Anatomical Properties of *Platan Orientalis* L. which Grows in the Rosdside Plantations in the City of Hudzhand

1,2Olga Alexandrovna Neverova and 2Rahmat Sanginovish Zokirov

1Kemerovo Institute of Food Science and Technology, 47 Stroiteley Boulevard, 650056 Kemerovo, Russia
2Institute of Human Ecology SB RAS,10 Leningradskiy street, 650065 Kemerovo, Russia

**ABSTRACT**

The investigation examines the anatomical properties of the oriental plane (*Platan orientalis* L.), which grows along the streets with the intensive traffic in Hudzhand, an industrial centre of the Republic of Tajikistan. These soils are characterized by the high content of sulfur and heavy metals (Pb, Cu, Zn, Ni, Co, Cr), which violate the sanitary-hygienic standards and lead to the following changes: the thicker lamina, the thicker cuticle, as well as the thicker higher and lower epidermis and columnar / spongy mesophyle. The results show the reinforced xeromorphous structure which is an adaptive attribute under the higher environmental footprint. The higher xeromorphous structure of the plane leaves is clearly seen on Lenin street and 34 – district street with their more intense traffic and higher soil pollution. The correlation analysis defines a wide range of the positive correlations between the anatomical attributes: the thickness of the leaves, the height of the columnar mesophyle and the accumulation of the chemical elements in the leaves – sulfur, lead, a specific amount of heavy metals – (r=0.61…0.94, nup p<0.05, n=400). Thus we can come to the conclusion that positive correlations are responsible for the adaptive changes of the plants and they are likely to maintain the existing sustainability of the oriental plane (*Platan orientalis* L.). The results of the experimental research prove the anatomical sustainability of the oriental plane in the roadside plantations in Hudzhand and are a chain in the formation of the general sustainability of the plants to the anthropogenic environmental factors.

**INTRODUCTION**

Hudzhand is an administrative center of Leninabad oblast’ of the Republic of Tajikistan, the 2nd city in terms of the number of population and the production volume. Solid wastes account for 40% of the hazardous emissions, incl. from mining plants. An increase of the transport means, with some vehicles in use for 10 years, is another source of the pollution.

The green plantations have unique sorption capacity: they absorb from the air and neutralize a great amount of harmful elements contained in the industrial emissions and keep the optimal gas balance in the atmosphere. Thus the evaluation of the plants condition as well as the ecological condition of the city environment based on the examination of the plants properties is considered to be topical.

The characteristics of the assimilative organs in the man-caused medium are used to diagnose the condition of the wooden plants. The assimilative organs, due to their function of the interchange of gases, are the primary barrier for the penetration of the atmospheric toxicants inside the leave [1]. The literary sources state the fact that the chronic impact of the atmospheric toxicants causes serious changes in the anatomical organization of the leaves and fir-needles [2,3].

The purpose of the research is to examine the anatomical properties of the oriental plane (*Platan orientalis* L.), which grows in the roadside plantations in the city of Hudzhand.

*The object and the methods of the investigation:*

The object of the investigation is the wood species – oriental plane Объектом *Platan orientalis* L., often seen in the roadside plantations in the city of Hudzhand. The areas under investigation are along 4 streets of the city characterized by the intense traffic: Lenin street, K. Khudzhandi street, 34-district street and 50-years of the
USSR street. All of them have the belt planting on the sunny side of the road. The soils of the roadside areas accumulate heavy metals such as: Pb, Cu, Zn, Ni, Co, Cr with their contents higher than the sanitary – hygienic standards permit. However, there no high contents of manganese and cobalt [4]. The highest contents are for copper, the lowest for manganese and cobalt. The maximal concentrations of TM (Cr, Zn, Pb, Ni, Mn) are usual for those soils which grow along 34-district street. The checking spot is located on the territory of the botanical garden. The investigation was carried out in July which is characterized by the maximal development and physiological activity of the photosynthetic properties of the wooden species. There were used 10 specimens min. from each area of the middle-aged generative condition.

There leaves were collected from the lower third part of the crown from the south side of the oriental plane (Platan orientalis L.) and was processed in the solution of ethyl spirit. The cross-section was made from the middle part of the leaf which then was put into glycerin. The anatomic and morphological attributes of the leaves were investigated via microscope Aksioskop model ZEISSN HBO103 and N XBO75 (Germany) with the camera adapter and all the necessary software. During the investigation the following attributes were defined: the thickness of the lamina, the thickness and the width of the upper and lower epidermis, the thickness of the cuticle as well as of the columnar and spongy mesophile; the coefficient of the multiple planting capacity was defined through the calculation. Image Tools program was used to determine the areas of the anatomical properties. Statistica 6.0 was used for the statistical processing of the experimental data.

Results:
The results of the investigation show that the oriental plane (Platan orientalis L.) in the roadside plantations has the reinforced xeromorphous structure of the leaves comparing with the control which could be viewed as the adaptive attribute in the conditions of the higher man-caused impact. There are only differences in the level of the alterations in values under examination which depend on the location of the spraying. It was defined that more substantial alternations of the plane were seen on Lenin street (the left side of the city) and in 34-district street (the right side of the city). The leaves of the plant become thicker by 63% comparing with the control, the thickness of the upper and lower epidermis increase by 42%, 71% and 53% per cent respectively and twice as much for the amount of the layers of the columnar mesophile; the thickness of the cuticle and lower epidermis does not increase much – only by 16% and 4% respectively, the value for the multiple planting capacity increases by 6% (table 1, drawing 1). The leaves of the plane which grows along 34-district street have thicker lamina comparing with the control by 55%, the upper epidermis increases by 67%, the thickness of the columnar and spongy mesophile increases by 49% and 22% respectively whereas the value for the multiple planting capacity grows by 11%.

Table 1: Anatomical properties of the structure of the leaves of the plane which grows in the roadside plantations on Khudjand city.

<table>
<thead>
<tr>
<th>Values</th>
<th>Area No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamina thickness, microns</td>
<td></td>
<td>179.8±6.1*</td>
<td>151.6±3.4*</td>
<td>114.1±1.0</td>
<td>171.2±6.2*</td>
<td>110.3±2.7</td>
</tr>
<tr>
<td>Cuticle thickness, microns</td>
<td></td>
<td>4.9±0.2</td>
<td>5.5±0.2*</td>
<td>7.0±0.3*</td>
<td>4.6±0.2</td>
<td>4.4±0.2</td>
</tr>
<tr>
<td>Upper epidermis height, microns</td>
<td></td>
<td>23.5±0.4*</td>
<td>19.1±0.9</td>
<td>20.8±1.0*</td>
<td>27.6±1.0*</td>
<td>16.5±0.5</td>
</tr>
<tr>
<td>Columnar mesophile thickness, microns</td>
<td></td>
<td>7.6±0.15*</td>
<td>5.6±0.07*</td>
<td>4.5±0.26</td>
<td>6.6±0.1</td>
<td>4.4±0.57</td>
</tr>
<tr>
<td>No. of the columnar mesophile layers</td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Spongy mesophile thickness, microns</td>
<td></td>
<td>66.7±0.8*</td>
<td>57.3±1.5*</td>
<td>40.0±2.0</td>
<td>53.4±2.0*</td>
<td>43.6±1.7</td>
</tr>
<tr>
<td>Spongy mesophile No. of layers, microns</td>
<td></td>
<td>3-5</td>
<td>3-5</td>
<td>3-4</td>
<td>3-5</td>
<td>3-4</td>
</tr>
<tr>
<td>Lower epidermis thickness, microns</td>
<td></td>
<td>14±0.7</td>
<td>15±0.6</td>
<td>15±0.2</td>
<td>15±0.8</td>
<td>14.0±0.6</td>
</tr>
<tr>
<td>Multiple planting factor, %</td>
<td></td>
<td>53.28±0.73*</td>
<td>49.43±0.56</td>
<td>53.3±0.47*</td>
<td>55.1±0.34*</td>
<td>50.04±0.32</td>
</tr>
</tbody>
</table>

Notes: 1 – Lenin street, 2 – Khudzhandi street, 3 – 50-years USSR street, 4 – 34-District street, 5 – control, * – shows the actual differences from the control.

Drawing 1: Cross-section of the oriental plane (10×40) (Platan orientalis L.).
Discussion:
There are many works devoted to the impact of the environmental factors on the anatomical and morphological attributes of the wooden species in world literature. The analysis of these works shows the conflicting data on the anatomical and morphological alternations of the plants under the man-caused pollution which is defined by the kind peculiarities of the trees and the level of the man-caused impact. Thus, Bruno Francisco Sant’Anna-Santos et. al. investigated the impact of the acid rains on the structure of the leaf *Genipa americana* L.: there were found necrotic spots on the lamina, the rupture of the cuticle in the necrosis, the cell breakage of epidermis and columnar mesophile, the hypertrophy of the spongy mesophile. M. M. Liezel, G. M. Deemson and P. L. Fideliz define the alternation in the length of *Tithonia diversifolia* leaf (Hemsli) as well as the length of the internodes, thickness and density of the epidermis under the influence of the emissions of the vtransport vehicles in Bagio city. M. Kurteva, M., Katerina and K. Stambolieva, [7] determine the lower linear growth of the current twig and leaves of Acer pseudoplatanus, Acer platanoides and Betula pendula Roth under industrial pollution in Sofia. Elina O Ksanen et al. define the negative impact of ozon and CO$_2$ on the anatomical attributes of the chemical elements in the leaves: the height of the anatomical attributes of the leaves of european birch (Betula pendula Roth.). Higher concentration of ozon and CO$_2$ resulted in the lower thickness of the leaves. The impact of ozon and CO$_2$ resulted in the lower thickness of columnar mesophile. Johanna Riikonen Kevin and E. Percy et. al. prove that under the impact of ozon and CO$_2$ the birch has a smaller size and density of the epidermis cells. A. Kulagin and U. Shagieva notice that there is a general trend for all the species which is the reduction of the assimilating structures and the lowering of the photosynthetic capacity of the leaf with the higher environmental impact of the city [10].

There is a variety of works the authors of which indicate the adaptive alterations in the morphological, anatomical, physical and chemical attributes of the plants under unfavorable environmental factors which allow them to survive [11,12,13,14,15].

In our research the oriental plane (Platan orientalis L.), in the roadside plantations has a wide range of the positive correpations between the anatomical indicators of the leaves (the thickness of the leaf, the height of the spongy mesophile and the height of the columnar mesophile) and the accumulation of the chemical elements in them – sulfur, lead, total concentraton of the heavy metals ($r=0.61...0.94$, under $p<0.05$, $n=400$). IT is should be noted that the positive correlations are responsible for the adaptive alterations of the plants and are likely to promote the sustainability of the plane. The results of the experimental research preliminarily allow us to recommend the oriental plane (Platan orientalis L.) for the wider use in the landscape gardening of the roadside and industrial areas of North Tajikistan.

Conclusion:
The investigation conducted states that the oriental plane (Platan orientalis L.), which grows in the roadside plantations in the city of Khudzhand, has the reinforced xemorphous structure of the leaves. In particular, there is a trend to the higher thickness of the lamina, the cuticle, the upper and lower epidermis, the higher thickness of the columnar and spongy mesophile. There are only differences in the level of the alterations in the attributes under investigation which depend on the sprouting location. The more reinforced xemorphous structure is clearly seen on Lenin street, 34-district street (substantial thickness of the leaves, upper epidermis as well as columnar and spongy mesophile). The soils of the roadside areas have higher contents of sulfur, heavy metals which violate the sanitary – hygienic standards (Pb, Cu, Zn, Ni, Co, Cr). The correlation analysis defines a wide range of the positive correlations between the anatomical indicators of the oriental plane leaves’ (the thickness of the leaf, the height of the spongy mesophile and the height of the columnar mesophile) and between the contents of the chemical elements in the leaves – sulfur, lead, heavy metals ($r=0.61...0.94$, при $p<0.05$, $n=400$). The positive correlations are responsible for adaptive alterations of the plants and are likely to maintain the existing level of the oriental plane’s sustainability. The results of the experimental research confirm the anatomical sustainability of the leaves of the oriental plane (Platan orientalis L.) in the roadside plantations of the city. The oriental plane (Platan orientalis L.) is the important chain in the formation of the overall sustainability of the plants to the man – caused factors of the environment. The results of the experiment have some limitations in recommending of the green spaces arrangement basing on the anatomical attributes of the leaves. It is necessary to continue surveys of the oriental plane’s (Platan orientalis L.) sustainability in the roadside areas of North Tajikistan with taking into account some other aspects of the plants’ life cycle.

REFERENCES
