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# Allometry of four European beech stands growing at the contrasting localities in small-scale area

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**Abstract**

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The aim of this study was to describe and compare biometrical parameters (such as breast height diameter (DBH), tree height, length of a crown, leaf area index (LAI), xylem biomass) of trees of four forest stands growing at contrasting sites in the small-scale area of 30 km$^2$ and to calculate and compare their allometrical models of these parameters on DBH. All forest stands were monocoenoses of European beech (*Fagus sylvatica* L.) more than 160 year old. We found statistically significant differences among the localities almost in all investigated parameters. Also proposed allometrical models were different. None of the simple allometrical models from the literature fit to all of the localities. Thus allometric models should be used only with respect to local site conditions such as soil and climatic conditions and level of competition among trees and not only with respect to certain geographic region.

**Key words**

allometry, *Fagus sylvatica* L., tree biometry

## Introduction

European beech is one of the most common tree species in the forest across Europe. Its natural range spans from Spain to the Black sea and from the Sicily to the Southern part of Norway (Jahn, 1991). An interest in the tree biomass led to development of several allometric models (Bartelink, 1997; Ter-Mikkelian and Korzukhin, 1997; Forstreuter, 1999; Santa Regina and Tarrazona, 2001; Zianis and Mencuccini, 2003; Cienciala et al., 2005). Most of them use as scaling parameter only tree diameter at breast height (DBH) using equation of the type $y = a + DBH^b$. Some models apart from the DBH include also tree height using three parameter model $y = a + DBH^b + h^c$ (Zianis and Mencuccini, 2003; Cienciala et al., 2005). Each of these models was developed by analysis of trees of a different range of DBH in one particular geographic region which is one of the reasons for the difference in results obtained by different models running over similar data. However the tree biomass vary considerably not only with species, its size and geographic location but also with stand age, site quality, climate and stocking density of stands (Cannell, 1982; Bartelink, 1997). Therefore the most sophisticated models (usually growth models) take into account not only tree height but also other parameters e.g. tree position within the canopy, the site and climatic conditions etc. (Fabrika and Ďurský, 2005).

In theory, the allometric equations describing tree shape are affected by the physiological requirements of the tree. The most important are water transport, light interception and mechanical support of trees against the gravity or wind (Niklas, 1994). From the hydraulical point of view tree may be seen as a network of interconnected pipes (Zimmerman, 1983). By the "pipe rule theory" (Shizonaki et al., 1964) the amount of roots should be sustained by the unit of sapwood area of a tree and by the unit of evaporating leaves. West et al. (1999) integrated both biomechanical and hydraulical parameters of the tree and developed a model which predicts several plant variables (tree height and DBH, number of leaves, etc.) in relation to plant biomass.

The aim of this study is to compare the stand structure of the mature European beech forest stands growing on contrasting localities in a small-scale area of Buchlovske vrchy hills, East Bohemia. The obtained equations are compared with the allometric equations for the beech found in the literature.

## Material and methods

Studied sites are located in the east of the Czech Republic, at the outer margin of western Carpathian geographic region, in area of Chriby ridges (Rauser, 1971). The mean annual temperature at these plots was 7.0 °C, the mean annual precipitation 744 mm.

In this region we chose four plots of the size of 100 × 100 m at sites "Rynek, Holy kopec, Machova dolina and Ocasek". The studied plots were located at different soil and phytocoenosis types (Table 1). The soil types were different types of cambisols from nutrient poor (oligotrophic) to rich (mesotrophic) with different proportion of skeleton, sometimes with marks of a gley process. Types of phytoceonosis in different plots was indicating nutrient poor (Machova dolina plot), medium (Holy kopec) and nutrient rich (Rynek, Ocasek) site. Currently all plots are covered with monocoenosis of mature European beech forest stands. All forest stands are from the 1990 excluded from forest management being a part of natural reserve.

In all four localities were set the research plots 100 × 100 m where the measurements were taken. Aboveground structure of forest stand we measured by FieldMap (IFER, Jílové u Prahy); the number and position of trees (with declared accuracy of 3 cm), their breast height diameter (DBH, accuracy 1 cm), height of trees and their crown base (with resolution 0.25 m), and crown projection area ($A_{pro}$) was measured in all trees with DBH larger than 10 cm. Additionally we measured position of snags together with the level of decomposition. Data were exported in form of maps as the dBase format. Parameters of trees were exported in a form of MS Access file. When considering the equipment we used a laser distance meter Impulse 200LR with resolution 1 cm, electronic compass MapStar Module II, Hammerhead laptop and ranging poles with reflecting glass. GPS coordinates were measured with Trimble Pro XH device. Tree diameters were measured by caliper with resolution of 1 cm from perpendicular sides of the tree. Heights were measured by the height meter Vertex IV with resolution 0.25 m. Leaf area index (LAI) was measured by "pitching method" on whole-stand level. After leaf-fall the samples of litter were collected with the pointed stick from the randomly chosen places in the forest. The number of leaves collected during one pitch expressed the LAI of the stand. Four hundred samples were taken from each stand.

To estimate individual tree biomass we used SIBYLA model (Fabrika and Ďurský, 2005). SIBYLA is a growth model representing East-Czech and Slovakian growth conditions and management environment. The model requires input of individual tree data (DBH, height, coordinates, crown parameters and tree quality – in means of its social position in the forest and health condition). The second part of input requires data about site conditions (climate, type of soil). Input data was generated from forest inventory made by FieldMap as described above. As an output a table was generated with each individual tree characterized by the dry weight of stem-wood, dry weight of roots and stump-wood, dry weight of branches, dry weight of bark and dry weight

Table 1. Description of the four investigated localities

| Description/Locality | Rynek | Holy kopec | Machova dolina | Ocasek |
|---|---|---|---|---|
| Number of stand in forest management plan | 204A17 | 203E17 | 402E17 | 57B17/1 |
| Age [years] | 167 | 165 | 190 | 186 |
| Forest type (Plíva, 1991) | 3B9<br>Sloping Querceto-Fagetum mesotrophicum | 4D9<br>Sloping Querceto-Fagetum acidophilum | 3K6<br>Musci Querceto-Fagetum acidophilum | 3A2<br>Tilii-Querceto-Fagetum acerosum lapidosum with Melica uniflora |
| Soil type (Nemecek, 2001) | Cambisol mezotrophic | Gleyly cambisol mesotrophic | Cambisol oligotrophic | Rankered cambisol |
| Type of biotope (Natura 2000) | 9130 Asperulo fagetum | 9130 Asperulo fagetum | 9110 Luzulo-fagetum | 9130 Asperulo fagetum |
| Type of phytocoenosis – association (Moravec, 2000) | Melico-Fagetum | Carici-pilosae-Fagetum | Luzulo-Fagetum | Dentario-eneaphylli-Fagetum |
| Type of geobiocen | 3BC3 | 4B(BC)3 | 3A2-3 | 3BC3 |
| (Bucek and Lacina, 2002) | Querci-Fageta aceris | Fageta typica | Fageta quercina | Querci-Fageta aceris |
| Relative order in fertility | 1. | 2. | 3. | 1. |
| Altitude [m] | 490 | 480 | 430 | 550 |
| Longitude [°N] | 49.10 | 49.11 | 49.16 | 49.10 |
| Latitude [°E] | 17.28 | 17.29 | 17.31 | 17.24 |

Table 2. Allometric equations from the literature used to calculate aboveground biomass of the trees. Abbreviations: DBH, stem diameter in the breast height; h, height of the tree

| | | Parameters | | |
|---|---|---|---|---|
| Author, site | Equation | a | b | c |
| Ter-Mikkelian, 1997, Maine | y = a.DBH$^b$ | 0.2013 | 2.2988 | |
| Ter-Mikkelian, 1997, New Hampshire | y = a.DBH$^b$ | 0.1957 | 2.2538 | |
| Bartelink, 1997 | y = a.DBH$^b$ | 0.0798 | 2.601 | |
| Santa, 2001 | y = a.DBH$^b$ | 0.1326 | 2.4323 | |
| Zianis, 2003 | y = a.DBH$^b$ | 0.2511 | 2.3485 | |
| Forstreuter, 1999 | y =a.DBH$^b$ | 0.1293 | 2.44 | |
| Cienciala, 2005 | y = a.DBH$^b$ | 0.453 | 2.139 | |
| Cienciala, 2005 | y = a.DBH$^b$+h$^c$ | 0.047 | 2.121 | 0.697 |
| Bartelink, 1997 | y = a.DBH$^b$+h$^c$ | 0.0306 | 2.347 | 0.59 |

of leaves. All output data are in kg units with resolution of two digits.

Tree biomass was additionally estimated using nine other allometric models (Table 2). Seven of them were based only on relation to DBH (Bartelink, 1997; Ter-Mikkelian and Korzukhin, 1997 (two models for Maine and New Hampshire); Forstreuter, 1999; Santa Regina and Tarrazona, 2001; Zianis and Mencuccini, 2003; Cienciala et al., 2005), remaining two (Barte-link, 1997; Cienciala et al., 2005) used DBH together with height of the tree to calculation. One-way analysis of variance (anova, α = 0.05) was used to find diffe-rences among the models.

Statistical analysis was performed using software Statistica 8.0 (StatSoft, Inc.). To test the hypothesis and scale-up parameters to the stand level linear and non-linear regression analysis, analysis of variance (anova) and general linear model analysis was used. To estimate allometric relationships one-dimensional regression analysis was used. From the linear and several non-linear regression models the one with the highest $r^2$ was chosen. The significance of the $r^2$ and of the model was tested by anova (α = 0.05 and one degree of freedom). In case the calculated F value was higher than the threshold for $F_{0.05,\ n\text{-}2,1}$ we considered the proposed model as significant. In linear models we also tested the significance of the absolute coefficient by a t-test for $t_{0.025,\ n\text{-}2}$; if the calculated value was lower than the threshold value the coefficient was excluded from the equation. To test the difference between individual parameters of selected plots one-way anova was used. The α value was set to 0.05 and P value to 95%. In case the parameter was dependent on tree DBH and comparing of similar-sized trees was required, general linear model analysis was used instead of anova.

## Results and discussion

The highest number of trees was growing at the site Machova dolina and the lowest at Rynek and Ocasek site, 292 and 123 (124) pcs ha$^{-1}$ respectively. The number of trees at localities under investigation was inversely correlated with mean DBH of trees. The thickest trees were at the localities Rynek and Ocasek, having mean DBH of 61 and 64 cm, with thickest trees of DBH 117 and 100 cm respectively. Despite the equal number of trees at these two localities the DBH distribution in diameter classes was different with more trees of lower DBH (understorey trees) at Rynek. The lowest mean DBH of 37 cm was observed at locality Machova dolina (Table 3). The variation coefficient was similar in all localities; the lowest variability in DBH distribution was found at locality Holy kopec (Table 3). The highest value of stem basal area in breast height (BA) per hectare was measured at Holy kopec (48 m$^2$), the lowest value of 34 m$^2$ despite the highest number of trees, at Machova dolina (Table 4, Fig. 1).

The tallest trees were found at Holy kopec site having in average as much as 38 m in height. Trees at Rynek and Ocasek were only a bit smaller (however there was statistically significant difference) having mean height 36 and 34 m respectively. Trees from the Machova dolina site with mean height of 16.5 m was reaching less than half of the height of trees from another sites. At this site was also found the highest variability in the height distribution. In contrary the lowest variability was observed at Holy kopec. Trees there were rather uniform in their height what is described by low index of variation (7%) (Table 3). The height of trees over diameter classes may be described by allometrical equation in the shape of the logarithmic function. Equations and corresponding coefficients of determination ($r^2$ between 0.33 and 0.42) are in Table 5 and Fig. 2a. The heights of the trees in the four studied sites were also modeled using equations of Levakovič, Michajlov and Näslund based on measured DBH and corresponding height of a certain tree (Michajlov, 1952; Korf, 1972). The heights calculated using these three models did not significantly differ from the heights calculated by logarithmic function.

Our proposed models were compared with the logarithmic model of Guericke (2001) and with another

Table 3. Basic statistical characteristics of biometrical characteristics of trees at four studied localities

| | Site | Number of trees | Mean value | Standard deviation | Maximal value | Minimal value | Index of variability [%] |
|---|---|---|---|---|---|---|---|
| DBH [cm] | Rynek | 123 | 61.0 | 16.0 | 117.0 | 29.0 | 26 |
| | Holy kopec | 233 | 50.0 | 11.0 | 80.0 | 26.0 | **22** |
| | Machova dolina | 292 | 37.0 | 10.0 | 73.0 | 10.0 | 27 |
| | Ocasek | 124 | 64.0 | 16.0 | 100.0 | 29.0 | 25 |
| Height [m] | Rynek | 123 | 36.2 | 3.8 | 45.0 | 21.0 | 10 |
| | Holy kopec | 233 | 38.1 | 2.6 | 43.0 | 25.0 | **7** |
| | Machova dolina | 292 | 16.5 | 4.6 | 31.5 | 2.5 | 28 |
| | Ocasek | 124 | 34.5 | 3.1 | 40.0 | 25.0 | 9 |
| Crown length [m] | Rynek | 123 | 18.0 | 6.1 | 31.0 | 4.0 | 34 |
| | Holy kopec | 233 | 17.0 | 4.5 | 30.0 | 4.0 | **26** |
| | Machova dolina | 292 | 11.0 | 3.12 | 20.0 | 3.0 | 29 |
| | Ocasek | 124 | 17.0 | 4.7 | 21.0 | 6.0 | 28 |
| Crown projection area [$m^2$] | Rynek | 123 | 82.0 | 71.0 | 409.0 | 3.0 | 87 |
| | Holy kopec | 233 | 34.0 | 24.0 | 142.0 | 1.2 | 71 |
| | Machova dolina | 292 | 42.0 | 21.0 | 116.0 | 6.0 | **50** |
| | Ocasek | 124 | 49.0 | 37.0 | 171.0 | 0.5 | 76 |

Table 4. Leaf area index (LAI), cumulative values of basal areas (BA), crown ground projection areas ($A_{PRO}$) per hectare of forest stand and their ratios

| Site | BA [$m^2$] | $A_{PRO}$ [$m^2$] | LAI | $A_{PRO}$/BA ratio | LAI/$A_{PRO}$ ratio |
|---|---|---|---|---|---|
| Rynek | 38.9 | 10,146 | 3.9 | 261 | 3.8 |
| Holy kopec | 48.2 | 7,839 | 4.2 | 163 | 5.4 |
| Machova dolina | 33.8 | 12,359 | 3.6 | 366 | 2.9 |
| Ocasek | 41.9 | 6,050 | 3.8 | 144 | 6.2 |

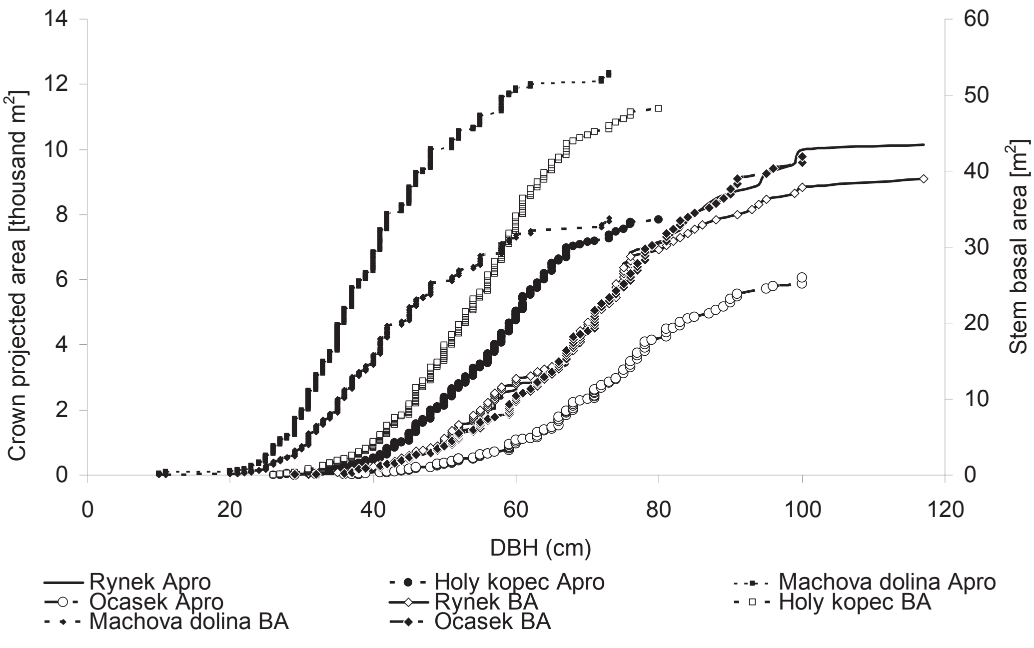


Fig. 1. Cumulative distribution of the crown projected area ($A_{PRO}$, single line) and stem basal area in the breast height (BA, double line) over the diameter classes in four studied localities

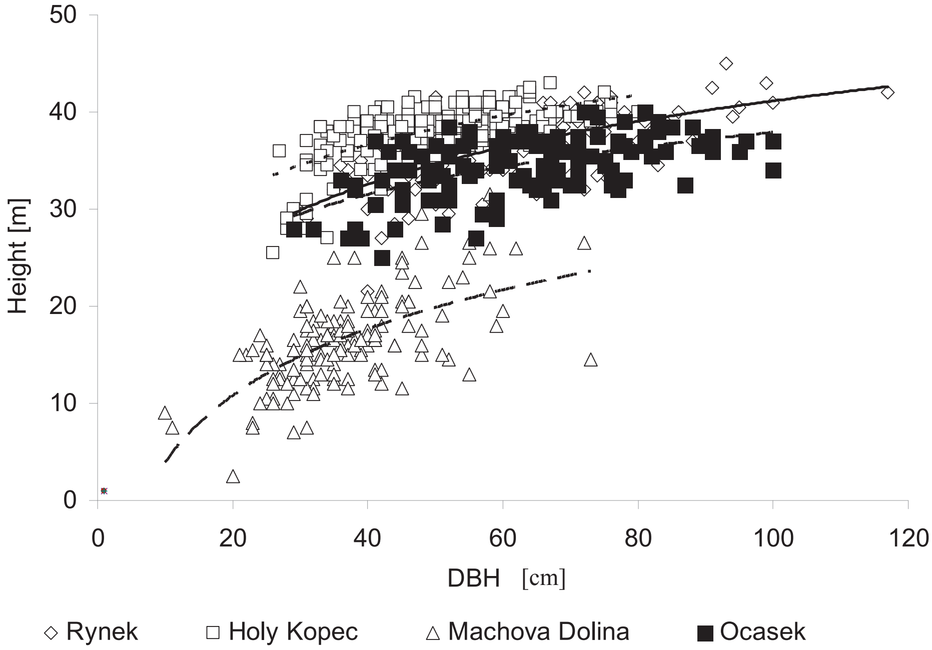


Fig. 2a. Dependence of tree height on the DBH (breast height diameter) at the four studied localities. Allometric equations with corresponding correlation coefficients are written in the Table 5. Smallest trees are at nutrient poor site Machova dolina, tallest at the Holy kopec.

Table 5. Allometrical equations for calculation of the tree height (H). Seven equations have been taken from the literature, last four equations are the proposed logarithmical models derived from the parameters of the trees at our sites. Abbreviation DBH is stem diameter in the breast height.

| Author/Site | Model | $R^2$ |
|---|---|---|
| Guericke, 2001 | $H = 11.447.ln(DBH) - 11.885$ | |
| Kinderman, 1998 | $H = 1.3 - \frac{DBH^2}{2.07 + 0,507 + 0.0215.DBH^2}$ | |
| Bartelink,1997 | $H = 1.732 + DBH^{0.769}$ | |
| Forstreuter,1999 | $H = 3.24083DBH^{0.613065}$ | |
| Widlowski, 2003 | $H = 1.3 + \left(\frac{DBH}{1.31811 + 0.151515.DBH}\right)^2$ | |
| Levakovič | $H = 1.3 + a\left(\frac{DBH}{1 + DBH}\right)^b$ | |
| Michajlov | $H = 1.3 + ae^{\frac{b}{DBH}}$ | |
| Näslund | $H = 1.3 + \frac{DBH^2}{a + b.DBH^2}$ | |
| Rynek | $H = 9.35.ln(DBH) - 1.92$ | 0.42 |
| Holy kopec | $H = 7.34.ln(DBH) + 9.53$ | 0.40 |
| Machova dolina | $H = 9.87.ln(DBH) - 18.76$ | 0.39 |
| Ocasek | $H = 6.99.ln(DBH) - 5.69$ | 0.33 |

exponential models (Bartelink, 1997; Kinderman, 1998; Forstreuter, 1999; Widlowski, 2003). None of the models from the literature fit to all localities. The lowest values of height were obtained by Bartelink (1997) model. This model fits to the data from Machova dolina plot (Fig. 2b). Thus Bartelink (1997) model is suitable for the small trees of less than 30 cm in DBH growing at nutrient poor site. Models of Kinderman

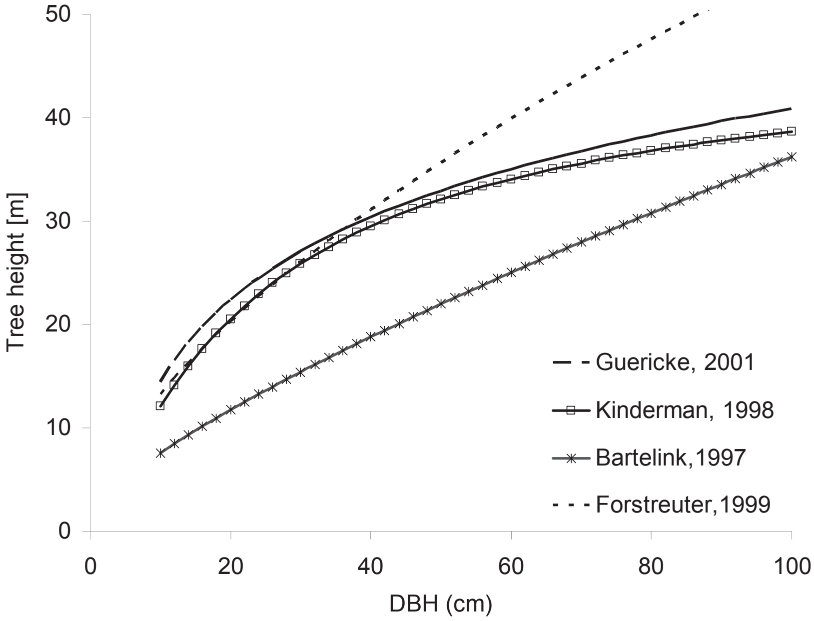


Fig. 2b. Allometric relationship of the tree height on breast height diameter (DBH) estimated by different models.Model of Bartelink, 1997 fit to the data from the nutrient poor site Machova dolina. Remaining models fit to the sites Rynek and Ocasek. None of the models from the literature fit to the tall and thin trees from the Holy kopec.

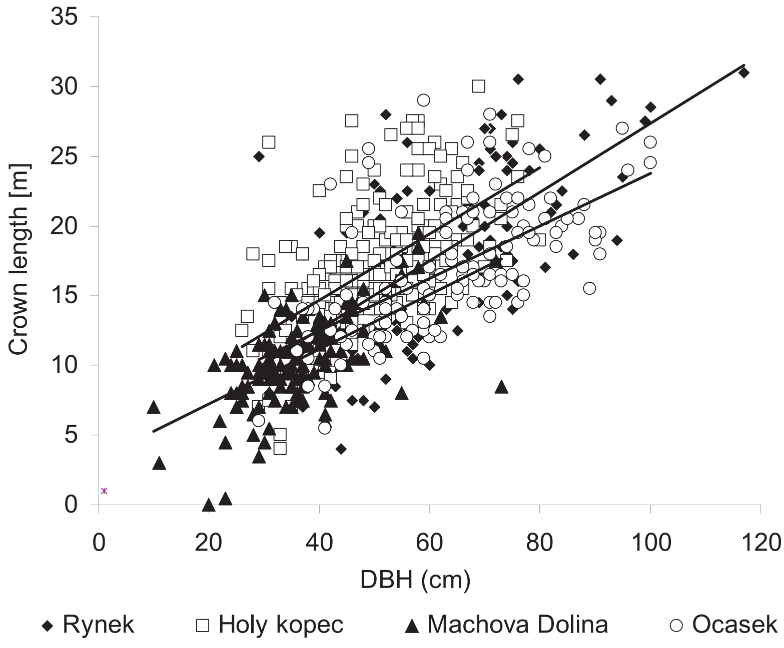


Fig. 3. Dependence of the length of the crown on the DBH. Allometrical equations and corresponding $r^2$: Holy kopec: $y = 0.24DBH + 5.17$, $r^2 = 0.34$, Rynek: $y = 0.25DBH + 2.73$, $r^2 = 0.43$, Machova dolina: $y = 0.20DBH + 3.29$, $r^2 = 0.40$, Ocasek: $y = 0.19\ DBH + 4.95$, $r^2 = 0.39$. Abbreviation: DBH, breast height diameter

(1998), GUERICKE (2001) and WIDLOWSKI (2003) fit to trees at the Ocasek site. Guericke's model fit also to data from locality Rynek; it is the only model that fit to data from two localities. None of the models from the literature fit to the Holy kopec locality with thin and tall trees. Model by FORSTREUTER (1999) is useful for studying smaller trees (DBH less than 40 cm) and overestimates the height of the large ones, so did not fit to any of localities.

The mean length of the crown reaching 17 to 18 m was similar in almost all localities with exception of Machova dolina where the mean crown length was only 11.5 m. Length of the crown was linearly dependent on the size of a tree ($r^2$ = 0.34–0.43, Fig. 3). We found a significant difference in height of crown base between the localities however no correlation with tree diameter ($r^2$ less than 0.10), which is in contrary with some other authors that provide allometric equations, though rather for lower DBH (BARTELINK, 1997; GUERICKE, 2001).

Crown ground projected area ($A_{PRO}$) was positively correlated with tree DBH (Table 6). The highest mean $A_{PRO}$ was measured in trees at the site Rynek, reaching as much as 82 $m^2$. At this locality was also the highest scatter in the crown size, because of presence of the extremely large trees. The smallest ground projection areas were at the site Machova dolina. However these differences in absolute values were evoked by different size of the trees in different localities. Trees at Machova dolina in spite of being smallest had the biggest $A_{PRO}$ /basal area ratio and thick trees at Holy kopec and Ocasek had

Table 6. Allometrical equations for the calculation of the crown ground projected area (CA). Three equations are from the literature, last four equations are our proposed models for the different sites.

| Author/site | Model | $R^2$ |
|---|---|---|
| GUERICKE, 2001 | $CA = \pi \,.\, (0.0821DBH + 0.76694)^2$ | |
| NAGEL et al., 2002 | $CA = \pi \left( (1.04185 + 0.075DBH).\left(1 - \exp^{-\left(\frac{DBH^{1.3341}}{5.7292}\right)}\right) \right)^2$ | |
| BARTELINK, 1997 | $CA = \left( 8.560 + 0.0286.DBH^{2.623} \right)^{0.98232}$ | |
| Rynek | $CA = 3.99 \,.\, e^{0.04DBH}$ | 0.65 |
| Holy kopec | $CA = 1.35 \,.\, e^{0.06DBH}$ | 0.64 |
| Machova dolina | $CA = 1.41DBH - 9.87$ | 0.51 |
| Ocasek | $CA = 7.10^{-5} \,.\, DBH^{3.18}$ | 0.67 |

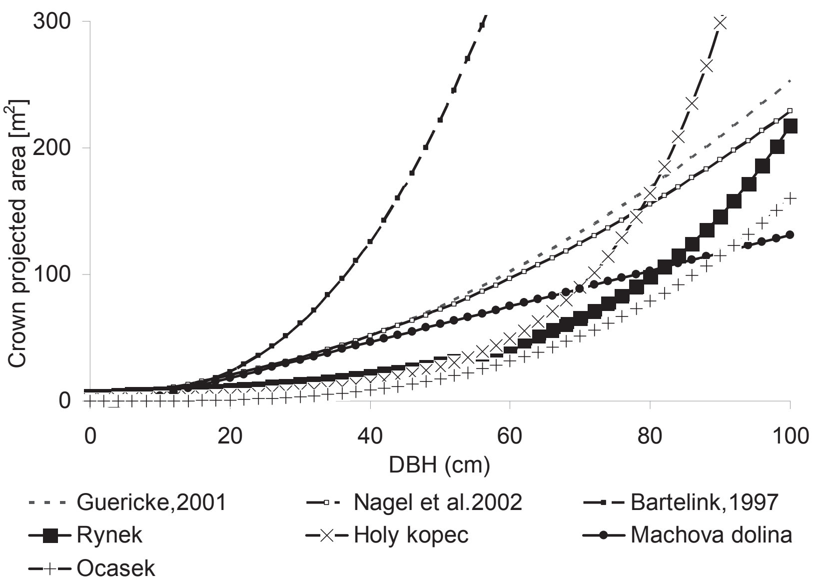


Fig. 4. Dependence of the crown ground projection area ($A_{PRO}$) on the DBH. Allometric equations with corresponding correlation coefficients are written in the Table 6. Exponential models from the literature were calibrated on smaller trees and therefore overestimates $A_{PRO}$.

relatively small crowns (Fig. 4, Table 4). In the locality Machova dolina without extremely huge crowns the best fitting equation had the linear shape whereas in the remaining localities was its shape exponential. The highest cumulative value of crown projected areas was measured at Machova dolina reaching 12,300 $m^2$, the lowest of 6,100 $m^2$ at Ocasek (Table 4, Fig. 1).

Leaf area index (LAI) was highest at Holy kopec (4.2); somewhat lower LAI was measured at Rynek (3.9) and Ocasek site (3.8). The lowest LAI was at Machova dolina (3.6). Density of crowns was estimated as a ratio between LAI and sum of $A_{PRO}$. Densest crowns were at Holy kopec and Ocasek, sparse at Machova dolina (Table 4). The sum of $A_{PRO}$ at Rynek and Machova dolina is higher than actual size of the plot which suggests mutual shading of the trees. Crowns are relatively wide but with low density of leaves. The remaining two localities are much less covered with tree crown (which are, in contrary, denser, Table 4); thus light can be intercepted not only by the top of the crown but also by its sides. Than the amount of sun leaves (Čermák, 1989) which are most important for tree transpiration and photosynthesis may be higher.

Proposed allometric models between DBH and $A_{PRO}$ were compared to exponential models found in the literature. The model of Bartelink (1997) was calibrated to relatively small trees (DBH less than 30 cm) and was not suitable to our purposes (Fig. 4). Models of Guericke (2001) and Nagel et al. (2002) were fitting to the trees from Machova dolina however at remaining localities overestimated $A_{PRO}$ in trees of lower dimensions (DBH less than 60 cm). Our proposed models fit to the trees in particular localities but can be used (as well as any exponential model) only within a given range of DBH. Effort to use exponential models in trees thicker than calibration limit leads to the overestimation of results.

Tree aboveground biomass estimated by SIBYLA model was between 199 and 587 $m^3\,ha^{-1}$ for Machova dolina and Holy kopec respectively (Table 7). Total tree biomass in all stands together estimated by different models ranged between 1,408 Mg for model calibrated to Maine (Ter-Mikkelian and Korzukhin, 1997) and 2,943 Mg estimated by model calculating with both DBH and tree height (Bartelink, 1997).

Overall the biomass estimates running the models using DBH as a single predicting parameter was significantly lower than estimation of models based on both DBH and tree height (with the exception of the SIBYLA model). The values obtained by model for Maine (Ter-Mikkelian and Korzukhin, 1997) were the lowest in all sites. The results of the models based on DBH (Santa Regina and Tarazona, 2001; Forstreuter, 1999 and Cienciala et al., 2005) were similar. The values calculated by models using both DBH and tree height (Bartelink, 1997; Cienciala et al. 2005) were the highest (Table 7).

Forest stands of a same species composition growing even in small-scale area may have different structure due to local differences in site conditions and different competition pressure (different stand density) during their development. Therefore allometric equations should be used with this precaution. Their selection should depend not only on the geographic region but also, if possible, on the knowledge of site conditions, age and level of competition between trees. Growth and development of the trees was mostly influenced by the site fertility (e.g. soil, climatic conditions, and slope exposition). The differences among the localities with comparable site conditions were smaller, however still statistically significant.

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Table 7. Results of the calculations of the tree biomass for our stands using different models (t $ha^{-1}$). Three different types of models were used. Calculations of the seven models were based only on tree diameter in the breast height (DBH), three of the models were based on using both DBH and tree height (h). The growth model Sybila was based on nine parameters including e.g. DBH, height, competition between trees, site fertility. Note the high biomass estimates of the models calculating with the tree height. For the references to the models see the text.

| Equation type | $y = a\ DBH^b$ | | | | | | | $y = a\ DBH^b + h^c$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Author/Site | Maine | Santa | Forstreuter | Cienciala | Bartelink | New Hampshire | Zianis | Cienciala | Bartelink | SYBILA |
| Rynek | 353 | 410 | 413 | 404 | 505 | 509 | 544 | 749 | 811 | 472 |
| Holy kopec | 407 | 458 | 460 | 484 | 541 | 574 | 620 | 761 | 799 | 587 |
| Machova dolina | 264 | 287 | 288 | 327 | 326 | 364 | 397 | 435 | 445 | 199 |
| Ocasek | 383 | 445 | 449 | 437 | 550 | 553 | 590 | 819 | 888 | 488 |
| Total aboveground biomass | 1,408 | 1,600 | 1,610 | 1,653 | 1,922 | 1,999 | 2,151 | 2,765 | 2,943 | 1,746 |

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# Alometria štyroch európskych bukových porastov rastúcich na kontrastných lokalitách v maloplošných územiach

## Souhrn

Cieľom tejto štúdie bolo opísať a porovnať biometrické parametre (napríklad priemernej hrúbky v $d_{1,3}$ (DBH), výšky stromov, dĺžky koruny, index listovej plochy (LAI), xylémovej biomasy) stromov štyroch lesných porastov pestovaných v rozdielnych lokalitách v maloplošnom merítku na ploche 30 km$^2$, vypočítať a porovnať ich alometrické modely. Študované lokality sa nachádzajú vo východnej časti Českej republiky, na vonkajšom okraji geografickej oblasti západných Karpát, v oblasti Chřibů (Rauser, 1971). Všetky lesné porasty pochádzajú z monokultúr buka lesného (*Fagus sylvatica* L.) viac ako 160 rokov starých. Zistili sa štatisticky významné rozdiely medzi lokalitami takmer vo všetkých sledovaných parametroch. Výsledky porovnávaných modelov boli odlišné. Žiaden z analyzovaných jednoduchých alometrických modelov nebol vhodný pre všetky lokality. Alometrické modely by mali byť použité so zreteľom na miestne podmienky, ako sú pôdne a klimatické podmienky a úroveň sociálneho postavenia stromu (jedinca) v poraste, ale aj s ohľadom na určité geografické oblasti.

Najhrubšie stromy boli na lokalitách Rynek a Ocásek, ktoré mali priemer 61 a 64 cm, resp. 100 a 117 cm. Variačný koeficient bol podobný vo všetkých lokalitách, najnižšia variabilita v distribúcii DBH bola na lokalite Holý kopec (tabuľka 3). Najvyššia hodnota kruhovej základne porastu (BA) na hektár bola nameraná v lokalite Holý kopec (48 m$^2$), najnižšia hodnota 34 m$^2$ napriek najväčšiemu počtu stromov v lokalite Máchova dolina (tabuľka 4, obrázok 1).

Index listovej pokryvnosti (LAI) bol najvyšší v lokalite Holý kopec (4,2), o niečo nižší LAI bol nameraný na lokalite Rynek (3,9) a Ocásek (3,8). Najnižšie LAI bol na ploche Máchova dolina (3,6). Hustota korún sa odhaduje ako pomer medzi LAI a celkovou výškou $A_{PRO}$.

Najviac rozdielne sú biometrické parametre na lokalite Máchova dolina. Tu sa vyskytuje najviac stromov na plochu. Najviac podobné sú lokality Rynek a Ocásek.

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