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BIOMETRIC AND MORPHOLOGICAL OBSERVATIONS ON *POPULUS TREMULA* L. (SALICACEAE) LEAVES

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ABSTRACT
The paper presents a research model of leaf investigation, based on biometrical measurements and morphological observations. In literature, there are only few studies concerning the biometrical investigation and analysis applied on spontaneous and cultivar plants leaves. The article comprises biometrical investigations on Populus tremula L. leaves. The measurements and morphological observations were performed on 40 mature leaves collected from the apex, middle and base crown of the tree. The measurements included: linear measurements, percentage ratios, angular measurements and other measurements such as the number of teeth/cm, the number semi-sum of secondary pairs of veins and the the leaf surface. The biometric measurements were the basis of a mathematical calculation formua of the average values on the studied genotype. Based on the biometric measurements it could make a more complete characterization of the leaves of this species

KEY WORDS: *foliar biometriy, measurements, lamina, mathematical calculation, Populus tremula.*

INTRODUCTION

Populus tremula L. is a species of *Populus* (fam. Salicacaceae) known as Common aspen, Eurasian aspen, European aspen or quaking aspen, is wild spread from Europe, including Britain, from south-east Iceland, Siberia to northern Africa, temperate Asia to Japan. The plant grows in valleys, open or scattered, hills, arriving to coniferous forests area, from 700-2.300 m. *Populus tremula* is a deciduous tree growing up to 20-30 m (Yang, 1999). The tree has a straight trunk, with a smooth pale greenish-grey bark, with visible lenticels at young trees and at maturity the bark color turns into dark-gray to blackish–gray, is cracked with polygonal scales. The crown is oval to pyramidal, with flexible glabrous, reddish-brown tendrils (Rushforth, 1999; Stace, 2010). The shiny brown buds are oval, elongated, pointed and hairless. The leaves lamina is thin, glabrous, and have suborbicular shape with a long petiole that allows them swaying in the slight breeze. The dioecious flowers, are grouped in thick, long gray hairy catkins. The female catkins are shorter than the males. They are covered by palmate-lacinia scales, with long cilia though. It blooms annually from March to April, opening before the leaves. The fruits are capsules with small fluff seeds. In Romania, it is common everywhere, valleys, hils, mountains, often invading the forests (till 1.600 m) where it forms clean clumps

cuts or with *Salix caprea*, *Betula verrucosa*. *Populus tremula* tolarates all type of soils (Ciocarlan, 2000; Niculescu, 2009; Savulescu, 1957).

The paper presents a research model of leaf investigation, based on biometrical measurements and morphological observations. In literature there are few examples of biometric leaf investigation applied on spontaneous plants leaves, mostly of them being paleontological studies (Mouton, 1966a,b, 1867, 1976; Roth & Dilcher, 1978; Givulescu, 1999, Givulescu & Soltesz, 2000; Hably & Zastawniak, 2001). Many sets of terms and methods have been devised for describing leaves (e.g. Hably & Zastawniak, 2001; Dale *et al.* 1971; Dickinson *et al.,* 1987; Hickey 1973; Ianovici *et al.* 2009; Ianovici *et al*. 2015a,b; Jensen, 1990; Melville, 1976; Ray, 1992; Roth & Dilcher, 1978). In Romanian literature are few studies focused on spontaneous plants leaves (Bercu & Bavaru, 2007; Bercu, 2013a,b; Bercu, 2015), most of data refers to some general biometric features such as lamina venation, mentioned in lectures and manuals of Anatomy and Morphology of Plants (e.g. Andrei, 1997; Buia & Péterfi, 1965; Niculescu, 2004).

MATERIALS AND METHODS

The morphological observations and biometric measurements were performed on 40 mature leaves of *Populus tremula*, collected from the apex, middle and base of the tree crown. The leaves were collected from Tabacarie Lake Park (Conatantza City) in August 2015. The methods and terms for the leaves description form, size, margin and venation follow the leaf architectural system of Mounton (1966a, b, 1967, 1976) and Roth & Dilcher (1978).

The biometrical measurements which had been calculated are: a. the linear measurements: L- leaf length, l- leaf width, h- the height of the maximum width of lamina; A- the tip length, I-I'- the apex width; Lp- the petiole length, followed by b. the percentage ratios: L/l- the finesse of leaf; A/L- the acuminate ratio, h/L- the ovality ratio; A/I-I'- the lamina apex finesse. c. The angular measurements: α- the apical angle, β- the emergent angle of the secondary veins with primaries, ɣ- the emergent angle of the tertiary veins related to the primary one and finally d. other measurements: the teeth number/cm (D), the number semi-sum of secondary pairs of veins (Np) and the lamina surface (S). For each leaf were carried out 20 measurements, amounting 800 determinations, performed for all 40 leaves.

RESULTS AND DISCUSSIONS

Biometric observations. The biometrical measurements was performed on *Populus tremula* 13 leaves from the crown apex (leaves no. 1-13), 13 leaves from the middle crown (leaves no. 14-26) and 14 from the base of the crown (leaves no. 27-40) (40 leaves in total) (Tables 1, 2, Fig. 1) and represented the base for a mathematical calculation formula for the average values of measurements for all three groups of leaves (Tables 3, 4).

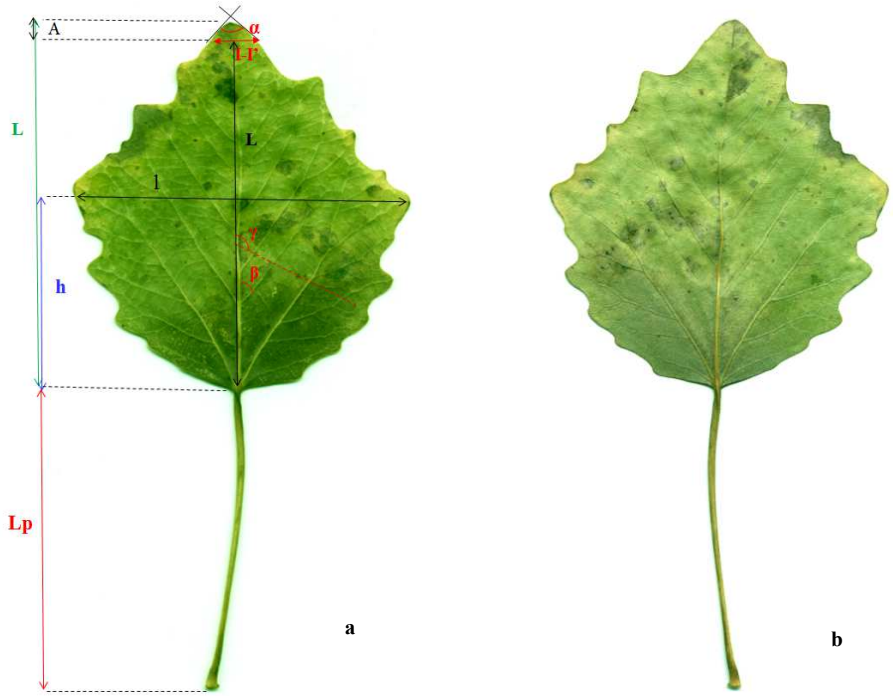

FIG. 1. *Populus tremula* L. leaf**.** Ventral lamina surface with liniar and angular measurements (a). Dorsal lamina surface (b).

1. The average of biometric measurements of *Populus tremula* leaves from the apex of the crown (n = 13).

Liniar measurements:

$$\overline{L_{Pt}} = \sum_{i=1}^{n} \frac{L_{Pt}}{n} = \frac{L_1 + \ldots\ldots\ldots\ldots + L_n}{n} = \frac{108 + \ldots\ldots\ldots\ldots + 73}{40} = 93.38mm$$

$$\overline{l_{Pt}} = \sum_{i=1}^{n} \frac{l_{Pt}}{n} = \frac{l_1 + \ldots\ldots\ldots\ldots + l_n}{n} = \frac{96 + \ldots\ldots\ldots\ldots + 77}{40} = 84.15mm$$

$$\overline{h_{Pt}} = \sum_{i=1}^{n} \frac{h_{Pt}}{n} = \frac{h_1 + \ldots\ldots\ldots\ldots + h_n}{n} = \frac{46 + \ldots\ldots\ldots\ldots + 36}{40} = 38.69mm$$

$$\overline{A_{Pt}} = \sum_{i=1}^{n} \frac{A_{Pt}}{n} = \frac{A_1 + \ldots\ldots\ldots\ldots + A_n}{n} = \frac{13 + \ldots\ldots\ldots\ldots + 13}{40} = 12.53mm$$

$$\overline{I-I'_{Pt}} = \sum_{i=1}^{n} \frac{I-I'_{Pt}}{n} = \frac{I-I'_1+.....+I-I'_n}{n} = \frac{23+.....+15}{40} = 17.61mm$$

$$\overline{Lp_{Pt}} = \sum_{i=1}^{n} \frac{Lp_{Pt}}{n} = \frac{Lp_1+.....+Lp_n}{n} = \frac{94+.....+77}{40} = 78.53mm$$

Percentage ratios:

$$\overline{\frac{L}{l}_{Pt}} = \sum_{i=1}^{n} \frac{\left(\frac{L}{l}\right)_{Pt}}{n} = \frac{\left(\frac{L}{l}\right)_1+.....+\left(\frac{L}{l}\right)_n}{n} = \frac{1.12+.....+1.14}{40} = 1.11\%$$

$$\overline{\frac{h}{L}_{Pt}} = \sum_{i=1}^{n} \frac{\left(\frac{h}{L}\right)_{Pt}}{n} = \frac{\left(\frac{h}{L}\right)_1+.....+\left(\frac{h}{L}\right)_n}{n} = \frac{0.42+.....+0.40}{40} = 0.41\%$$

$$\overline{\frac{A}{L}_{Pt}} = \sum_{i=1}^{n} \frac{\left(\frac{A}{L}\right)_{Pt}}{n} = \frac{\left(\frac{A}{L}\right)_1+.....+\left(\frac{A}{L}\right)_n}{n} = \frac{0.12+.....+0.14}{40} = 0.13\%$$

$$\overline{\frac{A}{I-I'_{Pt}}} = \sum_{i=1}^{n} \frac{\left(\frac{A}{I-I'}\right)_{Pt}}{n} = \frac{\left(\frac{A}{I-I'}\right)_1+.....+\left(\frac{A}{I-I'}\right)_n}{n} = \frac{0.56+.....+0.86}{40} = 0.74\%$$

Anglar measurements:

$$\overline{\alpha_{Pt}} = \sum_{i=1}^{n} \frac{\alpha_{Pt}}{n} = \frac{\alpha_1+.....+\alpha_n}{n} = \frac{79+.....+64}{40} = 70.61^o$$

$$\overline{\beta_{1Pt}} = \sum_{i=1}^{n} \frac{\beta_{1Pt}}{n} = \frac{\beta_{1_1}+.....+\beta_{1_n}}{n} = \frac{29+.....+38}{40} = 39^o$$

$$\overline{\beta_{2Pt}} = \sum_{i=1}^{n} \frac{\beta_{2Pt}}{n} = \frac{\beta_{21}+.....+\beta_{2n}}{n} = \frac{29+.....+32}{40} = 38.46^o$$

$$\overline{\beta_{3Pt}} = \sum_{i=1}^{n} \frac{\beta_{3Pt}}{n} = \frac{\beta_{31}+.....+\beta_{3n}}{n} = \frac{37+.....+41}{40} = 40.92^o$$

$$\overline{\gamma_{1Pt}} = \sum_{i=1}^{n} \frac{\gamma_{1Pt}}{n} = \frac{\gamma_{1_1} + \ldots\ldots\ldots\ldots + \gamma_{1_n}}{n} = \frac{125 + \ldots\ldots\ldots\ldots + 125}{40} = 124.23^{o}$$

$$\overline{\gamma_{2Pt}} = \sum_{i=1}^{n} \frac{\gamma_{2Pt}}{n} = \frac{\gamma_{2_1} + \ldots\ldots\ldots\ldots + \gamma_{2_n}}{n} = \frac{124 + \ldots\ldots\ldots\ldots + 124}{40} = 123.84^{o}$$

$$\overline{\gamma_{3Pt}} = \sum_{i=1}^{n} \frac{\gamma_{3Pt}}{n} = \frac{\gamma_{3_1} + \ldots\ldots\ldots\ldots + \gamma_{3_n}}{n} = \frac{120 + \ldots\ldots\ldots\ldots + 126}{40} = 123.76^{o}$$

Other measurements:

$$\overline{Np_{Pt}} = \sum_{i=1}^{n} \frac{Np_{Pt}}{n} = \frac{Np_1 + \ldots\ldots\ldots\ldots + Np_n}{n} = \frac{5 + \ldots\ldots\ldots\ldots + 5}{40} = 5\,\text{sec}.veins$$

$$\overline{D_{Pt}} = \sum_{i=1}^{n} \frac{D_{Pt}}{n} = \frac{D_1 + \ldots\ldots\ldots\ldots + D_n}{n} = \frac{1 + \ldots\ldots\ldots\ldots + 1}{40} = 1tooth/cm$$

$$\overline{S_{Pt}} = \sum_{i=1}^{n} \frac{S_{Pt}}{n} = \frac{S_1 + \ldots\ldots\ldots\ldots + S_n}{n} = \frac{69.465 + \ldots\ldots\ldots\ldots + 45.399}{40} = 53.53/cm^2$$

2. The average of biometric measurements of *Populus tremula* leaves from the middle of the crown (n = 13).

Liniar measurements:

$$\overline{L_{Pt}} = \sum_{i=1}^{n} \frac{L_{Pt}}{n} = \frac{L_1 + \ldots\ldots\ldots\ldots + L_n}{n} = \frac{73 + \ldots\ldots\ldots\ldots + 77}{40} = 93mm$$

$$\overline{l_{Pt}} = \sum_{i=1}^{n} \frac{l_{Pt}}{n} = \frac{l_1 + \ldots\ldots\ldots\ldots + l_n}{n} = \frac{74 + \ldots\ldots\ldots\ldots + 74}{40} = 86.53mm$$

$$\overline{h_{Pt}} = \sum_{i=1}^{n} \frac{h_{Pt}}{n} = \frac{h_1 + \ldots\ldots\ldots\ldots + h_n}{n} = \frac{23 + \ldots\ldots\ldots\ldots + 22}{40} = 38.69mm$$

$$\overline{A_{Pt}} = \sum_{i=1}^{n} \frac{A_{Pt}}{n} = \frac{A_1 + \ldots\ldots\ldots\ldots + A_n}{n} = \frac{9 + \ldots\ldots\ldots\ldots + 6}{40} = 12.92mm$$

$$\overline{I - I'_{Pt}} = \sum_{i=1}^{n} \frac{I - I'_{Pt}}{n} = \frac{I - I'_1 + \ldots\ldots\ldots\ldots + I - I'_n}{n} = \frac{13 + \ldots\ldots\ldots\ldots + 12}{40} = 19.23mm$$

$$\overline{Lp_{Pt}} = \sum_{i=1}^{n} \frac{Lp_{Pt}}{n} = \frac{Lp_1 + \ldots\ldots\ldots\ldots + Lp_n}{n} = \frac{71 + \ldots\ldots\ldots\ldots + 75}{40} = 78mm$$

Percentage ratios:

$$\overline{\frac{L}{l}}_{Pt} = \sum_{i=1}^{n} \frac{\left(\frac{L}{l}\right)_{Pt}}{n} = \frac{\left(\frac{L}{l}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{L}{l}\right)_n}{n} = \frac{0.98 + \ldots\ldots\ldots\ldots + 1.04}{40} = 1.08\%$$

$$\overline{\frac{h}{L}}_{Pt} = \sum_{i=1}^{n} \frac{\left(\frac{h}{L}\right)_{Pt}}{n} = \frac{\left(\frac{h}{L}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{h}{L}\right)_n}{n} = \frac{0.31 + \ldots\ldots\ldots\ldots + 0.28}{40} = 0.38\%$$

$$\overline{\frac{A}{L}}_{Pt} = \sum_{i=1}^{n} \frac{\left(\frac{A}{L}\right)_{Pt}}{n} = \frac{\left(\frac{A}{L}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{A}{L}\right)_n}{n} = \frac{0.12 + \ldots\ldots\ldots\ldots + 0.07}{40} = 0.14\%$$

$$\overline{\frac{A}{I-I'}}_{Pt} = \sum_{i=1}^{n} \frac{\left(\frac{A}{I-I'}\right)_{Pt}}{n} = \frac{\left(\frac{A}{I-I'}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{A}{I-I'}\right)_n}{n} = \frac{0.69 + \ldots\ldots\ldots\ldots + 0.50}{40} = 0.67\%$$

Anglar measurements:

$$\overline{\alpha_{Pt}} = \sum_{i=1}^{n} \frac{\alpha_{Pt}}{n} = \frac{\alpha_1 + \ldots\ldots\ldots\ldots + \alpha_n}{n} = \frac{81 + \ldots\ldots\ldots\ldots + 73}{40} = 70.76^o$$

$$\overline{\beta_{1Pt}} = \sum_{i=1}^{n} \frac{\beta_{1Pt}}{n} = \frac{\beta_{11} + \ldots\ldots\ldots\ldots + \beta_{1n}}{n} = \frac{44 + \ldots\ldots\ldots\ldots + 36}{40} = 37^o$$

$$\overline{\beta_{2Pt}} = \sum_{i=1}^{n} \frac{\beta_{2Pt}}{n} = \frac{\beta_{21} + \ldots\ldots\ldots\ldots + \beta_{2n}}{n} = \frac{37 + \ldots\ldots\ldots\ldots + 41}{40} = 40.07^o$$

$$\overline{\beta_{3Pt}} = \sum_{i=1}^{n} \frac{\beta_{3Pt}}{n} = \frac{\beta_{31} + \ldots\ldots\ldots\ldots + \beta_{3n}}{n} = \frac{45 + \ldots\ldots\ldots\ldots + 35}{40} = 41.69^o$$

$$\overline{\gamma_{1Pt}} = \sum_{i=1}^{n} \frac{\gamma_{1Pt}}{n} = \frac{\gamma_{11} + \ldots\ldots\ldots\ldots + \gamma_{1n}}{n} = \frac{120 + \ldots\ldots\ldots\ldots + 119}{40} = 120.76^o$$

$$\overline{\gamma_{2Pt}} = \sum_{i=1}^{n} \frac{\gamma_{2Pt}}{n} = \frac{\gamma_{21} + \ldots\ldots\ldots\ldots + \gamma_{2n}}{n} = \frac{122 + \ldots\ldots\ldots\ldots + 119}{40} = 121.61^o$$

$$\overline{\gamma_{3Pt}} = \sum_{i=1}^{n} \frac{\gamma_{3Pt}}{n} = \frac{\gamma_{31} + ... + \gamma_{3n}}{n} = \frac{123 + ... + 123}{40} = 123^{o}$$

Other measurements:

$$\overline{Np_{Pt}} = \sum_{i=1}^{n} \frac{Np_{Pt}}{n} = \frac{Np_1 + ... + Np_n}{n} = \frac{4 + ... + 5}{40} = 4.76 \sec .veins$$

$$\overline{D_{Pt}} = \sum_{i=1}^{n} \frac{D_{Pt}}{n} = \frac{D_1 + ... + D_n}{n} = \frac{1 + ... + 1}{40} = 1 tooth / cm$$

$$\overline{S_{Pt}} = \sum_{i=1}^{n} \frac{S_{Pt}}{n} = \frac{S_1 + ... + S_n}{n} = \frac{36.193 + ... + 38.176}{40} = 54.73 / cm^2$$

3. The average of biometric measurements of *Populus tremula* leaves from the base of the crown (n=14).

Liniar measurements:

$$\overline{L_{Pt}} = \sum_{i=1}^{n} \frac{L_{Pt}}{n} = \frac{L_1 + ... + L_n}{n} = \frac{87 + ... + 64}{40} = 93.78 mm$$

$$\overline{l_{Pt}} = \sum_{i=1}^{n} \frac{l_{Pt}}{n} = \frac{l_1 + ... + l_n}{n} = \frac{82 + ... + 73}{40} = 92.71 mm$$

$$\overline{h_{Pt}} = \sum_{i=1}^{n} \frac{h_{Pt}}{n} = \frac{h_1 + ... + h_n}{n} = \frac{30 + ... + 27}{40} = 33.64 mm$$

$$\overline{A_{Pt}} = \sum_{i=1}^{n} \frac{A_{Pt}}{n} = \frac{A_1 + ... + A_n}{n} = \frac{10 + ... + 12}{40} = 12.57 mm$$

$$\overline{I - I'_{Pt}} = \sum_{i=1}^{n} \frac{I - I'_{Pt}}{n} = \frac{I - I'_1 + ... + I - I'_n}{n} = \frac{14 + ... + 20}{40} = 19.21 mm$$

$$\overline{Lp_{Pt}} = \sum_{i=1}^{n} \frac{Lp_{Pt}}{n} = \frac{Lp_1 + ... + Lp_n}{n} = \frac{75 + ... + 45}{40} = 70.57 mm$$

Percentage ratios:

$$\overline{\frac{L}{l}_{Pt}} = \sum_{i=1}^{n} \frac{\left(\frac{L}{l}\right)_{Pt}}{n} = \frac{\left(\frac{L}{l}\right)_1 + ... + \left(\frac{L}{l}\right)_n}{n} = \frac{1.06 + ... + 0.87}{40} = 1\%$$

$$\overline{\frac{h}{L}_{Pt}} = \sum_{i=1}^{n} \frac{\left(\frac{h}{L}\right)_{Pt}}{n} = \frac{\left(\frac{h}{L}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{h}{L}\right)_n}{n} = \frac{0.34 + \ldots\ldots\ldots\ldots + 0.42}{40} = 0.35\%$$

$$\overline{\frac{A}{L}_{Pt}} = \sum_{i=1}^{n} \frac{\left(\frac{A}{L}\right)_{Pt}}{n} = \frac{\left(\frac{A}{L}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{A}{L}\right)_n}{n} = \frac{0.11 + \ldots\ldots\ldots\ldots + 0.18}{40} = 0.13\%$$

$$\overline{\frac{A}{I-I'}_{Pt}} = \sum_{i=1}^{n} \frac{\left(\frac{A}{I-I'}\right)_{Pt}}{n} = \frac{\left(\frac{A}{I-I'}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{A}{I-I'}\right)_n}{n} = \frac{0.71 + \ldots\ldots\ldots\ldots + 0.60}{40} = 0.65\%$$

Anglar measurements:

$$\overline{\alpha_{Pt}} = \sum_{i=1}^{n} \frac{\alpha_{Pt}}{n} = \frac{\alpha_1 + \ldots\ldots\ldots\ldots + \alpha_n}{n} = \frac{70 + \ldots\ldots\ldots\ldots + 83}{40} = 78.07^o$$

$$\overline{\beta_{1Pt}} = \sum_{i=1}^{n} \frac{\beta_{1Pt}}{n} = \frac{\beta_{11} + \ldots\ldots\ldots\ldots + \beta_{1n}}{n} = \frac{44 + \ldots\ldots\ldots\ldots + 67}{40} = 43^o$$

$$\overline{\beta_{2Pt}} = \sum_{i=1}^{n} \frac{\beta_{2Pt}}{n} = \frac{\beta_{21} + \ldots\ldots\ldots\ldots + \beta_{2n}}{n} = \frac{38 + \ldots\ldots\ldots\ldots + 45}{40} = 42.64^o$$

$$\overline{\beta_{3Pt}} = \sum_{i=1}^{n} \frac{\beta_{3Pt}}{n} = \frac{\beta_{31} + \ldots\ldots\ldots\ldots + \beta_{3n}}{n} = \frac{37 + \ldots\ldots\ldots\ldots + 54}{40} = 43.28^o$$

$$\overline{\gamma_{1Pt}} = \sum_{i=1}^{n} \frac{\gamma_{1Pt}}{n} = \frac{\gamma_{11} + \ldots\ldots\ldots\ldots + \gamma_{1n}}{n} = \frac{122 + \ldots\ldots\ldots\ldots + 118}{40} = 119.85^o$$

$$\overline{\gamma_{2Pt}} = \sum_{i=1}^{n} \frac{\gamma_{2Pt}}{n} = \frac{\gamma_{21} + \ldots\ldots\ldots\ldots + \gamma_{2n}}{n} = \frac{118 + \ldots\ldots\ldots\ldots + 119}{40} = 119.14^o$$

$$\overline{\gamma_{3Pt}} = \sum_{i=1}^{n} \frac{\gamma_{3Pt}}{n} = \frac{\gamma_{31} + \ldots\ldots\ldots\ldots + \gamma_{3n}}{n} = \frac{121 + \ldots\ldots\ldots\ldots + 123}{40} = 119.92^o$$

Other measurements:

$$\overline{Np_{Pt}} = \sum_{i=1}^{n} \frac{Np_{Pt}}{n} = \frac{Np_1 + \ldots\ldots\ldots\ldots + Np_n}{n} = \frac{4 + \ldots\ldots\ldots\ldots + 6}{40} = 5\,\mathrm{sec}.veins$$

$$\overline{D_{Pt}} = \sum_{i=1}^{n} \frac{D_{Pt}}{n} = \frac{D_1 + ... + D_n}{n} = \frac{1 + ... + 1}{40} = 1 tooth / cm$$

$$\overline{S_{Pt}} = \sum_{i=1}^{n} \frac{S_{Pt}}{n} = \frac{S_1 + ... + S_n}{n} = \frac{47.797 + ... + 31.302}{40} = 59.39 / cm^2$$

Morphological observations. All *Populus tremula* leaves are symmetrical simple leaves with rombic-obovate lamina shape (the maximum width is in the upper part of the lamina), with a ovality ratio average (h/L) 0,38%. Lamina is ended in an acuminate large apex with an average α = 73.14° (Table 2, 3). The lamina has a slightly cuneate base and regular lobulate with rounded teeth margin with one tooth/cm. The lamina is glabrous with the ventral surface brightly greenish and slightly white on the dorsal one (glauscent). It has coriaceous texture (Fig. 1, a, b). The percentage ratio of all *Populus tremula* leaves indicate a finesse leaf (average L/l = 1,06%) and a fine apex (average A/I-I' = 0,68%) (Table 1, 3). The larger-sized leaves are at the base of the crown (S = 31,302– 84.781 cm^2), classified in the mesophyll class, followed by those from the middle (S = 35.463– 81.681 cm^2) which are mesophyll and occasionally notophyll. The smaller surface – mesophyll - have the lamina from the apex of the crown (S = 34.993 – 83.254 cm^2) (Table 2, 4). By Mouton (1966a) the leaves size class values are registered as: leptophyll (0-0.25 cm^2), nanophyll (0.25-2.25 cm^2), microphyll (2.25 - 20.25 cm^2), notophyll (20.25 - 40.00 cm^2), mesophyll (40.00 - 182.25 cm^2), macrophyll (182-1640.2 cm^2) and megaphyll (over 1600.20 cm^2). The lamina has a coriaceous texture. The mid vein is right and lamina have craspedodromous secondary veins (Andrei, 1997; Buia & Péterfi, 1965; Givulescu, 1999) with a number of 4-5 obvious secondary veins (Fig. 1).

The emergent angle between the primary and the secondary veins (β) is norrow acute for all leaves (under 45°). The emergent angle (β) values decrease from the leaf base to the apex. The tertiary veins are oblique constant towards the secondary's, forming an obtuse angle (all leaves average ɣ = 119,43-123,94°) with the primaries, for all three groups of leaves (Table 2, 4). This angle of the tertiary vein (ɣ) to the primary decrease from the apex to the base of the crown. The green glabrous petiole is long, strongly laterally flattened, with a lenght average Lp = 75.70 mm for all leaves. The longer petiole have the leaves from the apex (Lp = 78.53 mm) and middle (Lp = 78) of the crown, the the smaller are those of the base crown (Lp = 70.54).

The lamina size: the apex of the crown L = 93.38 mm, l = 84.15 mm; the middle crown L = 93 mm, l = 86.53 mm and the base L = 93.78 mm, l = 92.71 mm.

CONCLUSIONS

The linear measurements of *Populus tremula* laminas have high values concerning the length (L) and lower for the apex length (A). The percentage ratios of all leaves indicate a fineness of leaf (L/l) and a fineness apex (A/I-I'). Lamina has simple craspedodromous secondary veins. Concerning the leaves angular measurements of *Populus tremula*, the apex is large acuminate (α). The emergent angle between the primary and the secondary veins (β) is norrow acute and whereas the tertiary to the primaries (ɣ) are obtuse. Coriaceous texture. The petiole is green, laterally flattened and long (Lp). Laminas have a more or less large surface area (S) including the species leaves in the mesophyll size class and occasionally notophyll for

the leaves of the middle crown. The biometrical measurements have high values for the leaves of the apex crown and medium values for the middle crown leaves. The lowest values have the base crown leaves, being over shadowed by the other leaves of higher levels. The morphological and morphometric features such as the ovality ratio, the membranous texture, the venation type and the preponderant mesophyll size class (small surface area with higher leaf mass per unit area) allow *Populus tremula* to be adaptable for the temperate zones and less for the semiarid regions.

TABLE 1. Liniar measurements and percentage ratio of *Populus tremula* leaves

Leaf no.	L mm	l mm	h mm	A mm	I-I' mm	Lp mm	L/l %	h/L %	A/L %	A/I-I' %
1	108	96	46	13	23	94	1.12	0.42	0.12	0.56
2	90	75	45	14	16	77	1.20	0.50	0.15	0.87
3	90	79	31	10	10	75	1.13	0.34	0.11	1
4	110	106	54	11	12	104	1.03	0.49	0.10	0.91
5	93	86	44	11	17	74	1.08	0.47	0.11	0.64
6	109	114	29	12	23	83	0.95	0.26	0.11	0.52
7	90	79	34	10	12	75	1.13	0.37	0.11	0.83
8	108	88	34	11	21	72	1.22	0.31	0.10	0.52
9	82	84	40	15	24	75	0.97	0.48	0.18	0.62
10	88	77	40	16	18	74	1.14	0.45	0.18	0.88
11	79	67	38	15	21	68	1.17	0.48	0.18	0.71
12	79	66	32	12	17	73	1.19	0.40	0.15	0.70
13	88	77	36	13	15	77	1.14	0.40	0.14	0.86
14	73	74	23	9	13	71	0.98	0.31	0.12	0.69
15	100	96	30	15	28	85	1.04	0.30	0.15	0.53
16	100	87	35	15	17	80	1.14	0.35	0.15	0.88
17	98	100	32	12	16	73	0.98	0.32	0.12	0.75
18	79	67	31	16	18	68	1.17	0.39	0.20	0.88
19	92	83	45	13	15	82	1.10	0.48	0.14	0.86
20	116	89	52	20	26	85	1.30	0.44	0.17	0.76
21	83	75	43	11	20	73	1.10	0.51	0.13	0.55
22	100	122	38	10	23	92	0.81	0.38	0.10	0.43
23	108	99	36	18	22	75	1.09	0.33	0.16	0.81
24	83	74	43	10	21	73	1.12	0.51	0.12	0.47
25	100	85	43	13	19	77	1.17	0.43	0.13	0.68
26	77	74	22	6	12	75	1.04	0.28	0.07	0.50
27	87	82	30	10	14	75	1.06	0.34	0.11	0.71
28	88	87	46	10	16	68	1.01	0.52	0.11	0.62
29	114	111	47	12	20	75	1.02	0.41	0.10	0.60
30	84	88	22	11	23	75	0.95	0.26	0.13	0.47
31	88	79	21	10	18	68	1.11	0.23	0.11	0.55
32	110	105	44	13	18	79	1.04	0.40	0.11	0.72
33	114	111	35	10	17	81	1.02	0.30	0.18	0.58
34	98	97	44	14	27	74	1.01	0.44	0.14	0.51
35	118	105	30	18	21	80	1.12	0.25	0.15	0.85
36	98	102	42	14	22	65	0.96	0.42	0.14	0.63
37	80	78	30	18	21	69	1.02	0.37	0.22	0.85
38	86	92	27	14	19	73	0.93	0.31	0.16	0.73
39	84	88	26	10	13	60	0.95	0.30	0.11	0.76
40	64	73	27	12	20	45	0.87	0.42	0.18	0.60

TABLE 2. Angular measurements, other measurements and the size class of *Populus tremula* leaves

Leaf no.	α°	β1°	β2°	β3°	γ1°	γ2°	γ3°	Np	D/cm	S (cm²)	Size class
1	79	29	29	37	125	124	120	5	1	69.465	Mesofil
2	60	41	35	35	124	120	120	6	1	45.225	Mesofil
3	60	57	32	44	125	125	126	5	1	47.637	Mesofil
4	60	36	41	41	123	126	126	5	1	78.122	Mesofil
5	77	49	46	46	122	126	125	5	1	53.586	Mesofil
6	82	40	36	39	126	122	123	5	1	83.254	Mesofil
7	66	39	48	42	125	124	124	5	1	47.637	Mesofil
8	82	57	67	49	126	125	125	5	1	63.676	Mesofil
9	83	33	32	42	122	126	122	5	1	46.149	Mesofil
10	63	39	43	49	124	123	125	5	1	45.399	Mesofil
11	71	33	34	32	123	120	124	4	1	35.463	Mesofil
12	71	38	25	35	125	125	123	5	1	34.933	Mesofil
13	64	38	32	41	125	124	126	5	1	45.399	Notofil
14	81	44	37	45	120	122	123	4	1	36.193	Notofil
15	88	39	43	41	122	123	125	5	1	64.320	Mesofil
16	60	44	52	42	119	125	122	5	1	58.290	Notofil
17	69	41	36	47	121	122	120	5	1	65.660	Mesofil
18	29	32	39	38	120	120	122	5	1	35.463	Notofil
19	60	32	49	48	119	119	120	5	1	51.161	Mesofil
20	65	43	31	53	122	118	123	4	1	69.170	Mesofil
21	86	36	38	37	120	124	126	5	1	41.707	Mesofil
22	85	27	43	39	124	126	122	6	1	81.740	Mesofil
23	67	39	41	43	123	121	126	4	1	71.636	Mesofil
24	84	36	37	43	120	120	122	4	1	41.151	Mesofil
25	72	32	34	31	121	122	125	5	1	56.950	Mesofil
26	73	36	41	35	119	119	123	5	1	38.176	Notofil
27	70	44	38	37	122	118	121	4	1	47.797	Mesofil
28	83	32	38	39	119	124	119	5	1	51.295	Mesofil
29	83	39	44	51	118	117	123	5	1	84.781	Mesofil
30	85	35	30	39	119	118	117	5	1	49.526	Mesofil
31	87	40	45	41	122	120	118	5	1	46.578	Mesofil
32	80	36	44	44	120	118	121	5	1	77.385	Mesofil
33	77	39	41	34	121	121	122	5	1	84.781	Mesofil
34	84	38	34	45	120	118	117	5	1	63.690	Mesofil
35	63	45	39	51	120	117	119	5	1	83.013	Mesofil
36	86	81	82	45	118	122	118	5	1	66.973	Mesofil
37	63	38	40	45	120	121	119	5	1	41.808	Mesofil
38	78	29	32	41	119	118	120	5	1	53.010	Mesofil
39	71	39	45	41	122	117	122	5	1	49.526	Mesofil
40	83	67	45	54	118	119	123	6	1	31.302	Notofil

TABLE 3. The average of the linear measurements and percentage ratio of all *Populus tremula* leaves

Specia	L (mm)	l (mm)	h (mm)	A (mm)	I-I´ (mm)	Lp (mm)	L/l (%)	h/L (%)	A/L (%)	A/ I-I´ (%)
Populus tremula L.	93.38	87.79	37	12.67	18.68	75,70	1.06	0.38	0.13	0.68

TABLE 4. Angular measurements and other measurements of all *Populus tremula* leaves

Specia	α^o	β^o	γ^o	Np	D/cm	S (cm²)	Size class
Populus tremua L.	73,14	40.49	121.78	4.92	1	55.88	Mesophyll

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