0–5 cm; date: 21/06/2004; author: Stančić; **relevé 14:** NW of Vransko Lake Nature Park; Gauß-Krüger coordinates: 5541460, 4865816; depth of water: 0–10 cm; date: 24/06/2004; author: Stančić; **relevé 15:** Vransko Lake, Ornithological Reserve, Popovka-Vrbice; Gauß-Krüger coordinates: 5543910, 4866595; depth of water: 20 cm; date: 10/06/2006; author: Stančić; **relevé 16:** Vransko Lake, Ornithological Reserve, Južne bare-Vrbice; Gauß-Krüger coordinates: 5542696, 4866644; depth of water: 5 cm; date: 05/07/2006; author: Stančić; **relevé 17:** Vransko Lake, Ornithological Reserve; Gauß-Krüger coordinates: 5546169, 4864073; depth of water: 0–3 cm; date: 10/06/2006; author: Stančić; **relevé 18:** NW of Vransko Lake Nature Park; Gauß-Krüger coordinates: 5541348, 4865811; depth of water: 5 cm; date: 24/06/2004; author: Stančić; **relevé 19:** Vransko Lake, Ornithological Reserve; Gauß-Krüger coordinates: 5544466, 4866165; depth of water: 10 cm; date: 06/07/2006; author: Stančić; **relevé 20:** Vransko Lake, Ornithological Reserve, near Lateralni kanal; Gauß-Krüger coordinates: 5544346, 4866231; depth of water: 10 cm; date: 06/07/2006; author: Stančić; **relevé 21:** Vransko Lake, Ornithological Reserve, Južne bare-Vrbice; Gauß-Krüger coordinates: 5543341, 4866643; depth of water: 0 cm; date: 05/07/2006; author: Stančić; **relevé 22:** NW of Vransko Lake Nature Park; Gauß-Krüger coordinates: 5541519, 4865804; depth of water: 20 cm; date: 24/06/2004; author: Stančić.