

BIOMASS OF FOREST AND MEADOW IN THE EASTERN CARPATHIANS

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Abstract

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A comparison between the biomass, primary productivity and distribution of organic matter in native mixed beech forest dominated by beech (*Fagus sylvatica* L.) and secondary meadow dominated by *Nardus stricta* L. within the beech forest belt in the Eastern Carpathians has been made. In the forest a total biomass of 371.9 t.ha⁻¹ was found with 286.4 t.ha⁻¹ and 85.5 t.ha⁻¹ for aboveground and belowground biomass respectively. Corresponding results for the primary productivity were 17.0, 13.1 and 3.8 t.ha⁻¹.year⁻¹. A productivity of ground vegetation was equal to 0.7 t.ha⁻¹.year⁻¹. The litter fall reached an average 3.6±0.1 t.ha⁻¹.year⁻¹. In the meadow biomass of above and belowground parts was 2.3 and 8.1 t.ha⁻¹. The primary productivity was 4.6 t.ha⁻¹.year⁻¹ (43 % above and 57 % belowground portions).

Introduction

Up to now various studies on the biomass content have been carried out and published mainly for Western Europe. However, so far estimation on the extent of biomass in the former USSR was scarcely published in the western journals. Whereas the results on forest production in the Carpathian arch in Poland (Myczkowski, 1967; Medwecka-Kornas, et al., 1974; Traczyk, 1981), Czechoslovakia (Biskupský, 1981; Kubíček, 1983; Tokár, 1987) and Hungary (Jakucs, 1981), are world – wide known, results from Ukrainian part are unknown in the western literature.

In this paper the estimation of accumulation of organic matter and productivity in a natural mixed beech forest and secondary meadow ecosystems was given. Consideration of the accumulation of organic matter allows for a functional analysis of a forest and a meadow ecosystem. It is important for an approximation of forestry and agriculture in the region of the Eastern Carpathians.

Materials and methods

Study was performed in Gorgany Mts (Central part of the Eastern Carpathians) at the territory of Carpathians National Natural Park (Pidlisniv forest region, Ukraine). Study plots were situated on 800-850 m a. s. l., at 22-25° slope exposed to the south. The soil was cambisol at the Carpathians flish. Study plot No. 1 was located in beech forest dominated by *Fagus sylvatica* with fir (*Abies alba* L.) and spruce (*Picea abies* L. [K a r s t.]) as subdominants. The study plot association was *Abieto-Piceto-Fagetum oxalidozum*. For beech, spruce and fir the average age was 56, 55 and 58 years, the average height – 21.1, 24.3, 22.8 m and the average diameter – 19.7, 29.5, 25.8 cm. Basal area was 23.1, 11.6, and 5.0 m².ha⁻¹ for those species. The number of stems per ha was 755, 170, 95 individuals, and stems volume was 255, 136 and 70 m³.ha⁻¹ for beech, spruce and fir. The different fractions of the stems, branches and assimilative organs were analyzed in 1984-1988 years. The data on biomass are concerning dry weight. Model trees were selected according to the DBH distribution and 18 model trees were cut at the end of vegetation period (August-September) and divided into 1 m sections. In each section the mass of separate fractions were measured according to Newbould (1967), Utkin (1975). An estimation of underground biomass was performed according to the methods of Lohmus and Oja (Lochmus, Oja, 1983). Plot No. 2 was situated in meadow dominated by *Nardus stricta* L. Structure and mass of the meadow ecosystem were studied using the harvest quadrat methods (Newbould, 1967). Obtained data were analyzed with variation statistics. The determination of biometrics indices was made to an approximation of 2-10%.

Results

Beech forest has 371.9 t.ha⁻¹ of total biomass. The mass of beech trees constituted 67%. The mass of spruce and fir trees reached 21 and 12%. The main mass of organic matter (243.7 t.ha⁻¹, or 65.5%) is concentrated in the stems. The mass of living branches was 32.8 t.ha⁻¹ (8.8%), where 6.7 t.ha⁻¹ (1.8%) constituted mass of living branches at the diameter up to 1 cm. The mass of current twigs was 0.5 t.ha⁻¹ (0.2%), short twigs – 0.4 t.ha⁻¹ (0.1%) and leaves with needles – 9.0 t.ha⁻¹ (2.4%). The biomass of belowground organs was 85.5 t.ha⁻¹ (23%).

Ratio of belowground mass to aboveground mass was 1 to 3.4 for study stand. For beech, spruce and fir it was 1 to 3.0, 1 to 4.4, 1 to 4.0. Stems mass was higher in aboveground part of the forest. Branches constituted 10% of considerable part of mass in beech. In spruce branches has 8.8% and in fir – much lower (4.1%). The primary productivity for total, aboveground and belowground parts was 17.0, 13.1 and 3.8 t.ha⁻¹.year⁻¹ respectively. The aboveground productivity of the ground flora was 0.7 t.ha⁻¹.year⁻¹. The litter fall reached an average 3.6±0.1 t.ha⁻¹.year⁻¹. The dead organic matter was 10.7±0.2 t.ha⁻¹.year⁻¹.

In the meadow ecosystem the total biomass was 10.4 t.ha⁻¹. Ratio of belowground mass to aboveground mass was 3.4 to 1. In the meadow ecosystem the aboveground biomass was smaller than belowground biomass. In aboveground part of meadow ecosystem stems mass equals 46% with domination of *Nardus stricta* L. The primary productivity was 4.6 t.ha⁻¹.year⁻¹ (43 % above and 57 % underground portions).

Discussion

We compared present results with those from geographically close areas and we found that beech forests in the Ukrainian Carpathians were more productive than forests in Poland. According to Medwecka-Kornas et al. (1974) the total dry biomass was 275.9 t.ha^{-1} in 100 years old oak-hornbeam forest in Ispina. The total primary productivity for stem wood, stem bark, branches and foliage was $7.4 \text{ t.ha}^{-1}.\text{year}^{-1}$. According to the Traczyk (1981) total biomass of 85 years old pine forest in Kampinos National Park was 307.8 t.ha^{-1} . The 75 years old beech forest in Ojców near Krakow has 297 t.ha^{-1} total dry biomass. Ratio of belowground mass to aboveground mass was 1 to 5. Tree cover production has been estimated to approximate $10.9 \text{ t.ha}^{-1}.\text{year}^{-1}$ (Myczkowski, 1967). In Slovakia the oak-hornbeam forest has 244 t.ha^{-1} dry tree biomass (Kubíček, 1972) and 237.7 t.ha^{-1} (Biskupský, 1981). Beech forest in the Low Carpathians (Slovakia) has 422.9 t.ha^{-1} dry tree biomass and productivity $21.4 \text{ t.ha}^{-1}.\text{year}^{-1}$ (Kubíček, 1983). In Hungary 65 years old oak forest has 238.5 t.ha^{-1} of the dry biomass (Jakucs, 1981).

In the Ukrainian Carpathians the accumulation of organic matter of 100 years old beech forests was more than 600 t.ha^{-1} (Golubets, Kozak, 1996). Beech forests were more productive than oak and hornbeam forests in this region and also more productive than oak forests in the Russian plain (Bazilevich, 1993) or in the Crimea and Caucasus Mts (Gasarov, 1980).

The maximal accumulation of plant mass in a Carpathian meadow reached 14 t.ha^{-1} (Malinovskij, 1974). In Caucasus it was $12\text{--}14 \text{ t.ha}^{-1}$ (Bazilevich, 1986). The productivity of meadow in forest zone ($4.6 \text{ t.ha}^{-1}.\text{year}^{-1}$) was 3.7 times lower than productivity of forest.

Conclusions

The comparison between forest and meadow areas showed that higher amount of plant mass was present in the forest (371.9 t.ha^{-1} , without humus). In the meadow the total plant mass reached only the 10.4 t.ha^{-1} (without humus). The ratio of belowground and aboveground biomass was almost 1 to 3 for forest and 3.4 to 1 for meadow.

Beech forests of the Ukrainian part of the Eastern Carpathians were the most productive among the mountain forests not only in the Carpathians but also in the neighbouring regions as well as in Crimea and Caucasus Mountains. Meadows of the Ukrainian Carpathians showed lower productivity comparing to beech forests of the Eastern Carpathians, as well as to meadows of other mountain regions.

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Kozak I.: Biomasa lesov a lúk vo Východných Karpatoch.

Porovnávali sme biomasu, primárnu produkciu a distribúciu organických látok v prirodzenom miešanom bukovom lese s prevahou *Fagus sylvatica* L. a sekundárnu lúku s prevahou *Nardus stricta* L. v bukovom lesnom pásme vo Východných Karpatoch. V lese celková biomasa bola 371,9 t.ha⁻¹, nadzemná biomasa bola 286,4 t.ha⁻¹ a podzemná biomasa 85,5 t.ha⁻¹. Zodpovedajúce výsledky pre primárnu produktivitu boli 17,0; 13,1 a 3,8 t.ha⁻¹. Produktivita prízemnej vegetácie sa rovnala 0,7 t.ha⁻¹.rok⁻¹. Podstielka dosiahla priemer 3,6 ± 0,1 t.ha⁻¹.rok⁻¹. Lúčna biomasa nadzemných a podzemných častí bola 2,3 a 8,1 t.ha⁻¹. Primárna produkcia bola 4,6 t.ha⁻¹.rok⁻¹ (43% nadzemnej a 57% podzemnej časti).