

DISTRIBUTION AND COMMUNITIES OF *CRYPISIS ACULEATA* AND *HELEOCHLOA SCHOENOIDES* IN SLOVAKIA

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Abstract

The distribution and communities of two annual grasses *Crypsis aculeata* and *Heleochloa schoenoides* were studied in Slovakia during 2003–2007. Herbarium and field data were used to reconstruct the occurrence of both taxa. A strong decline in *C. aculeata* localities was observed. This was mainly due to the destruction of periodically flooded saline habitats. By contrast, the occurrence of *H. schoenoides* was changed only slightly. This species survives in secondary habitats (rural roads, field margins, field depressions). Point maps of historical and recent distribution are presented. Halophile vegetation of *Crypsis aculeata* and *Heleochloa schoenoides* has been sampled with the adapted Braun-Blanquet method. All collected relevés have been classified using the JUICE software. The results showed that the *Crypsidetum aculeate* Wenzl 1934 community is missing now in Slovakia, but *Heleochloetum schoenoidis* (Soó 1933) opa 1939 was still recorded at a few sites. However, the community contained many ruderal plant species.

Key words: *Crypsis aculeata*, *Heleochloa schoenoides*, halophytes, saline soils, distribution, vegetation, Slovakia

Izveleček

Raziskave razširjenosti dveh enoletnih trav *Crypsis aculeata* in *Heleochloa schoenoides* smo raziskovali na Slovaškem med letoma 2003 in 2007. Za rekonstrukcijo pojavljanja obeh vrst smo uporabili herbarijske in terenske podatke. Opazili smo močno upadanje števila nahajališč, kjer se pojavlja *C. aculeata*. Razlog je predvsem uničenje periodično poplavljenih slanih rastišč. Nasprotno pa se je pojavljanje vrste *H. schoenoides* le malo spremenilo. Vrsta lahko uspeva tudi na sekundarnih rastiščih (kolovozi, robovi njiv, uleknine na njivah). Historično in recentno razširjenost smo prikazali na točkovnih kartah. Halofilno vegetacijo vrst *Crypsis aculeata* in *Heleochloa schoenoides* smo vzorčili s prilagojeno Braun-Blanquetovo metodo. Vse popisno gradivo smo klasificirali s programom JUICE. Rezultati so pokazali, da asociacije *Crypsidetum aculeate* Wenzl 1934 na Slovaškem ne najdemo več, medtem ko je bila asociacija *Heleochloetum schoenoidis* (Soó 1933) opa 1939 najdena na nekaj rastiščih, vendar se v njej pojavljajo številne ruderalne rastlinske vrste.

Ključne besede: *Crypsis aculeata*, *Heleochloa schoenoides*, halofiti, slana tla, razširjenost, vegetacija, Slovaška

1. INTRODUCTION

Saline soils belong to hydromorphic soils which are strongly influenced by intensive water evaporation, and the salt dynamics of ground water is

the most important factor in their formation. The saline soils contain toxic concentrations of soluble salts in the root zone. The soluble salts consist of chlorides and sulphates of sodium, calcium and magnesium (Buol et al. 1997, Boros 2003). Areas

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of saline soils are widely distributed over the world and constitute approximately 10 % of the terrestrial surface (Szabolcz 1991, O'Leary & Glenn 1994). In Central European countries with an arid continental climate, saline soils are widely spread mainly throughout Hungary, where alkali habitats cover nearly 400 000 ha (Molnár & Vajda 2000).

In Slovakia, saline soils covered by halophytic plant communities are distributed mainly in warm and dry lowland regions. The largest areas of saline soils are concentrated in the Danube Lowland – they are distributed from the surroundings of towns of Komárno and Štúrovo to the town of Nitra (Krist 1940, Krippelová 1965). The second area of saline soils is in the East Slovakian Lowland in the neighbourhood of the villages of Malčice, Zemplínske Kopčany, Malé Raškovce, and Ve kú Raškovce (Vicherek 1964). The last small area near the town of Malacky in the Záhorská nížina Lowland (Krist 1940) was destroyed in the sixties. Saline soils created by the mineral springs in basins of northern Slovakian mountains represent special habitats (Šmarda 1961, Vicherek 1973, Dít & al. 2004).

The areas of saline soils have all been markedly reduced during the last few decades due to human activities. For instance, Osvačilová & Svobodová (1961) mentioned approximately 8300 ha of soil with saline vegetation in the Danube Lowland, but today only 500 ha have been re-discovered there (Sádovský & al. 2004b). It is this reduction that strongly affects these plant communities distributed on soils with high salinity and a high level of underground water level during spring months. For example, we confirmed that *Camphorosmetum annuae* now covers only a few square metres in Slovakia, but the typical vegetation was found only at some of the last square decimetres. Initial stages of periodically flooded saline soils are now rare and are usually developed in secondary biotopes (fields and field borders, depressions in rural roads etc.).

Plant communities of periodically flooded saline habitats represent unique initial stages of plant succession. They cover river banks as well as terrain depressions. The formation of these plant communities is closely associated with annual water level decrease and we can usually find it in the second half of the vegetation period. This type of biotope is rare in Slovakia nowadays; it has predominantly developed in wet depressions of intensively farmed fields. Vegetation of saline flooded banks is even more seldom – only two micro-localities still exist (Sádovský & al. 2004a).

Typical dominants of periodically flooded saline soils are annual grasses *Crypsis aculeata* (L.) Aiton and *Heleocholea schoenoides* (L.) Host ex Roem. *Crypsis aculeata* occupies a wide area from North Africa, Spain and Portugal to northern China and Mongolia. Distribution of *Heleocholea schoenoides* is very similar. However, the area of the species gets larger towards Tibet and northwestern India; in Africa from Senegal to Mozambique, Malawi, Tanzania, and Madagascar (Conert 1983). The northern distribution border of both species passes through Central Europe (Holub & Grulich 1999a, b), occurrence of these species in this region has always been rare. The situation of historical and present occurrence in the Czech Republic was described by Grulich (1987). Both species are evaluated as critically endangered in Slovakia (Feráková & al. 2001) and the Czech Republic (Holub & Procházka 2000). In Austria, *Crypsis aculeata* is evaluated as endangered, while *Heleocholea schoenoides* as strongly endangered (Niklfeld & Schratt-Ehrendorfer 1999).

Crypsis aculeata and *Heleocholea schoenoides* plant communities are usually included in classis *Crypsidetia aculeatae* Vicherek 1973, ordo *Crypsidetalia aculeatae* Vicherek 1973 and alliance *Cypero-Spergularion salinae* Slavnič 1948. Within the frame of this alliance both taxa are components of some associations and subassociations (see Vicherek 1973, Mucina & Maglocký 1985, Mucina 1993, Borhidi 1996, Pop 2002 etc.).

The aims of our paper were:

- a) to describe the historical and recent distribution of *Crypsis aculeata* and *Heleocholea schoenoides* in Slovakia,
- b) to assess the recent stage of initial *Crypsis aculeata* and *Heleocholea schoenoides* saline communities in Slovakia,
- c) to compare present vegetation data with older works published by Krist (1940) and Vicherek (1973).

2. MATERIAL AND METHODS

The study was carried out during the years 2003–2007. The data concerning the distribution of the species were obtained from herbariums BP, BRA, BRNU, BRNM, NI, NIM, KO, MMI, PMK, PR, PRC, SAV, SLO and ZV. Herbarium specimens collected during field research are stored in herbarium



Figure 1: Area of study.

Slika 1: Območje raziskav.

NI. Herbarium abbreviations are used according to Holmgren & al. (1990) and Vozárová & Sutorý (2001). The active field research was carried out to confirm recent localities of these species. Results of this study are presented on the point maps constructed using DMAP software. The grid on the maps (5'×3') follows one that was described by Niklfeld (1971).

The vegetation relevés were sampled according to the Zürich-Montpellier approach using the adapted Braun-Blanquet scale (Barkman & al. 1964). All relevés were stored using the TURBOVEG database software (Hennekens & Schaminée 2001) and data analyzed in JUICE software (Tichý 2002).

The nomenclature of ferns and flowering plants follows Marhold & Hindák (1998), the names of syntaxa are used in accordance with Molnár & Borhidi (2003). The abbreviations of works published before 1956 follows Futák & Domin (1960). Phytogeographical divisions of Futák (1980) are also used (Fig. 1).

3. RESULTS AND DISCUSSION

3.1 Distribution of *Crypsis aculeata* (L.) Aiton in Slovakia

The species is distributed only on the Danube Lowland in Slovakia. In the course of our study we found all together 30 localities of *Crypsis aculeata*. Half of them were documented by herbarium specimens, the other part was mentioned only in the literature (see Fig. 2 and data below). However, we would here like to refer to frequent determination mistakes – young individuals of *Heleochoa schoenoides* were often determined as *Crypsis aculeata*. Hence we take it that approximately a third of all the literature data are probably erroneous and therefore they need to be used with care. Our deduction is based on the fact that *C. aculeata* is an obligate halophyte and it grows only on strongly salinized soils of saline lakefronts (Krist 1940). On the other hand, *Heleochoa schoenoides*, although included in

the group of obligate halophytes (Krist 1940) colonizes even more dry sub-saline and ruderal habitats (field depressions, rural roads, fallows etc.). Sádovský & al. (2004a) interpreted it as an effect of a wider ecological amplitude of *H. schoenoides*.

Novák (1954) also mentioned the species from saline biotopes of the Záhorská nížina lowland, but he did not point out any exact site. We consider this record doubtful.

We established a marked reduction of *Crypsis aculeata* distribution (Fig. 2.) with respect to strong changes in Slovak saline areas (see Sádovský & al. 2004b). The species occurs now only at two microsites in the village of Tvrdošovce. We ascertained during our field research that all other localities were destroyed – predominantly by land reclamation (Búč, Dolný Jatov, Hájske, Močenok, Nový Život, Palárikovo, Šurany, Trnovec nad Váhom, Ve ká Dolina, Zlatná na Ostrove), but also by building development (Komárno, Malá Ma a) and forestation by hybrid poplars (Ve ké Kosihy).

A specimen of *Crypsis aculeata* collected by Samuel Kupčok was found in the herbarium BP. The specimen's label mentioned the village of Pukanec (the Štiavnické vrchy Mts. in the Carpathicum phytogeographical region). We assumed that this specimen probably had its label accidentally exchanged,

because no saline habitats exist in this region (neither presently nor historically) and Kupčok did not include this species in his review of Pukanec flora (Kupčok 1956).

3.2 Distribution of *Heleochloa schoenoides* (L.) Host ex Roemer in Slovakia

The occurrence of *Heleochloa schoenoides* is concentrated in the southwestern and southeastern part of Slovakia. Most of the 30 localities are known from the territory of the Danube Lowland, but one locality was reported from a lower reach of the river of Ipe (Zalaba) and circa 10 locations were found in the East Slovakian Lowland (Fig. 3).

Novák (1954) mentioned the occurrence of this species in the Záhorská nížina Lowland. However, the origin of this reference is not clear. Similarly as in the case of *Crypsis aculeata*, we found no other literature reference or herbarium specimen of *Heleochloa schoenoides* from this region. However, a recent occurrence of *Heleochloa schoenoides* on the sand bank of the Dyje River (near the junction with the Morava River) was published in South Moravia (Šumberová et al. 2000). A recent occurrence is also known from the Austrian part of Marchfeld

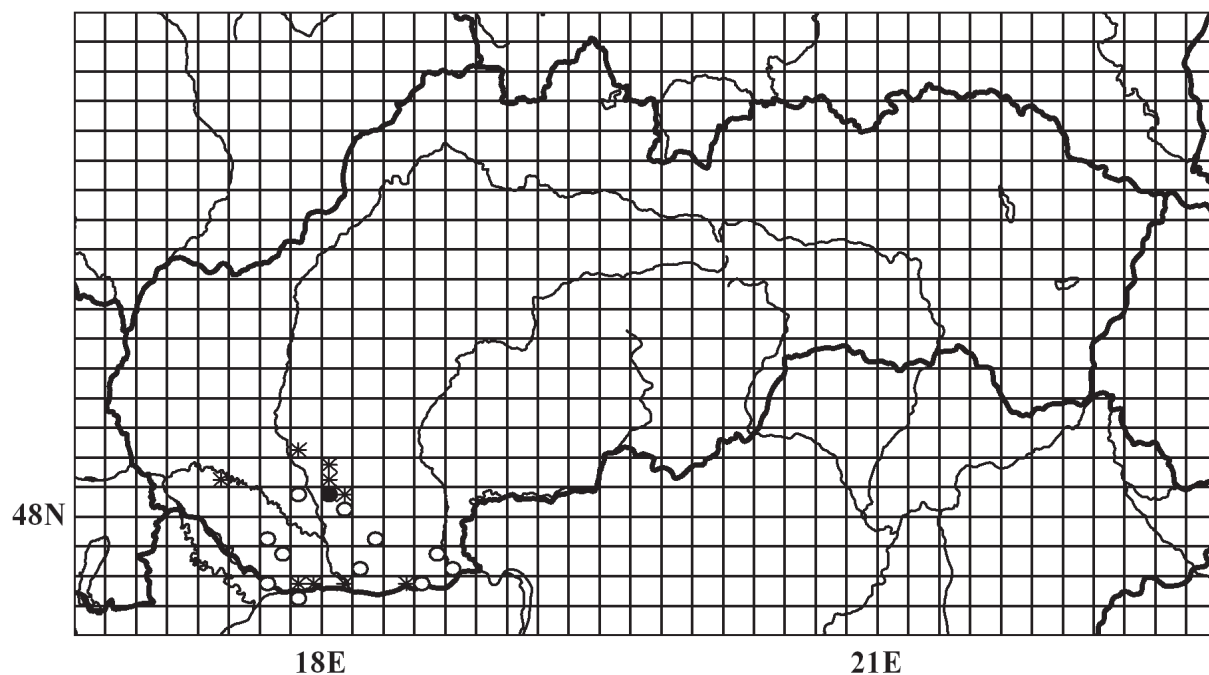


Figure 2: Historical and recent distribution of *Crypsis aculeata* in Slovakia: * – data from literature, ● – before 1980, ○ – 1980 onwards.

Slika 2: Historična in recentna razširjenost vrste *Crypsis aculeata* na Slovaškem: * – literaturni podatki, ● – pred 1980, ○ – po 1980.

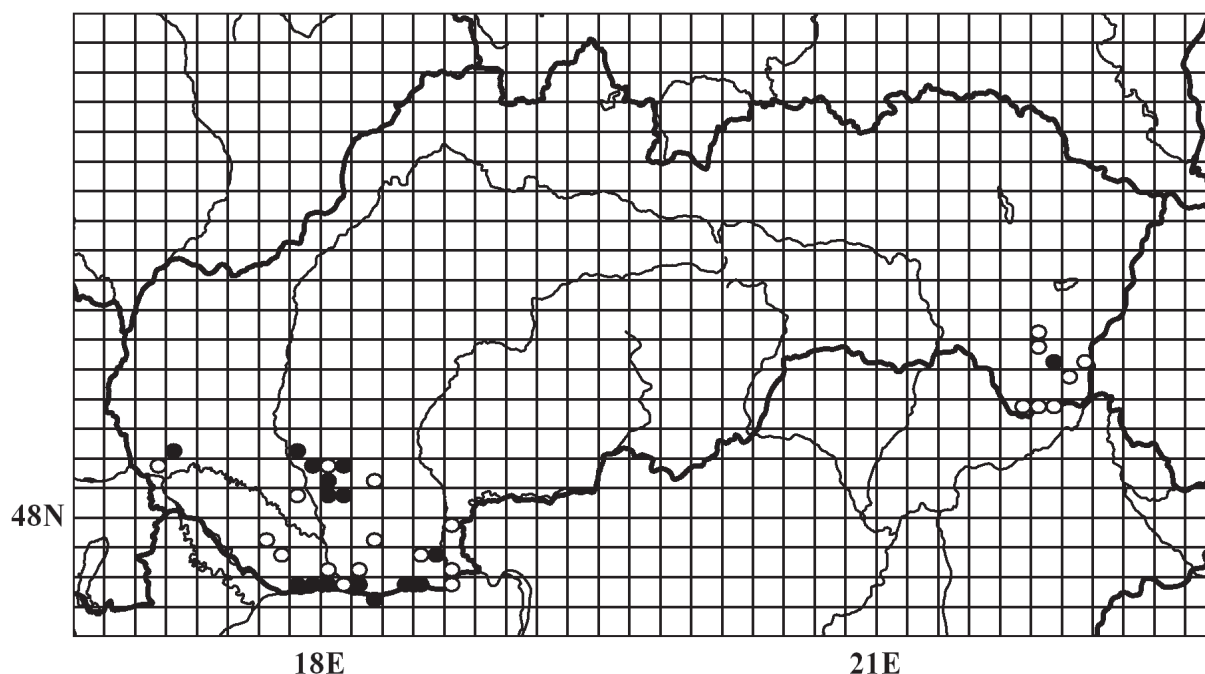


Figure 3: Historical and recent distribution of *Heleochloa schoenoides* in Slovakia: ○ – before 1980, ● – 1980 onwards.
Slika 3: Historična in recentna razširjenost vrste *Heleochloa schoenoides* na Slovaškem: ○ – pred 1980, ● – po 1980.

(Schratt-Ehrendorfer 1999). These findings evoke an idea of the species possibly occurring on the Záhorská Lowland in Slovakia as well.

Heleochloa schoenoides hybridizes with its sibling species *H. alopecuroides*. Both species grow in similar ecological conditions and are often found together. The hybrid – *Heleochloa* × *bernatskyana* (Degen) Boros – was reported from the surroundings of the Muž a Village. The specimen is deposited in the herbarium in Budapest (Boros 1917 BP). This hybrid needs further study: it is not clear if the cited specimen represents a real hybrid combination or only an extreme variability of one of the supposed parents.

Recent distribution of the species more or less corresponds to pre-existent localities. Contrary to previous species, *Heleochloa schoenoides* is adapted to the strong disturbance of saline habitats (amelioration, ploughing) and it also frequently colonizes secondary sites. We found the species at 18 localities on the Danube Lowland. We did not confirm its occurrence on the East Slovakian Lowland. On the other hand, Zlacká (2006) confirmed one locality in East Slovakia in 2005 and many localities were found here earlier in the past (Vicherek 1964). On the basis of these data, we now assume a more frequent occurrence of *H. schoenoides* in the area.

Many plant species of denuded beds (e. g. *Carex bohemica*, *Dichostylis micheliana*, *Schoenoplectus supinus* etc.) occur irregularly – in years with favourable climatic conditions they create large populations but in years of unfavourable climatic conditions they are missing (Hejný 1960, Holub 1999).

3.3 Communities with dominance of *Crypsis aculeata* in Slovakia

We found a biotope of periodically flooded saline banks with the presence of *Crypsis aculeata* only at two microlocalities during our study. Both were situated in the urban area of Tvrdšovce village (Fig. 4).

Vegetation on flooded lakesides fluctuated distinctively from year to year depending on the water levels of the two lakes mentioned above. A high abundance of vascular plants was observed during the relatively dry and warm years of 2003 and 2004. By contrast in years 2005–2006 the water level was relatively stable and no contiguous plant cover was discovered. Abundance of *Crypsis aculeata* was always rather low in those two habitats – the species covered only 5–50 % area of the relevés, usually 10–25 %. The number of all species recorded



Figure 4: Village of Tvrdošovce: one of two last microsites of *Crypsis aculeata* in Slovakia. Denuded waterbanks of the small pool are in optimal conditions covered by an ephemeral community with presence of this species. Photo: D. Dítě, 21. 9. 2004.

Slika 4: Pri vasi Tvrdošovce: eno od dveh zadnjih mikrorastišč vrste *Crypsis aculeata* na Slovaškem. Goli bregovi manjših mlak so v najugodnejših razmerah porasli z efemerno združbo te vrste. Foto: D. Dítě, 21. 9. 2004.

per plot was also relatively low. The species richness varied from 6 to 16 species per relevé (average 9.8). On the basis of these data we classified both communities as association *Heleochoetum schoenoidis* (Soó 1933) opa 1939 [syn. *Crypsidetum schoenoidis* (Soó 1938) opa 1939]. It must be noted that this vegetation was also strongly ruderalized (Table 1, relevés no. 3–10).

We found that the recent conditions are not optimal for the existence of *Crypsidetum aculeatae* at the two above mentioned microlocalities in the area of Tvrdošovce village (and in the whole of Slovakia respectively). We therefore suppose that this plant community is now missing in Slovakia. The last occurrence of *Crypsidetum aculeatae* in Slovakia was thus confirmed by Valachovič (1995) in the same village in the first half of the nineties. It is interesting that the author did not mention *Heleochoa schoenoides* in his relevés, since we found *Crypsis aculeata* always together with *H. schoenoides*

there. This change could be a result of desalination of the soil.

By comparing our data with the work of Vicherek (1973) from the former Czechoslovakia, the correctness of our conclusions that the studied vegetation is now missing in Slovakia can be clearly confirmed. The author differentiated two subassociations within the scope of *Crypsidetum aculeatae* using data from South Moravia and south-west Slovakia. Subassociation *typicum* Vicherek 1973 is characterised by strong dominance of *Crypsis aculeata* species (over 75 %) and the very low number of other taxa per relevé (3–6 species). Subassociation *chenopodietosum glauci* Bojko ex Vicherek 1973 was distinguished based on the dominance of *Chenopodium glaucum* (abundance 75–100 %) and *Spergularia salina* (up to 50 %). By contrast *Crypsis aculeata* was present only sparsely, the author mentioned maximal abundance up to 25 %. The number of species per relevé was low again (3–7 species).



Figure 5: The Kelemen-Szék Lake in Hungary, typical association of *Crypsidetum aculeatae* on denuded saline bank. Photo: D. Dítě, 11. 9. 2007.

Slika 5: Jezero Kelemen-Szék Lake na Madžarskem, tipična asociacija *Crypsidetum aculeatae* na golih slanih brežinah. Foto: D. Dítě, 11. 9. 2007.

Vicherek (1973) regarded *Crypsidetum aculeatae* as a Pontic-pannonian community. Outside Slovakia, the association was reported from north-eastern Austria (Bojko 1931, 1932, Wendelberger 1959), southeastern part of the Czech Republic (Vicherek 1962, 1973, Šumberová 2007), central and eastern Hungary (Soó 1934, Timár 1954, Borhidi 1996, Molnár & Borhidi 2003), northern part of Serbia (Slavnić 1948, Kojić et al. 1998), Romania (Popa 1939, Sanda et al. 1999, Popescu 2005a) and Ukraine (Bilik 1937, 1963). Hilbig (2000) mentioned the community from Mongolia which was the reason why Šumberová (2007) assumed occurrence of the association on salt steppes in southern Russia. On the other hand, Mucina (1993) mentioned the community only from Austria, the Czech Republic, Slovakia, Hungary, and Serbia. In addition to that, Micevski (1965) described a Macedonian endemic community *Crypsidetum aculeatae balcanicum*, which was developed in small depres-

sions and channels in Ovče Pole. The author described this community on the basis of the occurrence of species *Puccinellia convoluta* and *Spergularia marginata* which are not present in *Crypsidetum aculeatae* described from Central Europe. Revision of his data is needed in the future.

A survey of the saline lakes in Central Hungary (surroundings of the villages of Akasztó, Fülöpszálás, Harta and Solt) was made in 2006 and 2007 to obtain comparative data of vegetation with *Crypsis aculeata*. We found a typical cover of the species comparable to data given by Timár (1954), Wendelberger (1959) and Vicherek (1973) (Tab. 2). We recorded a wide area of dry saline lakes overgrown by thousands of individuals of the species (Fig. 5). On the other hand, it seems that this community is abundant only locally in Hungary, because Varga & Várgáné (1999a) included it in the Red book of Hungarian vegetation. Similarly, the community is sporadic in Austria – it occurs only in the area of

the Neusiedler See (Mucina 1993, Körner 2006). In Serbia *Crypsidetum aculeatae* is rare and occurs mainly in northern Serbia (Vojvodina: Potamišje, Derečka bara). Only a few isolated sites are found in southern parts of the country in the surroundings of the Bujanovac settlement (Vučković 1983, Knežević 1994, Zlatković et al. 2005). According to Popescu (2005a) recent distribution of *Crypsidetum aculeatae* in Romania is limited; the community still occurs in regions of Muntenia, Moldova, Dobrogea and in the Danube Delta. The author supposes that the community presently covers an area of approximately 5–10 hectares only and that conservation of the association is inadequate. Similarly, Micevski's *Crypsidetum aculeatae balcanicum* has recently been threatened by limited distribution and is under direct destruction (Matevski et al. 2003). Apart from Slovakia, the community is also missing in the Czech Republic (Danihelka & Hanušová 1995, Dít 2006 ined., Šumberová 2007) and moreover the species survive there thanks only to human support (Holub & Grulich 1999a).

3.4 Communities with dominance of *Heleochloa schoenoides* in Slovakia

Occurrence of vegetation with dominance of *Heleochloa schoenoides* was recorded at several localities during recent times. In 2004 we found typical vegetation mainly at the bottom of a small periodical pool near the Tvrdošovce railway station, (Tab. 1, relevés 1, 2, Fig. 6). It was distinguished by great dominance of the species (nearly 100 %) and low richness and abundance of other species (5 species in relevés with abundance to 5 %). Similar vegetation was found at a periodically flooded habitat of a field depression in the surroundings of the village of Močenok in 2006 (Tab. no. 1, relevés no. 12, 16–20). However, also many synanthropic species grew there. Other habitats of *Heleochloa schoenoides* were found on field margins and at open places strongly affected by man (field depressions, field roads, wet fallows, Fig. 7). The presence of ruderal species was caused by lower soil salinity and direct contact with intensively managed fields. Therefore this vegeta-



Figure 6: *Heleochloetum schoenoidis* on drying lake bank in Tvrdošovce. Photo: P. Eliáš jun., 30. 8. 2004.

Slika 6: *Heleochloetum schoenoidis* na izsušenem jezerskem bregu pri vasi Tvrdošovce. Foto: P. Eliáš jun., 30. 8. 2004.

tion was modified and the presence of many ruderal plant species was recorded (e. g. *Amaranthus retroflexus*, *Atriplex sagittata*, *A. tatarica*, *Echinochloa crus-galli*, *Lepidium ruderales*, *Polygonum ruriuagum* etc.). In some extreme cases the cover of ruderal species was close to 50 % per plot. Despite this fact, all samples in Slovakia can be assigned to the association *Heleochloetum schoenoidis* (Soó 1933) opa 1939 [syn. *Crypsidetum schoenoidis* (Soó 1938) Topa 1939] even though they are more or less ruderalized. In some cases, when the soil salinity was low, we found a transition to communities of the class *Isoëto-Nanojuncetea* (e.g. on a dry bed of a small pool in Komárno – ulov dvor farmstead). The same pattern was recorded by Šumberová (2007) in degraded saline pools of Southern Moravia. We suppose that this change is probably irreversible and will result in full extinction of the community.

The community is distributed in the Pontic-pannonian region (Vicherek 1973). Reliable data about its occurrence were given from the Czech Republic (Vicherek l. c., Šumberová 2007), Slovakia (Krist 1940, Vicherek 1964, 1973, Sádovský & al. 2004b), Hungary (e. g. Soó 1940, 1947, Bodrogközy 1962, Borhidi 1996, Molnár & Borhidi 2003), Romania (opa 1939, Pop 2002, Popescu 2005b), and Mongolia (Hilbig 2000). Following Hilbig's data Šumberová (2007) suggested the occurrence of the community in Ukraine and in steppe areas of southern Russia. Nevertheless, the community was not mentioned in published surveys of saline vegetation of Ukraine and Russia (Solomakha 1996, Freitag et al. 2001, Voityuk 2005). This stage could also be caused by different syntaxonomical treatment of the *Heleochloa schoenoides* communities.

Vicherek (1973) mentioned that *Heleochloetum schoenoidis* included two subassociations on the territory of the former Czechoslovakia: subass. *typicum* and subass. *spargularietosum marginatae*. Similarly as in the case of *Crypsidetum aculeatae* association the presence of 3–5 plant species was typical for subass. *typicum*. The second subassociation was characterised by slightly higher species richness (7–9 plant taxa per relevé). In our relevés it was approximately two times greater due to penetration (invasion?) of ruderal species (8–16 plant species per relevé, Tab. 1). Therefore it is now impossible to distinguish the above mentioned subassociations. *Heleochloetum schoenoidis* sites were mainly on the area of agricultural crops and they were usually destroyed in years with dry weather. The same stage was pointed out by Šumberová (2007); the author reported ca. 10 species per plot.



Figure 7: Rural roadside – a secondary habitat of *Heleochloa schoenoides*. Photo: P. Eliáš jun., 16. 7. 2005

Slika 7: Kolovoz – nadomestni habitat vrste *Heleochloa schoenoides*. Foto: P. Eliáš jun., 16. 7. 2005

The comparative findings were made near the villages of Solt (Table 1, relevés no. 13, 14) and Balmazújváros in Hungary (Table 1, relevé no. 11). Only ruderalized *Heleochloetum schoenoidis* vegetation was found and the community was established just on secondary habitats (field depressions, field margins). Despite our findings, the community is the most common in Hungary; the occurrence was mentioned mainly from the large region of the Great Hungarian Plain (Soó 1939, 1964). In this region approximately 1200 ha of saline lakes and 13,000 ha of salt meadows and marshes were mentioned (Molnár & Varga 2000). However, Varga & Várgáné (1999b) have recently included the association into the Red book of Hungarian vegetation. Distribution in Romania is very scattered, Popescu

(2005b) mentioned the community mainly from districts of Transylvania, Banat, Muntenia, and Moldova. The author estimated that the total area covered by *Heleochloetum schoenoidis* is no larger than 35–40 hectares, and the community needs active protection. The association is infrequent in Serbia as well (Knežević 1990, Kojić et al. 1998). It is centralised in the Vojvodina region and some localities are situated in the central and southern part of the country. The community is also very rare in the Czech Republic, recent occurrence was confirmed in south-eastern Moravia (Daníhelka & Hanušová 1995, Šubmerová 2007). These data suggest that the community is presently uncommon in the whole of Central and Eastern Europe.

4. CONCLUSIONS

A stronger decrease of saline areas was recorded in the last 30–40 years in the Czech Republic and Slovakia. Most of the habitats were fully destroyed by agriculture and construction activities (Sádovský et al. 2004b). The small fragments were conserved to the present time, but the habitats are situated among crop fields where the water regime is being changed. Habitat degradation caused changes of vegetation cover. Soil salinity has decreased and the attack of weedy species has been recorded. Because *Crypsis aculeata* is unable to adapt to these changes the number of localities markedly decreased and the species is threatened with extinction. Typical communities with dominance of the species were not found at two still existing micro-sites. It survived scattered in ruderalized vegetation. On the other hand, *Heleochloa schoenoides* is partly adapted to the ecologically changed conditions and thus historical and present distribution of the species is practically identical. But the *Heleochloa schoenoides* communities were modified dramatically – they occurred usually at secondary habitats and the ruderal species were very abundant. Finally, our data pointed out that *Crypsis aculeata* and *Heleochloa schoenoides* communities are now endangered in the whole Pannonian region.

5. ACKNOWLEDGEMENTS

We are grateful to Milan Valachovič (Bratislava, Slovakia) for valuable comments and contributions, Viktor Kerényi-Nagy (Budapest, Hungary) for his help with the herbarium data excerption.

We are indebted to Rozália and Zoltán Orosi (Harta, Hungary) and Alexander Fehér (Nitra, Slovakia) for help with field research in Hungary. This paper was particularly supported by the grants of the Grant Agency for Science “VEGA”, Bratislava, Slovakia (grants No. 1/3446/06 and No. 1/0672/08) and of the Ministry of Education of the Czech Republic (grant no. 0021622416).

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- 1951 BRNU; Šourek 1951 PR). – Hájske, Mešterik farmstead (Weber 1918 BRNM, 1935 BRA). – Močenok, Siky farmstead (Weber 1935 BRA; Krist 1937 BRNU; Krist 1940; Valenta 1938 BRA). – Dolný Jatov (Weber 1935 BRA; Futák 1949 ined.). – Ve ká Dolina, Kokaš farmstead, saline drainage chanel (Osvačilová 1953 NI). – Tvrdošovce (Weber 1935 BRA; Vozárová 1994 BRA; Eliáš jun, Dít , Kolník & Sádovský 2002 NI; Grulich 2002 BRNU – near the railway station). – Tvrdošovce, small fishpond on northern margin of the village (Grulich 1985 MMI; Pluha 1986 BRNU; Grulich & Kochjarová 1988 SLO). – Palárikovo, near railway station (Weber 1936 BRA). – Palárikovo, Ve ké Čiky farmstead (Weber 1933 BRNM; Smejkal 1965 BRNU). – Palárikovo, Malé Čiky [= Čiastka] farmstead (Weber 1935 BRA; Valenta 1937 BRA; Krist 1938 BRNU, Krist; 1940). – Palárikovo, Bačala farmstead (Weber 1935 BRA). – Búč (Dvo ák 1965 BRA; Unar 1965 BRNU, Vicherek 1973).

b) Literature references without confirmation of herbarium specimens:

4. The Záhorská nížina lowland (Novák 1954) [not mapped]. 6. Tô , wetland site in the village surrounding (Futák 1949 ined.). – Opatovský Sokolec, southern margin of the village (Vicherek 1973). – Okoč, southern margin of the village (Vicherek 1973). – K úcovec, bank of small pond in the village (1975) (Svobodová 1988: 11). – Malé Kosihiy, in the village (Vicherek 1973). – Žihárec, near the railway station (Vicherek 1973). – Palárikovo, Horný Jur farmstead (Futák 1949 ined.). – Chotín, bank of small pond in the village (1974) (Svobodová 1988: 11). – Pribeta, saline site near railway station (Futák 1949 ined.). – Muž a (Feichtinger 1899: 392; Domin 1933: 247). – Nána (Feichtinger 1899: 392; Domin 1933: 247). – Kamenín (Feichtinger 1899: 392; Domin 1933: 247).

List of localities of *Heleochoa schoenoides*:

2. Zalaba (Hejný 1951 SLO). 4. Záhorská nížina lowland, saline soils (Novák 1954) [not mapped].

6. Bratislava, wetlands near Istrochem factory (Feráková 1972 SLO). – Bratislava-Vajnory, Čierna Voda farmstead (Ondrášek 1986 MMI). – Svätý Jur, Pálffyovský dvor farmstead (Holuby 1913 PRC). – Svätý Jur, site Šúr (Zigmundík 1913 BRA; Holub & Grulich 1999b) [data probably refer to the previous]. – Hájske (Krist 1936 BRNU, 1937 BRNU; Weber 1931 BRNM, 1937 BRA; Krist 1940; Vicherek – SW margin of the village; Sádovský & al. 2004a). – Hájske, Mešterik farmstead (Weber

7. APPENDIX

List of localities of *Crypsis aculeata*:

a) Herbarium specimens and confirmed literature references

6. Nový Život, part Eliášovce (Mergl 1902 SAV). – Ve ké Kosihiy, salt pasture near pri skladoch (Májovský 1963 SLO; Májovský & al., *Acta Fac. Rer. Natur. Univ. Comen.*, Bot. XXIII: 7, 1974). – Zlatná na Ostrove (Weber 1936 BRA; 1949 BRNM; Vicherek 1973). – Komárno, near the railway station (Futák 1949 ined., Šmarda 1951 BRNM; Smejkal

1935 BRA, 1936 BRNM; Krist 1937 BRNU; Klokner 1955 SLO; Weber 1970 PR, 1977 PR; Eliáš jun. & Dít 2005 NI). – Močenok, Síky farmstead (Weber 1935 BRA, 1936 BRNM; Krist 1937 BRNU; Krist 1940; Klokner 1955 SLO; Unar 1965 BRNU ut “salt meadow Močenok”; Weber 1970 PR, 1977 PR; Eliáš jun. & Dít 2005 NI). – Cabaj-Čapor, Szík farmstead [locality probably refers to the previous] (Vlach 1935 PRC). – Ša a, Andelek farmstead (Weber 1936 BRNM). – Trnovec nad Váhom, near the railway station (Weber 1935 BRA, 1936 BRNM). – Horný Jatov (Krist 1936 BRNU; Weber 1936 BRNM; Sádovský 2002 NI). – Dolný Jatov, Čierny vršok farmstead (Osvačilová 1953 PRC, Dostál 1955 PRC). – Dolný Jatov (Weber 1935 BRA, 1936 BRNM; Holub & Grulich 1999b; Grulich 1988 MMI – wet place 1 km SSW from the village). – Polný Kesov (Dostál 1955 PRC). – Komjatice, Ružový dvor farmstead (Vlach 1934 PRC; Krist 1940; Sádovský & al. 2004a). – Tvrdošovce (Krist 1924 BRNU, 1936 BRNU; Krist 1940; Weber 1935 BRA, 1936 BRA, BRNM; Pospíšil 1952 BRNM; Pokluda 1961 BRNM; Dostál 1966 PR; Vicherek 1973 – small fishpond on N part of the village; Weber 1977 PR; Grulich 1985 MMI – small fishpond on N part of the village; Grulich 1985 MMI – wet pastures on NW part of the village; Grulich 1986 MMI – 1.5 km NW from the railway station; Pluha 1986 BRNU; Grulich & Kochjarová 1988 SLO; Vozárová 1994 BRA; Svobodová 1994 NI; Eliáš jun., Dít, Kolník & Sádovský 2002 NI). – Palárikovo (Krist 1924 BRNU; Krist 1940; Scheffer 1923 BRNU – in agris; Weber 1935 BRA, 1936 BRNM; Skivánek 1948 BRNM; Futák 1949 SLO; Dvoák 1952 BRNM; Pospíšil 1952 BRNM; Šourek 1954 PR – NW from the railway station; Pokluda 1961 BRNM; Vicherek 1973 – NE margin of the village; Grulich 1985 MMI – NW from the railway station; Holub & Grulich 1999b). – Palárikovo, Berchtold farmstead (Weber 1936 BRNM). – Palárikovo, Bačala farmstead (Weber 1935 BRA, 1936 BRNM). – Palárikovo, Ve ké Čiky farmstead (Weber 1936 BRNM; Klokner 1955 SLO; Smejkal 1965 BRNU; Unar 1965 BRNU ut *Heleochoa alopecuroides*). – Palárikovo, Malé Čiky farmstead [= Čiastka] (Weber 1933 BRNM, 1935 BRA, 1936 BRNM; Krist 1937 BRNU; Krist 1940; Weber 1977 PR; Grulich 1988 MMI; Eliáš jun. & Sádovský 2003 NI). – Šurany, Akomá farmstead (Weber 1936 BRNM; Weber 1977 PR; Grulich 1987 MMI; Holub & Grulich 1999b). – Malá Ma a, small fishpond in the village (Vicherek 1973). – Žihárec, small fishpond near the railway station (Vicherek 1973). – Tô (Futák 1949 SAV; Vicherek 1973). – Okoč (Krist

1940; Vicherek 1973). – Ve ké Kosihy (Májovský 1963 SLO; Holub & Grulich 1999b). – Okánikovo, Mostové Nature Reserve [= Dérhídia] (Čvančara & Šourková 1972 BRNM, BRNU, PR; Grulich 1986 MMI; Eliáš jun. & Dít 2004 NI). – Okoličná na Ostrove, near the railway station (Májovský 1963 SLO; 1966 SLO, 1969 SLO). – Okoličná na Ostrove, Ekelský dvor farmstead (Krippelová & Zahradníková 1962 SAV). – Zlatná na Ostrove (Valenta 1936 BRA; Weber 1936 BRA, BRNM, 1937 BRNM; Šourek 1954 PR; Hajdúk & Krippelová 1962 SAV; Holub & Grulich 1999b; Grulich 1987 MMI – 0.5 km E from the railway station). – Kameničná (Feráková 1971 SLO; eho ek & Svobodová 1971 NI ut *Crypsis aculeata*). – Komárno, osada Pavel (Klokner 1966 PMK). – Komárno, osada Nová Stráž (Krist 1940; Magic 2002 BRA). – Komárno, near railway station (Náb lek 1936 BRA; Hrab tová 1947 BRNU ut *Crypsis aculeata*; Hrab tová 1951 BRNU – field margin; Dvoák 1952 BRA – dno jamy ne aleko mostu; Smejkal 1951 BRNU; Šmarda 1951 BRNM; Hejný 1953 PR; Šourek 1954 PR). – Komárno, ulov dvor farmstead (Klokner 1967 PMK; Eliáš jun. 2003 NI). – Chotín (Futák 1949 SLO; Šourek 1954 PR – W from elevation point 109 m). – Iža, Bokroš hamlet (Svobodová 1991 NI; Eliáš jun., Dít & Sádovský 2006 NI). – Pribeta (Klika 1937 PR). – Búč (Feichtinger 1899: 392; Májovský 1963 SLO; Vicherek 1963 BRNU, Biológia, 19: 463, 1964; Dvoák 1965 BRA; Čvančara 1970 BRNM, 1971 PR; Nevrlý 1971 BRNM; Dorotovičová 1994 PMK; Eliáš jun., Dít & Sádovský 2005 NI). – Gbelce (Krist 1936 BRNU; Vicherek 1973). – Muž a (Feichtinger 1899: 392; Domin 1933v: 247; Šmarda 1949 BRNM; Májovský 1963 SLO; Eliáš jun. & Sádovský 2006 NI). – Štúrovo, Boží kopec hill, waterbank of the Danube (Hejný 1953 PR). – Nána (Feichtinger 1899: 392; Domin 1933v: 247). – Kamenný Most, Čistiny Nature Reserve [= Irtoványi rétek] (Šourek 1954 PR). – Kamenín (Feichtinger 1899: 392; Domin 1933v: 247; Klika 1931 NI, 1936 NI; Náb lek 1936 SAV; Weber 1936 BRNM; Futák 1948 SLO; Osvačilová 1956 NI ut *Crypsis aculeata*; Černoch, Biológia, 15/11: 818, 1960; Májovský 1965 SLO; eho ek 1981 NI; Murín, Feráková & Činčura 1982 SLO; Grulich 1985 MMI; Svobodová 1982 NI; Eliáš jun. 2005 NI). 8. Kačanov, S obce (Vicherek, Biológia 19: 556, 1964). – Malčice, 2 km SW from the village (Vicherek, Biológia 19: 556, 1964). – Beša (Zlacká 2005 NI). – Somotor, under northern slope of Tarbucka hill (Vicherek, Biológia 19: 556, 1964). – Viničky, river branch of the Bodrog River (Májovský 1964 SLO). – Ve ký Kamenec, S from

the village (Vicherek 1962 BRNU; Vicherek, Biológia 19: 556, 1964). – Velký Kamenec, hamlet Bukov [= Ružový dvor farmstead?], river branch Velká Krčava (Hejný 1953 PR). – Strážne, waterbank of Krčava canal 3 km W from the village (Vicherek, Biológia 19: 556, 1964). – Malý Horeš, SW from the village (Vicherek, Biológia 19: 556, 1964). – Leles,

3 km N from the village (Vicherek Biológia 19: 556, 1964). – Leles, Kapo a hamlet, sandy field south from the village (Májovský & Záborský 1961 SLO). – Ruská, in the village (Vicherek, Biológia 19: 556, 1964; Vicherek 1973). – Morčany, W from the village (Vicherek, Biológia 19: 556, 1964) [not mapped; unidentified locality].

Table 1: Analytical table of recent *Crypsis aculeata* and *Heleochloa schoenoides* plant communities in Slovakia and Hungary.

Tabela 1: Analitična tabela recentnih rastlinskih združb s *Crypsis aculeata* in *Heleochloa schoenoides* na Slovaškem in Madžarskem.

Relevé number:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Relevé surface (m ²)	16	16	10	8	4	2	10	9	8	16	12	16	8	16	16	16	16	16	9	8	16	10	
Coverage E ₁ %	80	95	45	35	75	35	70	60	60	70	25	95	55	60	45	85	80	45	60	70	45	45	
Coverage E ₀ %	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	
Number of species per relevé	5	5	7	7	8	6	16	12	9	14	8	15	13	11	10	15	15	8	12	11	16	8	
<i>Potentilla anserina</i>	r	1	+	+	1	+	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Xanthium strumarium</i>	1	r	+	r	+	.	+	+	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Persicaria lapathifolia</i>	r	r	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Chenopodium glaucum</i>	.	.	3	.	1	1	+	+	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.
<i>Crypsis aculeata</i>	.	.	b	b	a	a	3	1	b	b	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Agrostis stolonifera</i>	.	.	.	.	1	.	a	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Carex secalina</i>	.	.	.	.	.	.	r	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Plantago major</i> ssp. <i>intermedia</i>	.	.	.	.	.	.	+	+	+	.	.	1	+	.	.	+	.	.	.	.	.	.	.
<i>Lotus tenuis</i>	.	.	.	.	.	.	1	+	+	1	.	+	.	.	.	.	.	.	.	.	.	1	.
<i>Bidens tripartitus</i>	.	.	.	.	.	.	a	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Spergularia salina</i>	.	.	.	.	.	.	.	+	.	1	+	a	a	1	.	.	.	.	.	.	.	.	.
<i>Tripleurospermum perforatum</i>	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	+	+	+	.	.	.	.
<i>Polygonum rurivagum</i>	.	.	.	.	.	.	.	.	.	.	.	+	+	+	a	1	a	b	1	3	3	3	3
<i>Echinochloa crus-galli</i>	.	.	.	.	.	.	.	.	.	.	.	1	+	.	a	1	1	a	a	r	+	r	.
<i>Puccinellia distans</i>	.	.	.	.	.	.	.	.	.	a	+	.	1	+	1	.	.	.	1	+	1	+	.
<i>Matricaria chamomilla</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	r	.	+	+	.	.
<i>Plantago major</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	r	.	.	.
<i>Potentilla supina</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+	.	+	.	.
<i>Elytrigium repens</i>	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	.	.	1	1	+	.
<i>Atriplex tatarica</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.
<i>Heleochloa schoenoides</i>	5	5	1	b	a	b	3	b	a	3	b	5	3	4	3	4	5	3	3	a	a	a	a
<i>Atriplex prostrata</i>	+	.	1	+	1	1	1	.	+	1	.	a	1	+	1	+	+	.	+	.	+	.	.
<i>Juncus compressus</i>	.	r	+	+	a	.	a	a	b	a	.	.	.	+	.	.	1	+	.	.	+	.	.
<i>Aster tripolium</i> ssp. <i>pannonicus</i>	.	.	.	.	.	1	+	a	a	1	+	.	.	.	.	.	.	.	.	+	.	.	.

* Characteristic species of *Cypero-Spergularion salinae* Slavnić 1948 are marked in bold.

Species recorded in two relevés only: *Artemisia monogyna* 1 (20), + (21), *Atriplex littoralis* + (22), r (23), *Bolboschoenus maritimus* 2a (4), 1 (13), *Cirsium arvense* + (12), + (19), *Cynodon dactylon* + (13), r (21), *Hibiscus trionum* r (16), r (17), *Chenopodium*

hybridum r (14), r (16), *Kochia scoparia* 1 (15), + (23), *Lepidium ruderales* 1 (11), r (15), *Plantago tenuiflora* 1 (11), 2a (22), *Rumex stenophyllus* + (18, 19), *Taraxacum* sect. *Ruderalia* + (12), + (19), *Triticum aestivum* r (12), 1 (16).

Species recorded in one relevé only: *Alisma plantago-aquatica* r (13), *Amaranthus retroflexus* r (16), *Atriplex sagittata* 1 (23), *Brassica napus* + (16), *Capsella bursa-pastoris* + (16), *Datura stramonium* + (12), *Eleocharis palustris* 1 (17), *Epilobium tetragonum* 1 (17), *Hordeum geniculatum* + (11), *Chenopodium rubrum* 1 (13), *Chenopodium urticum* + (12), *Inula britannica* + (12), *Juncus bufonius* + (14), *Lythrum hys-sopifolia* 1 (17), *Pulicaria vulgaris* r (23), *Pericaria amphibia* 1 (7), *Pericaria hydropiper* r (17), *Rumex crispus* + (14), *Sclerochloa dura* r (22), *Sonchus arven-sis* + (7), *Sonchus asper* + (20), *Trifolium fragiferum* ssp. *bonanii* r (17), *Trifolium repens* + (23).

Localities of relevés (number of relevé, locality, exposition, elevation, altitude, sampling date):

1, 2: Tvrdošovce, denuded bottom of lake near the railway station, 110 m n. m., 21. 9. 2004, 3–6: Tvrdošovce, denuded waterside of lake, 115 m n. m., 21. 9. 2004, 3: South, 5°, 4: South-eastern, 3°, 5: East, 7°, 6: East, 2°. 7–10: 7: Tvrdošovce, denud-

ed waterside of lake near the railway station, East, 3°, 8. 10. 2003, 8: South-eastern, 3°, 8. 10. 2003, 9: East, 6°, 115 m n. m., 21. 9. 2004. 10: East, 2°, 8. 10. 2003, 11: Hungary, Hajddúb szórmény, Kispród farmstead, saline pasture near road, 100 m a. s. l., 11. 7. 2007, 12: Močenok, Siky farmstead, depression in cereal field, 130 m a. s. l., 5. 10. 2006, 13, 14: Hungary, Solt, dry depression in maize field, 98 m n. m., 18. 9. 2006. 16: Močenok, Siky farmstead, depression at rural road through a cereal field, 130 m a. s. l., 5. 10. 2006., 15. Ve ké Kosihy, Mostové Nature Reserve (=Dérhidja), slopes on ploughed salt meadow, 115 m n. m., 17. 9. 2006, 17, 19: Močenok, Siky farmstead, depression in lucerne field, 13. 9. 2005, 18: Močenok, Siky farmstead, dry depression in lucerne field, 13. 9. 2005, 20, 22: Ve ké Kosihy, Mostové Nature Reserve (=Dérhidja), rural road, 115 m a. s. l., 21. 9. 2004, 21: Ve ké Kosihy, rural road in ploughed part of Mostové Nature Reserve, 115 m a. s. l., 21. 9. 2004.

Tab. 2: Analytic table of the *Crypsidetum aculeatae* Wenzl 1934 recorded in Hungary

Tabela 2: Analitična tabela asociacije *Crypsidetum aculeatae* Wenzl 1934 na Madžarskem.

Relevé number:	1	2	3	4	5	6	7
Relevé surface m ²	16	16	16	16	16	16	16
Coverage E ₁ (%)	35	40	70	60	85	80	80
Coverage E ₀ (%)	0	0	0	0	0	0	0
Number of species per relevé	1	1	2	2	2	1	1
<i>Crypsis aculeata</i>	3	3	4	4	5	5	5
<i>Puccinellia distans</i>	.	.	+	1	.	.	.
<i>Bolboschoenus maritimus</i>	.	.	.	.	+	.	.

Localities of relevés (number of relevé, locality, exposition, elevation, altitude, sampling date):

1–7: Kiskunság National Park, denuded waterside of the Kelemén-Szék Lake, 92 m a. s. l., 11. 9. 2007.

Recieved 14. 1. 2008
Revision recieved 31. 3. 2008
Accepted 3. 4. 2008