Proceedings of the

# "RESEARCH, CONSERVATION, MANAGEMENT"

Conference

Edited by Erika Tóth & Róbert Horváth

1997
ANP




**Aggtelek**
Hungary, 1-5 May 1996

Volume I.

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## EDITOR'S FOREWORD

The lectures and the poster presentations of the "Research, Conservation, Management" Conference are published in two volumes because of the size of the proceedings.

The Proceedings Volume I. contains the papers arranged in groups according to the sessions of the conference, in alphabetical order.

The presentations on the results of complex ecological status survey in Aggtelek National Park and Biosphere Reserve are collected in the Proceedings Volume II. It is completed irregularly with an appendix containing species lists (based on the results of the status survey) which was not presented in the conference.

## A SZERKESZTŐ ELŐSZAVA

A "Kutatás, Megőrzés, Kezelés" címmel megrendezett konferencián elhangzott előadások és bemutatott poszterek terjedelmi okok miatt két kötetben kerülnek kiadásra.

Az első kötetben a konferencia szekcióí szerint csoportosítva, szerzők szerinti abc-sorrendben találhatók az anyagok.

A második kötet az Aggteleki Nemzeti Park és Bioszféra Rezervátum területén folyt komplex természeti állapot felmérés eredményeit tartalmazó cikkeket gyűjti össze és rendhagyó módon kiegészítve a konferencián be nem mutatott fajlistákat tartalmazó melléklettel.

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Herewith we would like to express our appreciation for the help of the staff of the **Speleological Institute, National Authority for Nature Conservation, Hungarian Ministry for Environment and Regional Policy** (Budapest) and the **Slovak Karst Landscape Protection Area** (Brzotin) during the organisation of the "Research, Conservation, Management" Conference.

We offer grateful thanks to each of the organisations and foundations for the financial and material supports:

Ezúton szeretnénk köszönetünket kifejezni a **Környezet és Területfejlesztési Minisztérium Természetvédelmi Hivatal Barlangtani Intézetének** (Budapest) és a **Szlovák Karszt Tájvédelmi Körzet** (Brzotin) munkatársainak a "Kutatás, Megőrzés, Kezelés" címmel, 1996. május 1-5. között megrendezett nemzetközi konferencia szervezésében nyújtott segítségéért.

Köszönet illeti a konferencia létrejöttéhez nyújtott pénzügyi és anyagi támogatásért:

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# FOREWORD

# REFLEXIONS ON A NATIONAL PARK RESEARCH CONFERENCE

**DR. JÁNOS TARDY**
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In 1992, after one year of preparation and based on a new concept, the National Authority for Nature Conservation (within the Ministry for Environment and Regional Policy, MERP) launched a national and complex natural status survey. Let me now share with you my personal experience with this programme. In 1987, at the honourable request of the Hungarian Academy of Sciences, I began working on the professional concept of the environmental and nature conservation chapter of the Hungarian National Atlas. The concept was finalised by including the opinion of numerous experts and then I elaborated the maps and commented on them. One of our unconventional objectives was to represent obvious and already verified correlations on these maps, e.i. to elaborate both chartographically and scientifically reformed, complex synthesis maps instead of, or rather, in addition to traditional analytical ones. During the work, it turned out that not all our goals can be achieved: some of us lacked the professional courage to take certain (sometimes personal) risks which the representation of some obvious correlations would have implied (bear in mind that it was before the political changes), and we had to face a rather tough circumstances which could be best described by saying: *"everywhere we study something, but nowhere everything..."*.

The official Hungarian nature conservation bodies and the co-operating scientific institutes and individual researchers may stand up to international comparison with a clear conscience: some of our national parks (for example, the Hortobágy NP, the Kiskunság NP and parts of the Aggtelek NP) and reserves are much better studied biologically than the international average. The situation is similar with certain plant and animal species and breeds. Today, decades after the first thorough survey, monitoring in the classic sense of the word has become possible by remapping. This means that the changes occurred can be tracked down, albeit so far only in tiny sites such as the Bátorligeti Marsh, Sas Hill, etc. Considering the whole of Hungary, however, the picture is not everywhere so favourable. Our shortcomings are obvious in certain regions or concerning certain natural values, or where the data are not quite profoundly analysed. Some smaller or even medium-sized areas as well as some protected sites are very poorly known. The reasons for these disproportions can be fairly well outlined, which brings the solutions much closer. Here are some of the most obvious reasons:

- the *geographical or "geopolitical" position* of the site or protected area: a number of them were formerly inaccessible, lying near the border or within closed military areas (e.g. sites along the River Drava, on the western border or in the Hortobágy bombardment area),
- the *organisational and financial problems* of nature conservation research: the funds allocated for research have always depended on the actual "hierarchy" within the supreme authority. Out of budgetary "considerations", most contracts were drawn after the vegetational season ended, and the financing of research ranging over two or more calendar years, which is often the case in nature conservation, was always (and sometimes still is) uncertain. No adequate data bank or information system existed to exclude parallel working or to indicate deficiencies. We lacked and for financial reasons we are still short of digitised working maps with uniform projection and scale, although only this would make comparison possible. A uniform map code system of the various branches of science important for nature conservation was also lacking. And last but not least, by January 1991, "thanks" to multiple reorganisations, moving to new buildings and other factors, and perhaps some "beneficial friends", the research reports and documentations prepared for state nature conservation during nearly 30 years have almost all disappeared. Many thanks to all universities, academic, educational and research institutes which help us solve this awkward situation.

In spite of the still desperate financial situation of research institutes and the above-described anomalies, some branches of science and some regions boast results that command respect even by international standards. In other cases changes have proved inevitable. The economic and political changes demanded faster reactions from nature conservation, too: if we were to answer adequately the questions raised by actual infrastructure development projects (the construction of motorways, airports, transmission lines and power stations), if we were to efficiently safeguard our designated areas or those proposed for designation from the outrages of privatisation, then we had to start elaborating our information system. We had to realise that thousands of data-laden sheets cannot be handled efficiently enough, whereas the establishment and continuous operation of a regularly updated and easily mobilised nature conservation database and information system would not be favourable to everyone during these changing times.

Independent from the actual budget available for nature conservation research, we have always wished to give priority to status surveys which are indispensable in professional planning, policy-making and while elaborating the zonation of protected areas. And let us admit: as long as we do not possess a comprehensive yet not over-detailed set of key parameters, every report or summary attempting to cover the whole of the country must be considered of dubious worth. These parameters must be produced as quickly

as possible, since the trends and regularities cannot be outlined without a well-defined base of comparison. Moreover, "no data" category must also be introduced very soon, just like in the Natural Environment of Japan atlas and the thematic maps of nature conservation in some EU countries. Of course, such a category implies that most areas are indeed explored... By now we have got relatively well ahead. The new methods and information supply system introduced by the Corine Biotopes mapping programme have placed Hungary among the leading countries in this respect. Hopefully, large scale evaluation, an indispensable factor in the daily practice of nature conservation, will soon be possible by filling the databases with the records already available.

The former name of the programme, complex ecological status survey, has been intentionally changed for complex natural status survey. We must accept the fact that exactly beacuse the above reasons no research programme may attempt to cover the whole of the country in ecological detail. Thus, we aim at much less detail, but thematically the programme is intended to be all the more comprehensive (the survey of the abiotic natural heritage is also justified and indispensable).

We intended to introduce and follow a uniform syllabus and methodology already when the programme was launched, since methodological disharmony would again make comparisons impossible. As we had no background institute at the time, we turned to scientists. Without going into details, let me just say it was difficult to reach a concensus... It was our intention that our tried team of researchers and research institutes work on a designable and conceptional programme which also fits their purposes. It was also our intention that our own expert colleagues who probably know their particular sites best should also participate. I still think that only such a co-operation will give the joy of good work without which no practically useful result can be achieved. In the new system, each status survey programme normally lasts several years and consists of three parts: 1. The preparation of an annotated, thematical bibliography, i.e. the exploration and preliminary evaluation of already available databases. 2. The results of research, inventories of natural values, species lists, maps, etc. 3. Practical guidelines for nature conservation bodies explaining what to do (research must not finish with checklists).

We often speak about three major nature conservation programmes: complex natural status survey, nature conservation information system and biodiversity monitoring network. Obviously, they are strongly interrelated and are built on one another. We must be aware of the fact, however, that in the foreseeable future it will not be impossible to expand monitoring to all protected areas let alone the whole country. The best way for tracking down changes is probably to repeat status surveys every 5-10 years (as far as possible, with similar methods and parameters) and to evaluate the thematical maps by superimposition. With all probability, this will only be possible in some selected model areas and habitat types. The continuation of

our comprehensive status survey programme, the launching of a well-organised biodiversity monitoring programme (the last obstacles have been removed by 1997), and the permanent harmonisation of these two are among our priorities as well as the operation of a nature conservation information system, the continuous filling of databases, and making them compatible with status surveys and biodiversity monitoring programmes (the necessary hardware and software have become available by 1997, but the personal conditions are still deficient).

Our primary obligations include the preparation of national cadastres and classification systems of the most valuable Hungarian habitat types and natural values (the "ex lege" protected caves, springs, moors, sink-holes, salt lakes, tumuli, earthen fortifications as well as geological-geomorphological values, various types of grasslands and wetlands, etc.) and the elaboration of nature conservation management guidelines to help managers outline site-specific conservation/management requirements (the publications for woodlands and grasslands have been accomplished, the one for wetlands is under preparation).

In the spirit of the above, the programme was launched in 1992, but of course, it also built (with strong modifications) on earlier achievements. Our national park and nature conservation directorates, in cooperation with the researchers concerned, regularly present their regional achievements on their own workshops. These 1-2 day, open conferences produce most fruitful discussions. The Aggtelek Conference, as these two volumes prove, has gone beyond the scope of the mere presentation of research carried out in a single national park. Although it could not aim at completeness, we get some brief insights into nature conservation research in Hungary, and of course, particularly in the Aggtelek National Park, as in May 1996.

I warmly recommend the proceedings of this exemplary and successful conference to all our keen and committed scientist and researcher friends, to the active supporters of these World Heritage caves, " fans " of the Karst, the local inhabitants as well as all professional and amateur naturalists concerned about the future.

Budapest, 8 March 1997.

# GONDOLATOK EGY NEMZETI PARKI KUTATÁSI KONFERENCIA KAPCSÁN

**DR. TARDY JÁNOS**
helyettes államtitkár
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A KTM Természetvédelmi Hivatala 1992-ben, egyéves előkészítést követően új koncepcióval fogott hozzá az ország komplex természeti állapotfelvételi programjához. Engedje meg a T. Olvasó, hogy e törekvésünkkel összefüggésben személyes tapasztalataimat is megosszam Önnel. A Magyar Tudományos Akadémia megtisztelő felkérésére 1987-ben hozzáfoghattam az akkor tervezett Magyar Nemzeti Atlasz környezet- és természetvédelmi fejezete szakmai koncepciójának kimunkálásához, majd annak széleskörű megvitatását követően a térképlapok és magyarázó szövegeinek érdemi kidolgozásához. A hagyományoktól eltérően meghirdetett célok egyike volt a nyilvánvaló, immáron bizonyított összefüggések térképi ábrázolása, vagyis a tradicionális analitikus térképek helyett (avagy tán inkább mellett) kartográfiailag és szaktudományi szempontból is újtípusú, összetett szintézis-térképek kidolgozása. A munka során kiderült, hogy törekvéseink csak részben megvalósíthatók: többekből hiányzott a szakmai "virtus", a nyilvánvaló összefüggések ábrázolásával együtt járó, esetleges személyes "kockázatok" vállalása (a nyolcvanas évek végén járunk ekkor), s rá kellett döbbennünk egy talán még sajátosabb, ám meglehetősen objektív körülményre, amit talán úgy jellemezhetnénk: "*mindenütt kutatunk valamit, de sehol sem mindent...*"

A magyarországi hivatásos természetvédelem és a vele együtt munkálkodó tudományos intézmények, egyéni kutatók joggal és "nyugodt lelkiismerettel" állhatnak a világ előtt: egyes nemzeti parkjaink (pl. HNP, KNP, az ANP egyes részei stb.), rezervátumaink biológiai tekintetben a nemzetközi átlagnál lényegesen alaposabb megkutatottak. Hasonló a helyzet bizonyos növény- és állatfajok, fajták esetében. Az első, immáron történelminek tekinthető alapos felvételezést évtizedekkel követően, újratérképezés révén ma már a legklasszikusabb monitorozásra, a bekövetkezett változások tényleges megállapítására is mód nyílik, igaz, egyelőre csak terület-parányokon (pl. Bátorligeti-láp, Sashegy stb.). A paletta azonban -- Magyarország egésze tekintetében -- közel sem ilyen kedvezően egyveretű. Tájegységenként és értéktípusonként, vagy akár a feldolgozottság mélységét illetően hiátusaink szembetűnőek. Egyes hazai közép- és kistájakról, egyes védett területekről csaknem semmit, vagy alig valamit tudunk. Ezen aránytalanságok okai meglehetősen jól körülírhatók, ily

módon a változtatás lehetősége is többé-kevésbé adott. Íme néhány a nyilvánvaló okok közül:

- a vizsgálati térség, a védett terület *földrajzi, "geopolitikai" helyzete:* jó néhány megközelíthetetlen határmenti, vagy zárt katonai terület volt (pl.: Dráva-menti területek, nyugati határsáv, HNP bombázótér stb.),
- A természetvédelmi kutatások *szervezeti és finanszírozási rendezetlenségei:* a kutatásokra szánt költségkeret mindenkori a főhatóságon belüli "hierarchia" függvénye volt. A szerződéskötésekre költségvetési "megfontolásokból" az esetek többségében a vegetációs időszak lezárultával kerülhetett sor, a természetvédelmi célokat szolgáló kutatások esetében elkerülhetetlen áthúzódó kutatások finanszírozása mindenkor bizonytalan volt (és részben az ma is). nem állt rendelkezésre olyan adatbank, információrendszer, amely kizárhatta volna a párhuzamosságokat, egyúttal jelölte volna a tényleges hiányokat. Hiányoztak (és anyagi okokból részben ma is hiányznak) azok az egységes vetületi rendszerű, léptékű, digitalizált alap- (munka-) térképek, amelyek szavatolták volna a mindenkori összevethetőség lehetőségét. Hiányzott a természetvédelem számára fontos szakterületi kutatások egységes térképi jelkulcsrendszere. És végül, de nem utolsó sorban, a sokszori átszervezésnek, költöztetésnek és alighanem egyéb okoknak "köszönhetően", valami vagy valakik jóvoltából 1991. januárjára gyakorlatilag teljes mértékben eltűntek a természetvédelmi állami megrendelésre csaknem harminc éven át készült kutatási jelentések, dokumentációk... Köszönet azoknak az egyetemi, akadémiai és más oktató és kutató intézményeknek, akik segítettek és segítenek felszámolni e lehetetlen állapotot.

A kutatóhelyek pénzügyi tekintetben ma is szembetűnő kiszolgáltatottsága és a fentiekben vázolt anomáliák ellenére az elért eredmények egyes szakterületeken és régiókban nemzetközi összevetésben is tiszteletet parancsolóak, másutt a változtatások elkerülhetetleneknek bizonyultak. A gazdasági-politikai átalakulás a természetvédelem számára is felgyorsított reakció-készséget követelt: ha a tervezett, konkrét térhez kötött infrastruktúra-fejlesztés (autópálya-, repülőtér-, távvezeték-, erőmű- stb. építés) konkrét kérdéseire a siker reményében konkrét válasszal kívántunk szolgálni, ha védett és védelemre tervezett területeinket a privatizáció "vadhajtásaitól" a lehetséges legnagyobb hatékonysággal mentesíteni akartuk, meg kellett kezdeni információrendszerünk felépítését. Látnunk kellet, hogy a papírlapok ezrein rögzített adatsorok a szükséges gyorsasággal nem válogathatók, ugyanakkor egy naprakész, "mobilizálható" természetvédelmi adatbázis és információrendszer létrehozása és folyamatos működtetése az átalakulás időszakában nem mindenkinek érdeke.

A mindenkor rendelkezésre álló természetvédelmi kutatási keretösszeg nagyságától függetlenül abszolút elsőbbséget kívántunk adni (és adunk ma

is) azoknak az állapotfelvételeknek, amelyek nélkül sem szakmailag megalapozott tervezésnek, övezeti rendszerek kialakításának, sem mértékadó döntéselőkészítésnek nincs helye. És valljuk meg: amíg a lehető leggyorsabb ütemben, a legrövidebb időn belül nem rendelkezünk átfogó, nem túlrészletezett, de meghatározó jelentőségű paraméterekkel, kétkedéssel kell fogadnunk minden olyan jelentést, összegzést, amely az ország egészéről kíván állapotjellemzést adni. A változások trendje, törvényszerűségei csak abban az esetben fogalmazhatók meg, ha adott a viszonyítás alapja. Mihamarabb el kell érnünk, hogy a Japán Természeti Környezete c. Atlaszhoz és egyes EU tagországok természetvédelmi tematikus térképezéséhez hasonlóan önálló jelkulcsi kategóriát képezhessen a "nincs adat" kategória. Ez ugyanis annyit jelent majd, hogy a zömről pedig van... Mára elmondhatjuk: viszonylag jól állunk. A Corine Biotopes-térképezés területén megkövetelt adatszolgáltatással és a metodikai újdonságokkal Magyarország az élenjárók közé került. Adatbázisainknak a már meglévő adatokkal történő feltöltése pedig a napi természetvédelmi gyakorlathoz nélkülözhetetlen nagyobb méretarányú értékelést is reményeink szerint rövidesen lehetővé teszi.

A "komplex természeti állapotfelvétel" programjának elnevezéséről annyit, hogy tudatosan változtattuk meg az eredeti elnevezést ("komplex ökológiai állapotfelvétel"). Tudomásul kell ugyanis vennünk, éppen a fentiekben vázoltak miatt, hogy "ökológiai mélységű" kutatásokra belátható időn belül az egész országterületre kiterjedően nincs és nem is lesz módunk. Mélységét illetően tehát annál lényegesen kevesebbre vállalkozhatunk, tematikailag viszont (indokolt és elengedhetetlen az abiotikus, élettelen természeti értékek számbavétele is) annál számottevően szerteágazóbb programot kell folytatnunk.

Már a program indításakor egységes tematikát és módszertant szerettünk volna bevezetni, illetve követni. A metodikai egyveretűség hiánya ugyanis újfent az összevethetőség hiányához vezetne. Saját szakmai háttérintézmény hiányában a tudományos körökhöz fordultunk. A részletes taglalása nélkül mondhatom: a konszenzus megteremtése nehéz volt... Szándékunkban állt, hogy a természetvédelem területén már többszörösen bizonyított kutatók, kutatóhelyek tervezhető, koncepciózus és számunkra is elfogadható munkát folytathassanak. Szándékunkban állt, hogy a feltáró kutatási programoknak a területet alighanem legjobban ismerő saját szakember-munkatársaink is alkotó részesei legyenek. Ma is úgy gondolom, hogy csakis ilyen típusú együttműködés okozhat örömöt, amely nélkül nem születhetnek valós, a kutatás és a természetvédelem gyakorlata számára egyaránt újat hozó eredmények. Változtatási szándékunknak megfelelően egy-egy (az esetek többségében több éves) állapotfelvételi program alapvetően három részből ál: 1. Annotált tematikus bibliográfia készítése, vagyis a már valahol rendelkezésre álló adatbázisok feltárása és előzetes értékelése. 2. Kutatási eredményes, értékleltár, fajlisták, térképek stb. 3. Gyakorlati útmutató a természetvédelmi szervezet számára (vagyis: mi a

teendő? A kutatási program a fajlisták rögzítésével nem tekinthető befejezettnek).

Sokszor három, kiemelkedően fajsúlyos természetvédelmi programról beszélünk: komplex természeti állapotfelvétel, természetvédelmi információrendszer, biodiverzitás-monitorozó hálózat. Nyilvánvaló, hogy valójában egy nagy rendszer egymásra és egymásba épülő mozaikjairól van szó. Tudnunk kell azonban, hogy belátható időn belül nem lesz rá módunk, hogy a monitorozást az ország egész területére, de akárcsak az összes védett területre kiterjesszük. Alighanem a változások nyomon követésének leghatásosabb módszere az állapotfelvételek 5-10 év utáni (lehetőleg hasonló módszerrel és hasonló paraméterekre kiterjedő) megismétlése, s a készített tematikus térképek szuperponált kiértékelése. Erre alighanem csak megkülönböztetett mintaterületeken, élőhelytípusokon lesz lehetőség. A széleskörű állapotfelvételi program folytatása és a biodiverzitás-monitorozás szervezett keretek közötti beindítása, a két program mindenkori harmonizálása ma különösen fontos feladatunk. (Ez utóbbi 1997. évi indításának immáron nincs akadálya). Természetvédelmi információrendszerünk működtetése, az adatbázisok folyamatos feltöltése, az állapotfelvételi- és a monitorozó programmal a kompatibilitás megteremtése ugyancsak nélkülözhetetlen. (1997-re e hálózat tárgyi - hardver és szoftver - feltételei adottak, a személyi feltételek hiányosak).

Kiemelt kötelezettségünk a legértékesebb magyarországi élőhely- és értéktípusok (az "ex lege" védelem alatt álló barlangok, források, lápok, víznyelők, szikes tavak, kunhalmok, földvárak, továbbá a földtani-felszínalaktani értékek, füves- és vizes élőhely-típusok stb.) országos leltárainak, minősítési-osztályozási rendszerének elkészítése, a konkrét védett területre irányuló védelmi-kezelési követelményrendszerek megfogalmazásához a természetvédelmi kezelési irányelvek kimunkálása (védett erdőkre, füves területekre készült, megjelent, a vizes területekre készül.).

Az 1992-ben a fentiek szellemében megkezdett, illetőleg a korábbi évek eredményeire erőteljes változtatásokkal épülő program regionális eredményeiről nemzeti parki- és természetvédelmi igazgatóságaink az érintett kutatók közreműködésével külön-külön, saját szakmai rendezvényeiken adnak számot. Ezek az 1-2 napos, termékeny vitákkal színesített konferenciák nyitottak mindenki számára. Az aggteleki rendezvény - miként e két kötet is alátámasztja ezt - kilépett a kizárólag nemzeti parkra irányuló kutatások ismertetésének köréből. Ha teljességre nem is törekedhetett, egy-egy rövid kitekintés erejéig némi képet kapunk arról, hol is tartottak a természetvédelmi kutatások 1996. májusában, kiemelten és elsősorban természetesen az Aggteleki Nemzeti Park területén?

Jó szívvel ajánlom e példamutató, sikeres rendezvény emlékét és mondandóját megörökített két tanulmánykötetet a megszállott, a természetvédelemért és tudományukért mindenkor elkötelezett tudósoknak,

kutató barátainknak, hivatásos és nem hivatásos, elkötelezett, jövőt építő természetvédőknek, az UNESCO természeti világörökség címét elnyert barlangvilág sorsáért (nemcsak aggódó, de) tenni kész érdeklődőknek, a térség lakóinak, a Karszt "szerelmeseinek", pártolóinak.

Budapest, 1997. március 8.

# I. SESSION:

# SPELEOLOGICAL RESEARCH

# NEW CONCEPTION AT BUILDING UP CAVES

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**Abstract:** Building up and showing of the most important, wellknown caves in Hungary for tourism goes back to the last 2oo years. Earlier building up of caves were generally local initiation, did not go beyond what strictly necessary because of the lack of funds.

After the World War II. the built up show caves worked under control of some state owned tourist companies. Mark an era that building and maintaining the cavefitting was financed by the state and sometimes caused unnecessary large transformation of nature.

It is characteristic of earlier building up caves that the aim of this was to serve the heavy tourism. This conception caused the quick and irreverse demaging of caves in many respects.

New idea about cave building up came up in the middle of 1970-ies when the National Authority for Nature Conservation was consolidated. Nowadays the process of the building in caves is relies upon uniform principles under the professional guidance of the Speleological and Geological Department of the National Authority for Nature Conservation.

I try to show these new ideas in practice by introducing some recently built up caves in my paper.

## Introduction

From the beginning of the 19th century various building up had been in several caves in Hungary. The aim of this was to serve totally the heavy tourism, meanwhile the protection and the conservation of the natural condition of the caves relegated to the background. Serious and irrevocable damages were caused by the permanent mending of the unsuitable technical equipment and the repeated complete reconstruction in most of the built up caves. New idea about cave building up came up in the middle of 70-ies when the Natural Conservation Council was consolidated. Nowadays in the process of the building in caves relies upon uniform principles under the professional guidance of the Speleological and Geological Department of the National Authority for Nature Conservation.

It is essential to cause the least transformation of nature by setting up there technical equipment which are suitable for their function for a long time. Repairing and maintaining should be simple.

## New conception in practice

### Concrete structures

Lot of damages were caused by the repeated breaking up and repairing (eg. because of cable defect) the various concrete structures in the earlier built up caves. To avoid these problems, all new concrete structures are built by piping the cast concrete for the different cables and wires or are built with

a wire-chase that can be opened from above in its whole length. So the problem of changing and repairing the cables or other wires are solved without breaking up the pavement and stairs.

**Ironworks**

The proper and lasting construction of the railings and other steel construction in the caves are not settled yet because of the strong corrosion. After many unsuccesful trials it seems to be the proper solution to use incorrodible material or structural units coated with zinc by chemical process. The reconstruction of the railing system in Baradla cave is planned in the near future from stainless steel material.

**Selection and placing the light-sources**

Generally in the old systems few high capacity glow lamps were used. This system did not fit the aesthetical illuminating engineering aspects and took to vigorous lamp vegetation.

Building new fittings, the type, number and position of the lamps, are fixed after test lighting. To avoid lamp vegetation the capacity and the period of lighting are reduced. We take precious good care of placing and setting of light sources.

In contrast to the earlier method we do not use light sources in narrow caverns because the strong lighting of the close surface cause rapid lamp vegetation. The old pavement lighting in Baradla cave is a good example for this. The light-sources were in the sidewall`s caverns. The new fittings solved this problem as the light-sources of the pavement are fixed on the railing far from the wall.

Well, using many, but low capacity light-sources we have the required light effect. We try to avoid the direct lighting effects by setting the light-sources. It is sufficient to use soft light for spectacular parts when the visitors pavement is in semi-darkness.

According to the above principles we reached that the capacity of the new lighting fell to the half of the earlier one while the scenery is constant in the Baradla cave.

**Lighting controll - operation**

Forming and linking individual lighting sectors according to the local circumstances are different. Usually the proper overlapped placing of the operating studs (press-buttons) ensure smooth leading of large groups too.

The timerate of light, in the Baradla cave is a new lighting system was developed to reduce. There is a general lighting system separated for relatively long sectors. This allowes the sightseeing of the cave (sector by sector). The stop-points can be found at the scenic parts in the larger halls. At these points special illumination electric circuits are developed, switchable locally and stop working when the visitors passed these points. Hereby the

switching on of the high capacity electric circuits can be limited for very short time. This new method helps to reduce lamp vegetation significantly.

In the St. István Cave electronic programgoverned controlls the lighting. But it is not really appropriate in spite of many advantages, because it does not adapt to the size of the visitors group.

The Speleological and Geological Department has been carried out infrared lighting controll experiences in Baradla cave`s Jósvafő section since 1988. After 8 years the experience shows that this is a good solution, so it is planned to innovate in wide range.

The infrared lighting-controll is for substitution the conventional studs-controll and reducing the timerate of putting on light. Extra advantages are: adaptation to the different strenght of groups, it hardly need maintenance and it is impossible to leave on.

The main point of it`s operation is that the longitudinal straight cave sections are observed by infragates, operating with modulated infrared ray. The visitor appearing in the section crosses the infrared ray and switches on the light, at the same time starts delaying the timer. As the delaying time is up the lighting switches off. One infrared ray can be 50m long, therefore the visitor can cross the ray several times. Each cross starts delaying the timer again. The delaying is adjustable. The adjustment must be adopted to the local circumstances, so the sections can be visited conveniently and safely. (During last 8 years the test equipment had one operating trouble.)

**Cave building up nature conservation purposes**

In Hungary there are caves rich in formations which can be damaged easily. Most of these are not suitable the develop them as showcaves. In these caves the moving of the professional visitors (scientists, explorers, prospectors), accidentally, can cause damages. To avoid this some caves had been built up specially for nature conservation purposes.

In Rejtek shaft cave fixed ladder had been built in to avoid damaging the formations by descending on ropes. In the most sticky part of this cave which is a crater-shape shaft widening down, a 28m long ladder was fixed at one point. Under the given circumstances the task could be carried out without damages.

Similar building up for protection were done at Esztramos in Rákóczi and Földvári caves.

Electric lighting had been set up in Földvári cave. This was made to avoid getting dirty of the formation and for better showing of the most scenic parts.

The Rákóczi cave is one of the most scenical and interesting caves in Hungary. In this cave each inch is covered with some kind of formation. The cave had to be maintained untouched as much as possible during (and after) the building up. Complying with the special requirements there were built welded steelstructured stairs and pavements fitted together on spot. Carrying

the track we try to follow the highly various shapes of the cave. Therefore the structures hardly disturb the view. The pavements are mostly fixed to the sidewall so the bottom rich in formation remained untouched. The steelstructure was fixed by welding to ironpins bored into the sidewall. The construction of the steelstructure provides fixing the cables of electric lighting and the placing the cablejoints. A bitumen based covering helps the corrosion protection. Compared to the conventional concret structures these pavement-stairs system is light, airy-fairy and needs less place. It hardly causes irrevocable damages in the cave. The expectation of life is about 20-25 years. It can be changed without any further damaging of the cave.

Electric lighting was made in the Rákóczi cave, too. This was also for the cave protection (no naked light) meanwhile it serves the better showing of the scenic formations. Building up both caves at Esztramos were meanly for conservation for the professional public but it also allowes to show the cave for tourists in smaller groups.

# CONDITION ASSESSMENT AND PC-RECORDING SYSTEM OF CAVES

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The registration and documentation of caves, the knowledge of the exploratory and scientific results achieved in them, are essential for their further researches as well as for their protection.

The first attempts to list the Hungarian caves were made as early as in the middle of the last century, and later at the beginning of this century when the Speleological Commission was established within the frame of the Hungarian Geological Society. Unfortunately, these works have disappeared and there is no detailed information on their content.

Though part-registers for smaller regions had been completed, the first comprehensive cave inventory of Hungary - based mainly on literature data - was compiled in the seventies only, by the commission of the National Authority for Nature Conservation. This inventory included the synonyms, geographical and administrative location, entrance data, dimensions, character, utilization possibilities and main bibliographical references for altogether 1322 caves, listed in alphabetical order within the main geographical units.

The first cave register regarding also the aspects of cave conservation and based upon systematic field surveys was developed by the precursor of our Institute, the IEP (Institute for Environment Protection) Speleological Division in 1982. For identification and classification of the caves the cadastral numbering system developed by the Documentation Section of the Hungarian Speleological Society in 1971-72 was adopted; which is based on a gradual, four-level geographical area division, with serial numbers up to three digits for the caves within each unit. The standard cadastral sheet of this registration system contained already 32 entries: besides the above data, it gave information on the bedrock, cave morphology, solid fill, hydrological and climatological features, discovery, previous studies and documentations, technical and administrative conditions of visiting, the developed length and reason of development, installations, endangering factors and surface protection category. The standard cadastral sheet was completed by an inset of 1:10.000 scale topographic map, and was accompanied not only by sheets listing the researches, the available maps, references, and photographs, but by related documents, too.

The field work started in the Bükk Mountains in 1982, and soon revealed the shortages of the former inventory. Several objects listed as caves proved

to be exploration sites, not cave-sized cavities or artificial tunnels; some others proved to be synonyms, indicated caves getting demolished in the meantime, or were unidentifiable due to insufficient data. On the other hand, hundreds of caves without any previous reference were found, too. Against the former 317, this work resulted the registration of 830 caves in the Bükk Mountains between 1982-85.

By a reorganization in 1986, the main activity of the former Speleological Division shifted towards state administration, controlling and direction of practical cave conservation and management. Cave registration tasks were continued mainly by commissioned cave researcher groups, and by the mid 90-ies significant progress were achieved in the Buda Hills, Aggtelek Karst, as well as in the Bakony, Gerecse and Pilis Mountains (Fig. 1). As a result, the detailed documentation of some 2000 of the currently known 3000 caves of Hungary are at disposal.

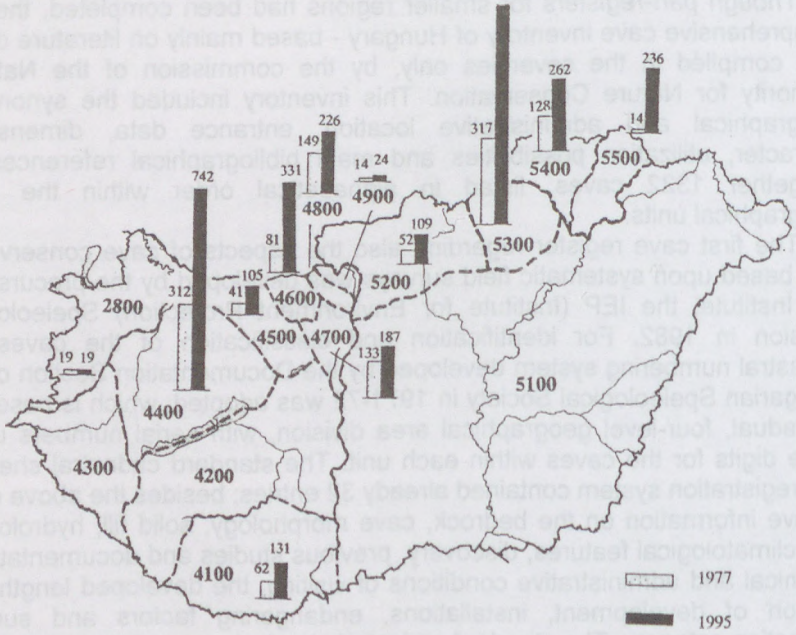



Fig. 1. Number of registered caves within the main cadastral units of Hungary

Practical work in cave conservation, however, has soon revealed, that the data of above cadastral system are insufficient to trace condition changes in the caves, as the entries record only the presence or absence of different features and effects, and give no information on their volumes, areal distribution and intactness. This demand resulted the compilation of an additional 'Condition record sheet' in 1988, and the condition survey of the increased protected caves soon began.

Parallel to the above efforts, the boom of personal computers raised also the demand for a computerized cave database system. For compatibility purposes with the planned central information system of nature conservation (Natinfo), a cave registration programmed was elaborated in 1991 by the application of the FOXPRO database-operation software. This numerical, coded data recording system already comprised condition information, too. In 1992 the code-lists were also elaborated, but before starting the data processing a central decision was made to apply the dBASE software, that operates data also in text format.

The currently used dBASEIV version of the speleological information system was developed in 1992. In this system each cave is characterized by 81 data fields. Three kind of fields are used. All the metrical data, where the demand of selection or sorting by values may occur (length, depth, water discharge, year of discovery etc.) are stored in numeric fields. Text data of similar size to all caves (name, geographical unit, responsible authority, etc.) are stored as characters; while information with very variable sizes (morphological elements, speleothem types, installation, etc.) are stored in special MEMO fields operating as auxiliary files.

To promote query operations, recording of text information is based on the key-words of the code-lists compiled for the FOXPRO-version, which refer mostly to the frequency, significance and condition of the given feature or formation. Of course, these key-words can be completed with additional remarks of any length.

The database involves 11 thematic groups:

I. IDENTIFICATION

1. Cadastral number - character field, 8 characters
2. Name - character field, max. 60 characters
3. Synonyms - character field, max. 120 characters

II. LOCALIZATION

4. County - character field, max. 60 characters
5. Settlement - character field, max. 60 characters
6. Geographical unit - character field, max. 40 characters
7. Entrance/s - MEMO field: topographical location *(e.g. hillside)*, environment *(e.g. forest)*, type *(e.g. natural)*, shape *(e.g. oval)*, direction *(e.g. vertical)* for each entrances + from the 4th entrance onwards co-ordinates, lot numbers, sizes.

8-16. X, Y, Z co-ordinates of entrance/s 1-3. - numeric fields, 6+6+3 characters
17-19. Lot number of entrance 1-3. - character fields, 10 characters
20-22. Width of entrance 1-3. - numeric fields, 5 characters/1 decimal
23-25. Height of entrance 1-3. - numeric fields, 5 characters/1 decimal

III. DIMENSIONS

26. Length - numeric field, 7 characters/1 decimal
27. Reliability - character field, max. 30 characters
28. Max. horizontal extension - numeric field, 7 characters/1 decimal
29. Volume - numeric field, 6 characters
30. Total vertical extension - numeric field, 5 characters/1 decimal
31. Reliability - character field, max. 30 characters
32. Depth *below the /main/ entrance* - numeric field, 5 characters/1 decimal
33. Height *above the /main/ entrance* - numeric field, 5 characters/1 decimal

IV. GEOLOGICAL-MORPHOLOGICAL CHARACTERISTICS

34. Bedrock age, type, formation - character field, max. 240 characters
35. Generic type and activity - character field, max. 240 characters
36. General shape - MEMO field: plan and vertical pattern *(e.g. multilevelled branchwork)*, cross-section types *(e.g. fissure-like)*
37. Morphological elements - MEMO field: the range and significance *(e.g. locally characteristic)* by types of
    - major formations (meandering channel, shaft, etc.);
    - smaller erosional features (scallops, anastomoses, etc.);
    - other bedrock-related features (fault plane, fossils, etc.)
    - morphological features of cave sediments (relict streambed, dripholes, etc.)

V. SOLID FILL

38. Cave minerals - MEMO field: the range and quantity of all speleothem types and minerals (stalactite, rimstone dam, gypsum, etc.) of the cave
39. Clastic sediments - MEMO field: the range and quantity by types of
    - autogenic cave sediments (breakdown, dripstone fragments, etc.)
    - allogenic cave sediments (quartz pebbles, loess, etc.)
40. Organic fill - MEMO field:
    - quantity and position of washed-in soil
    - nature and age *(e.g. pollens, Upper Pleistocene)* of fossil plant remnants
    - range and quantity of recent plants by classes (mosses, ferns, etc.)

- species and individual numbers *(e.g. one species in great number)* of fossil animals by classes (bats, other small mammals, etc.) and their age
- species, individual numbers and permanence of recent animals by classes
- age of fossil anthropogenic finds by types (fireplace, pottery, etc.)
- age of historic anthropogenic finds by types (coins, inscriptions, etc.)
- nature of modern anthropogenic deposits *(e.g. waste)*

VI. HYDROLOGY - CLIMATOLOGY

41. Average stream discharge - numeric field, 6 characters
42. Maximum stream discharge - numeric field, 7 characters
43. Number of inflows - numeric field, 2 characters
44. Average groundwater temperature - numeric field, 4 characters/1 decimal
45. Altitude of groundwater table - numeric field, 4 characters/1 decimal
46. Other hydrological features - MEMO field:
    - quantity and permanence of cave waters by types (dripping, stagnant, etc.);
    - average and maximum discharge of tributaries;
    - discharge and temperature of cave springs/inflows
    - number of relict, episodic and permanent cave sinks;
    - height of waterfalls;
    - number, depth and length of episodic and permanent sumps;
    - dimensions of groundwater table fluctuation
47. Average temperature - numeric field, 4 characters/1 decimal
48. Maximum $CO_2$-content - numeric field, 5 characters/2 decimals
49. Maximum Rn-activity - numeric field, 5 characters
50. Other climatological data and features - MEMO field:
    - temperature measurements: frequency, maximum value, its site and date;
    - humidity by senses, frequency of measurements, average and maximum values, site and date of the latter;
    - $CO_2$-content by senses, frequency of measurements, average value, site and date of maximum value;
    - episodic and permanent air flow by senses, frequency of measurements, maximum value, its site and date;
    - Rn-activity measurements: frequency, average value, site and date of maximum value

VII. STATE OF KNOWLEDGE

51. Year of discovery - numeric field, 4 characters
52. Year of first reference - numeric field, 4 characters
53. Exploration history - character field, max. 160 characters

54. Thematic elaboration - MEMO field: exhaustiveness of researches *(e.g. complete)* by topics (mineralogy, archaeology, mapping, etc.)

VIII. ACCESSIBILITY

55. Objective and subjective conditions - MEMO field:
    - approachability *(e.g. on signed trail)*
    - difficulty of trip *(e.g. easy walk)*
    - necessary equipment *(e.g. basic)*
    - subjective conditions *(e.g. with special permission)*

IX. INSTALLATIONS

56. Year of lock-up - numeric field, 4 characters
57. Reason(s) of lock-up - character field, max. 120 characters
58. Year of development - numeric field, 4 characters
59. Reason(s) of development - character field, max. 120 characters
60. Developed length - numeric field, 5 characters
61. Year of electric installation - numeric field, 4 characters
62. Artificial objects - MEMO field:
    - material, volume and condition of built structures by types (pavement, etc.);
    - condition and length of linear structures by types (water-supply, phone, etc.)
    - condition and number of instruments by types (water-gauge, etc.)
    - condition and volume of temporary installations by types (rope, ladder, etc.)

X. PROTECTION

63. Legal declaration of protection - character field, max. 30 characters
64. Declaration of increased protection - character field, max. 30 characters
65. Legal declaration as medicinal cave - character field, max. 30 characters
66. Archaeological-paleontological protection - character field, max. 20 charact.
67. Cancellation year of protection - numeric field, 4 characters
68. Year of destruction - numeric field, 4 characters)
69. Responsible authority - character field, max. 60 characters
70. Utilizer, number of authorization - character field, max. 60 characters
71. Caretaker - character field, max. 60 characters
72. Research permission(s) - character field, max. 120 characters
73. Protection category of surface - character field, max. 120 characters
74. Registration number of protected surface - character field, 9 characters
75. Surface economic conditions - MEMO field:

- rate of nature conservation and other properties; property nexus of entrance/s
- land use by order of dominance *(e.g.* dominant: *forest;* secondary: *pasture*)

76. Evaluation of endangering factors by types (quarrying, etc.) - character field, max. 240 characters
77. Condition by general view *(e.g. slightly modified)*, speleothems *(e.g. intact)* and floor sediments *(e.g. partly removed)* - character field, max. 240 characters

XI. DATABASE INFORMATION

78. Source of data *(e.g. complex condition assessment)* - character field, max. 40 characters
79. Date of survey - character field, 12 characters
80. Date, reason and nature of corrections - MEMO field
81. Remarks - MEMO field: suggestions, necessary measures, etc.

The field work required to obtain information on such a detailed level is carried out by specialists and cave researchers familiar with the given cave; and has already been completed for more than 100 increased protected and other significant caves of Hungary.

# RESTORATION WORK IN THE 'CAVE CELLARS' OF THE BUDA CASTLE HILL

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The cavities of the Buda Castle Hill represent a special group among the speleological values of Hungary. They are unique by their origin, as they were dissolved into a thermal spring travertine by a later generation of upsurging thermal waters; and they are unique by their role in the history of the Castle District. Widened to cellars and used for different purposes by the locals since the Middle Ages, these 'cave cellars' reveal a peculiar mixture of natural values and cultural relics.

## Geological and speleological setting

The main volume of the Castle Hill is built up of the Upper Eocene Buda Marl Formation. Alluvial silt, sand, and gravel deposited onto the surface of the marl prove, that in the Middle Pleistocene the area belonged to the flood-plain of the Ördögárok Creek. Thermal spring activity started here in the Mindel-Riss interglacial and resulted the deposition of a spring travertine complex in a thickness up to 14 m. This hard caprock preserved the underlying sediments from later erosion of the entrenching Danube and Ördögárok valleys.

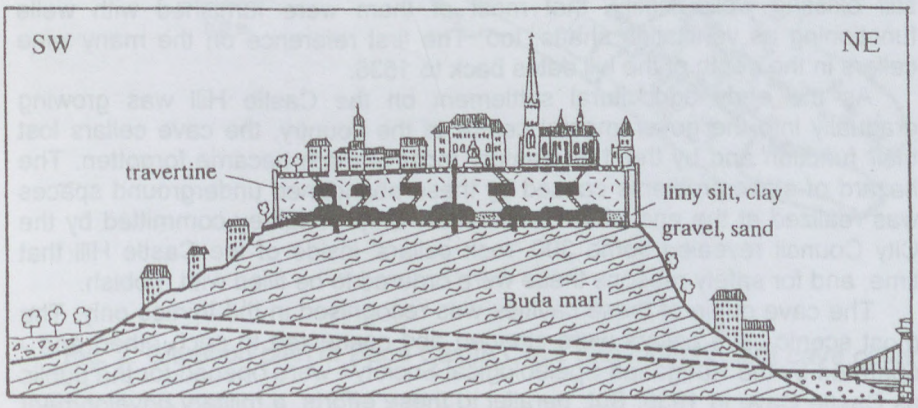



Fig. 1. Schematic section of the Buda Castle Hill (after KADIĆ, 1938)

The cave cellars are situated at the bottom of this travertine caprock in a depth of 4-12 m under the surface in the central and northern part of the Castle Hill. Their ceiling consist of travertine, where the spectacular dissolutional morphology refer to a cave origin of these cavities, while their walls expose mostly unkarstifiable sediments: limy silt, clay or weathered marl (Fig. 1). Based on these geological conditions, as well as the dissolutional morphology similar to those in Buda thermal caves, and the results of absolute dating which indicate a significantly younger age for the travertine in the southern part of the hill; the presence of natural caves can be interpreted by the dissolving effect of these later thermal waters moving horizontally along the boundary of the older spring travertine and the underlying clayey sediments. Artificial changes carried out in different ages modified essentially the original size and shape of these caves, but most probably they were isolated, low, anastomotic passages only, which were easy to widen to cellars toward the soft silt and clay layers below.

These modifications, on the other hand, have resulted an excellent insight not only into the nature of the travertine complex, but the stratification and the hydrology of the hill, too; and have exposed significant paleontological finds at some places.

**Historical aspects**

The inhabitants of the Castle District discovered the natural cavities probably while well-digging, and deepened them to wine cellars in the Middle Ages. That time - and even at the beginning of our century - the cave cellars formed separate units. Proved by stone gates and old stairs leading towards the higher cellars, each of them were accessible from the houses only (Fig. 1). Dozens of wide shafts carved thoroughly through the travertine, and many still existing wells testify, that most of them were furnished with wells functioning as ventilation shafts, too. The first reference on the many wine cellars in the depth of the hill dates back to 1536.

As the early agricultural settlement on the Castle Hill was growing gradually into the governmental centre of the country, the cave cellars lost their function and by the 18th century most of them became forgotten. The hazard of static problems caused by these abandoned underground spaces was realized at the end of the last century only. A survey committed by the City Council revealed some 300 'rock cellars' inside of the Castle Hill that time, and for safety reasons these were ordered to be filled with rubbish.

The cave origin of these cavities was recognised in the thirties only. The most scenic cave cellars were cleaned and connected to each other, and - operated by the Hungarian Speleological Society - were opened for the public as Castle Cave in 1935. But, parallel to these efforts, a military development of certain cave cellars also began, and later the events of the IInd World War determined the utilization of all cavities. By further connections a 4 km long system consisting of some 200 chambers was created (Fig. 2), which - implemented with water supply, electricity and canalisation as well as

emergency exits to the hillside - served as an air-raid shelter for thousands of people.

Though this interconnected system was strengthened with masonry walls, pillars and vaults in the fifties, it still preserves significant natural and historical values by its spectacular dissolutional ceiling morphology, geological curiosities (such as incrusted plant and bone remains or pisolite layers in the travertine), and by the several architectural relics of the one-time wine-cellars. Due to its complex significance, Buda Castle Cave was declared an increased protected cave in 1982.

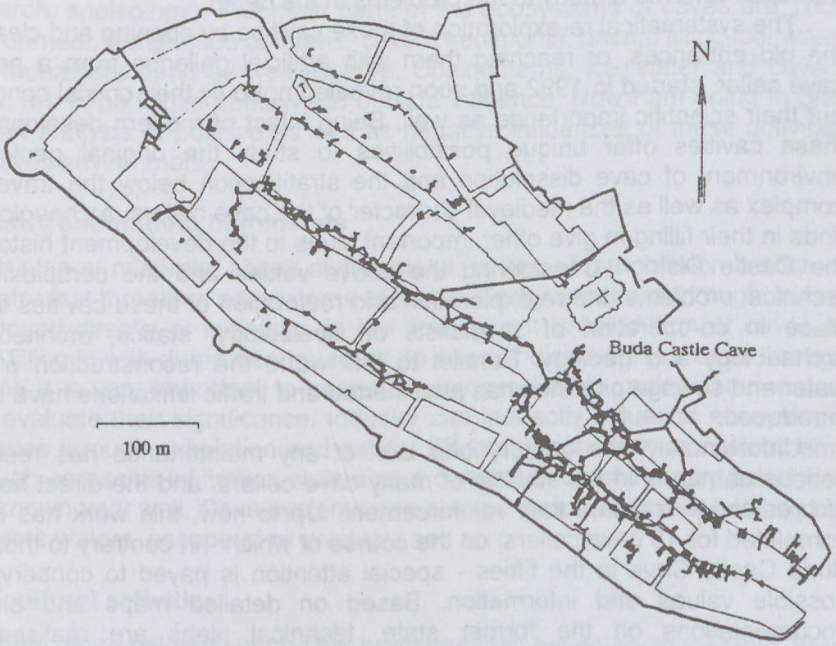



Fig. 2. Situation plan of Buda Castle Cave and independent cave cellars

**Conservation problems and restoration work**

Due to the geological conditions, the urban environment represent an intensive endangering factor for the cavities of the Castle Hill. Effects of the

increasing traffic and the leaking pipelines are weakening slowly but constantly their stability by widening the gaps within the travertine and by compressing and wetting the underlying soft sediments. Stability changes of the relatively shallow seated cavities, on the other hand, may directly endanger the monumental values of the Castle District belonging to the World Heritage.

All these problems are even more stressed in the case of the independent cave cellars situated to the north and to the south of Buda Castle Cave. These cavities, which have preserved their separated character, are mostly conserving a state from the turn of the century: filled up more or less with rubbish, they are inaccessible and abandoned; or hidden by later structures, are absolutely unknown today. These forgotten cave cellars drew attention at the beginning of the nineties only, when surficial damages referred already to the problems in the depth.

The systematical re-exploration of these cavities by opening and cleaning the old entrances, or reaching them with artificial galleries from a nearby cave cellar, started in 1992 and soon revealed not only their critical condition but their scientific importance as well. Being intact of modern development, these cavities offer unique possibilities to study the original geological environment of cave dissolution and the stratification below the travertine complex as well as the medieval character of the cave cellars; archaeological finds in their filling-in give other important clues to the development history of the Castle District. Considering the above values and the complexity of technical problems, the re-exploration and restoration of these cavities takes place in co-operation of specialists on speleology, statics, architecture, archaeology and geology. Parallel to this work, the reconstruction of the water and sewage pipelines has also started and traffic limitations have been introduced.

Unfortunately, the century-long lack of any maintenance has resulted serious damages in the stability of many cave cellars, and the direct hazard of breaking-in requires their reinforcement. Up to now, this work has been completed for 10 cave cellars, on the course of which - in contrary to those in Buda Castle Cave in the fifties - special attention is payed to conserve all possible values and information. Based on detailed maps and photo-documentations on the former state, technical plans are realised by permissions of nature conservation and monumental authorities, and modern walls, pillars or vaults are arranged with special care to preserve natural cave surfaces, interesting geological features and stratigraphical information as well as any architectural or historical values.

# ANTROPIC INFLUENCES ON THE ECOSYSTEMS OF CAVES

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Ecosystems of caves are in the last decades exposed to a growing pressure of many different human activities. One part of these activities has got economical character and is not directly connected with using of caves (industry and mining of minerals, agriculture, forestry, water supply, construction), the other part aims at direct using of caves environment and its natural resources (tourism and holiday traffic, speleotherapy, science research, speleology). The main parts of the ecosystems of caves are: rock environment, fillings (speleothems, cave`s sediments, animal filling,ice, water and fauna/flora dead as well as alive. Speleothems, ice, water and cave`s fauna are in particular sensitive to outside influence. Now I am going to give you an analysis of positive as well as negative influences of these activities on caves environment.

## Industry and mining of minerals

Mining of minerals, above all limestone, is one of the collision branch of industry that threatens ecosystems of caves. Ecosystems are through mining destroyed directly or indirectly. In the first case it is liquidation of caves or their filling in with dump near quarries. In case of discovering a cave through mining it is very important to search it very precise, to make documentary and evaluate their significance. Industry can indirectly influence ecosystems of caves through exhalation and ashes. Effects of corrosion of speleothems through agressive infiltration waters as a consequence of industry exhalation are known very well. Cave-systems can also be disturbed through letting out of waste waters, escape of oil products and so on.

## Agricultural activities

Agriculture belongs among the branches that, especially in the past, most deteriorated ecosystems of caves. Some negative effects continue until now, especially

- storing of chemical and stable dung in karst localities. Especially wild storing pollute a great part of storages of karst waters and ecosystems of caves in a direct or indirect way by destruction of karst rocks and of speleothems (it begins an increasing production of oxid in soil layer and the agression of infiltration waters increases). In principle storage of dung must be located outside karst areas !
- excessed dunging of agricultural area and concentrated letting out of dung-water in karst areas have similar unwanted effects. It is necessary to

establish a protected area for protecting of ponor and active flow caves with a separate water regime.
- unsuitable choice of agricultural culture as well as unsuitable way of ploughing on slopes increases soil erosion and washes down soil sediments into caves.
- unsuitable areal recultivation with an excessive removal of growth and with filling in of depression forms of terrain disturbs soil cover, promotes erosion and so threatens ecosystems of caves
- liquidation of dead animals and chemical waste into chasms and dolinas. This dangerous phenomenom can be prohibited by fencing around of the location together with an appropriate form of education.

**Forestry**

From the point of forestry ecosystems of caves are negatively influenced by deforestation especially by clearing. They increase erosion in karst regions that leads to quick wash out of soil sediments into caves as well as change the regime of infiltration vadoz waters that can have negative influence on the creation of speleothem. In principle clearings in karst regions are to be excluded !It is very important to preserve the original character of vegetation especially over ice caves (removal of vegetation may cause warming up of rock`s cover and reduction of ice filling). Several caves have been destroyed or filled in by construction of forest roads.

**Water supply**

Water dams and pumping water power stations mean a radical intervention into caves environment. Caves are in such a case directly destroyed either covered with concrete or flooded, their natural regime is possibly disturbed by change of water level of karst waters.
More frequent are cases of catching of water flows flowing from caves for drinking purposes. As a rule a case is at the same time closed.

**Construction**

There are cases of damaging of caves by destroying or filling them in by reconstruction of roads, buildings or tunnels.

**Tourism and holidays traffic**

The most widespread way of using caves is tourism. Caves as unusual natural phenomena are tourist attractive, especially in the vicinity of holiday resorts they attract a lot of visitors. A visit to a cave enriches cultural-aesthetic feeling of people, increases their relation to nature and home and with an appropriate explaining of a guide also contributes to the protection of cultural values. Touristic using of caves is however accompanied with undesirable effects as breaking of dripstones, interventions into caves

environment, partial changes of underground regime, microclimate and so on. There is a possibilty to use caves for tourism and holiday traffic besides their access also through guide service or individual tourism seeings.

**Accessibility to a cave**

It is realised through an opening of a cave or a part of it for public by securing safety communication of visitors, lighting of the spaces and paid guide service. These principles are to be stuck to before a cave is made accessible:

- a precise research of underground spaces must be made before a sight-seeing path is chosen. Course of the path is to be set in such a way that values of a cave are not damaged (decoration, archeological and paleonthological subjects, caves animals). Caves with particular precious elements must not be accessible for the public!
- to do only such interventions into cave environmental system that are reversible (i.e. can be set back in the original state). Remember a possibility of removal of each technical work from a cave!
- a seeing path should be realised in such a way that needed technical arrangements fit into the natural environment and use as few of foreign technical materials as possible.
- to secure a non-stop monitoring of visitor`s influence on cave`s environment, especially precise in ice and aragonit caves. The number and the frequency of visits set according to the feasibility. Unwelcome phenomena (as for example lampenflora) are to be removed regularly.
- a cave seeing should be done only with a guide and in such a number that the guide is able to supervise the whole visitor`s group. It is advisable that the guide`s explanation contains also passages with educational aim to the protection of caves and their components. Caves only in this case can fulfil their educational and instructional aim.

**Guide service**

Guide service is a form of organized seeing of non-accessed caves with a guide-caver. We do not recommend to realise the guide service in the following cases :

- in caves declared or suggested to be declared for a natural culture sight
- in winter time (during bats hibernation)
- in caves with permanent colonies of bats
- in caves with rich speleothem decoration or with precious sinter shapes, aragonits or other crystalic mineral shapes, ice or particularly precious cave`s animals

For realisation of guide service it is necessary:

- an efficient research and documentation of the cave with such a choice of seeing tour that will guarantee intactness of natural values (in particular of decoration and cave`s flora) of a cave and visitor`s safety.
- the feasibility and frequency of the visitor`s is not to be exceeded (on principle 5-8 people once or twice a week).

**Health**

Some caves are used for healing purposes of upper respiratory tracts as well as allergic illnesses by speleotherapy.Cave`s environment thanks to special microclimate, clean air without irritating elements, high contents of ions of calcium and magnesium in cave`s aerosol and probably also owing to favourable radiologic circumstances has a healing effect on these illnesses. This treatment does not cause marked and permanent changes in underground regime of a cave (after patients have gone the changed microclimate indices comparatively quickly return into the original state). It is the most human way of caves' using.

**Culture**

rganizing of cultural events in a cave does not influence in a considerable and permanent way the cave`s environment. But it is important to locate them in those parts of a cave where the bats do not stay.

**Science and sports (speleology)**

Speleology is the most widespread form of man`s contact with a cave at present. During practical speleologic activity from point of cave protection it is necessary to respect the following principles:

- do not leave any traces in the cave. Waste, used carbid, batteries are to be brought to the surface.
- do not smoke in the cave, do not make any inscriptions or drawing on the walls. Measure points mark inconspicuous with a rivet or a small colour mark.
- do not take any rocks from the cave unless they are taken for scientific research
- research and discovering works realise in such a way that causes fewest possible change in the cave`s environment, especially so that the sinter decoration is not damaged
- to recognize early archeological and paleonthological promising caves and continue research in them very sensitive and cautious
- do not disturb bats and other cave-animals. In winter do not make any research in those caves where bats stay
- for colouring of underground flows use organic colours

Speleological activity on condition of keeping above mentioned principles is to be understood as contribution to science, research and culture. On the

other side however a speleologist have to realise that he is not discovering a cave for himself but for the society that`s why it is necessary to respect universal, above all scientific interests.

**Commercial collecting of cave's material**

It is social the most dangerous activity in caves that is spreading out in last years and generally threatens natural and cultural-historical value of caves. It is above all illegal collecting of natural or cultural- historical material from caves, often also by foreign collectors for their sale on different stock exchanges and illegal business. They collect above all :

- dripstones and other speleothems
- cave-animals
- especially dangerous is the collecting of some kinds of genuine troglobionts that are at present seem to disappear from caves
- archeological and paleonthological subjects. By searching after them cave-sediments are usually non-professionally damaged and devaluated.

Against such an activity it is necessary to take some radical arrangements, especially:

- caves with significant animals, valuable sinter forms or archeological and paleonthological findings close preferencial and regularly the intactness of the seals ought to be controlled regularly.
- when a cave or chasm in view of their big dimensions cannot be closed it is necessary to mark them with "No Entrance" and increase control activity with wardens, cavers in connection with the police. In proved cases it is necessary to watch the locality non-stop at least during summer months.
- nature conservancy organizations should regularly attend stock exchanges and to take measures for stopping of sale of protected rocks.

It is necessary to preserve cave`s ecosystems with all their components in their present state of natural developement with permanent keeping of all natural factors that directly or inderectly influence a cave. Using of caves must be subordinated to this aim and must respect preserving of cave`s ecosystems.

# PC-PROCESSING OF THE SPELEOLOGICAL BIBLIOGRAPHY

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The PC-processing of the Speleological Bibliography was started in 1992 by the Institute for Speleology in the PC-language mIsis (developed by the commission of UNESCO), which was determined by the National Authority for Nature Conservation. The advantages of this program are: low hardware need, high speed, simple usability. Minimum hardware and operating system is: AT 286, 640 KB RAM, DOS 3.0.

Based on the manual data structure of the Institute, dr. Miklós Rajczy started to develop the structure of the database. For the usability of Hungarian and Central-European accents the data were recorded on DOS 852 code page. In case of suitable printer the direct printing is available, or print is available after running a word processor-macro which formats the text. All records contain 18 fields, 7 fields contain sub-fields. The program makes indexed files from 16 fields, which gives a high speed searching possibility. Free text searching is optional, and the combination of the two methods is give a powerful searching and selecting possibility.

The database contain 9000 records. Processed data are: the Speleological Bibliography 1915-1955; the bibliography of the caves of Aggtelek Karst; the annual reports of caving groups and a part of the registered literature at the Institute for Speleology. The Speleological Bibliography until 1914 and the periodicals of Hungarian Speleological Society are under processing. The records contain just partial information, only 870 records are completed.

# MANAGEMENT PLANS FOR WORLD HERITAGE SITES - APPLICATION OF IUCN GUIDELINES FOR CAVE AND KARST PROTECTION

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**Abstract:** Karst landforms and associated features such as caves are distributed widely throughout the world. They have many values and many are located in various protected areas including several sites designated on the World Heritage List.

Karst and cave areas require special management considerations often extending well beyond the formal boundaries of protected areas in which the more obvious features fall.

Caves and Karst are amongst the most vulnerable of landforms, and are often subject to degradation as a result of phenomena or events which occur at a considerable distance. Their effective protection and management therefore requires consideration and action at both regional and local levels.

The study compares the application possibilities of IUCN general management Guidelines with regional characteristics.

See in Proceedings Volume II. pp. 197.

# EFFORTS FOR THE RESTRICTION OF THE LAMP FLORA. RESULTS AND EXPERIENCES BETWEEN 1984 AND 1996

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## The flora of caves

The flora of caves can be grouped into three units, depending on the habitat: entrance flora, darkness flora and lamp flora. These three groups differ essentially not only in the habitat but also in species composition.
The flora of the cave entrance region is composed of species adapted to the special conditions found there, i.e., fairly constant temperature, high moisture and poor light conditions. Darkness flora comprises the plants living in the total darkness while the species of the lamp flora inhabit the illuminated areas around the lamps.

The analysis of species composition and immigration process proved that the alga and bryophyte species of the lamp flora originate mainly from the wider environment of the cave entrance. Both among the algae and the mosses we can find species typical of the entrance flora as well as the environs of the lamps, the bulk of the species, however, originates from different habitats. Lichens were, so far, not spotted in the Hungarian lamp flora, though we know one taxon which is present in almost all entrances. In case of Hepaticeae, the situation is similar: though they are frequent in the entrance region of caves, none of them was found in the lamp flora so far.

## Evaluation of the lamp flora

All over the World, including Hungary, a large number of scientific investigations and experiments have been devoted to lamp flora evolved in illuminated caves. Opinions vary if the green cover formed around the lamps can be considered useful, indifferent or harmful to the cave. Speaking on behalf of nature protection and health control, the answer is unambiguous: lamp flora is not desirable in caves.

Nature protection aims at possibly preserving protected objects in their original state. Lamp flora can be considered from all respects "alien" from the original flora of the cave and their propagation can be dangerous even for the non-organic formations of the cave. It will cover spectacular mineral formations and serve as a basis for the intrusion of flora and fauna dangerous for the original vegetation of the cave which were adapted to special conditions within the cave.

Lamp flora can be extremely harmful in therapeutical caves. The main factors of the healing effect of caves is purity of cave atmosphere, void of

dust, allergenic elements, bacteria and viruses. The whirling air caused by the lamps can move, even circulate, dust, vegetal particles, spores of fungi. In all caves used for therapeutical purposes the formation of lamp flora is most likely and most rapid just at the therapic zones due to frequent and long lasting illumination.

**Protection methods against the lamp flora**

All parties concerned agree that the best way of protection against thick vegetation cover around the lamps is prevention. Lamps of suitable type and light intensity should be planted, directed and enlighted to minimize the amount of light on a given surface. These factors can delay the appearance of the lamp flora. The idea may arise that improper handling of the cave is responsible for the appearance of the lamp flora; we should like to emphasise, that lamp flora will sooner or later appear in all lit caves as a regular consequence of the introduction of lamplight. The cave atmosphere is rich in moisture, the walls are wet, there is a lot of dripping water and the nutrients necessary of plant life are available. Therefore it is necessary that around the lamps, in the lamp-lit areas green plants will appear. By the minimization of light quantity and the use of proper lamp types this phenomenon can be restricted but for stopping the formation of lamp flora, visitors should be kept out. As a result of the new construction and reconstruction works in several Hungarian caves, the amount of light decreased essentially, in some caves close to optimal measures.

Unfortunately, while planning the light system of caves opened to public in the past this point was not considered. Thus in several caves the growth of lamp flora became dangerous, even catastrophic. The most grave consequences of bad lighting system were always observable in the Abaliget cave.

After the optimization of the light system, there are two possible ways of protecting the cave: mechanical cleaning and chemical treatment. Decision should be made individually for all caves, even for all green patches on the optimal and least harmful intervention. The amount of chemicals, by all means, should be kept on a minimum.

It is important to emphasize that the caves themselves are different as well as the lamp flora evolved in them. Therefore there is no all-round solution which could be used in all caves irrespective of local conditions. Different methods should be used, for example, in a cave largely covered by clay than in a cave with "popcorn-calcite" formations). In the course of our work special attention was paid to selecting solutions optimal to the site.

**Experiences:**

New, fresh patches can be efficiently cleaned with chemicals. These patches cannot be larger than a few square centimetres and not older than 6 months.

Old coatings, however thin they seem, probably form a continuous layer. This layer cannot be intruded efficiently by the chemical agents. In such cases, the coating should be detached mechanically (by brushing, scraping, burning) and the resulting surface should be sterilized by chemicals.

In the case when the growth of vegetation reaches a critical level, the vegetation cannot be cleared away without damage to the cave.

There are hopeless situations like in case of the travertine (calcareous tuff) surfaces of the Anna-cave.

The most important and most promising method is prevention and regular treatment (at least two times a year).

## EXPERIENCES ON THE CAVES TREATED BY THE AUTHORS

### Szemlő-hegy Cave

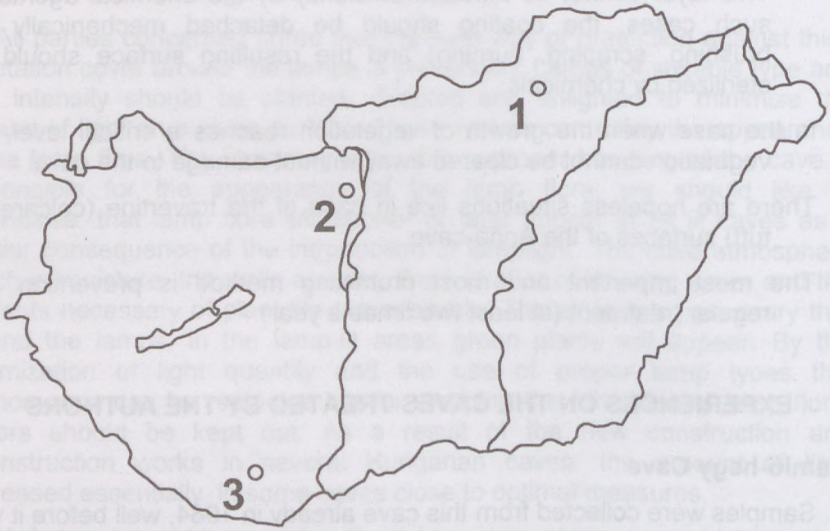
Samples were collected from this cave already in 1984, well before it was opened to the public. Since October 1986, the cave is regularly monitored. Due to this special care, coatings have never developed to a degree that would necessitate mechanical detachment. The pale spots of the forming vegetation were immediately sterilized by chemicals. On the arborescent "popcorn-calcite" formations of exceptional variety and beauty no mechanical treatment could be accomplished without destroying the formations themselves. A special problem encountered in this cave is that the light system planned for tourism is recently used too long during therapic treatments.

### Pál-völgy Cave

This cave is the oldest illuminated cave in Hungary, opened for public already in 1927 by lamp-light. In the past few decades it has been working, with minor breaks, as a show cave. Consequently, since the 60-ies we have proofs on the existence of lamp flora in the cave. There were several efforts by several colleagues to eliminate the unwanted vegetation with variable methods. The light system of the cave was rebuilt several times. The current system can be considered best against the propagating of the lamp flora.

In our practice, chemical treatment by the usual chemicals in normal dose (concentration, quantity) did not work, thus we had to clean off the

surface mechanically and after this, the surface was sterilized by the chemicals. This method proved generally adequate, but the plant-free condition of the cleaned phases, exposed for long time to light, was not very lasting. In places like this only an essential decrease in the amount of light emitted could be effective.




Caves treated by the authors: 1. Anna and István Cave; 2. Pál-völgy and Szemlő-hegy Cave; 3. Abaliget Cave

**Abaliget Cave**

As this cave is unique in the Mecsek Hills, the cave was already illuminated by the end of the 50-ies. Huge reflectors with strong light offered ideal conditions for plant life and propagation. As a result of a series of reconstruction, the intensity of light is currently only a fraction of the original, though it is still too much. In 1992, when we started our efforts the cave formations were covered with thick moss cushions and maidenhair spleenwort (*Asplenium trichomanes*), a fern species grew in great quantities all over the cave.

During the treatment of the cave all green surfaces were cleaned mechanically as well. Chemicals alone were used in exceptional cases like unreachable places or travertine encrustation. On the ceiling covered by small stalactites burning was also tried with hot air current. Unfortunately this burning is very time-consuming, therefore it was used only at a few places. After the mechanical detachment of the green cover, the surfaces were sterilized by a solution of 5% formaldehyde.

By the autumn of 1992, the Abaliget Cave awaited for visitors void of lamp flora in its original beauty. We were confident that the laborious cleaning will solve problems, if not forever but for a long time. As to the plans the treatment should have been followed by the reconstruction of the light system. Cleaning and a cave-friendly light system would save the cave from the lamp flora for a long time.

Unfortunately this was not the case. After three years, the cave is again full with green plants. The reason for this is the inadequate light system favouring the formation of lamp flora combined with bad and careless practice of operation.

**István Cave**

The cave was opened to public quite early, already in 1931 by electrical light and had a heavy traffic till the World War II. In 1944 the cave was closed and opened again for a short time in 1953. After this, the cave was closed again. In 1955 it was finally opened to visitors. The tour offered to the public was shortened. The cave has been open ever since with short reconstruction breaks.

Collections proved the existence of mosses already in 1962 within the cave. By 1982, ferns were also spotted. In those times, the well-lit areas had already a rich green vegetation.

To our best knowledge, there were two occasions before our trials when the detachment of the lamp flora was essayed, i.e., in 1977 and 1980. The authors of this paper cleaned off the vegetation at the most important points in February 1995.

The current light system of the cave, planted during the winter of 1988/89 can be considered adequate for preventing the propagation of vegetation. The lamp flora was considerably driven back by the decrease of light intensity and illumination breaks. There are still some coatings on several places, but they are hardly noticeable in the dim light. Most of the stronger coatings were detached.

**Anna Cave**

The construction of the cave for visitor traffic started together with the development of the local resort place, Lillafüred in 1928. The cave was already open to public, but the electrical light was introduced only in 1931. The cave was ruined during the World War II. It was temporarily restored by 1952, and in 1955 it was supplied with a new light system. Reconstruction of the light system took place first in 1974. In 1986, the cave was temporarily closed for safety reasons. In 1988, considerable work was performed here and finally after the total replacement of the light system the cave was opened again on the 1st of April 1989.

We have data on the lamp flora of the cave also from 1962. In the 80-ies, the environs of the lamps were covered by an almost continuous fur of

mosses. During the long break (more than three years), the thick moss coating was essentially diminished. The current situation is much better, due to the break in operation and the new light system.

An experimental cleaning of the lamp flora was started in February 1995. On the travertine (calcareous tuff) formations of the cave representing the special attraction of the place no intervention was made because former studies indicated, that

1. it is impossible to detach the green coating from the mineral formations without destroying them;
2. the light chemicals used by our team are not adequate, and the use of strong chemicals like solutions of chlorine are not acceptable because of their effect on the cave fauna;
3. application of heat is practically not feasible.

We can say that the cleaning of the dripstones of the cave is possible though its efficiency will be far from that of the treatment in other dripstone caves. Only further studies will tell the extent of plant-free state and its lasting effect here. The situation is not very promising as the dripstone formations cover only a minor portion of the cave, and about half of them were already included in the experiments.

A plant-free state for the travertine formations of the cave can be achieved only, disregarding strong chemicals, by longer phases of break in operation or the shifting of the tourist routes to provide lasting darkness at some parts of the cave.

**Acknowledgements**

The authors are greatly indebted to the staff of the Speleology Department of the Hungarian Ministry of Environment and Regional Policy as well as to the keepers of the caves involved. The study was supported by the Hungarian Ministry for Environment and Regional Policy.

# A REVIEW AND EVALUATION OF THE SPELEOLOGICAL VALUES OF THE BÉKE CAVE AIMING AT A COMPREHENSIVE SCIENTIFIC RESEARCH PROGRAM

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**Abstract:** On the assignment and with the financial assistance of the Institute of Speleology a 1:100 scale map of the Béke Cave has been completed with the contribution of Judit Kisbán, M Sc. Mining engineer. In the course of the survey such details of the cave were revealed to the author that had not been commonly known formerly. The complex research of these details would present the speleological attractions of the Béke Cave in a focus, their research would significantly improve the knowledge of the Aggtelek caves. The experienced facts were recorded in a report of 93 pages. The report reviews the unique speleological values of the Béke Cave, the scientific problems conserning particular phenomena and also suggests a schedule and pattern of organization for the research. The paper spotlights - without aiming at completeness - some of the speleological peculiarities of the Béke Cave.

See in Proceedings Volume II. pp. 233.

# THE MENDING OF MAN MADE DESTRUCTION IN THE BÉKE CAVE AND WAYS OF THE RESTORATION OF THE ORIGINAL CONDITIONS

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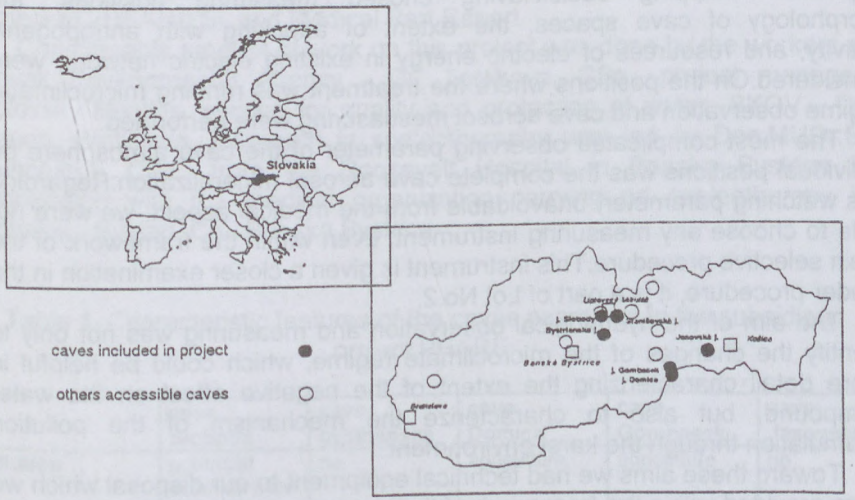
**Abstract:** More than one technical interventions happened during the recent decades that have substantially changed the original image of some sections of the cave passages thus harming the natural asset, the cave. The author reports about the results of the survey of these damages done in contract with the Speleological Institute in 1994-1995 and about the necessary measures to be taken for the reconstruction of the original conditions.

See in Proceedings Volume II. pp. 241.

# PROTECTION OF NATURAL RESEOURCES IN KARST AREAS - SLOVAK REPUBLIC

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Caves representing not only contemporary speleotherapeutic utilisation in Slovakia but also the diversity of natural conditions, and antropogenic factors in Slovak territory were chosen for the realization of the project.The following caves were observed:Demenovska cave of Sloboda, Domica cave, Gombasecka cave, Bystrianska cave. The ongoing monitoring was also performed in Jasovska cave, natural environment monitoring in Stanisovska which is not open for public but was chosen as a perspective one, as it could be used for speleotherapy in future, after building the technical infrastructure.




The method of measurement of physico-chemical parameters in the cave atmosphere was worked out on the base of the nowadays point of view on the problem of cave microclimate, regarding several-years experience of speleolaboratory employee in Gombasecka cave.

Such experiences enable to specify the range/extent/ of monitoring parameters from the aspect of the natural environment protection in selected karst territories with ongoing speleotherapy.

The air temperature and the humidity show to be the most sensitive for antropogenic activity consequences in karst objects. Another significant parameter reviewing the antropogenic activity interaction on natural environment in karst objects is the cave atmosphere chemism, especially $CO_2$ content and the cave aerosol chemism.

An important indicator on the negative influence on the natural environment is the considerable increase of $CO_2$ content in the cave climate and the content of pollutants in the cave aerosol. Besides these parameters, there are other important physical parameters of the cave atmosphere: the free atmospheric ion concentration-as the result of natural radionuclides and thoron emanation.Studying these physical parameters enable to characterize the natural environment of the karst object, especially from the aspect of speleotherapeutic utilisation.

The measurement of physico-chemical parameters in the cave atmosphere was performed on every locality on chosen measuring positions.Invidual measuring positions were evidenced graphically, namely in digitalized mapping basis.Having chosed measuring positions, the morphology of cave spaces, the extent of attacking with antropogenic activity, and resources of electric energy in existing electric network, were considered.On the positions where the treatment was running microclimate-regime observation and cave aerosol mesuasuring were performed.

The most complicated observing parameter of the cave atmosphere on individual positions was the complete cave aerosol mineralization.Regarding this watching parameter, unavoidable from the medical aspect, we were not able to choose any measuring instrument, even within the framework of the main selective procedure.This instrument is given a closer examination in the tender procedure, it is a part of Lot No.2.

The aim of the hydrological observation and measuring was not only to identify the changes of the microclimate regime, which could be helpful in more detail characterizing the extent of the negative effect on the water compound, but also to characterize the mechanism of the pollution acumulation through the karst environment.

Toward these aims we had technical equipment to our disposal which we were provided within the framework of the programme PHARE EC/10 SI, and the subsidiary project financed by The Ministry of The Environment Slovak Republic.

Evaluation and characterization of the delivered technique is worked out in the following part.

## Accommont of the Project Results

The main project EC/HEA/10 SI was aimed at the realization of the delivery of technical equipments the mean of support from countries EU to Slovakia.

The realization of these intentions was performed in two subsidiary projects:

A/.Monitoring natural environment /realized by Slovak Environmental Agency in cooperation with the Service for quality and protection of water, SKOV/.

B/. The speleotherapy-monitoring medical parameters /realized by The F.D.Roosvelt Hospital in Banska Bystrica/.

The work on both tasks continued simultaneously in the caves selected in advance.

The caves selected for the research showed the high degree of influences specified within both sets of problems.The position of the caves in Slovakia is illustrated by the scheme on title page. The basic information about the selected caves is summarized in the chart page 16.

All the results are summarized in the final comprehensive report " Monitoring the natural environment in the karst areas - subsidiary project for project EC/HEA/10 SI, and Medical Part Report.

Considerable amount of work on this project was done by the workers of Slovak Environmental Agency - Dr. Terekova, CSc., project manager, Liptovsky Mikulas, service for quality and protection of water- SKOV - Dr. Klauco, Bratislava. Research in speleotheraphy was led by Doc.MUDr.S-Dluholucky, CSc., from the Roosevelt Hospital in Banska Bystrica in cooperation with the medical organization carrying on speleotherapy in Slovakia - Svejan, Co., Banska Bystrica.

Table 1. Characteristic features of the caves examined in the subsidiary project PHARE

| | cave Sloboda | cave bystrianska | cave Domica | cave Gombasek | cave Jasovská |
|---|---|---|---|---|---|
| pollution | potencial pollution from tourism | no | agriculture | agriculture | no |
| speleotherapy | yes | yes | no | limited | yes |
| geomorphologic unit | Nízke Tatry, Ďumbierske Tatry, Demänovské vrchy | Horehronské podolie, Bystrianske podhorie | Slovenský kras, Silická planina | Slovenský kras, Silická planina | Košická kotlina, Medzevská pahorkatina |

| | cave Sloboda | cave bystrianska | cave Domica | cave Gombasek | cave Jasovská |
|---|---|---|---|---|---|
| type of karst | karst of monoklinal rodges | karst of monoklinal rodges | plain karst | plain karst | plain karst |
| underground stream | Demänovska | Bystrianska | Styx | Čierna voda | - |
| altitude of the entrance (m a.s.) | 870 | 566 | 339 | 249 | 256 |
| relative difference of cave elevation | cca 173 m | cca 92 m | cca 100 m | cca 70 m | cca 42 m |
| lenght of the cave | cca 7000 m | cca 2000 m | cca 5900 m | cca 1525 m | cca 2122 m |
| lenght of the viewing circuit | 1870 m | 700 m | 1715 m | 300 m | 490 m |
| number of visitors in the period I.-X. 1995 | 121 559 | 31 413 | 24 087 | 15 820 | 20 489 |
| operation | all year round | all year round | all year round | April - Oktober | all year round |

## Protection of cave natural environment against pollution: Penetration of pollutants into the system through groundwater

Hydrochemical mapping of the caves under examination shows that the caves mostly affected by human activities are Gombasek and Domica caves, in the Gombasek cave higher concentrations of nitrates were found in the groundwaters caused by agricultural activities in the unfiltration area of the karst waters in Silica Plateau and its surroudings. The main sources of pollution are agriculture and human settlement.

The Domica cave shows above all the negative influence of the pollutants produced by animal breeding which can be identified not only visually, but also by the increa-sed contents e.g. ammonium ions. Owing to the high starting contents of the dilluted materials in the karst waters the ingress of the relatively less concentrated precipitation waters transporting pollutants of predominantly organic origin /soil particles, dung water and the like/ results in a conspicuous decrease of water temperature. Such concentration changes, identifying the transport of surface materials, occur by leaps. The difference between the starting condition and the maximum degree of changes is less than two hours.Such changes take place not later than 24 hours after the original impulse starting the pollution e.g. the wash down of the contaminants by precipitation waters.

The karst systems of the other examined / Bystrianska, Stanisovska and Jasovska caves/ are not directly endangered by the passage of pollution through the groundwaters.

## Protection of cave environment while used for speleotherapy: The impact of speleotherapeutic procedures on the climatic components of the cave system

The information obtained through the research of the impact speleotherapy on the atmochemical and atmophysical properties of the cave atmospheris, in our opinion, both original and in principle, new. This information is based on the results obtained by the so called complex observations of the cave atmosphere while speleotherapeutic procedures were going on. With regard to the measuring time the results obtained and their further interpretation are limited to the termodynamicaly determined summer period.

The most important change , manifesting itself immediatelly after the patients entered the cave space, is the rise of the atmospheric temperature. This phenomenon was unambigously confirmed in all the caves examined irrespective of their microclimatic conditions. The rise of temperature in relation to the initial temperature of 6 to 8°C, ranges from 0, 3 to 1, 0°C. The rise of temperature preserves during the whole stay of patients in the cave.The temperature variations during the procedures are small /max. 0,5°C/ and depend mostly on the intensity of the breathing exercises performed by the patients, to a lesser degree on the ventilation of the cave space. When comparing the cave lit by bulbs /source of heat/ e.g. Bystrianska and Jasovska caves with those lit by tubes /without heat radiation/- Slobody cave, it is evident that this factor does not affect the temperature changes of the atmosphere.

Further substantial change is the lowering of the relative humidity and the acceleration of the air flow of the atmosphere. As evident from pictures 2, 3, 4 these changes as against the temperature manifest themselves quite directly. The degree and duration of the change mostly depended on the parameters of the above mentioned properties of the atmosphere before the start of the speleoprocedure. In the caves with higher relative humidity the changes are more conspicuous /Bystrianska and Sloboda caves/. Similarly, where the air flow prior to the treatment continues, the change of this property is less conspicuous/ Bystiranska cave/.In both cases the initial state of these properties is more important than the number of patients or the size of the treatment area.

A significant atmochemical change is the growth of the $CO_2$ contents resulting from breathing of a greater number of patients. The concentration increase ranges from 50 to max. 200 ppm.

The concentration increases observed, however, do not reach their peak at the beginning of the procedure / exercise/, but at its end. Before interpreting this phenomenon any further, more detailed studies will be needed. From the time being, we can state that the amount of the total concentration change mostly depends on the intensity of the kinetic activities on the patients / intensive breathing./

Special changes caused by stay of patients in the treatment area were found in the group of radiologic indicator. In accordance with the measurements performed it is possible to state that the contents of radon and thoron as well as their daughter products explicit depend on the thermodynamic conditions in the cave as confirmed by the surface measurement of radon in the caves. Nevertheless , the changes in the contents of radon and its daughter products during the stay of patients in the cave manifest themselves in the temporary fall of these values, as well / observed in the cave Sloboda cave/. So far the mechanism of this decrease is not clear. First of all, we do not know means of breathing, by the particles clinging to their clothes, and the like/, or whether it may result from the atmosphere being stirred by the activities of the patients. While the changes in the radon contents do not display in the caves examined common characteristics the changes in the atmospheric ionization are very similar in all the caves. This can be seen in the decrease of the nubmber of ions. The change is small but clearly observable. Especially significant for all caves is the fall of the number of negative ions / Bystrianska cave/ . On the other hand, the fall of the number of positive ions is not always detectable /Sloboda cave/. The decrease of ionization starts immediatelly after the arrival of patients to the treatment area and lasts up to their departure.

The mechanism of these changes cannot be satisfactorily interpreted so far, especially when taking into account the fact that their origin and subsequently their number depend above all on their emanation in the process of radioactivite fission of radon. This dependence is unambiguously manifested in the long run.

Besides the primary changes of the cave atmosphere described above, secondary changes in the microclimatic regime of the cave environment, resulting from speleoterapeutic procedures were observed. Such changes have been observed in Jasovska cave.

As obvious from the picture after the beginning of the procedures the above described changes took place first.

This is followed by the phase when the values return to their long time average. After the end of the procedures they fall below the average. Striking changes can be observed in the air temperature, $CO_2$, contents, further in the contents of radon concentration, in the equilibrium radon concentration and the radon daughter products, as well as in ionization.

All these changes correspond to the extreme acceleration of the air flow in that part of the treatment area where this is joined to the surface through the rock funnel.

When taking into consideration the course of the changes, we can assume that is the case of a temporarly localized ingress of the outer atmosphere or the atmosphere near the surface.

All the changes, both primary and secondary, in the cave environment are not irreversibile. This fact is of the utmost importance both from the point of view of the protection of the cave environment against the effects of the patients stay in the cave and from the point of view of the exploitability of the cave area for speleotherapy.

Moreover, the return of the values is relatively fast, the restabilization of the air system taking from 2 to 8 hours. In the case of the emergence of secondary phenomena, the restoration period takes 10 to 12 hours. The restoration of the original equilibrium depends above all on the size of the treatment area and the number of patients. In our opinion, this information, is of crucial importance for the further use of the cave for speleotherapy.

## B: Medicfal parts report

The new era of the speleotherapeutic activities has been introduced after the final realization of PHARE EC/HEA/10 SL Project in Slovak Republic during l995. Until this time the speleotherapeutic activities were done without the own possibility to monitor of cave environmental microclimatic factors as well as to evaluate of some medical parameters. Only adjacent hospital facilities were utilised before. The medical equipments were distributed to two hospitals - Country Hospital. Liptovsky Mikulas - for speleotherapy in cave Slobody, and F.D.Roosevelt Hospital for cave Bystrianska. Since this time only cave Bystrianska had realized the speleotherapy according to the proposal of the Project.
Submitted report is presenting results and experiences from this cave.
Speleotherapeutic courses were done in two different ways:

a/ Speleo-Summer Bystrianska cave

- Ambulantory courses including two hours stay in the cave with rehabilitatory breathing excersizes, lasted 14 days. Experienced medical personal / nourses and doctor/ provided these activities, followed-up of the patients, and provided appropriate investigations.
Accomodation in Bystra and vicinity was not included in this form of speleotherapy.

b/ Full Time Speleotherapy

- Fortnight courses with time care in hotel Bystra / pediatrician, rehabilitation and pediatric nourses, teacher and hotel staff/. Except stay in the cave , the rehabilitation, autogenic training, excersises trips were included into the treating program. Since September 3th., to October 28th. four courses were done.

One of them was offered for children of Ziar country - heavy industry area with extraordinatory heavy air pollution in near past.

190 patients were treated in cave Bystrá during 1995 - predominantly children. Date of the courses, spectrum of diagnoses and number of the patients are presented in picture 5. and table 1. The clinical state of the patients was monitored using devices of PHARE EC/HEA/10 SI project. No medical complications were registered in patients. Nowadays the medical questionaire is distributed to all patients for evaluation their clinical state - half year after speleotherapy. Nevertheless, immediate improvement of clinical status and breathing was stated by nearly all patients.

/co-author of medical part of project: doc. MUDr.S.Dluholucky, CSc.,/

## The global evaluation of project EC/HEA/10 SI

Within the framework of the programme PHARE, EU provided Slovakia finance for delivery of the top technical equipment that can be used for solving highly specific problems concerning karst environment.

The delivery of the monitoring technique enables continuous observations of the environment and gives an opportunity of determinanting characteristic parameters of the environment, determinating the time needed for its regeneration, choosing another caves for treatment and research, etc.

The delivered technical equipment enabled us to determine the principles of monitoring natural environment and to select patients for the speleotherapy on the international level within the framework of UIS.

The delivered medical equipment enabled us to evaluate: the status of the treated patients, parameters of the treatment, and in case of need, an ocassional treatment process.

Having acquired experiences utilization of the instruments for original purposes shows to be the optimum. Using the complete set of these instruments any other way /in common ecological research/ will call for another complementary technical equipment depending on the orientation of further eventual utilization.

The optimum seems to be using the delivered instruments for original purposes by top-specialists in this branch.This way there will be reasonable costs and an adequate utilization of time.We suggest to make a working group of specialists (on the basis of The Ministry of The Environment SR) for given problems, which will continue in the project and ensure another research tasks concerning environment by means of using delivered equipment.

At last I would like to appreciate greatly the EU countries financal support on the delivery of technical equipment, without which the project could not be realized. I would like to thank The Ministry of The Environment SR for coordination, special guarantee, and financing the support project.

Special thanks to partner organizations for support in solving problems.

Especially I would like to thank The Management of Slovak Caves, The Slovak Speleologic Society in Liptovsky Mikulas, The F.D.Roosvelt Hospital in Banska Bystrica and the Firm Service for quality and protection water from Bratislava.

# II. SESSION:

# GEOLOGICAL RESEARCH

# THE SOURCE OF THE JÓSVA STREAM AND THE NAME OF THE TOWN OF JÓSVAFŐ

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**Abstract:** The township of Jósvafő, one of the headquarters of the Aggtelek National Park in the Aggtelek Karst, now part of the World Heritage is situated at the banks of the Jósva Stream. The name of the Jósva Stream was recorded in a 1272 Latin language royal document as *fluvius Ilsuafey*, that is Jósvafej~Jósvafő Stream. Since the "-fej" or "-fő" (-head) did not only mean a part of the body but also carried a meaning of „upper end, origin of something" and „spring" in old Hungarian hydrographic names. The 13th century hydrographic name could be said now: the stream of the Jósva Spring or the watercourse of the spring of the Jósva Stream. The geographic name Jósvafő was originally the name of a spring that means Jósva Spring or the Spring of the Jósva Stream. There was no settlement in the vicinity of the spring in the 13th century, a small community developed only later, in the 14th century. This hamlet was named the same as the spring, Jósvafő, obviously because it was built at a spring having the same name. On the other hand numerous karstic springs occur in the vicinity of the township of Jósvafő and the question has been raised which one of these was mentioned in the 1272 document, which one was considered as the source of the Jósva Stream, the one that is the name giver of the community. The analysis of a 1295 document, geographical and hydrographical evidences as well as references in the geographical literature of the last two centuries confirm that the resurgence of the waters of the Baradla Cave, the karstic spring of very abundant discharge west of the township of Jósvafő that is consequently referred to as Jósva Spring can be anything but the Jósvafej~Jósvafő Spring mentioned in the 13 century document, consequently it can not be the original name giver of the township of Jósvafő. All data and evidences that turned up in the course of the research that preceded the writing of this paper proved that the spring that was named Jósvafej~Jósvafő before the community came into being was nothing else but the spring of abundant discharge at the north municipal limit of the present community and that is the resurgence of the Kossuth Cave waters. This spring did no have a name in recent centuries, it was referred to by locals as „the spring" and has been labelled as Greater Tohonya Spring by professionals only for several decades. The hamlet developing in the 14th century was referred to by the population of the vicinity the same as to the spring Jósvafő. The geographic name Jósvafő was originally a hydrographic name indicating a spring and that became secondarily the name of the community developing nearby.

See in Proceedings Volume II. pp. 247.

# GEOLOGY OF THE STUDY-PATHS OF THE AGGTELEK NATIONAL PARK

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**Abstract:** The bulk of the Aggtelek National Park area is made up of Triassic rocks, the physical properties of which played a decisive role in the formations of the world-famous caves and other karstforms, and in the general geomorphological evolution of the area.

In Hungary, the Aggtelek area is the only one, where this very particular rock suite is exposed and can be studied on the surface. Therefore all the measured reference sections of the Aggtelek Triassic (on the surface and underground) are located within the premises of the National Park.

Key sections and other geological features along the study-paths together form an integral part of the conservation and presentation of geological phenomena in the Park.

See in Proceedings Volume II. pp. 221.

# RELATION BETWEEN MORPHOLOGY AND ROCK-OUTCROPPING ON SOME PLATEAUS NEAR JÓSVAFŐ (NE HUNGARY)

**JÓZSEF KNAUER**
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**Abstract:** The geological maps relating to the area investigated (Balogh 1948, 1964, Grill *et al.* 1985, Less 1993) do not mark off the covered fields lying among outcrops from the exposures because of their scale and maybe of their authors' attitude.

In the course of 1992-1994 the author surveyed an area NE of Jósvafő on scale 1:5000 on behalf of the Aggtelek National Park Directorate. This area is built up mainly of the Wetterstein Formation. The main goal of the work was to survey the terrain where karstic forms are common within the area mentioned. While surveying the author marked the grade of outcropping, the type of the landforms and mapped the Quaternary rocks, too.

See in Proceedings Volume II. pp. 209.

# KARST WATER LEVEL MEASUREMENT OF BÜKK MOUNTAINS AND ITS APPLICATION IN NATURE CONSERVATION

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*(Field measurement and data processing were carried out with the participation of* ***Cs. Sándor****)*
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## Introduction

Many important natural values can be found in the Bükk Mountains. In this work only subsurface water supply and its changing of lifeless natural assets will be discussed in detail. The mountains consist of karstified rocks for the greatest part, so we are talking about karst water during our examination.

This paper deals with partly researching partly protection of karstic water. The Bükk Mountains is a protected area (Bükk National Park), therefore protection also means nature conservation. In this region one of the most important long-term goals can only be preserver water resources management. For this reason just limited quantity of water can be produced from the Bükk Mountains. Such amount of drinking water can be removed that should not be imperilled either long-range drinking water demand or water demand of plants and animals or regional assets are rich in water.

Karst water resources can be protected and utilised reasonably unless has been creating irreversible changing in it for the nature. In the Bükk region there are serious conflicting interests between social and ecological water demand respectively its satisfaction. It is a great task to be absolved but come to arrangement is unavoidable.

The law number LVII. of Water Management was published in 1995, its chapter V. had disposal of order of water demand as follows:

a) communal water consumption, water demand for disaster-averting
b) water demand for therapy and service,
c) water demand for commercial fishing and watering,
d) water demand for nature conservation,
e) water demand for economic
f) water demand for another purpose (sport, recreation, bathing, tourism etc.).

By the terms of the law drinking water supply stand first on the priority order. Water demand for nature conservation representing ecological one "is inserted in" among five groups of mainly social water demand. Henceforward water demand for nature conservation must be considered, so it might signify a great planning safety for it.

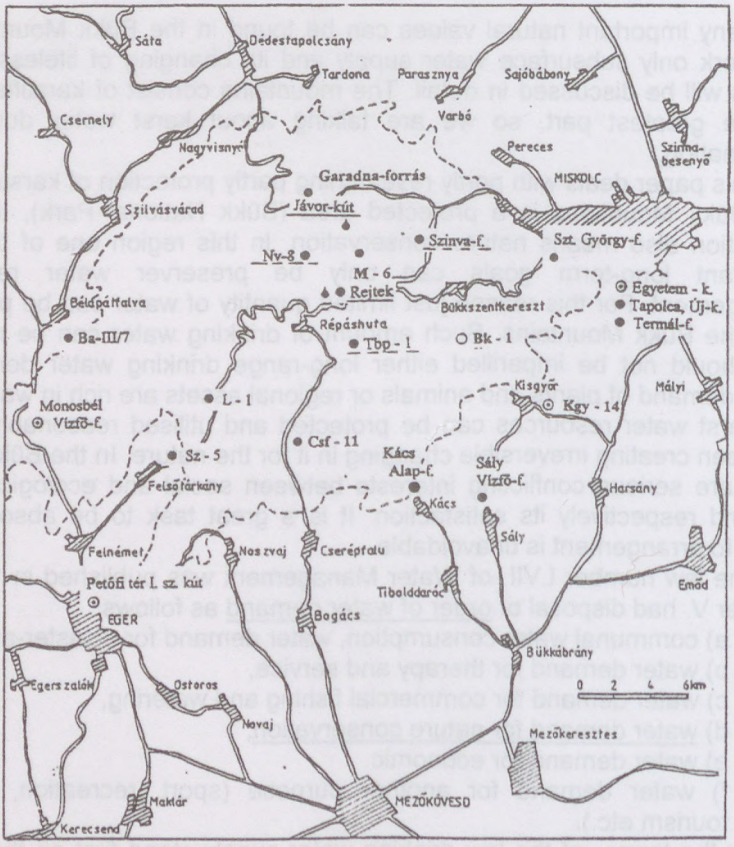



Fig. 1. Hydrogeological monitoring system in the Bükk Mountains (1996)

(- - - Borders of the Bükk National Park; ♦ precipitation gauge station;
◎ non-working measuring point; ● working measuring point;
O planned measuring point)

## The aim of karst water level measurements of Bükk Mountains

- basic research (long-term assembling data),
- help to satisfy social water demand with basic data processing of hydrogeological, water resources management and water supply purpose,
- help to satisfy ecological water demand with basic data processing of nature conservation purpose.

## Place, instruments and method of measurements

The monitoring system was established by our Institute (on behalf of three great water works in Bükk region and with water authority's help) in summer of 1992. Water level has continuously been measured per 30-60 minutes with pressure-gauge in six water level observer wells, three dug wells and three springs (Fig. 1). Besides four measuring points have been closed and another one will be operated in the future. Practically we can measure almost everywhere, where it is possible or we are thinking it necessary. It should also be noted that further "observer wells" would have to be on the Bükk Plateau, but a cost of establishing wells comes very expensive (more than 10 million Forints) therefore the realisation of our neds a lot of time. Nv-8, Tbp-1 and Szinva-springs have proved to be the most important measuring points in our experiments.

The development of precipitation of Bükk Mountains has been established using many years' data of more than 20 meteorological stations. Precipitation data of this measuring cycle are originated from the own planted measuring points of Rejtek and Jávor-kút gauge daily data processing using former measuring data.

Water production data have been given by three great water works every month. The small water works data are taken into account that monthly data are increased with 6-7 per cent average water production.

## Measuring data processing

### Distribution of precipitation

According to our calculation 80% of precipitation data of Jávor-kút gauge (Bükk Plateau) can be considered characteristic for the whole Bükk.
We have found that annual average precipitation of Bükk Mountains had been decreasing (similarly to the lowland-areas of the country).

| Period | Winter Precipitation | | Summer Precipitation | | Annual Precipitation | |
|---|---|---|---|---|---|---|
| | [mm] | [%] | [mm] | [%] | [mm] | [%] |
| 1939-1995 | 328 | 100.0 | 483 | 100.0 | 811 | 100.0 |
| 1960-1995 | 318 | 97.0 | 462 | 95.6 | 780 | 96.2 |
| 1972-1995 | 294 | 89.6 | 467 | 96.7 | 761 | 93.8 |
| 1985-1995 | 297 | 90.5 | 412 | 85.3 | 709 | 87.4 |

From a nature conservation point of view summer period precipitation has a determining function and decreasing of precipitation is the most significant in this period. If we add moreover higher social water demand of summer period then we can appreciate that the realm of Nature of the Bükk region is threatened.

Since beginning of the sixties lack of precipitation has been characteristic. Deviation of summer period precipitacion from the average is shown in Fig. 2.

With a view to interpretation of changing of water supply must be mentioned that the lack of summer precipitation was 183 mm in 1992. It was followed by the greatest lack of winter precipitation of the last 30 years, it was 194 mm in 1993. At last in summer 93 the lack of precipitation was as considerable as 135 mm.

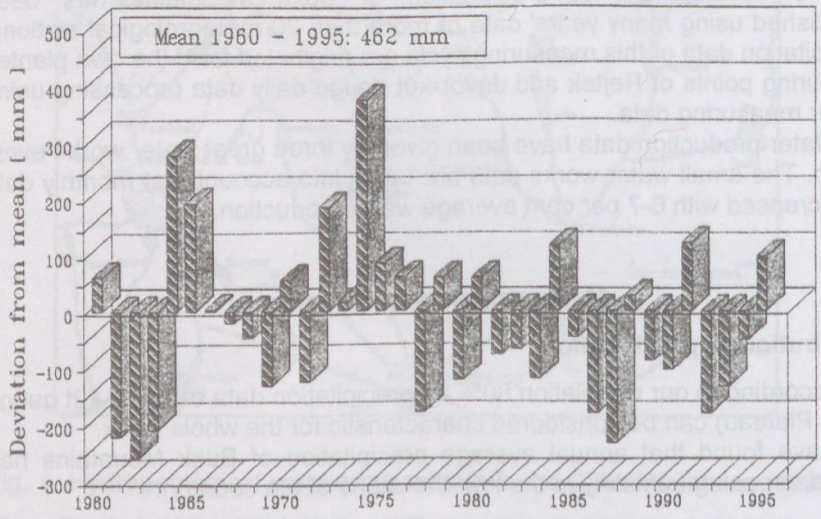



Fig. 2. Deviation of summer period precipitation from the average

The minimum karst water level [ 0 = 522.98 mBf (height above The Baltic See Level)] is also determined by these factors together that is starting-point in our further examinations.

## Changing of karst water level

Changing of karst water level measured daily of Nv-8 well and dynamic karst water resources calculated are shown in Fig. 3. ("n" means gap-volume, based on the reference data and own researching the calculated water supply using two different "n" values given in the figure). In Central Bükk nearly 20 meter fluctuation of karst water level has been registered. To this belonging to quantity of dynamic karst water resources ranged between 1 200 000 - 24 500 000 $m^3$/month.

Changing of water level of springs being in the greatest valleys can be demonstrated on the observed data of Sziva-spring (Fig. 4). Discharge of Szinva-spring completely (or 20 000 $m^3$/day in greater discharge) get to the distribution network of Miskolc in the gravitational way. On Fig. 4. the water level is marked with dotted line above water can get to the channel and from it derives Szinva-brook.

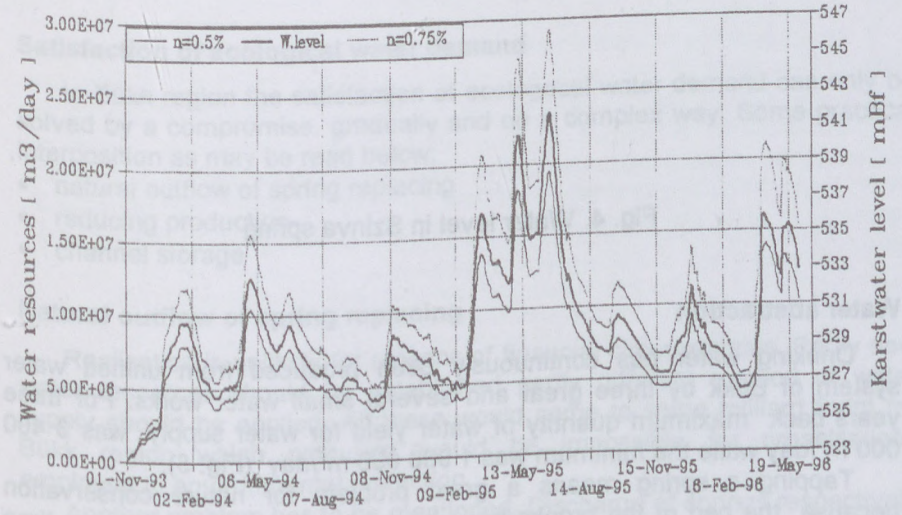



Fig. 3. Dynamic karstic water resources
Based on water level of Nv-8 well

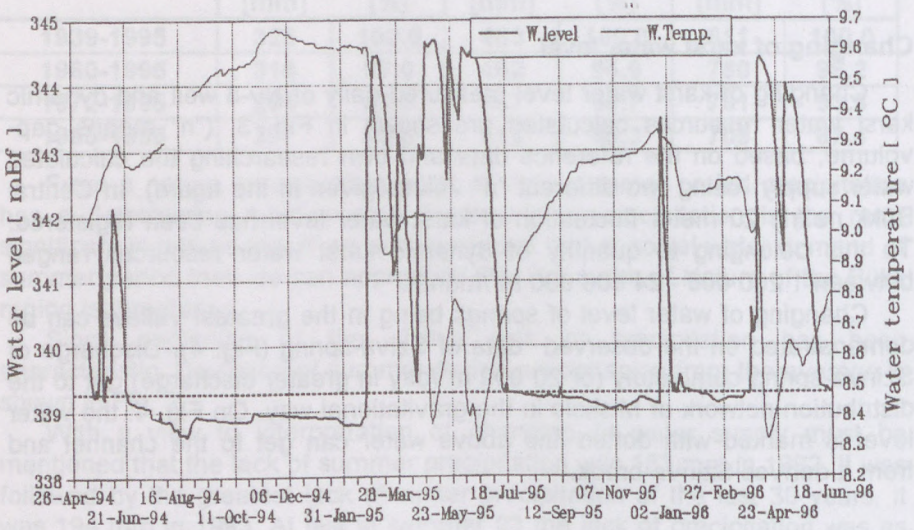



Fig. 4. Water level in Szinva spring

## Water abstraction

Drinking water has continuously been produced from unified water system of Bükk by three great and several small water works. For three years back maximum quantity of water yield for water supply was 3 400 000 $m^3$/day while the minimum was 1 900 000 $m^3$/day (Fig. 5).

Tapping a spring means a great problem for nature conservation because the bed of the brooks have become partly or nearly every time dry. In addition it can also be mentioned that the authorities don't determine minimum karst water level but set a limit to the maximum quantity of water production.

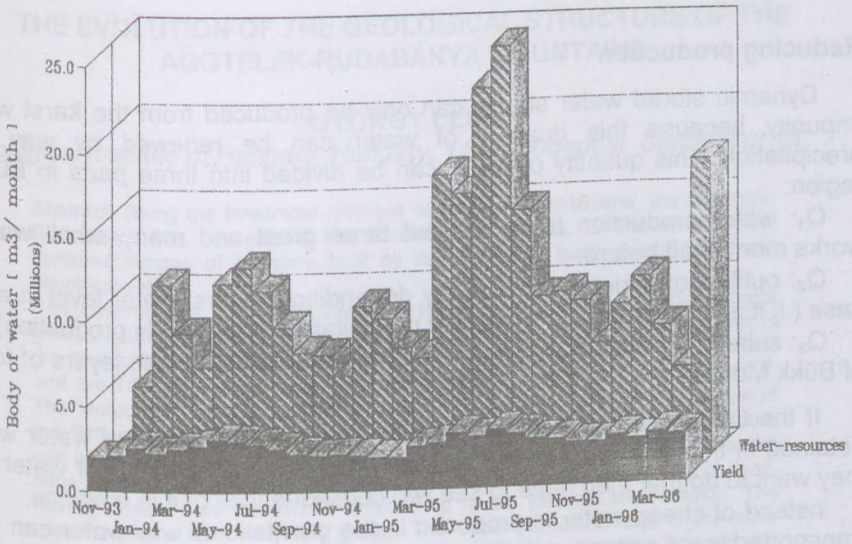



Fig. 5. Yield, dynamic karstiv water resources
Nv-8, water-works

## Satisfaction of ecological water demand

In Bükk region the satisfaction of ecologocal water demand can only be solved by a compromise, gradually and on a complex way. Some practical interposition as may be read below:

- natural outflow of spring replacing
- reducing production
- channel storage

## Natural outflow of spring replacing

Realisation is unlikely for reasons of financial circumstances. Partly new water resources should be established partly different method of water supply should be applied. All these would come to some milliard forint for Bükk region which procuring would be impossible for organisations employed in environmental protection.

Another problem has to be mentioned. Discharge of springs respectively karst water level are decreasing parallel with decreasing of precipitation. Nowadays it might easily happen that the natural outflow level of springs have unlikely been to replace.

## Reducing production

Dynamic stored water supply can only be produced from the karst with impunity because this quantity of water can be renewed by way of precipitation. This quantity of water can be divided into three parts in Bükk region:

- $Q_1$: water production is carried out three great and many small water works mentioned before.
- $Q_2$: outflow of springs and spillway depending on karst water level in any case ( if it is on account of quantity of precipitation respectively production).
- $Q_3$: subsurface transmitted quantity of water towards detritic layers of foot of Bükk Mountains.

If the $Q_1$ component is limited by water works the quantity of water was obtained in this way may get to spillway increasing $Q_2$ quantity of water. If they want to do that then have to see two consequences of it in advance:

- instead of cheap water is produced in the gravitational way water can be transported more expensive to the place of karst water consumption,
- in Bükk region the possibility of storage inside the mountains is limited temporally because water can flow out through the springs.

## Channel storage

It can be the only effectual intervention in environmental protection respect. Discharge of seasonal springs and spillways would be got into the channels which are able to storage it in natural circumstances. It can be an insulated channel, sequence of tiny barrages or marshy, damp part of flooded areas maybe they all together. Amount of water getting to it would flow in the channel more slowly than now. In this way living components of the nature could more easily survive the lack of precipitation of the summer period.

# THE EVOLUTION OF THE GEOLOGICAL STRUCTURE OF THE AGGTELEK-RUDABÁNYA MOUNTAINS

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Abstract: Being the innermost member of the NW Carpathians, the Aggtelek-Rudabánya Mts., as part of the Southern Gemerides, is one of the most complex regions of Hungary both by its geological build-up and structural development.

Its basement is formed mostly by Triassic rocks ranged into three major groups responding three tectonic units in superposition. The lower of them is the "autochton" with a Paleozoic basement of the Szendrő and Uppony Mts. and the Triassic Torna series (e.g. on the Esztramos), lying probably upon it. The "autochton" represents the pre-Cretaceous Southern continental margin of the Tethys and recently is of low grade metamorphism. The middle structural unit is the Meliata nappe built up by the Tornakápolna, Meliata and Bódvarákó series (known mostly from boreholes), representing the oceanic Tethys itself, having existed from the Middle Triassic up to the Middle-Late Jurassic. The metamorphism is of very low grade. The upper structural unit is the non-metamorphic, detached Silica nappe consisting of (in Hungary) the Triassic and subordinately Jurassic Bódva, Szőlősardó (in the Rudabánya Mts.) and Aggtelek series (in the Aggtelek Mts.), forming most of the surface outcrops. They, with their original basement, the Paleozoic of the Gemer-Spiš Metalliferous Mts., represent the pre-Cretaceous Northern continental margin of the Tethys. The basal, evaporitic layers of the Silica nappe contain the tectonically reworked blocks of the Tornakápolna series, too. The Tertiary cover is represented by Upper Oligocene-Lower Miocene, Pannonian and Quarternary beds.

Four major stages can be distinguished in the structural evolution:

1. The Middle Triassic rifting, having created the three major paleogeographic units mentioned above.
2. The Middle Jurassic to Early Cretaceous subduction, collision and overthrust processes, having formed the three major tectonic units in superposition.
3. The probably Middle Cretaceous folding process, having also created the thrusts of southern vergence, characteristic for the mountains, and the small klipps of the Alsó-hegy-Derenk belt, too.
4. The Late Oligocene to Middle Miocene sinistral movements of the Darnó-zone that removed the Rudabánya Mts., having situated until that time to the S from the Aggtelek Mts., in three segments with a few 10 kilometres to the NE, to its recent place.

Since then only brick-tectonic movements can be shown. The newest uplift of the mountains started at the end of the Pliocene, and took place in the foreground of the general emergence of the Carpathians. In the previously karstified large limestone bodies (mostly of the Aggtelek series) the mass pebble material coming from the Carpathians played the dominant role in developing the huge cave systems.

See in Proceedings Volume II. pp. 205.

# KARST DRAINAGE SYSTEMS ESTABLISHED BY WATER TRACING METHODS IN AGGTELEK NATIONAL PARK

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**Abstract:** The first water tracing in the karst areas of Aggtelek-Rudabánya Mountains including also Aggtelek National Park was carried out in the thirties in Baradla Cave. The first major test series took place at the beginning of the fifties, in order to establish the spring connections of the large sinks at the southern part of the region. In the sixties and the seventies systematical researches were continued at the Alsó-hegy area by cavers and the specialists of the Water Resources Research Center; and after 1984 the Hungarian Geological Survey carried out some tracings at further unknown systems. Up to now altogether 105 experiments have been reported, still there are several areas to be investigated, and many tests should be repeated because of uncertain data.

From among the rock formations building up the Aggtelek-Rudabánya Mountains, the oldest one is an impermeable Permian-Lower Triassic evaporitic complex, with outcrops around Perkupa as well as between Bódvaszilas and Derenk in form of narrow strips. The younger, mostly karstifiable formations are generally underlain by this complex. The higher parts of the Lower Triassic are characterised by upwards increasing carbonate contents within a sandstone - marl - platy limestone sequence. The uppermost formations are moderate to well karstifiable Middle and Upper Triassic limestones, the thickness of which is more than 1000 m in some places.

On the evidence of water tracing experiments, the underground streams sinking in the passages of Baradla Cave (the largest system of the region) emerge in Jósva spring group via two lower systems. The cave sinks between Aggtelek entrance and Vörös-tó Branch drain to the lukewarm Medence Spring; while the water from the sinks between Vörös-tó Branch and Óriás-terem get to the Short Lower Cave feeding Táró Spring. On the basis of one tracing, Medence Spring is in connection with the waters sinking in the Slovakian part of Kecsô Valley, too.

The presence of several independent karst drainage systems were established by water tracing in the fifties, which were followed by successful cave explorations in some cases (Béke Cave, Szabadság Cave, Danca Cave). The system of Teresztenye Spring still withstands the attacks of explorers.

In the southeastern part of the region two minor systems were only established eastward from Szőlősardó (from Túrós dolines to Bedela-kút Well, and from Szén Valley to Sárkány-kút Well). The streams disappearing in the many sinks of Szalonna area have not been traced yet; while the tracings carried out in Telekes Valley Sink have had no result.

In the central part of the region the best studied underground system is that of Kossuth Cave feeding Nagy-Tohonya Spring; its connection to six surficial sinks have already been established on the karst plateau northward from Jósva Valley. The probable flood bifurcation of Vass Imre Cave with Milada Cave (Slovakia) should be confirmed. From among the surface connections of Kopolya Spring, Hálórét Sink and Kopolya Shaftcave have been identified.

In the northeastern part of the region several hydrological connections have been detected in the area of Bába and Acskó Valleys. Besides of five minor systems, three larger ones have been established in the case of the sinks draining to Csörgő Spring, Vecsem Spring and Köszörű Spring (Slovakia). The tracing experiments carried out in the potholes of Alsó-hegy Plateau revealed mostly very slow flows at the karst water table.

See in Proceedings Volume II. pp. 207.

# THE ROLE OF KARSTIC SPRINGS IN THE DEVELOPMENT OF INDUSTRIES IN JÓSVAFŐ

**PÉTER SZABLYÁR**
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**Abstract:** The karstic springs of decisive importance in the vicinity of Jósvafő rise in the outskirts of the township. The importance of these springs was recognised as early as in the Middle Ages. The energy of the springs has ever been utilised from ore crushing to milling grains. Even electricity was generated in the first half of the 20th century by the water of the Jósva Spring thus creating public lighting in Jósvafő and later in the Baradla Cave. The new sources of energy developing in the 19th and 20th centuries made local generation of electricity obsolete so much so that even the remains of this industry have vanished. The search, conservation, exhibition of said remains and to make them accessible to the public is the responsibility of our days.

See in Proceedings Volume II. pp. 253.

# PROVIDING A GEOLOGICAL-GEOPHYSICAL BASIS FOR DECLARING A SITE A NATURE CONSERVATION AREA
## (the examples of Lake Balaton and the Balaton Highland)

**TIBOR CSERNY**
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## Introduction

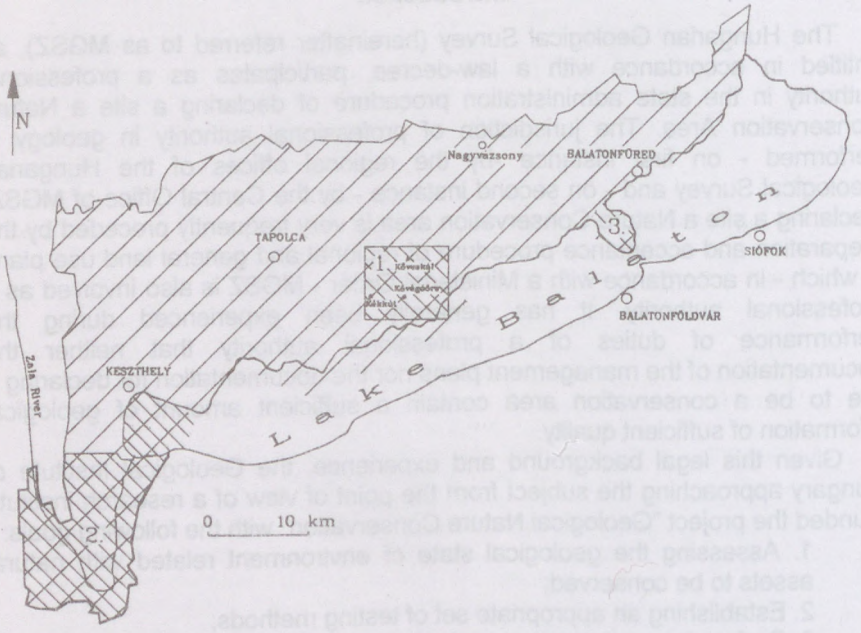
The Hungarian Geological Survey (hereinafter referred to as MGSZ), as entitled in accordance with a law-decree, participates as a professional authority in the state administration procedure of declaring a site a Nature Conservation Area. The jurisdiction of professional authority in geology is performed - on first instance -by the regional offices of the Hungarian Geological Survey and - on second instance - by the Central Office of MGSZ. Declaring a site a Nature Conservation area is very frequently preceded by the preparation and acceptance procedure of regional and general land use plans in which - in accordance with a Ministerial Order - MGSZ is also involved as a professional authority. It has generally been experienced during the performance of duties of a professional authority that neither the documentation of the management plans nor the documentation for declaring a site to be a conservation area contain a sufficient amount of geological information of sufficient quality.

Given this legal background and experience, the Geological Institute of Hungary approaching the subject from the point of view of a research institute founded the project "Geological Nature Conservation" with the following goals:

1. Assessing the geological state of environment related with natural assets to be conserved;
2. Establishing an appropriate set of testing methods;
3. Performing an integrated evaluation of test results;
4. Involving the obtained results into the scientific propagation of information.

In accordance with these goals, we assessed the state of environment between 1993 and 1995 in nature conservation areas. These investigations were based on the results of geological and geophysical research performed by the Geological Institute of Hungary in areas previously coordinated with the competent chief authorities i.e. in the Balaton Highland National Heritage Park to be established. Priorities in the selection of specific areas were given (1) to ensuring that our research covers the widest sphere of topics possible, (2) to applying the most efficient scientific methods available; and (3) to providing an answer, through integrated evaluation of the results, to the specific questions.

# ENVIRONMENTAL-GEOLOGICAL ACTIVITY IN THE NATURE PROTECTION AREA




Designated Balatonfelvidék National Park

Regions for environmental assessment

1. Káli-basin
2. River Zala - Kis Balaton - Keszthely bay
3. Tihany-peninsula

In this paper, a few examples will be shown in the spirit of the above ideas, without striving for completeness.

## Model Area One: Káli-medence (Káli-basin)

Káli-medence, possessing an independent water catchment area, is a Nature Conservation Area since 1984. It is one of the areas having the most geological and biological assets in the Balaton Highland National Heritage Park to be established. The Theodora spring of Kékkút, one of the most significant mineral water sources in Hungary, is located also in this area.

In the selected nature conservation area, a special emphasis was put on hydrogeological surveying for subsurface waters playing a major role in the propagation of pollutants, having a considerable effect on on the protection of the rare plant associations and the enviroment of potable water bases. Getting an accurate knowledge on hydrogeological flow patterns and developing a hydrogeological model allowed us to specify the limit conditions for water management, a drastic intervention into which (for instance: an excessive water intake, amelioration, canalization, etc) may upset the optimum hydrogeological conditions required for the ecological equilibrium. Consequently, relying upon our archive geological and geophysical data, additional satellite and aerial imagery analyses (satellite imagery and gravitational lineament determinations), renewed environmental assessment based on a uniform approach, as well as additional geoelectrical tests and hydrogeological field work were performed.

As a result, a map series showing the state of environment of the Káli-medence has been completed. It consist of the following maps:

1. Drift geological map
2. Solid geological map
3. Map of the Paleozoic-Mesozoic surface
4. Hydrological map
5. Geological map for nature conservation
6. Bouguer anomaly and gradient map
7. Satellite map of lineaments
8. Landsat TM imagerys (7 pcs) and the results of their processing

Digital processing of derived geological maps and the establishment of their GIS database was completed in Integraph MGE and Oracle environment, in accordance with an internal standard specified by the Geological Institute of Hungary. The geophysical, remote sensing and topographic data were converted into the ARC/INFO-ARC/VIEW GIS system of the Geophysical Institute of Hungary. Data exchange between the systems of these two institutes proceeds smoothly.

The related database can be processed in any GIS system, and it is accessible for the municipalities and environmental and nature conservation authorities concerned. Combining maps 2, 3 and 5, of the above-mentioned

database a map version showing the vulnerability of environment in the Káli-medence has already been completed.

Additionaly, a textual field guidebook describing the sites of geological and geomorphological value encountered in the Káli-medence has been prepared. It will serve us to involve the geological assets into the public propagation of information promoting thus their conservation.

The geological and hydrogeological conclusions of the scientific results have been discussed - in more detail - by G. Csillag, K. Gondár-Sőregi and L. Koloszár, whereas the geophysical, satellite imagery and GIS related interpretations were summarized in a lecture given by L. Vértessy and J. Kiss at the Symposium on Research, Conservation and Management (Aggtelek-Jósvafő, 1996).

**Model area Two: River Zala - Kis-Balaton - Keszthelyi-öböl (bay) system**

Kis-Balaton has been a nature conservation area since 1986. The two sub-basins of the present "marshy area" have been formed artificially (their construction is still in progress) in order to reduce the amount of nutrients and bedload reaching the Keszthelyi-öböl. This enlargement of the water system may cause significant changes in the distribution of certain elements (for instance, accumulation, trapping, or mobilization) and in the bio-geochemical processes. We considered advisable and professionaly important to study the geochemical state of Kis-Balaton and the related water system, as well as so-called retaining capacity of the "marshy area". It allowed us to assess the state of the environment by subjecting the suspended and deposited bedload taken from the River Zala - Kis-Balaton - Keszthelyi-bay system to geochemical tests for trace element analyses during which the following topics were examined:

* Trace element concentration with respect to a specified, possibly natural background level (for instance, the global average of oceans);
* The origin of higher, deviating concentrations (human, geological, or biological sources);
* The chemical forms of elements with particular regard to toxic forms, the toxicity, and their mobility;
* The physical, chemical and biological processes controlling the distribution of elements and chemical forms in time and space.

The investigations launched to give an answer to these questions are still in progress. The expected results will allow us to draw a picture about the efficiency of the so-called filtration capacity of Kis-Balaton as well.

During the recent activities, 16 trace elements (V, Cr, Mn, Co, Ni, Cu, Zn, As, Rb, Sr, Mo, Cd, Sb, Cs, Ba, Pb) were tested for concentration using ICP-MS method, determined in water, suspended and sediment phases. In order to ensure the high accuracy of measurements and due to the very low dissolved solid content, the high technology acquired during the past ten years was used in the course of the sampling and laboratory tests in order to avoid contamination. Simultaneously, in situ test of some other important features

were performed (pH, Eh, alkalinity, KOI), and the concentration of major elements were determined in routine laboratory tests (Na, K, Ca, Mg, Fe, $PO_4$-P, $NO_3$-N, and Cl). To examine the interaction between water and sediments, it was necessary to study the mineralogical composition of suspended and deposited sediments as well (RTG, DTA).

By the time of the preparation of this paper only the laboratory tests of water samples taken from the water-suspension-sediment system had been done. It shows that the system contains no metal pollution and the concentrations measured are comparable with those in the oceans, except for lead, zinc, cadmium and copper (atmospheric pollution). For the rest of the research, mud samples and suspended deposits taken from the Zala - Kis-Balaton - Keszthelyi-öböl (bay) system will be subjected to similar tests and evaluated.

The results obtained so far are discussed in detail in a separate paper in this volume. An interesting feature of this research is that it is conducted by an international team. It has also been supported by National Committee for Technological Development (in Hungarian OMFB). Participants in the investigations have been A. Nagy (Geophysical Institute of Hungary), Françoise Elbaz-Polichet (University of Montpellier, Department of Geology and Geochemistry), T. Cserny (Geological Institute of Hungary) and P. Pomogyi (NYUVIZIG, Kis-Balaton Maintenance Center).

**Model Area Three: Lake Balaton and the Tihany Peninsula**

The third model area was subjected to complex geological and geophysical examinations. Their integrated evaluation gave answer to questions such as the history of geological and ecological development of Lake Balaton and its immediate environments, the change of water level and quality in the lake, the rate of mud development and the distribution of accumulated mud in space. Of the research methods applied, geophysical, paleontological and isotope geochemical tests have proved to be the most efficient.

In addition to the geological, paleoecological and volcanological investigations of the Tihany Peninsula, we also wish to prepare some describing geological field trip routes to disseminate results for the public. The investigations in the Tihany Peninsula, including their results will also be presented in two separate papers in the final volume of the Symposium, therefore, they will not be discussed separately here. I only note that the volcanological studies were performed by K. Németh, whereas the complex geological investigation of Külső-tó (Outer Lake) and Belső-tó (Inner Lake) represented a joint work performed by an international team of scientists. In addition to experts from the Geological Institute of Hungary (T. Cserny, M. Földvári, A. Siegl-Farkas), participants in the latter project included Lars Königsson (University of Uppsala, Department of Quaternary Geology), Klaus Oegl and Franz Bortenschlagen (University of Insbruck, Department of Botany).

The geological investigation of Lake Balaton has a long history involving a large number of research teams. In addition to the author of this summary, E. Nagy-Bodor (Geological Institute of Hungary, Palynology), M. Orosz-Hajós (Geological Institute of Hungary, Diatoma) and A. Szuromi-Korecz (MOL, Ostracoda) studied the geological and ecological state of the lake and its environs in detail. The related results can be summarized as follows:

The Quaternary soft deposits in Lake Balaton have a thickness of 5 m as an average, the upper portion of which ranging from 0.1 to 0.2 m is a colloid. The mud thickness in the lake bed varies in a wide range reflecting the diverse and broken-up morphology of the basement. The fault zones of the tectonically preformed meridional valleys can be well traced. The places of the so-called embryonal or initial sub-basins are also visible. The average mud thickness is 6 m, 5 m and about 4 m, in the western sub-basins, in its middle part and in the eastern sub-basin, respectively. Data aquired by radiocarbon dating 12 to 13 thousand years BP and mud thickness values available indicate that the rate of mud development related to the entire Quaternary profile is 0.38 to 0.48 mm per annum. The lower and the higher values have been detected in the Siófok and Keszthely sub-basins, respectively. All these can be explained by the size of the water catchment area related to unit water surface and the amount of deposits transported by the water input.

Apart from the ecological history of Lake Balaton and its environs, the integrated evaluation of results from paleontological examinations (sporomorphs, diatoms, ostracods) has allowed us to detect the begining of human activities and the changes of water depth and -quality in the lake. Using palynological tests, the evolution of vegetation in the immediate vicinity of the lake has been assessed for the period of the past some 15 thousand years. In Pleistocene time (till 10000 yrs BP), *Pinus* and *Betula* forests were dominant, whereas the role of the latter became less important in the Holocene and the deciduous forest became prevailing. Studying the sporomorphs of herbaceous plants has allowed us to trace some human activities such as forest clearing, and growing cultivated plants. Particularly new and interesting results were obtained from the examinations of microplankton organisms existed and still existing in the lake and of the sporomorphs of aquatic plants of higher order. The latter allowed us to trace the changes in water level and quality from the period of the lake's formation until today. The examination of the remains of siliceous algae (diatoms) has promoted us to determine the change in limpidity and chemical reaction (pH) of water and the composition of the basement. The ostracodal species were excellent to indicate the variation in water temperature and limpidity during the history of evolution of the lake. For instance, the distribution pattern of *Cytherissa lacustris* gives clear evidence of humid climate as well as cold and clear water prevailing at the end of the Pleistocene and at the very beginning of the Holecene (*Pinus* - *Betula* vegetation period). The extinction of the species taking place in the beginning of the *Corylus* vegetation phase indicates warm-up and aridity, as well as euthophication of the lake.

## References

Cserny, T. (1994) Geological Nature Conservation in Hungary, in proceedings of The Malvern 93 Conference, U.K., pp. 249-253.

Cserny, T. & Józsa, G.: Földtani értékek Magyarországon, Környezet és fejlődés VI./3-4, pp. 58-62.

Cserny, T. & Nagy-Bodor, E. (in print): Limno-geological investigations on Lake Balaton. GLOPALS Volume 2., (ed. Gierlowsky-Kordesch, E. and K. Kelts)

Csillag, G.-Gondár-Sőregi, K. & Kolosszár, L. (1994) A földtani felépítés meghatározó szerepe a Káli-medence felszínalatti-víz rendszerében, Kárpát-medence Vízkészlete és Vízi Környezetvédelme Kongresszus, Eger, X. 17. pp. 136-156.

Nagy A. - F. Elbaz-Poulichet - Cserny, T. & Pomogyi P. (1995) Biochemical behavior of trace metals in the Zala river and Kis-Balaton, EUROECO '95 7th European Ecological Congress, Budapest, Abstract p. 21.

Nagy, A.-Cserny, T. & Elbaz-Poulichet, F. (1996) Geochemical investigations in a protected area. Case study: Trace metals in the system of Zala-river - Kis-Balaton - Keszthely-bay. Research, Conservation, Management, Aggtelek-Jósvafő, Symposium Abstract Volume p. 33.

Nagy-Bodor, E. & Cserny T. (1995) A Keszthelyi- és Szigligeti-öböl palynológiai vizsgálata, Poszter előadás. EUROECO '95 7th European Ecological Congress, Budapest, Abstract p. 166.

Németh, K. (1996) A Plan of Volcanic National Monument in Tihany Peninsula. Research, Conservation, Management, Aggtelek-Jósvafő, Symposium Abstract Volume p. 34.

Siegl-Farkas, Á. & Cserny, T. (1996) Palaeoecological reconstruction in a nature conservation area. Case study: the Tihany lakes. Research, Conservation, Management, Aggtelek-Jósvafő, Symposium Abstract Volume, p. 36.

Tóth, Gy.-Kuti,L. & Cserny,T. (1994) Környezetgeológiai kutatások. (Environmental Geological Research) In: 125 éves a Magyar Állami Földtani Intézet, tanulmányok (Studies), Budapest, pp.99-108 (107-115).

Vértesy, L.-Csillag, G.-Gondár-Sőregi, K.-Gulyás, Á.-Kiss, J. & Kolosszár, L. (1996) Geological and Geophisical Data in Nature Conservation - GIS Computer Show. Research, Conservation, Management, Aggtelek-Jósvafő, Symposium Abstract Volume p. 38.

# GEOCHEMICAL INVESTIGATIONS IN A NATURE CONSERVATION AREA.

CASE STUDY: TRACE METALS IN THE SYSTEM OF RIVER ZALA - KIS-BALATON - KESZTHELY BAY

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## Introduction

The protected areas in the industrialized countries are subjected to a strong anthropogenic pressure and our duty is to prevent these sites from the deterioration. For this reason it is very important to know the initial environmental status and also the processes which control the changes in this state. Trace element fluxes into the environment have also increased. These elements have been applied for a long time in a large scale of studying geological and environmental processes. Hence the idea of investigating the state of an ecosystem through the biogeochemical behaviour of trace elements occured.

Our study is focused on a system consisting River Zala (main input) - Kis-Balaton (former bay of Lake Balaton, nowadays a wetland area) - Keszthely Basin (hypertrophic part of Lake Balaton).

In particular, the increased nutrient supply has perturbated the natural biogeochemical cycles.

## Study site

In the past, River Zala, which represents the main water and solid supply for the lake, discharged its water volume into a bay that was separated from the Keszthely Basin by an arm. This bay, overgrown with reed and aquatic vegetation, was named Kis-Balaton. In 1866, after lowering the water level of the lake, Kis-Balaton almost completely dried up. That was the situation for a period of 100 years. Due to the increased nutrient supply, eutrophication of Lake Balaton has increased during the last 40 years. This eutrophication as well as an increase in sedimentary inputs to the lake have speeded up the filling of the lake. This process was mainly attributed to an increasing nutrient discharge of River Zala which is responsible for 45 % of total discharge in the Balaton. Experts proposed the reconstruction of the Kis-Balaton with the aim of creating a natural filter on the lower Zala River.

The recent Kis-Balaton consists of two reservoirs with controlled outlets. Internal dikes allow to retain the water for a period of about 50 days. During this period the sediment settles out and the nutrients are consumed by algae.

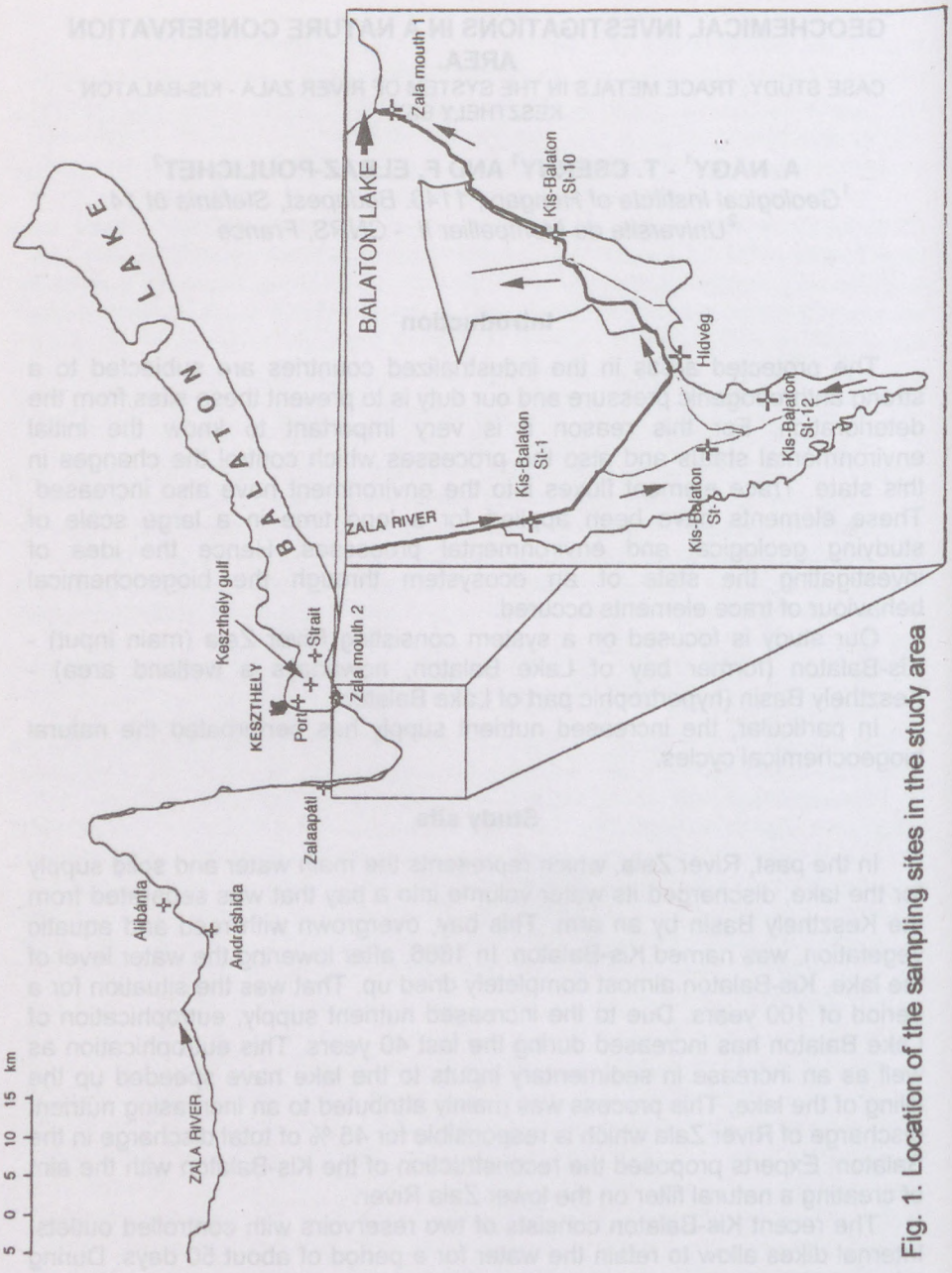



Fig. 1. Location of the sampling sites in the study area

The first reservoir is an open water lake, whereas the second one is covered by aquatic vegetation. Today, Kis-Balaton is a nature conservation area.

We were interested in studying the effect of this filter on the trace metals distribution. Moreover, we wanted to know to which extent the system has been polluted.

## Sampling and analytical methods

Since the main process controlling physicochemical characteristics is the algal productivity, that depends on the biological cycles, sampling was carried out on a seasonal basis. Water samples were taken at 15 sites along the River Zala, in Kis-Balaton and the Keszthely Basin during 3 surveys in May and September, 1994 and February, 1995 (Fig. 1). Sediment cores were also taken at each site during the survey in September.

Since we had to measure very low concentrations of trace metals, ultra clean sampling and analysis techniques were used. Water samples were collected in high density poliethylene bottles. They were washed three times with aqua regia, nitric acid and chlorhidric acid respectively. Merck® Suprapur quality acids and MilliQ water were used for each operation. 0,5 L of water was filled to a bottle by hand using plastic gloves. The samples were filtered within 24 hours after sampling on 0,2 mm pore size Millipore teflon membranes. The filters were previously cleaned with acids, dried and weighed. In order to avoid the contamination after sampling the filtration was performed using a plastic glove bag filled with pure nitrogen. The filtered samples were acidified, than the bottles were kept in a dark place prior to analysis.

The atmospheric fallout was also estimated by collecting precipitation over a period of four month.

Sediment cores were taken using a special plexiglass sampling tool. The cores were divided in three centimeter pieces and stored in plastic bags.

The determination of 15 trace elements (V, Mn, Ni, Cu, Zn, As, Rb, Sr, Mo, Cd, Sb, Cs, Ba, Pb and U) was performed using ICP-MS technique. The instrument used is a VG PlasmlaQuad 2. The calculation of concentration was done using calibration curves drawn up by using trace element standard solutions. Indium internal standard was added to correct instrumental drift. The accuracy of the method was checked using the SLRS-2 trace element standard (Riverine Water Reference Material for Trace Metals, National Research Council of Canada).

Major element concentrations (Na, K, Ca, Mg, Cl, SO4) were determined on unfiltered samples. Water temperature, pH and alcalinity were measured in situ during the sampling.

## Results and discussion

The results presented here are only the dissolved concentration in the system Zala River - Kis-Balaton - Keszthely Basin.

Comparing the dissolved concentration of some trace elements with those encountered in open oceans and seas (Fig. 2), similar values can be obtained except for Cd, Zn, and Cu. For these elements, the increased amount of atmospheric fallout can probably explain the higher concentrations. In addition the concentrations are nearly the same as those that have been reported from other lakes such as Lake Baikal, Lake Constance. Only lead occurs at high level due to the high atmospheric fallout as a consequence of lead emitted by cars all over the world.

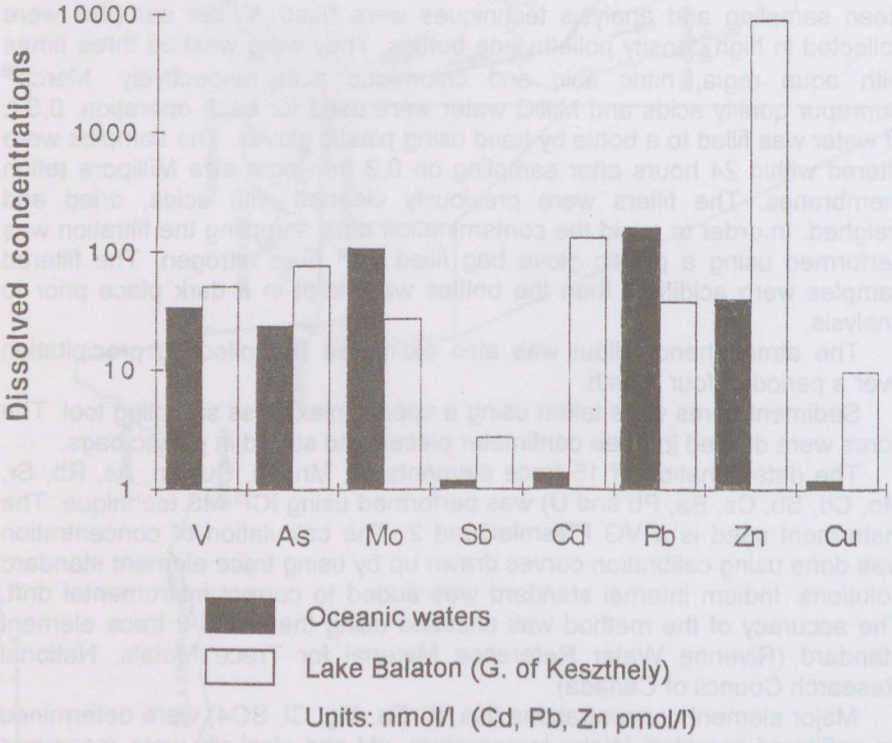



Fig. 2. Dissolved solid contents in oceans and in Keszthely-bay

It can be finally concluded that the system is not particularly polluted with these trace metals and elements. The environmental state of Kis-Balaton and also that of the whole system is close to a natural state.The main processes controlling dissolved trace element distribution are more or less known.

V, Mo and U are redox sensitive elements. Their similar trends express a similar chemical behavior (Fig. 3). The distribution of these metals depends upon the pH and redox potential encountered in the water column.

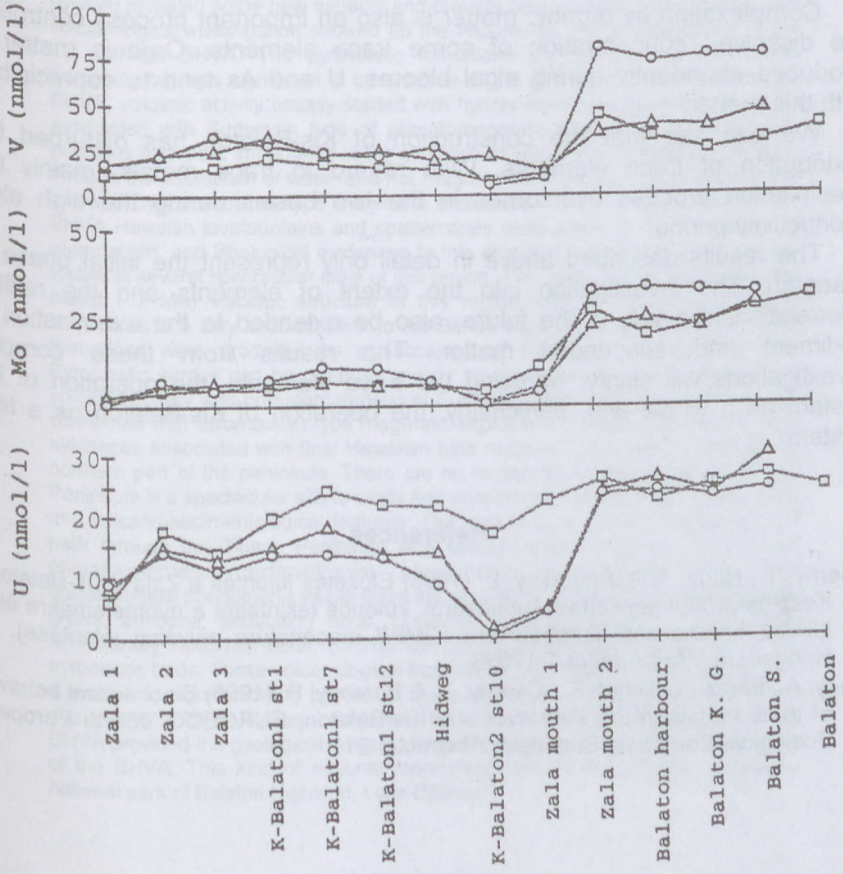



Fig. 3. V, Mo, and U distribution in the system Zala river - Kis Balaton - Keszthely-bay.

The high primary production plays an important part in the determination of the distribution of trace element in the water column. First at the high activity period it causes oversaturation with respect the $CaCO_3$. Some elements such as Ba, Cu, Mn and Sr can coprecipitate with calcite or form carbonates.

Other interesting processes are pH depending sorptions. The pH increase considerably in Kis-Balaton and the Keszthely Basin during high primary production period. Zn and Pb show inverse correlation with pH probably due to desorption at higher pH.

Complexation by organic matter is also an important process controlling the dissolved concentration of some trace elements. Organic matter is produced abundantly during algal blooms. U and As tend to coprecipitate with this matter.

We can see that the construction of Kis-Balaton has disturbed the distribution of trace elements. With regard to trace metals, mainly the precipitation process overcomes in the two basins during the high algal productivity period.

The results described above in detail only represent the initial phase of research. The investigation into the extent of elements and the related interrelationships will, in the future, also be extended to the examination of sediment and suspended matter. The results from these complex investigations will clarify, by using the trace elements, the operation of the system as a whole and, particularly, the operation of Kis-Balaton as a filter system.

## References

Cserny, T., Nagy, A. & Andrássy, L. (1995) Előzetes jelentés a Zala - Kis-Balaton - Keszthelyi-öböl geokémiai kutatásáról, különös tekintettel a nyomelemekre és a LIPS-2 berendezés kipróbálására (OMFB mecenatúra pályázat jelentése). (in Hungarian) MÁFI Adattár T 17056

Nagy, A., Elbaz-Poulichet, F., Cserny, T. & Pomogyi P. (1995) Biochemical behavior of trace metals in the Zala river and Kis-Balaton, EUROECO '95 7th European Ecological Congress, Budapest, Abstract p 21.

# A PLAN OF VOLCANIC NATIONAL PARK IN TIHANY PENINSULA

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**Abstract:** Detailed volcano-sedimentological investigations, structural studies, analitical research review the eruptive history of the Tihany Volcano (TV). Preliminary physical volcanological studies in the Balaton Highland Volcanic Area (BHVA) revealed some new aspects and brought new volcanological results. This volcanological investigation showed up the importance and unique nature of the TV and the BHVA. The pyroclastic formations are common in the Tihany Peninsula but less significant in other areas of the BHVA, than lavaflows. In the BHVA, volcanic activity usually started with hydrovolcanic explosions that can be associated with Surtseyan type of phreatomagmatic explosions. Hydrovolcanic eruptions had great importance in the evolution of volcanic edificies brought about through the interaction of water and hot magma. The Surtseyan type activity was followed by Strombolian type magmatic explosions. In the western part of the BHVA Hawaian lavafountains and spattercones were active in the final stage of magmatism, and lithological evidences to this complex volcanological history are visible at several spectacular sites of this region. The Tihany Volcano which is the oldest ( 7 MA) volcanic structure in this region with its complex pyroclastic sequences is a very important link to the BHVA volcanic history. The pyroclastic formations were produced by a succesion of pyroclastic surges and falls. Pyroclastic surges can be regarded mainly as base surges. The initial stage of volcanic activity was phreatomagmatic of Surtseyan type, while the final one was connected with Strombolian type magmatic explosions. Several sedimentological evidences associated with final Hawaiian type magmatic explosions occur at the northern part of the peninsula. There are no evidences to any lavaflows. Tihany Peninsula is a spectacular site to study and understand hydrovolcanic phenomena and volcano-sedimentological features. Our idea is to organize a volcanological path through the Tihany Peninsula with several stops. They would represent phreatomagmatic (hydrovolcanic) phenomena in outcrops. The main volcanological phenomena visible there are as follows: crossbedding, dunebedded layers, antidune, undulating beds, U-shaped erosion channels, impact sags, accretionary lapilli rich beds, Strombolian scoria layers, mantle xenoliths in the pyroclastic beds. These volcanological trips will be supported by a guidebook with a map, and signs allowing people to study the sedimentological features. This designated Volcanic National Park may be extended to the western part of the BHVA provided the geological investigations bring some new results at other sites of the BHVA. This kind of national monument concept fits into the nominated national park of Balaton Highland, Lake Balaton.

## Introduction

The description of phreatomagmatic (hydrovolcanic) volcanic activity, and the exact interpretation of produced deposits have resulted from active volcanological investigations performed in recent decades. As a result of these investigations, the phreatomagmatic explosion taking place in response to an encounter of basaltic magma and external water has become by now a very

well studied field of volcanology (Chough & Sohn 1990; Godchaux *et al.* 1992; Houghton & Hackett 1984; Houghton & Naim 1991; Houghton & Schmincke 1989; Sheridan & Wohletz 1983; Sohn & Chough 1989, 1992; Wohletz & Sheridan 1983). The morphological forms featuring this type of volcanic areas are tuff rings, tuff cones and maars (Heiken 1971; Wohletz & Sheridan 1983; Cas & Wright 1989). Wohletz & Sheridan (1983) distinguished the tuff cones and tuff rings on morphological and stratigraphic basis. The most significant difference between these two forms is in their shape and size. For tuff rings, the maximum thickness of volcanic deposit bed measured at the crater edge amounts to 50 m, with the dipping only rarely exceeding 10°. For tuff cones, the maximum thickness of volcanic deposit measured at the crater edge may exceed even 100 m and the dipping may also exceed even 30°. In the sequence of tuff rings, the initial explosion breccia series is followed by a thin-bedded sequence which contains a lot of sedimentary structures and are primarily base surge and subordinately ash-fall beds. Cross-beddings are general in this sequence. The tuff cones also begin with a sequence similar to the previous ones but are overlain by a thick, massive poorly bedded sequence. The similarities and differences between the two morphological types can be searched for in the magma-to-water quantity ratio during the interaction between magma and water (Sheridan & Wohletz 1983; Wohletz & Sheridan 1983). The maar volcanism as an eruption type representing an independent hydrovolcanic activity is separated in a paper by Lorenz 1986, Cas & Wright (1989). Other authors mention maar type as a special type of tuff ring where the crater of the formed tuff ring collapses in response to the explosions, resulting in a morphological form with a base deeper than the original surface (hole in the ground structure) (Wohletz & Sheridan 1983).

Despite the fact that the volcanological descriptions were made on the basis of deposits of volcanoes that are mainly young, or still active volcanic structures at present, a number of investigations revealing the history of evolution of comparatively older hydrovolcanic structures were also performed in the region of the Pannonian Basin (Harangi *et al.* 1994; Harangi *et al.* 1995; Harangi & Harangi 1995). The hydrovolcanic structures - reflecting a great diversity in regard to tectonics and sedimentology, associated with hydrovolcanic processes - show that all types of hydrovolcanic activities can be encountered in the regions of Balaton Highland and the Little Hungarian Plain. The volcanic activity is featured by the fact that the variation in the magma-to-water ratio causes diverse volcanic structures to form. Of these structures, tuff rings and maar structures are dominant in the Tihany Peninsula (Harangi *et al.* 1995; Németh in press; Németh & Harangi in prep.).

## Hydrovolcanism

The phreatomagmatic eruption types associated with basaltic magma are referred to as Surtseyan type eruptions according to a classification by Walker

(1973). In a description by Cas & Wright (1987), the Surtseyan type is referred to as a humid pair of the Strombolian type eruption. However, studies by Kokelaar (1986) had formerly indicated that the hydrovolcanic eruptions are much more diverse than experienced when the Surtsey volcano erupted in 1963-64 (Thorarinsson *et al.* 1964; Kokelaaar 1983; Moore 1985). According to Kokelaar, in the case of the Surtsey volcano, considering that its crater was open, the sea water could flow into it freely. Thus, during the Surtsey activity (str.s.), the hot magma got in contact with a sludge that was constantly subjected to mixing, and the explosions were induced by the explosivity of the internal steam. In this case, two kinds of explosion took place: 1. Pyroclast was disseminated from the tephra clouds having a high humidity and continuously uprushing into the air (continuous uprush); 2. explosions with high energy, occurring intermittently which result in "crest" clouds (Kokelaar 1986). Among the pyroclastic beds produced this way, the beds of base surge origin are subordinate.

In a description by Kokelaar (1986), of hydromagmatic explosions those which cause the formation of primarily base surge are referred to as a separate type of theirs (Capelinhos, The Azores, 1957-58; Machado *et al.*, 1962; Waters & Fischer 1971; Taal volcano, The Philippines, 1965; Moore *et al.*. 1966; Moore 1967; Waters & Fischer 1971).

The eruption of Capelinhos started in a way that is primarily typical of Sursteyan type eruptions, and was followed by an active base surge operation. The deposits of base surge produced in response to a gravitational collapse of the eruption clouds with a height of several kilometres were dominant in the pyroclast series produced (Waters & Fischer 1971). In a paper by Kokelaar (1986), this type of eruption is distinguished from the Surtseyan type by the degree of explosivity and the geometry of mixing of water and magma. This type is referred to by Kokelaar (1986) as Ultra Surtseyan type.

The eruption of Taal volcano which took place on 28th to 30th September, 1965 was considerably different from the eruptions of the Surtsey and Capelinhos volcanoes. The eruption began under terrestrial conditions in the middle of a lake on a volcanic island. A considerable collapse of the crater caused maar volcanism to form where the non-juvenile torn-up fragments had a considerable proportion in the produced deposits and the juvenile pyroclasts were only subordinate. The initial igneous activity was replaced by base surge operation. This type of eruption which can be characteristically distinguished was referred to by Kokelaar (1986) as Taal type eruption. In a paper by Kokelaar (1986), the three types of eruption - Surtseyan str., Capelinhos, Taal - can be featured by different eruption feature, water-to-magma ratio and eruption energy. Of course, these differences may cause volcanic superstructures with a different geomorphology to be produced.

## The Tihany volcano

The first accurate description of volcanic formations in the Tihany Peninsula is assumed to have been prepared at the end of the last century (Lóczy 1894, 1913). As a result of a work by Lóczy (1913), the first volcanological reconstructions were done in regard to the features of the Tihany volcanites. Lóczy (1913), by interpreting his morphological observations, could identify 23 eruption centers and was able to confirm the presence of 8 of them. Of observations made by Lóczy (1913) it is noteworthy that he assumed, describing the plastic feature of pyroclast beds, the existence of a sedimentary medium with a high humidity. Therefore, he frequently referred to these volcanoes as mud volcanoes. Cholnoky (1936), based on his morphological observations, attributed the subsidences found in the peninsula to the effect of a wind raging in a glacial dessert. In a paper by Papp (1931), during the mapping of formations in the peninsula the Outer lake (Külső-tó) appears as a morphological unit of tectonic origin. Hoffer (1941a; 1941b) - on the basis of his own geological observations - reported explosion tuff craters, traces of explosion volcanic activity and polygenetic volcanic system. During the geological mapping performed by Varrók (1957), the Outer and Inner lakes (Külső-tó és Belső-tó) appear as an eruption center of a polygenetic volcanic formation. Following the geological mapping performed by Láng (1970) in 1970, the siliceous content, carbonate content, grains size and weldedness conditions meant a basis for a partial separation of volcanic formations. The ring structure distribution of volcanic structures was explained by the existence of the Outer and Inner lakes as eruptive centres.

During the period of 20 years after getting a detailed knowledge and performing an intensive research of hydrovolcanic processes, no up-to-date volcanological investigations were done into the Tihany Peninsula. The interpretation of hydrovolcanic phenomena and the precise description of volcano-sedimentological features have appeared as a result of active investigations performed in recent years only (Németh *et al.* 1993; Németh 1995, 1996; Harangi *et al.*. 1995; Németh and Harangi in prep,). According to K/Ar radiometric dating, the volcanosediment formations are dated to be as old as 7.54 Ma but at least 6 Ma (Harangi *et al.* 1995; Balogh 1995). The volcanic activity was featured, during its initial period, by Surtseyan type eruptions acc. to Walker's (1973) classification. The formations consisting of tuff having a large amount of additional lithic detritus, and subordinately lapilli stone pyroclastite rocks indicate, in accordance with a classification by Kokelaar (1986) an activity that is rather close to the basic type of a real maar volcanism. The eruption cycles that can be linked with this initial part of operation of the Tihany Volcano can be classified as Taal type eruptions (Németh and Harangi in prep).

As changes in the magma-to-water ratio and in the positions of eruption centers (depth, surface wondering) took place, the initial phreatomagmatic

feature of eruption types reached the status of igneous explosive activity through a gradual transition. The Tihany Volcano was featured, in the final phase of its activity, first of all by Strombolian or possibly Hawaian to Strombolian transition type of activity (Harangi *et al.* 1995, Németh and Harangi in prep). The sedimentological features containing evidences to a varied hydromagmatic activity of the pyroclastite sequence of the Tihany Volcano are considered - due to the fact that they are well exposed - to be an excellent demonstration site where the conservation of phenomena of each exposure may prove to be an important task in the life of a nature conservation area that has been operating for a long time. An exceptional range of sedimentological features of hydrovolcanic phenomena is indicated by several, well accessible exposures in the Tihany Peninsula. Out of these phenomena, the cross-beddings, dune structures, undulatory fine-grained tuff beds, U-shaped erosion channels, baggings produced due to ballistically transported bombs, traces of base surge referring to horizontal transport, and accretionary lapilli beds are of major importance.

The interpretation of volcanic phenomena featuring the Peninsula may represent an important contribution to having a better understanding of hydromagmatic volcanic phenomena, by marking the best exposures of the above phenomena, forming a volcanological study path, and by using field guidebooks giving an accurate description of history of the Tihany Volcano.

## 1. Cross-beddings

In the fine grained tuff beds, cross beddings are encountered mainly in the so-called friars' dwellings. These forms are in connection with the horizontal flow of base surge produced in response to phreatomagmatic explosion, thus, their precise analysis allows for the calculation of the source of base surge and, thus, the eruption center. Based on the analysis of these structures, it has been found that a structural element of major importance for the Tihany Volcano is represented by the Outer lake as an eruption center. The Outer Lake as an explosion center of maar volcanism, can be considered to be evidenced even when calculated on the basis of the size and distribution of ballistic bombs encountered in pyroclastite beds. Two types of cross bedding can be distinguished. One of them is a flat cross-bedding with a small angle (with a dipping of about $10^{o}$), and the dune structures and antidune structure with smaller scale. An additional analysis of cross-beddings may supply important information concerning the description of physical conditions of base surge. The statistical evaluation of the structures allows of the determination of degree of turbulence of the flowing medium.

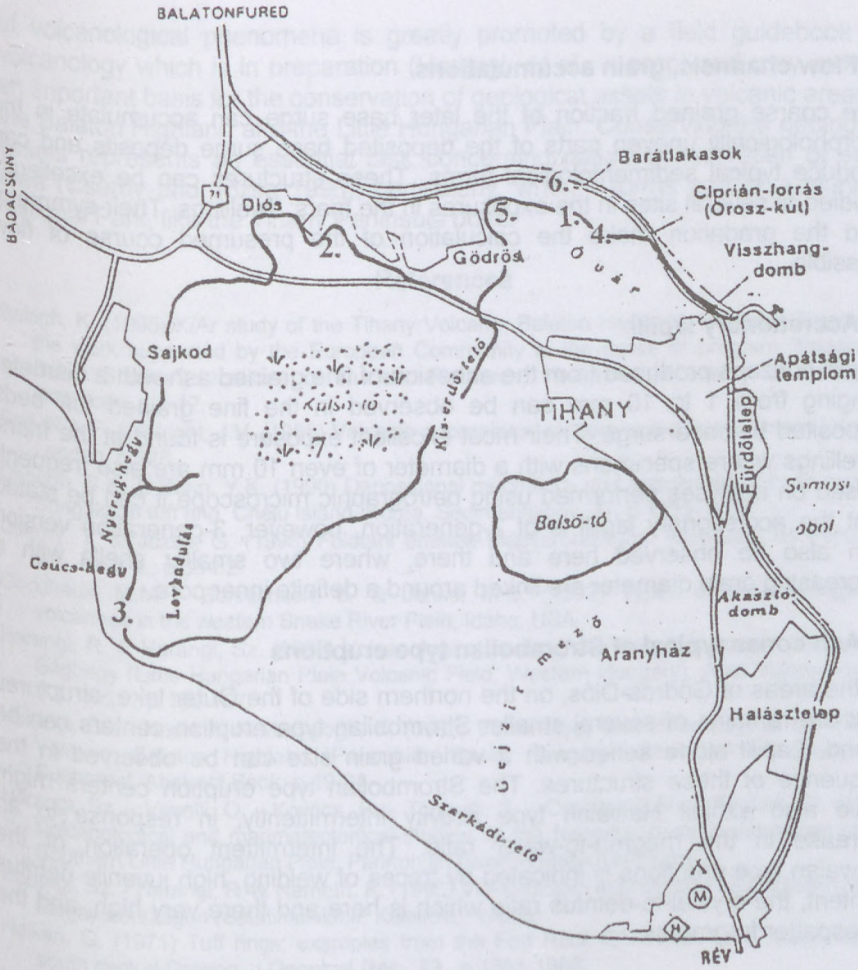
## 2. U-shaped erosion channels

The structural elements that can be observed at several sites in the friers' dwellings are the so-called erosion channels. Their development is also associated with the horizontal transport processes. When rushing down the

slope of the volcano, the base surge flowing horizontally, had cut a channel in which the deposited pyroclast was accumulated.

### 3. Impact sags

During the hydromagmatic (phreatomagmatic) eruption, due to the mechanism of eruption, ballistically transported material may also get out of the eruption center. During the Surtseyan type (s. str.) eruptions, the hot magma being in contact with the detrital mud being in continuous connection with the open sea water and falling-back of fine-grained pyroclasts blown up into the air in response to the explosions resulted in the formation of disseminated pyroclast beds into which ballistic bombs, blocks might have also got by blowing out larger torn-up fragments. If the steam explosion occurs at a greater depth, in response to subsurface waters, then base surges may form. A great number of ballistical bombs and blocks get into the depositing base surge beds by tearing out the subsurface beds (Fisher & Schmincke 1984; Kokelaar 1986; Cas & Wright 1987). During the initial phreatomagmatic activity of the Tihany Volcano, pieces of the basement rock torn-up by subsurface explosion were transported through ballistical transport into the embedding fine grained base surge deposits (Harangi *et al.*. 1995). Based on bed deflection caused by the hitting of ballistical bombs, the direction of throwing can be calculated, thus, they supply information of great importance on the position of eruption centers in space. The plasticity, or rigidity of bed deflections is linked with the humidity of the embedding deposits. For the Tihay Volcano, the embedding rocks are base surge deposits deposited by base surge, thus supply information on its humidity. Based on the analyses of these phenomena, the pyroclastite formations described in the exposures found in the friars' dwellings can be considered to be humid base surge deposits. In the western areas of the Tihany Peninsula, the rigid bed deflection phenomena become frequent in the late series of pyroclastite formations of base surge origin. This means that the magma-to-water ratio increased during the hydromagmatic activity and an almost continuous transition is visible between the hydromagmatic and igneous processes. Ballistical bombs are encountered in greatest variety in exposures in the friars' dwellings.




1. Surtseyan type phreatomagmatic base surge (wet) sequences
2. Strombolian type scoria sequences
3. Dry base surge layers
4. Accretionary lapilli layers
5. Impact sags
6. Crossbeddings and evidences of horizontal displacements
7. Maar structure

Volcanological study path

### 4. Flow channels, grain accumulations

The coarse grained fraction of the later base surge can accumulate in the morphologically uneven parts of the deposited base surge deposits and can produce typical sedimentological forms. These structures can be excellently studied at several sites in the exposures in the friars' dwellings. Their symmetry and the gradation make the calculation of the presumed course of flow possible.

### 5. Accretionary lapilli

Lapilli horizons produced from the adhesion of fine grained ash with a diameter ranging from 1 to 10 mm can be observed in the fine grained tuff beds deposited by base surge. Their most excellent exposure is found at the friars' dwellings where specimens with a diameter of even 10 mm are also frequent. Based on analyses performed using petrographic microscope it can be stated that the accretionary lapilli is of 2-generation, however, 3-generation version can also be observed here and there, where two smaller shells with a decreasing grain diameter are linked around a definite inner core.

### 6. Ash cones typical of Strombolian type eruptions

In the areas of Gödrös-Diós, on the northern side of the Outer lake, structures that are remains of several smaller Strombolian type eruption centers can be found. Lapilli stone series with a varied grain size can be observed in the sequence of these structures. The Strombolian type eruption centers might have also exhibit Hawaian type activity intermittently, in response to an increase in the magma-to-water ratio. The intermittent operation of the Hawaian type eruptions is indicated by traces of welding, high juvenile detritus content, the crystal-to-detritus ratio which is here and there very high, and the lavaspatter fragments.

### Summary

A wider propagation of latest results from the investigations in the Tihany peninsula may play an important role in the fields of the propagation of geological information for the public, the geological nature conservation and the education alike. As shown by latest examinations, a complex hydrovolcanic history of evolution can be interpreted on the basis of the pyroclastite formations found in the peninsula, of the distribution thereof in space. Opening a Volcanological national park may provide a good opportunity to propagate the science of volcanology, the sedimentological phenomena produced in response to hydromagmatic processes, through a presentation of results from previous investigations. The pecularity of geological features concerning the peninsula clearly contribute to the justification of the planned Balaton Highland National Park, to the elaboration of specific tasks of conservation. The review

of volcanological phenomena is greatly promoted by a field guidebook on volcanology which is in preparation (Harangi *et al.*. in prep) and may provide an important basis for the conservation of geological assets in volcanic areas in the Balaton Highland and the Little Hungarian Plain. Conserving the geological assets represents an essential task concerning nature conservation of each area (Cserny and Józsa 1996), particularly, when it forms part of a planned National Park, like the Tihany Peninsula does.

## References

Balogh, K. (1995) K/Ar study of the Tihany Volcano, Balaton Highland, Hungary (Report on the work supported by the European Community in the frame of program "Integrated Basin Studies"). Institute of Nuclear Research, Hungarian Academy of Sciences, Debrecen, p.1-12.

Cas, R.A.F. & Wright, J.V. (1988) Volcanic succesions, modern and ancient. Unwin Hyman, London, p.528.

Chough, S.K. & Sohn, Y.K. (1990) Depositional mechanics and sequences of base surges, Songaksan tuff ring, Cheju Island, Korea. Sedimentology, 37, p.1115-1135.

Cserny, T. & Józsa, G. (1996) Földtani értékek Magyarországon. Környezet és Fejlődés, v.6., No.3-4., p.58-62.

Godchaux, M.M. - Bonnichsen, B. & Jenks, M.D. (1992) Types of phreatomagmatic volcanoes in the western Snake River Plain, Idaho, USA.

Harangi, R. & Harangi, Sz. (1995) Volcanological study of the Neogene basaltic volcano of Sághegy (Little Hungarian Plain Volcanic Field, Western Hungary). Acta Vulcanologica, V.7., No.2., p.189-197.

Harangi, Sz. - Németh, K. & Balogh, K, (1995) Volcanology and chronology of the Tihany Volcano, Balaton Highland (Pannonian Basin, Hungary). XthR.C.M.N.S. Congress, Bucharest, Abstract Book, p.19-21.

Harangi, Sz. - Vaselli, O. - Kovács, R. - Tonarini, S. - Coradossi, N. & Ferraro, D. (1994) Volcanological and magmatectonical studies on the Neogene basaltic volcanoes of the Southern Little Hungarian Plain, Pannonian Basin (Western Hungary).

Harangi, Sz. - Harangi, R. & Németh, K. (1996) Vulkanológiai kirándulásvezető Északnyugat-Magyarországon (Balatinfelvidék, Kisalföld), in prep.

Heiken, G. (1971) Tuff rings: examples from the Fort Rock Christmas Lake Valley basin, south central Oregon. J.Geophys.Res., 83., p.1961-1988.

Hoffer, A. (1941a) A Tihanyi-félsziget vulkáni képződményei. MÁFI Jel., 1941., p.375-429.

Hoffer, A. (1941b) Diatrémák és explóziós tufatölcsérek a Tihanyi-félszigeten. MÁFI Jel., 1941., p.151-158.

Houghton, B.F. & Hackett, W.R. (1984) Strombolian and phreatomagmatic deposits of Ohakune Craters, Ruapehu, New Zealand, a complex interaction between external water and rising basaltic magma. J.Volcanol.Geotherm.Res., 21., p.207-231.

Houghton, B.F. & Hackett, W.R. (1991) The 1976-1982 Strombolian and phreatomagmatic eruptions of White Island, New Zealand: eruptive and depositional mechanisms at a "wet" volcano. Bull.Volcanol., 54., p.25-49.

Houghton, B.F. & Schmincke, H-U. (1985) Mixed deposits of simultaneous strombolian and phreatic volcanism, Rothenberg Volcano, East Eifel Volcanic Field. J.Volcanol.Geotherm.Res., 25., p.117-130.

Kokelaar, P. (1983) The mechanism of Surtseyan volcanism, J.Geol.Soc.London, 140, p.939-944.

Kokelaar, P. (1986) Magma-water interactions in subaqueous and emergent basaltic volcanism, Bull.Volcanol., 48, p.275-289.

Láng, I. (1970) Magyarázó a Balaton környéke 1:10 000 építésföldtani térképsorozatához, Tihany. Földt. Int. Kiadv.

Lóczy, L. (1894) A Balaton geológiai történetéről és jelenlegi geológiai jelentőségéről. Földrajzi Közl., XXII. volume.

Lóczy, L. (1913) A Balaton környékének geológiai képződményei és ezeknek vidékek szerinti telepedése. Balaton Tud.Tan. Eredm. I.

Lorenz, V. (1986) On the growth of maars and diatremes and its relevance to the formation of tuff rings, Bull.Volcanol., 48., p. 265-274.

Machado, F. - Parsons, W.H. - Richards, A.F. & Mulford, J.W. (1962) Capelinhos eruptions of Fayal Volcano, Azores, 1957-1958., J.Geophys.Res., 67., p.3519-3529.

Moore, J.G. (1967) Base surge in récent volcanic eruptions. Bull.Volcanol., 30., p.337-363.

Moore, J.G. - Nakamura, K. & Alcaraz, A. (1966) The 1966 eruption of Taal volcano. Science, 155., p.955-960.

Németh, K. (1995) Vulkanológiai rekonstrukció a Tihanyi-félszigeten. M.Sc.Thesis, Eötvös University, Budapest, p.226.

Németh, K. (1996) A Tihanyi-félsziget vulkanológiai története. Természet Világa (Természettudományi Közlöny) v.127.,No. 1., p.18-21.

Németh, K. & Harangi, Sz. in prep. Miocene hidrovolcanic activity in the Western Pannonian Basin: evolution of Tihany Volcano.

Németh, K. - Kovács, R. & Bada, G. (1993) Pliocene basaltic pyroclastic sequence in the Tihany Peninsula, Lake Balaton, Hungary: a volcano-sedimentological study. Terra Abstracts, 5., p.534-535.

Papp, F. (1931) Tihany geológiai reambulációja. Magyar Biológiai Kutató Intézet I. osztályának munkái. IV.volume.

Sheridan, M.F. & Wohletz, K.H. (1983) Hydrovolcanism: basic considerations and review. J.Volcanol.Geotherm.Res., 17., p.1-29.

Sohn, Y.K. & Chough, S.K. (1989) Depositional processes of the Suwolbong tuff ring, Cheju Island (Korea). Sedimentology, 36, p.837-855.

Thorarinsson, S. - Einarsson, T. - Sigvaldason, G. & Elisson, G. (1964) The submarine eruption of the Vestmann Islands 1963-64. A preliminary report, Bull.Volcanol., 27., p.435-445.

Varrók, K. (1957) Jelentés az 1957. évben a Tihanyi-félszigeten végzett munkáról. Földt. Int. Adattár, kézirat.

Walker G.P.L. (1973) Explosive volcanic eruptions - a new classification scheme. Geol.Rundsch., 62., p.431-446.

Waters, A.C. and Fisher, R.V. (1971) Base surges and its deposits: Capelinhos and Taal volcanoes. J.Geophys.Res., 76., p.5596-5614.

Wohletz, K.H. & Sheridan, M.F. (1983) Hydrovolcanic explosions II. Evolution of basaltic tuff rings and tuff cones. Am.J.Sci.283., 385-413.

# PALEOECOLOGICAL RECONSTRUCTION IN A NATURE CONSERVATION AREA. CASE STUDY: THE TIHANY LAKES

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## Introduction

Efficient protection of environment is impossible without knowing its past. It is true for learning both the details of the history of Mankind through archaeological studies and the more remote history of our palaeoenvironment, using modern methods of geological investigation.

## Description of the site

The Tihany Peninsula (Fig. 1) that was declared a nature conservation area in 1952, represents the pearl of the designated National Heritage Park in the Balaton Highland. The peninsula has two lakes located 25 m above Lake Balaton's level. In 1991 an international research team has been established in order to perform a complex geological investigation in them. Led by the Geological Institute of Hungary, Austrian (Botanical Institute of the Innsbruck University) and Swedish (Faculty of Quaternary Geology of the Uppsala University) experts carried out geological (sedimentological, mineralogical and geochemical), palaeontological (palynological and palaeobotanical) as well as archaeological investigations. An integrated interpretation of results aiming at portraying the geological and ecological history of the evolution of the lakes and their immediate surroundings is recently being carried out.

## Results and discussions

Of the above-mentioned studies this paper is focused on the geological and palynological results. The main points of presentation can be summarized as follows:

In February 1995, four boreholes penetrating the ice cover of each lake stopped at a depth of 0,70 to 1,70 m, and revealed Late Pleistocene and Holocene formations. Sedimentologically, the profile can be subdivided into three layers wich are as follows: lower calcareous marl, middle clayey silt bearing organic matter, and upper silt of high organic matter content with intercalation of peat and gyttja. The boundaries between the layers are sharp

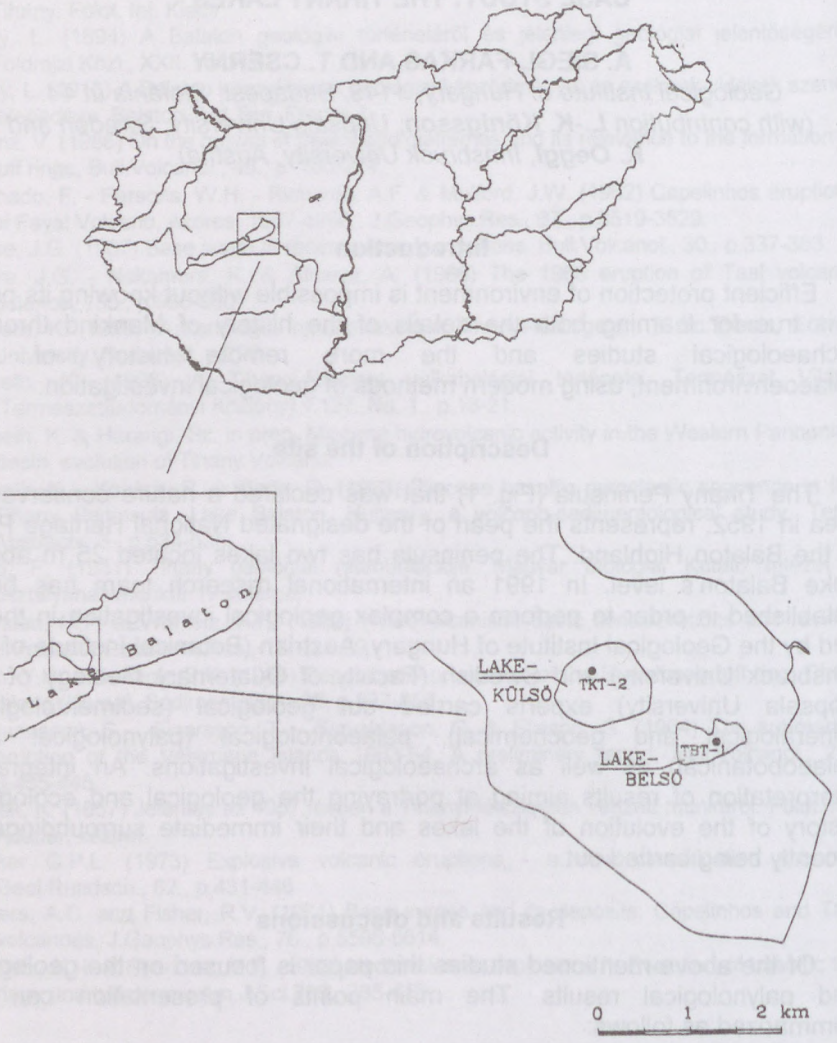



Fig. 1. Layout of the Tihany Peninsula, the Lakes and the Bore Holes

witnessing sudden changes in the palaeoenvironment of the lakes (e.g. drying out). The latter assumption is supported by the results obtained from mineralogical and geochemical analyses. Regarding mineralogical composition, carbonates, the proportion of organic matter and the presence of secondary minerals, all indicate the nature of the fluctuation of water level along with changes in water quality.

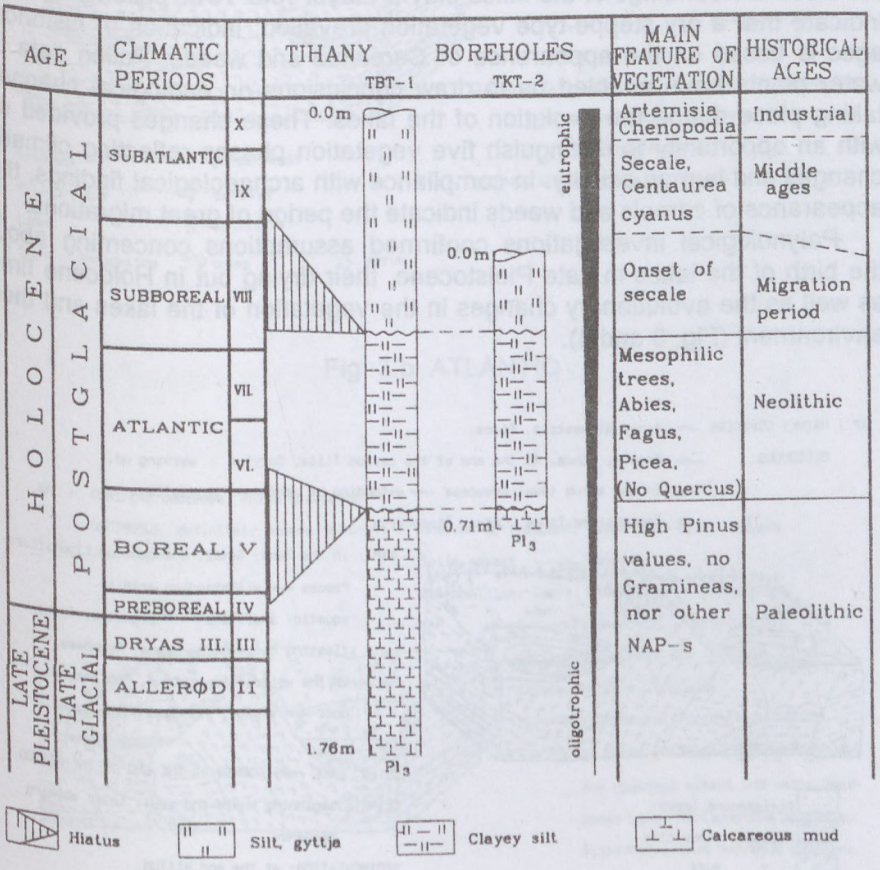



Fig. 2. Quaternary Geological Sequence of Tihany Lakes

Based on the palynological data, the sediments exposed in the Belső-tó (Inner Lake) were deposited during the Late-Pleistocene and the Sub-Atlantic climatic periods. The sediments in the Outer-Lake were formed during the Atlantic and Sub-Atlantic. The determination of climatic periods is based on the quantitative changes in Arbor Pollen (AP). AP pollen diagrams allowed us to trace distinctively the progressive withdrawal of pine forests giving slowly way to deciduous trees from the Late Pleistocene until recently. Among Non Arbon Pollen (NAP), grass and weed species living in the close surroundings of the lakes play a mayor role. NAP pollen diagrams indicate that a dry steppe-type vegetation prevailed. Indication of historical ages is based on the appearence of Cerealiae and weeds. Pollen data of water plants have enabled us to draw conclusions on ecological changes taking place during the evolution of the lakes. These changes provided us with an opportunity to distinguish five vegetation phases reflecting climatic changes and human activity. In compliance with archaeological findings, the appearance of cereals and weeds indicate the period of great migrations.

Palynological investigations confirmed assumptions concerning about the birth of the lakes in Late Pleistocene, their drying out in Holocene time as well as the evolutionary changes in the vegetation of the lakes and their environment (Fig. 3 and 4).

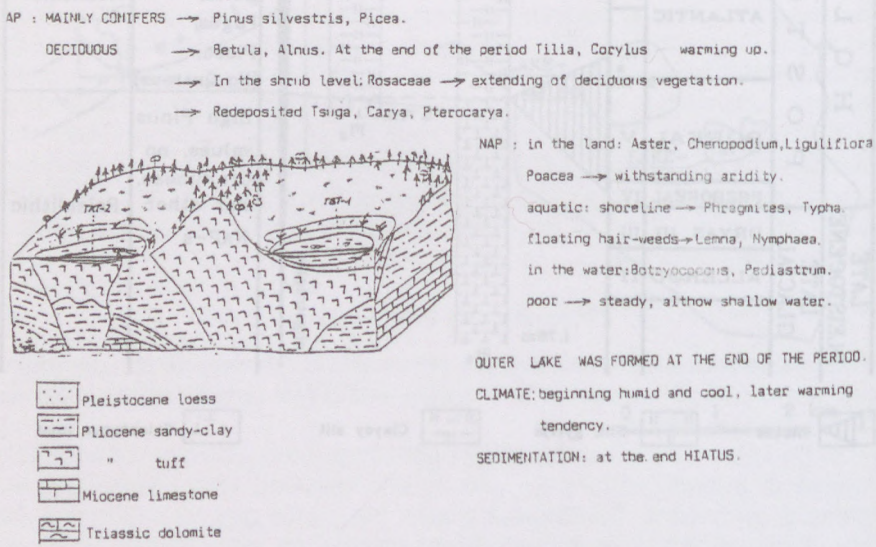



Fig. 3.a LATE PLEISTOCENE

AP : CONIFERS are dominant: Pinus frequent, Picea, Abies rare.

DECIDUOUS Alnus, Betula, Corylus, Fagus, Ulmus common.

Shrub level : maximum appearance of Rosaceae → spreading the leafy shrub.

NAP : in the land:grass and weeds frequent

aridity

aquatic:.in both shallow lakes beginning

poor, later more frequent Typha-Sparganiu

floating hair-weeds:Lemna dominant,

Nymphaea few.

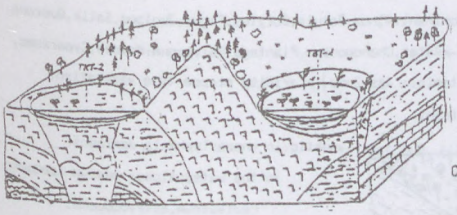
Algae very rare.

CLIMATE: favorable to spreading of deciduous trees,

AP/NAP rate: decrease precipitation,

increase temperature.

SEDIMENTATION: at the end HIATUS.



Nymphaea
Miriophyllum
Lemna
Typha - Phragmites
grass-weeds
ceraals
Conifarae
trees
shrub

Fig. 3.b ATLANTIC

AP : CONIFERS decrease, Abies disappear

DECIDUOUS definitely became dominant Quercus is frequent, Carpinus, Fagus, Juglans,

Salix appear → Warming.

redeposition: Carya, Pterocarya → denudation.

NAP : revolutionary change → appearance of

cultivated Cereals and weeds:

Secale, Hordeum, Triticum.

Artemisia,Centaurea,Chenopodium,Humulus...

aquatic: in shoreline:poor Typha.Sparganium

The greatest extent and water depth

Inner Lake: Miriophyllum spicatum.

Algae:Pediastrum boryanum dominant.

CLIMATE : composition of the "forest" indicates warming.

HUMAN ACTIVITY APPEAR.



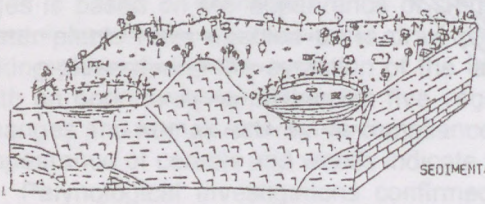
Fig. 4.a SUBATLANTIC I. Migration Age

AP : Pinus less dense, DECIDUOUS trees are dominant:Alnus,Betula,Corylus,Fagus,Juglans,Salix,Quercus.

NAP : in the land grass and weeds spreading→Aster,Chenopodium,Plantago,Polygonum:Poacea,Cyperacea.

Artemisia is dominant (Artemisia Ass.Zone)→ aridity steppe-type vegetation.

Cultivated: Secale is dominant.



aquatic:in shore: Typha is dominant,

in the water: algae medium frequen

Pediastrum,Botryococcus.

floating hair-weeds:Lemna,Nymphaea

Miriophyllum disappear → low wate

SEDIMENTATION cease in the Outer Lake ; no synchro

association.

Fig. 4.b SUBATLANTIC II. (cc. 1000-1800) and Present Time

# III. SESSION:

# RESULTS AND EXPERIENCES OF THE COMPLEX ECOLOGICAL STATE ASSESSMENT (1992-95) AND THE FIRST STEPS OF DEVELOPING THE NATIONAL BIODIVERSITY MONITORING PROGRAM

# BIOMONITORING AS A TOOL FOR NATURE MANAGEMENT AND POLICY

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The Dutch National Forest Service (NFS) introduced last year a new planning system for the management of forests and nature reserves. It was necessary to set clear targets in order to be able to negotiate with the government about the yearly budget for managing nature and forests. The government will control the NFS on results, to get value for money. It has made for that purpose a list of so called target species and target nature types in the Netherlands.

Target species are species wich are either of international value and endangered, or of international value and rare, or endangered and rare. They are meant to be conserved or reintroduced in Dutch nature.

Target nature types are the rough long term goals in governmental nature conservation policy, devided in 4 categories of naturalness. From these types NFS derived more specified subtypes in wich long and short term goals are specified. These specifications are defined following the suitability they have for nature, timber production, outdoor recreation and landscape. Short term biotic goals show the direction in wich the development goes and must be reached in 10 years. The abiotic field conditions must be reached in 5 years. The NFS estimates in this new system for the long and the short term how many target species can be conserved, which quality of nature can be developed and how their areas can serve for timber production, outdoor recreation and landscape. That gives the possibility to plan measures and thus to estimate costs and benefits of nature management.This is going to play a major role in the yearly negotiations between NFS and the government about the budget. The so called "year plan" forms the contract, in wich the management measures are described.

Because biomonitoring is a necessary instrument to check the results of the year contracts, the NFS is recently developing a monitoring system.

Apart from checking the contracts' result, the 3 most often heard questions to be answered by monitoring are:

- what is the quality of "my" nature reserve or national park
- what are the effects of disturbance from outside
- what are the effects of nature management measures

The species and conditions to be monitored can be identified and selected after the vegetation is mapped and surveys are made of the occuring species and field conditions and after we roughly understand the ecosystem.

To monitor we distinguish:
- target species
- indicator species (indicating a development)
- field conditions essential for species ( e.g. hydrologic information, water quality, soil quality, rest, openess)
- management measures

Monitoring should be:
- sustainable ( the yearly budget in time and money must be available over the period to monitor.)
- comparable (keep using the same methods, if possible by the same person)
- cost effective (monitor a restricted and selected number of species and fieldconditions wich gives the best and most information for the lowest price).

Frequency of monitoring:
- mapping of the vegetation and survey of species once in 10 years
- field conditions depends on the condition and costs.
- effects of management once a year or once in 2 to 3 years, depending on the speed of the development
- management measures once a year

Some statements:
- Think in targets and in quality.
- Scientific research in nature reserves in the first place must serve the needs of the nature manager and the policy maker.
- There must be an intensive cooperation between management and research, wich is one of the intentions of this symposium.
- The nature manager must be able to understand the monitoring results and its consequences. He must be able to translate them into the required measures. Needless to say that qualified fellow workers are indispensable.
- Monitoring doesn't explain the relation between cause and effect, therefore you need research.
- Monitoring can give you an idea of which topics need research for a better understanding of the ecosystem and for a better nature management.
- Vegetation maps can be linked with pointwise sampled abiotic field conditions (e.g. pH and watertable) to interprete the abiotic conditions areawise.

- Be in the field apart from monitoring and without being programmed, having an open mind for the unexpected. It is the only way of integrated observation.
- Be in the field in all seasons and on special moments when extreme conditions occur like inundations, snow cover and fire. Extreme situations rules the ecosystems.
- Be in the field intuitively on the right moment on the right place for the best observations.

Monitoring and other field observations are the base of research and management. They can be seen as one of the most important nature management measures. In that way I agree with the organisers of this symposium who stated in their second circular that "The most important part of nature management is the exploring investigation and the state assesment of the object".

# BIOGEOGRAPHICAL CHARACTERISATION OF THE MOLLUSC FAUNA ON SZATMÁR-BEREG PLAIN

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## Introduction

Connected to the biological inventory on the territory of the Hortobágy National Park Directorate in 1993 and 1994 we could investigate the land snail fauna in 20 of the Szatmár-Bereg Plain forests.

Besides the supply of data, we were looking for answers to some zoogeographical questions. From where and how can we trace the descent of snail fauna of the forests of Bereg Plain? Is the migration of the species still in process? What kind of connection is there between the faunas of the relatively close NE-Carpathians and the forests of the Bereg Plain.

## The inventory of the forests of the Szatmar-Bereg Plain.

In the course of the field researches we collected soil samples for the malacological investigations according to the quadrat method (25x25x5 cm/quadrat). We usually took 10 samples in each forest. Besides the quadrat method we applied the bulk collection method.

We worked on 390 quadrats, from wich 3264 entities were examined. These entities belong to 43 species. 1000 entities are from the snail bulk collection method.

It is typical of the species-abundance of the Bereg Plain that 64% of the 74 species possibly found on the Great Plain can be traced here (BÁBA, 1983). The land-snail fauna of the plain is outstanding not only nationally but also on the Great Plain. Because of the relatively high percentage (11%) of the Carpathians species and the dominance of closed forest species the fauna of the plain hardly fits into the fauna of the dominant, forest-steppe vegetation of the Great Plain. It is reasoned by two facts, first the territory was covered with closed forests, second the origin of the Molluscs of the plain should be searched in the subcarpathian mountain ranges of the Easter-Carpathians.

The territory can be properly typized with a snail-community which consists of the following species: *Aegopinella minor, Cochlodina laminata, Clausilia pumila, Balea stabilis, Perforatella dibothrion, Perforatella vicina.* The coexistance of the first three and the last species on the Great Plain indicates that the region is touched by mountainous influences (eg. Bátorliget). The species which live only on one- or two spots are: *Discus perspectivus, Vitrea diaphana, Bielzia coerulans, Ruthenica filograna, Balea biplicata.* A similar place can be found along River Tisza, the Bagiszeg

Forest. Its connection with the subcarpathion region is still ensured by Tisza. On the Szatmár Plain there is only one similar but poorer site, the Cserköz Forest near Magosliget. The undergrowth is rich in Carpathian *Crocus Heuffelianus* and the snail-community consisting of *Aegopinella minor, Cochlodina laminata, Clausilia pumila, Perforatella vicina* can be also found here. Since fauna of the similar kind cannot be seen anywhere else on the Szatmár Plain, we rank Cserköz Forest to the Bereg Plain from a zoogeographycal point of view.

The closeness of the Carpathians, the transportation-role of Tisza river, the relatively high vapour content and the cold mezoclimate determine the zoogeographical features of the plain (BÁBA, 1983).

Table 1. List of species collected by us on the Szatmár-Bereg Plain

*Carychium minimum* O. F. Müller 1774
*Carychium tridentatum* (Risso 1826)
*Succinea oblonga* Draparnaud 1801
*Succinea putris* (Linnaeus 1758)
*Cochlicopa lubrica* (O. F. Müller 1774)
*Cochlicopa lubricella* (Porro 1838)
*Columella edentula* (Draparnaud 1805)
*Truncatellina cylindrica* (Férrussac 1807)
*Vertigo angustior* (Jeffreys 1830)
*Pupilla muscorum* (Linnaeus 1758)
*Vallonia pulchella* (O. F. Müller 1774)
*Acanthinula aculeata* (O. F. Müller 1774)
*Chondrula tridens* (O. F. Müller 1774)
*Punctum pygmaeum* (Draparnaud 1805)
*Arion subfuscus* (Draparnaud 1805)
*Vitrina pellucida* (O. F. Müller 1774)
*Vitrea diaphana* (Studer 1820)
*Vitrea crystallina* (O. F. Müller 1774)
*Vitrea contracta* (Westerlund 1871)
*Aegopinella minor* (Stabile 1864)
*Nesovitrea hammonis* (Ström 1765)
*Zonitoides nitidus* (O. F. Müller 1774)
*Limax maximus* Linnaeus 1758
*Limax cinereoniger* Wolf 1803
*Lehmannia marginata* (O. F. Müller 1774)
*Bielzia coerulans* (M. Bielz 1851)
*Euconulus fulvus* (O. F. Müller 1774)
*Cochlodina laminata* (Montagu 1803)
*Ruthenica filograna* (Rossmässler 1836)
*Clausilia pumila* C. Pfeiffer 1828

*Laciniarai plicata* (Draparnaud 1801)
*Balea biplicata* (Montagu 1803)
*Balea stabilis* (L. Pfeiffer 1847)
*Bradybaena fruticum* (O. F. Müller 1774)
*Perforatella bidentata* (Gmelin 1788)
*Perforatella dibothrion* (M. v. Kimakowicz 1884)
*Perforatella vicina* (Rossmässler 1842)
*Perforatella rubiginosa* (A. Schmidt 1853)
*Euomphalia strigella* (Draparnaud 1801)
*Chilostoma banaticum* (Rossmässler 1838)
*Cepaea vindobonensis* (Férrussac 1821)
*Helix pomatia* Linnaeus 1758
*Helix lutescens* Rossmässler 1837

Most of these forests are cut down and are replaced with pastures. Consequently the grassy biotops are secondary features of the plain. The spread of the snails in lack of rivers is very slow. Because of all these factors the land-snail fauna of these fields and pastures are very poor or in most of the cases "snail-free". The change is still in process and we can observe the sudden advance of termophilous and draught-resistante elements. A very good example of this advance is the appearance of the steppe "dweller" *Chondrula tridens* along the sides of the paved road leading through Lónyai-forest. A considerably greater expansion was achieved by the *Cepaea vindobonensis* partly along the pathes in the forests and partly in the bushes along the roads. The advance of this species started earlier and is still in process. This change - in the lack of sufficient data about holocen fossil Molluscs - cannot be traced. The forests of the Tiszahát region represent the territory of great changes because of the antropogen-effects and the fact that the climate of the region becomes more and more arid. The forests of Szatmár died, so their undergrowth cannot be typized with the spring-time geophitons any more but with different grass species like *Alopecurus sp.* These events had a great effect on the land-snail fauna. The forest-species disappeared or the shells found reminded us to subfossil forms. While other species like *Pupilla muscorum, Vallonia pulchella* and *Truncatellina cylindrica* appeared.These species which are so typical of the areas, stand out from and do not fit into the species of a closed-forest on the Szatmár Plain. The Bereg Plain from this point of view is in a more favourable position, though changes can be also observed here and will strenghten. With the improvements of infrastructure probably irreversible changes will happen. With permanent monitoring we can easily follow these changes.

**Carpathian effects on the fauna of the Bereg inselberg: Kaszony Hill.**

In the course of malakofaunistical examination of the Kaszony Hill we distinquished 7 typical biotops (in accordance with the things mentioned

above). All of these forests are planted or naturally revived. We cannot find Molluscs on vineyards and on greens. In accordance with the biotopes we worked on 70 quadrats and determined 913 entities. Besides, 200 entities were collected with the bulk method. The list of species includes 23 taxons and hopefully it will be enriched with the number of the naked-snail species.

The examination proved that in comparison with the surrounding territories the land-snail fauna of the Kaszony Hill is very rich. The fauna of the S-E.n exposed bushes correspond to the snail communities of the zonal wooded-steppe vegetation of the Great Plain, with an element from the NE-n part of the Plain (*Helix lutescens*). The relationship can be traced between the enpoverished faunas of the southern hillsides and oak forest spreaded on the hill-country.

In the snail-faunas of the Eastern hill-sides in considerable proportion, we can find such fauna elements that recquire forest-environment. These are the Carpathian (*Balea stabilis, Perforatella vicina*), the middle-European species (*Vitrea diaphana, Vitrea contracta, Clausilia pumila, Balea biplicata*) and species that are wide-spread in mountain-ranges. This fauna combination is not typical of the Great Plain. Even on the northern part of the Plain, which has great precipitation and mostly covered with forests, it can be considered irregular (esp. because of the presence of *Balea stabilis* and *Vitrea diaphana*). In our oppinion relationships can be traced between this fauna-combination and the one on the mountain-range of medium hight of the Carpathians. The land-snail fauna of the Kaszony Hill, although most of the species can be in the undisturbed forests of the surrounding plain-regions, still shows (in an ecological sense) features of an island fauna. It rises above its surrounding plain as an island in which faunas corresponding with 3 fauna-zones distinct from one another, have survived still in these days.

**Malakofaunistical evaluation of two floodplain forests.**

The *Chilostoma banaticum* species, according to our researches live on two floodplain regions of the Szatmár-Bereg Plain. It was first discovered by BÁBA (1969) in the Bagiszeg Forest belonging to a town of Vásárosnamény. Later it was also found in Szabó-füzes Forest near Tiszabecs (FINTHA *et al.* 1993).

In the course of the biological inventory we collected samples from 8-8 quadrats, and a great amount of material was collected with the bulk method. On the two territories we found 26 species altogether which is more than 50% of the species found on the Szatmár-Bereg Plain. The common species almost without exception, are of SE-European, European and Carpathian expansion.

Most of the snails, living only near Bagiszeg, are species existing in European closed forests. All of the species living only in Tiszabecs are wide-spread holarctic and palearctic ones which favoure humid, watery biotops

independetly from light intensity. The spectacular difference comes from the water-supply of the biotops. The odd thing is that we found twice as many entities in Bagiszeg as in Tiszabecs from the same amount of quadrats (8-8). This diversity cames from the great density of entities of the small-sized species, which is due to the luxuriant undergrouth and the thicker forest floor meaning a more favourable biotop for them.

According to our research besides *Chilostoma banaticum* as the dominant species - we can also find *Bradybaena fruticum, Helix pomatia, Cepaea vindobonensis* on the flood plain. In Bagiszeg *Perforatella bidentata, Perforatella vicina* enrich this community.

The nearest locality of the population of this species was found along River Tisza at the town Huszt (recently Ukraine).

On the basis of earlier assumptions the Bagiszeg substance was due to the result of a transport by River Szamos (BÁBA, 1969; DOMOKOS, 1987). Their appearance on the banks of river Tisza and in Hungary near Tiszabecs questions this assumption. To sum it up, the population at Tiszabecs if not constantly but periodically, at the time of great floods is in connection with the population near Huszt. The population living in Bagiszeg forest probably has already detached from the mountain biotopes. The most evident explanation though is ecological, namely that the microclimate of the two examined territories are differe

Table 2. Valuation of the quadrats and sporadic data on two floodplain biotopes
(Bagiszeg Forest, Szabó-füzes)

| | Bagiszeg | Forest | Tiszabecs | Szabó-füzes |
|---|---|---|---|---|
| **common species** | **quadrat** | **sporadic** | **quadrat** | **sporadic** |
| *Carychium minimum* | 200 | | 4 | |
| *Succinea oblonga* | 1 | | 1 | |
| *Succinea putris* | 1 | | 1 | |
| *Cochlicopa lubrica* | 5 | | 20 | |
| *Punctum pygmaeum* | 19 | | 1 | |
| *Arion subfuscus* | 0 | * | 0 | * |
| *Zonitoides nitidus* | 1 | | 5 | |
| *Limax maximus* | 0 | * | 0 | * |
| *Bradybaena fruticum* | 9 | | 15 | |
| *Perforatella vicina* | 6 | | 0 | |
| *Perforatella rubiginosa* | 2 | | 6 | |
| *Chilostoma banaticum* | 5 | | 8 | |
| *Cepaea vindobonensis* | 0 | * | 0 | * |
| *Helix pomatia* | 1 | | 2 | |
| *Helix lutescens* | 0 | * | 0 | * |

| | Bagiszeg | Forest | Tiszabecs | Szabó-füzes |
|---|---|---|---|---|
| **only Bagiszeg** | **quadrat** | **sporadic** | **quadrat** | **sporadic** |
| *Carychium tridentatum* | 30 | | | |
| *Vitrea crystallina* | 199 | | | |
| *Aegopinella minor* | 1 | | | |
| *Bielzia coerulans* | 0 | * | | |
| *Cochlodina laminata* | 10 | | | |
| *Laciniaria plicata* | 1 | | | |
| *Perforatella bidentata* | 7 | | | |
| **only Tiszabecs** | | | | |
| *Vitrea contracta* | | | 2 | |
| *Nesovitrea hammonis* | | | 6 | |
| *Euconulus fulvus* | | | 0 | * |
| *Euomphalia strigella* | | | 0 | * |
| **together** | 498 | | | |

## Summary

In the course of a 2 years long biological inventory carried out on the Szatmár- Bereg Plain, more than 4000 entities of land snails were identified and classified into 43 species. Consequently, we could enlarge our information about the range of land snail species with 218 data.

On the basis of the outstanding 11% presence of Carphatian species within the 30% of Middle-European mountain elements found in the forests, we suggest that "Praecarpathian", as a new distinctive zoogeographical unit should be introduced.

## References

Bába, K. (1969) Die Malakozoologie einiger Moorwalder in Alföld. Opusc. Zool. 9. pp. 71-76.

Bába K. (1983) A Szatmár-Beregi sík szárazföldi csigái és környezetükre levonható következtetések. Acta Acad. Pead. Szeged Ser. Biol.-Geogr. 12. pp. 27-41.

Deli, T.-Kiss, J. & Sümegi, P. (1993) Előzetes adatok a barabási Kaszonyi-hegy Mollusca faunájához. Mal. Táj., 12: 75-77

Deli T. & Kiss, J. (1994) A Beregi-síkság zoogeográfiai jellemzése a Mollusca fauna alapján. KLTE, Debrecen, Kézirat

Domokos, T. (1992) A klíma hatása a *Helicigona banatica* csigafaj házának alaki jellemzőire egyik alföldi előfordulási helyén. Alföldi Tanulmányok, 11. pp. 46-57

Fintha, I.- Sümegi, P. & Szilágyi, G. (1993) A *Chilostoma banaticum* faj új élőhelye Magyarországon. Malakológiai Tájékoztató, 12: 29-33

Kerney, M. P. - Cameron, R, R. A. D. & Jungbluth, J. H. (1983) Die Landschnecken Nord - und Mitteleuropas. Parez Kiadó, p. Hamburg und Berlin

Pintér, L. - Richnovszky, A. & Szigethy, A. (1979) A magyarországi recens puhatestűek elterjedése. Soosiana, Suppl. p. 350. Budapest
SOÓS L. (1943): A Kárpát-medence Mollusca faunája. Budapest

# TERMET
# META-DATABASE ON MONITORING PROJECTS: A TOOL FOR MANAGING BIODIVERSITY MONITORING AND OVERVIEWING THE RESULTS

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**Abstract:** A working group was set up to discuss and plan the concept, role, structure and functions of TERMET: meta-database on biodiversity monitoring projects.
The aims of TERMET are to provide assistance in nature conservation management, facilitate decision making and research, promote co-ordination and co-operation between participating organizations and provide clear information on distributed research and monitoring activities in Hungarry.
There are three basic plans: *project (PR), products (AN)* of a project and *links* among projects and products, which are defined in related tables in the proposed database. Meta-information on projects and products consist of identification, general searching attributes, detailed descriptions, linkages, access and meta-data references (see the Appendix).
The working group addressed recommendations to the National Authority for Nature Conservation for developing and setting up the system.

## Introduction

A complex project was started in 1995 to develop the basic concepts of a biodiversity monitoring programme in Hungary (Kovács-Láng *et al.* 1995b, Kovács-Láng 1995c). Previously, some reports were elaborated (Kovács-Láng *et al.* 1995a; Dévai, Szilágyi 1995) to prepare this project, which concluded that a meta-database has to be one of the key issues of the proposed information system. A working group was set up (see the acknowledgements) to work out the details of a meta-database, which we suggest being called TERMET originated from the Hungarian title: *"TERmészetvédelmi biodiverzitás-monitorozó programok és eredmények META-adatbázisa"*.

The following basic assumptions and considerations discussed prior to and during the meetings were adopted by the working group:

-monitoring activity will be carried out by many institutions
-monitoring activity will be financed from more than one source
-biodiversity monitoring has to be organized into operative activity units:
*PROJECTS* (with clearly defined aim, object and methodology described in a standard documentation)

-the project produces different materials: *PRODUCTS* (written materials, measured or estimated records, graphics/images both on digital and traditional media)
-there should be different kinds of databases, datasets and information systems for managing products, instead of a centralized one
-databases, datasets and information systems are possessed and managed by different owners
-*LINKING* of the successive projects will ensure the continuity of monitoring activities, while other linkages will point to main/subprojects, thematic related projects and all of the resulted and referenced products

An effective co-ordination and co-operation of projects are inevitably necessary, aiming at defining, setting up and managing the meta-database. The working group discussed the concept and role of the meta-database, prepared a brief review of similar systems and worked out its structure and functions, and then addressed practical recommendations to the National Authority for Nature Conservation (Horváth *et al.* 1996) for realization.

## The concept and role of TERMET

Based on the above considerations, the database has to be a centrally managed directory on *nature conservation monitoring projects*, carried out by different institutions and organizations and on its *products*. The records of the meta-database should describe projects and linked products briefly, but not contain the data and monitoring information, rather the places of the occurrence of products and their accessibility.
The role of TERMET was intended for

- promoting and forcing standard documentation of projects
- promoting co-ordination and co-operation among nature conservation authorities, participating institutes, directorates, NGO's etc.
- ensuring the clear overview of all projects and results, but leaving original datasets under the control of the owners
- providing assistance in decision making and managing the projects
- providing assistance in cross-referencing the monitoring results

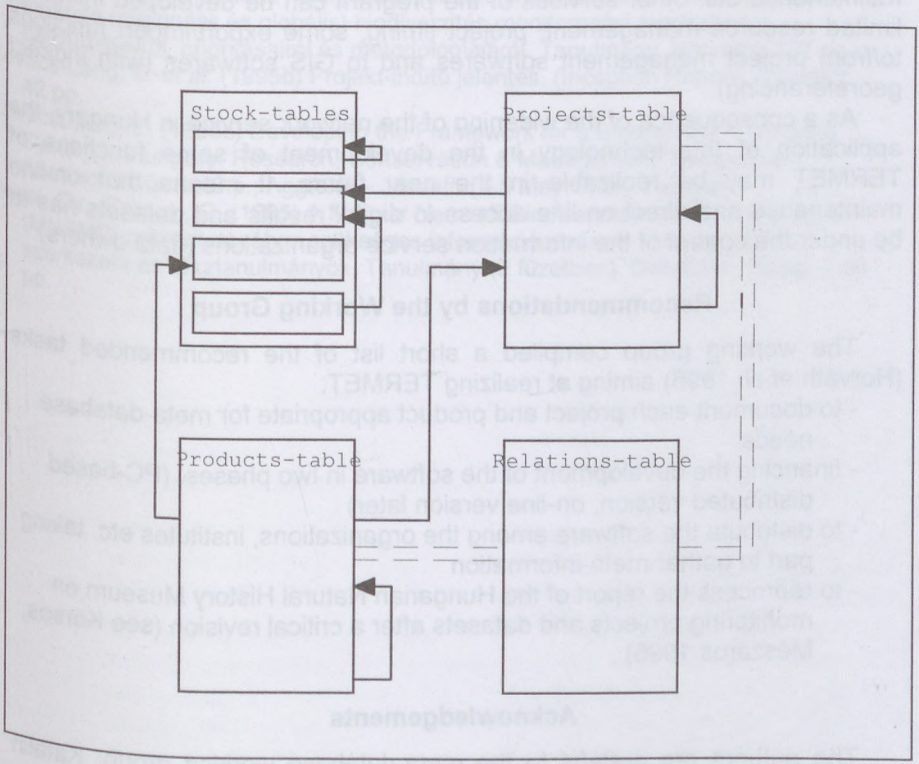
## TERMET, its structure and functions

The detailed contents of the meta-database are defined here. It consists of two parts: the descriptions of projects and products. Each of them has separate chapters for identification; searching for general attributes, details, but short descriptions, description of access rules in the case of products, defining linkages, and for meta-data reference (see the Appendix).

The structure of the planned database drafted in the Fig. 1. will be more sophisticated, because a separate linkage-table and pre-defined or centrally managed stock-tables are planned to organize the database efficiently. There will be two kinds of linkage between the tables: one-to-one relations

(which is represented with solid lines in the diagram) and one-to-several relations (which will be managed in a separate linkage-table, represented with dashed lines).

Fig. 1. Draft structure of the planned meta-database: TERMET (see explanation in the text)




The main functions of the database will focus on flexible searching, ordering and listing capabilities;

- on PROJECTS by an identifier, leader and accompanying persons, institutions/organizations, date interval, type/status/significance of the projects, period of time referred to, geographical region referred to, general target groups (e.g. vascular plants, birds, dragonflies etc.), standard sampling methods, habitats and indexed words referred to in the detailed descriptions
- on PRODUCTS by an identifier, authors, titles (and keywords or indexed words), date and media/type/occurrence
- on PROJECTS TO PROJECTS by the above attributes and hierarchy, monitoring-line (forward, backward) and related projects

- on PROJECTS TO/FROM PRODUCTS (MATERIALS, RESULTS) by the above attributes, belongings referred to and materials cross-referenced
- on PRODUCTS TO PRODUCTS (MATERIALS, RESULTS) by the above attributes and the materials cross-referenced.

Beyond the standard functions such as on-line help, printing, maintenance etc. other services of the program can be developed including limited resource management, project timing, some export/import functions to/from project management softwares and to GIS softwares (with indirect georeferencing).

As a consequence of the widening of the network service in Hungary, the application of this technology in the development of some functions of TERMET may be realizable in the near future. It means that on-line maintenance and direct on-line access to digital results and datasets has to be under the control of the information service organizations (data owners).

## Recommendations by the Working Group

The working group compiled a short list of the recommended tasks (Horváth *et al.* 1996) aiming at realizing TERMET:

- to document each project and product appropriate for meta-database needs
- financing the development of the software in two phases, (PC-based distributed version, on-line version later)
- to distribute the software among the organizations, institutes etc. taking part to gather meta-information
- to reprocess the report of the Hungarian Natural History Museum on monitoring projects and datasets after a critical revision (see Korsós, Mészáros 1995)

## Acknowledgements

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## References

Horváth, F., Rapcsák, T., Fölsz, F., Balla, K., Hoffer, J., Rajczy, M., Samu, F. & Szép, T. (1996) A META-adatbázis munkacsoport jelentése és ajánlásai. (Report and recommendations of the META-database Working Group). Tanulmány. Vácrátót. 42 pp.

Korsós, Z., Mészáros, F. (1995) A Magyar Nemzeti Biodiverzitás Monitoringba (MNBM) beépíthetô hazai adatforrások feltárása és annotálása. Tanulmány. Budapest. 150 pp.

Kovács-Láng, E. *et al.* (1995a) Tanulmány a Magyar Nemzeti Biodiverzitás-monitorozási Rendszer (MNBMR) kifejlesztésének alapelvei, magyarországi céljainak és feladatainak kidolgozása, és áttekintés az európai országokban működô (regionális és globális) biodiverzitás-monitorozási rendszerek célkitűzéseirôl, prioritásairól és metodológiájáról. Tanulmány. Vácrátót. 101 pp.

Kovács-Láng, E. *et al.* (1995b) Projekt-indító jelentés. (Inception Report). Vácrátót. 42 pp.

Kovács-Láng, E. (1995c) Developing the Framework for a Biodiversity Monitoring System in Hungary. Research, Conservation & Management, Symposium Abstract Volume 46 p., Aggtelek - Jósvafô (1-5 May 1996), Hungary

Dévai, Gy., Szilágyi, G. (1995) A Magyar Nemzeti Biodiverzitás Monitoring program (MNBMP) működtetéséhez szükséges információrendszer elvi alapjai és szerkezete és résztanulmányok. Tanulmány (2 füzetben). Debrecen. 25 pp. + 65 pp.

## Appendix

Detailed content of the proposed meta-database TERMET

### PROJECTS (PR)

| | |
|---|---|
| PR.I | PROJECT IDENTIFICATION |
| PR.I.1 | project identifier |
| PR.I.2 | project name |
| PR.I.3 | period of study |
| PR.I.4 | responsible person, project leader |
| PR.I.5 | institution |
| PR.I.6 | funding organization |
| PR.I.7 | project status *(planned, on-going, finished)* |
| PR.I.8 | project hierarchy (*main project, subproject)* |
| PR.II | GENERAL ATTRIBUTES FOR SEARCHING |
| PR.II.1 | project type *(scientific/preparatory, monitoring, synthetic etc.)* |
| PR.II.2 | significance *(local, regional, national, international importance)* |
| PR.II.3 | referred time interval |
| PR.II.4 | referred area |
| PR.II.5 | priority of the project *(trend monitoring of ...)* |
| PR.II.6 | general object category |
| PR.II.7 | standard sampling methods |
| PR.II.8 | general habitat |
| PR.III | DETAILED DESCRIPTIONS |
| PR.III.1 | aim |
| PR.III.2 | description of the object |
| PR.III.3 | short methodology |
| PR.III.4 | general sample sites/time table |
| PR.III.5 | next sampling period |
| PR.III.6 | disposal comments |
| PR.III.7 | contributing persons |
| PR.IV | LINKAGES |
| PR.IV.1 | proceeding project |
| PR.IV.2 | subproject |
| PR.IV.3 | other projects interested because of thematic/methodological reason |
| PR.IV.4 | linked products: reports, datasets, documents, maps etc. |
| PR.V | PROJECT META-DATA REFERENCE |
| PR.V.1 | date of the meta description |
| PR.V.2 | latest check |
| PR.V.3 | latest update |
| PR.V.4 | document access information |
| PR.V.5 | descriptor person |

## PRODUCTS (AN)

AN.I IDENTIFICATION
AN.I.1 identifier
AN.I.2 author
AN.I.3 owner
AN.I.4 title
AN.I.5 media *(paper, magnetic, digital file etc.)*
AN.I.6 library/occurrence

AN.II GENERAL ATTRIBUTES FOR SEARCHING
AN.II.1 type

AN.III DETAILED DESCRIPTION
AN.III.1 short description
AN.III.2 interface and language or file format
AN.III.3 hardware/software environment
AN.III.4 latest update

AN.IV ACCESS
AN.IV.1 access rules
AN.IV.2 access method
AN.IV.3 responsible person for controlling access

AN.V LINKAGES
AN.V.1 project (producer)
AN.V.2 other referred documents

AN.VI MATERIAL META-DATA REFERENCE
AN.VI.1 date of the meta description
AN.VI.2 latest check
AN.VI.3 latest update
AN.VI.4 document access information
AN.VI.5 descriptor person

# ECOSYSTEM - MONITORING IN CONSERVATION MANAGEMENT SELECTED RESULTS OF AN INTERNATIONAL SURVEY OF 152 NATIONAL PARKS

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**Abstract:** This international survey examines, analyses and compares the problems, objectives and strategies of national parks (joint study by the Austrian Federal Environmental Agency and the Institute for Applied Ecology).

The study deals with special aspects of planning, setting up and managing national parks and it based on 152 replies recieved from parks of all continents. Ecosystem monitoring is percieved as being of particular interest as an instrument for natural process research and for the practical management of nature conservation work.

Developments in monitoring systems are well advanced. Most parks have set up (72%) or are planning (24%) permanent observation of selected species, habitats and ecosystems. But the systems vary greatly in terms of objectives, basic structure and methodology. Examples are given to illustrate theses differences.

The results of the international survay show that unified approaches and methods for ecosystem monitoring are called for which need to be defined by an international body of experts. This requirement should also be seen against the background of another of the survey's findings: namely that 97% of the national parks the replied would welcome more international cooperation, especially in scientific field.

## Introduction: General Approach

It ist said, that economists and ecologists do not get on together too well. But both sciences have a similar field of research: They have to understand and manage systems that are:

-complex,
-dynamic and
-unpredictable.

Economists have developed different intruments to deal with these systems. Some of these tools - amongst them monitoring - can be or have been adapted for ecological matters.

Monitoring is a tool to reduce complexity, understand dynamics and improve predictibility.

Anticipating a summary of the results it can be said that monitoring has therefore become very popular in ecologal basic research and practical conservation matters.

## Questionaire: Intention, Structure and Replies

Dealing with national park planning and national park management means usually dealing with international standards, international criterions and international demands.

The intention of the questionaire was to describe and analyse different solutions to realize these standards. The questionaire focused on different aspects of protected area management:

-Historical development of the park (initiative, conflicts, duration of installation...)
-Protection (instuments, subjects, conservation management...)
-Ecosystem monitoring (state of monitoring, subject of monitoring, methodology...)
-Administration (staffmembers, budget, financiation, number and regulation of visitors...)
-Problems (kind of ploblem...)
-International contacts(membership, cooperation, interests to increase cooperation...)
-Historical land-use (kind, intensity, area, time...)
-Recent land-use (kind, intensity, area, time...)
-Conflicts between land-use and intentions of conservation
-Strategies in dealing with these conflicts
-Participation and cooperation between land-users and administration

The response to the questionaire was remarkable (Fig. 1). 152 national parks - amongst them Aggtelek National Park - answered and formed the basis for statistical analyses.

The results are going to be published by the Austrian Federal Environmental Agency within the next month (Jungmeier, 1966). The results conserning ecosystem monitoring are beeing presented in this lecture.

## Monitoring: State of Developement

Almost each national park has already established or is planning to install a monitoring system (Fig. 2). Only 4% of the answering parks do not intend to do so. It can be shown that monitoring systems in European national parks are more well developed than outside Europe.

Of course these results also show the importance of strictly protected areas for long-term ecological research.

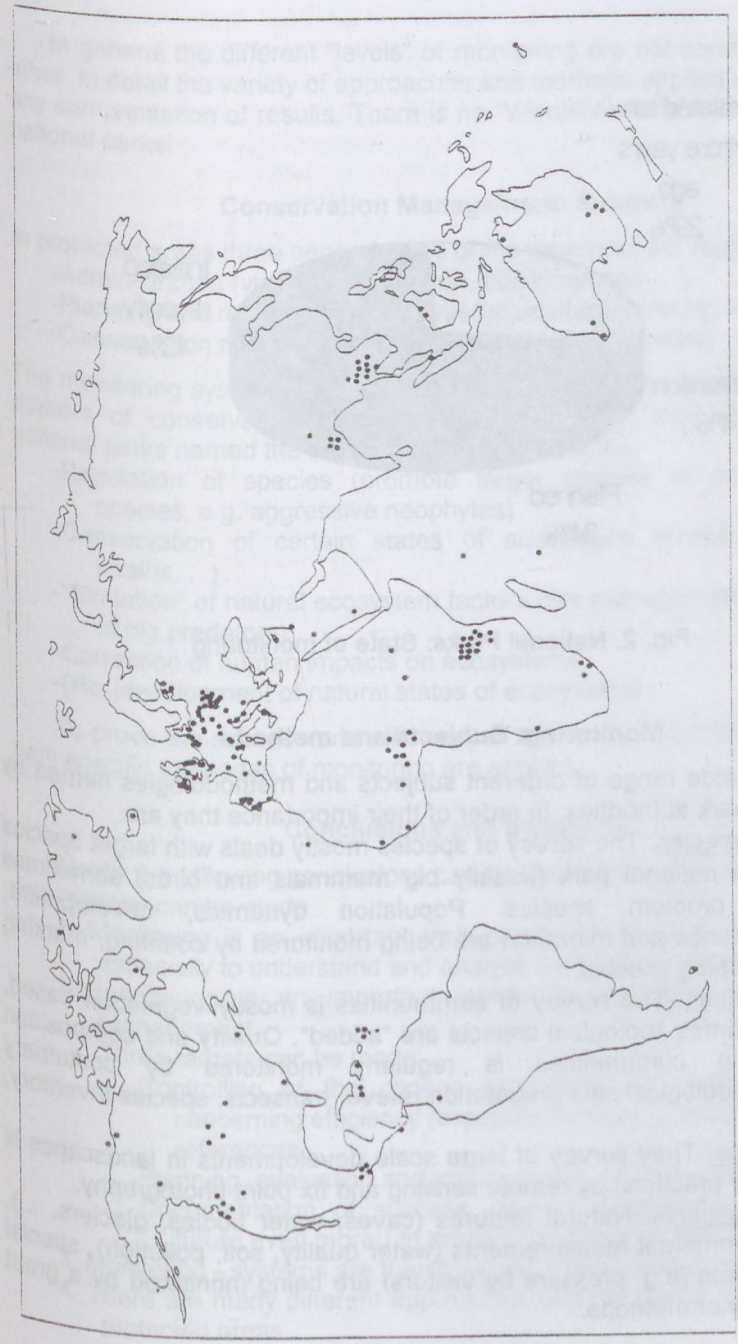


Fig. 1. National Parks answered to the questionaire (●)

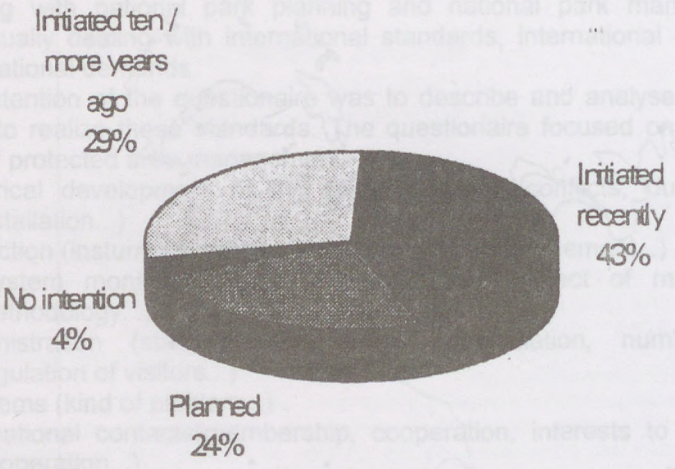



Fig. 2. National Parks: State of monitoring

**Monitoring: Subjects and methods**

There is wide range of different subjects and methodologies named by the national park authorities. In order of their importance they are:

-Special species. The survey of species mostly deals with target species of the national park (usually big mammals and birds) sometimes with problem species. Population dynamics, development, abundance and migration are being monitored by counting, marking or trapping species.

-Communities. The survey of communities is mostly vegetation based, sometimes zoological aspects are "added". Quality and composition of the communities is regularly monitored by costumary methodological sets (vegetation relevé, transects, species inventory, ...).

-Landscape. They survey of large scale developments in landscapes is mostly practiced by remote sensing and fix point photography.

-Special aspects. Natural features (caves, water bodies, glaciers, ...), environmental measurements (water quality, soil, pollution), special problems (e.g. pressure by visitors) are being monitored by a great variety of methods.

In general the different "levels" of monitoring are not connected to each other. In detail the variety of approaches and methods applied does not allow any comparisation of results. There is no "WorldWideWeb" for monitoring in national parks!

## Conservation Management: Subjects

In protected areas three general types of management are required:

-Administration (visitors, information, public relation, ...)
-Planning and regulation of land-use (agriculture, forestry, hunting, ...)
-Conservation management in a literal sense (see below)

The monitoring systems in the parks are mostly in close relation to different matters of conservation management. In order of their importance the national parks named the following types of measures:

-Regulation of species (promote target species or control problem species, e.g. aggressive neophytes)
-Conservation of certain states of succession (preserve meadows, heaths, ...)
-"Simlation" of natural ecosystem factors (fire management, replacement of big predators)
-Correction of human impacts on ecosystems
-(Re-)development of natural states of ecosystems

To prove the success and efficiency of the measures different and often very specific methodes of monitoring are applied.

## Conclusions and prospects

Finally the following conclusions can be drawn from the results and some suggestions can be made.

1. Monitoring is an important instrument in ecological basic research, especially to understand and analyse complex dynamic systems.
2. monitoring is an important instrument in practical conservation management.
   Three targets can be made:
   -Controlling of the chosen management - system, especially concerning efficiency (expenditure/results), target reaching and references
   -Planning, evaluation and improvement of measures and programs
   -Documentation of success. Nature conservation has (and in future even more!) to prove its success to public and policy.
3. Monitoring - systems are therefore well established in national parks.
4. There are many different approaches and standards for monitoring in protected areas.

5. The development od unified set of methods is neccessary. This should be defined by an international body of experts. A modular system would be appropiate to both guarantee the compatibility and focuse on the specific problems of each national park or ecosystem. The basic module is suggested to consist of three levels:
   - Large scale landscape monitoring (remote sensing and statistical data)
   - Monitoring on communitiy level (mainly vegetation based)
   - Monitoring of special species.

The discussion about the unified methods should not be a big problem, since the interest in international contacts and cooperation is extremely high. 97% of the answering national parks replied that there was a high interet in increasing international cooperation! Most national parks would emphasize especially on improving the cooperation in scientific field. (Fig. 3).

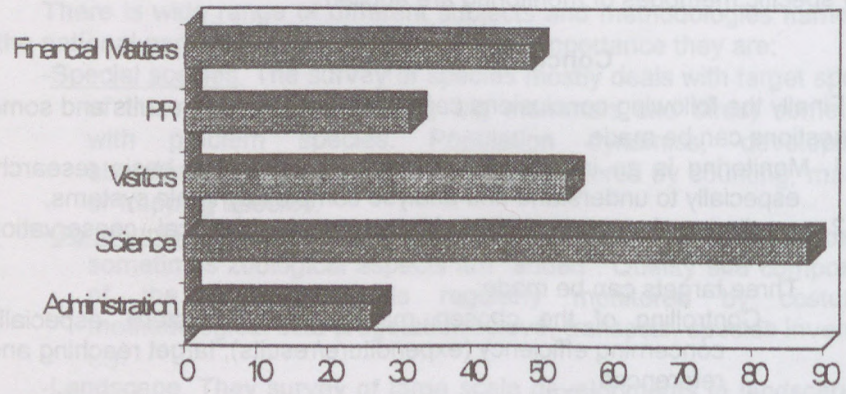



Fig. 3. National Parks: Interest to increase International Cooperation

## References

Anderson, P. & Romelig, M.G. (1992) Mowing experiments to restore a species rich sward on sand dunes in Jersey, Channel Islands, GB. In: Carter *et al.* (1992) Costal Dunes. Balkema, Rotterdam, pp. 219-243)

Burton, R. (Hrsg.) (1992) Nature's Last Refuges - Conserving the World's Wild Places. Andromeda Oxford Ltd. pp. 256.

Canadian parks Service (1991) Park Conservation Plan - Grassland National Park. Datenbankauszug des Canadian Parks Service, ca. pp. 180.

Groombridge, b. (1992) Global Biodiversity - Status of the Earth's Living Resources. pp. 585. Chapmann & Hall London / Glasgow / New York / Tokyo / Melbourne / Madras.

IUCN (1994b) Richtlinien für Management - Kategorien von Schutzgebieten. IUCN, Cambridge/Gland. pp. 23.

IUCN (1994c) Parks for Life - Action Plan for Protected Areas in Europe. IUCN, Cambridge/Gland. pp. 150.

Jungmeier, M., Egger, G., Golob, B., Petutschnig, W. & Schaffler, K. (1993) Kulturlandschaftsprogramm Mallnitz - Grundlagenerhebung, Konzeption, Umsetzung. UBA Monographien, Bd. 31, 138. S. und Anhang, Wien.

Jungmeier, M. (1996) Nationalparke: Probleme - Ziele - Strategien. Dokumentation, Analyse und Interpretation einer internationalen Umfrage. UBA Monographien, drezeit in Druck, Wien.

Killarney National Park (1992) The Oakwoods of Killarney. Killarney, Irland, pp. 48.

Nationalpark Niedersächsisches Wattenmeer (1994) Ökosystemforschung Wattenmeer - Niedersachsen. Informationsbroschüre der Nationalpark-verwaltung, Wilhelmshaven, pp. 52.

Romeril, M.G. (1989) Dune Management on les Quennevais, Jersey, Channel Island, GB. In: Meulen *et al.* (1989) Perspectives in Costal Dune Management, SPB Academic Publishing, The Hague, NL. pp. 255-260.

VDBiol (1995) Stand und Aussichtes des Biotop - Monitoring: Fachtung in Bochum, 12-13. 10. 1995. Tagungsband in prep

# DEVELOPING THE FRAMEWORK FOR A BIODIVERSITY MONITORING SYSTEM IN HUNGARY

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The objective of the Project supported by PHARE is to provide a methodological and informatical basis for a long-term biodiversity monitoring programme and network in Hungary, which will be an integral part of a comprehensive biological information system supporting the activity of Nature Conservation Authorities, environmental policy, decision making, environmental management and public relation activity.

The activities of the project can be divided into five main components as follows:

- establishing a biological data recording system and network for the biodiversity monitoring programme in Hungary, which is compatible with similar foreign and Hungarian information systems,
- survey and inventory of main habitat types and elaboration of a habitat identification guide for Hungary,
- establishing the basis for monitoring specific taxa, vegetation and habitats
- publication of Biodiversity Monitoring Manuals,
- establishing of a Pilot Project to test the process and methods of biodiversity monitoring.

In the monitoring programme particular attention should be paid to specifying the questions that monitoring is intended to answer and validating the relationships between indicators and the components of biodiversity they represent.

The activities are focused on the elaboration of a nested hierarchical sampling system corresponding to the levels of biological organization, where higher levels of organization incorporate and constrain the behaviour of lower levels.

A fundamental task is the elaboration of the sampling strategy to be followed at the different levels of biodiversity in Hungary.
Constraints:

- it is necessary to define the purpose of monitoring and the obtainable information,
- monitoring of both the natural trends and the impact of threatening factors and conservational activity (trend monitoring and hypothesis monitoring) is necessary,

- we cannot monitor all the objects, selection is needed during the planning,
- planning must be done at national level making local connections and alterations possible,
- careful selection of objects, attributes, localities, and timing is needed,
- it must represent not only the values to be protected, but even non-protected objects and territories of agricultural and forest magement,
- compatibility of the different scales must be carried out,
- we must take into consideration the obligations of the National Authority for Nature Conservation, Ministry for Environment and Regional Policy arising from international agreements,
- we must make clear the interfaces to the sites of the Corine Biotopes, the records of the national park surveys, the Integrated Monitoring in the Biosphere Reserves (BRIM), the planned NATURA 2000 (EC Habitats Directive, special areas for conservation), the planned EECONET (European Ecological Network, IUCN), the forest reserves, wetland programmes and light-trap network, the regional or local biomonitoring programmes being in progress.

**Planned levels of monitoring:**

**I. Diversity of habitat patterns on the landscape level**

It is studied by making aerial photos combined with field studies, which result in maps on the basis of the patches of the identifiable habitat units.
The aim is to follow the changes in landscape features such as patch size, heterogeneity, perimeter - area ratio, connectivity - e.t.c. The changes in land management, the processes of fragmentation are also critical.
The information can be obtained:

- on the state and trends of dynamics of the habitats or territories,
- information on the trend of changes in the land management (type and intensity of land management),
- information on the impact of the threatening factors (climate change, other human impacts),
- information on the state and changes of naturalness,
- we can follow the impact of conservational activities as well.

The Objects of monitoring:

1. The territories of great conservational importance (e.g.:biosphere reserves, national parks, conservation areas)
2. Habitats threatened by regional factors (Szigetköz, surroundings of industrial or urban areas)
3. Characteristic and frequent habitats in Hungary

Sampling has to take into consideration the number of units (quadrats), allocation and timing,

- number and size of the units: some 125 of 5x5 km quadrats,
- allocation: directed placing considering the objects of monitoring and the patterns of the different regions; compatible with the UTM grid system,
- timing: repeated in every 3-5 year, in the same season.

This type of monitoring can be carried out by skilled experts only.

**II. Monitoring Diversity of communities and communitiy complexes**

The designation of permanent sampling units inside and outside the quadrats of the previous level is desirable.

The aim is to obtain long-term records on the attributes of communities and complexes of communities at permanent localities, using standardized methods at a frequency dependent on the goals and the object of monitoring.

The information can be obtained:

- information on the natural changes in the state of the communities,
- information on the dynamic processes (succession, degradation, invasion; e.g.:oak-decay),
- information on human impacts,
- information on the state and the change of naturalness,
- the impact of different land management types and their changes,
- the impacts of conservational activities.

The selection of objects:

- it must cover wide range of communities, including rare and protected, charasteristic and natural communities, indicator communities, threatened communities, as well as weed communities, tree plantations and agricultural communities,
- special emphasis must be put on zoological representation, the light-trap network being in operation, biosphere reserves, forest reserves must be considered,
- designation of community complexes is needed,
- implementation of practical viewponts (former records, easy observation etc) is needed,
- the safety of long-term observations and records is indispensible.

The selection of attributes: some textural and structural properties of the communities, species lists, abundance selection of key species, determination of critical limits are necessary.

The allocation and representation of various communities has to be done according to their frequency and importance.

The time of sampling and consideration of the aspects of the vegetation are determined by the aim of the monitoring and the features of the object.

This type of monitoring can be performed by the skilled employees of the network, by skilled teachers and students with the guidance of experts, and handbooks.

### III. Monitoring Diversity of species and populations

At this level monitoring of species characteristic for the region and conservationally important (protected, rare, threatened) is planned.
The aims are

- to monitor the changes of the populations of certain selected species to test the trend of the changes and certain hypotheses,
- to follow the change of the distribution of species,
- to follow the the changes of density and reproductive capacity and the age distribution, in certain populations,
- to determine and follow the changes of genetic diversity in certain populations.

The scheme of planning:

1. Selection of species on the basis of the criteria given above and determination of the scale of the monitoring.
   The criteria for selection: species of various life-forms, type of distributions, frequency, the species of outbreaks, the species of invasions, as well as the dominant species of communities, key species, rare species, threatened species have to be taken into consideration.
2. Selection of the attributes to be monitored, which are appropriate for the purpose of monitoring: presence-absence, population size or density, reproductive attributes, age distribution, population genetic attributes (e.g.: protein polymorphism).
3. Detailed elaboration of the methods of monitoring. The detailed methodology of the sampling for the taxa is being elaborated by the specialist.

The number and allocation of the populations to be monitored require careful planning.

In this type of monitoring wide range of experts, skilled volunteers and organisations, teachers, students, local authorites can be involved with the guidance of experts and the planned manuals.
The active participation of local people can raise the level of knowledge and environmental awareness.

# DIVERSITY AS AN INDICATOR IN ENVIRONMENTAL ASSESSMENT: A CASE STUDY FOR CARABIDS (*COLEOPTERA: CARABIDAE*)

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**Abstract:** We have compared the carabid communities of an extrazonal submontane beech forest and two pine plantations (black pine and Scotch fir) at the Aggtelek National Park using pitfall traps. The number of species, diversity statistics and diversity orderings were used. Diversity statistics and diversity profiles suggest that the carabid community of the Scotch fir forest is more diverse than the others. The ecological interpretation of the results is also discussed.

See in Proceedings Volume II. pp. 123.

# RESEARCH ESTABLISHING THE BIOMONITORING OF LAKE BENCE (BENCE-TÓ) AT THE NORTHERN PART OF THE GREAT HUNGARIAN PLAIN

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## Introduction

Lake Bence (Bence-tó) is a C-shaped, silted oxbow lake which is situated on the Bereg Plain east of the town Vásárosnamény, among Tákos, Csaroda and Fejércse (Fig. 1). It is approximately 1.5 km long and 70 m wide. It was first registered in the Hortobágy National Park Directorate on the basis of ISTVÁN D. PETHE's report as new location of occurrence of *Sphagnum* species in the Samicum in 1990. The discovery was of a high importance since peat bog associations are uncommon in Hungary (due to their geographic locality). Because of this rarity, these associations are to be protected. These areas present the marginal zone for the associations, and they are extremely sensitive to the changes of their environment. Some of these changes have natural origin (e.g. climatic change), but some have anthropogenic one (fertilizers and pesticides from agricultural management, elimination of the buffer zone owing to the felling of the fringing forests and the destruction of meadows, decrease of the soil water level, just to mention the most frequent examples).

The buffer zone is absent from lake Bence: it is surrounded by arable lands from all sides instead of the usual fringing forest and meadow. Remaining spots of the *Querco robori-Carpinetum hungaricum* (Soó 1940) association can only be found at its eastern corner (on the other side of the dirt road).

## Material and methods

I have been conducting field work in the area since August 1994. Coenological relevés were made at 7 different sites of lake Bence (also marked on the vegetation map). These plots are intended to be chosen so that most of the associations can be sampled.

**The first** sampling area consists of three transects parallel to each other and directed NE-SW, each including four 5x5 m plots in the community characterized by tall sedge at the NE part of the lake. The easternmost plot is I/1 and the westernmost is III/4.

**The second** group of sample plots is close to the above site, at the southeasternmost part of the willow marsh, where peat mosses do still not

occur. Two by two adjacent, 5m x 5m plots were marked, the sides of the obtained 10x10 m square are directed NW-SE and SW-NE.

**The third** sampling area is in the peat bog, where no permanent plots, but 24 permanent *Sphagnum* tussocks were marked.

**The forth** area is at the deepest part of the lake, it is covered by water for the longest time. Here 18 adjacent plots form a transect perpendicularly to the borders of the lake. Plot 1. is at the southernmost, plot 18. is at the northernmost side of the lake. The sizes of the plots are: 1.-2.: 5x5 m; 3.-18.: 2x2 m.

**The fifth** sampling area is a transect consisting of 10 2x2 m plots. It is west to the forth sampling area and is directed parallel to that. It was intended to sample the *Sparganion erecti* association

**The sixth** group of plots is situated between the fifth and the seventh (closer to the latter one). It is a transect along the whole width of the lake directed NE-SW, consisting of 33 plots. The sizes of the plots are: 1.-23. and 27.-33.: 2x2 m; 24.-26: 5x5 m. Plot 1. is at the northwestern shore of the lake.

**The seventh** sampling area is in the northwestern third of the lake, close to the road leading to the lake from Csaroda. 2x3 adjacent, 2x2 m plots were marked here. The 6 m long side is directed NNE-SSW, the 4 m long is ESE-WNW.

In case of the permanent plots total cover percentage and cover percentage by species were estimated.

At the third sampling area two characteristic, possibly perpendicular length and direction of the chosen *Sphagnum* tussocks, the ratio of *Sphagnum* species to each other and the vascular plants within the tussocks were recorded.

The vegetation map (Fig. 2) has been drawn with the help of using aerial photographs following a former vegetation map draft (KALAPOS and TÓTH 1993).

This study deals only with associations found within Lake Bence in details, other nearby natural and anthropogenic areas are not described, just marked on the map.

Nature conservation values were used according to BORHIDI (1993).

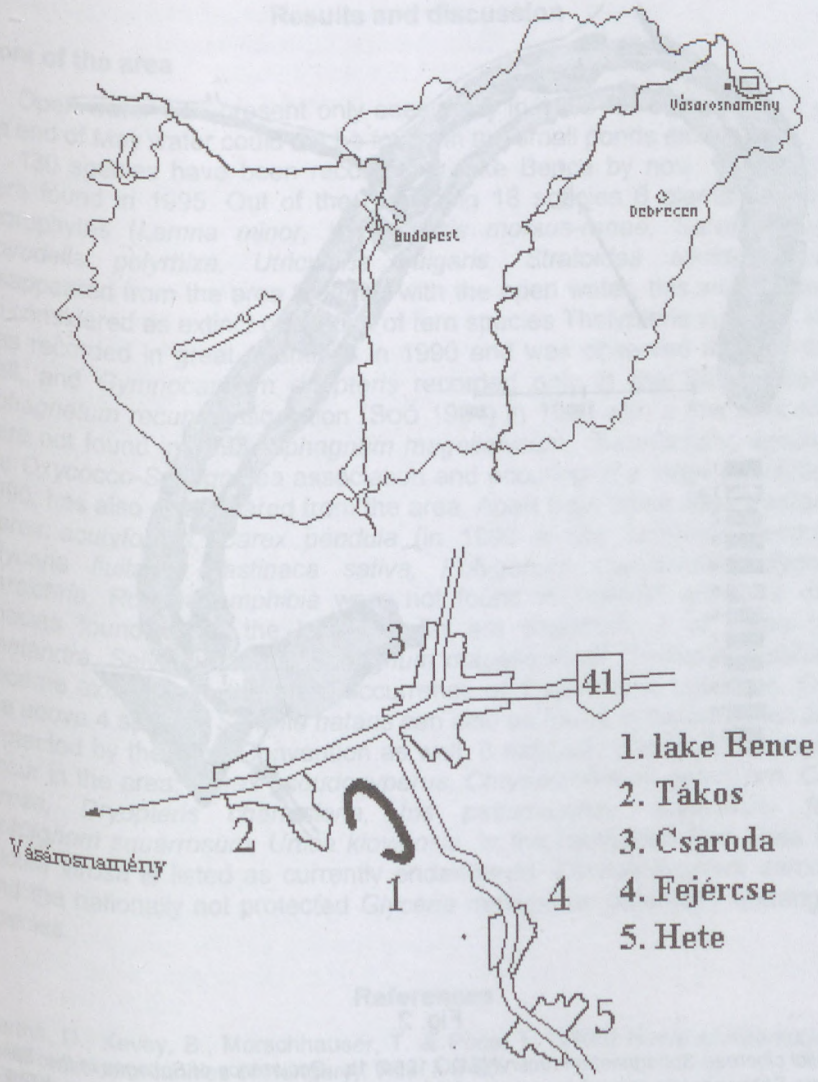

Vásárosnamény
Debrecen
Budapest
3
41
1. lake Bence
2. Tákos
3. Csaroda
4. Fejércse
5. Hete
Vásárosnamény
2
1
4
5

Fig. 1.

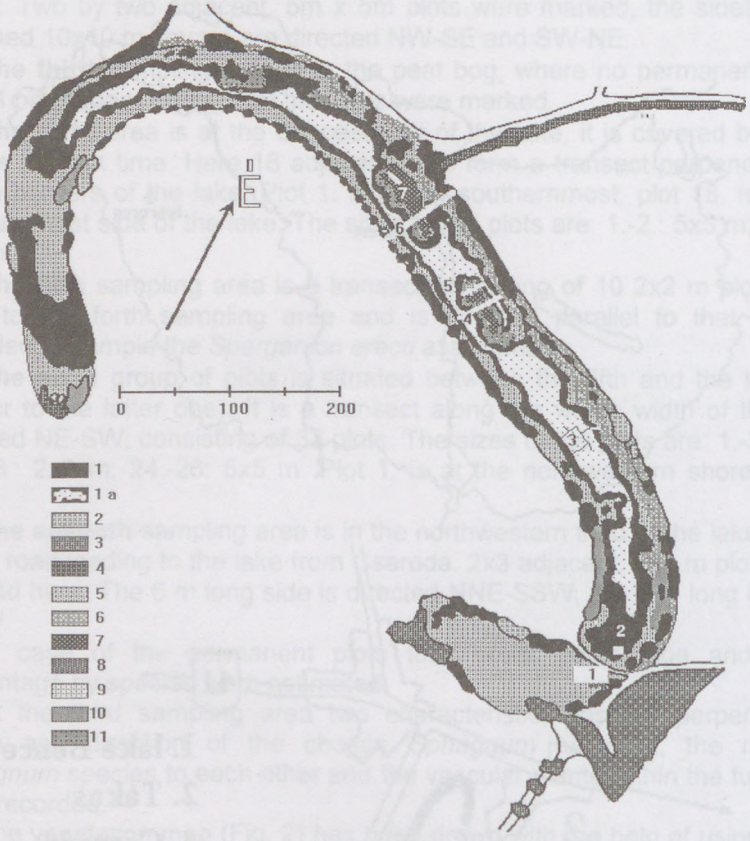



Fig. 2.

**1**., *Salici cinereae-Sphagnaetum recurvi* (SOÓ 1954) **1a.**, *Occurrence of Sphagna in the Salici cinereae-Sphagnaetum recurvi association*(SOÓ 1954) **2**., *Leucojo aestivo-Salicaetum* (KEVEY 1993), **3**., *Querco robori-Carpinaetum* (SOÓ et PÓCS 1940), **4**., *Pruno spinosae-crataegetum* (HUECK 1931), **5**., *Glicerietum maximae* (HUECK 1931), **6**., *Carici-Typhoidetum* (SOÓ 1971), **7**., *Polygono lapathifolio-Bidentetum* (KILKA 1935), **8**., *Caricetum elatae* (W. KOCH 1926), **9**., *Sparganietum erecti* (ROLL 1938), **10**., *Scirpo-Phragmitetum* (W. KOCH 1926), **11**., *Typhetum angustifoliae* (PIGN. 1953)

## Results and discussion

### Flora of the area

Open water was present only seasonally in 1995 for one month (i.e. by the end of May water could not be found in the small ponds either).

130 species have been recorded in lake Bence by now, 112 of these were found in 1995. Out of the remaining 18 species 6 plants are strictly hydrophytes (*Lemna minor, Hydrocharis morsus-ranae, Salvinia natans, Spirodella polyrhiza, Utricularia vulgaris, Stratoides alloides*), which disappeared from the area together with the open water, this way these can be considered as extinct ones. Out of fern species Thelypteris vulgaris, which was recorded in great quantities in 1990 and was observed in 1992-93 as well, and *Gymnocarpium driopteris* recorded only in the *Salici cinereae-Sphagnetum recurvi* association (Soó 1954) in 1990 with a few specimens, were not found in 1995. *Sphagnum magellanicum*, characteristic species of the *Oxycocco-Sphagnetea* association and occuring in a large population in 1990, has also disappeared from the area. Apart from these *Salix pentandra, Carex acutyformis, Carex pendula* (in 1990 a few hundreds recorded), *Glyceria fluitans, Pastinaca sativa, Polygonum convolvulus,Polygonum persicaria, Rorippa amphibia* were not found in 1994-95 either.12 of the species found within the lake this far are protected. 4 of these (*Salix pentandra, Salvinia natans, Sphagnum magellanicum, Thelypteris palustris*) became extinct from the area, occurrence of 1 species is uncertain. Out of the above 4 species *Salvinia natans* can also be found in the IUCN list and is protected by the Bern Convention as well. 8 nationaly protected species still occur in the area: *Carex pseudocyperus, Chrysanthemum serotinum, Cicuta virosa, Dryopteris chartusiana, Iris pseudacorus, Sphagnum fallax, Sphagnum squarrosum, Urtica kioviensis.* In the Hungarian Red Data Book *Cicuta virosa* is listed as currently endangered, *Chrysanthemum serotinum* and the nationally not protected *Glyceria maxima* as potentially endangered species.

## References

Bartha, D., Kevey, B., Morschhauser, T. & Pócs, T. (1995) Hazai erdőtársulásaink (Forest communities of Hungary). Tilia. I: 8-85.

Borhidi, A. (1993) A magyar flóra szociális magatartás típusai, természetességi és relatív ökológiai értékszámai (Social behaviour types (SBT) of the Hungarian flora, ITS naturelness values (Val.) and relative ecological indicator values (TB-SB) ) - A KTM Term. Hiv. és a JPTE Kiadványa. Pécs, pp.93.

Fintha, I. (1994) Az Észak-Alföld edényes flórája (Vascular flora of the northern Great Plain). Budapest, Természetbúvár Alapítvány Kiadó pp. 314-315.

Kovács, J. A. (1995) Lágyszárú növénytársulásaink rendszertani áttekintése (Taxonomic studies on the herbaceous associations of Hungary). Tilia. I: 86-144.

Kovács, M. & Priszter, Sz. (1977) Védelmet kívánó növényfajaink és növénytársulásaink (Plant species and associations requiring protection in Hungary). - MTA Biol. Oszt. Közlem. 20:161-192.

Rakonczay, Z. (1990) Vörös Könyv (Red Book). Budapest, Akadémiai Kiadó

Simon, T. (1953)Torfmoore im Norden des Ungarischen Tietlándes. Acta. Biol. Hung. IV 249-252.

Simon, T. (1960) Die Vegetation der Moore in den Naturschutz-gebieten des Nördlichen Alföld. Acta Botanica. VI.107-137.

Simon, T. (1968b) Die Torfmoor-Gesellschaften Ungars. - Acta Geog-raphica Debrecina 7. (14): 201-206.

Simon, T. (1992) Vegetation change and the protection of the Csaroda relic mires, Hungary. Acta Societatis Botanicorum Poloniae,Vol. 61., Nr.1: 63-74., pp. 63-74.

Simon, T. (1985) A csarodai Nyírestó és Bábtava növényzete 1960-1985. évi változása és természetvédelmi értékelése (Changes and nature conservation evaluation of the Vegetation of the "Nyírestó" and "Bábtava" near Csaroda). In: Zárójelentés "A csarodai lápok (Nyírestó és Bábtava) környezeti állapotfelmérése és rekonstrukciós feladatai" c. kutatási szerződés keretében 1984-1985-ben végzett munkáról. KLTE Ökológiai Tanszéke. Kézirat. Debrecen.

Tóth, Z. & Kalapos, T. (1992) Jelentés a Bence tavi láp botanikai felméréséről (Report on the botanical surveillance of lake Bence), ELTE Növényrendszertani és Ökológiai Tanszék 1992. XI. 27.

Tóth, Z. & Kalapos, T. (1993) Jelentés a Beregi-sík 1993. évi botanikai felméréséről (Report on the botanical surveillance of the Bereg plain in 1993), ELTE Növényrendszertani és Ökológiai Tanszék 1993. XI. 22.

# COMPLEX ASSESSMENT OF VEGETATION IN PROTECTED AREAS: POSSIBILITIES AND PITFALLS

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## Introduction

Assessing the state of vegetation in protected areas is of vital importance in nature conservation. The reasons for carrying out vegetaion survey or monitoring are legion. A typical exercise is to compare the status of vegetation in a protected (or threatened) area with that of earlier times in order to test the effectiveness of conservation measures. In Hungary, this type of studies is usually based on floristic and/or phytosociological data collected by the members of the Hungarian geobotanical school. These records come from as early as the 1930's.

The aim of this paper is to explain by example the strenght and limit of some widely used methods of these comparative vegetation studies. For this purpose some results of a complex survey are used. The survey was carried out in the Bátorliget Nature Reserve between 1988 and 1990 and was aimed at comparing the state of this unique area with that of earlier times (1930's).

Three different approaches were applied:

1) The floristic composition and different indicator value spectra of bryophytes and vascular plants were analysed and compared with that of the 1930's.
2) The vegetation map of the reserve was also prepared. It was compared with the maps of earlier times (1909, 1934, 1979).
3) Detailed phytosociological surveys of selected community types were also made.

The results of the whole survey are given elsewhere (Standovár *et al.* 1990). In this paper, accepting the constraints of the predefined length, only the floristic and the phytosocilogical approaches are discussed using the vascular flora and the oak-elm-ash gallery forest as examples.

## Study area and the source of former data

The great dune land in the northeastern part of the Great Hungarian Plain is called the Nyírség. Its topography is quite diversified, because wind has built a mosaic of abandoned riverbeds and sand dunes from the silicic sand deposits of the Tisza river. This area used to be covered by extensive

forest, aquatic, mire and wet meadow vegetation. Two types of drastic human impacts have changed the landscape in this region in the past two centuries: vast areas of the once extensive forest were clear-cut, and even more drastic and irreversible changes have taken place after the drainage of this area.

The Bátorliget area with its mires and gallery forest was discovered within this period in 1914. Four separate fragments became protected in 1938, which were united into a protected area of about 60 hectares in 1951. Figure 1. shows the vegetation map of the area after Standovár & Tóth (1989).

The first floristic studies of this uninhabited area were done by Árpád Dégen, Rajmund Rapaics and Géza Lengyel after 1914, and were continued by Ádám Boros in the 1920's. After 1930 phytosociological studies were carried out by Rezső Soó and Bálint Zólyomi.

## Floristic approach

By applying this approach the main task is to give an interpretation of the detected changes in the flora. In this case it is a bit difficult, since the list published in 1953 (Soó 1953) contains species not only from this 60 ha, but also from the dry sandy grassland near the village called "Bátori-legelő" and from a forest called "Közbirtokossági-erdő".

## Methods

The species list of the area was compiled during several weeks we had spent in the reserve between 1988 and 1990. Then this species list was compared with those of earlier times.

Several non-floristic characteristics of species were used for the interpretation. Ecological requirements of vascular species were characterized by T (temperature optimum), W (humidity optimum) and R (acidity optimum) indicator values. They were used after Zólyomi *et al.* (1967). To investigate the level of the degradation we used Nature Conservation Ranks (NCR) of species (Simon 1988).

## Results and Discussion

In the past 80 years altogether 804 vascular taxa have been recorded. The flora published by Soó (1953) contains 707 taxa (including several infraspecific ones) after taxonomic and nomenclatural revision (according to Soó & Kárpáti 1968), whereas we found 500 species between 1988 and 1990. There are 415 taxa that were recorded both before 1953 and between 1988 and 1990.

Fig. 1. Vegetation map of Bátorliget Reserve

There are 258 taxa that were mentioned only by Soó (1953). Since we wish to interpret the changes of the past 50 years, it is important to investigate the causes of this large number. There are several subspecies and hybrids among them. The exact number of those species that were recorded outside the 60 ha area of the present study cannot be given. This fact stresses the importance (and the ordinary lack of) exact determination of locations. A possible way of showing the relative importance of sandy grassland species among these 258 taxa is to illustrate their non-floristic characteristics together with those of the 500 species that we were recoerded. Figure 2. shows the distribution of W indicator values of selected lists. These 258 taxa indicate drier habitats than it is characteristic of the area according to our list. NCR spectra (Fig.3) also express the role of sandy grassland species by having more rare, protected (KV, V) steppe species (*Pulsatilla spp., Adonis vernalis, Iris aphylla ssp. hungarica*, etc.) and weeds (GY).

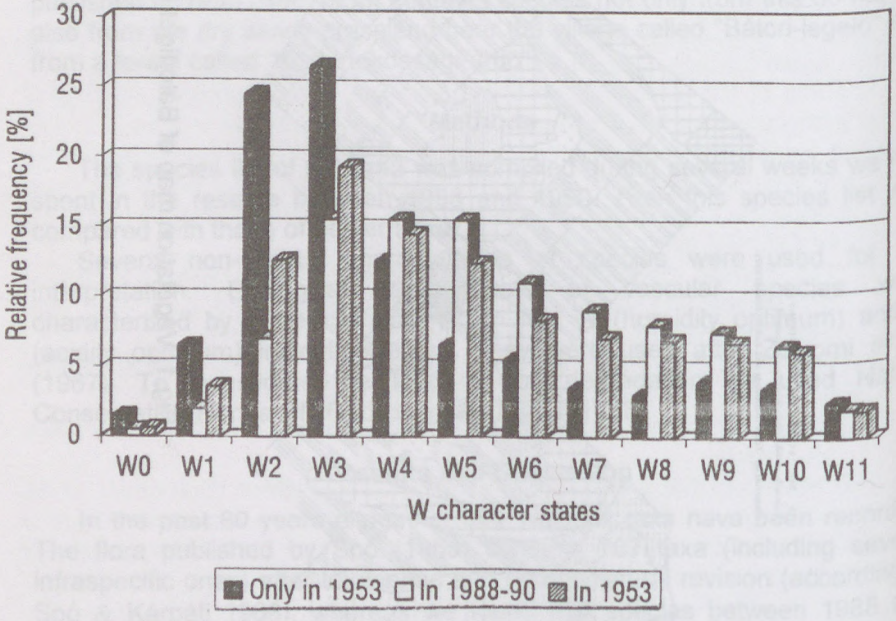



Figure 2. The distribution of W (humidity optimum) indicator values in selected species list.

The comparisons of non-floristic charaster state distributions of the whole 1953 and the 1989-90 lists have led us to following conclusions.

NCR spectra of the two lists are practically the same (Fig.3). This indicates no degradation at the floristic level in the past 50 years. But one should be cautious drawing a rash conclusion from this fact.

If we compare the W distributions (Fig.2) of the two lists it is striking that in 1989-90 the relative importance of aquatic species (W=10-11) is much less than it was before. Here again the effect of overall drying is apparent, since the species of open aquatic communities (e.g. *Nymphaea alba, Nuphar lutea, Lemna gibba, Potamogeton gramineus, P. crispus*) have disappeared.

There are 9 protected species among the 97 new species that were found after 1953. Most of them occur in young planted forest, or at abandoned meadows, where self-regenerating forest grows (*Cephalanthera damasonium, C. longifolia, Orchis militaris, O. purpurea, Pyrola minor, Campanula macrostachya, Ophioglossum vulgatum, Carduus collinus*). *Utricularia minor* occurs at most sites with relatively open water table.

Some of the newly established weeds threaten the area because of their aggressive behaviour (e.g. *Asclepias syriaca*). The establishment of these weedy and adventive species is encouraged by overall drying and by the presence of arable fields (!) within the borders of the protected area.

There are quite a few montane species among the newly recorded 98 species (e.g. *Ophioglossum vulgatum, Dryopteris filix-mas, D. carthusiana, Athyrium filix-femina, Veronica officinalis, Pyrola minor, Monotropa hypopitys*, etc.), which have inhabited both old and newly regenerating forests.

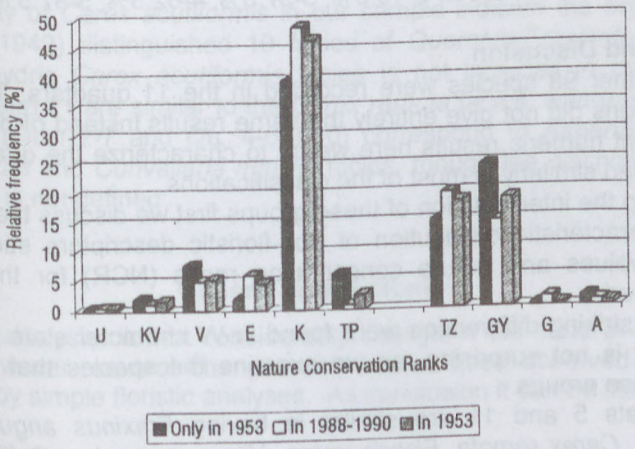



Figure 3. The distribution of Nature Conservation Ranks (NCR) in selected species lists.

## Phytosociological approach

### Introductory remarks

All the former phytosociological data were collected between 1930 and 1936 by Soó and Zólyomi. The comparison of the present state with that of the 1930's is difficult, since in addition to methodical difficulties (choice of sampling plot, subjectivity of abundance-dominance estimates, etc.), in most cases neither the exact location of sampling plots nor the data of individual quadrats are available.

Here we present the study on the extensive and relatively untouched stands of oak-elm-ash gallery forest, since this is the only community for which Soó (1942) published not only the synthetic table but the data of individual relevés as well. The opportunity of recognizing changes are given, since the approximate location of relevés is also available (Soó 1953).

### Methods

Eleven sampling plots (25 $m^2$ each) were used. Quadrat size and abundance-dominance scale were used as it is described by Felföldy (1943), since original samples were taken by using this method. The species were recorded in April and June 1990. In 1942 Soó published the data of 12 quadrats, most of which were placed in the same stands as ours in 1990.

To identify possible subgroups cluster analyses were performed using different algorithms (Ward's method, global and fuzzy clustering) of the SYN-TAX IV computer package (Podani 1990). Squared Euclidean distance served as resemblance function and it was calculated by using cover percentages that were the group averages of abundance-dominance classes as follows: 1-2,5%; 2-15.0%; 3-37.5%; 4-62.5%; 5-87.5%.

### Results and Discusion

Altogether 98 species were recorded in the 11 quadtars. The different classifications did not give entirely the same results.Instead of discussing all the different numeric results here we try to characterize the quadrat groups that behaved similarly in most of the classifications.

To help the interpretation of these groups first we discuss the differences in the characteristic distribution of non-floristic descriptors such as TWR indicator values and nature conservation ranks (NCR) for the 3 groups distinguished.

The most striking differences were found in W character state distributions (Fig. 4). It is not surprising, as we examine the species that differentiate among these groups.

Quadrats 5 and 11 are similar in having *Fraxinus angustifolia ssp. pannonica, Carex remota, Ficaria verna, Viburnum opulus, Caltha palustris, Leucojum aestivum, Rubus caesius, Urtica dioica, Ranunculus repens* and *Iris pseudacorus* exclusively, or at higher aundance than the other groups.

These places are covered by excess water in spring for a shorter or longer period.

The other two groups are similar in lacking excess water cover in spring, and having many early spring geophytes at high abundance. This latter characteristic is common with montane beech and oak-hornbeam forests. Quadrats 4-6-8-10 contain some hydric species (*Ficaria verna, Paris quadrifolia*) that are less important in the other group (Qu. 1-2-7). The abundance of certain montane (*Fagetalia*) species (*Dentaria bulbifera, Asperula odorata, Isopyrum thalictroides, Allium ursinum*) is also higher. Regarding NCR spectra we can state, that disturbance tolerating (TZ) and weedy (GY) species are more important at places with excess water cover.

If we compare this 11 relevés with the 12 published by Soó (1942), some conclusions can be drawn. It should be emphasized here that the exact places were not recorded in the 1930's, so we assume that our 11 quadrats are as representative to these old stands as the 12 recorded by Soó.

The NCR spectra are quite similar, which indicates the lack of considerable degradation during the past 60 years. However, if W spectra are concerned, it is striking that the relative frequency of aquatic species (W=10-11) decreased in the past 60 years within this forest type (Fig. 4).

If we describe the changes in terms of species, the disappearance of certain species indicates at least two things. Some of them are light-demanding (*Asperula rivalis, Filipendula ulmaria, Lastraea thelypteris, Lythrum salicaria, Trollius europaeus*). Their presence in previous relevés must be the results of the fact that an earlier successional stage was represented. Others (*Alisma plantago-aquatica, Galium palustre, Lycopus europaeus, Mentha aquatica, Oenanthe aquatica*) could easily grow in the most hydric facies of this community. So the lack of these species together with the rarity of *Carex acutiformis* in our sample indicate the drying of the area. Soó (1942) distinguished 10 facies of *Querceto-Fraxineto-Ulmetum*. The most hydric *Carex acutiformis* facies is not included in our sample. Quadrats 5 and 11 are similar to the *Carex remota* facies, whereas the other two groups (Qu.1-2-7 and Qu. 4-6-8-10) correspond to *Asperula odorata, Allium ursinum* and *Convallaria majalis* facies, though the distinction among these facies is not defined.

## General conclusions

Floristic analysis did not considerably change in the state of the nature reserve. However, several changes could have been observed that were overlooked by simple floristic analyses. As conclusion it can be stated that in

several cases the floristic approach provides not sufficiently sensitive indicators of changes.

The comparison of the status of vegetation by the phytosociological approach was difficult for the methodical reasons mentioned above. In spite of this fact it provided a much more sensitive tool for detecting changes. All these call for the application of easily repeatable standardized methods in vegetation description. This is a prerequisite of long-term monitoring of the composition and structure of vegetation for any conservational purposes.

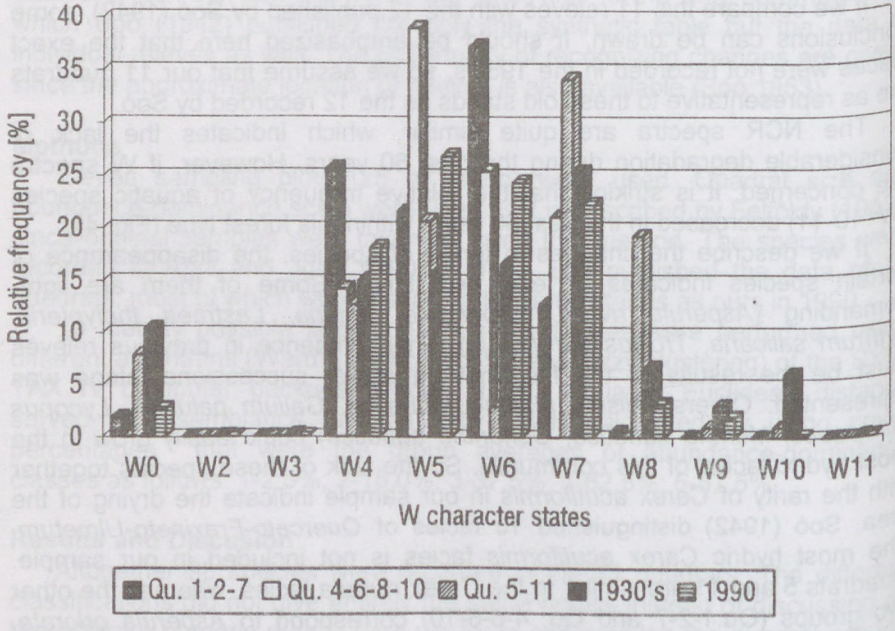



Figure 4. The average distribution of W (humidity optimum) indicator values in selected groups of oak-elm-ash gallery forest relevés.

**Aknowledgements**

We are grateful to Prof. Tibor Simon, who supervised our work, and to Judit Bajzáth, Katalin Barabás and Tibor Kalapos for their help in our field-work.

## References

Felföldy, L. (1943) Növényszociológia. Nagy Károly Grafikai Műintézete, Debrecen.
Podani, J.(1990) SYN-TAX IV. User's manual. ITCP Trieste.
Simon, T. (1988) A hazai edényes flóra természetvédelmi-érték besorolása. Abstracta Botanica 12:1-23.
Soó, R. (1935) A pusztuló Bátorliget. Természettudományi Közlöny 67:14-21.
Soó, R. (1942) A nyírségi erdők a növényszövetkezetek rendszerében. Acta Geobotanica Hungaric 5:315-352.
Soó, R. (1953) Bátorliget növényvilága. In: Székessy, V. (ed.) (1953) Bátorliget élővilága. Akadémiai Kiadó, Budapest.
Soó, R. & Kárpáti, Z. (1968) Magyar flóra. Növényhatározó II. Harasztok - Virágos növények (4. kiadás). Tankönyvkiadó, Budapest.
Standovár, T. & Tóth, Z. (1989) Vegetation map of the Bátorliget Mire Reserve. In: Mahunka, S. (ed.) (1991) the Bátorliget Nature Reserves - after forty years. Studia Naturalia No. 1. Vol. 1:57-118., Hungarian Natural History Museum, Budapest.
Székessy, V. (ed.) (1953) Bátorliget élővilága. Akadémiai Kiadó, Budapest.
Zólyomi, B. *et al.* (1967) Einreinhung von 1400 Arten der ungarischen Flora in ökologische Gruppen nach TWR-Zahlen. Fragmenta Botanica 4:101-142.

# NEW TRENDS IN MEASURING DIVERSITY

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**Abstract:** Recently, diversity orderings have been developed to improve diversity comparisons based on numerical valued diversity indices. In this case a community is characterized by a *diversity profile* instead of a numerical value. Community *A* is said to be *more diverse* than community *B* when the diversity profile of *A* is above or equal to the diversity profile of *B* on the whole range of a scale parameter. The scale parameter is related to the sensitivity to rare and frequent species. Thus, a scale-dependent diversity comparison can be achieved. It is also reflected when one of the communities is more diverse for the rare species while the other one is more diverse for the frequent ones. A tree diagram is presented for the diversity orderings and the density and/or pattern dependent and/or independent representations, which are especially important in ecological applications, are also mentioned.

## Introduction

There is a long history and tradition of diversity in ecology. Tremendous number of indices were published to measure it. These statistics are also used in other sciences, especially in economics and physics. Rényi (1961) has published the first generalized entropy function. Generalized entropies are heavily used in physics nowadays (Hentschel and Procaccia 1983). At that time, ecologists did not recognize one of the most useful properties of these diversity index families; i.e., that they can be used for scale-dependent diversity characterization of the communities and for diversity ordering of the communities according to their diversity. It was recognized and emphasized by Patil and Taillie (1979); see also Solomon (1979). Tóthmérész (1993a, 1995) reviewed them; he has also proposed a new one.

## A general characterization of diversity

Generally, a *community A* may be characterized by an abundance vector $n=(n_1,n_2,...,n_S)$, where $n_i$ is the abundance of the *i*-th species of the community. Frequently it is enough to know the relative abundances of species. Thus, a community may be described by a $p=(p_1,p_2,...,p_S)$ relative abundance vector. Using more formal terminology we can say that $(p_1,p_2,...,p_S)$ is a discrete probability distribution and

$$\Gamma := \left\{ (p_1, p_1, \ldots, p_S) : p_i \geq 0, \sum_{i=1}^{S} p_i = 1 \right\}$$

is the set of discrete probability distributions. The diversity is a real function defined on $\Gamma$. Patil and Taillie (1979) stressed the view that community diversity can be defined to be the average species rarity. Denote the rarity of species *i* of the studied community by *R(i;p)*; i.e., a numerical measure of rarity is to be associated with each species. Therefore, the diversity measure of a community is defined as its average rarity:

$$D : \Gamma \to \Re , \; D(p) := \sum_{i=1}^{S} p_i R(i;p) ,$$

where $\Re$ is the set of real numbers. Depending on the rarity functions, great many diversity functions can be defined. This is a fairly general definition of diversity. By nowadays, even this definition looks a bit obsolete and a more general definition looks inevitable based on the notion of Schur-concavity, and the idea of majorization and weak majorization. In the following section I review very briefly the one-parameter diversity index families.

**Why diversity profiles?**

Different diversity indices may rank inconsistently a given pair of communities. For example, two communities with the following abundances

$A = (33, 29, 28, 5, 5)$ , $B = (42, 30, 10, 8, 5, 5)$,

are ranked differently by the Shannon, *H*, and Simpson, *D*, indices:

$H(A) = 1.3808 < 1.4574 = H(B)$ , $D(A) = 0.7309 > 0.7194 = D(B)$.

The problem is related to the different sensitivities of diversity indices. The Shannon index is more sensitive to the effect of rare species; while the Simpson tends to stress the effect of dominant species. A possible solution is to use *parametric families of diversity indices* instead of a numerical-valued diversity index. An important property of the family of diversity indices is their variable sensitivity to rare and frequent species. A one-parameter family of diversity indices may be portrayed graphically by plotting diversities against the scale parameter. This curve is frequently mentioned as the *diversity profile* of the community. Diversity profiles of communities *A*, *B* and *C* = (32, 21, 16, 12, 9, 6, 4) are presented in Fig. 1.

Using diversity profiles we can define the *diversity ordering* of communities in the following way: *Community A is more diverse than community B (written A>B) when the diversity profile of A is above or equal to the diversity profile of B on the whole range of the scale parameter.* Curves of two diversity profiles may intersect. In this case the two communities are not comparable; this means that one of them is more diverse for the rare species, while the other is more diverse for the dominants. In Figure 1 we can see that *A* and *B* are non-comparable, but that *C>A* and *C>B*.

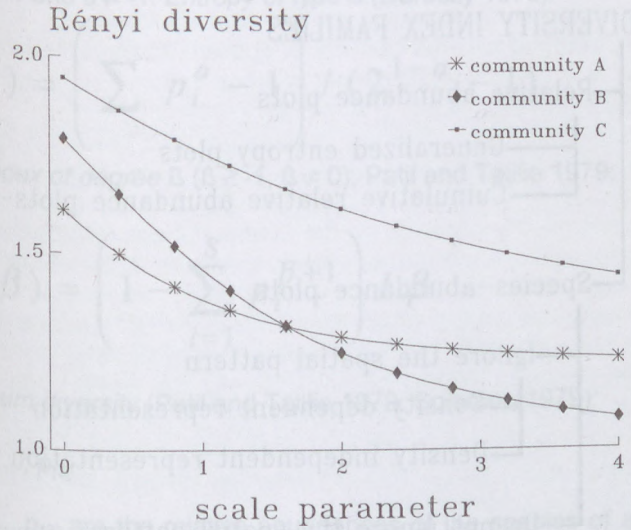



Fig. 1. Diversity profiles of three communities. Community C is the most diverse (C>A and C>B). Communities A and B are non-comparable because the diversity profiles intersect.

**Scale-dependent diversity characterization: one parametric diversity index families**

There are two main groups of diversity index families (Fig. 2). In the first group the scale parameter is related to the dominance structure of the community. In the second group there is a straightforward interpretation of scale parameter related to different sample sizes. Thus, the meaning of scale parameter is somewhat different for the two groups.

There are two subgroups of the first group; they can be mentioned as *generalized entropy plots* (**GenE** plots) and *cumulative relative abundance plots* (**CuRe** plots). All the diversity index families included in a subgroup are closely related; see Tóthmérész (1993a, 1994c). The first one includes the methods of Rényi, Daróczy, and Patil & Taillie; the second one contains the logarithmic dominance plot and right-tail-sum diversity plots. For the members of the first subgroup there is a scale parameter which runs from 0 or -1 to infinity. For the members of the other subgroup the range of scale parameter is "automatically" defined by the number of species.

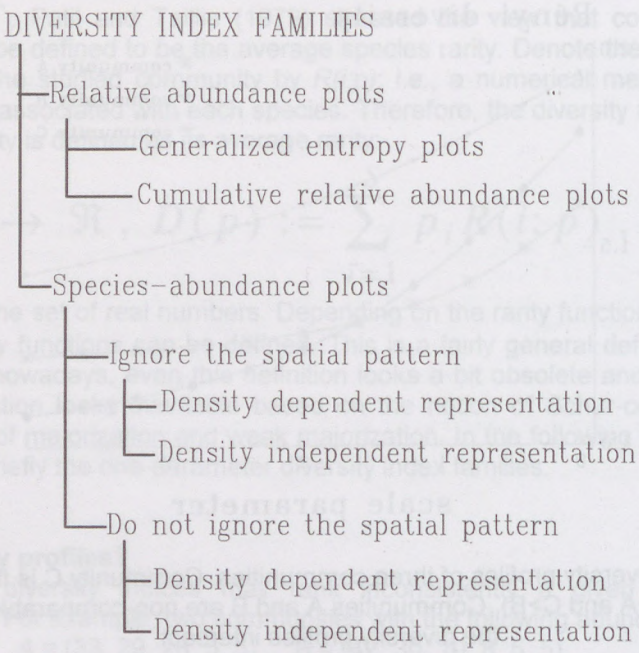



Fig. 2. Tree diagram of diversity index families.

The diversity index families are defined in the following way. *Entropy of order* ($a>0$, $a \neq 1$); Rényi 1961:

$$H(a) = (\log \sum_{i=1}^{S} p_i^a) / (1 - a)$$

It was the first published family of diversity indices. In ecological applications the natural logarithm is the most frequently used. It is important to know the special cases of diversity index families during the interpretation of the results. For Rényi diversity the following relations are valid. $H(0)$ = logarithm of the total number of species; $H(a \rightarrow 1)$ = Shannon index; $H(2)$ = logarithmic form of Simpson index; $H(a \rightarrow +\infty)$ = logarithm of the reciprocal of Berger-Parker diversity index.

Let $a \geq -1$ and $a \neq -1$. *Entropy of type* a (Daróczy 1970):

$$DH(a) = \left( \sum p_i^a - 1 \right) / (2^{1-a} - 1)$$

*Diversity index of degree* ß (ß $\geq -1$, ß $\neq 0$); Patil and Taillie 1979:

$$DPT(\beta) = \left( 1 - \sum_{i=1}^{S} p_i^{\beta+1} \right) / \beta$$

*Right-tail-sum diversity* (Patil and Taillie 1979, Solomon 1979):

$T(i) = p_{[i+1]}, \ldots, p_{[S]}$

where $p_{[1]}, \ldots, p_{[S]}$ are the relative abundances of the species of a community arranged in *descending order*. In the form of a *logarithmic dominance plot* is advised to use as a diversity profile (Tóthmérész 1993a, 1995).
*Species-individual curve* is defined as follows:

$$S(m) = S - \sum_{i=1}^{S} (1 - p_i)^m$$

The expected number of individuals in an area is proportional to the size of the area. Therefore, we can calculate the *species-area curve* using the following relationship: $m = N$ *(plot size / total area)*, where $N$ is the total number of individuals on the area. Smith and Grassle (1977) presented the minimum variance unbiased estimation of $S(m)$.

All these diversity profiles and the density dependent and density independent representations are calculated by the **DivOrd** and the **NuCoSA** program packages on PC's (Tóthmérész 1993a, 1993b, 1994b).

**Diversity and pattern analyses and the density dependence**

The number of species depends on the number of individuals, although this relationship is not linear. When the densities of the compared communities are strikingly different, the validity of the comparison is rather dubious. In this case a density independent representation may be used to eliminate the influence of different densities. Depending on the research problem, the traditions are different. In botany, density dependent

representation is applied always entirely, because plots of the same size is used for comparisons. In algology, and in zoology frequently 100 or 1000 individuals are counted and the number of species richness is determined in this way. This is a density independent representation. For a more detailed discussion of the problem see in Tóthmérész (1994c).

The species-abundance diversity profiles are well known in botany and zoology as species-area and species-individual curves. More exactly these are the curves of a "random" or unstructured community. However, the diversity of a community depends on the spatial pattern (Tóthmérész 1993a, 1994c). The importance of the patchiness on the community level was recognized very early in botany. Watt (1947) suggested that plant communities are comprised of a mosaic pattern of patches which are dynamically related to each other. Ecologists always profess the importance of multispecies patterns. Instead of that, diversity and pattern analyses have a long history to develop independently. The pattern dependent representation of species-abundance profiles may provide a very important tool to study them at the same time. All the other diversity profiles ignore the spatial pattern of the communities.

In fact, the pattern dependent representation of species-abundance diversity profiles is not really a one-parametric index family. It should be mentioned as *direct spatial series analysis* (Tóthmérész 1994a). Historically, although there were some preliminaries of direct spatial series analysis, the *indirect spatial series analysis* was first developed systematically. What does a spatial series analyses mean? I mention it as spatial because the goal is to analyze the spatial structure of a community. The 'series' comes from the technique, how it is achieved. Analogously to the temporal series analyses, the pattern is analyzed for a series of increasing sized plots. For each plot size a statistics, characterizing the spatial pattern of vegetation, is calculated and plotted against the plot size. In the case of direct spatial series analysis, a statistics calculated directly from the vegetation of the sample plots is plotted; e.g. number of species, diversity, variance of the number of species, etc. (Tóthmérész 1994a). Indirect spatial series analysis is much more sophisticated. In this case, using a large number of sample plots for each plot size, the frequency of the plots containing the same species are counted and then, indirectly, from this derived data set, is calculated a statistics characterizing the spatial pattern of the community. Details of the method can be found in the papers of Juhász-Nagy, who invented and developed this approach (Juhász-Nagy 1976, 1993, Juhász-Nagy and Podani 1983, Podani *et al.* 1993). There are special programs for indirect spatial series analysis (Erdei and Tóthmérész 1993, Podani and Czárán 1996) or general-purpose packages including procedures for indirect spatial series analysis (Podani 1995).

## References

Daróczy, Z. (1970) Generalized information functions. Information and Control 16, 36-51.

Erdei, Zs. & Tóthmérész, B. (1993) MULTI-PATTERN 1.00. A program package to analyze and simulate community-wide patterns. Tiscia 27: 45-48.

Hentschel, H.G.E. and Procaccia, I. (1983) The infinite number of generalized dimensions of fractals and strange attractors. Physica 8D: 435-444.

Juhász-Nagy P. (1976) Spatial dependence of plant populations. Acta Botanica Hungarica 22: 61-78.

Juhász-Nagy P. (1993) Notes on compositional diversity. Hydrobiologia 249: 173-182.

Juhász-Nagy P. & Podani J. (1983) Information theory methods for the study of spatial processes and succession. Vegetatio 51: 129-140.

Patil, G.P. & Taillie, C. (1979) An overview of diversity. In: Ecological Diversity in Theory and Practice (Ed by J.F. Grassle, G.P. Patil, W. Smith, & C. Taillie), pp. 3-27. International Cooperative Publishing House, Fairland, Maryland.

Podani, J. (1995) Multivariate Data Analysis in Ecology and Systematics. A methodological guide to the SYN-TAX 5.0 package. SPB Publishing bv., The Hague.

Podani, J., Bartha, S. & Czárán, T. (1993 Pattern, area and diversity: the importance of spatial scale in species assamblages. Abstracta Botanica 17: 37-51.

Podani, J. & Czárán T. (1976) Individual-centered analysis of mapped point patterns representing multi-species assamblages. Journal of Vegetation Science (to appear).

Rényi, A. (1961) On measure of entropy and information. In: Proceedings of the 4th Berkeley Symposium on Mathematical Statistics and Probability (Vol. I.) (Ed by J. Neyman), pp. 547-561. University of California Press, Berkeley.

Smith, W. & Grassle, F.J. (1977) Sampling properties of a family of diversity measures. Biometrics 33: 283-292.

Solomon, D.L. (1979) A comparative approach to species diversity. In: Ecological Diversity in Theory and Practice (Ed by J.F. Grassle, G.P. Patil, W. Smith, & C. Taillie), pp. 29-35. International Coowrative Publishing House, Fairland, Maryland.

Tóthmérész, B. (1993a) DivOrd 1.50: A Program for Diversity Ordering. Tiscia 27: 33-44.

Tóthmérész, B. (1993b) NuCoSA 1.0: Number Cruncher for Community Studies and other Ecological Applications. Abstracta Botanica 17: 283-287

Tóthmérész, B. (1994a) Statistical analysis of spatial pattern in plant communities. Coenoses 9: 33-41.

Tóthmérész, B. (1994b) DivOrd 1.60. Diversity Ordering: finite and infinite samples. Tiscia 28: 63-65.

Tóthmérész, B. (1994c) Diversity Orderings and Spatial Series Analyses. DSc. Dissertation (in Hungarian: Diverzitási rendezések és térsorozatok. Akadémiai Doktori Disszertáció).

Tóthmérész, B. (1995) Comparison of different methods for diversity ordering. Journal of Vegetation Science 6: 283-290.

Watt, A.S. (1947) Pattern and process in the plant community. Journal of Ecology 35: 1-22.

# IV. SESSION:

# BIOMONITORING OF KIS-BALATON

# PATHOGENIC FUNGI ON ULIGINAL PLANTS OF KIS-BALATON CONSERVATION AREA

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## Introduction

Kis-Balaton is a nature conservation area. Its fauna and flora are diverse, forming a characteristic natural ecosystem. Together with aquatic plants and tree species common reed (*Phragmites communis*), sedges (*Carex sp.*), glyceria (*Glyceria maxima*) and bulrush (*Typha sp.*) play an important role mainly because of their great biomass production.

There are only a few data about fungi representing an independent phylogenetic branch in biology, especially microscopic phytopathogenic fungi in the ecosystem of wetland. Based on the results of the research work from 1990 the authors show the common fungal diseases of the most important uliginal plants, their spatial and temporal distribution as well as their usefulness in the nature conservation biomonitoring programme started in 1993.

## Review of references

Apart from fungi living in the water (Nilsson 1964, Ingold 1975, Tóth 1980, Gönczöl 1993, Révay 1993) there are only a few data available on pathogens (viruses, bacteria and fungi) of uliginal plants and their damage either in Hungary or worldwide.

Moesz (1930) was the first in Hungary to highlight the insufficiencies of the topic from a mycological point of view. He described 21 fungal species on reed, bulrush, sedges and glyceria. Further examinations were only carried out in fifty years on viruses (Horváth *et al.* 1987, 1988, Pocsai & Horváth 1966) and on microscopic fungi (Kovács *et al.* 1979, 1994, Érdiné Szekeres 1991, Fischl 1993, 1994, 1995a, b, 1996, Fischl & Berke 1993, Bán *et al.* 1994, Dinka *et al.* 1994, Agárdiné Bán *et al.* 1995, Botta-Dukát *et al.* 1995a, Agárdiné Bán 1996). Extended research was carried out on reed because of decline processes at Lake Balaton and other large ponds (Ruttkay *et al.* 1964, Kovács *et al.* 1979, 1994, Érdiné Szekeres 1991, Fischl 1993).

## Materials and Methods

Collection of diseased plant material are carried out regularly from 1990 at Kis-Balaton.

Aerial photographs and video films were also made in order to follow changes.

Samples were examined under laboratorial conditions including wet chamber, incubation, light microscopy, culturing and microphotography etc. The incidence, frequency and dinamics of diseases are measured by a scale up to 5 in each sampling site. Disease indices were calculated.

## Results

Vegetation is rather diverse at reservoir I. and II. of Kis-Balaton. Before flooding the area of reservoir I. was mainly covered by sedges while reeds were rare. After flooding reservoir I. of 18 000 hectare has evolved. The ancient and the current vegetation of reservoir I. highly differ from that of the flooded and not flooded areas of reservoir II. (16 000 and 35 000 hectare, respectively). There are reeds of 2 000 hectare in the area of reservoir II. Studies according to the aims of the nature conservation biomonitoring project began in 1993 (Botta-Dukát *et al.* 1995b) revealed different phytopathogenic fungi on reed by survey plots. The most common fungal pathogens are the biotroph rusts, *Puccinia phragmitis* and *P. magnusiana* on reed. Both species are heteroecious showing a different dominance by survey plots.

Observations showed that rusts are very common in reeds, but there are significant differences in the extent of diseases by survey plots. Lower leaves were much heavily infected than upper ones. Heavy infection of uredo and teleutosori of these rusts by a pycnidial hyperparasite fungus, *Sphaerellopsis filum* (syn.: *Darluca filum*) was an interesting and of new finding. Though this phenomenon has been observed before data on such a heavy infection in natural ecosystems was not found yet.

This hyperparasite also occurred in the sori of rusts of sedges and that of glyceria.

Another known fungal disease on reed is a smut, *Ustilago grandis*. This smut can be found at reservoir I. and II. as well but the occurrence is sporadic. In case of heavy infection reed cannot be used in the industry. Knowing the centre of disease and slow spread of the fungus usage in the biomonitoring system as an indicator should be considered.

Furthermore *Deightoniella arundinacea* and *Polythrinciopsis phragmitis* causing foliar diseases were isolated, too.

Sedges are dominant in the areas not being flooded. Rust (*Puccinia* spp.) is the most common fungus on the different sedge species. Besides *Septoria* (*Septoriella*) *caricis* and *Deightoniella caricis* described as a new pathogen in this area also have to be mentioned.

*Typha angustifolia* and *Typha latifolia* are rather widespread in some places of Kis-Balaton. *Phyllosticta typharum*, a pycnidial fungus causes a common disease of bulrush.

The most widespread diseases of glyceria are caused by *Puccinia coronifera* f.sp. *glyceriae* and *Ustilago longissima*. The latter was mentioned even by Moesz (1930).

Fungal diseases of other uliginal plants were also described. Foliar disease of *Sagittaria sagittifolia*, *Phyllosticta sagittifoliae* was describe as a new finding in the area of reservoir II.

*Calystegia sepium* is a characteristic plant of wetland which is a dangerous weed of some field crops. Two pycnidial fungi were isolated on this plant (*Stagonospora calystegiae*, *Ascohyta kleinii*). The previous one is considered as a biological control agent.

Along dikes in the not flooded areas there are homogenous stands of *Solidago gigantea*. This introduced plant is not an uliginal one but it can be considered as an indicator because of its fast spread. Its common foliar disease is caused by *Septoria virgaureae* causing grey spots 8-12 mm in diameter.

*Echinocystis lobata* is only scattered in the area. *Pseudoperonospora cubensis* being a dangerous pathogen of cucumber in greenhouses as well as in fields was first described here in Hungary.

## Summary and Conclusion

There are only a few data on fungal diseases of plants common and scattered at Kis-Balaton reservoir I. and II. Description of the present state and observation on the phenomena in time and space were the main task in the research work and biomonitoring. Besides the greatest biomass producers like reed, sedges and bulrush diseases of other plants more scattered in the area were also examined.

Many fungal pathogens new to Hungary were isolated. Survey on the health condition of reed was carried out, too (incidence and severity of diseases, their spatial and temporal spread). At present we cannot explain the heavy infection by the hyperparasite of rusts, *Sphaerellopsis filum* and consider its role in the biomonitoring program.

Pathogens infecting either uliginal plants or field crops are especially important. This host-pathogen relationship reveals the connection between the two pathosystem which is not neglectible from a plant protection point of view.

The above described research work can reveal indicator agents (eg.: fungi) for indicating changes and applying treatments.

## Acknowledgements

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## References

Agárdiné Bán, R. (1996) A Keszthelyi-öböl menti és a velencei-tavi nádasok kórokozó gombáinak vizsgálata. Növényvédelmi Tudományos Napok, Budapest /Scientific Meeting on Plant Protection, Budapest, Hungary/. Abstr. 97. p.

Agárdiné Bán, R., Fischl, G. & Virányi, F. (1995) A nád (*Phragmites communis* Trin.) patogén gombáinak vizsgálata a Balatonon és a Velencei-tavon. I. Orsz. Agrár PhD konf. és találkozó, Debrecen /Ph.D Conference and Meeting, Debrecen, Hungary. 186-188. pp.

Bán, R., Weirach, A. & Fischl, G. (1994) Data involving the pathogenic fungi of Lake Balaton and Small-Balaton. Environmental Microbiology. Proc. VIII. Symp. Nyíregyháza. 151-152. pp.

Botta-Dukát, Z., Fischl, G., Szabó, I. & Szeglet, P. (1995a) On the role of macrophytes and their mycophytes in the biological monitoring of Kis-Balaton wetland landscape protection area. EURECO'95. 7th European Ecological Congress. Budapest, Abstr. 27. p.

Botta-Dukát, Z., Szabó, I. & Szeglet, P. (1995b) Biológiai monitorozás a Kis-Balaton természetvédelmi biológiai monitorozásához. Kari jegyzet és kutatási segédanyag. Keszthely /Lecture notes and research guide/ 1-84. pp.

Dinka, M., Fischl, G. & Szeglet, P. (1994) A Fertő nádasainak kutatása és a nádpusztulás lehetséges okai. Növényvédelmi Tudományos Napok, Budapest /Meeting on Plant Protection, Budapest, Hungary/ Abstr. 103. p.

Érdiné Szekeres, R. (1991) Környezetvédelmi helyzetkép nádasainkról. Környezet és fejlődés. 12: 48-50.

Fischl, G. (1993) Nádpusztulás - nádbetegségek. XXXV. Georgikon Napok, Keszthely. /Georgikon Meeting XXXV, Keszthely, Hungary/ 209-217.

Fischl, G. (1994) A nád betegségei. Agrofórum 5: 11, 39. p.

Fischl, G. (1995a) *Deightoniella arundinacea* (Corda) Hughes a nád félreismert beteg-sége. Növényvédelmi Tudományos Napok, Budapest /Meeting on Plant Protection, Budapest, Hungary/ Abst. 82. p.

Fischl, G. (1995b) A Balaton mocsári növényein előforduló mikroszkópikus gombafajok. Növényvédelem, 31 (5) 229-232.

Fischl, G. (1996) Néhány lágyszárú makrofiton gombabetegsége a Kis-Balaton II. ütem területén. Növényvédelmi Tudományos Napok, Budapest /Meeting on Plant Protection, Budapest, Hungary/ Abstr. 108. p.

Fischl, G. & Berke, J. (1993) Adatok néhány vízi és mocsári növény rozsdabetegségeinek elterjedéséhez. Növényvédelem, 29 (11) 512-513.

Gönczöl, J. (1993) Vízi *Hyphomycetes* tanulmány - aljzat és vízminőség. MTM, Növénytár, Budapest. Kandidátusi értekezés /Thesis/.

Horváth, J., Juretic, N., Mamula, D. & Krajacic, M. (1987) Vízi növényvírusok ökológiája. Növényvédelmi Tudományos Napok, Budapest /Meeting on Plant Protection, Budapest, Hungary/ Abstr. 63. p.

Horváth, J., Nienhaus, F., Beczner, L., Kárpáti, I. & Szeglet, P. (2988) A vízi hídőr (*Alisma plantago-aquatica* L.) és gyűrűs süllőhínár (*Myriphyllum verticillatum* L.) vírusfertőzöttsége a Hévízi-csatornában, a Kis-Balatonban és a Balatonban. Növényvédelmi Tudományos Napok, Budapest /Meeting on Plant Protection, Budapest, Hungary/ Abstr. 56. p.

Kovács, M., Szabó, Sz., Busics, I. & Kaszab, L. (1994) A balatoni nádasok területének változása, degradációjuk. Magyar Hidrológiai Társaság XII. orsz.

vándorgyűlése, Siófok. I. köt /Meeting XII of the Hungarian Hidrologycal Society, Siófok, Hungary, vol.1./ 250-258.

Kovács, M., Tóth, L., S. Dinka, M. & Podani, J. (1979) A balatoni nádpusztulás feltételezhető okai. Magyar Hidrológiai Társaság orsz. vándorgyűlése, Keszthely, III. A /Meeting of the Hungarian Hidrological Society, Keszthely, Hungary, III.A/ . 3: 1-12.

Moesz, G. (1930) Gombák a Balaton mellékéről és a Bakonyból. Magyar Biol. Kut. Int. I. oszt. munkái. Tihany /Researches of the Hungarian Biological Society, Tihany, Hungary/ 88-119.

Nilsson, S. (1964). Guide to Aquatic *Hyphomycetes*. Freshwater Biol. Assoc. Sci. Publ. No. 3. 30, 1-90.

Pocsai, E. & Horváth, J. (1996) Növényvírusok kimutatása a magyarországi folyók és tavak vizeiből. Növényvédelmi Tudományos Napok, Budapest /Scientific Meeting on Plant Protection, Budapest, Hungary/ Abstr. 130. p.

Pomogyi, P. (1991) A Kis-Balaton védőrendszer kémiai, biológiai, anyagforgalmi vizsgálatai. Össz. jelentés 1985-1990 közötti kutatásokról, Szombathely-Keszthely /Summary of the researches between 1985-1990, Szombathely-Keszthely, Hungary/ 1-258.

Révay, Á. (1993) Erdei avar tanulmány - *Dematiaceae Hyphomycetes* fajok és ökológiájuk. MTM, Növénytár, Budapest. Kandidátusi értekezés /Thesis/

Ruttkay, A., Tilesch, S. & Veszprémi, B. (1964) Nádgazdálkodás. Mezőgazdasági Kiadó, Budapest.

# BIOLOGICAL RESEARCHES AT KIS-BALATON

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The marsh of Kis-Balaton had been dried out by decreasing the water level of Lake Balaton since the second half of the last century. With this a natural bay of Lake Balaton came to an end that was sometime a natural filter of Balaton. River Zala that crossed sometime the marsh now is transporting its own stream deposit directly into Lake Balaton, into the Bay of Keszthely. In the period of the socialist agriculture the use of cheap artificial fertilizers were wide spread and often unprofessional. So enermous amount of P and N had been transported into Lake Balaton by River Zala causing a large scale eutrophication of the lake. Since the seventies of this century the water quality of Balaton has been deteriorating. It has become so bad that idea of recreating the marsh of Kis-Balaton has born.

Creating the Kis-Balaton Water Quality Protecting System as a technical project, recreation of habitats have been also created as the new wetlands offer new habitats for several plants and animals. That is why Kis-Balaton Landscape Protection Area was established here in 1986. The Kis-Balaton Water Quality Protecting System has two parts. The first part of the System on the west side has been working from 1985 and the larger one in the east is under construction. The water surface of the complete area covers 17.8 $km^2$. That part was flushed with water suddenly. Avoiding this drastic means the 51 $km^2$ area of the second part will be flushed with water step by step. (A 16 $km^2$ area of the second part has been working yet.) Creating new habitats here is an unprecedented outdoor experiment as well. Now the end of this experiment cannot be seen exactly. That is the reason why biomonitoring has started in the autumn of 1993 to detect the change of ecosystems.

The following taxons are studied within the scope of Kis-Balaton Biomonitoring Researches : algae, microscopic fungi of macrophytons, macrophytons, *Rotatoria*, *Crustacea*, *Turbellaria*, *Hydrachnidae* (*Acaridea*), *Trichoptera*, *Odonata*, *Chironomidae*, *Culicidae*, *Gastropoda*, *Bivalvia*, *Hirudinoidea*, *Pisces*, *Amphibia*, *Aves*. This list shows the '96 situation. In the previous years this list was different and changes in this list is expected in the near future (Table 1). In this stage studies can be regarded as a basic research. Many rare species were found here. Some of them can be found only at Kis-Balaton in the country what is more *Batracobdelloides moogi* (*Hirudinoidea*) genus and species is new to the whole continent (Nesemann, H. & B. Csányi : Description *of Batracobdelloides moogi* n. sp., a leech genus and species new to the European fauna with notes on the identity of *Hirudo paludosa* CARENA 1824 (*Hirudinea : Glossiphoniidae*) , *Lauterbornia*,

Dinkelscherben, 1995.). It is also expected that researches must provide practical suggestions for the staff of nature conservation. That is why we are planning to revise the whole project from the point of view of practical usefulness. Thus practical researches are going to start in this year. These researches can help us to manage, protect, replant and transplant reeds, sedgy and swampy marshes. They can provide us a useful help to solve such problems like botulism, spreading of fish etc.

In many cases it is difficult for the staff of nature conservation to use in practice the results of researches. In several cases research reports are an abstract and scientific dissertations and sometimes it is impossible to 'translate' into the language of rangers working on the field. In a worse case research reports do not contain any prognostical and analytical part or sometimes these parts are exist but they are too short or/and meaningless. But it could not be expected from any specialist to give any suggestion about e.g. how must we manage the locks. To make such a complex decision we must synthetize the results of all researches. Things mentioned above gave reasons for starting new practical botanical and zoological researches from this year parallel with basic researches. The practical botanical researches will search answers for the following important question : as flushing will be progressed macrophytons will going to rearrange their territories. It probably not will be free from problems. Reeds, sedgy and swampy marshes might disappear from certain places and it is a big question that they would be able to appear at places where we wait for. And when? So, our task is to find out how to help nature rearrange itself without shocks and more serious problems. The practical zoological researches will search answers for the following important questions : searching density of birds as we know that settling down here is not limited by the amount of food but by the quality of nesting places. We must also study the problem of fish-ladders in the near future. Today the necessity of fish-ladders seems probable but how to manage them is not cleared up exactly. Botulism is also a regularly appearing problem and we must study it, too.

According to the things mentioned above our tasks are described as the followings :

1) On an ecological basis we must think over and clearly fix our expectations about habitats taking into consideration realized and future water conservancy-technical investments. E.g. do not wait for reeds where it will not be able to exist at all.
2) Taking into consideration existing and future habitats and professional aspects of biomonitoring we must think over the list of taxons studied. Which of them need more research and which of them do not? We must omit latter taxons from the project or make study years rare, e.g. searching it in every fifth year in the future. It is important to determine indicator organisms and study them more carefully.
3) In the contracts sometimes it is necessary to tighten the topics within wider researc possibilities of a taxon. E.g. where is the verge of botulism

as far as we have to intervene and how can we intervene or what about nests when inundation is coming ? Where is the verge again as far as we have to intervene ? (The role of ecological catastrophes in the ecosystem) But studying the problem of fish-ladders is also an important part of our future tasks.

4) It is necessary to employ a full time biologist at Little-Balaton Landscape Protection Area synthetizing the results of both practical and basic researches. Relying upon these findings he/she will have to work out the managment plan for the area. It must also deal with damage to ship like it was the invasion of fish from Balaton two years ago. Over and above that a full time biologist at the area with his/her field experiences and knowledge of biology will be able to manage Kis-Balaton Landscape Protection Area with a view to ecology.

| 1993. | 1994. | 1995. | 1996. |
|---|---|---|---|
| -- | algae | algae | **algae** |
| microscopic fungi of macrophytons | microscopic fungi of macrophytons | microscopic fungi of macrophytons | **microscopic fungi of macrophytons** |
| macrophytons | macrophytons | macrophytons | **macrophytons** |
| willow shrubbery | -- | -- | -- |
| *Trichoptera* | *Trichoptera* | *Trichoptera* | ***Trichoptera*** |
| *Amphibia* | *Amphibia* | *Amphibia* | ***Amphibia*** |
| *Rotatoria* | *Rotatoria* | *Rotatoria* | ***Rotatoria*** |
| water bugs and beetles | -- | water bugs and beetles | -- |
| *Pisces* | *Pisces* | *Pisces* | ***Pisces*** |
| -- | macrozoobenthon | *Hirudinoidea* | ***Hirudinoidea*** |
| *Odonata* | *Odonata* | *Odonata* | ***Odonata*** |
| *Turbellaria, Mollusca, Hirudinoidea, Crustacea, Hydrachnidae (Acaridea)* | *Turbellaria, Mollusca, Hirudinoidea, Crustacea, Hydrachnidae (Acaridea)* | *Turbellaria, Crustacea, Hydrachnidae (Acaridea)* | ***Turbellaria, Crustacea, Hydrachnidae (Acaridea)*** |
| -- | -- | *Mollusca* | ***Mollusca*** |
| *Aves* | *Aves* | *Aves* | ***Aves*** |
| *Culicidae* | *Culicidae* | *Culicidae* | ***Culicidae*** |
| *Chironomidae* | *Chironomidae* | *Chironomidae* | ***Chironomidae*** |
| -- | *Oligochaeta* | -- | -- |
| -- | -- | -- | **small Mammals** |
| *Gastropoda, Bivalia* | -- | -- | -- |
| parasite worms and their larvas | -- | -- | -- |
| | -- | -- | -- |
| -- | -- | -- | **practical botany** |
| -- | -- | -- | **practical zoology** |

# V. SESSION:

# NATURE MANAGEMENT: METHODS, RESULTS AND PROBLEMS

# ECOFAUNISTICAL INNVESTIGATIONS ON THE LARVAE OF RARE ENDANGERED ODONATA SPECIES IN HUNGARY

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**Abstract:** As a result of intensive investigations during the last 4 years, authors give a general overview from the distribution of larvae of some dragonfly species threatened in Europe, using UTM grid-maps. They also make some comments on their ecological demands. The species involved are *Aeshna viridis, Stylurus flavipes, Ophiogomphus cecilia, Onychogommhus forcipatus, Somatochlora flavomaculata, Leucorrhinia caudalis, L. pectoralis.*
The composition of the real and potential Odonnata assembleges of some more important types of biotope are given, and the consequences of different positive and negative changes ( i.e. climate, succession, human impact... and so on) are also mentioned. The types discussed are as follows: streams - *Cordulegaster heros, C. bidentata, Calopteryx virgo, Pyrrhosoma nymphula*, rivers - *Stylurus flavipes, Ophiogomphus cecilia, Onychogomphus forcipatus*, moors, marshes and fens - *Somatochlora flavomaculata, Leucorrhinia pectoralis*, lakes, gravel pits, dead arms with dense vegetation - *Epitheca bimaculata, Leucorrhinia caudalis*, alkaline lakes - *Lestes macrostigma, Aeshna affinis, Sympetrum meridionale*, shallow, throughly warming water bodies - *Coennagrion scitulum, Hemianax ephippiger, Sympetrum fonscolombii, S. depressiusculum.* The importance of dragonflies as a target group of biodiversity monitoring is highlighted. Possibilities of preservation and maintenance are suggested.

## Introduction

Some of the stenotopic dragonflies have retreated in this century, especially in the last decades, because of serious loss of their habitats, declining of water quality and other human impacts. The five Bern Convention, and other endangered species in Hungary need special conservational measures, and the existence of Central European populations seems to be essential in their survival in Europe. Authors has started countrywide survey of threatened dragonflies concentrated on the larval occurrence of the species since 1992.

## Material and Methods

The sampling took place regularly along the surveyed area three times a year, the team searched for larvae and exuviae usually for half an hour on one spot. Strong underwater net is used for collecting larvae from the sediments and submerged vegetation. Exuviae are counted on the relevant unit of the shore, river bank, etc.

The regular samplings covered the NW and NE parts of Hunngary, and there are additional sampling plots at the SW and E parts of the country. There are about 20,000 larval records from more than 350 localities.

## Results

The dragonfly studies are incorporated in the national wetland inventory and biodiversity monitoring programs and other biomonitoring procedures as well. The records of the Hungarian Odonata Larva Team are partly published ( Ambrus *et al.* 1992, 1994a, 1994b ) or under way, and all are fed in database. The records are represented by geographical coordinates and 10 x 10 km UTM grid map. Individual places have 3-4 year old series of records which can be analysed over time ( Szigetköz, Kis-Balaton, Bereg-Szatmár ). The new larval studies give background information about the natural changes of abundance caused not directly by human impact ) e.g.: meteorological conditions i.e. dry summer periods ), and help us to recognize certain important habitat types from the viewpoint of the most threatened dragonfly species, which need special attention, or action:

### 1. Streams of mountainous, forested areas

***Cordulegaster heros***: This species was described only in 1979 from Burgenland. Its distribution area is restricted only to E-Austria, Slovenia and some spots along the Balkan and W.Hungary. There are strong populations at the valleys of the Sopron-mts, Örség and Mecsek-mts. It is populated the lower courses of streams.

***Cordulegaster bidentata*** : This is a bit well distributed species, it can be found at the Central-European mountains. The larvae can develop in the springs, and extreme upper flows. There are populations at the Kőszeg-mts, Mátra-mts and reported to live in other mountains of the country as well. Main threats: clearcuts of the watersheds, regulation, dam / reservoire construction and fish farming. It is important to recognize the localities of the populations of Cordulegasterids and preserve the forest stands at the surroundings as far as possible.

### 2. River systems

***Stylurus flavipes***: The species prefers the lower course of rivers with soft sediments. The larva is living inside the mud, so it cannot tolerate the bad water quality, and toxic or anaerob conditions. Where *S. flavipes* occurs in Hungary, it is usually abundant. The populations are restricted to the largest rivers, Duna, Mosoni-Duna, Tisza, Rába and so on.

***Ophiogomphus cecilia:*** This species prefers the upper courses of bigger running waters with rough sandy sediments. It seems to be sensitive to the oxygen content of the water. It can produce strong populations in relatively quick rivers ( with good water quality ), such as Tisza ( upper flow ), Rába,

Dráva. Another typical habitat type is smaller, unregulated rivulet in forested areas ( Gyöngyös ).

***Onychogomphus forcipatus***: This species seems to prefer the smaller rivulets and faster courses of large rivers, with gravel bottom and submerged vegetation. In the last two decades it became the rarest of the four Gomphids in Hungary. The known strongest population is along the rivulet Kerka. It is in good number at the upper flow of Tisza also.

The niche segregation between the species is more or less well expressed and can be characterized by the mean size of granules of the sediment. The natural heterogeneity of the habitat is one of the basic principles of high diversity of a dragonfly community in a riverine system.

Main threats: regulation, canalization, pollution.

**3. Moors, marshes and fens**

***Somatochlora flavomaculata***: This vulnerable species tends to become very rare recently, we have found stable populations at few localities. There is no evidence of the serious decline, investigation is needed. Stable populations are known from Tornanádaska and Bereg-Szatmár region.

***Leucorrhinia pectoralis:*** There used to be some strong populations, but recently they declined. Usually it lives in small waterbodies, but there are populations in marshy parts of lakes too ( Kis-Balaton ). As it accept the manmade wetlands, we can offer suitable biotopes.

Main threats: the populations of small waters are suffering from the decreasing of groundwater table and other impacts ( drying up, filling inn or declining the water quality).

**4. Lakes, gravel pits, dead arms with dennse vegetation**

***Aeshna viridis***: The first larval record from Hungary is not too old, dated in 1992 ( Ambrus *et al.*). Recently there are new records all over Hungary, due to the intensive, thorough search for it. The species developes usually in oxbows, side-arms of lowland rivers and other stagnant waters ( sometimes with slow flowing ), where *Stratiotes aloides* can fully overgrow the water. The most abunndant populations are: Kis-Balaton, Hortobágy, Bereg.Szatmár.

***Epitheca bimaculata***: It was regarded as a dragonfly close to extinction from large part of Europe, and Hungary. Recently there are good populationns anywhere, especially gravel pits, oxbows and reservoires.

***Leucorrhinia caudalis***: This species shows similar tendencies to *L. pectoralis*, but its status is more critical. Recently we have records only from clear gravel pits with *Ceratophyllum* vegetation, and oxbows - Sw Dunántúl, Tatabánya, Tiszadorogma. It would be important to know the remained populations all over the area. After analysing the habitats of the strongest populations, the principles of the habitat creation, restoration and mannagement techniques can be elaborated.

Main threats: pollution, eutrophication, intensive fish farming, restarting of gravel mining. All *Stratiotes* populations should be checked up. The biotopes with water soldier may deserve habitat protection.

### 5. Alkaline lakes, shallow, throughly warming water bodies

The shallow quickly warming, sometimes temporary small waters usually have special dragonfly communities. The species of such a community are not necessarily threatened, but some of them have special, ecological and faunistical interest. These waters are typical of the Hungarian Plain. Recently these habitats are regularly populated by the eremial, wandering species *Hemianax ephippiger* ( larval development is confirmed in Örség, Szigetköz, Hortobágy ). *Sympetrum fonscolombii* following the similar strategy. *Coenagrion scitulum* ( vulnerable ) and *Sympetrium depressiusculum* ( vulnerable ) can be found sometimes together with them. The alkalinn steppe lakes with extremly short wet periods are the habitat of *Lestes macrostigma*.
Main threats: filling in, eutrophication, pollution, mining. These habitats may deserve more attention and protection against the deterioration ( e.g.: herds of cattles ).

## References

Ambrus, A., Bánkúti, K. & Kovács, T. (1992) A Kisalföld és a Nyugat-Magyarországi peremvidék Odonata faunája. Győr, 1992 1-81.

Helsdingen, P.J., van Willemse, L. & Speight, M.C.D. ( 1996 ) Background information on Invertebrates of the Habitats Directive and the Bern Convention, II. - Strasbourg, Council of Europe

Tol, J., van Vrdonk, M.J. ( 1988 ) The protection of dragonflies ( *Odonata*) and their biotopes. Strasbourg, Council of Europe: 1-181.

Ambrus, A., Bánkuti, K. & Kovács, T. ( 1994a) Adatok az északborsodi-hegyvidék Odonata faunájához. Fol. Hist.-nat. Mus. Matr. 19: 51-58.

Ambrus, A., Bánkuti, K. & Kovács, T.( 1994b) Laying of a foundation of the Odonata fauna of West-Pannonia on the basis of spreading the larvae - Abstr. Pap. 1st Odonatol. Symp. Alps-Adriatic reg. Comm.,Maribor, Slovenia, p.5.

Ambrus, A., Bánkuti, K. & Kovács, T. A Bereg-Szatmári sik szitakötő (*Odonata*) faunája - Fol. Hist.-nat. Mus. Matr. 20. ( in print).

Ambrus, A., Bánkuti, K. & Kovács, T. Az Örség szitakötő (Odonata ) faunája - Az Örség Tájvédelmi Körzet Természeti Képe ( in print ).

Ambrus, A., Bánkuti, K. & Kovács, T. The Odonata fauna of the Szigetköz - Folia ent. hung. ( in print ).

# PRACTICAL CARE ABOUT PROTECTED SPECIES

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Slovak Enviromental Agency, branch office Košice is a specialized organization of the Ministry of Environment of the Slovak Republic. One of its activities is the implementation of working measures for nature protection or preservation of nature, its plant and animal species and their habitats. A special attention is devoted to the protected, rare and endangered species and to the protected territories as well.

In the field of the animal kingdom it is especially a higher care for those species, which have their natural area of distribution in the territory of our branch office (7 districts within the Eastern Slovakia, its southern and eastern part ).

Monitoring and definite practical steps for the protection are carried out above all with the avifauna, particularly larger birds of prey ( Aquila pomarina, Aquila heliaca, Falco cherrug) and white storks ( Ciconia ciconia ). Considering that this activity in the frame of the whole process of conservancy needs time, specialty, personnel and last but not least finances, there is a need of mutual very good cooperation of more subjects. Our permanent colleagues are members of the Slovak Union of Nature Conservationists, specialized ornithological groups, museologists and often citizens themselves.

This way in the field of nature conservation an effort of the state organization, voluntary interest groups and not least the citizens is put together into one common conservancy activity.

Relatively broad conservation activity associated with financially demanding procedures is in the sector of a care for the white stork. In 1994 an international counting of the storks took place in the territory of the Slovak Republic, the fifth in a row (1934, 1956, 1974, 1984) and in Slovakia this nation-wide counting was the sixth.

In a coordination of a coordinator of the Slovak Environmental Agency for the stork protection RNDr. Miroslav Fulín, CSc. workers of our branch office were actively engaged in this activity.

The monitoring of the nesting sites of storks was permanently ensured in 1995 and in this year as well. In the districts of the territory of our branch office 505 nests of white storks are recorded (Fulín, M.: Report on Counting White Storks Nesting in 1994 on the Territory of the Slovak Republic, 1995). Most of the nests are located in the south districts: Michalovce, Trebišov and Košice-Country. For example in the village of Zemplínske Hradište in the district of Trebišov there are 21 nests . In Buzica village in the district of

Košice-Country 14 nests were occupied in this season. Buzica village is in the close vicinity of the border of Hungary and is 40 km far from Aggtelek.

Stork nests situated outside of the villages or eventually on the trees are rare. The most often cases of nesting are on the supporting posts of the electric lines. This unfavourable and undesirable high number of cases and the increase of conflict situations connected to the operation of the electric transmission networks forces us to take corrective solutions. In 1994 we have organized a widespread action of the replacements of stork nests on the substitute nesting bases in the districts Košice-Country and Vranov. For 330 000 Slovak crowns 35 nests were relocated on the separate concrete posts with specially made substitute nest bases. The action took place in October - November. Relatively demanding step was to find a suitable new site for the installation of the post in the closest distance from the original nest and particularly to obtain an approval from the property´s owner. At present a nest occupied by a pair of storks located close to a busy pavement, garden or yard does not find such an understanding with the citizens as it used to be once and that is because of those negatives - falling of the mutes, soiling of the vicinity with the food residues, falling of the nesting material. For example in this spring season a case of an urgent relocation occurred, when a stork has built his nest on a rooftop above the entrance to a church and falling of the droppings at the least appropriate moments on the believers in their best clothes triggered off a negative attitude toward the existence of the nest.

The installation of the substitute bases on the independent concrete posts seems to be not the most suitable way of the relocations and it is so because of the following negatives - creating a habit of the young ones to this type of stand, which is outwardly mistakable for the functional electric post and a high financial demand for the heavy technical equipment, which must be used when fixing the concrete post into the concrete basement. At the global replacements which we carried out in 1995 and at the replacements which we are planning to carry out this year we aimed at creating new nesting possibilities on the roofs and chimneys on specially made nesting basements. In 1995 12 pieces of nests were transferred with the expenditure of 70 000 Slovak crowns in the districts Vranov and Michalovce mostly on such sites.

One of the important principles for the success of a relocation is an arrangement of the nesting material on the new nest and taking care of preventing the storks from nesting on the previous site again. We have recorded many cases when a stork took the twigs from a new nest to the old place. That is why at the last year and this year replacements we insert special, steady fixed nesting crown into the substitute base. In order to eliminate creating the nests on the electric posts we ask the management of the electric distribution facilities to place sufficiently effective protections on the electric posts. But this measure is usually not carried out or only a

makeshift protection is done. It is not known to us if in Slovakia a special protection exactly for these cases is produced for this purpose.

The situations with the nesting storks on the electric posts are not appropriately solved in this way by the management of the electric distribution facilities and thus the replacements of the stork´s nests are a permanent problem.

### Protection of Amphibians During the Spring Migrations in 1996

Košice´s branch office of the Slovak Environmental Agency included a protection of amphibians during the spring migrations among its main activities in this year. In the preceding years the mapping took place of the road divisions crossing the migration routes of the frogs, in which an excessive loss-rate of these animals occurred. In the Košice region 8 critical divisions of roads were recorded. All of them are situated in the vicinity of water surfaces convenient for the breeding of the amphibians. First measures for the protection of frogs were done last year. Six road divisions were marked with the pictographs of frog´s outline in order to warn drivers and to effect a lowering of speed of the motor vehicles. From the last year experiences follows that in spite of signing these divisions the number of died frogs was not decreased mainly because drivers didn´t respect the above mentioned pictographs at all or only seldom. The situation could be solved in the future with additional signs requiring the reducing of speed on the mentioned short divisions.

We tried a few other methods besides the signs in this year. On a location a hand-picking and transfer of the frogs across the road was carried out. This method did not prove to be right, it is time and personnel consuming and in the evening hours totally unusable. On another chosen location an elongated foil with trapping buckets submersed into the foundation was set up. We carried out this activity in cooperation with local government and elementary school. The division was checked daily 2 to 3 times and catched frogs were transported to the other side of the road and released directly in the water reservoir. On this location a number of frogs which died was considerably lowered and we obtained a relatively exact overview on the quantity and species composition of amphibians on a given site. In the preceding years during the culmination of the migration 400 to 500 frogs died, this year it was possible to lower it to 40 - 150. From an efficiency point of view we consider this method as the most suitable and in the future we would like to use it on the other recorded locations as well.

# MANAGEMENT OF LOESS GRASSLANDS IN THE KÖRÖS-MAROS REGION

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The loess grassland, the most typical association of the Körös-Maros region has remained only on small territories, but it had covered 7.5 per cent of Hungary before. The improvement of riverways and later the developing agricultural activity have made a radical alteration in the scenery of the Alföld. In the Körös-Maros region loess grasslands were ploughed up in the first place, since these areas provided soil of the best quality. Different types of loess grasslands can be found in this region: small patches surrounded by alkaline pastures, grasslands of barrows, ridges near ancient roads, unploughed parts of earthworks and ramparts. The most important and valuable territories in the Körös-Maros region are the following: 20 hectares of contiguous grassland near Battonya-Kistompapuszta, Pitvarosi grasslands, Tatársánc of Pusztaföldvár (0.5 ha), *Salvia nutans* habitat near Kondoros and *Adonis transsylvanica* habitat near Csorvás.

Inspite of many damaging factors several protected plants live here: *Sternbergia colchiciflora, Adonis vernalis, Phlomis tuberosa, Viola ambigua, Ranunculus illyricus*. Two strictly protected plants whose Hungarian stand can be found only in this region are the *Adonis transsylvanica* and *Salvia nutans*. *Adonis transsylvanica* is a relict-endemic species in the Carpathian-basin. Besides its Hungarian stand only one habitat is known, so it drifted to the verge of extinction. *Salvia nutans* immigrated to the Great Hungarian Plain from the eastern grasslands after the ice-age when the climate was getting warmer. It was widespread on the loess grasslands but with the expansion of plough-lands the number of this plant decreased. Their stands are endangered because of the small population size and the agricultural activities in the neighbourhood of the habitats, therefore it is essentially important to preserve them and to manage their habitat satisfactorily.

The most important managements are the prevention of ploughing the loess grasslands, forming a buffer zone around small patches of grasslands. Besides the determination of the date and pattern of mowing we have to prefer cutting the grass by hand rather than mowing. Extensive grazing can preserve the diversity of the territory. The success of the management will be controlled by standard sampling sites.

Grassland restoration experiments are going to begin on the the plough-lands inserted in the loess grasslands in 1996 with the survey of the starting-state. From the following year the efficiency of the restoration with different methods will be examined. We have to work out the methods of the

propagation of the two strictly protected species. Their stands can be enlarged by the resettlement of the grown up individuals to the remained and restored grasslands.

### The Loess Grasslands of Nagytatársánc near Pusztaföldvár

The earthwork of Nagytatársánc which lies west of Pusztaföldvár has remained from the last period of prehistoric ages, from the end of the Bronze Age. This semicircular, double slope is situated along its diameter on a long, natural depression, which is an ancient bed of a river. The rampart was built between the VIII-V. centuries B.C. The range of depression could be the river-bed of an ancient river that belonged to the watershed of the ancient River Maros. Unfortunately the grassland has remained only on a small territory (0.5 ha). It lies on the outer side of the external rampart looking to the moat and not far from the south-east edge of the rampart-system.

The typical plant association *is Salvio (nutanti-nemorosae)-Festucetum rupicolae*. Its strictly protected plant is *Salvia nutans* that is a postglacial relict of loess grasslands and it came from the eastern grasslands to the Great Hungarian Plain during the warmer period after the ice age. It was widespread on the loess grasslands but after the ploughing of the grasslands it became very rare. Among the plants of the ancient, aboriginal grasslands *Sternbergia colchiciflora, Teucrium chamaedrys, Phlomis tuberosa, Salvia nutans, Viola ambigua, Fragaria viridis, Asperula cynanchica* and *Thalictrum minus* can be found. In 1985 some individuals of *Adonis transsylvanica* were planted here. Approximately 100 plant species were found on this small territory. The most important task in the management of the remained grassland is to preseve one of the two existing habitats of *Salvia nutans* in Hungary. On the middle, deeper part it is necessary to cut down the grass more often because it is very weedy. Around the territory a grassy buffer zone is needed because it could prevent the continuous spread of the weeds from the surrounding plough-lands.

The biggest endangering factor is that the size of the territory is small, so every activity around the grassland effects the area directly. Chemicals, especially herbicides have a negative effect on loess grasslands, because they kill not only the weeds of the plough-lands but also many rare plants. The inflow of organic manure is favourable for the nitrophilous species (*Urtica dioica, Conium maculatum*) to the detriment of loess species. Pasturing is out of question because of the small size and vulnerability of the area. The best way of management is cutting down the grass by hand after the ripening of seeds of *Salvia nutans*. The hay has to be removed without treading the territory. The buffer-zone around the grassland may decrease the possibility of the inflow of organic wastes and the spread of weeds. Besides it would be advisable to expand the buffer zone to the other remained grassy parts of the ramparts.

## The Habitat of *Adonis transsylvanica*

One representative of the climatic loess grasslands of the Hazelnut Age after the Ice Age is the strictly protected *Adonis transsylvanica*. Its first Hungarian stand was found in Hungary in 1935 near Csorvás. In 1936 14 additional habitats were found in the surroundings of Csorvás, but in the spring of 1961 only eight habitats existed, on six places only one individual was present. Today only one stand is known near Csorvás along the railway line and on a wayside ridge in three patches, on an area of approximately 0,4 ha. Besides the Hungarian stand only one population is known near Kolozsvár with approximately 400 individuals. Other valuable species of loess grasslands can be found here: *Vinca herbacea, Viola ambigua, Sternbergia colchiciflora, Ajuga laxmanni*. The reduction of *Adonis transsylvanica* stands was caused by the expansion of plough-lands, the usage of herbicides on the nearby plough-lands, the disarrangement of ridges and roads, the altered microclimate resulted from the cutting down the wayside trees and the steady collection of this plant as a medicinal herb used for the treatment of animals.

Until 1995 the whole area was mown. Since 1995 the ridge has been divided into three parts. The first part was mown, on the second part a cow was graizing, and the third part was the controll area and was not managed. After the ripening of seeds the grass was cut down by hand around the *Adonis* stems. The territory along the railway line was not managed, but after the results of the study these will be included in the management. Here the stands are endangered by the spread of shrubs (mainly *Prunus spinosa* and *Eleagnus angustifolia*). The buffer zones have to be sown with grass to prevent weeds from spreading to the loess grasslands. The most important task is to work out the propagation by seeds of *Adonis* and after the successful propagation the seedlings have to be planted to places with favourable microclimate.

## Loess Grasslands of Kistompapuszta

The grassland of Kistompapuszta is situated on the loess deposit of an ancient tributary of River Maros that is called Szárazér of Királyhegyes. Its survival is due on the one hand to the streamlet that surrounds the area and on the other hand to the fact that it is far from any settlements. The nature conservation value is great because the size of the loess grassland is large (20,9 hectares), and it is surrounded by natural borders. Great stand of *Stipa capillata* can be found here with *Botriochloa ischaemum*. Important species are: *Rhinanthus rumelicus, Ranunculus illyricus, Vinca herbacea, Linum austriacum, Filipendula vulgaris, Phlomis tuberosa, Ornithogalum pyramidale* and *Dianthus pontederae, Verbascum phoeniceum. Adonis transsylvanica* was planted here during the 1980's. 10-20 individuals of *Spalax leucodon* live in this territory. Certain parts of the territory have to be left out of the management to provide habitat for the insects, other parts would be

necessary to mow in stripes. The stripes have to be mown in every second year. The mowing has to start after 30 of June. The patches with *Aster sedifolius* and *Phlomis tuberosa* have to be left out of mowing. On the weedy places it is neccessary to mow more often. Until now the territory was mown with a mowing-machine but it would be better to mow by hand. It would make possible the temporal differences in the ripening of seeds and the diversity of habitat. We should expand the territory to the ploughlands that provides good habitat for *Spalax leucodon*.

### The Habitat of *Salvia nutans* near Kondoros

This habitat is a wayside ridge with row of *Fraxinus pennsylvanica* trees. One of the two last Hungarian stands of a post-glacial, relict plant *Salvia nutans* (150 stems) can be found here. Besides, *Sternbergia colchiciflora* (200 individuals) and *Phlomis tuberosa* are characteristic plants of the area. The extinction of the two Hungarian stands can be avoided with the enlargement of the areas and solving the problems of artificial propagation. Until now its annual management was the following: in spring: weeding the grassland around the *Salvia* stems, in early summer: before flowering cutting the grass by hands on those parts of the area where there are not any *Salvia* stems and at the end of summer after the ripening of seeds the mowing of the whole territory. Close to the road the road maintenance is limited (for example substance deposition, chemical weed-killing). On the other side the area is neighbouring with a ploughland which also dangers the territory because of chemicals and weeds spreading to the grassland. Similarly to other loess grasslands the largest danger is that the area is small and isolated.

### Loess Grasslands of Pitvaros

The plant associations of Pitvaros-puszta has a great variety and it is mosaic-like.

Three different types of loess grasslands has survived on this territory: little or big bulges surrounded by alkaline grasslands, grasslands of steep slopes of moulds and ridges of old roads. On the territory loess grasslands survived on 15 different patches and on an area of approximately 40 hectares. The most valuable loess plants occur on the ridges and loess patches inserted in alkaline grasslands: *Sternbergia colchiciflora, Adonis vernalis, Phlomis tuberosa, Thalictrum minus, Anchusa barrelieri, Viola ambigua, Ranunculus illyricus, Carduus hamulosus, Linaria x kocianovichii.* The largest population of *Adonis vernalis* (3000 individuals) of south-east Hungary is on the northern part of Blaskovics-puszta. *Agropyron pectinatum* lives on the disturbed loess grasslands and on barrows. 80-100 large patches of Phlomis tuberosa can be found on the puszta, sometimes on pastures where they flower rarely because of animal-trampling. 15-20

patches of *Ranunculus illyricus* live here on different parts of area. The size of *Sternbergia colchiciflora* stand is very large (100000 individuals) and it is one of the largest stand in Hungary.

A dangering factor can be the fact that the number of the grazing animals is not enough or too much and the nearby grasslands are ploughed progressively. Plouglands inserted in the nearby loess grasslands will be restored and different methods will be examined. This loess grassland reconstruction is going to begin this year with the study of the starting-state.

### Loess Grassland near Fehértó of Kardoskút

Around the natron lake large areas are covered with secondary loess grasslands that formed on chernozem soil on plough-lands during the last 20 years. The number of species is small and mainly weeds dominate. Only one ancient loess patch can be found here on the south-west part of the lake. 20000 individuals of *Sternbergia colchiciflora* live here with *Thalictrum minus*. Today the grassland is grazed by too many animals.

### Loess Grassland of Biharugra

On the higher parts among the alkaline grasslands near Mezőgyán and Nagygyanté small loess grasslands survived. The characteristic plants are: *Verbascum phoeniceum, Salvia pratensis, Salvia nemorosa, Salvia austriaca, Salvia aethiopis, Filipendula vulgaris* and *Phlomis tuberosa*. On the area near Zsadány and Orosi, on the place of the so called Szalontai pasture plough-lands also can be found instead of the large areas of the former *Cynodonti-Poetum angustifoliae* association. Now larger part of the area is a pasture, and the remaining parts are mown. Valuable loess grasslands can be found also near Biharugra, close to the marshlands of Sző-rét and Ugrai-rét.

### References

1995. március 20-án készült - a löszpusztagyepek problémáiról tartott megbeszélés összefoglalója.

Bíró, I. (1995) A Biharugrai Tájvédelmi Körzet. Kézirat

Csathó, A. (1984) A Battonya-Kistompapusztai löszrét növényvilága. Környezet és Természetvédelmi Évkönyv 7. pp.103-115.

Kiss, I. (1964) Az Adonis volgensis lelőhelyei és népies gyógyászati vonatkozásai Magyarországon. Acta Academiae paedagogiae Szegediesis. pp. 25-50.

Kiss, I. (1976) A pusztaföldvári Nagytatársánc és a rajta lévő ősgyep természetvédelmi, tudományos és közművelődési jelentősége. Békés Megyei Természetvédelmi Évkönyv1. pp.35-59.

Molnár, Zs. (1992) A Pitvarosi-puszták növénytakarója, különös tekintettel a löszpusztagyepekre. Botanikai Közlemények 79. kötet pp.19-27.

Molnár, Zs. & Bíró, M.(1994): A Pitvarosi-puszták Tájvédelmi Körzet és környékük botanikai-természetvédelmi értékelése.Vácrátót

Molnár, Zs. & Bíró, M. (1995) A kardoskúti Fehér-tó Természetvédelmi Terület kezelési tervet alapozó botanikai felmérése és természetvédelmi értékelése.Vácrátót

Sterbetz, I. (1976) A Volga menti hérics. Békés Megyei Természetvédelmi Évkönyv 1. pp.83-93.

V. Sipos J., Varga, Z.: Löszpusztai reliktumok Békés megyében (előzetes közlemény)

# FACILITIES OF NATURE CONSERVATION MANAGEMENT METHODS (REHABILITATION, RECONSTRUCTION) ON WETLANDS

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Our investigations were made on the area of the Egyek-Pusztakócs Marshes (Hortobágy National Park). The analysis of the effects of the rehabilitation activities, which had been started in 1982, is based on the condition and activity of the birdlife.

During the survey, it seemed to be necessary to analyse some theoretical and practical problems which touch the general relations of nature conservation management methods starting with a basic inventory, carried out on scientific basis ending with the practice of nature conservation.

There is a gap between the research carried out with a view to nature conservation and the practice of nature conservation, which seems to be irreconcilable. In this situation, the responsibility is neither the researchers' nor the nature conservation officers'. Despite quickly increasing knowledge, ecology is unable to comprehend and explain the complete function of ecological systems, and is quite far from knowing the possible activities for managing the processes of degradation, or for achieving the desired result for the system which has to be preserved. While still trying its wings, conservation biology is already capable of explaining the apparently more complicated genetic issues, but concerning the function of supraindividual systems, we are still taking the first steps. A series of theories and models are of help in understanding the details of the function, but the question of what to do in order to optimize the status of the system or to conserve an advantageous status can not yet be correctly answered.

A conflict arising from the lack of scientific knowledge is that researchers accuse nature conservation experts of not formulating what they are interested in; on the contrary, the charge is brought that researchers are dealing only with details, because they do not find answers for the questions put by nature conservation. Actually, neither of the two parties are right, because the same lack of knowledge exists on both sides.

Research materials and suggestions concerning nature conservation management today tend to confirm professionally evident, mainly empirical knowledge which can not be underestimated. They are known and evaluated nearly equally by both sides. At the same time, endangered habitats and species require immediate action. These emergency actions for preservation are often caught in the crossfire of professional debate.

Knowledge can be gained for increasing different methods or facilities of nature conservation management by investigating the changes in status of the systems which have been destroyed or are being degradated.

Based on the knowledge of the history of the sites to be managed (for example rehabilitate), and on the basis of the degradation process, it can be stated that the stronger competition induced by the more adverse environmental conditions can have positive effects, which through an internal re-structuring and through a developing mosaic-structure, ensures refuge (internal refuge) for the elements which compose the system; that is to say, the "frame" of the original system remains. This mosaic-like structure is the basis of the phenomenon we call "internal edge effect." This mosaic structure is a stabilizing factor, and the edges of the mosaic patches serve as microrefuges and later, during nature conservation rehabilitations, become the distribution centers of the recolonization.

A basic problem is to define from the nature conservation point of view "advantageous status;" it is even more difficult to actually manage, conserve or rehabilitate the system.

At the same time, nature conservation has to make the decision, as soon as possible, that, for example, the conservation or the preservation of the typical succession processes of the system is to be considered its task.

It is very difficult to determine the aims and tools of management, and this provides occasion for several discussions. Continuous debate is going on if an intervention is right, necessary, about what kind of effects can be expected, or if it is professionally well-founded. One can ask the question, whether it is appropriate to fasten with active management the natural processes in order to achieve the desired status. We are still not sure that our activities will open a way to processes of degradation. According to our experience the degree of the management influence is determined by the degree of changes.

Besides the preservation of complete structure and function of natural and semi-natural systems, one of the tasks of conservation biology is to work out the management and rehabilitation of natural systems which are damaged and suffering from ecological dysfunctions. The possible adoptation of different methods of management have to be investigated which, depending on our management experience obtained on different types of wetlands, can be the following:

1. preservation
Maintenance of the advantageous environmental conditions of the natural succession.

2. conservation
Maintenance of a status which is valuable or favourable from a nature conservation (ecological) point of view.

3. rehabilitation
The restoration of a previous status which has value from a nature conservation point of view or has disappeared from the system to be protected. The restoration is based on the remains ("frame") of the partly-damaged natural system, including the restoration of the altered environmental conditions.

4. reconstruction
The restoration of a natural system which was previously existing in the area and which belonged to the original components of the area, but over time became completely extinct.

5. creation
Construction of habitats which were not existing in the area previously, but probably were present in the wider surroundings. This habitat has to be created preferably by introducing native species and will make the surrounding cultivated landscape more colourful.

Due to the natural endowment of our country and the large scale trasformation of the landscape, rehabilitation and reconstruction play an important role in the practice of our nature conservation. These two methods of management (conservation could be also included) are still not well established professionally and require detailed discussion and the creation of principles.

In the course of rehabilitation and reconstruction, only the most necessary work should be implemented, leaving the largest part to the ability of nature to regenerate. The only task of nature conservation is "to give help." The principles of rehabilitation and restoration are the followings:
Only those habitats proven to be existed before should be restored. Changes that have taken place in the meantime must be considered, the valuable habitats developed secondarily have to be preserved during the rehabilitation and reconstruction. Attention has to be paid to the connections (corridors) between both near and distant refuges, gene-centers, and those places which assure the natural recolonization of the restored site. Part of the rehabilitation and reconstruction work is to restore the natural migration corridors, the typical "ecological network" of the region. Before the beginning of the rehabilitation and reconstruction, the basic causes for the transformation of the area have to be known. The work can only be started when the causes of the previous destruction are stopped. Important task of preparation is to carry out a detailed survey on the wildlife and the ecological status of the area which is to be rehabilitated or reconstructed. During the first two years of the rehabilitation and reconstruction - in the so called

stabilization period - the artifical reintroduction of species which have became extinct should be avoided. The development of the "ecological framework" of the habitat should be left to nature.

## Comparative study of the avifauna of the area

The analysis of the ornithological changes following the rehabilitation of our study area has proven that the principles stated above are correct.

The territorial distribution of the waterbirds was investigated in connection with the transformation of the mosaic structure of the vegetation and the characteristic point of the recolonization process. Between the two phenomenon, the principles of the successional processes can be connected. The investigation on the Fekete-rét proved that, due to the rapid ecological changes, special and stable bird communities do not belong to a certain part of the marsh. As time proceeds, continous translocation occurs in space. Data are available about the changing of the composition of the avifauna of the Fekete-rét since the time it was first flooded in 1982 until today. We can now state that - in this case - this transformation process has become slower year by year and this indicates that a birdlife will develop that is typical of the permanent marshes. In this kind of investigation, it is very important that the data of the complete nesting period are compared since, according to our experiences, the samples in early spring - among different habitats - show much higher similarity than the annual summarized samples.

Continuing with the previous surveys, the Kis-Jusztus Marsh and some other typical wetland habitats of the Hortobágy region were comparatively investigated. Sampling places:

1. Fekete-rét 1st year
2. Fekete-rét 2nd year
3. Fekete-rét 3rd year
4. Fekete-rét 4th year
5. Hortobágy Fish Pond
6. Kunkápolnás Marsh
7. Polturás Marsh
8. Kis-Jusztus Marsh

The data analysed by Jaccard Principal Coordinate Alysis and Rogers-Tanimoto Nonmetric Multidimensional Scaling is shown by Figure 1. and 2.

## Ornithological relations of changes following wetland restorations

The investigations done after the rehabilitation focused on the process of the recolonization of the area. On the basis of the characteristic points of the process, we have obtained valuable new data for improving the tools of nature conservation management and the conservation biological approach of this issue.

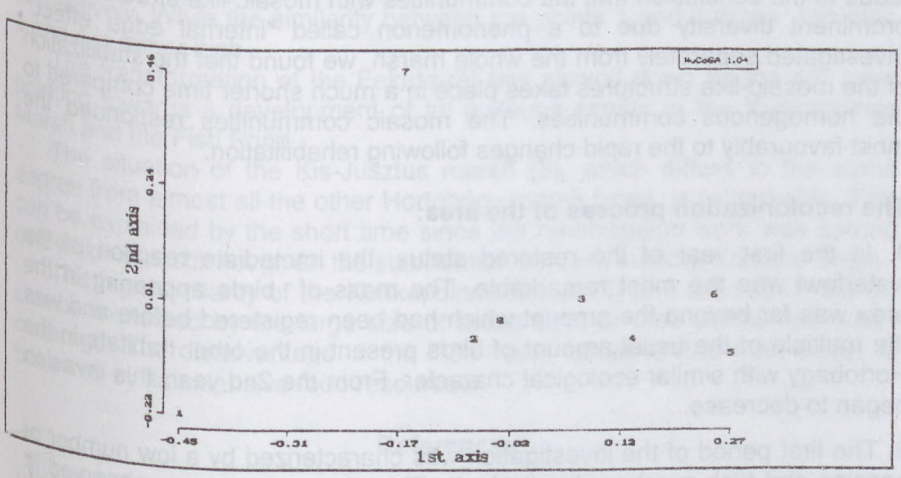



Fig. 1. Jaccard Principal Coordinate Analysis

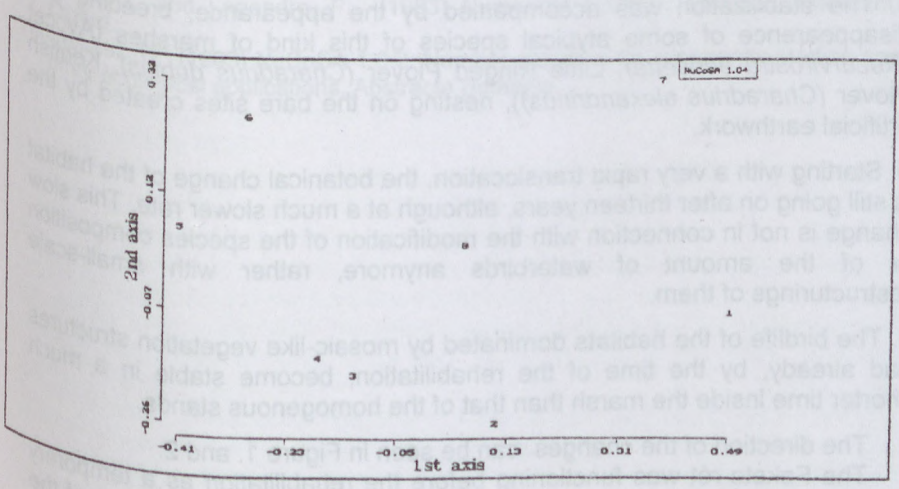



Fig. 2. Rogers-Tanimoto Nonmetric Multidimensional Scaling

Studying the birdlife and the recolonization process of these marshes leads to the conclusion that the communities with mosaic-like structure show prominent diversity due to a phenomenon called "internal edge effect." Investigated separately from the whole marsh, we found that the stabilization of the mosaic-like structures takes place in a much shorter time compared to the homogenous communities. The mosaic communities responded the most favourably to the rapid changes following rehabilitation.

**The recolonization process of the area:**

1. In the first year of the restored status, the immediate reaction of the waterfowl was the most remarkable. The mass of birds appearing in the area was far beyond the amount which had been registered before and was the multiple of the usual amount of birds present in the other habitats in the Hortobágy with similar ecological character. From the 2nd year, this invasion began to decrease.

2. The first period of the investigation was characterized by a low number of species and high number of individuals. This phenomenon was observed in the case of all restoration works.

3. In the second period, the number of species began to slightly rise while that of individuals decreased. This immediate stabilization of the species composition can probably be explained by the effect of the sourrounding areas as well (marshes, fish ponds).

4. The stabilization was accompanied by the appearance, breeding and disappearence of some atypical species of this kind of marshes (Avocet *(Recurvirostra avosetta)*, Little Ringed Plover *(Charadrius dubius)*, Kentish Plover *(Charadrius alexandrinus)*), nesting on the bare sites created by the artificial earthwork.

5. Starting with a very rapid translocation, the botanical change of the habitat is still going on after thirteen years, although at a much slower rate. This slow change is not in connection with the modification of the species composition or of the amount of waterbirds anymore, rather with small-scale restructurings of them.

6. The birdlife of the habitats dominated by mosaic-like vegetation structures had already, by the time of the rehabilitation, become stable in a much shorter time inside the marsh than that of the homogenous stands.

The direction of the changes can be seen in Figure 1. and 2.

The Fekete-rét was functioning before the rehabilitation as a temporary marsh, it was dry during the most part of the year. After the first year of the restoration, the temporary, dry character was still dominant. This can be the explanation for the closeness of points 1-7 on the figure.

The downward trend of the distance between the points of the series 1-2-3-4 indicates growing similarity and the slowing down of the change respectively. While the similarity between the points 1 and 2 is low, between 3 and 4 is rather high.

The transformation of the Fekete-rét has slowed down by the 4th year, pointing towards a development of an avifauna similar to the Kunkápolnás Marsh and the Fish Pond.

The situation of the Kis-Jusztus marsh (8), which differs to the same degree from almost all the other Hortobágy marsh types, is remarkable. This can be explained by the short time since the rehabilitation work was carried out, which has still not given the stabilization process sufficient time to begin.

The high similarity of the Kunkápolnás Marsh (5) and the Fish Pond (6) can be explained by the large size of these sites or their permanent water coverage. The disadvantage of the Fish Pond, because it is man-made, is balanced by its extensive food resources.

## References

Aradi, Cs. (1984) A Fekete-rét kezelési alapelvei. Kézirat.

Aradi, Cs. (1990) A Fekete-rét mozaikosságának mértéke, ökológiai természetvédelmi jelentősége a madárvilág fajösszetétele alapján. Kézirat.

Dévai, Gy. (1991) A mozaikosság természetvédelmi jelentőségének elemzése a Fekete-rét példáján. Kézirat.

Góri, Sz. (1993) Az Egyek-Pusztakócsi mocsarak természetvédelmi kezelése és rekonsrtukciós lehetőségei. Szakdolgozat. KLTE Ökológiai Tanszék.

Legendre, L. and Legendre, P. (1983) Numerical ecology. Elsevier. Asterdam, Oxford.

Tóthmérész, B. (1993) NuCoSA 1.0.2: Number cruncher for community studies and other ecological applications. Abstracta Botanica.

# FIRST YEAR EXPERIENCES IN THE RESTORATION OF SANDY GRASSLANDS AT CLEAR-CUT FOREST SITES IN THE KISKUNSÁG NATIONAL PARK

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**Abstract:** There are vast areas within the Kiskunság National Park, such as the low productive black locust *(Robinia pseudo-acacia)* plantations, which reduce the nature conservation value of the park. The decrease in the water table and a prolonged drought period result in suitable habitats for sandy grasslands. Self-rehabilitation is slow (needs more decades) with an invasive weed community. The objective of the research was to speed up succession of native open sandy grassland *(Festucetum vaginatae)* at clear-cut black locust forest sites. Experiments began in 1995 at three sites differing in the availability of propagules of sandy grassland species. First year treatments involve mowing and litter removal. Vegetation and soil variables were tested. No significant effect of treatment was detected during the first year, but the expansion of sandy grassland species and the divergence between the vegetation of control and treatment plots are encouraging.

## Introduction

As a result of the afforestation of the Alföld region, cultivated forests, mainly black locust (*Robinia pseudo-acacia*), occupy its territories in a scattered pattern. A large proportion of these forests were planted at habitats of sandy grasslands (*Festucetum vaginatae*), where the soil was not nutrient rich enough to support profitable forest production. The effort of the Kiskunság National Park to raise the nature conservation value of its territories meets the intention of forestry to withdraw from low productive areas (Gőbölös 1994).

The self-rehabilitation of clear-cut black locust forest sites is hindered by the sprouting of the species and the high N content of the soil that provides habitat for weeds for a long period of time (Tóthmérész 1993). This supports the need for experiments to accelerate succession towards natural vegetation. Ecological rehabilitation experiments are carried out all over the world with various success, but the discipline itself is still in an early stage of development (Cairns 1995, Urbanska 1995, Jordan et al. 1987, Wathern 1986, Urbanska 1996).

Experiments started in 1995 at 3 sites in the Kiskunság National Park (KNP) to speed up succession after clear-cutting. The sprouting of black locust and the high N content of the soil are the main targets during the restoration experiments. Management practices for the change of soil properties will produce suitable habitat for natural vegetation. This hypothesis is planned to be tested during the 4 years of study.

## Material and methods

### Sites

The three selected sites differ in the availability of propagules of sandy grassland species. 1.The experimental area near *Fülöpháza* (1 ha) lays between the moving sand dune and the education centre of the KNP. It is a small hill surrounded by grassland and forest patches. 2.The clear-cut forest site at *Izsák* (0.4 ha) is about 400 m far from the southern part of Lake Kolon. The original forest was embedded in an extended sandy grassland. 3.In contrast to the previous sites, the experimental area of *Bugac* (1.1 ha) was selected to represent an example with no propagule availability. A black locust forest patch within a large mixed aged forest, south of Bugacpuszta, was clear-cut on a dune top. Propagule source, a grassland patch, was only found about 100 m far from the area.

### Treatments

A chemical (GARLON 4E) was used to hinder black locust sprouting. Treatment was repeated twice, as during the summer an intensive re-sprouting was found.
The same experiments and treatments were set up in the three areas. Experimental design implies 6 control and 6 treatment plots of 10x10 m at each site, selected in a random manner. Treatments involved mowing and litter removal twice a year after vegetation sampling to avoid weed re-seeding and to reduce soil humus content.

### Sampling

Vegetation composition was checked twice (May, Sept.) by 3 samples of 2x2 m per plot. The Braun-Blanquet approach was used. A reference sandy grassland patch was also selected and sampled outside the experimental area at Fülöpháza and Izsák. At Bugac, beside the reference sandy grassland patch, the herb layer of the remaining forest was sampled as well. Soil seed bank was tested twice during the vegetation season (May, Sept.) by 2 samples of 100 $cm^3$ soil per plot. Samples were taken outside the experimental area as well, in 4 directions and 2 distances (10 and 20 m). In Bugac, additional samples were taken from the reference grassland patch, as here no grasslands occurs near the plots. Seeds were identified by specialist.
Soil moisture was measured once at each site to test possible differences between control and treatment plots. Total N content of soil was selected to demonstrate differences between control and treatment plot soil quality.

## Data analysis

The A-D (abundance-dominance) values were transformed to an ordinal scale (van der Maarel 1979) which ranges from 0 to 9 and avoids the overestimation of abundant species. The unified table of the three sites for May and September resulted in a 224x107 matrix. This data set was subjected to simple statistics and multivariate analyses (SYN-TAX 5.0 Podani 1993).

Four species categories were created in terms of their role during the rehabilitation process based on their social character: 1. sandy grassland species (SG), 2. grassland species (G), 3. grassland weeds (GW), 4. other species with no definite social character and herb layer species of black locust forests (O). Species were assigned to the categories on the basis of Simon (1992) and experiences. These categories were used for simple statistics. (For species lists see the Appendix.)

## Results

### Soil composition

Total N content of black locust forest soils exceeds that of sandy grasslands by one order of magnitude. No significant decrease of total N content was detected as a result of treatments during the first year. Three sites average values are as follows:

| Total N | Control | Treatment |
|---|---|---|
| May | 0.4% | 0.29% |
| September | 0.71% | 0.33% |

This value in the soil of reference sandy grasslands was 0.07% in spring and 0.05% in September. Literature data for similar soil in Bugac ranged from 0.012 to 0.021% (Simon & Kefeli 1991). Treatments of first year did not produce differences in soil moisture content either.

### Vegetation

The result of PCoA was selected for demonstration of multivariate analyses (Fig.1-3.).

The distribution of samples in the ordination space indicates that seasonal composition difference is the main driving force. Treatment and control samples are nearly randomly distributed.

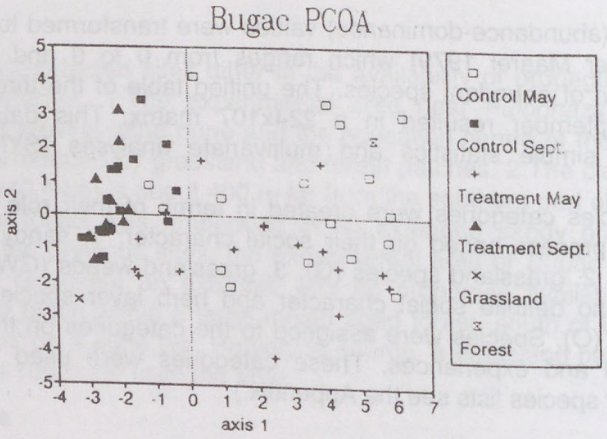



Fig. 1. BUGAC - PCoA result of vegetation data (1995).

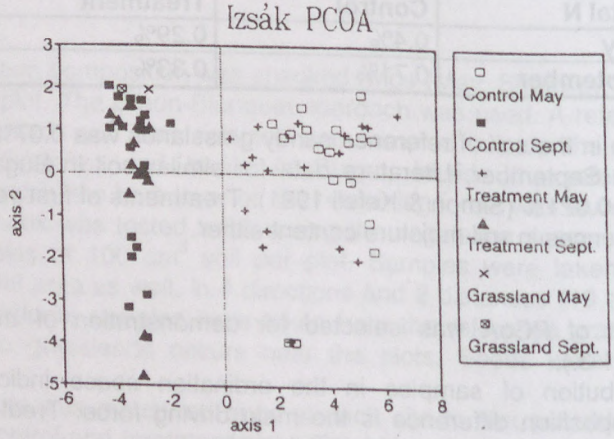



Fig. 2. IZSÁK - PCoA result of vegetation data (1995).

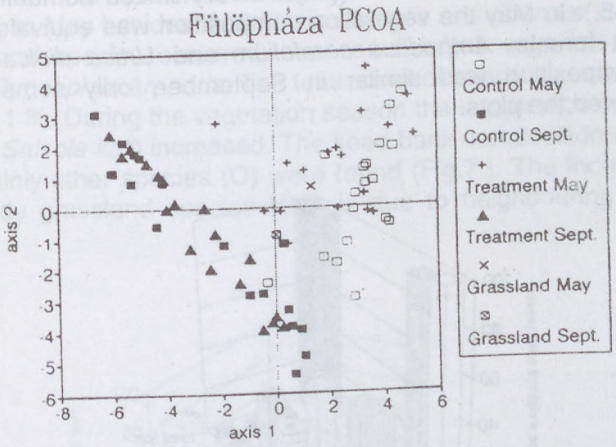



Fig. 3. FÜLÖPHÁZA - PCoA result of vegetation data (1995).

**Result of treatments**

To check the effect of treatments on a species level, the share of common species in control and treatment samples was calculated for spring and summer data at each site. The results are as follows:

| Common species | Izsák | Fülöpháza | Bugac |
|---|---|---|---|
| May | 64.4% | 68% | 68.4% |
| September | 51.4% | 61% | 53.5% |

The decrease of common species ratio is the first sign of vegetation divergence as a result of treatments.

**Seasonal changes**

Vegetation change showed two directions: at the sites with propagule sources (Fülöpháza, Izsák) species replacement was detected, while in the forest clearing (Bugac) species dominance stayed similar. The distribution of social character types provides explanation for the changes. Treatment and control plot data are considered together.

The social character distribution did not change in Bugac significantly. The constant dominance of other species (O) is the result of the lacking

seeds: grassland species were found in a very limited number in the seed bank (Fig.4-5.). In May the vegetation composition was equivalent to that of black locust forests: *Anthriscus cerefolium* and *Urtica dioica* dominated. Species composition was similar in September, only some *Solanacea* species entered the plots.

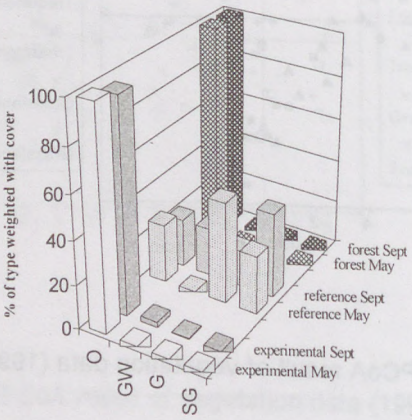



Fig.4. Distribution of species groups in the **vegetation**, Bugac 1995

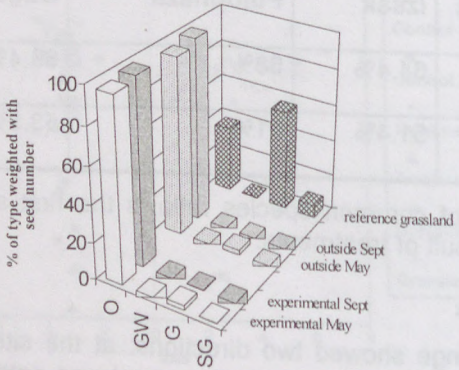



Fig.5. Distribution of species groups in the **seed bank**, Bugac 1995

A larger seasonal difference in vegetation composition was detected in Izsák (Fig.6.). In May besides *Anthriscus caucalis* and *Bromus sterilis* some sandy grassland species occurred, such as *Festuca vaginata*, *Euphorbia sequeriana*, *Gypsophila arenaria*. The total cover of sandy grassland species did not reach 1 %. During the vegetation season the importance of grassland species (e.g. *Salsola kali*) increased. The seed bank composition was similar to Bugac, mainly other species (O) were found (Fig.7.). The increase in the cover of sandy grassland species (SG) is due to neighbouring propagule sources.

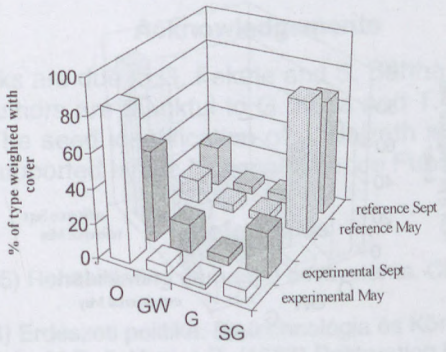



Fig.6. Distribution of species groups in the **vegetation**, Izsák 1995

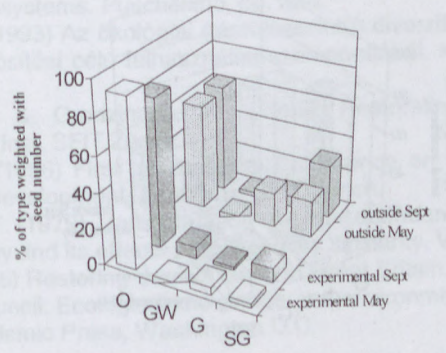



Fig.7. Distribution of species groups in the **seed bank**, Izsák 1995

In May the samples of Fülöpháza showed great variance, *Cynodon dactylon*, *Calamagrostis epigeios*, *Ballota nigra*, *Secale silvestre* dominated patches equally occurred. Similarly to Izsák, sandy grassland species were found as well. During the first year the cover of *Corispermum nitidum*, *Kochia laniflora* and *Salsola kali* increased mainly, but the young tussocks of *Stipa borysthenica* were noticed as well. The cover of grassland species reached 20% in the western plots. The ratio of sandy grassland species (SG) did not change in the vegetation, but increased in the seed bank (Fig.8-9.). Changes in vegetation composition are due to available propagule sources.

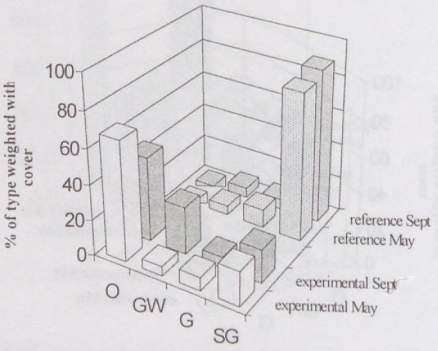



Fig.8. Distribution of species groups in the **vegetation**, Fülöpháza 1995

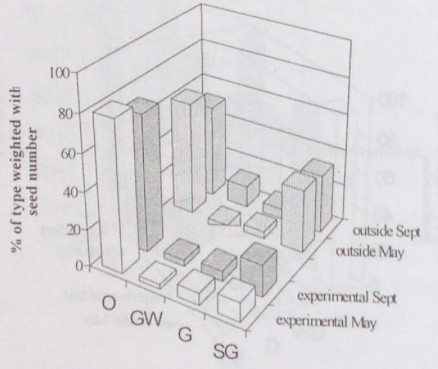



Fig.9. Distribution of species groups in the **seed bank**, Fülöpháza 1995

## Conclusions

The vegetation and soil analyses from the first experimental year did not significantly support yet the hypothesis that the succession towards a natural sandy grassland at clear-cut forest site can be accelerated. A slight divergence in the vegetation composition of the control and treatment plots and the expansion of grassland species give hope to the positive effect of treatment during the coming years. The differences between the sites show that the distance of the propagule source is a key factor during restoration. The elaboration of more effective methodologies for the reduction of soil N content is under way.

## Acknowledgements

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## References

Cairns, J. Jr. (1995) Rehabilitating damaged ecosystems. CRC Press, Boca Raton, Florida

Gôbölös, A. (1994) Erdészeti politika. Biotechnológia és Környezetvédelem. 8(1):6.

Jordan, W. R., Gilpin, M.E. & Aber, J.D. (1987) Restoration Ecology, a synthetic approach to ecological research. Cambridge University Press.

Podani, J. (1993) SYN-TAX-pc, Computer Programs for Multivariate Data Analysis in Ecology and Systematics. Version 5.1. User's Guide. Scientia, Budapest

Simon, T. (1992) A magyarországi edényes flóra határozója. Tankönyvkiadó, Budapest.

Simon, T. & Kefeli, V.I. (1991) Dynamics of primary production and soil processes in grassland ecosystems. Puschchino, pp. 236.

Tóthmérész, B. (1993) Az ökológiai (társulásszintű) diverzitás mérésének problémái környezetminôsítési célú felhasználás szempontjából. KLTE Ökológiai Tanszék, kézirat

Urbanska, K.M. & Grodzinska, K. (1995) Restoration Ecology in Europe. Geobotanical Inst. SFIT Zürich.

Urbanska, K.M. (1996) First International Conference on Restoration Ecology and Sustainable Development. Abstracts. SFIT Zürich.

van der Maarel, E. (1979) Transformation of cover-abundance values in phytosociology and its effects on community similarity. Vegetatio 39:97-114.

Wathern, P. (1986) Restoring derelict lands in Great Britain. szerk. National Research Council. Ecological knowledge and environmental problem-solving. National Academic Press, Washington D.C.

## Appendix

Note that species group 4 (O, other species) is not included in this list.

| 1.Sandy grassland species (SG) | 2.Grassland species (G) | 3.Grassland weeds (GW) |
|---|---|---|
| Botchriochloa ischaemum | Achillea pannonica | Camelina microcarpa |
| Carex liparicarpos | Alyssum alyssoides | Cenchrus incertus |
| Centaurea arenaria | Arenaria serpyllifolia | Chondrilla juncea |
| Corispermum nitidum | Artemisia campestris | Crepis rhoeadifolia |
| Dianthus serotinus | Asparagus officinalis | Crepis setosa |
| Euphorbia sequeriana | Bromus squarrosus | Cynodon dactylon |
| Festuca vaginata | Bromus tectorum | Erigeron canadensis |
| Fumana procumbens | Cerastium semidecandrum | Eryngium campestre |
| Gypsophila fastigiata | Erophila verna | |
| Juniperus communis | Linaria angustissima | |
| Kochia laniflora | Medicago lupulina | |
| Onosma arenarium | Poa bulbosa | |
| Plantago arenaria | Potentilla arenaria | |
| Polygonum arenarium | Saxifraga tridactylites | |
| Salsola kali | Scabiosa ochroleuca | |
| Secale sylvestre | Stachys recta | |
| Silene otites | Stipa capillata | |
| Stipa borystenica | Tragopogon dubius | |
| Tribulus terrestris | | |

# SOME ASPECTS OF COMMUNITY RELATIONS AND CONSERVATION OF TWO RARE SEDGE SPECIES IN HUNGARY, *CAREX BUXBAUMII* WAHLENBERG AND *CAREX HARTMANII* CAJENDER

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## Introduction

The sedge species discussed in this paper belong to the rarest plant species of Hungary.

According to the Hungarian Red Data Book (Rakonczay 1989), *Carex hartmanii* is an endangered, protected species. It has 3 populations known at present: Bakonyalja: Nyirád, Őrség: Szőce, Zempléni hg.: Drahos. *Carex buxbaumii* was unknown in Hungary until 1995 when it was recorded from two localitites (Lájer 1996a): Káli-medence, Vindornya. This species is not protected yet and not included in the Hungarian Red Data Book.

## Methods

In order to explore community relations of the investigated sedge species, I sampled the vegetation by the Braun-Blanquet method. The extent of a stand was recognized on its floristic and physiognomic features. The stands selected represent the main developments of the vegetation at each site and are free from obvious structural and floristic boundaries. The relevée sizes were 50 $m^2$ as a rule but in two cases I had to use smaller sample areas because of the community boundaries. All vascular plants were recorded, the moss level was missing or minor in all plots delimited. The samples were recorded during the summer of 1995. The classification was performed by the Zürich-Montpellier table method combined with cluster-analysis. Full details are given by Lájer (1996a,b). The species-individual diversity was evaluated by diversity ordering (Tóthmérész 1993) for each examined vegetation unit.

As to reveal close species relations an other sampling method was applied. In the circles of a 0.5 m radius around the investigated sedge stems all vascular plant species were recorded. 424 plots were surveyed in this way. On the basis of these data the ecological indicator values according to Borhidi (1993) were calculated.

In the populations investigated some individuals were selected randomly to assess morphological variability. Top spike lengths and widths, inflorescence lengths, lowest bract lengths, stem lengths, leaf widths, utricle lengths and widths were measured. The diversity ordering (Rényi diversity, etc.) was performed on samples with 18 individuals.

The magnitudes of the morphological parameters were evaluated statistically. The sample sizes were 27 for Vindornya, 25 for Káli-medence, 33 for Nyirád, 31 for Szőce and 18 for Zemplén. The standard deviations were comparable. F- and t-test were used to reveal significant differences in average values.

## Results

The first locality where *Carex buxbaumii* was found is the fen destroyed by drainage towards the end of the 19th century. Borbás, V. (1900) refering to collections of Szenczy, Hutter and Wierzbicky, reported that in the middle of the last century such plants typical of peat fens grew here as *Andromeda poifolia, Oxycoccus palustris, Drosera anglica, Drosera rotundifolia, Comarum palustre, Menyanthes trifoliata, Sphagnum ssp.*, etc. After the ceasing of the peat-work in this century some ponds had developed then got swampy. Now enormous stands of *Cladium mariscus*, here and there mixed with reeds, are characteristic. The *Carex buxbaumii* population is situated in one of the few tall sedge marsh spots at the edge of an area with standing water. It seems to be vigorous on this 20 $m^2$ spot: the plants grow tall (90 cm), have wide leaves (up to 7 mm), the population has a relatively large abundance (Lájer 1996a).

The other site at which *Carex buxbaumii* was found is in Káli-medence where Albert, É. discovered the only yet viable population of *Primula farinosa* in Hungary. This site characterized by a mosaic of reeds and fen meadows was dried by drainage ditches. The individuals of *Carex buxbaumii* grow in a purple moor-grass meadow. Compared to Vindornya site they appear in a larger area but in much smaller density, they have smaller growth and narrower leaves. The presence of some other species ( eg. *Primula farinosa, Cladium mariscus, Carex flava, Schoenus nigricans*) suggests that the drying of the fen meadow has begun recently. The Middle Transdanubian Nature Conservation Directorate carries out a restoration by stopping up of drainage ditches. The relevées concerning Káli-medence (Lájer 1996a) are close to *Succiso-Molinietum* Soó 1968, but the presence of *Caricion davalliane* Klika 1934 character species refers to a transition nature. It's about an intermediate stadium of the drying process of fen meadows. This could also be regarded as a subassociation differentiated by *Cladium mariscus, Phragmites communis, Carex buxbaumii, Primula farinosa, Carex flava, Schoenus nigricans*. A continuous transition in the composition of vegetation can be experienced between purple moor-grass and wet fen meadows. According to the ecological indicator values (TB=5, WB=8, RB=7, NB=4, LB=7, CB=4, SB=0), the Hungarian habitats of *Carex buxbaumii* can be characterised as: montane mesophilous broad-leaved forest belt, basic, moist soils with short floods, submesotrophic habitats, suboceanic climate.

The most important habitat of *Carex hartmanii* (over 1000 individuals) is near Nyirád (Bakonyalja). This occurence was recorded first in Hungary by

Szodfridt and Tallós (1962). *Carex hartmanii* can be found here in tall sedge marshes (*Magnocaricion*), purple moor-grass meadows adjacent to the former (*Succiso-Molinietum caricetosum hartmanii*), and the total transition between them. A type of the tall sedge marshes represent those *Carex lasiocarpa* stands I described as a new association (*Caricetum elato-lasiocarpae* Lájer 1996b). This association differs from other Carex lasiocarpa-dominated associations such as *Caricetum lasiocarpae* Koch 1926, *Carici lasiocarpae-Sphagnaetum* Zólyomi 1931 em. Soó 1954, *Sphagno-Caricetum lasiocarpae* Steffen 1931, *Comaro-Caricetum lasiocarpae* Balátová-Tulácková et Hübl 1985, by species comoposition and physiognomy. It can be characterised by a constant summer watertable of 10-15 cm depth, and the lack of peat mosses (*Sphagnum* spp.). *Carex lasiocarpa* can be regarded as a local character species. It's large abundance values suggest that it has optimal conditions in this association. Tall sedge (eg. *Carex elata, Carex hartmanii*) and other swamp species (*Lythrum salicaria, Stachys palustris, Lysimachia vulgaris, Iris pseudacorus*) are also abundant. This association can be ranked to the alliance *Magnocaricion* Koch 1926. It is the only known association dominated by *Carex lasiocarpa* in Transdanubia. *Carex hartmanii* can also be found in *Caricetum elatae* Koch 1926, *Caricetum gracilis* Tx 1937., *Carici-Typhoidetum* Soó 1971, and *Calamagrosti-Salicetum cinereae* Soó et Zólyomi 1955.

The stands of *Succiso-Molinietum* Soó 1968 *caricetosum hartmanii* Lájer 1996 represent the other important habitat of *Carex hartmanii*. They are located at the borders of the ponds turned into swamps, immediately following the tall sedge communities. Stands of wet fen meadows (*Caricion davallianae* Klika 1934) are absent here (eventually a fragment of *Seslerietum uliginosae* Soó 1941 is present) but their characteristic species (*Carex hostiana, Sesleria uliginosa, Carex davalliana*) refer to locally appropriate ecological conditions. A possible explanation is that the edges of the depressions are too steep for the conditions required to exist in a minimum area. In addition to *Carex hartmanii, Galium palustre* is also a differental species of *Magnocaricion* type. The presence of *Cnidium dubium, Juncus conglomeratus* and *Danthonia alpina* is characteristic too.

In Őrség, near Szőce, in a peculiar *Junco-Molinietum* Prsg. 1951 association occurs *Carex hartmanii* with *Juncus conglomeratus* and *Achillea ptarmica*. This community can be distinguished by the regular presence of *Filipendula ulmaria, Luzula multiflora, Carex gracilis, Carex nigra, Holcus lanatus, Carex brizoides, Cirsium palustre* and *Galium uliginosum*, on the other hand *Nardus stricta, Festuca ovina* and *Sieglingia decumbens* are absent. It represents a transition to *Filipendulo-Geranietum palustre* Koch 1926. This community was described as *Junco-Molinietum filipenduletosum ulmariae* provisionally (Lájer,1996b). This meadow is mown once a year.

*Carex hartmanii* grows in a typical *Junco-Molinietum* meadow in the Zemplén mountains (Drahos). This meadow is endangered by forest succession.

A very small population near Barcs (in *Caricetum elatae*) has probably died out due to environmental fluctuations. The water level changes year by year extremely here.

On the basis of the ecological indicator values (TB=5, WB=8, RB=6, NB=4 LB=7, CB=4, SB=0), the Hungarian habitats of *Carex hartmanii* can be characterised as: montane mesophilous broad-leaved forest belt, more or less neutral, moist soils with short floods, submesotrophic habitats, suboceanic climate. These values are close to that of *Carex buxbaumii* but *Carex hartmanii* proved to be somewhat less basifrequent.

The average, minimum and maximum of species number in the sampling circles are as follows:

| | average | minimum | maximum | around |
|---|---|---|---|---|
| Szőce | 15.97 | 10 | 21 | Carex hartmanii |
| Drahos | 12.95 | 11 | 16 | Carex hartmanii |
| Káli-medence | 10.13 | 8 | 12 | Carex buxbaumii |
| Nyirád | 7.63 | 2 | 14 | Carex hartmanii |
| Vindornya | 6.4 | 4 | 7 | Carex buxbaumii |

According to the diversity ordering, the *Junco-Molinietum filipenduletosum ulmariae* prov. of Szőce has the greatest species-individual diversity among the communities investigated. The *Junco-Molinietum* of Zemplén, the *Succiso-Molinietum* of Káli-medence and Nyirád are incomparable in that their order depends on the scale parameter. They all have larger diversity than the tall sedge communities.

Among the *Magnocaricion* stands, *Caricetum elato-lasiocarpae* (Nyirád) seems to be the most diverse. It is followed by the Vindornya habitat of *Carex buxbaumii, Caricetum gracilis, Caricetum elatae, Carici-Typhoidetum* and a mosaic of *Calamagrosti-Salicetum cinereae* (Nyirád). The latter communities are incomparable.

For the morphological diversity of the populations the following results were obtained (a<b, a>b, a<>b denote 'a' population is more diverse than 'b', 'a' population is less diverse than 'b', 'a' and 'b' populations are incomparable, respectively):

***Carex buxbaumii***

**Diversity ordering:**

| | |
|---|---|
| top spike length: | Vindornya > Káli-medence |
| inflorescence length: | Vindornya < Káli-medence |
| stem length: | Vindornya < Káli-medence |
| leaf width: | Vindornya < Káli-medence |

For the other investigated characters the populations proved to be incomparable.

Regarding parameter sizes, the following values were obtained (all in millimetres):

Top spike width:

| population | average | sx |
|---|---|---|
| Vindornya | 9.7 | 0.21 |
| Káli-medence | 6.6 | 0.22 |

where sx is the standard deviation of the average. The difference in averages is significant ($p<0.001$).

Top spike length:

| population | average | sx |
|---|---|---|
| Vindornya | 19,7 | 0,46 |
| Káli-medence | 13,6 | 0,47 |

The difference in averages is significant ($p<0.001$).

Inflorescence length:

| population | average | sx |
|---|---|---|
| Vindornya | 46,2 | 2,03 |
| Káli-medence | 46,2 | 2,11 |

The length of the lowest inflorescence bract:

| population | average | sx |
|---|---|---|
| Vindornya | 66,1 | 3,50 |
| Káli-medence | 40,0 | 3,64 |

The difference obtained is not significant ($p>0.1$).

Stem length:

| population | average | sx |
|---|---|---|
| Vindornya | 774 | 13,1 |
| Káli-medence | 461 | 13,6 |

The averages differ significantly ($p<0.001$).

Leaf width:

| population | average | sx |
|---|---|---|
| Vindornya | 5,41 | 0,130 |
| Káli-medence | 3,54 | 0,136 |

The averages differ significantly ($p<0.001$).

On the basis of the sizes of vegetative and reproductive organs, the Vindornya population seems to be more vigorous than the Káli-medence one.

***Carex hartmanii***

**Diversity ordering:**

top spike width :

Nyirád > Szőce
Nyirád > Drahos
Szőce <> Drahos

top spike length:

Nyirád > Drahos
Szőce <> Drahos
Szőce <> Nyirád

inflorescence length:

Drahos > Nyirád
Szőce > Nyirád
Szőce > Drahos

inflorescence bract:

Drahos > Szőce > Nyirád

leaf width:

Drahos > Nyirád > Szőce

utricle width:

Drahos > Szőce > Nyirád

utricle length:

Szőce > Drahos > Nyirád

In terms of the stem length the populations proved to be incomparable.

Regarding parameter sizes, the following values were obtained:

Top spike width:

| population | average | sx |
|---|---|---|
| Nyirád | 6.48 | 0.119 |
| Szőce | 5.48 | 0.123 |
| Zemplén | 6.19 | 0.161 |

The average value in the Szőce population is significantly less than the others ($p<0.001$).

Top spike length:

| population | average | sx |
|---|---|---|
| Nyirád | 22,5 | 0,447 |
| Szőce | 24,5 | 0,461 |
| Zemplén | 19,5 | 0,605 |

The Szőce average value is significantly greater than the others ($p<0.001$ and $p<0.01$ regarding Zemplén and Nyirád, respectively). The Nyirád average is significantly greater than the Zemplén one.

Inflorescence length:

| population | average | sx |
|---|---|---|
| Nyirád | 80,7 | 3,04 |
| Szőce | 78,4 | 3,13 |
| Zemplén | 68,3 | 4,11 |

The Nyirád average is significantly greater than the Zemplén one ($p<0.05$).

The length of the lowest inflorescence bract:

| population | average | sx |
|---|---|---|
| Nyirád | 76,7 | 3,82 |
| Szőce | 68,1 | 3,94 |
| Zemplén | 61,3 | 5,17 |

The Nyirád average is significantly greater than the Zemplén one ($p<0.05$).

Stem length:

| population | average | sx |
|---|---|---|
| Nyirád | 587 | 16,2 |
| Szőce | 550 | 16,7 |
| Zemplén | 499 | 21,9 |

The Nyirád average is significantly greater than the Zemplén one ($p<0.05$).

Leaf width:

| population | average | sx |
|---|---|---|
| Nyirád | 2,86 | 0,0763 |
| Szőce | 3,14 | 0,0787 |
| Zemplén | 3,36 | 0,103 |

The Nyirád average is significantly less than the others ($p<0.001$ and $p<0.05$ regarding Zemplén and Szőce, respectively).

Utricle width:

| population | average | sx |
|---|---|---|
| Nyirád | 1,99 | 0,0340 |
| Szőce | 1,59 | 0,0351 |
| Zemplén | 1,75 | 0,0461 |

The Nyirád average is significantly greater than the others ($p<0.001$). The Zemplén average is significantly greater than the Szőce one ($p<0.01$).

Utricle length:

| population | average | sx |
|---|---|---|
| Nyirád | 3,06 | 0,0288 |
| Szőce | 2,95 | 0,0297 |
| Zemplén | 2,97 | 0,0390 |

The Nyirád average is significantly greater than the Szőce one ($p<0.05$). The small diference between Szőce and Zemplén averages is also significant ($p<0.001$).

## Discussion

Each population discussed here displays individual features. The order of the populations is different according to the variety of morphological parameters. Therefore, each population is valuable by itself, conservation of which is worth dealing with. The small populations of *Carex buxbaumii* have

very restricted areas, they are the most endangered. The Vindornya one, which is unprotected at present, seems to be more vigorous, but has a much smaller area. The survival of these populations can be provided only by continuous monitoring their state and carrying out the interventions needed. It is crucial to avoid environmental disturbances including fluctuations of water level.

The Zemplén habitat of *Carex hartmanii* is endangered by forest succession. The individuals of tree and shrub species (eg. *Betula pendula, Salix* spp.) should be removed. The Szőce population has a rather small size (100-200 individuals) and area (250-300 $m_{.}$), therefore it is endangered. Its habitat is covered by a vegetation which is prominently the most diverse among the sites investigated. Regular mowing is necessary in order to prevent the expansion of *Solidago gigantea.*

The Nyirád population with more than 1000 individuals seems to be the most important one for the survival of *Carex hartmanii* in Hungary. This species grows here in several communities and in the transitions between them. Their vegetation shows a quite original picture. Perhaps the most interesting association is represented by the *Carex lasiocarpa* stands of tall sedge marsh character (*Caricetum elato-lasiocarpae*). The Nyirád habitat is unprotected, therefore it is subject to the risk of future destructions.

In order to assess long term growth rates of the populations some data concerning the distribution of life cycle stages, and the transition probabilities between them, are necessary. Too little information is available about them at present. Investigations lasting several years are intended to fill this gap.

For *Carex buxbaumii* and *Carex hartmanii* the conservation of habitats is of an overriding importance. The significance of the tall sedge communities and successional stages developing immediately from them is emphasized by relatively frequent occurence of the treated sedge species. Constant, appropriate water levels are necessary for the survival of these communities. The habitats of purple moor-grass meadows are usually favourable for forest vegetation (these are potential forest habitats), so, near water supply, preventing of forest succession is also needed.

## References

Albert, É.(1990): A Sásdi-rétek botanikai értékei és javaslat megőrzésükre (Diplomamunka). Budapest, ELTE Növénytan és Ökológia Tanszék.

Borbás, V.(1900): A Balaton tavának és partmellékének növényföldrajza és edényes növényzete (A Balaton tudományos tanulmányozásának eredményei II.). Budapest.

Borhidi, A.(1993): A magyar flóra szociális magatartás típusai, természetességi és relatív ökológiai értékszámai. (Social behaviour types and naturalness values of the Hungarian flora.) Pécs.

Lájer, K.(1996a): A *Carex buxbaumii* Wahlenb. Magyarországon. Kitaibelia 1:36-45. (with english abstract).

Lájer, K.(1996b): Vázlatok a *Carex hartmanii* Cajander magyarországi elterjedéséről, cönológiai viszonyairól. Kitaibelia, manuscript accepted (with english abstract).

Rakonczay, Z.(ed.)(1989): Vörös Könyv. A magyarországon kipusztult és veszélyeztetett növény- és állatfajok (with english summary). Akadémiai Kiadó, Budapest. (with english summary)

Szodfridt, I.-Tallós, P.(1962): A *Carex hartmani* Magyarországon és újabb florisztikai adatok a Bakonyaljáról. Bot. Közl. 49:258-262.

Tóthmérész, B.(1993): Divord 1.50: A Program for Diversity Ordering. Tiscia 27:33-44.

# REGENERATION OF SAND GRASSLANDS: CASE STUDIES IN TWO DIFFERENT SCALES.

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## Introduction

Strong natural and human disturbances destroy the vegetation, that can recover by spontaneous revegetation or by planned restoration. Understanding how communities develop following a disturbance - which is a process of succession - is fundamental to developing and understanding of maintenance, and restoration of diversity in plant communities (Gross 1987). Long-term experiments have to set up to study the possible pathways of vegetation succession on a grassland. Several such studies were carried out in Hungary. Primary succession was studied on dumps of a strip coal-mine (Bartha 1992), herbicides induced regeneration processes in a perennial grassland community (Virágh 1987), and pioneer ruderal succession on sandy and clayey soils (Matus and Tóthmérész 1995).

The main goal of this study was revealing the possible pathways of artificially induced vegetation succession on a sand grassland where the soil properties and the close natural species pool made possible the relatively short regeneration period. Such study of spontaneous revegetation could provide important knowledge for planning grassland restoration, for example knowledge about the factors determining the colonization ability of the natural species and selection a suitable starting species set from the natural species composition matching the properties of site and its potential natural vegetation.

## The study area, and the experiment

The study site is situated in the Bugac core area of the Kiskunság National Park, in Hungary. Four main plant associations occur here, on the inland sand dunes and flat "puszta" areas:

*Festucetum vaginatae danubiale* Soó 29 on the dunes,
*Molinio-Salicetum rosmarinifoliae* (Soó 33) 57 in the wind grooves
*Potentillo-Festucetum pseudovinae* Bodrogk. 59 in the flat areas, which have been used as pastures for several hundreds of years;
*Astragalo-Festucetum rupicolae* Soó 56 remnants in the ungrazed parts

The recent vegetation is a mosaic like complex of these four associations, and also contains different transitional and degraded stands of

them. The experimental plots were positioned in an approximately 10 ha area.

**Small scale experiment (SSE)**: 1 $m^2$ large propagulum free plots were established in ten slightly different vegetation types in winter, 1992. The occurrences of colonizing plants in 5x5 cm subplots were recorded in spring, summer and autumn in the second and third years of regeneration. In the first year very few plants were detected in the plots, so these data are not evaluated here.

Description of the study sites. **CLSD:** Sand dune vegetation, dominated by *Carex liparicarpos*; **FVSD:** Sand dune vegetation, dominated by *Festuca vaginata*; **SBSD:** Sand dune vegetation, dominated by *Stipa borysthenica*; **PASD:** Sand dune vegetation, in the pasture; **FPFL:** Flat area, with *Festuca pseudovina* as dominant species; **SCFL:** Flat area, with *Stipa capillata* dominant species; **FKWG:** Wind groove vegetation with *Festuca pseudovina* and *Koeleria cristata*, **FRWG:** Wind groove vegetation with *Festuca rupicola*, **PAWG:** Wind groove vegetation in the pasture; **MOWG:** Wind groove vegetation with *Molinia hungarica*.

**Large scale experiment (LSE)**: a 600 $m^2$ vegetation free plot was established by removing the vegetation with 20 cm of topsoil in 1991. This plot represented two characteristic relieves of a sand dune area with about 1 m elevation difference. Classical cenological relevés of permanent plots were taken in summer between 1982-1995.

## Results and Discussion

### 1. Site and climatic effects

The colonization rate of natural species is highly dependent on the site microclimate. Colonization speed is higher in the wind groove position, where soil moisture is higher (Fig. 1). The depressions between the sand dunes may work as safe-sites, where the site attributes are favorable to germination and establishment (Urbanska 1995).

Similarly, the cover values in the lower relief LSE plots were usually higher than in the upper relief plots, after the 2nd year. Precipitation peaks in 1984, 1987 and 1991 caused a detectable larger increase of species number and total cover than in the other years, especially on the upper relief. Saturation of species number occurred in the sixth year with 27 species, and later it decreased with the stabilization of communities. (Fig. 2).

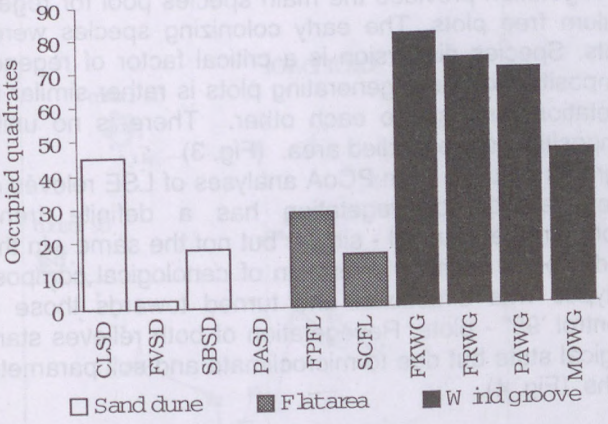



Fig. 1. Colonization rate of the natural species into the SSE plots in three different site positions.

Changes of plant coverage and species number during successive years in the LSE plots

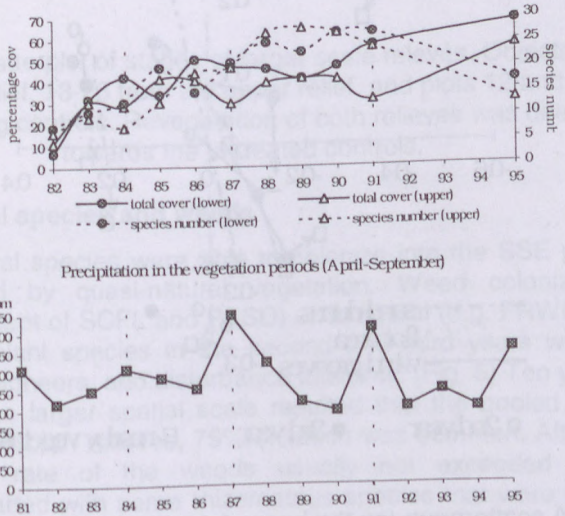



Fig. 2. Effect of precipitation on the revegetation of the LSE plots. Increase of coverage values seems to respond to more precipitation of the previous year, but the species number is the function of successional state.

## 2. Composition of the colonizing species

Nearby vegetation provided the main species pool for regeneration of 1 $m^2$ propagulum free plots. The early colonizing species were different in different plots. Species dispersion is a critical factor of regeneration. The species composition of the regenerating plots is rather similar to that of the nearby vegetation, and not to each other. There is no uniform pioneer species composition in the studied area. (Fig. 3)

Scattergrams resulted from PCoA analyses of LSE relevés demonstrate, that the regeneration of vegetation has a definite trend, and the recolonization is rather parallel - similar but not the same - in the sand dune and the wind groove position. Alteration of cenological composition of both vegetation types was directional and turned towards those of untreated stands - "control '95" - plots. Revegetation of both relieves started from the same ecological state but due to microclimate and soil parameters, they ran different paths. (Fig. 4).

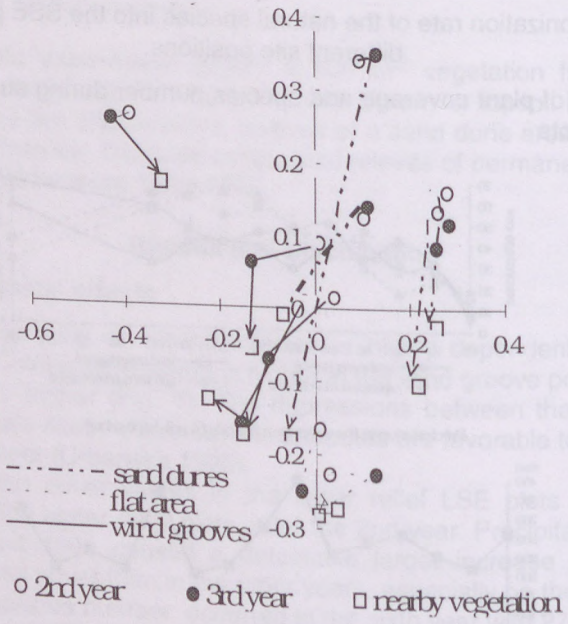



Fig. 3. PCoA scattergram (on the base of Jaccard similarity indices) of SSE plots and their nearby vegetation. Arrows indicate the direction of compositional changes.

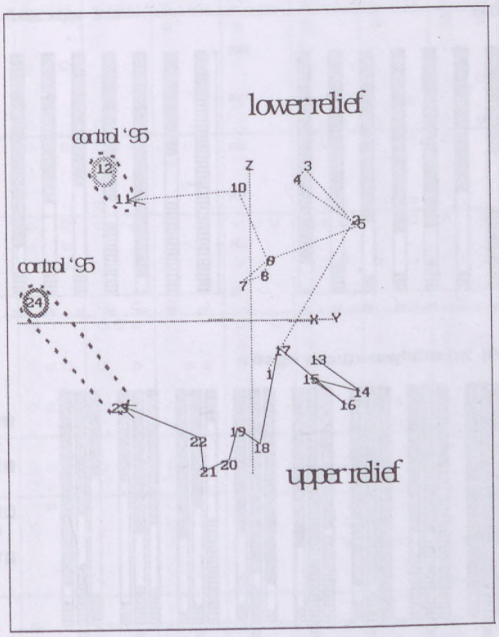



Fig. 4. PCoA-scatterplot of stages of larger scale relevés. Objects 1-11 are from the lower relief, 13-23 from the upper relief, and plots 12 and 24 are the corresponding controls. Revegetation of both relieves was directional towards the untreated controls.

### 3. Rate of natural species and weeds

Several natural species were able to colonize into the SSE plots which were surrounded by quasi-natural vegetation. Weed colonization was relatively low (except of SCFL and PASD) or temporal (e.g. FRWG), most of the newcoming plant species in the second and third years were natural species, natural pioneers, and disturbance tolerants. (Fig. 5) Ten years of the succession on the larger spatial scale resulted that the pooled number of species was 41 on both relieves, 75% of which was common. After the third year the cover rate of the weeds usually not exceeded 20%. Re-establishment started with some rhizomatous species that were remainders of the original vegetation.

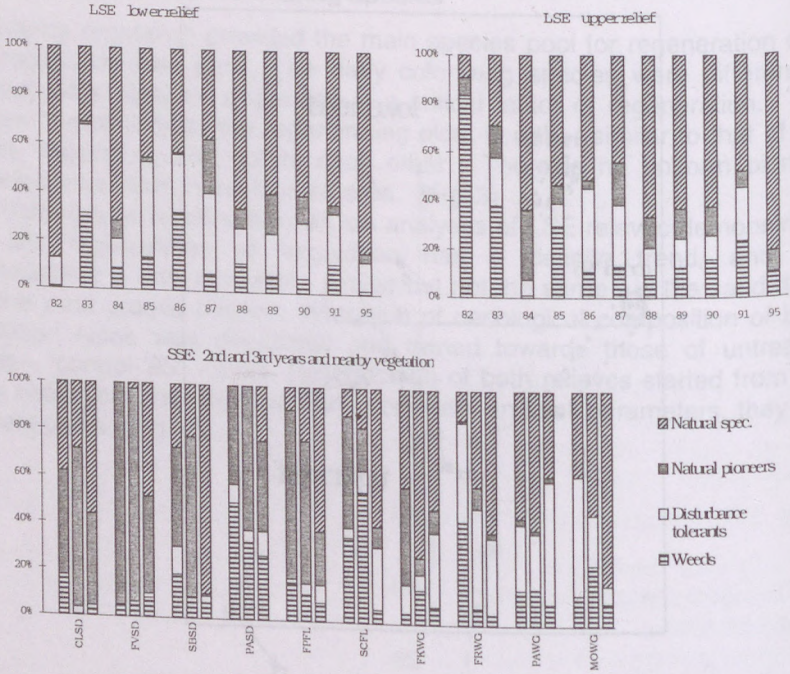



Fig. 5. Cover rates of different species categories. Classification of the species into these categories was made on the base of their social behaviour types (Borhidi 1993), with some modification.

## 4. Colonizing ability of the natural species

Certain natural species proved to be good colonizers in the small scale experiment, (e.g. *Festuca rupicola, Festuca pseudovina, Koeleria cristata, Thymus degenianus, Potentilla arenaria*) (Table 1.), but in the large scale experiment where the species pool was farther, their colonization was detected several years later. Spontaneous reestablishment of other dominant natural species was very low, so they need extra care, and further studies before using in restoration attempts (e.g. *Festuca vaginata, Stipa borysthenica, Molinia hungarica*). Early spontaneous recolonization of three protected species was recorded: *Alcanna tinctoria, Sedum hillebrandtii* and *Corispermum nitidum*.

| Sites | CLSD | | | FVSD | | | SBSD | | | PASD | | | FPFL | | | SCFL | | | FKWG | | | FRWG | | | PAWG | | | MOWG | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | C2 | C3 | R | C2 | C3 | R | C2 | C3 | R | C2 | C3 | R | C2 | C3 | R | C2 | C3 | R | C2 | C3 | R | C2 | C3 | R | C2 | C3 | R | C2 | C3 |
| Achillea pannonica | | | | | | | o | | | o | | | o | | | o | | | O | o | | O | o | | O | o | o | o | | |
| Agrostis alba | | | | | | | | | | | | | | | | | | | | | | | | | | | | o | o | |
| Alkanna tinctoria | o | o | o | | | | | | | | | | | | | | | | | o | | | | | | | | | | |
| Arabis recta | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bromus sqarrosus | | | | | | | o | | | o | | | o | o | | | o | | | | | | | | | | | | | |
| Carex liparicarpos | O | | | O | | | | | | | | | O | o | o | o | | | O | o | | o | | | o | o | | | | |
| Cerastium arn idecandrum | o | o | | o | o | o | | | | o | | | o | o | | o | o | o | o | o | | | o | o | | o | o | | | |
| Colchicum arenarium | | | | | | | o | | | | | | o | | | | | | | | | | o | o | | | | | | |
| Coripem um nitidum | | | | | | | | o | o | | | | | | | | | | | | | | | | | | | | | |
| Dianthus pontederae | | | | o | | | | | | | | | o | o | o | o | o | o | | | | o | | | o | | o | | | |
| Erysim un diffusum | o | o | | o | o | o | o | o | | o | o | o | o | o | o | | | o | o | o | | o | o | | | | | | | |
| Euphorbia seguieriana | o | o | | | | | o | o | o | | | | o | | | | | | o | | | | | | | | | o | | |
| Festuca pseudovina | o | o | | | | | | | | o | | | O | o | o | o | | o | O | o | o | | | | o | o | o | | | |
| Festuca rupicola | | | | | | | | | | | | | | | | | | | | | | o | o | o | | | | | | |
| Festuca vaginata | | | | O | | o | | | | | | | | | | | | o | | | | | | | | | | | | |
| Kochia laniflora | o | | | o | o | o | | | | o | | o | o | | | | | | | | | o | | | o | o | o | | | |
| Koeleria cristata | | | | | | | | | | o | | | o | | | | | | o | o | o | | | | | | | | | |
| Medicago m inim a | o | o | o | o | | o | | o | o | o | | | o | | o | o | o | o | o | | o | | | | | | | o | | |
| Molinia hungarica | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Polygonum arenarium | o | o | o | o | o | o | o | | | o | | | o | | | o | o | | | | | | | | | | | | | |
| Potentilla arenaria | | | | | | | o | | | o | | | o | o | o | | o | | O | | o | o | | | | | | o | o | o |
| Salix rosm arinifolia | | | | | | | | | | | | | | | | | | | | | | | | | | | | o | | |
| Secale silvestris | o | o | o | o | o | o | o | | | | | | | o | o | o | | | | o | o | | | | | | | | | |
| Sedum hillebrandtii | O | o | o | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Silene otites | | o | o | | | | | | | o | | | | | | | | | o | | | | | | o | o | o | | | |
| Stipa borysthenica | o | | | | | | o | o | o | | | | | | o | | | o | o | | | | | | | | | | | |
| Stipa capillata | | | | | | | | | | | | | o | o | o | o | o | o | o | o | o | O | | | | | | | | |
| Taraxacum laevigatum | | o | | | | | | | | | | | o | | | o | | | o | | | | | | o | | | | | |
| Teucrium cham aedrys | | | | | | | | | | o | | | | | | | | | o | | | O | | | | | | o | | |
| Thesium arvense | | | | | | | | o | | | | | | | | | | | | | | | | | | | | o | o | |
| Thym us degenianus | o | | | | | | | | | o | | | o | o | o | o | o | o | O | o | | o | o | | o | o | | | | |
| Verbascum lichnitis | | | | | | | | | | o | | | o | | o | o | o | | o | | | o | o | o | | | | | | |
| Viola kitaibeliana | | | | | o | | | o | o | | | | | | | o | | | o | o | | | | | | | | | | |
| Viola rupestris | | | | | | | | | | | | | | | | | | | | | | | | | | | | o | o | o |

Table 1. Colonization of the most important species into the SSE plots. R: resident in the nearby vegetation, C2 and C3: colonization in the 2dn and 3rd years, O: high cover, o: low cover

## References

Bartha, S. (1992) Preliminary scaling for multi-species coalitions in primary succession. Abstracta Botanica 16:31-41.

Gross, K. (1987) Mechanism of colonization and species persistence - in Jordan, W.R., Gilpin, M.E. and Aber J.D. eds.: Restoration Ecology. A synthetis approach to ecological research. Chambridge Univ. Press.

Matus G. & Tóthmérész B. (1995) Pioneer ruderal succession on sandy and clayey soils. 7th Europaean Ecological Congress, Budapest, August 20-25, 1995. Abstracts p. 241.

Urbanska, K. (1995) Safe-sites - interface of plant population ecology and restoration ecology - Abstracts of the First International Conference on Restoration Ecology and Sustainable Development, Zurich, March 27-29 1995.

Virágh, K. (1987) The effect of herbicides on vegetation dydamics: Comparison of Classifications, Abstracta Botanica 11:53-70.

# BIO-DIVERSITY CONSERVATION IN THE NETHERLANDS

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## Introduction

In the Netherlands, in nine physical-geographical regions (like the river area, sand region, dune area, peat area, etc.) a wide variety of ecosystems are distinguished.

Unfortunately, in the last decades there has been a steady decline in habitats and species. The reasons for this decline are found in urbanisation, road-building and intensified agriculture, which had a great impact on Dutch nature. Fragmentation of nature is the result. Areas of significance are relatively small, widely spread and isolated. Thus, much of the original flora and fauna of the Netherlands persists in nature reserves and natural ecosystems are rare.

Under these conditions nature management is very difficult. Adequate buffering against acidification and eutrophication is hardly possible.

## Nature policy

In order to turn these developments for the better, in 1990 the Dutch Ministry of Agriculture, Nature Management and Fisheries issued a Nature Policy Plan. This plan focuses on the establishment of a coherent **Ecological Network**. A network that must be build up of "core areas" and "connecting zones". Core areas are formed by all current nature conservation areas, but also by still to be developed nature (current agricultural) areas. Future ecological corridors will relieve the isolation of species in the current fragmented habitats.
This network must be in place by 2020.

## Objectives

Before the National Ecological Network could be established efficiently and systematically the objectives of the Dutch nature policy needed further clarification. There were questions to be answered about the quality of nature that can be developed and the quality that should be aimed at, about how large nature conservation areas should be and about which abiotic requirements should be fulfilled and which biotic and abiotic parameters should be monitored.

In answering these questions two principles were regarded important as starting point for elaborating "target nature types". These principles are "biological diversity" and "naturalness".

## Target species

The principal of biological diversity is defined in terms of plant and animal species that are of national and international interest. Such species are regarded as "target species", if they meet at least two of the following three criteria.

- the species is of international importance; a relatively large part of the biogeographical range is located in the Netherlands
- the distribution or the number of individuals of a species exhibits a downward trend
- the species is rare in the Netherlands

## Management strategies

The principle of naturalness is defined in terms of "human interference". Of course the best way to maintain biological diversity is by conserving the natural habitats. However - as indicated in the introduction - natural ecosystems are rare in the Netherlands. Therefore any system of target nature types in our country has inevitably to consider degrees of naturalness and human interference.

Consequently, the following four main categories of target nature types are distinguished, which are separated on the aspect of human interference:

- nearly natural ecosystems, in which natural processes are relatively undisturbed by man
- guided natural ecosystems, in which to a limited extent (landscape scale) processes are manipulated in order to improve bio-diversity
- semi-natural ecosystems, more or less like the regular management of pastures and hay-land
- multifunctional ecosystems, in which species and ecotopes co-exist with different forms of land use

By combining target species with physical-geographical ranges and the four categories of human interference, 132 target nature types are distinguished in the Netherlands.

The relevant characteristics of each of these target nature types are systematically described.

- the intended structure of vegetation and landscape and the position within the surrounding landscape are described.
- a "reference" gives the dominant vegetation types that are derived from historical data, scientific literature and examples in other countries (in case the specific type has disappeared from the Netherlands).
- the essential management-activities (grazing, mowing, water table manipulation, etc.) are listed as well as the degree of human interference.

- "process-indicating parameters" describe for each target type the abiotic optima in terms of moisture nutrients and the acidity of the substrate. A limited number of abiotic and biotic parameters are used for monitoring
- all target species that depend on the specific target nature type are listed. This list is used as an indicator of bio-diversity and as a tool for evaluating the effectiveness of nature conservation.

## Planning

Thus described, the set of target nature types can be used as a tool box for planning within the framework of the Ecological Network. Comparing the specific abiotic optima for each target nature type with existing field data on soil, deposition, hydrology, geomorphology, etc., results in the most favourable areas for nature development.

**Any further information can be obtained from:**

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# SOME CONSIDERATIONS ABOUT OPTIMAL SIZE OF NATURAL RESERVES

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## Introduction

The intricate problem of optimal size of a protected area was studied by many researchers (see for details: M.E.Soule and B.A.Wilcox 1980 English edition and 1983 Russian translation; and also A.Beeby 1993). In Romanian literature concerning nature conservation this problem, to a certain extent unsolved, was raised by V.Soran and M.Borcea (1983). The problem is to know accurately what area must have a nature reserve or park (national and natural parks or biosphere reserve). Would be the best to have a larger or a smaller size? An answer to this important problem is not a simple one because in some cases a smaller area seems to be suitable for several reasons (J.F.Quinn and S.P.Harrison 1988) and in the others, as Emil Racovitza (1937) has been mentioned sixty years ago, the larger areas reveal many advantages (S.L.Pimm 1991; A.Beeby 1993 and others).

Taking in account the weight of some points of view that have been discussed still now by several well known ecologists (see for details A.Beeby 1993) the authors try to suggest some criteria suitable especially for communities. These can be utilized to establish the right size of a protected area.

In our opinion these criteria would be the followings:

**I. The reckoning thus a protected area needs that to fulfil the biological, ecological and behavioural requirements of the species which lay towards the top of ecological (trophical or Eltonian) pyramid.**

Within the main European ecosystems (particularly various forests) the species that lay towards the top of trophical pyramid are the great herbivorous and carnivorous like the red deer (*Cervus elaphus*), roe-deer (*Capreolus capreolus*), chamois (*Rupicapra rupicapra*), brown bear (*Ursus arctos*), wolf (*Canis lupus*) and lynx (*Felix lynx*).

In the reckoning of protected areas for these species one must take in account the following considerations:

a). the energetical needs of a single mature breeding animal per day and year and starting from these must be count the area of an ecosystem that can feed an individual;

b). the minimum population size must be beyond the danger to fall in a genetical drift, at least in the next 1000-2000 years;

c). the optimal area of a particular species must accomplish its sexual behaviour and other behavioural acts;

d). the optimal area of a natural biotope must be suitable for a particular species (see table no.1).

Table no.1: The optimal areas suitable to protect some big European mammals taking in account their bioenergetical, behavioural and genetical needs (partly after: V.Soran and M.Borcea 1983; V.Soran, Gh.Racoviță and M.Dordea 1995).

| Species | Optimum area for protection in ha | Vital space in ha per one mature animal | Optimum number of breeding individuals in a mendelian population | Position in ecological pyramid |
|---|---|---|---|---|
| *Cervus elaphus* | 25.000-50.000 | 50-150 | 180-500 | I |
| *Capreolus capreolus* | 5.000-10.000 | 8-20 | 400-1250 | I |
| *Rupicapra rupicapra* | 8.000-20.000 | 15-40 | 400-1300 | I |
| *Ursus arctos* | 20.000-50.000 | 1000-4000 | 2-5 | I / II-III |
| *Canis lupus* | 10.000-25.000 | 800-1600 | 2-6 | II-III |
| *Felis lynx* | 10.000-25.000 | 600-1000 | 4-10 | II-III |

**Legend:**

I - Primary consumers;
II - Secondary consumers;
III - Tertiary consumers.

The figures of Table 1. may fluctuate between some values but they cannot be lower than the main vital needs (feeding and breeding). The data of Table 1. also assert that there are good correlations between the reverse pyramid of biotop (Ch.Elton 1927), optimal size of populations and the extent of optimal protected areas.

The reason of reckoning the right size of a protected area taking in account the data of Table 1. (i.e. according to the species laying toward the top of ecological pyramid) is that we may protect together on the same place, many ecosystems and biotopes from a particular landscape, with their natural resources for all living communities.

**II. The reckoning of a protected area may be done taking in account the ecological needs of builder or "architect" species of an ecosystem, species that have also an informative value for researcher.**

This model of reckoning the size of a protected area is based on primary producers (vegetation). The characteristics for instance of a beech forest (*Fagetum*) arise from the presence of beech on a large area. A single or several beech threes can not make out a forest. But surface must have a beech forest? The answer to this question is not a simple one. Several considerations must be taken in account:

a). if the microclimate of the forest during vegetation period was obtained and maintained;

b). if the characteristic species (animal or plants) of a forest ecosystem or other ecosystems are present;

c). if there are several populations (at least 5-8) of builder or "architect " species with their own genetic pool within a particular ecosystem.

If we use, as a good bioindicator, for the optimal size of the forests (oak, beech or spruce fir) the red deer (*Cervus elaphus*) then these ecosystems may be protect on area of 5000 ha. Frequently the red deer avoids forests smaller than 5000 ha according to V.Cotta and M.Bodea (1969). This means probably that the coenotical homeostasis of natural equilibrum of the forest have been accomplished.

**III. The protected area of particulary meadows or grasslands cannot be maintained without severe measures for the protection of all animal species that pollinate flowers or disperse seed of the plants.**

There are many flowering plants whose life, multiplication and dispersal depend on insects or other animals (G.F.Oster and E.O.Wilson 1978); G.H.Pyke 1978 and P.Colinvaux 1993). The studies particularly performed on the relationship between polliniferous insects and pollinated plants showed that these flying pennes (J.R.Krebs 1979), i.e. insects, must have a larger protected area than that of endangered and threatened with disappearance plant species (I.Washitoni 1994). In the case of bumble bee, bee and butterflies the protected area must be at least about 2000 ha. In our opinion this area would be an optimal one for a safe and sound protection of rare, endemic species, endangered and theatened by the disappearance plant species.

**IV. Other important criteria** for the selection of nature (scientific) reserves, National or Natural Parks and reckoning their suitable areas would be:

a). the possibility of maintaining the biotopes in unalterable natural conditions;

b). the strength of aesthetic or ecological consciousness (i.e. ethical reasons) or both of them.

## V. The possible categories of protected areas in Europe

Because the majority of European countries keeps few natural areas, the size of National Parks and Scientifical Reserves, with some exceptions (France, Norway, Russia), is smaller than 100.000 ha. There are countries like Romania where the smallest reserves are predominant (about 70%). How efficient are these smaller natural or scientifical reserves may be understood from those five categories that we tried to distinguish (A.Ardelean, C.Bindiu, N.Donița and V.Soran, 1994). Starting from smallest to greatest these five categories are the following:

**1. Botanical Gardens and Zooparks in natural conditions** (according to R.B.Foster's proposal, 1980)

Area: 0.1 - 99 ha

Characteristics: Frequently they are situated in dense inhabited regions under the greatest human impacts.

Conservancy efficiency: Near zero; any species cannot survive without man's interventions in energy and money according to our (A.Ardelean, C.Maior, I.Puia and V.Soran 1995) ecological aphorism *"The smaller a protected area the greater to upkeep"*. This is a corollary to E.Racovitza's (1937) idea: *"Des nombreuses petites reserves, de meme region biogeographique, ne peuvent remplacer avec profit une grande reserve, meme moins etendue que le somme de leur surfaces"*.

**2. Protected areas with small or restricted size**

Area: 100 - 999 ha

Characteristics: Frequently they are situated in natural areas but with insufficient size in order to originate the setup of a real natural balance (coenotical homeostasis in a climax climatic).

Conservancy efficiency: Smallest; man's intervention is necessary, i.e. the expense of some money and energy; they can protect some small animals (insects for instance) and plants (lichens and mosses).

**3. Reserves with average size area**

Area: 1000 - 9.999 ha

Characteristics: They are situated only in natural areas; to them may be notice that the beginning of setup of a real (true) natural balance

Conservancy efficiency: Natural true balance begins to be constantly present; they need lower expenses of money and energy; man's intervention has a small degree; they can well protect great animals (herbivorous and carnivorous mammals, birds and the builder or architect species).

**4. Reserves with extensive size**

Area: 10.000 - 999.999 ha

Characteristics: If the man's impacts are absent the climax climatic with its natural or ecological balance may become stronger.
Conservancy efficiency: They have a better conservancy efficiency; they need lower expenses of money and energy; man's intervention is important only to an administrative level (ecological management).

5. **Reserves with immense size**
Area: higher than 100.000 ha
Characteristics: They are rare in Europe - several (six) in France, one in Norway, 19 in Russia and another one in Romania *"The Danube Delta Biosphere reserve"* estimated to 580.000 ha by *V.Cristea* (1995).
Conservancy efficiency: They have the highest conservancy efficiency; they need lowest expenses of money and energy; they may well conserve the large bioms of the biosphere from a particular biogeographical region.

## Conclusions

Our short considerations about optimal size of natural reserves led us to Stuart L.Pimm's (1991) observations:

1. A widely distributed population or community may be less vulnerable to environmental catastrophes than a locally concentrated or limited population, so it is better to have reserves of categories IV and V of our classification.
2. The smaller reserves in our opinion are risky sizes from ecological point of view, particularly the categories I and II ofour classification.
3. The good ecologist manager must look anywhere and at any time if possible toward the setting up of large protected area versus smaller one.

## References

Ardelean A., Bindiu C., Donița N. and Soran V., 1994. Some remarks on scientific reserves and nature protection in Romania, Intecol. Proc.VI Internat. Congr.Ecology, Manchester 21-26 August 1994, p.359.

Ardelean A., Maior C., Puia I. and Soran V., 1995. Nature Conservancy and Environment protection inside of Carpatian Mountains Region taking a particular view on Arad, Bihor, Satu-Mare and Timiş counties (in Romanian), A VI Conferință Națională de Ecologie, Procese ecologice - Bază a dezvoltării societății, Arad, Univ.de Vest Vasile Goldiş, p.1-10.

Beeby A., 1993. Applying Ecology, Chapman and Hall,London - Glascow - New-York - Tokyo - Melbourne - Madras.

Colinvaux P., 1993. Ecology, 2-nd ed., John Viley and Sons Inc., New-York - Chichester - Brisbane - Toronto - Singapore.

Cotta V. and Bodea M., 1969. Vânatul României (Romanian Game), Editura Agro-Silvica, Bucureşti (in Romanian).

Cristea V., 1995. La conservation de la nature en Roumanie, Departimento di Botanica ed Ecologia dell'Universita Comerino (Macerata), Italia.

Elton C.S., 1927. Animal Ecology, Sidgwick and Jakson, London.

Foster R.B., 1980-1983. Geterogenosti I narushenja tropiceski rastitelnosti, In " Biologia okrany prirody", Mir, Moskva, 1983, p.97-116 (Russian version of "Conservation Biology", An evolutionary - ecological perspective", eds.M.E.Soule and B.A.Wilcox Sinauer Associates, Inc.Publ.Sunderland, Massachusetts, 1980).

Krebs J.R., 1979. Coevolution of bees and flowers, Nature, t.278, p.689.

Oster G.F. and Wilson E.O., 1978. Caste and Ecology in the Social Insects, Princeton University Press, Princeton.

Pimm S.L., 1991. The Balance of Nature ? Ecological Issues in the Conservation of Species and Communities. The University of Chicago Press, Chicago and London.

Pyke G.H., 1978. Optimum foraging in bumble bees in coevolution with their plants, Oecologia, t.36, p.281.

Quinn J.F. and Harrison S.P., 1988. Effects of habitat fragmentation and isolation on species richness: evidence from biogeographic patterns, Oecologia, t.75, p.132-140.

Racovitza E., 1937. Les Monuments Naturells (M.N.) Definiton, Classification. Norme pour l'application des lois et reglements. Ce qu'il foudrait faire et ce qu'il foudrait ne point faire. Contribution a l'etude des Reserves natturelles et des Parcs nationaux Societe de Biogeographie, t.5, p.15-27.

Soran V. and Borcea M., 1983. Ethological and ecological criteria of optimal area of a preserved land (in Romanian with a short English summary), Ocrot.nat.med.înconj., t.27, nr.1, p.5-10.

Soran V., Racovita Gh. and Dordea M., 1995, Les principes racovitziens primordiaux de protection de la nature et leur developpement actuel, Evolution and Adaptation. Babeş-Bolyai University of Cluj-Napoca, Department of Biology and Geology, t.5, p.29-42 (In English with a short summary in Romanian).

Soule M.E. and Wilcox B.A., 1980. Conservation Biology. An evolutionary - ecological perspective, Sinauer Associates, Inc.Publ., Sunderland massachusetts.

Washitani I., 1994. Habitat fragmentation, pollinator fauna degradation and anomalous fertility patterns of Primula sieboldii, Intecol. Proc. VI Internat. Congr. Ecology, 21-26 August, Manchester 1994, p.72.

# ZONATION AND MANAGEMENT PRACTICES IN NATIONAL PARKS AND NATURE RESERVES

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**Abstract**: Only large-scale international conservation measures are able to decelerate the global and regional loss of biodiversity. The "SLOSS"-alternative is outdated: isolation and fragmentation are among the basic causes for loss of genetic variability, impoverishment of species composition, degradation of ecosystems and uniformisation of landscape. Minimum area concepts may be often misleading and confine nature conservation within the boundaries of nature reserves. We need strict reserves of large extension consisting of several intact ecosystems in core areas of high genealogical diversity (i.e. centres of endemisms) and ecological networks consisting of several core areas and different zones of transition (ecotones, corridors) in areas of high compositional diversity (i.e. areas of overlap of diverse biogeographical elements). The European strategy of nature conservation based on the integration model provides the achievment of both basic requirements and will lead to reform the overall landscape management.

From this general situation two basic consequences are coming for Hungary.

- Because our country is lying on the lowest, heavily polluted, greatly deforested and by global climatic changes mostly affected part of a basin surrounded by water-supplying, forested mountains, Hungary cannot implement any effective ecological network and cannot stabilise the ecological conditions without developing transboundary ecological networks of the Carpatho-European region.

- Because our protected landscapes and nature reserves of any order of rank can function only as elements of a transnational network, generally harmonised zonation principles should be applied in different types of reserves. It means that by all possible means, the larger protected areas (national parks, protected landscape areas) should fulfill the criteria of the IUCN II. cathegory and the smaller ones (nature reserves) of the I. one (scientific reserve).

In connection to these purposes we should gain more efforts to investigate the functional aspects of biodiversity which was and can be sustained in our region only by reasonable management practices based on experiences of the traditional land use. *We should not forget that nature conservation is the most effective and preventive and the cheapest way to the environmental protection.*

## Introduction

### Nature reserves and ecological networks

The initial, reversible stages of biodiversity loss often proceed rather slowly. Its rapid decline is, however, usually irreversible. Degradation of an ecosystem does not succeed by gradual, step-by-step disappeareance of species, but by loss of functional connections between species populations. If a "point of no return" is reached, the loss of species will be accelerated. Such ecosystems are, as a rule, no more to be restored. The general decline

of faunal richness in Central Europe clearly demonstrates that this "point of no return" is already reached in most countries of this region. It means that we have a chance to save the of our natural heritage only by a rapid change of our conservation strategy.

The alternative strategy should be based on the insight that biodiversity has two basic aspects. Biodiversity arises by branching processes: by self-reproduction of individual (s.l.) biological entities, from molecular level (DNA-replication) to species level (speciation). This kind of biodiversity is the *genealogical* one, its core areas are the centres of endemism. A high level of diversity arises, however, by co-existence of many different "kinds" of species populations, i.e. *compositional* diversity, in areas of overlap diverse floral and faunal elements. These belts of biogeographical overlap are to be found in richly structured landscapes, in mosaic-like, complex ecosystems. Core areas of genealogical diversity primarily need undisturbed conditions for development of natural processes; areas of overlap need undisturbed tracks, corridors for dispersal, colonisation and survival.

As a consequence of this dual nature of biodiversity, its conservation needs differentiated measures. Strict reserves should be established primarily in those regions where extended self-regulated natural or nature-like ecosystems are preserved, in which conservation by natural succession is possible (e.g. virgin forests in not densely populated continents or regions). In the Carpatho-European region, this type of nature reserves could be established at first in high mountains with numerous endemic species, less influenced by men. Unfortunately, in the Carpathians only the large nature reserves in the High Tatra (mostly the E., calcareous part: Belanské Tatry) and in the Retezat mountains fulfill these criteria. At least 4-5 further large reserves should be established, mostly by extension and connection of important former protected areas (e.g. in the Slovakian and Aggtelek karst, in the W Transsylvanian/Apuseni mts., in Pareng and Piatra Craiului mts. in the Southern Carpathians etc.).

The large national parks of the Pannonian lowland display rather peculiar conditions. They cannot fulfill, of course, several criteria of strict natural reserves, conserved by natural succession, because they are established in ancient pasture-landscapes under traditional use. As the African savannah cannot exist without many thousands of large grazing mammals, these semi-natural, semi-anthropogenous extended open landscapes also need a vast biomasse of phytophagous animals of diverse body size: from mining micro-moths ( - from which they are inhabited by numerous endemic taxa! - ) and small grasshoppers to large ungulates. They are, at the same time, elements of a large transboundary system of bird habitats and bird migration routes from which some kinds of disturbance should be absolutely excluded. Thus, in some respect they function as corridors, in other ones as core areas. These protected areas should be large enough in order to fulfill both of their basic functions. In spite of all this: they should also have a general environmental function in stabilising the ecological conditions at landscape

level including the buffering of climate changes. I should believe that without preserving and managing the water budget of these large protected areas, the sinking the water-table in some regions of the lowland would be much more catastrophic and consequently, the general conditions for agricultural production would be much more deteriorated.

We also need several areas of transition between the large nature reserves of the mountains and large national parks and protected landscapes of the lowland. These "landscape-ecotones" are the river valleys and the hilly regions of foothills near the Alps and Carpathians which usually sustain a rather high level of compositional diversity due to overlap of different floral and faunal elements arriving from different directions. Mosaic-like structure of their nature-like, semi-natural and traditionally managed ecosystems promote the coexistence of them. They function also as water-supply systems of the inner part of the basin. Protection of them also has a general environmental function, because the global deterioration of ecological conditions in the lower parts of the basin can be hindered only by a "green ring" around them.

*The only hopeful strategy: transboundary, regional ecological networks*

It is a generally accepted opinion that only large-scale international conservation measures are able to decelerate the global and regional loss of biodiversity. Also our experiences from the Carpatho-European region clearly demonstrate: the "SLOSS"-alternative is outdated. Isolation and fragmentation are among the basic causes for loss of genetic variability, impoverishment of species composition, degradation of ecosystems and uniformisation of landscape. Minimum area concepts may be often misleading and confine nature conservation within the boundaries of nature reserves. Only a "multi-level" conservation: landscape, ecosystem, community, species population and gene-pool protection can effectively serve the aims of biodiversity conservation. The European strategy of nature conservation based on the integration model provides the achievment of these basic requirements and will lead to reform the overall landscape management.

The environmental, ecological and political situation in all countries of the Carpatho-European region show essentially the same basic challenges: to replace the strictly planned, to mass-production oriented, uniformized state-farm agriculture by a more elastic, adaptive and differentiated environmentally sound agriculture which does not eradicate the major or minor heterogeneities of the landscape. Parallelly with the reform of the land use, these countries should also change their concepts of nature conservation. Together with their planned joining to the European Community, they should re-structure their agriculture and reduce the extension of the agricultural area. The only reasonable answer on this challenge would be to increase the areas with ecological and human healthy function. By afforestation of some abandoned lands the more nature-like forests could be preserved and the timber production should be stopped in

them. This case, the core areas of strict reserves would be no more isolated islands surrounded and permanently polluted by areas of intensive, "industrialised" production, consumpting much irrigation water, chemical agents and pesticides, but the most valuable components of a network: effectively protected nature-like or semi-natural habitats preserving a rich variety of natural resources. The states of the region should have the possibility to protect them by buffer zones established from traditionally managed and newly reconstructed habitats which have a significant ecological and human welfare function, as well. It is quite clear that all these purposes cannot be achieved at national level but only by a wide regional cooperation.

This statement is strongly supported by many facts. Not only the Danube, but nearly all important rivers of the region are subdivided by two or more states or they are the boundaries between them. It means that many of the ecological corridors between uplands and lowlands of this region are also subdivided and they will be utterly dissected in the case of missing cooperation. It means that all countries of this region should avoid any one-sided change of ecological conditions which could have consequences outside of its boundaries. Furthermore, it means that more transboundary reserves and national parks are necessary and the corridors between them should be implemented by regional harmonisation. The recent political history of this region was characterised by a tendency of splitting: earlier geopolitical units were dissolved and all nations tried to protect the own national identity and territorial souverainity. Thus, the future-oriented regional cooperation is often hindered by historical factors. All governments of this region have to realize that there are no distinct Austrian, Croatian, Hungarian, Romanian, Serbian, Slovakian or Slovenian atmospheres, hydrospheres and also no separated and on national basis separable ecological problems. We, all countries of this region share the environmental resources and natural heritage of this region and we are all faced the same challenges and loaded by the same unsolved questions, as well. All responsibly thinking persons should try the possibility, how to overcome the unsolved economical, historical, ethnical etc. problems by strengthening the cooperation in solving the environmental problems of the region. Obviously, our country has a so vulnerable geographical position that we can only win by this way.

## Possibilities of a successful conservation strategy in Hungary

From this general situation two basic consequences are coming for Hungary.

*(i)* Because our country is lying on the lowest, heavily polluted, greatly deforested and by global climatic changes mostly affected part of a basin surrounded by water-supplying, forested mountains, Hungary cannot implement any effective ecological network and cannot stabilise the

ecological conditions without developing transboundary ecological networks of the Carpatho-European region. Therefore the initiation of such networks belongs also to our own interests.

The Hungarian elements of this network should have the following major ecological functions:

- To connect the forested mountains to the foothills and to the lowland regions by forested corridors, mostly following the course of running waters and wetlands, in order to sustain the possibility of the gene-exchange between natural populations of given species living in different regions. The most important corridors are mainly along the running waters coming from the Alps in western and southern Transdanubia, near the right-sided tributaries of River Tisza which subdivide the Northern Middle range and its foothills and the tributaries of Tisza which connect the eastern part of the lowland to the hilly and mountaneous regions of Transsylvania.
- To increase the proportion of forested areas within our country in order to reduce the extremities of the climate and reduce the risk of catastrophic environmental changes, mainly in lowlands and lower hilly areas. Timber production should be allocated more to the new, but environmentally sound plantations in order to preserve more nature-like forests.
- To decrease the loss of running waters and to store more water in former river-beds in order to stabilise the water-budget of those regions which are affected by damages of increasing aridity. To connect the oxbow-lakes with the living river-systems in order to re-vitalise them by regular water-supply, simulating the effects of regular floods of the past. Connection of wetland and grassland habitats by wide ecotones has a crucial importance in the fluctuating, balanced ecological stability of lowland and lower hilly landscapes.
- To conserve all nature-like and semi-natural habitats in the stage of the possible maximal stability and diversity. Old, natural forests should be preserved as gene reserves; younger nature-like forests should be conserved mainly by natural succession. Edaphic and semi-natural grasslands of high species-diversity are to manage partly by strict protection and partly by traditional methods, based on very cautiously prescribed management plans.
- Strict conservation of isolated, vulnerable habitats (e.g. peat-bogs, edaphic grasslands with shallow, clastic topsoil, ravine-forests and island-like steppe forests of the lowland etc.). Very important task to protect these habitats by buffer-zones of other nature-like and semi-natural habitats which reduce the effects of isolation and fragmentation.

All these measures serve the protection of functional integrity and stability of nature-like and semi-natural ecosystems, furthermore the heterogeneity and ecological stability of landscapes. The extended strict

reserves and the landscape-wide protected regions are guarding our natural and cultural heritage for the future generations. Protection of core areas (natural elements) and sustainable use of the buffer zones and ecological corridors are complementing parts of the conservation strategy according to the integration model of nature conservation.

*(ii)* Because our protected landscapes and nature reserves of any order of rank can function only as elements of a transnational network, generally harmonised zonation principles should be applied in different types of reserves. It means that by all possible means, the larger protected areas (national parks, protected landscape areas) should fulfill the criteria of the IUCN II. category and the smaller ones (nature reserves) of the I. one (scientific reserve).

This principle seems to be in contradiction with the fact that in densely populated countries of western and central Europe there are practically no natural ecosystems: virgin forests, never managed natural grasslands, intact wetlands. It means that the criteria of the I. zone ("strictly natural zone") of national parks of II. category are hardly fulfilled in these countries. I think that this view is only partly correct. In most European countries, mainly in the mountains, there are numerous such ecosystems in which the capacity for auto-regulation has not been lost. They should be conserved primarily by natural succession which is only possible if the strictly protected area is large enough for preserving different successional stages by spatial heterogeneity. Strict protection, guaranteed by the I. zone, is necessary in forested regions to stop the timber production in natural forests; in grasslands, in order to avoid the overgrazing, trampling and terrestrial eutrofication. A more loose form of protection, given by protected landscape regions, is often not enough, at least in our region. This level of conservation, marked by the IUCN V. category, is too often insufficient to stop the harmful, ecologically not sound methods of exploitation of nature resources. Protected landscape regions provide the sufficient protection only in regions where environmentally sound land use predominate and where the proportion of nature-like ecosystems is not significant.

Thus, the critical question:

*"Do we need more national parks in Hungary?"* should be answered with *"yes"*. How many, how large and where: these are the main problems. Proportion of nature-like habitats is one of the most important points of views. Protection and reconstruction of environmentally damaged landscapes should be solved by other methods. Establishment of national park in the lower Danube - Drava region was a correct decision. The decisions on the Balaton-upland and Danube-Börzsöny national parks have more problematic features. The Körös-Maros area would also be suitable for a higher category than a landscape region (V.). Unfortunately, some of the most valuable forests of this region could not be legally declared as protected until yet. More difficult to understand why the foothills of the Alps ("Őrség),

the Tokaj-Zemplén mountains and the northeastern part of the Pannonian lowland: the Bereg-Szatmár plain could not seriously come into consideration. All these regions have such nature-like ecosystems which could fulfill the criteria of the natural zone of the category II.

The other important question: *how can we more effectively protect those areas which fulfill higher criteria than their actual level of conservation* and they are suitable for implementation of the international standards of zonation. The best solution of this problem would be the development of the network of Biosphere reserves in this region. Diversity of biogeographical elements and the richness of species composition in more regions of Carpatho-Europe strongly supports this thesis.

In connection to these purposes we should gain more efforts to investigate the functional aspects of biodiversity which was and can be sustained in our region only by reasonable management practices based partly on strict protection of vulnerable habitats and on experiences of the traditional land use. *We should not forget that nature conservation is the most effective and preventive and the cheapest way to the environmental protection.*

# VI. SESSION:
# RESEARCH AND MANAGEMENT OF FOREST ON CONSERVATION PURPOSE

# CONSERVATION OF THE DENDROFLORA IN SLOVAKIA AND LONG-TERM ECOLOGICAL RESEARCH AND MONITORING NETWORK

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## Introduction

Considering the knowledge of the evaluation of forest ecosystems, under the term "original tree species composition" we understand the composition and structure of the forests during the stabilisation period of the present day vegetation belts, i.e. in the Subatlantic (2,OOO years ago) in the period of the largest expansion of the beech-fire woods. Newertheless, today, it is necessary to take into account changing ecological conditions due to atmospheric pollution.

Throughout history, forest ecosystems have been a basic support system for society, providing goods such as timber, game meat, fodder, and medicinal plants, and services such as soil formation, watershed protection, and climate improvement. People have often sought to enhance a certain attribute of forests at the expense of others, thereby providing - in the judgement of those making the decisions - the best mix of forest benefits to society. However, these judgements have not always led to sustainable use of forest products. The choices about the use of forest resources have nevertheless had a great influence on the structure and composition of the forest ecosystem (McNeely 1994). Conservation has been based on the idea of setting aside large tracts of nature tha are in a state of imagined innonce and converning them into national parks and other kinds of protected areas. Forests which are "virgin" or "primary" or "pristine" are thuse given particularly high value for conservation and considered likely to have particularly high biodiversity. The dendroflora of the forest ecosystem recovery and improvement of resistance depend not only on the original composition of synusial complex of dendroflora, but also on their natural structure in relation to space, age, thicness, and height.

The preserved parts of dendroflora represent an important basis for knowledge about the original structure of forests. Therefore, they are specifically protected in forest reserves. In particular, virgin forest reserves are a precious etalon for the creation of models of resistant and stable forest ecosystems. Information about the species richness of Slovak forests in relation to phytocomponent of ecosystems was provided by the research of forest habitats. The species richness of the dendroflora in Slovakia is represented by 5O tree species and 48 shrub species. Out of more than 2,5OO species of higher plants in Slovakia, only 8OO species are recorded as forest species.

The nature reserves and protected sites (in accordance with Act of the National Council of the Slovak Republic No. 287/1994 on Nature and Landscape Protection) in general represents well the biodiversity of Slovak Nature. It would however be necessary to complete more reserves within the forest types.

## Biodiversity of the indegenous forests of Slovakia

It is known that species richness generally decreases with decreasing latitude, i.e. it is lower at the poles and higher at the equator. The influence of the temperature gradient is manifested by the fact that in otherwise identical conditions the species richness decreases with increasing altitude, i.e. in the lowlands the biodiversity is greater than in the high mountains.

In Slovakia the highest phytodiversity is found in the communities of the oak and beech-oak vegetation belt (from 118 to 224 higher plants). From the wiewpoint of the trophic ecological series and sets, the highest phytodiversity is in the plant communities of the alcalocalciphil trophic series, followed by nitrophile series and mesotrophic series. The tendency of phytodiversity increasing from the oligotrophic series to a series with higher contents of mineral nutrients has been confirmed. High species richness is found in communities of the forest type groups of nitrophile series, where the growth has a naturally smaller conopy and lower trunk density. This also applies to the communities of calcilophile series, with extreme soils of rendzina types.

The highest richness of lichenes species is in the plant communities of oligo-acidophile trophic series. The richest in mosses are communities of mesotrophic series. Certain relation appear to exist between the number of species and ecotop conditions.

The number of species sets in the oak and beech-oak vegetation belt communities is not just a result of habitat conditions (climate, contents of nutrients, warmth, and light), but also a result of the anthropic influence in the past when the original forest communities were, to a certain measure, convered into "steppes" throught agriculture. This was manifested in the wood species synuzial complex by the retreat of oak and beech and the expansion of hornbeam, maples, and shrubs in general.

The relatively balanced number of the higher plants and mosses species in the communities of nitrophile trophic series should be placed on practically the same conditions of ecotop, namely soil conditions. These are stony and scree soils with a high content of humus and very favourable humification processes (mull form of humus).

The plant community poorest in the number of species is the group of forest types *Querceto-Pinetum* on the sand dunes and the group *Pineto-Quercetum* on the substrates poor in minerals. Concerning the number of species, the group of the forest types *Saliceto-Alnetum* with the decisive role of water (permanently flooded areas) is very close to it. From the acid-

oligotrophic series, the community with the highest species richness is Quercetum, exceedin in this aspect all the other communities of this trophic series from more than 100-400 %.

The group of forest types *Ribeto-Mughetum* is the poorest in number of species out of the mesotrophic series, which is the result of the influences of high altitude and low temperatures. The second poorest group of forest types is *Fagetum pauper* from the beech vegetation belt, which is caused (apart from other reasons) by relatively thick layer of undecomposed beech foliage. Also the number of dominant species is the smallest in this group of forest types.

From hydrically conditioned communities, the richest in species is the group of forest types *Ulmeto-Fraxinetum*, followed by *Alnetum incanae*. Regular floods cause the accumulation of relatively rich deposits in mineral nutrients, which is reflected in a rich synusia of herbs.
The forest steppe communities of the group of forest types *Corneto-Quercetum* have the highest absolute richness of higher plants (224 species of higher plants).

The group of forest types *Sorbeto-Piceetum* is richest in the number of mosses and the group *Abieto-Piceetum* in the number of lichenes.

A very significant characteristic of the forest biodiversity is the occurrence of tree species within the nature reserves and protected sites. From the comparison of the present occurence of tree species in forest of Slovakia it is obvious that in forest nature reserves Norway spruce (by 10 %) and silver fir (by 14 %) have a higher occurrence. In case of silver fir it seems to be very promising phenomenon, for due to the anthropic activity and clearcut management forms of the occurrence of silver fir is being endangered. A lower proportion, compared to Slovak mean value, has Scots pine (by 6 %). The proportion of larch and mountain pine in forest reserves corresponds with the Slovak mean. In comparison with the Slovak mean, in total, the coniferous tree species have a higher occurrence in nature forest reserves (by 22 %) and in contrast, the proportion of broadleavels is lower - beech (by 8 %) and oak (by 8 %), the occurrence of maples correspond with the Slovak mean. Other tree species have lower proportions than those in forest of Slovakia. Given relations could be explained by the fact that size prevalence of the reserves is in spruce-beech-fir and spruce vegetation belts, comprising 48 % of all nature reserves. In this two vegetation belts the spruce is the most common tree species. The fir-beech vegetation belt comprises 17 % of the total area of nature reserves. In these vegetation belts are also the most favorable conditions for the development of silver fir, and this is why its proportion is by 14 % higher than the Slovak mean.

In relation to the trophic series and sets the most common are the associations of the alcalocalcilophile series and heminitrophilous series, which are representing by 50 % in the nature reserves. In the protected sites the most common are the communities of mesotrophic series, which represent 46 % of all series and sets.

The groups of forest types are not always representatively occuring. In Slovakia the most common is the group of forest types *Fagetum pauper*, followed by *Fageto-Quercetum, Abieto-Fagetum, Fageto-Abietum, Querceto-Fagetum, Carpineto-Quercetum* and *Fagetum delapinum*. In the nature reserves the order of groups of forest types is following : *Fageto-Piceetum, Fageto-Aceretum, Fagetum dealpinum, Pineto-Piceetum, Acereto-Piceetum*. This is due to the fact that the largest nature reserves are in the High Tatra (Tatra National Park) with prevailing groups of forest types *Pineto-Piceetum, Fageto-Piceetum, Acereto-Piceetum* and *Lariceto-Piceetum*.

The nature reserves and protected sites, generally, represent well the biodiversity of Slovak nature. It would however be necessary to complete more nature reserves within the group of forest types of *Carpineto-Quercetum, Fageto-Quercetum, Fagetum pauper, Fagetum quercinum, Fagetum abietino-piceosum, Abieto-Fagetum* and *Fraxineto-Aceretum*. This groups of forest types belong mainly prevailing into the category of management forests and that is why it is to be expected that under present ownership conditions the efforts to conserve this category as reserves will be rather complicated and not always straightforward.

## Legislation

The Act of the National Council of the Slovak Republic 287/1994 on Nature and Landscape Protection constitutes a legal framework for nature protection in Slovakia. Coming into force in January 1995, it replaced the Act of the Slovak National Council 1/1955.

This Act is "to support the conservation of diverse living conditions and life forms on Earth, to create the conditions for sustainability, restoration and rational use of natural resources, preservation of natural heritage, characteristic landscape features and to reach and maintain ecological stability".

The Act regulates the responsibility of the state administration bodies and municipalities, and the rights and obligations of legal persons and natural persons in nature and landscape protection.

Nature and landscape protection, according to this Act, is defined as the prevention and limitation of impacts which endanger, damage or destroy life conditions and forms, the natural heritage and landscape features, decreas its ecological stability, as well as the removal of the results of these impacts. Nature protection is also defined as the car of ecosystems.

The Act defines the complex nature and landscape protection, differentiated according to natural values of areas into five levels of protection. This differentiations is based on the Territorial System of Ecological Stability of the Slovak Republic, which is being developed at national, regional (district) and local level. The General Framework of the Territorial System of Ecological Stability, approved by the Government and the National Council of the Slovak

Republic in 1992, is the core for elaboration of projects at regional and local scale.

The Act on Nature and Landscape protection further specifies responsibilities of state bodies during the decision making processes and the approval procedure. The state administration with respect to the nature and landscape protection, is executed by the Ministry of the Environment of the Slovak Republic, the Slovak Environmental Inspection and district environmental offices.

The Act has introduced personal reponsibility for the state of nature. Persons "who through their activities influence ecosystems, their components or elements, are obliged, at their own expenses, to provide measures to prevent and limit their damage and destruction ... and obliged to include measures which ensure nature protection, into project proposals, programs, plans and other documentation".

The Act, furthemore, has established several economical instruments. The owner (administrator, lessee) is entitled to apply for a grant from the State Environmental Fund of the Slovak Republic in order to manage his land or significant landscape element. This Fund is the financial source for projects related to management of protected areas and other specially protected parts of nature.

The owner of the lands is obliged to allow for restrictions which are results of prohibitions and other conditions of nature and landscape protection. If due to this restriction, property loss occurs, the owner is entitled to compensation for the property loss, which is paid by the state.

The Act on Nature and Landscape Protection is based on the Constitution of the Slovak Republic (Act 460/1990). According to the Constitution natural heritage, underground water, natural healing sources and water streams are owned by the state.

The Act 17/1992 on the Environment is an umbrella law, which has introduced basic terminology with respect to the environment such as the environment itself, ecosystems, ecological stability, carrying capacity, sustainable development, ecological loss and others. In addition, this Act has established principles of environmental protection, including the institute environmental impact assessment (EIA). The special EIA Act was approved under 127/1994.

Apart from above legislation, protection of several components of the environment (such as water, air, soil, forests) and economic activities (forestry, hunting, fishing) are subject to special legislation. Though the Ministry of Land Use of the Slovak Republic is in charge of state administration for agriculture, forestry, hunting and fishing, their decision making process is obligatory based on writte comments of the nature protection body. The nature protection body also gives comments for other activities, such as building.

There are two important economic tools for nature and landscape protection - the Act 128/1991 for the State Environment Fund and Act

317/1992 on Property Tax as amended by the following regulations. According to this Act the landowner does not pay the property tax for protected areas (with the exception of protected landscape areas), marshes, peatbogs or other wetlands, hedgerows, groves, of not used for enterprenial or other profit activities, or lease. The tax manager may also decide on easing property tax for the following areas : norrow valleys, hedgerows with bushes, places with significant genetic resources, riverbank vegetation and other planted areas outside forest which are of soil protective, ecological or aesthetic value or are significant landscape elements.

The Act deals with both protected areas and rare, endangered or otherwise significant species of plants, animals, minerals, fossils and woods. Species protected by international agreements binding the Slovak Republic are also considered protected according to this Act. The Slovak Republic is party to six international conventions : Convention on Wetlands of International Importance expecially as Waterfowl Habitats, Convention concerning the protection of World Culture and Nature Heritage, Convention on International Trade in Endangered Species of Wild Fauna and Flora, Convention on Biological Diversity, Convention on the Conservation of Migratory Species of Wild Animals, Convention on the Conservation of European Wildlife and Natural Habitats.

The Act also prohibits destruction or damage to woods growing outside the forest. Approval from the nature protection body is required for their cutting, except for trees with a trunk diameter of less than 5O cm (measured at the heigh of 13O cm above ground), for trees growing in parks, rows, as part of the riverbank vegetation, bushes covering less than 1O square m, orchard trees or for trees that can cause immediate threat to human health, life or property. Extraordinarily significant trees may be designated as protected trees, along with their protective zones. Evaluation of damaging, killing, destroying or other prohibited activities concerning protected species of plants, animals and woods growing outside the forest is based on the Order of the Ministry of the Environment of the Slovak Republic 192/1993 on societal evaluation of selected parts of nature.

Significant or endangered parts of nature and landscape may be designated as protected areas in the following categories : protected landscape area (the second level of protection), national park (the third level of protection), protected site (the fourth level of protection), nature reserve (the fifth level of protection), nature monument (the fifth level of protection).

There are 16 protected landscape areas, covering 13,47 % of the territory of the Slovak Republic, five national parks, covering 4,O7 % (together with their protective zones 9,15 %) of the territory of the Slovak Republic, 172 protected sites, 331 nature reserves, 231 national nature reserves, 2O7 nature monument and 38 national nature monuments.

There are 7 Protected Trees: *Cerasus mahaleb, Cornus mas, Fraxinus ornus, Pinus cembra, Pinus mugo, Sorbus chamaemespillus, Taxus baccata* and 8 Protected Shrubs: *Arctostaphyllos uva-ursi, Colutea arborescens,*

*Cotinus coggygria, Daphne arbuscula, Daphne cneorum, Dryas octopetala, Ledum palustre, Rhamnus saxatilis.*

## Long-Term ecological research and monitgoring network

We understand nature conservation as a scientific discipline which investigates causal relationships between the human society and the nature. We also understand it as a specific biocoenotically-social process in natural systems, which determines the impact of negative socially-economic activities, and defines necessary preventive, protective, and defensive measures and actions, with the aim to preserve main ecological processes in the ecosystems, to preserve biodiversity, to maintain ecologically optimal and rational use of ecosystems, as a protection of territories, natural phenomena and organisms because of their scientific, cultural, educational, economic and social importance.

Nature conservation requires a highly objective and impartial approach towards evaluation of interactions between the human society and the nature.

Management of protected areas and biodiversity is a new activity in the sphere of nature conservation. We understand management as a tool for transferring theoretical scientific knowledge into the real world of nature conservation. Such management is based on scientific results of research activities in protected ecosystems and species, and also incorporates reasearch results of the ecosystems and species, especially those, which may be important for influencing of processes in natural systems, and which may assist in objective management of anthropogenetic activities in protected areas (prevention, regulation and even prohibition of human activities) or in conservation work. Decisions concerning the management of natural resources will always be made in the political arena, usually based on the values expressed by many constituencies.

The term "monitoring" is today used in many ways. Our understanding is that of a long-term and systematic observation of the state and development of individual parts of monitored unit from the functional point of view. In order to record long-term changes it is necessary to use permanent stacionary research plots and areas. We understand that each monitoring system should be open, with the possibility of updating, and having a necessary level of flexibility. The goals of the monitoring of the nature in protected areas is to provide up-to-date information about the state and the development of mentioned system which are necessary for decision-making, management and control, legislative and science research activities, and for public awarness too.

From point of view of monitoring and research of nature environment in protected areas a goal is establish a long-term ecological research and monitoring network. Some such projects already is occuring in the

administration of the protected areas, but they are spearheaded by University or Academy researchers and personnel from other scientific agencies without protected areas so there is no grantee they would continue. Different situation is in Biosphere Reserves which are the representative ecological regions, and have the research and monitoring projects.

In conformity with the Statutes of the Association of Carpathian National Parks and Reserves (ACANAP) we proposed on International Conference "Methods of Monitoring in Carpathian National Parks and Protected Areas", held in Carpathian Biosphere Reserve in Rachiv, Ukraine, at October 1995, to establish the Carpathian long-term ecological reserach and monitoring network. We support to organizing domestic long-term ecolgical reserach and monitoring programs in Biosphere Reserves and National Parks, creating conditions for exchanges at the individual scientist and site research program levels to participation on international meetings and collaboration and developing linkages with other relevant long-term research and monitoring programs, sites networks, and science centers. We support organize yearly scientific conference on actual problems within the framework of ACANAP.

## References

McNeely, J.A. (1994) Coping with Change. People, Forest and Biodiversity. IUCN, Gland, Switzerland and Cambridge, UK.

Vološčuk, I. (1994) Biodiversity of the Forest in Slovakia according to the Forest Vegetation Types. Presented at the WWF Workshop "Conservation of Forest in Central Europe" held in Zvolen July 7-9, 1994.

# RESTRICTION OF FORESTRY IN THE MAIN FOREST TYPES OF THE AGGTELEK NATIONAL PARK, BASED ON THE SURVEY OF NESTING BIRD COMMUNITIES

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**Abstract:** As a consequence of its geographical situation, 75.8 % of the total area of the Aggtelek National Park is covered by forests.

Although as much as 90 % of the forested areas is state-owned, thus the proportion of other owners (collective farms, municipalities, private owners) is insignificant, it is still the profit oriented forest management which is dominating on protected areas. (By the long term management strategy of the ANP this would be replaced first by a forestry practice, which serves nature conservation purposes, and later even this kind of activity should be given up).

The Aggtelek National Park Directorate can restrict and regulate forestry activity in time, space and methodology as an authority, using relevant legislation tools.

Bird communities of the Aggtelek National Park area are studied since 1986 with various sampling methods (nest, revier and point mapping, measurement of changes in the population size of the different species, ornithofaunistical studies, etc.).

Based on the data and experience of these studies species lists of nesting bird communities of the different biotope types (beech and mixed beech, pure and mixed pine, oak-hornbeam, thermophilous and sessile-Turkey oak forests) have been compiled.

Besides this, for species characteristic of the area parameters of average density, nesting, clutch and breeding period are given in detail. Some species of special environmental demands (nesting, feeding, biotope), especially the rare, strictly protected species (raptors, owls, Hazel Grouse, White-backed Woodpecker) occur accidentally or locally. In these cases it is required to assure imperturbability of the most valuable species and on these areas it could be necessary to give up with all the forestry activities even for the long term.

Overviewing the tables one can state in general that except for some special cases (nesting of *Corvus corax, Aquila heliaca, Strix uralensis*, etc.) it is necessary to prohibit forestry activitiy on protected areas in time, between 15 March and 31 July.

Based on these lists, the Aggtelek National Park Directorate, as an authority responsible for nature conservation (special authorithy for the Forestry Inspectorates), is capable to restrict the profit-oriented forestry activities in time and space, preventing - among others - the destruction of natural values enumerated on the lists.

See in Proceedings Volume II. pp. 177.

# EFFECT OF FOREST-EDGE TO MAINTAIN THE DIVERSITY OF A CARABID (*COLEOPTERA*) COMMUNITY

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**Abstact:** We have studied the carabid communities along a forest - forest edge transect in a *Querco-Carpinetum* forest using pitfall traps. We can discriminate the carabid communities of the different habitats by multivariate statistical methods, although they are not segregated strongly. We have found that the diversity of the carabid community is correlated with the diversity of the (herbaceous) vegetation. The diversity of the carabid community increased along the transect with the increment of the vegetation diversity. It was the highest in the forest edge. Therefore, the forest edge has a crucial role in the maintenance of the diversity of carabid communities. It may also serve as corridor for the migration of the individuals. They are important in preventing the isolation of the populations.

See in Proceedings Volume II. pp. 127.

# COMPARISON OF THE CARABID COMMUNITIES OF A ZONAL QUERCO-CARPINETUM AND PINE PLANTATIONS

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**Abstract:** The carabid communities of zonal *Querco-Carpinetum* forest and plantations (young spruce plantation, aged spruce plantation and black pine plantation) were analysed at the Aggtelek National Park using pitfall traps. Our results suggest that young plantations have very low diversity for many years after the establishment and it is not explained by the food resources. It may be related to microclimatic conditions and especially to the structure of litter layer and herbaceous vegetation. In the aged plantations, where the shrubs and herbs of the native vegetation are present, the diversity and composition of the carabid communities are similar to the communities of zonal forests. So the adequate forestry treatment has an important role in the maintenance of the diversity of the carabid communities.

See in Proceedings Volume II. pp. 131.

# VII. SESSION:

# VEGETATION MAPPING AND BOTANICAL RESEARCH ON NATURE CONSERVATION PURPOSE

# COMPARISON OF TWO DISTANT *CROCUS HEUFFELIANUS* HERB. POPULATIONS IN HUNGARY

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## Introduction

The most important task for nature conservation is to preserve natural diversity around us. This task can be completed only, if detailed information is available on the value of entities that deserve protection. The aim of our investigations was to collect this sort of information by comparing two populations of a rare plant species in Hungary.

The genus *Crocus* (*Iridaceae*) contains 80-100 species on the Earth. The Carpathian Crocus (*C. heuffelianus* Herb.) belongs to a minor group (*C. vernus* aggregate) occuring in the alpine meadows of the Carpathians and the Alps among damper soil conditions. Species in this group are taxonomically closely related, and these relationships are not fully clarified yet. This further increases the importance of a comparative research.

## Objects and methods

*Crocus heuffelianus* is found in two distant regions of Hungary. The first one is the Bereg Plain (Beregi-sík) in the northeastern corner of the Great Hungarian Plain, at the foothills of the Carpathian Mts., the other one is at the pediment of the Bakony Hills (Bakonyalja) in Transdanubia.

Two major isolated populations are known on the Bereg Plain, the Téb-Forest population at Tarpa and the Cserköz-Forest population at Magosliget. Soó reported first the former (Soó 1949), the latter was discovered later, in 1972 (Simon and Molnár 1972). In addition to these populations we know several smaller populations. The biggest of them was found in the border line of Garbolc (Farkas 1942). Other smaller populations is known in the environs of Uszka, Kishódos, Kispalád and Márokpapi (Fintha 1994). *Crocus heuffelianus* was probably widespread in this region as relict from the postglacial Bükk I. Age (Simon 1954, 1957, 1972).

The population in Transdanubia was discovered by Tallós in 1954 in Kupi-Forest (Tallós 1956). The question of the origin of this population has already been propounded by Tallós, but this question has not been answered since that (Németh 1956).

We made the following research. We determined the borders of the Bakony population in 1994. Following marginal individuals of the population, the trunk of nearby trees were marked. Their coordinates were determined

by measuring-tape and kompass. Population size and coenological attributes were determined by assigning a„core-area". Inside this area, the cover of the *Crocus heuffelianus* was at least 2 on the basis of the Braun-Blanquet's A-D-scale.

We assigned altogether 100, 0.25 sq. m. quadrats with quasirandom method inside the „core-area". We counted the flowering and the 2-3-leaved, non-flowering individuals in the quadrats. We did not count the 1-leaved individuals, because they are too young, sprouting or 1 year old plants with low survivorship. So the estimated size of the population was smaller than the real size: firstly, we only considered the „core-area", and secondly we did not count the young individuals.

We assigned 10x10 m squares in the Cserköz-Forest, Téb-Forest and Kupi-Forest for the coenological relevés.

The taxonomical investigations consisted of two parts. The difficulties of the cytogenetical properties of the *Crocus vernus* aggregate is known from the literature (Skalinska 1966; Brighton *et al.* 1973, Mathew 1982), thus a better understanding of the Hungarian populations in this respect was highly needed. We determined the karyotype of the populations at Magosliget and Kup, using of the root-tip of 11-11 specimen (Barabás 1993). We also made the micromorphological comparison of the leaf epidermis, and we investigated the morphological characteristics of flowers yearly on 150-150 randomly choosen specimen from 1993 to 1995. To identify flower color, the tip-form of the outer perigon segments, and the shape of the pattern under the tip we determined standard types, these facilitate work and made it as objective as it possible.

## Results

The area of the population of Kupi-Forest is 3 ha on basis of the assigned coordinates, and the size of the „core-area" is 0.6 ha. The average number of the flowering plants in the 0.25 sq. m. squares was 2,45 ($\delta$=3.16) $\pm$ 0.31, and the average number of the 2-3 leaved, non-flowering plants was 6.28 ($\delta$=8.08) $\pm$ 0.8. This means 35 potential reproducing plants per square-meter, the ratio of the flowering and the non-flowering individuals was 1:2.5. There are approximately 200.000 potential reproducing individuals on the basis of these details obtained in the „core-area". The real size of the population may be 500.000 (Köteles 1995).

The average number of the potential reproducing plants in the Cserköz-Forest was 20-40/sq. m., in the Téb-Forest 100/sq. m. The ratio of the flowering and non-flowering individuals in the two forests was 1:1 and 1:2 respectively, and the population sizes were 4 millions and 10 millions (Fintha 1994).

In the Kupi-Forest we discovered a little population of several hundred individual in the direction of south-southwest, it is about at 500 m distance

from the known population. This suggests a larger area covered once by Crocus in this forest (Köteles 1995).

The result of the coenological studies corresponded with literature data: all the 3 populations are mainly in Hornbeam-Pedunculate Oak forest (*Querco robori-Carpinetum* Soó et Pócs) stands, uniformly in asperulatosum type which is characteristic of damper soil conditions. These soil conditions are in a great degree similar to the conditions of the subalpin meadows, where the *Crocus heuffelianus* lives originally. If the quantitative aspects of the coenological components of the 3 forests are considered as weights, then we get the following results (Fig. 1). We should assign the smaller differences to plant geographical reasons and to sylvicultural management.

. If we investigate the 3 forest communites on basis of the nature conservation ranks (Simon 1988), we find, that the dispersions are not significantly different, and all of them are in good conditions (Fig. 2).

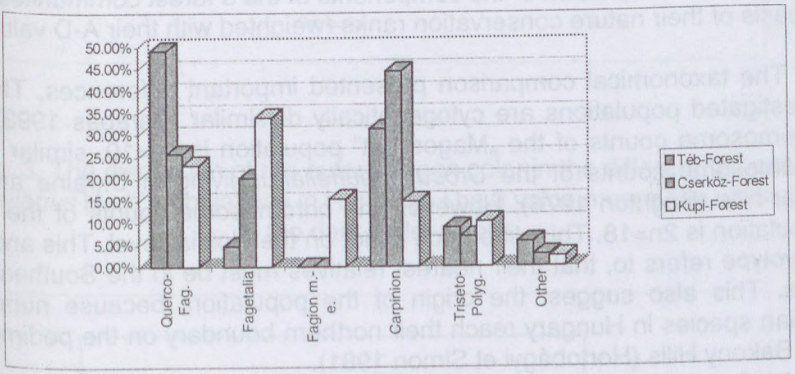



Fig. 1. The dispersion of the components of the 3 forest communites on the basis of their coenological identification (weighted with their A-D values).

The detailed comparision of coenological tables was made with principal component analysis (PCA), and with 4 kind of classification analysis (single and complete link methods). The results of these analyse are equivocial: The forest communites of Kup and the Beregi-sík where *Crocus heuffelianus* lives, do not separate clearly from each other (Köteles 1995).

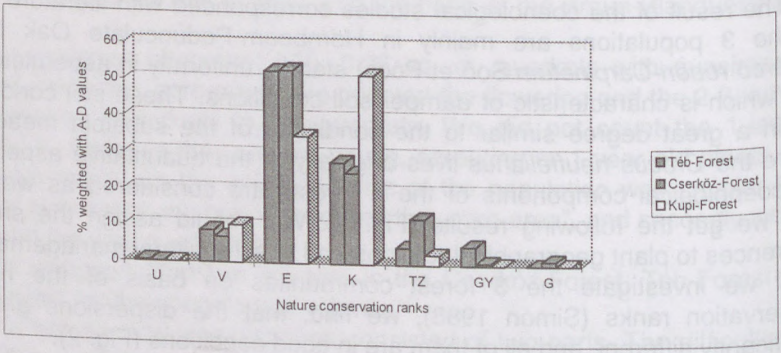



Fig. 2. The dispersion of the components of the 3 forest communites on basis of their nature conservation ranks (weighted with their A-D values).

The taxonomical comparison presented important differences. The two investigated populations are cytogenetically dissimilar (Barabás 1993). The chromosome counts of the „Magosliget" population is 2n=10, similar to the chromosome counts of the *Crocus heuffelianus* living in Ukraine and the Bihar-hills (Brighton 1976). However, the chromosome counts of the „Kup" population is 2n=18. This difference is not on the ploidial level. This and their karyotype refers to, that their nearest relatives must be in the Southeastern-Alps. This also suggest the origin of the population, because numerous Illyrian species in Hungary reach their northern boundary on the pediment of the Bakony Hills (Hortobágyi et Simon 1981).

Leaf epidermis cells were significantly different in lenght, both in the lower and upper epidermis, and stomatal density in the abaxial epidermis was significantly different too. (See below)

| | KUP | MAGOSLIGET |
|---|---|---|
| The length of the cells in the lower epidermis. | n=110<br>**av=213,4 μm**<br>V=3924,9 | n=170<br>**av=159,2 μm**<br>V=2390,5 |
| The length of the cells in the upper epidermis. | n=94<br>**av=437,6μm**<br>V=11506,8 | n=163<br>**av=314,7 μm**<br>V=6203,8 |
| The number of the stomas per 0,1 sq. mm. | n=26<br>**av=9,46**<br>V=1,2985 | n=26<br>**av=13,46**<br>V=6,0985 |

The macromorphological chracteristics of the flowers were in more point of view different. In the throat of the perigon, there are the flowers of the

„Kup" populations hairy, and the flowers from the Beregi-sík hairless. The dispersion of the color of the outer perigon segments were unambiguosly dissimilar (Fig. 3), the form of the tip of the outer perigon segments, and the shape of the pattern under the tip displayed dissimilarity, too (Fig. 4-5). There are differences in the width of the leaves, but we have not enough data for the exact investigation yet.

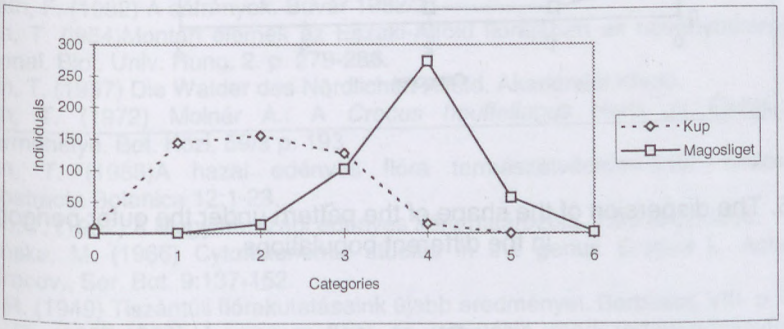



Fig. 3. The dispersion of the outer perigon color in the different *Crocus heuffelianus* Herb. populations in Hungary. The 0 value means the white, the 6 the dark-violet colors.

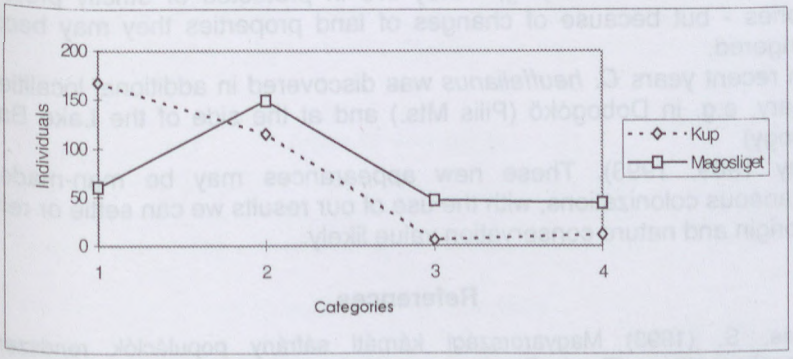



Fig. 4. The dispersion of the form of the outer perigon tips in the different populations.

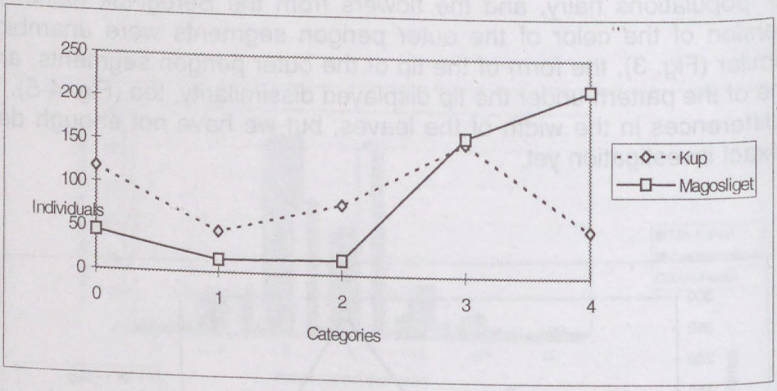



Fig. 5. The dispersion of the shape of the pattern under the outer perigon-tips in the different populations.

## Discussion

Although the plant communites, where the studied *Crocus heuffelianus* Herb. populations live, are essentialy identical, there are big differences in the morphology and taxonomy of plants. This fact increases first of all the value of the population in the Kupi-Forest, because this represents a taxon, which does not occur elsewhere in Hungary, and their size quite small. Their present position is satisfying, - they live in protected or strictly protected territories - but because of changes of land properties they may become endangered.

In recent years *C. heuffelianus* was discovered in additional localities in Hungary, e.g. in Dobogókő (Pilis Mts.) and at the side of the Lake Baláta (Somogy)
(Kevey 1989, 1993). These new appearances may be man-made or spontaneous colonizations, with the use of our results we can settle or render their origin and nature conservation value likely.

## References

Barabás, S. (1993) Magyarországi kárpáti sáfrány populációk rendszertani összehasonlítása. Thesis, Bp.
Brighton, C. A., Mathew, B. (Marchant, C. J. (1973) Chromosome counts in the Genus *Crocus* (*Iridaceae*). Kew Bulletin Vol. 28 (3).
Brighton, C. A. (1976) Cytological problems in the genus *Crocus* (*Iridaceae*): I. *Crocus vernus* aggregate. Kew Bulletin Vol. 31 (1).
Fintha, I. (1994) Az Észak-Alföld edényes flórája. TermészetBÚVÁR Alapítvány Kiadó, Bp.

Kevey, B. (1989) Adatok Magyarország flórájának és vegetációjának ismeretéhez V. BK 76/1-2.
Kevey, B. (1993) Adatok Magyarország flórájának és vegetációjának ismeretéhez VI. BK 80/1.
Köteles, F. (1995) Vizsgálatok a kupi *Crocus heuffelianus* állomány őshonosságának kérdéskörében. Thesis, ELTE TTK, Bp.
Mathew, B. (1980) Crocus in Vol. 5 of Flora Europaea, ed. T. G. Tutin, V. H. Heywood *et al.* Cambridge.
Mathew, B. (1982) The Crocus, a revision of the genus *Crocus* (*Iridaceae*), London.
Németh, F. (1982) A sáfrányok. Búvár 1982/2.
Simon, T. (l954)Montán elemek az Északi-Alföld flórájában és növénytakarójában. Annal. Biol. Univ. Hung. 2. p. 279-286.
Simon, T. (1957) Die Walder des Nördlichen Alföld. Akadémiai Kiadó.
Simon, T. (1972) Molnár A.: A *Crocus heuffelianus* Herb. új Észak-Alföldi termőhelye. Bot. Közl. 59/3 p. 193 .
Simon, T. (1988)A hazai edényes flóra természetvédelmi-érték besorolása. Abstracta Botanica 12:1-23.
Simon, T. (1992) A Magyarországi edényes flóra határozója. Tankönyvkiadó.
Skalińska, M. (1966) Cytotaxonomic studies in the genus *Crocus* L. Acta Biol. Cracov., Ser. Bot. 9:137-152.
Soó, R. (1949) Tiszántúli flórakutatásaink újabb eredményei. Borbásia, VIII. p. 57.
Soó, R. (1957-1983) A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve I-VII. Akadémiai Kiadó.
Tallós, P. (1952) Érdekes és újabb florisztikai adatok a Bakonyból és Magyarország egyéb tájairól. Bot. Közl. 46. p. 313-314.

# LICHENS OF THE DANUBE DELTA BIOSPHER RESERVE , ROMANIA

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**Abstract.** The lichen flora of the DDBR was studied between 1991 - 1992. The sampling sites are located in : strictly protected areas (Insula Popina, Caraorman, Cap Dolosman), buffer zone (Malius) and in extra-Delta areas (Babadag, Enisala). A number of 108 species (37 genera), from 16 families, are reported. Three species *Ramalina evernoides* Nyl., *Phaeophyscia poeltii* Frey and *Leprocaulon microscopicum* (Vill.) Gams are reported for the first time in Romania.

The Danube Delra Biosphere Reserve (DDBR) has a total area of about 5800 $km^2$, the delta itself is the largest component of this reserve, with an area of about 4178 $km^2$, out of which 3446 $km^2$(82 %) are on the territory of Romania.

The DDBR, the greatest wetland of Europe, is a vital centre for biodiversity, and a natural genetic bank with incalculable value for global natural heritage.

Little previous work has been done on the lichens of the Danube Delta. Cretzoiu (1934 - 1936, 1942) , Cretzoiu and Badea (1937) reported some species in Letea and Babadag areas. Between 1972 - 1974, Vezda studied the Dobrogea's lichenflora, and he identified two epiphyte lichen species belonging to *Physciaceae* family, on the DDBR border zone, in Babadag's vicinity forests (Table 1).

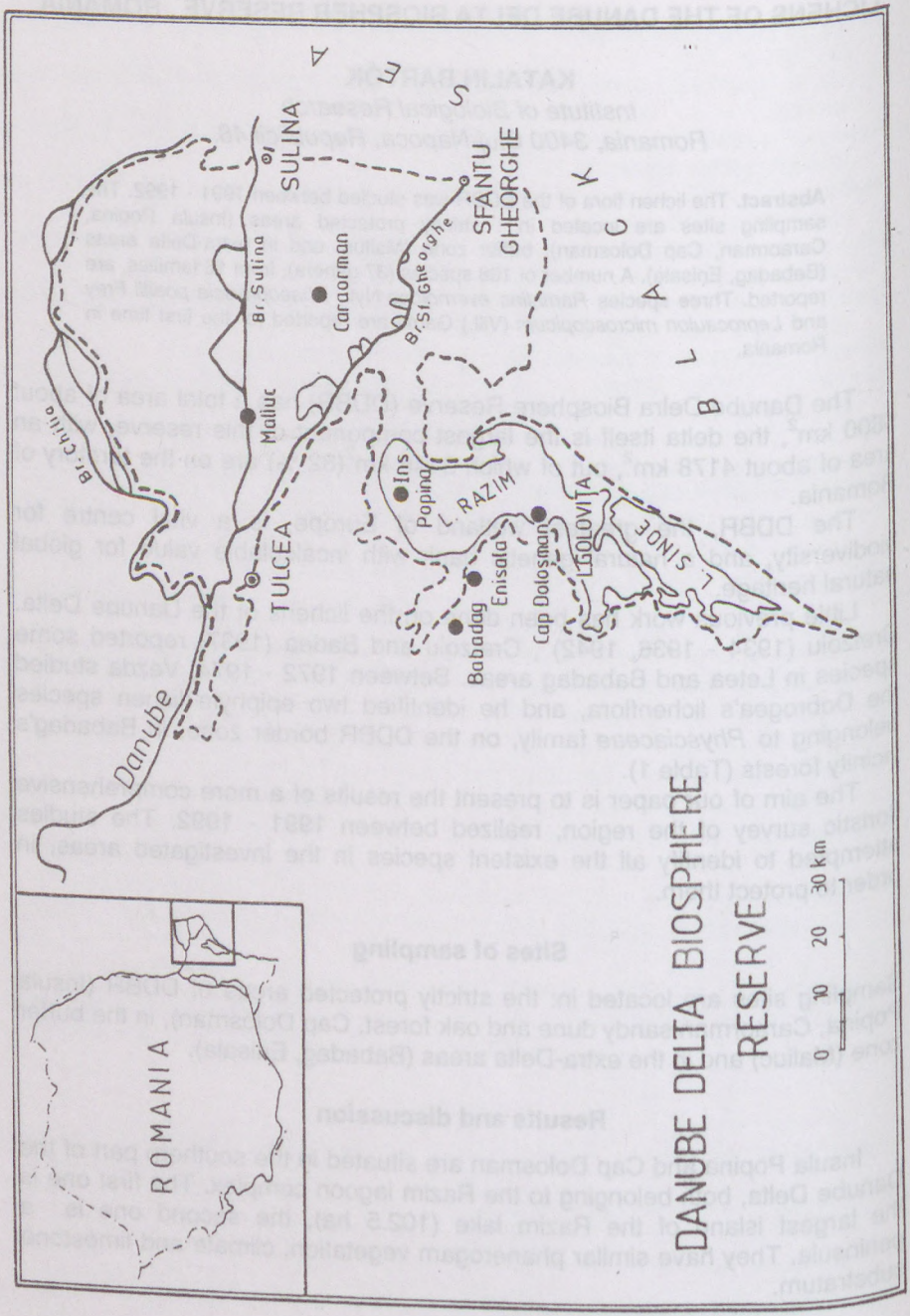
The aim of our paper is to present the results of a more comprehensive floristic survey of the region, realized between 1991 - 1992. The studies attempted to identify all the existent species in the investigated areas, in order to protect them.

## Sites of sampling

Sampling sites are located in: the strictly protected areas of DDBR (Insula Popina, Caraorman sandy dune and oak forest, Cap Dolosman), in the buffer zone (Maliuc) and in the extra-Delta areas (Babadag, Enisala).

## Results and discussion

Insula Popina and Cap Dolosman are situated in the southern part of the Danube Delta, both belonging to the Razim lagoon complex. The first one is the largest island of the Razim lake (102.5 ha), the second one is a peninsula. They have similar phanerogam vegetation, climate and limestone substratum.


ROMANIA
DANUBE DELTA BIOSPHERE RESERVE
0 10 20 30 km
Danube
Br. Chilia
Malluc
Br. Sulina
SULINA
TULCEA
Caraorman
Br. Sf. Gheorghe
SFANTU GHEORGHE
BLACK SEA
Ins
Popina
L. RAZIM
Babadag
Enisala
Cap Dolosman
LEGOVITA
L. SINOE

The wooden vegetation is very scarce, consisting mainly of shrubs, no lichen vegetation was identified on them.

The soil of both sites is covered with abundant herbaceous vegetation, among rocks and stones of different sizes. Most of the lichen taxa in both sites (Insula Popina and Cao Dolosman) occur exclusively on rocks, showing a high similarity (Fig. 1). In the initial stage of succession, the endolithic crustose lichens (Jonaspis) established on these rocks, followed by the epilithic *Lecanora* and *Lecidea* species, in the last phase of succession the foliose *Parmelia* and *Placodium* type lichens (*Caloplaca, Xanthoria, Physcia* etc.) appeared. A few lichens (*Collema, Leptogium*) occurred primarily on submerged rocks.

Lichens were found rarely on soil, mosses and decaying vegetable matter, excepting the *Cladonia* Species, which form moderately extensive patches (over 3 % covering).

The atmospheric humidity is high (over 60-70 %), due to the vicinity of the Razim lake, the precipitation is low (300-400 mm/year). Therefore the lichenflora of Insula Popina and Cap Dolosman is photophilous, xerophilous, well adapted to arid conditions, strong insolation and winds.

The sand dunes of Caraorman are characterized by a specific salt - and sand loving vegetation. *Cladonia foliacea* var. *convoluta* is the most frequent species, exclusively terricolous, xerophilous, well adapted to survival through long arid periods. On these dunes, *Leprocaulon microscopicum* (Vill.) Gams, a species generally found in southern hemisphere, has been identified for the first time in Romania.

A lot of corticolous lichens were found in the oak (*Quercus pubescens, Quercus petraea*) forest from Caraorman, most of them similar to those from Enisla. *Ramalina evermoides* Nyl. is a new record for Romania. This species required high air humidity and warm climate.

In the Maliuc stationary a poplar plantation grew vigorously, in the easy flooded places. The poplar trunks have been invaded by *Xanthoria* and *Physcia* species, which are cosmopolitan with large ecological amplitudes.

At the border of DDBR, on the Babadag plateau, some oak forests have been studied, namely: ' 6 Martie', ' Doi iepurasi' and ' Padurea de tei' nearby Babadag and Enisala localities. The Babadag plateau is situated at the border between a continental climate, with some piemontan nuances and a maritime seaside climate. So, the Babadag plateau climate is moderate - continental, submediterranean. The phanerogam vegetation, which is the main substratum for lichens, is formed by submezotherme - up to werotherme species: *Quercus petraea, Quercus pubescens, Tilia plathyphyllos, Fraxinus excelsior, Acer campestris, Carpinus orientalis* etc.

A complexity of factors (Physico - geographical, geo - morphological and pedo - climatical), and the arboreal vegetation have determined and favoured the development of a rich lichenflora (Table 2).

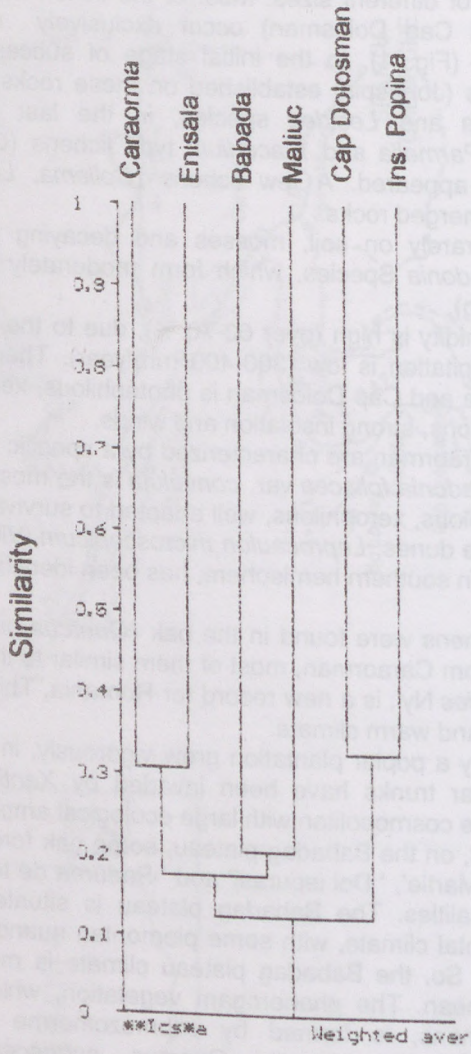



Fig. 1. Similarity of biotops based on lichen species (Soerensen Index).

The epiphyte lichens are dominant, the foliose life - forms have a higher diversity as compared with the crustose ones. *Phaeophyscia poeltii* Frey was reported for the first time in Romania, in ' Padurea de tei' from Babadag.

Several clear differences concerning frequency, abundance and areas of lichen species have been reported. Rare and very rare taxa are most important taxonomically and ecologically.

Table 1. Lichens of the Danube Delta Biosphere Reserve (records before 1990)

| Systematic arrangement/Species | Sampling site | Author | Year of recording | Information source |
|---|---|---|---|---|
| Cl. Ascolichenes<br>Subcl. Pyrenolichenes<br>Ord. Lecanorales<br>Fam. Cladoniaceae | | | | |
| Cladonia foliacea var. convoluta | Letea | Cretzoiu P.<br>Badea M. | 1937 | Rev. St. Adamachi XXXIII, 3, 145 |
| Cladonia rangiformis | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |
| Fam. Parmeliaceae | | | | |
| Parmelia verruculifera var. conspurcata | Letea | Cretzoiu P.,<br>Badea M. | 1937 | Rev. St. Adamachi XXXIII, 3, 145 |
| Parmelia sulcata | Letea | Cretzoiu P.,<br>Badea M. | 1937 | Rev. St. Adamachi XXXIII, 3, 145 |
| Parmelia tiliacea | Letea | Cretzoiu P.,<br>Badea M. | 1937 | Rev. St. Adamachi XXXIII, 3, 145 |
| Parmelia molliuscula ssp. vagans | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |
| Parmelia prolixa var. ryssolea | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |
| Evernia prunastri | Enisala | Cretzoiu P. | 1942 | Sond. Muz. Mitt. Tech. Hoch. Bucuresti 71 |
| Fam. Teloschistaceae | | | | |
| Xanthoria parietina | Letea | Cretzoiu P.,<br>Badea M. | 1937 | Rev. St. Adamachi XXXIII, 3, 145 |
| Caloplaca callopisma var. enisalae | Enisala | Cretzoiu P. | 1942 | Sond. Muz. Mitt. Tech. Hoch. Bucuresti 71 |
| Fam. Physciaceae | | | | |
| Physcia leptalea | Babadag | Vezda A. | 1974 | Lich. Sel. Exs. Fasc.LI nr.126l |
| Physcia leptalea | Letea | Cretzoiu P.,<br>Badea M. | 1937 | Rev. St. Adamachi XXXIII, 3, 145 |
| Physcia adscendens | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |
| Physcia orbicularis | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |

| Systematic arrangement/Species | Sampling site | Author | Year of recording | Information source |
|---|---|---|---|---|
| Physcia stellaris | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |
| Anaptychia ciliaris | Letea | | 1937 | Rev. St. Adamachi XXXIII, 3, 145 |
| Anaptychia ciliaris f. actinota | Letea | | 1937 | Rev. St. Adamachi XXXIII, 3, 145 |
| Anaptychia ciliaris v. romanica | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |
| Anaptychia setifera | Babadag | Vezda A. | 1972 | Lich. Sel. Exs. Fasc.LI nr. 1124 |
| Fam. Lecideaceae | | | | |
| Lecidea parasema | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |
| Fam. Lecanoraceae | | | | |
| Lecanora muralis | Enisala | Cretzoiu P. | 1942 | Sond. Muz. Mitt. Tech. Hoch. Bucuresti 71 |
| Lecanora calcarea | Enisala | Cretzoiu P. | 1942 | Sond. Muz. Mitt. Tech. Hoch. Bucuresti 71 |
| Lecanora syringea | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |
| Ord. Pyrenulales Fam. Pyrenulaceae | | | | |
| Arthopyrenia sphaeroides | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |
| Fam. Opegraphaceae | | | | |
| Opegrapha atra | Letea | Cretzoiu P. | 1934-1936 | Bul. Soc. St. in St. Nat. Bucuresti, 126 |

Table 2. Lichens of the Danube Delta Biosphere Reserve (1991-1992)
( Site I. - Delta strictly protected areas, Site II. - Extra Delta)

| Systematic arrangement / Species | Site I. | Site II. | Subtrate | Biotope | Quantity | Novelty |
|---|---|---|---|---|---|---|
| Incr. Lichenophyta Cls. Ascolichenes Ord. Pyrenulales Fam. Pyrenulaceae | | | | | | |
| Pyrenula nitida | Cap Dolosman | Babadag | Ep. | Frax., Tilia, Carp. | C | L |
| Arthopyrenia punctiformis | | Babadag | Ep. | Frax. | C | L |
| Ord. Graphidales | | | | | | |
| Fam. Arthoniaceae | | | | | | |
| Arthonia cinnabarina | | Babadag | Ep. | Frax. | R | L |
| Arthonia tumidula | | Babadag | Ep. | Frax. | R | L |
| Fam. Graphidaceae | | | | | | |
| Graphis scripta | | Babadag | Ep. | Carp., Tilia | rC | L |

| Systematic arrangement / Species | Site I. | Site II. | Subtrate | Biotope | Quantity | Novelty |
|---|---|---|---|---|---|---|
| Fam. Opegraphaceae | | | | | | |
| Opegrapha varia | | Babadag | Ep. | Tilia | rC | L |
| Opegrapha atra | | Babadag | Ep. | Tilia, Quer., Acer | rC | L |
| Opegrapha betulina | | Babadag | Ep. | Tilia | rC | L |
| Melaspilea arthonioides | | Babadag | Ep. | Tilia | vR | L |
| Ord. Lecanorales Fam. Collemaceae | | | | | | |
| Collema auriculatum | Insula Popina | | Sax. | Wet stone | rC | L |
| Collema flaccidum | Insula Popina | | Sax. | Wet stone | C | L |
| Leptogium lichenoides | Insula Popina | | Sax. | Wet stone | C | L |
| Fam. Lecideaceae | | | | | | |
| Lecidea parasema | Maliuc | Babadag | Ep. | Frax., Pop. | C | L |
| Lecidea rubella | Maliuc | Babadag | Ep. | Cor., Pop. | C | L |
| Lecidea viridens | Maliuc | Babadag | Ep. | Acer, Pop. | C | L |
| Lecidea lepicida var. lactea | Insula Popina | | Sax. | Stone | R | L |
| Lecidea elaeochroma | | Negru Voda | Ep. | Quer. | C | L |
| Lecidella carpathica | Insula Popina | | Sax. | Stone | rC | L |
| Rhizocarpon badioatrum | Insula Popina | | Sax. | Stone | C | L |
| rhizicarpon viridiatrum | Cap Dolosman | | Sax. | Stone | rC | L |
| Toninnia aromatica tenuissima | Cap Dolosman | | Sax. | Stone | rC | L |
| Toninia coeruleonigricans | Cap Dolosman | | Sax. | Stone | C | L |
| Fam. Cladoniaceae | | | | | | |
| Icmadophyla ericetorum | | Babadag | Ep. | Acer, Frax., Cor. | C | L |
| Cladonia foliacea var. convoluta | Caraorman, Insula Popina | | Terr. | Soil | rC | L |
| Cladonia subcerviformis | Insula Popina | | Terr. | Soil | vR | Ro |
| Cladonia tenuata | Insula Popina | | Terr. | Soil | vR | Ro |
| Fam. Hymeneliaceae | | | | | | |
| Aspicilia caesiocinerea | Cap Dolosman | | Sax. | Rock | C | L |
| Aspicilia cinerea | Cap Dolosman | | Sax. | Rock | C | L |
| Aspicilia radiosa | Cap Dolosman, Insula Popina | | Sax. | Rock | C | L |

| Systematic arrangement / Species | Site I. | Site II. | Subtrate | Biotope | Quantity | Novelty |
|---|---|---|---|---|---|---|
| Ionaspis epulotica | Insula Popina | | Sax. | Rock | C | L |
| Ionaspis cyrtaspis | Insula Popina | | Sax. | Rock | C | L |
| Fam. Lecanoraceae | | | | | | |
| Lecanora pallida | Caraorman | Babadag, Enisala | Ep. | Quer., Acer, Tilia, Carp. | C | L |
| Lecanora carpinea | Cap Dolosman | Babadag, Enisala | Ep. | Cor., Tilia, Quer., Acer | C | L |
| Lecanora conizaeoides | | Babadag, Enisala | Ep. | Cor., Tilia, Carp. | C | L |
| Lecanora subfusca | Cap Dolosman, Caraorman | Babadag, Enisala | Ep. | Acer, Quer. | C | L |
| Lecanora symmicta | | Babadag | Ep. | Acer, Quer. | rC | L |
| Lecanora confusa | | Babadag | Ep. | Carp. | rC | L |
| Lecanora populicola | | Babadag | Ep. | Carp. | rC | L |
| Lecanora muralis | Cap Dolosman | | Sax. | Stone | C | L |
| Lecanora campestris | Cap Dolosman | | Sax. | Stone | rC | L |
| Lecanora intricata | Cap Dolosman, Insula Popina | | Sax. | Stone | C | L |
| Lecanora rupicola | Cap Dolosman, Insula Popina | | Sax. | Stone | C | L |
| Lecanora polytropa | Insula Popina | | Sax. | Stone | C | L |
| Lecanora atra | Insula Popina | | Sax. | Stone | C | L |
| Lecanora badia | Insula Popina | | Sax. | Stone | C | L |
| Lecania cyrtella | | Babadag | Ep. | Carp. | rC | L |
| Fam. Candellariaceae | | | | | | |
| Candelaria concolor | | Babadag | Ep. | Cor., Tilia, Acer | C | L |
| Candelaria xanthostygma | | Babadag | Ep. | Carp. | C | L |
| Candelariella corallina | | Babadag | Ep. | Cor., Tilia, Acer | C | L |
| Candelariella vitellina | Cap Dolosman, Insula Popina | | Ep., Sax. | Carp., Rock | C | L |

| Systematic arrangement / Species | Site I. | Site II. | Subtrate | Biotope | Quantity | Novelty |
|---|---|---|---|---|---|---|
| Fam. Parmeliaceae | | | | | | |
| Parmeliopsis hyperopta | | Babadag | Ep. | Cor., Carp., Frax. | C | L |
| Parmeliopsis ambigua | | Babadag | Ep. | Carp. | C | L |
| Parmeliopsis aleuritens | | Babadag | Ep. | Carp. | C | L |
| Parmelia conspersa | Insula Popina | | Sax. | Rock | C | L |
| Parmelia quercina | | Babadag, Enisala | Ep. | Carp. | C | L |
| Parmelia tiliacea | | Babadag, Enisala | Ep. | Tilia, Acer, Quer., Ulmus | C | L |
| Parmelia caperata | | Babadag, Enisala | Ep. | Tilia | C | L |
| Parmelia dubia | | Babadag | Ep. | Tilia | C | L |
| Hypogymnia physodes | | Babadag | Ep. | Carp., Frax., | C | L |
| Evernia prunastri | | Babadag | Ep. | Frax., Acer, Quer. | C | L |
| Fam. Ramalinaceae | | | | | | |
| Ramalina pollinaria | | Babadag | Ep. | Frax. | C | L |
| Ramalina evernoides | Caraorman | | Ep. | Quer. | vR | Ro |
| Ramalina farinacea | Caraorman | | Ep. | Quer. | rC | L |
| Ramalina fastigiata | Cap Dolosman | | Ep. | Carp. | C | L |
| Ord. Teloschistales Fam. Teloschistaceae | | | | | | |
| Caloplaca citrina | Cap Dolosman, Insula Popina | | Sax. | Rock | C | L |
| Caloplaca chalybea | Cap Dolosman, Insula Popina | | Sax. | Rock | C | L |
| Caloplaca saxicola | Insula Popina | | Sax. | Rock | C | L |
| Caloplaca flavovirescens | Insula Popina | | Sax. | Rock | C | L |
| Fam. Telocarpaceae | | | | | | |
| Xanthoria parietina | Cap Dolosman, Caraorman, Insula Popina, Maliuc | Babadag | Ep. | Carp., Acer, Tilia, Pop. | C | L |
| Xanthoria polycarpa | Cap Dolosman, Caraorman, Maliuc | Babadag | Ep. | Carp., Cor., Acer, Quer., Pop., Pirus | rC | L |

| Systematic arrangement / Species | Site I. | Site II. | Subtrate | Biotope | Quantity | Novelty |
|---|---|---|---|---|---|---|
| Xanthoria substellaris | | Enisala | Ep. | Frax., Carp. | rC | L |
| Xanthoria elegans | Cap Dolosman, Insula Popina | Babadag | Ep., Sax. | Cor., Rock | rC | L |
| Xanthoria lobulata | Cap Dolosman | | Ep. | Carp. | R | L |
| Xanthoria aureola | Cap Dolosman | | Ep. | Carp. | R | L |
| Xanthoria fallax | Cap Dolosman | | Sax. | Rock | R | L |
| Fam. Physciaceae | | | | | | |
| Buellia epipolia | Insula Popina | | Sax. | Rock | rC | L |
| Buellia badia | Insula Popina | | Sax. | Rock | rC | L |
| Rinodina bischoffii | Cap Dolosman | | Sax. | Rock | R | L |
| Rinodina immersa | Cap Dolosman | | Sax. | Rock | R | L |
| Physcia stellaris | | Babadag | Ep. | Carp., Acer | C | L |
| Physcia aipolia | | Babadag | Ep. | Cor. | C | L |
| Physcia tenella | Cap Dolosman, Caraorman, Insula Popina, Maliuc | Babadag | Ep., Sax. | Cor., Acer, Frax., Quer., Pop., Pirus, Rock | C | L |
| Physcia adscendens | Maliuc | Babadag, Negru Voda | Ep. | Cor., Acer, Quer., Pop. | C | L |
| Physcia pulverulenta | | Enisala, Babadag | | | C | L |
| Physcia leptalea | Caraorman | Babadag | Ep. | Acer, Quer., Cor., Carp., | C | L |
| Physcia leucoleiptes | | Enisala, Babadag | Ep. | Frax. | C | L |
| Physcia caesia | Caraorman | Enisala | Ep. | Quer. | C | L |
| Physcia pallescens | Caraorman | Enisala | Ep. | Quer. | C | L |
| Phaeophyscia orbicularis | Caraorman | Babadag | Ep. | Carp., Tilia, Acer, Frax., Quer. | rC | L |
| Phaeophyscia nigricans | | Babadag | Ep. | Carp. | vR | L |
| Phaeophyscia poeltii | | Babadag | Ep. | Quer. | vR | Ro |
| Physconia grisea | | Babadag | Ep. | Cor., Acer, Frax. | rC | L |

| Systematic arrangement / Species | Site I. | Site II. | Subtrate | Biotope | Quantity | Novelty |
|---|---|---|---|---|---|---|
| Physconia muscigena | | Babadag | Terr., Mus. | Tilia | R | L |
| Anaptychia ciliaris | | Babadag | Ep. | Acer | C | L |
| Anaptychia speciosa | | Babadag | Ep. | Acer | C | L |
| Ord. Pertusariales Fam. Pertusariaceae | | | | | | |
| Phlyctis agelaea | | Babadag | Ep. | Frax., Quer., Carp., Tilia, Acer | C | L |
| Phlyctis argena | | Babadag | Ep. | Frax., Quer., Carp., Tilia, Acer | C | L |
| Pertusaria lactea | | Babadag | Ep. | Acer | C | L |
| Pertusaria pertusa | | Babadag | Ep. | Acer, Frax., Carp. | | |
| Pertusaria multipunctata | | Babadag | Ep. | Frax., Quer. | C | L |
| Pertusaria hymenea | | Babadag | Ep. | Frax., Carp. | C | L |
| Pertusaria hemispherica | | Babadag | Ep. | Quer. | C | L |
| Pertusaria amara | | Babadag | Ep. | Carp. | C | L |
| Cl. Hypholichenes | | | | | | |
| Lepraria candelaria | | Babadag | Ep. | Cor., Tilia, Acer | C | L |
| Lepraria incana | | Babadag | Ep. | Carp., Acer | C | L |
| Lepraria latebrorum | | Babadag | Ep. | Frax. | C | L |
| Leprocaulon microscopium | Caraorman | | Terr. | Soil | vR | Ro |

**Legend:**

Site I. - Delta strictly protected areas
Site II. - Extra Delta

Ep. - epiphyte
Mus. - muscicolous
Sax. - saxicolous
Terr. - terricolous

Carp. - Carpinus
Corn. - Cornus
Frax. - Fraxinus
Pop. - Populus
Quer. - Quercus

C- common
rC - relatively common

R - rare
vR - very rare

L - first recorded in DDBR
Ro - first recorded in Romania

## References

Cretzoiu, P. (1934-1936) Catalogul lichenior cunoscuti pina acum din Dobrogea. Bul. Soc. Studentilor in St. Nat. Din Bucuresti. 12.

Cretzoiu, P. (1942) Due bisher aus der Dobrogea bekannt gewordenen Lecanoraceae. Sondardruk Mus. Mittl. Techn. Horchs. Bucuresti. 71.

Cretzoiu, P. & Bodea, M. (1937) Raport asupra lichenilor din Delta Dunarii. Rev. St.V. Adamachi, Iasi, 23, 3, 145.

Vezda, A. (1974) Lichenes Selecti Exsiccati. Editi ab Inst. Botanico Universitatis Agriculturae et Silviculturae, Brno, Czechoslovakia, Fasc. XLV, 1972, Fasc. LI.

Management Objectives for Biodiversity Conservation and Sustainable Development in the Danube Delta Biosphere Reserve. Draft. 1995.

# ENZYMATIC ACTIVITY IN PEAT UNDER DIFFERENT PLANT ASSOCIATIONS IN THE MOOR MOLHAŞUL CEL MARE DE LA IZBUC

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**Abstract:** Enzymological analyses were carried out on 25 peat samples taken from different depths in 5 plant asociations belonging to the moor Molhaşul cel Mare de la Izbuc: *Sphagno-Piceetum* (Tx 37) Hartman 42, *Carici echinatae-Sphagnetum* Soó (34) 35, *Pino mugo-Sphagnetum* Köstner et Flössner 33, *Eriophoro vaginati-Sphagnetum recurvi* Hueck 25 and *Caricetum limosae* Br-Bl 21. Six enzymatic and nonenzymatic catalityc activities were measured in peat samples. The highest activities were registered in the peat under the. The maximum stability of the enzymatic and nonemzymatic activities was found in the peat under the association *Eriophoro vaginati-Sphagnetum recurvi.*

Molhaşul cel Mare de la Izbuc, lying at an altitude of about 1 100 m high, on the upper course of Someşul Cald, on the right side of Izbuc river, has an area of approximately 8 ha and a moorish deposit of about 320,000 $m^2$. It is one of the biggest deposits from Apuseni mountains, and at the same time it is the most genuine peat bog of the area and among the most genuine all over the country.

In the process of peat formation, the enzymes, come as a result of the activity of the microorganisms, play an important role besides other factors involved in the process.

In the present paper, we describe our enzymological studies on some peat samples, collected from the Molhaşul cel Mare de la Izbuc moor.

## Material and methods

For the enzymological analyses we studied 5 profiles of peat, under the following plant associations, characteristic for the peat bog: *Sphagno-Piceetum* (Tx 37) Hartman 42, *Carici echinatae-Sphagnetum* Soó (34) 35, *Pino mugo-Sphagnetum* Köstner & Flössner 33, *Eriophoro vaginati-Sphagnetum recurvi* Hueck 25 and *Caricetum limosae* Br-Bl 21.

Five peat samples were collected from each moor profile. The peat was sampled from 0-10 cm to 40-50 cm.

The following enzymatic and nonenzymatic catalytic activities have been measured in the peat samples: phosphatase, nonenzymatic hydrolase of disodium phenilphosphatase, catalase, nonenzymatic $H_2O_2$ splitting, present and potential dehydrohenase (TTC reduction). In order to measure the nonenzymatic activities, thermically inactivated samples were used. The inactivation was carried out at 120°C/hour in three succesive days. The methods used are discribed by [1], [3] and [5]. For the enzymological

analyses the peat with natural humidity was used. The content in dry matter of the peat was measured by its drying at 105°C/72 hours.

Phosphatase activity and nonenzymatic hydrolase of disodium phenilphosphatase are expressed in mg phenol/2.5 g peat dry matter. Catalase activity and nonenzymatic $H_2O_2$ splitting are expressed in mg decomposed $H_2O_2$/1.5 g peat dry matter. TTC reduction activities are expressed in mg triphenylformazan/3 g peat dry matter.

## Results

The analytical information obtained at the 5 peat profiles are rendered in Table 1. (pp. 298-299). The content in dry matter is extremely low and it ranges between 5.88 and 13.06%. Out as the information Table 1. (pp. 298-299), we notice that the enzymatic and nonenzymatic activities were pointed out in all the peat samples, registering as a whole oscillation as related to the collecting depth of the samples. The enzymatic catalytic activities are by far more intensive than the nonenzymatic ones. The most important values were obtained in the peat collected under the associations: *Caricetum limosae* (nonenzymatic hydrolase of disodium phenyl-phosphate, actual and potential dehydrogenase), *Eriophoro vaginati-Sphagnetum recurvi* (catalase and nonenzymatic $H_2O_2$ splitting), and in the peat under the association *Carici echinatae-Sphagnetum* for the phosphatase activity.

The analytical results out of Table 1. (pp. 298-299) were the basis for the enzymological comparison of the peat sampled under the 5 plant associations. The enzymological comparison was made:

1) according to the absolute and relative mean values of the enzymatic and nonenzymatic catalytic activities and to the enzymatic indicator of peat quality;

2) according to the variability coefficient of the enzymatic and nonenzymatic catalytic activities and to the variability enzymatic indicator of peat quality.

In the Table 2. (pp. 300) the absolute and relative mean values of enzymatic and nonenzymatic catalytic activities are rendered, as well as the enzymatic indicators of peat quality under the 5 plant associations.

Out of the information of this table, which reflects the intensity of the activities, we can observe that the peat under the association *Carici echinatae-Sphagnetum* is the most active, as it results out of the maximum value of the enzymatic indicators of peat quality (546.37).

The variability coefficiens, their relative values, as well as the variability enzymatic indicators of peat quality are presented in Table 3. (pp. 301). The minimum variability of the enzymatic activities can be interpreted as maximum stability from the biological point of view, as the enzymatic activity is tightly conected with the life of the peat, the enzymes being produces by the living beings.

Out of the information of Table 3. (pp. 301) we can notice that the peat under *Eriophoro vaginati-Sphagnetum recurvi* association has a more emphasised stability of the enzymatic activities. Its variability indicator is the lowest (128.50). The most pronunced variability namely the largest instability of the enzymatic activities was registered in the peat under the *Caricetum limosae* association (variability indicator = 366.55).

## Conclusions

1. In the 25 peat samples, collected from different dephts under 5 plant associations from Molhaşul cel Mare de la Izbuc moor, it was possible to point out all the 6 enzymatic and nonenzymatic catalytic activities: phosphatase, nonenzymatic hydrolase of disodium phenilphosphatase, catalase, nonenzymatic $H_2O_2$ splitting, present and potential dehydrohenase.

2. On the base of the enzymatic indicators (intensity) and of the variability enzymatic indicators (stability) of peat quality, one may notice that the enzymatic potential of the peat under *Carici echinatae-Sphagnetum* is the highest and the peat under *Eriophoro vaginati-Sphagnetum recurvi* is the most stable.

## References

Casida, L.E.jr., Klein, D.A. & Santoro, T. (1964) Soil dehidrogenase activity, Soil Sci., 98:371-376.

Crişan, R., Paşca, D. & Kiss,S. (1992) Enzymatic activity in peat under different plant associations in the moors Căpăţâna and Blăjoaia (Cluj county), Lucr. Congr. Nat. Biol. "Emil Racovită, Iaşi, 122.

Kappen, H.(1913) Die katalytische Kraft des Ackerbodens, Fühlings Landw. Ztg. 62:377-392.

Krámer, M. & Erdei, G.(1959) Primenenie metoda opredeleniia aktivnosto fosfatazî v agrohimiceskih issledovaniiah, Pocivivedenie, Nr.9:99-102.

Paşca, D., Crişan,R., Zborovschi, E., Pintea, H. & Radu, H. (1989) Analiza enzimologică a zăcămintelor de turbă din bazinul Someşului Rece şi Cald, Publicţiile Societăţii Naţionale Române pentru Ştiinţa Solului, 26A: 227-235.

Sachs, L. (1968) Statistische Auswertungsmethoden, p.485, Springer, Berlin.

| Plant association | Depth (cm) | Dry matter | Phosphatase activity | Nonenzymatic disodium phenylphosphate hydrolyse | Catalase activity | Nonenzymatic $H_2O_2$-splitting | Dehydrogenase activity | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Present | Potential |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Caricetum limosae | 0-10 | 6.99 | 13.228 | 2.394 | 374.777 | 70.694 | 11.911 | 11.638 |
| | 10-20 | 7.36 | 12.690 | 2.055 | 321.785 | 75.035 | 5.063 | 5.033 |
| | 20-30 | 7.21 | 12.210 | 2.385 | 158.988 | 54.403 | 3.534 | 3.637 |
| | 30-40 | 5.88 | 11.882 | 2.178 | 120.205 | 81.095 | 2.232 | 3.188 |
| | 40-50 | 6.55 | 10.501 | 2.287 | 71.704 | 70.156 | 2.001 | 2.987 |
| Pino mugo-Sphagnetum | 0-10 | 9.87 | 6.500 | 1.397 | 277.008 | 48.279 | 5.103 | 5.567 |
| | 10-20 | 9.24 | 5.443 | 0.989 | 215.492 | 60.733 | 3.220 | 3.442 |
| | 20-30 | 12.45 | 3.541 | 0.742 | 165.059 | 41.022 | 2.359 | 2.894 |
| | 30-40 | 12.41 | 4.023 | 0.846 | 182.545 | 57.215 | 2.231 | 2.678 |
| | 40-50 | 11.50 | 3.914 | 0.558 | 134.947 | 64.975 | 2.263 | 2.571 |

Table 1. The enzymatic and nonenzymatic catalytic activity of the peat under dofferent plant associations from the Molhasul cel Mare de la Izbuc Moor.

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Eriophoro vaginati-Sphagnetum recurvi | 0-10 | 13.06 | 9.923 | 1.146 | 205.673 | 70.198 | 2.759 | 2.951 |
| | 10-20 | 10.82 | 10.081 | 1.247 | 312.156 | 65.849 | 1.924 | 2.636 |
| | 20-30 | 9.39 | 10.661 | 1.204 | 375.720 | 85.297 | 2.174 | 2.875 |
| | 30-40 | 9.09 | 10.663 | 1.318 | 410.421 | 104.464 | 2.616 | 2.748 |
| | 40-50 | 9.58 | 10.529 | 1.218 | 375.731 | 78.420 | 2.196 | 2.783 |
| Carici echinate-Sphagnetum | 0-10 | 8.10 | 15.160 | 2.368 | 281.267 | 65.100 | 11.153 | 11.333 |
| | 10-20 | 9.08 | 13.654 | 2.198 | 280.716 | 69.248 | 9.787 | 9.924 |
| | 20-30 | 10.72 | 11.690 | 1.369 | 286.860 | 14.516 | 7.223 | 7.789 |
| | 30-40 | 8.60 | 13.705 | 2.009 | 276.703 | 69.175 | 7.358 | 7.793 |
| | 40-50 | 7.02 | 13.624 | 1.802 | 283.715 | 79.960 | 6.250 | 7.119 |
| Sphagno-Piceetum | 0-10 | 8.59 | 9.321 | 1.363 | 363.757 | 49.603 | 4.582 | 6.933 |
| | 10-20 | 10.16 | 5.486 | 1.020 | 252.626 | 46.930 | 3.976 | 5.542 |
| | 20-30 | 12.37 | 3.319 | 0.903 | 166.426 | 37.165 | 2.776 | 3.231 |
| | 30-40 | 12.30 | 2.652 | 0.722 | 156.413 | 40.134 | 2.962 | 3.064 |
| | 40-50 | 12.61 | 3.922 | 0.788 | 169.933 | 37.799 | 2.608 | 2.589 |

Table 1. (continued)

| Plant association | Expression of activity | Phosphatase activity | Nonenzymatic disodium phenylphosphate hydrolyse | Catalase activity | Nonenzymatic $H_2O_2$-splitting | Dehydrogenase activity | | EIPQ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Present | Potential | |
| Caricetum limosae | amv* | 12.102 | 2.259 | 209.491 | 70.276 | 4.948 | 5.297 | 458.10 |
| | rmv** | 89.27 | 100 | 62.43 | 86.92 | 59.23 | 60.25 | |
| Pino mugo-Sphagnetum | amv* | 4.540 | 0.906 | 195.010 | 54.439 | 3.053 | 3.448 | 274.81 |
| | rmv** | 33.49 | 40.10 | 58.12 | 67.34 | 36.54 | 39.22 | |
| Eriophoro vaginati-Sphagnetum recurvi | amv* | 10.367 | 1.226 | 335.540 | 80.845 | 2.333 | 2.798 | 390.49 |
| | rmv** | 76.47 | 54.27 | 100 | 100 | 27.93 | 31.82 | |
| Carici echinate-Sphagnetum | amv* | 13.556 | 2.003 | 281.852 | 59.599 | 8.354 | 8.791 | 546.37 |
| | rmv** | 100 | 88.66 | 83.99 | 73.72 | 100 | 100 | |
| Sphagno-Piceatum | amv* | 4.936 | 0.959 | 221.837 | 42.326 | 3.380 | 4.253 | 286.14 |
| | rmv** | 36.41 | 42.45 | 66.11 | 52.35 | 40.45 | 48.37 | |

amv* = absolute mean values rmv** = relative mean values

Table 2. The absolute and relative mean values of the enzymatic and nonenzymatic catalytic activities of the peat under different plant associations from the Molhasul cel Mare de la Izbuc Moor and enzymatic indicators of peat quality (EIPQ).

| Plant association | Expression of activity | Phosphatase activity | Nonenzymatic disodium phenylphosphate hydrolyse | Catalase activity | Nonenzymatic $H_2O_2$-splitting | Dehydrogenase activity | | VEIPQ |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Present | Potential | |
| Caricetum limosae | vc* | 8.50 | 6.37 | 62.89 | 14.08 | 83.43 | 68.60 | 366.55 |
| | rvc** | 15.75 | 18.27 | 100 | 32.53 | 100 | 100 | |
| Pinomugo-Sphagnetum | vc* | 30.62 | 34.86 | 27.85 | 17.81 | 40.38 | 35.60 | 344.57 |
| | rvc** | 56.75 | 100 | 44.28 | 41.15 | 48.40 | 51.89 | |
| Eriophoro vaginati-Sphagnetum curvi | vc* | 3.33 | 5.13 | 24.11 | 18.77 | 14.73 | 4.31 | 128.50 |
| | rvc** | 6.17 | 14.71 | 38.33 | 43.36 | 17.65 | 6.28 | |
| Carici echinate-Sphagnetum | vc* | 9.09 | 14.64 | 1.33 | 43.28 | 24.37 | 20.14 | 221.92 |
| | rvc** | 16.84 | 41.99 | 2.14 | 100 | 31.60 | 29.35 | |
| Sphagno-Piceetum | vc* | 53.95 | 26.34 | 39.77 | 13.26 | 25.33 | 43.73 | 363.56 |
| | rvc** | 100 | 75.56 | 63.28 | 30.63 | 30.30 | 63.74 | |

vc* = absolute mean values

rvc** = relative mean values

Table 3. Variability coefficiens of the enzymatic and nozymatic catalytic activities in peat and variability of the enzymatic indicators of peat quality (VEIPQ).

# THE STATE OF NATURALNESS OF MEADOWS ON THE DRAVA LOWLAND (SOUTH HUNGARY) A FLORISTICAL EVALUATION

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## Introduction

The lowland of River Drava is counted by Hungarian phytogeography the region *Eupannonicum* (Great Hungarian Plain), but its climate represents a transition to that of hilly regions; therefore it belongs to the zone of closed oak forests, instead of forest steppes (Borhidi 1961). Its flora is characterized by a high proportion of mountain and hilly elements, especially in hornbeam-oak forests (Horvát-Kevey 1983). Previous floristical and vegetation studies have mostly dealt with forests; this paper gives a floristical characterization of meadows and pastures in the western part of Drava lowlands on the left bank (Fig.1), using Borhidi's (1995) social behaviour types and naturalness values.

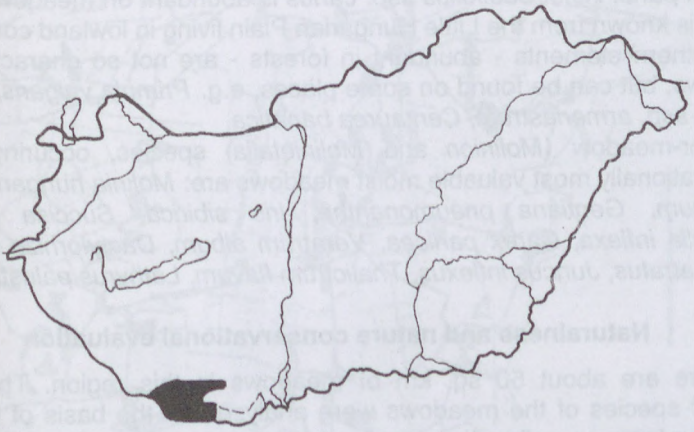


Fig. 1. Map of evaluated areas in the Drava lowland

## Results

Meadows are developed primarily in the place of old oxbow-lakes or secondarily in the place of natural forest communities. Their vegetation can be different, depending on moisture conditions and soils (moor-meadow, alluvial-meadow and meadow soils). Typical communities of

*Magnocaricetalia*: *Caricetum elatae*, *Caricetum acutiformis-ripariae*, *Caricetum vulpinae*; *Agrostion*: *Alopecuretum pratensis*, *Festucetum pratensis*, *Deschampsietum caespitosae* (Kovács-Kárpáti 1973). There are some smaller patches of *Succiso-Molinietum* communities. A widespread mesophilous meadow community is *Alopecuro-Arrhenateretum*. On some sandhills we can find a short grassland dominated by *Festuca rupicola* and *Anthoxanthum odoratum*, with some steppe elements (*Dianthus pontederae*, *Filipendula vulgaris*, *Rosa gallica*, *Peucedanum cervaria*).

## Floristical evaluation

Like forests, meadows also bear similarities to hilly and mountain areas. On lowlands in other places which are not of the typical Transdanubian type, the following mountain species are found: *Moenchia mantica*, *Saxifraga bulbifera*, *Trisetum flavescens*. *Cirsium rivulare* and *Veratrum album* are common west of Drava lowland, but reach it only on its western parts. *Orchis laxiflora ssp.elegans* is a typical species, which can be found in Nyírség and Northern Great Hungarian Plain too. *Anthoxanthum odoratum*, *Oenanthe fistulosa*, *Dianthus armeria*, *Colchicum autumnale*, *Glyceria plicata*, *Sanguisorba officinalis*, *Iris graminea*, *Festuca rubra* are rare hilly or mountain species of the Great Hungarian Plain, more abundant only on its northern parts. *Aster sedifolius ssp. canus* is abundant on meadows of Pécs plain; it is known from the Little Hungarian Plain living in lowland conditions.

Southern elements - abundant in forests - are not so characteristic on meadows, but can be found on some places, e.g. *Primula vulgaris*, *Dianthus armeria ssp. armeriastrum*, *Centaurea banatica*.

Moor-meadow (*Molinion* and *Molinietalia*) species, occuring only in conservationally most valuable moist meadows are: *Molinia hungarica*, *Allium angulosum*, *Gentiana pneumonanthe*, *Iris sibirica*, *Succisa pratensis*, *Succisella inflexa*, *Carex panicea*, *Veratrum album*, *Dactylorhiza incarnata*, *Juncus atratus*, *Juncus inflexus*, *Thalictrum flavum*, *Lathyrus palustris*.

## Naturalness and nature conservational evaluation

There are about 50 sq. km of meadows in this region. The lists of vascular species of the meadows were analysed on the basis of the social behaviour type, as well as the degree of naturalness value. Generally we can state, that the proportion of the generalist (G: 14-41 p.c.) and of the disturbance tolerant (DT: 31-75 p.c.) species are high. On the most valuable meadows the proportion of the specialists (S: 7.6 p.c.), and of the ruderal species (weeds /W/, agressive invadors /AC/, ruderal competitors /RC/, adventives /A/,) (3,6 p.c.) is small. In process of degradation appear the ruderals, and disappear the specialists, the presence of the generalists will

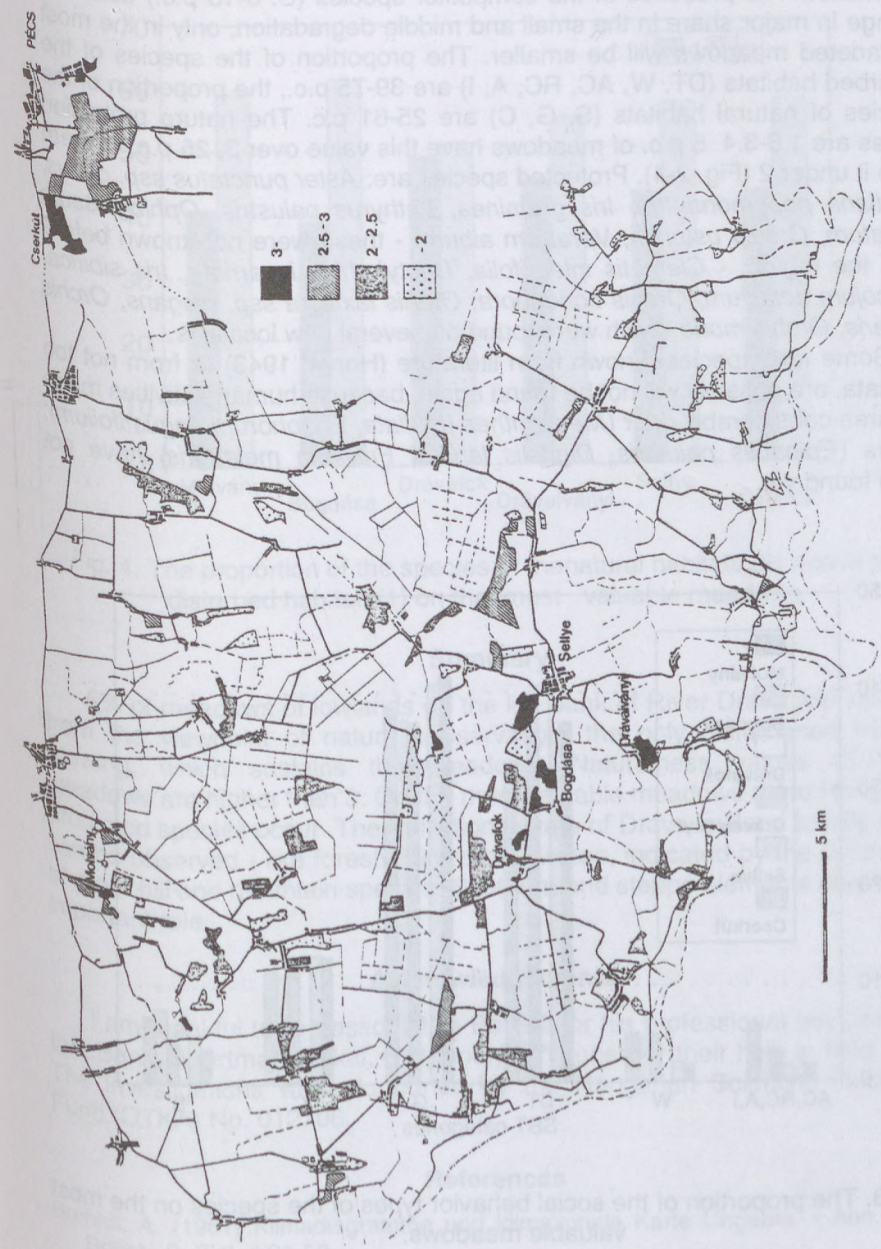



Fig. 2. Naturalness values of meadows of Drava lowlands

be smaller. The presence of the competitor species (C: 8-13 p.c.) does not change in major share in the small and middle degradation, only in the most degradeted meadows will be smaller. The proportion of the species of the disturbed habitats (DT, W, AC, RC, A, I) are 39-75 p.c., the proportion of the species of natural habitats (S, G, C) are 25-61 p.c. The nature protection values are 1.6-3.4. 5 p.c. of meadows have this value over 3, 25 p.c. of them have it under 2 (Fig. 2-4). Protected species are: *Aster punctatus ssp. canus*, *Gentiana pneumonanthe*, *Iris graminea*, *Lathyrus palustris*, *Ophioglossum vulgatum*, *Orchis ustulata*, *Veratrum album* - these were not known before from the region, - *Clematis integrifolia*, *Dactylorhiza incarnata*, *Iris sibirica*, *Leucojum aestivum*, *Orchis coriophora*, *Orchis laxiflora ssp. elegans*, *Orchis militaris*, *Orchis morio* - wich were found on several new localities.

Some rare species, known from literature (Horvát 1943) or from not too old data, are possibly will not be found again, because human activities made the area considerably drier (*Menyanthes trifoliata*, *Eriophorum angustifolium*); others (*Epipactis palustris*, *Digitalis lanata*, *Fritillaria meleagris*) have not been found yet.

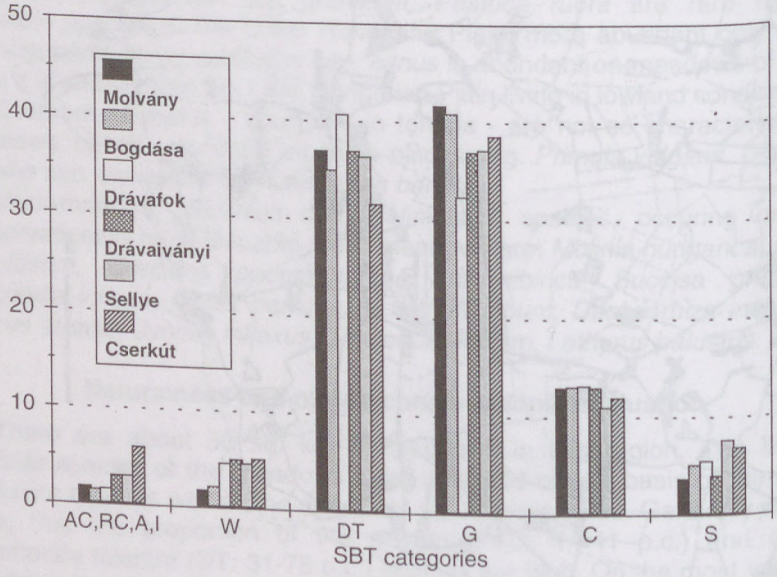



Fig. 3. The proportion of the social behavior types of the species on the most valuable meadows.

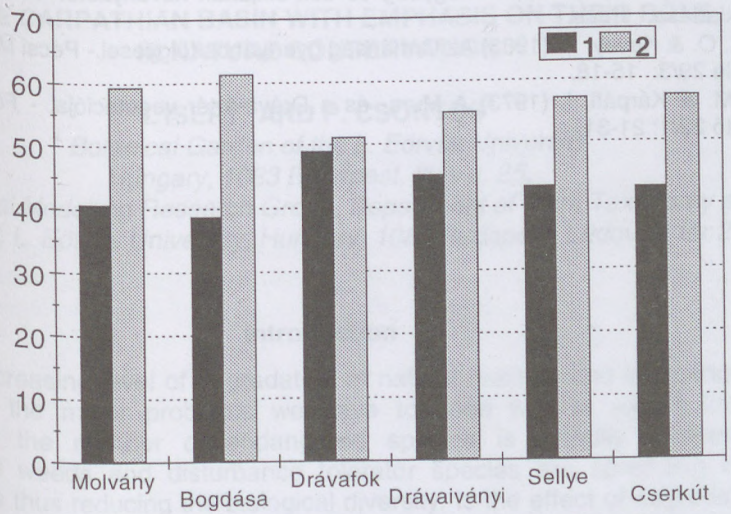



Fig. 4. The proportion of the species of thenatural habitats (2) and of the disturbed habitats(1) on the most valuable meadows.

## Summary

5% of meadows of lowlands on the left bank of River Drava are valuable from the viewpoint of nature conservation: the only disturbance here is mowing, which sustains the meadows. Naturalness values of these meadows are higher then 3. On the most valuable meadows more Hungarian protected species occur. The transitional state of Drava lowland to hilly areas can be observed - like forests - in meadows too, indicated by the occurence of more hill and mountain species. Southern and steppe elements play a less important role.

## Acknowledgements

I am thankful to Professor Attila Borhidi for his professional advices, and to L.Bank, A.Ortmann-Ajkai, G.Vágner, L.Wágner for their help in field work. The investigations were supported by the Hungarian Scientific Research Fund (OTKA) No. 012706.

## References

Borhidi, A. (1961) Klimadiagramme und klimazonale Karte Ungarns. - Ann. Univ. Bpest., S. Biol. 4:21-50

Borhidi, A. (1995) Social behavior types, the naturalness and relative ecological indicator values of the higher plants in the Hungarian flora. - Acta Bot. Hung. 39.(1-2) 97-181.

Horvát, A. O. (1942) A Mecsek hegység és déli síkjának növényzete. -A ciszterci rend kiadása, Pécs.

Horvát, A. O. & Kevey, B. (1983) Az Ormánság gyertyános-tölgyesei.- Pécsi Müszaki Szemle 29/3: 15-18.

Kovács, M. & Kárpáti, I. (1973) A Mura- és a Dráva-ártér vegetációja. - Földrajzi értesítö 22/1: 21-31.

# COMPARISON OF 24 GRASSLAND COMMUNITIES IN THE CARPATHIAN BASIN WITH EMPHASIS ON THEIR ROLE IN NATURE CONSERVATION

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## Introduction

The increasing level of degradation of natural habitats and biocoenoses is one of the major problems we have to cope with in recent times. Meanwhile the number of endangered species is steadily increasing, opportunist weeds and disturbance tolerator species are spreading over large areas thus reducing the biological diversity. Is the effect of degradation uniform for every plant community? Which are the most vulnerable ones? Are there communities that could resist disturbance and degradation so far? These are the main questions in our comparative analyses of grassland communities.

## Materials and Methods

For the analyses constancy data of 86 phytosociological tables were used (except few cases where only presence-absence type data were available). Of the tables 72 originated from various grassland stands in Hungary (Soproni Mts.; Hungarian Midrange: from Keszthelyi Mts. to Zempléni Mts.; South-Transdanubia: Mecsek Mts., Villányi Mts., Hilly-region of Somogy: and the Great Hungarian Plain) while further 14 were made at other places of the Carpathian Basin (Appendix 1. pp. 316-318). According to Borhidi's coenosystematic nomenclature the investigated grassland stands belong to 25 associations (see Appendix 1. pp. 316-318) of which 22 are known from Hungary (Borhidi 1995). Among them xerotherm rock grasslands and steppe types (*Festuco-Brometea*), hay-meadows (*Arrhenatheretea*), mat-grass meadows (*Nardo-Callunetea*) and calciphobe pionir grasslands (*Sedo-Scleranthetea*: *Thero-Airetalia*) can be mentioned. We aimed to gather every phytosociolgical tables published between 1930 and 1995 (and we also considered several unpublished works, especially from the latest years) however some papers might be missed. For the nature conservation ranks of species Simon's classification was used (Simon 1988, Horváth *et al.* 1995).

## Results and Discussion

In spite of the increasing human impact and disturbance more than eight hundred species (about one third of the vascular flora of Hungary) were found in the considered 86 phytosociological tables (altogether about 15 hundred releves).

Based on the average species number data and on the ratio of constant and sub-constant species the following trends appeared for the compared plant communities.

The lowest species numbers were characteristic for the rock-grasslands (*Seslerietum sadlerianae, Poetum pannonicae, Stipo-Festucetum pallentis*), the pionir sandy grasslands (*Filagini-Vulpietum*) and the hay-meadows (*Arrhenatheretum*) (Fig. 1).

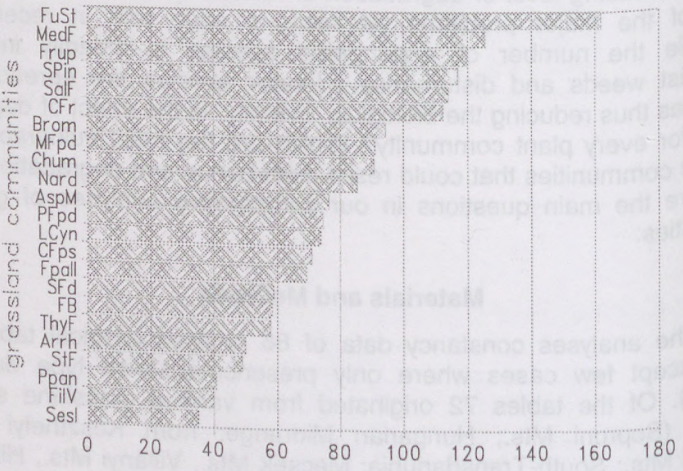



Fig. 1. The average species numbers of the studied communities.

The most species rich vegetation types were the loess grasslands (*Medicagini-Festucetum valesiacae, Salvio-Festucetum rupicolae*), the submediterranean slope-steppe (*Cleistogeni-Festucetum rupicolae*) and two associations reported from Burgenland (*Fumaneto-Stipetum and Seslerio-Pinetum*, Wagner 1940).

The number of species with pronounced conservation value were 114 (the sum of the protected=V, highly protected=KV and unique=U, categories according to Simon 1988). However 44 of the 114 had lower frequency than 1%. The most frequent 12 protected species (*Festuca pallens* Host, *Pulsatilla grandis* Wender., *Adonis vernalis* L., *Fumana procumbens* (Dun.) Gren. et Godr., *Stipa pulcherrima* C. Koch, *Stipa eriocaulis* Borb., *Stipa pennata* L., *Poa badensis* Hke, *Iris pumila* L., *Paronychia cephalotes* (M.B.) Bess., *Seseli*

*leucospermum* W. *et* K., and *Thalictrum minus* ssp. *pseudominus* (Borbás) Soó) are characteristic for the communities of the Festucetalia valesiacae association-series. In a reduced scale study this vegetation type proved to be the most valuable, too, with nine species abundantly present from the list above (Csontos & Lőkös 1992).

The frequency of the unique species were always below 5%, and they were present in open rock grassland communities: *Sesleria varia* (Jacq.) Wettst., *Festuca dalmatica* (Hack.) Richt., *Globularia cordifolia* L., *Linum dolomiticum* Borb., *Primula auricula* ssp. *hungarica* (Borb.) Soó, *Thlaspi montanum* L., *Tragopogon floccosus* W. et K., *Onosma tornensis* Jáv. and *Woodsia ilvensis* (L.) R. Br.

Among the 90 weeds registered *Euphorbia cyparissias* L. was the most frequent occurring in more than 50% of the phytosociological tables. The other weeds were much less frequent and apart from *Alyssum alyssoides* (L.) Nath. did not exceed 10%. Considering the associations more than ten weeds occurred in average in the following types: *Lolio-Cynosuretum, Salvio-Festucetum* and *Cleistogeni-Festucetum rupicolae*. But in the endemic and relic rock grassland communities (*Seseli leucospermo-Festucetum pallentis, Festuco pallenti-Brometum erecti, Stipo-Festucetum pallentis, Seslerietum sadlerianae* and *Poetum pannonicae*) weeds had much less contribution with 1-2 species present in average. Furthermore one of the two weeds in these cases are usually the *Euphorbia cyparissias* L. which was recently considered rather a "disturbance tolerator" than a weed according to Borhidi's classification of social behaviour types (Borhidi 1993, 1995).

The share of constant and sub-constant species (C: V-IV) depends more or less on the number of phytosociological tables considered for the given association. Since more number of tables from distinct geographical regions are considered for a community the higher the chance of constancy decrease for a certain species, therefore we considered the more or less equally represented associations in the following comparison (Table 1). The most stable constancy structure was characteristic to the *Seseleo-Festucetum pallentis, Seslerietum sadlerianae* and *Festuco-Brometum* associations. The first one is a relic while the latter two are endemic grassland communities on the dolomite hills of Hungary (Zólyomi 1958). Thus our results highlight the pronounced selective effect of the dolomite bedrock on the species composition of its covering grasslands.

Table 1. Associations with highest ratio of constant species. [Percentages were calculated as $(C_V + C_{IV})$/ species number * 100]

In case of 4 considered Tables:

| | Order of associations | | | | |
|---|---|---|---|---|---|
| abbreviated names | Sesl | FB | Asp.M | Pfpd | PPann |
| ratio of constant species | 18% | 16% | 11% | 10% | 9% |

In case of 8-12 considered Tables:

Order of associations

| abbreviated names | F.pall | Chum | Frup | Brom |
|---|---|---|---|---|
| ratio of constant species | 7% | 4% | 3% | 3% |

Proportions of species indicating natural conditions are shown in Fig. 2. There were four communities with more than 90% ratio of this species group: *Stipo-Festucetum, Seslerietum sadlerianae, Festuco-Brometum* and *Seseleo-Festucetum pallentis*. They can be considered the most natural, untouched vegetation types. In the other communities the ratio of natural species are gradually decreasing and falls below 70% (Fig. 2). In the most disturbed cases, like loess grasslands surrounded with cultivated fields or in pionir sandy grasslands and hay-meadows, this value can be lower than 60% (*Salvio-Festucetum, Filagini-Vulpietum, Festuco-Thymetum, Arrhenatheretum* and *Lolio-Cynosuretum*).

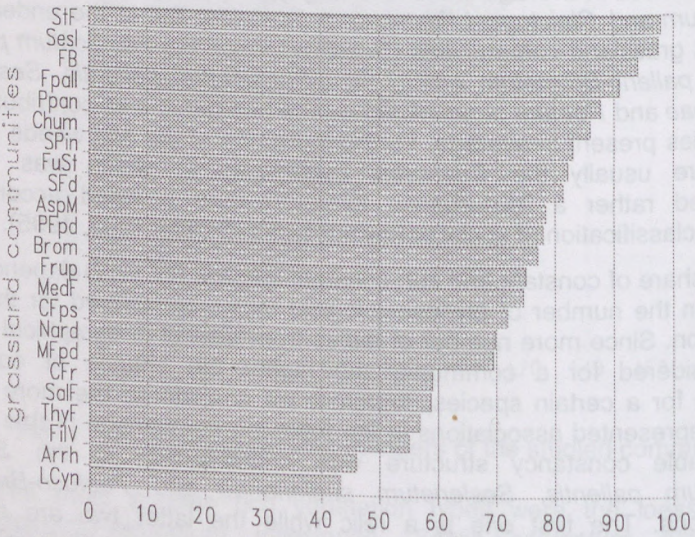



Fig. 2. Proportion of species indicating natural conditions.

The two way ordination of communities according to the ratio of weedy and protected species (V, KV, U) as percentages of their total species number are seen in Fig. 3.

The positions of the communities seems to follow a more or less hyperbolic arrangement in the ordination space. At the two ends of their range, associations of two high-rank coenotaxonomical units can be recognized. At the "good" end, where high number of protected species and low number of weeds are characteristic we can find the associations of the

*Bromo-Festucion* group. In the opposite end the acidophil, pionir sandy grasslands (*Thero-Airetalia*) and the mountain pastures (*Lolio-Cynosuretum*) are found. The latter association was the most degraded member of the *Arrhenatheretalia* series.

Several associations fall in the intermediate range, where the importance of both species groups are between 5 and 10%. Among them the rock grasslands on andezite or limestone and the steppe communities should be noted. Their position indicates vulnerability, since the rest of their species pool (apart from the protected species and weeds) are composed mainly by disturbance tolerators (instead of natural accompanying species) that is the sign of the initial stage of degradation.

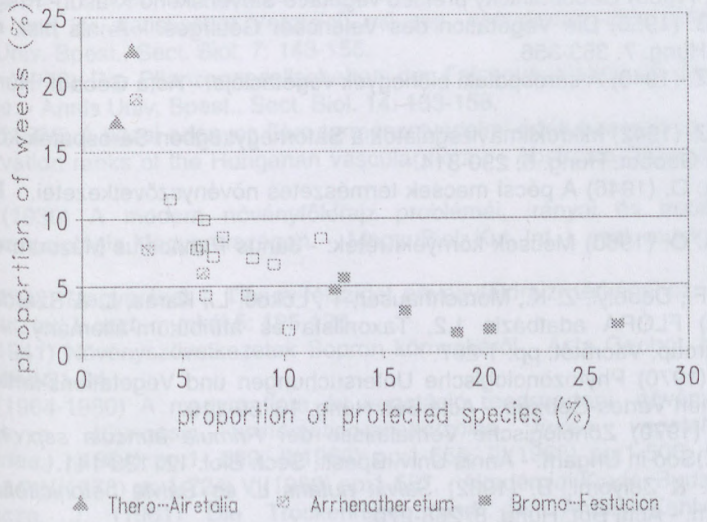



Fig. 3. Contribution of protected and weedy species to the flora of the studied communities.

## References

Babay, Á. (1966) Cönológiai és talajökológiai vizsgálatok a *Botrychium lunaria* (L.)Sw. kis-szénási lelőhelyén. - Acta Biol. Debr. 4: 3-15.

Baráth, Z. (1964) Waldsteppenwiese, *Stipetum stenophyllae pannonicum*, in Ungarischen Mittelgebirge. - Annls hist. nat. Mus. natn. Hung. 56: 215-227.

Borhidi, A. (1958) Belső-Somogy növényföldrajzi tagolódása és homokpusztai vegetációja. - MTA Biol. Oszt. Közlem. 1: 370-371.

Borhidi, A. (1993) A magyar flóra szociális magatartás tipusai, természetességi és relativ ökológiai értékszámai. (Social behaviour types of the Hungarian flora, its naturalness and relativ ecological indicator values.) - A KTM és a JPTE kiadványa, Pécs, pp: 1-94.

Borhidi, A. (1995) Social behaviour types, the naturalness and relative ecological indicator values of the higher plants in the Hungarian flora. - Acta Bot. Hung. 39: 97-181.

Csontos, P. & Lőkös, L. (1992) Védett edényes fajok térbeli eloszlás-vizsgálata a Budai-hg. dolomitvidékén. - Szünbotanikai alapozás, természetvédelmi területek felméréséhez. (The analysis of the spatial distribution of protected vascular plant species on a dolomite region of Budai-Mts., Hungary. - Synbotanical approach to evaluation of nature reserves.) - Bot. Közlem. 79: 121-43.

Debreczy, Zs. (1966) Die xerothermen Rasen der Péter- und Tamás-Berge bei Balatonarács. - Annls hist. nat. Mus. natn. Hung. 58: 223-241.

Dostal, J. (1933) Geobotanicky prehled vegetace Slovenskeho Krasu. - Prage.

Fekete, G. (1956) Die Vegetation des Velenceer Gebirges. - Annls hist. nat. Mus. natn. Hung. 7: 353-356.

Hargitai, Z. (1940) A sárospataki előhegyek vegetációja. - Acta Geobot. Hung. 3: 18-29.

Hargitai, Z. (1942) Mikroklimavizsgálatok a Sátorhegységben Sárospatak környékén. - Acta Geobot. Hung. 5: 290-314.

Horvát, A. O. (1946) A pécsi mecsek természetes növényszövetkezetei. - Pécs, pp: 1-52.

Horvát, A. O. (1960) Mecsek környéki rétek. - Janus Pannonius Múzeum évkönyve 1960.

Horváth, F., Dobolyi, Z. K., Morschhauser, T., Lőkös, L., Karas, L. & Szerdahelyi, T. (1995) FLÓRA adatbázis 1.2, Taxonlista és attribútum-állomány. - FLÓRA workgroup, Vácrátót, pp: 1-267.

Isépy, I. (1970) Phytozönologische Untersuchungen und Vegetationskartierung im östlichen Vértes-Gebirge. - Acta Bot. Hung. 16: 59-110.

Isépy, I. (1970) Zönologische Verhaltnisse der *Primula auricula ssp. hungarica* (Borb.)Soó in Ungarn. - Annls Univ. Bpest., Sect. Biol. 12: 133-141.

Jankó, B. & Zólyomi, B. (1962) *Salvia nutans* L. és *Salvia betonicifolia* Ettl. in Ungarn. - Acta Bot. Hung. 8: 268-270.

Kovács, M. & Máthé, I. (1964) A mátrai flórajárás (*Agriense*) sziklavegetációja. - Bot. Közlem. 51: 1-18.

Majovszky, J. (1954) Geobotanicke pomery kapucianskych kopcov. - Biologia 9: 160-161.

Majovszky, J. (1955) Asociacia *Festuca pseud. - Potentilla arenaria* na Vychodnom Slovensku. - Biologia 10: 672-673.

Máthé, I. & Kovács, M. (1960) Vegetationsstudien im Matragebirge. - Acta Bot. Hung. 6: 366-372.

Máthé, I. & Kovács, M. (1961/1962) Erodierte Weiden in der Umgebung von Parád. - Acta Agron. Hung. 11: 383-404.

Máthé, I. - Kovács, M. (1962) A gyöngyösi Sár-hegy vegetációja. - Bot. Közlem. 49: 309-315.

Máthé, I. (1956) Vegetációtanulmányok a nógrádi flórajárás területén, különös tekintettel rétjeinek, legelőinek ökológiai viszonyaira. - MTA Agrártud. Oszt. Közlem. 9: 38-39 and 41-42.

Mészáros-Draskovits, R. (1967) A *Linum dolomiticum* Borb. cönológiai viszonyai - Bot. Közlem. 54: 193-201.
Michalko, J. (1957) Geobotanicke pomery pohoria Vihorlat. - Vydavatelstvo Slov. Akad. Vied., Bratislava.
Penksza, K., Benyvoszky, B. M., Ötvös, E. & Asztalos, J. (1995) Phytosociological studies of the cliff Fehér-szirt, near Kesztölc, Hungary. - Acta Bot. Hung. 39: 71-95.
Polgár, S. (1933) A bakonyi Tobán-hegy vegetációja. - Bot. Közlem. 30: 32-47.
Schmoltzer, A. (1995) Erdőspuszta rétek a Mátrában. - Diákköri pályamunka, manuscript.
Schmoltzer, A. (1995) Félszáraz gyepek fitocönológiai vizsgálata a Bükk-hegységben. - Diákköri pályamunka, manuscript.
Seregélyes, T. (1974) Über die Felsenvegetation des Gerecsegebirges - Annls Univ. Bpest., Sect. Biol. 16: 123-144.
Simon, T. (1964) Entdeckung und Zönologie der *Festuca dalmatica* (Hack.)Richt. in Ungarn und ihr statistischer Vergleich mit ssp. *pseudodalmatica* (Kraj.)Soó - Annls Univ. Bpest., Sect. Biol. 7: 143-156.
Simon, T. (1972) Die Pflanzengesellschaften der Felsenvegetation im Zempléner Gebirge. - Annls Univ. Bpest., Sect. Biol. 14: 133-158.
Simon, T. (1988) A hazai edényes flóra természetvédelmi-érték besorolása. (Nature conservation ranks of the Hungarian vascular flora.) - Abstracta Botanica 12: 1-23.
Soó, R. (1930) A modern növényföldrajz problémái, irányai és irodalma. A növényszociológia Magyarországon. - Magy. Biol. Kut. Int. I. oszt. munkái 3: 29-31.
Soó, R. (1932) Magyarázat a Tihany-félsziget növényföldrajzi térképéhez. - Magy. Biol. Kut. Int. I. oszt. munkái 5: 125-126.
Soó, R. (1941) Növényszövetkezetek Sopron környékéről - Acta Geobot. Hung. 4: 27-28 and 31-34.
Soó, R. (1964-1980) A magyar flora és vegetáció rendszertani- növényföldrajzi kézikönyve. (*Synopsis systematico-geobotanica florae vegetationisque hungariae.*) I(1964) pp:1- 589, II(1966) pp:1-655, III(1968) pp:1-506, IV(1970) pp:1-614, V(1973) pp:1-724, VI(1980) pp:1-557. - Akadémiai Kiadó, Budapest.
Szujkó-Lacza, J. (1961) Die Trockenrasen und der Andesit-Kahlwald im Börzsönygebirge. - Annls hist. nat. Mus. natn. Hung. 53: 225-240.
Wagner, H. (1940) Die Trockenrasengesellschaften am Alpenostrand. - Denkschr. Akad. d. Wiss. Wien, Math. - Naturw. Klasse 104: 1-81.
Zólyomi, B. (1936) Übersicht der Felsenvegetation in der pannonischen Florenprovinz und dem nordwestlich angrenzenden Gebiete. - Annls hist. nat. Mus. natn. Hung. 30: 136-147.
Zólyomi, B. & Bacsó, N. (1936) A bükkhegységi szőrfüves rétek szociológiai és ökológiai viszonyai. - Tisia 1: 180-208.
Zólyomi, B. (1958) Budapest és környékének természetes növénytakarója, pp:510-642, in: Pécsi, M. (ed.) Budapest természeti képe. - Akadémiai Kiadó, Budapest.

## Appendix 1.

List of the investigated grassland communities.

| Abbr. | High syntax categories and Association names | Geographic regions | Sources of data Author(s) 19..yr. |
|---|---|---|---|
| | Nardo-Callunetea | | |
| | Nardetalia | | |
| | Nardo-Agrostion tenuis | | |
| Nard | Festuco ovinae-Nardetum | Bükk | Zólyomi 36 |
| | | Mátra | Máthé & Kovács 60 |
| | | Slovakia | Dostal 33 |
| | Sedo-Scleranthetea | | |
| | Thero-Airetalia | | |
| | Thero-Airion | | |
| FilV | Filagini-Vulpietum | Belső-Somogy | Borhidi 58 |
| ThyF | Festuco-Thymetum | Belső-Somogy | Borhidi 58 |
| | Festuco-Brometea | | |
| | Festucetalia valesiacae | | |
| | Festucion valesiacae | | |
| Frup | Cleistogeni-Festucetum rupicolae | Balatonfelvidék | Soó 30, 31 |
| | | Budai-hg. | Zólyomi 58 |
| | | Mátra | Máthé & Kovács 62 |
| | | Nógrád | Máthé 56 |
| | | Sárospatak | Hargitai 43 |
| | | Velencei-hg. | Fekete 56 |
| | | Bakony | Polgár 33 |
| | | Mecsek | Horváth 46, 60 |
| | | Diósd | Isépy & Házkötő ined. |
| | | Vihorlat | Mihalko 57 |
| | | Slovakia | Dostal 33 |
| CFps | Cynodonti-Festucetum pseudovinae | Gyöngyös | Máthé & Kovács 62 |
| MedF | Medicagini-Festucetum valesiacae | Sopron | Soó 41 |
| | | Keleti-Alpokalja | Wagner 40 |
| PFpd | Potentillo-Festucetum pseudodalmaticae | Börzsöny | Szujkó-Lacza 61 |
| | | Vihorlat | Mihalko 57 |
| | | Presov (Slovakia) | Majovski 54, 55 |
| SalF | Salvio-Festucetum rupicolae | Tiszántúl | Jankó & Zólyomi 62 |
| | Cirsio- Brachypodion | | |
| Brom | Polygalo-Brachypodietum | Keleti-Alpokalja | Wagner 40 |
| | | Bükk | Schmotzer 95 |
| | | Mátra | Schmotzer 95 |
| | Asplenio-Festucion pallentis | | |
| AspM | Asplenio ruta-murariae--Melicetum ciliatae | Gerecse | Seregélyes 74 |
| | | Pilis-hg. | Penksza & al. 95 |
| MFpd | Minuartio-Festucetum pseudodalmaticae | Mátra | Máthé & Kovács 64 |
| | | Zempléni-hg. | Simon 72 |

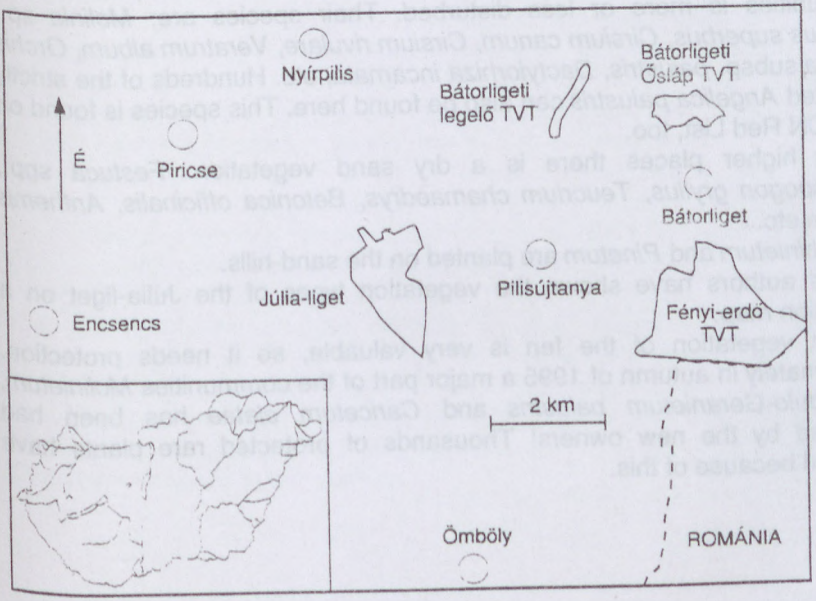
| Abbr. | High syntax categories and Association names | Geographic regions | Sources of data Author(s) 19..yr. |
|---|---|---|---|
| Ppann | Poetum pannonicae | Börzsöny | Zólyomi 36 |
| | | | Szujkó-Lacza 61 |
| | | Mátra | Kovács & Máthé 64 |
| | Bomo-Festucion pallentis | | |
| Chum | Chrysopogono-caricetum humilis | Balatonfelvidék | Soó 30, 41 |
| | | Balatonfelvidék | Debreczy 66 |
| | | Budai-hg. | Zólyomi 58 |
| | | Vértes | Isépy 70 |
| | | Diósd | Isépy & Házkötő ined. |
| | | Vihorlat | Mihalko 57 |
| | | Slovakia | Dostal 33 |
| FB | Festuco pallenti-Brometum erecti | Budai-hg. | Zólyomi 58 |
| | | Budai-hg. | Csontos & Tamás ined. |
| | | Vértes and Bakony | Isépy 70a, 70b |
| Fpall | Seseli leucospermo--festucetu pallentis | Budai-hg. | Zólyomi 58 |
| | | Budai-hg. | M. Draskovits 67 |
| | | Budai-hg. | Babay 66 |
| | | Balatonfelvidék | Soó 41 |
| | | Vértes | Isépy 70b, ined. |
| | | Diósd | Isépy & Házkötő ined. |
| | | Vihorlat | Mihalko 57 |
| | | Slovakia | Dostal 33 |
| Sesl | Seslerietum sadlerianae | Budai-hg. | Zólyomi 58 |
| | | Bükk | Zólyomi 36 |
| StF | Stipo-Festucetum pallentis | Budai-hg. | Zólyomi 58 |
| FuSt | Fumaneto-Stipetum | Keleti-Alpokalja | Wagner 40 |
| Spin | Seslerio-Pinetum | Keleti-Alpokalja | Wagner 40 |
| | Saturejon montanae | | |
| SFd | Sedo sopianae-Festucetum dalmaticae | Villányi-hg. | Simon 64 |
| | Danthonio-Stipion | | |
| Brom | Campanulo-Stipetum tirsae | É-Középhegység | Baráth 64 |
| | Brometalia erecti | | |
| | Xerobromion | | |
| Brom | "Xerobrometum" | Balatonfelvidék | Debreczy 66 |
| | | Vértes | Isépy ined. |
| | Molinio-Arrhenatheretea | | |
| | Arrhenatheretalia | | |
| | Arrhenatherion | | |
| Arrh | Arrhenatheretum | Mátra | Kovács & Máthé 60 |
| CFr | Festuco rubrae-Cynosuretum | Mátra | Kovács & Máthé 60, 61/62 |
| LCyn | Lolio-Cynosuretum | Mátra | Kovács & Máthé 61/62 |

## A NEWLY DISCOVERED RELIC FEN IN NORTH-EAST HUNGARY
(poster)

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The Nyírség (NE Hungary) is the greatest acidic sandy region of the Great Hungarian Plane. Among the sandy hills on lower position there were many large wetlands in the prehistoric times. From them only a few have remained by this time. The preservation of theese remained relic fens is one of the most important problems for nature conservation nowadays. Privatisation ( incorrect usage as agricultural territories ) and aridity ( lack of water ) mean the greatest danger for these territories.

In 1995 the authors found a new relic fen closed to village Piricse. Its name is Júlia-liget. The territory of the fen is about 70 hectares. No scientific publications were written before of this unknown fen though its vegetation is quite valuable and its territory is relatively great. The discovered territory has not been declared protected yet!



The vegetation and the development of Júlia-liget is the same that of the famous Bátorliget Nature Reserve. Many rare plant communities can be found there:

The most valuable one is the ***Salici pentandrae-Betuletum pubescentis*** (birch swamp). This community is relic in the Carpathian basin. Its territory is about 10 hectares! It is probably the greatest birch swamp in Hungary. The characteristic trees of the community are *Betula pubescens* and *Salix pentandra*. Even big, old ones can be found here. It is worth mentioning another plant species, *Sphagnum fimbriatum*. *Sphagnum* species are quite rare in the Nyírség. The authors have also found a rare *Epipactis* species on the birch swamp. Another interesting species are: *Thelypteris palustris, Dryopteris carthusiana, Dryopteris assimilis* (?), etc.

***Calamagrostio-Salicetum cinereae*** (willow swamp) Willow swamps are situated around the birch swamp. Interesting species of them are: *Myosotis caespitosa, Menyanthes trifoliata, Ranunculus lingua, Carex appropinquata.*

***Filipendulo-Geranietum palustris*** There were great stands of it in the southern part of the Júlia-liget, *with Geranium palustre, Filipendula ulmaria, Iris sibirica*. Thousands of *Veratrum album* could be found here, too.

***Caricetum elatae*** and ***Carici-Menyanthetum*** (tussock and tufted sedge community) Its protected species are: *Comarum palustre* (40-50 pieces), *Menyanthes trifoliata, Calamagrostis stricta.*

***Molinietum*** Great part of the fen is covered by these communities. The conditions in one part of them are nearly natural, but the other part of these communities is more or less disturbed. Their species are: *Molinia* sp., *Dianthus superbus, Cirsium canum, Cirsium rivulare, Veratrum album, Orchis laxiflora* subsp. *palustris, Dactylorhiza incarnata*, etc. Hundreds of the strictly protected *Angelica palustris* can also be found here. This species is found on the IUCN Red List, too.

On higher places there is a dry sand vegetation: *Festuca* spp., *Chrysopogon gryllus, Teucrium chamaedrys, Betonica officinalis, Anthemis tinctoria* etc.

*Robinietum* and *Pinetum* are planted on the sand-hills.

The authors have shown the vegetation types of the Júlia-liget on a vegetation map.

The vegetation of the fen is very valuable, so it needs protection. Unfortunately in autumn of 1995 a major part of the communities *Molinietum, Filipendulo-Geranietum palustris* and *Caricetum elatae* has been had ploughed by the new owners! Thousands of protected rare plants have perished because of this.

**Suggestion** of authors for protection and conservation:

-The Júlia-liget should be declared protected as soon as possible. The nationalization of the territory would be useful, too. The Hortobágy National Park Directorate has already made the first steps to it.
-The necessary, high level of the water should be kept continuously on the fen. The drainage canals should be closed.
-Research should be continued on the territory.
-A buffer zone should be established around the important fen.
-The damaged territories should be reconstructed.

# ACTUAL VEGETATION MAP OF THE BARCS NATURE RESERVE, 1985 (HUNGARY)

**MAGDOLNA JUHÁSZ**
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**Abstract:** The vegetation map was prepared on scale 1:10 000, the basic maps were the stereographic topographic map scale 1:10 000 and working map used by the forestry.
On the basis of the vegetation map it can be concluded that more than half (53,6%) of the nature reserve area is covered with monocultures of exotic tree species. A large area (30,7%) suffered from strong anthropogenic effects here only very few species can be found. These are the young monocultures of the native tree species, most of the overgrown pastures (with a lot of Scots Pine), and the drained, weedy, degraded alder woodlands.
Only a small part (15,7 %) of this nature reserve can be considered as a semi-natural area, rich in species, but anthropogenic effects can be seen here, too. Only the alder swamp woods and riverside softwoods (only 2,5% of the nature reserve) were in near-natural conditions, but recently their condition has also become worse.

## Introduction

This nature reserve is located in the south-east ernpart of the Inner-Somogy. Its area is about 3500 hectares. Height above sea-level is varying between 100 and 150 metres. Climate is influenced by sub-Mediterranean and sub-Atlantic effects. Annual precipitation is approx. 800 mm. Bedrock is mainly acidic sand originating from bed of the ancient Danube river. This sand was redeposited by the wind in the Pleistocene. Its southern boundary is River Drava, here the bedrock is young river drift in a narrow strip.

In the area there had been a lot of small swamp ponds, fed by precipitation, so they dried out periodically in every year. Most characteristic habitats of the Nature Reserve - beside alder swamp woods - had been open places with changing water conditions: plants like *Ludwigia palustris, Apium repens, Eleocharis carniolica, Montia fontana, Carex hartmannii*, etc. were living there. Swamp ponds had been bordered by alder swamp woods, with four species of *Sphagnum* living in them. On higher-lying areas natural vegetation consisted of various types of *Quercus robur* forests, on the highest sandhills existed possibly smaller sand grasslands too. Oak forests had been cleared and turned into overgrown pastures 200-300 years ago. Swamps had been drained in our century.

## Material and methods

The actual vegetation map was prepared in 1984-85. Basic maps were the stereographic topographic map scale 1:10 000 and working map used by the forestry. Boundary lines of the various vegetation types were determined by information gained by field surveying and from black-and-white aerial photographs. There are seventeen different types of vegetation indicated on the map. The sizes of these areas as well as percentage rates were determined by planimeter and quadratic method, on the basis of vegetation map drawn in scale 1:10 000.

## Results

According to the vegetation map (Fig. 1. pp.326-327), the most widespread vegetation type is pine plantation (46%, Table 1); most of it consist of *Pinus silvestris*, but there are *Pinus nigra*, *Picea abies* and *Pseudotsuga menziesii* too.

Other nature-alien monocultures are *Robinia pseudoacacia* plantations (73%), cultivated poplar plantations (0,1%) and *Quercus rubra* plantations (0,1%). *Quercus petraea* did not live here originally, so it has to be regarded as an alien species (0,1%).

Most stands of native tree species are affected by strong anthropogenic disturbance. Former pastures have been reforested spontaneously, but mostly from the seeds of neighbourong pine plantations; so mixed forests came into existence dominated by *Pinus silvestris. Betula pendula, Quercus robur* and *Alnus glutinosa* can mix into them in various proportions. *Betula pendula* forms in some places decorative birch-juniper stands (0,5%).

Forests of *Quercus robur* were grouped into two categories: old (6,7%) and young stands (6,0%). The herbaceous layer of the young oak forests is very poor and lacks characteristic species; they were planted on ploughed land, sometimes mixed with *Quercus rubra.*

Alder groves cover a relatively large area (13,9%). They can be planted, or remains of former alder swamp woods. Because of drying out and excessive thinning most of them is absolutely dominated by weeds, their herbaceous layer consist almost exclusively of *Rubus* spp. and *Urtica dioica.*

There are two small stands of nude hornbeam forests (0,2%).

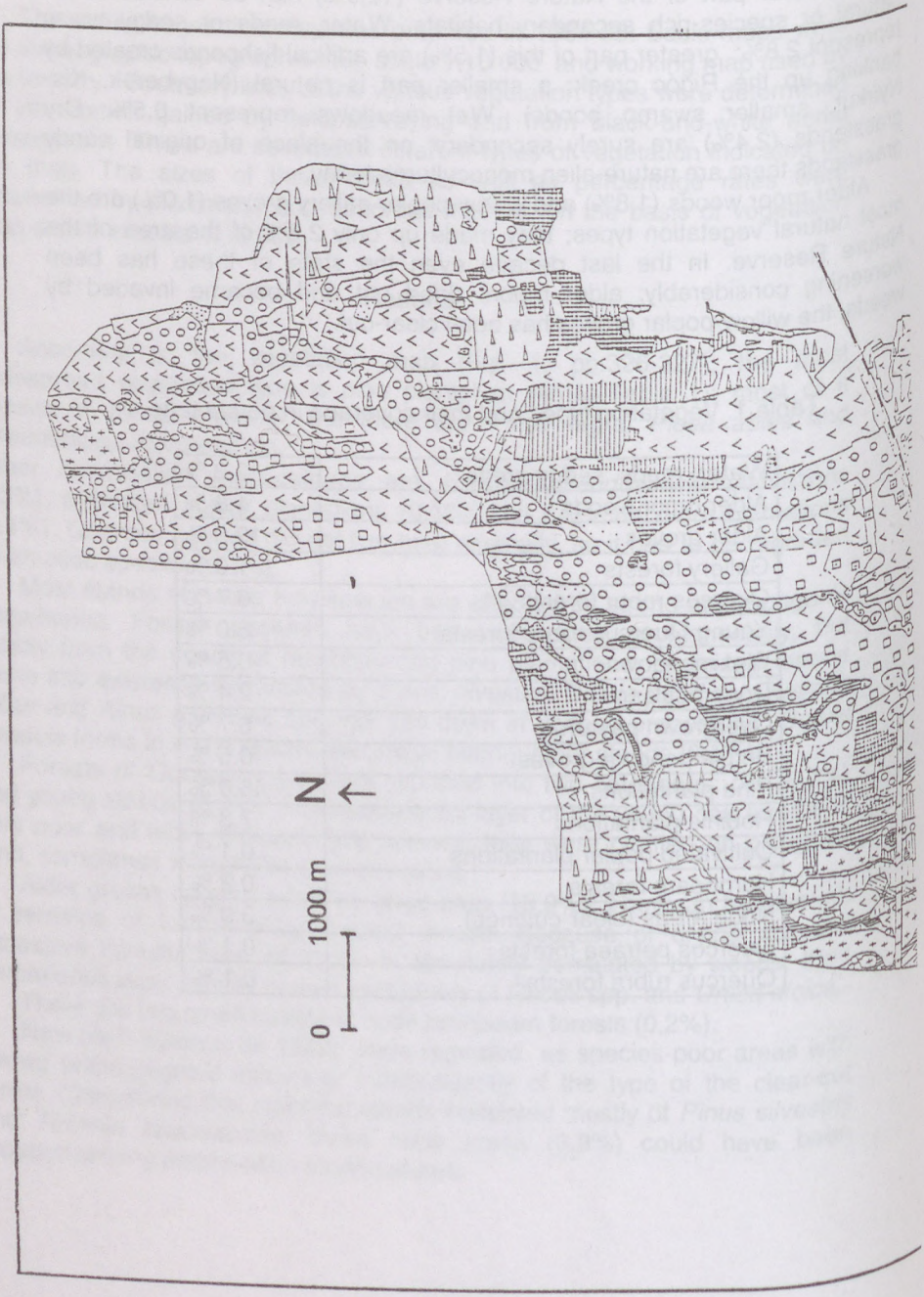
New clear-cuttings (in 1985) were regarded as species-poor areas with strong anthropogenic influence, independently of the type of the clear-cut forest. Considering that clear-cut stands consisted mostly of *Pinus silvestris* and *Robinia pseudacacia*, these nude areas (3,9%) could have been grouped among nature-alien monocultures.

A smaller part of the Nature Reserve (12,9%) can be considered as natural or species-rich secondary habitats. Water, reeds or sedgy areas represent 2,8%: greater part of this (1,5%) are artifical fishponds created by banking up the Rigóc creek; a smaller part is natural (Nagyberek, Kis-Nyírkút, smaller swamp ponds). Wet meadows represent 0,5%. Dry grasslands (2,4%) are surely secondary; on the place of original sandy grasslands there are nature-alien monocultures today.

Alder moor woods (1,8%) and willow-poplar gallery groves (1,0%) are the most natural vegetation types; they made up only 2,8% of the area of the Nature Reserve. In the last decade even the state of these has been worsening considerably: alder moors dried out and became invaded by weeds, the willow-poplar groves has been clear-cut.

Table 1. Vegetation types and their coverage in percentage

| | |
|---|---|
| Water, reeds, sedgy areas | 2.8 % |
| Alder moor woods | 1.8 % |
| Alder groves | 13.9 % |
| Gallery forests | 1.0 % |
| Quercus robur forests | 6.7 % |
| Young Quercus robur forests | 6.0 % |
| Wet meadows | 0.5 % |
| Dry grasslands | 2.4 % |
| Overgrown pastures | 6.7 % |
| Betula pendula groves | 0.5 % |
| Pine plantations | 46.0 % |
| Robinia plantations | 7.3 % |
| Cultivated poplar plantations | 0.1 % |
| Hornbeam forests | 0.2 % |
| Nude areas (clear-cuttings) | 3.9 % |
| Quercus petraea forests | 0.1 % |
| Quercus rubra forests | 0.1 % |


N
1000 m
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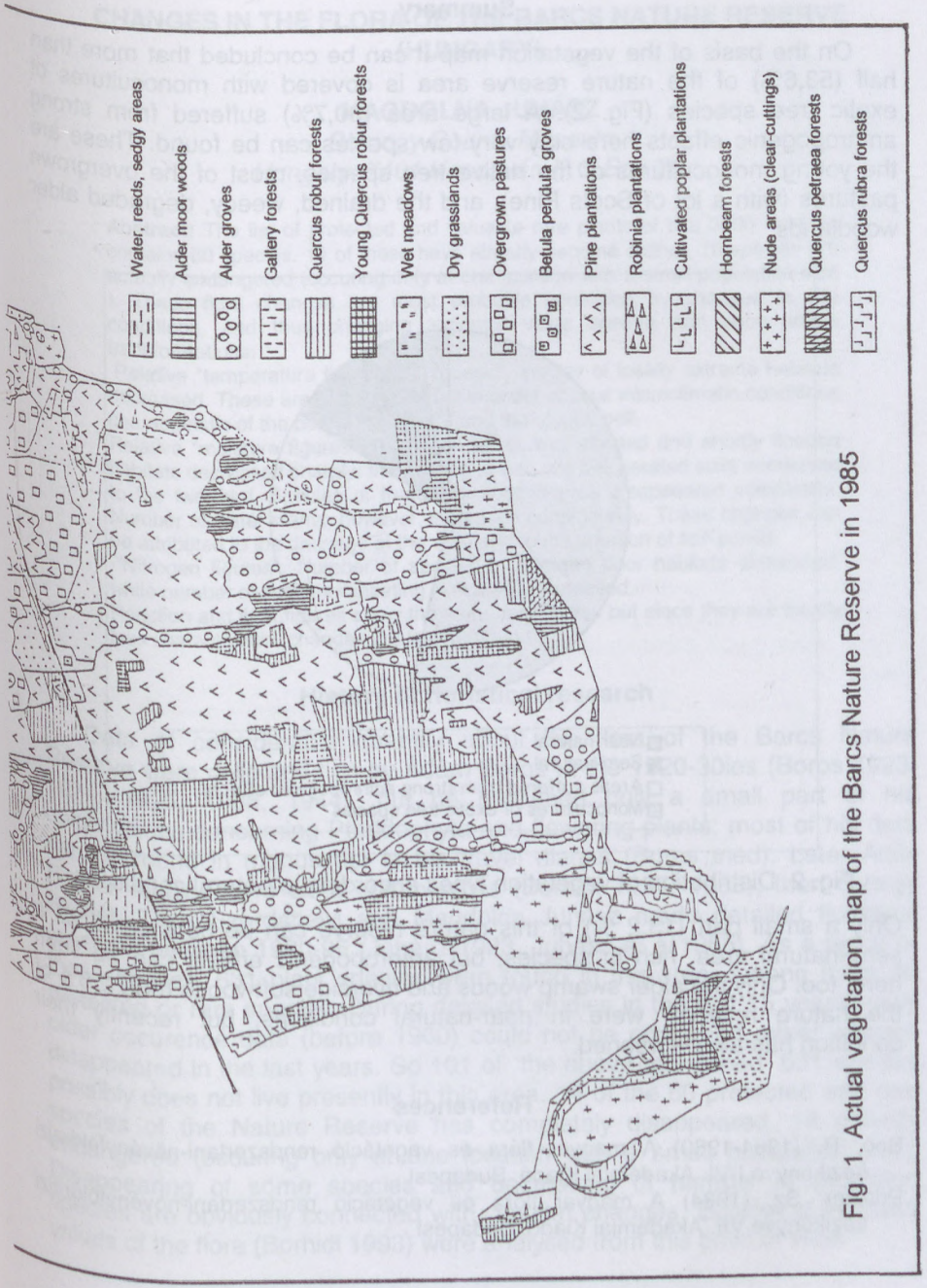



Fig. 1. Actual vegetation map of the Barcs Nature Reserve in 1985

## Summary

On the basis of the vegetation map it can be concluded that more than half (53,6%) of the nature reserve area is covered with monocultures of exotic tree species (Fig. 2). A large area (30,7%) suffered from strong anthropogenic effects here only very few species can be found. These are the young monocultures of the native tree species, most of the overgrown pastures (with a lot of Scots Pine), and the drained, weedy, degraded alder woodlands.

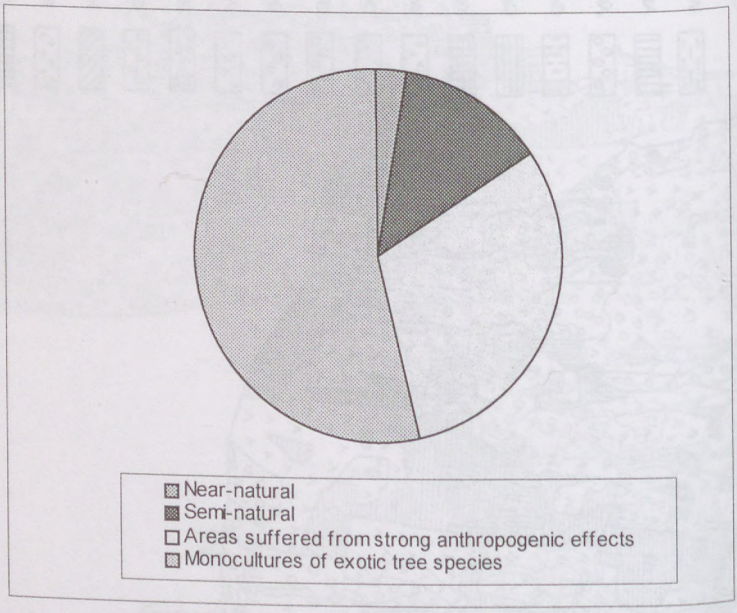



Fig. 2. Distribution of vegetation types according to natural conditions

Only a small part (13,2 %) of this nature reserve can be considered as a semi-natural area, rich in species, but anthropogenic effects can be seen here, too. Only the alder swamp woods and riverside softwoods (only 2,5% of the nature reserve) were in near-natural conditions, but recently their condition has also worsened.

## References

Soó, R. (1964-1980) A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve I-VI. Akadémiai Kiadó, Budapest.

Priszter, Sz. (1984) A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve VII. Akadémiai Kiadó, Budapest.

# CHANGES IN THE FLORA OF THE BARCS NATURE RESERVE (HUNGARY)

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**Abstract:** The list of protected and valuable rare plants of this 3500 ha area contains 60 species. 14 of these have already become extinct, 18 species are actually endangered (occuring only at one location with a small population size ). These flora changes are most probable controlled by changes in site conditions, and thus changing indicator value spectra can show these transformations.

Relative "temperature figures": Number of species of locally extreme habitats decreased. These are species which live under special microclimatic conditions characteristic of the boreal, subboreal and the steppe belt.

Relative "moisture figures": Plants of damp, well aerated and shortly flooded habitats decreased sharply, those living in wet, not well aerated soils decreased to the two-third. Species of frequently flooded soils disappeared completely. Number of water plants, however, increased considerably. These changes can be attributed to the drainage of the area and to the creation of fish ponds.

"Nitrogen figures": Number of species in nitrogen poor habitats decreased, while number of species indicating N rich soils increased.

Reaction and light figures show the same tendencies but since they are locally less characteristic, changes are less profound.

## History of floristical research

Data of considerable quantity about the flora of the Barcs Nature Reserve were collected first by Ádám Boros in the 1920-30ies (Boros 1923, 1924, 1925, 1936, 1944), but he published only a small part of his observations concerning Pteridophyta and flowering plants; most of his data can be found in manuscript in his travel diaries (Boros ined). Later Attila Borhidi studied here sand communities (Borhidi 1957, 1958), then György Szollát, Tibor Szerdahelyi and Magdolna Juhász made detailed floristical research between 1980-95 (Juhász 1983, Juhász *et al.*1985). As a result of these studies, 631 plant species were found in the area, among them 60 protected or rare species. During detailed studies in the last 15 years many older occurencé data (before 1960) could not be confirmed, other species disappeared in the last years. So 101 of the above-mentioned 631 species possibly does not live presently in this area. 14 of the 60 protected and rare species of the Nature Reserve has completely disappeared, 18 actually endangered (occuring only at one location with a small population size). Disappearing of some species and decreasing of number of protected species are obviously connected with habitat changes. Ecological indicator values of the flora (Borhidi 1993) were analysed from this point of view.

## Methods

Ecological indicator values were analysed by groups as follows: total flora (631 species), species not found in the last 15 years (101) rare and protected species (60), protected species living recently in the area in viable populations (28), extinct or actually endangered species (32). Since we does not have appropriate quantitative data about the species, analyses were based on presence-absence data.

It was found that environmental changes are reflected best by analyses of ecological indicator values of protected species. In the following I compare all protected and rare species (Table 1.) and species recently living in the area by their percentage distribution in categories of certain ecological indicator values.

## Results

Diagrams of relative temperature values (Fig. 1) show, that species, which like or tolerate extremities of temperature disappeared first of all. Species demanding a microclimate corresponding to boreal (TB=2) or subboreal (TB=3) zones (*Sphaghnum* spp., *Betula pubescens*) completely drew back. Alder swamp woods - whose cool and damp microclimate was appropriate for these species - dried out because of former drainage of water, inadequate precipitation in the 80es and other, maninly anthropogenic reasons.

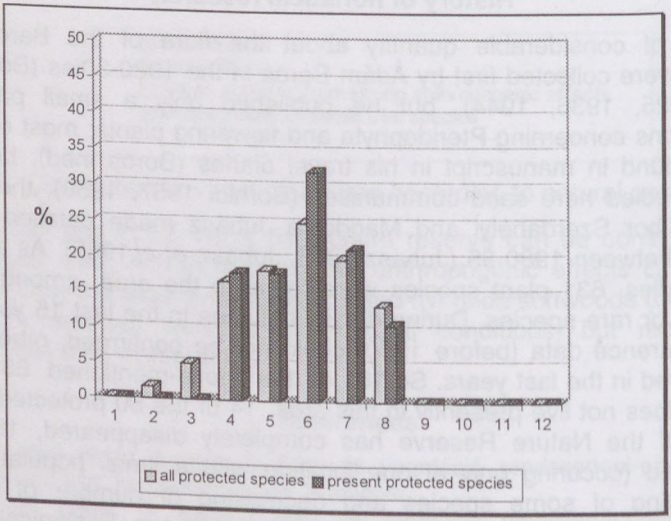



Fig. 1. Percentage distribution of protected species by relative temperature values

Table 1. Protected and rare species in the Barcs Nature Reserve

| Protected and rare species | | Disappeared | Actually endangered |
|---|---|---|---|
| Achillea | ptarmica | + | |
| Apium | repens | + | |
| Asplenium | adiantum-nigrum | | |
| Asplenium | trichomanes | | |
| Betula | pubescens | | + |
| Carex | hartmannii | + | |
| Carex | lasiocarpa | | |
| Cephalanthera | longifolia | | |
| Dianthus | deltoides | | |
| Dianthus | serotinus | | + |
| Dryopteris | assimilis | | + |
| Dryopteris | carthusiana | | |
| Dryopteris | cristata | | + |
| Dryopteris | pseudo-mas | | + |
| Elatine | alsinastrum | + | |
| Eleocharis | carniolica | | + |
| Epipactis | helleborine | | |
| Equisetum | hyemale | | |
| Gentiana | pneumonanthe | + | |
| Helichrysum | arenarium | | + |
| Hemerocallis | lilio-asphodelus | | |
| Hottonia | palustris | | |
| Hydrocotyle | vulgaris | | + |
| Hypericum | maculatum | + | |
| Iris | variegata | | |
| Lathyrus | pannonicus | + | |
| Lilium | martagon | | + |
| Lindernia | procumbens | + | |
| Ludwigia | palustris | | + |
| Lychnis | coronaria | | |
| Lycopodium | clavatum | | |
| Menyanthes | trifoliata | + | |
| Montia | fontana | + | |
| Muscari | botryoides | | |
| Nymphaea | alba | | |
| Nymphoides | peltata | | |
| Orchis | militaris | | |
| Orchis | morio | + | |
| Osmunda | regalis | | |
| Peucedanum | arenarium | | + |
| Peucedanum | verticillare | | |
| Polystichum | aculeatum | | |
| Polystichum | setiferum | | |
| Primula | vulgaris | | + |
| Pulsatilla | nigricans | | |
| Radiola | linoides | + | |
| Sagittaria | sagittifolia | + | |
| Salvinia | natans | | |
| Sphagnum | inundatum | | + |
| Sphagnum | palustre | | + |
| Sphagnum | recurvum | | + |
| Sphagnum | subsecundum | | + |
| Spiraea | salicifolia | | |
| Tamus | communis | | + |
| Teesdalia | nudicaulis | | |
| Thalictrum | aquilegiifolium | | + |
| Thelypteris | palustris | | |
| Trapa | natans | | |
| Veratrum | album | | |
| Vitis | sylvestris | + | |

The other temperature extremity of the area is steppe temperature climate (TB=8). Number of species, demanding this climate, also decreased (*Lathyrus pannonicus, Apium repens, Peucedanum arenarium*). This is a consequence, first of all, of natural and anthropogenic afforestation of open areas, which can quickly get warm.

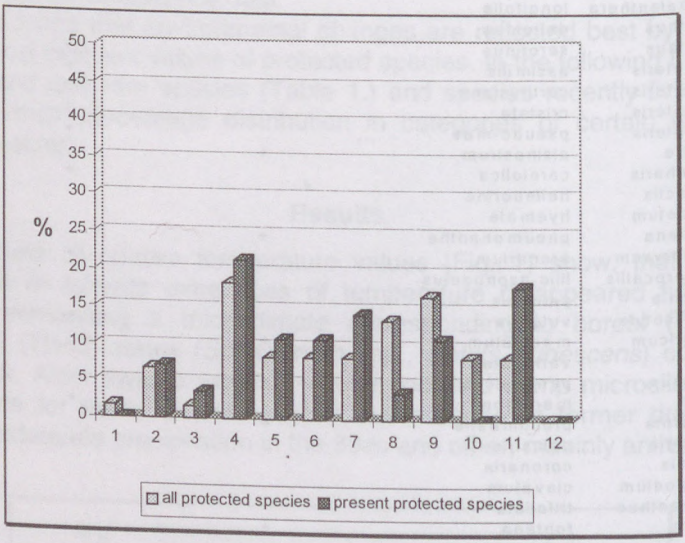



Fig. 2. Percentage distribution of protected species by relative moisture values

Analysing diagrams of relative moisture values (Fig. 2), we found that mostly species of transitional habitats - demanding or tolerating flooding in a part of the year - decreased. Number of plants of moist soils, tolerating short floods (WB=8, *Achillea ptarmica, Carex hartmannii, Montia fontana*) strongly decreased. Number of plants of wet, not well aerated soils (WB=9, *Eleocharis carniolica, Lindernia procumbens, Sphagnum* spp.) decreased. Plants of frequently flooded soils (WB=10, *Apium repens, Ludwigia palustris, Menyanthes trifoliata, Elatine alsinastrum*) completely disappeared. Proportion of true water plants (WB=11, flooting or rooting in water) is high, because of artifical fish ponds and Drava oxbow lakes belonging to the Nature Reserve.

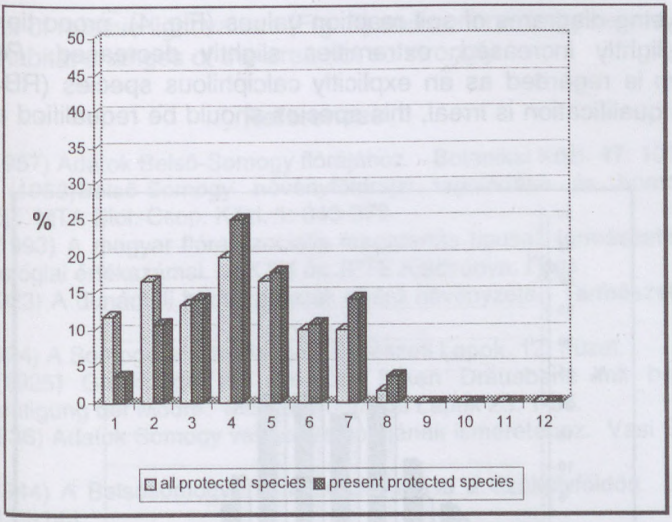



Fig. 3. Percentage distribution of protected species by nitrogen values

Diagrams of relative nitrogen values (Fig. 3) show, that number of species living on nitrogen-poor soils considerably decreased (NB= 1 and 2, Sphagnum spp., Radiola linoides, Hypericum maculatum, Eleocharis carniolica and others). Proportion of species of nitrogen-rich habitats slightly increased.

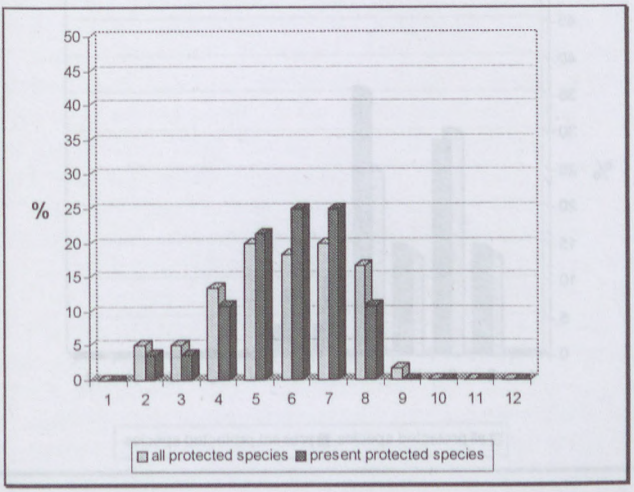



Fig. 4. Percentage distribution of protected species by soil reaction values

Analysing diagrams of soil reaction values (Fig. 4), proportion of middle values slightly increased, extremities slightly decreased. *Peucedanum arenarium* is regarded as an explicitly calciphilous species (RB=9); in this area this qualification is irreal, this species should be requalified as RB=7 or 8.

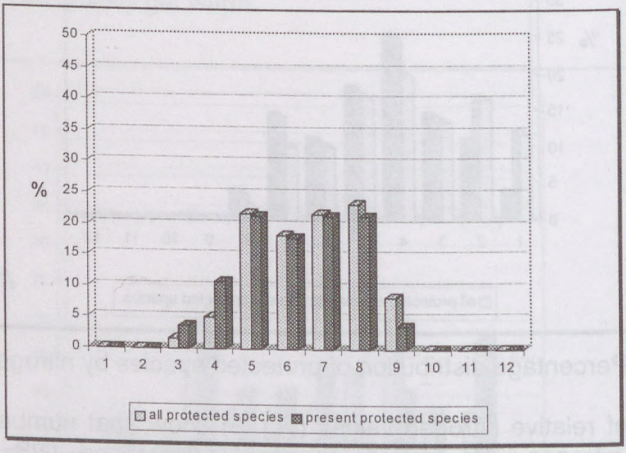



Fig. 5. Percentage distribution of protected species by relative light values

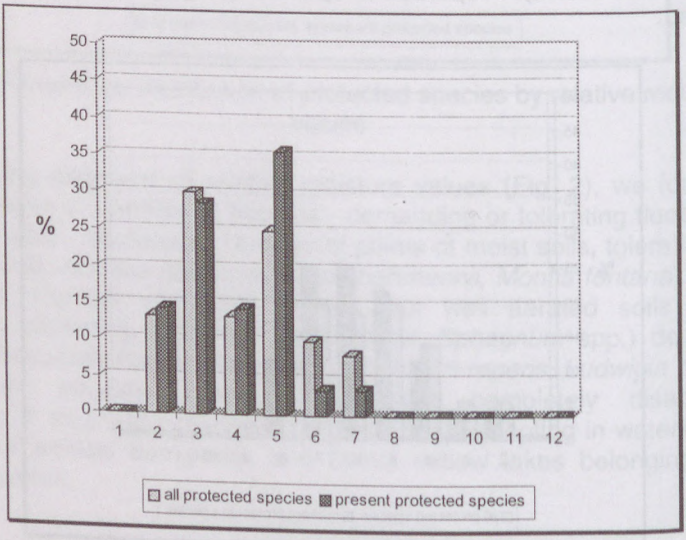



Fig. 6. Percentage distribution of protected species by continentality values

Diagrams of relative light values (Fig. 5) and continentality values (Fig. 6). indicate habitat changes of the area not so strongly.

## References

Borhidi, A. (1957) Adatok Belső-Somogy flórájához. - Botanikai Közl. 47: 107-108.
Borhidi, A. (1958)Belső-Somogy növényföldrajzi tagolódása és homokpusztai vegetációja. MTA Biol. Csop. Közl. 1: 343-378.
Borhidi, A. (1993) A magyar flóra szociális magatartás tipusai, természetességi és relativ ökológiai értékszámai. A KTM és JPTE Kiadványa, Pécs.
Boros, Á. (1923) A dunántúli homokpuszták eltérő növényzete. Természettud.Közl. 55.
Boros, Á. (1924) A Somogyi sík erdőségei. Erdészeti Lapok, 12. Füzet.
Boros, Á. (1925) Grundzüge der Florader linken Drauebene mit besonderer Berücdsichtigung der Moore. Magyar Botanikai Lapok 23: 1-56.
Boros, Á. (1936) Adatok Somogy vármegye flórájának ismeretéhez. Vasi Szemle 3: 79-86.
Boros, Á. (1944) A Belsősomogyi homokterület mása a Székelyföldön. Dunántúli Szemle 139-144.
Boros, Á. (ined.) Kéziratos útinapló, 1915-1972. TTM Növénytár.
Juhász, M. (1983). A Barcsi borókás tájvédelmi körzet magasabbrendű növényei. Dunántúli Dolg. Term. tud. Sor. 3: 35-46.
Juhász, M.-Szerdahelyi, T.-Szollát, Gy.: Újabb adatok a Barcsi Tájvédelmi Körzet flórájához. Dunántúli Dolg. Term. tud. Sor. 5: 35-50.

# RED LIST OF LICHENS OF HUNGARY*
# (A PROPOSAL)

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**Abstract:** Adapting the latest IUCN categories to the recent Hungarian lichen flora, extinct, critically endangered, endangered and vulnerable species were separated. In lack of sufficient information on population or habitat size the problematic species were not categorized, they were simply omitted from the list or were placed into a fifth group ("rare") needed more information for categorization.

## Introduction

Nowadays red (data) lists of extinct, endangered, rare, threatened or vulnerable species are prepared world-wide for conservation biological purpose, even in case of cryptogams (Clerk *et al.* 1992, Cieslinsky *et al.* 1986, Hauck 1992, Jacobsen *et al.* 1992, John 1992*a*, 1992*b*, Kappen & Müller 1982, Kashiwadani & Kurokawa 1995, Pisút 1985, Pisút *et al.* 1993, Scholz 1992*a*, 1992*b*, Siebel *et al.* 1992, Tschabanenko 1995, Trass & Randlane 1987, Türk & Wittmann 1987, Wirth 1977, 1984, Wirth *et al.* 1996). Due to their usually inconspicuous appearance and the difficulties of their identification in practice cryptogams have simply regarded to be unimportant to deal with also in Hungary. However, they also play an important role in particular places, and need protection especially in case of species living in vanishing habitats, endangered by air pollution, and those subject to mass gathering for decoration, food, therapeutic or perfume industry.

Protected habitats, characterized by high number of endangered animal species or vascular plants, are not necessarily also rich in threatened lichens. Management methods, conservation techniques elaborated for preservation of the higher plants and animals are not appropriate for lichens in all cases. Lichens colonize special habitats. Protection of their habitats, like various stones, old trees, etc., is enough for their survival, but protection of a particular species is also very important. The relatively small growth rate of lichen thalli increases their vulnerability, but on the other hand their dispersion might be very rapid. Their relatively high sensitivity for disturbance (e.g. air pollution) also makes them vulnerable, but they have extreme tolerance for climatic factors.

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A red list is often not more than a status list but it could help nature conservation agencies for habitat evaluation and to elaborate appropriate management practice. It also calls the scientists' attention to the little known groups of lichens and areas.

Very few lichens are under legal protection: 2 lichen species in the United States, 26 in the United Kingdom and a lichen community as a natural monument in Japan. The awareness of importance of lichens increased slowly in the last years, not only the scientists, but the government nature protection agencies started to understand the contribution of lichens to the biological diversity, their role in ecosystems, the threats they suffer from and the possibility to use them as tools for biomonitoring.

In Hungary cryptogams have been also neglected by the nature conservation measures and omitted from the red data lists for a long time (Rakonczay 1989). However, 84 bryophytes were also included in the Red Data Book, but only 20 are protected by law. Siller & Vasas (1993, 1995*a, b*) prepared the first red lists on Hungarian macrofungi. Verseghy (1994) published the first list on the rare (18), endangered (16) and vulnerable (30) lichen species in Hungary, but the categories she used are defined in a different way.

Although the protection of biological diversity got into focus of the nature conservation programme of the Government, the legal protection of the cryptogams has not been solved in Hungary so far. The extinction of a lichen species means the same loss of the biological diversity as the extinction of any other living organism.

The International Committee for Conservation of Lichens (ICCL) was set up by the International Association of Lichenologists (IAL) to collect information about endangered lichens, prepare a list of threatened species, develop conservation strategies and encourage researches on endangered species following the guidelines of Species Survival Commission of the International Union for Conservation of Nature and Natural Resources (IUCN) in 1992. A questionnaire was elaborated in order to survey the conservation status of lichens and their habitats on a global scale. The information from lichenologists from all over the world were analysed by G. Thor and P. Wolseley, and the results show the critical points of work for conservation of lichens (Thor 1995, Wolseley 1995). For example:

- the knowledge on conservation status of lichens is not in the same level in the different parts of the world,
- there are great number of poorly investigated taxa in uncertain situation,
- there are large poorly investigated areas,
- lack of detailed information of the ecology of threatened species.

Preliminary world-wide Red Data List was prepared and presented at the Conservation Workshop of General Assembly of IAL in 1996 in Salzburg.

Joining to the international lichen red list initiative with adapting the latest IUCN categories (1994) to the recent Hungarian lichen flora, extinct, critically

endangered, endangered and vulnerable species were separated to make an attempt to compile the Hungarian lichen red list.

## Materials

The list proposed here based on primarily Verseghy's recent lichen flora (1994), on our own experiences and observations, and on the lichen records from the following Hungarian herbaria: BP, EGR, SZE, SZO and VBI. The nomenclature of names also based on Verseghy's lichen flora (1994).

Definitions for the IUCN categories are rather unusual in the Hungarian lichenology, so we had to face serious lack of information on distribution, population size, habitat size or the changes of these. Comprehensive mapping studies are necessary to eliminate these insufficiencies and to promote an adequate categorisation.

In addition, records of the above mentioned herbaria are inhomogeneous, frequently irrelevant, burdened with several misidentified specimens. In several cases collections were made only at a popular, particular locality in different time by various collectors with different purpose and thoroughness.

## Discussion

The categorisation were performed with great difficulties under these circumstances. We could separate 30 extinct, 24 critically endangered, 44 endangered and 45 vulnerable species. About 260 lichen species were impossible to arrange into any categories. For future judgement a fifth group (rare) was set up for the problematic species. Literature data without voucher specimens and the new findings with no further information on the distribution are also belonging to this category.

## The proposed red list of lichens of Hungary

### Extinct

*Acarospora gallica, Anema nummularium, Bacidina sphaeroides, Biatorella hemisphaerica, Buellia margaritacea, Dermatocarpon cinereum, Endocarpon adscendens, Fulgensia schistidii, Heppia lutosa, Lecidea hypnorum, Lobaria pulmonaria, Micarea cinerea, Micarea lignaria, Microglaena modesta, Microthelia micula, Pachyphiale carneola, Peltigera leucophlebia, Peltigera venosa, Phaeophyscia pusilloides, Rinodina archaea, Rinodina polyspora, Rinodinella dubyanoides, Solorinella asteriscus, Staurothele ambrosiana, Staurothele hymenogonia, Umbilicaria cylindrica, Verrucaria floerkeana, Verrucaria macrostoma, Verrucaria veronensis, Verrucaria viridula*

### Critically endangered

*Bacidia rosella, Calicium quercinum, Cetraria aculeata, Chaenotheca brunneola, Gyalecta truncigena, Gyalecta ulmi, Haematomma ochroleucum, Menegazzia terebrata, Nephroma parile, Nephroma resupinatum, Parmelia hypoclysta, Parmelia perlata, Phaeocalicium populneum, Sphinctrina turbinata, Umbilicaria deusta, Umbilicaria grisea/hirsuta, Umbilicaria*

*polyphylla, Usnea ceratina, Usnea diplotypus, Usnea filipendula, Usnea florida, Usnea fulvoreagens, Usnea subfloridana, Usnea wasmuthii*

## Endangered

*Acarospora irregularis, Acarospora miskolensis, Calicium adspersum, Calicium salicinum, Calicium trabinellum, Caloplaca vitellinaria, Caloplaca vitellinoides, Cetraria chlorophylla, Cetraria islandica, Chaenotheca ferruginea, Chaenotheca furfuracea, Chaenotheca hispidula, Chaenotheca trichialis, Cladonia coccifera, Cladonia floerkeana, Cladonia pleurota, Cladonia polydactyla, Cladonia strepsilis, Cladonia verticillata, Mallotium tomentosum, Mölleropsis nebulosa, Ochrolechia pallescens, Pannaria leucophaea, Pannaria pezizoides, Parmelia exasperata, Parmelia loxodes, Parmelia pastillifera, Parmelia protomatrae, Parmelia pulvinaris, Parmelia ryssolea, Parmelia subdiffluens, Parmelia tinctina, Peltigera collina, Peltigera degeni, Peltigera elisabethae, Peltigera hymenina, Peltigera lepidophora, Peltigera malacea, Peltigera neckeri, Peltigera polydactyla, Pycnothelia papillaria, Solorina saccata, Usnea glabrata, Usnea glabrescens*

## Vulnerable

*Acarospora macrospora, Anaptychia ciliaris, Anema decipiens, Arthroraphis citrinella, Bryoria chalybeiformis, Bryoria implexa, Bryoria subcana, Calicium glaucellum, Cetraria pinastri, Cetrelia olivetorum, Chaenotheca chrysocephala, Chrysopsora testacea, Cladonia arbuscula, Cladonia botrytes, Cladonia cenotea, Cladonia cornuta, Cladonia crispata, Cladonia gracilis, Cladonia mitis, Cladonia rangiferina, Cladonia uncialis, Gyalecta jenensis, Hypogymnia bitteriana, Hypogymnia tubulosa, Lecanora demissa, Lecanora garovaglii, Lecanora riparia, Lempholemma botryosum, Lempholemma chalazanum, Leptogium diffractum, Leptogium plicatile, Leptogium schraderi, Leptogium sinuatum, Parmelia caperata, Parmeliopsis aleurites, Peltula euploca, Peltula tenebrata, Petractis clausa, Phaeophyscia luganensis, Physcia biziana, Placocarpus schaereri, Squamarina lentigera, Verrucaria hydrela, Xanthoparmelia angustiphylla, Xanthoria papillifera*

## Rare

*Acarospora atrata, Acarospora inaequalis, Acarospora suzai, Acarospora umbilicata, Agonimia tristicula, Arthonia didyma, Arthonia galactites, Arthonia punctiformis, Arthonia tumidula, Arthonia exilis, Arthonia lapidicola, Arthonia patellulata, Arthonia spadicea, Arthopyrenia analepta, Arthopyrenia biforme, Arthopyrenia cerasi, Arthopyrenia fraxini, Arthopyrenia grisea, Arthopyrenia rhyponta, Arthothelium ruanum, Arthothelium spectabile, Aspicilia ceracea, Aspicilia gibbosula, Aspicilia microspora, Aspicilia mutabilis, Aspicilia silicea, Aspicilia viridescens, Bacidia acclinis, Bacidia arceutina, Bacidia arnoldiana, Bacidia beckhausii, Bacidia friesiana, Bacidia fusca, Bacidia hegetschweileri, Bacidia incompta, Bacidia inundata, Bacidia laurocerasi, Bacidia naegelii, Bacidia phacodes, Bacidia polychroa, Bacidia trachona, Bactrospora corticola, Buellia aethalea, Buellia alboatra, Buellia ambigua, Buellia chloroleuca, Buellia chlorophaea, Buellia erubescens, Buellia heppiana, Buellia hungarica, Buellia lutosa, Buellia pharcidia, Buellia schaereri, Buellia sororia, Caloplaca agardhiana, Caloplaca balatonica, Caloplaca biatorina, Caloplaca chrysodeta, Caloplaca chrysophthalma, Caloplaca gialolechiaeformis, Caloplaca granulosa, Caloplaca hungarica, Caloplaca likensis, Caloplaca macrocarpa, Caloplaca necator, Caloplaca nubigena, Caloplaca obliterans, Caloplaca percrocata, Caloplaca polycarpa, Caloplaca rubelliana, Caloplaca scotoplaca, Caloplaca steropea, Caloplaca viridirufa, Candelariella reflexa, Candelariella viae-lacteae, Catillaria chalybeia, Catillaria globulosa, Catillaria griffithii, Catillaria nigroclavata, Cetraria sepincola, Cladonia cariosa, Cladonia conista, Cladonia decorticata, Cladonia glauca, Cladonia ochrochlora, Cladonia phyllophora, Cladonia pityrea, Cladonia polycarpoides, Cladonia rei, Cladonia scabriuscula, Collema callopismum, Collema coccophorum, Collema fragrans, Collema leptogioides, Collema multipartitum, Collema tuniforme, Collema undulatum, Cyphelium notarisii, Dermatocarpon bachmannii, Dermatocarpon michelii, Dermatocarpon moulinsii, Dermatocarpon subcrustosum, Dermatocarpon trachyticum, Diploicia canescens,*

*Diploschistes ochrophanes*, *Dirina stenhammari*, *Epilichen scabrosus*, *Hyperphyscia adglutinata*, *Hypocenomyce friesii*, *Jonaspis epulotica*, *Lecanactis dilleniana*, *Lecania cyrtellina*, *Lecania dubitans*, *Lecania fuscella*, *Lecania koerberiana*, *Lecanora agardhiana*, *Lecanora atra*, *Lecanora campestris*, *Lecanora cenisia*, *Lecanora coilocarpa*, *Lecanora expallens*, *Lecanora gangaleoides*, *Lecanora grumosa*, *Lecanora hypoptoides*, *Lecanora intricata*, *Lecanora leptyrodes*, *Lecanora magyarica*, *Lecanora pinastri*, *Lecanora piniperda*, *Lecanora populicola*, *Lecanora subcarnea*, *Lecanora subcarpinea*, *Lecanora subintricata*, *Lecanora subplanata*, *Lecanora subradiosa*, *Lecanora varia*, *Lecidea distans*, *Lecidea erratica*, *Lecidea fuscocinerea*, *Lecidea insularis*, *Lecidea lithophila*, *Lecidea monticola*, *Lecidea plana*, *Lecidea sarcogynoides*, *Lecidea segregula*, *Lecidea speirea*, *Lecidea tesselata*, *Lecidea uliginosa*, *Lecidea viridescens*, *Lecidella laureri*, *Lecidella scabra*, *Lecidella subincongrua*, *Lepraria lobificans*, *Leproloma vouauxii*, *Leptogium minutissimum*, *Leptogium tenuissimum*, *Leptogium tremelloides*, *Leptoraphis amygdali*, *Leptoraphis parameca*, *Leptoraphis quercus*, *Leptoraphis tremulae*, *Melasilea gibberulosa*, *Micarea melaena*, *Micarea misella*, *Micarea nitschkeana*, *Microthelia marmorata*, *Mosigia gibbosa*, *Mycocalicium subtile*, *Opegrapha chevallieri*, *Opegrapha devulgata*, *Opegrapha mougeotii*, *Opegrapha personii*, *Opegrapha saxicola*, *Opegrapha variaeformis*, *Opegrapha viridis*, *Pertusaria chiodectonoides*, *Pertusaria coccodes*, *Pertusaria dealbescens*, *Pertusaria flavicans*, *Pertusaria flavida*, *Pertusaria hemispherica*, *Pertusaria hymenea*, *Pertusaria leioplaca*, *Pertusaria leucosora*, *Pertusaria leucostoma*, *Pertusaria pustulata*, *Phaeophyscia ciliata*, *Phaeophyscia endococcina*, *Phaeophyscia endophoenicea*, *Phaeophyscia hirsuta*, *Phaeophyscia sciastra*, *Phlyctis agelaea*, *Physcia dubia*, *Physcia semipinnata*, *Placynthiella dasaea*, *Placynthiella icmalea*, *Placynthiella uliginosa*, *Placynthium filiforme*, *Placynthium garovaglii*, *Placynthium hungaricum*, *Placynthium subradiatum*, *Platismatia glauca*, *Polyblastia albida*, *Porina aenea*, *Porina affinis*, *Porina chlorotica*, *Porpidia albocoerulescens*, *Porpidia cinereoatra*, *Porpidia glaucophaea*, *Porpidia macrocarpa*, *Porpidia tuberculosa*, *Protoblastenia calva*, *Protoblastenia incrustans*, *Psorotichia schaereri*, *Pyrenopsis rhodosticta*, *Pyrenula corylii*, *Pyrenula laevigata*, *Pyrenula leucoplaca*, *Pyrenula nitidella*, , *Ramalina baltica*, *Ramalina calicaris*, *Rhizocarpon alpicola*, *Rhizocarpon cinereovirens*, *Rhizocarpon geminatum*, *Rhizocarpon grande*, *Rhizocarpon petraeum*, *Rhizocarpon polycarpum*, *Rinodina albana*, *Rinodina calcarea*, *Rinodina dubyana*, *Rinodina efflorescens*, *Rinodina exigua*, *Rinodina gennari*, *Rinodina immersa*, *Rinodina occulta*, *Rinodina oxydata*, *Rinodina sophodes*, *Rinodina subglaucescens*, *Rinodina teichophila*, *Rinodina trachytica*, *Sarcogyne simplex*, *Staurothele clopima*, *Staurothele fissa*, *Stereocaulon tomentosum*, *Strangospora moriformis*, *Strangospora ochrophora*, *Thelidium acrotellum*, *Thelidium austriacum*, *Thelidium decipiens*, *Thelidium immersum*, *Thelidium incavatum*, *Thelidium olivaceum*, *Thelidium papulare*, *Thelidium pyrenophorum*, *Thelidium umbrosum*, *Thrombium epigaeum*, *Thyrea pulvinata*, *Tomasellia arthonioides*, *Toninia caradocensis*, *Toninia cinereovirens*, *Toninia toniniana*, *Toninia tristis*, *Toninia tumidula*, *Toninia zsákii*, *Trapelia mooreana*, *Trapelia obtegens*, *Verrucaria baldensis*, *Verrucaria calciseda*, *Verrucaria elaeomelaena*, *Verrucaria fuscella*, *Verrucaria glaucina*, *Verrucaria hochstetteri*, *Verrucaria laevata*, *Verrucaria parmigera*, *Verrucaria sphinctrinella*

## References

Clerc, P., Scheidegger, C. & Ammann, K. (1992) Liste rouge des macrolichens de la Suisse. (The red data list of Swiss Macrolichens.) Bot. Helv. 102: 71–83.

Cieslinsky, S., Czyzewska, K. & Fabiszewski, J. (1986) Red list of threatened lichens in Poland. In: Zarzycki, K. & Wojewoda, W. (eds) List of threatened plants in Poland, pp. 83–107. Panstwowe Wydawnictwo Naukowe, Warszawa.

Hauck, M. (1992) Rote Liste der gefährdeten Flechten in Niedersachsen und Bremen. – Informationsdienst Naturschutz Niedersachsen 12(1) 1–44.

IUCN (1994) The IUCN Red List Categories. IUCN Species Survival Commission. IUCN, 21 pp.

Jacobsen, P., Scholz, P., John, V. & Wirth, V. (1992) Bearbeitungsstand und metodische Probleme bei der Erstellung von Roten Listen gefährdeter Flechten. Schr. Reihe Vegetationskde. 23: 113–121.

John, V. (1992a) Bearbeitungsstand Roter Listen Pflanzen in Rheinland–Pfalz. Schr. Reihe Vegetationskde. 23: 27–28.

John, V. (1992b) Bearbeitungsstand Roter Listen Pflanzen in Saarland. Schr. Reihe Vegetationskde. 23: 28–29.

Kappen, L. & Müller, K. (1982) Rote Liste der Flechten des Landes Schleswig-Holstein. Schriftenreihe des Landesamtes für Naturschutz und Landschaftspflege 5: 53–56.

Kashiwadani, H. & Kurokawa, S. (1995) Endangered lichens in Japan. Mitt. Eidgenöss. Forsch.anst. Wald Schnee Landsch. 70: 141–146.

Pisút, I. (1985) Zoznam vyhynutych, nezvestnych a ohrozenych lisajníkov Slovenska (1. ver.). (List of extinct, missing and threatened lichens in Slovakia (1st draft).) Biológia (Bratislava) 40(9) 925–935.

Pisút, I., Lackovicová, A. & Lisická, E. (1993) Súpis lisajníkov Slovenska. (Checklist of Slovak Lichens). Biológia (Bratislava), 48(Suppl. 1) 53–98.

Rakonczay, Z. (ed.) (1989) Vörös Könyv. A Magyarországon kipusztult és veszélyeztetett növény- és állatfajok. [The Hungarian Red Data Book. Extinct and threatened plant and animal species in Hungary.] Akadémiai Kiadó, Budapest, 360 pp.

Scholz, P. (1992a) Synopse der Roten Listen Flechten. Schr. Reihe Vegetationskde. 23: 73–111.

Scholz, P. (1992b) Rote Liste der Flechten des Landes Sachsen-Anhalt. Berichte des Landesamtes für Umweltschutz Sachsen-Anhalt 1: 38–43.

Siebel, H. N., Aptroot, A., Dirkse, G. M., van Dobben, H. F., van Melick, H. M. H. & Touw, A. (1992) Rode Lijst van in Nederland verwenen en bedreigde mossen en korstmossen. Gorteria 18: 1–20.

Siller, I. and Vasas, G. (1993) Védelemre javasolt magyarországi nagygombák. (List of the mushrooms recommended for protection in Hungary). Mikol. Közlem., Clusiana 32(1–2) 75–80.

Siller, I. and Vasas, G. (1995a) List of the mushrooms recommended for protection in Hungary. Acta bot. hung. 38(1–4) 309–314. (1993–1994).

Siller, I. and Vasas, G. (1995b) Red list of macrofungi of Hungary (revised edition). – Studia bot. hung. 26: 7–14.

Thor, G. (1995) Red Lists – Aspects of their Compilation and Use in Lichen Conservation. Mitt. Eidgenöss. Forsch.anst. Wald Schnee Landsch. 70: 29–39.

Tibell, L. (1992) Crustose lichens as indicators of forest continuity in boreal coniferous forests. Nord. J. Bot. 12: 427–450.

Tschabanenko, S. I. (1995) Rare and vulnerable species of lichens in the southern part of the Russian Far East – Primorye and Sakhalin Regions. Mitt. Eidgenöss. Forsch.anst. Wald Schnee Landsch. 70: 147–152.

Trass, H. & Randlane, T. (1987) Extinct macrolichens of Estonia. Folia Cryptog. Eston. 25: 1–16.

Türk, R. & Wittmann, H. (1987) Flechten im Bundesland Salzburg (Österreich) und im Berchtesgadener Land (Bayern, Deutschland) – die bischer beobachtenten Arten und deren Verbreitung. Sauteria 3: 1–313.

Verseghy, K. (1994) Magyarország zuzmóflórájának kézikönyve. Magyar Természettudományi Múzeum, Budapest, 415 pp.

Wirth, V. (1977) Rote Liste der Flechten (Lichenes). – Naturschutz aktuell 1: 60–64.

Wirth, V. (1984) Rote Liste der Flechten (Lichenisierte Ascomyzeten). In: Blab, J., Nowak, E., Trautmann, W. & Sukopp, H. (eds) Rote Liste der gefährdeten Tiere und Pflanzen in der BRD. Greven (Kilda), pp. 152–162.

Wirth, V., Schöller, H., Scholz, P., Ernst, G., Feuerer, T., Gnüchtel, A., Hauck, M., Jacobsen, P., John, V. & Litterski, B. (1996) Rote Liste der Flechten (Lichenes) der Bundesrepublik Deutschland. Schr.-R. f. Vegetationskde. 28: 307–368.

Wolseley, P. A. (1995) A Global Perspective on the Status of Lichens and their Conservation. Mitt. Eidgenöss. Forsch.anst. Wald Schnee Landsch. 70: 11–27.

# THE LAND-USE HISTORICAL APPROACH TO STUDY VEGETATION HISTORY AT THE CENTURY SCALE

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**Abstract:** In ecology and nature conservation emphasis is laid more and more on the landscape context and long-term dynamics. The goals of the land-use historical approach is to study the effects of past human land-use on vegetation, in order to recognize human induced patterns and processes in present vegetation. This paper shows the goals, methods and data sources of land-use historical studies and gives some examples of the use of this approach in vegetation science.

**Keywords:** ancient vs. recent habitats, nature conservation management, historical maps, aerial photos and documents, succession, vegetation pattern

## Introduction

Why do we need land-use historical data? Because in the cultural landscape - in the areas of the Hungarian Great Plain that have been studied especially - vegetation has been radically transformed by past human use, and thus present vegetation phenomena can not often be explained purely by natural factors (cf. Frisnyák 1990, Foster 1992, Molnár *et al.* unpubl.). Botanical landscape historical studies can provide data about those past events and states which played an important role in the shaping of the present vegetation pattern and dynamics.

Field botanical studies seldom use the hidden botanical data of historical maps and written historical documents. Though data is often scattered in literature, the vegetation history of a landscape can often be reconstructed in detail for the last centuries (cf. Zólyomi 1945-46, Molnár 1996).

Historical studies cover longer time scales than usual field botanical investigations do and thus facilitate the recognition of long-term vegetational processes, allowing estimations of their speed and direction. Long-term ecological studies also aim at studying long-term processes (Gisser 1991), but mainly on the decade time scale.

Long-term processes can also be investigated by the Space-for-Time substitution method. A great disadvantage of this methods is that it presumes that the past is the same everywhere. In spite of this limitation, this approach can help to recognize e.g. large scale phenomena, major steps in succession, and formulate hypothesis about the dynamics of vegetation (Pickett 1991). Efficiency of the methods could, however, be greatly improved by a detailed reconstruction of the history of the investigated sites.

Better understanding of the past can also improve the reliability of our predictions. Both ecological research and nature conservation need predictions. E.g. active nature conservation management is becoming more and more important, since our natural heritage can often be conserved or

maintained in our cultural landscape by management. Management decisions need information about the functioning of the system. The study of ecological systems is, however, very time consuming and expensive. A partial solution would be if we could reconstruct the past environments of the system (e.g. past land-use, past hydrological states) and if these seem to be beneficial for the system, we can try to imitate them.

## Goals of the land-use historical approach

The main goal of the land-use historical studies is to draw more emphasis on the fact that human land-use has considerably transformed even our seemingly "natural" vegetation patches and that present vegetation phenomena are often the consequence of past human effects. The general goal of this approach is to study the effects of past human land-use on the present vegetation pattern and dynamics. Those parts of the history are the most important and interesting to reconstruct, which can not be deduced from or explained by the present vegetation and environment.

Writing the history, includes 1. the reconstruction of the particular order of vegetational events over time, since these can influence the subsequent trajectory of a system (priority effects) and 2. the reconstruction of past constraining or enabling conditions, external to the system, since these can affect its performance (boundary conditions) (Pickett 1989, 1991). The botanical land-use historical studies can either aim at reconstructing the history of the whole vegetation mosaic of a landscape or concentrate on the histories of certain vegetation types. In Hungary, the time scale is generally 200-300 years because detailed historical data are only available since the 18th century.

The "by-products" of the studies (the collected, classified and botanically interpreted historical data) are made available for other botanical studies.

In our botanical land-use historical studies, we are collecting data to answer the following questions:

- To what degree can the landscape scale pattern and dynamics of the present vegetation be traced back to human land-use of the last 250 years?
- To what degree is human land-use (its type and intensity) controlled by site conditions (soil, hydrology, topography, etc.). To what degree can this cause the regional differences in the vegetation history of the two lowland regions under investigation (the sandy Kiskunság vs. the former floodplain: Tiszántúl)?
- To what degree can the local vegetational phenomena be ascribed to the specific local land-use history?
- After classifying plant species as indicators of ancient or recent habitats (determined in historically well known areas), is it possible to use present species composition (without historical data) to distinguish ancient and recent vegetation patches?

## Methods and data sources of land-use historical studies

In the Hungarian Great Plain, the following periods of the last 250 years are to be reconstructed in detail (selection was based on the general density of data sources over time and the most important changes in land-use systems):

- Re-emergence of the cultural landscape after the Turkish Occupation (Second half of the 18th century)
- Development of the small-farm agricultural system (1850-1890)
- Transition from the capitalist to the socialist agricultural system (1950-60s)
- The effects of the drought period (1980- ) and the social changes after 1989

The following main boundary conditions are to be reconstructed:

- abiotic changes e.g. in hydrology (caused by river control and drainage) and in soil conditions (alkalization, stabilization of moving sand dunes, drying),
- land-use effects like deforestation, afforestation, ploughing of grasslands, abandonment, grazing, river control, and drainage.

### Sampling of the vegetation

The first step of data collection is to survey present vegetation in detail. This generally means a floristical as well as a plant sociological description and the drawing of a vegetation map, i.e.

- flora lists of chosen vegetation patches
- distribution maps of certain indicator species
- coenological relevees
- stand relevees (cca. coenological relevees, but the size and shape of the quadrat is the size and shape of a vegetation patch)
- vegetation maps which are generally not traditional plant sociological maps, but maps which illustrate the distribution of certain successional stages or stands with different histories.

Any kind of quantitative ecological method can be used to analize collected data, but data are usually classified according to the historical attributes of the samples e.g. how ancient or of what age they are.

### Collection of historical data

Historical botanical data (floristical and coenological surveys e.g. Jankó 1886, Ujvárosi 1940, Bodrogközy 1966) can serve with concrete data about past vegetation states. This data also provides important information concerning the sort of boundary conditions which are most necessary to reconstruct.

The most important historical sources are the maps, especially the military survey maps. The first was made by Joseph II between 1782 and

1785 and is supplemented with a detailed Country Description (Eperjessy 1971). The second was made between 1829 and 1866, the third between 1872 and 1884. The fourth one was incomplete, the fifth was completed between 1953 and 1959. Cadaster maps, maps of the fields of a village (for an outstanding collection see Tóth 1992), and other thematic maps also help the reconstruction of past landscape pattern.

Aerial photographs contribute to more detailed reconstructions. In Hungary, photos since the early 1950s are available. Present day photos make field sampling more easy and accurate. Historical documentary photographs (e.g. about a lake shore, or a hillside) can help us to follow changes even in smaller scale vegetation mosaics (cf. Rogers 1982, photos of Sterbetz in: Molnár & Biró 1995b).

A wide range of historical documents and data help the reconstruction. Since the methodology of the different disciplines is specific, a botanist has to rely on data collected, classified and interpreted by other specialists (historians, geographers, linguists, etc.). The task for the botanist remains to find the data related to the vegetation in these sources.

Historical geography describes the geographic history of landscapes and studies the effects of human land-use on landscape (Somogyi 1988). Along with other disciplines of geography, it provides useful data for a botanist about the changes to human society, as well as the abiotic and biotic environment (e.g. Szabolcs 1961, Somogyi 1965). Publications about agricultural and forestry history provide direct data about past land-use practices (e.g. Szenti 1983, Hábel 1948, Elek 1937). Toponyms often contain plant names, or information about the land-use of certain areas which makes them an important source of reconstructions (e.g. Győrffy 1966, Tábori 1957).

Local human historical sources provide data about local land-use systems and local society. The counties and most settlements have published histories, but some of them are difficult to acquire or are of poor quality, especially those which are still manuscripts. It is advisable to read the county histories first and then the histories of the neighbouring larger cities.

The living memories of local inhabitants can provide very important and detailed data about the last 60-70 years. Data from personal communications, however, often involve the risk of subjectivity (cf. Winsor 1987, Mitchell 1991), therefore the most important data has to be verified.

## Examples of the use of landscape historical data

Based on our studies in the Hungarian Great Plain, we would like to show what sort of questions can be answered by the land-use historical approach.

### 1. Reconstructions of vegetation changes at the landscape scale

The vegetation pattern of a landscape can change dramatically fast. Map series can be drawn to show vegetation pattern transformation at the

landscape scale. Since land-use is often controlled by site conditions (cf. Foster 1992, Frisnyák 1990), the proportion of habitats can also change radically.

In the south of the Tiszántúl region, at Kardoskút, based on the data of Szenti (1983), the soil map of Hahn and Witkovski (1938) and the military survey maps, the history of the grassland-arable field mosaic can be reconstructed. In the studied area, between 1847 and 1884, 84 % of the loess grasslands and 27 % of the alkali grasslands were ploughed. By 1970, 99.9 % of the loess and 49 % of the alkali grasslands disappeared. In these periods, 80 % of the flooded, most alkali areas remained ancient (Molnár & Biró 1995b).

Radical changes are often followed by more stable periods (cf. Berglund 1991). For example, in the south of the Tiszántúl region, at Pitvaros, the extent of the grasslands has not changed since 1884. By this time, all of the area suitable for farming had been ploughed (Molnár 1996). In the same period, another landscape with very similar vegetational conditions (the neighbouring Kardoskút area) experienced profound changes. After the 1880s, breaking of grasslands did not seize. Abandonment and ploughing in the last 130 years resulted in a fine scale mosaic of different aged grasslands, where richness in specialist species seems to be a good indicator of ancient patches (Molnár & Biró 1995b).

In the Kiskunság region, at Fülöpháza, grasslands in the transition zone of the alkali lakes and the dry sand dunes, were completely ploughed between the 1850s and 1950s (military survey maps). Based on the timing and spatial distribution of ploughing (military maps and aerial photos) and the topography of the area, two habitat types may be inferred; one (a meadow?) surrounding the lakes and ploughed first, and a drier, less fertile one (a dry steppe grassland?) bordering the dunes. At the same time the area of the dry open sand grasslands and the alkali lakes has changed to a much lesser degree (at least till the drought period of the 1980s).

## 2. The ancient character of certain habitats

Ecological studies and also nature conservation often need to know the degree of naturalness of the vegetation. Though the century scale botanical historical studies of landscapes cannot identify whether a vegetation patch behaves naturally or not, they can recognize the greater human impacts that happened in the last centuries. The traditional school of plant sociology paid less attention to the vegetation history of this period. It could be the case that the recent (secondary) origin of certain vegetation patches has not been recognized and so partly or totally secondary vegetation was considered as "natural".

Since it is difficult to prove that a certain vegetation patch is primary with historical continuity from the pre-Neolithic Period, we usually distinguish ancient and recent patches (Rackham 1980, Peterken & Game 1984). Ancient patches which retained unploughed soils and have kept more

valuable species than our recent and thus secondary vegetation patches are those which developed before 1783 (the publication of the first military survey map) (cf. also Fekete *et al.* (1981) for the distinction of natural woodlands and recent plantations).

It is an unsolved question, for example, whether the juniper forests of the Bugac sand dunes are ancient or recent. According to Simon *et al.* (1985) they originated from sand oak woodlands by cutting and grazing. Fekete (1992) assumes, that the dry juniper-poplar forest is the climax woodland type of the dry sand dunes, which implies that the Bugac juniper forest could be ancient and not necessarily a degraded forest. The first military survey map from 1783 shows that in this area, only 30-40 tree-sized plant individual could be found in the northern part of the present "ancient juniper forest", while in the neighbouring Bócsa area, a dense vegetation cover (bushes with scattered trees) can be seen. Consequently the Bugac juniper forest - though it has very high natural values - can not be considered as ancient, but as a regenerated, seemingly near-natural, recent juniper forest.

18th century maps imply that the woodlands around Tiszadob could also be ancient. These riverhine forests have a 70-115 years old canopy layer, but the herb layer is characterless. As it turned out, this contradiction is the result of forestry management, since the ground of the forest was ploughed and cultivated for several years after the trees were cut last time (cf. Hábel 1948). Comparison of the species composition of young stands (less than 20 years old, and undergoing the same method of cultivation) and older stands (above 60 years) revealed that even in the older stands, only species which can survive this management can be found (e.g. *Polygonatum latifolium, Viola odorata, Geranium robertianum* and *Brachypodium sylvaticum*), others are very rare (e.g. *Carex remota, Carex sylvatica* and *Neottia nidus-avis*) or are confined to forest edges and road verges where the possibility of survival might be greater (e.g. *Stachys sylvatica, Bromus ramosus* and *Melica altissima*) (Molnár unpubl.).

In the Tiszántúl region, those alkali steppes can be regarded as ancient where local hydrology was mostly independent of the river floodings, i.e. spring floodings were caused by inland waters, and if these areas were not drained considerably (cf. Szabolcs 1961, Somogyi 1965). Based on the first military survey map and its Country Description, cadaster maps (Tóth 1992), a soil map (Hahn & Witkovski 1938), local historical sources (Tábori 1957, Elek 1937, Gazdag 1964) and in the case of Pitvaros, a pasture map from 1805 (Vedres in Tóth 1992) the ancient character of the Pitvaros steppes, and the secondary but in a smaller area partly ancient character of the Cserebökény steppes could be observed. Abundance of alkali specialist species and the distribution of loess grasslands correspond with the degree of ancientness. The number of specialists and the extension of high quality loess grasslands is the highest in the Pitvaros steppes and lowest in the

most secondary part of the Cserebökény steppes (Molnár 1996, Molnár & Biró 1995a).

Survival of loess steppe grasslands in alkali steppes was found to be controlled by the property conditions of the 19-20th centuries. At Kardoskút between 1847 and 1970, during the small-farm system, 99.9 % of the loess grasslands were ploughed. Ploughing pressure (Elek 1937) was so high that even the smallest (less than 0.1 hectare) loess grasslands were used for cultivation and were abandoned only in the late 1940s. Today these grasslands are about 50 years old (and thus secondary) and contain only one loess specialist plant species (*Astragalus austriacus*) (Molnár & Biró 1995b). The loess grasslands in the Pitvaros steppes belonged to the Blaskovics large estate, where land-use was coarser scale, and so the loess grasslands have survived and remained ancient (Molnár 1996). They are relatively species rich, 47 % of the regions loess specialists can be found in these grasslands (e.g. *Sternbergia colchiciflora, Phlomis tuberosa* and *Thalictrum minus*) (Molnár 1992).

### 3. Accurate localization of historical botanical data

Historical, floristical and coenological data are often important sources of vegetation history and biogeography. Occurrences with toponyms (i.e. geographic names) can be localized with the help of contemporary maps subject to the accuracy of the toponym.

Through the use of historical information, the accuracy of localization can often be improved. For example, the rare steppe plant *Salvia nutans* is mentioned in the flora list of Tótkomlós (Jankó 1886) with the notice: on meadows. Based on the I. and III. military survey maps and local historical sources (Tábori 1957), the accuracy of the localization can be improved from 5400 hectares to 410 hectares and the probable area can be identified where this species was found. Since this area has remained a grassland, there is a chance of finding the species - thought to be extinct previously - again.

## Conclusion

Better understanding of past land-use facilitates the understanding of present vegetation phenomena. New questions and hypothesis can be formulated about the history of the vegetation, about the ancient or recent character of certain vegetation types and thus about the possible nature conservational priorities and the adequacy of management options in our nature reserves.

Historical reconstructions are, however, sometimes difficult to carry out owing to the scarcity of historical data. For example,

- if the changes to be reconstructed can not be followed on maps and in written sources (e.g. changes in species composition of grasslands in the 18-19th centuries),
- if land-use varied in space and time at a fine scale,

- if the history of a "too small" area is to be studied before the times of aerial photographs,
- if the area to be studied belonged to a large estate whose archive was destroyed or to a bigger city but lay far from it.

In spite of these shortcomings, land-use historical studies often bring unexpected results too about "well-known" vegetation, which makes this kind of investigation especially interesting and worthwhile.

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## References

Berglund, B.E. (ed.) (1991) The cultural landscape during 6000 years in southern Sweden - the Ystad Project. Ecological Bulletin, 41. Copenhagen.

Bodrogközy, Gy. (1966) Ecology of the halophilic vegetation of the Pannonicum. V. Results of the Investigation of the "Fehértó" of Orosháza. Acta Bot. Hung. 12: 9-26.

Elek, P. (1937) Gazdaságföldrajzi kutatások Szarvas és Szentes vidékén. (Economical geography of the Szarvas and Szentes region) Budapest.

Eperjessy, K. (1971) Csanád megye az elsô katonai felvétel idején. (Csanád county at the time of the I. military surveying) Makói Múzeum Füzetei 7., Makó.

Fekete, G. (1992) The holistic view of succession reconsidered. Coenosis 7: 21-29.

Fekete, G., Zólyomi, B., Jakucs, P., Horánszky, A. & Csapody, I. (1981) Természetes erdôk, mesterséges állományok. (Natural woodlands, man-made plantations) Bot. Közl. 68: 133-142.

Foster, D.R. (1992) Land-use history (1730-1990) and vegetation dynamics in central New England, USA. Journal of Ecology 80: 753-772.

Frisnyák, S. (1990) Magyarország történeti földrajza. (Historical geography of Hungary) Tankönyvkiadó, Budapest.

Gazdag, L. (1964) A Száraz-ér vízrendszere. (River-system of the Száraz-ér) Földr. Ért. 13: 367-374.

Gisser, P.G. (ed.) (1991) Long-term Ecological Research. SCOPE, Johh Wiley and Sons.

Győrffy, Gy. (1966) Az Árpád-kori Magyarország történeti földrajza I. (Historical geography of Hungary during the Árpád dynasty) Akadémiai Kiadó, Budapest.

Hábel, Gy. (1948) Ismerjük meg az erdôgazdaságokat: Tiszadob. (Get acquainted with the forestry state holdings: Tiszadob) Erdôgazdaság 2/18: 2-4.

Han, F., Witkowsky, E. (1938) A tótkomlósi térképlap talajainak regionális leírása. (Soils of Tótkomlós and its neighbourhood) Kreybig-féle talajtérképezés. Talajtani és Agrokémiai Kutatóintézet, Budapest.

Jankó, J. (1886) Tótkomlós flórája. (Flora of Tótkomlós) Természetrajzi Füzetek 10: 175-180.

Mitchell, P.B. 1991. Historical perspectives on some vegetation and soil changes in semi-arid New South Wales. Vegetatio 91: 169-182.

Molnár, Zs. (1992) A Pitvarosi-puszták növénytakarója, különös tekintettel a löszpusztagyepekre. (Vegetation of the Pitvarosi-puszták, with particular reference to the loess steppes) Botanikai Közlemények, 79: 19-27.

Molnár, Zs. (1996) A Pitvarosi-puszták vegetáció- és tájtörténete az Árpád-kortól napjainkig. (Vegetation and landscape history of the Pitvarosi-puszták from the Middle Ages to the present) Natura Bekesiensis, In Print.

Molnár, Zs. Ártéri vegetáció Tiszadob és Kesznyéten környékén II.: A keményfaligetek (*Fraxino pannonicae - Ulmetum*) története és mai állapota. (Floodplain vegetation in the region of Tiszadob and Kesznyéten II. History and present state of the riverine forests (*Fraxino pannonicae-Ulmetum*)) Botanikai Közlemények, Accepted.

Molnár, Zs. & Biró, M. (1995a) A Cserebökényi-puszták Tájvédelmi Körzet és környéke botanikai, ornithológiai és általános természetvédelmi felmérése és értékelése. (Botanical, ornithological and nature conservational survey of the Cserebökényi-puszták Nature Reserve) Körös-Maros vidéki Természetvédelmi Igazgatóság, pp. 62.

Molnár, Zs. & Biró, M. (1995b) A kardoskúti Fehér-tó Természetvédelmi Terület botanikai felmérése és értékelése. (Botanical survey and evaluation of the Fehér-tó Nature Reserve at Kardoskút) Körös-Maros vidéki Természetvédelmi Igazgatóság, pp. 57.

Molnár, Zs, Horváth, F., Litkey, Zs. & Walkovsky, A. A Duna-Tisza közi kőrises égerláperdők története és mai állapota. (History and present state of the fen woodlands of the Duna-Tisza köze, Hungary) Természetvédelmi Közlemények, Accepted.

Peterken, G. & Game, M. (1984) Historical factors affecting the number and distribution of vascular plant species in the woodlands of central Lincolnshire. Journal of Ecology 72: 155-182.

Pickett, S.T.A. (1989) Space-for-Time Substitution as an Alternative to Long-Term Studies. In: Likens, G.E. (ed.) Long-term Studies in Ecology: Approaches and Alternatives, pp. 110-135., Springer.

Pickett, S.T.A. (1991) Long-term Studies: Past Experience and Recommendations for the Future. In: Gisser, P.G. (ed.) Long-term Ecological Research. SCOPE, pp. 71-88., John Wiley and Sons.

Rackham, O. (1980) Ancient Woodland. Arnold, London.

Rogers, G.F. (1982) Then and Now: A Photographic History of Vegetation Change in The Central Great Basin Desert. Univ. of Utah Press, Salt Lake City.

Simon, T., Rajkai K. (1985) A bugaci flóra, a növénytársulások és a talaj. In. Tóth, K. (ed.). Tudományos kutatások a Kiskunsági Nemzeti Parkban. pp. 146-152. Hungexpo, Budapest.

Somogyi, S. (1965) A szikesek elterjedésének időbeli változásai Magyarországon. (History of alkali steppes in Hungary) Földrajzi Közlemények 41-55.

Somogyi, S. (1988) A magyar honfoglalás földrajzi környezete. (Geographical environment of the Hungarian Conquest) Magyar Tudomány 11.

Szabolcs, I. (1961) A vízrendezések és öntözések hatása a tiszántúli talajképzôdési folyamatokra. (Effect of drainage and irrigation on the soil development in the Tiszántúl region) Akadémiai Kiadó, Budapest.

Szenti, T. (1983) Újabb levéltári adatok a Vásárhelyi-pusztáról. (New archive historical data about the Vásárhelyi-puszta, Hódmezővásárhely) Békés megyei Múzeumok Közleményei 7: 279-295.

Tábori, Gy. (1957) Tótkomlós földrajzi nevei. (Toponyms of Tótkomlós) Kőrös Népe II., 71-84, Békéscsaba.

Tóth, F. (1992) Makó régi térképei. (Old maps of Makó) Makó Monográfiája 1., Makó.

Ujvárosi, M. (1940) Növényszociológiai tanulmányok a Tiszamentén. (Plant sociological studies in the Middle-Tisza valley) Acta Geobot. Hung. 3: 30-42.

Winsor, R.A. (1987) Environmental imagery of the wet prairie of east central Illinois, 1820-1920. Journal of Historical Geography 13: 375-397.

Zólyomi, B. (1945-1946) Természetes növénytakaró a tiszafüredi öntözőrendszer területén. (Natural vegetation of the irrigation system at Tiszafüred) Öntözésügyi Közl. 7-8: 62-75.

Titles are tentative translations for original titles in Hungarian by the author.

Historical military survey maps can be found in the Museum of War History, present maps and aerial photographs can be purchased from the Tóth Ágoston Cartographic Institute, Budapest and the Institute of Cartography and Remote Sensing, Budapest.

# INVESTIGATION OF CLUB MOSS POPULATIONS IN THE ZEMPLÉN MOUNTAINS

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## Introduction

The investigated club moss species (*Lycopodium clavatum* L. [LC], *Lycopodium annotinum* L. [LA] and *Diphasium complanatum* L. (Rothm) [DC]) have circumpolar distribution (1). The southern boundary of their area reaches the Carpathian basin and they are relative abundant only in the Zemplén mountains (2, 3) and in the Vendvidék (4, 5).

There are some differences among these species regarding their habitat requirements. The [DC] is restricted to the dry, oligotrophic scots pine woods in the boreal and Central European regions (6, 7). [LA] is a characteristic species of the spruce forests of boreal and mountane region (6, 8) and very abundant in the boreal birch woods (9). [LC] is an early element of the secunder succession in boreal habitats, where disturbance (e.g. forest fire) plays an important role in its existence (10, 11).

Both their generative and clonal reproduction is very peculiar. The spore production is very high (9), but the development of the saphrophytic gametophytes and sporelings is very slow (15-20 years long) and sensitive (12, 13, 14). Thus, sexual reproduction leads not only to spatial but also to temporal separation among genets (10). Their modular growth and its function are very important, and it is researched in detail in case of [LA]. It can adapt to extreme harsh conditions by its highly effective resource utilisation, opportunistic, guerrilla growth form (15), nutrient and water allocation among modules (16, 17, 18, 19) and the dominance of apices (21). By these strategies the competition with other plants (e.g. evergreen dwarf shrubs, (20)) can be minimized, because it is presumably a poor competitor, because of its undeveloped root system (17).

The vegetation in the Zemplén mountains is very different from boreal and alpine habitats. The club moss populations in this area are ideal objects to investigate the behavioural change of a species due to the effect of other biological conditions. These species are protected, very rare and important elements of Hungarian flora. The present study is aimed at exploring differences among habitat requirements of certain club moss species and drawing conclusions concerning their conservation management.

## Study Area

This investigation was carried out in the Conservation Area of Zemplén between Nagyhuta, Telkibánya, Regéc villages. The study area was located at 200-500 m above see level, annual temperature is 8-9 °C, annual precipitation is approximately 700 mm. The bedrock of the area is sarmatic andesite and rhyolite (22, 23). The flora of the mountain range is influenced by the effect of the Carpathians. The most abundant vegetation on the hills is submountainous, mountainous and acidophilous beech woods (*Aconito, Melitti, Luzulo-Fagetum),* and sessile oak-hornbeam woods (*Querco petreae-Carpinetum*). In the valleys alder groves can be found (*Alnion glutinosae-incanae*) (23, 24). The vegetation in the area is considerably modified by forestry and agricultural management. In the place of natural beech woods we can found extensive disturbed areas (clearings, deforestation areas), and planted spruce woods. The acidic brown forest soil is characteristic in the beech woods (23).

## Methods

The first stage of the research was to make a distribution map of the club mosses. Vegetation of club moss colonies was described by using classical coenological methods (25). Fifty quadrat of 5x5 m were used. Bryophytes and vascular plants were recorded. The importance of species was characterized by estimating abundance-dominance values (25, 26). For data analyses AD categories were coded by their cover values as follows: +=0.1 %; +-1=1 %; 1=2.5 %; 1-2=5 %; 2=15 %; 2-3=25 %; 3=37.5 %; 3-4=50 %; 4=62.5 %; 4-5=75 %; 5=87.5 %. The relevés were grouped on the basis of species composition (without tree layer) using multivariate methods (27, 28). Hierarchical clustering was carried out by using consensus distance matrix from Euclidean and Ruzicka (29) distances matrices (standardisation with range), and β-flexible agglomerative function (β=-0.25) (30). Principle Coordinates Analysis of the relevés was also carried out using the consensus distances matrix (Podani unpubl.). The environmental conditions of the received groups were characterised by non-floristic descriptors of the species (31, 32) on the basis of their dominance (without tree layer). In case of WB (relative humidity scale) and LB (relative light requirement scale) all species were used, in case of phytosociological groups and SBT (social behaviour types) only the vascular plants.

## Results

The agglomerative classification resulted in six groups (Fig. 1.) cutting the dendrogram at the fifth step. There are no sharp borders among the groups, except for I., and the groups are incoherent (Fig. 2.). Relevés were groupped

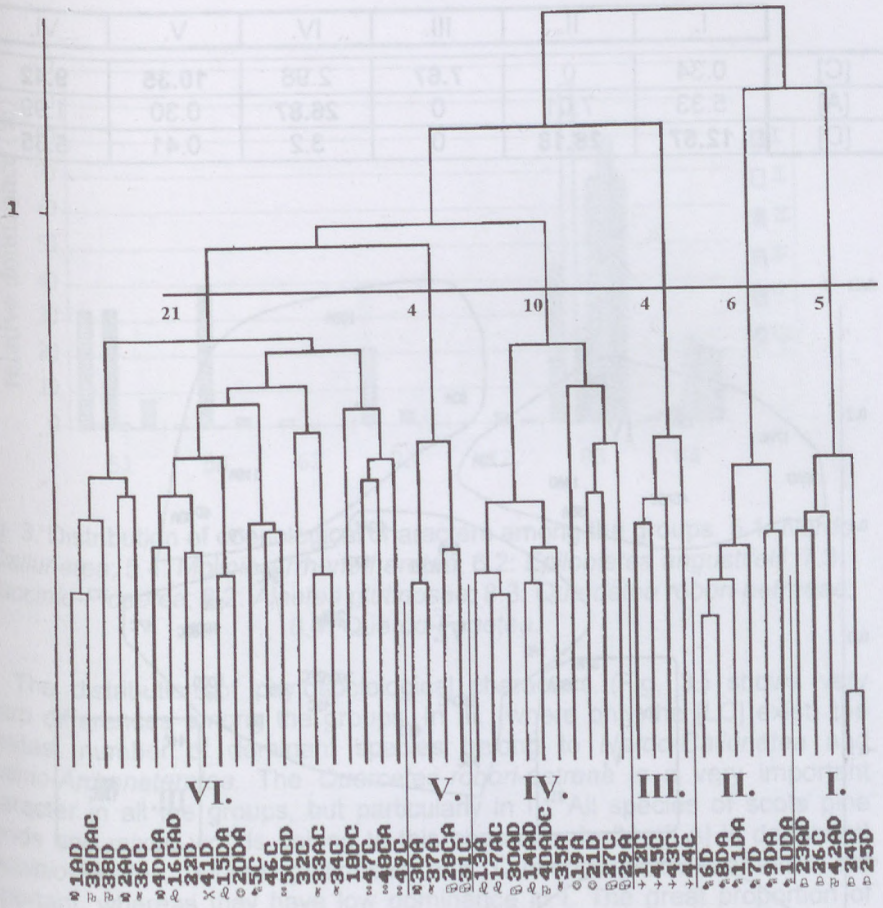



Fig. 1. Hierarchical classification of the relevés. C, D, A mean the presence of the [LC], [DC], [LA].

The markers mean the location of the relevés: -Borinzás hill, deforested area; -Ördög valley, deforested area; -Senyő valley, deforested area; -Vajda-hill, forestry road; -Hercegfia hill, edge of a spruce wood, forestry road; -Repka valley (southern part); - Bika valley, spruce wood; -Repka valley (northern part), deforested area; - Komlóska valley.

mostly according to locality, particularly in the case of I., II., III. (Fig 1., Fig. 2). The cover of [DC] is great in I. and II. (Table 1.), and the cover of [LA] is also considerable. [LA] has considerable dominance in group IV. In III. and V. [LC] is the dominant. In VI. [LC] and [DC] can be found in higher proportion. This group contains the greatest number of relevés (21), which come from different locations and habitats (spruce woods, forestry roads, clearings).

Table1. Average dominance (%) of club moss species in the groups

| | I. | II. | III. | IV. | V. | VI. |
|---|---|---|---|---|---|---|
| [C] | 0.34 | 0 | **7.67** | 2.98 | **10.35** | **9.42** |
| [A] | 5.33 | 7.01 | 0 | **26.87** | 0.30 | 1.99 |
| [D] | **12.57** | **28,18** | 0 | 3.2 | 0.41 | **5.65** |

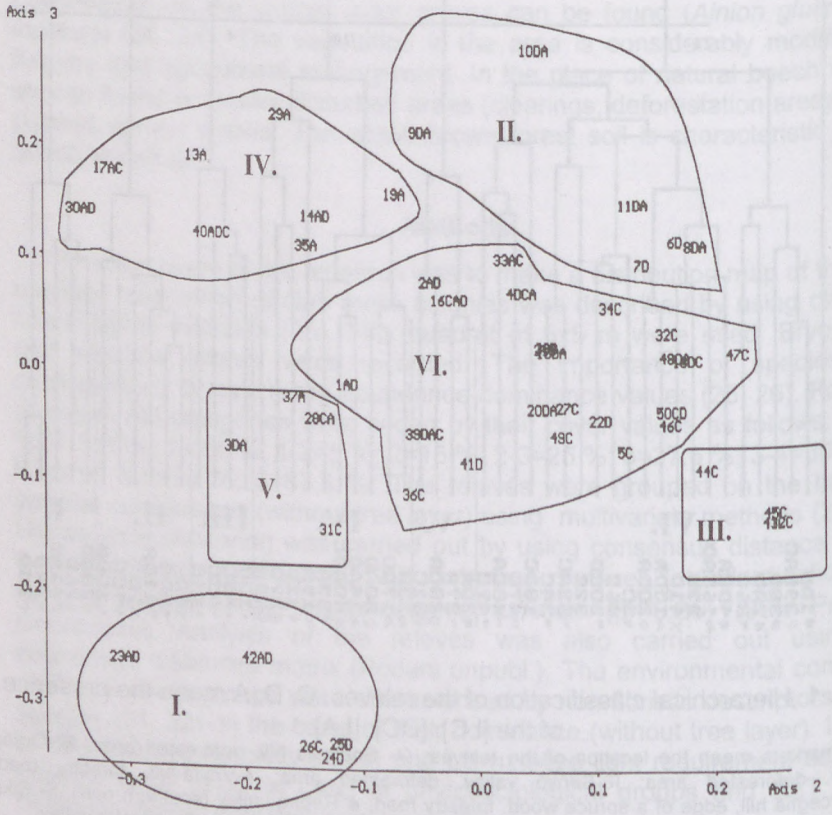



Fig. 2. Ordination of the relevés. The groups are bordered.

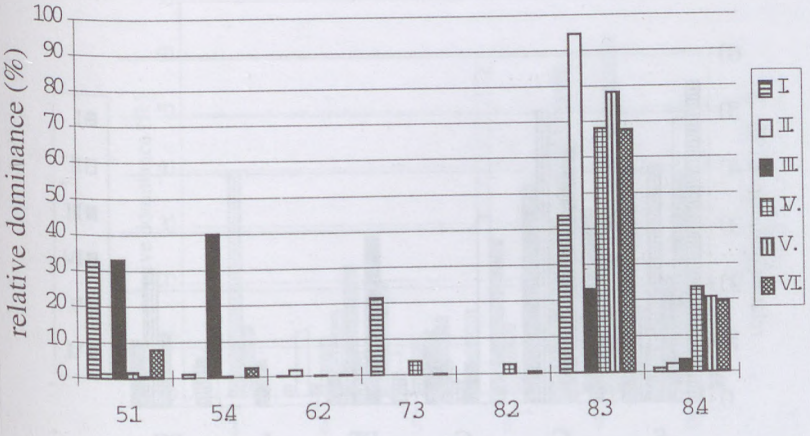



Fig. 3. Distribution of coenological characters among the groups. 5.1: *Nardo-Callunetea*; 5.4: *Molinio-Arrhenetheretea*; 6.2: *Epilobietea angustifolii*; 7.3: *Vaccinio-Piceetea*; 8.2: *Alnetea glutinosae*; 8.3: *Quercetea robori-petraeae*; 8.4: *Querco-Fagetea*.

The distribution of phytosociological characters (Fig. 3.) shows very sharp differences among the groups. In III. (where only the [LC] exist) the greatest number of dominant species belong to *Nardo-Callunetea* and *Molinio-Arrhenateretea*. The *Quercetea-robori-petreae* is a very important character in all the groups, but particularly in II.. All species of scots pine woods and mixed woods belong to this character. In IV. ([LA] is dominant) *Vaccinio-Picetea, Alnetea-glutinosae* and *Querco-Fagetea* elements are important, whereas they have low dominance in I. The great proportion of *Vaccinio-Picetea* elements is explained by the great cover of planted *Picea abies* seedlings in I.

The distribution of SBT values (Fig. 4.) shows, that the specialist and competitor species have very high proportion in all groups. In I. and VI. other elements are negligible (except for about 10% ruderal component), but in I. the specialists and in VI. the competitors are are of high importance. In III. and V. ([LC] is dominant) competitors with high proportion can be found, but in addition in III. the disturbance tolerant and in V. the ruderal species (eg. Calamagrostis epigeios) play an important role. In II. ([DC] are dominant) about 30% of the species are generalists.

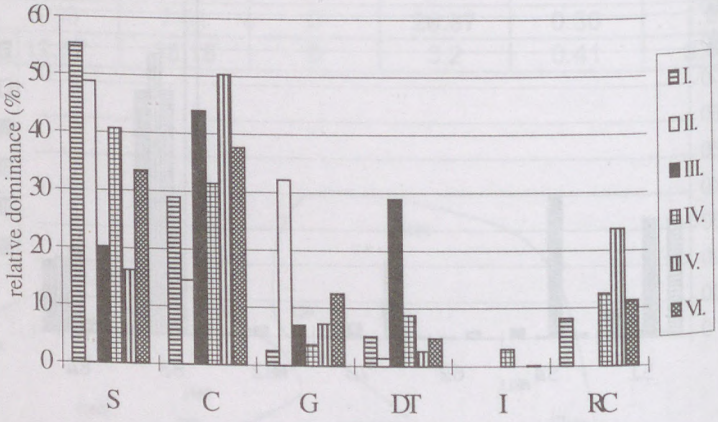



Fig. 4. Distribution of social behaviour types (SBT). S: Specialists; C: Competitors; G: Generalist; DT: Disturbance tolerants; I: Introduced alien species; RC: Rudelar competitors.

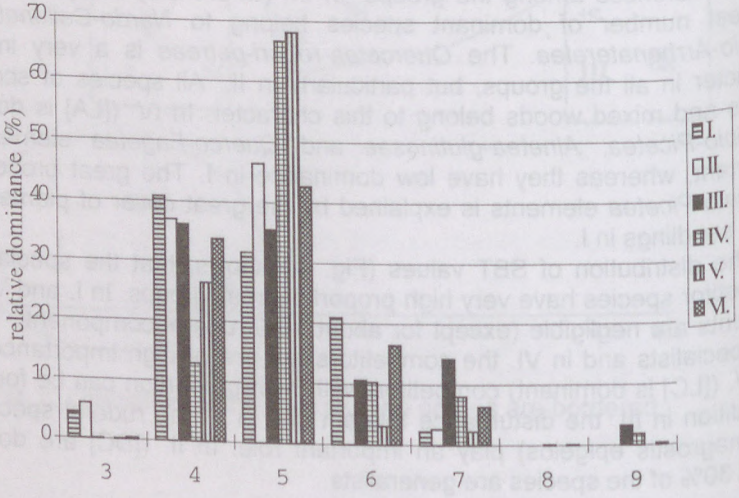



Fig. 5. Distribution of WB values.

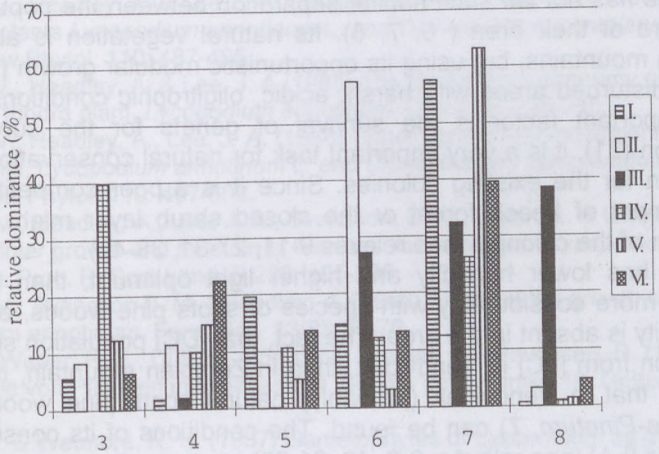



Fig. 6. Distribution of LB values.

About the 70% of cover are created in IV. and V. consist of the species with 5 WB values (Fig 5.), whereas by other groups more uniform distribution can be shown. The proportion of species with 3 WB values is of much higher dominance in I. and II. ([DC] is dominant), than in other groups. It can be observed in the distribution of LB values (Fig. 6.), that in IV. ([LA] is dominant) the species with 3, in other groups the species with 6, 7 and (in case of III:) 8 LB values, are dominant.

## Discussion

Club mosses often occur together in the Zemplén mountains. Their dominance do not differ considerably, although [LC] is the most abundant. They can be found in disturbed habitats, with harsh, extreme acidic soil conditions: in deforested areas, along edge of beech woods, along forestry roads and in birch heath (2). The similarity between the relevés is basically due to locality not to the club moss species. In Vendvidék the [LA] is very rare, and the other two club moss species appear rarer together, and among the [LC] and [DC] relevés higher compositional similarity can be found even though their location can be quite distant (33, 4).

Although in Zemplén mountains the separation is not considerable among the received groups, the dominance distribution of club moss species is different among them, and is some difference indicated among habitat requirements of investigated club moss population on the basis of the species composition of the groups.

[LA] ecological light expectation is lower, but its humidity expectation is higher (1, 4, 33), than the other two club moss populations, but this difference has not led such habitat separation between the population, as in the centre of their area ( 6, 7, 8). Its natural vegetation is absent in the Zemplén mountains, but using its opportunistic modular growth (9, 10) it can exist in disturbed areas with harsh, acidic, oligitrophic conditions. Since the most important factor is the survival of genets for the survival of the population (21), it is a very important task for natural conservation to provide protection for the existing colonies. Since it is a poor competitor (20), the development of beech forest or the closed shrub layer might lead to the extinction of the colonies (see relevés 9-11, 27-31, 38-42).

[DC] has lower humidity and higher light optimum, than [LA], and it coexists more considerably with species of scots pine woods, although this community is absent in the area. The fact, that [DC] population shows higher separation from [LC] in Vendvidék, than in Zemplén mountain, may roots in the fact, that in Vendvidék (probably) natural scots pine woods (*Genisto nervateae-Pinetum*, 7) can be found. The conditions of its conservation are similar, as [LA] (see relevés: 6-8, 18, 21-25).

The [LC] is an element of secunder succession in the centre of his its area (10, 11), thus it can adjust to disturbant habitats in Zemplén better than the other club moss species (Fig. 4.). This difference is considerably revealed in Vendvidék (4, 33). These populations are not threatened by extinction in Hungary.

The conclusion can be drawn by this study, that although the basic ecological features of club moss species are remained the same, the ecological and phytosociological behaviour of their population is considerably modified due to the effect of vegetation along the edge of the area. This conclusion could also be valid for other populations of the Hungarian flora.

## Acknowledgements

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## References

Bierhorst, D. W. (1971) Morphology of Vascular Plants. Macmillan, New York.

Borhidi, A. (1993) Social behaviour types of the Hungarian flora, its naturalness and relativ ecological indicator values. Jannus Pannonius Tudományegyetem, Pécs.

Braun-Blanquet, J. (1951) Pflanzensoziologie. 3. ed., Wien.

Callaghan, T. V. (1980) Age-related patterns of nutrient allocation in *Lycopodium annotinum* from Swedish Lapland. Oikos 35: 373-386.
Callaghan, T. V., Headley, A. & Lee, J. A. (1988) Phosphate and nitrate movement in the clonal plants *Lycopodium annotinum* L. and *Diphasiastrum complanatum* (L.) Holub.. New Phytol. 110: 487-495.
Callaghan, T. V., Headley, A. & Lee, J. A.(1985) The phosphorus economy of the evergreen tundra plant, *Lycopodium annotinum*. Oikos 45: 235-245.
Callaghan, T. V., Headley, A., Lee, J. A. (1988) Water uptake and movement in the clonal plants, *Lycopodium annotinum* L. and *Diphasiastrum complanatum* (L.) Holub.. New Phytol. 110: 497-502.
Callaghan, T. V., Headley, A., Lee, J. A., Svensson, B. M., Lixian, L. & Lindley, D. K. ( 1986) Modular growth and function in the vascular cryptogam *Lycopodium annotinum*. Proc. R. Soc. Lond. B 228: 195-206.
Callaghan, T. V., Svensson B. M. &Headley, A. (1986) The modular growth of Lycopodium annotinum. Fern. Gaz. 13(2): 65-76.
Ellenberg, H., Weber, H. E., Düll, R., Wirth, W., Werner, W., Paulinsen, D. (1991) Zeigerwerte von Pflanzen in Mitteleuropa. Scripta geobotanika 18. Goltze Verl., Göttingen.
Freeberg, J. A. & Wetmore, R. H. (1957) Gametophytes of *Lycopodium* as grown in vitro. Phytomorphology 10: 204-217.
Freeberg, J. A. (1957) The apogamous development of sporelings of *Lycopodium cernuum L., L. complanatum* var. *flabelliforme* Fernald and *L. selago* L. in vitro. Phytomorphology 10: 217-229.
Harper, J. L. (1985) Modules, branches and the capture of resources. In: Jackson, J. B. C., Buss, L. W. & Cook, R. E. (eds.), Population biology and evolution of clonal organism. Yale Univ. Press, New Hven, pp. 1-33.
Jahn, Gisela. (1985) Chorological phenomena in spruce and beech communities. Vegetatio 59: 21-37.
Jakucs, P. (1981) A társulások felvételezése, a társulástabella készítése (Phytosociological survey of communities). In: Simon, T & Hortobágyi, T. (eds.), Növényföldrajz, Társulástan és Ökológia. Tankönyvkiadó, Budapest.
Lance, G. N. & Williams, W. T. (1967) A general theory of classificatory sorting strategies. I. Hierarchical systems. Comput. J. 9: 373-380.
Mátyás, E. (1984) A tájvédelmi körzet geológiai jellemzése( Geological description of the landscape protection area). In: Szeremley, Sz. (ed.), Zempléni Tájvédelmi Körzet. Miskolc, (1984.
Meusel, W. & Hemmerling, J. (1968) Die Barlappe Europas. Willy Kolbe, Leipzig.
Ódor, P. (1994) A vendvidéki korpafű populációk cönológiai vizsgálata (Coenological study of club moss populations in Vendvidék). TDK dolgozat (manuscript), Budapest.
Ódor, P. (1996) Coenological study of club moss populations in western Hungary. Abst. Bot. (in press).
Oinonen, E. (1968) The size of *Lycopodium clavatum* L. and *L. annotinum* L. stands as compared to that of *L. complanatum* L. and *Pteridium aquilinum* (L.) Kuhn stands, the age of the tree stand and the dates of fire, on the site. Acta Forest. Fenn. 87: 5-53.
Pócs, T. (1965) A magyarországi tűlevelű erdők cönológiai és ökológiai viszonyai (The coenological and ecological relationship of coniferous forests in Hungary). Kandidátusi ért. (manuscript), Eger.

Podani, J. (1989) SYN-TAX: Számítógépes programcsomag ökológiai, cönológiai és taxonómiai osztályozások végrehajtására (SYN-TAX: Computer program package for cluster analyses in ecology, phytosociology and taxonomy). Abstracta Botanica 6: 1-158.

Podani, J. (1993) SYN-TAX-pc Computer Programs for Multivariate Data Analysis in Ecology and Systematics Version 5.0, User's Guide. Scientia Publishing, Budapest.

Polunin, O. & Walters, M. (1985) A guide to the vegetation of Britain and Europe. Oxford Univ. Press, New York.

Ruzicka, M. (1958) Anwendung matematisch-statisticher Methoden in der Geobotanik. Syntetische Bearbeitung von Aufnahmen. Biologia, Bratislava 13: 647-661.

Simon, T. (1977) Vegetationsuntersuchungen im Zempléner Gebirge. Akadémiai Kiadó, Budapest.

Simon, T. (1984) A növényvilág és termőhelyi viszonyai (The flora and its coenological relations). In: Szeremley, Sz. (ed.), Zempléni Tájvédelmi Körzet. Miskolc.

Simon, T. (1992) Korpafüvek a Zempléni-hegységben (Club mosses in the Zemplén mountains). In: A "Lippai János" tudományos ülésszak előadásai , pp 220-223. Kertészeti és Élelmiszeripari Egyetem, Budapest.

Svensson, B. M., Callaghan, T. V. (1988) Apical dominance and the simulation of metapopulation dynamics in *Lycopodium annotinum*. Oikos 51: 331-342.

Svensson, B. M., Callaghan, T. V. (1988) Small-scale vegetation pattern related to the growth of *Lycopodium annotinum* and variations of its micro-enviroment. Vegetatio 76: 167-177.

Tímár, G. (1995) A Vendvidék védett és veszélyeztetett növényei (Protected and endangered plants in the Vendvidék). Vasi Világ: 3-18.

Tuba, Z. & Herczeg, F. (1986) A korpafüvek zempléni-hegységi új lelőhelye (New club moss home in Zemplén mountains). Bot. Közlem: 73-76.

# COMPARATIVE COENOLOGICAL STUDIES IN FORESTS OF THE PLAIN OF RIVER DRAVA

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## Introduction

The plain of River Drava is one of the great wet lowlands of Hungary, representing landscape types and habitats endangered all over the world. In recent years, due to the planned Danube-Drava National Park, more studies were directed to this area, which led to the discovery of many valuable places. There is an urgent need of detailed studies of these habitats, because their future existence perhaps depends on whether they would be annexed, on the basis of results of these studies, to the planned National Park.

From the viewpoint of plant geography, the plain of Drava belongs to the phytogeographical district *Titelicum*, region *Eupannonicum* and province *Pannonicum*, it represents a transitional area towards the province *Illyricum* (Borhidi 1958).

Based on its geological sedimentation, the area can be divided into two parts: lower-lying areas are inundation areas of the river, which previously - before river regulation - were flooded year by year, higher-lying areas are terraces of Drava, which never have been flooded. Natural vegetation on the lower parts consists parts of willow groves (*Salicetum albae-fragilis*), elm-ash-oak groves (*Fraxino pannonici-Ulmetum*), alder groves (*Carici-Alnetum*), meadows and vegetation of dead-arms. On the higher parts there are lowland hornbeam-oak forests (*Querco roboti-Carpinetum*).

Vegetation zones of the inundation area of Drava - including willow and elm-ash-oak groves - were studied by Kovács and Kárpáti (1973, 1974). Elm-ash-oak and alder groves near Kisszentmárton were mentioned first by Horvát (1972). Coenological data from hornbeam -oak forests of the plain of Drava were published ba Horvát (1968) AND Horvát and Kevey (1983).

Various coenological, ecological and naturalness indicator values (Zólyomi *et. al.* 1967, Simon 1988, Borhidi 1995), and computer programs, which make calculations based on these indicator value much easier and faster, allow us to give a more comprehensive, many-sided evaluation, analysis and comparison of plant communities.

## Methods

### Study area

Studies were made in the neighbourhood of village Vajszló, in two extended forest stands (cc. 5 sq. Km each) and in and around Ataki-forest near Kisszentmárton, which was proposed to be annexed to the national Park.

### Sampling

Coenological relevés - using quadrats of 20 x 20 m - were taken in the above mentioned forest communities between April and August 1995.

### Data analysis

Various communities were compared by species composition, dominance relations, coenological and phytogeographical groups, social behaviour types, naturalness and relative ecological indicator values (temperature, moisture, soil reaction, nitrogen, light, continentality). Calculations were made using Excel 4.0.

## Results and Discussion

### Species composition

There is a considerable overlap between species occurring in the different communities: in most cases the proportion of common species is around 40 %, therefore all further calculations were based on coverage data.

### Coenological composition

During succession - parallel to the fact, that habitats become drier - the proportion of hygrophilous elements (wtar, swamp and moor species) constantly decreases, proportion of *Fagetalia* and *Querco-Fagetea* elements increases. Weeds and coenologically indifferent species play a significant role in the first three communities - communities directly influenced by water (Fig.1.).

### Composition by phytogeographical groups

The four forest communities are clearly separated here. In the first three communities a strong mediterranean influence can be recognized: in willow groves eurasian-mediterranean species dominate (58 %) and the proportion of cosmopolitans is high too, in alder groves european-mediterranean and eurasian-mediterranean elements dominate in approximately equal proportions (46,rep. 35 %). In elm-ash-oak forests mediterranean and submediterranean elements together represent 30 %, and there is a considerable amount of euasian-mediterranean and european-

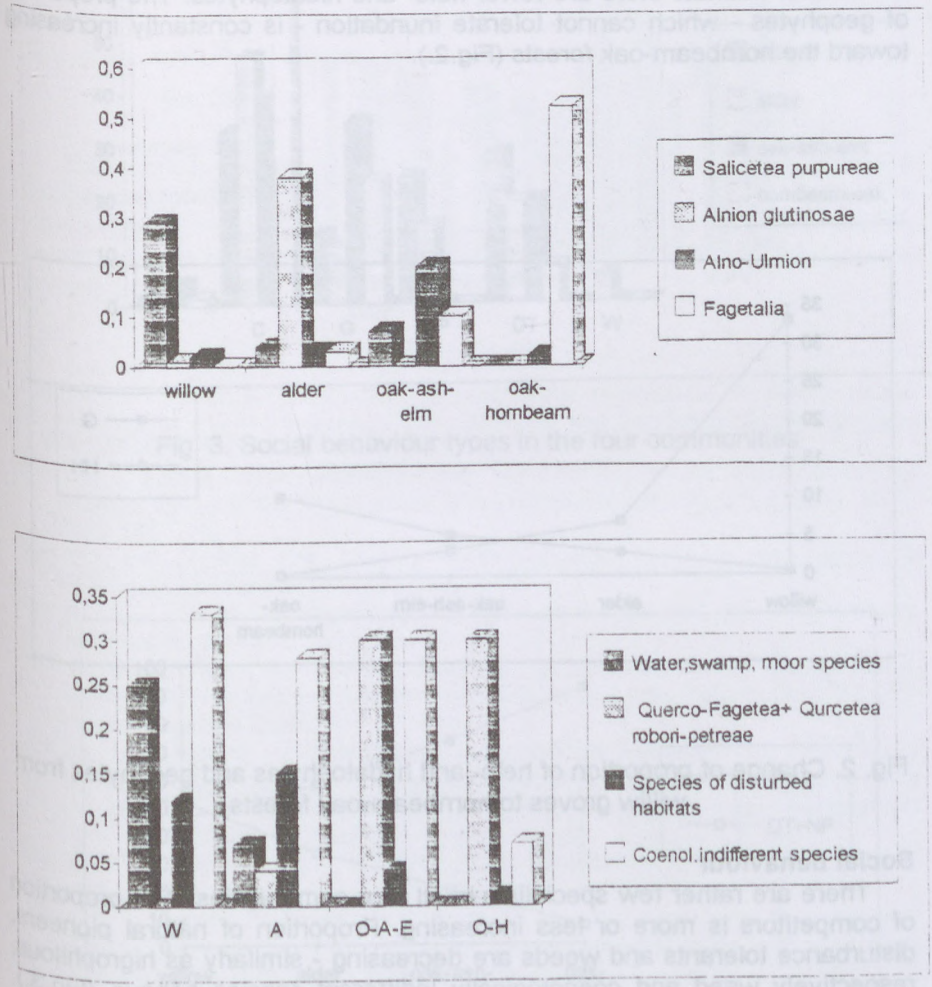



Fig. '1. Coenological composition of the four communities

mediterranean species (18, rep. 17 %). On the other hand, in hornbeam-oak forests middle-european elements dominate (44 %), and there are a lot of european-mediterranean species too (26 %).

**Life form types**

In drier habitats there are fewer helo- and hidatophytes. The proportion of geophytes - which cannot tolerate inundation - is constantly increasing toward the hornbeam-oak forests (Fig.2.).

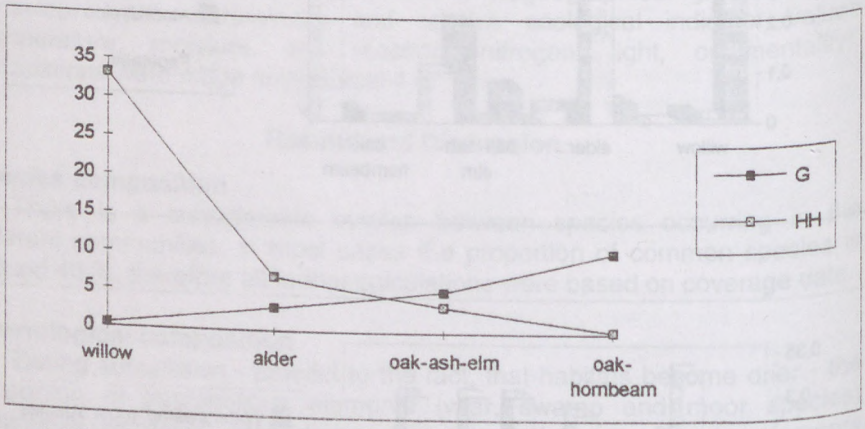



Fig. 2. Change of proportion of helo- and hydatophytes and geophytes from williw groves to hornbeam-oak forests

**Social behaviour**

There are rather few specialists in all four communities. The proportion of competitors is more or less increasing. Proportion of natural pioneers, disturbance tolerants and weeds are decreasing - similarly as higrophilous, respectively weed and coenologically indifferent species behave (Fig.3.). Sum of proportions of competitors and generalists - species important in determining the structure of communities - increase parallel to that sum proportions of natural pioners and disturbance tolerants - species filling gaps: appear to utilize free resources - decrease (Fig.4.).

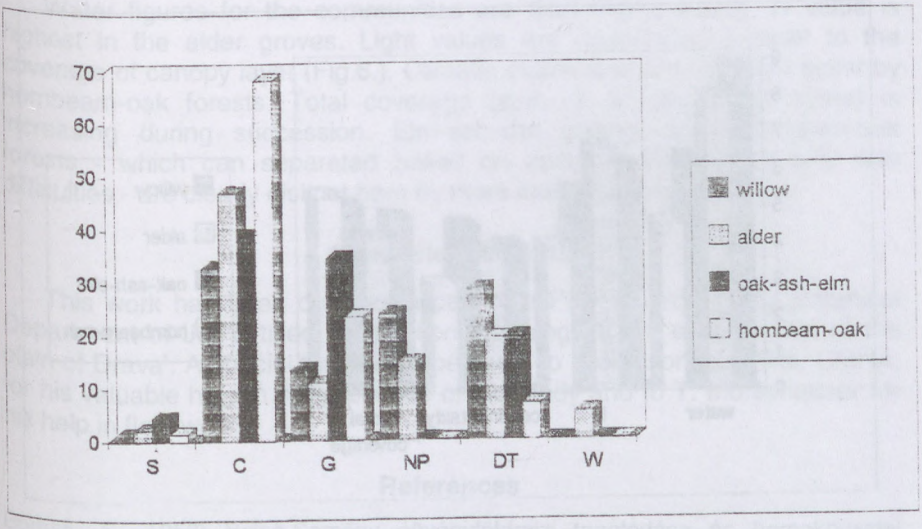



Fig. 3. Social behaviour types in the four communities

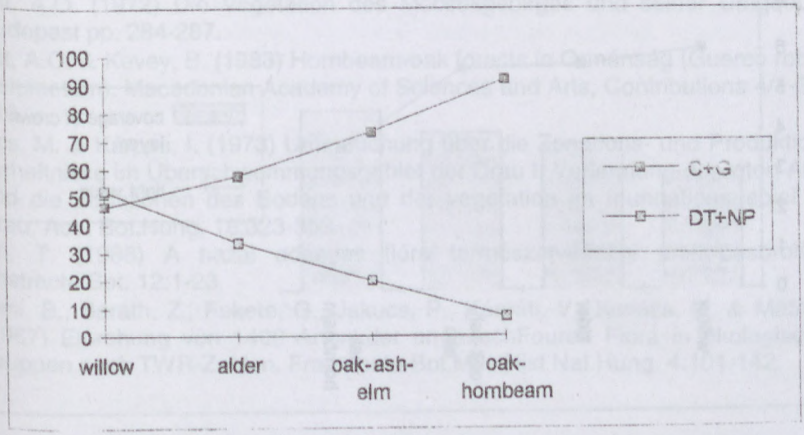



Fig. 4. Change of proportion of "structure-building" (C+G) and opportunistic (NP+DT) species in the four communities

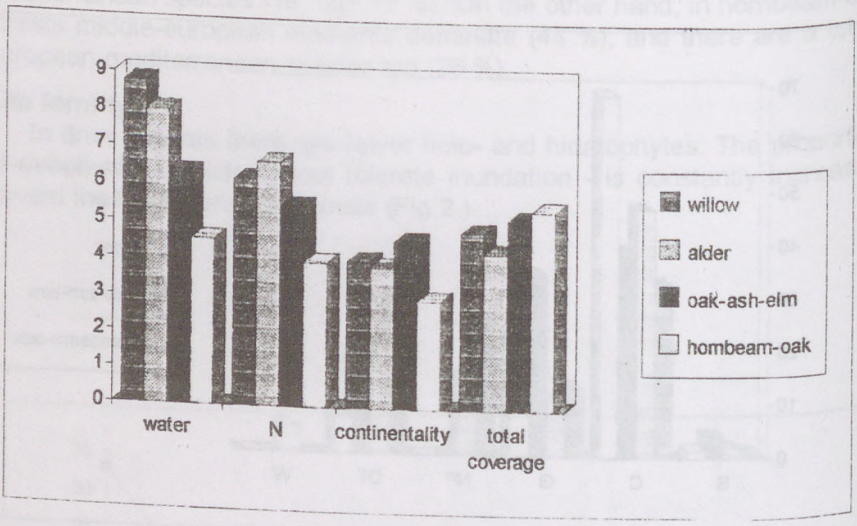



Fig. 5. Comparison of communities by water, nitrogen and continentality values and total coverage

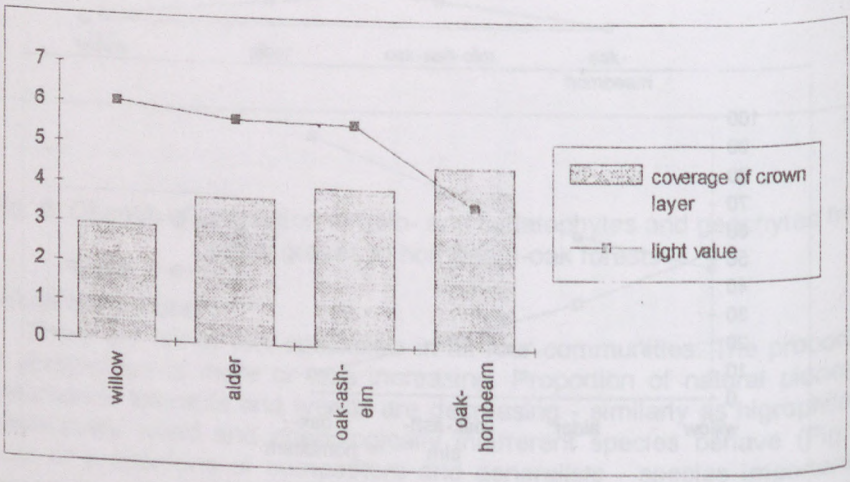



Fig. 6. Coverage of crown layer and light indicators value in the four communities

## Naturalness and relative ecological indicator values

Water figures for the communities are descending evenly. N value is highest in the alder groves. Light values are descending parallel to the coverage of canopy layer (Fig.6.). Climatic extremities are tolerated worst by hornbeam-oak forests. Total coverage (sum of coverages by layers) is increasing during succession. Elm-ash-oak groves and hornbeam-oak forests - which can separated based on species composition only with difficulties - are clearly distinct here by more indicator values (Fig.5.).

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## References

Borhidi, A. (1958) Belső-Somogy növényföldrajzi tagolódása és homokpusztai vegetációja. Pflanzengeographische Einteilung und Sandsteppenvegetation von Belső-Somogy. MTA Biol. Csop. Közl. 1:343-378

Borhidi, A. (1995) Social behaviour types, the naturalness and relative ecological indicator values of the higher plants in the Hungarian flora. Acta Bot.Hung. 39 (1-2):97-181.

Horvát, A.O. (1968) Die Hainbuchen-Eichenwalder der Mecsek-Gegend in Südungarn Feddes Rep. 77: 163-176.

Horvát, A.O. (1972) Die Vegetation des Mecsekgebirges und seiner Umgebung. Budapest pp. 284-287.

Horvát, A.O. & Kevey, B. (1983) Hornbeam-oak forests in Ormánság (Guerco robori-Carpinetum). Macedonian Academy of Sciences and Arts, Contributions 4/1-203-210.

Kovács, M. & Kárpáti, I. (1973) Untersuchung über die Zonations- und Produktions-verhaltnisse im Überschwemmungsgebiet der Drau I. Verlandung der toten Arme und die Zonationen des Bodens und der vegetation im Inundationsgebiet der Drau. Acta Bot.Hung. 18:323-353.

Simon, T. (1988) A hazai edényes flóra természetvédelmi érték-besorolása. Abstracta Bot. 12:1-23.

Zólyomi, B., Baráth, Z., Fekete, G., Jakucs, P., Kárpáti, V., Kovács, M. & Máthé I. (1967) Einrehung von 1400 Arten der ungarischFouren Flora in ökologischen Gruppen nach TWR-Zahlen. Fragmenta Bot.Mus.Hist.Nat.Hung. 4:101-142.

# HORIZONTAL SPATIAL PATTERN OF VEGETATION STRUCTURE IN WET MEADOW COMMUNITIES

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**Abstract:** Studying the vegetation of wet meadow communities arises the problem of drawing a borderline between vegetation units. The description of communities consisting of a similar set of species and therefore separated on the basis of quantitative features is also complicated by the so-called overlapping species (Soó 1932,1933, Kovács & Felföldy 1958). For these reasons community complexes are being talked of (Soó 1930), which also have a horizontal spatial mosaic feature. The co- and polydominant relationship of species may be characteristic, determining the position of a community in the system by the proportions of the species. The floristic composition is regulated most of all by local factors: the water content of the soil, the type of soil, physical (structural) and chemical (pH, lime content, etc.) factors. The character species of communities indicate the coenological nature and they can be good indicators of characteristics of soils as well (Soó 1930, Kovács 1962).

The mosaic-like differences in soil features are well reflected by the various wet meadow communities, which make up a mainly continuous transition on the field. Showing a real picture of vegetation, this structure has to be reflected in the description as well. For this it seems to be a good device to represent the vegetation data associated with the samples taking with a multi-functional, map-like method, the so-called isodominance representation.

The analysis based on 60 phytocoenological samples, made in 1993 uses the coenological type of vegetation patches, their quantitative features (i.e. cover values) and the relating groups of phytosociological (SBT) and nature conservation (NCR) category systems to describe the vegetation structure. Additional assistance to the characterization of the samples is the cluster analysis with the use of quantitative comparative functions (dissimilarity, complete link, mean character)

**Keywords:** vegetation pattern, calciphilous wet meadows (*Caricion davallianae, Molinion coeruleae*), Social Behaviour Types (SBT), Nature Conservation Ranks (NCR), isolines (interpolation method)

## Introduction

The protected areas in Hungary more and more play a role of model areas for vegetation studies. The results of these studies give assistance to the examination of habitats with similar status and to the development of concrete intervention strategies. The quality of vegetation and the quantitative extents of the constituting plant species are signs on their own (Juhász-Nagy 1979). In the estimation of the state and developmental stage of the vegetation, the internal organization of the communities can be given significance, which could be expressed in the composition and mass relations of the constituting plant species. There are four studies in which the indexes, defining the most frequent role of plant species in a community are

defined (SBT, NCR) allowing evaluations from different viewpoints. The category system of Social Behaviour Types (Borhidi 1995a) mostly signifies the behaviour, status of the elements of the community in the whole structure and so can be used to explore the internal dynamics of the vegetation. The results transformed with numerical values (VAL) make the comparisons from different aspects possible. The Nature Conservation Ranks (NCR) frequently used in the practice of nature conservation were made with the view of giving significance to the aspects' protection (Simon 1984,1988, 1992). During the analysis of a concrete area the supervision, possible correction of the role of species in their currently localized stand may be necessary (Bagi 1991).

The expressive representation that uncovers the regularities working in a concrete case and can be associated with the area on a map level, always closely belongs to the application of vegetation analysis with nature conservation purposes. One of the methods of this could be the so-called place in abstract spaces about which comparative information can also be obtained. Another possibility is the so-called isoline method completing the traditional vegetation maps representing the vegetation or increases their information content. This method is suitable for evaluating data characterizing the vegetation, among others at small scale representations showing the horizontal patterns of plant communities or vegetation complexes (Mucina et al. 1988, Falinski 1991, Kostrowiczki et al. 1991, Pignatti 1991).Well interpretable results can be obtained also in case of combination with indexes represented as a function of environmental factors or various phytoindicational indexes (Kazda et al. 1991, Morschhauser 1994, Morschhauser & Salamon-Albert 1995).

## Methods

### Study area

The study area is situated in the western part of Hungary in the Káli basin that is parallel with the northern shore of the Lake Balaton (Fig.1) Its size is about 72 ha and it is under strict protection since 1992. Its lowest point rises only about 50 to 70 meters above the surface of the lake (135-140 m). The base rock is triassic limestone giving shelter to subterranean or outbursting springs through karstification processes. The subterranean karst water, the precipitation distribution with two peaks per year (6th-7th and 11th months) and the peat soil that has transformed to different extents by now, created the possibility a of basiphilous wet meadow community formation. As a result of melioration activities in the early 1980s, the area has been cut by water canals, by which the rapid transformation of the vegetation was initiated.




Fig. 1. Geographical situation of the study area

## Sampling

60 coenological reléves were taken in 1993 with the quadrate method. The size of the sample squares was 25 $m^2$ according to the type and extent of the vegetation patches. Sampling was done randomly as typical of the patch in vegetation units separable in their fenology, their number is in direct proportion with the expansion of the vegetation patch. In the samples the cover values (percentage) and the abundance-dominance data (AD) of the plant species are listed from the phase of vegetation period showing multitudinousness (6th-7th month). The samples comprise ones that from a coenological point of view are typical of the vegetation units moreover ones that represent the transitions in the initial and terminal phases and between communities. The nomenclature of communities is based on Soó (1973) and Borhidi (1995b).

## Data analysis

The analysis of the vegetation took place after the incorporation of the data taken on field into the relational database (dBASE IV) related with indexes that can be used adequately (SBT, modified NCR). The estimation of the developmental stage of the coenological samples was assisted by a numerical classification method: cluster analysis for AD values, complete link method (Sorensen 1964), dissimilarity version, mean character difference (Cain & Harrison 1958) making use of Syntax 5.0 (Podani 1980,1993). Instead of the traditional diagrams and maps the results were represented with isolines displaying a horizontal section. It shows the value distributions have been calculated with the interpolation procedure (Kriging method) from the data associated with the spatial coordinates (X, Y) of the designated sample points in the area. Representations come from the cover-based calculation showing the mass relations of the species.

## Results and discussion

The separated vegetation units in the study area are: *Seslerietum uliginosae* (Sesl), *Succiso-Molinietum schoenetosum* (SMsch), *Succiso-Molinietum hungaricae* (SMh), *Succiso-Molinietum arundinaceae* (SMa), *Succiso-Molinietum caricetosum paniceae* (SMcp). According to the result of quantitative cluster analysis various communities were well differentiated in the proportion of the mass relations of plant species.

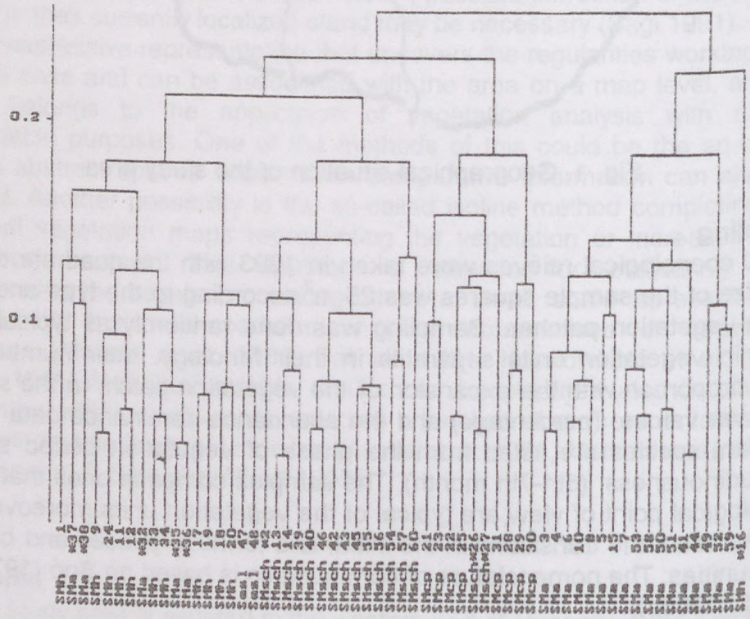



Fig. 2. Tree-diagram as a result of wet meadow communities by cluster analysis (mean character difference, complete link)

The dendrogram shows the typical samples and the ones with a non-typical, transitional location (Fig. 2). These samples as the representatives of a transitional stand (2,16) and the initial or terminal phase (26,27,32,35,36,37,38) belonging to a given vegetation unit are designated with a (*). Coenological samples from the area containing these ones can be ordered on the basis of a linked value with the respect to the developmental relations. From this a map of vegetation pattern can be drawn and the borders of the communities can be interpreted as a continuous transition (Fig.3/a). The large patches appearing on the map are the SMa (SW corner) and the SMcp (NW corner). The big patch on the eastern part is the SMsch-Sesl-SMh complex which cannot be differentiated properly because of the great similarity of the composition of species. Their transition into each other

can be made more accurate after correction of the numbers related to the samples according to strength of transitions (Fig. 3/b). The vegetation units at the two ends of the scale appear more defined in the differentiated representation (1,5). From the comparison of two separated patches of the SW corner the relative dominance can be deduced (SMh, SMa). It can be seen that the SMh is rather situated in the southern part while the SMa in the upper area. In case of the other NW-SE area the upper part of the two eastern density centers designates the typical appearance of SMsch while the lower one designates the unit containing Sesl.

The comparison of pattern maps of the dominant species in different communities further elaborates on the differentiable patches (Fig. 4-5). The characteristic species of *Caricion davallianae* are displaying the wet, and those of *Molinion* are showing the dry regions. The dominance center of *Schoenus nigricans* (Fig. 4) exactly indicates the wettest spots in the eastern (SMsch) and south-western part (SMh) leaving the area of Sesl present on the map of vegetation pattern. The *Cirsium canum* (Fig. 5) indicating dryness appears in small quantities in the patch of SMh with greater dominance in the unit of SMa and SMcp. Comparing the dominance maps of *Molinia hungarica* and *Molinia arundinacea*, it is observable that the dominant species display an overlapping quality in many patches with their high proportion of mingling. Because of this the high degree of mosaic-like quality the vegetation is apparent supported by the isodominance maps of several species, not mentioned in this article (e.g. *Allium suaveolens*, *Serratula tinctoria*).

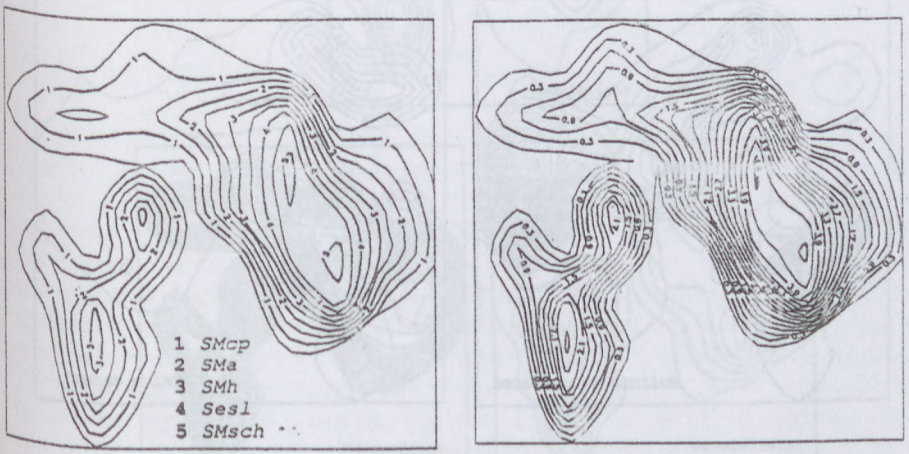



Fig. 3. Pattern maps of the vegetation

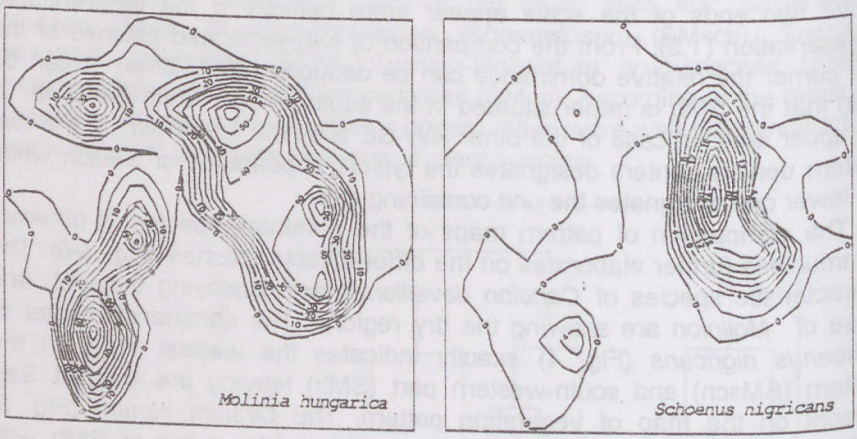



Fig. 4. Izodominance maps of wet patches by *Molinia hungarica* and *Schoenus nigricans*

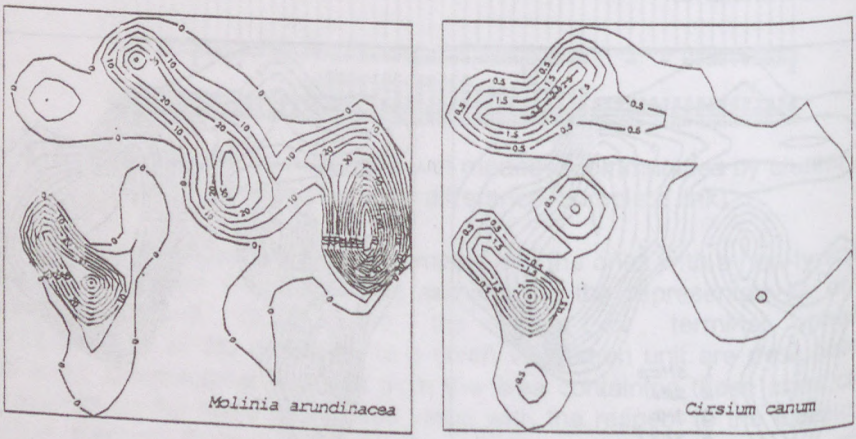



Fig. 5. Izodominance maps of dry patches by *Molinia arundinacea* and *Cirsium canum*.

The connection of the vegetation with SBT categories reflecting on their internal structure is a new view in the interpretation of vegetation patterns. The Specialist-Competitors-Generalists triad representing the mass of natural, community building species create a unit co-moving with and sensitively following the changes of the vegetation mosaics (Fig. 6). The most flexible vegetation unit able to transform (SMcp) is shown by the low ratio of C matched with a high ratio of G, taking free positions of missing competitors. In this process the main role is played by the *Phragmites australis* (C) intruding into the fresh patches as well, although with a slighter coverage appearing there as a disturbance tolerant (DT). The ratio of the two groups (C/G) shows the rather unstable state of the SMcp community. The highest competitor coverage falls on the area of SMa and SMsch. A patch of SMh and SMa excel with a high ratio of S, the latter one shows a high degree of stability. These units can be regarded as the latest phase of succession in this area this time therefore the G part is the lowest. The maximum of presence of the unique and rare specialist (Su, Sr) is in the SMh and SMsch stands.

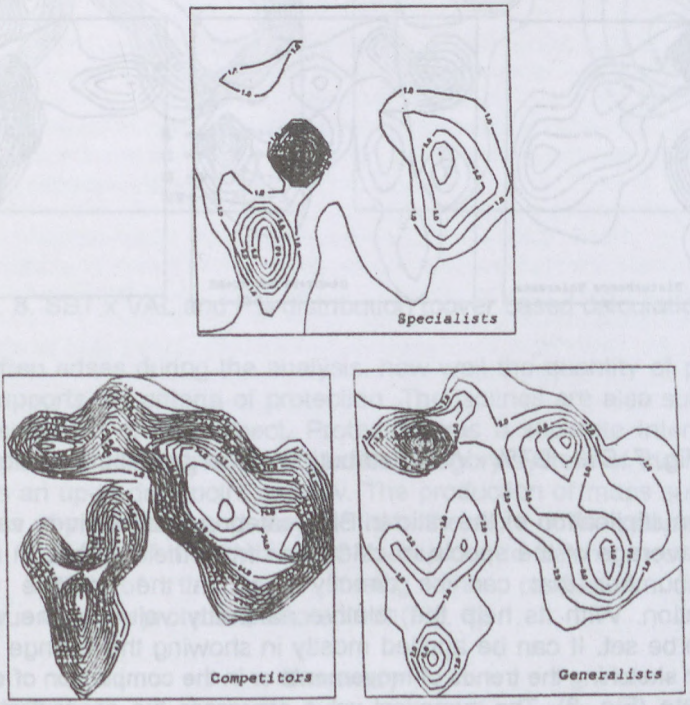



Fig. 6. S-C-G distribution (%, cover based calculation)

The participation of weeds (W), disturbance tolerants (DT) and agressive-ruderal competitors (AC-RC) disintegrating the internal organization of the communities from outside show the potential points of weakness. Their total representation (D%=W+DT+AC+RC) displays the degree of degradation (Fig. 7). The concentrated parts of the areas in question are situated in the units SMa and SMcp. In the former one the elements of DT and RC categories are dominant, in the latter one those of W and AC. The weeds belonging to the natural set of species are mostly signs of the beginning transformation in the patch of SMsch. In the area of SMcp the *Lysimachia vulgaris* (DT), *Cirsium vulgare* (W), *Cirsium arvense* (RC) and *Solidago canadensis* (AC) are present simultaneously. In the eastern stand of the SMa mostly the Solidago canadensis and *Eupatorium cannabinum* (DT) are signs of degradation.




Fig. 7. D% - DT% - W% distribution (cover based calculation)

The multiplication of the ratio in SBT categories by a given value (VAL) and the average of the spectrum calculated from the distribution result in a relative number that can be directly used in the practice of nature conservation. With its help the relative naturality value of the vegetation units can be set. It can be applied mostly in showing the change according to time, in sketching the trends of movements or in the comparison of stages in a given state (Fig. 8). The numerical value expresses the concentrated part of SBT categories' neighborhood occurring of species in the community. Because of the negative value of the last two members (AC, RC) the positive

value of D% is decreased as much as the proportion of the species indicating the degradation. In this sense the compositions that are close to the natural one the most valuable units are the SMsch-Sesl and SMh in our case. The former one with the average of 4.4 shows the multitudiousness of the competitors leaning towards the generalists. It is restricted to a small patch in the SMcp, the characteristic average is 3.4 places the emphasis on the indicators of disturbance.

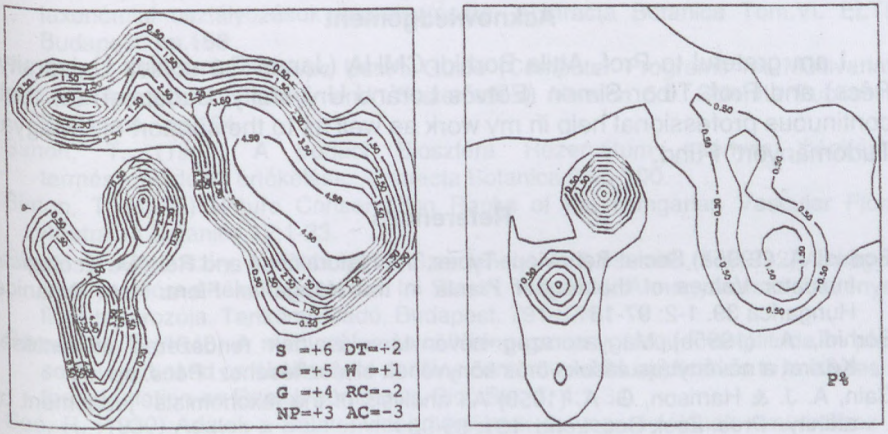



Fig. 8. SBT x VAL and P% distribution (cover based calculation)

It is often arises during the analysis, how well the quantity of protected species supports the criteria of protection. The isolines are also suitable for the representation of this aspect. Protection has a separate interpretation from the groups indicating naturality in the category system of the NCR and so reflects an up-to-date point of view. The production of maps suitable for the aspects of practicality and may facilitate the work of the people making decisions. The area of the SMh and SMsch prove to be the most valuable on the basis of the map fusing the protection categories (P%=Unique+Strictly protected+Protected) (Fig. 8).

## Summary

The description of the vegetation pattern can be further refined beside the traditional devices (coenological samples, vegetation map) by analysis uncovering the horizontal structure in more details. Using these maps,

information can be obtained about the vegetation as a whole and a functional unit - connected with spatial localization. The pattern maps appearing along the various isolines mean an approach of a dynamic point of view, which are suitable for spatial comparison of vegetation patches taken at a given time as well as the chronological comparison taken at different times. With the help of phytosociological indexes (SBT) an answer can be obtained for the translocation in the internal structure of the vegetation and the direction of phenological changes will be predictable. It can be a useful assistance to the active nature conservation (NCR) as well with the representation of concrete values (VAL, P%).

## Acknowledgement

I am grateful to Prof. Attila Borhidi CMHA (Janus Pannonius University, Pécs) and Prof. Tibor Simon (Eötvös Loránd University, Budapest) for their continuous professional help in my work as well as to the support of "Magyar Tudományért" Fund.

## References

Borhidi, A. (1995a) Social Behaviour Types, the Naturalness and Relative Ecological Indicator Values of the Higher Plants in the Hungarian Flora. Acta Botanica Hungarica 39. 1-2: 97-181.

Borhidi, A. (1995b) Magyarország növénytársulásainak rendszeres áttekintése. Kézirat a növénytársulások vörös könyvének elkészítéséhez. Pécs. pp. 80.

Cain, A. J. & Harrison, G. A. (1958) An analysis of the taxonomists judgement of affinity. Proc. Zool. Soc. Lond. 131: 85-98.

Falinski, J. (1991) Cartographical presentation and interpretation of ecological phenomena and processes. Proceedings of XXXIII. Symposium of IAVS: Vegetation processes as subject of geobotanical map. Coenosis Vol. 3. (N.S.) Suppl. Cartographiae Geobotanicae 2:7-36.

Juhász-Nagy, P. (1979) A környezetvédelem ökológiai alapjai. MTA Biológiai Osztály Közleményei 22: 279-309.

Kazda, M., Verbücheln, G., Brans, S. & Luwe, M. (1991) Mapping of vegetation and soil changes in an alder carr affected by a decrease of water table height. Proceedings of XXXIII. Symposium of IAVS: Vegetation processes as subject of geobotanical map. Coenosis Vol. 3. (N.S.) Suppl. Cartographiae Geobotanicae 2:243-250.

Kostrowicki, A. S., Roo-Zielinska, E. & Solon, J. (1991) Changes of meadow communities - phytoindicative evaluation (Nida Valley Case Study). Proceedings of XXXIII. Symposium of IAVS: Vegetation processes as subject of geobotanical map. Coenosis Vol. 3. (N.S.) Suppl. Cartographiae Geobotanicae 2:111-117.

Kovács, M. (1962) Die Moorwiesen Ungarns. Magyarország láprétjei. A Magyar Tájak Növénytakarója 3. Akadémiai Kiadó, Budapest. pp. 214.

Kovács, M. & Felföldy, L. (1958) Vegetáció-tanulmányok az Aszófői Séd mentén. Annales Instituti Biologici Tihany 25:137-163.

Morschhauser, T. (1994) Application of isodegradion curves in nature conservation. Symposium on Community Ecology and Conservation Biology. Abstracts.: MO/1B.

Morschahuser, T. & Salamon-Albert, É. (1995) Space informatical application of botanical indicator values in surveys of state and changes of the environment. EN+IN Conference Proceedings: 216-225.

Mucina, L., Cík, V. & Slavkovsky, P. (1988) Trend surface analysis and splines for pattern determination in plant communities. Coenoses 3:89-105.

Pignatti, S. (1991) The map of vegetation complexes. Proceedings of XXXIII. Symposium of IAVS: Vegetation processes as subject of geobotanical map. Coenosis Vol. 3. (N.S.) Suppl. Cartographiae Geobotanicae 2:95-99.

Podani, J. (1980) SYN-TAX: Számítógépes programcsomag ökológiai, cönológiai és taxonómiai osztályozások végrehajtására. Abstracta Botanica Tom.VI. ELTE, Budapest. pp.158.

Podani, J. (1993) Syn-Tax-pc User's Guide (Computer Programs for Multivariate Data Analysis in Ecology and Systematics). Version 5.0. Scientia Publishing Budapest. pp.104.

Simon, T. (1984) A bugaci Bioszféra Rezervátum edényes flórájának természetvédelmi értékelése. Abstracta Botanica 9:95-100.

Simon, T. (1988) Nature Conservation Ranks of the Hungarian Vascular Flora. Abstracta Botanica 12:1-23.

Simon, T., Horánszky, A., Dobolyi, K., Szerdahelyi, T. & Horváth, F. (1992) A magyar edényes flóra értékelő táblázata. In: Simon, T. (szerk): A magyarországi edényes flóra határozója. Tankönyvkiadó, Budapest. 791-874.

Sorensen, T. (1948) A method for establishing groups of equal amplitude in plant sociology based on similarity of species content and its application to analyses of the vegetation on Danish commons. Biol. Skr. 5. 4:1-34.

Soó, R. (1930) Adatok a Balatonvidék flórájának és vegetációjának ismeretéhez II. Magyar Biológiai Kutató Intézet Munkái Tihany 5:169-185.

Soó, R. (1932) Adatok a Balatonvidék vegetációjának ismeretéhez IV. Magyar Biológiai Kutató Intézet Munkái Tihany 5: 112-121.

Soó, R. (1933) A Balatonvidék növényszövetkezeteinek szociológiai és ökológiai jellemzése. Matematikai és Természettudományi Értesítő 50: 669-712.

Soó, R. (1973) A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve V. Akadémiai Kiadó, Budapest.pp.724.

# INVESTIGATION OF BRACHYPODIUM PINNATUM-DOMINATED SEMI-DRY GRASSLANDS IN THE BÜKK MOUNTAINS (NORTH-EAST HUNGARY)*

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Abstract: The coenological treatment of semi-dry grassland communities in Hungary including *Polygalo-Brachypodietum pinnati* Wagner 1940 hasn't been completed yet. Though in Western Europe and in the neighbouring countries (e.g. Slovakia, Austria) many *Brachypodium pinnatum* dominated grassland types are described. This closed community is rather frequent in the Bükk mountains, but it occurs only in small localities, mainly on calcareous rocks (limestone, dolomit, loess). Beside the derivative types ("clearing meadows": wood edges, former vineyards), which were developed by secondary succession some natural-like primary types were also observed. After the preliminary research we chose three different stands deviated in altitude zones and bedrocks: 1. Nagy-Eged (SW-Bükk, 400 meters) on eocenic limestone, in the place of xerotherm oak-woods (*Corno-Quercetum, Ceraso-Quercetum*) or mixed with them. 2. Nagymező (Bükk-Plateau, 800 meters) on triassic limestone, mountain beechwood zone (*Aconito-Fagetum*), close relation with different meadow communities (moorlands, *Nardetum* types, steppe fragments). 3. Kerékkötő (SE-Bükk, 600 metres) on dolomite rocks, alternated with dolomite oakwoods (*Cirsio pannonici-Quercetum*). In consequence of species richness (more than 160 species) and special coenological status this community has great importance from the viewpoint of nature conservation.

* OTKA F6263 No. 4

## Introduction

The main distribution of *Brachypodium pinnatum* dominated grasslands can be found in Western Europe, under a balanced atlantic climate. Many types have been discovered in West and Middle-Europe which can be seen in the new division of *Festuco-Brometea* (Passarge 1978), including all the degraded, eastern-like steppe communities (*Cirsio-Brachypodion, Danthonio-Stipion*) and mesophyl deforested grasslands (*Mesobromion* (Passarge 1978)). In the area *-Pannonicum- Mesobromion* is followed by *Brachypodion* group distributing to East to Mezőség in Transsylvania with an increasing continental influence.

The studied *Brachypodium pinnati* was described in Wiener Forest, East Austria (Wagner 1941). This community had not been examined until the 60's in Hungary because these types of communities were considered to be secondary and coenologists examined communities which were easier to explain or wich were determined by geographical features (for example: dolomite, sand and alkaline /szik/ vegetation). Soó (1959, 1964) introduced

these communities into the Hungarian bibliography and he differentiated *Cirsio-Brachypodion pinnati* group and within this he mentioned *a Polygalo-Brachypodietum pinnati* community which he regarded as an eastern type of the mesophyl deforested meadows (*Mesobromion*) in the West. There are many places in Hungary from where similar communities were mentioned but wihout any coenological examination. The communities mentioned above considered to be secondary ones which can follow vineyards or former oak forest (Soó 1959, 1964). These facts were supported by Baráth who made some examinations in old vineyards (Baráth 1963). During the examination of the Hungarian plant communities Simon considers the mountain grassland as *Lino tenuifolio - Brachypodietum pinnati* (Simon 1992). In addition to the derivative types which were formed by secondary succession new primary stands have been discovered as well (Vojtkó 1993). The Polygalo-Brachypodietum pinnati the frequent but only local, closed community of the Bükk mountains occuring mainly on calcareous bedrock (limestone, dolomite, loess).

The examined stands are different in their species composition. The reason of it can be found in the different climate and vegetation history. During the discovery of the probable successional relationships it can be seen that these grasslands have a forest-grassland complex origin and it appears in the richness of forest and forest-steppe elements in these communities. On one hand the local character species are the relicts of the former grasslands and forests; and on the other they are the invadors of the neighbouring communities. The species richness (more than 160 species) is due to the fact that these communities include not only continental steppe elements but mesophyl ones as well and even more species from the mountain Nardetum.

In the 80's the *Brachypodium pinnatum* dominated grasslands came to the center of interest in Western Europe. The appearance of *Brachypodium pinnatum* of increasing dominance on the semi-natural steppe-meadows caused the reduction of the number of species and degradation. We can find the reason of these processes in air-pollution in the growth of N-level (Bobbink - Willems 1987, 1992, Willems 1990, Willems - Bobbink 1990). Our permanent quadrate examinations supported these degradation processes together with species reduction not considering the results of five years yet (Vojtkó - Matus - Aszalós 1996).

## Sites and methods

During the research the communities were examined in three altitude zones on three different bedrocks.

1. Nagy-Eged: The sample area was pointed out on the extreme southwest point of the Bükk mountains. The bedrock is eocene limestone. The stands of *Polygalo-Brachypodietum pinnati* can be found where former extrazonal xerotherm calciphilous oak forests (*Corno-Quercetum, Ceraso-Quercetum*)

used to exist, or it alternates with them (characterized by Jakucs 1961). The southern-southwestern slope of Nagy-Eged is under a strong submediterranian-continental influece that is why *Polygalo-Brachypodietum* has a xerotherm appearance and it is different from the *Festucetalia*-type grasslands only in species-composition. The important factor of its formation could be burning and deforestation. This semi-dry type occurs only on fragmented eocene limestone in a not totally closed form.

2. Nagymező: The semi-dry grasslands were examined in the altitude of 800m above sea level on the Central Plateau of the Bükk mountains. The classical *Polygalo-Brachypodietum pinnati* is a community which occurs in the kollin-submontain zone mainly following oak forests but on the Bükk Plateau it appears in the mountain beech-zone, too (*Aconito-Fagetum*). The development of the community accelerated by deforestation and the quick change of climatic factors and drying processes. The expanded mountain meadows (*Arrhenatheretalia, Molinietalia*) can exist due to mowing after deforestation. In the heavily grazed acidic gallies typical *Nardetum* has developed (*Festuco ovinae-Nardetum*) (Bacsó - Zólyomi 1934, Zólyomi 1936, 1983, Zólyomi *et al.* 1954). This classical vegetation sketch has changed by now: the strong expansion of semi-dry grasslands can be recognized, while the area of *Nardetum* grasslands has decreased.

3. Kerékkötő: On the southeastern part of the Bükk mountains the semi-dry grasslands, which were examined, developed on dolomite bedrocks in the altitude of 600 m above sea level. In the zone of mixed turkey oak - sessile oak forest forest-grassland mosaic-complex has been formed. The forest patches can be considered to be xerotherm oak forests (*Cirsio pannonici-Quercetum*) and the patches without trees are semi-dry grasslands (*Polygalo-Brachypodietum pinnati*) rich in species (Less 1991). The survival of the these complexes can be due to the calcareous bedrocks because this dolomite oak forest cannot close (Zólyomi 1942, 1958).

## Results

1. Nagy-Eged: The most prominant grassland species are common with the species of *Pulsatillo-Festucetum* but some different elements occur as well which are tipical for semi-dry grasslands: *Centaurea sadleriana, Cirsium pannonicum, Linum flavum, Polygala major, Scabiosa ochroleuca.* The high rate of *Quercetalia* species shows a close relationship with contact forest communities: on one hand they are relic shrub species (*Berberis vulgaris, Cotinus coggygria, Viburnum lantana*); and on the other the herbs marking skirts such as *Libanotis pyrenaica, Peucedanum cervaria.* Typical forest-steppe elements are: *Teucrium chamaedrys, Viola hirta, Geranium sanguineum, Carex michelii.* The total lack of *Querco-Fagetea* and the low rate of mesophyl meadows (*Molinio-Arrhenatheretea*) show dry habitat conditions. The constant (V) species are: *Brachypodium pinnatum* (1-5), *Inula ensifolia* (+-2), *Dorycnium herbaceum* (+), *Asperula cynanchica* (+),

*Libanotis pyrenaica* (+-2), *Melampyrum arvense* (+-1), *Centaurea sadleriana* (+-2), *Centaurea micranthos* (+-1), *Achillea pannonica* (+), *Festuca rupicola* (+-2), *Teucrium chamaedrys* (+-1), *Viola hirta* (+-1). The subconstant (IV) species are: *Aster amellus* (+-1), *Stachys recta* (+-1), *Lembotropis nigricans* (+-1), *Cornus sanguinea* (+-1), *Euphorbia cyparissias* (+).

2. The analyses of the Nagymező: the temporary character of the community is shown by the common occurance of dry grassland species (*Festucetalia, Festuco-Brometea*), the species of mesophyl meadows (*Molinio-Arrhenatheretea*) and forest element (*Quercetalia, Querco-Fagetea*). This community can be considered as *Polygalo-Brachypodietum* on the basis of semi-dry elements (*Cirsium pannonicum, Hypochoeris maculata, Prunella grandiflora*) steppe species derived from former refugium areas (*Dracocephalum ruyschiana, Dianthus pontederae, Pulsatilla grandis*) and forest-steppe species (*Brachypodium pinnatum, Betonica officinalis, Geranium sanguineum, Teucrium chamaedrys*). In the *Querco-Fagetea* group the elements of the former *Aconito-Fagetum* are found (*Primula elatior, Senecio fuchsii, Aconitum gracile*). There are numerous *Nardetalia* type species too (*Alchemilla monticola, Potentilla erecta, Gentiana pneumonanthe*). The constant (V) species are: *Brachypodium pinnatum* (2-5), *Carex tomentosa* (+-3), *Fragaria vesca* (+-1), *Festuca rupicola* (1-3), *Cirsium pannonicum* (+-2), *Galium verum* (+-1), *Asperula cynanchica* (+-1). The subconstant (IV) species are: *Centaurea sadleriana* (+-3), *Phleum phleoides* (+-2), *Betonica officinalis* (+-2), *Filipendula vulgaris* (+-1), *Geranium sanguineum* (+-2), *Dianthus pontederae* (+), *Ranunculus cassubicus* (+), *Cruciata glabra* (+), *Achillea millefolium* (+), *Trifolium montanum* (+), *Pimpinella saxifraga* (+).

3. The results of Kerékkötő: It is important to mention the high rate of forest elements in these stands among which there are many forest-steppe ones (*Geranium sanguineum, Teucrium chamaedrys, Senecio integrifolius*). The rate of *Querco-Fagetea* species is high (*Viola mirabilis, Melittis carpatica, Fragaria vesca*). Of the semi-dry (*Cirsium pannonicum, Prunella grandiflora, Polygala major, Hypochoeris maculata, Scabiosa ochroleuca*) can be mentioned. The community is rich in orchids as well, there are 10 species in the community (*Anacamptis pyramidalis, Cephalanthera rubra, Cypripedium calceolus, Gymnadenia conopsea, G. odoratissima, Epipactis atrorubens, E. microphylla, E. helleborine, Orchis militaris, Neottia nidus-avis*). The constant (V) species are: *Brachypodium pinnatum* (2-5), *Convallaria majalis* (+-3), *Geranium sanguineum* (1-2), *Vincetoxicum hirundinaria* (+-2), *Peucedanum oreoselinum* (+-2), *Teucrium chamaedrys* (+-1), *Anthericum ramosum* (+-1), *Euphorbia cyparissias* (+-1). Subconstants are (IV): *Peucedanum cervaria* (+-1), *Chrysanthemum corymbosum* (+-1), *Polygonatum odoratum* (+-1), *Carex michelii* (+-2), *Quercus petraea* (+-1), *Cruciata glabra* (+).

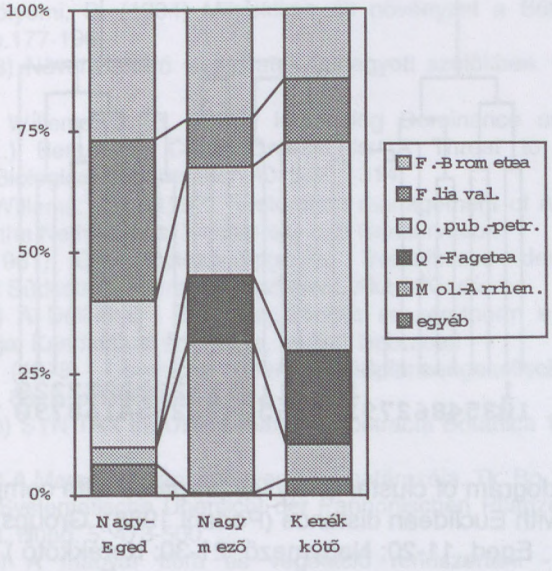



Fig. 1. Distribution of coenological characters of the community

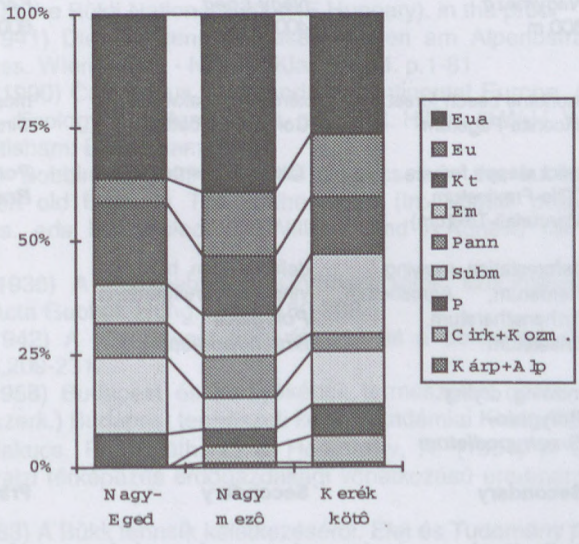



Fig. 2. Distribution of floral elements of the community

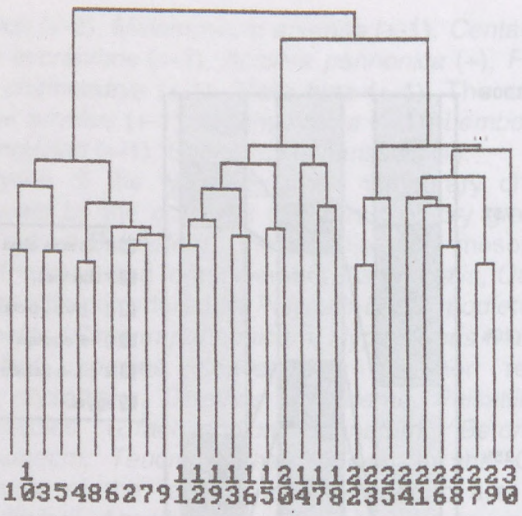



Fig. 3. Dendogram of cluster analyses prepared with complete linkage calculated with Euclidean distance (Podani 1988). Groups: 1-10: Nagy-Eged, 11-20: Nagymező, 21-30: Kerékkötő )

| **Bedrock** | **LIMESTONE** | | **DOLOMITE** |
|---|---|---|---|
| | **TRIASSIC** | **EOCENE** | |
| **Site** | *Nagymező* | *Nagy-Eged* | *Kerékkötő* |
| **Altitude** | 800 m | 400 m | 600 m |
| **Community** | montane beech forest: Aconito-Fagetum + relict steppe forests (Tilio-Fraxinetum, Mercuriali-Tilietum) | xerotherm oakwood: Corno-Quercetum + Ceraso-Quercetum | mosaic steppe forest: Cirsio-Quercetum + ***Polygalo-Brachypodietum*** |
| **Effect Community** | deforestation, mowing Nardetum, Agrostietum, Arrhenatheretum, Trisetetum | deforestation, burning vineyards, fruitgardens ***Polygalo-Brachypodietum*** | |
| **Effect Community** | mowing, drying ***Polygalo-Brachypodietum*** | | |
| **Status** | **Secondary** | **Secondary** | **Primary** |

Fig. 4. Hypothetical succession scheme of semi-dry grasslands (Cirsio-Brachypodion group) in the Bükk mountains

## References

Bacsó, N. & Zólyomi, B. (1934) Mikroklima és növényzet a Bükkfennsíkon. Az Idôjárás. X. p.177-196.

Baráth, Z. (1963) Növénytakaró vizsgálatok felhagyott szôlôkben. - Földr. Ért. 12: 341-357.

Bobbink, R. & Willems, J. H. (1987) Increasing Dominance of Brachypodium pinnatum (L.) Beauv. in Chalk Grasslands: A Threat to a Species-rich Ecosystem. Biological Conservation 40. p.301-314.

Bobbink, R. & Willems, J.H. (1992) Restoration management of abandoned chalk grassland in the Netherlands. Biodiversity and Conservation

Jakucs, P. (1961) Die phytozönologishen Verhaltnisse der Flaumeichen-Buschwalder Südostmitteleuropas. Budapest, Akad. Kiadó

Less, N. (1991) A Délkeleti - Bükk vegetációja és xerotherm erdôtársulásainak fitocönológiája. Kandidátusi értekezés. kézirat Debrecen

Passarge, H. (1978) Übersicht über Gefäßplanzengesellschaften. Feddes Repertorium, 89. 2. p.133-195.

Podani, J. (1988) SYN-TAX III. User's manual. Abstracta Botanica 12. suppl. 1. p.1-183.

Simon, T. (1992) A Magyarországi edényes flóra határozója. Tk. Bp. 892 pp.

Soó, R. (1959) Systematische Übersicht der Pannonischen Pflanzengesellschaften II. - Acta Bot. Hung. 5: 473-500.

Soó, R. (1964) A magyar flóra és vegetáció rendszertani - növényföldrajzi kézikönyve. - I. Bpest

Vojtkó,A. (1993) A Bükk hegység Festuco-Brometea osztályának fitocönológiája. Egyetemi doktori értekezés Eger-Debrecen

Vojtkó, A., Matus, G. & Aszalós, R. (1996) First five years of a game exclosure experiment at the Bükk National Park (NE Hungary). in the proc.

Wagner, H. (1941) Die Trockenrasengesellschaften am Alpenostrand. Denkschr. Akad. d. Wiss. Wien, Math. - Naturn. Klasse 104. p.1-81.

Willems, J.H. (1990) Calcareous grasslands in continental Europe. (In: Calcareous grasslands - Ecology and Managment. eds: S.R. Hillier, D.W.H. Walton and D.A. Wells) Bluntisham: Bluntisham Books

Willems, J.H. - Bobbink,R. (1990) Spatial processes in the succession of chalk grassland on old fields in The Netherlands. (In: Spatial processes in plant communities. eds F.Krahulec, J.H.Willems and A.Agnew) pp. 237-249. The Hague.

Zólyomi, B. (1936) A Bükkhegységi szôrfüves rétek szociológiai és ökológiai viszonyai. Acta Geobot. Hung. I. 1. p.180-208.

Zólyomi, B. (1942) A középdunai flóraválasztó és a dolomitjelenség. Bot. Közl. XXXIX. 5. p.209-231.

Zólyomi, B. (1958) Budapest és környékének természetes növénytakarója. - In Pécsi, M. (szerk.) Budapest természeti képe. Akadémiai Kiadó, Bp. p.509-642.

Zólyomi, B., Jakucs, P., Baráth, Z. & Horánszky, A. (1954) A Bükk- hegységi növényföldrajzi térképezés erdôgazdasági vonatkozású eredményei. Az Erdô 3-4-5. száma

Zólyomi, B.(1983) A Bükk fennsík keletkezésérôl. Élet és Tudomány p. 1173.

# DISTRIBUTION AND COENOLOGICAL PREFERENCE OF SPHAGNUM SPECIES IN THE VENDVIDÉK

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## Introduction

Hungary creates a border from the point of view of distribution of peatmosses. The area of *Sphagnum* is disjunct in the Carphatian basin. In the westernmost part of Hungary, called Vendvidék, numerous *Sphagnum* occurrences can be found.

Floristical exploration of the area bears special importance because, on one hand, there was no bryologycal work on the area in the last 20 years and, on the other hand, the climate of Vendvidék became drier in the last decades (Ódor 1994, Tímár 1985). The aim was to map the Sphagnum occurrences and to make a comparison between the new and old floristical data.

The great varieties of *Sphagnum* occurrences in fens has become apparent even during floristical work. This diversity was visible partly in the number and quantity of *Sphagnum* species and in the general view of habitats. The coenological work, after the floristical one, started on the basis of these primary observances. The aim of this work was to answer the following questions:

Are there any differences among the vegetation of habitats?

Are these differences in floristic composition indicated in the qualitative and quantitative properties of *Sphagnum spp.*?

Are these differences in floristic composition indicated in the distribution of ecological character of species?

## Study area

Vendvidék is the westernmost part of Hungary with a strong influence of the Alps (Pócs *et al.* 1962, Simon 1991). Average annual precipitation is approximately 770 mm and mean annual temperature is 9,1 C. The bedrock of the area is alluvial drift-boulder and clay and it is covered by brown forest soil which is poor in nutrients. The study area is a hilly country and is located at 250-300 m above sea level. The direction of hill ranges is from north to south and in the valleys several streams can be found.

On the hill-tops zonal mixed coniferous deciduous forests (*Genisto nervate-Pinetum*, Pócs 1965) can be found and in the degraded parts heats also appear (Ódor 1995). There are extrazonal spruce forests (*Bazzanio-Abietetum*) on the northern slopes with colder microclimate. On the slopes with favourable soil conditions acidophilous beech-woods (*Luzulo-Fagetum*)

and oak-hornbeam woods (*Carpino-Quercetum*) grow (Borbás 1897, Zsohár 1941, Ódor 1995). In the valleys fen communities (*Scheuchzerio-Caricetea nigrae*) appear. Grow along the stream banks Alder forests (*Alnetea glutinosae*) (Borbás 1897, Zsohár 1941, Pócs *et al.* 1962).

## Methods

The first stage of this work was to prepare the distribution map of *Sphagnum* occurrences. For the exact localisation of occurrences the proper sections of military maps and forestry maps as well as the tourist map of the area were used. The results of the floristical work were compared with the old floristical data of Vendvidék (Boros 1964, Boros-diaries 1920-70, Zsohár 1941, Pócs 1958 and herbarium data supplied by Á. Boros, L. Vajda, Á. Károlyi, B. Zólyomi).

The vegetation of *Sphagnum* habitats of fens was described by recording the cover of all vascular plants and bryophytes in systematically distributed 1 $m^2$ quadrats. For each location the cover values of each species were averaged. Hierarchical numerical methods were used to distinguish vegetation types. The Sphagnum habitats were classified on the basis of coverage of species with the aid of hierarchical agglomerative methods (Podani 1980). The distance matrix was calculated by Ruziczka coefficient and the cluster analysis was made by β-flexible method (Lance and William's) (β=-0.25). For data analysis SYN-TAX V. (Podani 1993) was used. The groups emerging from the classification were characterised by the coverage of Sphagnum species and non-floristic descriptors of all species. These values were calculated on basis of cover values. For the characterisation the WB (moisture figures), RB (reaction figures) and NB (nitrogen figure) values of vascular plants (Borhidi 1993) and F (moisture figures) and R (reaction figures) values of bryophytes (Ellenberg *et al.* 1991) as well as the phytosociological groups of vascular plants (Borhidi 1993) and bryophytes (Orbán-Vajda 1983) were used. Except for moisture figures, the non-floristic descriptors of bryophytes and vascular plants are compatible.

## Results and discussion of floristical work

The floristical work resulted in detecting 39 *Sphagnum* occurrences in the area: 2 intermediate mires, 19 *Sphagnum* occurrences in fens and 17 *Sphagnum* patches in forests (Fig. 1.). 12 of 18 Hungarian *Sphagnum spp.* can be found in Vendvidék. The detailed results of this work are presented in the Table 1. where the habitats of fens are attached to streams.




Fig. 1. Map of the study area with Sphagnum occurences

**Key:**

1-5: number of Sphagnum occurences in fens and intermediate mires,
F: Sphagnum patches in forests

Table 1. The results of floristical work

| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | old | new | old | new | old | new | old | new | old | new | old | new | old | new | old | new | old | new | old | new |
| Sphagnum palustre | ✓ | | | | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | |
| Sphagnum quinquefarium | | | | | | | | | | | | | | | | | ✓ | ✓ | | ✓ |
| Sphagnum capillifolium | | | | | | | | | | | ✓ | ✓ | | | | | ✓ | ✓ | | ✓ |
| Sphagnum capillifolium var. rubellum | | | | | | | | | | | | | | | | | ✓ | ✓ | | |
| Sphagnum russowii | | | | | | | | | | | | | | | | | ✓ | ✓ | | |
| Sphagnum squarrosum | | | | | | | | | | | | | | ✓ | | | ✓ | | | |
| Sphagnum subsecundum | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | ✓ | | | ✓ | ✓ | ✓ | | |
| Sphagnum subsecundum ssp inundatum | | | | | | | | | | | | | | | | | ✓ | | | |
| Sphagnum platyphyllum | ✓ | | ✓ | ✓ | | | ✓ | ✓ | | | | | ✓ | | | | | | | |
| Sphagnum contortum | | | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | |
| Sphagnum obtusum | ✓ | | | | ✓ | ✓ | | | | | | | | | | | | | | |
| Sphagnum flexuosum | | ✓ | | | | | | | | | | ✓ | | ✓ | | | | | | |
| Sphagnum rec. var. mucr. | | ✓ | | | | | | | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | | | |
| Sphagnum angustifolium | | ✓ | | | | | | | ✓ | | | ✓ | | ✓ | | | ✓ | | | |
| Sphagnum compactum | | | | | | | | | | | | | | | | | | | | |

**Key:**
1=valley of Grajka stream, 2= valley of Szakonyfalui stream, 3= valley of Hársas stream, 4= valley of Zsida stream, 5=Fekete-tó, 6=Ördög-tó, 7=Felsőszölnök:under Hegyes hill, 8=Alsószölnök, 9=forests among Kétvölgy,Apátistvánfalva and Szakonyfalu, 10=forests around Fekete-tó , old=old data from references and herbarium, new=new data

The result of the floristical work is the summerized follows:

- Sphagnum compactum and *Sphagnum subsecundum ssp. inundatum* weren't found in forests.
- *Sphagnum palustre* disappeared from Grajka-valley.
- *Sphagnum contortum* disappeared from Zsida-valley.
- Some described *Sphagnum* occurrences weren't found in Vendvidék.
- *Sphagnum capillifolium var. rubellum* was detected as a new varietas in this area.

## Results and discussion of coenological studies

The classification on the basis of cover values of 178 species is resulted 5 groups (Fig. 2). The number of species within the groups varies from 86 to 112.

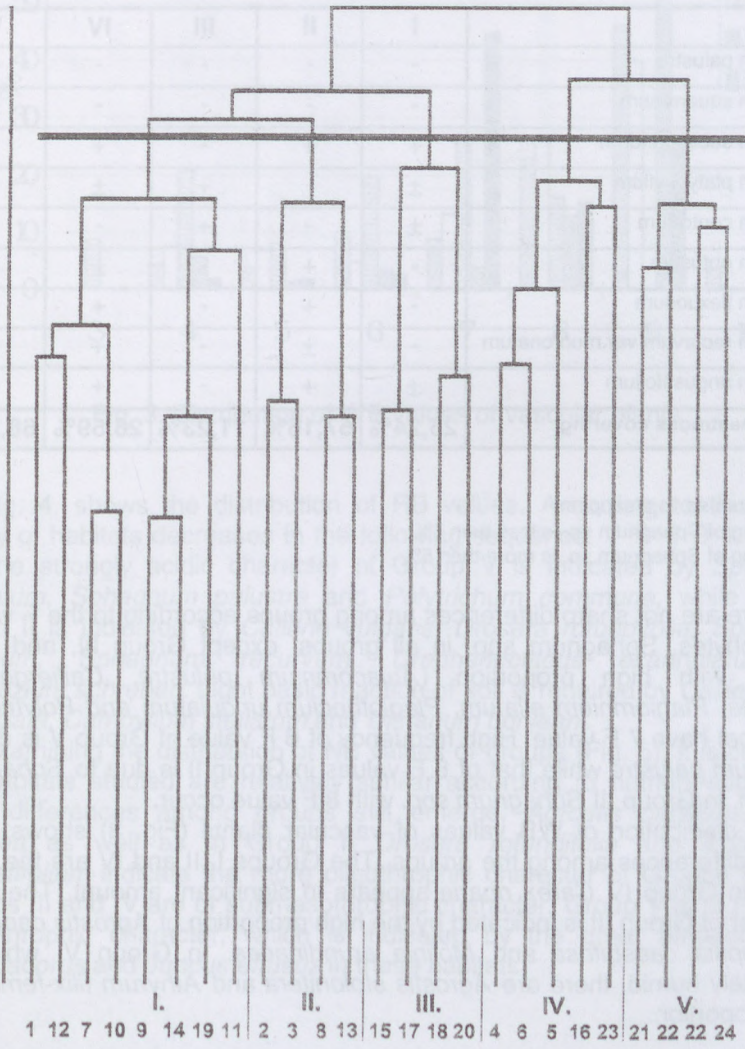



Fig. 2. Classification of Sphagnum occurences (25) based on the basis of coverage of species.

Table 2. shows important differences among the groups in the average cover of Sphagnum species. These results also support grouping.

Table 2. Coverage of Sphagnum species in groups

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| Sphagnum palustre | - | - | - | - | + |
| Sphagnum squarrosum | - | - | - | - | ± |
| Sphagnum subsecundum | + | + | - | + | - |
| Sphagnum platyphyllum | ± | - | + | ± | - |
| Sphagnum contortum | ± | - | + | - | - |
| Sphagnum obtusum | - | + | - | ± | - |
| Sphagnum flexuosum | - | + | - | + | ± |
| Sphagnum recurvum var.mucronatum | - | ± | - | + | + |
| Sphagnum angustifolium | ± | + | - | + | + |
| **average peatmoss covering** | **25,24%** | **57,16%** | **11,23%** | **26,59%** | **68,24%** |

**Key:**
–=Sphagnum sp. is disappear
±= covering of Sphagnum sp. is less then 5%
+= covering of Sphagnum sp. is more then 5%

There are not sharp differences among groups according to the F values of bryophytes. Sphagnum spp. in all groups, except Group III, and other species with high proportion (*Aulacomnium palustre, Calliergonella, cuspidata, Plagiomnium ellatum, Plagiothecium undulatum and Polytrichum commune*) have 7 F value. High frequency of 6 F value of Group V is due to *Sphagnum palustre* while that of 8 F values in Group II is due to *Sphagnum obtusum*. In Group III *Sphagnum spp.* with 8 F value occur.

The distribution of WB values of vascular plants (Fig. 3) shows more striking differences among the groups. The Groups I, II and IV are the most humid. In Group IV *Carex riparia* appears in significant amount. The dryer character of Group III is indicated by the high proportion of *Agrostis capillaris, Descampsia caespitosa* and *Molinia arundinacea*. In Group V, which is moderately humid, there are *Agrostis stolonifera* and *Athyrum filix-femina* in great proportion.

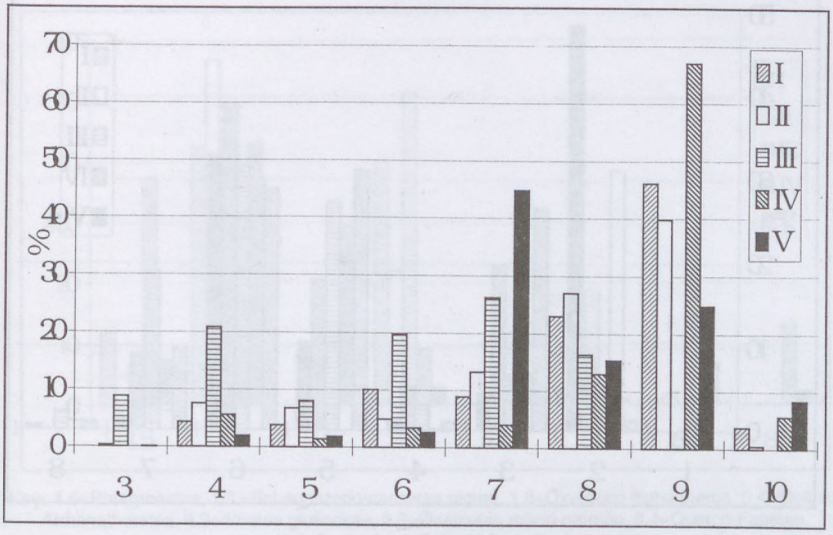



Fig. 3. Distribution of WB values of vascular plants

Fig. 4. shows the distribution of RB values. According to this figure, acidity of habitats decreases in the following sequence: V → II → I → IV → III. The strongly acidic character of Group V is indicated by *Sphagnum recurvum*, *Sphagnum palustre* and *Polytrichum commune*, while that of Group II is indicated by *Calluna vulgaris*, *Drosera rotundifolia*, *Sphagnum obtusum*, *Sphagnum recurvum*, *Drephanocladus exannulatus* and *Pleurozium schreberi*. Light basic reaction of soil is required by *Calliergonella cuspidata*, *Campylium stellatum* and *Dicranum bonjeani*.

Examining the distribution of NB values of groups (Fig. 5), it is clear that the habitats studied are relatively similar according to nutrient-supply, yet mind differences among groups still emerge. *Agrostis capillaris*, *Carex panicea* as well as in Group II *Drosera rotundifolia* and *Eriophorum angustifolium* indicate the more oligothrophic character of Groups I and II. Groups III and IV are of submesothrophic character. Group V is of the most mesothrophic character, which is indicated by the great amount of *Iris pseudacorus* and *Juncus effusus* in these habitats.

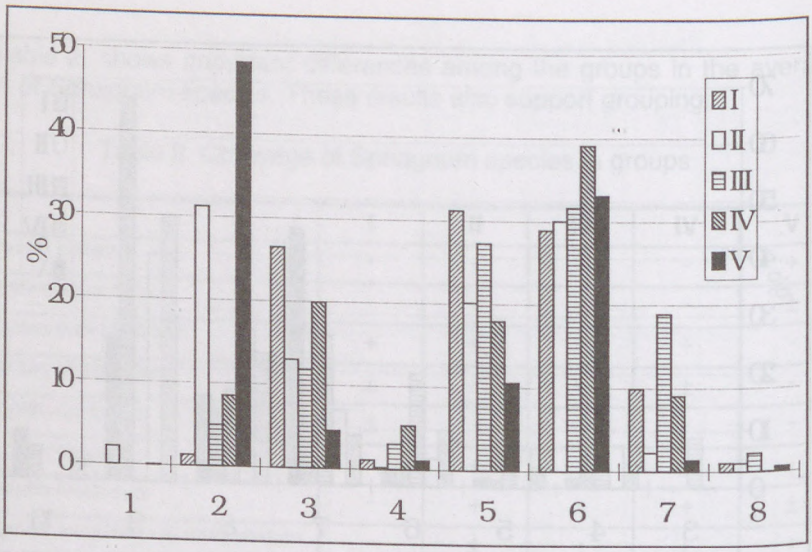



Fig. 4. Distribution of RB values

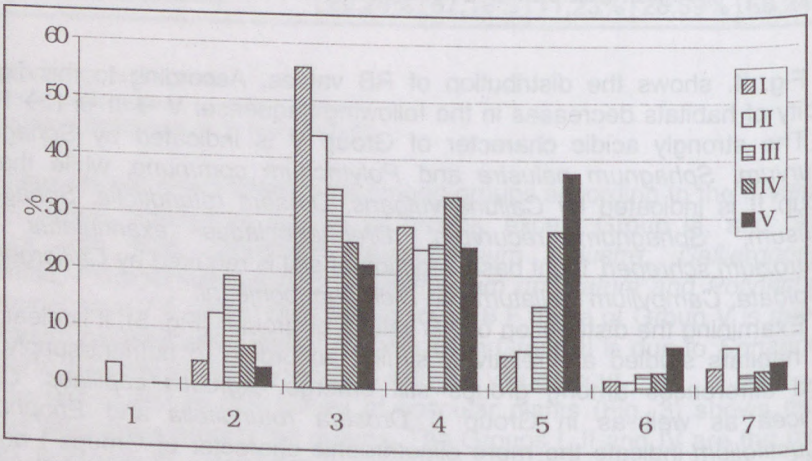
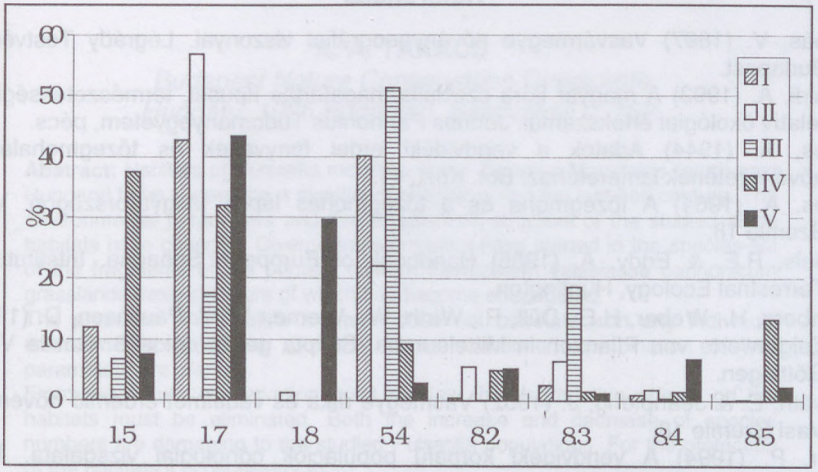



Fig. 5. Distribution of NB values of vascular plants

The distribution of phytosociological groups (Fig. 6) also shows an interesting picture. The distribution of groups between communities of fens and communities of meadow can easily be examined. The high proportion of *Phragmitetea* and *Franguletea* in Group IV, the high proportion of *Querco robori-petreae* in Group III is worth considering, these results correlate well with the distribution of WB values (Fig. 3).




**Key:** 1.5=Phragmitetea, 1.7.=Scheuchzerio-caricetea nigrae, 1.8=Oxycocco-Sphagnetea, 5.4=Molinio-Arrhanatheretea, 8.2=Alnetea glutinosae, 8.3=Quercetea robori-petreae, 8.4=Querco-Fagetea, 8.5=Franguletea(Salicetaria auritae)

Fig. 6. Distribution of phytosociological groups

To sum of the results, can state the groups emerging from the classification can be separated well and characterised by the values mentioned above.

The moisture figure of bryophytes and vascular plants of Group III contradicts each other for which the following may account: the habitat of Group III is merged in spring but the open water disappears by summer. The *Sphagnum contortum* and *S. platyphyllum*, found in this group only (Table 2.), like merged habitats and they can often be observed floating in open water (Daniels & Eddy 1985). Thus, the reason for the relatively small peatmoss cover in these habitats is, probably, the fact that they find favourable circumstances only in spring.

**Acknowledgements**

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## References

Borbás, V. (1897) Vasvármegye növénygeográfiai viszonyai. Légrády Testvérek, Budapest.

Borhidi, A. (1993) A magyar flóra szociális magatartás típusai, természetességi és relatív ökológiai értékszámai. Jannus Pannonius Tudományegyetem, pécs.

Boros, Á. (1944) Adatok a vendvidéki erdei fenyvesek és tőzegmohalápok növényzetének ismeretéhez. Bot. Közl. 41.

Boros, Á. (1964) A tőzegmoha és a tőzegmohás lápok Magyarországon. Vasi Szemle 18.

Daniels, R.E. & Eddy, A. (1985) Handbook of European Sphagna. Intstitute of Terrestrial Ecology, Huntington.

Ellenberg, H., Weber, H.E., Düll, R., Wirth, W., Werne,r W. & Paulinsen, D. (1991) Zeigerwerte von Pflanzen in Mitteleuropa. Scripta geobotanica18. Gotzle Verl., Göttingen.

Horváth, E. & Jeanplong, J. (1962) Vasmegye ritka és védelmet érdemlő növényei. Vasi Szemle 18.

Ódor, P. (1994) A vendvidéki korpafű populációk cönológiai vizsgálata. TDK dolgozat (kézirat), Budapest.

Orbán, S. & Vajda, I. (1983) Magyarország mohaflórájának kézikönyve. Akadémiai kiadó, Budapest.

Pócs, T. (1958) Beitrage zur Moosflora Ungarns und der Ost- und Südkarpaten. Ann. His.-Nat. Mus. Hung. IX.

Pócs, T. (1965) A magyarországi tűlevelű erdők cönológiai és ökológiai viszonyai. Kandidátusi értekezés (kézirat), Eger.

Pócs, T., Gerencsér, I., Szodfridt, I., Tallós P. & Vida G. (1962) Szakonyfalu környékének vegetáció Az Egri Ped. Főisk. Füz. 268.

Podani, J. (1994) SYN-TAX Version 5.0, User's guide. Scientia publishing, Budapest.

Podani, J. (1980) SYN-TAX: Számítógépes programcsomag ökológiai, cönológiai és taxonómiai osztályozások. Abstacta Botanica 6: 1-158.

Szurdoki, E. (1994) A vendvidéki tőzegmoha populációk florisztikai vizsgálata. TDK dolgozat (kézirat), Budapest.

Tímár, G. (1995) A Vendvidék védett és veszélyeztett növényei. Vasi világ: 3-18.

Zsohár, Gy. (1941) Őrség növényföldrajzi vázlata. Dunántúli Szemle Könyvei 180.

# CONSERVATION ECOLOGY OF PULSATILLA MONTANA (HOPPE)

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**Abstract:** Habitats of Pulsatilla montana in the Zemplén Mountains (north-east Hungary) have undergone a significant change during the last half century. The environmental parameters and the floraelement-structure of the studied slope habitats have changed. Diverge transformation have started in the species-set of the fragments of the primary uniform Festucetum valesiacae pannonicum grasslands basic structure of which has become endangered.
The presence of Pulsatilla montana does not correlate with any individual environmental parameter but the above mentioned combination of soil parameters are grantee.
From the nature conservation point of view the degradative effects on the habitats must be eliminated. Both the increase and decrease of species numbers are damaging to the studied Pulsatilla populations. For the protection of the habitats it is necessary to:
- declare protected the studied areas,
- eliminate the degradative effects,
- control the succession with fire management, shrub assarting,
- study the effects of grass competition in the Pulsatilla habitats.

## Introduction

The populations of the protected *Pulsatilla montana* (Hoppe) (Syn.: *P. zimmermanni* SOÓ 1966) still persist on the Southern part of the Zemplén Mountains. The first Pulsatilla data of the region was mentioned by CHYZER 1905, describing *Pulsatilla grandis* at the Sátor Hill. The first detailed botanical study was carried out by HARGITAI 1940 who initiated the nature protection of Mandulás Hill (Sárospatak). The protection of the Mandulás Hill of Sárospatak on local level adjudged only forty-four years later by the # 04/32/TT/84 order extending only for 3 ha. The worthiness of the study is the professionalism, the insufficiency of it is the unrepeatablity of the phytosociological sampling.

The main aims of my study were:
to cover the ecological need of Pulsatilla montana,
to support data for the conservation biology of the species,
to accelerate the protection process of the habitats.

## Material and Methods

Seven habitat has been studied during the work. I used classical phytosociological sampling with relative percentage coverage on seven habitats, using 2x2 metres releves (BRAUN-BLANQUET 1951, JAKUCS and PRÉCSÉNYI 1981). The field work has been carried out in 1992 (TAKÁCS 1994). I have recorded the number of Pulsatilla individuals around the sampling sites in 4x4 metres. The data has been analysed by multivariate

methods (SIMON and JURASSA 1970, ORLÓCI 1975,) using SYNTAX (PODANI 1980, 1988) and STATISTICA for Windows.

I characterised the sample areas with environmental soil parameters from 5-20 cm depth of the root-zone.

## Description of the sample area

I have studied seven different Pulsatilla montana habitats (see table 1.).

| Sample habitats | Relevé # | sample area (ha)* | exposal | altitude (m) | gradient degree | total # of Pulsatilla ind. |
|---|---|---|---|---|---|---|
| *1. Mandulás Hill East (Sárospatak)* | 1-8 | 1.2 | NW | 130-140 | 35 | 76 P. montana +23 P. grandis. |
| *2. Páncél Hill (Sárospatak)* | 9-16 | 2 | NW | 130-154 | 25-30 | 1200 P. montana |
| *3. Gombos Hill (Sárospatak)* | 17-24 | 0.8 | NW | 130-145 | 1st to -5th -10 the others are steeper | 840 P. montana |
| *4. Vég Hill (Erdőhorváti)* | 25-32 | 1.3 | W | 140-160 | 25 | 153 |
| *5. Mancsalka Hill (Bodrogolaszi)* | 33-40 | 1.5 | W | 132-143 | 5 | 7 |
| *6. Mandulás Hill West (Sárospatak)* | 41-48 | 2 | W-NW | 110 | 10 | 0 |
| *7. Hosszú Hill (Sárospatak)* | 49-56 | 2 | W | 240-275 | 7 | 391 |

Table 1.

The study area is based by surface-close chilled andezite-lava of the tertiary period. Later the erosion was the main surface forming agent (PINCZÉS 1961).

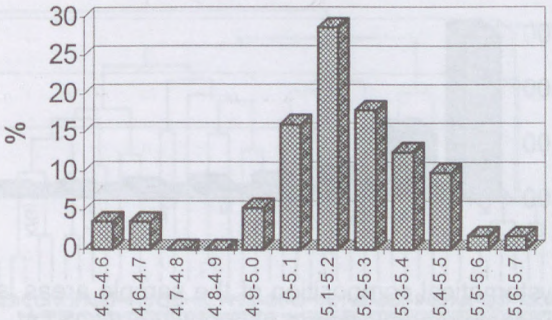
The vegetation is secondary because of human deforestation of the former Quercetum pubescentis-petraeae. The brown, podsoled forest transformed into ranker with extreme water regime (HARGITAI 1940). The soil of the studied hills is very shallow (below 30 cm) (HARGITAI 1943).

## Results

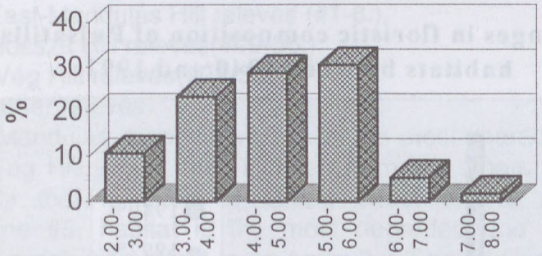
### I. Results of the environmental parameters

1. pH/$H_2O$ mean=5,16. The areas have acidified one pH unit since the results of 1938-1940.

**Frequency distribution of pH in Pulsatilla montana habitats**




**Frequency distribution of Humus contents**



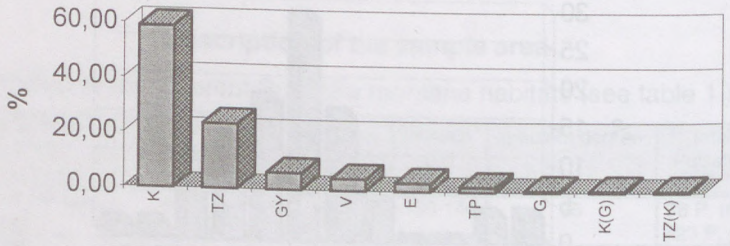

2. The KA mean of the areas=37,32.
3. Humus content (%) mean=4,48 in moderately humic, shallow soil.
4. Carbonated whitewash content (y1) mean=17,09; acid soil with limited lime.

There was no correlation between the environmental parameters and the number or location of Pulsatilla individuals. The study has not found any salience environmental parameter in correlation of the Pulsatilla space pattern.

**II. Coenological results**

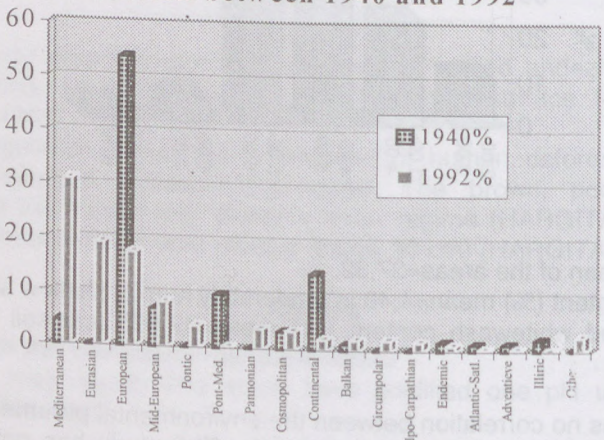
1.The nature conservation values (SIMON 1988) of the study areas indicate stabile associations.

**Nature conservation values (TVK - Simon 1988) of the study areas**



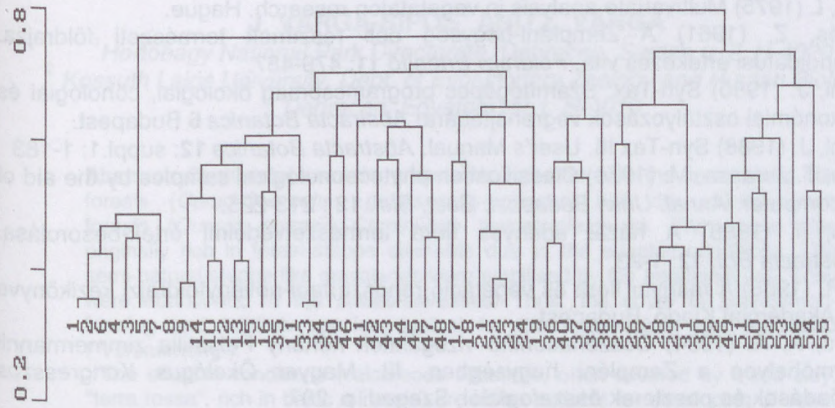

2. The coeno-systematical composition of the sample areas is characteristic to the uniform Festucetum valesiacae pannonicum (DOSTÁL 1933, KLINKA 1939) association, that is in fact apprehensible as a Festuca valesiaca consociation of Festucetum sulcatae.
3. The distribution of the sample areas by life-styles refer to dry rock-grassland with crescive scrubbing. The process demands active conservation works in the future.

**Changes in floristic composition of Pulsatilla habitats between 1940 and 1992**




4. By the correspondence of the species number of the habitats and the Pulsatilla stools it can be remarked that the plant association of 69 species at the Páncél Hill (no.2.) has the largest Pulsatilla population

**The Classification of the relevés**




The agglomerative type classification of the coenological relevés (binary conversion, group-average algorithm, similarity ratio Wishart) segregated 4 main groups as follows (see the diagram above):

-The East-Mandulás Hill relevés (#1-8.),
-The Hosszú Hill relevés(#49-56.),
- The Vég Hill relevés(#25-32.),
- The other relevés.

The East-Mandulás is considered to be the most characteristic Pulsatilla habitat. The Vég Hill is the most isolated from the others and the species composition of that is under a strong effect of the adjoining mown grasslands. The #5. habitat is the most degraded one with 10% weed infection. The distributing effect is an agricultural aerial filling station on the top of the hill. The Pulsatilla montana disappeared form the 60 species association of #6. area. The reason of the isolation of Hosszú Hill sample areas in the dendrogram is the intervening afforestation with fir. The P. montana population of the habitat is under sentence of death by the Forestry.

## References

Chyzer, K. (1905) Adatok északi Magyarország, különösen Zemplénmegye és Bártfa sz. kir. város flórájához. Előadás a Magyar orvosok és természetjárók XXXIII-ik vándorgyűlésén. Szeged.

Dostál, J. (1933) Veštnik Králové České Společnosti Nauk. Tr. II.

Hargitai, Z. (1940) A Sárospataki előhegyek vegetációja. *Acta Geob. Hung.* III 18-29.

Hargitai, Z. (1943) Mikroklímavizsgálatok a Sátorhegységben Sárospatak környékén. *Acta Geob. Hung.* V. 290-314.

Jakucs, P., Précsényi, I. (1981) A fitocönózisok. In: Hortobágyi, T., Simon, T. (eds): Növényföldrajz, társulástan és ökológia. Tankönyvkiadó, Budapest, 192-223.
Klinka, I. (1938) Beihefte zum Botanischen Centralblatt, Abteilung B. 58.
Orlóci, L (1975) Multivariate analysis in vegetataion research. Hague.
Pinczés, Z. (1961) A Zempléni-hegység déli részének természeti földrajza. Kandidátusi értekezés vita. *Földrajzi Értesítő* **11**: 479-487.
Podani, J. (1980) Syn-Tax: Számítógépes programcsomag ökológiai, cönológiai és taxonómiai osztályozások végrehajtására. *Abstracta Botanica* **6** Budapest.
Podani, J. (1988) Syn-Tax III. User's Manual. *Abstracta Botanica* **12**: suppl.1: 1-183
Simon, T. Jurassa, M. (1970) Classification phytoceonological samples by the aid of a computer. *Annal. Univ. Budapest. Sect. Biol.* **12** : 213-225.
Simon, T (1988) A hazai edényes flóra természetvédelmi érték-besorolása. *Abstracta Bot.* **12**: 1-23.
Soó, R. (1966) A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve II. Akadémiai Kiadó, Budapest.
Takács, A. A. (1994) Összehasonlító vizsgálatok néhány Pulsatilla zimmermannii termőhelyen a Zempléni hegységben. III. Magyar Ökológus Kongresszus előadások és poszterek összefoglalói, Szeged. p. 207.
Zólyomi, B., Précsényi I. (1964) Methode zur ökologishen Characterisierung der Vegetationeinheien und zum Vergleich der Standorte. *Acta Bot. Hung.* **10**: 337-416

# PHYTOCENOLOGY OF SEMI-DRY GRASSLANDS IN THE AGGTELEK KARST AREA (N. HUNGARY)

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**Abstract:** Continental semi-dry grasslands replaced here the xerothermic oak forests (*Corno-Quercetum pubescentis-petraeae*) and dry oak-hornbeam forests (*Querco petraeae-Carpinetum waldsteinietosum*). They were also originally rich in forest-steppe elements due to the edaphic conditions. The semi-natural steppe-like grasslands were stabilised by the traditional use. They were abandoned in the sixties-seventies. Thus, the cover of polycormon-forming and tall-forb species, typical for the forest-skirts, has increased ("Versaumung").

The edaphic conditions (calcareous substrate, often covered by a red clay: "terra rossa", rich in basic minerals) are rather suitable for developing of semi-dry grasslands, rich in species. They belong mainly to the federation *Cirsio-Brachypodion*, the representation of *Bromion erecti* is questionable.

See in Proceedings Volume II. pp. 59.

# VIII. SESSION:

# INVESTIGATION OF PEDOFAUNA AND OTHER INVERTEBRATE TAXA

# COLLEMBOLA COMMUNITIES IN THE DANUBE DELTA BIOSPHERE RESERVE

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**ABSTRACT.** Collembola communities from the Danube delta Biosphere Reserve were investigated during 1991 - 1993, in ten localities representing seven types of ecosystems: mixed *Quercus* spp. Forests, steppic grasslands, salt steppic grasslands, wet *Salix* forests, costal dunes - *Quercus* spp. Forests, salt costal dunes and wet costal dunes. A total of 57 *Collembola* species was recorded. Dominance, abundance, specific diversity, evenness were used to compare the communities. Abundance and specific diversity were high in the forest areas, evenness in grasslands.

## Introduction

Collembola represents one of the most important groups of the soil fauna, in terms of species and individual numbers. So far in the Danube Delta Biosphere Reserve area, this group was not subject to extensive faunal and ecological studies. However, Bulimar (1992) studied the faunal composition and structure of Collembola communities of reed ecosystems in the Danube Delta.

## Study area

Our investigation was carried out between 1991 and 1993, usually in June - July and August - September, in various ecosystems of the Danube Delta. The sampling sites are located in the following ecosystems:

1. Mixed Quercus spp. Forests (Manastirea Cocos, Enisala, Bestepe)
2. Steppic grasslands (Capul lancila)
3. Salt steppic grasslands (Lacul Sarat)
4. Wet Salix forests (Madgearu Canal)
5. Costal dunes - mixed Quercus spp. Forests (Letea I, Letea II)
6. Salt costal dunes (Letea Saraturi)
7. Wet costal dunes (Letea Fatana)

Some of the sampled sites are located within the main inland reservation (Madgearu Canal, Letea sites), while others are located outside the proper Danube Delta Biosphere Reserve.

## Material and methods

Litter layer and the upper part of the A horizon (0 - 10 cm and 10 - 20 cm) were sampled. Tullgren funnels were used for animal extraction. A total of

about 3,000 Collembola individuals were collected. The following dominance categories of the species were used (Dunger, 1976): eudominant (more than 10 %), dominant (5.1 - 10 %), subdominant (2.1 - 5 %), recedent (1.1 - 2 %), and subrecedent (less than 1 %). The specific diversity is expressed by Shannon's index (H').

## Results

### Faunistical data

A number of 57 Collembola species belonging to 12 families was identified (Table 1). The following species are recorded for the first time in the Romanian fauna:

*Pseudostachia populosa* (Selga 1963O (*Odontellidae*) (Enisala, 2.05.1993, 3 males, 2 females), described in Spain, and also identified in Corsica (Deharveng, 1981), France (Thibaud, 1995)), Canary Islands (Fjellberg, 1995) and Poland (Thibaud, 1995).

*Doutnacia xerophilia*, Rusek 1974 (*Onychiuridae*) (Bestepe, 30.04.1993, 2 ind.), described from Czechoslovakia, and also identified in southern Europe (Zimdars and Dunger, 1994).

*Mesaphorura hylophilia* Rusek, 1982 (*Onychiuridae*) (Manastirea Cocos, 3.05.1993, 8 ind.), described from Czechoslovakia, also identified in Europe and Baleare Islands.

*Mesaphorura macrochaeta* Rusek,1976 (Letea Saraturi, 14.09.1993, 3 ind.), described from Canada and also identified in Europe (Arbea and Jordana, 1991).

### Structure of communities

In the mixed forest from Manastirea Cocos 15 species are identified. *Folsomia manolachei, Parisotoma notabilis, Proisotoma minuta, Mesaphorura critica* are dominant. *Oncopodura crassicornis* and *Sminthurus flaviceps* are found exclusively in this habitat.

In the forest from Enisala 18 species are recorded: the hemiedaphic *Folsomia manolachei, Parisotoma notabilis* and the edaphic form *Onychiurus* sp. 1 and *Willemia scandinavica* are dominant. In this habitat the exclusive species are *Pseudostachia populosa* and *Micranurida sensillata*, also in the beech forests in the Apuseni Mts. (The Carpathians).

In the mixed *Carpinus - Quercus* spp. Mixed forest from Bestepe 24 species are identified. As in the case of other forests, the dominant species are *Folsomia manolachei, Parisotoma notabilis, Onychiurus* sp. 1, *Onychiurus glebatus*. The rates of recedent and subrecedent species are higher in this biotope compared with the others. *Willemia anophthalma, Micranurida pygmaea, Megalothorax minimus* are confident species.

In the steppic grassland of Iancila 7 species are located. The small edaphic psammophilous species *Osotomodes sexsetosus, Doutnacia*

*xerophila* and *Axenyllodes bajeri*, which are characteristic of dry, xeric habitats, are dominant in this biotope.

In the salt steppic grassland of Lacul sarat 8 species are reported, *Ceratophysella denticulata, Brachystomella parvula* and the edaphic *Mesaphorura critica* being dominant. *Brachystomella parvula, Stenaphorura quadrispina* and *Isotomodes productus* are specific to this habitat.

In the wet *Salix* forest the dominant species are *Folsomia manolachei, Anurida* sp. and *Folsomia bisetosa*. The hygrophilous Isotomurus palustris is common and specific to the habitat.

In the various sampling sites of the Letea forest, the variety of species depends on vegetation and soil moisture. Thus, in the forest belts with *Quercus* spp., 9-15 species are present, while in the dry, salty *Juncus* grasslands only 4 species sustain the communities. The nucleus of dominant species is similar to other ecosystems.

Abundance of the Collembola communities is higher in the forest ecosystem (Fig. 1) approx. 6,000-28,000 ind. / sq. m . Most of the animals are concentrated in the upper part of the soil A horizon, while in the litter layers, the number of the animals is low. In the steppic grasslands and salt steppic grasslands, abundance of collembolans has lower values, approx. 2,000-4,000 ind. / sq. m.(Fig. 2).

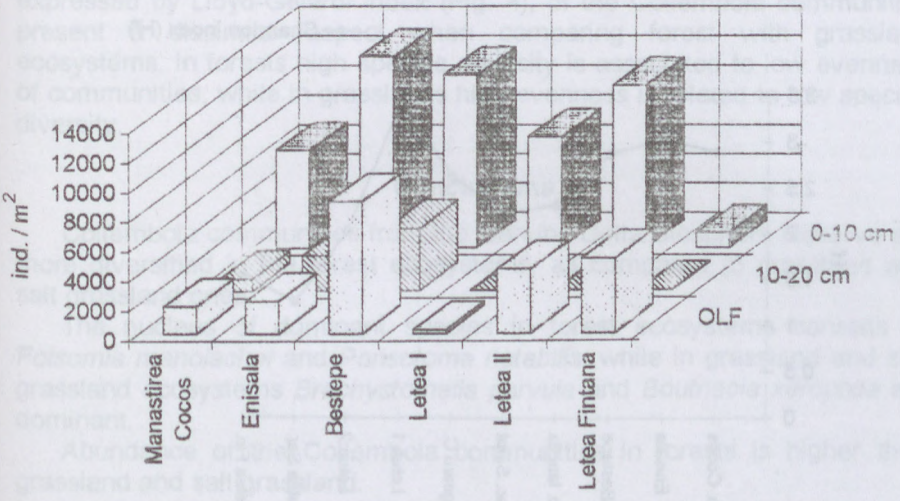



Fig. 1. Abundance of Collembola communities in the studied forest areas

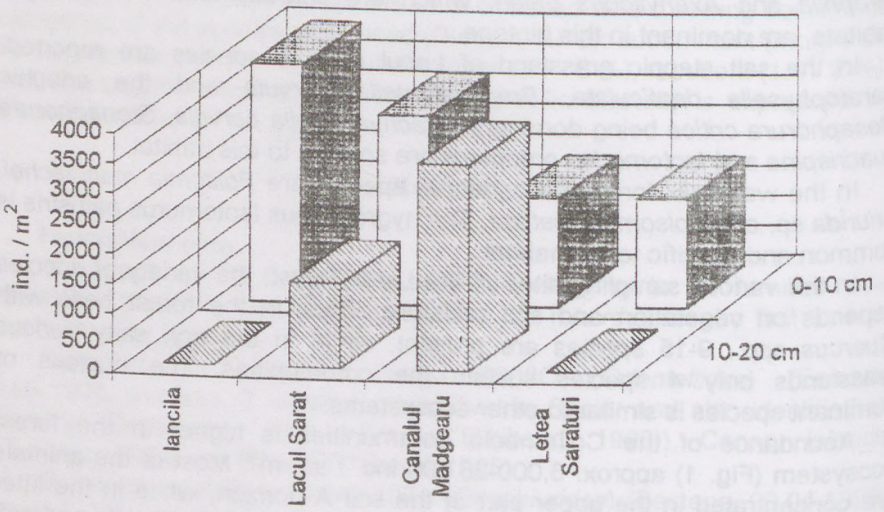



Fig. 2. Abundance of Collembola communities in the studied grassland areas

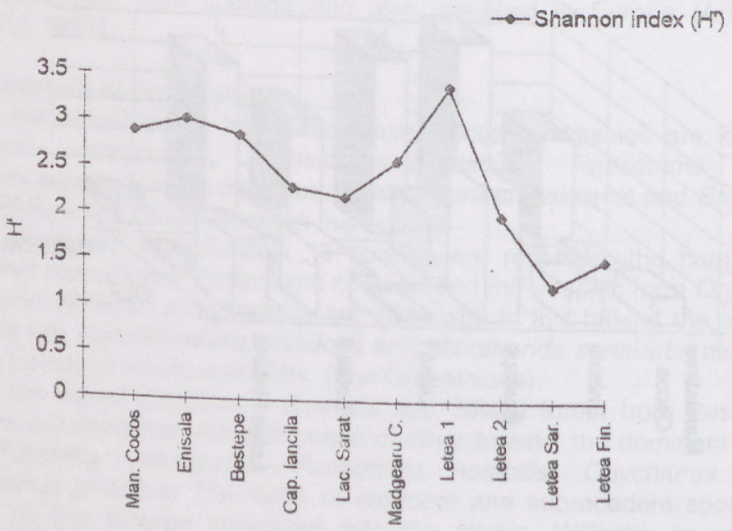



Fig. 3. Specific diversity of Collembola communities in the studied areas

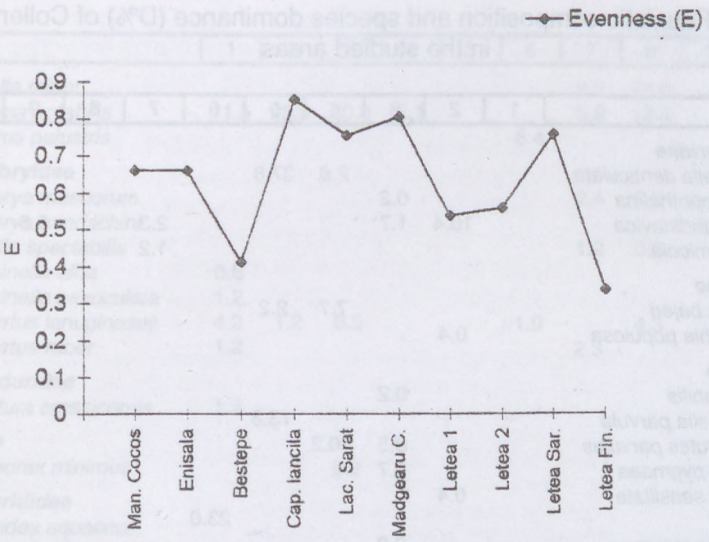



Fig. 4. Evenness of Collembola communities in the studied areas

Species diversity expressed by Shannon's index (Fig. 3), and evenness expressed by Lloyd-Gelardi index (Fig. 4), of the Collembola communities present a dissimilar aspect when comparing forest with grassland ecosystems. In forests high species diversity is associated to low evenness of communities, while in grasslands high evenness is related to low species diversity.

## Conclusions

Collembola communities from the Danube Delta Biosphere Reserve are more diversified in the forest ecosystems, as compared to grassland and salt grassland ones.

The nucleus of dominant species in forest ecosystems consists of *Folsomia manolachei* and *Parisotoma notabilis*, while in grassland and salt grassland ecosystems *Brachystomella parvula* and *Boutnacia xerophila* are dominant.

Abundance of the Collembola communities in forests is higher than grassland and salt grassland.

Most of the soil Collembola are concentrated in the A horizon of the forest soils. In grasslands and salt grasslands vertical distribution of animals seems to be relatively well balanced.

Species diversity of the Collembola communities in forest ecosystems presents higher values than in grassland and salt grassland ecosystems.

Table 1. Faunistic composition and species dominance (D%) of Collembola in the studied areas

| Species | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Hypogastruridae*** | | | | | | | | | | |
| *Ceratophysella denticulata* | | | | 2.6 | 37.8 | | | | | |
| *Willemia anophthalma* | | | 0.2 | | | | | | | |
| *Willemia scandinavica* | | 10.4 | 1.7 | | | | 2.3 | | 5.5 | 1.1 |
| *Xeenylla humicola* | | | | | | | 1.2 | | | |
| ***Odontellidae*** | | | | | | | | | | |
| *Axenyllodes bajeri* | | | | 7.7 | 2.2 | | | | | |
| *Pseudostachia populosa* | | 0.4 | | | | | | | | |
| ***Neanuridae*** | | | | | | | | | | |
| *Friesea mirabilis* | | | 0.2 | | | | | | | 1.1 |
| *Brachystomella parvula* | | | | | 13.3 | | | | | |
| *Pseudachorutes parvulus* | | | 0.5 | 10.2 | | | | | | |
| *Micranurida pygmaea* | | | 0.7 | | | | | | | |
| *Micranurida sensillata* | | 0.4 | | | | | | | | |
| *Anurida* sp. | | | | | | 23.0 | | | | |
| *Neanura muscorum* | | | 0.3 | | | | | | | |
| *Deutonura phlaegrea* | | | 0.3 | | | | | | | |
| *Lathriopyga longiseta* | | 0.8 | 0.8 | | | | | | | |
| ***Onychiuridae*** | | | | | | | | | | |
| *Onychiurus armatus* | | 1.5 | 0.2 | | | | 16.4 | | | 1.1 |
| *Onychiurus fimatus* | | | 0.3 | | | | | | | |
| *Onychiurus sp. 1* | | 20.0 | 8.2 | | | | | | | |
| *Onychiurus sp. 2* | | | | | | 3.8 | | | | |
| *Onychiurus glebatus* | | 1.5 | 9.3 | | | | 11.8 | | | |
| *Onychiurus rectopapillatus* | 0.6 | 2.7 | 0.2 | | | | | | | |
| *Metaphorura affinis* | | 3.5 | 5.0 | | 4.4 | | | | | |
| *Stenaphorura quadrispina* | | | | | 4.4 | | | | | |
| *Mesaphorura critica* | 8.5 | 1.2 | 3.0 | | 33.0 | | 7.4 | | | |
| *Mesaphorura hylophila* | 4.8 | 0.8 | | | | | 2.3 | 3.0 | | |
| *Mesaphorura italica* | | 3.0 | | | | | 2.3 | | | |
| *Mesaphorura macrochaeta* | | | | | | | | | 16.6 | |
| *Mesaphorura yosii* | | | | | | | | | | 2.3 |
| *Mesaphorura krausbaueri* | | | | | | | | | | 0.4 |
| *Mesaphorura sylvatica* | | | | | | | 5.9 | | | |
| *Doutnacia xerophila* | 0.6 | 2.7 | 0.3 | 43.6 | | 3.8 | | | | |
| ***Isotomidae*** | | | | | | | | | | |
| *Folsomia bisetosa* | | | | | | 21.1 | | | | |
| *Folsomia quadrioculata* | | | 3.3 | | | | | | | |
| *Folsomia manolachei* | 41.2 | 22.4 | 30.0 | 10.2 | | 32.7 | 15.3 | 51.0 | 72.3 | 70.2 |
| *Folsomides parvulus* | | | | | | | 17.6 | 4.6 | | 0.4 |
| *Proisotoma minuta* | 9.0 | | 2.0 | | | | | | | |
| *Isotomodes productus* | | | | | 2.2 | | | | | |
| *Isotomodes sexsetosus* | | | | 20.5 | 2.2 | | | | | |

| Species | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| *Isotomiella minor* | | | | | | | 8.2 | 23.0 | | 3.4 |
| *Parisotoma notabilis* | 11.5 | 25.5 | 30.0 | 5.1 | | | 5.9 | 12.4 | | 17.5 |
| *Isotomurus palustris* | | | | | | 6.4 | | | | |
| ***Entomobryidae*** | | | | | | | | | | |
| *Entomobrya muscorum* | | | | | | | 2.4 | 0.9 | | |
| *Entomobrya handschini* | | | | | | | | | 5.5 | |
| *Orchesella spectabilis* | | | | | | | 1.2 | 0.3 | | |
| *Pseudosinella alba* | 0.6 | | | | | | | | | |
| *Pseudosinella sexoculata* | 1.2 | | | | | | | | | |
| *Lepidocyrtus lanuginosus* | 4.2 | 1.2 | 0.5 | | | 1.9 | | 4.3 | | |
| *Lepidocyrtus ruber* | 1.2 | | | | | | 2.3 | | | |
| ***Oncopoduridae*** | | | | | | | | | | |
| *Oncopodura crassicornis* | 1.2 | | | | | | | | | |
| ***Neelidae*** | | | | | | | | | | |
| *Megalothorax minimus* | | | 0.2 | | | | | | | |
| ***Sminthurididae*** | | | | | | | | | | |
| *Sminthurides aquaticus* | | | | | | | | | | 0.8 |
| *Sphaeridia pumilis* | 6.0 | 0.8 | 0.7 | 1.1 | | | | | | |
| ***Arrhopalitidae*** | | | | | | | | | | |
| *Arrhopalites caecus* | | | | | | 1.9 | | 0.3 | | |
| ***Kantiannidae*** | | | | | | | | | | |
| *Sminthurinus aureus* | | | | | | 3.8 | | | | 0.4 |
| *Sminthurinus niger* | 2.4 | 1.2 | 0.5 | | | | | | | |
| ***Sminthuridae*** | | | | | | | | | | |
| *Sminthurus flaviceps* | 6.6 | | | | | | | | | |
| *Sminthurus viridis* | | | | | | 1.9 | | | | |

**Legend:**
1 - Manastirea Cocos, 2 - Enisala, 3 - Bestepe, 4 - Cap Iancila, 5 - Lac Sarat, 6 - Madgearu Canal, 7 - Letea 1, 8 - Letea 2, 9 - Letea Saraturi, 10 - Letea Fantana.

## References

Arbea, J.I., Jordana, R., (1991) Collembolos de la Navarra (Norte de la Peninsula Iberica). I. Orden *Poduromorpga* (*Collembola*). Publ. Biol. Univ. Navarra, ser.zool. 22: 1-149.

Bulimar, F., (1992) Compozitia faunistica si structura comunitatilor de colembole (*Collembola, Insecta*) in ecosistemele stuficole din Delta Dunarii. A. St. Inst. Delta Dunarii: 95-100.

Dunger, W., (1976) Structurelle Untersuchungen an Collembolengemeinschaften des Hruby Jesenik Gebirges (Altvatergebirge, Cssr). Abh.Ber.Naturkundemus. Görlitz, 50: 1-43.

Fjellberg,A., (1995) Collembola of the Canary Islands. II. Family Odontellidae. Ent. Scand. 26: 153-158.

Thibaud, J.-M., (1992) Collemboles des sables littoraux d'Albanie et de Roumanie. Revue. Fr. Ent., (N.S.) 14: 21-23.

Thibaud, J.-M., (1995) Recherches sur la faune insterstitielle aerienne des sables fins: les Collemboles littoraux de l'Herault. Ann. Soc. Entomol. Fr. (N.S.), 31: 31-37.

Zimdars, B. and Dunger, W., (1994) Synopseson Palearctic Collembola. Part I. Tulbergiinae Bagnall, 1935. Abh. Ber. Naturkundemus. Görlitz 68: 1.71.

# MALACOSTRACA OF THE BIOSPHERE RESERVE OF THE SLOVAK KARST AND THE ADJACENT REGIONS

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**Abstract:** Basic information on water amphipods, isopods and crayfish are reported from BR Slovak Karst and adjacent regions. The most common amphipods of spring openings and waterstreams is *Gammarus fossarum* Koch and *Synurella ambulans* (Müller). Relatively rare amphipod of some springs and effluents is *Niphargus tatrensis* Wrzesniowski. *Gammarus roeselii* Gervais was reported only from few spring openings and in lower part of Slana River and some brooks. Few individuals of *Gammarus balcanicus* Schaffer were recorded from Slana River (Plesivec-over), but we presume that this species is not native here and that it has been transported from upper part of Slana River outside of BR Slovak Karst.The next isolated population of *G. balcanicus* was found in the uppermost part of Turna and Blatnica Brook and populations are located outside of karstic ground.

Asellus aquaticus L. is relatively abundant in the lower part of Slana River, Muran and Turna Brook.

Crayfish *Astacus astacus* Fabricius is rare and it is known from Slana River, Muran and Turna Brooks.

This contribution follows up Balthasar (1936) and Straskraba (1953, 1962). Common information on fauna of karstic springs in BR - Slovak Karst were published by Kosel (1994).

Crayfish of this region were published by Hudec (1992, 1994).

In this paperwe are focusing on more detailed distribution of malacostracans taxocoenoses in surface waters (karstic springs, brooks and river) in the Slovak region of BR Slovak Karst and its buffer zone.

## Materials and methods

We collected the material in the surface lotic part of springs using the hydrological net. We visited all main karstic springs of the BR Slovak Karst. They are mostly located on its boundary. So that our results give representative information on the ampipod fauna of this habitat.

The same method was used for amphipods and isopods in surface streams in BR Slovak Karst and its buffer zone. All records are summarised in Tab. 1 and 2.

## Results and discussion

Malacostracans are characteristic, permanent and dominant group of springs and lotic part of brooks and rivers. Species composition depends on physical and chemical conditions of the environment.

**Springs and cave effluents** (Tab. 1)

The most dominant amphipods of BR Slovak Karst are *Gammarus fossarum* Koch and *Synurella ambulans* (Müller) in solid permanent and cool springs (summer water temperature below 12oC) with stony bottom. For comparison in the same type of spring in Muranska planina (Karst) and Slovensky Raj (Karst) only *Gammarus fossarum* can be found under the same conditions.

The dominance of *Gammarus fossarum* decreases and that of *Synurella ambulans* increases with the spring flow decrease in BR Slovak Karst. Such a correlation has not been confirmed in karstic springs of Muranska planina (Karst) and Slovensky Raj (Karst).

Only *Synurella ambulas* was recorded in a small pit and temporary springs of BR Slovak Karst (Vidova and spring near Lucanske Lake). We do not know such composition of amphipods
in other examined Slovakian springs.

*Gammarus roeselii* Gervais was recorded in two karstic springs (Jelsavska Teplica and Drienovec : spring over Pansky Les).

Both springs are oriented to the south and their summer water temperature is about 15o C. Both springs have limnetic part with aquatic and wetlands macrovegetation near the margin. *G. roeselii* co-occurrs there with *G. fossarum* and *S. ambulans.*

It seems that *Gammarus roeselii* is a more common species in Karst in Hungarian. We found it in the effluent from Baradla Cave and Kossut L. Cave where it mainly lives between macrophytes.

*Niphargus tatrensis* Wrzesniowski is common species of karstic caves but it is very rare and temporary element of karstic springs. It was recorded in 3 karstic springs (Tab.1). However we presume that it could be occasionaly found in all cave effluents and in many springs. We did not find other malacostracans in karstic springs of BR Slovak Karst.

**Surface streams** (Tab. 2)

Gammarus fossarum was recorded as the only species of upper and middle parts of nearly all brooks.

Only isolated and native populations of *Gammarus balcanicus* were found in the uppermost part of Turna Brook (above Silicka Jablonica) and Blatnica Brook (over Zadiel Gorge).These populations are located outside of karstic area.

The next record of *G. balcanicus* was from Slana River (over Plesivec). We presume that this species is not native here and it has been transported from upper part of Slana River outside of BR Slovak Karst.

The increase of *G. roeselii* and *Asellus aquaticus* and decrease *of G. fossarum* abundance corresponds to the increase of water temperature, decrease of the flow speed and presence of water vegetation in the bank zone.

Crayfish *Astacus astacus* Fabricius (Fig. 3) is rare and of low abundance. It is known from Slana River, Muran and Turna Brooks. Additional information is given by Hudec (1994).

## References

Balthasar V. (1936) Limnological researches is Slovak waters (in Slovak). Bratislava, Ucena spol. Safarikova: 75 pp

Hudec, I. (1992) Notes to the distribution of amphipods (Amphipoda) and shrimps (Decapoda) in Bodva and lower part of Hornad watersheds. (in Slovak) Zbor. Vychodoslov. TOP 15, Moldava nad Bodvou:Ź33-39.

Hudec, I. (1994) The distribution of shripms (Crustacea, Decapoda) in Eastern Slovakia. (in Slovak) Zbor. Vychodoslov.Muz., Prir. Vedy,Ź Kosice 35: 9-13

Kosel, V. (1994) Animal of karstic waters. In: M. Rozloznik, & M Karasova (eds.): The Slovak Karst - a Biosphere Reserve (in Slovak). Osveta, Martin: 235-240.

Straskraba, M. (1953) Preliminary report of distribution of the genus Gammarus in CSR (in Czech). Vest. Ceskoslov. zool. spolec. 17: 212-237.

Straskraba, M. (1962) Amphipoden der Tschechoslowakei nach den Sammlungern von Prof. Hrabe. I. Vest. Ceskoslov. zool.spolec. 26: 117-145.

Tab. 1. Percentage composition of ampipods in karstic springs of BR-Slovak karst (*Gammarus fossarum, G.roeselii, Synurella ambulans* and *Niphargus tatrensis*).

| Locality | alt. [m] | temp. [°C] | foss | roes | ambu | tatr | date |
|---|---|---|---|---|---|---|---|
| Koniarska planina (plateau) | | | | | | | |
| Gemerské Teplice spr. | | | 46 | 27 | 27 | | 16.7.1994 |
| Plešivecká planina (plateau) | | | | | | | |
| Hučiaca I (Zugó II, N part) | 279 | 9.7 | 53 | | 46 | 1 | 5.3.1991 |
| Hučiaca II (Zugó I, S part) | 270 | 9.6 | 86 | | 14 | | 5.3.1991 |
| Kunová Teplica | 263 | 10.2 | 87 | | 13 | | 5.3.1991 |
| Plešivec Studená studňa | 225 | 10.1 | 92 | | 8 | | 5.3.1991 |
| Plešivec (above railw. st.) | 220 | 10.9 | 45 | | 55 | | 5.3.1991 |
| Vidová Brzotín (from old cave) | 240 | 10.2 | - | | 100 | | 8.3.1991 |
| | | 8.3 | 12 | | 88 | | 8.3.1991 |
| Brzotín (from new cave) | 270 | 9.4 | 87 | | 13 | | 8.3.1991 |
| Horný vrch (plateau) | | | | | | | |
| spring above Lučanské Lake | 740 | 8.4 | | | 100 | | 17.8.1991 |
| Lúčka village | 525 | 9.6 | 88 | | 12 | | 2.5.1991 |
| Hrušovo (Eveteš spr.) | 270 | 11.2 | 96 | | 4 | | 6.3.1991 |
| Hrhov Haj village | 250 | 11.0 | 88 | | 12 | | 6.3.1991 |
| (spr. Bírešová) | 240 | 10.8 | 98 | | 2 | | 7.3.1991 |
| Drienovec (Drienovská effl.) | 245 | 9.2 | 79 | | 21 | | 1.5.1991 |
| | | 9.1 | 80 | | 19 | 1 | 9.5.1992 |
| Drienovec (spr. over Pánsky Les) | | 14.2 | 48 | 41 | 11 | | 9.5.1992 |
| Silická planina (plateau) | | | | | | | |
| Silica Sokolí spr. | 350 | 8.4 | 95 | | 5 | | 6.3.1991 |
| Buzgó spr. (easter part) | 300 | 8.9 | 88 | | 12 | | 2.5.1991 |
| Buzgó spr. (western part) | 315 | 9.5 | 96 | | 5 | | 29.4.1991 |
| Gombasek (Biela spr.) | 240 | 10.2 | 95 | | 5 | | 29.4.1991 |
| | | | 93 | | 6 | 1 | 18.6.1992 |
| Gombasek (Čierna spr.) | 250 | 9.6 | 91 | | 9 | | 29.4.1991 |
| Kečovo (Kečovská spr.) | 355 | 8.6 | 81 | | 19 | | 30.4.1991 |
| Hungary | | | | | | | |
| Jósvafö (Baradla C. effl.) | 300 | 14.2 | 90 | 2 | 9 | | 16.8.1993 |
| Jósvafö (Kossut C. effl.) | | 15.4 | | | | | |
| -lotic part | | | 94 | | 6 | | 16.8.1993 |
| -lenitic part (from veget.) | | | 42 | 57 | 1 | | 16.8.1993 |
| Jósvafö (Komlos spr.) | | 10.2 | 93 | | 7 | | 16.8.1993 |

Tab. 2. Percentage composition of ampipods (*Gammarus balcanicus, G. fossarum, G.roeselii*) isopods (*Asellus aquticus*) and crayfish (*Astacus astacus*) in river and brooks of BR-Slovak karst and buffer zone

| Locality | balc | foss | roes | Aaqu | Aast | Date |
|---|---|---|---|---|---|---|
| Muráň Brook | | | | | | |
| Jelšavská Teplica | | 5 | | 95 | | 9.12.1992 |
| Gemerské Teplice | | | | | | |
| (fish pond) | | | 100 | | + | 16. 7.1994 |
| Meliata (mouth) | | 1 | 89 | 10 | + | 9.10.1992 |
| Štítník Brook | | | | | | |
| Pašková | | 100 | | | | 18. 6.1992 |
| Plešivec(mouth) | | 31 | 69 | | | 18. 6.1992 |
| Slaná River | | | | | | |
| Brzotín | | 5 | 95 | | | 9.10.1992 |
| Slavec | | 1 | 94 | 5 | + | 21. 6.1992 |
| Plešivec (over) | 7 | 93 | | | | 21. 6.1992 |
| Bretka | | 1 | 88 | 11 | | 9.10.1992 |
| Čermošná Brook | | | | | | |
| Drnava | | 100 | | | | 9.10.1992 |
| Lipovník | | 15 | 85 | | | 7. 3.1995 |
| mouth | | | 94 | 5 | | 9.10.1992 |
| Turňa Brook | | | | | | |
| Silická Jablonica | 49 | 51 | | | | 6. 3.1991 |
| (above 260 m alt.) | | | | | | |
| Včeláre | | 79 | 17 | 4 | + | 8. 8.1991 |
| mouth | | 46 | 44 | 10 | + | 8. 8.1991 |
| Hrušov (fish pond) | | | 98 | 2 | + | 8. 8.1991 |
| Blatnica Brook | | | | | | |
| Dvorníky (over) | 2 | 98 | | | | 8. 8.1991 |
| mouth | | 100 | | | | 8. 8.1991 |
| Hájsky Brook | | | | | | |
| Háj (over) | | 100 | | | | 8. 8.1991 |
| Drienovec Brook (mouth) | | | 100 | | | 8. 8.1991 |
| Brook in Baksova valley | | 100 | | | | 2. 5.1991 |
| Bodva Brook | | | | | | |
| Budulov | | 26 | 64 | 10 | | 8. 8.1991 |
| Moldava nad Bodvou | | | | | | |
| (over) | | 100 | | | | 12. 6.1995 |
| over Štósky Brook | 52 | 48 | | | | 8. 8.1991 |

# SOIL ARTHROPOD COMMUNTIES OF THE SLOVAK KARST BIOSPHERE RESERVE WITH SPECIAL REFERENCE TO COLLEMBOLA (*HEXAPODA*)

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**Abstract:** In territory of the Slovak Karst Biosphere Reserve eight localities were chosen for study of soil arthropod communities. These sites involve forest and open habitats and caves. Leaf litter and soil organic layer was the main microhabitat under study. Several samples come from moss on rocks and tree trunks. In total 17 soil samples were taken (soil samples 15x15 cm in area and 10 cm deep, samples from moss 30x30 cm in area). In caves flooded organic material and bat guano were sampled.

Arthropod abundance in forest soils was considerably high, between 124 x 103 and 236 x 10 3 ind. m -2. Similarly collembolan abundance in these soils was high and varied between 22 x 103 and 66 x 103 ind..m-2. 71 species of Collembola were recorded, 5 of them are new for Slovak fauna and 7 are rare forms, probably new for science. Genus *Stachorutes* Dallai,1973 and *Pumilinura* Cassagnau,1979 are reported from Slovakia for the first time. Ecological and zoogeographical analysis of collembolan communities is given.

Key words: soil arthropods, Collembola, Slovak Karst

## Introduction

Soil arthropods have not been explored satisfactorily in Slovak Karst yet. Data on soil mites were published by Kaluz (1992, 1994). The first data on *Collembola* from Slovak Karst come from Paclt (1957), who reported two species in Domica Cave. In the same cave Nosek (1975a, 1975b) found eight collembolan species in bat guano mixed with limestonic detritus, two of them new for science. List of collembolan species from five localities within territory of Slovak Karst was given by Carnogursky (1994).

## Methods

In course of investigations of soil fauna of the Slovak Karst we focused on both basic types of habitats, e.g. forest and open habitats. List of habitats, microhabitats and their location is given in Table 1. Within forest sites we chose following plant communities (site number in parenthesis):

- xero-thermic community with *Quercus pubescens* and *Fraxinus ornus*, Hrusov forest steppe (1)
- *Carpineto - Quercetum*, Ardovo (2)

- *Corneto - Quercetum*, Zadiel Gorge (3)
- *Pinetum dealpinum*, Sorosks (4)
- *Fagetum typicum*, Silicka Brezova (5)
  Silica (6)
  Zadiel Gorge (7)
  Soroska (8)
- *Fageto - Aceretum*, Zadiel Gorge (9)

As cave habitat Ardovo Cave and Domica Cave were sampled. Qualitative samples were taken from organic material on the floor (flooded soil, bat guano).

Investigations were carried out at 8 localities that comprised 17 sites. From each site one sample 15 x 15 cm in area and 10 cm deep was taken. Samples from moss were 30 x 30 cm in area (sites 10 and 11). Samples from sites 12, 16 and 17 have just qualitative character. Quantitative samples were analysed according to community parameters: abundance, group richness (soil arthropods) and species richness (*Collembola*). Sites were sampled on 13.X.1994 (1-7, 9-14, 16), on 20.X.1994 (8 and 15) and on 27.XI.1994 (17).

Soil samples were extracted in Tullgren funnels and material was fixed in 70 % alcohol.

## Results and discussion

### Soil arthropod communities

Total of soil arthropods identified to main groups comprises 65 815 individuals. *Oribatida, Collembola, Actinedida* and *Gamasina* were the most abundant sharing 92,3 % of all individuals.

Abundance of particular soil arthropod groups is given in Table 2. Considerably higher abundance in forest soils comparing with moss growth on rocks and soil of open habitats is apparent. Exception is high abundance in the soil covered with herbal vegetation at Soroska (site 15), where rendzina was the soil type with deeper organic layer. On the other hand, in sites 13 and 14 lithosol poor in humus was developed as soil type. This was the reason of low abundance of soil Arthropoda in these sites. Abundance values of forest soils between 124 x 103 ind. m-2 and 236 x 103 ind. m-2 are high with respect to extraction method used. In spite the fact, that soil samples were taken in period of abundance maximum of soil fauna, these results show high biological activity of forest soils in the Slovak Karst territory.

Group richness of soil arthropods was higher in forest soils comparing with open habitats and moss growth on rocks on the average. In meadow soils several groups were rare: *Pseudoscorpionida, Acaridida, Tarsonemida, Isopoda, Symphyla, Diplopoda, Protura, Diplura, Elateridae* and *Formicidae. Uropodina, Pauropoda* and *Carabidae*

were completely absent. Similarly, *Symphyla, Protura* and *Elateridae* were missing in moss growth on rocks.

*Pauropoda* and *Protura* are known as indicator of soil food web stability and they are connected with last successional stages of ecosyetem. Abundance 100 - 1.000 ind. m-2 for *Pauropoda* and 100 - 5.800 ind. m-2 for *Protura* in forest soils (Tab. 2) confirm results found in overall arthropod abundance.

**Collembolan communities**

Similarly as in arthropods also in *Collembola* the highest abundance was found in forest sites, where it ranged between 22 x 103 and 66 x 103 ind. m-2 (Tab. 2). Those are high values comparing with data summarized by Petersen and Luxton (1982) for temperate deciduous forests and more effective (high - gradient) extraction technique. High abundance was found in wet moss growth in the bottom of Zadiel Gorge (site 11) and in well developed rendzina soil covered with herbal xerothermic community in Soroska (15). On the other hand, exposed xerothermic sites (10, 13, 14) were apparent by low collembolan abundance that varied between 4 x 103 and 6 x 103 ind. m-2.

71 collembolan species from five sites were identified (Tab. 3). The list consists of 71 species. Carnogursky (1994) found 53 species at five localities.

From Pannonian oak-hornbeam wood (*Carpineto-Quercetum*) close to Ardovo (site 2) 21 species were recorded. Population of ubiquistic, forest soils preferring species *Folsomia quadrioculata* had the highest density in this site. Ubiquistic *Lepidocyrtus lignorum,* forest species *Pseudosinella horaki* and *Protaphorura procampata* were also abundant. Two species are worth to mention because of their rarity. *Anurida endroedii* and *Pumilinura loksai* were only known from their type locality Borzsony mountains, northern Hungary (Dunger, 1973). They are recorded in Slovakia for the first time. Moreover, this is the first slovak record of genus *Pumilinura* Cassagnau, 1979, distributed mainly in South Europe.

In *Corneto-Quercetum* in the bottom of the mouth of Zadiel Gorge 43 species of *Collembola* were recorded. *Folsomia manolachei*, ubiquistic *Isotomiella minor* and south-european *Hymenaphoruta variotuberculata* had the highest population density. *Neanura pseudoparva* and *Onychiurus rectopapillatus* represent Carpathian endemic species. *Orchesella multifasciata* is an east-european element. Three species were found as new for Slovak fauna: *Ceratophysella scotica, Xenylla subacauda* and *Micranurida hygrophila. C. scotica*, living in wet soils, is distributed in Western Europe, Scandinavia, Belorussia and in East Carpathians (Ukraina). *X. subacauda* is known from Caucasus and East Carpathians. *M. hygrophila* has been only recorded in Moravia yet. In this community several new species, all from family *Neanuridae* were found. *Stachorutes*

sp., *Micranurida* cf. *forsslundi, Endonura* cf. *tetrophthalma,* and *Neanura* cf. *parva* do not fit well with any described collembolan species. Genus Stachorutes Dallai, 1973 is new for Slovakia and his puzzle distribution is very unusual. It has been only found in Alaska, Southern Africa, Spain, Italy and Switzerland.

On meadow at Hrusov forest-steppe low species richness was found: 14. Species composition reflects xerothermic character of this site. *Lepidocyrtus lanuginosus, L. lignorum* and *Orchesella albofasciata* are classified as xerotolerant species. *O. albofasciata* and *Entomobrya handschini* are Eastern European species. Montane *Isotomodes sexsetosus*, on the other hand, has center of his distribution located in Southern and Central Europe. *Odontella* sp. is probably new for science.

Underground spaces serve as a specific habitat for soil fauna. *Collembola* belong to the fauna groups well adapted to life in caves and especially here it is still possible to find a lot of rare and for science new forms. Information on *Collembola* from Ardovo Cave and Domica Cave confirms this fact. In bat guano in Domica Cave we recorded six *Collembola* species. But interesting material was gained from flooded soil on the floor in Ardovo Cave with 10 species. *Arrhopalites slóvacicus* is troglobiont, that has been just recorded in Domica Cave (Nosek, 1975b). Species *Mesaphorura* sp. and *Isotomiella* sp. are probably new for science. Their taxonomical status can be explained after studying more specimens.

## Summary

1. Abundance of soil arthropods and their group presence in woodland biotopes of the Slovak Karst indicate high biological activity of forest soils within this territory.

2. Synecological study of *Collembola* showed high quantitative presence of this group in forest soils in the Slovak Karst. Species analysis of selected sites showed presence of rare species especially in *Corneto-Quercetum* vegetation community in the mouth of Zadiel Gorge. Several rare and from taxonomical viewpoint interesting species were found also in Ardovo Cave and that outlines outstanding importance of cave habitats for biodiversity estimation.

3. According to zoogeographical analysis of collembolan communities the Slovak Karst is territory where Carpathian elements occur together with south-european species. Genus *Pumilinura* Cassagnau,1979 was found to have northern limit of his distribution in this territory. Several species reach this area from East Europe.

4. In soil samples from five selected sites 5 new species for Slovak fauna and 7 probably new for science were recorded. Presence of this rare

forms signalizes exceptionality of the Slovak Karst Biospheric Reserve, that serves as gene pool source of international importance.

Table 1: List of habitats, microhabitats and sites

| | H-MH | Site | |
|---|---|---|---|
| 1. | FO-SH | Hrusov | forest-steppe |
| 2. | FO-SH | Ardovo Cave | surroundings |
| 3. | FCO-SH | Zadiel Gorge | |
| 4. | FP-SH | Soroska | |
| 5. | FB-SH | Silicka Brezova | |
| 6. | FB-SH | Silica | |
| 7. | FB-SH | Zadiel Gorge | |
| 8. | LB-SH | Soroska | |
| 9. | FMB-SH | Zadiel Gorge | |
| 10. | FO-PM | Hrusov | forest-steppe |
| 11. | FMB-PM | Zadiel Gorge | |
| 12. | FO-AM | Ardovo Cave | surroundings |
| 13. | O-SRh+SM | Hrusov | forest-steppe |
| 14. | O-SRh+SM | Ardovo Cave | surroundings |
| 15. | O-SRh | Soroska | |
| 16. | C-PP | Ardovo Cave | |
| 17. | C-PG | Domica Cave | |

**Legend:**
Habitats (H):
F - forest /FO - oak, FP - pine, FB - beech, FMB - maple-beech, FCO - cornel-oak/
O - open
C - caves
Microhabitats (MH):
S - on the soil surface /SH - leaf litter, SRh - herb rhizosphere, SM - moss growths on the soil/
P - on rocks /PM - moss and lichen growth, PP - soil in cavities, PG - bat guano/
A - on tree trunks /AM - arboricolous moss/

Table 2. Abundance of soil arthropod groups /x $10^3$ ind. $m^{-2}$/ in forest and open habitats /site numbers see Tab. 1/

| Group | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 13. | 14. | 15. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pseudoscorp. | 0,2 | 0,1 | 1,0 | 0,1 | 0,1 | 0,1 | 0,7 | 0,1 | 1,7 | 0,1 | 0,1 | 0,1 | - | - |
| Araneida | 0,4 | - | 0,3 | 0,1 | 0,2 | 0,1 | 0,4 | 0,3 | 5,3 | 0,1 | 0,1 | 0,1 | 0,1 | 0,6 |
| Oribatida | 98,8 | 95,9 | 98,2 | 60,0 | 61,5 | 81,0 | 85,6 | 87,4 | 64,1 | 10,6 | 46,7 | 6,0 | 17,1 | 100,7 |
| Actinedida | 54,9 | 22,5 | 14,9 | 41,2 | 76,2 | 8,3 | 86,9 | 35,7 | 11,7 | 3,2 | 7,1 | 8,7 | 1,2 | 11,3 |
| Acaridida | - | 0,8 | 5,2 | 0,6 | 0,9 | 2,2 | 1,7 | 4,5 | 0,7 | - | 3,2 | - | 0,1 | 0,1 |
| Tarsonemida | - | 0,9 | - | 0,2 | 0,1 | 0,3 | 0,3 | 2,8 | - | - | 0,8 | - | 0,2 | - |
| Gamasina | 55,9 | 11,1 | 4,6 | 6,0 | 6,1 | 15,5 | 5,9 | 22,2 | 8,1 | 2,7 | 5,3 | 4,5 | 0,9 | 14,3 |
| Uropodina | 0,4 | 1,7 | 1,6 | 0,3 | 0,2 | 2,3 | 0,1 | 0,1 | 2,8 | 0,1 | 0,4 | - | - | - |
| Isopoda | 0,1 | 0,2 | 0,3 | 0,2 | - | 0,3 | - | 0,1 | 0,1 | 0,1 | - | - | - | 0,1 |
| Pauropoda | 0,2 | 0,7 | 1,0 | 0,4 | 0,6 | - | 0,3 | 0,2 | 0,1 | 0,1 | - | - | - | - |
| Symphyla | - | 0,1 | 0,1 | - | 0,3 | - | 0,4 | 0,1 | 0,1 | - | - | 0,1 | - | - |
| Chilopoda | 0,2 | 0,1 | 0,4 | - | 0,1 | 0,3 | 0,5 | 0,1 | 1,0 | 0,1 | 0,1 | 0,1 | - | 0,2 |
| Diplopoda | 0,4 | 0,1 | 0,1 | 0,2 | 3,1 | 2,8 | 0,1 | 0,3 | 0,3 | 0,1 | - | - | - | 0,1 |
| Protura | 0,5 | 1,4 | 2,4 | 5,8 | 1,6 | 1,8 | 3,4 | 0,1 | - | - | - | - | 0,1 | - |
| Diplura | - | - | 0,2 | 0,1 | 0,9 | 0,3 | 0,3 | 0,1 | 0,5 | 0,1 | - | - | 0,1 | - |
| Collembola | 21,8 | 47,3 | 59,1 | 37,6 | 56,0 | 66,0 | 31,5 | 37,4 | 25,0 | 4,1 | 34,4 | 5,8 | 5,2 | 34,0 |
| Carabidae | - | 0,1 | 0,3 | - | 0,2 | - | 0,4 | 0,2 | 0,1 | - | 0,1 | - | - | - |
| Silaridae | - | - | - | 0,1 | - | - | - | - | - | - | - | 0,1 | - | - |
| Staphylinidae | 0,2 | 0,5 | 0,2 | 0,2 | 0,4 | 0,3 | 0,3 | 0,5 | 0,1 | 0,1 | - | - | 0,1 | 1,0 |
| other Coleopt. | 0,1 | 0,7 | 0,5 | 0,9 | 0,4 | 0,4 | 0,2 | 0,1 | 1,1 | 0,1 | 0,4 | 0,1 | 0,1 | 0,3 |
| Formicidae | 0,5 | 0,1 | 0,6 | 0,1 | 0,7 | 0,1 | 0,1 | 0,1 | - | 0,1 | - | - | 0,1 | 0,1 |
| other Hymenopt. | - | 0,2 | 0,4 | 0,1 | 0,1 | 0,1 | - | 0,1 | 0,1 | 0,1 | - | 0,1 | 0,1 | 0,1 |
| Diptera | 0,4 | 0,4 | 1,2 | 0,2 | 0,1 | 0,3 | 0,3 | 1,2 | 0,9 | - | 0,1 | 0,2 | 2,0 | 0,4 |
| Psocoptera | 0,4 | 1,4 | 0,2 | 0,5 | 1,2 | 0,8 | 0,7 | - | 0,1 | 0,2 | 0,1 | 0,3 | 0,1 | 0,1 |
| Lepidoptera | 0,5 | 0,1 | 0,2 | 0,1 | 0,4 | - | 0,2 | 0,1 | 0,1 | 0,1 | 0,1 | 0,1 | 0,1 | 0,6 |
| Thysanoptera | - | 0,1 | 0,1 | 0,1 | 0,1 | 0,1 | 0,1 | 0,1 | - | - | 0,1 | 0,3 | 0,4 | 0,5 |
| Heteroptera | - | - | 5,6 | - | - | 0,2 | - | 0,1 | - | - | - | - | - | 0,5 |
| other Insecta | - | 0,1 | - | 0,1 | - | - | - | - | - | - | - | - | 0,1 | 0,4 |
| total | 235,9 | 186,3 | 198,7 | 155,2 | 211,5 | 184,2 | 228,4 | 194,0 | 124,0 | 22,1 | 99,1 | 27,2 | 36,1 | 166,11 |
| group richness | 18 | 24 | 25 | 24 | 24 | 22 | 23 | 24 | 21 | 18 | 16 | 15 | 18 | 19 |

| | 2. | 3. | 13. | 16. | 17. |
|---|---|---|---|---|---|
| *HYPOGASTRURIDAE* | | | | | |
| *Hypogastrura socialis* (Uzel,1891) | 0,4 | – | – | – | – |
| *Ceratophysella armata* (Nicolet,1841) | 4,4 | – | – | – | – |
| *Ceratophysella scotica* (Carpenter et Evans,1899) | – | 2,5 | – | – | – |
| *Xenylla brevisimilis* Stach,1949 | – | – | 0,3 | – | – |
| *Xenylla subacauda* Stebaeva et Potapov, 1994 | – | 1,0 | 23,0 | – | – |
| *NEANURIDAE* | | | | | |
| *Friesea truncata* Cassagnau,1956 | – | – | – | – | + |
| *Pseudachorutes dubius* Krausbauer,1898 | 0,9 | – | – | – | – |
| *Pseudachorutes parvulus* Börner,1901 | 5,3 | 0,3 | – | – | – |
| *Pseudachorutes subcrassus* (Tullberg,1871) | – | 1,0 | – | – | – |
| *Stachorutes sp.* | – | 1,0 | – | – | – |
| *Micranurida pygmaea* Börner,1901 | – | 0,5 | – | – | – |
| *Micranurida cf. forsslundi* Gisin,1949 | – | 0,8 | – | – | – |
| *Micranurida hygrophila* Rusek,1973 | – | 1,3 | – | – | – |
| *Anurida endroedii* Dunger,1974 | 2,2 | 0,5 | – | – | – |
| *Deutonura albella* (Stach,1920) | – | 0,3 | – | – | – |
| *Deutonura conjuncta* (Stach,1926) | – | 1,5 | – | – | – |
| *Endonura cf. tetrophthalma* (Stach,1929) | – | 0,8 | – | – | – |
| *Neanura pseudoparva* Rusek,1963 | – | 1,0 | – | – | – |
| *Neanura cf. parva* (Stach,1951) | – | 4,5 | – | – | – |
| *Pumilinura loksai* (Dunger,1974) | 0,9 | – | – | – | – |
| *ODONTELLIDAE* | | | | | |
| *Odontella pseudolamellifera* Stach,1949 | – | 0,3 | – | – | – |
| *Odontella sp.* | – | – | 0,3 | – | – |

Table 3. List of collembola species and their abundances (x $10^2$ ind. $m^{-2}$)
(see Table 1. for site numbers)

| | 2. | 3. | 13. | 16. | 17. |
|---|---|---|---|---|---|
| *ONYCHIURIDAE* | | | | | |
| *Tetrodontophora bielanensis* (Waga,1842) | – | 0,3 | – | – | – |
| *Kalaphorura paradoxa* (Schäffer,1900) | – | 20,3 | – | – | – |
| *Hymenaphorura variotuberculata* (Stach,1934) | – | 60,3 | – | – | – |
| *Protaphorura armata* (Tullberg,1869) | – | – | – | + | – |
| *Protaphorura furcifera* (Börner,1901) | – | – | – | – | + |
| *Protaphorura glebata* (Gisin,1952) | – | – | – | + | – |
| *Protaphorura procampata* (Gisin,1956) | 21,8 | 38,5 | – | – | – |
| *Protaphorura tetragrammata* (Gisin,1961) | – | – | 2,8 | – | – |
| *Onychiurus rectopapillatus* Stach,1933 | – | 4,0 | – | – | – |
| *Paronychiurus pseudogranulosus* (Gisin,1951) | 4,0 | 23,0 | – | – | – |
| *Mesaphorura critica* Ellis,1976 | – | 4,0 | – | + | – |
| *Mesaphorura hylophila* Rusek,1982 | – | 0,5 | – | – | – |
| *Mesaphorura italica* (Rusek,1971) | – | – | – | + | – |
| *Mesaphorura krausbaueri* Börner,1901 | – | 0,3 | 0,5 | – | – |
| *Mesaphorura tenuisensillata* Rusek,1974 | – | 0,3 | – | – | + |
| *Mesaphorura sp.* | – | – | – | + | – |
| *Stenaphorura quadrispina* Börner,1901 | – | – | – | – | + |
| *Doutnacia xerophila* Rusek,1974 | 3,6 | – | – | – | – |
| *ISOTOMIDAE* | | | | | |
| *Tetracanthella fjellbergi* Deharveng,1987 | – | 0,3 | – | – | – |
| *Folsomia quadrioculata* (Tullberg,1871) | 326,3 | – | – | – | – |
| *Folsomia manolachei* Bagnall,1939 | – | 234,3 | – | – | – |
| *Folsomia penicula* Bagnall,1939 | – | 3,3 | – | – | – |
| *Isotomodes productus* (Axelson,1906) | – | – | 0,3 | – | – |
| *Isotomodes sexsetosus* Gama,1963 | – | – | 1,0 | – | – |
| *Isotomiella minor* (Schäffer,1896) | 4,9 | 62,0 | – | – | – |
| *Isotomiella sp.* | – | – | – | + | – |
| *Pseudisotoma sensibilis* (Tullberg,1876) | – | 25,0 | – | – | – |
| *Isotoma notabilis* Schäffer,1896 | 17,8 | 36,8 | – | – | + |

Table 3.

| | 2. | 3. | 13. | 16. | 17. |
|---|---|---|---|---|---|
| *ENTOMOBRYIDAE* | | | | | |
| *Entomobrya handschini* Stach,1922 | – | – | 2,8 | – | – |
| *Entomobrya multifasciata* (Tullberg,1871) | – | – | 0,5 | – | – |
| *Entomobrya quinquelineata* Börner,1901 | – | 1,3 | – | – | – |
| *Orchesella albofasciata* Stach,1960 | – | – | 6,8 | – | – |
| *Orchesella bifasciata* Nicolet,1842 | 0,4 | 1,5 | – | – | – |
| *Orchesella flavescens* (Bourlet,1839) | 2,2 | – | – | – | – |
| *Orchesella multifasciata* Stscherbakow,1896 | – | 2,3 | – | – | – |
| *Seira domestica* (Nicolet,1842) | 0,9 | 0,3 | – | – | + |
| *Lepidocyrtus cyaneus* Tullberg,1871 | 2,7 | – | – | – | – |
| *Lepidocyrtus lanuginosus* (Gmelin,1788) | – | – | 9,3 | – | – |
| *Lepidocyrtus lignorum* Fabricius,1871 | 26,6 | 18,8 | 7,5 | + | – |
| *Pseudosinella horaki* Rusek,1985 | 33,3 | 20,3 | – | – | – |
| *TOMOCERIDAE* | | | | | |
| *Pogonognathellus flavescens* (Tullberg,1871) | – | 2,3 | – | – | – |
| *CYPHODERIDAE* | | | | | |
| *Oncopodura crassicornis* Shoebotham,1911 | – | 0,5 | – | + | – |
| *NEELIDAE* | | | | | |
| *Megalothorax incertus* Börner,1903 | – | 0,3 | – | + | – |
| *Megalothorax minimus* Willem,1900 | 7,1 | 12,0 | 0,3 | – | – |
| *SMINTHURIDIDAE* | | | | | |
| *Sphaeridia pumilis* (Krausbauer,1898) | 0,4 | 0,3 | – | – | – |
| *ARRHOPALITIDAE* | | | | | |
| *Arrhopalites slovacicus* Nosek,1975 | – | – | – | + | – |
| *Arrhopalites sp. juv* | – | 0,8 | – | – | – |
| *KATIANNIDAE* | | | | | |
| *Sminthurinus bimaculatus* Axelson,1902 | 6,7 | – | – | – | – |
| *Sminthurinus elegans* (Fitch,1863) | – | – | 2,3 | – | – |
| total | 472,8 | 591,2 | 57,7 | | |
| species richness | 21 | 43 | 14 | 10 | 6 |

Table 3.

## References

Carnogursky J., (1994) Chvostoskoky (Collembola). In: Rozloznik M., Karasova E. (eds.): CHKO - biosfericka rezervacia Slovensky kras. Osveta, Martin, 154-157

Dunger W., (1973) Neue und bemerkenswerte Collembolenarten der familie Neanuridae. Abh. Ber. Naturkundemus. Gorlitz 48, 5: 1-20

Kaluz S., (1992) Podne roztoce (Acarina) Slovenskeho krasu (ŠPR Pod Fabiankou). Ochrana prirody, 1: 245-257

Kaluz S., (1994) Podne roztoce (Acarina). In: Rozloznik M.,Karasova E. (eds.): CHKO - biosfericka rezervacia Slovensky kras. Osveta, Martin, 144-148

Nosek J., (1975a) A contribution to the knowledge of the collembolan fauna in the Domica Cave (SE Slovakia). Vest. Cs. spol. zool., 39 (3): 220-223

Nosek J., (1975b) Arrhopalites slovacicus, a new species of Collembola from the Domica Cave

Paclt J., (1957) Collembola z kvaplovej jaskyne "Dupna diera" v Strazovskych vrchoch. Acta rer. nat. mus. slov., 3: 1-6

Petersen H. (Luxton M., (1982) A comparative analysis of soil fauna populations and their role in decomposition processes. Oikos, 39 (3): 288-388

# DIVERSITY OF EARTHWORM COMMUNITIES IN THE DANUBE DELTA BIOSPHERE RESERVE

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**Abstract.** Four species, namely *Allolobophora dubiosa* (an indicative lumbricid of the lower Danube), *A. leoni, Eiseniella tetraedra, Octodrilus transpadanus*, and to some extent, *Proctodrillus antipai*, are characteristic of wetland and swampy soil. Other three, *A rosea, Octolasium lacteum* and *Lumbricus rubellus* are very commom, ubiquitous species. Community structures are compared in terms of alpha and beta diversity values. A single general pattern, labelled as the 'community with *Allolobophora dubiosa*', is considered to be characteristic of the Danube Delta. *Dendrobaena auriculata* (Rosa) 1897 is recorded for the first time in the Romanian fauna.

## Introduction

The study of the biodiversity and community structure of earthworms (Lumbricidae, Oligochaeta), carried out between 1991 and 1995, is part of an extensive research programme aiming at the assessment and conservation of the genofond of the Danube Delta Biosphere Reserve (DDBP).

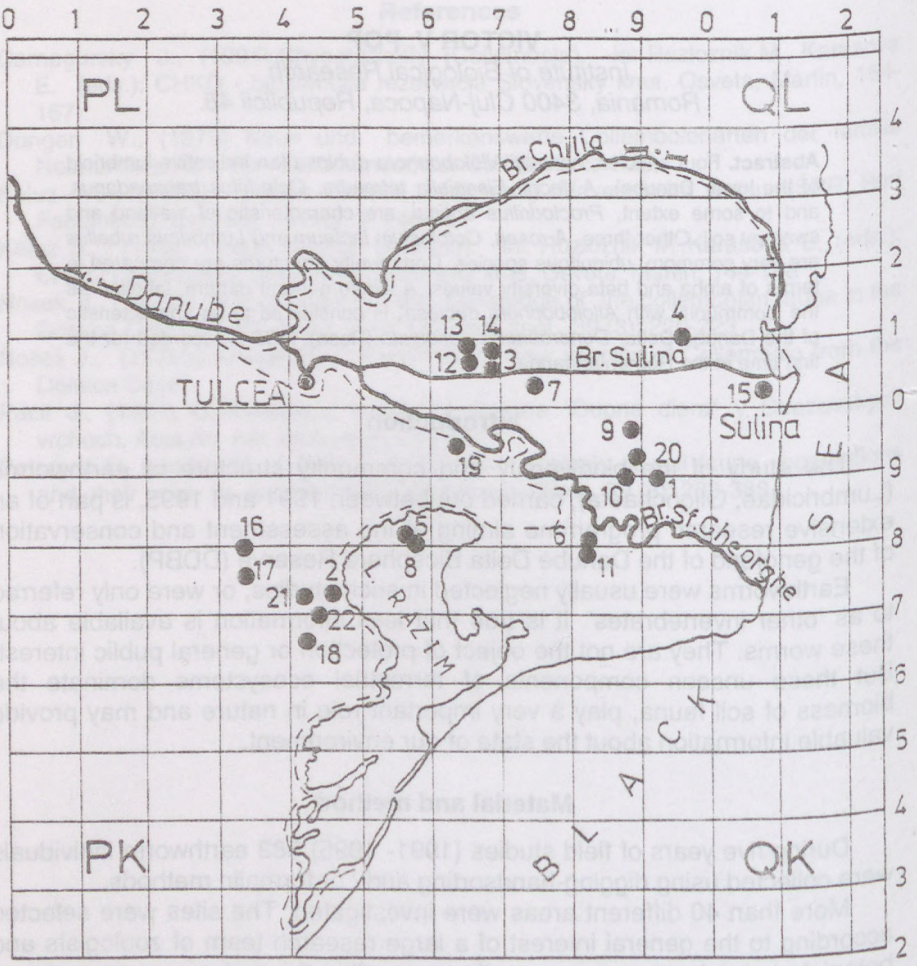
Earthworms were usually neglected in such studies, or were only referred to as 'other invertebrates'. It is true that less information is available about these worms. They are not the object of protection or general public interest. But these unseen components of terrestrial ecosystems dominate the biomass of soil fauna, play a very important role in nature and may provide valuable information about the state of our environment.

## Material and method

During five years of field studies (1991- 1995) 583 earthworm individuals were collected using digging-handsorting and / or formalin methods.

More than 40 different areas were investigated. The sites were selected according to the general interest of a large research team of zoologists and botanists trying to cover as correctly as possible the major ecosystem types of the Danube Delta. Besides the areas situated within the limits of DDBR, neighbouring habitats were also investigated. (Fig. 1).

The Danube Delta has a large variety of biotopes, with a high density of plants and animal species. However, for reasons of simplicity, considering the level at which earthworm-vegetation-soil relationships could be detected, the biotopes studied are grouped as shown in Table 1.




Babadag - 16,17,18, Bestepe - 19, Caraorman - 1,9,10,20, Dranov - 6,11, Enisala - 2,21,22, Gorgova - 7, Maliuc - 3,12,13,14, Magiaru - 4, Insula Popina - 5, Sulina - 15.

---- limit of the DDBR.

Fig. 1. Sampling sites for earthworms in the Danube Delta Biosphere Reserve

| Biotope | Swamp - Reed | | | | | Grassland | | | Poplar plantation | | | | | | Agr. | HomMap | | Oak wood | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SR | SR | SR | SR | SR | GR | GR | GR | PP | PP | PP | PP | PP | PP | AC | HM | HM | OK | OK | OK | OK | OK |
| Locality | Ca | En | Ma | Mg | Po | Da | Go | Po | Ca | Ca | Da | Ma | Ma | Ma | Su | Ba | Ba | Ba | Bp | Ca | En | En |
| Nr. of sample | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| *Allolobophora dubiosa* | 8 | 37 | 2 | 5 | 6 | 7 | 12 | 0 | 2 | 0 | 3 | 8 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Allolobophora leoni* | 0 | 0 | 9 | 1 | 0 | 0 | 19 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Allolobophora rosea* | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 0 | 0 | 0 | 0 | 0 | 11 | 1 | 85 | 16 | 5 | 8 | 0 | 20 | 30 |
| *Dendrobaena auriculata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Eiseniella tetraedra* | 1 | 0 | 0 | 2 | 0 | 3 | 17 | 0 | 4 | 0 | 0 | 15 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lumbricus rubellus* | 0 | 0 | 1 | 0 | 0 | 0 | 30 | 0 | 0 | 3 | 0 | 3 | 1 | 15 | 12 | 2 | 6 | 0 | 1 | 0 | 0 | 0 |
| *Octolasium lacteum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 2 | 0 | 0 | 2 | 0 |
| *Octodrilus transpadanus* | 6 | 0 | 0 | 20 | 0 | 0 | 3 | 0 | 2 | 3 | 6 | 0 | 4 | 7 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 |
| *Proctodrilus antipai* | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 5 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 |

Table 1. Distribution of lumbricids in the Danube Delta Biosphere Reserve

- Swamps with Reed (*Phragmites* spp, *Typha* spp) (SR) along the water banks, with very young wt alluvial soils (1-Caraorman, 2-Enisala, 3-Maliuc, 4-Magiaru, 5-Popina).
- Grasslands or meadows (GR) on higher places, with very different vegetational cover. Alluvial, often gleic soils (6-Dranov, 7-Gorgova, 8-Popina).
- Poplar plantations (*Populus* spp), (PP) sometimes in places with previous willow trees (*Salix* spp), distributed all over the Danube Delta. Alluvial soils, generally dryer than those mentioned above (9,10-Dranov, 12,13,14-Maliuc).
- Oak woods (*Quercus robur* and *Q. pedunculiflora*) (OK) present especially on continental embankments, inside DDBR, or in the neighbouring hills (300 m altitude) (18-Babadag, 19-Bestepe, 20-Caraorman, 21,22-Enisala, Letea).
- Mixed hornbeam (*Carpinus betulus*) - Maple (*Acer* spp) - lime (*Tilia* sp) woods (MH), on chestnut forest soils, in the surrounding hills (16,17-Babadag).
- Agricultural (farm) fields (AG), near human settlements. Alluvial soils, with different humus content and water regime (15-Sulina).

Sandy dunes, all over the Danube Delta, covered or not by vegetation (near 20-Caraorman).

- Salt-affected lands, especially along the sea shore, or on maritime embankments, different vegetation and salt-like soils (Black Sea shore).

Data processed by Biodiv 5.1., Pensoft (1995) program.

## Results and discussion

### Species diversity

Of more than 40 sample sites studied, earthworms were found only in 21 places, of which 15 within the DDBR limits, and 7 out of its boundaries.

Earthworms were not found, as a rule, in salt-affected soils, in dunes or sandy dry soils with scarce vegetation. It is curious that I have not found a single worm, during several days of digging, in the well known Letea oak forest on the largest continental embankment. The earthworm fauna of the neighbouring oak forests is even poorer. Here the accurrence of Dendrobaena auriculata gives a note of peculiriaty.

In the DDBR territory only seven lumbricid species were found, in the near proximity, other two. Some of these species were also reported by Pop (1938, 1948, 1964) and Falca (1993).

The scarcity of lumbricid species may be explained by the history of the Delta, with sandy-allivial-waterlogging young soils.

Local species diversity, expressed by species richness, is very different, ranging between 0-7 species / bitope (Fig. 2).

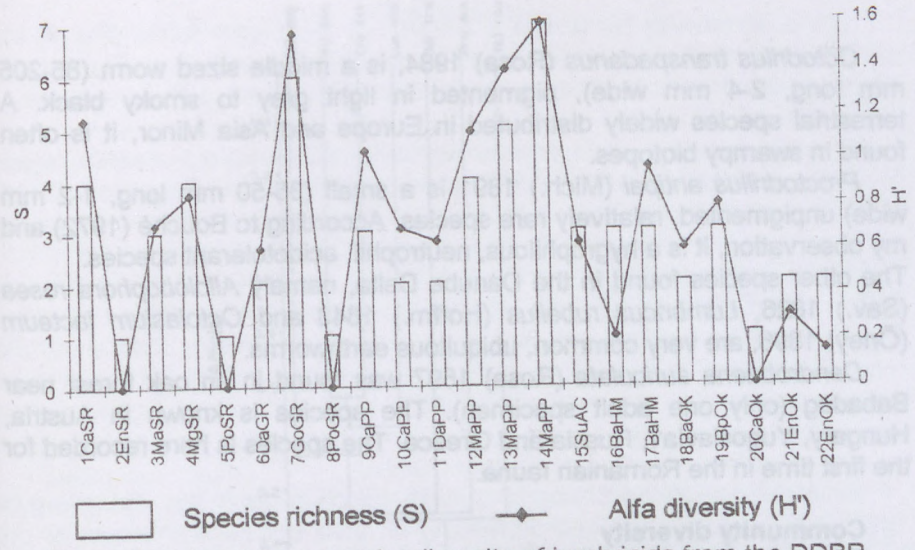



Fig. 2. Species richness and a diversity of lumbricids from the DDBR

It should be stressed that, in spite of low species diversity, the present species are representative of wetland and swampy soils. These earthworms, have, besides the characteristic features of species, some general common characters representing adaptation to wet soil conditions, like the peculiar movements of the caudal part of the body enhancing water oxygenation (Bouché, 1970, Zicsi,1963).

*Allolobophora dubiosa* (Örley) 1880 is a rather big worm (150-250 mm long, 4-5 mm wide) with intense green-grey or greenish black dorsal pigmentation. It is found almost everywhere in the Danube Delta. It is an aquatic earthworm, confined to the middle and inferior danube, and in some of its tributary rivers. Pop (1938, 1964) deals with the systematic status of the larger form found in the inferior Danube. Zicsi (1963) reports interesting ecological data and laboratory experiments concerning the reproductive biology of the species. It lives among the roots of aquatic plants, or in waterlogging river banks, less frequently in dryer alluvial soils.

*Allolobophora leoni* (Mich.) 1891 is a middle sized (90-160 mm long, 3.5-6.3 mm wide) white or pink endogeic earthworm. It was described in Romania, but subsequently found in Hungary, Yugoslavia and Italy. The species has a very strong body wall, well adapted for digging in compact soils. It is found in very different habitat, from alluvial soils to chernozems, but mostly in wet soils.

*Eiseniella tetraedra* (Sav.) 1826, is a small (30-100 mm long, 1-2 mm diameter) reddish-brown or yellowish, well known typical amphibious earthworm, with a large distribution.

*Octodrilus transpadanus* (Rosa) 1984, is a middle sized worm (85-205 mm long, 2-4 mm wide), pigmented in light grey to smoky black. A terrestrial species widely distributed in Europe and Asia Minor, it is often found in swampy biotopes.

*Proctodrillus antipai* (Mich.) 1891 is a small (35-50 mm long, 1-2 mm wide) unpigmented, relatively rare species. According to Bouché (1972) and my observation, it is a hygrophilous, neutrophil, acidotolerant species.

The other species found in the Danube Delta, namely *Allolobophora rosea* (Sav.) 1826, *Lumbricus rubellus* (Hoffm.) 1843 and *Octolasium lacteum* (Örley) 1896, are very common, ubiquitous earthworms.

*Dendrobaena auriculata* (Rosa) 1897 was found in an oak forest near Babadag (only one adult specimen). The species is known in Austria, Hungary, Yugoslavia?, Russia and Greece. The species is here recorded for the first time in the Romanian fauna.

**Community diversity**

The structure of earthworm communities, all over the DDBR is simple and can be reduced to a single pattern. This pattern as the 'community with *Allolobophora dubiosa*' includes a few typical species, strictly limited to wet or waterlogging soil conditions. The characteristic and dominant species is A. dubiosa, found in 87 % of biotopes (places with no earthworms are excluded from the evaluation). *Octodrilus transpadanus*, found in more than 50 % of biotopes, is considered a constant species, while *A. leoni* and *E. tetraedra* (50-25 %) are accessory species. *Proctodrilus antipai* (less than 25 % of samples) is accidental. In establishing this pattern I followed the model used when studying the structure of earthworm communities in the Carpathians (V.V. Pop, 1984, in press).

The rather low values of Jaccard index (Fig. 3) with diffuse clusters, showing only slight coenotic affinities, are difficult to evaluate. Nevertheless the hydrophilous species are grouped together, showing the nucleus of the community.

Alpha diversity values (Fig. 2) estimated by Shannon index are much influenced by species richness. These values should be evaluated taking into account the particular position of earthworms in nature. Even in well developed climax forest ecosystem, the cohabitation of more than 8-10 species is rare. Thus, a low Shannon index does not necessarily show a lack of equilibrium in the ecosystem. The community is effectively saturated with individuals, not with species.

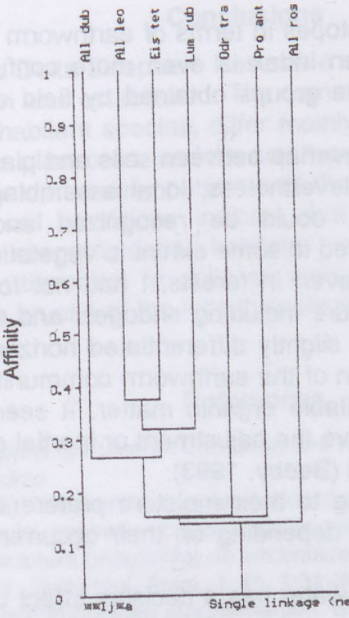



Fig. 3. Coenotic affinities of lumbricid species in the DDBR

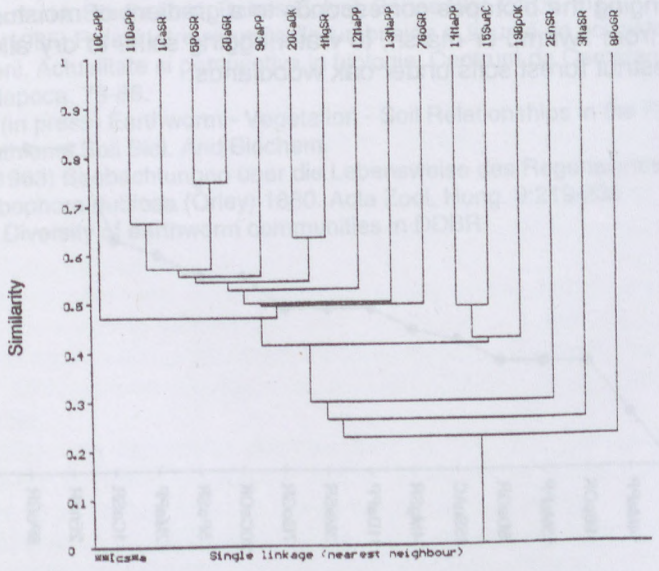



Fig. 4. Biotope similarities (Soerensen Index) from the DDBR reckoned by earthworm fauna

When comparing the biotopes in terms of earthworm fauna (Fig. 4) the picture obtained by Sorensen index is even more confusing. The cluster does not correspond with the groups obtained by field data, presented in Table 1.

There is a considerable overlap between soils and plant cover in regard to their earthworm fauna. Nevertheless, local assemblages of cohabitant species, as shown above, could be recognized and considered as earthworm communities related to some extent to vegetation and soil.

In the habitats studied, even in forests, I had not found the classical earthworm community structure including endogeic and anecique species. The undeveloped soils, with slightly differentiated horizons also show the lack of ecological stratification of the earthworm community. All the present species can exploit the available organic matter. It seems to be a case when simple communities have the adjustment or inertial stability to survive in very variable environments (Beeby, 1993).

When classified according to their moisture preferences, the group of species could be recognized depending on their occurrence in wet or dry biotopes.

In the Delta Danube, the water has a decisive effect on the earthworm species distribution and the community structure. Four of the most hygriphilious species occur here. Beta diversity values (Fig. 5) rank the biotopes, and their earthworm communities, according to their water regime. Ranging the biotopes corresponds to a gradient of moisture content of the soil, from swamp or marsh, to waterlogging soils, to dry alluvial soils and dry chestnut forest soils under oak woodlands.

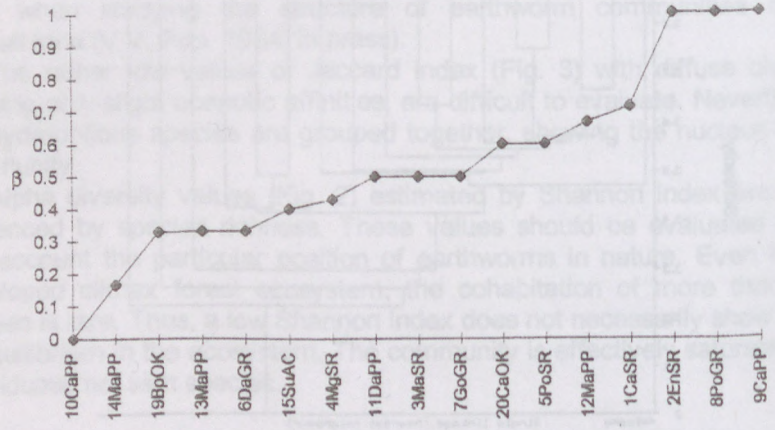



Fig. 5. Ranking of biotopes according to β diversity

## Conclusions

In the Danube Delta Biosphere Reserve a single but constant earthworm community pattern was established. The community structure, especially the dominance of cohabitant species, differ mainly in relation to the air - water regime, less to the plant cover and the soul type.

Stability of the community pattern and the high adaptation of dominant species to wet soil conditions indicate that earthworms are successful colonizers of ever changing deltaic habitats.

Therefore, earthworms, in spite of their low species and community diversity, seem to be one of the less threatened animal group of the Danube Delta.

## References

Beeby A. (1993) Applying Ecology. Chapman and Hall, London, Glasgow, New York, Melbourne, Madras.

Bouché M.B. (1970) Observations sur les Lobricides. Une adapationa écologique a la vie amphibie: la respiration caudale aquatique. Rev.Ecol.Biol.Sol. 533-537.

Falca M. (1993) Structura populatiilor de lumbricide (Oligochaeta) din Delta Dunarii. Stud. Cerc. Biol., Seria biol. Anim., t. 45, 1:31-36.

Pop V. (1938) Neue Lumbriciden aus Rumanien. Bul.Soc. St. Cluj 9 (134-152).

Pop V. (1948) Lumbricidele din Romania. An.Acad,Rep.Pop.Rom.Sect. st. Geol.geogr.biol., serf. A. T.1, mem.9.

Pop V. (1964) Noi date faunistice si sistematice asupra lumbricidelor (Oligochaeta) din Romania. Studia Univ. Babes-Bolyai, Series Biol. 2:106-116.

Pop V.V. (1985) Relatii intre sinuziile de lumbricide si tipurile de ecosistem in Muntii Apuseni. Actualitate si perspectiva in biologie. Centrum de Cercetari Biologice Cluj-Napoca, 79-86.

Pop V.V. (in press) Earthworm - Vegetation - Soil Relationships in the Romanian Carpathians. Soil Biol. And Biochem.

Zicsi A. (1963) Boebachtungen über die Lebensweise des Regenwurmes Allolobophora dubiosa (Örley) 1880. Acta Zool. Hung. 9:219-236.

V.V. Pop Diversity of earthworm communities in DDBR

# NEMATODE DIVERSITY OF THE VEGETATED CLIFFS OF THE ROMANIAN CARPATHIANS

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**Abstract:** Specific and trophic structure of pioneer nematode communities established on vegetated cliffs of the Romanian Carpathians are investigated. An astonoshingly high specific and trophic diversity of soil nematode communities is found in different rocky sites of the Romanian Carpathians (195 taxa, 5 main trophic groups). Changes of these specific and trophic structures under the influence of plant cover composition and climatic conditions could be noted: the preferences of dorylaimids (omnivores) and some rhabditids (bacterial feeding) for poorly vegetated limestone habitats at high altitudes, or the preponderance of tylenchids (plant feeding) oligotrophic grassland soils. The affinity of the biotopes based on nematode communities is characterized by the delimitation of three main clusters marked by different plant cover of habitats.

The assessing of biodiversity and its changes under different conditions are the main items of recent research programmes initiated on a global scale.

The soil- as an essential habitat for plants and most of animals- is vulnerable to the disturbances caused either by human activities or by environmental factors.

Free living soil nematodes are important components of ecosystems. Over 5600 nematode species are already known from terrestrial habitats (Andrassy, 1991) and their population density is surpassed only by microorganisms.

Many nematodes feed on the primary decomposers (bacteria and fungi) or they are important consumers (plant feeders, predators or other animals or omnivores) (Yeates *et al.* 1993).

The nematodes have been used as models and indicators to assess the quality of ecosystems (Samoiloff 1987, Freckmann 1988, Bongers 1990). Changes of their community structure have been noted under various kinds of habitat disturbances (Bongers *et al.* 1991, Yeates *et al.* 1993, Popovici 1992, 1993a).

An outlook on nematode communities of the main ecosystems in the Retezat National Park (Romania) could serve as a guide for free-living nematodes of protected areas in Romania (Popovici 1993b).

No information is available on pioneer nematodes on "just born habitats" like those represented by the vegetated cliffs at high altitude.

The paper presents first observations on specific and trophic structure of the nematode communities developed mainly on calcareous cliffs in the

Romanian Carpathians. A comparative analyses with the nematode communities of neighbouring grassland ecosystems is also discussed.

## Site description

Seventeen areas of vegetated cliffs, most of them cretaceous or jurassic limestone (if otherwise not specified), have been investigated. These are distributed in eight massifs of the Romanian Carpathians (Fig. 1) and are under different protective conditions.

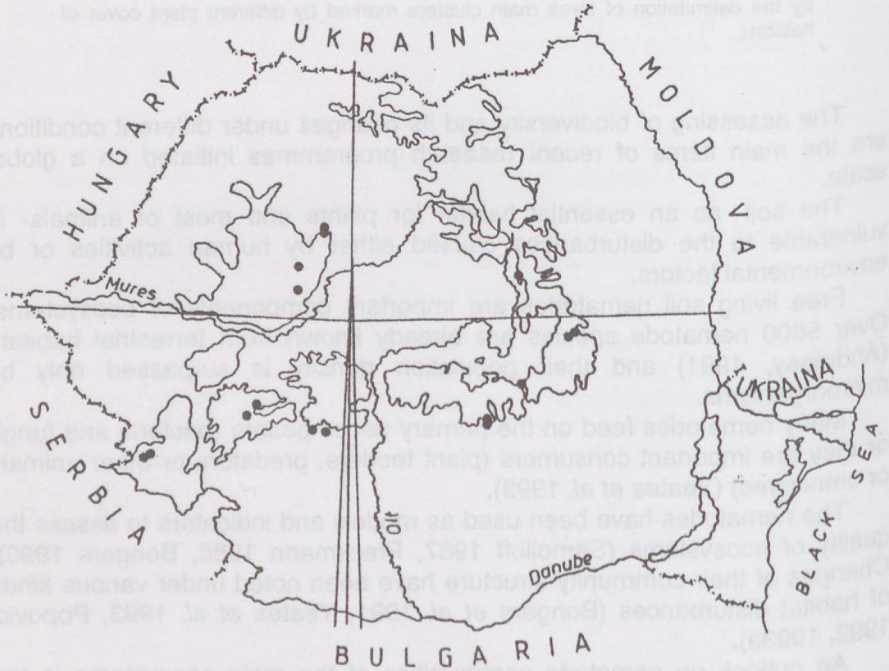



Fig. 1. Chart of site's location in the Romanian Carpathians (UTM grid system)

Five representative grasslands, located nearby these cliff areas, have also been investigated.

The site description includes a codification (in brackets) of the samples as reference data used in comments and figures.

**A. Scientific reserves (IUCN category I.):**

1. Cheile Beuşniţei (Beusnit) located in the Aninei Mountains, on sandstone and clay, at 300 m altitude(vegetation: waterfall mossess and ferns;

2. Cheile Nerei (Cnerei) located in the Aninei Mountains, at 200 m altitude, cliff vegetation: mosses and ferns;

3. Valea Jepii Mici-Bucegi (Bucegi) located in the Bucegi Mountains, at 2060-2200 m altitude, cliff vegetation: *Carex curvulata, C. sempervirens, Sesleria haynaldiana, Festuca sp., Saxifraga paniculata, Dianthus gelidus*;

**B. National Parks (IUCN category II.):**

a) The Retezat National Park located in the Retezat Mountains, (the Southern Carpathians):

4. Piatra Iorgovanului (IorgoSa), 1950 m altitude, cliff vegetation: *Saxifraga moschata, S. rocheliana* and *Sedum atratum*;

5. Piatra Iorgovanului (IorgoDr), 1950 m altitude, cliff vegetation*: Dryas octopetala*;

6. Piatra Iorgovanului (IorgoAn), 2000 m altitude, cliff vegetation: *Androsace villosa*;

7. Albele (Albele), 2000 m altitude, cliff vegetation: *Saxifraga moschata* and *S. rocheliana*;

b) The Cheile Bicazului-Hăşma(National Park (recently proposed) located in Hăşma(Mountains (the Eastren Carpathians):

8. Suhardu Mic (Suhard) at 1400 m altitude, cliff vegetation: *Saxifraga moschata* and *Gentiana* sp.;

**C. Managed nature reserves (IUCN category IV.):**

9. Cheile Turului (CTuruA) (proposed reserve), located in the Trascău Mountains (the Apuseni Mountains) at 350 altitude, cliff vegetation: *Sedum atratum, Sempervivum schlechanii*;

10. Cheile Turului (CTuruB) as above but with the following cliff vegetation: *Minuartia verna, Arenaria serpyllifolia, Paronychia cephalotes, Asplenium trichomanes*;

11. Cheile Turzii (Cturzii) located in the Trascău Mountains at 400 m altitude, with cliff vegetation: *Carex humilis, Paronychia cephalotes, Festuca rupicola, Stipa pulcherrima, Phleum montanum*;

12. Cheile Tişiţei (Ctisita) located in the Vrancea Mountains (the Eastern Carpathians), on sandstone, at 830 m altitude, cliff vegetation unnoted (possible *Dianthus* sp.);

13. Cheile Galbenului (Cgalben), near Peştera Muierii in the Parâng Mountains (the Southern Carpathians), at 570 m altitude, cliff vegetation:

*Saxifraga paniculata, Asplenium trichomanes, Campanula divergens, Thymus pulegioides, Bryum pseudotriquotrum, Racomitrum aquaticum*;

14. Muntele Roşu (MRosu) (proposed reserve) located in the Ciuca(Mountains at 1400 m altitude, cliff vegetation: Festuca saxatilis, *Gypsophyla petraea, Campanula carpatica, Dianthus simonkaianus, Sempervivum montanum*;

**D. Multiple use areas (IUCN category VIII.):**

15. Cheile Găldiţei (Cgaldi) located in the Trascău mountains (the Apuseni Mountains) at 430 m altitude, cliff vegetation: *Sedum atratum*;

16. Cheile Poşaga (Cposaga) located in the Trascău mountains, at 440 m altitude, cliff vegetation*: Sesleria moschata, Ditrichum flexicaule, Hypnum cupressiforme*;

17. Păpuşa (Papusa) located in the Parâng Mountains (the Southern Carpathians), on granitic rocks, at 1900 m altitude, cliff vegetation: *Rhododendron myrtifolim*;

Five grasslands have been selected, their location are as follows:

18. Cheile Turului (CTuruGr) (see site nr. 9.) - as. *Melico-Phleetum montani* Boşcaiu *et al.* 1966, characteristic species: *Phleum montanum* and *Melica ciliata v. flavescens*(the soil - rendzina;

19. Cheile Poşaga (CposagGr) (see site nr. 16.) - as. *Asperulo capitatae-Seslerietum rigidae* Zoly. 1939, characteristic species: *Asperula capitata* and *Sesleria rigida*(the soil-rendzina;

20. Piatra Iorgovanului (IorgoGr), located in the Retezat Mountains, at 1650 m altitude, a subalpine grassland belonging to as. *Festucetum xantinae* Boşcaiu 1971, characteristic species: *Dianthus kitaibelii, Athamantha turbith sp. hungarica* and *Festuca xantina*(the soil-litic rendzina;

21. Păpuşa Mountains (PapusGr) located in the Parâng Mountains, on granitic rocks, at 1900 m altitude, a subalpine grassland as. *Violo declinatae-Nardetum* Simon 1966, characteristic species: *Nardus stricta, Viola declinata, potentilla ternata*(litic podzol;

22. Muntele Roşu (MRosuGr) (see site nr. 14.) as. *Violo declinatae-Nardetum* Simon 1966, at 1900 m altitude, the soil-rendzina;

## Materials and methods

Three to seven soil samples have been collected from the above mentioned sites during 1992-1995. Nematodes have been extracted by the centrifugation method (DeGrisse 1969), fixed and preserved in 4% formaldehyde solution.

At least 150 nematode individuals were identified on mass-slides to specific and trophic level. Microscopic permanent slides, in glycerine, have also been used.

The BIODIV computed program has been used for the data analysis.

## Results and discussion

The specific structure of nematode communities includes 195 taxa (137 identified species, 51 genera, 7 taxa at the higher rank) (Table 1). Most of nematode species are bacterial feeding (79) and omnivores (43).

Table 1.
Specific structure of nematode communities from vegetated cliffs and grasslands (the Romanian Carpathians)

Achromadora ruricola
Acrobeles ciliatus
Acrobeles complexus
Acrobeloides buetschli
Acrobeloides nanus
Acrobeloides tricornis
Acrolobus emarginatus
Aglenchus agricola
Alaimus
Alaimus meyli
Alaimus parvus
Alaimus primitivus
Allodorylaimus
Allodorylaimus allgeni
Allodorylaimus andrassyi
Amplimerlinius
Anaplectus granulosus
Aphanolaimus attentus
Aphelenchoides
Aphelenchus avenae
Aporcelaimellus obtusicaudatus
Aporcelaimus
Aporcelaimus regius
Aquatides intermedius
Araeolaimida
Axonchium
Bastianai longicaudata
Bastiania
Bastiania gracilis
Boleodorus thylactus
Boleodorus volutus
Bunonema reticulatum
Bunonema richtersii
Cephalobidae
Cephalobus
Cephalobus persegnis
Ceratoplectus armatus
Ceratoplectus assimilis
Cervidellus
Chilloplacus
Chiloplectus loricatus
Chitwoodius
Chronogaster typica
Clarkus papilatus
Coomansus menzeli
Coomansus parvus
Deladenus durus
Diphtherophora communis
Discolaimus
Ditylenchus
Ditylenchus dipsaci
Ditylenchus intermedius
Dorylaimellus
Dorylaimellus demani
Dorylaimellus micoletzkyi
Dorylaimida
Dorylaimoides elegans
Dorylaimoides limnophilus
Dorylaimoides teres
Dorylaimus stagnalis
Ecphyadophora tenuissima
Ecumenicus monohystera
Enchodelus arcuatus
Enchodelus macrodorus
Enchodelus saxifragae
Epidorylaimus
Epidorylaimus consobrinus
Epidorylaimus lugdunensis
Epidorylaimus pseudoagilis
Eucephalobus
Eucephalobus mucronatus
Eucephalobus oxyuroides
Eucephalobus striatus
Eudorylaimus
Eudorylaimus "group" carteri
Eudorylaimus acuticauda
Eudorylaimus carteri
Eudorylaimus centrocercus
Eudorylaimus leuckarti
Eudorylaimus opistohystera
Eumonhystera
Eumonhystera dispar
Eumonhystera filiformis
Eumonhystera vulgaris
Euteratocephlus palustris
Filenchus
Filenchus polyhypnus
Filenchus vulgaris
Funaria
Geomonhystera villosa
Gracilacus
Helicotylenchus
Leptonchidae
Longidorella
Longidorella microdorus
Longidorella parva
Longidorus
Malenchus bryophilus
Mesodorylaimus
Mesodorylaimus bastiani
Mesorhabditis
Metateratocephalus crassidens
Metateratocephalus gracilicaudata
Miconchus
Microdorylaimus
Microlaimus globiceps
Mylonchulus
Mylonchulus branchyuris
Mylonchulus sigmaturus
Nygolaimus
Odontolaimus chlororurs
Ogma menzeli
Ogma octangulare
Panagrolaimus
Panagrolaimus subelongatus
Panagrolaimus verrucosus
Paractinolaimus macrolaimus
Paramphidelus
Paramphidelus dolichurus
Paramphidelus uniformis
Paraphelenchus pseudoparietinus
Mylonchulus
Mylonchulus branchyuris
Mylonchulus sigmaturus
Nygolaimus
Odontolaimus chlororurs
Ogma menzeli
Ogma octangulare
Panagrolaimus
Panagrolaimus subelongatus
Panagrolaimus verrucosus
Paractinolaimus macrolaimus
Paramphidelus
Paramphidelus dolichurus
Paramphidelus uniformis
Paraphelenchus pseudoparietinus
Paratylenchus
Paratylenchus microdorus

Coslenchus costatus
Criconema
Criconema annuliferum
Criconema princeps
Criconemella
Criconemella macrodora
Cylindrolaimus communis
Plectus geophilus
Plectus longicaudatus
Plectus parietinus
Plectus parvus
Plectus rhizophilus
Plectus silvaticus
Pratylenchus
Prionchulus muscorum
Prionchulus punctatus
Prismatolaimus
Prismatolaimus dolichurus
Prismatolaimus intermedius
Prismatolaimus leptolaimus
Pristionchus lheritieri
Prodorylaimidae
Protorhabditis
Psilenchus
Pungentus silvestris
Rhabditidae
Rhabditis terricola
Heterocephalobus
Heterocephalobus elongatus
Hoplolaimidae
Iotonchus
Laimaphelenchus
Lelenchus
Lelenchus leptosoma
Rhabdolaimus terrestris
Rotylenchus
Rotylenchus robustus
Sectonema
Steinernema
Takamangai
Teratocephalus
Teratocephalus costatus
Teratocephalus tenuis
Teratocephalus terrestris
Tobrilus gracilis
Trichodorus
Trichodorus sparsus
Tripyla
Tripyla affinis
Tripyla filicaudata
Tripyla setifera
Tripylella intermedia
Tripylina
Tripylina arenicola
Paraxonchium laetificans
Plectus
Plectus "A"
Plectus "B"
Plectus acuminatus
Plectus aquatilis
Plectus cirratus
Tubixaba
Tylenchida
Tylencholaimellus affinis
Tylencholaimus
Tylencholaimus "A"
Tylencholaimus "B"
Tylencholaimus minimus
Tylencholaimus minutus
Tylencholaimus mirabilis
Tylencholaimus stecki
Tylenchorhynchus
Tylenchorhynchus dubius
Tylenchus
Tylenchus davainei
Tylocephalus auriculatus
Tylolaimophorus
Wilsonema otophorum
Ypsylonellus vexilliger

High values of nematode richness (at genera level) are noted in the majority of the studied sites (Fig. 2). The greatest richness characterised the nematode communities from the Bucegi Mts. (60 genera) and those from grasslands developed on rendzinic soils (52-57 genera). The lowest nematode richness (12-16 genera) was found in some samples taken at high altitude from the Retezat and the Parâng Mountains, from cliffs vegetated by *Dryas, Androsace, Saxifraga* and *Rhododendron* species.

Disimilarities of nematode communities ((diversity) are marked between the fragile habitats vegetated by chionophylous plants (Fig. 2) at high and mediun altitudes. There is the lowest number of commonly shared species, giving the highest (diversity values.

The severe climatic and edaphic conditions like strong winds, insolation, dryness and soil oligotrophicity could be the main environmental stress for the nematode surviving at such high altitude.

Out of all identified nematodes (Table 1.) only 45 taxa have high relative abundance (D>5%) and only three to seven taxa are dominant at a specific site.

The nematodes belonging to genera *Enchodelus, Eudorylaimus, Mesodorylaimus* and *Tylencholaimus* (*Dorylaimida*) and to *Acrobeles* and *Teratocephalus* (*Rhabiditida*) live predominantly on limestones vegetated by *Saxifragaceae* species at high altitudes.The communities developed on

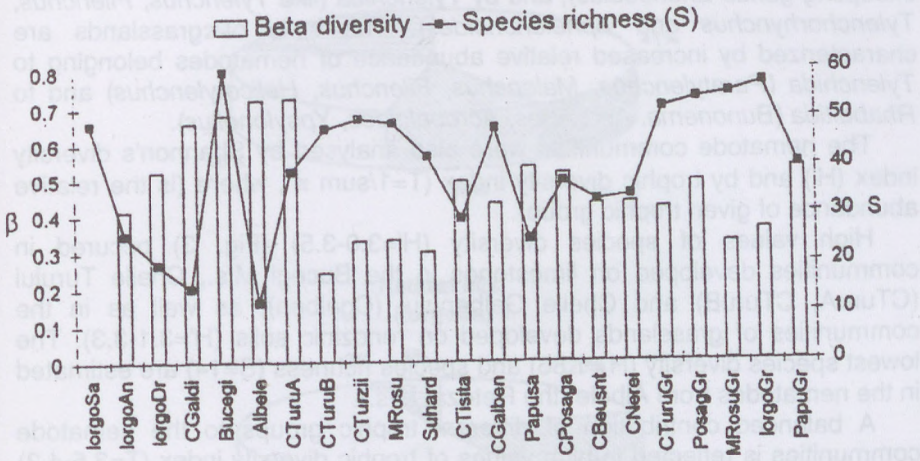



Fig. 2. Species richness (S) and (diversity (β) of nematode communities from the Romanian Carpathians

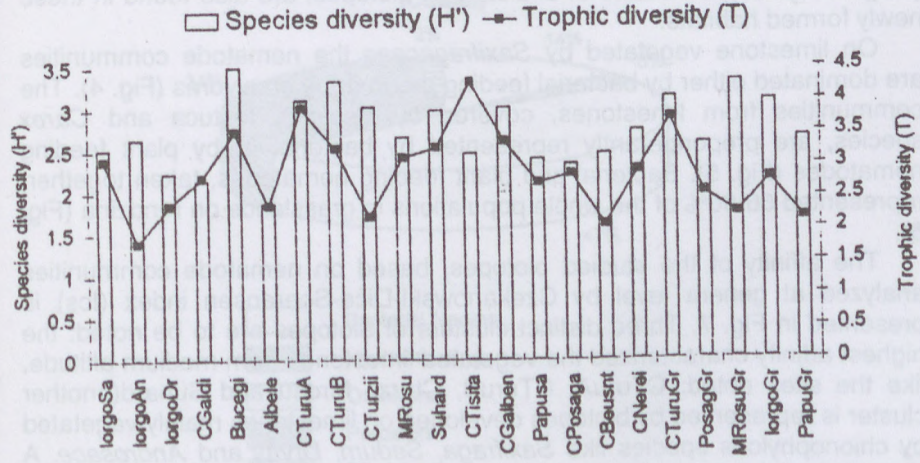



Fig. 3. Species diversity (H') and trophic diversity (T) of nematode communities from the Romanian Carpathians

limestones vegetated by mixed plant cover are dominated by *Cephalobidae* (*Acrobeles, Cephalobus, Heterocephalobus*), by *Dorylaimida* (as above, excepting genus *Enchodelus*), and by *Tylenchida* (like *Tylenchus, Filenchus, Tylenchorhynchus* and *Aphelenchoides*). The soils of grasslands are characterized by increased relative abundance of nematodes belonging to *Tylenchida* (*Paratylenchus, Malenchus, Filenchus, Helicotylenchus*) and to *Rhabditida* (*Bunonema, Acrobeles, Acrobeloides, Ypsylonellus*).

The nematode communities were also analysed by Shannon's diversity index (H') and by trophic diversity index ($T=1/\text{sum } \pi^2$, where (is the relative abundance of given trophic group).

High values of species diversity (H'=3.0-3.5) (Fig. 3) occured in communities developed on limestones in the Bucegi Mts., Cheile Turului (CTuruA, CTuruB) and Cheile Galbenului (Cgalben), as well as in the communities of grasslands developed on rendzinic soils (H'=3.1-3.3). The lowest species diversity (H'=1.86) and species richness (S=14) are estimated in the nematodes from Albele (the Retezat Mts.).

A balanced contribution of different trophic groups to the nematode communities is reflected in high values of trophic diversity index (T=3.5-4.2) like those from Tişiţia, bucegi, Cheile Galbenului, Cheile Turului (Fig. 3). An unbalanced participation of these groups, with high dominance of only one group, (i.e. either omnivores/bacterial or plant feeding nematodes) is expressed by low values of T index, between 1.7 and 2.3.

The vegetated cliffs are mainly populated by bacterial feeding nematodes known as first colonizers (short life cycles), but the omnivorous nematodes (long life cycles), indicators of undisturbed biotopes, are also found in these newly formed habitats.

On limestone vegetated by *Saxifragaceae* the nematode communities are dominated either by bacterial feeding group or by omnivores (Fig. 4). The communities from limestones, covered by *Sesleria*, festuca and *Carex* species, are preponderantly represented by bacterial or by plant feeding nematodes (Fig. 5). Bacterial and plant feeding nematodes, taken together, represented 66-90% of the whole populations in grasslands on rendzina (Fig. 6).

The affinity of the studied biotopes, based on nematode communities analyzed at genera level by Czekanowski-Dice-Soerensen index (Ics) is presented in Fig. 7. Three distinct clusters of biotopes are to be noted: the highest affinity characterized the vegetated limestones from medium altitude, like the sites noted: CTuruA, CTuruB, Cturzi, Mrosu and Suhard(another cluster is represented by biotopes developed on limestones mainly vegetated by chionophylous species like *Saxifraga, Sedum, Dryas* and *Androsace*. A distinct cluster is formed by the grassland ecosystems.

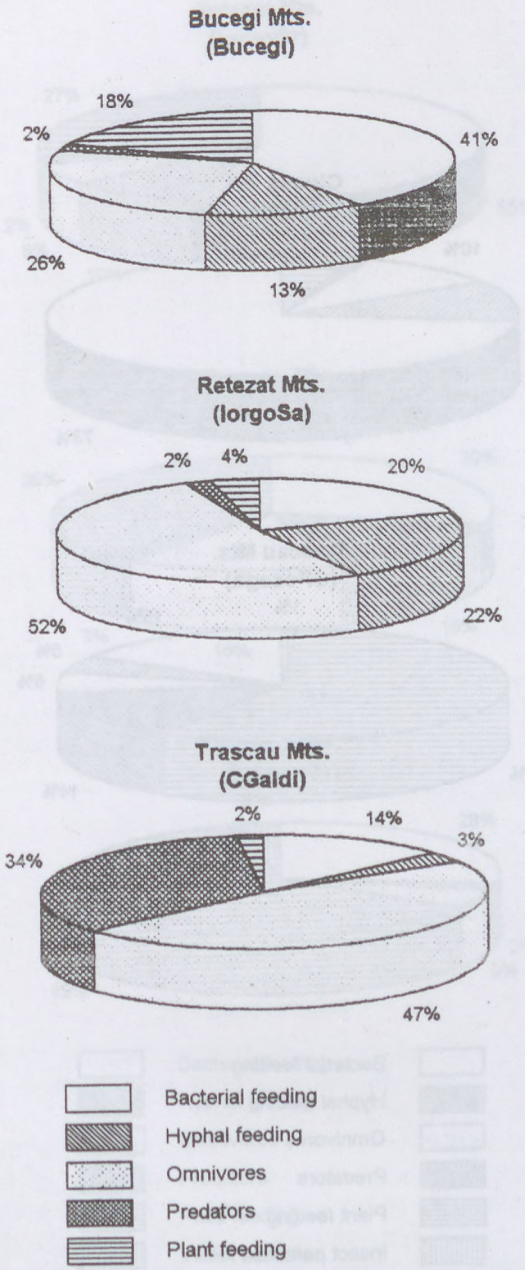



Fig. 4. Trophic structure of nematode fauna from cliffs vegetated by Saxifragaceae species (site's code in brackets)

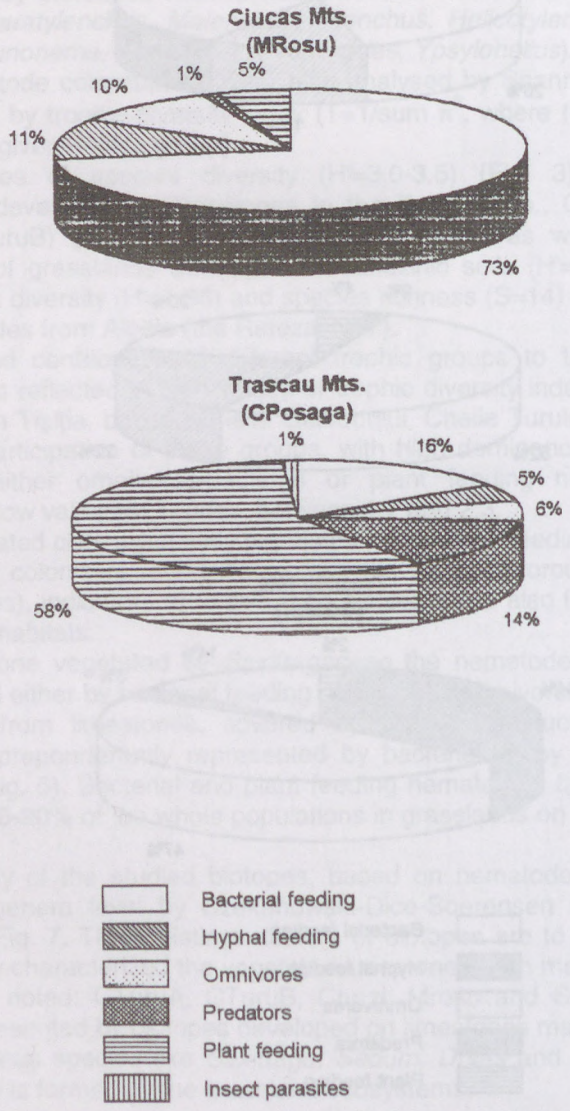



Fig. 5. Trophic structure of nematode fauna from cliffs vegetated by *Sesleria*, *Festuca* and *Carex* species (site's code in brackets)

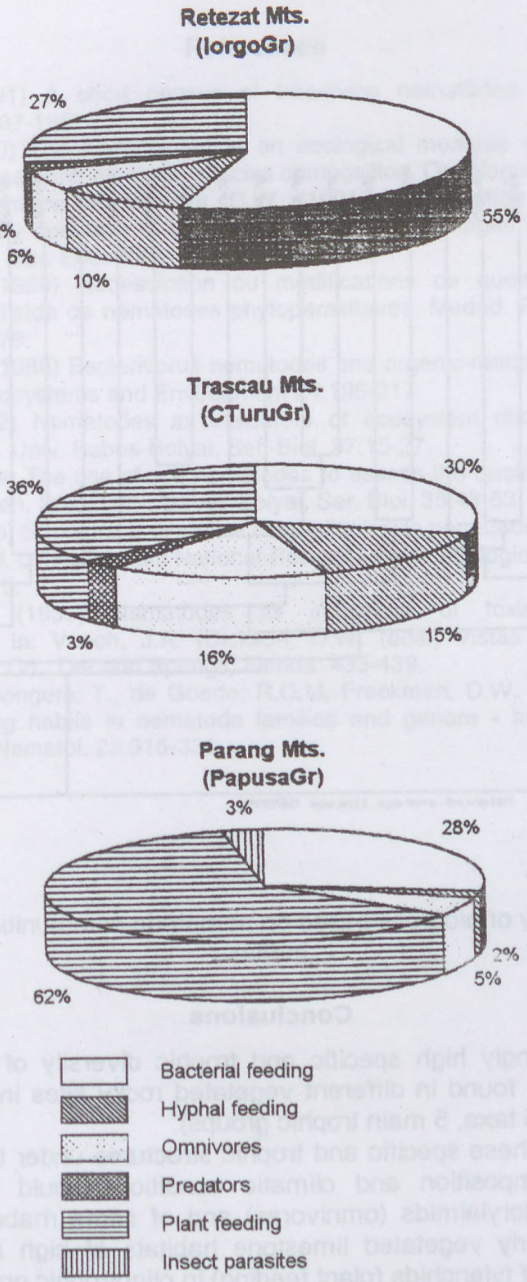



Fig. 6. Trophic structure of nematode fauna from grassland ecosystems (site's code in brackets)

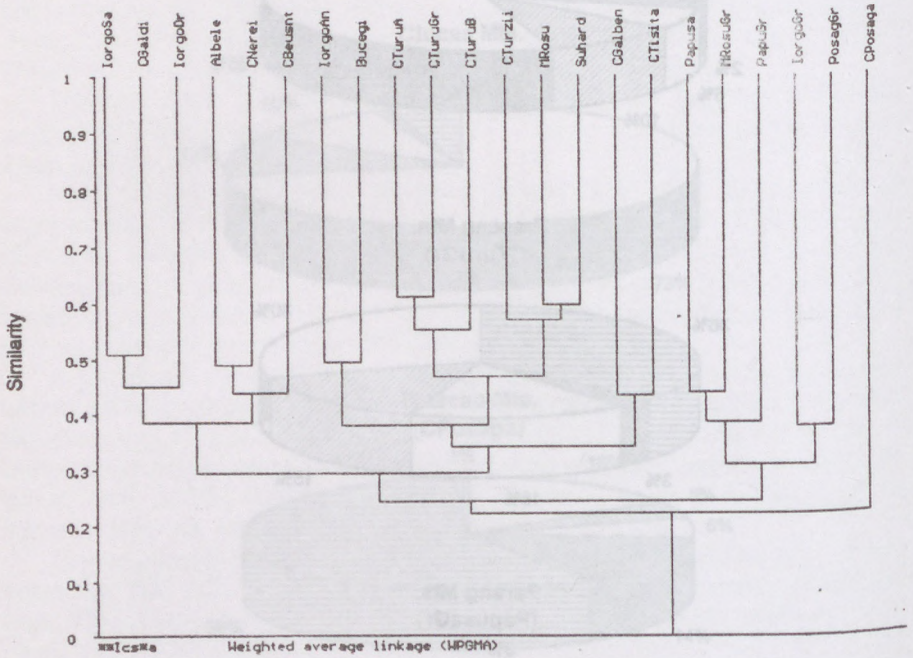



Fig. 7. Similarity of biotopes based on nematode communities (Soerensen Index)

## Conclusions

An astonishingly high specific and trophic diversity of soil nematode communities are found in different vegetated rocky sites in the Romanian Carpathians (195 taxa, 5 main trophic groups).

Changes of these specific and trophic structures under the influence of plant cover composition and climatic conditions could be noted: the preferences of dorylaimids (omnivores) and of some rhabditids (bacterial feeding) for poorly vegetated limestone habitats at high altitude, or the preponderance of tylenchids (plant feeding) in oligotrophic grassland soils.

The affinity of the biotopes is characterized by the delimitation of three main clusters marked by different plant cover.

## References

Andrassy, I. (1991) A short census of free-living nematodes. Fundam. Appl. Nematol. 15_187-188.

Bongers, T. (1990) The Maturity Index: an ecological measure of environmental disturbance based on nematode species composition. Oecologia 83:14-19.

Bongers, T., Alkemade, R. (Yeates, G.W. (1991) Interpretation of disturbance-induced maturity decrease in marine nematode assemblages by means of the maturity index. Mar. Ecol. Prog. Ser. 76:135-142.

DeGrisse, A.T. (1969) Redesciption ou modifications de quelques techniques utilisées dans l'etde de nématodes phytoparasitaires. Meded. Fak. Landbouww. Gent 34:351-370.

Freckman, D.W. (1988) Bacterivorus nematodes and organic-matter decomposition. agriculture, Ecosystems and Environment 24:195-217.

Popovici, I. (1992) Nematodes as indicators of ecosystem disturbance due to pollution. Stud. Univ. Babes-Bolyai, Ser. Biol. 37:15-27.

Popovici, I. (1993a) The use of soil nematodes to assess the quality of technogenic soil rehabilitation. Stud. Univ. Babes-Bolyai, Ser. Biol. 38:43-53.

Popovici, I. (1993b) Structura şi dinamica comunităţilor de nematode (Nematoda). In: Popovici, I. (ed. coord.) Parcul National Retezat - Studii ecologice. Ed. West Side Braşov:200-215.

Samoiloff, M.R. (1987) Nematodes as indicators of toxic environmental contaminants. In: Veech, J.A. (Dickson, D.W. (eds.) Vistas on Nematology. Painter Printer Co., DeLeon Springs, Florida: 433-439.

Yeastes, G.W., Bongers, T., de Goede, R.G.M, Freckman, D.W. (Georgieva, S.S. (1993) Feeding habits in nematode families and genera - an outline for soil ecologists. J. Nematol. 25:315-331.

# PEDOFAUNA OF LIMESTONE AREAS IN THE RETEZAT NATIONAL PARK (ROMANIA)

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**Abstract**: Data on abundance, diversity and affinity of the soil fauna communities, with special emphasis on nematodes, enchytraeids, lumbricids and springtails are presented. Different ecosystem types were investigated including montane grassland, beech, mixed and timberline spruce forests, Swiss pine shrubs and subalpine grasslands, located on limestone areas in teh Retezat Mountains. The abundance of soil fauna ranged between 0.4 and 2.2 mil. individuals $m^{-2}$, nematodes, mites and springtails represented together 91.5 to 98.9% of whole soil assemblages. A rich species diversity (261 taxa) was identified for four faunal groups and its decrease at high altitude was noted. The affinity of soil fauna communities, especially of lumbricid ones, proved their relationships with vegetation and soil.

The complexity of the biological diversity of the earth's natural resources, its inventory and strategy for a global biodiversity conservation became a major concern for governmental, intergovernmental and international organizations (Groombridge 1992).

The current status, lack of information and particular contribution of scientists to the knowledge of European mountain biodiversity were underlined at the recent workshop on the "European Mountain Biodiversity" organized by ICALPE (International Centre for Alpine Environments, 1995).

Any effort to generate the biodiversity database is hindered by gaps in our knowledge as well as the shortage of well trained scientists.

The invertebrate soil fauna remained one of the major unknowns of mountain biodiversity as compared either to epigeic insects or vertebrates. Some quantitative data on abundance, biomass and production of soil fauna in different types of ecosystems are summarized by Petersen and Luxton (1982).

The South-Eastern Carpathians or the Romanian Carpathians, and particularly their spectacular Retezat Mountains, have attracted the interest of taxonomists both for plants and animals since the 18th century. In the last two decades a broad ecological research programme has been developed in the Retezat National Park, designated as Biosphere Reserve in 1980. Detailed floristic and faunal data, syntaxonomic, ecophysiologic, microclimatic, pedologic and pedoenzymologic studies - all are summarized in a comprehensive overview published in 1993 (Popovici ed.).

A general taxonomical and ecological research on the soil invertebrate communities developed in several ecosystems within the limestone area of the Retezat National Park is presented in this paper. A special emphasis is laid on soil worm groups (nematodes, enchytraeids, lumbricids) and on springtails.

## Site description

Nine sites, including montane grassland, beech, mixed and timbereline spruce forests, Swiss pine shrubs and subalpine grasslands were investigated. They are located along an altitudinal gradient on carbonate rocks. A brief characterization of these sites is given below. A code, given in brackets, is used to indicate the sites in the comments and figures.

1. Montane grassland (MonGras) - as. *Festuco rubrae-Agrostetum capillaris* Horv. 51, Retezatul Mic. Câmpuşel, 1000 m altitude, plain, brown earth soil;
2. Beech forest (Beech) - as. *Phyllitidi-Fagetum* Soó 63, Retezatul Mic, Fata larului, 1250 m altitude, S aspects, 25(slope, rendzina;
3. Mixed forest (Mixed) - as. *Leucanthemo waldsteinii-Piceo-Fagetum* Soó 63 *saxifragetosum* Coldea 91, Retezatul Mic, Scocul larului, 1200 m alttitude, SW aspect, 25(slope,acid brown umbric soil;
4. Timberline spruce forest (Tspruce) - as. *Bruckenthalio-Piceetum* Borh. 69 *saxifragetosum rotundifolii* Coldea 91, Retezatul Mic, Piatra lorgovanului, 1700 m altitude, SW aspect, 25(slope, brown earth soil;
5. Swiss pine shrubs (Dwpine1) - as. *Rhododendro myrtifolii-Pinetum mugi* Borza 59 em. Coldea 85, Retezatul Mic, Piatra lorgovanului, 1750 m altitude, S aspect, 15(slope, rendzinic lithosol;
6. Swiss pine shrubs (Dwpine2) - plant association as above,, Retezatul Mic, Piule Mts., 1900 m altitude, SE aspect, 35(slope, rendzinic lithosol;
7. Swiss pine shrubs (Dwpine3) - as. *Rhododendro myrtifolii-Pinetum mugi* Borza 59 em. Coldea 85, Retezatul Mic, Seaua Scorota, 1850 m altitude, NE aspect, 35(slope, lithic rendzina;
8. Subalpine grassland (SalpGr1) - as. *Festucetum xantinae* Boscaiu 71, Retezatul Mic, Piatra lorgovanului, 1700 m altitude, S aspect, 35(slope, rendzina;
9. Subalpine grassland (SalpGr2) - plant association as above, Retezatul Mic, Piule Mts., 1850 m altitude, S aspect, 45(slope, rendzinic lithosol;

## Material and methods

Samples were collected and prepared by specific methods according to the faunal groups investigated (Harsia 1993, Pop 1993, Popovici 1993b). Samples in five replications were taken by different cores from three-four levels: litter or soil, A horizon (0-5, 5-10 and 10-15 cm). Earthworms were expelled by formalin. Field studies have been performed in June of 1986 and 1988.

Details for specific and thropic identification of the soil fauna are also specified in the overview mentioned above (Popovici ed., 1993a).

The BIODIV computed programme was used for the analysis of data.

## Results and Discussion

The soil fauna of limestone areas is represented by nine faunal groups (Fig. 1-3). The abundance of these groups, taken together, ranged between $464.8 \times 10^3$ and $2.212 \times 10^3$ individuals $m^{-2}$.

The nematodes, orbatid-mites and springtails had the major contribution to the soil fauna abundance (Fig. 4.). The highest contribution is estimated for nematode communities which represented 62.6% to 88.7% of the whole soil invertebrate assemblages. The earthworms, the biggest soil invertebrates, had the lowest density but the highest biomass (Pop 1987, 1993). Forest ecosystems permitted a rich development of the soil fauna communities. The parasitiforme-mites, insects and protura are remarkably abundant in beech forests; the nematodes, enchytraeids and myriappods are mostly abundant in mixed forest soil while the Swiss pine ecosystem shelter the highest populations of lumbricids, oribatid-mites and insect-larva (Fig. 1-3).

In the Retezatul Mic, the beech and mixed forests have a reverse distribution due to the warmer microclimate of limestone areas and/or the southern aspect; these deciduous forests are extended up to the timberline spruce forest. These conditions could also explain the highest lumbricid density in Swiss pine ecosystem and not in montane spruce forest where it was usually estimated.

Vertical patterns of distribution of soil fauna are characterized by major concentration of oribatids, parasitiformes and insects in litter/sod and by the preponderance of the other faunal groups in the first 5 cm of the A humiferous horizon.

The conditions developed on the mountainous massifs, such as altitude, general releif, parent rocks, soil trophicity and climate are reflected in the biodiversity of the soil faunal components.

The species richness of our analyzed faunal groups (nematodes, enchytraeids, lumbricids and springtails) is estimated at 261 taxa.

A rich diversity of the studied soil fauna is found in the mixed forest (131 taxa), followed by the montane grassland (126 taxa) and by the beech forest (125 taxa) (Table 2).

High species richness characterized the nematode and springtail communities.

Table 2. Species richness of some soil faunal groups in ecosystems of the limestone areas in the Retezat National Parks (See site codes in the text)

| Faunal group | Ecosystems | | | | | |
|---|---|---|---|---|---|---|
| | MonGras | Beech | Mixed | Tspruce | Dwpine3 | SalpGr2 |
| Nematodes | 107 | 97 | 86 | 85 | 85 | 90 |
| Enchytraeids | 2 | 4 | 11 | 4 | 4 | 3 |
| lumbricids | 3 | 5 | 4 | 3 | 2 | 3 |
| Springtails | 14 | 19 | 30 | n.det. | 26 | 20 |

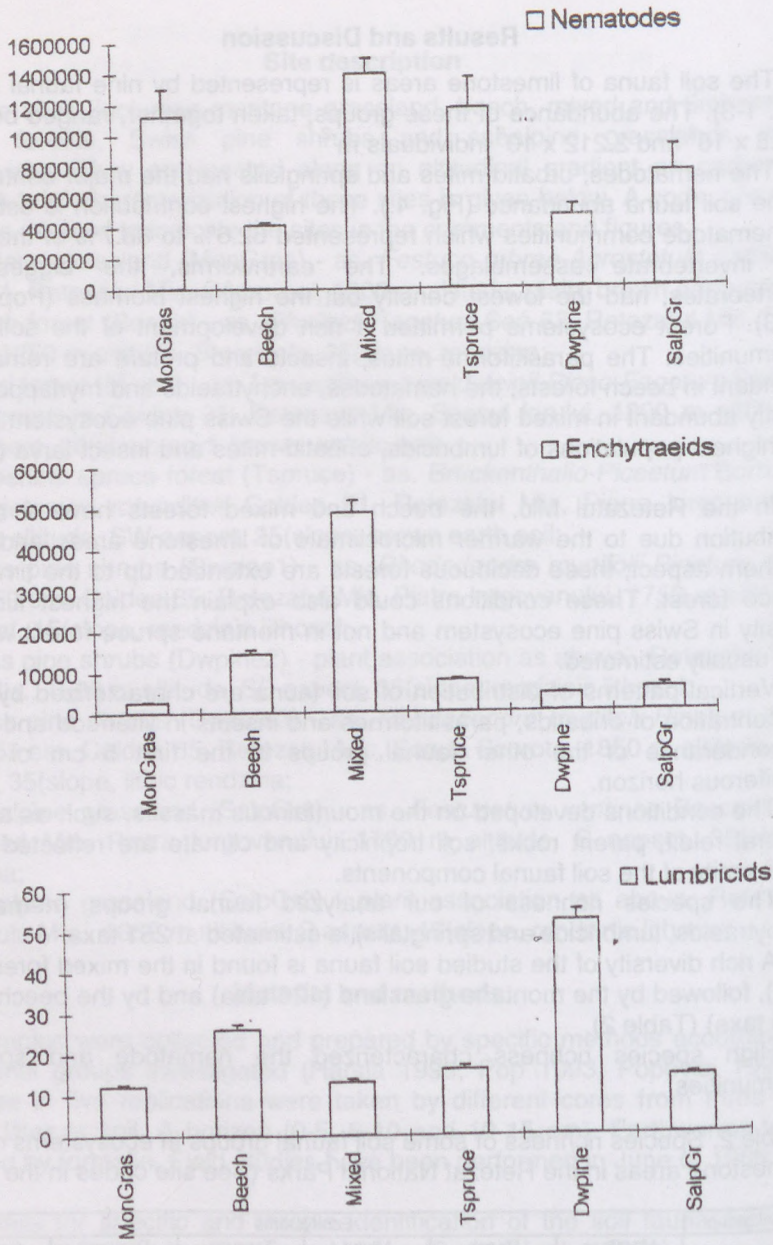



Fig. 1. Soil fauna abundance ($\bar{X}$ ±SE $m^{-2}$) in ecosystems from the Retezat National Park (site's code as in the text).

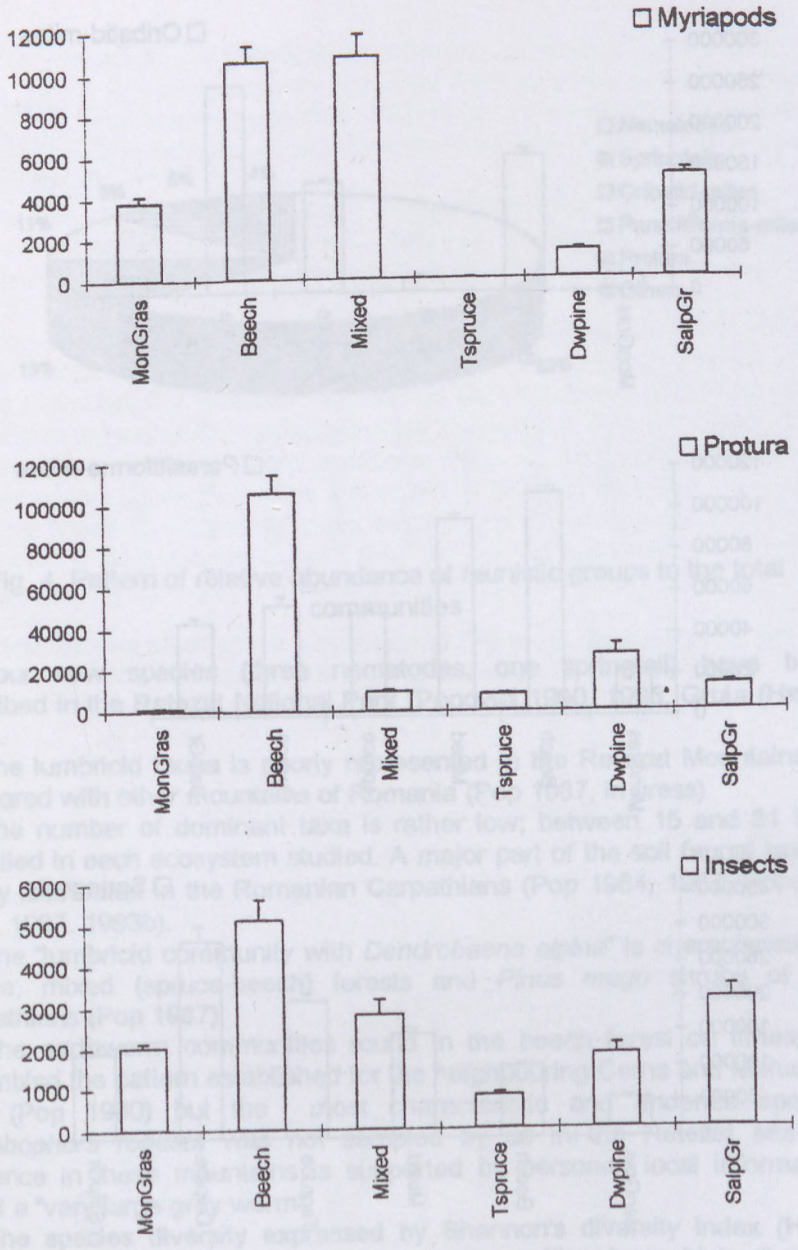



Fig. 2. Soil fauna abundance ($\bar{X}$ ±SE $m^{-2}$) in ecosystems from the Retezat National Park (site's code as in the text).

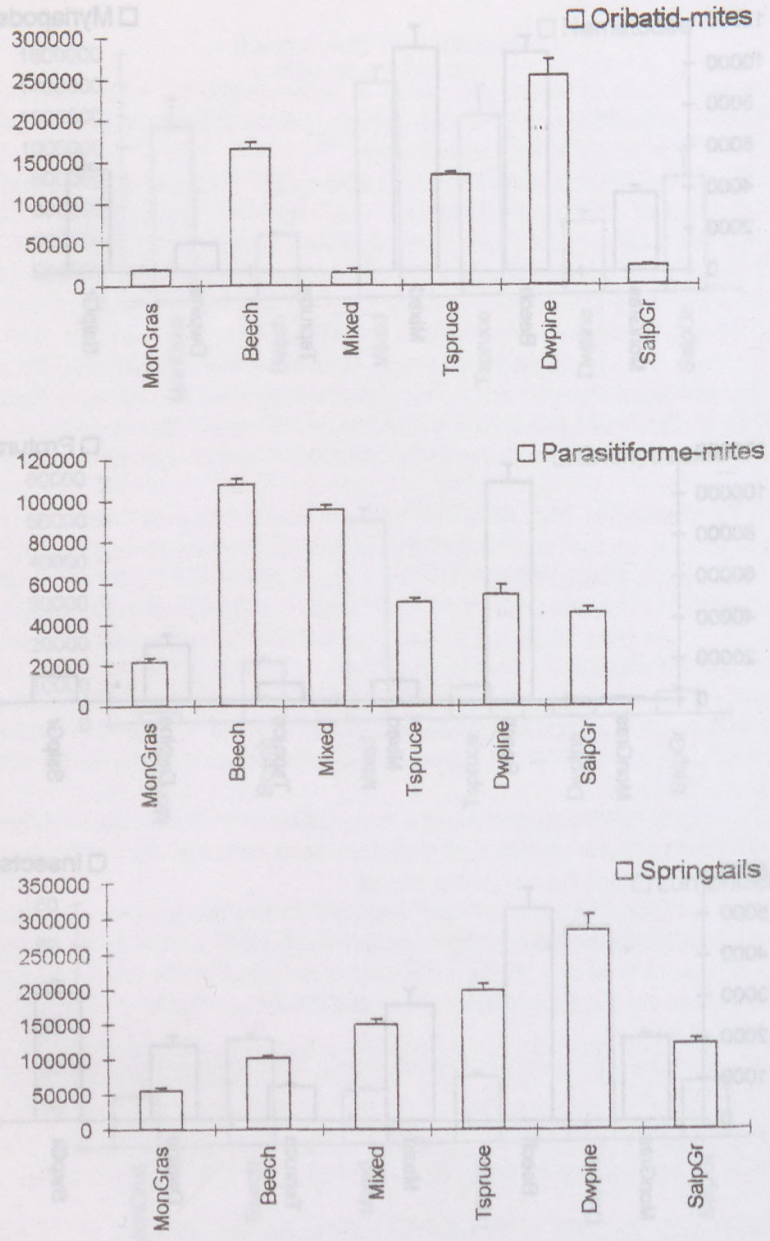



Fig. 3. Soil fauna abundance ($\bar{X}$ ±SE $m^{-2}$) in ecosystems from the Retezat National Park (site's code as in the text).

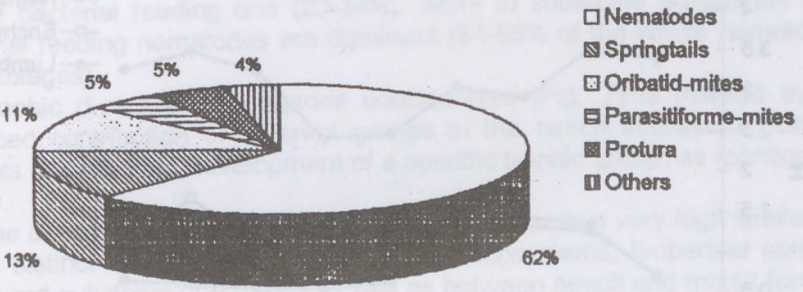



Fig. 4. Pattern of relative abundance of faunistic groups to the total communities

Four new species (three nematodes, one springtail) have been described in the Retezat National Park (Popovici 1990, 1995, Gruia (Harsia 1990).

The lumbricid fauna is poorly represented in the Retezat Mountains as compared with other mountains of Romania (Pop 1987, in press).

The number of dominant taxa is rather low; between 15 and 31 taxa prevailed in each ecosystem studied. A major part of the soil faunal taxa is widely distributed in the Romanian Carpathians (Pop 1984, 1987, Popovici 1984, 1987. 1993b).

The "lumbricid community with *Dendrobaena alpina*" is characteristic of spruce, mixed (spruce-beech) forests and *Pinus mugo* shrubs of the Crapathians (Pop 1987).

The earthworm communities found in the beech forest on limestone resembled the pattern established for the neighbouring Cerna and Mehedinti Mts. (Pop 1980) but the most characteristic and endemic species *Allolobophora robusta* was not sampled by us in the Retezat Mts. Its presence in these mountains is supported by personal, local information about a "very large grey worm".

The species diversity expressed by Shannon's diversity index (H') is illustrated in Fig. 5 and 6. Nematode communities have high diversity values (H'=2.4 - 3.5), lumbricid communities the lowest ones(H'=0.5 - 1.3).

Biodiversity tends to decrease at high altitude with the severity of environment and climate.

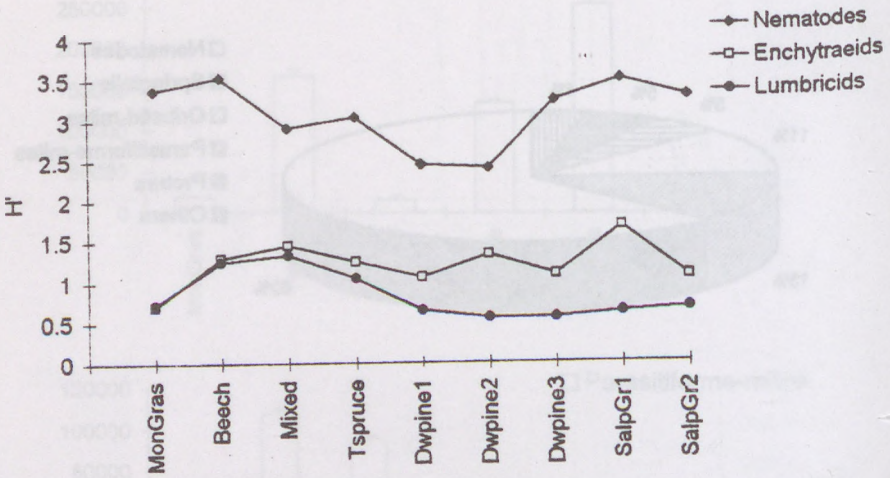



Fig. 5. Species diversity (H') of nematode, enchytraeid and lumbricid communities in ecosystems from the Retezat national Park

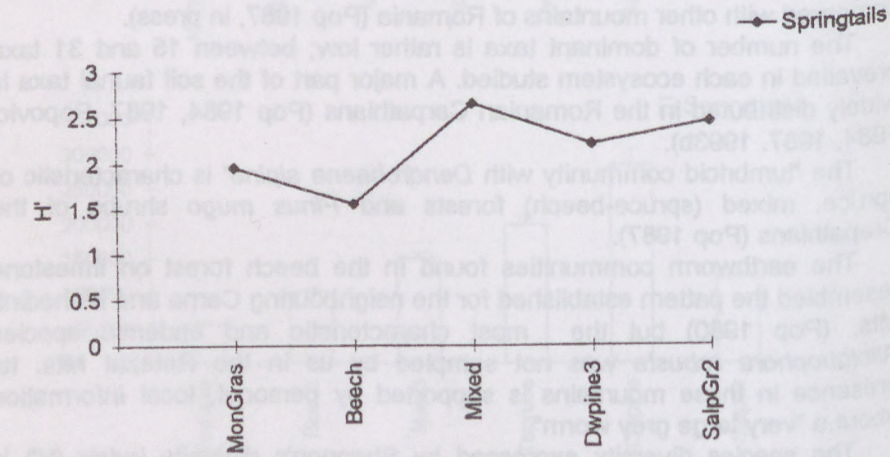



Fig. 6. Species diversity (H') of springtail communities in ecosystems from the Retezat national Park

The nematode communities of montane grassland, forest and *Pinus mugo* shrubs are dominated by the plant feeding group (44-64%) followed by the bacterial feeding one (23-34%), while in subalpine grasslands the bacterial feeding nematodes are dominant (51-55% of the whole nematode assemblages).

Trophic diversity of nematode communities (Fig. 7) is marked by a balanced contribution of different groups in the beech ecosystem. Other habitats favoured the development of a specific trophic group, as mentioned above.

The cluster analysis based on lumbricid fauna shows very high similarity (three distinct cluster) between Swiss pine ecosystems, timberline spruce forest and subalpine grasslands as well as between beech and mixed forest, proving direct earthworm-vegetation-soil relationship (Fig. 8). Lower affinity of habitats is shown when nematode (Fig. 9) and springtail (Fig. 10) communities are implicated as compared to the previous one. Two affinity clusters based on nematode assemblages tend to differentiate the montane ecosystems from subalpine ones (Fig. 9). the biotopes similarity based on enchytraeids (Fig. 11) needs more data for a better interpretation.

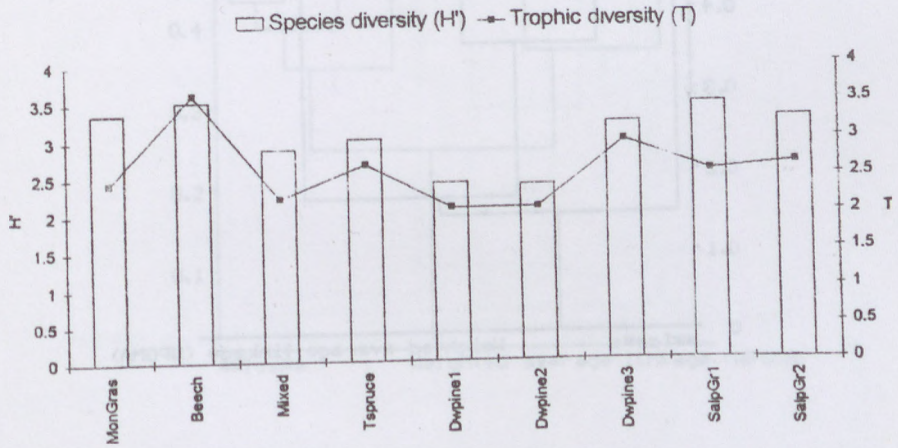



Fig. 7. Species and trophic diversity of nematode fauna

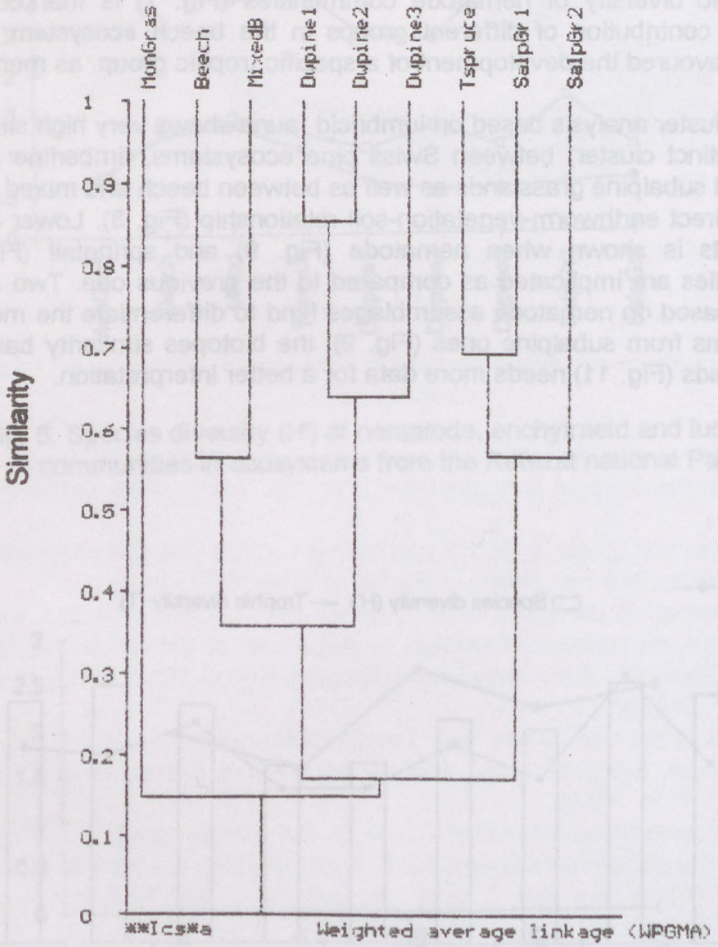



Fig. 8. Similarity of biotopes based in lumbricid communities (Soerensen Index)

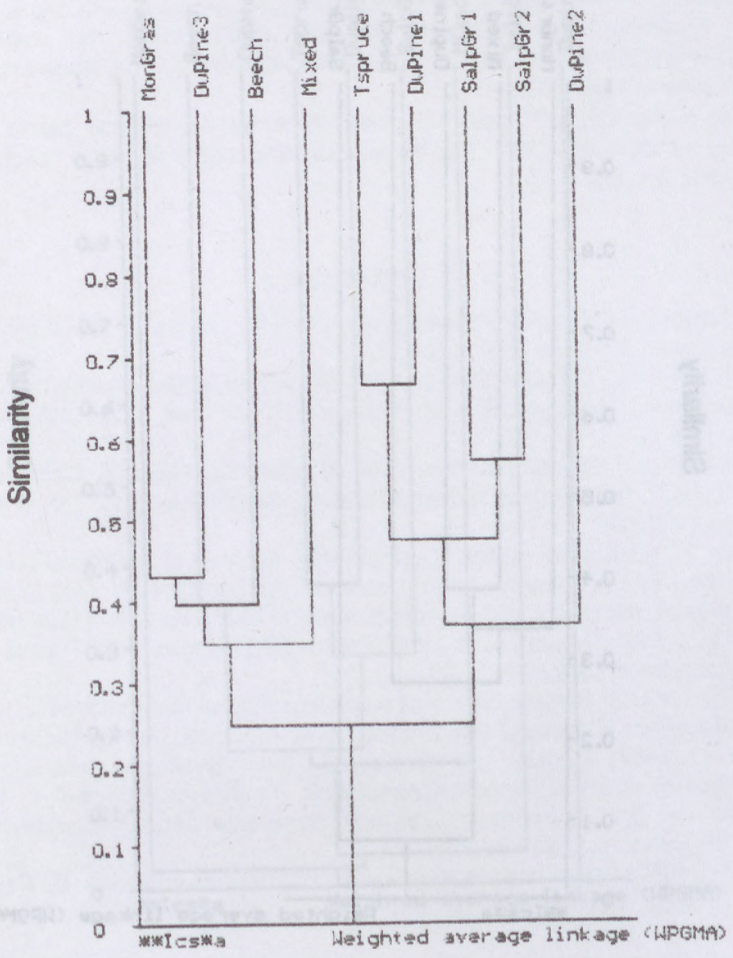



Fig. 9. Similarity of biotopes based in nematode communities (Soerensen Index)

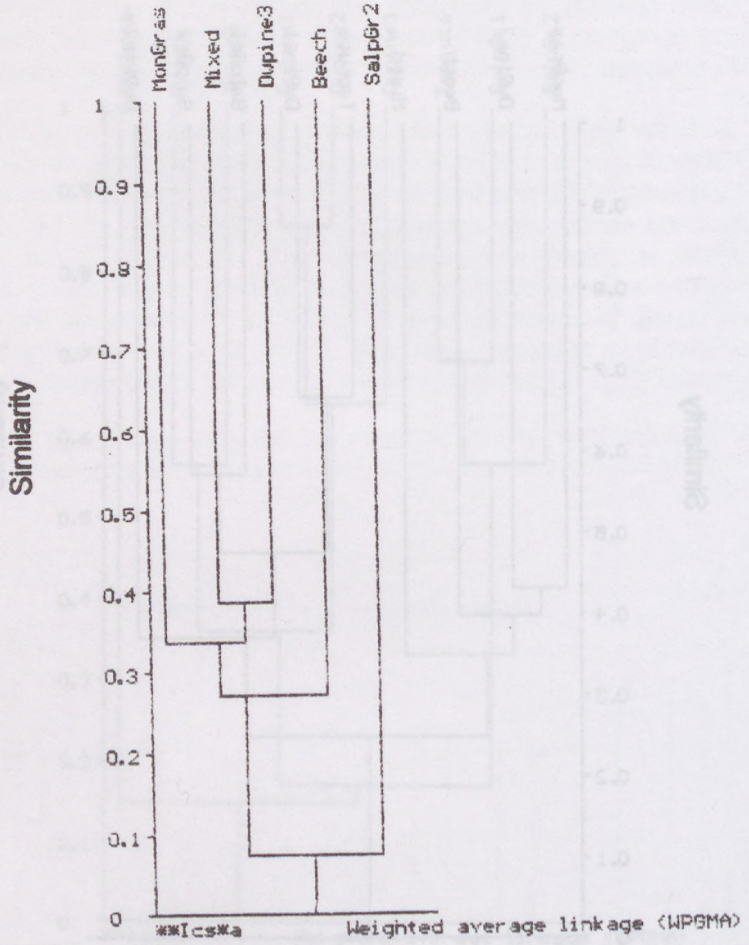



Fig. 10. Similarity of biotopes based in springtail communities (Soerensen Index)

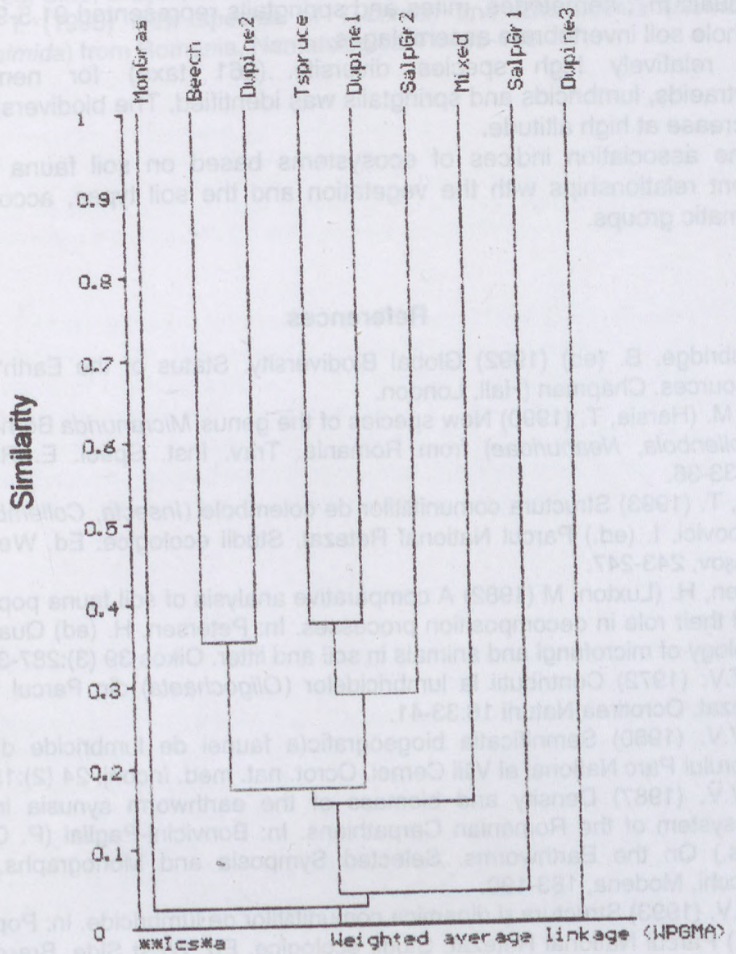



Fig. 11. Similarity of biotopes based in enchytraeid communities (Soerensen Index)

## Conclusions

The soil fauna abundance of limestone areas of the Retezat National Park (the Romanian Carpathians) ranged between 0.4 and 2.2 mil. individuals $m^{-2}$; nematodes, mites and springtails represented 91.5-98.9% of the whole soil invertebrate assemblages.

A relatively high species diversity (261 taxa) for nematodes, enchytraeids, lumbricids and springtails was identified. The biodiversity tends to decrease at high altitude.

The association indices of ecosystems based on soil fauna showed different relationships with the vegetation and the soil types, according to systematic groups.

## References

Groombridge, B. (ed) (1992) Global Biodiversity. Status of the Earth's Living resources. Chapman (Hall, London.

Gruia, M. (Harsia, T. (1990) New species of the genus *Micranurida* Börner, 1901 (*Collenbola, Neanuridae*) from Romania. Trav. Inst. Spéol. E. Racovitza 29:33-36.

Harsia, T. (1993) Structura comunităţilor de colembole (*Insecta, Collembola*). In: Popovici, I. (ed.) Parcul National Retezat. Studii ecologice. Ed. West Side, Braşov, 243-247.

Petersen, H. (Luxton, M (1982) A comparative analysis of soil fauna populations and their role in decomposition processes. In: Petersen, H. (ed) Quantitative ecology of microfungi and animals in soil and litter. Oikos 39 (3):287-388.

Pop, V.V. (1972) Contributii la lumbricidelor (*Oligochaeta*) din Parcul national retezat. Ocrotirea Naturii 16:33-41.

Pop, V.V. (1980) Semnificatia biogeografic(a faunei de lumbricide din zona viitorului Parc National al Vâii Cernei. Ocrot. nat. med. înconj. 24 (2):157-164.

Pop, V.V. (1987) Density and biomass of the earthworm synusia in forest ecosystem of the Romanian Carpathians. In: Bonvicini-Pagliai (P. Omodeo (eds.) On the Earthworms. Selected Symposia and Monographs. U.Z.I., mucchi, Modena, 183-190.

Pop, V.V. (1993) Structura şi dinamica comunităţilor de lumbricide. In: Popovici, I. (ed.) Parcul National Retezat. Studii ecologice. Ed. West Side, Braşov, 215-227.

Pop, V.V. (in press) earthworm-Vegetation-Soil Relationship in the Romanian carpathians. Soil. Biol. biochem.

Popovici, I. (1984) soil nematodes in forest ecosystems in the Retezat national Park (the Carpathians). In: Recherches écologiques dans le Parc National de Retezat, Cluj-Napoca, 175-184.

Popovici, I. (1990) New and known nematode species (*Nematoda: Dorylaimida*) from Romania, Nematologica 35 (4):455-460.

Popovici, I. (ed.) (1993a) Parcul National Retezat. Studii ecologice. Ed. West Side, Braşov.

Popovici, I. (1993b) Structura şi dinamica comunităţilor de nematode (*Nematoda*). In: Popovici, I. (ed.) Parcul National Retezat. Studii ecologice. Ed. West Side, Braşov, 200-214

Popovici, I. (1995) New species of *Tubixaba* and *Enchodelus* (*Nematoda: Dorylaimida*) from Romania, Nematologica 41:435-448.

# THE ENCHYTRAEIDAE (*OLIGOCHAETA*) COMMUNITIES IN THE DANUBE DELTA BIOSPHERE RESERVE

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**Abstract:** The long period study (1991 - 1995) carried out in Danube Delta Biosphere Reserve provided a rich *Enchytraeidae* material. So the structure of communities evidentiated by 44 *Enchytraeidae* species. Three species are recorded here for the first time in Romanian fauna. The new formated delta's soil is characterized by lack of uniformity in spreading *Enchytraeidae* species. The Sorensen similarity test applied to the studied biotops carried out six interesting groups of habitats with close inner correlations.

The *Enchytraeidae* are one of the most important soil fauna components. They contribute to the organic material decomposition, soil aeration, maintenance of hydric equilibrium, development of humic processes, etc.

The paper deals with faunal studies in the Danube Delta Biosphere Reserve, performed between 1991- 1995. The aim of this research is to show the *Enchytraeidae* diversity and their relations with soil and vegetation. It is the first study on the *Enchytraeidae* communities in the Danube Delta area.

## Methods

Twelve stations all over the Danube Delta area and other four in the very vicinity of the study area were investigated. The stations vary as far as soil and vegetation are concerned. Some of them are very humid, with herbaceous cover, others are covered with salty vegetation and most of them consist of woody vegetation, but there are also stations with scarce sandy vegetation. The soil was sampled with a metal soil corer with an inner diameter of 5 cm and 10 cm high. Every station was divided into five sampling areas, from which we sampled five soil cores. The anchytraeidae fauna was extractedfrom soil cores by the Bermann wet funnel method. The worms were preserved in 80 % ethanol. They were prepared for microscopy after a treatment with lactic acid (1.20 L). The worms prepared in this way were determined at the species level.

## Results

Community structure comprised 44 *Enchytraeidae* species with no uniform distribution (Table 1). The richness or scarceness of species depends on soil and especially on vegetation cover and humidity. We found the highest diversity in the forest: Manastirea Cocosul - 26 species, ' 6-

Martie' - 22 species, Bestepe - 21 species, Babadag - 17 species, Enisala - 13 species, the herbaceous covered sites include: Sf. Gheorghe - 14 species, Grindul Saraturi - 12 species, Periteasca - 11 species.

Table 1. Specific structure of Enchytraeidae communities from the Danube Delta Biosphere Reserve

| Site | Mcocos | Enisala | Bestepe | Lsarat | SfGhe |
|---|---|---|---|---|---|
| Species | E | E | ZT | SP | ZP |
| *Achaeta affinis* | 1 | 0 | 0 | 0 | 0 |
| *Achaeta bohemica* | 2 | 2 | 0 | 0 | 0 |
| *Achaeta camerani* | 1 | 4 | 0 | 0 | 0 |
| *Achaeta danica* | 3 | 0 | 0 | 1 | 0 |
| *Achaeta eiseni* | 7 | 3 | 0 | 0 | 0 |
| *Achaeta vesiculata* | 0 | 4 | 0 | 0 | 0 |
| *Achaeta sp. (im)* | 3 | 0 | 3 | 0 | 0 |
| *Buchholzia appendiculata* | 0 | 0 | 0 | 0 | 0 |
| *Buchholzia falax* | 0 | 0 | 0 | 0 | 0 |
| *Enchytraeus albidus* | 1 | 0 | 12 | 3 | 0 |
| *Enchytraeus buchholzi* | 6 | 0 | 24 | 0 | 4 |
| *Enchytraeus coronatus* | 0 | 0 | 0 | 0 | 0 |
| *Enchytraeus sp. (im)* | 3 | 1 | 14 | 0 | 1 |
| *Enchytronia parva* | 0 | 0 | 0 | 0 | 0 |
| *Henlea (cf) heleotropha* | 0 | 0 | 1 | 0 | 1 |
| *Henlea jutlandica* | 0 | 0 | 1 | 0 | 0 |
| *Henlea nasuta* | 0 | 0 | 0 | 0 | 0 |
| *Henlea perpusilla* | 2 | 1 | 1 | 0 | 0 |
| *Henlea similis* | 0 | 0 | 2 | 0 | 0 |
| *Henlea sp. (im)* | 0 | 0 | 4 | 0 | 0 |
| *Friderica alata* | 4 | 1 | 0 | 0 | 0 |
| *Friderica aurita* | 12 | 5 | 11 | 0 | 0 |
| *Friderica bisetosa* | 4 | 1 | 7 | 0 | 0 |
| *Friderica bulbosa* | 0 | 0 | 0 | 0 | 0 |
| *Friderica callosa* | 2 | 0 | 1 | 0 | 0 |
| *Friderica galba* | 5 | 2 | 0 | 0 | 1 |
| *Friderica gracilis* | 1 | 0 | 0 | 0 | 2 |
| *Friderica hegemon* | 4 | 0 | 4 | 0 | 0 |
| *Friderica leydigi* | 47 | 4 | 9 | 0 | 1 |
| *Friderica maculata* | 3 | 0 | 0 | 0 | 0 |
| *Friderica magna* | 0 | 0 | 2 | 0 | 0 |
| *Friderica paroniana* | 1 | 0 | 3 | 0 | 1 |
| *Friderica perieri* | 1 | 0 | 3 | 0 | 1 |
| *Friderica ratzeli* | 6 | 0 | 2 | 0 | 1 |
| *Friderica regularis* | 0 | 0 | 0 | 0 | 1 |
| *Friderica uniampulata* | 1 | 0 | 0 | 0 | 0 |
| *Friderica sp. (im)* | 39 | 15 | 17 | 2 | 5 |
| *Lumbricillus bulowi* | 0 | 0 | 0 | 0 | 0 |
| *Lumbricillus pagenstecher* | 0 | 0 | 0 | 0 | 2 |

| Site | Mcocos | Enisala | Bestepe | Lsarat | SfGhe |
|---|---|---|---|---|---|
| Species | E | E | ZT | SP | ZP |
| *Lumbricillus tuba* | 0 | 0 | 0 | 0 | 0 |
| *Lumbricillus sp. (im.)* | 0 | 0 | 1 | 0 | 0 |
| *Marionina argentea* | 0 | 0 | 0 | 0 | 0 |
| *Marionina communis* | 2 | 0 | 0 | 0 | 1 |
| *Marionina filiformis* | 0 | 0 | 0 | 0 | 0 |
| *Marionina riparia* | 0 | 0 | 2 | 0 | 0 |
| *Marionina simillima* | 1 | 0 | 0 | 0 | 0 |
| *Marionina spicula* | 0 | 0 | 0 | 0 | 0 |
| *Marionina tubifera* | 2 | 0 | 0 | 1 | 0 |
| *Marionina vesiculata* | 0 | 0 | 0 | 0 | 0 |
| *Marionina sp. (im)* | 5' | 6 | 10 | 0 | 2 |

**Legend:**
SP Strictly protected zone
ZP Transition areas
ZT Buffer zone
E Extra Delta

The forests on sandy soils are not rich and diverse in species composition, in the station from Maliuc there are only 12 species, at Caraorman 8 species, at Letea 3 species. The lowest diversity was found in some stations near the Black Sea shore: Gura Portita - 3 species, Sachalin Island - 3 species and Popina Island, situated in the north of Razim Lake, with only 2 species. We found a very interesting situation at Lacu Sarat and Grindul Saraturi where we described respectively 4 and 12 species.

Three species (Buchholzia appendiculata, Buchholzia falax and Enchytronia parva) are reported here for the first time in the Romanian fauna.

The most frequent species all over the Danube Delta area are Enchytraeus buchholzi and Marionina communis which are present in nine stations, Enchytraeus albidus - 8 stations, Fridericia galba and Fridericia paroniana in 6 stations, etc. The frequency of the species of the Danube Delta areas differs significally from other Romanian areas.

Similarity between stations, based on Enchytraeid communities, (Fig. 1) shows 6 clusters of habitats. The clustering revealed a tight relation between soil and vegetation. Thus, forest sites are divided in more than 3 groups: forests on sandy soils (Letea and Maliuc) have a similarity of 30 %, forests from west of the Danube Delta located on the hills (Manastirea Cocosul, Bestepe and Enisala) have 40 - 50 %, and those from extradelta (Babadag, ' 6 Martie') with 50 % similarity. The other groups similarity depends firstly on soil and secondly on vegetation, they are situated in the vicinity of the Black Sea shore and in the newly foermed sandy soils of the central part of the Danube delta.

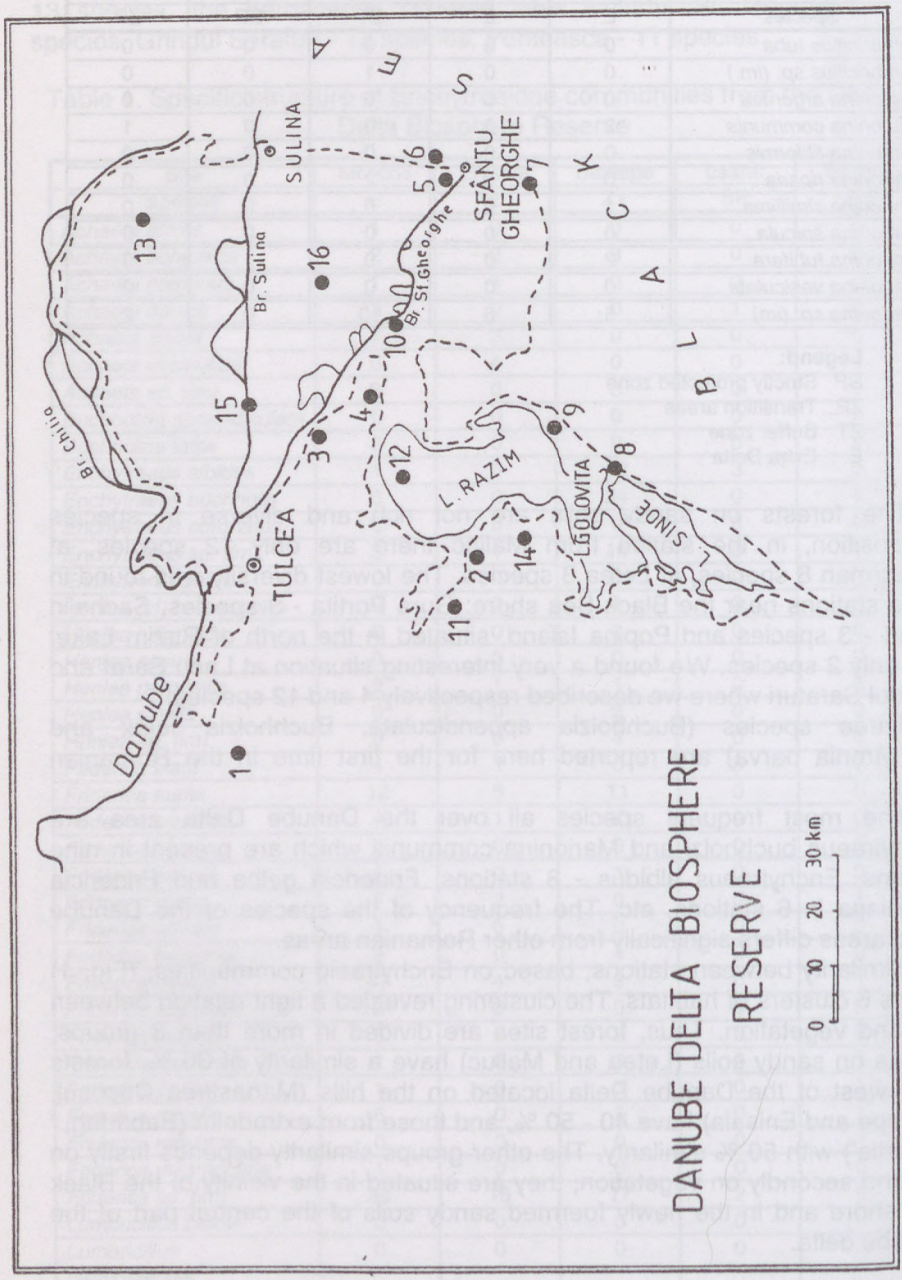



Fig. 1. The Enchytraeidae (*Oligochaeta*) communities in the Danube Delta Biosphere Reserve.

## Conclusions

The Danube Delta represents a very interesting area from the point of view of Enchytraeidae fauna. This fauna is different from that of the other Romanian areas. Differences may be observed in species composition, species frequency and similarity between stations.

## References

Stefan, V. (1994) Contributii la cunoasterea enchitreidelor din Delta Dunarii. Ann. St. Inst. Delta Dunarii, Tulcea, 155-158.


DANUBE DELTA BIOSPHERE
RESERVE

# IX. SESSION

# RESULTS OF COMPLEX ECOLOGICAL STATUS SURVEY IN AGGTELEK NATIONAL PARK

# MONITORING AND CONSERVATION OF HOUSE-DWELLING BAT COLONIES IN THE ADMINISTRATIVE AREA OF AGGTELEKI NATIONAL PARK

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[2]*Hungarian Bat Conservation Foundation, Törökszentmiklós, Fáy A. ltp. G/3/14. H-5200*

**Abstract:** The paper is about the results of bat-fauna monitoring work done by the authors in buildings on the area of the Aggtelek National Park (North-Hungary) during 1994-95. The research was carried out in 60 buildings of 48 settlements. The paper is about the ocurrence of 7 bat species: *Rhinolophus hipposideros, Rhinolophus ferrumequinum, Myotis blythi, Myotis emarginatus, Myotis dasycneme, Eptesicus serotinus, Plecotus austriacus.* The paper presents the location, composition of species and size of house-dwelling colonies living in the area of ANP. It also describes the endangering factors and actions for protection.

See in Proceedings Volume II. pp. 185.

# MALACOFAUNALISTICAL RESEARCHES IN THE AGGTELEK NATIONAL PARK

**TAMÁS DELI**
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**Abstract**: Systematic malacofaunistical investigation has not been carried out on the territory of Aggtelek National Park before. Expect for a few sporadic data, the malacofauna of the region is almost completely unknown.

The aim of my research work is to reveal and give a detailed characterization of the territories which are rich in Carpathian elements. I have carried out research works in the Ménes-valley and in its connected smaller valleys (Lizina-springs, Hidegvíz-kút, Patkós-valley) since 1994. I also analysed the material of those soil traps wich were placed at different points of the forests on the Haragistya platoue by Tibor Magura.

Together with the older data, I registered 78 land snail species on the territory of the National Park. Out of these species, 55 were discovered in the forests of different composition in the Ménes-valley. The odd thing about the fauna discovered here is that, the fauna expect for a few species, shows similarity with the fauna of the holocen formation of the Nagy-oldal shaft-cave wich is rich in original elements. Out of this original forest fauna, according to the data available, only just a few species could survive on other parts of the National Park. So on the basis of its land snail fauna this territory, with good reason, can be characterised as a holocen forest refugium.

To provide evidence for this we will have to examine the holocen material of the holes and caverns of Ménes-valley and other areas, and to carry out the malacofaunistical research of further biotopes.

See in Proceedings Volume II. pp. 95.

# INULA ENSIFOLIA (*ASTERACEAE*) AS FOOD PLANT PREFERED BY DAILY BUTTERFLIES (*LEPIDOPTERA: RHOPALOCERA*)

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**Abstract:** The connections of plants and phytophag species give the majority of ecological interactions. The phytophag insects play the main role in the vegetative sphere of plants either consumer or participant of mutualistic relations. We dealed with one of these latters, namely with food searching of daily butterflies, at the same time with their pollination role. Coevolution process goes on between the plant and the pollinator populations (Jermy, 1987.). This coadaptation process forms those plant species which are the main foods. In a phytocenosis there are many zoophyl plant species and this fact is in correlation with heterogenous structure and colour of flowers, they are various lure (Vogel & Westerkamp, 1991.). Despite of the variety of flowers we should pay attention to the fact that most of daily butterflies have mixed nutrition, and spread flower individuums are not acceptable sources (Gonseth, 1992., Vogel & Westerkamp, 1991.). Thus in visits on flowers there are time and place division.

The aim of these studies is to find out what assures the connections between daily butterflies (*Lepidoptera: Rhopalocera*) and their food plant.

See in Proceedings Volume II. pp. 79.

# THE SPIDER FAUNA OF THE AGGTELEK NATIONAL PARK
## A GUILD STRUCTURE EXAMINATION OF SOIL SURFACE-LIVING AND PLANT-LIVING SPIDER COMMUNITIES.

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**Abstract:** I have investigated the spider fauna by using Barber traps and grass-net in the National Park since 1992. The traps were placed - mainly in grass communities - on the Plateau, the Szőlőhegy and in the Lófej valley. Furthermore in the Szőlőhegy area I have also collected spiders in the thermophil oak forest and in its edge. I compared the spider communities of different plant associations and areas by cluster analyses and Principal Coordinate Analysis (PCoA). I also examined guild structure of the spider communities that live on the soil surface and those on the plants.

See in Proceedings Volume II. pp. 143.

# FISH-FAUNA OF THE WATERS IN THE AGGTELEK NATIONAL PARK

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**Abstract:** The streams from the territory of the Aggtelek National Park and the proposed Cserehát Landscape Protection Area belonging to it flow into the Bódva and Sajó rivers. Some of the smaller streams, e.g. Barakonyi, Réti, Telkes streams become dry in rainless years. In the others there is water for the whole year. These tested waters are: Sas, Ragya, Debrétei, Vecsem, Pasnyak, Jósva, Ménes, Rakaca, Szuha streams and the swamp at Tornanádaska village.

From this territory data are collected since 1984, but in 1987 and 1993 comprehensive tests were begun to depict the changes and the present status of the fauna.

Beside the estimation of the fauna the age distribution of populations and the growth of the individual species were studied. Our investigation covered the diversity and abundance of fishes living in the streams and rivers. Fishing was done by means of electric fishing machine and towing-net having 0,8 cm mesh size. In the streams 100 m sectors were investigated representing the zonation. Fishing data were collected from 57 sites.

See in Proceedings Volume II. pp. 155.

# SURVEY OF BIRD COMMUNITIES BY REVIER MAPPING IN THE AGGTELEK NATIONAL PARK

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**Abstract:** Populations of several nesting species display a remarkable decline in the last decade. The International Bird Census Commitee (Pinowski-Williamson 1974.) proposed the revier mapping method for the precise detection of these changes as early as in 1974.

Unfortunately this method - demanding much work - did not become widespread in Hungary, although there has been studies to prove its exactness not only abroad (Enemer *et al.*,1976.), but also in Hungary (Moskát 1986.). Despite of these the method was used only in some places and in short term (1-3 years) studies (Moskát 1988, 1990, Füri 1995,Gyurácz 1995.).

See in Proceedings Volume II. pp. 169.

# RED-BACKED SHRIKE R-BS (*LANIUS COLLURIO*) SCIENTIFIC RESEARCH IN THE AGGTELEK NATIONAL PARK (HUNGARY)

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**Abstract:** Until the nineties no noteworthy R-bS research projects have been made in the Carpathian Basin, publication were rather limited to the occasional feeding habits of this species. Only one study dealt with the ecology of the R-bS (Győrfi, 1968) in a more detailed.

In the course of our research we followed the tendency of the breeding birds of R-bS, as the function of the continuously changing land use forms between 1991 and 1995. We have separately analyzed the preferences and successfulness of 3 types of habitats and 3 types of nesting places. We have also attempted to reveal the selection factors influencing the breeding.

See in Proceedings Volume II. pp. 163.

# FISHFAUNISTICAL DATA FROM RIVER BÓDVA IN THE AREA OF THE AGGTELEK NATIONAL PARK

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**Abstract:** Between the 9th-16th of September 1994, I carried out a fishfaunistical survey on a section of river Bódva from the mouth of the stream Jósva to the road-bridge at Szalonna. The research was carried out with small-size nets.

I could catch altogether 21 species, among which there were 8 protected ones. Comparing this with the results of previous surveys the number of species seems to be acceptable. The *Barbus peloponnesius petényi*, the *Alburnoides bipunctatus* and the *Gobio kessleri* occured in large numbers among the protected species on the sample section. With the knowledge of earlier publications it seems that habitats of slowly flowing water have decreased on a large scale. The number of fish species typical of such habitats have fallen as spawning conditions are lacking. The small number of mature individuals of the *Leuciscus cephalus*, *L. leuciscus*, *Chondrostoma nasus* and the *Barbus barbus* indicates human interference or migration.

See in Proceedings Volume II. pp. 151.

# THE MACROSCOPIC FUNGI (*BASIDIOMYCETES*) OF THE "AGGTELEKI-KARSZT"

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Abstract: The fungus flora (*Basidiomycetes*) of the "Aggteleki-karszt" was studied during six (1987-1992) years (Locsmándi 1994). We collected mushrooms on the territory at about 36 times, first of all in the rainy period of early summer and autumn.

The investigations fill a gap on this field because it has been carried out neither floristical nor taxonomic examinations on the fungi of this region.

As a result of 36 collections 2313 records of 526 taxa (32 species new for Hungary and 103 rare) are documented.

See in Proceedings Volume II. pp. 39.

# A COMPARATIVE STUDY ON GRASSHOPPER (*ORTHOPTERA*) COMMUNITIES IN THE AGGTELEK BIOSPHERE RESERVE

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**Abstract:** 12052 grasshoppers were collected using a sweep-net and special 25cm-diameter-pitfall-traps at 25 sampling sites in 9 locations within the ABR in August 1994 and 1995. The two sampling methods were carried out in a parallel way.

Principal co-ordinate analysis (PCoA) was used to find out if the communities can be classified. We have found that the communities form two definitely separate groups and one uncertain, transitional group (the sampling sites of Lófej Valley). This latter can be recognised only by the results of cluster analysis, if the resemblance matrix was counted by a binary distance function (Jaccard): in this case the sweep-net samples from Lófej Valley are in the "Szőlő Mountain group" while the pitfall-trap samples collected from the same location are in the "Szilice Plateau group". Counting with a quantitative resemblance function (Matusita) the results are similar to the outcome of PCoA

See in Proceedings Volume II. pp. 109.

# BIOINDICATION OF HABITAT CONDITIONS WITH BRYOPHYTES AT SOME STREAMS IN AGGTELEK NATIONAL PARK AND BALATON-FELVIDÉK REGION, HUNGARY

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**Abstract:** The quality of water and near-water or aquatic habitats are often brought into the focus of nature conservation. Chemical and physical parameters are generally used for the determination of water quality. However, these parameters are continuously changing and average values give only superficial information about the influence exercised on the inhabitant organisms.

Bacteria, algae, aquatic invertebrates and fish are often used for bioindication of water quality, especially saprobity (the organic material dissimilation capacity of the water ecosystem, which is related to the quantity of organic materials in the water). There are data available on the use of bryophytes living in running water (Frahm 1974, Empain 1973, 1978, Peñuelas & Sabater 1987, VrhovŠek& al. 1984, 1985).

Investigations on the correlation between bryophyte vegetation and water quality were carried out in several mountain streams in Hungary. Hereby the results of research at two calcareous areas (Aggteleki-karst and Balaton-felvidék region) are presented.

See in Proceedings Volume II. pp. 47.

# STUDIES ON THE ORTHOPTERA FAUNA OF THE AGGTELEK KARST

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**Abstract:** Research of the Orthoptera fauna of this region, which is a very promising one in a faunistic and biogeographic point of view because of its geographic situation as well as surface and climatic conditions, began from the late 50's, and became to be regular from the middle of the 70's.

In the beginning the only purpose was to explore this group, which is so important in the grassland associations, as entirely as possible. In the knowledge of the results and having floristic and coenological data, and data of other investigated insect group of high importance (*Lepidoptera: Diurna and Noctuidae; Coleoptera: Carabidae*), beyond the above mentioned studies, we could undertake a role in declaring the territory to be a Nature Protection Area, and, later, in the formation of the National Park.

Quantitative collections supplemented microclimatic measures (Parragh 1987, Mező 1990, 1991) aimed at complex quantitative (faunistic, biogeographic, life-form types) studies to identify Orthoptera associations of some characteristic grass associations, and to trace their changes. Importance of these studies is that Orthoptera assemblages belonging to grass associations of near-natural, abandoned and different antropogenic areas could be simultaneously studied in a relatively small area.

Simultaneously, by population-dynamic study (capture-recapture) of some species (Mező 1992), we would like to answer the following questions:
(1) how populations of these species are closed or opened, i.e., how sensitive they are for changes of the relevant environmental factors,
(2) if there is territorial behavior of males of the studied species or not.

During the recent period of our research spreading pattern of Orthoptera species (Orci 1996) as well as life-form spectrum of Orthoptera associations of the different grass associations (Rácz and Varga 1996) were analyzed.

As a result, we would like to get data that are proper to found decisions about nature protection management of grass associations of different history and condition.

See in Proceedings Volume II. pp. 99.

# BIOGEOGRAPHICAL OUTLINE OF THE INVERTEBRATE FAUNA OF THE AGGTELEK KARST AND SURROUNDING AREAS

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**Abstract:** The Aggtelek karst is an area of overlap of several different biogeographical influences. Endemic taxa have been evolved here mainly in cave-dwelling animals (e.g. cavernicolous *Palpigradi, Isopoda, Coleoptera: Carabidae* etc.). Relict-like species inhabit the karst springs, they are in part Carpathian (*Sadleriana pannonica*), in part boreo-montane (*Crenobia alpina, Drusus trifidus, Rhyacophila septentrionis*) elements. Carpathian (incl. Carpathian-Sudetic) species are present in more different taxonomical groups (*Gastropoda, Orthoptera, Trichoptera, Coleoptera: Carabidae*). Some of the Dacian elements (*Pholidoptera transsylvanica*) reach here a westernmost boundary of distribution. Occurrence of numerous xeromontane insects (*Orthoptera, Lepidoptera: Noctuidae*) is connected to special edaphic and microclimatic conditions (xerothermic habitats with physical weathering). Those boreal (Siberian) species which usually occur at higher elevations of the Carpathians, often appear here in relatively low altitudes (e.g. in gorges or dolinas). Their populations are, however, subjected to significant fluctuations due to the recent climate changes; some of them are threatened marginal isolates. Ponto-pannonian steppe and forest-steppe elements could colonise this region through the valley of the river Bódva. Some of them are in decrease or vanishing due to the retreat of the traditional land-use (*Tettigonia caudata, Oria musculosa, Odice arcuinna* etc.). Submediterranean-pontomediterranean species are abundant in xerothermic oak forests, white oak scrub forests, steppe and rocky grasslands. Numerous species of this type reach here a northernmost limit of their geographical range.

See in Proceedings Volume II. pp. 87.

# CHANGES IN SPECIES COMPOSITION AND ABUNDANCE OF LEPIDOPTERA IN THE AGGTELEK KARST

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**Abstract:** Characteristic changes in species composition and abundance were observed within the following biogeographical components.

1. Species of the Siberian faunal type, connected to humid (mesophilous-wet) meadows. General tendency: decrease, with fluctuations in some years.
2. Species of the Siberian faunal type, connected to montane-subalpine elevations. They can be observed only in some years as a consequence of marginal area fluctuations.
3. Xeromontaneaous species of rocky grasslands with scarce populations. Because they fluctuate near the lower limit of observability, they seem to appear only in some years.
4. Xeromontane species of rocky grasslands with stable populations. They belong to the most typical and valuable species of the karst area. A slight increase (with fluctuations) of their population densities was observed during the last 15 years of drought.
5. Steppe-grassland species, typical for lowland and lower colline areas. They have, as a rule, a low, slightly fluctuating density without any marked tendency of change.
6. Mediterranean (submediterranean, ponto-mediterranean) species connected to the xerothermic oak forests and scrub-forests. They have stable but not very dense populations, near to the northernmost boundary of distribution.
7. Generally distributed specxies of colline-submontane deciduous forests. They have a high species number and mostly strong populations with insignificant fluctuations incl. slight decline in years of drought.
8. Siberian and southern continental species being in extension of their geographical range. Some of them are connected to wetlands, others to coniferous plantations. They could not reach, however, a harmful level of density.
9. Species connected to the traditional land use and segetal weeds.They are vanishing since the end of the sixties.
10. Protected species of high conservation value, connected to mixed broadleaved forests and forest-skirts and forest-steppe association complexes. They are vanishing or at least seriously threatened almost in the whole country. The Karst area is one of the most important refuges of numerous such species.

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