INVESTIGATIONS ON THE PLANTATION AND SOIL CONDITIONS IN BIOSPHERE RESERVE “PARANGALITZA”

Maria Sokolovska, Nadezhda Stoyanova, Miglena Zhiyanski
Forest Research Institute - Sofia

Abstract

The paper presents the objective conditions of climate elements, geology and soils that characterize the ecological peculiarities on the territory of biosphere reserve “Parangalitza”. There are described and differentiated the main forest types and an important part of this study is related to deep analysis of vegetable diversity and distribution of plants. The natural conditions in the biosphere reserve “Parangalitza” are favourable for forming the unique in their bio-productivity forests of conifers, where the dominant species in different forest ecosystems are Picea abies (L.) Karst., Abies alba Mill. or Pinus sylvestris L. The higher parts of the reserve are occupied by the communities of Pinus peuce Griseb and of Pinus mugo Turra., which formations have very high ecological significance. From the broadleaves species Fagus sylvatica L. is situated on the lower parts. In the composition of the herbal component of the reserve the participation of Vaccinium myrtillus L. is bigger. A part of the paper concerns the natural renovation in the forest ecosystems at the reserve. The high significance for biodiversity of the plantation at the southeast region of Europe is demonstrated herein.

Key words: ecological factors, diversity, forest types, natural renovation, plant coverage

INTRODUCTION

The biosphere reserve “Parangalitza” is located within the South-East Europe and it is one of the oldest reserves in Bulgaria. The natural conditions are in optimum for forming the unique in biological productivity forests of conifers. The region is announced as a reserve in the first half of the last century – in 1933. It is situated in the Southwest part of Rila mountain.


OBJECTS AND METHODS

The area of the reserve “Parangalitza” is 1507.6 ha. It is spread between 1470 m and 2490 m altitude. The protected territory is valued object of scientific researches on the natural processes and the regular evolution of the flora and the fauna. The object of
ur investigations is located on the border between the regions with cold and mild mountain climate and with west-southwest exposition. When Raev (1983) differentiated the mountain climates in Rila mountain, he formulates and divides a belt of optimal climate conditions for forest tree species between 900±250 m altitude and 1650±100 m altitude, where near to 53% from the forests are situated. The biosphere reserve Parangalitza* is settled in this zone of optimum.

The researches are released according to the complex methods. The route methods are also used. The purpose of the present topic is based on the aforementioned eco-physiological investigations and characteristics of the environmental conditions. A survey of the biodiversity and forests of the BR “Parangalitza” will be also presented. Data for the status of some ecological factors on the territory of the reserve are announced in the basis of investigations of different authors. The soils are studied according to the received methods for physic-chemical analysis in the Laboratory of Soil Science at the forest Research Institute. The forest types and plant biodiversity of dendrocanoses are determined by bio-silvicultural methods. The natural renovation is studied on transects at the trial places. There are made biometrical measurements of the growing plants and the plant bio-groups.

**STATUS OF ECOLOGICAL FACTORS**

**Climate and orography of the territory**

According to the data for the ecological conditions at the reserve, the climate is mountainous, from the middle and high mountain parts of the transitional continental climatic region. The climate on 1500 m altitude is characterized with an average annual sum of rainfalls estimated on 900 mm and an average annual temperature 6.6 °C. For the high-mountain part of the reserve, located between 2000-2490 m altitude, the average annual sum of rainfalls increases from 1050 mm to 1100 mm, and the average annual temperature varies from 3.6 °C on 2000 m altitude to 0.8 °C on 2490 m altitude.

It is determined that in the lower parts of the reserve the duration of the vegetation period is from 4 to 5.5 months, rather in the high parts it continues from 3 to 4 months.

The annual index for drying of de Marton moves between 54 and 77 on 1500-2000 m altitude and between 77 and 102 on 2000-2490 m altitude.

The orography of the terrain is described as a very steep relief. Predominated composition of the slopes is North-West.

The reserve “Parangalitza” is situated on the hard crossed terrain in the zone of conifers. The top of the reserve is presented with high-mountain meadows of sub-alp and alp vegetation.

**Geological and petrographical basis and soils peculiarities**


It is determined, that the soils in the region of “Parangalitza” are formed especially over senile products from middle-grained and coarse-grained biotitic granite. Blocks from south-Bulgarian granite are uncovered on some places.

In spite of the comparatively uniform geology-petrographical ground, differences in the soil cover are determined. The soil diversity includes Cambisols - eutric or dystric, Humic Cambisols, Eutric Gleysols, Ubrmic Gleysols and some specific combinations of soils.

The investigations show that the combination Humic Cambisols under junipers-grass ecosystems and Eutric Gleysols is widely distributed.

The soils in the lower part of the reserve are mainly Cambisols - eutric or dystrics. With raise in altitude the signs of Humic Cambisols increase.

The distribution of Gleysols is restricted. At the outskirts they precede into Ubrmic Gleysols.

**Cambisols - eutric or dystric** — these soils are spread in the lower part of the reserve, in the height zone between about 1500 to 1700 m altitude. The thickness of the litter is form 3 to 5 cm, and its quantity varies from 25.5 to 61 t/ha absolutely dried weight.

These soils are clay-sanded to slight sand-clayed granulometrically. The humid horizon is clear expressed, with dept 20-30 cm and with small-grained structure.

Variations in the humus reserves in the 1-m depth are determined: humus (451.5 - 740.4 t/ha), total nitrogen (11.25 - 19.16 t/ha) and movable phosphor (0.239 - 0.810 t/ha). There is also checked variation in the volume weight from 0.70 to 0.90 for A-horizon and for B-horizon from 1.06 to 1.19. The soil acidity (pH in water) for A and B-horizons is respectively from 4.30-4.80 and from 4.45-4.78.

**Humic Cambisols** — on the territory of the reserve these soils have middle depth. The total depth of A+B horizons is usually from 60 to 90 cm. In comparison with the Cambisols - eutric or dystric from the reserve, the Humic Cambisols has thicker litter. Its depth is limited between 5 and 10 cm. On some places its depth is 15 cm. The quantity of the litter varies from 48 to 91 t/ha absolutely dried weight.

The depth of the humid horizon of the Humic Cambisols soil in the reserve is in the main from 30 to 50 cm. These soils are characterized with dust-grained to small-grained granulometrical structure, light mechanical structure and temperate part of small and mean sized skeleton. The particles smaller than 2 mm have clay-sanded and light sand-clayed structure.

For the 1 m soil depth the variation is determined for the reserves of humus (452.9 to 1060 t/ha), total nitrogen (12.1 to 17.7 t/ha) and movable phosphor (0.159 to 0.459 t/ha).

The volume weight is low, from 0.64 to 0.93 for A-horizon, and for A-horizon the volume weight is from 1.03-1.10. The soil acidity (pH in water) is acid. The acidity for A-horizon is estimated on 4.0 and for B-horizon it varies from 4.15 to 4.75.

There are complexes between these two types of soils on the places of the transition from the Humic Cambisols to the Cambisols - eutric or dystrics. The distribution of Gleysols is restricted for the territory of the reserve.
junipers-grass communities and Eutric Glaysols - they are located at the top parts of the reserve. These soils are widespread and cover 70% from the total area of the reserve. They are remarkable with darker colour and have clear expressed peat layers all over the place.

Depending on the micro relief the variations in the depth of these soils are defined. These soils are mainly with average depth and for horizons A and B it is totally between 50-80 cm. The mechanical structure is clay-sanded and light sand-clayed. Etropolski et al. (1984) have studied the clay minerals in soils of the reserves. The investigations of Etropolski, Grozeva concern clarifying of the energetic parameters of soils in the reserve.

The premise for similarity of the mechanical structure of aforementioned soils from the biosphere reserve “Parangalitza” is connected to the uniformity of the underground rock.

COMPOSITION AND STRUCTURE OF THE PLANT COVERAGE IN BIOSPHERE RESERVE “PARANGALITZA”

The investigations in the reserve have scientific interest not only regarding the biodiversity and productivity of the forests. In Bulgaria the areas of the species Picea abies (L.) Karst. and Fagus sylvatica L. have a border character in respect of their distribution in the south-east region of European continent.

The results of the implemented studies in the forests of BR “Parangalitza”, made by Beliakov, Krustanov (1981), Marinov, Stoyanova (1985), etc. clarify some of the structural peculiarities of the plant coverage, the species composition and the natural renovation of the forests.

Vegetable diversity

The specific ecological conditions in the reserve cause the diversity of species composition of the forests. As a result of the completed investigations was established participation of the definite trees and bush species, which form the studied dendro-communities. It is noted in Table 1.

Our researches were realised trough transects, using of the route methods of studying in the placettes. The observations show, that on the territory of biosphere reserve “Parangalitza” the most widespread conifer species are Picea abies (L.) Karst. and Abies alba Mill. They form communities on the Cambisols - eutric or dystics and Humic Cambisols.

In higher parts of the reserve the main species, which forms the forests, is Pinus peuce Griseb. The area covered by formation of Pinus peuce is significant. Large space is occupied with Juniperus silicata Burgst.

The broadleaves are presented with Fagus sylvatica L. that covers the lower parts of the reserve and Alnus viridis (Chai. DC over the higher parts. There is preserved the formation from Alnus glutinosa, but the places are limited.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadleaves</td>
<td>Fagus sylvatica L., Alnus viridis (Chai. DC, Salix caprea L., Populus tremula L., Crataegus monogyna, Pyrus salicifolia L.</td>
</tr>
</tbody>
</table>

The data settled into Table 2 gives information about amount correlation between species from the reserve, defined according their geographical distribution. This table is created on the basis of the digital material from Bondev et al. (1981). The authors consider that not all of the vital forms and ecological groups have equal participation in the plant coverage of the reserve. On the territory of the BR “Parangalitza” are fixed 290 species high plants and it is 10% from the flora of Bulgaria.

The index of geographical distribution shows that the most of the species at the reserve have European (26.90%) and Euro-Asiatic (28.20%) distribution. The participation of the species with balkanise distribution is estimated on the 12.41%. The data shows, that in the reserve “Parangalitza” could be found at least species with Balkanise-Malasian distribution (1.03%).

<table>
<thead>
<tr>
<th>Vegetation type</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>Conifers</td>
<td>70%</td>
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<tr>
<td>Broadleaves</td>
<td>30%</td>
</tr>
</tbody>
</table>

Table 1

Vegetable diversity in forests of biosphere reserve “Parangalitza” and data for species widespread in the studied plant communities

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Table 2

Vegetable diversity in the forests of the BR “Parangalitza”

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</table>

Table 3

Vegetable diversity in the forests of the BR “Parangalitza”

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<td>30%</td>
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</tbody>
</table>
Table 2
Dissemination of plants species from biosphere reserve “Parangalitza” according their belonging and their geographical distribution

<table>
<thead>
<tr>
<th>Belonging to the geographical distribution of the plants species</th>
<th>Percent (Bondev et al.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>European distribution</td>
<td>26.90</td>
</tr>
<tr>
<td>Euro-Asiatic distribution</td>
<td>28.20</td>
</tr>
<tr>
<td>Euro-Asiatic-American distribution</td>
<td>21.05</td>
</tr>
<tr>
<td>Balkanis distribution</td>
<td>12.41</td>
</tr>
<tr>
<td>Balkanis-Malaisatic distribution</td>
<td>1.03</td>
</tr>
<tr>
<td>Boreal -Alp distribution</td>
<td>6.55</td>
</tr>
<tr>
<td>Cosmopolitic distribution</td>
<td>2.70</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>98.84</strong></td>
</tr>
</tbody>
</table>

Structure and condition of the plant coverage at the reserve

The investigations show, that the forests cover near 20% from the territory of the reserve. That is established on the basis of the researches according a complex methodology (Stoyanova, 1989, 1991, 1994 and others). The plant coverage of the biosphere reserve “Parangalitza” is formed from forests, bushes and grass formations.

In the lower parts of the reserve are formed from *Picea abies* (L.) Karst., *Abies alba* Mill., *Fagus sylvatica* L. On the west and southwest expositions the edificatory of the plantation is *Pinus sylvestris* L. The completed observations express that in the sub-alp belt of the reserve the formation of *Pinus mugo* Turra is prevalent.

There are determined formations from *Juniperus silicica* Burgst., *Pinus mugo* Turra, *Chamaecytis absinthioides* Kuzin., as well as grass formations of *Festucia sylvatica* (Uech.) Penzes and *Nardus stricta* L. with secondary origin. They were arisen on the places of *Pinus mugo*, where in the past they were destroyed by fire, before the nomination of the reserve.

Confirmations about this are the results of the analytical studies on pollen in peat to determine the vegetable and ecological changes in the region of the reserve for the last millenniums. These investigations are made from Bojilova (1981). As a result it is determined, that the upper forest board has endured significant and repeatable changes in the location and in the plant composition.

Forest types

The forests at the reserve have high productivity. It is related with the soil fertility and with the hydrothermal conditions that are favourable for growing and development of the trees species from the lower parts of the BR “Parangalitza”.

The determination of the forest types is realized according to the methodical instructions of Marinov et al. (1980). The plantations are described with the edificatory of the plantation, relief, exposition, soil, indicator qualities of the grass species and other indices. Table 3 shows the grouping of the widespread forest types in the reserve according the tree species.

The eco-phythoanalogical studies made on the territory of the reserve show, that on the north expositions the main species, which forms the plantations is *Picea abies* (L.) Karst. With smaller distribution are *Abies alba* Mill. and *Fagus sylvatica* L.

On the west and southwest expositions in the denrological composition of the forests from the reserve more often participates *Pinus sylvestris* L., rather on the places with higher altitude the species forming the plantations is *Pinus pese* Griseb.

The results of the accomplished investigations demonstrate, that in the biosphere reserve “Parangalitza” the formation of *Picea abies* (L.) Karst dominates. The ecological conditions of the growing environment are favourable for forming of the forest from *Picea abies* with high productivity.

Table 3
Grouping of the widespread forest types in the reserve “Parangalitza” according the tree species

<table>
<thead>
<tr>
<th>N</th>
<th>Forest type</th>
<th>Edificator of the plantation</th>
<th>Exposition</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>First group: Forest types of mixed conifers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Valley forest of <em>Picea abies</em>-<em>Abies alba</em></td>
<td><em>Picea abies</em> (L.) <em>Kart.</em></td>
<td>N, NE</td>
<td>Cambisols - cutric or dystric</td>
</tr>
<tr>
<td>2.</td>
<td>Middle mountain forest from <em>Picea abies</em>-<em>Pinus sylvestris</em> with * Vaccinium myrtillus* and <em>Luzula silvatica</em></td>
<td><em>Picea abies</em> (L.) <em>Kart.</em></td>
<td>N</td>
<td>Humic Cambisols</td>
</tr>
<tr>
<td>3.</td>
<td>Sub-alp forest of <em>Pinus mugo</em> with <em>Pinus pese</em> and <em>Picea abies</em></td>
<td><em>Pinus mugo</em> <em>Turra.</em></td>
<td>all</td>
<td>Peated Humic Cambisols</td>
</tr>
<tr>
<td>1</td>
<td>Second group: Forest types of conifers and broadleaves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Forest of <em>Picea abies</em>-<em>Abies alba</em>- <em>Fagus sylvatica</em> with <em>Luzula silvatica</em></td>
<td><em>Picea abies</em> (L.) <em>Kart.</em></td>
<td>N</td>
<td>Cambisols - cutric or dystric</td>
</tr>
<tr>
<td>3</td>
<td>Forest of <em>Picea abies</em>- <em>Fagus sylvatica</em> with <em>Geranium macrorrhizum</em></td>
<td><em>Picea abies</em> (L.) <em>Kart.</em></td>
<td>N, NE</td>
<td>Cambisols - cutric or dystric</td>
</tr>
<tr>
<td>1</td>
<td>Third group: Mono-dominant according tree species forest types</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Middle mountain forest of <em>Picea abies</em> with green mosses (Rhytidiadelphus triqueter, Pleurozium schmerli and Hylocomium prolifera) and <em>Vaccinium myrtillus</em></td>
<td><em>Picea abies</em> (L.) <em>Kart.</em></td>
<td>N, NE</td>
<td>Cambisols - cutric or dystric and Humic Cambisols</td>
</tr>
<tr>
<td>2</td>
<td>Forest of <em>Pinus sylvestris</em> with <em>mixtoherbosa</em></td>
<td><em>Pinus sylvestris</em> L.</td>
<td>SW, W, S</td>
<td>Cambisols - cutric or dystric</td>
</tr>
<tr>
<td>3</td>
<td>Forest of <em>Pinus mugo</em> with <em>Vaccinium myrtillus</em> and <em>Vaccinium vitis-idaea</em></td>
<td><em>Pinus mugo</em> <em>Turra.</em></td>
<td>all</td>
<td>Peated Humic Cambisols</td>
</tr>
</tbody>
</table>
The analyses show a presence of structural diversity in the studied plantations. There is a tendency of heterogeneous in the height structure that is better expressed in the mixed plantations. Indicators for activating the competition between the trees in the younger plantations are the increased trim and the complication of the height structure.

As a result of the completed typological investigations, eight forest types are differentiated. They have great distribution in the biosphere reserve “Paragalitza”. At the table 3 are shown the types that are widespread in the reserve. The first group of forest types formed of mixed conifers includes three types. These are two types with edificator Picea abies (L.) Karst.: Valley forest from Picea abies-Abies alba and Middle mountain forest from Picea abies-Pinus sylvestris with Vaccinium mirtillus and Larix sibirica. The third type is determined as a Sub-alp forest from Pinus mugo with Pinus pumila and Picea abies.

The second group of forest types formed from mixed conifers and broadleaves includes two types with edificator Picea abies (L.) Karst. The types are forest of Picea abies-Abies alba-Fagus sylvatica with Larix sibirica and of Picea abies-Fagus sylvatica with Geranium macrorrhizum.

The third group of the mono-dominant in composition of forest types belongs to three types, with edificators respectively: Picea abies (L.) Karst., Pinus sylvestris L. or Pinus mugo Turra. These types are Middle mountain forest of Picea abies with green mosses (Rhytidium rugosum, Pteridium aquilinum) and Vaccinium mirtillus. Forest of Pinus sylvestris with mixtoherboflora and Forest of Pinus mugo with Vaccinium myrtillus and Vaccinium vitisidaea.

From observations in forests of the reserve it could be concluded, that the structure of the forest-plant coverage is described more often with forest formed of mixed Picea abies with Abies alba or Picea abies with Pinus sylvestris. At top parts of the reserve the forest formed of Picea abies with Pinus pumila and Pinus mugo are located. The mono-dominant forest plantations with edificator Abies alba Mill. Fagus sylvatica L., Pinus sylvestris L. or Pinus pumila Gres. have less distribution. Therefore in the biosphere reserve “Paragalitza” the mixed forests with edificator Picea abies (L.) Karst have larger distribution.

Natural renovation

The results of investigations on natural renovation of forests in the reserve show that the sustainable bio-groups of new trees are formed. The saplings are described with a good growth in height.

In the studied matured plantations with edificator Picea abies L. Karst from the lower parts of the reserve, the observations show a domination of growing plants from Abies alba Mill. The data indicates a larger participation of the growing plants of Fagus sylvatica L., in comparison with Picea abies (L.) Karst. This is indicative for an intensive process of changing of the species.

The completed investigations express that the space structure of growing plants is described with a clear dynamics related with the differences in ecological conditions of growing environment. It is established that the quantity of the solar radiation in

studied dendro-communities is the main factor of quality differences between studied vegetation.

The analysis of the data shows, that as a result of the bigger maturity of the trees from first floor in the studied plantation an intensive process of unassisted decreasing is at presence. The uncovering of forest causes changes in ecological conditions.

The penetration of more solar energy into the lower forests floors in the ecosystems is a precondition for establishment of favourable environment for growing and development of growing plants.

Our investigation in forests of the reserve show a diversity of structures of plantations, located on the limited territories with similar conditions. This is related with the dynamics of the age and with the irregularity of the areas of forests in the BR “Paragalitza”.

The forests of biosphere reserve “Paragalitza” are unique in their productivity and genetic recourses. Their investigation has a big significance for clarifying the biodiversity at the Southeast Europe.

CONCLUSION

The specific ecological conditions in the biosphere reserve “Paragalitza” determine the differences in the species composition of the forests. The soil diversity includes Cambisols - eutric or dystric, Humic Cambisols, mountain meadow soil, mountain March soil and some specific combinations of these types.

From the conifers the most widespread are the species Picea abies (L.) Karst. and Abies alba Mill. They form plant communities on the Cambisols - eutric or dystrics and Humic Cambisols. The higher parts of the reserve are occupied from the communities of Pinus pumila Griseb. The area of Pinus mugo Turra formations is significant. Comparatively large parts are occupied with Juniperus sabina Burgst.

From the broadleaves species Fagus sylvatica L. is situated in the lower parts, rather Alnus viridis (Dhais) DC is located on higher parts of the reserve.

In the composition of the herbal component of the reserve the participation of Vaccinium myrtillus L. is bigger. On the open aired parts Rubus idaeus L. could be found. From the grass species Asperula odorata L., Ocaea acetosa L., Larix sibirica (maxima) Huds., Calamagrostis arundinacea L., Geranium macrorrhizum L., ferns and others are widely distributed.

The typological diversity of forests in the lower parts of the reserve is formed from Picea abies (L.) Karst., Abies alba Mill., Fagus sylvatica L. On the west and southwest exposition the edificator of the plantation is Pinus sylvestris L. In the sub-alp zone the formation of Pinus mugo Turra predominates.

On the territory of biosphere reserve “Paragalitza” dominates the formation of Picea abies (L.) Karst. The ecological conditions of the growing environment are favourable for forming of the forests of Picea abies with high productivity. On the slopes with north exposition the main species that forms the stands is Picea abies (L.) Karst.
The structure of plant coverage is described with forest types formed from mixed species. The predominating types are *Picea abies* with *Abies alba* and *Picea abies* with *Pinus sylvestris*. For higher parts is widely distributed the type formed of *Pinus mugo* with *Pinus mugo* and *Picea abies*.

The mono-dominant types with edificator *Abies alba* Mill., *Fagus sylvatica* L., *Pinus sylvestris* L. and *Pinus mugo* Grøn. are less distributed. The mixed forests with edificator *Picea abies* (L.) Karst. are widespread.

The natural conditions in the biosphere reserve “Parangalitza” are favourable for forming the unique in their bio-productivity forests of conifers. Their genetic resources have a high significance for biodiversity of the plantation at the southeast region of Europe.

REFERENCES


