INVESTIGATIONS ON THE FLORA AND VEGETATION OF KESZTHELY HILLS (HUNGARY) WITH SPECIAL REGARD TO THEIR SOUTHERN ELEMENTS

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Abstract

Studies on geographical properties - especially from the point of view of phytogeography - are summarized by the author with a brief historical review of botanical investigations of Keszthely hills.
Keszthely hills with their highest point of 447 m above the sea level - are the western constituents of the Hungarian mountain range of medium height level. From the point of view of floristical geography they belong to the Balatonicum floristical district (on the northern shore of Balaton) of Bakonyicum floristical region in the Pannonian flora. The territory of Keszthely hills is dissected into two parts: the Northern basalt- and the Southern dolomite region by the Pannonian sediments of Vindornya-Zsid-basin (Fig. 1.).
The dolomite vegetation of Keszthely hills can be regarded as one of the areas of the richest floristical composition in Hungary because of several phytogeographical properties as follows. Pannonian endemisms, European, Eurasian elements take part up to 50 % of the flora. Serious evolutionary effect has been taken on the establishment of endemic species and plant communities by the litological and geomorphological features of dolomite raw material(e.g. *Sesceli leucospermum*, karstic dolomite grass and shrub vegetation *Festuca pallens-Seseli leucospermum* swards, *Fraxinus ornus-Quercus pubescens-Cotinus coggygria* shrubs). The Northern slopes of cold microclimate play a role as shelters for glacial relict vegetation(e.g. *Primula auricula subsp. hungarica, Festuca pallens-Bromus pannonicus* swards, *Calamagrostis varia, Carex alba, Fraxinus- Fagus* mixed forests). The grass and shrub communities of hillsides of Southern exposition contain several thermophylous species of Illyric, Submediterranean and Subatlantic regions(e.g. *Hippocrepis comosa, Daphne laureola, Jurinea mollis* - beside the species of the Pannonian sand region - *Fumana procumbens, Onosma visianii, Iris arenaria*...) A number of species demonstrates the historical-phytogeographical importance of Archimatricum(the medium height mountains) on the floristical migration and on the development of vegetation in and after the Glacials from the Carpathians to the Hungarian Plain(e.g. *Daphne cneorum subsp. cneorum, Dianthus lumnitzeri, D. plumarius, Stipa-species*). Some Submediterranean-Subatlantic species reach the Northern-North- Eastern border of their area in grass and forest communities of the region studied(e.g. *Ruscus aculeatus, R. hypoglossum, Asphodelus albus, Tamus communis, Cyclamen europaeus, Ophrys fuciflora*). Several species of Boreal, Alpine and Carpathian origin increase the richness of vegetation(e.g. *Sphagnum species, Drosera species+, Andromeda polifolia+, Cimicifuga europaea, Cardaminopsis petraea, Leontodon incanus* and *Myurella julacea, Scapania calcicola bryophytes*). The forest communities of Keszthely hills are enumerated on the basis of climatic zonality:
- communities of climatic zonality are *Quercus cerris-, Q. petraea-, Quercus- Carpinus* forests,
- extrazonal communities are *Fagus*-forests,
- intrazonal communities are *Fraxinus ornus-Quercus pubescens-Cotinus coggygria* shrub-forests,
- azonal(non-zonal) communities are *Alnus glutinosa* groves with *Petasites hybridus* or with *Dryopteris cristata, Salix cinerea bushes* with *Sphagnum species* and *Thelypteris palustris*.
A number of exogenetic vegetation units developed by human activity can be distinguished in this area(e.g. pastures heavily grazed earlier but degradated today, *Pinus nigra, Larix decidua, Quercus borealis* plantations, *Robinia pseudo-acacia* forests).

Introduction

When regarded from a phytogeographical point of view, the Keszthelyi-hegység (Keszthely hills) the westernmost member of the Dunántúli-középhegység (the Transdanubian hill range) together with the basalt hills and the Balaton-felvidék (Balaton highlands) constitutes the Balatonicum flora district of the floristic region of the Bakonyicum in the Pannonicum (Pannonian flora sector). It's the outermost stretch of the Pannonian floristic regions where the effect of other floristic areas can also be felt.(Fig. 3.,Fig. 2:3c)
The range of medium height hills (mountains) was a significant factor in the development of flora and vegetation of the neighbouring hills and plains. "*The Bakony hills (their southern slopes, the Balaton coast),*

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the broken range of the Vértes, the Pilis, the Nagyszál, the Cserhát, the Mátra, the Bükk and the Hegyalja hills can be considered as a chain if regarded from botanical point of view" - wrote BORBÁS (1900). As opposed to the other floristic territories of Europe, this range together with the surrounding plains have individual, specific phytogeographical features.

This range of hills being almost continuous is on one hand the preserver of the ancient saxatile vegetation of the Carpathians and the Balkans, bridge of the flora migrations of the northern and southern chain of mountains. On the other hand, this is where the flora of the plains situated on either side comes from. This "*Ancient-Matra*" theory of BORBÁS, who after KERNER's "Pontian story" (1863 referred by RAPAICS1918) more properly considers that the phenomena of karst and steppe formation, which are from a certain aspect parallel with each other, are important not only because of the identical species but because of the 2 phenomena's different species substituting one another.

The theory is proved by several common, in most cases endemic species as included in the list of the endemisms of the Balaton district, the Ősbakony (Ancient Bakony) by BORBÁS 1900. From the "*aged natives of the Bakony*" he considers the *Seseli leucospermum* the most remarkable, calling it "*a really enigmatic phenomenon of phytogeography*".

The most important flora dividing is established by the Danube's breakthrough at Visegrád, which divides the Ősmátra (Ancient-Matra) into two remarkably different groups of flora regions. North-east of this "*Middle-Danube flora divider*" (ZÓLYOMI1942) there are mainly areas of Transsylvanian, East-Balkanic, more continental species; south-west of it there are mainly Mediterranean, Illyric and several other species of southern origin reaching the north boundary of their area here.

Under the specific environmental influence of the dolomite rock bed (physical erosion, restricted soil erosion, steep slopes, ridges, microclimatic variability) the *dolomite phenomenon* is represented in endemic and relic species, development of varied plant communities of relic plants which remain inside or hardly extend over the boundaries of the middle-height mountain territory. The boreal, pre- or interglacial relic species often join the community of relict closed dolomite grass and mixed karst forest. ZÓLYOMI (1942) found significant differences of saxatile plant communities of the Ősmátra (Archimatricum) on limestone and dolomite.

The present investigation gives an outlook on the phytogeographical relationships of the flora of Keszthely hills, on the basis of geological and climatical conditions and as a consequence of the peculiarities of its vegetation.

Physical environment

The Keszthely hills and the Bakony are connected by Triassic formations. The hills got their name from their central settlement the town situated at the southern feet, Keszthely. The configuration of the terrain is the result of polygenetic development (MAROSI-JUHÁSZ-SZILÁRD 1984) (Fig.1.). It's main row material is the upper Triassic dolomite with marl and blanked limestone laying on eroded Permo-Carbon, middle- and lower Triassic layers (PÁLFY1981). According to LÓCZY (1913) and BULLA (1928) it's morphogenesis originates in Jurassic-Cretaceous fractures. The basalt-tufa and lava top layer of the Tátika-Kovácsi hills, so rich in geological formations, was developed by Pliocene volcanic activity and by the deflation of the Pannonian deposits. At places carbonate bound Pannon sandstone is also characteristic.

The soil formation on the dolomite bedrock starts from a moving skeletal soil, then black and brown rendzina gets formed. The soil formation on basalt mesa proceeds towards the dark forest soils. The peat of the Vindornya and Zsid basins is drained and exploited to day, there are boggy meadow soil and destroyed peat bog.

The annual precipitation of the Keszthely hills is rather steady, the average being 715 mm, 20-25 % of which falls in spring, cca 30-30-15 % falls in summer, autumn and winter, respectively (Fig. 5.). All this has resulted in the formation of the most beautiful and sometimes in spite of the unfavourable soil conditions, the biggest continuous forests of Balaton region. In the hills the climatic differences are caused by the relief of the ground. There is a sharp difference observed between the hot, dry southern slopes and the cooler northern sides. There are some really cold microclimatic corners as shelters for glacial relics *Primula auricula, Calamagrostis varia, Carex alba*, the closed dolomite slope association of grey fescue (*FESTUCO PALLENTI-BROMETUM PANNONICI*), the mixed karst forest of *FAGO-ORNETUM*. According to CHOLNOKY (1900) the hills belong to the Balaton reservoir. Owing to their N-S inclination some of their waters run directly into the Balaton, other get there in a stream and temporary

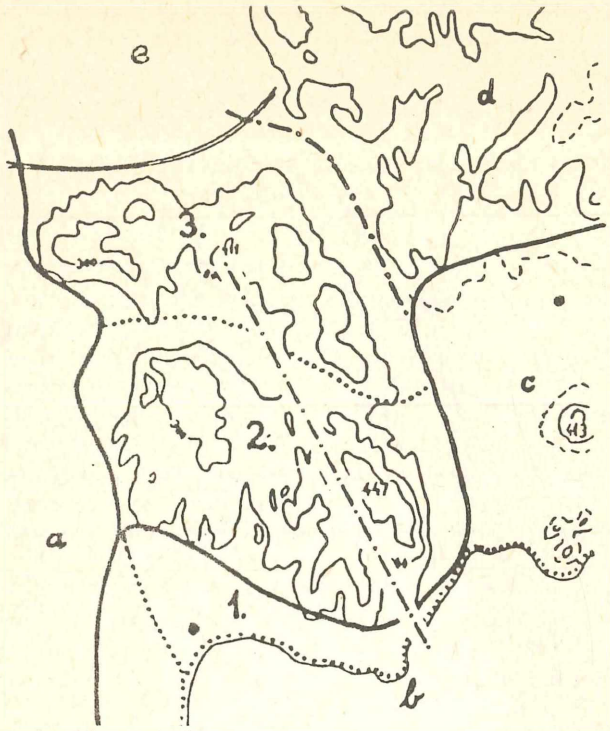

Fig. 1. The geographical units of Keszthely hills

1. Hill foots and lake shore ("Balaton-Riviera")
2. Dolomite plateu
3. Basalt hills
_._. the direction of the cross-section represented in Fig. 4.
• Keszthely

a. Zala hill country
b. Balaton
c. Tapolca basin
d. West-Bakony
e. The cathment area of Marcal river

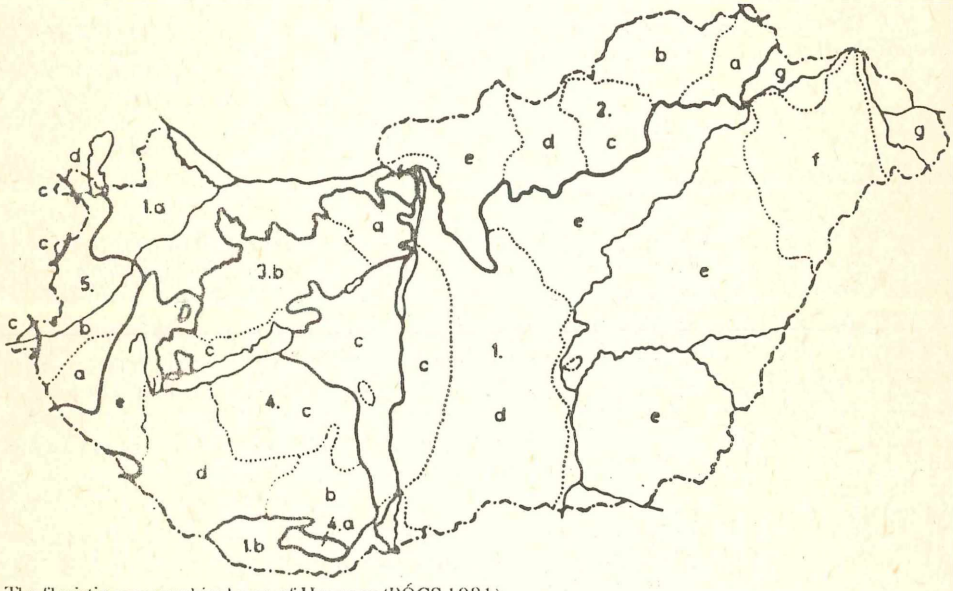

Fig. 2. The floristic-geographical map of Hungary (PÓCS 1981)

I. Pannonicum, 1. Eupannonicum, 2. Matricum, 3. Bakonyicum, 4. Praeillyricum 5. Praenoricum
II. Carpathicum
III. Noricum
IV. Illyricum

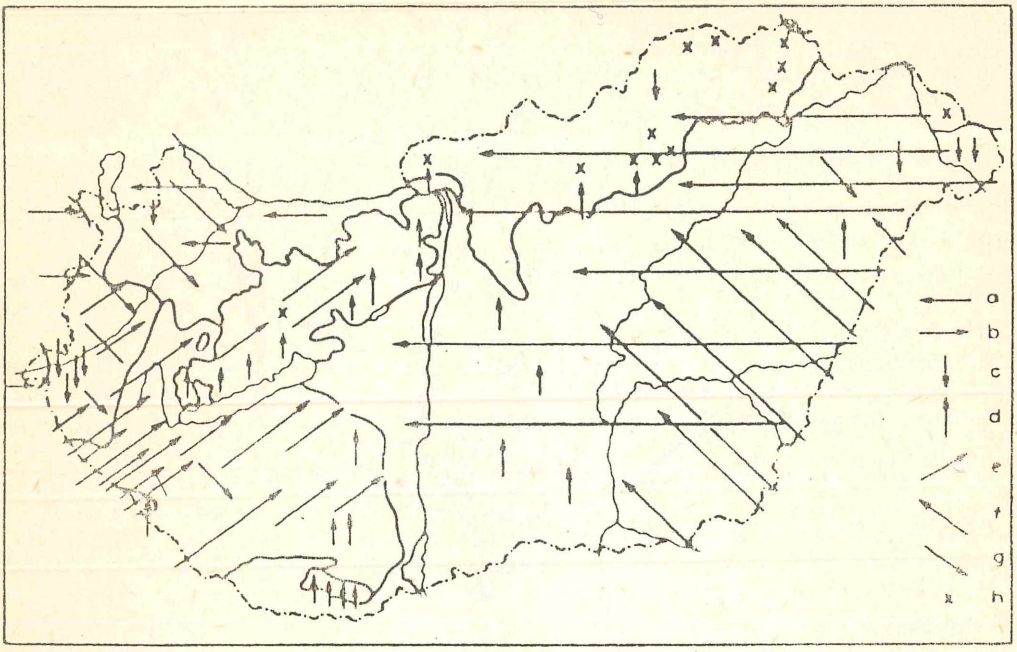

Fig. 3. The distribution of the areal-geographic elements in Hungary by PÓCS 1981 (The length and density of arrows depends on the frequency and phytogeographical importance of the elements.) a - Continental, b - Alpine and Subalpine, c - Boreale, d - Mediterranean and Submediterranean n, e - Illyric and Alpine-Balkanic, Pontian, Pontic-Mediterranean, f - Subatlantic, Atlantic, h - Carpathian

brooks. The river Marcal carries only a little water into the Danube from the northern edge. There are karst springs between Keszthely and Balatongyörök at the foot of the dolomite slopes, only two of them gushing forth inside the plateau.

Development of the floristic investigation

The beginning of the floristic researches of the Keszthely hills was summarized by BORBÁS (1900). In his classical work he evaluated KITAIBEL's travel diaries (from 1799), his Additamenta (KANITZ after 1863), ÁRVAY's plant list from 1804, some of HUTTER's plants from the early 1800-es, WIERZBICKY's manuscript and 30 wonderful plant paintings (Plantae Rariores... 1820), the Elenchus Plantarum of "reliable botanists" SZENCZY-HUTTER-WIERZBICKY (1843), articles and essays by SZENCZY (1847, 1863), HEUFFEL (1856), POKORNY (1860), HABERLANDT (1861), SIMONKAI (1874); personal communications, plants sent by CZAKÓ, DEGEN and PIERS. WIERZBICKY PETER, whose life verged on the romantic, used to be a teacher at the GEORGIKON later fell victim to his profession (GOMBOCZ 1936, BODNÁR 1955, PRISZTER 1959).

After his Flora Mosoniensis he described and illustrated the rare plants of the Keszthely area (Plantae Rariores... 1820). BODNÁR (1957) presented an until then unknown manuscript by WIERZBICKY: Flora Keszthelyiensis. It containes about 950 plant names cramped on 2 and half pages. It's obsoleted nomenclature was updated by PRISZTER. It was WIERZBICKY who gave the first data of *Ruscus hypoglossum, Eryngium planum, Hemerocallis fulva, Andromeda polifolia, Convolvulus cantabrica, Dentaria trifolia, Comarum palustre, Sternbergia colchiciflora, Drosera rotundifolia, D. longifolia* and many others in the Keszthely area.

Some of the10-20 thousand pages of the Herbarium of the Keszthely Grammmar School were also created by WIERZBICKY, SZENCZY and HUTTER in the 1820-es. The best part of it was collected by NÉMETH DEZSŐ, teacher of biology in the 1820-es (PRISZTER 1959). At the same place PRISZTER mentioned the 33 volume exsiccata of the Balatoni Muzeum with some 1600 pages by SOÓ REZSŐ from 1928-31.

In the enumeration of BORBÁS (1900) some 1000 vascular plants can be regarded to have originated from the Keszthely hills (the helo- and hydatophytes of Balaton are not included). His statement saying *"the literature of the flora region of Balaton apart from a few major publications consists of some rather scanty additional material"* has been true ever since. In the opening volume of the series entitled The results of the Scientific Researches of the Bakony FEKETE (1964) keeping to the structural proportions gave the basic, exact phytocenological and phytogeographical description of the Keszthely hills as a region belonging both geo- and phytogeographically to the Bakony (BULLA 1928, 1962, SOÓ 1960, 1964). The independent botanical description of the Keszthely hills hasn't been created ever since PAPP's botanical bibliography of the Bakony went to press (PAPP 1965).

BORBÁS (1900) wrote that *"the illyric flora ends here* (on the southern coast of the Balaton - auct.) *it's scarcity on the Bakony side"* The same opinion is upheld by SOÓ (1964) et al. and DEBRECZY (1981) as the latest contributors, which means that it is the Balaton along which there is an overlap of the northern, Praeillyricum floristic region of the West Balcanic flora sector through the Bakonyicum floristic region into that of the Eupannonicum. Others are of the more "moderate" opinion that it is only the Villányi hills, the area of Zákány-Őrtilos which belongs to the West-Balcanic flora sector (Illyricum) as it was put by PÓCS (1981) and JEANPLONG (1980) who reconed the Dél-Dunántúl (Southern Transdanubia) as a floristic region belonging to the Pannonicum calling it Praeillyricum. According to BORBÁS (1900) *"the boundary of the western floristic region"* runs from the Vág valley, cuts Csallóköz and Mosoni-sziget almost in half all through the Kemenesalja and the east side of the Zalai-dombság (Zala hill country) towards Zákány and Zrinska Gora (Zrínyi hills). SOÓ as well as PÓCS and JEANPLONG (1980) follow BORBÁS when they mark the Göcsej boundary of the Praenoricum (alpine) floristic region (SOÓ 1962) and the West Transdanubian floristic region classify it as belonging to the Pannonicum (PÓCS 1981 and JEANPLONG 1980).

Opinions vary, however, the floristic boundaries being so near, their influence on the dolomite vegetation is undoubtedly of the greatest values of the Keszthely hills. BORBÁS (1900), GÁYER (1924, 1925), ZÓLYOMI (1950, 1959), BOROS (ined.) agreed that it is the flora of Gyenesdiás that is the most informative

Vegetation features

In earlier centuries forests used to cover a much greater territory of the Keszthely hills as do today. Owing to geological, geomorphological peculiarities of the hills Turkey oak (*Quercus cerris*) forests of climatic zonality are less common (FEKETE 1964) than all extra-, intra- and nonzonal vegetation units taken together. According to HORVATH (ex verbis) *horn-beam-oak-forests* are zonal here as mapped by BORHIDI (1961, cit. SOÓ 1964, DEBRECZY 1981). DEBRECZY (l.c. page 80) classified the beech wood of Bakony hill as not belonging to the sub-mountain belt of forests (BORHIDI 1961) and re-classified them as mountain ones. The beech wood over 250 m above the sea level in Transdanubian hills are taken into account as of zonal mountain or submountain character by PÓCS (1960). In the Balaton highlands we can trace how the zonal, calciphilous karst oaks (*QUERCETUM PUBESCENTI-CERRIS*) growing mainly in the north eastern part of it, turn intrazonal in the zone of the Turkey oaks (*QUERCETUM CERRIS*), how they become stunted and break down to intrazonal karst scrub forests(*COTINO- QUERCETUM PUBESCENTIS*). The horn beam- pedunculated- and sessile-oak forest are considered together with the calciphilous beeches to be a kind of extrazonal communities characterized by a greater phytomass production as in the case of the local zonal communities regarding more advantegous environmental conditions of a so called "positive extrazonality" (-auct.).

There were non-zonal vegetation units in the Keszthely hills maintained by the soil water regime of the habitat, for the most part, rather independently of climatic zonal conditions: sedgy- and coltsfoot-alder-grove belts (*CARICI- PETASITI-* and *DRIOPTERIDI- ALNETUM*) along streams, willow-bushes (*CALAMAGROSTI-SALICETUM CINEREAE, SALICI CINEREAE SPHAGNETUM*), peat-bogs (*SCIRPO-PHRAGMITETUM SPHAGNETOSUM*), peat-fern-gray-willow bushes (*THELYPTERIDI SALICETUM CINEREAE*). They have almost deteriorated by now or are highly endangered. (BOROS 1964., BOROS VAJDA 1965., 1968., SIMON 1970.,UHERKOVICH 1984.)

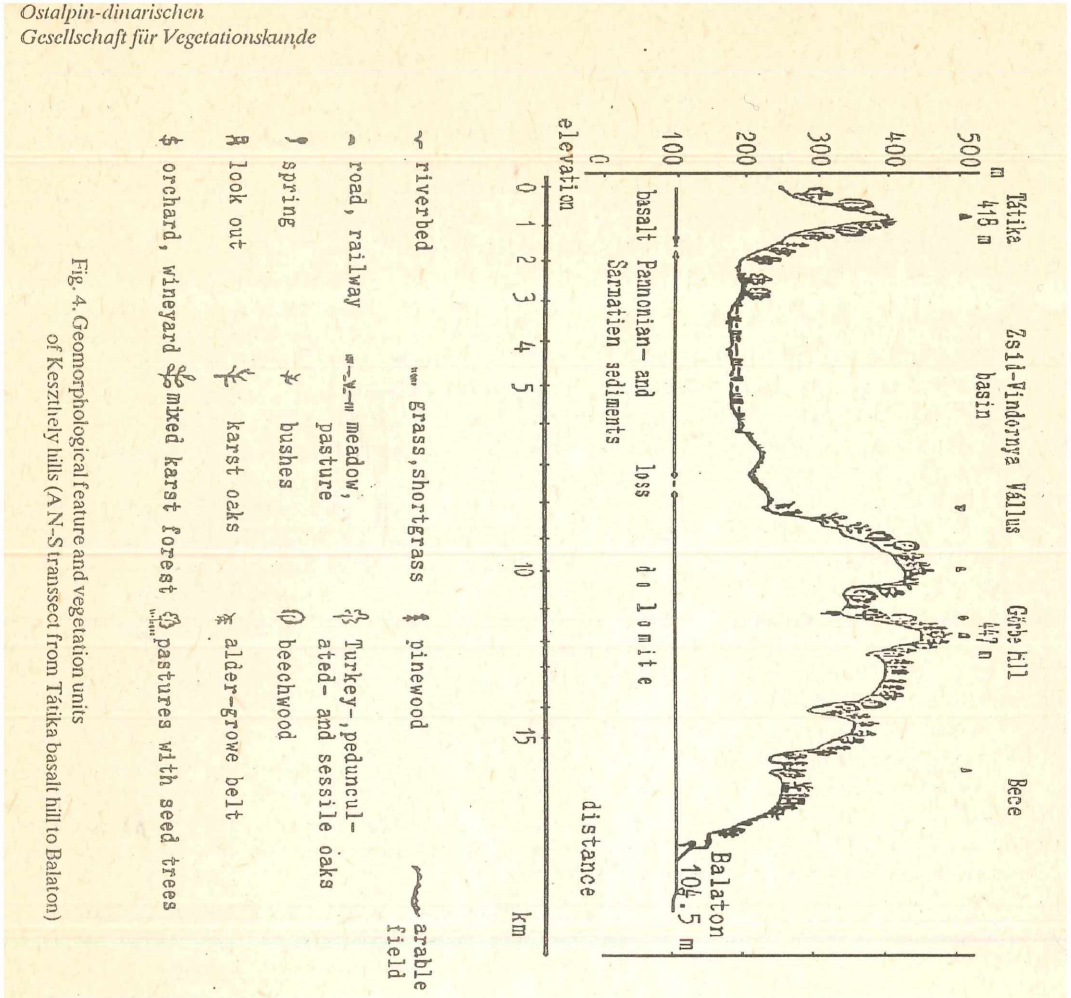

Fig. 4. Geomorphological feature and vegetation units of Keszthely hills (A N-S transsect from Tátika basalt hill to Balaton)

Pastures with seed trees (*Pyrus achras, Carpinus betulus, Quercus cerris, Q. pubescens*), notch pastures, hillside steppe vegetation becoming brushy in lack of grazing, black pine afforestations in dolomite fells and grasslands, tree of heaven (*Ailanthus glandulosa*) groves, false acacia (*Robinia pseudo-acacia*) and other plantations can be considered exogenetic stands.(Fig. 4.)

Phytogeographical sketch

The areal-geographical analysis and evaluation of the species of the Hungarian flora started with the floristic and vegetation mapping initiated by SOÓ (1933). The most elaborated areal-geographical flora evaluation was provided by MÁTHÈ (1940). These two authors have been most often quoted ever since; though there have been significant changes during the past decades. On one hand e. g. a trenchant revision has picked up several new species from the earlier agglomerative taxa. On the other hand, MEUSEL (1943) and then WALTER (1954) laid the foundations of new areal-geographical classification. As a result of these changes home authors have their own initiatives and efforts, however they feel it their duty to stick to the earliest achievements (KÁRPÁTI Z. 1960, SOÓ 1962, PÓCS 1981, BORHIDI, FEKETE, JAKUCS etc). In this paper the areal-geographical classification of SOÓ (1964-1986) is followed after all.

In addition to the phytogeographical properties detailed earlier (the post- glacial flora migration, the Ancient-(Ős)Mátra (Archimatricum) theory, the dolomite phenomena) the vegetation of the Keszthely hills represents both the overlapping of phytogeographical regions of Eurasian forested steppe zone and (Central) European oak forests by it's intrazonal dolomite xerosere full of southern elements. 50 % of the Keszthely hills' flora is constituted by Eurasian, European, Central-European species, the common species of the sand plains and steppe meadows of the Great Hungarian Plain, beside which the

Submediterranean, Subatlantic, Illyric and Prealpine species often appear, what's more form communities indicating a rather balanced climate (FEKETE 1964). The highest proportion of Atlantic-Mediterranean, Pontic-Mediterranean species of Sub-Mediterranean character is established in the open dolomite short grass (*SESELI LEUCOSPERMO-FESTUCETUM PALLENTIS* ZÓLY. *BALATONICUM* SOÓ) in our country (28% by ZÓLYOMI). This community has best developed at Balatonfüred and in the Keszthely hills.

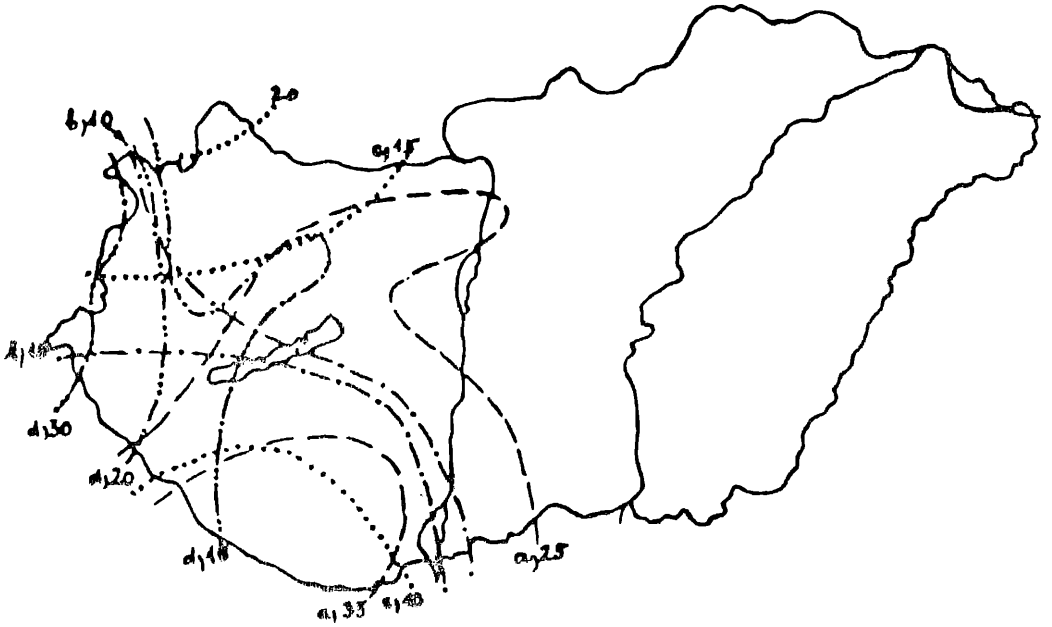

Fig. 5. The distribution of the yearly precipitation (by BORHIDI 1961)
a - Submediterranean type (25-35 %) ----------
b - Alpine-West-Balcanic type (15-10 %) -*-*-*-*-
c - Mid-European-Continental type (10-15 %) *********
d - Alpine-Atlantic type (25-15 %) -***-***-

FEKETE (1964) found that beside the Pannonian dolomite vegetation the strong submediterranean character and the Zala region floristic influences are typical. From the Atlantic-submediterranean species he mentioned the rare *Ophrys fuciflora, Ruscus aculeatus, Ruscus hypoglossum, Tamus communis, Daphne laureola*; as well as the *Leontodon incanus*, which is rare in Hungary but frequent in dolomite short grass here, the boreal relict *Cardaminopsis hispida* and *Cimicifuga foetida*.

The common species of the Dunántuli Középhegység (Transdanubian Hill Range) and the Praeillyricum in the Keszthely hills are: *Hepatica nobilis* (Euras.), *Cotoneaster tomentosa* (Submed.), *Ononis pusilla* (Submed.), *Coronilla coronata* (Submed.), *Lathyrus sphaericus* (Submed.), *Daphne cneorum* (Submed.), *Cotinus coggygria* (Pont.-Med., S-Euras.), *Galium parisiense* (Atl.-Med.), *G. sylvaticum* (C-Eur.-Med.), *Valerianella pumila* (Submed.), *V. coronata* (Submed.- C-Eur.), *Knautia drymeia* (Illyr.), *Mercurialis ovata* (Balk.), *Euphorbia segueriana subsp. minor* (Euras.-Medit.), *Fraxinus ornus* (Submed.), *Convolvulus cantabrica* (Pont.-Med.), *Onosma arenaria* (Pann.-Pont.), *Thymus serpyllum* (Eur.), *Plantago argentea* (Submed.), *Dentaria enneaphyllos* (Illyr.-Carp.), *Helianthemum nummularium* (Med.- C - Eur.), *Fumana procumbens* (Submed.), *Artemisia alba subsp. saxatilis* (Med.-C.Eur. seu Submed.), *Tunica saxifraga* (Med.-C.-Eur.), *Carpesium cernuum* (Eua.-Med.), *Scorzonera humilis* (C-Eur.-Med.), *Dianthus barbatus* (Med.-Alpin), *Primula vulgaris* (Atl.-Med.), *Cyclamen purpurascens* (Alpin-Illyr.), *Castanea sativa* (Submed.), *Allium ursinum* (Atl.-Med.-C-Eur.), *Allium atropurpureum* (Balk.), *Asphodelus albus* (Submed.), *Ruscus aculeatus* (Atl.-Med.), *Tamus communis* (Atl.-Med.), *Limodorum abortivum* (Med.-C-Eur.), *Spiranthes spiralis* (Atl.-Med.), *Ophrys insectifera* (Atl.-C-Eur.), *Orchis tridentata*

(Med.-C-Eur.), *Carex alba* (Med.-C-Eur., Euras.), *Bromus pannonicus* (Balk.-Pann.). From the characteristic species of the Praeillyricum as *Ruscus aculeatus, Ruscus hypoglossum, Lamium orvala* only the *Ruscus aculeatus* can be found in the Keszthely hills. WIERZBICKY's record of *Lamium orvala* hasn't been proved ever since. The situation is almost the same with the *Ruscus hypoglossum*. The South-East-European *Doronicum orientale* represents an extraordinary value of the Keszthely hills and of the Sopianicum (Mecsek mountains), which are among its few habitats to be found in Hungary.

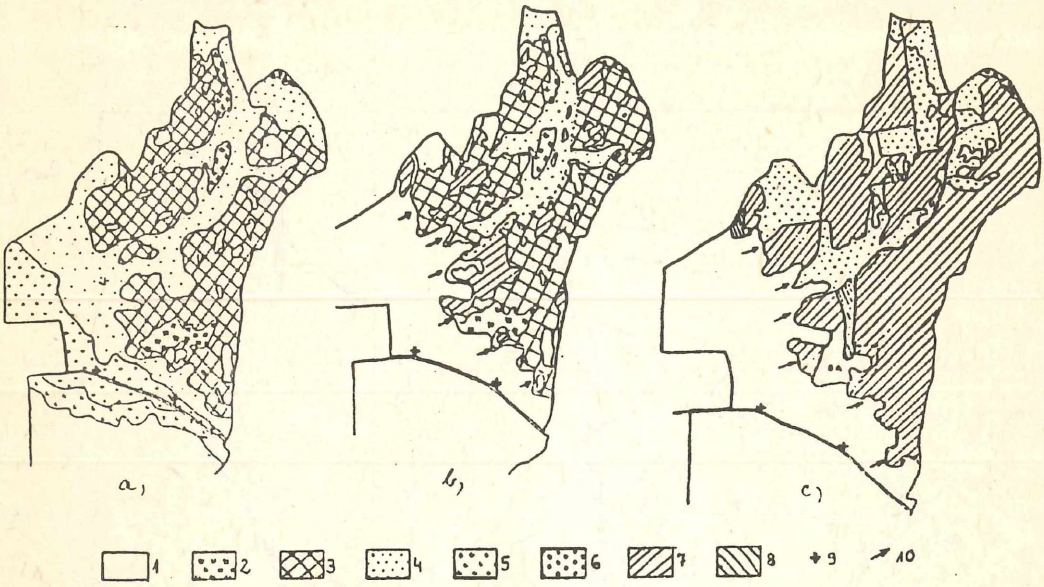

Fig. 6. The withdrawal of the natural vegetation units caused by afforestation and settlement expansion (Gyenesdiás - Keszthely hills)
a. probably original vegetation (reconstructed by (HUNYADI 1968)
b. vegetation registred in 1968 by HUNYADI (1968)
c. the present state by SZABÓ (1987 1. ridgen, dolomite shortgrass, 2. steppe, 3. pubescent oaks, 4. Turkey oaks, 5. hornbeam-oak, 6. beech wood, 7. black locust, 8. scotch pine (pine woods), 9. church, 10. the expansion of the inhabited area

Some of the Eastern-Balkanic-Dacian species reaching the Hungarian middle-height hill range are characteristic only for the Transdanubian part (Dunántúli Középhegység). The Keszthely hills provide habitats for some of them e.g. *Amelanchier ovalis, Coronilla emerus* (Submed.-C-Eur.), *Coronilla vaginalis* (Alp.-Balk.), *Anthyllis vulneraria subsp. alpestris* (Alp.-Carp.= *A. calcicola, A. alpestris*), *Daphne laureola* (Atl.-Med.), *Myosotis stenophylla* (C-Eur.), *Aethionema saxatile* (Submed.), *Hornungia petraea* (Atl.-Med.), *Cardaminopsis hispida* (N-,C-Eur.), *Paronychia cephalotes* (Pontic-Pann.-Balk.), *Allium moschatum* (Pontic-Medit.), *Ophrys fuciflora* (Atl.-Med.), *Ophrys apifera* (Atl.-Med.), *Stipa eriocaulis* (W-Submed.). In the Keszthely hills the *Sternbergia colchiciflora* (East-Med.) is dubious or hiding but e.g. at Tihany it is typical of the loess steppe slopes, as well as the *Scilla autumnalis* (Submed.). On the basalt hills of the Tapolca basin, the habitats of the *Physocaulis nodosus* get quite near the Keszthely hills, which are rich in endemic species. From the endemic species of the Dunántúli Középhegység the *Thalictrum minus subsp. pseudominus*, the *Seseli leucospermum*, and a number of apogamous and hybridogen-apomyct subspecies and transitions of *Hieracium* and *Sorbus genera* occur here. Carpathian endemic species are represented by the *Draba lasiocarpa*, the *Primula auricula subsp. hungarica*. Pannonian endemic species are represented by the *Astragalus vesicarius subsp. albidus*, the *Melampyrum barbatum*, the *Dianthus plumarius subsp. lumnitzeri var. soói*, the *Dianthus plumarius subsp. regis-stephani var. jóvorkae*, the *Dianthus pontederae* (incl. *giganteiformis*) and the *Dianthus collinus* (see SOÓ op.cit.).
An other side of the areal-geographical correspondence between the vegetation of the Keszthely hills and South-East Europa should be gathered perfecly from the manual writen by HOVÁT-GLAVAC-ELLENBERG (1974), and, what is more, the "bricks of the Illyrian bridge" are represented by the *Epimedium alpinum* (a novelty for Hungary!),the *Ostrya carpinifolia*, the *Lamium orvala*, the *Anemone trifolia*, the *Dentaria trifolia*, the *Erythronium dens-canis*, the *Helleborus dumetorum subsp. atrorubens* etc. all over South-Transdanubia (MARKGRAF et al. 1975).

So far we have known of 800 species of flowering plants which constitutes 37 % of the flora of Hungary (2148 taxa according to SOÓ, 1980), 171 species of them (21.2 %) are of Mediterranean, Submediterranean, Illyric, Balkanic, Atlantic-Mediterranean origin and species the area of which stretch up to Middle Europe. 22 species have cosmopolitan or Eurasian and Middle European of Mediterrane origin become 12.9 %). In the Keszthely Hills the number of common elements with the southern floristical regions is increased by the amount of 138 species of Eurasian, European, and Mid-European origin (17.1 %), which irradiated through the Pannonicum, strictly speaking, through our Keszthely hills to the Mediterranean region.

Conclusions

The Keszthely hills are particularly rich as to flora and vegetation. This fact is considered a consequence of the variety of substrates and of micro- and meso-climatic conditions in the area. The Keszthely hills played a central role in the floristic exchanges among the components of the Pannonian flora and most of the rare and localized species found in this area are a testimony of cool and thermic phases of the Postglacial. The theories of earlier uthors on the origin and composition of the Balatonicum floristical district apper confirmed.

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