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## ECOLOGY (Bratislava)

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**Special sections:** Terminology, Discussion, Chronicle.

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# ECOLOGICAL CONDITIONS, AREA DIFFERENTIATION AND BIODIVERSITY OF BULGARIAN FORESTS


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Abstract

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The present article includes a synthesis survey of the forest stands and the specific vegetation on the territory of Bulgaria. On the basis of the detailed characteristic of the ecological conditions the data for distribution of the natural vegetation in different thermo-climate belts are presented and in accordance with these data our country has the following belts: alpine, sub-alpine, high-mountain, middle-mountain, and low-mountain and zonal afore-mountain belt. The forest growing zones are differentiated in Zone of *Pinus mugo*, Zone of *Picea abies* and *Pinus peuce*, Zone of *Fagus sylvatica* and conifers, Zone of *Quercus species*. There are three forest-growing belts, respectively high-mountain forest-growing belt, middle mountain belt of beech and coniferous forests, where the beech forests are widespread, lower plain-hilled and hill-fore-mountain belt of oak forests and each have three sub-belts. This study shows actual information for the distribution and natural renovation of the main forest types in Bulgaria. There are indicated the basic forest trees, forming the structure of the natural forest ecosystems according altitude and soil-climatic conditions. In the structure of the natural forests the species *Picea abies* (L.) K a r s t., *Pinus sylvestris* L., *Abies alba* M i l l., *Fagus sylvatica* L., *Carpinus betulus* L., *Quercus petraea* L i e b l., *Quercus cerris* L., *Quercus pubescens* W i l l d. and in rare occasions *Quercus robur* L., *Quercus coccifera* L., *Quercus hartwissiana* S t e v. with their companion species prevail from the high to the lower parts of the country.



*Key words:* ecological factors, forest formations, forest-growing belts and sub-belts, natural renovation


## Introduction

One of the special features of the Bulgarian forests is their area differentiation. The distribution of the natural forest vegetation is examined trough the characterizing of the forest biodiversity in relation with the ecological conditions. There exists dependence between

the forest distribution and the altitude. The borders of areals of *Picea abies* (L.) K a r s t., *Fagus sylvatica* L. and other trees are passing across the territory of our country and the Bulgarian forests are presented as a big reserve of biodiversity.

In the structure of the natural forests the species *Picea abies* (L.) K a r s t., *Pinus sylvestris* L., *Abies alba* M i l l., *Fagus sylvatica* L., *Carpinus betulus* L., *Quercus petraea* L i e b l., *Quercus cerris* L., *Quercus pubescens* W i l l d. and in rare occasions *Quercus robur* L., *Quercus coccifera* L., *Quercus hartwissiana* S t e v. with their satellite species prevail from the high to the lower parts of the country.

The forests have good-presented vertical bio-climatic zones, which are related to the ecological conditions. Consider the vertical zones, the natural vegetation could be divided as follows: alpine, sub-alpine, high-mountain, middle-mountain, and low-mountain and zonal afore-mountain belt. The information for the actual condition of the regions of forest vegetation in Bulgaria at the present moment is presented herein also and it reflects the area differentiation and the biodiversity of the forest ecosystems.

## Characteristic of the ecological factors

The specific of the growing conditions in forest ecosystems settled in the individual forest-vegetation zones is modified by the ecological factors. On different hypsometric levels, the climate, soils and vegetation are changing.

### *Relief*

The territory of Bulgaria is described with various relief and significant differences in altitude of each parts of the country. The zonal climate, soils and phyto-geographic regulars are very strong modified in the regions by the geological structure, hydrological structure and geomorphologic conditions, especially the altitude, separation and exposition of the slopes. On the basis of hypsometric data for Bulgaria, the percentage distribution of the zonal areas with different altitude is as follows: 31.1% (from 0 to 200 m), 34.5% (200-500 m), 21.5% (500-1000 m), 11.7% (1000-2000 m) and 1.2% (>2000 m). The big range in height restricted from 0 to 2925 m altitude determines the vertical zones and the intensive alteration of the natural factors. On the territory of Bulgaria some structural units of the relief are determined: tabular-layered lands, young-undulated zones and old volcano massifs.

The relief of the country formed under these conditions is complete and crossed. As a main natural component the bigger part of the forests are forming, growing and developing under conditions of specific hydrothermal regime in the mountain regions.

### *Climate*

The climatic conditions of the country are multifarious and are determined from the geographical location and the relief. In meteorological attitude there is an influence of Island and



Mediterranean cyclones, the Siberia anticyclones and the atmospheric processes, developed over North Atlantic, Continental Europe, Siberia, Mediterranean regions and wilderness parts of Asia, according Pavlov (2002). The climate is continental. At the south parts of the country the Mediterranean climatic influence is strong presented. In the studies of Subev, Stanev (1963) the circulation conditions over the Balkan Peninsula are described in details.

The peculiarities of the Bulgarian climate are characterized with irregular distribution of the rainfall and large range in the thermal conditions in altitude. In accordance with the data of Slavov, Alexandrov (1996), done the last century in our country for the periods 1927-1935, 1945-1952 and 1982-1994, three prolonged desertification are detected.

The nearness of the Black Sea has a big importance for the climate in the east part of Bulgaria. By that reason the temperature regime of the air is varied, despite of the small differences in the latitude between the north and the south regions.

T a b l e 1. Characteristic of climate – general data

| Indices | Meteorological stations | | | |
|---|---|---|---|---|
| | Tcherni vrah | Sofia-IMH | Sandanski | Varna |
| 1. Location of the meteorological station | | | | |
| – east geographic length – Greenwich | 23°16' | 23°23' | 23°16' | 27°65' |
| – north latitude | 42°35' | 42°39' | 41°33' | 43°12' |
| – altitude - m | 2295 | 586 | 206 | 39 |
| 2. Average annual data (2000) for | | | | |
| – atmosphere pressure [hPa] | 772.1 | 948.4 | 992.8 | 1011.9 |
| – relative humidity [%] | 76 | 64 | 60 | 72 |
| – temperature of the air [°C] | 1.2 | 11.5 | 14.9 | 13.0 |
| – annual sum of the rainfall [mm] | 549 | 304 | 237 | 239 |
| 3. Average data of many years for | | | | |
| – temperature of the air, [°C] – average for the period 1931 – 1970 | 0.3 | 10.0 | 13.9 | 12.1 |
| – annual sum of the rainfall [mm] – average for the period 1931 – 1985 | 1178 | 636 | 533 | 513 |

In Table 1 are placed some of the total meteorological data from the year 2000 (NSI, 2001). There are used data from four meteo-stations, located at different altitudes – from 39 m (Varna) to 2295 m (Tcherni vrah). The average data for many years are determined for the longer periods, as follows: temperature of the air for the period from 1931 to 1970 according to the Climate Manual (1983) and rainfall, average for the period 1931-1985 (Koleva, Peneva, 1990).

The comparison of the results shows, that for each meteorological station the average annual temperature of the air in 2000 has been higher than the average temperature of many years. Respectively, the annual sum of the rainfalls is two times smaller than the average sum of the rainfalls of many years, as is shown in Table 1.

The altitude, the form of the relief and the nearness to the Black Sea, affect the temperature of the air. The rainfall is irregular distributed over the territory and in the year seasons. In accordance with Koleva, Peneva (1990), the distribution of rainfalls is closely tied with the atmosphere circulation that is influenced by the orographical peculiarities at some regions.

*Soils*

The forest soils in Bulgaria are very diverse. Through the altitude in district from the higher parts to the lower parts, the forest soils are ordered as follows: Humic Cambisols, Rendzinas, Cambisols, Gray Luvisols or Hromic Luvisols.

As all, the soils in the mountain regions are affected by destructive and degradation processes in different reveal rate. In some mountain territories of Bulgaria, 88% from the soils have light granulo-metric structure and small flow potential on the surface. 70% from the soils disposed on the hill terrains have intermediate granulo-metric structure (Bojadjiev et al., 2001).

The silviculture properties, the quality and the distribution of the forest zonal formations cause the growing characteristics and quantity-qualitative specific and the distribution of the zonal types of forest soils. According to Penev et al. (1969) the climatic, forest-vegetation and soil zones are indivisible.

## Area differentiation of the forests

The species composition of the natural forest-tree vegetation is determined by the changes of climate in vertical and horizontal direction. The results of many investigations show and prove, that the increase or decrease of the temperature, air humidity and solar radiation affect on the regular variations in the forest compound and outline the vertical-horizontal zones of the forests in the country.

*Distribution of the natural vegetation in thermo-climate belts*

The forests in Bulgaria have good-expressed vertical bio-climatic zones. The horizontal zones in the plains and the vertical belts of the natural forests in the mountains are bind with the climate regime. According to the Pavlov (1997), on the territory of Bulgaria are formed six thermo-climate zones with adopted gradient of the radiation balance 10 kkal/cm$^2$.year.

They are alpine, sub-alpine, high-mountain, middle mountain, low-mountain and zonal fore mountain belt (Table 2). They could be examined as analogs of the natural zones in the North Hemisphere. It is clear from the Table 2, that when R is near to the 10 kkal/cm$^2$.year the alpine belt is formed. When the R = 21-30 kkal/cm$^2$.year – in the range to R = 50-60 kkal/cm$^2$.year are formed the following belts: sub-alpine, high-mountain, middle-mountain, low-mountain and fore mountain.



Table 2. Potential forest vegetation from different belts in Bulgaria, examined as analogs of the natural zones of North Hemisphere

| Indices (according Pavlov, 1997) | | | |
|---|---|---|---|
| Belt | Thermo zone | Radiation balance (R) kkal/cm$^2$.year | Predominate classes formations of the potential vegetation in Bulgaria |
| Alpine | Arctic | to 10 | *Herbosa (Frigoherbosa)* |
| Sub alpine | Sub arctic | 11 – 20 | *Fruticieto-Herbosa* |
| High-mountain | Boreal | 21 – 30 | *Aciculilignosa* |
| Middle-mountain | Sub boreal | 31 – 40 | *Aciculilignosa, Aestilignosa* |
| Low-mountain | Middle European | 41 – 50 | *Aestilignosa* |
| Fore mountain | Mediterranean | 50 – 60 | *Aestilignosa, Durilignosa, Aestiduriherbosa* |

This vertical division in zones, that is typical for the higher mountains in Bulgaria, gives a possibility an analogy with the horizontal zones in Eurasia in respect of climate changes, altitude and main types of relief to be made.

*Forest – growing zones and distribution of the zonal formations*

According to the studies of Penev et al. (1969), four forest-growing zones could be specified in Bulgaria. There are determined their ecological areals also.

With arrangement of the forest-growing zones in descending range in respect of the altitude, the different zones could be determined. They are the following: zone of *Pinus mugo*, zone of *Picea abies* and *Pinus peuce*, zone of *Fagus sylvatica* and conifers and zone of *Quercus species*. For each of the zones are defined the zonal types of forest vegetation formations:

**Zone of *Pinus mugo*** – zonal formation of *Pinus mugo* Turra., with *Alnus viridis* (Chaix) DC.

**Zone of *Picea abies* and *Pinus peuce*** – zonal formation of *Picea abies* (L.) Karst., zonal formation of *Picea abies* (L.) Karst. – *Pinus peuce* Gris. – *Pinus heldreichii* Chris.

**Zone of *Fagus sylvatica* and conifers** – zonal formation of *Pinus sylvestris* L., zonal formation of *Abies alba* Mill. – *Fagus sylvatica* L. – *Picea abies* (L.) Karst., zonal formation of *Fagus sylvatica* L.

**Zone of *Quercus species*** – zonal formation with predominate species *Quercus robur* L., zonal formation with predominate species *Quercus frainetto* Ten. and *Quercus cerris* L., zonal formation with predominate species *Quercus petraea* Liebl.; zonal formation with predominate species *Quercus petraea* Liebl. and *Fagus orientalis* Lipsky.

*Forest-growing belts and sub-belts*

The natural conditions in Bulgaria are multiform. That requires the forestations to be made in accordance with the specific ecological conditions in the specific regions (Milev et al.,

2001). On the base of the studies prepared by Zahariev et al. (1979) the forest-vegetation partition is made and it is a thing of present interest.

In territorial aspect, the partition in three forest-vegetation regions is done. They are: Mizia, Trakia and South Border region. In each of them according to the altitude there are divided three belts with three sub-belts for each belt, as it is shown at Table 3. In vertical direction they differ in climate conditions and include: high-mountain belt, middle mountain belt of beech and coniferous forests; and lower plain-hilled and hill- fore-mountain belt of oak-tree forests.

Table 3. Forest-vegetation belts, sub-belts and regions in Bulgaria distributed according to the altitude

| Forest-vegetation belts and sub-belts (acc. Zahariev et al., 1979) | Forest-vegetation region | | |
|---|---|---|---|
| | Mizia | Trakia | South near to the border |
| | altitude [m] | | |
| High-mountain belt: | over 1800 | over 2000 | over 2200 |
| – sub-belt of the alpine meadows and grazing | over 2200 | over 2500 | over 2700 |
| – sub-belt of the sub-alpine formations of single trees | 2000-2200 | 2200-2500 | 2500-2700 |
| – sub-belt of high-mountain forests from *Picea abies* and *Pinus peuce* | 1800-2000 | 2000-2200 | 2200-2500 |
| Middle mountain belt of beech and coniferous forests: | 600-1800 | 700-2000 | 800-2200 |
| – sub-belt of the high-mountain forests from *Picea abies* | 1500-1800 | 1700-2000 | 1900-2200 |
| – sub-belt of the middle-mountain forests from beech, pine spruce and spruce. | 1000-1500 | 1200-1700 | 1500-1900 |
| – sub-belt of the lower forests of *Quercus petraea*, beech and pine spruce | 600-1000 | 700-1200 | 800-1500 |
| Lower plain-hilled and hill-fore-mountain belt of oak forests: | 0-600 | 0-700 | 0-800 |
| – sub-belt of the hill-fore-mountain mixed broadleaves forests | 400-600 | 500-700 | 600-800 |
| – sub-belt of the plain-hilled broadleaves oak and xerotherm forests | 0-400 | 0-500 | 0-600 |
| – sub-belt of the watered and close the river forests. | 0-600 | 0-700 | 0-800 |

**The high-mountain forest-growing belt** starts from 1800-2000 m altitude and reach to 2200-2500 m altitude, commonly for the country. It is divided in three sub-belts: sub-belt of the alpine meadows and grazing, sub-belt of the sub-alpine formations of single trees; sub-belt of high-mountain forests from *Picea abies* and *Pinus peuce*. The climate is cool and humid, with long winter and deep cover of snow. The vegetation period has comparatively short duration – 3 – 3.5 months.

The basic forest-forming species for the high-mountain forest-vegetation belt are *Picea abies* (L.) K a r s t. and *Pinus peuce* G r i s., and on some places *Pinus heldreichii* C h r i s t.



These trees form as well as clean stands so mixed stands. In the lower part of the high-mountain belt the mixed stands with *Pinus sylvestris* L. are forming, but on sunny expositions.

**Middle mountain belt** of the oak and coniferous forests is located lower, between 600-700 m altitude and 1900-2200 m altitude. Because of the non-homogeneous climate in the vertical range in this belt, here are described three sub-belts: sub-belt of the high-mountain forests from *Picea abies*; sub-belt of the middle-mountain forests from beech, pine spruce and spruce; sub-belt of the lower forests of *Quercus petraea*, beech and pine spruce.

In the middle mountain belt in Bulgaria are widespread the most valuable mixed coniferous forests of *Pinus sylvestris* L. and *Picea abies* (L.) K a r s t., of *Abies alba* M i l l. and *Picea abies* (L.) K a r s t. etc., and mixed forests of conifers and *Fagus sylvatica* L.

The lower plain-hilled and hill-fore-mountain belt of oak forests is the lowest forest-growing belt. It starts from the sea level and finishes near to 700-800 m altitude. This forest –vegetation belt is separated into three sub-belts: sub-belt of the hill-fore-mountain mixed broadleaves forests; sub-belt of the plain-hilled broadleaves oak and xerotherm forests; sub-belt of the watered and close the river forests. The forests are formed from *Quercus sp.* and their satellites. The lowest parts of our country and the coastlands out rivers are also involved in this belt.

Ought to draw attention to this, that in the limits of each forest-growing belt on the territory of our country are determined forest growing types. The forest growing types are included into groups in the limits of the smallest climate homogeneous unit – the sub-belt (Garelkov, 1989). The groups have homogeneous soil conditions and similar relief, exposition and gradient of the slope. For their explanation the definite marks, categories and criteria are applied.

*Variation of the tree-forest vegetation with major economic importance*

The tree species in Bulgaria (trees, bushes and semi-bushes) are near to 370, which belong to 49 families and 23 genders (Urukov, 2001). With major economical importance for the forestry are the species: *Picea abies* (L.) K a r s t., *Pinus sylvestris* L., *Pinus nigra* A r n., *Abies alba* M i l l., *Fagus sylvatica* L., *Quercus robur* L., *Quercus petraea* L i e b l., *Quercus frainetto* T e n., *Quercus cerris* L., *Fraxinus excelsior* L., *Fraxinus oxycarpa* W i l d., *Acer pseudoplatanus* L. etc. In the thin oak forests the soil-protection species is *Carpinus betulus* L.

There exists dependence between the forest distribution and the altitude. The species that dominate in the composition of the natural forests in high-low direction are: *Picea abies* (L.) K a r s t., *Pinus sylvestris* L., *Abies alba* M i l l., *Fagus sylvatica* L., *Carpinus betulus* L., *Quercus petraea* L i e b l., *Quercus cerris* L., *Quercus pubescens* W i l l d. and rarely *Quercus robur* L., *Quercus coccifera* L., *Quercus hartwissiana* S t e v. and their satellites. The stands formed by this vegetation have a big importance for the economy.

On the territory of the country the borders of the areals of *Picea abies* (L.) K a r s t., *Fagus sylvatica* L. and other species are crossing and the Bulgarian forests present a considerable reserve for the biodiversity.

The forest-fruit species have also big role for the forestry. In Bulgaria the tree *Juglans regia* L. is cultivating up to 1000 m altitude. There are selected over 10 sorts (Stoyanov,

2001). The species *Castanea sativa* M i l l., *Corylus avellana* L. and others have perspectives as forest-fruit trees.

*Distribution and natural renovation of the forests*

The specific for Bulgarian forests is their good expressed bio-climate zones in vertical direction, which are related to the natural ecological factors. In the mountain regions with decrease of altitude the general compounds of dendrozeanosis are defined by the areals of the following species: *Pinus mugo* T u r r a, *Pinus peuce* G r s b., *Picea abies* (L.) K a r s t., *Abies alba* M i l l., *Pinus sylvestris* L., *Fagus sylvatica* L. and *Quercus petraea* L i e b l.

For the top parts of our mountains the most adapted forests are the clean and mixed forests formed by *Pinus peuce* G r s b. and by *Pinus heldreichii* C h r i s t.

***Picea abies* (L.) K a r s t.** The clean spruce forests are wide-spread in the high forest zone. The spruce form stands with *Abies alba* M i l l., *Pinus sylvestris* L., *Pinus nigra* A r n. and *Fagus sylvatica* L., and also mixed forests with *Pinus peuce* G r s b., *Pinus heldreichii* C h r i s t.

The natural renovation of *Picea abies* (L.) K a r s t. goes tardy and with difficulties in the high parts of the spruce belt and its renovation is comparatively good in the lower parts of this belt. As a result of the long-term stationer observation the structure of the young growing plants and the ecological successions are investigated (Stoyanova, 1989, 1998, 2001). There are specified biometric indices for the young growing plants and for the character of renovation according to the different types of silviculture activities: selective, step-by-step and clear felling. The renovation processes in the spruce stands are appreciated in accordance with the degree of anthropogenic impacts. The data for the plantation in the forest ecosystems of the high mountain belt are settled in Table 4.

T a b l e 4. Diversity of the vegetation communities in forests ecosystems from the high mountain belt on the west slopes of Rila Mts

| Edificatory of stand | Determined plant communities |
|---|---|
| *Picea abies* (L.) K a r s t. | ass. *Picea abies – Vaccinium myrtillus + Luzula sylvatica* |
| | ass. *Picea abies – mixtoherbosa* |
| | ass. *Picea abies + Abies alba – Sanicula europaea* |
| | ass. *Picea abies + Fagus sylvatica – Geranium macrorrhizum* |
| | ass. *Picea abies + Pinus sylvestris – Vaccinium myrtillus* |
| | ass. *Picea abies + Pinus sylvestris – Luzula sylvatica* |
| | ass. *Picea abies + Pinus peuce – Vaccinium myrtillus* |
| | ass. *Picea abies + Pinus peuce – mixtoherbosa* |
| *Abies alba* M i l l.<br>*Pinus sylvestris* L.<br>*Fagus sylvatica* L.<br>*Pinus peuce* G r s b. | ass. *Abies alba – Fagus sylvatica + Picea abies – Oxalis acetosella*<br>ass. *Pinus sylvestris + Picea abies – Vaccinium myrtillus*<br>ass. *Fagus sylvatica + Abies alba + Picea abies – Oxalis acetosella*<br>ass. *Pinus peuce + Rubus idaeus – Calamagrostis arundinaceae* |



The study was held on the west slopes of Rila Mts and the purpose was the species composition, the structure of forest vegetation coverage and the natural renovation in the biosphere reserve "Parangalitza" to be determined. The investigations include clean and mixed forests of conifers and forests formed by *Fagus sylvatica* (L.). They are prepared in accordance to ecological profiles, marked in dependence of relief and slope exposition.

It is determined, that the forest formations with edificatory *Picea abies* (L.) K a r s t. have comparatively the biggest cover at the reserve. The mixed dendrozeanoses of spruce and fir-tree are unique in their productivity on the territory of the reserve. The investigations confirm the attitude of other authors, that in the region of the reserve there exist the best ecological conditions of development for the species *Picea abies* (L.) K a r s t. and *Abies alba* M i l l. not only for Bulgaria, but also for Europe.

For mixed phytozeanoses of *Picea abies* (L.) K a r s t. and *Pinus sylvestris* L., where the edificatory is *Picea abies* (L.) K a r s t., the participation of Scotch pine in the first floor of the stand is specific. At the reserve the distribution of forest ecosystems formed by edificatory *Abies alba* M i l l., *Pinus sylvestris* L., *Fagus sylvatica* L. and *Pinus peuce* G r s b. is more restricted.

***Pinus sylvestris* L.** The tree forms clean stands and mixed stands with other conifers and broadleaves. For the mountain region is typical a distribution of mixed forests of *Pinus sylvestris* L. and *Picea abies* (L.) K a r s t. From the mixed stands of pine with broadleaves, more widespread are these with *Fagus sylvatica* L. or with *Betula pendula* R o t h.

A special mark for the renovation of pine-tree stands located at fresh places is the domination of the young growing spruce plants (Stoyanova, 1994, 1997). It is done analyses and ecological assessment for the conditions and factors that could be presented as a precondition for successions in the forests of *Pinus sylvestris* L. The change of the pine-tree with spruce could be frequently found in our forests. It is typical for rich and wet sites.

***Fagus sylvatica* L.** The beech is the most widespread species in the middle mountain belt. The biggest part belongs to the clean beech forests.

*Fagus sylvatica* L. forms clean and mixed stands with practically all of our conifers – *Picea abies* (L.) K a r s t., *Abies alba* M i l l., *Pinus sylvestris* L., *Pinus nigra* A r n. and often with *Pinus peuce* G r s b. Stoyanova (1992) investigated some types of forests in the areal of *Fagus sylvatica* L. The peculiarities of the natural renovation in the beech forests are clarified according to the forest type and ecological conditions. (Stoyanova, 1992; Sokolovska, Stoyanova, 1998; Stoyanova, 2001 and others). A regular phenomenon for the mature pine-beech stands on fresh and wet sites is the change of pine with beech or in other case the change of beech with pine. On the basis of prepared studies for the north slopes of the Middle Stara Planina Mts some of the specific forest ecosystems in the areal of *Fagus sylvatica* (L.) and *Quercus petraea* L i e b l. were determined, as is placed at Table 5.

The dendrozeanoses with edificatory *Fagus sylvatica* (L.) have more widespread distribution. The mono-dominant associations of formation *Fageta sylvaticae*: ass. *Fagus sylvatica – Luzula albida,* ass. *Fagus sylvatica – Asperula odorata,* ass. *Fagus sylvatica – Mercurialis perennis*, could be found more frequently.

***Quercus sp.*** In the areal of the oak forests there are a great variance of soil-climatic conditions and peculiarities (Marinov, Stoyanova, 1986). The amelioration of the structure

Table 5. Diversity of plant communities in forest ecosystems in the areal of *Fagus sylvatica* (L.), and *Quercus petraea* Liebl. in North Bulgaria

| Edificatory of the stand | Specific plant associations and geographical location |
|---|---|
| | 1. For plant communities in forest mountain ecosystems from the north slopes of Middle Stara Planina Mts |
| *Fagus sylvatica* L. | ass. *Fagus sylvatica – Asperula odorata* |
| | ass. *Fagus sylvatica – Mercurialis perennis* |
| | ass. *Fagus sylvatica – Luzula albida* |
| | ass. *Fagus sylvatica + Quercus petraea + Carpinus betulus – Luzula albida* |
| | ass. *Fagus sylvatica+ Carpinus betulus – Luzula albida* |
| *Quercus petraea* Liebl. | ass. *Quercus petraea + Fagus sylvatica + Carpinus betulus – Asperula odorata* |
| | ass. *Quercus petraea + Fagus sylvatica + Carpinus betulus + Tilia parvifolia* |
| | 2. For hill-afore-mountain forest of mixed broadleaves in North Bulgaria |
| *Quercus petraea* Liebl. | ass. *Quercus petraea – mixtoherbosa* |
| | ass. *Quercus petraea – + Fagus sylvatica + Carpinus betulus – mixtoherbosa* |
| | ass. *Quercus petraea + Quercus frainetto – mixtoherbosa* |
| | ass. *Quercus petraea + Quercus frainetto + Quercus cerris – Festuca ovina* |
| *Quercus frainetto* Ten. | ass. *Quercus frainetto + Quercus petraea + Quercus cerris +Carpinus orientalis* |
| | ass. *Quercus frainetto + Quercus cerris – Vicia cassubica* |
| | ass. *Quercus frainetto + Quercus petraea – Festuca ovina* |

and productivity in oak forests is one of the most important purposes for the forest economy. The satellites of the oak are *Fraxinus excelsior* L., *Fraxinus oxycarpa* Will d., *Acer campestre* L., *Carpinus betulus* L. etc.

The replacements in the oak forests, arisen out of different conditions, could be with *Tilia argentea* Des f., or as follows: *Quercus frainetto* Ten. replaced with *Quercus cerris* L.; *Quercus petraea* Liebl. replaced with *Carpinus betulus* L. and other examples. With regulation of the processes of renovation it could be directed the changing of tree species in order increase the forests productivity.

For the hill-afore-mountain mixed forests of broadleaves in North Bulgaria (Table 5) are divided association with edificatory *Quercus petraea* Liebl. or *Quercus frainetto* Ten. The productivity of the forests formed by *Quercus petraea* Liebl. and *Fagus sylvatica* L. is comparatively high.

The biggest massif formed by high-stem oak forests in Bulgaria is located in Strandja Mts. In order their biodiversity to be protected the National Park "Strandja" was created in 1995. These oak forests are with different age and they have complicated structure and compounds. The age of the forests is near to 180-200 years and they have a unique character for Europe. There could be found trees with diameter 200-250 cm, and age 700-900 years (Patronov, 2001). All forest formations in the National Park are relicts and have high conservation value. The forests have rich biodiversity, but the stands with evergreens and the communities near to seaside are worth much.



## Conclusion

The differences in altitude and soil-climatic conditions between the individual forest vegetation belts render an influence on the distribution of forest vegetation in Bulgaria. In the structure of the natural mountain forests the most dominated species are *Picea abies* (L.) Karst., *Pinus sylvestris* L., *Abies alba* Mill., *Fagus sylvatica* L., *Quercus petraea* Liebl., *Quercus cerris* L., *Carpinus betulus* L.

A big soil-climatic impact exists on the areal of distribution of oak forests. The forests formed especially of *Quercus frainetto* Ten., *Quercus cerris* L., *Quercus petraea* Liebl., *Quercus pubescens* Willd. and in rare cases *Quercus robur* L., *Quercus coccifera* L., *Quercus hartwissiana* Stev. and their satellites *Fraxinus excelsior* L., *Fraxinus oxycarpa* Willd., *Tilia argentea* Des f., *Acer campestre* L., *Carpinus betulus* L. and others are distributed on the lower parts.

In accordance with the actual forest vegetation partition three regions are specified. In respect of altitude they are divided in three belts: high-mountain belt, middle mountain belt of beech and coniferous forests, lower plain-hilled and hill-fore-mountain belt of oak forests.

The differences in the structure of the natural forest vegetation in respect of altitude and soil-climatic conditions show a clear expressed interaction between the plants and the environment. The presented data confirms that in Bulgaria dominate the coniferous forests on areas with high altitude and with decrease of altitude the participation of cover-seed tree plants increases.

*Translated by M.K. Zhiyanski*

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Stoyanova N., Zhiyanski M.: **Ekologické podmienky, priestorová diferenciácia a biodiverzita lesov v Bulharsku.**

V práci predkladáme syntetický prehľad o lesných porastoch a špeciálnej vegetácii na území Bulharska. Údaje o rozšírení prirodzenej vegetácie v rôznom tepelno-klimatickom pásme opisujeme na základe podrobnej charakteristiky ekologických podmienok. Zistili sme, že naša krajina má tieto pásma: alpínske, subalpínske, vysokohorské, stredohorské, nízkohorské a zonálne predhorské pásmo. V prípade lesov rozlišujeme zónu *Pinus mugo*, zónu *Picea abies* a *Pinus peuce*, zónu *Fagus sylvatica* a ihličňanov, zónu druhov *Quercus*. Výškové lesné pásma sú tri, a to vysokohorské, stredohorské pásmo bukového a ihličnatého lesa, nižšie nížinno-hornaté a hornaté predhorské pásmo dubových lesov. Každý z nich má tri podpásma. V práci prezentujeme aktuálne informácie o rozšírení a prirodzenej obnove hlavných lesných typov v Bulharsku. Označené sú hlavné lesné stromy formujúce štruktúru prírodných lesných ekosystémov podľa nadmorskej výšky a pôdno-klimatických podmienok. V štruktúre prírodných lesov prevažujú druhy *Picea abies* (L.) K a r s t., *Pinus sylvestris* L., *Abies alba* M i l l., *Fagus sylvatica* L., *Carpinus betulus* L., *Quercus petraea* L i e b l., *Quercus cerris* L., *Quercus pubescens* W i l l d. a zriedkavo *Quercus robur* L., *Quercus coccifera* L., *Quercus hartwissiana* S t e v. od vysokých po nižšie položené časti krajiny.





# EVALUATION OF GRASSLAND QUALITY

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Abstract

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This paper has a methodical character. Evaluation of grassland quality was verified over years in 1200 floristic analyses of grassland in the Western Carpathians. The quality of grassl can be understood on the base of floristic analysis. This analysis consists of the dominance of individual species in floristic groups (in %):

1. Monocotyledoneae – grasses (Poaceae)
2. Monocotyledoneae – sedge and rush family (Cyperaceae + Juncaceae)
3. Monocotyledoneae – families Liliaceae, Orchidaceae and Iridaceae
4. Dicotyledoneae – leguminous plants (Fabaceae)
5. Dicotyledoneae – other families of dicotyledonous species
6. Pteridophyta – pterydophyte ferns (Aspidiaceae, Equisetaceae, Hypolepidaceae), and rest constituted by Bryophyta (mosses) with a share of empty places, and their forage va (FV) in the grassland within the scale from -4 to 8 (Table 1), calculated by the formula:

$$E_{GQ} = \frac{\Sigma(D.FV)}{8}.$$

Evaluation of grassland quality ($E_{GQ}$) oscillates within the range from minus values (tox through deleterious, worthless, low values, lower values, valuable, high values to top values grassland with maximum value of 100. It can serve for the research and practical survey of quality of pasture and meadow grasslands. The advantage of the given evaluation in comparis with the other types is the wider scale of forage values, simplicity of calculation and practi use of 100 point scale. The evaluation of grassland can give a clue for the general or par reconstruction, eventually revitalisation to increase forage value. There must be ma a compromise between aesthetic and feeding value of grassland. As the high portion of aesth species has low feeding value, and does not meet the requirements for animal nutrition, i necessary to revitalise the grasslands by the additional seeding of valuable or high valua species, accordingly to the intensity of use, even to the detriment of aesthetic value of the grassla

*Key words*: grassland, floristic analysis, forage value, evaluation of quality

## Introduction

Vegetation because of its content of aboveground phytomass encroaches most part of environment and creates the most important sustainable source for herbivores in the ec