A COMPARATIVE ANALYSIS OF THE HISTOLOGICAL STRUCTURE OF THE AERIAL ORGANS OF PLANTS GROWN ON STERILE HEAPS AND RESPECTIVELY IN ORDINARY SOIL

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ABSTRACT. The living conditions offered by the sterile heaps are not favourable to the development of plants, especially if the heaps have not been placated with phytosoil. But there are a small number of species showing various degrees of tolerance towards these conditions, and that manage to grow in the respective areas (Gh. Bârlea, 2008).

Keywords: Robinia pseudacacia L., Centaurea cyanus L., Polygonum cuspidatum Sieb. et Zucc. (Reynoutria japonica Houtt.), sterile heaps, petiole, stem, aerial stem

INTRODUCTION
Our paper is going to make a comparison between the microscopic structure of certain aerial organs of plants that grew on the sterile heaps in Sasar and witness plants that grew in ordinary farming soil.

MATERIALS AND METHODS
Materials consist in: petiole of Robinia pseudacacia L. prevailed from a plant that grew in normal soil, and another plant that grew on sterile soil (from the heap in Sasar), a stem of Centaurea cyanus L. prevailed from a plant that grew in normal soil and a plant that grew on sterile soil (from the Sasar heap), an aerial stem of Polygonum cuspidatum Sieb. et Zucc. (Reynoutria japonica Houtt.), prevailed from a plant that grew in normal soil and from a plant that grew on sterile soil (from the Sasar heap), methyl red dye, optic microscope.

Methods consists in identifying the differences between the histological structure of the plants that grew on the sterile heaps (devoid of soil), as compared to the ones that grew in ordinary farming soil. In order to do this we have cut cross-sections of the aerial organs that were then dyed in red with methyl, and have taken comparative photos on the optic microscope, at first with a small lens (4X), then with a more powerful one (10X or 40X), in order to highlight the inner tissues. The witness-plants had been picked from farming areas not far from the Sasar sterile heap, but on the other shore of the river with the same name, so as not to be susceptible of the same kind of pollution. The identification of the species was done in accordance with „Flora ilustrată a României” (Ciocârlan V., 2000) and, “A Magyar flora kepekben” (Javorka and Csadody, 1968). These species had been decided on bearing in mind the fact that they can be found in large numbers in the Baia-Mare Depression and on sterile heaps.

RESULTS AND DISCUSSIONS
On analysing the microscopic samples of fresh plants we were able to conclude that differences exist between the plants that grow in ordinary farming soil and the plants from sterile heaps. These differences were analysed under the microscope and will be presented in the microscopic pictures that follow:

1. Petiole of Robinia pseudacacia L.
By comparison we can observe that:
- With the plant that grew on the sterile heap the cuticle is thicker which shows a tendency of self-defence against the polluting agents, especially the dust that goes up from the substratum, and then sets down on the leaves and the petioles (Fig.5).
- With the plant that grew on the sterile heap the outer bark is thicker (3 layers) also as a form of self-defence against the pernicious facts from the outside, whereas with the plant that grew in normal soil, and which does not need these alterations, the outer bark is thinner (2-3 layers).
- With the plant that grew on the sterile heap the inner bark is thinner (2-3 layers of cells) compared to the plant that grew in normal soil (with which the inner bark has 3-4 layers of cells), which shows a poorer growth on the polluting sub-stratum.
- No essential alterations can be observed in the structure of the strengthening tissue in the plant that grew on the sterile heap, the tissue contains 3-4 layers that contain rare cells with chloroplasts that come from the bark.
- With the plant that grew on the sterile heap, most of the ligule is metaphloem, except that with the plant that grew in normal soil the ligule ring is larger, as the metaphloem occupies most of the space.

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- With the plant that grew on the sterile heap, the ligule is not so well developed, probably because of the pollutant agents that hinder the normal growth of the tissues.

- With the plant that grew on the sterile heap there are no substantial alterations of the medulla and the cambium, which look normal both in the plant that grew on the sterile heap and the one that grew in normal soil.
normal soil, although the sclerenchyma, the collenchyma, and the liber tissue seem less developed.

2. A stem of Centaurea cyanus L.

The Centaurea genus is well represented on the sterile heaps, especially on the one from Sasar, not so much in the number of species, but mainly in the number of plants and the area on which they grow. This is the reason why I have decided to have microscopic samples of the stem, and to compare them with plants that grow in normal soil. Thus, one can observe that the plants from this species as well as other species that grow on the sterile, show a higher degree of weathering and ageing than the plants that grow in normal soil. Thus, at the level of the stem we can observe in the cross-section that:

- With the plant that grew on the sterile heap the epiderm is badly exfoliated compared to the plant from the normal soil, which shows a higher degree of weathering, a thing which can be seen with the naked eye through macroscopic analysis. This exfoliation may be due to the anorganic dust which causes the dehydration of the cells leading to the detaching of some of them and thus creating flaws.

- With the plant that grew on the sterile heap the outer bark is also more exfoliated than with the one that grew in normal soil (which also has 3-4 layers of cells), thus continuing the process started in the epiderm.

- With the plant that grew on the sterile heap the inner bark shows no flaws, but shows a slight tendency towards growing thinner (2-3 layers) compared to the plant that grew in normal soil (3-4 layers) most probably as a manifestation of the lack of the nourishing substances that the sterile soil has not been able to offer.

- With the plant that grew on the sterile heap the medullary rays are narrower compared to the plant that grew in normal farming soil with which the rays are normal up to the bark.

- With the plant that grew on the sterile heap the ligule (which contains more metaxylem) and the liber tissue seem less developed.

3. Aerial stem of Polygonum cuspidatum Sieb. et Zucc. (Reynoutria japonica Houtt.).

The aerial stem of Polygonum cuspidatum Sieb. et Zucc. (Reynoutria japonica Houtt.) is at least similar at the plant from the sterile soil to the plant grown in normal soil. Thus:

- With the plant that grew on the sterile heap the medulla is normal, but has smaller cells than the witness plant.

4. Aerial stem of Reynoutria japonica Houtt. (Polygonum cuspidatum Sieb. et Zucc.)

With the plant that grew on the sterile heap the medulla is normal, but has smaller cells than the witness plant.

5. Aerial stem of Centaurea cyanus L.

With the plant that grew on the sterile heap the medulla has somewhat smaller cells than the normal plant, but no major differences are evident, except that the cells are larger at the exterior and having more amyloplasts.
Fig. 7 Cross-section in a stem of *Centaurea cyanus* L., a plant that grew on sterile soil, x 10

Fig. 8 Cross-section in a stem of *Centaurea cyanus* L., a plant that grew in normal soil. Detail, x 40

Fig. 9 Cross section in aerial stem of *Polygonum cuspidatum* Sieb. et Zucc. (*Reynoutria japonica* Houtt.). A plant that grew in normal soil, x 10

Fig. 10 Cross section in aerial stem of *Polygonum cuspidatum* Sieb. et Zucc. (*Reynoutria japonica* Houtt.). Plant grown in normal soil, x 10

Fig. 11 Cross section in aerial stem of *Polygonum cuspidatum* Sieb. et Zucc. (*Reynoutria japonica* Houtt.). Plant grown in normal soil, x 10

Fig. 12 Cross section in aerial stem of *Polygonum cuspidatum* Sieb. et Zucc. (*Reynoutria japonica* Houtt.). Plant grown on sterile soil x 10
These are the main reasons why all the sterile heaps, at least in the Bia-Mare Depression have *Robinia pseudacacia* L., as main arboriculous fixing element. Even though on smaller areas can be seen *Populus alba* L., *Populus nigra* L., *Populus tremula* L., *Quercus petraea* (Mattuschka) Liebl., *Quercus robur* L., and even *Cassiea sativa* Miller (*Cassiea vesca* Gärtn.), the acacia remains by far the most widespread, and the most constant plant on the sterile heaps.

To conclude with, *Robinia pseudacacia* L. is a species which, even though on the sterile heaps has a growth which is hindered, as compared to normal, this plant easily adapts itself to settle and regenerate the soil on the sterile heaps, the histological alterations being insignificant for the development of the plants.

2. The *Centaurea* genus is well-represented on the sterile heaps (especially on the one in Săsar), but has a low degree of coverage due to the rare distribution of the plants. *Centaurea cyanus* L. is a species which, as we have shown above is not greatly affected by the sterile substratum, but then, it can neither be considered essential for the forming of soil directly on the sterile, at least because of its reduced density. However, after a previous placating of the heaps with phytosol in a thin layer, *Centaurea cyanus* L. might help a lot to cut down on the cost of ecologising, as it is a true settler of soil, at least till the natural development of other species of plants.

3. Out all the species dealt with in this paper, *Polygonum cuspidatum* Sieb. et Zucc. (*Reynoutria japonica* Houtt.) is the one that is least affected by what kind of sterile substratum it grows on, and this is why it may be considered as a pioneer of vegetal expansion on the sterile heaps, and mainly in the farming fields in the area. Although the species is recognised as being spread at the level of Romania mainly in Maramures (V. Cioacărlan, 2000), it grows on the sands in the north-west of the country (G. Ardelean, C. Karácsonyi, 2005), up to the Ieru valley (G. Ardelean, C. Karácsonyi, 2002), but cannot be found south of the Bihor County (A. Ardelean, 2006). This plant was initially cultivated to be eaten and as ornament, but it spread and grew wild, covering larger and larger expanses of land, without the intervention of man, who tried then to reduce its expansion because it was threatening the cultivated plants. *Polygonum cuspidatum* Sieb. et Zucc. (*Reynoutria japonica* Houtt.) can be grown either after rooting, or directly as cuttings, even in sterile substratum, but, if only a very thin layer of soil is used, through its rich network of roots, it fixes the soil very well, and the rich foliage consistently contributes to the generating of new soil. Taking into account everything we have stated above, we can conclude that *Polygonum cuspidatum* Sieb. et Zucc. (*Reynoutria japonica* Houtt.) is a species that might become one of the biological materials that can be used for settling and ecologising the sterile heaps.
REFERENCES
Bârlea Gh., 2008, A study on barren gangues in the Baia Mare Depression, “V. Goldiș” University Press Arad.
Ciocârlan V., 2000, Flora ilustrată a României, Editura Ceres.
Nădișan I., 1979, Implicațiile poluării asupra vegetației din zona Municipiului Baia Mare, Baia Mare.