ACTA BIOL. SZEGED. 36. PP. 27–42 (1990)

THE VEGETATION MAP OF THE SZAPPAN-SZÉK UNESCO BIOSPHERE RESERVE CORE AREA, KISKUNSÁG NATIONAL PARK HUNGARY

I. BAGI

Department of Botany, József Attila University H-6701 Szeged, P.O.B. 657, Hungary

(Received: January 19, 1990)

Abstract

The paper presents the vegetation map, on a scale of 1:4500, of the Szappan-szék UNESCO biosphere reserve core area and a short description of the mentioned vegetation units.

The dominant association in the exceedingly alkaline water of the Szappan-szék lake is *Parvipotameto-Zannichellietum*. The following associations form zones after the drying out of the lake (towards the deeper parts): *Agrostio-Caricetum distantis, Lepidio-Puccinellietum limosae* and *Suaedetum maritimae hungaricum*. The dominant associations of the surrounding sandy territories are *Brometum tectorum* and *Festucetum vaginatae*. The *Diplotaxi-Agropyretum* and *Tribulo-Tragetum* associations can be found in the old-fields and the abandoned vineyards, respectively. A scheme of the possible transformation processes of these weed communities into the natural ones is also presented.

The most important environmental problems of the core area can be traced back to the regional decrease of the water-table.

Key words: aerial photograph, biosphere reserve, halophilic vegetation, saline lakes, vegetation mapping, vegetation of sand dunes

Introduction

The Szappan-szék UNESCO biosphere reserve core area is situated in territory IV of the Kiskunság National Park (Fig. 1). It borders on the Szívós-szék core area, the vegetation map of which has been presented (BAGI, 1988). The area of Szappan-szék is about 25 hectares (cf. TÓTH, 1985).

Szappan-szék is one of the saline lakes which has emerged in a dip between the sandy dunes, that consist of sand of Danubian origin. It covers a long stretch with an orientation in a NW -SE direction due to the most frequent NW directional wind. The lake emerged at the end of the Pleistocene period. It has been proven that the water-impermeable carbonate mud layer was sedimented directly onto the loess of the Würm$_3$ glacial (MOLNÁR and MURVAI, 1976). On the strength of this finding, the lake can be regarded as the oldest one in the Kiskunság National Park since the surrounding lakes undoubtedly emerged in the Holocene period (cf. MIHÁLTZ and FARAGÓ, 1946; ZÓLYOMI, 1953; MUCSI, 1963; JÁRAI-KOMLÓDI, 1966; 1969). The difference in the location of the buried carbonate mud and the present situation of the lake bed shows that the extension and location of Szappan-szék had changed a lot since the time of its emergence.The area of the lake, in all probability, decreased since a carbonate mud layer has also been deposited under the bordering sand dunes.

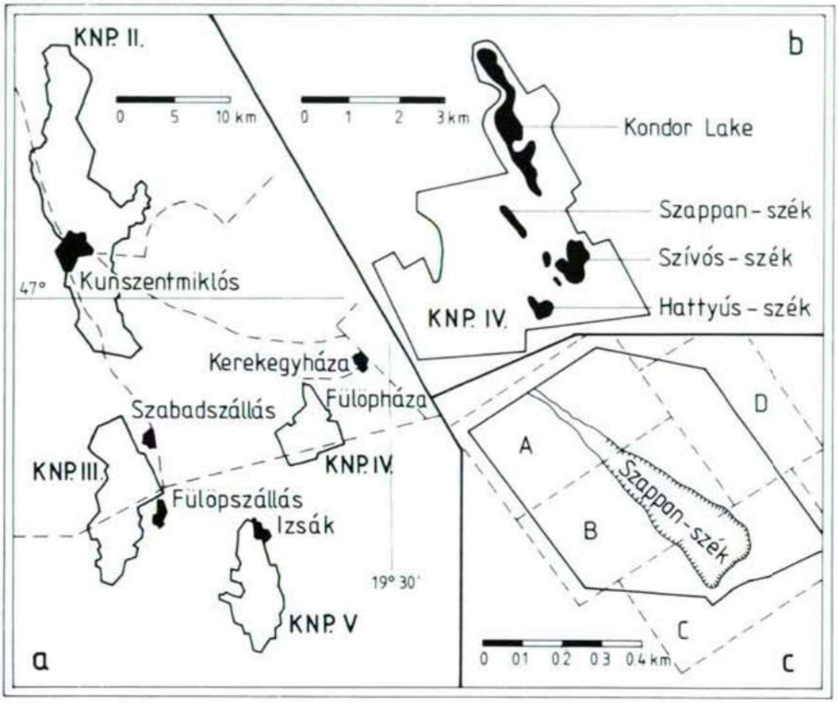


Fig. 1. Geographical location of territory IV of the Kiskunság National Park (a) and the Szappan-szék biosphere reserve core area (b). The figure 'c' shows connection of four map sheets (A,B,C,D).

Szappan-szék belonged to the lakes with the most permanent water level; it very rarely dried out entirely in the past (e.g. in the '40s), but the decrease of the water level of Szappan-szék was especially in recent years, and, furthermore, it dried out in years 1987-1989. According to opinion of many scientists, the permanent lack of water is traced back to the undesirable effects of water management; The water management works implied a drastic interference in the life of lakes: It led to a regional decrease in the water-table, which is the water source of these lakes (ANDÓ, 1964). The direction and intensity of salt and water transport were considerably modified by the diking. Due to canalization, the water impervious carbonate mud layer has been damaged, therefore, a large amount of water may infiltrate to the lower sand layers (MOLNÁR, 1985). Apart from the decrease of the average water level, the salt loss of the lakes can also be detected. The water of the Szappan-szék lake shows the most alkaline pH reaction in the Kiskunság National Park. (Its Hungarian name refers to this, the word Szappan is soap in English.) The pH value of the water may be 11 by the end of summer.

The fast hydro- and haloecological changes caused a radical transformation in the vegetation of the lake. Such drastic vegetation change has to be taken into consideration in the sandy territories that surround the Szappan-szék core area: a significant part of these territories was plough land, the cultivation of which was ceased for an environmental protection reason. Therefore, an important task is also to pay attention to the regeneration processes of the natural vegetation of the sand dunes. Apart from this, vegetation transformation processes are induced by the decreasing water-table (SZODTFRIDT and FARAGÓ, 1968; SZUJKÓ-LACZA, 1986). Hence, it is important to elaborate and documentate the present state of the vegetation of the biosphere reserve core area and its surroundings. The first step is the preparation of a vegetation map.

Materials and Methods

The vegetation map has been prepared on the basis of a colour aerial photograph, the magnification of which was to a scale of 1:5000. The mapping of the relatively narrow zones of vegetation in the lake required a magnification of the aerial photograph to a scale of 1:4500, hence, the scale of the published map is also 1: 4500. The map shows the core area with its surroundings. The map is issued in the form of sheets joining without overlap. The four map sheets and their key are formally published as an appendix to this paper (BAGI, 1987; 1988).

The description of vegetation units follows the system and methodology of the Zürich-Montpellier Phytosociology School, despite the fact that the categorization of several transitional vegetation units (which have been developed due to the intensive vegetational transformation processes) encountered difficulties. The denomination of the species and syntaxa are according to the work of SOÓ (1980).

The map was elaborated in 1987.

Results

The associations of the mapped territory can be classified into two quite different groups. The vegetation units of the first group have evolved on soil deposited onto the terrestrial sediment of the former bed of the lake. Due to the water-impermeability of carbonate mud, these associations have high water demands Depending on the salt content of the surface layers, the spectrum of the soils covers the soil-types from solonchaks to solonetzic meadow soils (VÁRALLYAY et al., 1985). Dryness tolerant associations belong to the other group. These vegetation units have evolved on sandy soils.

The mentioned cenotaxa may be classified by the cenosystematical order as follows:

LEMNO-POTAMEA SOÓ 68
Potametea TX. et PRSG. 42
Ruppietalia J.TX. 60
Ruppion maritimae BR.-BL. 31
Parvipotameto-Zannichellietum pedicellatae SOÓ (34) 47
Ranunculo (Batrachio) aquatili-Ranunculetum polyphylli SOÓ (33) 47

PUCCINELLIO-SALICORNEA SOÓ 68
Thero-Salicornetea (TX.55) TX. et OBERD. 58
Thero-Salicornion (BR.-BL. 33) TX. 50
Suaedetum maritimae hungaricum SOÓ 47
– *Puccinellia* facies
Cypero-Spergularion SLAVNIC 48
Acorelletum pannonici SOÓ (39) 47
– *puccinellietosum limosae*

FESTUCO-PUCCINELLIETEA SOÓ 68
Puccinelietalia SOÓ 40
Puccinellion peisonis (WENDELBG. 43) SOÓ 57
Lepidio-Puccinelietum limosae (RAPCS. 27) SOÓ 57
– *Puccinellia* facies
– *Acorellus* facies
– *Aster tripolium* facies
Juncion gerardii WENDELBG. 43
Agrostio-Caricetum distantis (RAPCS. 27) SOÓ 30
– *festucetosum pseudovinae*
Artemisio-Festucetalia pseudovinae SOÓ 68
Festucion pseudovinae SOÓ 33
Achilleo-Festucetum pseudovinae (MAGYAR 28) SOÓ (33) 45

FESTUCO-BROMEA JAKUCS 67
Festucetea vaginatae SOÓ 57
Festucetalia vaginatae SOÓ 57
Bromion tectorum SOÓ 40
Brometum tectorum (SOÓ 25) BOJKO 34
– *Secale silvestris* facies
– *Cynodon dactylon* facies
Festucion vaginatae SOÓ 29
Festucetum vaginatae (RAPCS. 23) SOÓ 29
– *stipetosum sabulosae*
– *salicetosum rosmarinifoliae*
— *Holoschoenus* facies
— *Calamagrostis* facies
Festuco-Brometea BR.-BL. et TX. 43
Festucetalia valesiacae BR.-BL. et TX. 43
Cynodonto-Festucion SOÓ (40) 71
Potentillo-Festucetum pseudovinae danubiale BODROGKÖZY 59
– *cynodontetosum*

CHENOPODIO-SCLERANTHEA HADAC 67
Secalietea BR.-BL. (31) 51
Eragostetalia J.TX. 61

Tribulo-Eragrostion minoris SOÓ et TÍMÁR 57
Tribulo-Tragetum SOÓ et TÍMÁR 54
- *corispermetosum*
Digitario-Portulacetum (FELFÖLDY 42) TÍMÁR et BODROGKÖZY 55
Chenopodietea sensu SOÓ 71
Onopordetalia (BR.-BL. et TX. 43) GÖRS 66
Dauco-Melilotion GÖRS 66
Diplotaxi tenuifoliae-Agropyretum repentis MÜLLER et GÖRS 69

The cenological characterization of these vegetation units is reported at a depth necessary for the interpretation of the units on the vegetation map. The cited literature can be regarded as a comparative cenological standard.

a) VEGETATION OF THE LAKE BED

Due to the high pH value of the water, *Parvipotameto-Zannichellietum pedicellatae* association develops in the water of the lake. A large amount of the biomass of *Zannichellia palustris* ssp. *pedicellata* and the *Potamogeton pectinatus* is produced towards the middle of summer. The denominative species of *Ranunculo aquatili-Ranunculetum polyphylli* association can also be found (PIETSCH, 1982).

After the drying out of the lake, *Suaedetum maritimae hungaricum* association develops in the deepest part of the lake, where perennial species are not able to survive the long inundation. The coverage of the annual vegetation sometimes reach a level of 80%. The decisive majority of the vegetation consists of only one species, which is *Suadea maritima*. The *Chenopodium glaucum* and *Chenopodium opulifolium* are found by threads. The pH value of the surface layer of the soil is usually more than 10 in the case of this association (cf. TÍMÁR, 1954; 1957; BODROGKÖZY, 1962; 1977).

The perennial *Puccinellia limosa* is able to survive, where the period of water coverage is shorter than the deepest part of the lake, at the same time, the *Suaeda maritima* still has a significant coverage. The spreading of *Puccinellia limosa* well reflects the direction of vegetation transformation processes of the next years, which will be manifested in a gradual turfing of the lake bed. Besides the above mentioned species, the *Aster tripolium* ssp. *pannonicus*, the *Bolboschoenus maritimus* and the *Acorellus pannonicus* also appear by threads.

The next mapped zone towards the higher reliefs are covered by *Puccinellia* facies of *Lepidio-Puccinellietum limosae* association. The facies is poor in species, the vegetation almost entirely consists of *Puccinellia limosa*. *Acorelletum pannonici* association develops where the *Puccinellia* grass become thin (caused by grazing or trampling). Moreover, the *Acorellus pannonicus* appears in a significant percentage in the higher parts of *Lepidio-Puccinellietum* community, it is particularly characteristic of the western side of the lake. The *Aster tripolium* ssp. *pannonicus* form facies at the highest parts of the zone of *Lepidio-Puccinellietum* association. Every vegetation unit characteristic of which the significant dominance (more than

50%) of *Puccinellia limosa* was drawn together into one zone in the vegetation map (cf. RAPAICS, 1927; MAGYAR, 1930; MOESZ, 1940; SOÓ, 1947; BODROGKÖZY, 1962).

The higher parts of the lake bed are covered by *Agrostio-Caricetum distantis* community. Due to the narrowness of this zone, it was not possible to separate the lower units of this association. (But cf. the case of Szívós-szék UNESCO biospere-reserve core area (BAGI, 1988).) Altogether two zones were distinguished in the vegetation map: the typicum of the association at lower reliefs and *festucetosum pseudovinae* at the higher reliefs. Due to the sand-blasts, the latter often forms transitions with the unit of *Festucetum vaginatae holoschoenosum*. Despite the fact that only the typicum and festucetosum are represented in the vegetation map, these units have no homogeneous vegetation. At the lower parts of the typicum unit, a zone highly dominated by *Juncus compressus* can be found. The 15-50% coverage of *Juncus compressus* is characteristic of this zone. Its most typical stands are at the north-western part of the lake. In the other parts of the lake it is substituted a zone in which the dominance of *Agrostis stolonifera* is higher, the dominance of *Carex distans* in this unit is lower than their coverage in the typicum: Coverage of *Agrostis stolonifera* here is 25-30%, the *Carex distans* has 1-3% coverage here. In the typicum unit, both have coverage of 20-25%.

In the higher parts of the *Agrostio-Caricetum distantis* association a *festucetosum pseudovinae* subassociation developed. The coverage of *Festuca pseudovina* is from to 10-20%. This zone also is not homogeneous: in some parts of the lake bed zones with a higher dominance of *Cynodon dactylon* and *Poa angustifolia* can be recognized. Due to their small width, these units have no representation in the vegetation map; the given scale did not make it possible (cf. KÁRPÁTI and KÁRPÁTI, 1959; BODROGKÖZY, 1960; BAGI, 1988). The nearness of the sandy territories in indicated by the occurence of the following species in their stands: *Silene conica, Holoschoenus vulgaris, Tragopogon floccosum, Scabiosa ochroleuca, Echium vulgare, Carex flacca*.

b) VEGETATION OF THE SANDY TERRITORIES

In previous years, wine-growing was the most important agricultural activity on the surrounding sand dunes. There were plough-lands on the flat territories. The cultivation of corn, first of all rye, was traditional here. Economical and environmental protection reasons caused agricultural utilization to be abandoned.

Depending on time of the giving up of agricultural utilization, the regeneration processes of the natural vegetation have reached different stages. On the site of the former plough-lands, *Diplotaxi tenuifoliae-Agropyretum repentis* association developed (cf. MÜLLER and GÖRS, 1969; MUCINA, 1982; GRÜLL, 1985; KOPECZKY, 1986). The characteristic vegetation type in the abandoned vineyards is *Tribulo-Tragetum corispermetosum*. Elements of *Digitario-Portulacetum* association often can be found (cf. FELFÖLDY, 1942; TÍMÁR, 1955; BODROGKÖZY, 1955, 1959a). The above mentioned associations can be regarded as the starting state of the regeneration processes of the vegetation. The direction and the speed of these processes are in close connection with the exposition and inclination of the slopes of the sand formations. A fast regeneration of *Festucetum vaginatae* typicum (rarely *stipetosum sabulosae* subassociation) takes place on the tops of sand dunes and their southern-like slopes. In the depressions between the sand dunes, the regeneration of subassociation of *salicetosum rosmarinifoliae* of *Festucetum vaginatae* community (often a *holoschoenosum* facies, occasionally *calamagrostiosum* facies of this unit) rapidly takes place. The regeneration processes are the slowest on northern-like slopes of the dunes. The weed communities develop in a direction of *Secale silvestris* facies (in a lower ratio *Cynodon dactylon* facies) of *Brometum tectorum* association.

The first step of regeneration on the more extended flat territories leads to the formation of *Brometum tectorum cynodonosum* community. Depending on the degree of grazing, later, this community develops in the direction of *Potentillo-Festucetum pseudovinae danubiale* (in the first step it has a *cynodonetosum* subassociation) or in a direction of *Festucetum vaginatae* (lower units of this are dependent on the relative distance of the surface from the water-table) (cf. BODROGKÖZY, 1959b; SZUJKÓ-LACZA, 1986).

Typical *Brometum tectorum* association has developed only in the south-east part of the mapped territory where an abandoned sand-pit can be found. The possible regeneration processes are summarized by means of a flow diagram (Fig. 2).

Typical stands of associations of the sandy succession can be studied on the high sandy dunes (sandy hills) and in territories that were not under agronomical utilization. They have been mentioned in connection with their regeneration processes (cf. SOÓ, 1929; ZSOLT, 1943; BORHIDI, 1956; BODROGKÖZY, 1957; 1982; BODROGKÖZY and FARKAS, 1981; KÖRMÖCZI, 1983). The associations of sandy vegetation, its lower units and the transitions between them were situated in a very detailed manner, in order that the vegetation map may be a useful basis for studies on the vegetation transformation processes, including also the regeneration processes.

The *Achilleo-Festucetum pseudovinae* association has very small stands in the core area. The more heavy soil and the high organic matter content are important edaphic factors in the development of this unit. Its small patches can be found in the shore zone of the lake (cf. SOÓ, 1947).

A smaller part of the territory is covered by a characterless woody-shrubby vegetation. This consists of the following species: *Robinia pseudo-acacia*, *Populus canescens*, *P. alba*, *Ailanthus glandulosus*, *Ribes aureum*, *Crataegus monogyna* and many kinds of fruit-trees. According to their herb layer, the stands can be classed into cenotaxon *Bromo sterili-Robinietum* (PÓCS 54) SOÓ 64 (cf. SOÓ, 1937; HARGITAI, 1940; PÓCS, 1954; BABOS, 1955). The herb layer sometimes overextends from beneath the woody vegetation and mixes with elements of *Festucetum vaginatae* association (more often with elements of *Calamagrostis* facies of *salicetosum* subassociation).

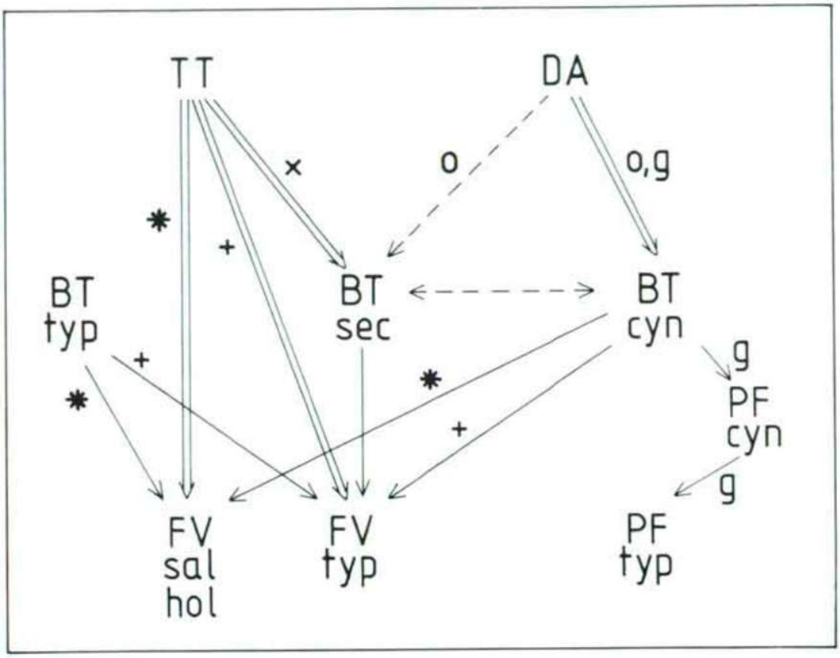


Fig. 2. Possible ways of regeneration of natural communities of sandy grassland; TT: *Tribulo-Tragetum*, DA: *Diplotaxi tenuifoliae-Agropyretum*, BT: *Brometum tectorum*, typ: typicum, sec: *Secale silvestris* facies, cyn: facies or subassociation of *Cynodon dactylon,* FV: *Festucetum vaginatae*. sal: *salicetosum rosmarinifoliae*, hol: *Holoschoenus* facies, PF: *Potentillo-Festucetum pseudovinae*, +: top of dune, #: depression between dunes, x: slope of dune, o: flat territories, g: grazing. Double arrow refers to fast, simple arrow to slow, dotted arrow to uncertain or probably insignificant processes.

c) RECOMMENDATIONS FOR THE PROTECTION OF VEGETATION AND UTILIZATION OF THE CORE AREA

The most important values of the nature in the Szappan-szék core area are the lake itself, the unique(plant)communities in the water and the special mud vegetation in the dried lake. Unfortunately, these will disappear if the decrease in the average water-level and the alkalinity of water continues. Further investigations are needed to search for the causes of the long term fluctuations of the water level and of the water-table: The insufficiently available data refer to a periodicity of 50 years: the water-table increases during 20-25 years and then after decreases to the same level during the same length of time. The investigations of the role of water management - including the diking - in the development of the present situation must be an issue to consider. Another question is: what if the diking caused an irreversible shift in the (determination of) level of the water-table.

Besides the regional problems of the Szappan-szék core area, there is a problem of this territory which needs obvious and urgent solution. The problem indirectly issues from the decrease in the height of the water level; the paths - originally leading to the shore - simultaneously with the water loss of the lake, moves more and more away towards the deeper parts. Trampling destructively affects the vegetation, even if the vegetation of territories that are no lower trampled on only very slowly regenerates (BAGI, 1988). The eastern part was spared in recent times, therefore, the vegetation form a complete zonation system there. Meanwhile, this part has become suitable for vehicles to be driven. The problem of such passage must be solved by increased control and there must be heavy penalties imposed on trespassers.

Acknowledgements

Thanks are due to the Directorate of the Kiskunság National Park - especially to Dr. I. TÖLGYESI, Botanical Inspector for his generous help. The author expresses his sincere thanks to Miss A.G. MOLNÁR for her assistance in field surveying. This work was supported by the Hungarian Ministry of Environmental Protection and Water Management.

References

ANDÓ, M. (1964): Geomorphologische und hydrographische Charakterisierung des Kunfehérsees und seiner Umgebung. - Acta Geographica Univ. Szeged *5*, Fasc. 1-7.

BABOS, I. (1955): A nyárfások homokbuckán előforduló megjelenési formái (Erscheinungsformen der auf sandhügeln stockenden Wacholder-Pappelbestände. In Hungarian with German summary). - Erd. Kut. *4*, 31-86.

BAGI, I. (1987): The vegetation map of the Kisapaj UNESCO biosphere reserve core area, Kiskunság National Park, Hungary. - Acta Biol. Szeged, *33*, 63-74.

BAGI, I. (1988): The vegetation map of the Szívós-szék UNESCO biosphere-reserve core area, Kiskunság National Park, Hungary. - Acta Biol. Szeged. *34*, 83-95.

BODROGKÖZY, GY. (1955): Das zönologische System und die Bodenindikator-Rolle der Unkrautgesellschaften der Sandweingärten des Dunau-Theiss-Zwischenstromlandes.-Acta Biol. Szeged. *1*, 3-16.

BODROGKÖZY, GY. (1957): Die Vegetation der Weisspappel-Haine in dem Reservat "Emlékerdő" bei Szeged-Ásotthalom.-Acta Biol. Szeged.*3*, 127-140.

BODROGKÖZY, GY.(1959 a): Adatok a délkelet-kiskunsági homoki szőlők gyomtársulásainak ismeretéhez (Beiträge zur Kenntnis der Unkrautassociationen in den Weingärten auf Sandböden im südöstlichen Teile des Kiskunság. In Hungarian with German summary). - Bot. Közlem. *48*, 81-94.

BODROGKÖZY, GY. (1959b): Ökologische Verhältnisse der Standortstypen der Sandweiden vom falschen Schafschwigel *Pontentillo-Festucetum pseudovinae danubiale*) in Süd-Kiskunság.-Acta Biol. Szeged. *5*, 145-160.

BODROGKÖZY, GY. (1960): Phytozönologische und bodenökologische Untersuchungen an den Sumpfwiesen im Süden des Gebietes Kiskunság (Klein-Kumanien).-Acta Bot. Hung. *6*, 171-207.

BODROGKÖZY, GY. (1962): Die standortsökologischen Verhältnisse der halophilen Pflanzengesellschaften des Pannonicum. I. Untersuchungen an den Solontschak Szikböden der südlichen Kiskunság.-Acta Bot. Hung. *8*, 1-37.

BODROGKÖZY, GY. (1977): A Pannonicum halophiton társulásainak rendszere és synökológiája (Syntaxonomy and synecology of the halophilous communities of Pannonicum. In Hungarian).- Thesis, Szeged.

BODROGKÖZY, GY. (1982): Hydroecology of the vegetation of sandy forest-steppe character in the Emlékerdő at Ásotthalom.-Acta Biol. Szeged. *28*, 13-39.

BODROGKÖZY, GY. and FARKAS, GY. (1981): Correlations between vegetation and hydroecology in the sandy grasslands of Kiskúnság National Park.-Acta Biol. Szeged. *27*. 33-53.

BORHIDI, A. (1956): Die Steppen und Wiesen im Sandgebiet der Kleinen Ungarischen Tiefebene.-Acta Bot, Hung. *2*, 241-274.

FELFÖLDY, L. (1942): Szociológiai vizsgálatok a pannóniai flóraterület gyomvegetációján (Soziologische Untersuchungen über die pannonische Ruderalvegetation. In Hungarian with German summary). -Acta Geobot, Hung. *5*, 87-140.

GRÜLL, F. (1985): Nové zjisztěná a přehlízsená ruderálni spolecsenstva na území Brna (Newly found or overlooked ruderal plant communities in Brno. In Czech with English summary).-Preslia, Praha *57*, 53-64.

HARGITAI, Z. (1940): Nagykőrös növényvilága. II. A homoki növényszövetkezetek (Die Vegetation von Nagykőrös. II. Die Sandpflanzengesellschaften. In Hungarian with German summary).- Bot. Közlem. *37*, 205-240.

JÁRAI-KOMLÓDI, M. (1966): Adatok az Alföld negyedkori klíma és vegetációtörténetéhez. I. (Quaternary climatic changes and vegetational history of the Greath Hungarian Plain. I. In Hungarian with English summary).-Bot. Közlem. *53*, 191-201.

JÁRAI-KOMLÓDI, M. (1969): Adatok az Alföld negyedkori klíma és vegetációtörténetéhez. II. (Quaternary climatic changes and vegetational history of the Great Hungarian Plain. II. In Hungarian with English summary).-Bot. Közlem. *56*, 43-55.

KÁRPÁTI, I. and KÁRPÁTI, V. (1959): Biotope im Szelider See und deren Lebewelt. Die Lebewelt des Litorals. In Das Leben des Szelider Sees (Ed.: DONÁSZY, E.).-Akadémiai Kiadó, Budapest, 163-206.

KOPECKY, K. (1986): Versuch einer Klassifizierung der ruderalen *Agropyron repens*- und *Calamagrostis epigejos*-Gesellschaften unter Anwerung der deduktiven Methode.-Folia Geobot. Phytotax.,Praha *21*, 225-242.

KÖRMÖCZI, L. (1983): Correlations between the zonation of sandy grasslands and the physico-chemical condition of their soil in Bugac.-Acta Biol. Szeged.*29*, 117-127.

MAGYAR, P. (1930): Növényökológiai vizsgálatok szikes talajon (Pflanzenökologische Untersuchungen auf Szikböden).-Erd. Kisérl. *32*, 75-118, 237-256.

MIHÁLTZ, I. and FARAGÓ, M. (1964): A Duna-Tisza közi édesvizi mészkőképződmények (Carbonate formations of terrestrial sedimentation from the Danube-Tisza Interfluve. In Hungarian).-Alföld Tud. Int. Évk. *1*. 371-384.

MOESZ, G.(1940): A Kiskunság és a Jászság szikes területeinek növényzete (Die Pflanzendecke der Alkalisteppen der Kiskunság und der Jászság, In Hungarian with German summary).-Acta Geobot. Hung. *3*, 100-115.

MOLNÁR, B. (1985): Földtani kutatások a Kiskunsági Nemzeti Parkban (Geological explorations in the Kiskunság National Park. In Hungarian with English summary). In Tudományos kutatások a Kiskunsági Nemzeti Parkban 1975-1984). (Ed.: TÓTH, K.).-Kiskunsági Nemzeti Park, Kecskemét, 29-58.

MOLNÁR, B. and MURVAI, I. (1976): A Kiskunsági Nemzeti Park fülöpházi szikes tavainak kialakulása és földtani története (Bildung und geologische Geschichte der Sodaseen Fülöpháza im Kiskunság National Park. In Hungarian with German summary).-Hidrológiai Közlöny *56*, 67-77.

MUCINA, L. (1982): Die Ruderalvegetation des nördlichen Teils der Donau-Tiefebene 3. Gesellschaften des Verbandes Dauco-Melilotion auf natürlichen Standorten.-Folia Geobot. Phytotax.,Praha *17*, 21-47.

MUCSI, M. (1963): Finomrétegtani vizsgálatok a kiskunsági édesvizi karbonátképződményekben (Studies on the fine stratification of the carbonate formation of the terrestrial sedimentation in Kiskunság region of Hungary. In Hungarian).- Földt. Közlem. *93*, 373-386.

MÜLLER, TH. and GÖRS, S. (1969): Halbruderale Trocken- und Halbtrockenrasen.-Vegetatio *18*, 203-221.

PIETSCH, W. (1982): Makrophytische Indikatoren für die ökonomische Beschaffenheit der Gewässer. In Ausgewählte Methoden der Wasseruntersuchung. Band II. (Eds.: BREITIG, G. and TÜMPLING, W.).-VEB Gustav Fischer Verlag, Jena, 67-88.

PÓCS, T. (1954): A rákoskeresztúri „Akadémiai erdő" vegetációja (Die Vegetation des "Akademischen Waldes" in Rákoskeresztúr, In Hungarian with German summary). - Bot. Közlem. *45*, 283-295.

RAPAICS, R. (1927): A szegedi és csongrádi sós és szikes talajok növénytársulásai (Die Pflanzengesellschaften der Salz- und Szikböden von Szeged und Csongrád. In Hungarian with German summary).-Bot. Közlem. *24*, 12-29.

SOÓ, R. (1929): Die Vegetation und die Entstelung der ungarischen Puszta.-J. Ecol. 27, 329-350.

SOÓ, R. (1937): A Nyírség erdői és erdőtípusai (Wälder und Waldtypen des Sandgebiets Nyírség. In Hungarian with German summary).-Erd. Kisérl. *39*, 337-380.

SOÓ, R. (1947): Conspectus des groupements végétaux dans les Bassins Carpathiques. I. Les associations halophiles.-Institut Botanique de l'Université a Debrecen, Debrecen.

SOÓ, R. (1980): Synopsis systematico-geobotanica florae vegetationsque Hungariae VI.-Akadémiai Kiadó, Budepest.

SZODFRIDT, I. and FARAGÓ, S. (1968): Talajvíz és vegetáció kapcsolata a Duna-Tisza köze homokterületén (Zusammenhang zwischen Grundwasser und Vegetation in Donau-Theiss Sandgebiet. In Hungarian with German summary).-Bot. Közlem. *55*, 69-75.

SZUJKÓ-LACZA, J. (1986): The vegetation of the Kiskunság National Park. In The fauna of the Kiskunság National Park. (Ed. Mahunka, S.).-Akadémiai Kiadó, Budapest, 15-57.

TÍMÁR, L. (1954): Egyéves növénytársulások a Szeged környéki szikesek iszapján I. (Einjährige Pflanzengesellschaften auf den Schlammeder Alkaliböden in der Umgebung von Szeged I. In Hungarian with German summary).-Ann. Biol. Univ. Hung. *2*, 311-321.

TÍMÁR, L. (1955): Pflanzenschädlinge Zwischen den eisenbahnschienen am Theissufer.-Acta Biol. Szeged. *1*, 95-112.

TÍMÁR, L. (1957 Zonációtanulmányok szikes vizek partján (Zonationsstudien an der Ufern von Sodahaltigen Gewässern, In Hungarian with German summary).-Bot. Közlem. *47*, 157-163.

TÓTH, K. [ed] (1985): Tudományos kutatások a Kiskunsági Nemzeti Parkban 1975-1984. (Research in the Kiskunság National Park 1975-1984. In Hungarian, with English summaries.) - Kiskunság National Park, Kecskemét.

VÁRALLYAY, GY., MOLNÁR, E. and RAJKAI, K. (1985): Talajtani kutatások (Soil research). In Tudományos kutatások a Kiskunsági Nemzeti Parkban 1975-1984 (Research in Kiskunság National Park 1975-1984). (Ed. TÓTH, K.).-Kiskunsági Nemzeti Park, Kecskemét, 59-92.

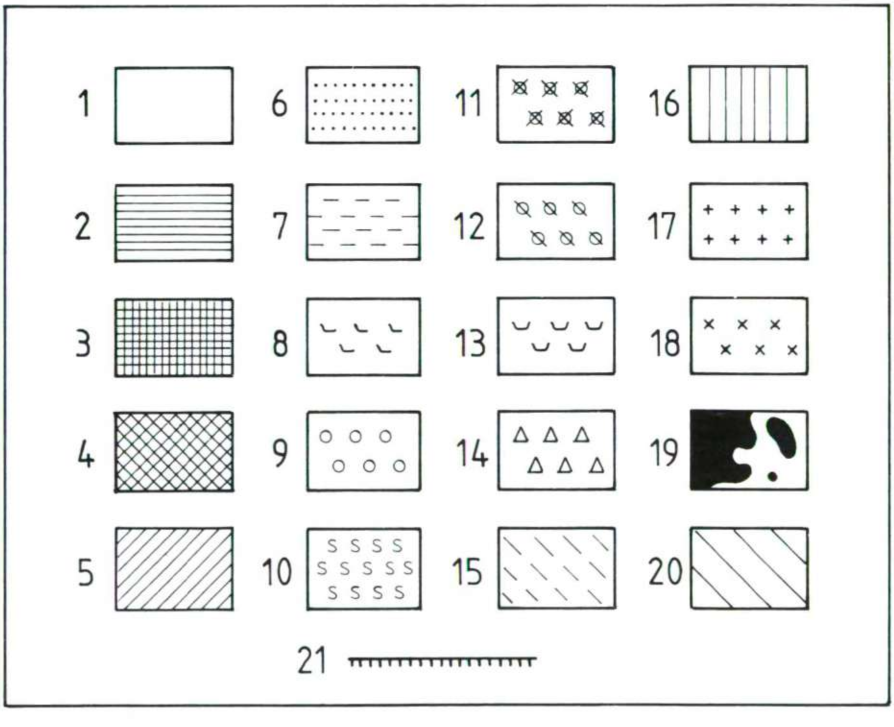
ZÓLYOMI, B. (1953): Die Entwicklungsgeschichte der vegetation Ungarns seit dem letzten Interglacial.-Acta Biol. Acad. Sci. Hung. *4*, 367-430.

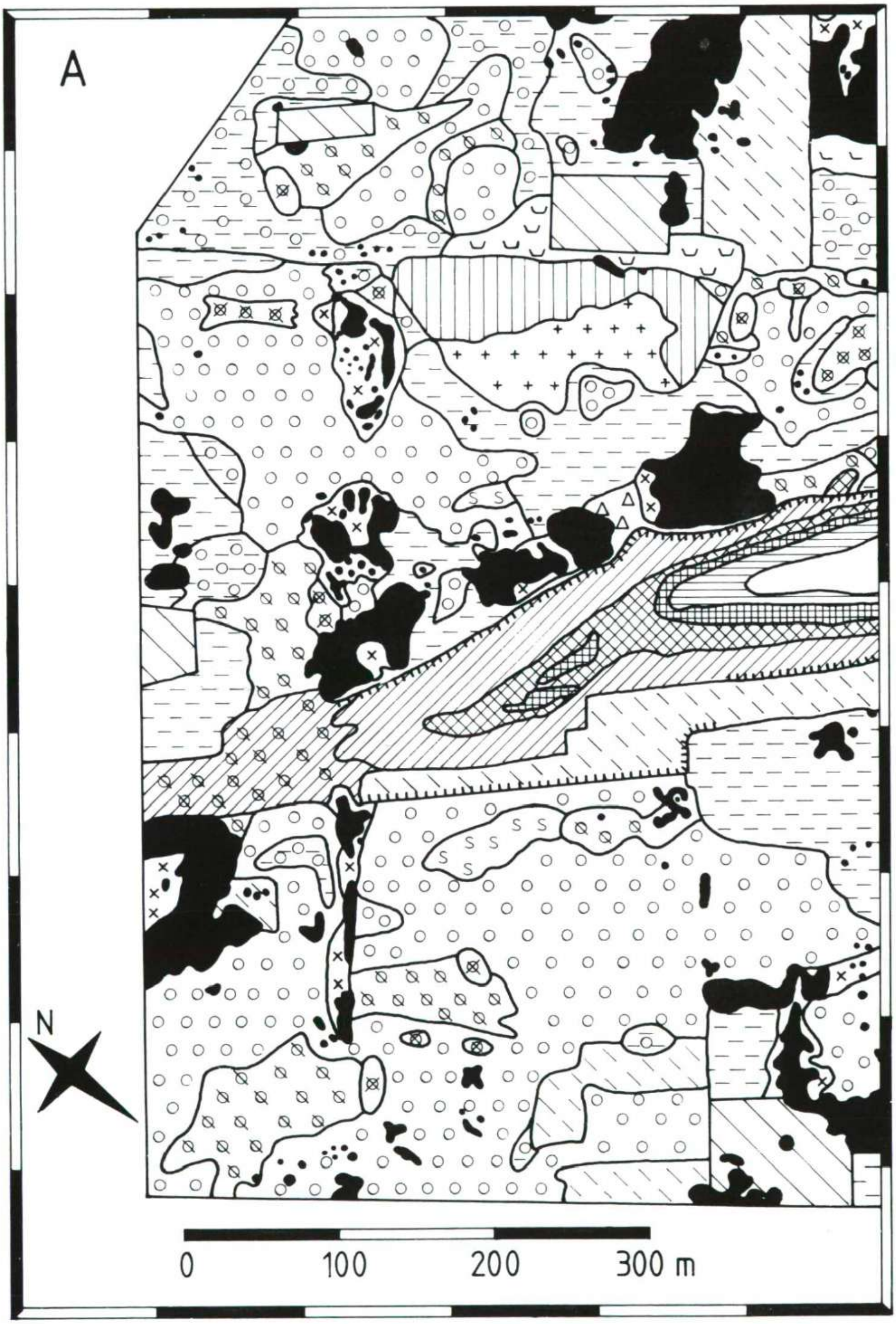
ZSOLT, J. (1943): A szentendrei sziget növénytakarója (Die Vegetation der Donau-Insel Szent-Endre. In Hungarian with German summary).-Index Horti Bot. Univ. Budapest *6*, 1-18.

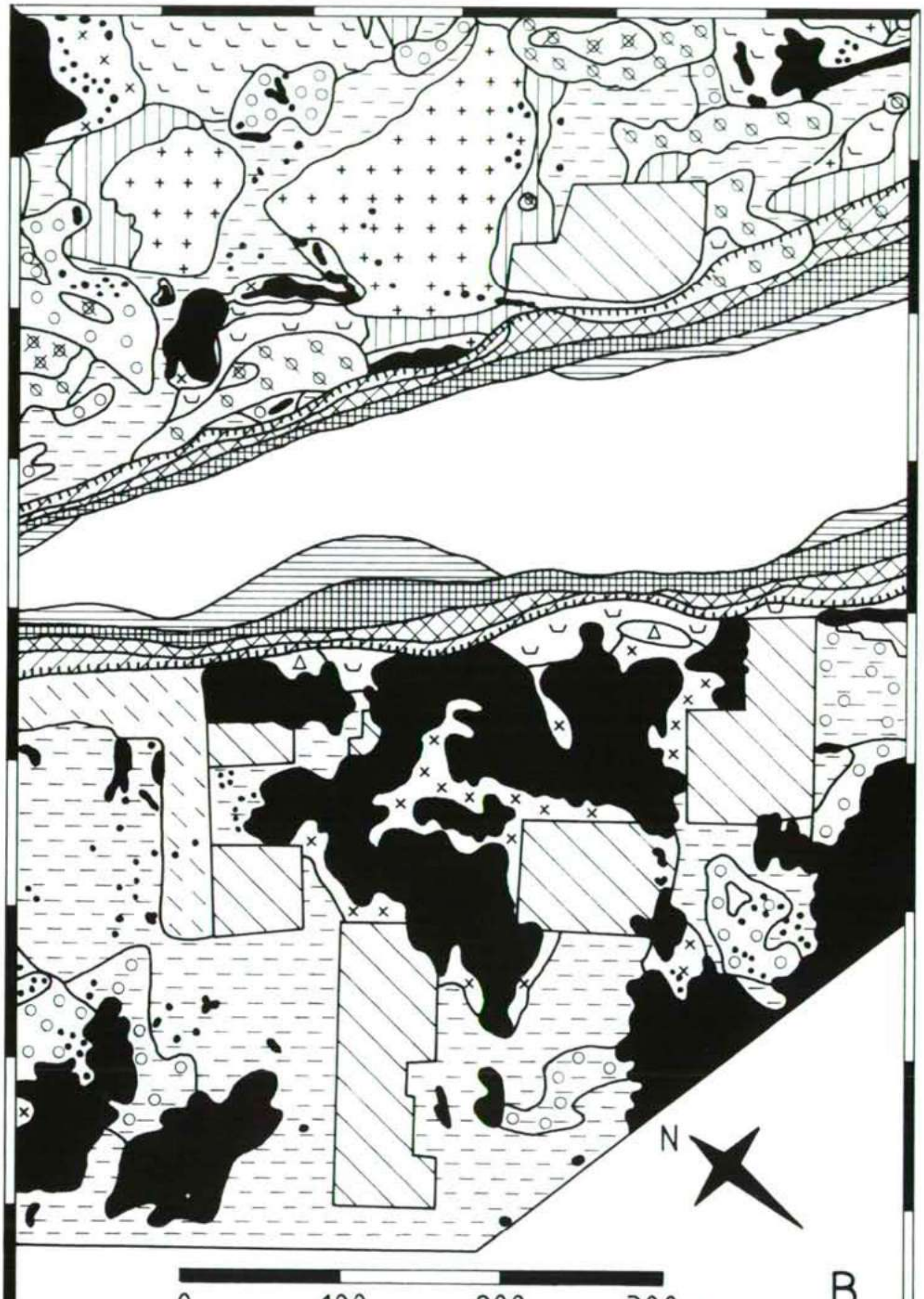
Appendix

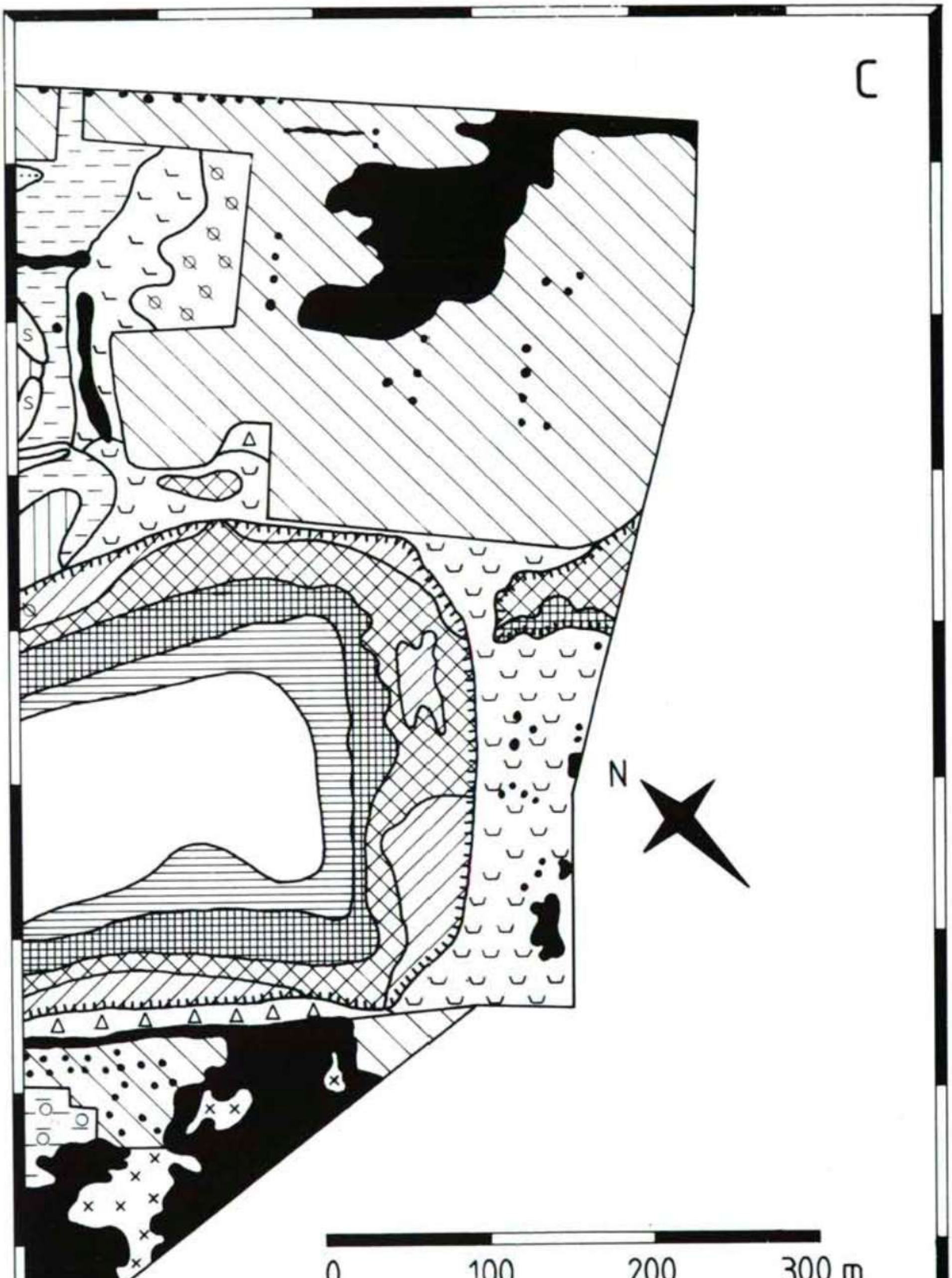
The key for the identification of the units of the vegetation map of the Szappan-szék biosphere-reserve core area: 1. *Suaedetum maritimae hungaricum*, 2. *Suaedetum maritimae hungaricum Puccinellia* facies, 3. *Lepidio-Puccinellietum limosae*, 4. *Agrostio-Caricetum distantis* typicum, 5. *Agrostio-Caricetum distantis festucetosum pseudovinae*, 6. *Brometum tectorum* typicum, 7. *Brometum tectorum Cynodon* facies, 9. *Festucetum vaginatae* typicum, 10. *Festucetum vaginatae stipetosum sabulosae*, 11. *Festucetum vaginatae salicetosum rosmarinifoliae* normale, 12. *Festucetum vagintae salicetosum rosmarinifoliae Holoschoenus* facies, 13. *Potentillo-Festucetum pseudovinae danubiale* mainly *cynodontetosum*, 16. *Diplotaxi tenuifoliae-Agropyretum*, 17. *Diplotaxi-Agropyretum* x *Brometum tectorum Cynodon* facies, 18. *Bromo sterili-Robinietum* underwood x *Festucetum vaginatae Calamagrostis* facies, 19. Forests, (clusters of) trees, 20. Cultivated lands: plough-lands, orchards, 21. steep slope of the lake shore.

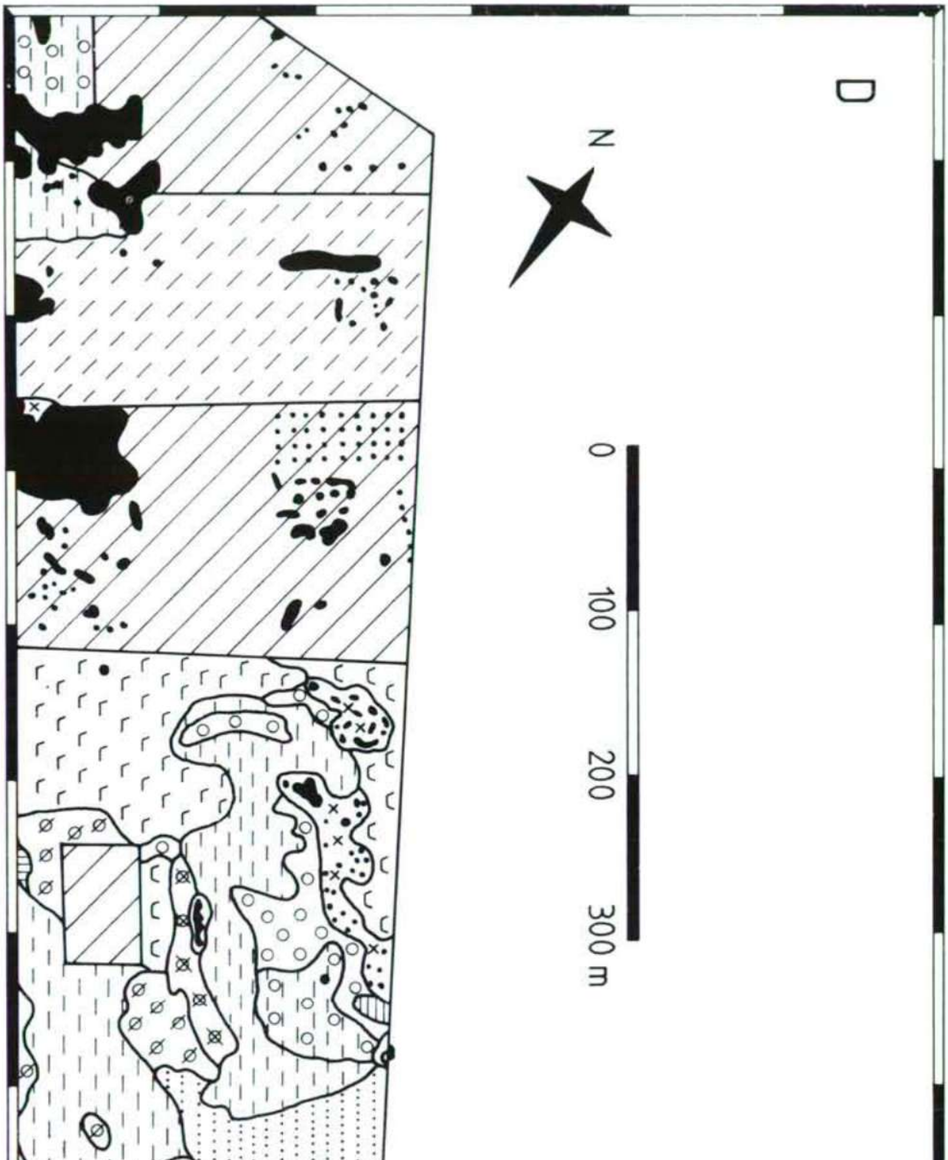
The combined symbols mean transitional vegetation units.




A
N
0
100
200
300 m


N
0
100
200
300 m
B


C
N
0
100
200
300 m


D
N
0
100
200
300 m