FOLIA OECOLOGICA – vol. 31, no. 2 (2004). ISSN 1336-5266

Tree species composition of natural geobiocoenoses in forest types in Slovakia

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Abstract

Vološčuk, I. 2004. Tree species composition of natural geobiocoenoses in forest types in Slovakia. *Folia oecol.*, 31 (2): 122–135.

The proposal of the target tree species composition for forest types in Slovakia suggested by Hančinský (1972) is mainly based on commercial aspects of forest management. As a result, spruce is supported as a dominant woody plant in a number of forest types where this species is not autochthonous. Up to present, this proposal has been used as the general basis for all forest categories concerned in forest management. From the scientific point of view, however, it is not suitable for management of protection forests and special purpose forests situated in national parks and nature reserves. We present here a proposal of nature-closed target composition consisting of indigenous tree species – founded on the author's authentic first-hand experience from survey of natural conditions and on the data provided by bibliographical resources. The proposal takes into account diverse habitat conditions in geobiocoenoses of forest types occurring in the territory of Slovakia, and is applicable to management of protection forests and special purpose forests. It can also serve as a methodical tool for determining ecological stability for all forest categories.

Key words

species composition, natural geobiocoenosis, forest type, ecological stability

Introduction

The contemporary species composition of Slovak forests (as part of the Carpathian range complex) is a result of natural processes in the post-glacial period, mutual interaction between woodland organisms and human influence.

The late glacial – early Holocene period (following the period of later Dryas with habitats of open formations ranging from cold-climate grasslands to cold-climate tundra; about 12,000 years ago) was in the Carpathians characterized by massive re-spreading of forests. The changes in the species composition were determined by a number of factors. The climatic factors were connected with changes in solar radiation affecting the temperature and precipitation. Consequences also followed from soil development, from distance between refuges where isolated forest communities survived the ice age and from genetic habits of the concerned tree species.

From the pre-boreal period (about 10,000 years ago) to Atlanticum period (about 6,000 years ago) the Carpathian nature wasn't significantly affected by human influence. The natural (autochthonous) species composition depended on the climatic and soil conditions only. Fir and beech had became natural components of our woodlands by the end of the Atlanticum period.

Succession cycle of these two shade-preferring tree species continues about 350–400 years. During the Epiatlanticum period (6,000–3,200 years ago) beech and fir gradually penetrated from the Balkan glacial refuges and invaded the zones of mixed oak woods and spruce forests. Oak and spruce had formed semi-shaded stands perfectly suitable for distribution of fir and beech. Within the following two thousand years a stable belt of fir and beech woods had been formed, wedged between the oak and spruce zones, pushing the mixed oak woods into lower altitudes, the spruce zone, on the other hand, was pushed up into higher sites.

In the early Sub-Boreal period (3.200 years ago), and even more intensively in the Sub-Atlanticum period (2.700 years ago), the human influence more and more affected the natural woodland succession. In the Sub-Atlanticum period (2.700–1.400 years ago), the indigenous local differentiation of altitudinal vegetation zones became stabilized (according to Ložek, 1973; Michal, 1992). Compact farming and settlement areas appeared in the countryside. Due to soil cultivation and due to increasing precipitation, severe soil erosion was frequent. As a result of agricultural cultivation practices (and livestock husbandry in particular), the natural indigenous forest complexes were gradually suppressed and replaced by expanding alternative communities. In such a way, a secondary cultural landscape was formed, which, in comparison with the original ecosystems, had a higher secondary biodiversity. The Slavic tribes, settling in the Carpathians in the 5th and 6th centuries, kept on the cultivation practices by further deforestation and farming, increasingly suppressing the original primeval forests. Each newly occurring form of forest utilization affected the natural ecotope as an alternative ecological factor, entailing specific changes in the plant species composition (including tree species) and wildlife distribution.

The impact of traditional farming on the natural life of animals and plants has pursued up to the modern times. Occurrence of cultural ecosystems reflected the small-scale land utilization practices. Since the 19th century, the industrial development, however, was connected with further intensification of the human influence on the natural surroundings. The persistent increase of the large-scale human impact on the nature resulted in decreased biodiversity of the landscape and its biotic subsystems. The most severe changes in forest species composition in the sub-montane and montane forest zones occurred in the period between the 13th and 17th century, following the mining boom and subsequent German colonization of the mining areas; and later the development of sheep farming introduced into the Slovak territory by the Walachian shepherds.

At the turn of the century, in the late 1890s and early 1900s, the European scientific and academic communities started to be more and more interested by the fragmented examples of the natural environment, especially virgin forests. In our country, at that time the "spruce-mania", imported from Germany, was gradually fading away. The economically profitable spruce was given precendence against nature – which severely affected the original beech woods, fir-beech woods and partly also oak-beech woods, by replacing these with spruce monocultures. The large-scale replacement of the original tree species caused severe deterioration of ecological stability of the woodland ecosystems, turning them vulnerable to harmful biotic and abiotic agents. Surviving fragments of natural forest communities were put under protection as nature monuments in the 19th century and as nature reserves and national parks in the 20th century, mainly thanks to the effort of scientists and forestry specialists.

The study research conducted on these natural forest ecosystems, situated in protected areas, provides tools and ideas for development of nature-oriented principles of forest management.

Material and methods

In the years 1995–1996, our team, involved in the project VEGA No. 95-5305/372 (carried out at the Institute of Forest Ecology, Slovak Academy of Sciences in Zvolen), was dealing with the chorology of autochthonous tree species of Slovakia. The forest typological investigation database of the Institute LESOPROJEKT Zvolen was used as a source for reconstruction of a pattern of the original tree species distribution. The research has been stopped due to lack of financial support. The problems, however, were got on again in 1999, within the partial project VEGA No. 1/6273/99, carried out at the Department of Applied Ecology of the Faculty of Ecology and Environmental Sciences in Banská Štiavnica, Technical University in Zvolen.

Focusing on the question of existence of the most original primeval ecosystems in our nature reserves, we concentrated our effort on investigation of the ecological stability of forest ecosystems situated in the Slovak nature reserves and national parks.

To specify the indigenous tree species distribution in the natural woodland habitats, we used the results of our own previous research, data from the forest typological survey carried out over 1958–1974 and published materials. The most detailed analysis of natural woodland species composition according to the forest type groups was performed and published by Zlatník (1935, 1956, 1959a, 1959b, 1975, 1976 and 1978).

In former years, the tree species composition of forests in the Hungarian Monarchy was surveyed by Fekete and Blattny (1913). The natural tree species distribution in Slovakia was later studied and published by Blattny and Šťastný (1959). The possibility to estimate and control the species composition of forest stands for management goals was studied by Grék (1966). The works of Randuška (1955) and Randuška et al. (1986) dealt with species composition based on the forest typology results. The paper of Faith et al. (1974) is concerned with the calculation of the target species composition according to the forest type groups in the spruce, fir and beech vegetation zones.

The species composition in selected typological units and the issue of forest ecosystem stability were treated by Vladovič et al. (1998), Vladovič et al. (1999) and Vološčuk (1966, 1968, 1973a, 1973b, 2000, 2001).

The presented summary of original tree species composition of natural geobiocoenoses in Slovak forest types enables us to calculate the degree of similarity between the currently existing and original species composition of these forest types. The degree of similarity is also a methodological tool for assessment of woodland ecosystem stability (according to Vološčuk, 2000). The forest types and their numbering were adopted from the work by Hančinský (1972), however, we have objections against specification of some forest types. This issue will be dealt with later in the text.

The original tree species composition in natural forest habitats is a common result of many-hundred-year forest development in the post-glacial period, influence of climatic, soil and site ecological conditions, and competitions between the tree species. The proposal of the species composition in the Slovak forest types, presented by the author (Vološčuk, 2000, 2001) has been in this paper partly modified in accordance with specific forest management approach required in the special purpose and protection forests.

“Available species composition“ is a term used in forestry, denoting the species composition of currently existing production stands at felling age. This term comprises the following items: target species composition of the concerned management groups of forest types, difference between the current state of the forest stand and the corresponding model, as well as possible changes (regulation) by means of stand regeneration and tending measures carried out with regard to the principles of rational forest management. The target is to be achieved by the end of the current felling period of the stand. Sustainable production and sustainable development have also important place in the design of the available species composition (Vladovič et al., 1998).

The regeneration species composition means the resulting tree species composition in a stand that is being regenerated. It is determined with regard to the current and target species composition as well as to the condition of the parent (regenerated) stand. Due to the influence of natural regeneration and the influence of external factors, the current figures characterising regeneration species composition may be modified during the regeneration period, if necessary.

Forest type groups and forest types are classified according to the ecological trophical series/interseries and hydric orders (by Zlatník, 1959a). Their titles and numbering are assumed from Hančinský (1972). The bioclimatic line is adopted from Zlatník (1959a).

Results

Oligotrophic (acidic) ecological series

Pineto-Quercetum
1101 : sp 40, so 55, bsp 5
1102 : sp 30, so 65, bsp 5
1103 : sp 25, so 60, sl 5, hb 5, bsp 5
1104 : sp 20, so 70, sl 5, hb 5

Quercetum
1111 : so 75, sp 15, bsp 5, ea 5
1112 : so 70, sp 10, hb 5, bsp 5, sl 5, ea 5
1113 : so 60, sp 10, hb 20, bsp 5, sl 5
1114 : so 50, sp 30, sl 10, bsp 5, hb 5
1115 : so 60, sp 20, sl 10, hb 10

Fagetum quercinum inferiora
2101 : poo+do 70, be 20, ba 10
2102 : poo+do 60, be 20, hb 10, ba 10
2103 : poo+do 60, be 25, hb 5, nm 5, sl 5

Fagetum quercinum superiora
3101 : be 50, so 35, ba 10, bsp 5
3102 : be 60, so 35, ba 5
3103 : be 65, so 30, ba 5

Querceto-Pinetum
4101 : sp 80, so 10, bsp 10
4102 : sp 75, so 15, bsp 10
4103 : sp 70, so 15, bsp 5, ba 10

Fagetum quercino-abietinum
4111 : be 60, so 20, sf 15, ba 5
4112 : be 60, so 15, sf 20, ba 5
4113 : be 55, so 20, sf 20, ba 5
4114 : be 65, so 15, sf 15, ba 5

Fagetum abietinum
4121 : be 80, sf 15, ba 5
4122 : be 75, sf 20, ba 5

Fagetum abietino-piceosum inferiora
The tree species distribution to the south of the bioclimatic line and that of the montane areas not included in the spruce altitudinal vegetation zone is given in the brackets.
5101 : be 40, sf 35, ns 20, ba 5 (be 50, sf 40, ns 5, ba 5)
5102 : be 35, sf 25, ns 20, sm 15, ba 5(be 55, sf 30, ns 5, sm 10)
5103 : be 35, sf 30, ns 20, sm 10, ba 5 (be 40, sf 45, ns 5, sm 10)
5104 : be 40, sf 30, ns 20, sm 5, ba 5 (be 60, sf 35, ns 5)
5105 : be 40, sf 35, ns 20, sm 5 (be 50, sf 35, ns 10, ba 5)

Fagetum abietino-piceosum superiora
The tree species distribution to the south of the bioclimatic line and that of the montane areas not included in the spruce altitudinal vegetation zone is given in the brackets.
6101 : ns 40, be 30, sf 15, el 5, ba 10 (be 35, sf 35, ns 15, ba 15)
6102 : ns 40, be 35, sf 20, ba 5 (be 40, sf 40, ns 5, ns 15)
6103 : ns 40, be 30, sf 15, sm 5, ba 5, el 5 (be 30, sf 40, ns 15, ns 5, ba 10)
6104 : ns 35, be 30, sf 25, sm 10 (be 45, sf 45, ns 10)
6105 : ns 40, be 25, sf 25, sm 10 (be 50, sf 45, ns +, ba 5)
6106 : ns 35, be 35, sf 20, el 5, ba 5 (be 40, sf 35, el 10, ba 10, ns 5)
6107 : ns 40, be 40, sf 20 (be 45, sf 30, ns 15, ba 10)

Pineto-Piceetum inferiora
5111 : ns 80, sp 10, sf 10
5112 : ns 75, sp 10, sf 15

Pineto-Piceetum superiora
6111 : ns 80, sp 5, el 5, sf 5, ba 5
6112 : ns 70, sp 5, el 10, sf 10, ba 5
6113 : ns 75, sp 5, el 5, sf 10, ba 5

Piceetum abietinum
6121 : ns 80, sp 10, sf 10
6122 : ns 75, sp 5, sf 10, el 5, ba 5
6123 : ns 80, sp 5, sf 10, ba 5, el +
6124 : ns 80, sp 5, sf 10, ba 5
6125 : ns 70, sp 5, sf 15, sm 5, el 5

Fagetum acidiphilum inferiora
5131 : be 70, sf 20, sm 5, se 5
5132 : be 70, sf 30

Fagetum acidiphilum superiora
6131 : be 80, sf 20
6132 : be 75, sf 15, ns 5, ba 5

Sorbeto-Piceetum
7101 : ns 95, ba 5
7102 : ns 90, ba 10
7103 : ns 85, ba 15
7104 : ns 80, ba 10, sm 10
7105 : ns 90, ba 10
7106 : ns 75, sm 15, ba 10

Lariceto-Piceetum
7110 : ns 80, el 10, cp 5, ba 5
in High Tatras: 11s 60, el 35, ba 5

Mughetum acidiphilum
8101 : mp 85, ba 10, siw 5
8102 : mp 75, ns 10, ba 5, cb 5, siw 5
8103 : mp 80, cb 10, ba 5, siw 5

Oligo-mesotrophic ecological interseries A/B

Fageto-Abietum inferiora
5201 : sf 55, be 35, sm 5, ns 5
5202 : sf 55, be 40, sm 5
5203 : sf 60, be 35, sm 5
5204 : sf 55, be 35, sm 5, se 5
5205 : sf 55, be 35, sm 5, se 5
5206 : sf 55, be 35, sm 5, se 5
5207 : sf 60, be 35, sm 5
5208 : sf 60, be 40
5209 : sf 60, be 35, sm 5
5210 : sf 50, be 35, sm 10, se 5

Fageto-Abietum superiora
The tree species distribution to the south of the bioclimatic line and that of the montane areas not included in the spruce altitudinal vegetation zone is given in the brackets.
6201 : ns 40, sf 40, be 20 (sf 60, be 40)
6202 : ns 40, sf 35, be 20, sm 5 (sf 50, be 35, sm 10, ba 5)
6203 : ns 35, sf 35, be 25, sm 5 (sf 50, be 40, sm 10)
6204 : ns 35, sf 35, be 25, sm 5 (sf 45, be 40, sm 10, se 5)
6205 : ns 35, sf 30, be 25, sm 10 (sf 50, be 30, sm 15, se 5)
6206 : ns 35, sf 35, be 30 (sf 60, be 30, sm 10)
6207 : ns 35, sf 30, be 20, sm 10, se 5 (sf 50, be 40, sm 10)
6208 : ns 35, sf 25, be 15, sm 15, se 10 (sf 40, be 40, sm 15, se 5)

Fagetum humile
6221 : be 90, sm 5, ba 5

Piceeto-Abietum inferiora
5231 : sf 75, ns 20, el 5
5232 : sf 70, ns 20, sm 5, se 5

Piceeto-Abietum superiora
6231 : ns 50, sf 50
6232 : ns 40, sf 45, sm 10, ba 5

Mesotrophic (nutritive) ecological series B

Carpineto-Quercetum
1301, 1302, 1303 : so 75, eo 5, hb 10, sl 5, asp 5
1304, 1305, 1306, 1307, 1308, 1309 : so 65, to 10, hb 5, nm 5, fm 5, sl 5
1310, 1311, 1312, 1313 : so 55, to 20, hb 5, nm 5, fm 5, sl 5, asp 5

Fageto-Quercetum
2301 : poo+do 55, be 15, nm 5, sl 5, hb 5, asp 5, sp 10
2302 : poo+do 50, to 5, be 15, hb 10, nm 10, sp 10
2303 : poo+do 65, to 10, hb 10, be 5, asp 5, sp 5
2304 : poo+do 60, to 5, be 20, hb 5, fm 5, asp 5
2305 : poo+do 70, be 10, hb 10, nm 5, sl 5
2306 : poo+do 60, to 5, be 15, hb 5, nm 5, sl 5, asp 5
2307 : poo+do 65, be 10, hb 10, nm 5, sl 10
2308 : poo+do 65, be 20, hb 5, nm 5, sl 5
2309 : poo+do 60, be 20, hb 10, nm 5, sl 5
2310 : poo+do 75, be 10, hb 5, nm 5, sl 5
2311 : poo+do 65, be 15, hb 5, nm 10, sl 5
2312 : poo+do 60, be 20, nm 10, sl 10
2313 : poo+do 60, eo 15, be 10, nm 5, sl 5, hb 5
2314 : poo+do 55, be 15, sl 10, nm 15, hb 5
2315 : poo+do 55, be 15, nm 15, sl 15
2316 : poo+do 50, be 20, hb 10, nm 10, sl 5, asp 5
2317 : poo+do 60, be 10, hb 15, nm 5, sl 5, asp 5

Querceto-Fagetum
3301 : so 20, be 60, ns 5, sl 5, hb 5, bch 5
3302 : so 20, be 60, ns 5, bch 5, sl 5, hb 5
3303 : so 20, be 60, ns 10, sl 5, ll 5
3304 : so 20, be 65, ns 5, sl 5, ll 5
3305 : so 20, be 65, ns 5, sl 5, ll 5
3306 : so 15, be 70, ns 5, sl 10
3307 : so 15, be 60, ns 10, sl 10, ll 5

3308 : so 10, be 60, ns 10, sl 10, ll 5
3309 : so 20, be 60, ns 15, sl 5

Fagetum pauper inferiora
3311 : so 5, be 85, sl 5, nm 5
3312 : so 5, be 85, nm 5, sl 5
3313 : be 95, nm 5
3314 : be 95, nm 5
3315 : so 5, be 80, sm 5, nm 5, sl 5
3316 : be 85, nm 10, sl 5
3317 : be 90, nm 5, sl 5
3318 : so 5, be 90, nm 5

Fagetum pauper superiora
4301 : be 85, sf 10, nm 5
4302 : be 85, sf 10, nm 5
4303 : be 80, sf 10, nm 5, sl 5
4304 : be 80, sf 10, nm 5, sm 5
4305 : be 70, sf 5, sm 10, nm 10, lpm 5
4306 : be 80, sf 5, nm 10, sl 5
4307 : be 80, sf 10, sm 5, nm 5
4308 : be 80, sf 10, ashsp 5, nm 5
4309 : be 80, so 5, sf 10, nm 5

Fagetum typicum
4311 : be 80, sf 10, ll 5, sm 5
4312 : be 85, sf 10, nm 5
4313 : be 75, sf 5, sm 10, nm 5, ll 5
4314 : be 80, sf 10, sm 10
4315 : be 80, sf 5, sm 15
4316 : be 80, sf 5, sm 5, se 5, ae 5
4317 : be 80, sf 10, sm 5, ll 5
4318 : be 75, sf 15, jsm5, ll 5
4319 : be 80, sf 10, sm 5, ll 5
4320 : be 80, sf 15, sm 5

Abieto-Fagetum inferiora
5301 : be 60, sf 35, sm 5
5302 : be 65, sf 25, sm 10
5303 : be 60, sf 35, sm 5
5304 : be 60, sf 30, sm 5, se 5
5305 : be 60, sf 35, sm 5
5306 : be 60, sf 30, sm 5, se 5
5307 : be 65, sf 35
5308 : be 60, sf 40

Abieto-Fagetum superiora
The tree species distribution to the south of the bioclimatic line and that of the montane areas not included in the spruce altitudinal vegetation zone is given in the brackets.

6301 : be 60, sf 20, ns 15, sm 5 (be 80, sf 20)
6302 : be 60, sf 20, ns 10, sm 5, se 5 (be 70, sf 25, sm 5)
6303 : be 55, sf 20, ns 15, sm 10 (be 60, sf 30, sm 10)
6304 : be 40, sf 20, ns 10, sm 15, se 15 (be 55, sf 25, sm 15, se 5)
6305 : be 65, sf 20, ns 10, sm 5 (be 65, sf 20, sm 15)

Mesotrophic-nitrophilous ecological interseries B/C

Carpineto-Quercetum acerosum
1401 : poo+do 80, to 5, fm 5, nm 5, sl 5
1402 : poo+do 75, to 5, fm 10, nm 5, asp 5
1403 : poo+do 80, to 5, fm 10, nm 5
1404 : poo+do 75, to 5, fm 5, nm 5, sl 5, asp 5

Fageto-Quercetum acerosum
2401 : poo+do 65, tor 5, be 5, nm 15, sl 10
2402 : poo+do 65, be 10, nm 10, sl 10, fe 5
2403 : poo+do 55, be 10, nm 15, sl 10, fe 10

Querceto-Fagetum tiliosum
3401 : be 60, so 20, nm 5, sl 10, fe 5
3402 : be 65, so 15, ll 5, sl 10, nm 5
3403 : be 60, so 15, sl 5, lpv 10, sl 10
3404 : be 60, so 20, ll 10, sl 5, nm 5

Fagetum tiliosum
4401 : be 65, sf 5, sm 10, nm 5, ll 10, se 5
4402 : be 60, sf 5, ll 15, sm 10, nm 5, se 5
4403 : be 55, sf 5, ll 20, sm 10, nm 5, se 5
4404 : be 55, sf 5, ll 20, sm 10, se 10
4405 : be 55, sf 5, ll 20, sm 15, se 5
4406 : be 50, sf 5, ll 20, sm 15, se 5, nm 5

Fageto-Aceretum inferiora
5401 : be 60, sm 20, sf 10, se 5, ae 5
5402 : be 60, sm 20, nm 5, sf 5, se 5, ae 5
5403 : be 60, sm 15, nm 5, sf 5, se 5, ae 10
5404 : be 55, sm 20, ae 10, nm 5, se 10
5405 : be 60, sm 25, ae 10, se 5
5406 : be 60, sm 15, se 15, sf 10
5407 : be 55, sm 20, se 20, sf 5

Fageto-Aceretum superiora
6401 : be 75, sm 10, se 5, sf 5, ae 5
6402 : be 70, sm 15, sf 5, se 5, ae 5
6403 : be 65, sm 15, se 10, sf 5, ae 5

6404 : be 70, sm 20, se 5, ae 5
6405 : be 75, sm 15, se5, sf 5
6406 : be 70, sm 20, se 5, sf 5
6407 : be 65, sm 20, se 10, sf 5
6408 : be 60, sm 20, se 15, sf 5

Fageto-Aceretum humile
6411 : be 80, sm 15, ba 5

Acereto-Piceetum
7401 : ns 80, sm 10, ba 10
7402 : ns 90, sm 5, ba 5
7403 : ns 90, sm 5, ba 5
7404 : ns 80, sm 15, ba 5
7405 : ns 80, sm 15, ba 5, be 5

Ribeto-Mughetum
8401 : mp 80, ns 5, cb 5, ba 5, sr 5

Eutrophic-nitrophilous (maplewood) ecological series C

Carpineto-Aceretum inferiora
1501 : oag 30, to 10, sl 20, fm 20, nm 15, asp 5
1502 : oag 45, to 10, fm 15, nm 15, fe 10, asp 5

Carpineto-Aceretum superiora
2501 : oag 40, to 5, sl 20, ll 10, nm 5, fm 10, fe 5, hb 5, asp +
2502 : oag 40, to 5, sl 15, ll 5, nm 15, fm 10, fe 5, hb 5, asp +
2503 : oag 40, be 5, nm 20, ll 10, sl 10, asp 10, hb 5

Tilieto-Aceretum inferiora
3501 : be 30, sm 15, nm 10, ll 20, sl 10, fe 5, asp 5, ba 5
3502 : be 35, sm 20, nm 20, ll 10, fe 5, se 5, ba 5
3503 : be 45, oag 5, sm 15, ll 20, sl 5, fe 5, se 5
3504 : be 40, sm 20, ll 20, dbagg 5, sl 5, nm 5, asp 5
3505 : be 35, sm 15, jvp 10, lpv 20, sl 10, asp 10,
3506 : be 30, sm 20, ll 20, jvm 10, sl 10, fe 5, se 5
3507 : be 40, sm 20, ll 20, nm 10, se 10

Tilieto-Aceretum superiora
4501 : be 40, sm 20, ll 20, nm 5, se 5, ae 5, ba 5
4502 : be 40, sm 25, ll 20, se 5, ae 5, ba 5
4503 : be 40, sm 20, ll 15, sf 10, ae 5, se 5, sl 5
4504 : be 35, sm 20, ll 20, sf 5, ae 5, sl 5, nm 5, se 5
4505 : be 40, sm 20, ll 15, sf 10, ae 5, se 5, nm 5
4506 : be 40, sm 25, ll 15, sf 5, ae 5, se 10

Fraxineto-Aceretum inferiora
5501 : be 30, sf 20, sm 20, ae 20, se 10
5502 : be 25, sf 15, sm 20, se 20, ae 20
5503 : be 25, sf 20, sm 15, se 25, ae 15

Fraxineto-Aceretum superiora
6501 : be 20, sf 20, ns 20, sm 20, se 10, ae 10
6502 : be 30, sf 15, ns 15, sm 20, se 10, ae 10
6503 : be 20, sf 20, ns 15, sm 20, ae 15, se 10

Eutrophic alkaline-calciphilous (limestone-based) ecological series D

Corneto-Quercetum
1601 : puo 40, to 20, vo 20, cch 10, ashsp 10
1602 : puo 30; oag 20, to 5, cch 15, chsp 10, ashsp 15, asp 5 1603 : puo 30, oag 15, hb 20, to 5, fm 5, ashsp 10, cch 5, asp 10
1604 : puo 20, oag 30, fm 10, nm 10, sl 10, ashsp 10, asp 5, bch 5
2601 : oag 40, puo 20, to 5, be 5, fm 10, sl 10, hb 10

Fageto-Quercetum dealpinum
2611 : poo 50, puo 15, be 10, fm 5, sl 10, cch 10
2612 : poo 45, be 10, puo 10, nm 5, fm 5, sl 10, cch 10, sp 5

Pinetum dealpinum
2621 : sp 85, oag 5, ashsp 5, asp 5
3621 : sp 80, oag 5, be 5, ashsp 5, asp 5

Corneto-Fagetum
3601 : be 65, oag 15, fm 5, cch 10, ashsp 5

Querceto-Fagetum dealpinum
3611 : be 20, oag 20, puo 15, hb 15, fm 15, cch 15
3612 : be 30, oag 25, puo 5, hb 10, nm 5, fm 10, sl 5, cch 10

Fagetum dealpinum inferiora
4601 : be 60, sf 20, ashsp 10, el 5, sp 5
4602 : be 50, nm 10, ll 10, sf 10, ashsp 10, el 5, sp 5
4603 : be 55, nm 10, el 5, sf 15, ashsp 10, sp 5
4604 : be 60, sf 30, el 5, sp 5
4605 : be 60, sf 20, nm 10, ashsp 10

Fagetum dealpinum superiora
5601 : be 50, sf 10, sp 10, el 10, ashsp 15, yew 5
5602 : be 45, sf 25, el 5, sp 5, ashsp 10, sl 5, yew 5
5603 : be 55, sf 20, sp 5, el 5, ashsp 10, nm 5
5604 : be 40, sf 30, sp 10, el 10, ashsp 5
5605 : be 60, sf 10, sp 10, el 10, sm 5, ashsp 5
5606 : be 50, sf 20, sm 10, se 5, sp 5, el 5, ashsp 5

Fageto-Piceetum inferiora
6601 : be 40, ns 20, sf 10, el 10, sp 5, ba 5, ashsp 10
6602 : be 40, ns 20, sf 10, el 10, ashsp 10, sm 5, ba 5
6603 : be 35, ns 20, sf 20, el 10, sm 5, ashsp 5, ba 5

Fageto-Piceetum superiora
7601 : ns 70, el 10, ashsp 10, ba 10
7602 : ns 70, el 20, ashsp 10
7603 : ns 70, el 10, ashsp 15, ba 5

Pineto-Laricetum inferiora
6611 : el 50, sp 30, ashsp 10, ba 10

Pineto-Laricetum superiora
7611 : el 40, ns 30, ashsp 10, ba 10, sp 10

Mughetum calcicolum
8601 : mp 80, ashsp 5, cb 5, ba 5, sr 5

Oligotrophic (acidic) hydric (waterlogged and wet) order of forest type groups "a"

Betuleto-Quercetum
001 : oag 50, bsp 30, sa 20
002 : oag 25, bsp 30, sa 45
003 : oag 65, bsp 20, sa 15

Betuleto-Alnetum
011 : sa 80, bsp 20
012 : ga 35, sa 15, bsp 25, ns 15, sp 5, wi 5

Abieto-Piceetum
021 : ns 60, sf 35, ba 5
022 : ns 65, sf 30, ba 5
023 : ns 70, sf 10, sp 10, bsp 10

Pinetum ledosum
031 : mp 60, sp 30, bsp 10

Eutrophic nitrophilous hydric (waterlogged and wet) order of forest type groups "c"

Fraxineto-Alnetum
901 : sa 80, eb 5, ae+nla 15

Alnetum incanae
911 : ga 80, ns 10, eb 5, wi 5

Saliceto-Alnetum
921 : sa 40, wpo 10, wi 40, eb 10
922 : wi 40, wpo 20, sa 30, eb 10
923 : wi 40, sa 30, wpo 30
924 : wi 45, sa 35, wpo 20
925 : wi 45, sa 25, wpo 30

Querceto-Fraxinetum
931 : eo 70, nla 20, eb 5, wpo 5
932 : eo 80, nla 20

Ulmeto-Fraxinetum populeum
941 : fe 35, wpo 20, nla 20, eo 20, eb 5
942 : fe 40, wpo 20, nla 20, eo 20
943 : fe 40, wpo 15, nla 25, eo 20

Ulmeto-Fraxinetum carpineum
951 : fe 40, eo 20, nla 20, hb 5, fm 5, eb 5, sl 5
952 : fe 40, eo 20, nla 20, sl 5, hb 10, fm 5
953 : fe 40, eo 20, nla 20, hb 10, fm 10
954 : fe 35, eo 25, nla 15, hb 15, fm 10

Ulmetum
961 : fe 80, fm 10, hb 5, nla 5

Explanation of the abbreviations

sp	Scotch pine	*Pinus sylvestris* L.
sf	silver fir	*Abies alba* Mill
mp	mountain pine	*Pinus mugo* Turra subsp. *pumilio*
cp	cedar pain	*Pinus cembra* L.
ns	Norway (common) spruce	*Picea abies* (L.) Karst.
el	European larch	*Larix decidua* Mill. (Haenke)
yew	yew	*Taxus baccata* L.
be	beech	*Fagus sylvatica* L.
bsp	birch sp.	*Betula* L. sp.
cb	Carpathian birch	*Betula pubescens* ssp. *carpatica* (Kit. ex Willd.) Aschers. et Graebn
asp	ash sp.	*Sorbus torminalis* (L.) Crantz
se	Scotch elm	*Ulmus glabra* Huds., syn. *Ulmus montana* Stock.
fe	field elm	*Ulmus minor* Mill., syn. *Ulmus campestris* L.
to	European Turkey oak	*Quercus cerris* L.
bch	bird cherry-tree	*Cerasus avium* (L.) Moench
eb	European bird cherry	*Padus avium* Mill., syn. *Prunus padus* L.
oag	oaks agg.	*Quercus* agg.
so	durmast oak, sessile oak	*Quercus petraea* (Matt.) Liebl.
eo	English (common) oak	*Quercus robur* L.
puo	pubescent oak	*Quercus pubescens* Willd.
poo	polycarpic oak	*Quercus polycarpa* Schur
do	dalechampic oak	*Quercus dalechampii* Ten
vo	live oak (virgiliana)	*Quercus virgiliana* Ten
cch	dog wood, cornelian cherry	*Cornus mas* L.
hb	hard beam, common hornbeam	*Carpinus betulus* L.
sa	sticky alder	*Alnus glutinosa* (L.) Gaertn.
ga	grey alder	*Alnus incana* (L.) Moench
ba	rowan, bird ash	*Sorbus aucuparia*
ae	European ash	*Fraxinus excelsior* L.
nla	narrow leaved ash	*Fraxinus angustifolia*
sm	sycamore maple	*Acer pseudoplatanus* L.
nm	Norway maple	*Acer platanoides* L.
fm	field maple, hedge	maple *Acer campestre* L.
sl	small leaved lime	*Tilia cordata* Mill.
ll	large leaved lime	*Tilia platyphyllos* Scop.
chsp	cherry sp.	*Cerasus mahaleb* (L.) Mill.
ashsp	ash sp.	*Sorbus aria* (L.) Crantz
ea	European aspen	*Populus tremula* L.
sr	stone ribes	*Ribes petraeum* Wulfen
wsp	willow sp. *Salix*	*caprea* L.
wpo	white poplar	*Populus alba* L.
wi	willows	*Salix* L. sp.
Siw	silesien willow	*Salix silesiaca* Willd.

Discussion

Species composition of the forests in Slovakia

The first concise data set on the species composition of the Slovak forests was obtained from the results of a comprehensive survey of their natural conditions carried out from 1950 to 1955. The general site survey was in 1956 followed by a detailed typological survey. The basic mapping unit used in the typological survey of Slovak forests was forest type – associated with the original geobiocoenosis and all modified geobiocoenoses derived from it, as well as its succession phases (Zlatník, 1975). For all Slovak forest types, apart from their characterization, also the target tree species composition has been proposed (Hančinský, 1972). The target species composition reflects the species composition in the stand model of the concerned management group of mature stand at felling age. As stated by Hančinský (1972), the broad proposal of target species composition is in principle a biological-commercial concept, drafted to satisfy economic requirements of forest management and, consequently, taking into account the biologically determined and commercially preferred tree species. The major drawback of such a design was the fact that it was meant to be applied on the corresponding forest types of all forest categories, irrespective of their specific differences. Peculiar requirements given on the species composition of protection forests category and special purpose forests category (in particular those situated in nature reserves and national parks) were completely ignored.

The main scientific disadvantage of the proposal presented by Hančinský (1972) is that it actually doesn't comply with the definition of a forest type. The target species composition of a managed geobiocoenosis was simply applied to the original geobiocoenosis and also to the other geobiocoenoses at the site derived from the original by human influence as well as to the variety of succession phases of both original and changed geobiocoenoses.

Attempt to remove this shortcoming (at least partially) was made in 1974 by a research team of several scientists (Faith et al., 1974). They proposed the target species composition of production forests for forest type groups in which spruce, fir and beech were meant to be the dominant trees. At the same time, the team emphasised the need to design the target species composition for the typological units of protection forests and special purpose forests.

Nevertheless, in Slovakia the economically oriented approach has in general been maintained up to present in management of forest types and of management groups of forest types. The proposed target composition has a great practical significance in forest management planning (forestation, tending and thinning practical measures, silviculture, forest protection and regeneration).

Species composition has a crucial role in dealing with the issue of ecological stability of forest ecosystems. The highest degree of ecological stability is observed in forest stands dominated by autochthonous tree species with natural density and age structure. Species distribution in the post-glacial period was primarily influenced by local climatic and soil conditions at individual sites, ecological requirements of the species, natural competition and selection, together with the general environmental conditions in living components of forest ecosystems according to the Schmid's vegetation belts (Zlatník, 1978).

At present, is air pollution the most significant external factor affecting the forests. In forest stands dominated by non-autochthonous tree species, attenuated by air pollution (especially in spruce monocultures) the risk of pest attack is increasing; sometimes also promoted by inappropriate forest management (e.g. improper tending practices). Restoration of ecological stability of forest ecosystems has become the major problem in forest science at the end of the 20th century.

Ecological stability of forest ecosystems

Ecological stability (ecological dynamic balance) is defined as the capability of an ecosystem to resist changes affecting its condition through a range of stress factors (this feature is defined as **resistance**) and, after the threat of stressors has been terminated, to restore its original dynamic balance or its course of development by means of its own internal mechanisms (defined as **resilience** or flexibility); (according to Vološčuk and Míchal, 1991; Vološčuk, 2000).

Ecosystem's stability depends on the speed of self-restoration and degree of deviation from its original status. In accord with this definition, the ecological stability is one of the ecosystem's capabilities to comply with agents threatening its original balance. Individual succession phases have varying proportions of resistance and resilience. If we focus on the resistance, we will deal with seeking equilibrium between the functions and structures in the ecosystem, and optimisation of the system by minimizing the risk of their fluctuation.

If we mean the resilience, we will try to find optimisation of several possible conditions in order to make the ecosystem capable to adapt itself to a variety of unpredictable stimuli. In forest ecosystems subjected to human use (especially in the category of production forests) the limits of tolerable environmental load are at present a problem of noticeable scientific and practical significance.

In practical management of human-used forests, the resistance, determined by strict keeping to the structure typical for virgin forests, is not the target objective. On the contrary, more emphasis should be put on the flexible resilience, connected with enhancing the ecosystem's capabilities to develop into desirable and scientifically determined condition (e.g. by means of tending measures). Young forest ecosystems have higher degrees of flexible resilience.

Choice of criteria needed for assessment of ecological stability depends on monitoring of the stressor or the group of stressors. One of the main indicators of a change in the ecological stability is the change in the species composition caused by direct introduction of non-autochthonous alien species, or their spontaneous expansion. Other indicators include reduction of organic biomass and minerals that are vital for the ecosystem, presence of fertilization and pollutants negatively affecting the ecosystem processes (airborne pollutants, soil and water contamination, radiation, excessive noise level, etc.).

From the above-mentioned facts it is evident that the reaching of the target ecological stability in human-used ecosystems (production forests) will depend on input of supplementary energy, necessary to invest by humans into inorganic ecotopes (soil, solar energy and precipitation). There is, on the other hand, no need to provide supplementary energy to natural self-regulated ecosystems with an appropriate feedback, which we actually don't want to change or disrupt. Such ecosystems, however, require protection against anthropic damage ensured by means of adaptability-oriented management.

Ecological stabilization may be sophisticated if we deal with internal relationships between living organisms and their environment and between the organisms themselves in conditions of categories of protection forests and special purpose forests. In these forests, any substantial biomass removal (planned felling) should be avoided and pollution prevented, so the stabilisation is only based on self-directed attributes and capacities of the ecosystem components. In the ecosystems of protective forests and special purpose forests, the process is based on mechanisms of self-regulation.

The original species distribution, resulting from the natural succession in the postglacial period, is the main criteria for assessment of ecological stability of protection and special purpose forests. The major role of these stands is their ecological and environmental influence along with other specific functions assigned for human benefit. The timber production in these forests can only be subsidiary. Natural forest ecosystems have a high degree of ecological stability.

As for the management in protection and special purpose forests in nature reserves and national parks, the production function must not be the priority; on contrary, the ecological and environmental aspect must be given the highest and only preference and, consequently, full respect. Measures of regulation of species composition must be applied in accord with the above mentioned priority functions – in order to restore and conserve the natural (origin) species distribution, along with the multi-layered and uneven age structure.

Ecological stability assessment is in principle associated with assessment of synecological stability determined on the background of natural competitions between the tree species, their health and layer structure, i.e. their exploitation of the available space for energy and substances uptake. At the same time, we have to consider the degree of static stability depending on the crown canopy and stem slenderness ratio in dominant and co-dominant trees – the upper and middle stand layers. Assessment of the ecological stability based on these characteristics can only be applied to certain specifically defined succession stages of natural forests, allowing also their mutual comparison. It is not correct to compare between the calculated degrees of ecological stability belonging to different succession stages.

The practical methodology of calculating the degree of ecological stability for mature (climax) forest ecosystems was elaborated by VOLOŠČUK (2000, 2001).

The calculation is based on similarity between the current and target species composition, the sanitary coefficient, the stand layering coefficient (the degree of divergence between the current and the original layer structure), the slenderness ratio (*h/d* ratio), the canopy coefficient and assessment of natural regeneration potential. One of the crucial variables entering the calculation is the degree of divergence between the current species distribution in the studied stands and the original species distribution in natural forest type geobiocoenoses. The percentage of the existing species composition in the forest types of a particular stand is calculated from the data collected on the surveyed research sites.

Data on nature-oriented composition, corresponding to the original proportion of the species in geobiocoenoses in natural forest types may be used in research works, in establishment of principles for forest management in protected areas and forest management of forests belonging to protection and special purpose categories.

Acknowledgement

The author would like to express many thanks to the VEGA Project Agency for the financial support of the Project No.1/0600/03 realized at the Applied Ecology Department of the Faculty of Ecology and Environmental Sciences in Banská Štiavnica of the Technical University in Zvolen.

References

BLATTNÝ, T., ŠŤASTNÝ, T. 1959. *Prirodzené rozšírenie lesných drevín na Slovensku* [Natural distribution of forest woody plants in Slovakia]. Bratislava: SVPL. 402 p.

FAITH, J, GREGUŠ, C., ANDRIŠIN, P., GRÉK, J. 1974. *Odvodenie cieľového zastúpenia drevín pre oblasť smreka, jedle a buka* [Deriving target species composition for area of spruce, fir and beech]. Lesnícke štúdie, č. 2. Zvolen: VÚLH. 132 p.

FEKETE, L., BLATTNY, T. 1913. *Az erdészeti jelentöségü fák és cserjék elterjedése a Magyar állam területén* [Distribution of trees and shrubs importat for forest management in Hungary]. 1. vyd. 793 p. 2. vyd. (Tabuľky). 150 p.

GRÉK, J. 1966. *Kontrola približovania druhového zloženia porastov k drevinovým prevádzkovým cieľom* [Control of similarity trend between the actual species composition of a stand and the target species composition following from forest management requirements]. *Les*, 6: 247–251.

HANČINSKÝ, L. 1972. *Lesné typy Slovenska* [Forest types of the Slovak Republic]. Bratislava: Príroda. 307 p.

HANČINSKÝ, L. 1977. *Lesnícka typológia v prevádzkovej praxi* [Forest typology in forest management use] Bratislava: Príroda. 223 p.

LOŽEK, V. 1973. *Příroda ve čtvrtohorách* [Nature in Quaternary period]. Praha: Academia. 372 p.

MÍCHAL, I. 1992. *Ekologická stabilita* [Ecological stability] Brno: Veronika. 244 p.

RANDUŠKA, D. 1955. *Stanovištný prieskum v lesníckej praxi* [Site survey in practical forest management]. Bratislava: ŠPN. 205 p.

RANDUŠKA, D., VOREL, J., PLÍVA, K. 1986. *Fytocenológia a lesnícka typológia* [Phytocoenology and forest typology]. Bratislava: Príroda. 339 p.

VLADOVIČ, J., GRÉK, J., MINĎÁŠ, J., BUCHA, T. 1998. *Prehodnotenie cieľového zloženia lesných drevín s dôrazom na využitie prirodzenej obnovy* [Reevaluation of the targer species composition of forest woody plants with emphasis on taking profit from natural regeneration]. Final Report of the Reference Task No. 14/98. Zvolen: Forest Research Institute. 53 p.

Vladovič, J. et al. 1999. *Ekologická stabilita lesných spoločenstiev* [Ecological stability of forest communities]. Final Report of a partial scientific-research project. Zvolen: Forest Research Institute. 201 p.

Vološčuk, I. 1966. *Príspevok k typologickému mapovaniu kosodreviny* [A contribution to typological mapping of dwarf pine]. *Lesn. Čas.*, 12: 791–804.

Vološčuk, I. 1968. *Dubové spoločenstvá v Liptovskej kotline* [Oak communities in the Liptovská kotlina basin]. *Les*, 4: 160–164.

Vološčuk, I. 1973a. *Príspevok k rekonštrukcii drevinového zloženia lesov Hornej Oravy* [A contribution to restoration of original tree species composition in forests of the region Horná Orava]. *Lesn. Čas.*, 19 (1): 81–90.

Vološčuk, I. 1973b. *Rast a produkcia smreka v bukovej jedline na Slovensku* [Growth and production of spruce in beech-fir stands in Slovakia]. *Ved. Práce Výsk. Úst. lesn. Hospod. Zvolen*, 17: 165–190.

Vološčuk, I. 2000. *Environmentálne systémy. Lesný ekosystém* [Environmental systems. Forest ecosystem]. Zvolen: Technická univerzita. 117 p.

Vološčuk, I. 2001. *Teoretické a praktické problémy ekologickej stability lesných ekosystémov* [Theoretical and practical questions connected with ecological stability of forest ecosystems]. Vedecké štúdie, 1/2001/A. Zvolen: Technická univerzita. 90 p.

Vološčuk, I., Michal, I. 1991. *Rozhovory o ekológii a ochrane prírody* [Interviews about ecology and nature protection]. Martin: ENVIRO. 162 p.

Zlatník, A. 1935. Vývoj a složení přirozených lesů na Podkarpatské Rusi a jejich vztah ke stanovišti [Development and species composition of forests in the Sub-Carpathian Ukraine]. In Zlatník A. et al. *Studie o státních lesích na Podkarpatské Rusi. Díl třetí.* Sborník výzk. Úst. zeměd. 127, p. 67–206.

Zlatník, A. 1956. Nástin lesnícke typologie na biogeocenologickém základě a rozlišení československých lesů podle skupin lesních typů [An outline of forest typology on the background of biocoenology and classification of Czechoslovak forests according to the groups of forest types]. In Polanský, B. (ed.) *Pěstění lesů III.* Praha: SZN, p. 317–401.

Zlatník, A. 1959a. *Přehled slovenských lesů podle skupin lesních typů* [A survey of Slovak forests according to the groups of forest types]. Brno: Lesnická fakulta Vysokej školy zemědělskej. 195 p.

Zlatník, A. 1959b. *Skupiny lesných typov Slovenska* [Groups of forest types in Slovakia]. Edícia Lesníctvo, 52. Bratislava: SVPL. 146 p.

Zlatník, A. 1975. *Ekologie krajiny a geobiocenologie* [Landscape ecology and geobiocoenology]. Brno: Zemědělská univerzita a TIS. 172 p.

Zlatník, A. 1976. *Přehled skupin typů geobiocénů původně lesních a křovinných v ČSSR* [A survey of types of geobiocenes – originally forest and bushy in the CSSR]. *Zprávy Geogr. Úst. ČSAV Brno*, 13 (3-4): 55–62 + tab.

Zlatník, A. 1978. *Lesnická fytocenologie* [Forest phytocoenology]. Praha: SZN. 495 p.

Zastúpenie drevín v prírodných geobiocenózach lesných typov Slovenska

Súhrn

Autor odvodil zastúpenie drevín pre pôvodné geobiocenózy lesných typov Slovenska na základe vlastných experimentálnych skúseností z typologického prieskumu lesov Slovenska v rokoch 1958–1974 a na základe publikovaných literárnych údajov. Číslovanie lesných typov je uvedené podľa Hančinského (1972). Názvy skupín lesných typov sú podľa Zlatníka (1956). Autor v práci využil poznatky z riešenia výskumnej úlohy o chorológii domácej dendroflóry v rokoch 1995–1996 na Ústave ekológie lesa SAV vo Zvolene. Naliehavosť potreby vypracovania návrhu zastúpenia drevín v pôvodných geobiocenózach lesných typov Slovenska vyplynula z riešenia grantovej úlohy VEGA 1/0600/03 na Katedre aplikovanej ekológie Fakulty ekológie a environmentalistiky TU vo Zvolene, zameranej, okrem iného, na výskum ekologickej stability lesných ekosystémov, osobitne prírodných rezervácií a národných prírodných rezervácií CHKO Štiavnické vrchy. Ekologická stabilita je schopnosť ekosystému odolávať zmene svojho stavu vplyvom stresových faktorov a po ukončení pôsobenia stresových faktorov vrátiť sa pomocou vlastných vnútorných mechanizmov k dynamickej rovnováhe, alebo k svojmu normálnemu vývojovému smeru. Významnou súčasťou metodiky stanovenia ekologickej stability je určenie aproximácie súčasného a pôvodného drevinového zloženia lesného ekosystému, stanovenie sanitárneho koeficienta (zdravotného stavu), koeficienta vrstevnatosti (odchýlenia súčasnej vrstevnatosti od pôvodnej), štíhlostného koeficienta (pomer výšky k hrúbke stromu), koeficienta korunovosti (pomer dĺžky koruny k celkovej výške stromu) a posúdenie schopnosti prirodzenej reprodukcie drevín. Drevinové zloženie má teda kľúčovú úlohu v stanovení synekologickej i statickej stability lesného ekosystému.

Predložený návrh pôvodného zastúpenia drevín v prírodných geobiocenózach lesných typov Slovenska možno využiť pri ekologickom výskume lesných ekosystémov, pri stanovení ich ekologickej stability, pri starostlivosti o ekosystémy chránených území a zariaďovaní ochranných lesov a lesov osobitného určenia.