Biomass and the mineral quantity in the herb layer litter-fall in the beech ecosystem Calamintho grandiflorae-Fagetum in Mavrovo National Park

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Abstract

The results of investigation of average biomass in the herb layer's litter-fall in the beech ecosystem Calamintho grandiflorae-Fagetum in Mavrovo National Park are presented in this paper. The herb layer in the investigated area was consisted of 53 species. The average litter-fall biomass in this layer was estimated to be 21.37 kg·ha⁻¹.

In the frame of the investigation, the content of the following mineral matters: K, Na, Ca, Mg, Fe, Mn, Zn, Cu, Cd, Co, total phosphorous and total nitrogen were estimated in separate species. The annual quantity of mineral matters in the herb layer litter-fall was estimated on the basis of the content of the mineral matters. The highest content has Ca with 0.544 kg·ha⁻¹, than total nitrogen (0.342 kg·ha⁻¹) and K (0.231 kg·ha⁻¹), the participation of the rest of the elements is represented with quantities less than 0.035 kg·ha⁻¹. The total quantity of mineral matters in the herb layer litter-fall was estimated to be 1.179 kg·ha⁻¹.

Keywords: beech ecosystem, herb layer, biomass, litter-fall, mineral matters.

Introduction

An important part of investigations for estimation of the aboveground litter-fall in the beech ecosystem Calamintho grandiflorae-Fagetum in Mavrovo National Park was estimation of biomass and the mineral quantity in the herb layer litter-fall. The importance of litter-fall is its involvement in mineral cycling in the ecosystem, as a first step in the process of mineral matter return. The role of the litter-fall from herb layer in mineral matter cycling can be noticed by the composition and ratio of minerals, continuous dyeing off of aboveground organs during summer and autumn period and intensive degradation of dead organic matter.

The investigation in the world include different types of forest ecosystems. There are few data for litter-fall from herb layer in beech ecosystems in Europe, for
North Poland (Rajchel, 1964; Kubiček and Jurko, 1975; Tumidajowicz, 1976, 1977; Towpaz & Tumidajowicz, 1977) and for South Sweden (Brunet et al., 1996; Nihlgård, 1972; Nihlgård & Lindgren, 1977).

In the R. Macedonia there are data for quantity and mineral participation in the herb layer litter-fall in Italian and Turkey oak ecosystem in Galichica National Park (Grupčev et al. 1995; Delrieva et al. 1995).

The main aim of this paper is to estimate the biomass and mineral matters' quantities that are returned to the beech ecosystem by the herb layer litter-fall. The investigation was performed during 3 years (1998, 2000 and 2001).

Site description

The investigation was performed in the frame of the project „Complex ecosystem investigation in stationary conditions in the beech ecosystem Calamintho grandiflorae-Fagetum in Mavrovo National Park“. Stationary is situated in well-developed middle aged beech forest in village Leunovo district, near Mavrovo Lake at the elevation of 1400 m. The community is developing on dystric cambisol soil type. Climate is mountain-continental with Mediterranean influence (Filipovski et al 1996).

Meteorological data according to Lazarevski (1993), based on the measurements of meteorological station Mavrovo (1240 m), show that the average annual temperature is 7.1 °C, the minimal average monthly temperature is below 0 °C (during the winter), the mean monthly maximal temperature is 16,3 °C (in July). The mean annual fluctuation of temperature is 18.7 °C. The mean annual precipitation is 1103 mm. In colder period of the year it consists mainly of snow. From October to March there is over 100 mm precipitation per month, April and May are characterized by 80-100 mm and July and August have less than 50 mm monthly precipitation.

Beech (Fagus sylvatica) absolutely dominates in the investigation locality with a density of 1200 trees · ha⁻¹. Mean DBH of trees is about 16 cm. Shrub layer is represented mainly by beech and fir (Abies borisii-regis) shrubs.

Aboveground annual litter fall biomass of the tree layer is 4.97 t·ha⁻¹ (Šušlevska et al. 2001).

Methods

Herb layer litter-fall was measured in the investigated ecosystem in the period of 3 years (monthly during vegetation period: March-September). The method used was line transect with sampling frames of 1m². About 100 samplings in average were performed in the buffer zone of the stationary. Frames were placed on the surface of the forest floor and all different plant species for the herb layer were collected in different paper bags. All collected material was dried to constant weight at 105 °C. The weight of different plant species was measured separately on 0.0001 g scale. The total litter fall biomass of the herb layer was estimated as sum of the maximum biomass of different species.

The 34 plant species were analysed by standard chemical methods. The total nitrogen was analysed by semimicro Kjeldahl method, total phosphorous - colorimetrically by Fiske & Subarow method and other cations: K, Na, Ca, Mg, Fe, Mn, Zn, Cu, Cd and Co by atomic absorption spectrometer.

Fig. 1. Biomass dynamics in the herb layer in the beech ecosystem Calamintho grandiflorae-Fagetum in Mavrovo National Park (kg·ha⁻¹)

Сл. 1. Динамика на биомасата во тревестиот кат во буковиот екосистем Calamintho grandiflorae-Fagetum во НП Маврово (kg·ha⁻¹)
Results and discussion

The herb layer litter-fall is participating in total aboveground litter-fall with low percentage (0.43%), but this fact does not reduce its role in the mineral cycling in the ecosystem.

The herb layer in the beech ecosystem Calamintho grandiflorae-Fagetum in Mavrovo National Park is heterogeneous in floristic composition (53 species were registered).

The dynamics of litter-fall biomass in the herb layer is presented on Fig. 1. The herb layer litter-fall biomass for different months are obtained by calculating average values for different years. The data on Fig. 1 show that maximum herb layer biomass is registered in May (15.67 kg·ha⁻¹) before completion of leaf development in the tree and shrub layers and minimum quantity during March and April (1.9 kg·ha⁻¹) on the beginning of vegetation period. During the dry summer period there is steady decrease in the biomass of herb layer litter-fall.

The similar dynamics (maximum biomass in May) of litter-fall biomass in the herb layer is presented in Towpasz & Tumidajowicz, 1977 for beech forest Fagetum carpaticum in the Gorce Mts in Poland. According to Ralchel, 1965 the maximum biomass in the herb layer in ass. Fagetum carpaticum of the Ojców National Park (Southern Poland) is registered in June.

The maximum annual biomass of investigated plant species in the herb layer is presented on Tab.1. The

<table>
<thead>
<tr>
<th>Species</th>
<th>kg·ha⁻¹</th>
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<th>kg·ha⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carex sp.</td>
<td>3.30</td>
<td>Aremonia agrimonoides</td>
<td>0.21</td>
</tr>
<tr>
<td>Daphne mezereum</td>
<td>3.25</td>
<td>Orthilia secunda</td>
<td>0.19</td>
</tr>
<tr>
<td>Asperula odorata</td>
<td>1.66</td>
<td>Hordeum sp.</td>
<td>0.18</td>
</tr>
<tr>
<td>Fagus sylvatica - branches</td>
<td>1.51</td>
<td>Galeobdolon luteum</td>
<td>0.14</td>
</tr>
<tr>
<td>Anemone nemorosa</td>
<td>1.48</td>
<td>Sanicula europaea</td>
<td>0.12</td>
</tr>
<tr>
<td>Dactylis glomerata</td>
<td>1.23</td>
<td>Symphytum tuberosum</td>
<td>0.12</td>
</tr>
<tr>
<td>Dentaria bulbifera</td>
<td>0.93</td>
<td>Euphorbia amygdaloides</td>
<td>0.09</td>
</tr>
<tr>
<td>Abies boris-is-regis</td>
<td>0.92</td>
<td>Neottia nidus-avis</td>
<td>0.07</td>
</tr>
<tr>
<td>Ajuga reptans</td>
<td>0.87</td>
<td>Polygonatum</td>
<td>0.07</td>
</tr>
<tr>
<td>Actaea spicata</td>
<td>0.80</td>
<td>Scilla bifolia</td>
<td>0.07</td>
</tr>
<tr>
<td>Fagus sylvatica - leaves</td>
<td>0.75</td>
<td>Viola reichenbachiana</td>
<td>0.05</td>
</tr>
<tr>
<td>Pteridium aquilinum</td>
<td>0.75</td>
<td>Potentilla micrantha</td>
<td>0.05</td>
</tr>
<tr>
<td>Rubus sp.</td>
<td>0.51</td>
<td>Acer sp.</td>
<td>0.04</td>
</tr>
<tr>
<td>Brachypodium sylvaticum</td>
<td>0.45</td>
<td>Mycelis muralis</td>
<td>0.03</td>
</tr>
<tr>
<td>Fagus sylvaticus - 1 year</td>
<td>0.43</td>
<td>Poa nemorosa</td>
<td>0.02</td>
</tr>
<tr>
<td>Pulmonaria officinalis</td>
<td>0.28</td>
<td>Juniperus communis</td>
<td>0.02</td>
</tr>
<tr>
<td>Digitalis viridiflora</td>
<td>0.24</td>
<td>Other species</td>
<td>0.53</td>
</tr>
</tbody>
</table>

| TOTAL                       | 21.37   |

![Fig. 2.](image)  
**Fig. 2.** Mineral matter quantity in the litter-fall of the herb layer (g·ha⁻¹)

**Cт. 2.** Количество минерални материи во опадот од тревестиот кат (г·ха⁻¹)
total litterfall was estimated to be 21.37 kg·ha⁻¹. The main part of the biomass is represented by biomass of Carex sp. and Daphne mezereum while other species participate with smaller percentage (Tab.1).

The results in our investigation are comparable with the results for other beech forests presented by other authors. Kubiček and Jurko (1975) found in the Luzulo-Fagetum deshampsietosum 40.65 kg·ha⁻¹. According to Kazmierczakowa, 1967 in Kubiček and Jurko, 1975 the biomass of litter-fall in the herb layer in the Fagetum carpaticum ecosystem is estimated to be 49 kg·ha⁻¹. Eber (1971) and Bornkman et Bennert (1971) in Kubiček and Jurko, 1975 indicate 12 and 80 kg·ha⁻¹, respectively, for the Luzulo-Fagetum. The data for Deschampsia type beech forest in South Sweden show < 100 kg·ha⁻¹ (Nihlgård & Lindgren, 1977).

However, in the literature there are data for herb litter for beech ecosystems which are higher than our results. The herb layer biomass for Fagetum carpaticum in Ponice - Poland is 216 kg·ha⁻¹ (Towpasz & Tumidajowicz, 1977), 282 kg·ha⁻¹ in Gorce Mts. - Western Carpathians (Tumidajowicz, 1976) and 900 kg·ha⁻¹ for Merculialis type beech forest in South Sweden (Nihlgård & Lindgren, 1977).

The mineral matter quantity in the litter-fall of the herb layer is presented on Fig.2. The highest content has Ca with 0.544 kg·ha⁻¹, than total nitrogen (0.342 kg·ha⁻¹) and K (0.231 kg·ha⁻¹) follow. The high values of quantity of phosphorus and magnesium (Fig.2) are very important because of their great significance in improvement of the quality of the litter and soil in the ecosystem. The rest of the mineral matter in the herb layer litter-fall are represented with lower quantities.

The total quantity of the investigated mineral matter in the herb layer litter-fall was estimated to be 1.179 kg·ha⁻¹.

Conclusions

The herb layer biomass and dynamics as well as mineral content was investigated in the frame of the complex ecosystem investigation in the beech ecosystem Calamintho grandiflorae-Fagetum in Mavrovo National Park.

In total 53 species were registered in the herb layer in the investigated area.

The average maximum litter-fall biomass in this layer was estimated to be 21.37 kg·ha⁻¹. The highest content has Ca with 0.544 kg·ha⁻¹, than follows total nitrogen (0.344 kg·ha⁻¹) and K (0.231 kg·ha⁻¹). The participation of the rest of the elements is represented with quantities less than 0.035 kg·ha⁻¹.

The total quantity of mineral matters in the herb layer litter-fall was estimated to be 1.179 kg·ha⁻¹.

References


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