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HYDROECOLOGICAL RELATIONS OF LITTORAL, MARSH AND MEADOW ASSOCIATION AT BODROGZUG

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Abstract

In the flood-plain of the Hungarian Upper-Tisza stretch, at the junction of the Tisza and Bodrog, the composition of vegetation cover of Bodrogzug, formed in the Tokaj-region differs significantly from that found in other locations of the Tisza flood-plain. This can be attributed in the first place to the mountain effect, and to the diversity of soil and hydroecological conditions. The southern region of the flood-plain converted into a nature conservation area is under environmental stress effect of damming. As a consequence large areas became occupied by *Scirpo-Phragmitetum* at the expense of other cenoses. In the middle and lower stretches due to mineralogen and biogen filling up the river-beds of dead-arms have been occupied by *Sparganio-Sagittarietum, Rorippo-Oenanthetum,* at places by *Glycerietum maximae* replacing hydatophyton associations. Propagation of *Caricetum gracilis* subassociation units was observed as well.

In degraded moist habitats mud vegetation of *Eleocharito-Schoenoplectetum supini* could be found.

In the middle and upper regions of Bodrogzug vast marshy green field developed. At another places of higher moisture content *Carici melanostachyae—Alopecuretum pratensis,* on higher reliefs *Lythro virgatae-Alopecuretum* played a subordinate role as compared to other locations of the Tisza flood-plain. In drier places *Poo angustifoliae—Alopecuretum* vegetation has been plough up. In moist places used for intensive grazing *Lolio—Potentilletum anserinae,* at places *Lolio-Alopecuretum pratensis* pastures developed.

Introduction

From the point of view of its vegetation cover Bodrogzug is one of the most valuable regions of the Tisza flood-plain. Due to its geographical position, under the mountain effect (SIMON 1950, 1960) its mesoclimate is cooler, richer in precipitation. However, the Tisza barrage damming significantly affected the habitat, in the first place the hydroecological relations. The repeated inundations of the Tisza and Bodrog and the Tisza flood-plain led to formation of stable dead-water patches in low reliefs. On high-lying areas the indigenous vegetation survived, and at present, with the establishment of the nature conservation area its preservation seems guaranteed.

The studies of the region began with the phytocenological investigations of ÚJVÁROSI (1940). Synecological investigations have been carried out since 1960 with shorter or longer intermissions (BODROGKÖZY 1962, 1982, 1985). This enabled a comparative analysis of the effect of changing hydroecological conditions on meadow associations. The results obtained were useful from nature conservancy point of

view as well, contributing to establishing of Tokaj—Bodrogzug Nature Conservation Area.

The introduction of nature conservancy regulations was essential, since in the beginning of the 80s the water-supply management urged building of a storage lake in this low-lying region. At present this plan has been ultimately rejected. The nature conservancy status of the area enables continuous complex hydrobiological and biogeocenological investigations, registration of seasonal dynamics changes and analysis of existing interactions in these specific ecosystems formed at the border of the Great Hungarian Plain and Central Highlands, and parallel to this a comparative analysis of meadow associations found in other locations of the Tisza flood-plain, as well as following the long-term changes, too.

Materials and Methods

In the framwork of the programme, parallel to the preparation of littoral, marsh and meadow cenosis tables, registration of existing soil and hydroecological conditions, their changes in time, as well as the prediction of future developments are of outmost importance. For this purpose, similarly to investigations carried out in other locations, species components belonging to the most wide-spread associations and smaller subassociation units found in this region were assigned to hydroecological categories. In order to establish the differences in soil ecological relations as compared to other flood-plain locations, soil analyses have been performed for several associations as well. The interdependence of these factors has been emphasized by several authors (SIMON 1960, WESTHOFF 1969).

Determination of moisture requirements of plant species and associations has been analysed by ELLENBERG (1952), as a reflection of the Western-European, and in the first place Atlantic influence, in the Hungarian relation the assignment corresponding to the continental effect and determination of W-values has been performed by ZÓLYOMI et *al.* (1967). Soó presented F-values for several plant species (1964—1970).

The generally applied ELLENBERG system, as well as the assignment based on moisture requirements used in the Hungarian relation as suggested by Soó and ZÓLYOMI et *al.* needed further refinement. Thus, within 10 hydroecological categories 30 subgroups could be distinguished (BODROGKÖZY 1985). For easier and faster survey graphical presentation of the data was deemed suitable (See Figs. 1—16). For simplification the names of different categories are given in abbreviated form. The subgroups are indicated by numbers. In the figures subgroups 1 and 3 indicate the transition to the preceeding or following category, while subgroup 2 marks the typical plant species in the particular category.

The hydroecological charts of different cenoses can be drawn only after the hydroecological curves of their species components are constructed. They are used for assignment to different subgroups. Since in the region studied no species living in extremely dry conditions were observed, the 10th category, i.e. steno xerophyta are not present. Among the smaller units within different associations only those reflecting preceeding, present or predictable future relations of cenosis succession have been analysed.

The importance of hydrobiological investigations from the practical point of view has been emphasized by SZALAY (1957).

Results and Discussion

Permanent dead-arms

In the first place of interest were the hydatophyta associations of the extended dead-arms like Fekete-tó and Nagy-tó, i.e.

Salvinio-Spirodeletum
Hydrochari-Stratiotetum
Potamogetonetum lucentis
Nymphoidetum albo-luteae

Trapetum natantis formed a mosaic complex with the above mentioned phytocenoses. Here they are not analysed in details. Cenosystematical classification of marsh and marshmeadow associations in Bodrogzug.
(Compiled on the basis of the Soó-system)

CYPERO—PHRAGMITEA Soó 68
PHRAGMITETEA Tx. et Prsc. 42
PHRAGMITETALIA W. Koch 26

Phragmition communis W. Koch 26

Sparganio-Sagittarietum Tx. 53
— — *myriophylletosum spicatae*
— — *sparganietosum erecti* (=typicum)

Scirpo-Phragmitetum austro-orientale Soó 57
— — *oenanthetosum aquaticae*
— — *phragmitetosum* (=typicum)
— — *caricetosum gracilis*

Rorippo-Oenanthetum aquaticae (Soó 27) Lohm. 50
— — *oenanthetosum aquaticae*
— — *caricetosum gracilis*

Glycerietum maximae Hueck 31
— — *oenathetosum aquaticae*
— — *glycerietosum* (=typicum)
— — *caricetosum gracilis*

NASTURTIO-GLYCERIETALIA Br.—Bl.25

Glycerio-Sparganion Br.—Bl. et Siss. 42

Sparganio-Glycerietum fluitantis Br.—Bl.25
— — *glycerietosum fluitantis* (=typicum)
— — *agrostetosum stoloniferae*

ISOETO-NANOJUNCETEA Br.—Bl.43
NANOCYPERETALIA Klika 35

Elatini-Lindernion Soó 71

Eleocharito acicularis—Schoenoplectetum supini Soó et Ubr. 48
— — *myriophylletosum spicati*
— — *eleocharetosum acicularis*
— — *agrostetosum stoloniferae*

BOLBOSCHOENETALIA Soó 62

Bolboschoenion maritimi continentale Soó 47

Polygono-Bolboschoenetum maritimi Bodrk. 62

MAGNOCARICETALIA Pign. 53

Caricion gracilis Neuhausl. 57

Caricetum gracilis (GRABNER et HUECK 31) TX. 37
— — *glycerietosum maximae*
— — *caricetosum gracilis* (= typicum)
— — *agrostetosum stoloniferae*
Caricetum acutiformis — ripariae (SOÓ 27/30)
— — (typicum)

MOLINIO-ARRHENATHEREA SOÓ 68
MOLINIO-JUNCETEA BR.—BL. 49
MOLINIETALIA W.KOCH 26

Deschampsion caespitosae HORVATIĆ 30

Agrostio—Typhoidetum SOÓ 71

Alopecurion pratensis SOÓ 71

Carici melanostachyae—Alopecuretum pratensis SOÓ 71
— — *caricetosum gracilis* (= typicum)
— — *agrostietosum stoloniferae*
— — *alopecuretosum pratensis*

Lythro virgatae—Alopecuretum pratensis BODRK. 62
— — *alopecuretosum pratensis*
— — *lythretosum virgatae* (typicum)
— — *agropyretosum repentis*

Poo angustifoliae—Alopecuretum pratensis BODRK. 62
— — *alopecuretosum pratensis*
— — *poëtosum angustifoliae* (= typicum)
— — *trifolietosum repentis*

ARRHENATHERETEA BR.—BL. 47
ARRHENATHERETALIA PAVL. 28

Arrhenatherion elatioris BR.—BL.25
Pastinaco—Arrhenatheretum elatioris (KNAPP 54) PASS. 64

CHENOPODIO-SCLERANTHEA SOÓ 71
BIDENTETEA TRIPARTITAE BR.—BL. et TX. 43
BIDENTETALIA BR.—BL. et TX. 43

Bidention tripartitae NORDH. 50
Bidentetum tripartitae (KOCH 26) LIBBER 32

PLANTAGINETEA MAJORIS TX. et PRSG. 50
PLANTAGINETALIA TX. (47) 50

Agropyro-Rumicion crispi NORDH. 40

Lolio-Potentilletum anserinae KNAPP 46.
— — *potentilletosum anserinae*
— — *lolietosum perennis* (= typicum)

Lolio-Alopecuretum pratensis BODRK. 62

Detailed analysis of the essential associations of the Bodrogzug flood-plain.

Sparganio-Sagittarietum Tx. 53

As a consequence of mineralogen and biogen filling up the littoral vegetation of older dead-arms penetrated deeply in the river-bed. At places it was restricted to wider or narrower river-side strips of the dead-arms. Under the effect of damming at Tiszalök mainly in the southern part of Bodrogzug they occupied the regions covered with helophyta as well. Otherwise the composition of the association is very similar to that of hydatohelophyta in other locations of the Tisza flood-plain ÚJVÁROSI (1940), HEJNY (1960), BODROGKÖZY (1965, 1976, 1982), TIMÁR (1950), TIMÁR and BODROGKÖZY (1959).

At the same time upon comparison with the descriptions of the association found in other parts of Europe (WESTHOFF et *al.* 1969) it could be seen that a number of similarity markers existed.

The stands were located in the strip of the littoral zone adjasent to water, often forming mosaic complexes with Lemno-Potamogetonetea cenosis. At places a transition between them was observed. Subassociation units:

Sp.—Sa. myriophylletosum spicati

At places of increased filling up transitional cenoses developed. Their differential species are: *Myriophyllum spicatum, Ceratophyllum demersum, C. submersum, Utricularia vulgaris,* at places *Stratiotes aloides.* In some drying out river-bed stretches of the dead-arms, having, however, fresh soil even in the autumn, propagation of *Myriophyllum spicatum* forma terrestris was observed.

Soil ecology. The laboratory analysis of the soil segment of this association probed in the autumn period showed that the lake and its surroundings had taken on a marshy character. Namely, in spite of the prolonged oxydation process the content of organic mater in the *A* level of the soil segment exceeded 7%. The total content of salts was high, though even in the *A*-level it did not reach the lower limit for alkalinity of 0,1%.

Hydroecology. The covering quota of its species components was the highest in the transitory subgroup of hydato-helophyton category (hhe1), but the quota of hydatophyta (hd3) was significant, too.

Sp.—Sa. sparganietosum erecti (= typicum)

The subassociation occupied the zona stretch adjacent to the bank. Its differential species originated from Phragmitetea elements, like *Sagittaria sagittifolia, Oenanthe aquatica, Butomus umbellatus.*

Hydroecology. The two subassociation units can be clearly distinguished from hydroecological point of view as well. Namely, in the latter beside the invariably dominant hhe1 not hd3, but rather hhe3 representatives reached a significant quota-value (Fig. 1).

Scirpo-Phragmitetum austro orientale Soó 64

Phragmitetalia is widely spread all over Europe. Several authors worked on its cenosystematics (BOER 1942, WESTHOFF et *al.* 1969). In the relation of Hungary the work of Soó (1964—1980) provides an overview.

In the region studied it was found in the littoral zone of the dead-arms, at some distance from the river-beds. A high variability of its stands' appearance was observed, depending on the character of adjacent vegetation as well. It can be found often in the immediate proximity of *Sparganio-Sagittarietum* described above, or forming

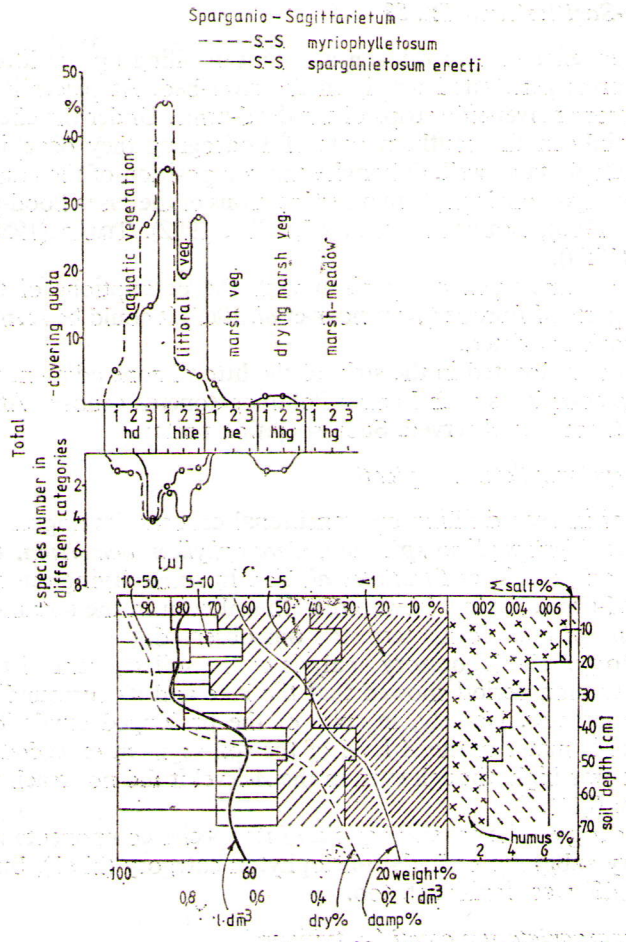

Fig. 1. Soil segment of two subassociations of *Sparganio-Sagittarietum* and *myriophylletosum*

a mosaic complex with it. It was not unfrequent that in cases of drying out due to filling up of dead-arms, or drainage, it formed complexes with *Myriophyllo-Potamogetonetum* or *Nymphaeetum albo-luteae*. From all this follows that several variants of *Scirpo-Phragmitetum* can be distinguished.

An indication for previously existing marsh habitat relations, is the fact that occasionally even species like *Ranunculus lingua, Carex vesicaria* could be observed, which are almost nonexistant in the southern region of the Tisza flood-plain. Widespread, essential variants:

Sc.—Phr. oenanthetosum aquaticae

Cenological relations. Soó (1957) assigned it to *Oenanthetum aquaticae*. In the low-lying reeds Lemno-Potamea species, like *Lemna minor, Nymphaea alba, Stratiotes aloides* were present, however, still the higher values of the covering quota

were reached by the representatives of Phragmitetea, such as the differential species *Oenanthe aquatica* and *Butomus umbellatus*.

Hydroecology. The changes caused by lengthening of inundation periods brought by damming of the barrage in the inner regions of the littoral zone are reflected in the constructed chart. It is valid in the first place for the lower region of Bodrogzug. Namely, here hydatophyta reached the total covering quota of 15%. Here the representatives of hhe category outnumbered those belonging to the transitory hel subgroup. The typical helophyta did not find yet their essential conditions.

Sc.—Phr. phragmitetosum (= typicum)

Cenological relations. It formed the second biggest zona region. Under the effect of damming, in the first place in the southern parts, the marsh-zone has been occupied by reeds. Thus, beside *Phragmites* and *Typha* species *Rorippa amphibia, Carex gracilis* were found in the lower grass level. Lately a drainage system has been built up for fast outlet of flood waters, which led to disappearance of Lemno-Potamea and Nymphaeion elements from the association.

Hydroecology. The changing hydrobiological conditions caused a significant shift as compared to the variant described above. The total covering quota of species components assigned to hidatohelophyton category (hhe2, 3) is surpassed significantly by the transitory hel subgroup.

Sc.—Phr. caricetosum gracilis

Cenological relations. This variant developed in the areas where the sedge zone was only partially occupied by reeds. Beside *Carex gracilis, Lathyrus palustris* and *Mentha arvensis* are its differential species.

Hydroecology. The transitory character of its stands from littoral vegetation zone to marsh zone is reflected in the constructed chart. It can be seen that the covering quota for the species decreased to the same extent as was the increase for the hel species (Fig. 2).

Rorippo—Oenanthetum aquaticae (Soó 27) Lohm. 50

The association has been described first by Soó (1927), its final nomenclature being published by Lohmeyer (1950). Though not very wide-spread, still it has been observed more often in the region studied as compared to other locations of the Tisza flood-plain. In general it appeared at places where reeds were missing from the littoral vegetation zone. Since its stands can tolerate without damages even prolonged inundations, some representatives of Lemno-Potamea could be found in its cenoses; in the first place *Myriophyllum spicatum, Hydrocharis morsus-ranae.* Its species composition is extremely poor. Character species are *Oenanthe aquatica, Rorippa amphibia.* Subassociation units:

R.-Oe. oenanthetosum aquaticae (= typicum)

Cenological relations. In its cenoses above the river-bed zone Lemno-Potamea species can be considered as differential elements, beside them *Oenanthe aquatica,* some Phragmitetea species like *Schoenoplectus lacustris, Iris pseudacorus* are present; *Eleocharis palustris* belongs already to Molinio-Juncetea.

Its hydroecology can be characterized by the dominant role of hydato-helophyta comprising the littoral zone. All the three subgroups (hhe1, 2, 3) are represented in its species components.

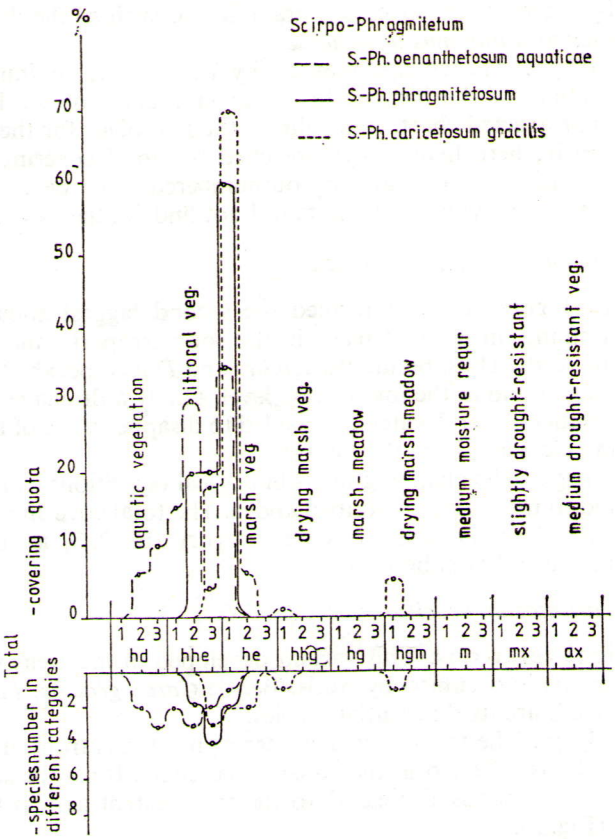

Fig. 2. Hydroecology of subassociation units of *Scirpo-Phragmitetum*

R.-Oe. caricetosum gracilis

Its differential species are: *Carex gracilis, Rorippa amphibia.* The stands forming this vegetation zone show transition towards the marsh zone.

Glycerietum maximae HUECK 31

Its cenoses are wide-spread, and are frequently found in the vegetation of the Tisza flood-plain. Thus, they are often observed in the region studied, and formed the next stretch of the littoral zone. It often replaced reeds. It formed extended stands mainly in the filled up river-beds of dead-arms. This is the explanation for the significant variations in species composition of its cenoses. Three very characteristic subassociations could be distinguished:

Gl. m. oenanthetosum aquaticae

Cenological relations. This is a relatively rare variant found in the upper regions of Bodrogzug, where the duration of the inundation effect is shorter, and it can be considered as a variant of *Glycerietum* pionir, which penetrates the river-beds of dead-arms. It often gets into contact with *Sparganio-Sagittarietum* cenoses.

Phragmitetea elements are dominant in species composition. At places it formed mosaic complexes with Scirpo-Phragmitetum.

Differential species: *Oenanthe aquatica, Schoenoplectus lacustris, Sagittaria sagittifolia.*

From hydroecological point of view it can be characterized by transitory hydatohelophyta (hdl) having covering quota above 10%. The highest quota is reached, however, by species components belonging to hhe3 subgroup. For further details see Table 3.

Gl. m. glycerietosum maximae (= typicum)

Cenological relations. This is the most wide-spread stand of the association, with a number of species somewhat higher as compared to the variant described above. Among species components beside Phragmitetea elements Caricion and Molinio—Juncetea species were found as well. Due to their tolerance characteristics, though their quota is still low, they succeeded in finding their essential conditions. In places close to reed zone *Phragmites australis* showed a significant expansion.

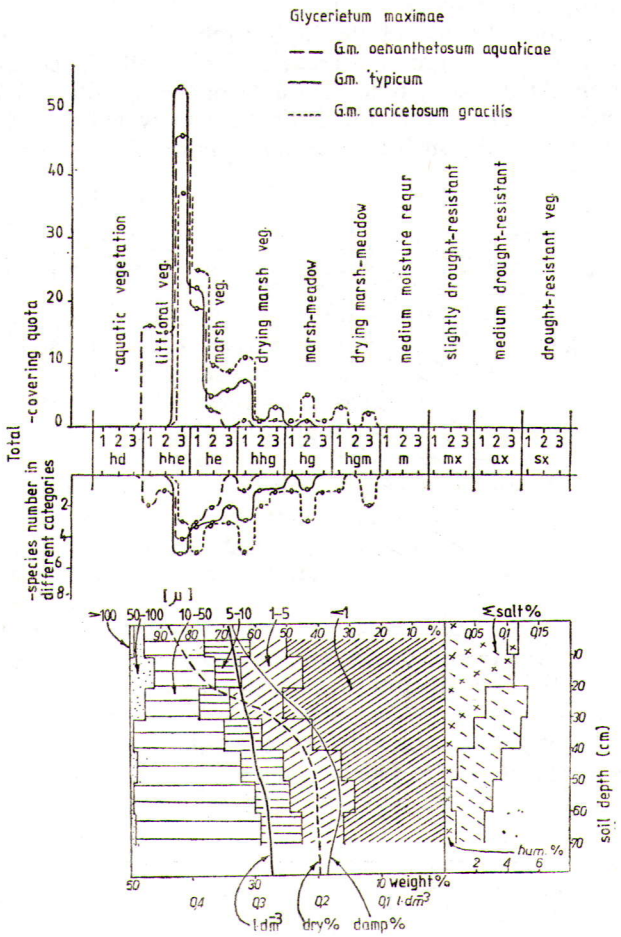

Fig. 3. Hydroecology of *Glycerietum maximae*; typicum soil segment in spring aspect

Hydroecology. Since the duration of inundation in early summer is shorter as compared to the previous variant, the effect of moisture supply on the distribution of species components is evident. This is reflected by the absence of hydatophyta. Similarly, the representatives of hhe1, 2 subgroup were missing, too. The highest covering quota in the subassociation was observed for hhe3 subgroup and reached 50%. The high values observed for he1 were caused by propagation of *Phragmites australis*. The species quota showed a steady decrease towards further hydroecological categories; *Lythrum salicaria, Veronica scutellata* and *Lycopus europaeus* belonged to hhg1 (Fig. 3).

Gl. m. caricetosum gracilis

Cenological relations. This is the most extensively spreading variant in the upper part of the region studied. This change brought by the last dry climatic period was at the expense of the typical variant of the association. The expansion of Carex variant have been going on for years.

Differential species are: *Carex gracillis, Myosotis palustris, Juncus inflexus.*

Hydroecology. The above conclusions are reflected in the chart constructed for the subassociation. Because of the higher relief the species components total covering quota in the hhe3 group decreased significantly in comparison with its typical association. At the same time the quota of the transitory he1 species of the marsh-zone increased. The decreasing moisture supply led to the appearance of hygro-mesophyta (hgm1, 3), such as *Mentha arvensis, Polygonum lapathifolium* in the stand.

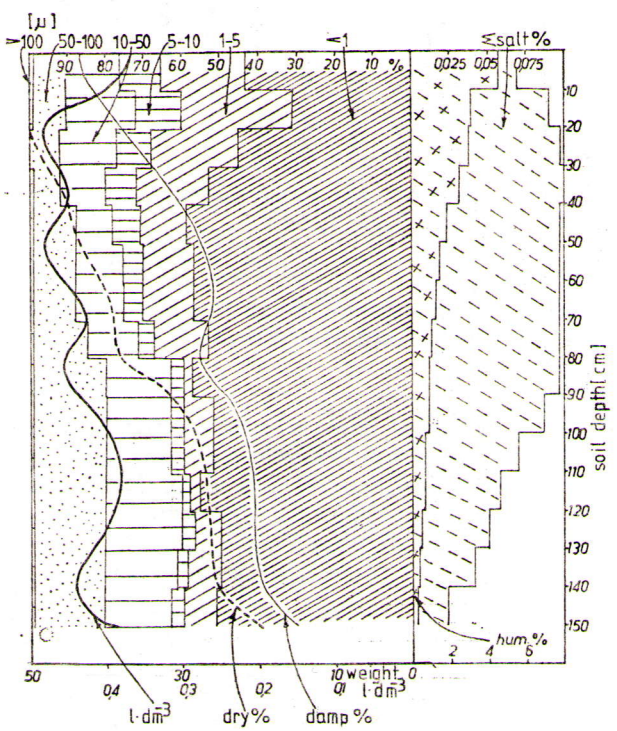

Fig. 4. Soil segment of *Oenanthe aquatica* subassociation in autumn aspect

Comparative soil ecological characteristics of the association

The laboratory analisys of soil segments probed in early summer in the habitat of different variants showed significant differences (Fig. 4).

In case of the typical variant the formation of the physical structure of the soil was related to the changes in the hydrological state. The changes in the total content of harmful salts expressed in percent here as well was an indication of the danger of later soil alkalization; though here the alkalization did not reach yet the dangerous limit of 0,10%. The diluting effect of the favourable water supply, protected the vegetation from damages, and halophyta did not appear yet in the cenoses.

The soil segment probed in the habitat of *Carex gracilis* variant was different. Binding relations were similar but the moisture content decreased, the salt content reached 0,1% and increased with depth. The concentration of the saline solution was, however, still low and could not ensure at present the appearance of less competitive halophyton elements, due to the competition effect of glycophytons.

Sparganio — Glycerietum fluitantis Br.—Bl. 25

This association is found when moving away from the littoral zone of the dead-arms and is not too frequent. Depending on the relief here as well significant differences were observed. Usually Phragmitetea elements, which could survive the dry summer periods, prevailed. In these cenoses everywhere a dominant role was played by *Glyceria fluitans*. The propagation of *Glyceria maxima* indicated the effect of the association bearing similar name. The same is valid for the propagation of *Oenanthe aquatica* observed at places. They all belonged to Phragmitetea elements. Two sub-association units could be distinguished:

Sp.-G. f. glycerietosum fluitantis (= typicum)

Cenological relations. As far as the species composition of its cenoses is concerned, as a consequence of increasing dryness they replaced *Sparganio-Sagittarietum*. Relict species like *Oenanthe aquatica, Butomus umbellatus* and *Alisma plantago-aquatica* could be considered as differential ones.

Hydroecology. The total covering quota of the relict species of the littoral zone contributed to the percentage value of hydato-helophyta. The species belonging to the three subgroups (hhe1, 2, 3) of the category taken together reached 30%. The representatives belonging to the transitory subgroup (he3) of the marsh zone had a remarkably high quota-value. However, none of the species components of its cenoses could be found in the drying marsh zone. Its cenoses were extremely poor in number of species.

Soil ecology. In order to detect the changes ocurring in the soil composition and moisture content during the vegetation period, soil segment has been probed in the autumn aspect. In the analysis of changes in moisture content, in the first place data expressed as volume weights provided reliable estimations. According to the data the vegetation cover utilized the moisture content of the soil up to depth of 30 cm. The binding relations, organic mater and salt content were similar to those observed for the previous association.

Sp.-G. f. agrostetosum stoloniferae

Cenological relations. The number of species components representing Phragmitetea decreased. Elements belonging to Molinietea and Agropyro-Rumicion came into prominence. The habitat relations manifested in the first place in a higher-

lying relief as compared to the previous variant were suitable for the propagation of *Agrostis stolonifera* and appearance of *Lythrum virgatum, Mentha arvensis* and even *Stellaria graminea* in the cenoses.

Hydroecology. It was characterized by the decrease in covering quota of the species components of both littoral and marsh zones and by increase of the values for drying marsh zone (he1, 3). At the same time single representatives of hgm and even m categories could be found.

Eleocharito acicularis — Schoenoplectetum supini Soó et Ubr. 48

It developed on the devastated patches of the filled up dead-arms of Bodrogzug, forming a wider or narrower mud vegetation zone. It had a wide range of possible occurrence from river-beds drying out in summer up to drying out marsh zone. Some of the representatives of its phytocenoses were relict species belonging to cenoses existing before the devastation, e.g. Phragmition—Phragmitetea elements. In the vegetation of diversified composition several subassociation units could be distinguished. Three of them are analysed in details:

E. a.-Sch. s. myriophylletosum spicati

Cenological relations. This mud vegetation variant penetrated in the deepest parts of the dead-arms river-beds, where Lemno-Potamea, Phragmitetea and Nanocyperion elements formed mosaic complexes. The differential species *Myriophyllum spicatum* (20%) and *Eleocharis acicularis* (30%) had a dominant role.

Hydroecology. Although it reached the highest covering quota in the transitory drying marsh zones (hhe1), the total covering quota of hydatophyta (hd1, 3) was significant as well (30%). Among the latter *Myriophyllum spicatum* f. *terrestris* and *Trapa natans* f. *terrestris* were present. *Oenanthe aquatica* and *Alisma plantago-aquatica* were found among hydato-helophyta; helophyta were represented by *Lymosella aquatica, Galium palustre.* Among the representatives of mud vegetation the leading role belonged to *Eleocharis acicularis* from the hhg1 subgroup (Fig. 5).

E. a.-Sch. s. eleocharietosum acicularis (= typicum)

Cenological relations. In comparison to the mud vegetation variant described above this variant is found in the devastated areas of the zone proximal to dead-arms banks and showed a significant species composition diversity. The differential species were: *Veronica beccabunga, Gnaphalium uliginosum.* The covering quota of its characteristic species increased and Lemno-Potamea and Nymphaeion elements were missing.

Hydroecology. Here the transitory helo-hygrophyta (hhg1) reached the highest total covering quota in the typical cenoses but there was a significant presence of helophyta (he1) as well.

E. a.-Sch. s. agrostetosum stoloniferae

Cenological relations. The initiation of succession towards marsh meadows is observed in the bank-side stretch of the mud vegetation zone and on the devastated patches of flat marsh meadows. The environmental hydrological conditions prevailing here are already favourable for the appearance of some Molinio—Juncete elements as well.

Its differential species are *Agrostis stolonifera, Juncus compressus* and *Gratiola officinalis.*

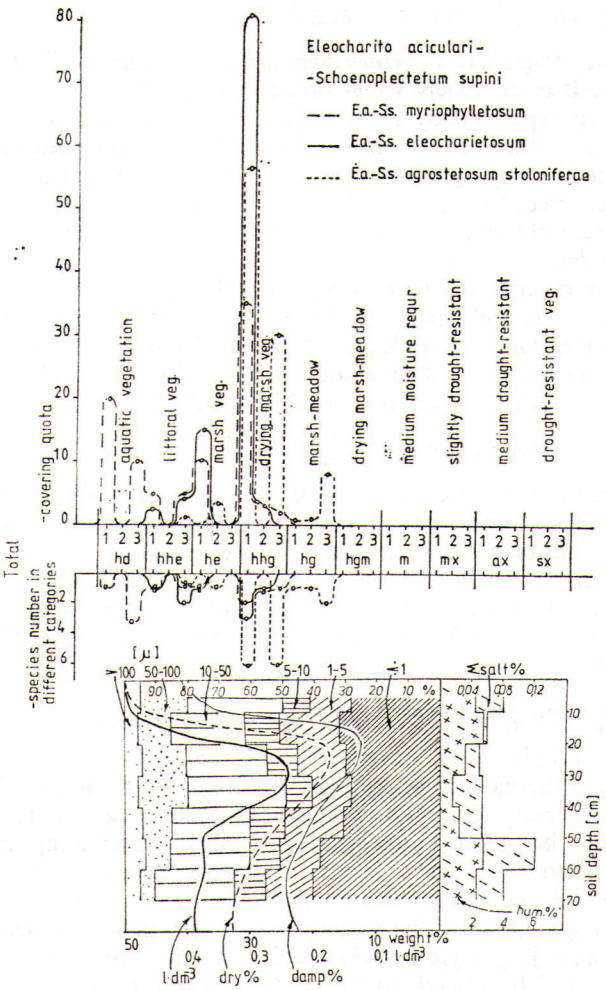

Fig. 5. Hydroecology of subassociation units of *Eleocharito-Schoenoplectetum*. Soil segment of *Myriophyllum* subassociation in spring

Hydroecology. As a consequence of reduced water supply the covering quota of its species components in respect of both species number and covering quota was distributed within hydato-helophyton category (hhg1 and hhg3), mainly through propagation of *Agrostis stolonifera, Veronica beccabunga, Rorippa armoracioides*. Within the hygrophyton category (hg1, 2, 3) propagation of *Polygonum hydropiper, P. mite* and *Ranunculus repens*.

Polygono-Bolboschoenetum maritimi BODRK. 62

It appeared partly in the dead-arm and partly in the flat marsh zones, when the content of harmful salts in the soil *A*-level exceeded 0,1%. Both from soil ecological and hydroecological point of view nearly identical results were obtained in the regions of Bodrogzug and Alpár. The detailed analysis of this association and its smaller units is presented by BODROGKÖZY (1962).

Caricetum gracilis (GRÄBER et HUECK 31) Tx. 37

Some authors assign it to the *Caricetum acuto-vesicariae* W. KOCH 26 cenosystematical category. It is extremely wide-spread in damp habitats of the Tisza flood-plain. This can be explained by the fact that in the flood-plain conditions it can tolerate better than other sedge cenoses the mud and mud-meadow soils poor in nutrients. Since in Bodrogzug, and in the first place in its upper areas drying out of sedge habitats occurred, they were replaced by *Caricetum acutiformis* cenoses. Thus, several variants resambling reeds could be distinguished. Other sedge cenoses could be traced up to *Glycerietum* zone.

Although a number of species components belonging to Phragmitetea was found in its cenoses, here as well many Molinio—Juncetea elements occurred, such as *Eleocharis palustris, Lathyrus palustris, Leucanthemum serotinum.* In the analysis of their distribution a number of subassociations and variants could be distinguished. In what follows three of them are discussed in details:

C. gr. glycerietosum maximae

Cenological relations. Its cenoses were in contact with *Glycerietum maximae.* Phragmitetea elements such as *Iris pseudacorus, Stachys palustris, Glyceria maxima* dominated and could be considered as differential species.

Hydroecology. Beside helophyta (hel) a significant quota of littoral zone representatives (hhe3) was observed. The quota of some drying marsh components (hhgl) such as *Lathyrus palustris, Lythrum salicaria* due to their broad tolerance range exceeded 10%.

C. gr. caricetosum gracilis (= typicum)

Cenological relations. In the region studied it formed extended stands, in the first place in the vicinity of Nagynádas-tó. If compared with the composition of the variant described above, the presence of species components indicating more arid conditions can be noted. Thus, beside Molinio—Juncetea, appear Molinietalia, Molinio-Arrhenatheretea species, such as *Mentha arvensis, Trifolium hybridum, Symphytum officinale* ssp. *uliginosum.*

Hydroecology. Among the variants described, here the species components reached the highest helophyton (hel) total covering quota, but within different categories they could be traced up to hygro-mesophyta. *Polygonum amphibium* f. *terrestris* appeared as a hgml component (Fig. 6).

C. g. agrostetosum stoloniferae

Among the variants distinguished within the association, it occupied the highest-lying relief, thus the water supply is decreased. Although the species components of the above two variants having a broad range of tolerance were present in these cenoses as well, new components were present, too, and could be considered as differential species. These were partly Molinio—Arrhenatherea representatives, such as *Trifolium hybridum,* and partly Plantaginetea elements like *Inula britannica.* The latter together with *Cirsium arvense,* belonging to Chenopodio-Scleranthea, indicated the beginning of weed overgrowth.

Hydroecology. From the constructed chart it can be seen that the total covering quota of the marsh species components further decreased and was only 40%. At the same time increased the expansion of helohygrophyta (hhgl, 3) and they could be traced on the chart up to mesophyta.

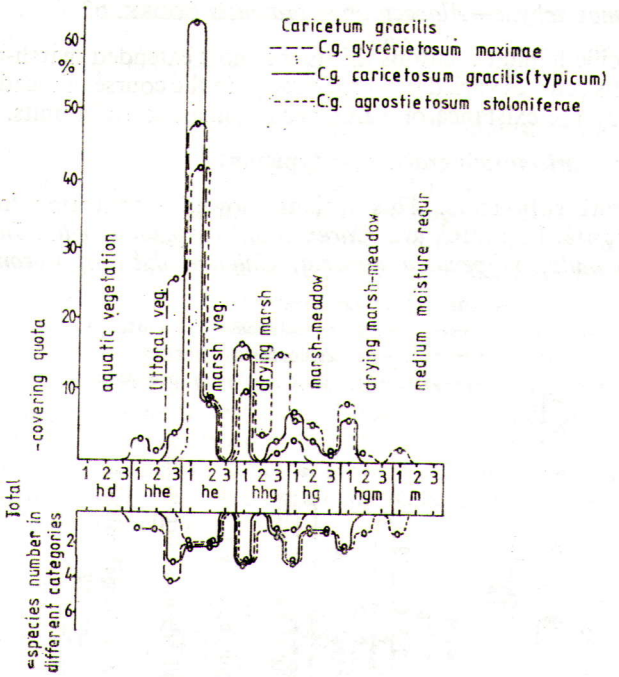

Fig. 6. Hydroecology of *Caricetum gracilis* subassociation; typicum soil segment in spring aspect.

As far as the number of species in different categories of the association is concerned, it was found that in this zone as well the number of species is extremely low. This can be explained in the first place by the fact that few species are able to tolerate the harmful effect of repeated floods.

In the Bodrogzug flood-plains dominated vast marsh-meadows. In their species composition prevailed components highly tolerant to the environmental stress effect of frequent floods. This negative effect, i.e. longer or shorter periods of inundation by stagnant water, has been compensated at places by favourable soil ecological conditions. Namely, before the construction of protective dams, in some areas of the flood-plain marshes dominated. Thus, marsh-meadows having vegetation richer than expected or than that found in other locations of the Tisza flood-plain were preserved there till to-day.

From cenosystematical point of view marsh-meadows of similar character have been introduced in the literature under the name *Alopecuretum pratensis* (REGEL 25) STETTEN 31 association (BALÁTOVÁ—TULÁCKOVÁ 1974, JEANPLONG 1960). However, in the Tisza flood-plain and adjoining tide lands *Alopecuretum pratensis hungaricum* (Soó 1952) due to differences observed both in species composition, as well as in habitat and hydroecological characteristics could be devided in several associations and subunits (BODROGKÖZY 1962). These cenoses could be clearly distinguished in the Bodrogzug region, too:

Carici melanostachyae—Alopecuretum pratensis BODRK. 62

Due to specific habitat relations this is the most extended marsh-meadow in the region studied. Its cenoses varied in a broad range in the course of meadow formation. This is proven by the existance of a number of subassociation units.

C. m.—A. p. caricetosum gracilis (= typicum)

Cenological relations. This variant showed a transition from ***Caricetum gracilis***. Differential species are: *Carex gracilis* ssp. *intermedia, Stachys palustris, Ranunculus flammula, Filipendula ulmaria, Cnidium dubium, Veronica scutellata.*

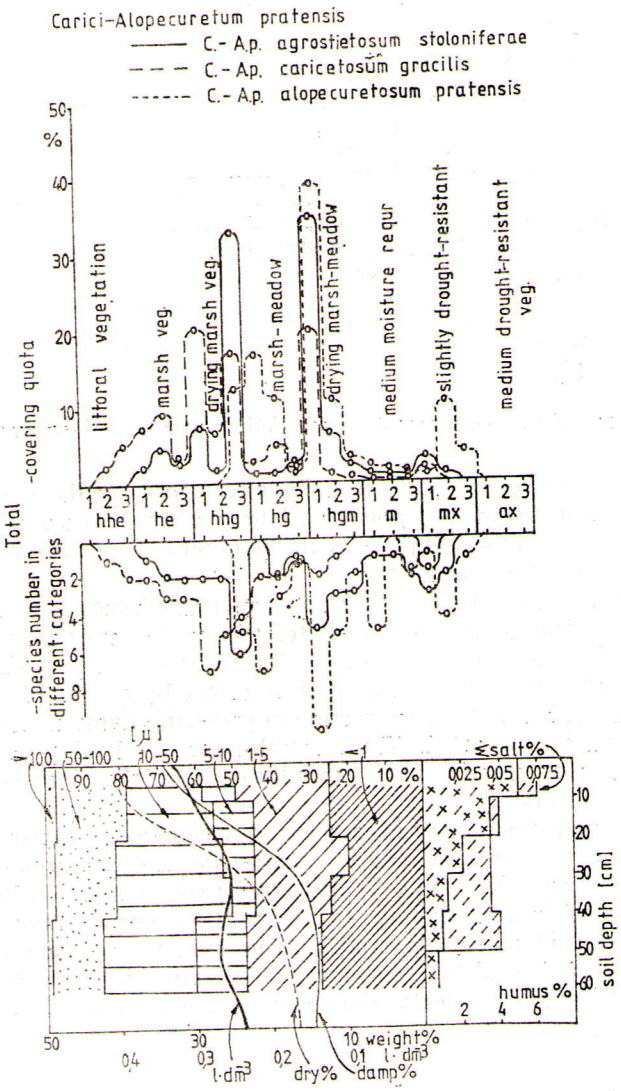

Fig. 7. Hydroecology of *Carici-Alopecuretum* subassociation; soil segment of ***Veronica scutellata*** facies in autumn

Beside Caricion gracilis elements, representatives of Phragmiteta, Molinio—Juncetea were present. The occasional occurrence of *Gentiana pneumonanthe, Serratula tinctoria, Cnidium dubium* among the species components was an indication of marsh origin.

Hydroecology. Three categories could be distinguished in this sedge-marsh-meadow: the dominant role was divided among the subgroups of the helo-hygrophyton category. The components belonging to hhg1 played the leading role. The total species number was as well the highest in this group. For further details see Fig. 7.

Soil ecology. In order to elucidate the soil relations within the variant, segments of the most important facies were probed. For the lowest-lying reliefs in case of *Eleocharis palustris—Iris pseudacorus* facies in spring aspect due to increased evaporation soil moisture expressed as volume weight decreased significantly, the content of organic matter was high and that of salts—negligible. In case of *Serratula* facies organic mater content reached 6%, which is an indication of marsh origin. For *Gentiana pneumonanthe* facies (along Füzes-tó) the moisture content decreased as compared to the facies described above, the soil was hummus, however, the salt content exceeded 0,1%. The salt content, however, did not evoke the appearance of halophyton elements in the cenoses. The occurrence of *Salix cinerea* was an indication of marsh origin as well (Fig. 8.9).

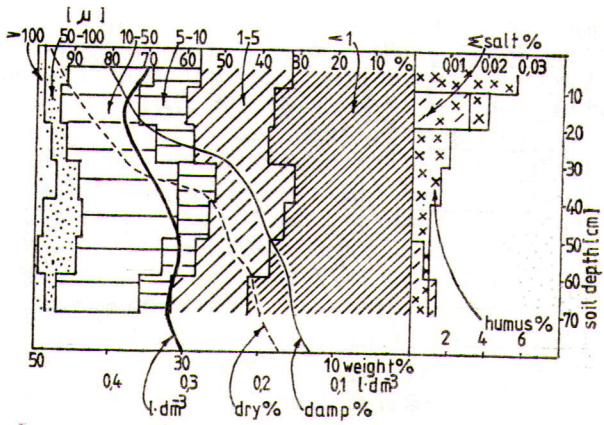

Fig. 8. *Serratula* facies in spring

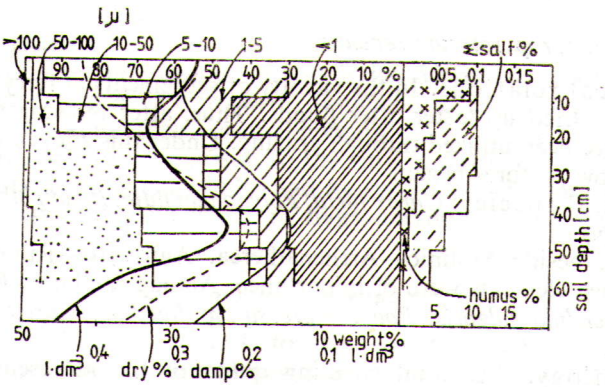

Fig. 9. *Gentiana pneumonanthe* facies in autumn aspect

C. m.—A. p. agrostetosum stoloniferae

Cenological relations. Its cenoses are often hardly distinguishable from those of the variant described above. However, in most cases the species components composition is a good basis for distintion. Its cenoses developed mostly on the highest-lying reliefs. The Phragmitetea representatives dropped out. Differential species are: *Scutellaria galericulata, Thalictrum lucidum, Ranunculus auricomus,* ssp. *binatus.* In general presence of Molinio—Arrhenatherea, Molinietalia, Calistegion elements was typical.

Hydroecology. On the constructed chart two maxima were observed: one at the transitory variant hhg3 within helohygrophyton category, the other — at the variant hgm1 of drying marsh-meadows.

Soil ecology. The results of the soil segment tests showed that the oxydation of the originally marsh soil was higher than in the previous variant and reached 3—4%. The salt content is still not significant. As far as the physical characteristics are concerned, it is less hard, which might be favourable from the point of view of eventual effect of dead-water content. The moisture content of the typical variant decreased significantly (Fig. 10).

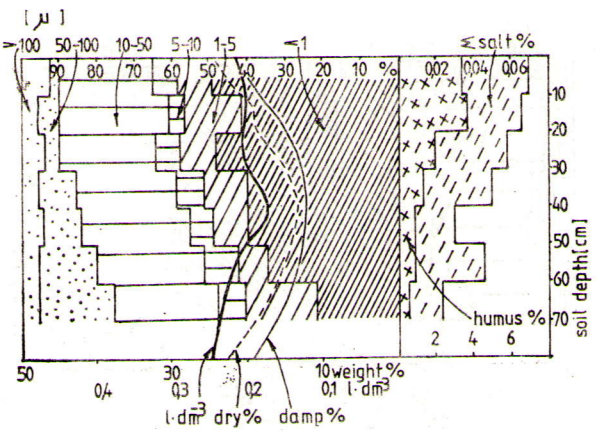

Fig. 10. Soil segment of *Agrostis stolonifera* subassociation

C. m.—A. p. agropyretosum repentis

Cenological relations. In the vicinity of settlements at ferry crossing points marsh-meadows dried up faster after floods. Thus, after mowing the stands their second yield have been utilized through grazing. Under this zoogen effect formation of marsh-meadow pastures began.

Differential species: *Carex hirta, Polygonum mite, P. amphibium* f. *terrestris, Agropyron repens.*

In general, beside Molinio—Arrhenatherea, Agropyro—Rumicion and even Festuco—Bromea elements were of importance. Among the latter *Ranunculus polyanthemos, Filipendula vulgaris, Poa compressa* ssp. *langiana, Carex praecox* should be emphasized.

Hydroecology. The total covering quota of the representatives of helohygrophyton and hygrophyton categories was of subordinate importance as compared

to that of hygro-mesophyta. The total species number was as well the highest in hgm1 subgroup. The distribution of species components could be traced up to meso-xerophyta.

Lythro vitgatae—Alopecuretum pratensis BODRK. 62

In Bodrogzug region it is found less frequently than in the southern Tisza flood-plain. This is due in the first place to the effect of damming at the Tiszalök hydro-electric power station. The flood-plain mixed flowery marsh-meadows changed into *Carici-Alopecuretum.* Some of its cenoses were driven back to the protective dams along the Tisza and Bodrog.

Characteristic species: *Thalictrum flavum, Lythrum virgatum, Lychnis flos -cuculi, Galium rubioides, Senecio erraticus* ssp. *barbereifolius.* Subassociation units:

L. v.—A. p. alopecuretosum pratensis (= typicum)

Cenological relations. It showed a transition towards the association described above. Beside Molinio—Juncetea and Molinietalia elements, the dominance of Alopecurion was significant, too.

Differential species: *Lathyrus palustris, Gratiola officinalis, Leucanthemum serotinum, Veronica serpyllifolia.*

Hydroecology. At places, where its cenoses came close to the littoral zone of dead-arms, beside the significant total covering quota of helo-hygrophyta and hygrophyta (hhg3, hg2), here as well a high quota of species components characteristic for drying out marsh-meadows (hgm1) was observed. They can be followed up to meso-xerophyton category on the constructed chart. Some of them still could not, while others already could tolerate the habitat moisture conditions.

Soil ecology. Soil segments probed in two early autumn aspects were analysed. In the root zone of damp habitats of *Cnidium dubium* facies soil moisture of 2,5 l/dm^3 was detected. In the course of oxydation process taking place in the original marsh soil at present 5% organic matter content was measured. The content of harmful sodium salts due to their upward flux reached 0,10% (Fig. 11; 12).

L. v.-A. p. agropyretosum repentis

Cenological relations. This variant showing signs of weed overgrowth was found as well in the vicinity of settlements at river crossing points. It was under the continuous joint effect of more arid habitat and increased zoogen effect due to grazing Differential species: *Agropyron repens Rorippa sylvestris, Calamagrostis epigeios, Carex praecox.*

In comparison to the previous variant beside Alopecurion, Molinio—Arrhenatherea, the representatives of Agropyro—Rumicion, Chenopodio—Scleranthea and Festuco—Brometea found their essential conditions.

Hydroecology. In comparison to the variant described above, it was found that the decrease in the quota of hhg and hg species components was of the same extent as the increase in the quota of hygro-mesophyta, mesophyta and meso-xerophyta.

Poo angustifoliae—Alopecuretum pratensis BODRK. 62

It occurs at Bodrogzug, similarly to other marsh-meadows along the Tisza, at comparatively higher-lying reliefs. Uneven relief provided different life conditions, due to which within the association a number of variants could be distinguished.

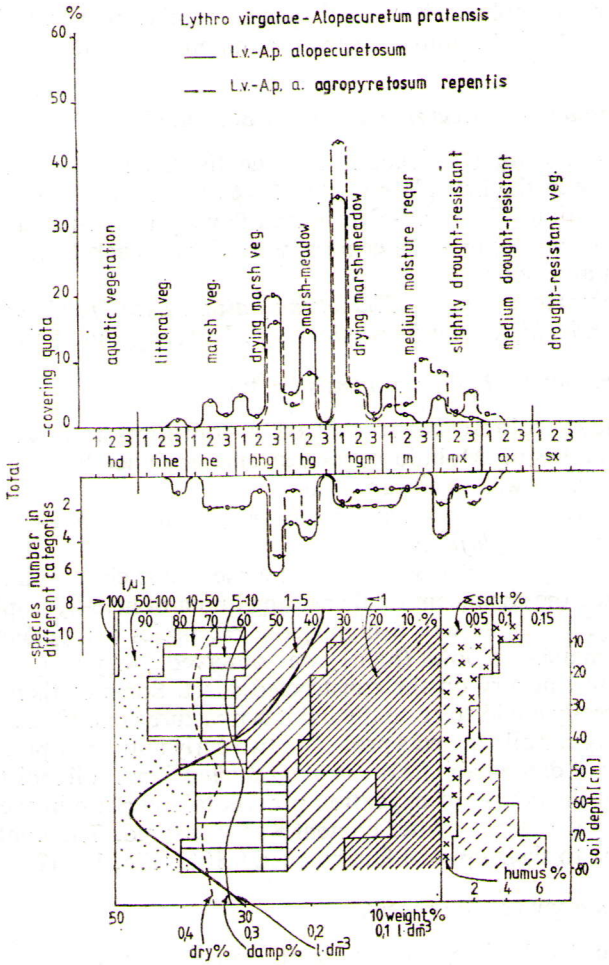

Fig. 11. Hydroecology of *Lythro virgatae—Alopecuretum*; typicum soil segment in autumn

Characteristic species: *Poa trivialis, Poa angustifolia, Stenactis annua, Rorippa austriaca.* Subassociation units:

P. a.—A. p. trifolietosum repentis

Cenological relations. Present were representatives of Molinio-Juncetea, such as *Lathyrus pratensis, L. palusrtis, Tanacetum serotinum.* Molonietalia elements were frequent as well, such as *Filipendula ulmaria, Valeriana officinalis,* which is an indication of marsh origin. *Thalictrum lucidum.* The facies forming *Ranunculus repens* belonging to Molinio—Arrhenaterea, *Agrostis stolonifera, Vicia cracca.*

Hydroecology. In comparison to the previous variant here hygrophyta propagation occurred at the expence of hhg species, this is valid for the total species number as well. Nearly equal total covering quota was reached by the drying out marsh-meadow components (hgm1), at reduced species number.

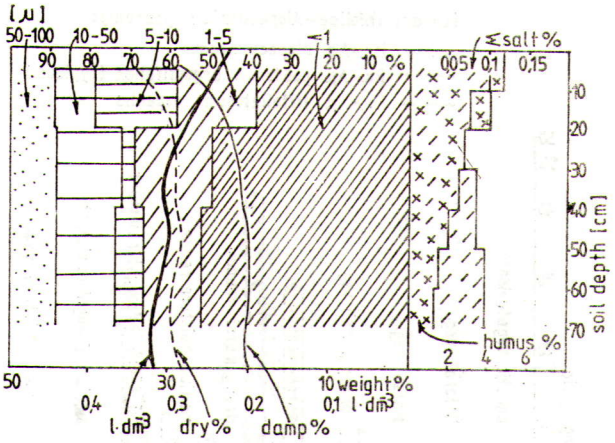

Fig. 12. Soil segment of typicum *Cnidium dubium* facies

P. a.—A. p. alopecuretosum pratensis

Cenological relations. Its cenoses were found at flood-plain locations characterized by lower moisture content, where beside *Alopecurus pratensis, Festuca rubra, Mentha arvensis, Aristolochia clematitis, Galium rubioides* were found. The extension of this marsh-meadow variant nowadays is significantly reduced, since due to increased grazing it underwent transition into different association.

Hydroecology. As compared to the variant described above in this subassociation hhg representatives entirely and overwhelming majority of hygrophyta were forced out, while the quota of hygromesophyta (hgm1) exceeded 40%, and that of the m1, 3 and mx2 representatives were above 5% (Fig. 13).

P. a.—A. p. poëtosum angustifoliae (= typicum)

Cenological relations. This association, similarly to other locations along the Tisza, is found in the highest-lying reliefs of the marsh-meadows. Since here drying occurs in shorter time after floods, in its cenoses Chenopodio-Scleranthea, Festuco—Bromea, even Festucion pseudovinae species propagation occurred. Among them the leading role is played beside *Alopecurus pratensis,* characterized by broad adaptation ability, by *Poa angustifolia* as well.

Hydroecology. In the species composition the decrease of marsh-meadow species was of the same extent as the increase in the mesophyta (m2, 3) and even more in meso-xerophyta (mx1, 2) total covering quota. The quota of dominant representatives of the drying out marsh-meadows hardly changed in comparison to the previous typical variant. In its cenoses, however, were found species characterized by such a tolerance in respect of moisture content and competitiveness that they can be considered drought-resistant (ax1, 3), e.g. *Festuca pseudovina* and *Carex praecox.*

Associations developing as a consequence of intensive grazing in the studied region:

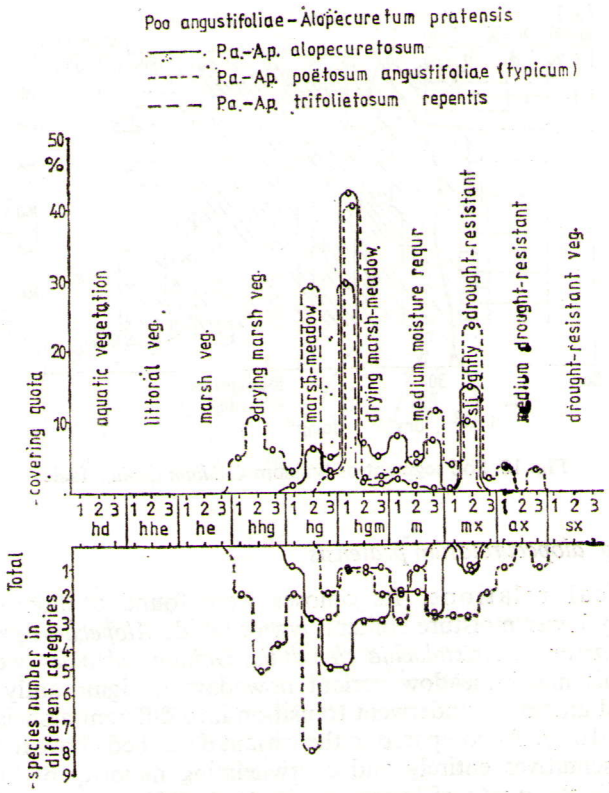

Fig. 13. Hydroecology of *Poo-Alopecuretum*

Lolio-Potentilletum anserinae KNAPP 48

In the Bodrogzug flood-plain in the vicinity of settlements marsh-meadow pastures have been marked for grazing. Under the intensive zoogen effect secondary cenoses developed depending on the relief relations. This association developed in places of higher moisture content. Two variants were analysed:

L.—P. a. potentillettosum anserinae (= typicum)

Cenological relations. Drying out marsh-meadow species dominated, such as treading tolerant *Potentilla anserina., Agrostis stolonifera, Potentilla reptans, Poa annua.* The species components belonged mainly to Agropyro-Rumicion, Plantaginetea, which were Molinio—Arrhenatherea elements.

Hydroecology. The highest covering quota was reached by helo-hygrophyta (hg2, 3). Beside the above mentioned species *Rorippa sylvestris, Potentilla supina* belonging to hg, hgm and m categories showed nearly equal quota (Fig. 14).

Lolio-Alopecuretum pratensis BODRK. 62

Lolio pastures have been studied in details by FOESTER (1968), the author determined their cenosystematical position and poor species composition.

In the territory studied, the highest-lying areas, emerging first after floods, were

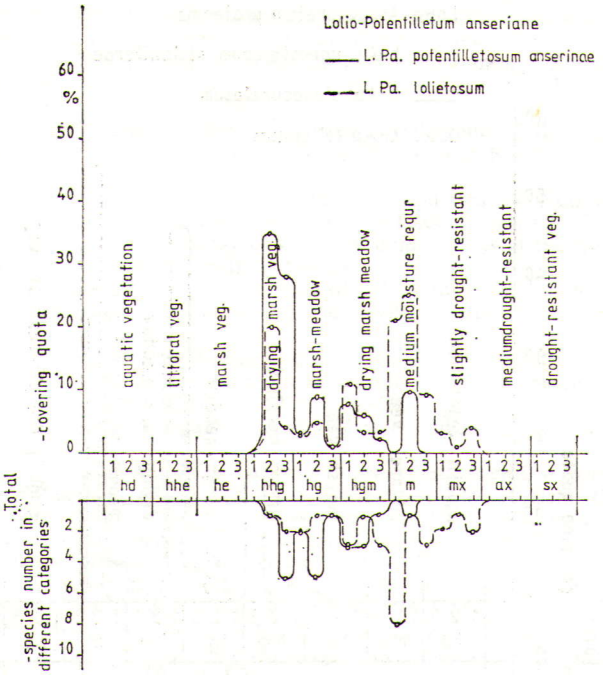

Fig. 14. Hydroecological relations of subassociation units of *Lolio-Potentilletum anserinae*

chosen as pastures. Under the influence of this harmful environmental effect, the species composition of the original marsh-meadow cenoses changed significantly. The sensitive components were replaced by more agressive ones. Depending on habitat moisture relations secondary associations developed from different original associations. Their composition is similar to that of marsh pastures in other locations of the Tisza flood-plain (BODROGKÖZY 1985).

L.—A. p. agrostetosum stoloniferae

Cenological relations. It developed in the first place from *Poo angustifoliae-Alopecuretum* under the increased zoogen effect. Its differential species are: *Euphorbia lucida, Carex vulpina, Agrostis stolonifera.* Among species components a number of Molino—Juncetea, Agropyro—Rumicion elements could be found.

Hydroecology. The total covering quota showed a steady increase from helo-hygrophyta towards hygrophyta up to mesophyta. Among helophyta *Euphorbia lucida,* in hygrophyton category *Ranunculus repens, Poa trivialis, Potentilla reptans,* and among mesophyta *Lolium perenne* presence should be emphasized.

L.—A. p. alopecuretosum pratensis

Cenological relations. Molinio—Arrhennatherea, Agropyro rumicion became dominant, Molinio—Juncetea elements dropped out. Differential species: *Rorippa austriaca, Mentha arvensis Althaea officinalis.*

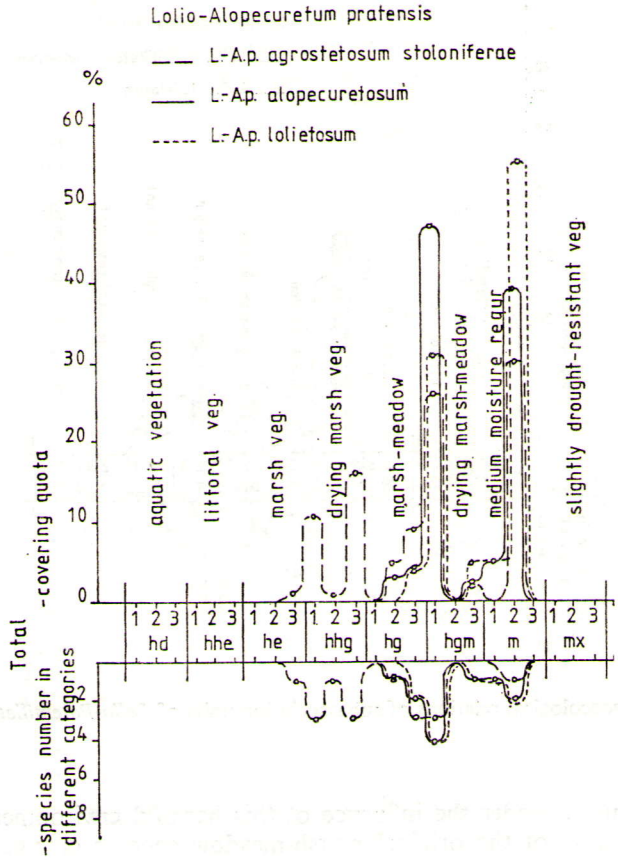

Fig. 15. *Lolio-Alopecuretum pratensis*

Hydroecology. Helo-hydrophyta dropped out, the highest covering quota was reached by hygro-mesophyta, the quota of species components belonging to mesophyton transitory subgroup increased (Fig. 15).

L.—A. p. lolietosum

Both in cenological relations and hydroecology it closely resembles the units described in other locations of the Tisza flood-plain or other more distant areas (MARKOVIĆ 1978, KÁRPÁTI et *al.* 1963, BODROGKÖZY 1985).

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Bodrogzug vízparti- mocsár és réttársulásai, hidroökológiai viszonyaik

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Kivonat

A magyarországi Felső-Tisza szakasz hullámterében a Bodrog és a Tisza összefolyásánál, Tokaj térségében kialakult Bodrogzug növénytakarójának összetétele jórészt eltér a Tiszahullámtér más vidékeinek állományaitól. Ez elsősorban a montán hatás, illetve az eltérő talaj- és hidroökológiai viszonyok következménye. A napjainkban már természetvédelmi területté nyilvánított hullámtér déli szakasza vízvisszaduzzasztás környezeti sztresszhatása alá került. Hatására a *Scirpo—Phragmitetum* más cönozisok rovására nagykiterjedésű területeket vett birtokba. A középső és alsó szakaszokon viszont a mineralogén és biogén feltöltődés következtében a holtágak medrét a hydatophyton állományok rovására *Sparganio—Sagittarietum, Rorippo—Oenanthetum,* másutt *Glycerietum maximae* foglalta el. Ugyancsak elterjedtek a *Caricetum gracilis* asszociáció alatti egységei.

A degradált nedves termőhelyeken az *Eleocharito—Schoenoplectetum supini* iszapnövényzete volt fellelhető.

Bodrogzug középső és felső szakaszán viszont végeláthatatlan mocsárrétek alakultak ki. A nedvesebb helyeken a *Carici melanostachyae—Alopecuretum pratensis,* magasabb térszínen a *Lythro virgatae—Alopecuretum* alárendeltebb szerepű mint a Tisza hullámtér más vidékein. A szárazabb szakaszokon a *Poo angustifoliae—Alopecuretum* állományait sokhelyen felszántották. — Intenzíven legeltetett helyeken nedvesebb körülmények között *Lolio—Potentilletum anserinae,* másutt *Lolio—Alopecuretum pratensis* legelők alakultak ki.

ГИДРО-ЭКОЛОГИЧЕСКИЕ ЗАВИСИМОСТИ ПРИБРЕЖНЫХ, ВОЛОТНЫХ И ЛУГОВЫХ СООВЩЕСТВ В ОБЛАСТИ БОДРОГЗУГ

Д. Бодрогкези

В поймах Верхней Тисы в районе Токая растительность области Бодрогзуг, образовавшейся при слиянии рек Бодрог и Тиса, отличается от сообществ пойм Тисы других областей. Это объясняется прежде всего холмистым характером данной области и является следствием различных почвенных и гидро-экологических условий. В настоящее время южный отрезок ноймы, объявленный заповедной областью, находится под стрессовым воздействием запружывания. Вследствие этого наблюдается значительное распространение *Scirpo-Phragmitetum* за счет других сообществ. В средней и верхней части области вследствие минералогенного и биогенного заполнения в руслах мертвых рукавов *Sparganio-Sagittarietum, Rorippo-Cenanthetum* в некоторых местах *Glycerietum maximae* вытеснили сообщества гидрофитонов. Также распространились элементы субассоциации *Caricetum gracilis.*

В низких, влажных местах произрастала ильная растительность *Eleocharito-Schoenoplectetum supini.*

В средней и верхней части Бодрогзуг образовались обширные болотные луга. Во влажных низких местах *Carici melanostachyae-Alopecuretum pratensis,* на более высоких участках *Lythro virgatae-Alopecuretum* играли второстепенную роль в сравнении с поймами других отрезков Тисы. Во многих местах на сухих участках сообщества *Poo angustifoliae-Alopecuretum* были перепаханы. В местах интензивного выгула в участках с повышенной влажностью образовались пастбища *Lolio-Potentilletum anserinae,* в других местах — *Lolio-Alopecuretum pratensis.*

Obalne i močvarne zajednice livade i hidroekološke osobine teritorije Bodrogzug

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Rezime

U gornjem otseku Tise nalazi se poplavno zemljište u ušću reke Bodrog (pored Tokaja), to je teritorija Bodrogzug, vegetacioni pokrov dosta razlikuje od biljnog pokrova ostalog poplavnog zemljišta. Ova činjenica objašnjava se prvotno sa gorskim (montan) uticajem, odnosno sa diferencijama hidroekoloških okolnosti i sa različitostima tla. Ova teritorija je prirodno zaštitna teritorija, južni otsek je ispod stresom smanjene vode. Zbog toga zajednica *Scirpo—Phragmitetum* je postao dominirajuća na račun druge zajednice. Srednji i donji otsek nasipava s mineralogenskim i biogenskim materijama, koren mrtvaje na teret hidatofiton vegetacije zauzimali su *Sparganio—Sagittarietum, Rorippo—Oenanthetum, Glycerietum maximae.* Jako su prošireni podasocijacije zajednice *Caricetum gracilis.*

Na degradiranim vlažnim mestima nađena je zajednica mulja *Eleocharito—Schoenoplectetum supini.* Na srednjem i gornjem otseku Bodrogzug dominirajuća je močvarna livada. Na vlažnijim mestima zeleni se zajednica *Carici melanostachyae—Alopecuretum pratensis,* a na višim terenima zajednica *Lythro virgatae—Alopecuretum.* Na suvim mestima zajednice *Poo angustifoliae—Alopecuretum* su nestali, napravili su oranicu od njih. Na pašnjacima među vlažnijim okolnostima rastu zajednice *Lolio—Potentilletum anserinae,* drugđe *Lolio—Alopecuretum pratensis.*