On possibility to use the mollusc component of geobiocenoses for delimitation of the framework of landscape stability

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ABSTRACT. This paper deals with the possibility of using the mollusc component of geobiocenoses as a bioindicator of the ecological conditions of an environment when establishing the framework of the landscape stability. Because of migration limitations, molluscs, like other animal components of geobiocenoses, react to changes in the landscape caused by human activity and are therefore an important indicator of environmental quality and landscape stability.

Keywords: *Ecosystem, landscape, ecologic net, framework of ecological landscape stability, geobiocenological conception of "type of geobiocen" in ZLATNÍK's sense, differentiation of the natural (potential) state of geobiocenoses.*

Civilization pressures on landscapes have increased during recent time, especially during the last decades of the 20th century. Human society and its activities impacts on the very substance of ecosystems themselves and, of course, transforms them. The ecologic lanscape stability is therefore disturbed. For this reason efforts are made to solve this difficult situation by creating theoretical fundamentals enabling renovation and preservation of ecologic landscape stability.

Biogeography and biogeographical research are moving ahead because they are able to provide more information about the state of the recent cultural landscape. These research fields deal with biota, which include the organic part of the landscape which is sensitive to a variety of changes including results of direct or indirect human activity. The recent cultural landscape is a mosaic of ecosystems influenced by human society to different degrees, an outstanding feature of which is its heterogenous structure and species diversity (Löw and comp. 1994 MS).

Ecological optimum of landscape and, consequently, the reaching of the harmonic stage of a cultural landscape is one topic of sciences dealing with landscape (e.g., landscape ecology, biogeography, etc.). In such an optimal landscape, there are destabilising areas counterbalanced with more stable natural areas. For this goal, a framework of landscape ecologic stability will have to be clearly defined as an **ecologic net** of segments whose outstanding feature is their very high ecological stability. Achieving this stage is facilitated by using the geobiocenologic conception of "type of gebiocen" in ZLATNÍK's sense (1976). It is "complex of the natural geobiocenoses and all the other (geobiocenoses) from that one originated and in different degree changed geobiocenoses within all its developmental stages, which can alternate in certain ecological conditions segments".

Biota, or the plant and animal components of geobiocenoses, reflect the degree of ecologic stability of landscape segments. The plant component of geobiocenoses plays significant role as a determinant on one hand, and, on the other hand, as a phyziognomically marked part of biota having the ability to inform us about the ecologic state of landscape segments. The animal component of geobiocenoses is not so conspicuous as the plant component, but its ability to migrate from ecologically unsuitable places provides a good bioindicator of ecological changes proceeding in a landscape. Its composition and species diversity give valuable information about the originality of geobiocenoses, about the beginning of initially hidden disturbances of the landscape (e.g., about changes of water regime). The animal component of geobiocenoses enables us to distinguish between apparently identical geobiocenoses and can indicate the dynamics of their development as well. We therefore consider the animal component of geobiocenoses as one of the important indicators of quality and stability of lansdcape segments.

It is clear that the animal component of geobiocenoses could not be determined in its total extent. To indicate the state of preservation of a landscape segment, it is better to use a proper **model animal group** in view of its ecological bond to habitat, its number of species, or identification difficulties, etc. One such animal group is **molluscs**, having, in my opinion, all the required characteristics, as was shown in many of LOŽEK's numerous papers. Molluscs show, from the ecological point of view, strong ties to specific habitats due to their limited mobility (small "operational range"). Because of this factor, they reflect, to a certain extent, their associated plant communities. In addition, they have the added important property of being a model animal group. The total number of species in the Czech Republic does not exceed 300. Because their shells are preserved in calcareous environments, they offer a good view of species composition during the whole year. Indentification of molluscan material can be performed by simple visual techniques immediately at a locality. Mollusc shells are a useful palaeontologic material too, giving us the possibility of reconstructing landscape development in the Holocene – the latest geologic period when the recent landscape was developed. It is obvious that molluscs are a very useful animal model group for biogeographical landscape investigation.

To establish the framework of landscape ecologic stability, it is necessary to do some essential operations (Löw and comp. 1994 MS):

- differentiation of the natural (potential) state of geobicenoses
- differentiation of the recent state of geobiocenoses
- classification of the recent geobiocenoses according to the intensity of anthropogene influence
- classification of the recent geobiocenoses according to the degree of the ecological stability
- evaluation of the geobiocenoses by its functional potentiality and by its significance in the landscape
- differentiation of the area from the point of view of landscape preservation and creation, including delimitation of landscape segments of ecologically outstanding features.

Molluscs and the differentiation of the natural (potential) state of geobiocenoses

Potential natural geobiocenoses is an imaginary state that would exist in modern ecological conditions only if human impact were eliminated. It is the starting point when evaluating the changes of biota both realized and expected in the future (intentional and spontaneous) of the lanscape. The first step of that procedure is the standardization of geobiocenoses into fundamental units of the *groups of geobiocen types* mentioned above. *Geobiocen types with similar permanent ecological conditions* are united into such groups which can be *discerned* using the **bioindiocation of plant communities.** These groups of *geobiocen types* are designated using names of main trees and shrubs of the natural forest geobiocenoses (e.g., *Corni-querceta pubescentis*, etc.). There are vegetation tiers and ecological series which are superstructural units of this standardisation. Vegetation tiers express the connection between both the sequence of the changes of the vegetation and changes of the climatic conditions at different elevations and aspects. *Ecological series* indicate fertility and acidity conditions of the soil substrate (*trophical series*) and dynamics of soils water holding properties (*hydric series*).

In the region of the Czech Republic, there are **8 vegetation tiers** named after the main trees of natural forest ecosystems: 1) oak tier; 2) beech-oak tier; 3) oak-beech tier; 4) oak-conifer tier in the basins of Czech Massif, and beech tier in the remaining region of the Czech Republic; 5) fir-beech tier; 6) spruce-beech-fir tier; 7) spruce tier; and 8) dwarf mountain pine tier.

The 4 basal **trophical series are:**

A – oligotrophic (poor and acidic)
B – mesotrophic (medium rich)
C – nitrophilous (enriched by nitrogen)
D – eutrophic (enriched by nutrients of basic rocks, especially calcareous ones)

Among the trophical series there exist interseries transitions: AB (oligo-mesotrophic), BC (mesotrophic-nitrophilous), and BD (nitrophilous-basic). **Hydric series** inform us about the dynamics of water holding properties of soils. These are designated as 1) arid, 2) restricted, 3) normal, 4) wet, 5) permanently wet, and 6) peaty.

It is obvious, that vegetation tiers and ecological series define a complex of ecological conditions. The mollusc communities respond very sensitively to the conditions and therefore they are the good bioindicators of ecological conditions in vegetation tiers and ecological series. For that reason, ecological demands of individual mollusc species are known very well.

Molluscs as bioindicators of ecological series

***Serie* A** (oligotrophic)

Podzolic soils and cambisols situated on mineral-poor geologic substrata with retarded humification processes.

Typical plants: *Avenella flexuosa, Luzula nemorosa, Vaccinium myrtilus.*

Mollusc bioindicators:

Poor mollusc fauna. Only species indifferent to the chemical composition of geological and soil substratum occur. In the lowland there are species with an affinity for the more acidophilous substratum – *Causa holosericea.* In the higher vegetation tiers (3rd, 4th, 5th), arboreal species, including, for example, *Discus ruderatus, Limax tenellus, Arion circumscriptus,* etc., occur. It is possible to say that the species composition is influenced by the state of preservation of geobiocenoses. In geobiocenoses in a high degree of preservation, there are malacocenoses that consist of a high number of species. Geobiocenoses with a poor plant component are unsuitable as mollusc habitats.

***Serie* B** – mesotrophic,

is from the botanical point of view rich in plant species, indicating a soil substrate with good humification processes and suitable soil moisture. That would indicate soils from moderate to medium (developed) podzols, cambisols and rendzina soils.

Typical plants:

Nitrophilous and subnitrophilous species such as *Galium odoratum, Sanicula europaea, Dentaria bulbifera,* etc.

Mollusc bioindicators:

Mollusc component of geobiocenoses comprises the arboreal, and possibly mezic elements, of central European forests such as *Cochlodina larninata, Monachoides incarnata, Discus rotundatus,* etc.

***Series* C** – eutrophic nitrophilous

is characteristic by the presence of ecologically "sophisticated" broad -leaved trees such as *Acer, Tilia, Fraxinus,* and *Ulmus.* From the point of view of ecological demands of molluscs, *Fraxinus* is an especially suitable tree because it has leaves that rapidly decompose and provide suitable conditions for molluscs.

The soil substrate is medium rich to rich.

Typical plants:

In the plant component of geobiocenoses there exist indicators of good humification and rich nitrification. With the except of species known from **series B** , there frequently occurs *Mercurialis perennis, Urtica dioica, Dentaria enneaphyllos, Allium ursinum* etc.

Mollusc bioindicators

The mollusc component of geobiocenoses show high species diversity and high number of individuals. Debris with a soil component within decomposed leaves is very suitable medium for molluscs, and provides a favourable microclimate for the rest of the invertebrates (good humidity and good aeration conditions). This series is represented by many species of the family *Clausiliidae* e.g. *Macrogastra plicatula, Clausilia dubia;* from the other families *Oxychilus glaber, Trichia unidentata, Sphyradium doliolum,* etc.

***Series* D** – eutrophic basic – alkaline

is characterized by a rich mineral substratum. It occurs on limestones, dolomites, loess, and other calcareous rocks. Rendzinas are the primary soils, and marly soils and chernozems occur less frequently. This series is typical of forest-steppes, loess-steppes and limy substrata in lowlands (1st and 2nd vegetation tiers). In the higher vegetation tiers (3rd, 4th, and 5th) are the geobiocenoses *Fageta dealpnia, Fageta dealpina inf.* and

Fageta dealpina superiora, etc., with the corresponding vegetation of undergrowth synusia.

Mollusc bioindicators

The mollusc component of this geobiocenoses consists of typical species of extreme habitat conditions: it includes species of xerothermic, calciculous, calciphilous, petrophilous and pedophilous environments. For example, in the 1st vegetation tier there are molluscs living on calcareous rocks with a southern exposure and/or typical steppe-species or species characteristic of geobiocenoses of *Corni-querceta pubescentis* or *Corni-querceta pubescentis acerosa (Granaria frumentum, Helicopsis atriata, Cepaea vindobonensis, Zebrina detrita*, etc. (conforme tab. No 1).

It is obvious that the species spectrum in different vegetation tiers in the ecological series corresponds to demands of individual molluscan species regarding elevation-climate, ecological conditions, to its chorology etc., of course (example tab. No 1).

As for moisture habitat conditions, it is possible to find molluscan species typical for all the hydric series mentioned. In table 2 there is an example from the alluvial forest near the community of Dolní Věstonice. The group of geobiocen types *Salici-alneta* (SALAL) and *Ulmi-fraxineta populi* includes geobiocenoses with high groundwater levels, being annually inundated. Molluscan fauna of *Salici-alneta* belong to the 5th hydric series, including permanently wet habitats (swamps, banks, fens, water); *Ulmi - fraxineta populi* belongs to 4th series of wet habitats (predominantly wet to mesic woodland habitats and mesic open habitats, beginning occurrence woodland species s. str., e.g., *Cochlodina laminata.*)

The group of geobiocen types of *Ulmi-fraxineta carpini* and the one of "hrůd" involve low groundwater level geobiocenoses. *Ulmi-fraxineta carpini* (UFRc) include a mollusc fauna belonging to the 3rd hydric series – normal habitats with woodland molluscan fauna (*Cochlodina laminata*, and *Discus rotundatus* etc.). Fauna of mesic habitats disappear. On sands (hrůd) (the 1st hydric series) xerothermic mollusc fauna occur, e.g,. *Cepaea vindobonensis, Vitrina pellucida, Cochlicopa lubricella* , etc.

From the above description, it is obvious that molluscs are a very suitable model animal group for the delimitation of the framework of landscape stability.

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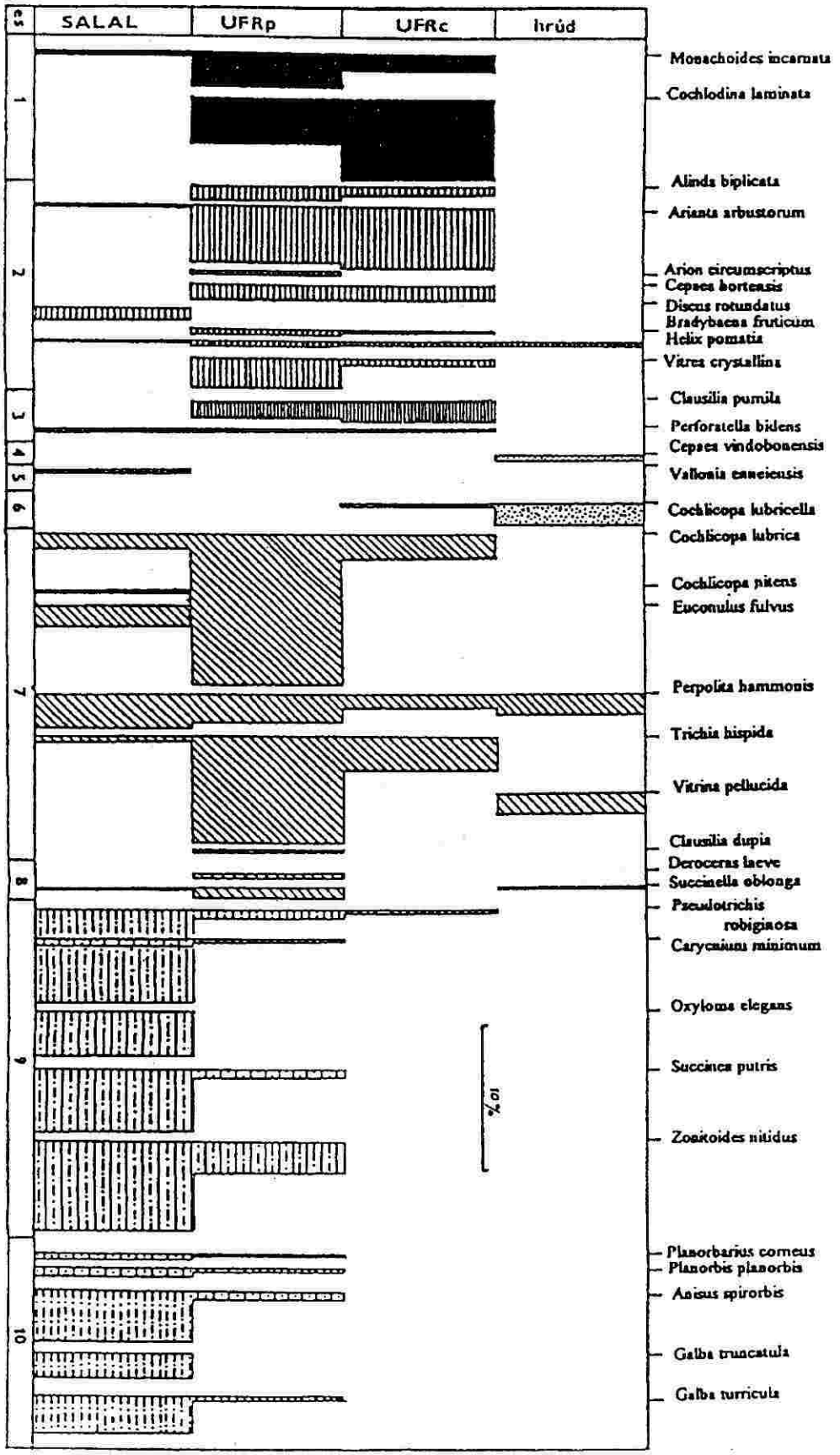
Tab. 1.

Ř	A (AB)	B (BD, BC)	C (CD)	D
VS	Querceta roboris betulina inf. QUERCETA PETREAE	Querceta petreae arenosa QUERCETA PETREAE TYPICA	CORNI-ACERATA CAMPESTRIS INF. ACERATA CAMPESTRIS	Corni-querceta pubescentis inf. CORNI-QUERCETA PETRAEAE PUBESCENTIS INF.
I.	without molluscs	Helix pomatia E. strigella, C. laminata, I. isognomostoma, D. rotundatus	Discus rotundatus T. unidentata C. laminata, H. obvoluta	C. vindobonensis T. cylindrica, Gr. frumentum, Chon. clienta, H. obvia, P. muscorum, C. acicula, O. inopinatus, Zebrina detrita
II.	Querceta pinea humilia Querceta petreae lichenoso-muscosa QUERCETA PETREAE SUBFAGINA FAGI-QUERCETA	Carpini-querceta muscosa FAGI-QUERCETA TYPICA FAGI-QUERCETA TILIAE	ACERATA-CAMPESTRIS SUP. CARPINI-ACERETA CORNI-ACERETA CAMPESTRIS TILIAE	Corni-querceta pubescentis sup. Pineta dealpinal CORNI-QUERCETA PETRAEAE-PUBESC. SUP.
		B. fruticum, A. minor, C. laminata, M. incarnata	C. dubia, V. pusilla, H. obvulata, M. ventricosa, L. plicata, M. plicatula, Rut. filograna, S. doliolum, c. pumila aj.	molluscs like in Ist. VS more spec. of fam. Clausilia M. plicatula, Gran. frumentum, H. obvia, H. striata, etc.
III.	Pineta quercina Querceta petraeae pinea QUERCETA PETRAEAE FAGINA QUERCI-FAGETA	Pini-querceta arenosa QERCI-FAGETA TYPICA QUERCI-FAGETA TILIAE	TILI-ACERATA TILI-ACERATA FAGI TILI-ACERATA CARPINI CORNI-ACERATA CARPINI	Corni-querceta pubescentis-fagi humilia Pineta dealpina sup. FAGI-QUERCETA DEALPINA
	Causa holocericea, penetrate D. ruderatus	Eumphalia strigella, H. obvoluta, A. minor, V. costata, A. biplicata, C. laminata, D. rufa, L. marginata	L. plicata, C. laminata, M. plicatula, V. turgida, C. cerata opaviensis, M. vicina, M. incarnata, D. ruderatus, I. isognomostoma, O. glaber, B. nitidosa, aj.	C. parvula, E. fulvus, on exp. rocks Gran. frumentum, P. tripicata, B. perversa, Helic. lapicida, A. polita, D. perspectivus O. orientalis, Ch. clienta, Ch. avenacea etc.
IV.	Pineta lichenosa Querceta petraeae fagino pinea Pineta abietina lichenosa FAGETA-QUERCINO ABIETINA QUERCI-ABIETA PINEO-PICEOSA FAGETA PAUPERA ABIETI-QUERCETA PINI	Fageta humilia FAGETA PAUPERA TYPICA FAGETA TYPICA FAGETA TILIAE ACERIS	TILI-ACERATA FAGI TILI-ACERATA CARPINI CORNI-ACERATA FAGI CORNI-ACERATA CARPINI	Pineta dealpina sup. fageta dealpina subhumilia CORNI-FAGETA FAGETA DEALPINA INF. ABIETA DEALPINA
	D. ruderatus, C. holosericea, penetrate Cl. cruciata	V. turgida, M. vicina, B. cana, H. obvoluta, T. unidentata, M. latestriata, Vestia ranojevici	C. orthostoma, V. gulo, O. dolium, H. faustina, C. holo sericea, C. bidentata, A. nitidula, E. diaphana, O. cellarius apod.	H. lapicida, P. rupestris, C. dubia, R. filograna, Ox. orientalis, I. isognomostoma, A. verticillus

Explanations to table 1: VS = vegetation tiers, I. = 1st oak vegetation tier, II. = 2nd beech-oak tier, III. = oak-beech tier, IV. = beech tier (in basins of of Bohemian mass oak-coniferous tier, Ř = series and interseries: A = oligotrophic, B = mesotropic, C = nitrophilous, D = eutrophic; AB, BC, CD = interseries; names of groups of geobiocen-types in normal hydric series are marked with majuskules, that one in arid and restricted series in minuskules.



Explanations to table 2.: SALAL = Salici-alneta, UFRp = *Ulmi-fraxineta populi*, UFRc = *Ulmi-fraxineta carpini*, hrúd = group of geobiocen types on elevations on sands drifts; es = ecological groups: 1 – Woodland s. str., 2 – Predominantly woodand, 3 – Damp woodland, 4 – Steppe and werothermic rocks to xerothermic woodland, 5 – Open landscape, 6 – 8 – Woodland and open grounds: 6 – xeric, 7 – mesic or diverse, 8 – damp; 9 Swampy habitats, banks, fens, etc., 10 – water (Molluscan ecological groups – according to Ložek 1964)