

# ENVIRONMENTAL CHANGE AND HUMAN ADAPTATION IN THE CARPATHIAN BASIN AT THE LATE GLACIAL/POSTGLACIAL TRANSITION

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*Considering climatic, bedrock and soil conditions from the viewpoint of early agriculture these conditions seem to form a limit within the Carpathian Basin which determined the chances of the northern distribution of Early Neolithic Körös-Starčevo culture of Balkan origin. We called this line, which during the Early Neolithic limited the northern distribution of Balkan type neolithization in the Carpathian Basin, Central European-Balkan Agroecological Barrier (CEB AEB).*

**KEYWORDS:** HOLOCENE, ENVIRONMENT, CLIMATE, NEOLITHIZATION, AGROECOLOGICAL BARRIER.

## Introduction

Different palaeoecological data indicate that a strong global climatic change occurred at the late glacial/postglacial transition, between approximately 12,000–9,000 years BP. Climate change at the late glacial/postglacial transition resulted in a dramatic change in the ecosystem because the rapid and strong change in climate resulted in some rapid changes in the environmental processes, such as landscape evolution, soil formation, plant succession and faunal migration (Roberts 1989). Thus, during a short transitional period from glacial to interglacial conditions a new environmental situation developed, and a new geological epoch started that is called the Holocene. This new environment transformed the habitats of the human populations and their physical and biological environment, thus the potentials of the human communities' economy changed again. As a result of these changes some cultural modification began, and Mesolithic followed by Neolithic cultures developed and spread out in many areas of the world. The archaeological data show that one of the most important and earliest agricultural centres formed in the Near East approximately 10,000 years ago and moved up to the Balkans finally reaching Northern Europe approximately between 5000–4000 BP (Ammerman & Cavalli-Sforza 1971; Zohary & Hopf 1988).

Regional effects of this global climate change can also be detected in the different palaeoecological sites of the Carpathian Basin (Willis et al. 1995, 1997; Sümegi 1996; Kordos 1977). This region (including Hungary) is an important intermediate zone between the Balkan Peninsula and the western, eastern and northern parts of Europe. Thus it plays an important role in understanding the interactions of migration, settlement process, culture spread and environmental changes in Europe.

Archaeological evidences suggest that the first farming communities developed in the Carpathian Basin from ca. 6500 cal BC (Hertelendi et al. 1996). The earliest agricultural communities belong to the Körös (including Transylvanian Körös) and Starčevo cultures, long recognised as a part of the Balkan Early Neolithic complex (Kutzián 1947; Kalicz 1980, 1983, 1990; Kalicz et al. 1998; Raczky 1988, 1989; Whittle 1996). These two groups developed parallelly in the south-eastern, eastern and southwestern parts of the Carpathian

Basin. According to archaeological data the first farmers of the Carpathian Basin operated agro-ecosystems strongly reminiscent of those developed in the Near East. The Early Neolithic cultures of the Carpathian Basin are characterised by dense occupation along the river and creek system (Kosse 1979). These alluvial environments were attractive to early farmers because crops were cultivated by intensive horticulture on hydromorphic soil (Sherratt 1980). Sheep, goat and emmer were their economic staples but these faunal and floral elements lived on the borderline of their natural distribution area so they could survive only with human protection (Bökönyi 1974).

To the north of this zone two groups of the Linear Pottery Culture (LPC) formed (Kalicz & Makkay 1977; Kalicz 1983; Makkay 1982) from 5500 cal BC (Hertelendi et al. 1996). The economy of LPC was based on cereals but animal husbandry switched from sheep and goat to the reliance on cattle and pig whose wild progenitors were available for local domestication in Southeast Europe (Bökönyi 1974). The Neolithic agro-ecological system had changed, too, when the first and local groups of the Linear Pottery Culture developed in the Carpathian Basin. These communities started using the loessic soil-vegetation ecosystem (Kosse 1979; Sherratt 1981, 1982). One of the first LPC developed in the western part of the Carpathian Basin. This branch of the LPC subsequently spread fast through the central, western and northern parts of Europe (Ammerman & Cavalli-Sforza 1971).

But why did the Balkan type of neolithization process stop in the central part of the Carpathian Basin? Why did animal husbandry, land use and culture change in this region? Were there any settled Mesolithic communities ready to accept farming as a way of life or was there a barrier? Archaeological and palaeoecological data suggest a number of possible explanations. Our investigation aims to find some answers to these questions.

## Methods

We collected samples from 25 Late Pleistocene/Holocene sediment sequences of different palaeoecological and geoarchaeological sites for sedimentological, geochemical, pollen and quaternary malacological analyses, wood anatomy, and radiocarbon dating (Kertész et al. 1994; Nyilas & Sümegi 1992;

Sümegei 1996; Willis 1997; Willis et al. 1995, 1998). Chronology was obtained from 118 radiocarbon age determinations. The radiocarbon dates were calibrated using the CALIB 3.0 program (Stuiver & Reimer 1993) and then converted to cal BC to enable comparison with archaeological data. According to these radiocarbon-dated palaeoecological records we reconstructed the vegetation, faunal, soil and environmental changes at the late glacial/postglacial transition and the early Holocene environment with the human impact.

For the archaeological interpretation, a review was made of published archaeological sites covering the time period from the Mesolithic to the Middle Neolithic within the Carpathian Basin (Bárta 1980; Dumitrescu & Vulpe 1988; Kalicz 1990; Kalicz & Makkay 1977; Kertész 1996; Makkay 1982; Matskevoí 1991; Pavúk 1980; Trogmayer 1968). We compare recent distributions of vegetation, faunal associations, recent climatic and soil zones and the development of Holocene fluvial systems with palaeoenvironmental records and the distribution of Mesolithic, Early and Middle Neolithic sites. We analyse the impact of environmental limiting factors to the Neolithic agro-ecology (climate, vegetation and soil type), and model the interfaces between the environment, society and economy during the Early Holocene (Sümegei & Kertész 1988).

## Results

The radiocarbon dated molluscan (Willis 1997; Sümegei 1996; Krolopp & Sümegei 1995) and pollen data (Willis et al. 1995, 1997) indicate that about 12,000 BP years ago the climate became progressively warmer and wetter in the Carpathian Basin. This increase in both precipitation and temperature have enabled transition from forest steppe to broadleaved coniferous forest and maximum expansion of coniferous forests. Within the boreal forest there were also pockets of deciduous trees. Composition of coniferous forests predominantly was composed of *Picea* and *Pinus* in the eastern, *Pinus*, *Picea* and *Larix* in the northeastern and *Pinus* in the central parts of the Carpathian Basin (Willis 1997). The combination of the acid litter of coniferous trees, and the cool late glacial climate could have ensured that a podzol soil developed in some places of this region (Willis et al. 1997) where the bedrock was acid. At the same time malacological records indicate that there could have been areas where the vegetation cover showed a mosaic pattern, although the dominance of open habitat preferring mollusc declined. The climatic and vegetation change resulted in the extinction of the cryophilous mollusc in the central part of the Carpathian Basin (so-called Pannonicum). These species started drawing back from low sea level altitudinal places of the Pannonicum to higher sea level altitudinal regions of the Carpathians. Composition of the Late Pleistocene mollusc faunas suggest that some palaeoecological barriers developed in the Carpathian Basin.

After the development of taiga environment the late glacial/postglacial transition occurred between approximately 10,000–9000 years BP. With the climatic warming in the early postglacial decrease in taiga forest and increase in deciduous woodland occurred in the Carpathian Basin. Composition of the woodland varied among regions with *Tilia* followed by *Quercus/Corylus* woodland in the eastern Carpathian Basin, *Corylus/Quercus* woodland in the northern and western Carpathian Basin and an open *Ulmus/Quercus*

parkland in the central part of the Carpathian Basin (Járai-Komlódi 1987; Willis 1997; Willis et al. 1995, 1997, 1998). The climate and vegetation change could have caused a change in soil formation processes and the final stage in this transition process was the transformation of podzol soil into brown earth (Willis et al. 1997). The molluscan records in the early postglacial also indicate an intermixture of two ecologically different faunas. There are characteristically late glacial, cold-resistant species and early postglacial thermophilous species. These highly mixed communities in which southeastern European and Boreo-Alpin mollusc species lived together, have no modern analogues. The composition of mollusc faunas varied among regions and it was very similar to the regional mosaic vegetation patterns (Sümegei 1996).

After the late glacial/postglacial transition, at about 9000 years BP the warm-loving postglacial vegetation, fauna and Holocene soil types had stabilised. On the other hand, the regional climatic, vegetational, faunal and perhaps soil type differences, which can be reconstructed by pollen (Willis 1997; Willis et al. 1995, 1997) and malacological data (Sümegei 1996; Krolopp & Sümegei 1995), continued on in different regions of the Carpathian Basin. These postglacial regional environmental differences are very similar to the recent deviations in climate (Fig. 1), vegetation (Fig. 2) and soil type (Fig. 3), which characterize the Carpathian Basin today (Sümegei & Kertész 1998; Kertész & Sümegei 1999).

Changes in palaeoecological records attributed to anthropogenic factors developed in two phases during the Early Holocene. The pollen and charcoal records of several Hungarian sites show correspondences between some small peaks of hazel pollen and microcharcoal (Willis 1997; Willis et al. 1995, 1997, 1998), which suggests that people may have brought about the vegetation change before 6500 cal BC. However, there is no archaeological evidence for Neolithic occupation of the Carpathian Basin before this time (Hertelendi et al. 1996; Chapman 1994; Whittle 1996). Probably, these palaeoecological and archaeological data indirectly show that the h-f-g peoples of the Mesolithic period used fire for the alteration of the vegetation in this region about 7000 cal BC. These results are consistent with both the new and old archaeological data (Gábori 1956; Bárta 1980; Kertész et al. 1994; Kertész 1996) as far as these data have indicate the development of Mesolithic activities within the Carpathian Basin at that time. Some excavated Mesolithic sites and finds are located close to the analysed palaeo-ecological sequences (e.g. the Cuimeşti II Mesolithic site can be found c. 2 km SW of Bátorliget marsh or the Mesolithic type harpoon finds of Sárrét are in the immediate vicinity of the Sárrét core-point). Thus there are some palaeoecological evidences for Mesolithic burning and vegetation modification in the Carpathian Basin at 7000 cal BC. These data suggest that the Mesolithic communities adapted to the transition of Neolithic agriculture life, and they were in the substitution phase (Zvelebil & Rowley-Conwy 1986) at that time.

The palaeoecological data (Willis 1997; Willis et al. 1995, 1997) indicate small increase in cereals, open ground herbaceous pollen types and decline in *Corylus/Quercus* pollen concentration. Washed in soil occurred in lake sequences of the southern, central and eastern parts of the Great Hungarian Plain and of Transdanubia between

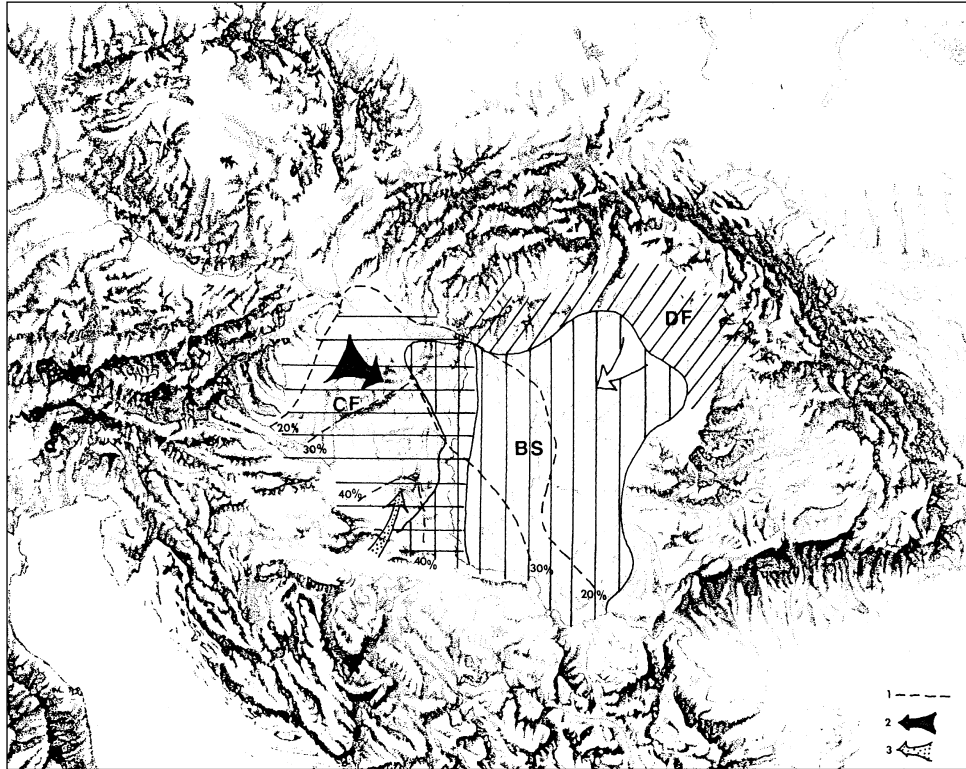


Fig. 1. Köppen's climatic regions in Hungary. CF = Temperate climatic zone, BS = Steppe-forest climatic zone, DF = Boreal climatic zone, 1. The frequency of submediterranean climatic years; 2. West European climatic effect; 3. Submediterranean climatic effect; 4. Submontan climatic effect.



Fig. 2. The distribution of vegetation zone, floral and faunal elements in the Carpathian Basin. P<sub>1</sub> = Pannonian steppe-forest, T<sub>2</sub> = Thermophilous, submediterranean type oak forest, 1. Early Holocene distribution of the Pontic *Pomatias rivulare*; 2. Distribution and boundary of the Pannonian steppe-forest; 3. Northern boundary line of *Tilia tomentosa* (silver lime); 4. Distribution of the *Quercetum frainetto* association (Balkan type oak forest); 5. Distribution of the thermophilous submediterranean type oak forest; 6. Distribution of the Central European oak forest; 7. Crossing zone between submediterranean and Central European type oak forests; 8. Boundary line of beech and boreal forests.

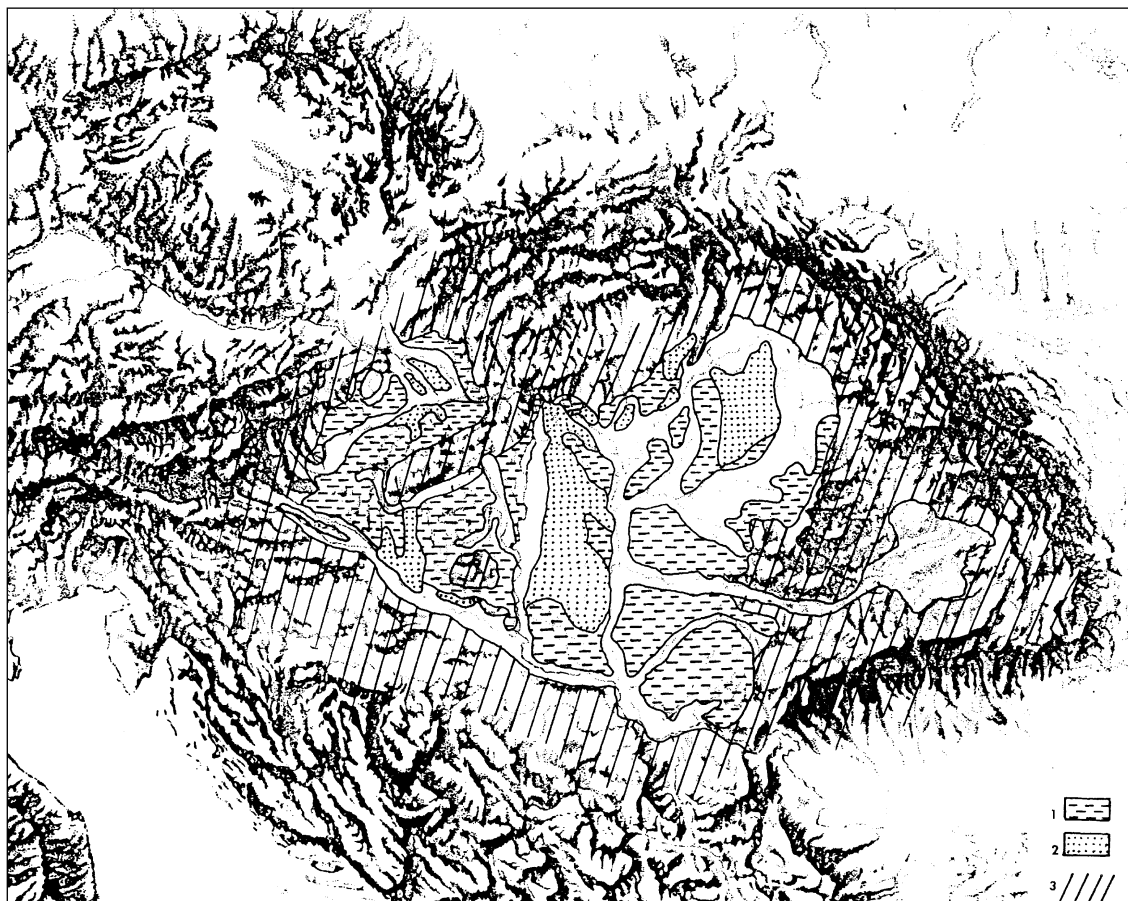


Fig. 3. Distribution of soil types in the Carpathian Basin.

1. Distribution of the soil types which developed on loess bedrock; 2. Distribution of the soil type which developed on sandy bedrock; 3. Distribution of the soil type which developed on compact bedrock (volcanic, metamorphic or limestone rock).

6000–6500 cal BC. Similar change prevailed in the Hungarian Low Mountain Region and northern part of the Great Hungarian Plain between 5000–5500 cal BC. The dominance of some open habitat preferring and thermophilous, SE European distribution molluscs (e.g. *Granaria frumentum*) increased and some cold-resistant Boreo-Alpin distribution relict molluscs (e.g. *Discus ruderalis*) declined in a parallel with the changes of woodland composition, soil formation and lake ontogeny. These strong changes indicate that a new period of human impact started around the analysed lakes and marshes. These results are consistent with archaeological data which indicate Neolithic activity within the Carpathian Basin at that time (Kalicz & Makkay 1977; Kalicz 1990; Makkay 1982; Raczky 1988, 1989). The earlier date for the detected impacts on the Carpathian sample sites correspond with the dated archaeological evidence of Early Neolithic settlements at 6000–6500 cal BC (Hertelendi et al. 1996). The later date of the first Neolithic human impact which developed in the Hungarian Low Mountain Region and northern part of the Great Hungarian Plain, shows that there could have been contact between the Middle Neolithic colonization process and the environmental transition-line at that time. Radiocarbon, palaeoecological data and archaeological evidences show that the Early neolithization process stopped in the central part of the Carpathian Basin. These data indicate that the mosaic pattern of the environmental factors, the neolithization process and the distribution of Early Neolithic settlements were interrelated in space and time.

The climatological, palaeoclimatological and palaeoecological records suggest that an important climatic and environmental change-line or zone developed in the central part of the Carpathian Basin. North of this boundary the climate is characterized by oceanic influence to the west while continental influence predominates in the east, superimposed by Subcarpathian influence overall this area. To the south and southwest of this marked climatic and environmental boundary line submediterranean climatic influence prevails. This climatic influence is reflected in the distribution of Balkan type *Quercetum frainetto* association (Fig. 2), which occupies the eastern part of the Great Hungarian Plain, and the northern boundary of *Tilia tomentosa* (silver lime) distribution. The pollen (Willis et al. 1995) and land snail (Sümege 1996) records (e.g. Early Holocene distribution) of the Pontic *Pomatias rivulare* indicate that this thermophilous vegetation developed on the border zone of the mountain and alluvial plains during the Early Holocene. Thus, the distribution of this vegetation type shows that the submediterranean climatic influence not only occurred in the southern and southwestern parts of the Carpathian Basin but also in the eastern part of the Great Hungarian Plain during the Early Holocene. This line marks the northern boundary of the distribution of Balkan fauna and flora elements within the Carpathian Basin. Climatic factors (the amount of warmth during the growing season, together with the number of days with sunshine and the distribution of rainfall during the season) played an important role in the formation of this line.

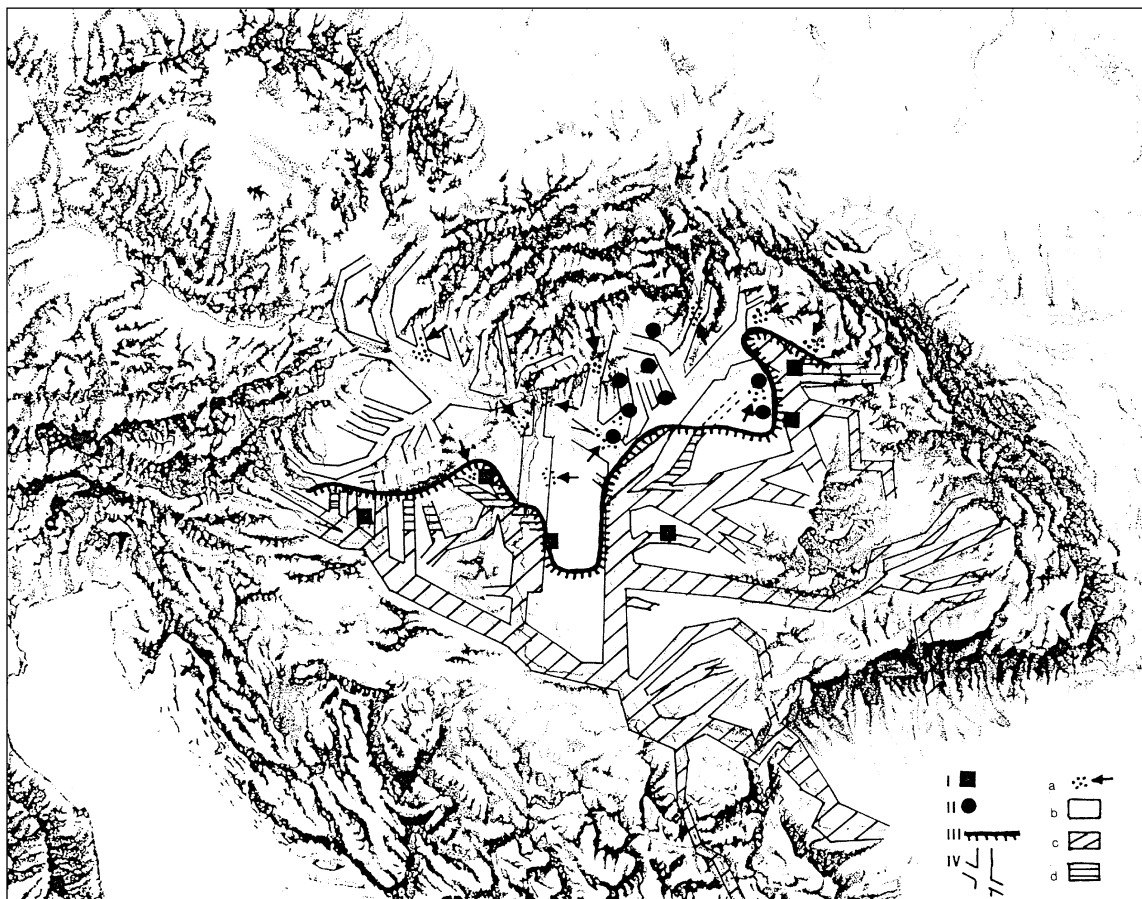


Fig. 4. Central European and Balkan Agroecological Barrier and the distribution of Mesolithic sites, green corridors, and the first traces of human impact on the vegetation.

I. Strong human impacts (burning, soil erosion) between 6000–6500 cal BC; II. Strong human impacts (burning, soil erosion) between 5000–5500 cal BC; III. Central European and Balkan Agroecological Barrier (CEB AEB); IV. Infiltration zones, a) Mesolithic localities, b) Mesolithic parts of the infiltration zones, c) Neolithic parts of the infiltration zones, d) The supposed Neolithic part of the infiltration zones without known Neolithic sites.

## Discussion

Palaeoenvironmental and recent climatological data suggest that the Carpathian Basin has been situated at a meeting point of different ecological and climatological zones since the Pleistocene up to present day. From this ecological/palaeoecological point of view it follows that a mosaic-like environment and some area-separating palaeoecological barriers developed in the Carpathian Basin during the Late Quaternary. The palaeoecological and archaeological data suggest that the ancient geographical distribution of plants, animals, soil-types and cultures with economy-types could have been modified and limited by palaeoenvironmental factors.

According to the palaeoecological and archaeological data the most important palaeoecological barrier formed in the central part of the Carpathian Basin. There seems to be relationship between this palaeoenvironmental line and the settling process of the Early Neolithic peoples in the Carpathian Basin. To the south, the southwest and east of this environmental transition-line submediterranean climatic, floral and faunal influences developed. On the other hand, we must be aware of the fact that in addition to climatic factors the food producing economy is also influenced by the character of soil, bedrock, hydrography and hydrological conditions, a rule which seems to be effective especially when the earliest food producing groups migrated to new areas, that

is in this case, came to the northern marginal area of Southeast European (Balkan) environment. Besides the factors mentioned above at this level of agriculture and production experiences, soil and hydrological conditions had most probably much greater effect on early agriculture. Therefore, early agriculture and movements of early agricultural populations were highly determined by these soil conditions (Fig. 3). Macroclimate zones were strongly modified by regional and local environmental factors (such as relief conditions, bedrock, soil type, groundwater level, etc.) from the viewpoint of the distribution of early agriculture. That is why the northern boundary of the distribution of Early Holocene submediterranean climatic and environmental influences and that of Early Neolithic culture of Mediterranean origin coincide only partly with each other. The best examples of this modifying effect of regional soil and hydrological conditions on human settlement can be observed in the Danube-Tisza Interfluvium area and in the Nyírség where sandy bedrock and sandy skeletal soil proved to be unsuitable for practising the earliest agriculture. Therefore, the strong submediterranean climatic influence existing in the Danube-Tisza Interfluvium area remained useless because soil and bedrock condition appeared as limiting factors forming an ecological barrier for Early Neolithic agriculture. This can be considered as an agroecological barrier. Considering climatic, bedrock and soil conditions from the viewpoint of early agriculture these

conditions seem to form a limit within the Carpathian Basin which determined the chances of the northern distribution of the Early Neolithic culture of Balkan origin. We called this line, which during the Early Neolithic period limited the northern expansion of Balkan type neolithization in the Carpathian Basin, Central European-Balkan Agroecological Barrier (CEB AEB: Sümege & Kertész 1998).

## Conclusion

CEB AEB, determining the northern distribution of the Körös-Starčevo culture groups with Balkan contacts in the Carpathian Basin, existed only in the earliest Neolithic. The expansion of populations having Mediterranean economic and cultural roots became less intensive in the marginal zone of the area where climatic and cultural influences of Balkan origin flourished, that is, during their northward movement within the Carpathian Basin, and even stopped when they reached CEB AEB. What did it mean from the viewpoint of those autochthonous Mesolithic communities which lived to the north of CEB AEB?

1. Human groups, possessing innovations from the Early Neolithic food producing economy had come close to them, thus creating possibility for acculturation.
2. Because of the depletion of possibilities to practise Balkan type agriculture in the area, Early Neolithic groups were unable to occupy the lands north of the barrier. Thus, Mesolithic communities gained time to accept technical innovations without being absorbed either culturally or economically or demographically into communities of Balkan origin. CEB AEB seems to play a fundamental role in the formation of the Neolithic culture with a completely new, different character, adapting to local conditions, north of this barrier.
3. Those Mesolithic communities which lived to the south of CEB AEB had absorbed both culturally and demographically into the neolithization process of Mediterranean type, except those places where the possibility for isolation was given for sometime (e.g. in the Iron Gate area).
4. CEB AEB existed only in the Early Neolithic since during the period after the formation of the Linear Pottery Complex the neolithization process to the north of CEB AEB produced cultural groups of not Balkan type but of local autochthonous character. Their plant and animal stock, production experiences were adapted to local conditions therefore from ecological point of view this agroecological limit did not mean a barrier for them.
5. Considering the importance of not only climatic, bedrock and soil conditions in the Carpathian Basin during the process of neolithization but also hydrographic conditions, it seems that within the Carpathian Basin neolithization process took place along the rivers, the so-called "green corridors". We consider green corridors to the south of CEB AEB as Neolithic infiltration zone, while those to the north of this barrier as Mesolithic infiltration zone. Archaeological data and palaeoecological records suggest that the Neolithic acculturation process of the Carpathian Basin took place in these infiltration zones between approximately 6500–5500 cal BC.

## Acknowledgements

This research was supported by OTKA (F-018058, F-23129), FKFP (No. 502 and 2006), and For Studies on the Prehistoric Archaeology of the Jászág Foundation.

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