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GENETIC TYPES, HUMAN IMPACT AND PROTECTION OF HUNGARIAN KARSTS

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Összefoglalás – A magyarországi karsztoknak két típusát különböztetjük meg: az aggteleki típust és a dunántúli típust. A dunántúli típus karsztjain tektonikai mozgások hatására a mészkő és dolomit blokkokra töredezett. Ezeken a karsztokon csak néhány dolina, víznyelő található, legtípusosabb felszíni forma a karr felszín. Az aggteleki típus tektonikailag kevésbé zavart és típusos karsztformák jellemzik. Környezeti hatások szempontjából a karsztok igen érzékeny területek. A karsztos tájak átalakulása az ősember megjelenésével indult. Az ősember a tűzifát a karsztokról gyűjtötte be, s ezzel megkezdődött az erdőirtás a karsztokon. Később az emberi beavatkozás egyrészt a mezőgazdaság, másrészt az ipar révén módosította a karsztok formálódását. Két karszt terület nemzeti park hazánkban, emellett néhány karsztunk természetvédelmi terület. A Természetvédelmi Törvény (1996) a forrásokat, dolinákat, barlangokat, az endemikus flórát és faunát, valamint a biotópokat védetté nyilvánította. Megállapíthatjuk, hogy a karsztok Magyarországon többnyire védettek, de napjainkban még vannak konfliktusok a természetvédelem és a tájhasználat között.

Abstract – There are two major types of Hungarian karsts: Transdanubian type and Aggtelek type. The Transdanubian type consists of those karsts that were significantly affected by tectonic movements and they are faulted into blocks of limestone and dolomite. Surface features in these karsts are scarce, only a few dolines and gorges are present, and karrenfields are the most typical features. The Aggtelek type karsts are tectonically less disturbed and usually characterized by typical karst features. From an environmental point of view, karsts belong to the most sensitive areas. Landscape transformation in the karst environment started with the appearance of early humans. Early man gathered firewood from the karsts, thus the deforestation of karst regions began. Later human activity modified karst formation due to agricultural activity on the one hand and by industry on the other. In Hungary two karst areas (Bükk- and Aggtelek Mts.) have been designated as national parks, and some are nature reserves. The Law on the Protection of Nature (1996) declared all the springs, dolines, caves, endemic flora and fauna protected. We can say that the karst areas of Hungary are mostly under protection but we still have some conflicts between nature protection and landuse on the karsts.

Key words: Hungarian karsts, genetic types of karsts, human impact on karsts, protection of karsts

INTRODUCTION

Hungary is situated in the central part of the Carpathian basin, surrounded by the Alp- Carpathian and the Dinaric mountain chains. Its area is 93,030 km^2. Its karst area is small, only 1.45% of the country's territory (1350 km^2). The climate is moderately continental, more precisely a transition between oceanic and continental climates. Sunshine duration is 1700-2100 hours; the annual average temperature varies between 8-11 ^{o}C. The annual precipitation is higher in the western regions (6-800 mm) than in the eastern parts

(5-600 mm). The main wind direction is northwest-southeast, but in the east north-eastern winds are common as well.

The characteristics of Hungary's geomorphology are determined by the Mesozoic karst blocks of the Transdanubian Mountain Ranges, the volcanic ranges of the Northern Mountain Ranges and the submerging basins of the Great and Small Plains. The general course of Hungarian Middle Mountain Ranges follows a southwest-northeast axis, the average height of the mountain ranges is below 1000 m. The geomorphologic characteristics of the country were further modified by Quaternary sediments, present in most areas.

The vegetation of Hungary, (the pannon flora domain), belongs to the Middle-European flora territory in the holarctic flora empire. The natural vegetation of the mountains consists of deciduous forests (Quercus, Fagus), while those of the forested steppe in the plains are either grasslands (on loess, sand or lick) or oaken (Quercus robur) groves. Only 15 % of the country's area is covered with natural vegetation.

In the above-mentioned environment the karst areas of Hungary are isolated patches within masses composed of volcanic rocks or sandstone. The tectonic and hydrological environments are varied; the karsts have diverse morphostructures (*Jakucs,* 1977).

Generally we can say that the karst areas of Hungary are mostly protected. Besides the different environmental factors man changes the natural condition of karsts.

DISCUSSION

Geomorphology evolution of Hungarian karsts

In the Palaeozoic and Mesozoic era the massif Tisia, remainder of the Variscides, was situated where now the Carpathian basin lies. Nowadays only isolated patches of this massif can be found on the surface in Hungary. During the Mesozoic era the sea Tethys covered it; the limestone and dolomite of the Transdanubian and Northern Mountain Ranges are of Triassic origin. The western parts of Mecsek Mountains also consist of Triassic limestone while the limestone in the eastern parts is of Jurassic origin.

By the end of the Mesozoic era, today's Transdanubian Mountain Range became part of the mainland. As a consequence of weathering in a subtropical climate karst bauxit formed on the limestone and dolomite, which was covered by marine sediments later, during the Cenozoic era. In the upper Tertiary period the area of the Carpathian basin was still a mainland of average height. During the lower Tertiary period the surrounding mountains began to emerge and the basin was formed. On the margins of the basin, along the faults, Europe's most intense volcanic activity took place. This activity resulted in the formation of the volcanic ranges of Börzsöny, Cserhát, Mátra and Zemplén Mountains. In the end of the Tertiary period the Pannon Sea covered the area of Hungary and that's when today's Great Plain submerged and the crystalline base became covered with marine sediment to a depth of 2-3000 m. When the sea was gone the pannon sediments were overlain by fluvial sediments of several hundred m depth. In Transdanubia and at the pediment of the mountains the pannon sediments formed hills. After the retreat of the Pannon Sea, the mountain ranges rose a further 2-400 m and their rise is continuous even today.

Genetic types of Hungarian karsts

Most of Hungary's karst areas are situated in the Transdanubian Mountain Ranges (*Fig.1*). They mostly consist of Mesozoic (especially Triassic) limestones and dolomites. The members of the Transdanubian Mountain Ranges in order from southwest are the Keszthelyi Mts (dolomite), the eastern area of Balaton hills (Mesozoic dolomite karsts), the Bakony Mts (Triassic limestone and dolomite karsts), the Vértes Mts (Triassic dolomite), Mt Gerecse (Triassic limestone karsts), Mt Pilis (Triassic limestone karsts) and the Budai Mts (hydrothermal karsts) with the Tétényi plateau (Sarmatian limestone).

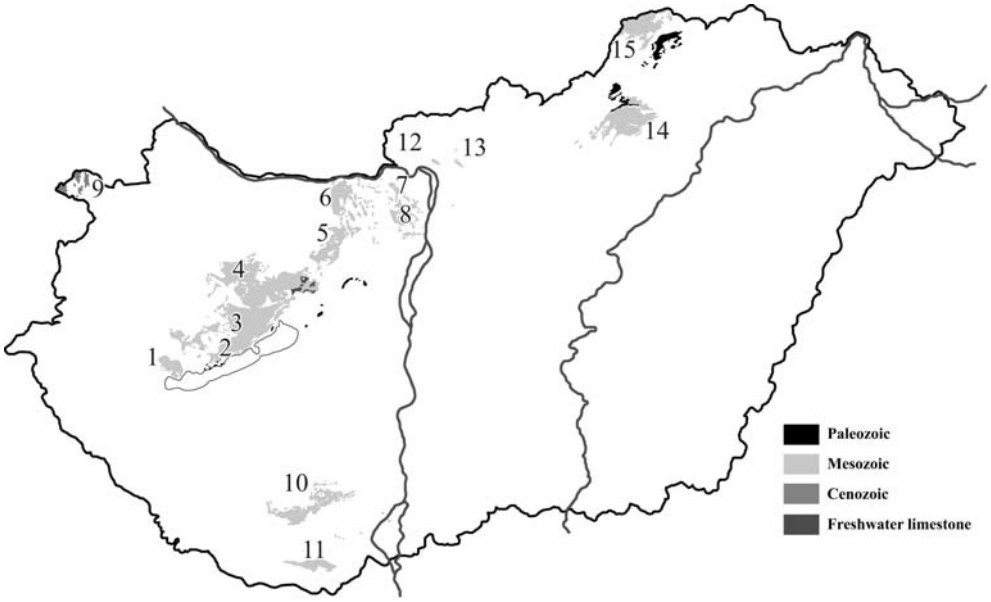

Fig. 1 Location of Hungarian karsts
1.Keszthely Mts., 2. Balaton Highland., 3. Southern Bakony Mts., 4. Northern Bakony Mts., 5. Vértes Mts., 6. Region of Gerecse Mts., 7. Pilis Mts., 8. Buda Mts., 9. Lajta Hills of Fertőrákos., 10. Mecsek Mts., 11 Villány Mts., 12. Szokolya Basin and Törökmező in the Börzsöny Mts., 13. Naszály, Romhány Mt. Csővár Mt. in the Region of Cserhát Mts.

In the Northern Mountain Ranges a few smaller limestone patches (Lajta limestone in South-Börzsöny, and the smaller blocks in Cserhát Mountains: Mounts Naszály, Romhányi and Csővári) can be found as foot hills of the main volcanic range. Karst areas in the Bükk and Aggtelek Mountains consist of Triassic limestone and dolomite.

Isolated karst blocks similar to the latter are situated in the south-eastern parts of Transdanubia: the Mecsek and Villány Mountains with the karst block of Beremend (Triassic and Jurassic limestone karsts), there's also an isolated patch in Transdanubia's north-western corner, at Fertőrákos (Lajta limestone)

Karst areas in Hungary are varied in terms of their geological composition, tectonics, landscape evolution and geomorphology (features both above and under the surface) alike. There are two major genetic types defined on the basis of the factors above: Transdanubian type and Aggtelek type.

The Transdanubian type consists of those karsts that were significantly affected by tectonic movements (like all those in the Transdanubian Mountain Range) and they are

faulted into blocks of limestone and dolomite. Surface features in these karsts are scarce, only a few dolines, sinkholes and gorges are present, and karrenfields are the most typical features. They are rich in caves and features formed by hydrothermal activity. Traces of the karstification that occurred on the border of the Cretaceous and the Paleocene were preserved under the coal and bauxite deposites.

The Aggtelek type karsts are tectonically less disturbed and usually characterized by typical karst features. They abound in both surface and underground features, their typical features include karrenfields, solution dolines and dry valleys. Caves (sinkhole caves, spring caves, through caves) are common. Karst areas of the Bükk, the Aggtelek-Rudabánya Mts and the western parts of the Mecsek Mts. belong to that type.

In Hungary's karst areas Triassic and Jurassic limestones are the most common rock types. The Triassic, Jurassic and Cretaceous limestones and dolomites of the sea Tethys can be found in both the Northern and Transdanubian Mountain Ranges, also in the Mecsek and Villányi Mts. These rocks are ideal for carstification and allow the formation of a rich variety of karst features.

Caves are important part of Hungary's natural resources. At the beginning of the 20th century, 200 caves were listed, while at the end of the century, 1314 were known. Nowadays, due to the increased interest in discovery research, 3700 caves are registered by the Institute of Speleology (*Székely,* 2003). Most of these can be found in the Bükk and Bakony Mts. There are 29 caves longer than 1 km, while 99 exceed 200 m in length. Longest of them is the Baradla cave in Aggtelek (25 km together with the Domica cave in Slovakia). The connection between Pálvölgyi and Mátyáshegyi caves in the Budai Mts. was revealed only in 2001, and together they form the second longest cave in Hungary (19 km). The third one, (the Béke cave in Aggtelek) is 7.2 km long. The deepest of the caves, the Istvánlápai cave can be found in the Bükk Mts, with a depth of 250 m.

Hungarian karsts are mostly residual karsts (*Jakucs*, 1977); the traces of earlier karstification are clearly noticeable in several places. Tectonic activity affected the formation of both surface and underground features. Hydrothermal phenomena are common. The most significant thermal water activity with cave and mineral formation, also specific surface rock features occurs mostly on Triassic dolomite and limestone, especially in the Budai and Keszthelyi Mts., also in Miskolc-Tapolca, situated in the foreground of the Bükk Mts. Hydrothermal activity with cave and mineral formation, sometimes also with special surface rock features, occurs especially on Triassic dolomite and limestone. These formations are the hydrothermal caves, dolomite powder, siliceous rock towers, pinnacles, travertines. The surface karst formations are the round karren with root karren, which are exposed at the surface. Typical bare karrenfields occur in Aggtelek and Villány Mnts., but similar formations can be found in the Transdanubian Mts. at Veszprém, Hajmáskér, Várpalota and Budaörs. On the Aggtelek type of karst occur the solution dolines. These features are primarily situated in formerly river valleys or on plateau surface as individual dolines. Erosional karst valleys and different cave systems are the results of erosion processes. These formations occur both in the Transdanubian and Aggtelek type karsts.

Human impact on karst in Hungary

From an environmental point of view, karsts belong to the most sensitive areas. Due to its open hydrological system and 3-dimensional reaction surface a karst area reacts very fast to anthropogenic activity.

Both fossil and recent karst features occur on Hungarian karsts. During the latest phase of karstification, landscape transformation in the karst environment started with the appearance of early humans. In the Middle and Upper Pleistocene prehistoric man used caves in Hungary. Early man gathered firewood from the karsts, thus the deforestation of karst regions began. Later human activity modified karst formation by agriculture on one hand and by industry on the other. Agricultural activity was intensive in Aggtelek and Villány Mountains at the turn of the century. For this reason soil erosion was so widespread that rock solution decreased. At the same time the microclimate and vegetation were also modified. With industrialisation and the beginning of mining, the undesired ground waters were pumped out.

In some of my previous studies, I have already introduced the model which summarises the connections of the karst ecological system (*Bárány-Kevei 1998a, 1998b*). Connected to this model, I study those factors and processes, which are relevant from the point of all the processes of the landscape changes in any karst environment. The climate-soil-vegetation system has crucial importance from the point of view of karst dynamism. The changes of these factors influence the intensity and tendency of the landscape change processes. The environmental problems in the Hungarian karsts are the following:

- In the karst region of Transdanubia bauxite mining resulted in the decrease of the karst water table from the '50s until the '90s.
- Industrial and agricultural pollution damaged the karst, which provides a very important drinking water supply in the mountain regions.
- The degradation phenomena of Aggtelek karst can be related to earlier agricultural use. At the same time the grazing demand of the settlements also exceeds the necessary extent.
- Agricultural and industrial use of the karst results in the soils being contaminated by heavy metals.
- Acidification of soils causes dripstone re-dissolution in some caves.
- In the Bükk Mountains forest management caused some places to develop extreme microclimate, which makes forest regeneration more difficult.
- Quarrying processes damage some Hungarian karsts.

The combinations of the above-mentioned processes prevail in a number of sites. The primary objective of this study is to point out the fact that environmental factors directly and indirectly affect the environment-sensitive karsts via different spheres of the karst system and these often disrupt the balance of the whole system. For this reason their research has been carried out in a complex manner; knowing the mutual effects of the processes it is possible to make suggestions for the planning.

The protection of Hungarian karsts

In Hungary, the Law on the Protection of Nature, which came into force in 1996, declares that "in karst areas, all the springs with a yield more than 5 l/min, all the dolines, caves, all endemic flora and fauna and their biotopes are under protection". Consequently in these areas all intervention changing the natural ecological state should be avoided.

Two karst areas have been designated as national parks (*Fig.2*), the first of them, Bükki National Park in 1976. Aggteleki National Park came into being in 1985. Together with the caves of the Slovakian karst, it is a UNESCO World Heritage site. In the national parks all the geological features, caves, springs, waters, natural flora and fauna are under strict protection.

In addition to these two national parks, there are several nature reserves, like the Gerecsei, Pilisi and Vértesi which include certain strictly protected areas.

In Hungary there are 29 caves longer than 1 km, while 99 exceed 200 m in length. Longest of them is the Baradla cave in Aggtelek (25 km together with the Domica cave in Slovakia). The connection between Pálvölgyi and Mátyáshegyi caves in the Budai Mts. was revealed only in 2001, and together they form the second longest cave in Hungary (19 km). The third one, (the Béke cave in Aggtelek) is 7.2 km long. The deepest of the caves, the Istvánlápai cave can be found in the Bükk Mts, with a depth of 250 m.

In European standards, the protection of karst areas and caves is very advanced in Hungary, due to the Law on the Protection of Nature and the Ministry of Environment Protection, which operates the Institute of Speleology to ensure high-level karst protection.

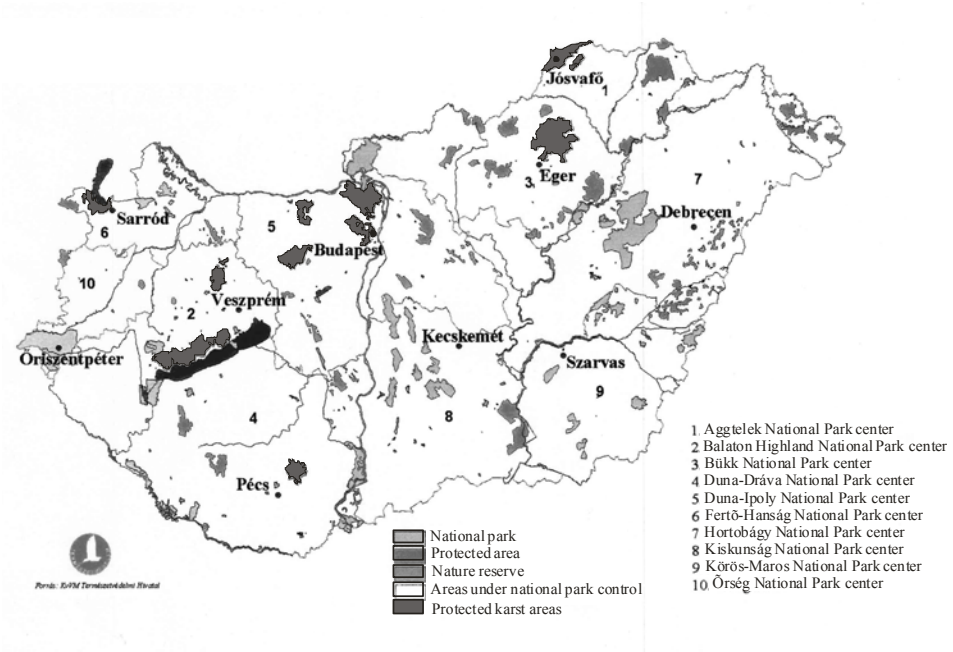

Fig 2. Protected areas of Hungary

CONCLUSION

(i) There are two major genetic types of Hungarian Karsts: Transdanubian type and Aggtelek type. Two karst areas (Bükk- and Aggtelek Mts.) have been designated as national parks, and some are nature reserves. Early man gathered firewood from the karsts, thus the deforestation of karst regions be gan. Later human activity modified karst formation by agriculture on one hand and by industry on the other.

(ii) The environmental factors directly and indirectly affect the environment-sensitive karsts via different spheres of the karst system and these often disrupt the balance of the whole system.

(iii) Generally we can say that the karst areas of Hungary are mostly protected. Besides the different environmental factors man changes the natural condition of karsts.

(iv) In the future we have a duty to manage the conflict between nature protection and landuse.

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