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CUPRINS

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THE INFLUENCE OF SOME FERTILIZERS AND BIOSTIMULANTS UPON THE STEM ANATOMY OF *CHRYSANTHEMUM INDICUM* L. (Ist NOTE)

TĂNĂSESCU (FLORIA) VIOLETA[1], DRAGHIA LUCIA[2], STĂNESCU IRINA[1]

Abstract. The results presented in this paper belong to the project "Elaborarea de soluţii şi tehnici de cultură neconvenţionale şi nepoluante la plantele ornamentale, în contextul dezvoltării durabile – The elaboration of unconventional and unpollutant solutions and culture techniques, in stable usage context" and is focused on the identification of structural modifications of *Chrysanthemum indicum* L. stem, as a consequence of treating plants with 3 types of foliar fertilizers and biostimulants (Maxiroot, Dacmarinur Maxi N, Aurora) in 3 variants of concentrations (0.2%, 0.4%, 0.6%). The cross sections through the stem indicate a variable diameter, depending on the concentration and the applied product. The modifications appeared in the sclerification and lignification degree, development of the pith, cortex, conductive and mechanic tissues. The study recommends the usage of unpollutant foliar fertilizers and biostimulants based on plant extract, in order to develop the elements which increase plant resistance in sustaining the inflorescence, favoring their utilitarian (economic) aspects of maintaining "cut flowers".

Key words: anatomic modifications, stem, *Chrysanthemum indicum*, fertilizers, biostimulants

Introduction

The culture of *Chrysanthemum indicum* L. in Romania is one of the most important flower sources, from economic point of view, facilitating the enlargement and enrichment of floral assortment during the year [VIDRAŞCU & MITITIUC, 2001; VIDRAŞCU & al., 1986; VIDRAŞCU & al., 1985]. *Chrysanthemum indicum* is one of the parental species of the cultivars which are nowadays in culture. The big interest manifested by the lovers of flowers for the culture of chrysanthemums is explained by their decorative qualities and their possibilities of long term usage [VIDRAŞCU & MITITIUC, 2001; VIDRAŞCU & al., 1986]. The results presented in this paper belong to the project "Elaborarea de soluţii şi tehnici de cultură neconvenţionale şi nepoluante la plantele ornamentale, în contextul dezvoltării durabile – The elaboration of unconventional and unpollutant solutions and culture techniques, in stable usage context" and is focused on testing the action of some fertilizers and biostimulants with unpollutant properties which may upgrade the classic culture technology that determine plant growing and development, including the increment of the decorative aspect [BIREESCU & al., 2002; DORNEANU & al., 2001; GAVRILUŢĂ & al., 2005].

The literature shows that in Romania *Chrysanthemum indicum* was taken into a special anatomic study [NIŢĂ & al., 2001] that is why in the present paper our interest is focused on the anatomic modifications appeared after the treatment with some fertilizers and biostimulants, in various concentrations, with the purpose of recommending their usage in culture technologies, in order to obtain plants of higher quality. The identification of the impact made by the above products could be explained by analyzing the anatomic

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modifications appeared in the stem (first note), knowing that the resistance of the inflorescence on the plants, as well as plant resistance to fall depends on the development and thickness of the stem tissues [TOMA, 1975, 1977; TOMA & al., 1985; TOMA & GOSTIN, 2000].

Material and methods

The experimental cultures have been initiated at the University of Agricultural Sciences and Veterinary Medicine of Iasi, and have been ordered in randomized blocks, with three repetitions. Four foliar treatments have been applied, at 10 days intervals, on various variants (V_1 – 0.2%, V_2 – 0.4%, V_3 – 0.6%), using the following products: Maxiroot, Dacmarinur Maxi N and Aurora. Maxiroot is a foliar fertilizer with biostimulating effect: N – 2%, K – 4%, Zn – 0.3%, Fe – 0.3%, organic material – 30%, free amino acids (tryptophan, arginine) – 3%, proteins, vitamins. Dacmarinur Maxi N is an ecologic foliar fertilizer from marine algae (*Ascophyllum nodosum*): N – 216 g/l, K – 96 g/l, P – 38 g/l, cytochinons – 7.5 mg/l, auxines – 11 mg/l, amino acids, vitamins, proteins. Aurora is a Romanian natural extract from plants, with biostimulant effect and contains N – 10%, K – 3.5%, P – 0.5%, B, Ca, Cu, Fe, Mg, Zn – 2% each of them, enzymes, amino acids, vitamins.

The stems have been preserved in ethylic alcohol 70% and cross sectioned at middle level. The sections were coloured with iodine green and carmine red and mounted in gel. The histological cuttings were analyzed in a Novex (Holland) microscope and photographed by means of a Sony DSC-W5/W7/W15/W17 photo camera.

Results and discussions

Maxiroot 0.2% (V_1). Young stem. The shape of the cross section is circular-ribbed, with rounded ribs. Epidermis bear tangentially elongated cells, having thickened external and internal walls (Pl. I: Fig. 4); the external wall is covered by a thin cuticle. Here and there, stomata are present, situated above the epidermic cells, as well as multicellular one-layered protective hairs and secretory trichomes.

The cortex is quite thin (5-6 layers of cells); the first subepidermic layer and the layers which belong to the ribs have the walls of the cells thickened that the rest. The cortex ends in a primary endodermis with small and ordered cells.

The vascular tissues form numerous phloemic-xylemic bundles of collaterally-opened type (Pl. I: Fig. 4), separated by weak lignified and sclerified medullary rays; there is an alternation between small and big bundles. The phloem forms a thin region of sieved tubes, guard cells and a few parenchyma cells. The xylem bears vessels separated by libriform at the external part and cellulosed parenchyma at the internal part. At the periphery of the phloem there is a sheath of mechanic fibers, with wide lumina and moderately thickened walls (Pl. I: Fig. 4).

The pith is thick, parenchymatous, with a lignificated perimedullar region.

Maxiroot 0.2% (V_1). Mature stem. The shape of the cross section is circular-ribbed, with wider ribs (Pl. I: Fig. 1). The diameter of the stem is twice bigger. The structure is of fascicular type. The epidermis bears cells with thickened external and internal walls; the cuticle is thin; stomata are situated above the epidermial cells, the protective hairs and the secretory trichomes are multicellular and one-layered.

The cortex is thin (5-6 layers) (Pl. I: Fig. 10), collemchymatised in subepidermic position, in the ribs.

In comparison with the anterior structure, there is a development of the mechanic tissue (Pl. I: Fig. 10) as well as of the xylemic conductive tissue, from both qualitative and quantitative point of view. The conductive tissues form phloemis-xylemic vascular bundles of medium dimensions, separated by sclerified and lignified multi-layered medullar rays (Pl. I: Fig. 1). The bundles bear cordons of sclerenchymatic fibers at the internal face of the primary xylem and, especially, at the external face of the phloem.

The pith has a big contribution in enlarging the diameter of the stem; it is cellulosed in the internal part and lignified in the external (perimedullar) region (Pl. I: Fig. 7).

Maxiroot 0.4% (V_2). In the following variants we will present only the modifications induced by the variants in work. This time the fascicular type structure has a similar aspect, with the following differences:

- the cortex bears more layers (6-7) (Pl. I: Fig. 2);
- the vascular tissue passes to the annular type, because of the sclerification and lignification of interfascicular medullar rays; the shape of the ring is sinuous, as well as of the cambial tissue which had produced it (Pl. I: Fig. 2);
- the biggest bundles have a thick sheath of sclerenchymatic fibers at their external part, with thicker wall than in V_1 (Pl. I: Fig. 11);
- the pith is thick, parenchymatous, with lignificated perimedullary region (Pl. I: Fig. 6).

Maxiroot 0.6% (V_3). Young stem. The fascicular structure shows the following differences:

V_3 variant indicates the activity of cellular division stimulation, because the diameter of the stem is bigger. The epidermis bears tangentially elongated cells with weaker thickened external and internal walls than in the young stem V_1 (Pl. I: Fig. 5).

The cortex, although well represented (7-8 layers) has a reduced collenchymatic region, visible only in the ribs, where the walls of the cells are weak thickened (Pl. I: Fig. 5). Between the xylem vessels, at their internal pole, numerous cells of cellulosed parenchyma and libriform with thin walls are displayed, while cordons of periphloemic sclerenchyma, although well represented, bear cells with thinner walls than in V_2. The division activity of the cambium is stimulated in this variant (Pl. I: Figs. 5 and 12); at the internal pole, the formation of numerous xylemic rays is in progress. The pith, although better represented than in V_2, is parenchymatous and lignificated only at the external part.

In the mature stem, the cross section has a circular irregular-ribbed profile (Pl. I: Fig. 3), but the ribs are less evident. By the hypodermic cortical layer, phellogen differentiates and produces 2-3 continuous layers of cork which will substitute the epidermis (Pl. I: Fig. 13). The collenchymatic region of the cortex is reduced to 1-3 layers in the ribs and in their lateral parts.

The conductive tissue passes to the annular type due to the sclerification and lignification of the medullar rays, weaker than in the anterior variant (mature stem) (Pl. I: Fig. 12).

Only in the ribs, where the vascular bundles were well developed, there is a thick cordon of mechanic fibers, with moderately thickened walls (Pl. I: Fig. 9).

The pith is thick, parenchymatous, with weak lignified perimedullar region; in the central part, the pith disorganizes itself (Pl. I: Fig. 8).

The blank sample. Although the structure of the species is well known in the specialty literature [METCALFE & CHALK, 1950], for a better understanding of the histological changes, we present only the image with the cross section through the stem, without interpretation, because the structure is similar to that of V_1 from Aurora product. The images are attached to confirm the similarity (Pl. III: Fig. 47-53).

Aurora 0.2% (V_1). The cross section has an elliptic-ribbed profile (Pl. I: Fig. 14).

The epidermis presents cells with external and internal walls thicker than the others (Pl. I: Figs. 14 and 17); the external wall is covered by a thick cellulosed cuticle, which forms a characteristic relief in the ribs. The epidermis shows protective hairs and secretory trichomes, in small number (Pl. I: Fig. 17), while stomata are situated at the same level with the epidermic cells and form a narrow substomatic chamber.

The cortex is thin (6-7 layers) and differentiated into cordons of annular collenchyma, well developed in the ribs, and assimilatory parenchyma in the rest; the most internal layer is a primary endodermis.

The vascular tissues form phloemic-xylemic bundles of collaterally-opened type (Pl. II: Figs. 24 and 29), separated by wide medullar rays, bearing cells with moderately sclerified and lignified walls. The biggest bundles present, at the external part of the phloem, a sheath of sclerenchymatic fibers with weak to moderately-thickened walls and wide lumina. The pith is thick, parenchymatous-cellulosed, formed by very big cells.

The mature stem has a circular-elliptic profile in cross section. The structure is similar to the anterior one, but with a better development of the sustaining tissues (Pl. I: Figs. 21, 25), by getting thickened cellular walls; the effect of these modifications could be seen in the pith which has a wider diameter and it is disorganized. There is an interesting aspect in this variant: in Aurora 0.2% the subepidermic phellogen appears early, especially in the ribs. It forms 1-2 layers of cork at the external part and phellodermis at the internal part.

A primary endodermis is present.

The vascular tissues form big phloemic-xylemic bundles separated by sclerified and lignified multilayered medulary rays (Pl. I: Fig. 14). The bundles have a secondary structure, presenting at the internal face of the primary xylem and especially at the external face of the phloem cordons of sclerenchymatic fibers (Pl. II: Fig. 21). Phloem consists of sieved tubes, guard cells and less parenchyma cells. The primary xylem has perimedullar position, while the secondary xylem is situated near the phloem; the vessels are separated by libriform in the last one (Pl. II: Figs. 28 and 30).

The pith is parenchymatous cellulosed, with tendencies of perimedullary lignifications (Pl. I: Fig. 14; Pl. II: Fig. 20).

Aurora 0.4% (V_2). The cross section of the stem has a circular-ribbed profile, with small ribs (Pl. I: Figs. 15 and 18). V_2 indicates a stimulating activity of the cellular divisions and, as a consequence, an increment in the diameter of the stem (Pl. I: Fig. 15). The cortex consists of 8-10 layers of small cells; it is differentiated into angular collenchyma (Pl. II: Figs. 26 and 27) in the ribs and a parenchymatic region which ends in a primary endodermis (Pl. I: Fig. 18). Although the cellular division is stimulated, the mechanic elements develop normally, being better represented than in V_1.

The vascular tissues form numerous bundles of collaterally-opened type, of bigger dimensions than in the anterior variant (Pl. I: Fig. 18), separated by wide medullar rays formed by cells with moderately sclerified and lignified walls. The xylemic vessels are irregularly disposed, in rows (Pl. II: Fig. 31).

The periphloemic sclerenchyma (Pl. II: Fig. 22) is well developed especially near the biggest vascular bundles (Pl. I: Figs. 15 and 18), while the pith is parenchymatous cellulosed (Pl. I: Fig. 18) with big cells in the central part and smaller near the xylem, where a few thickening tendencies could be observed.

Aurora 0.6% (V_3). The cross section through the stem has circular-ribbed profile (Pl. I: Fig. 16; Pl. II: Fig. 19). The phellogen is differenciated in hypodermic position and generates 2-3 layers of cork at the external part and phelloderm at the internal part (Pl. II: Fig. 32). The cork has various dimensions in the stem circumference.

The cortex consists of 4-5 layers of cells with cellulosed walls (Pl. II: Fig. 19).

The conductive tissues form 2 concentric rings (Pl. II: Fig. 19), with quite similar width, one of them is the phloem, situated at the external part and the other is the xylem, at the internal part, bearing big quantities of libriform. Only near the biggest vascular bundles, thick cordons of sclerenchymatic fibers are present, with big lumina and thick walls (Pl. II: Fig. 23).

The pith is thick, parenchymatous, meatous type, bearing big cells.

Dacmarinur 0.2% (V_1). The cross section through the stem has a circular elliptic-ribbed shape, with 4 prominent ribs (Pl. II: Fig. 33).

The epidermis consists of cells with thickened external and internal walls (Pl. III: Fig. 42), the external one being covered by thin cuticle. The cortex is thin and consists of 4-5 layers of cells (Pl. II: Fig. 33); collenchymatous in the ribs and parenchymatous-assimilatory in the rest; the collenchyma of the ribs is quite weak represented (Pl. III: Fig. 42). The endodermis is present (Pl. III: Fig. 39).

The conductive tissues form numerous vascular bundles of collaterally-opened type, the biggest bundles alternate with the smallest ones (Pl. II: Fig. 33; Pl. III: 43), the first mentioned have a cordon of mechanic fibers with thin walls (Pl. III: Fig. 39), with the process of lignification in progress and wide lumina. The vascular bundles are separated by wide parenchymatic medullar rays. The phloem consists of sieved tubes, guard cells and a few parenchymatic cells, while the xylem consists of vessels disorderly disposed, separated by cellulosed parenchyma; only near the phloem, between the xylem vessels, a few libriform elements could be observed, with thin walls (Pl. III: Fig. 43). The pith is thick and cellulosed.

Dacmarinur 0.4% (V_2). The cross section through the stem has a circular-ribbed shape (Pl. II: Fig. 34). The phellogen is differentiated in hypodermic position and forms 1-2 layers of cork at the external part and phelloderm at the internal one (Pl. III: Fig. 46).

The cortex consists of 7-9 layers of cells (Pl. II: Fig. 36).

The conductive tissues (Pl. II: Figs. 34 and 36) form big vascular bundles, separated by multi-layered sclerified and lignified medullar rays (Pl. II: Fig. 36; Pl. III: 44). The bundles present secondary structure, bearing at both the internal face of the primary xylem and, especially, at the external face of the phloem seaths of sclerenchymatic fibers with thick walls and narrow lumina. The phloem consists of sieved tubes, guard cells and a few phloemic parenchyma, while the xylem consists of vessels disorderly disposed in the fundamental libriform and lignified xylemic parenchyma (Pl. III: Fig. 40).

The pith is thick; the cells from the center are in disorganizing process, ending in aeriferous cavity; the cells near the xylem (perimedullar region) lignify their walls (Pl. III: Fig. 38).

Dacmarinur 0.6% (V_3). The cross section through the stem has a circular-ribbed shape, bearing attenuated ribs (Pl. II: Fig. 35).

The phellogen is differentiated in subepidermic position and forms 1-2 layers of cork at the external part and phelloderm at the internal one (Pl. III: Figs. 37 and 45).

The cortex has smaller dimensions in comparison with the anterior variant (5-6 layers of cells); it ends in a primary endodermis (Pl. III: Figs. 37 and 45).

The conductive tissue is somehow developed at a level between V_1 and V_2 (Pl. II: Fig. 35). The bundles are separated by wide multi-layered, sclerified and lignified medullar rays (Pl. III: Fig. 37). The components of the xylem and phloem are similar as in the anterior variants, with the difference that in V_3 the cordons of periphloemic sclerenchyma are less numerous, only in the ribs; they have moderately thickened walls and wide lumina (Pl. III: Fig. 41).

The same tendencies of disorganization appear in the central part of the pith, as in the anterior variant (V_2).

PLATE I

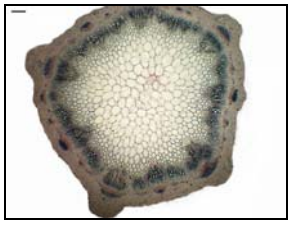


Fig. 1

Fig. 2

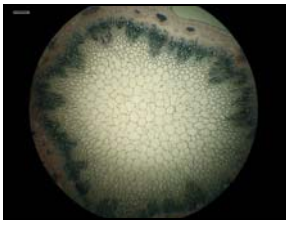


Fig. 3

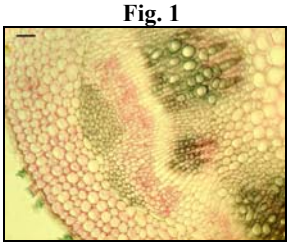


Fig. 4

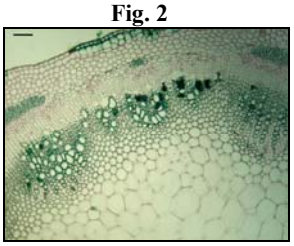


Fig. 5

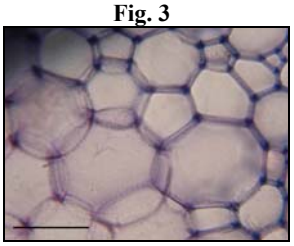


Fig. 6

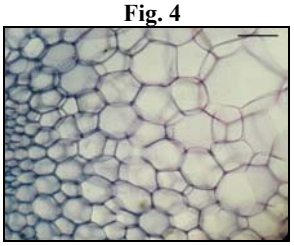


Fig. 7

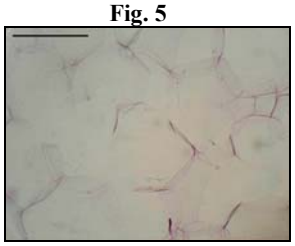


Fig. 8

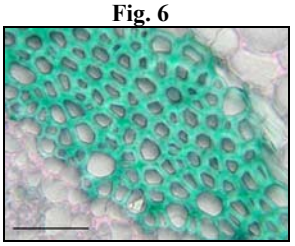


Fig. 9

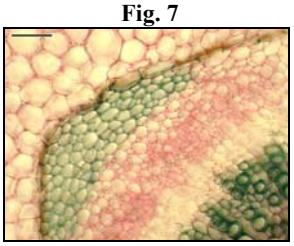


Fig. 10

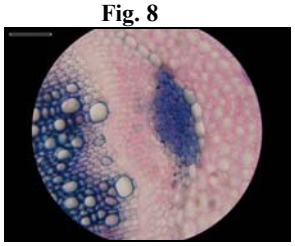


Fig. 11

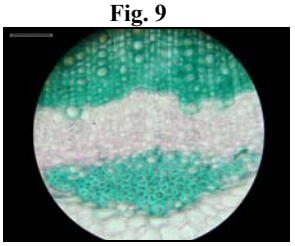


Fig. 12

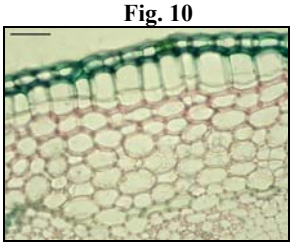


Fig. 13

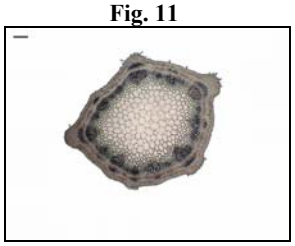


Fig. 14

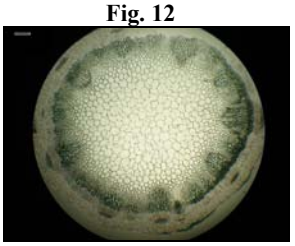


Fig. 15

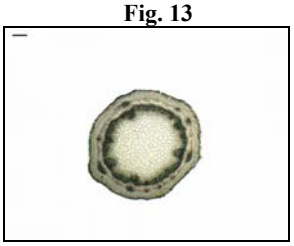


Fig. 16

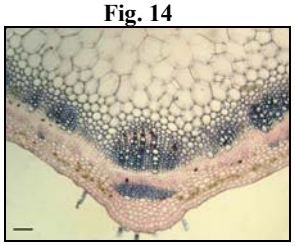


Fig. 17

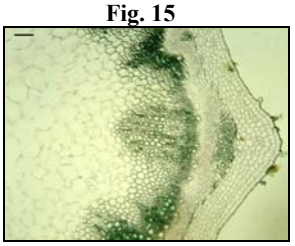


Fig. 18

PLATE II

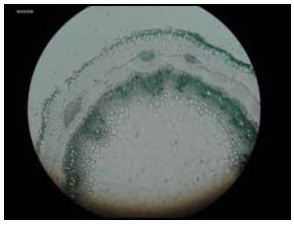


Fig. 19

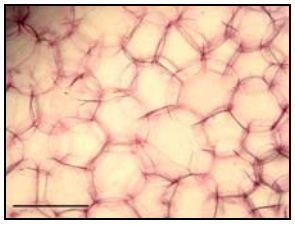


Fig. 20

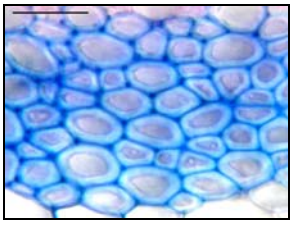


Fig. 21

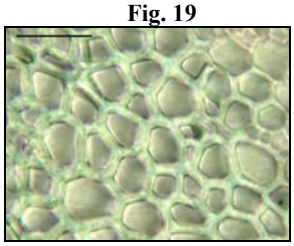


Fig. 22

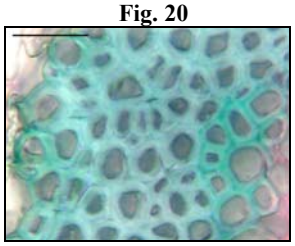


Fig. 23

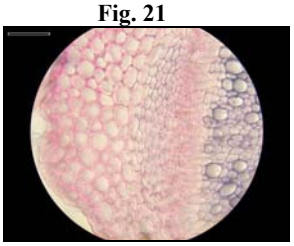


Fig. 24

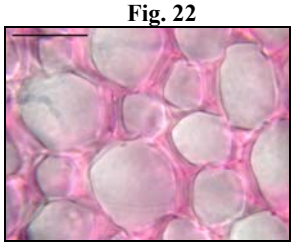


Fig. 25

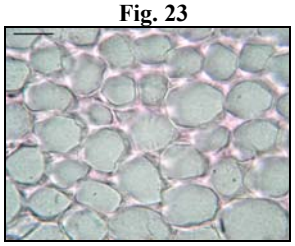


Fig. 26

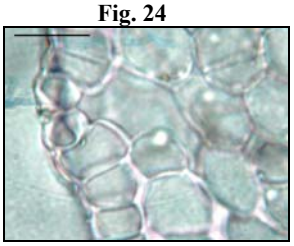


Fig. 27

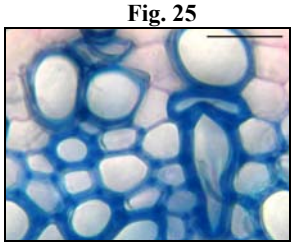


Fig. 28

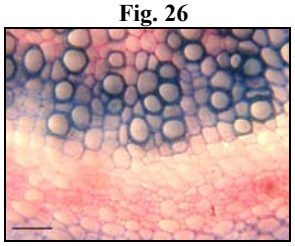


Fig. 29

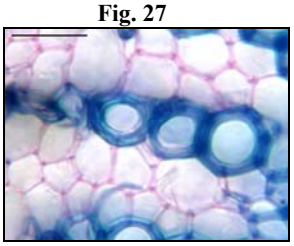


Fig. 30

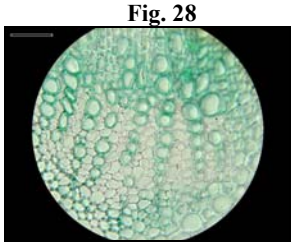


Fig. 31

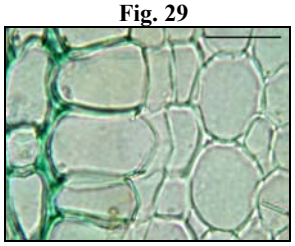


Fig. 32

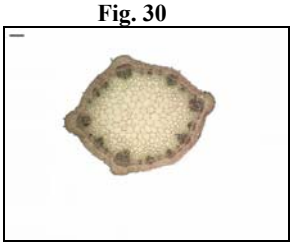


Fig. 33

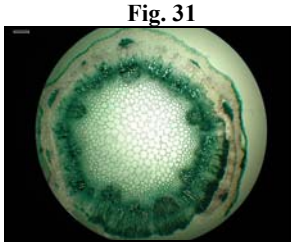


Fig. 34

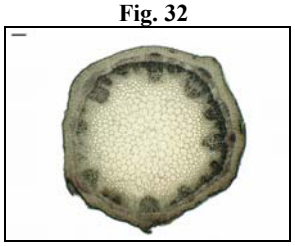


Fig. 35

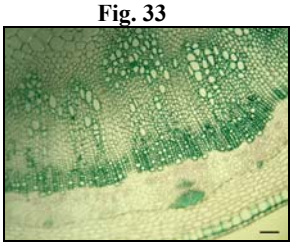


Fig. 36

PLATE III

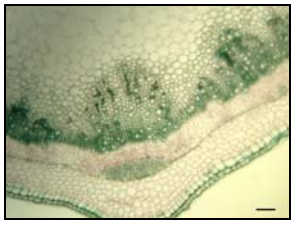


Fig. 37

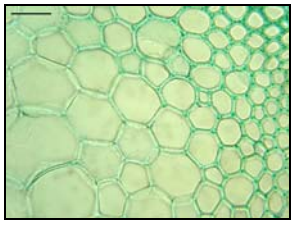


Fig. 38

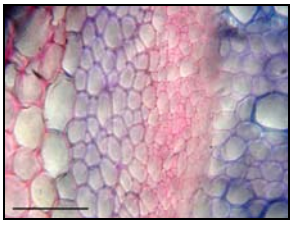


Fig. 39

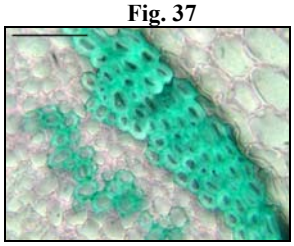


Fig. 40

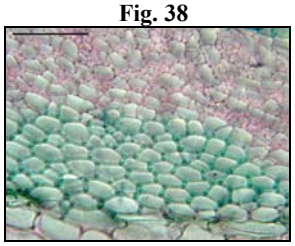


Fig. 41

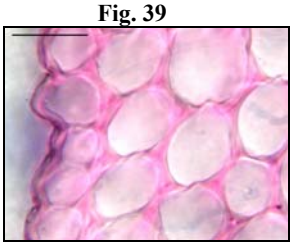


Fig. 42

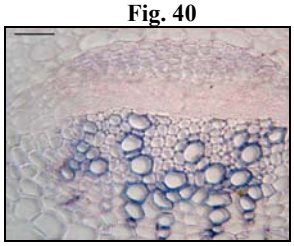


Fig. 43

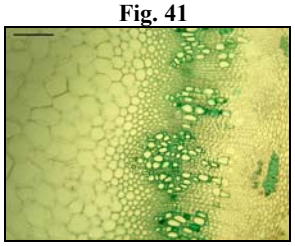


Fig. 44

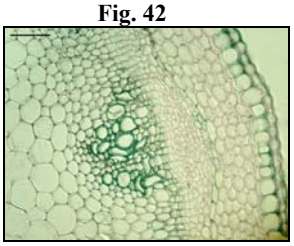


Fig. 45

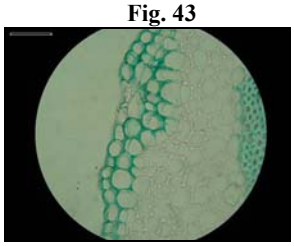


Fig. 46

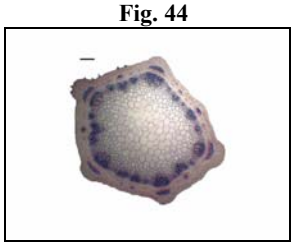


Fig. 47

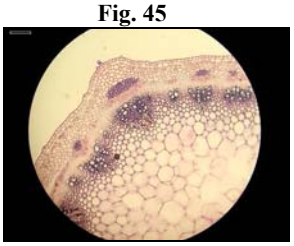


Fig. 48

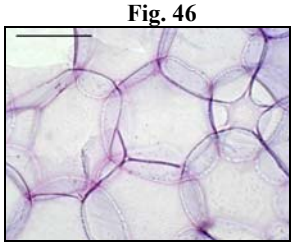
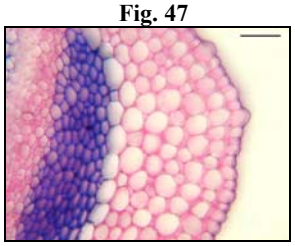


Fig. 49



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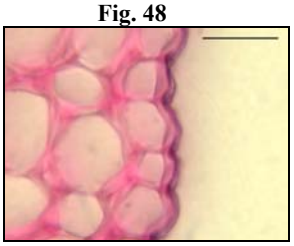

Fig. 51

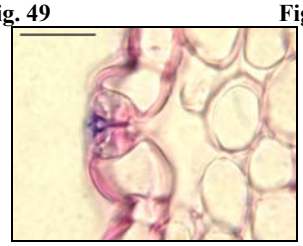

Fig. 52

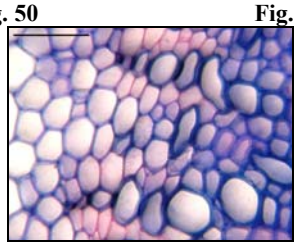

Fig. 53

Conclusions

In the plants treated with Maxiroot 0.2% there is a weak increment of the stem diameter, while the sclerification and lignification is advanced in comparison with the blank sample. In the plants treated with Maxiroot 0.4%, a strong development of the conductive tissue, from both qualitative and quantitative point of view, is displayed; the periphloemic sclerenchyma is more developed in comparison with the above variant. In V_3, although the diameter of the stem is the biggest, the collenchymatisation, sclerification and lignification of the tissues are weaker than in V_2. The comparative analysis of the young and mature stems in V_3 indicates an intensification of the cellular divisions which guides to an increment of the diameter. Due to some disruptions observed in the tissues, especially in the pith, we do not recommend the usage of V_3.

In the plants treated with Aurora, V_2 is superior to the others variants, V_1 and V_3. At 0.2%, although the structure is similar to that of the blank sample (the stem has a narrow diameter), the mechanic elements are well developed. Aurora can be successfully applied in all variants, although we recommend the variant 0.4%.

In the plants treated with Dacmarinur, in 0.4%, the diameter of the stem is big; this is a positive reaction because the tissues are well developed, while the cellular walls are thickened; the effect of the concentration 0.6% is also positive.

For all products, the modifications appeared in V_2 were insignificant in comparison with the blank sample, but also in a comparison between various products; in the other variants an activation of the cellular divisions is initiated. In Dacmarinur Max. N there is a strong stimulation in comparison with the other products.

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Explanation of plates

PLATE I. Details of the structure of the stems belonging to the plants treated with Maxiroot, in various concentrations (Figs. 1-13). Details of the structure of the stems belonging to the plants treated with Aurora, in various concentrations (Figs. 14-18):
Fig. 1. Maxiroot V_1
Fig. 2. Maxiroot V_2
Fig. 3. Maxiroot V_3
Fig. 4. Maxiroot V_1
Fig. 5. Maxiroot V_3
Fig. 6. Maxiroot V_2
Fig. 7. Maxiroot V_1
Fig. 8. Maxiroot V_3
Fig. 9. Maxiroot V_3
Fig. 10. Maxiroot V_1
Fig. 11. Maxiroot V_2
Fig. 12. Maxiroot V_3
Fig. 13. Maxiroot V_3
Fig. 14. Aurora V_1
Fig. 15. Aurora V_2
Fig. 16. Aurora V_3
Fig. 17. Aurora V_1
Fig. 18. Aurora V_2

PLATE II. Details of the structure of the stems belonging to the plants treated with Aurora, in various concentrations (Figs. 19-32). Details of the structure of the stems belonging to the plants treated with Dacmarinur, in various concentrations (Figs. 33-36):
Fig. 19. Aurora V_3
Fig. 20. Aurora V_1
Fig. 21. Aurora V_1
Fig. 22. Aurora V_2
Fig. 23. Aurora V_3
Fig. 24. Aurora V_1
Fig. 25. Aurora V_1
Fig. 26. Aurora V_2
Fig. 27. Aurora V_2
Fig. 28. Aurora V_1
Fig. 29. Aurora V_1
Fig. 30. Aurora V_1
Fig. 31. Aurora V_2
Fig. 32. Aurora V_3
Fig. 33. Dacmarinur V_1
Fig. 34. Dacmarinur V_2
Fig. 35. Dacmarinur V_3
Fig. 36. Dacmarinur V_2

PLATE III. Details of the structure of the stems belonging to the plants treated with Dacmarinur, in various concentrations (Figs. 37-46). Details of the structure of the stems belonging to the blank samples (Figs. 47-53):
Fig. 37. Dacmarinur V_3
Fig. 38. Dacmarinur V_2
Fig. 39. Dacmarinur V_1
Fig. 40. Dacmarinur V_2
Fig. 41. Dacmarinur V_3
Fig. 42. Dacmarinur V_1
Fig. 43. Dacmarinur V_1
Fig. 44. Dacmarinur V_2
Fig. 45. Dacmarinur V_3
Fig. 46. Dacmarinur V_2
Fig. 47. Blank sample
Fig. 48. Blank sample
Fig. 49. Blank sample
Fig. 50. Blank sample
Fig. 51. Blank sample
Fig. 52. Blank sample
Fig. 53. Blank sample

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THE INFLUENCE OF SOME FERTILIZERS AND BIOSTIMULANTS UPON THE ANATOMY OF THE FOLIAR LIMB OF *CHRYSANTHEMUM INDICUM* L. (IInd NOTE)

TĂNĂSESCU (FLORIA) VIOLETA[1], STĂNESCU IRINA[1]

Abstract. The results presented in this paper belong to the project "Elaborarea de soluţii şi tehnici de cultură neconvenţionale şi nepoluante la plantele ornamentale, în contextul dezvoltării durabile – The elaboration of unconventional and unpollutant solutions and culture techniques, in stable usage context" and presents the testing of three fertilizers and biostimulants (Maxiroot, Dacmarinur Maxi N, Aurora) upon the foliar limb of *Chrysanthemum indicum* L.; they were applied in 3 variants of concentrations (0.2%, 0.4%, 0.6%). The identification of the impact of the fertilizers has been analyzed by identifying the modifications of the foliar limb and middle vein, a comparative analysis of the number of epidermic cells and stomata which belong to both upper and lower epidermis, as well as measuring the dimension of stomata. In all applied products, a few differences appeared in comparison with the blank sample.

Key words: fertilizers and biostimulants, anatomic structure, foliar limb, *Chrysanthemum indicum*

Introduction

Many authors have taken into account the importance of *Chrysanthemum indicum* L. in enrichment of floral assortment [VIDRAŞCU & MITITIUC, 2001; VIDRAŞCU & al., 1986; VIDRAŞCU & al., 1985; BIREESCU & al., 2002; DORNEANU & al., 2001; GAVRILUŢĂ & al., 2005; TOMA, 1975, 1977; TOMA & al., 1985; TOMA & GOSTIN, 2000]. We continue our study regarding the testing of some fertilizers and biostimulants upon the anatomy of *Chrysanthemum indicum* L. In our first note [DELINSCHI & al., 2010], we analyzed the modifications appeared in the stem, while in the present paper we are going to emphasize the structural modification of the foliar limb.

Many papers present information regarding the normal structure of the leaves of *Chrysanthemum indicum* L. [NIŢĂ MIHAELA & al., 2001] or its varieties, but we have not find (in the literature we have) a special study were the variability induced by various substances (foliar fertilizers) could be observed.

The results presented in this paper belong to the project "Elaborarea de soluţii şi tehnici de cultură neconvenţionale şi nepoluante la plantele ornamentale, în contextul dezvoltării durabile – The elaboration of unconventional and unpollutant solutions and culture techniques, in stable usage context" and presents the testing of some fertilizers and biostimulants, with the purpose of identifying the most convenient variants of work which contribute to increasing the ornamental quality of *Chrysanthemum indicum* L. (a flower for all seasons), by using unpollutant products.

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Material and methods

The experimental cultures have been initiated at University of Agricultural Sciences and Veterinary Medicine of Iasi, and have been ordered in randomized blocks, with three repetitions. Four foliar treatments have been applied, at 10 days intervals, on various variants (V_1 – 0.2%, V_2 – 0.4%, V_3 – 0.6%), using the following products: Maxiroot, Dacmarinur Maxi N and Aurora. Maxiroot is a foliar fertilizer with biostimulating effect: N – 2%, K – 4%, Zn – 0.3%, Fe – 0.3%, organic material – 30%, free amino acids (tryptophan, arginine) – 3%, proteins, vitamins. Dacmarinur Maxi N is a n ecologic foliar fertilizer from marine algae (*Ascophyllum nodosum*): N – 216 g/l, K – 96 g/l, P – 38 g/l, cytochinons – 7.5 mg/l, auxines – 11 mg/l, amino acids, vitamins, proteins. Aurora is a Romanian natural extract from plants, with biostimulant effect an contains N – 10%, K – 3.5%, P – 0.5%, B, Ca, Cu, Fe, Mg, Zn – 2% each of them, enzymes, amino acids, vitamins.

The foliar limb has been cross-sectioned, at middle level; the epidermis, in front side view, has also been analyzed and the number of epidermic cells and stomata on surface area have been calculated. In order to identify the modifications appeared after the treatment with the mentioned substances, the length and width of stomata from both epidermis of the foliar limb has been measured.

The sections were coloured with iodine green and carmine red and mounted in gel. The histologic cuttings were analyzed in a Novex (Holland) microscope and photographed by means of a Sony DSC-W5/W7/W15/W17 photo camera.

Results and discussions

Blank sample (the epidermis)

In front side view, the upper epidermis (Pl. II: Fig. 20) consists of cells with polygonal to irregular profile, with curved walls; the stomatic cells, anomocytic type, are quite rare on the surface area. The secretory trichomes and the protective hairs are less numerous. The lower epidermis (Pl. II: Fig. 21) presents cells with moderately curved walls. Unlike the upper epidermis, in the lower epidermis, stomata, protective hairs and secretory trichomes are numerous.

In cross section, the middle vein is strongly prominent at the lower side of the limb and bears a single, big, vascular bundle (Pl. IV: Fig. 32). The protective hairs and the secretory trichomes are present in both epidermis, but more numerous in the lower one.

Judging upon the structure of the mesophyll, the foliar limb has a bifacial-heterofacial structure (normal dorsiventrality); one-layered palisade tissue is present towards the upper epidermis, while a compact lacunary tissue is present towards the lower one (Pl. IV: Fig. 43).

Dacmarinur V_1 (0.2%). The upper epidermis (Pl. I: Fig. 1) consists of cells of irregular shape, bearing weak to waved walls, unlike the lower epidermis (Pl. I: Fig. 2) where the walls are more waved and the number of stomata on surface area is increased. Apart of the anomocytic stomata, there are tetracytic stomata (Pl. I: Fig. 4), too, and, also, clusters of stomata (Pl. I: Fig. 2).

In cross section, a slow increment in the width of the foliar limb in comparison with the blank sample and the other variant could be observed. The mesophyll has a compact structure (Pl. IV: Fig. 40); the middle vein is more prominent, in comparison with the next variant (V_2) (Pl. III: Fig. 26).

Dacmarinur V_2 (0.4%). The action mode of this variant is very interesting; the upper epidermis (Pl. I: Fig. 5) bears polygonal to irregular-shaped cells, with waved walls, in comparison with the upper epidermis of the anterior variant. The lower epidermis (Pl. I: Fig. 3) presents cells of irregular shape, but with moderately waved walls. Stomata of the lower epidermis are more numerous that in the anterior variant.

In cross section, a decrement in the width appears, in comparison with both V_1 and V_3 (Pl. IV: Fig. 41). We can affirm that at this concentration, the modification in the width of the foliar, in comparison with the blank sample, is insignificant. Furthermore, the middle vein is smaller (Pl. III: Fig. 27).

Dacmarinur V_3 (0.6%). The upper epidermis (Pl. I: Fig. 7) presents cells of irregular profile, with moderately waved walls and reduced number of stomata, protective hairs and secretory trichomes. The lower epidermis (Pl. I: Fig. 6) consists of cells with moderately to strongly waved walls and numerous stomata, protective hairs and secretory trichomes.

In cross section, a good development (increment in width) of the foliar limb is displayed, in comparison with V_2, somehow similar to V_1 (Pl. IV: Fig. 42). The mesophyll has more compact structure, while the median vein is similar to that of the leaves used in V_1 (Pl. III: Fig. 28).

Aurora V_1 (0.2%). The upper epidermis (Pl. I: Fig. 10) presents cells of irregular profile with lateral moderately-waved walls in comparison with the lower epidermis which bears cells with strongly-waved walls (Pl. I: Fig. 11). The protective hairs and secretory trichomes from the lower epidermis are more numerous and there is a higher degree of clustering stomata.

In cross section (Pl. IV: Fig. 37), each and there, a second layer of palisade tissue appears and the lacunary tissue is more compact. The middle vein is moderately proemining at the lower epidermis (Pl. III: Fig. 29).

Aurora V_2 (0.4%). The differences between V_1 and V_2 are small (Pl. I: Figs. 12 and 13) and determined by the increment of the dimensions of the cells belonging to both epidermis; there is also an increment in the waving degree of the cellular walls on the lower epidermis (Pl. I: Fig. 13), number of stomata, as well as an increment in the number of protective hairs and secretory trichomes.

In cross section, an increment of the width of the foliar limb could be observed (Pl. IV: Fig. 38), as a consequence of becoming higher the single layer of palissade tissue as well as of the increment of the number of lacunary layers. Numerous regions of stomata with supraepidermic and subepidermic position could be observed, while the sclerenchyma of the middle vein is cellulosed and consists of cells with very thin walls. The middle vein is very good developed, in comparison with the other variants (V_1 and V_3) (Pl. III: Fig. 30).

Aurora V_3 (0.6%). The upper epidermis (Pl. I: Fig. 14) consists of cells with moderately-waved walls in comparison with the lower one (which bears strongly-waved walls) and a little less waved (Pl. I: Fig. 15) in comparison with the epidermis belonging to the leaves used in the anterior variant.

In cross section, there is a visible difference regarding the width of the foliar limb, compared with the other variants; wider than in V_1 but less wide than in V_2 (Pl. IV: Fig. 39). The middle vein is similar as dimension with the one belonging to the leaves of V_1 (Pl. III: Fig. 31).

Maxiroot V_1 (0.2%). The upper epidermis (Pl. II: Fig. 16) bears cells with irregular shape and moderately-waved lateral walls. The protective hairs and secretory trichomes are present in small number; stomata belong to the anomocytic type.

The lower epidermis (Pl. II: Fig. 17) bears cells of irregular profile, but with strongly-waved walls. The protective hairs and secretory trichomes are more numerous that in the upper epidermis; stomata are more numerous, too, and belong to the anomocytic type. Here and there, groups of stomata can be seen, in the axils of the veins (Pl. I: Fig. 9).

In cross section (Pl. IV: Fig. 33), the middle vein is strongly proeminent at the abaxial face of the foliar limb and bears a single, big vascular bundle, with a sheath of periphloemic sclerenchyma which consists of fibers with cellulosed walls. The protective hairs and secretory trichomes are present in both epidermis, but more numerous in the abaxial face.

The mesophyll (Pl. IV: Fig. 44) has a bifacial-heterofacial structure (mornal dorsiventrality); the one-layered palisade tissue towards the upper epidermis, while the lax lacunary tissue is at the lower epidermis; stomata are disposed under the level of the epidermis and presents a common, well developed substomatic chamber.

Maxiroot V_3 (0.6%). In V_3, a strong undulation of the walls of the epidermic cells can be observed (Pl. II: Figs. 18 and 19); the lower epidermis has cells with more curved walls than in the upper epidermis (Pl. II: Fig. 19). The protective hairs and secretory trichomes, as well as stomata are more numerous than in the upper epidermis and have strong tendencies of grouping (Pl. I: Fig. 8).

In cross section, there are no significantly modifications in comparison with the anterior variant; only the foliar limb is wider due to increasing the number of cellular layers in the lacunary tissue (Pl. IV: Fig. 45); the middle vein is a little more developed in comparison with V_1 (Pl. IV: Fig. 34).

In order to understand whether the variants used in the study can be easily identified upon their action in the anatomic structure, beside the mature leaves, we also studied the young leaves in Dacmarinur V_1 and V_3 and Maxiroot V_1 and V_3 (Pl. II: Figs. 22-25, Pl. IV: Figs. 46 and 47).

The analysis of the epidermis, in front side view or in cross section (Figs. 35 and 36) let us can affirm that there are very small differences, hardly visible in the initial stages of development that is why we took into account the anatomy of the mature leaves. The anatomic dates were accompanied by numeric dates referring to the number of epidermic cells and stomata (from the epidermis, on the surface area) in all variants of work (Table I), as well as dates regarding the variation of stomata dimension in both epidermis (μm), related to the substance and concentration used (Table II).

In order to identify the modifications appeared in the epidermis, in front side view, the epidermic cells and stomata were counted and the stomatic index was calculated (Table I).

In the upper epidermis, in comparison with the blank sample, in Maxiroot V_1 and Aurora V_1 and V_2 a higher number of cells on surface area can be observed, while in Dacmarinur V_3, in comparison with the blank sample, the difference is very small. The higher number of stomata appears in Maxiroot V_3 (6 cells), then in Dacmarinur V_1 (4 cells); the other differences are insignificantly (Table I).

In the lower epidermis, the modifications are visible; in comparison with the blank sample (42 cells), Aurora V_1 and V_3 and Maxiroot V_1 and V_3 determine an increment of cell dimensions. There is a large variation in the number of stomata in the lower epidermis (from 3 to 10). The most numerous stomata appear in Maxiroot V_3, then in Dacmarinur V_1 and V_3. In Aurora the differences are insignificantly, in comparison with the blank sample. The comparative analysis of the number of cells (epidermic cells and stomata) in the foliar limb of the young leaves demonstrates large variations which do not let us make an arguable conclusion, but we can affirm that Maxiroot is stronger than Dacmarinur, by its influence upon the cellular division.

Stomata dimension (Table II), in both epidermis, varies in more or less large limits. The biggest length of stomata of the mature upper epidermis appears in Dacmarinur V_1 and V_2 and Aurora V_1, while the biggest width appears in Dacmarinur V_1. In the lower epidermis, the biggest length of stomata appears in Aurora V_2 and Dacmarinur V_3, while the maximal width appears in Aurora V_2 and then in Aurora V_1 and Dacmarinur V_1.

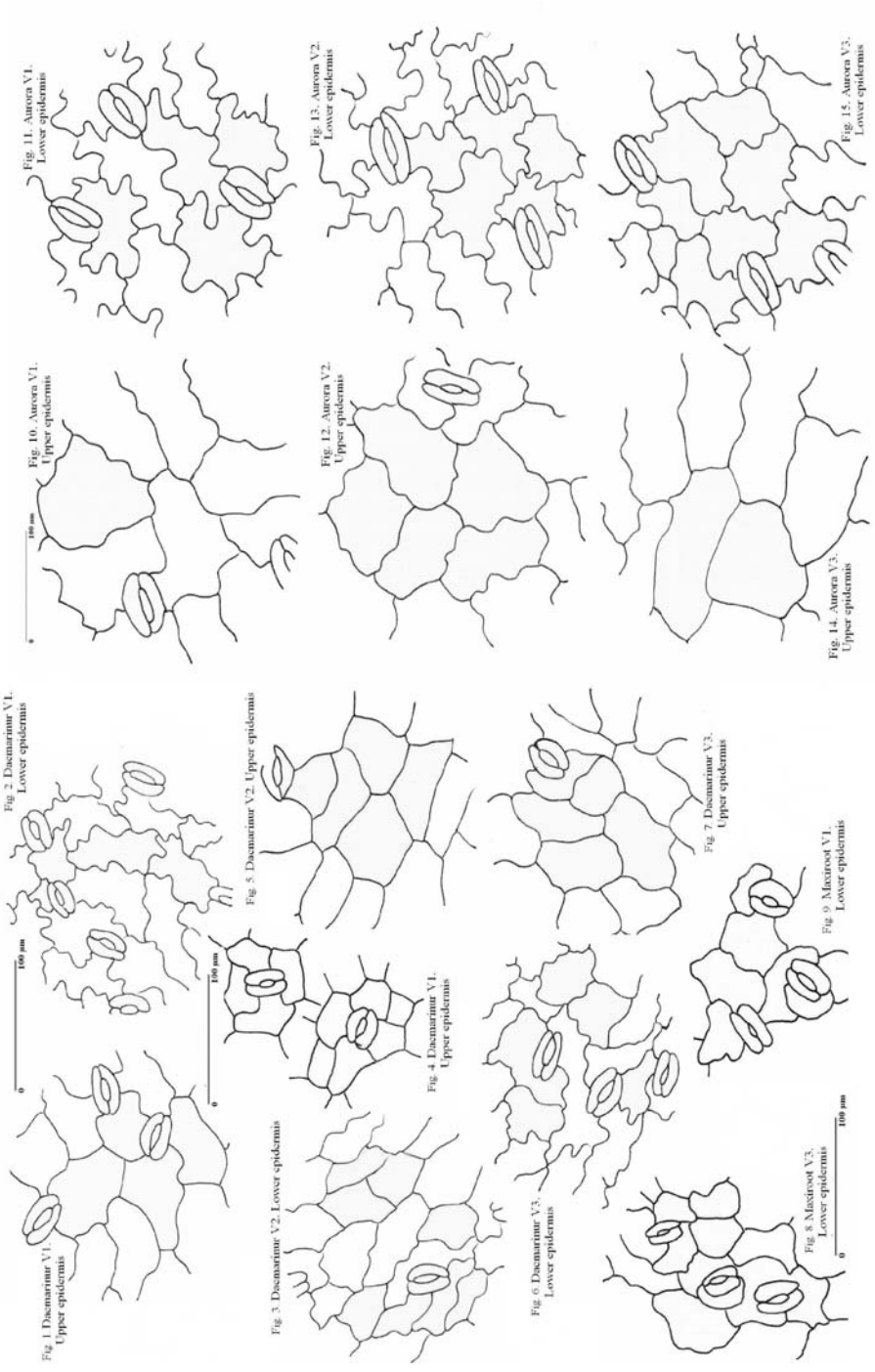
Tab. I. Dates referring to the number of epidermis cells and stomata in the foliar limb, on surface area (Surface=0.0941 mm^2)

Species	Substances	Variants	Upper epidermis			Lower epidermis		
			Number of cells	Number of stomata	Stomatic index	Number of cells	Number of stomata	Stomatic index
Chrysanthemum indicum		Blank sample	41	2	0.0465	42	6	0.1250
	Dacmarinur MAXI N	V_1 – young plant	44	2	0.0434	49	8	0.1403
		V_3 – young plant	35	1	0.0277	32	5	0.1351
		V_1 – mature plant	31	4	0.1142	42	8	0.1600
		V_2 – mature plant	34	2	0.0555	46	6	0.1153
		V_3 – mature plant	38	2	0.0500	40	8	0.1666
	Aurora	V_1	23	1	0.0416	32	5	0.1351
		V_2	26	1	0.0370	41	6	0.1276
		V_3	34	2	0.0555	37	5	0.1190
	Maxiroot	V_1 – young plant	71	1	0.0138	42	7	0.1428
		V_3 – young plant	44	1	0.0222	54	10	0.1562
		V_1 – mature plant	28	2	0.0666	38	10	0,2083
		V_3 – mature plant	30	6	0.1666	37	10	0.2127

Tab. II. Dimension of stomata (μm)

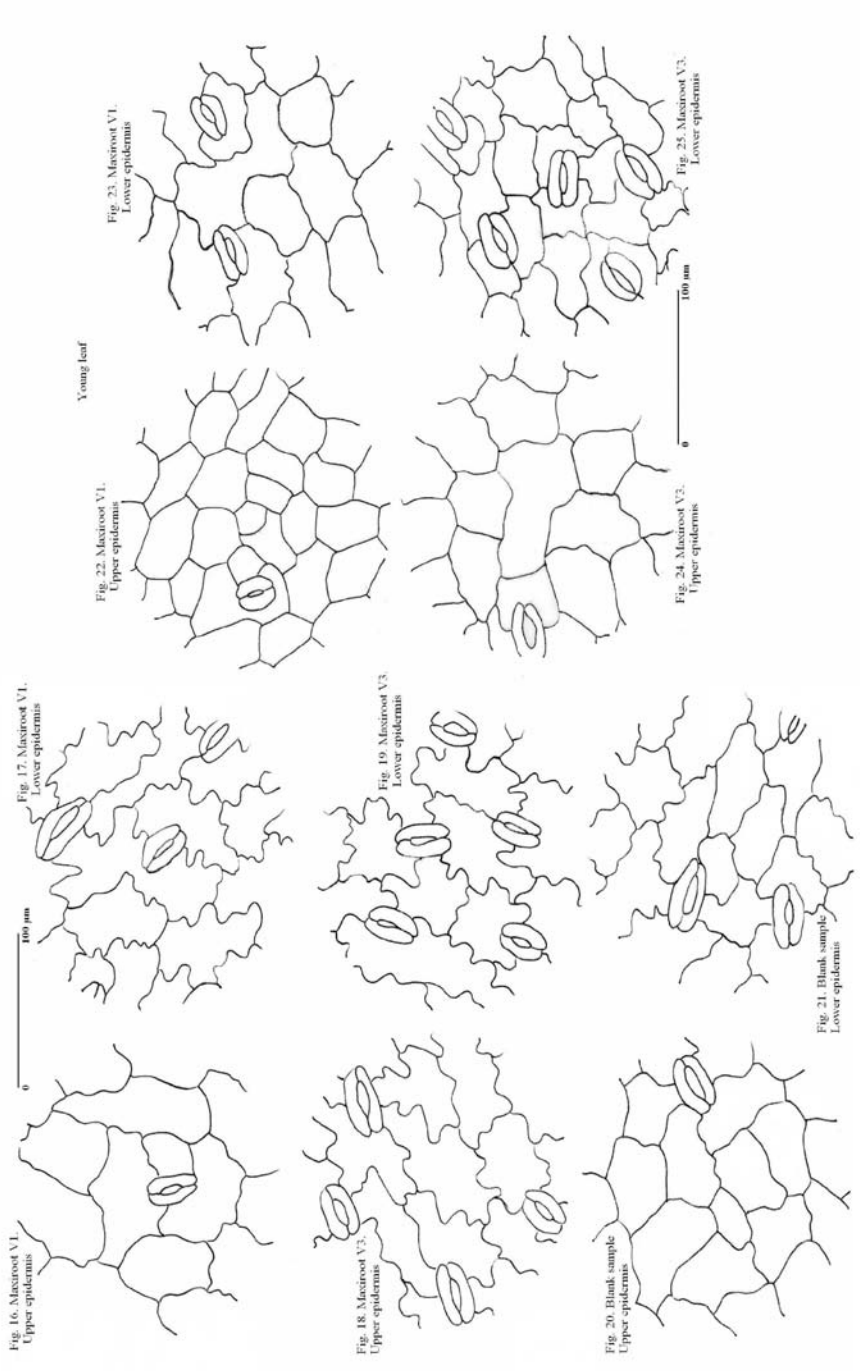
			Upper epidermis		Lower epidermis	
			Length	Width	Length	Width
Blank sample			43.254	30.616	44.144	28.836
Dacmarinur Maxi N	Mature plant	V_1	46.636	32.040	45.212	29.129
		V_2	46.636	28.836	43.788	27.946
		V_3	43.076	29.192	46.636	25.988
	Young plant	V_1	41.652	28.836	49.840	30.794
		V_3	48.060	27.412	48.416	25.988
Aurora		V_1	46.636	31.328	44.500	29.548
		V_2	43.432	30.616	47.348	30.260
		V_3	43.432	27.056	45.390	28.480
Maxiroot	Mature plant	V_1	45.568	30.260	44.856	28.480
		V_3	45.568	28.480	43.076	26.700
	Young plant	V_1	33.820	31.328	40.584	27.768
		V_3	43.289	30.260	45.746	23.140

PLATE I



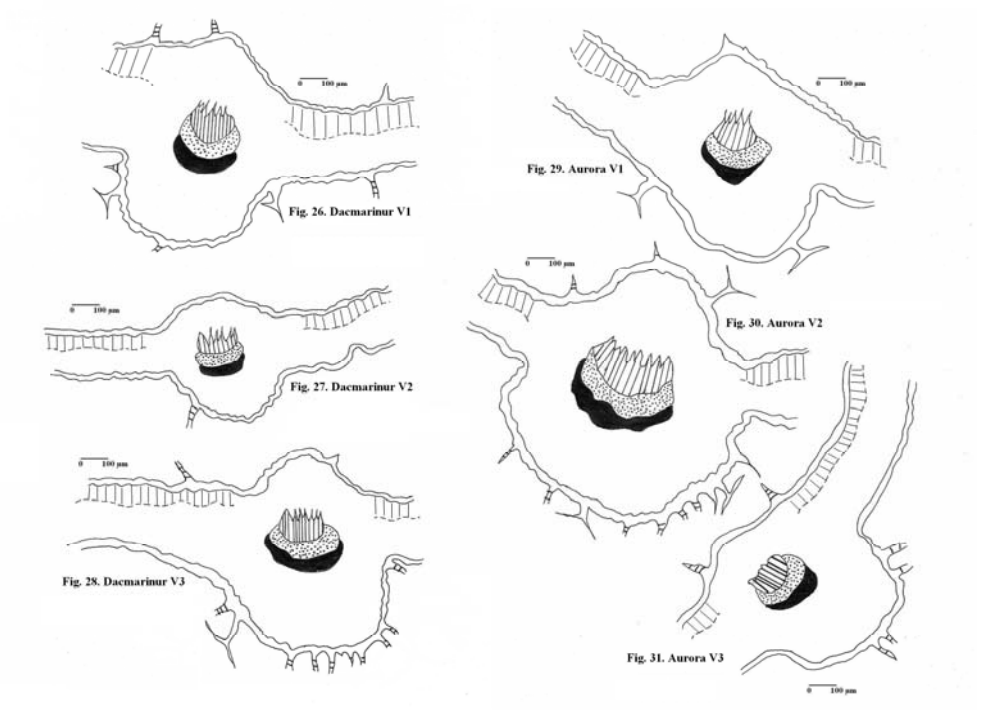
Epidermis in front side view (details)

PLATE II



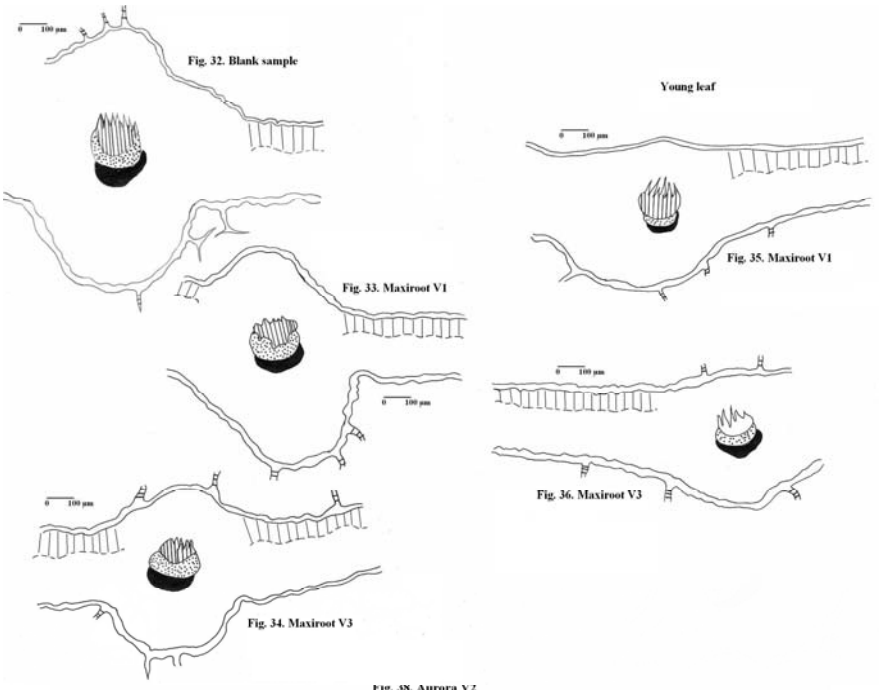
Epidermis in front side view (details)

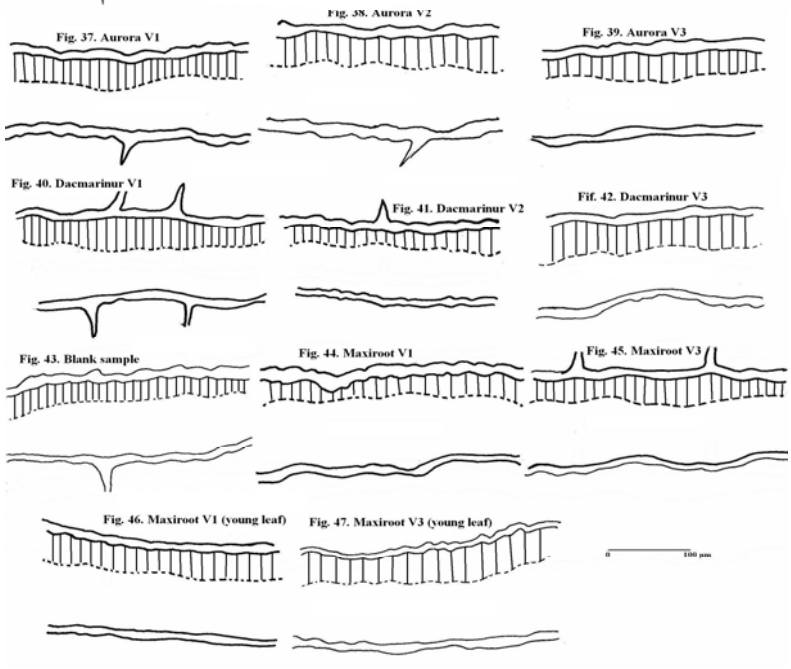
PLATE III



Plan of the cross sections through the foliar limb at middle level: middle vein and its lateral regions

PLATE IV





Plans of the cross sections through the foliar limb middle vein (Figs. 32-36) and its lateral regions (Figs. 37-47)

Conclusions

Judging the results of these products with no pollutant properties, applied in three variant of concentration, some significant differences appeared, in comparison with the blank sample; these differences are notable in various development stages of the foliar limb (young and mature).

A great receptivity of the foliar limb was observed, as a result of the action of the following products, used in various concentrations: Aurora V_2, Dacmarinur V_1 and V_3, Maxiroot V_3 and V_1.

The comparative analysis of cell number (epidermic cells and stomatic cells) of the mature foliar limb demonstrated large variations; Maxiroot is stronger in comparison with Dacmarinur, by influencing the cellular division process.

Stomata of both upper and lower epidermis belong to the following types: anomocytic and tetracytic and have different dimensions; clusters of cells appear in the axile of the veins (when plants are treated with Maxiroot). Although the literature explains that these clusters of stomata appear due to the hybridization phenomenon, in the present case, the foliar fertilizers play an important role in the grouping of stomata.

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CHARACTERIZATION OF THE LEAF EPIDERMIS OF TWO *SESLERIA* SPECIES

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Abstract: Leaf epidermis has been used as character in taxonomy of *Poaceae* family since the 1930s. The purpose of present study was to determine leaf epidermal features helpful in distinguishing two species of *Sesleria* genus – *Sesleria heufleriana* Schur and *Sesleria uliginosa* Opiz.
Both the abaxial and the adaxial epidermis have been examinated for each species.
So both examined species have Festucoid type of epidermis, but differences of some epidermal features exist at the species level. This include variation in number and size of epidermal cells and distribution patterns of stomata.

Keywords: *Sesleria*, epidermis, anatomy

Introduction

Sesleria heufleriana Shur and *Sesleria uliginosa* Opiz. form a very closely related group. They have some fundamental common characters, such as pruinous leaves, three floretted spikelets, dense spikes and the occurrence in lower altitudes. *S. heufleriana* is a limestone species, often tolerating a rare wood growth, while *S. uliginosa* is a species of calcareous swamps or clay soils which often withstands even the summer drying, growing sometimes also in the undergrowth of woods [DEYL, 1946].

The taxonomic value of the leaf epidermis in grass systematics has been demonstrated by many scientists [PRAT, 1932, 1936, 1948, 1961; TATEOKA et al., 1959; METCALFE, 1960; ELLIS, 1976, 1979]. Microscopic studies have found leaf surface characters of value in angiosperm taxonomy including size and shape of cells, cell wall undulations, morphology of stomata and stomatal patterning [STACE, 1984].

The aim of this study was to determine the patterns of variation in epidermal characteristics, assess their value in species identification and classification, and also to use the epidermal studies in establishing the taxonomic relationship between this two analysed species.

Material and methods

The plants were collected in 2010 from Hărman (*S. uliginosa*) and Turda Gorges (*S. heufleriana*), and transferred to Botanical Garden in Bucharest for cultivation. Voucher specimens of collected material were deposited in the Herbarium of Gradina Botanica "D. Brandza" in Bucharest (BUC). *S. uliginosa* was collected from alkaline swamp some 10 km east of Braşov in Hărman village, while *S. heufleriana* was collected in Turda Gorge (Cheile Turzii, Apuseni Mountains) from carbonate rocky grounds.

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For anatomical observations we have used leaves from living plants. We have examined adaxial and abaxial epidermis at the middle of the leaf blade.

The leaf blades were placed with the adaxial side upwards, and then scraped gently with a razor blade. The same procedure was followed to prepare the adaxial side of epidermis but the leaf was placed abaxial surface uppermost. After the upper epidermis and mesophyllous tissue were completely cleared away, the lower epidermis, which has great significance in taxonomy, was used for further investigations. It was stained with 1% safranin for half a minute, and immediately put under the light microscope for study and photographing.

All the leaves that were used for analyses were mature leaves, while the uppermost and the lowest ones were avoided.

For the description of the anatomical features, we use the nomenclature of PRAT (1932), METCALFE (1960) and ELLIS (1979).

The measurements of the individual structures were done with Digimizer programme 3.7.0. (MedCalc Software 2005-2010).

Results

Both adaxial and abaxial epidermis can be divided into costal and intercostal zones. The two mentioned zones differ adaxially and abaxially.

In *Sesleria uliginosa* abaxial side (Fig. 1A) in the costal zone consists of 1-3 layers of cells (Fig. 1B), and the intercostal zone (Fig. 1C) of 6-8 layers of cells. Prickle hairs are present on the leaf border in great numbers (Fig. 1D). Short cells are both costal and intercostal abundant. The long cells from costal zone are much shorter than those from the intercostal zone. On the adaxial side the costal zone consists of 2-3 layers of cells, and the intercostal zone of 8-12 layers of cells. Prickle hairs are present on the leaf border in great numbers.

In *Sesleria heufleriana* abaxial side (Fig. 1E) in the costal zone (Fig. 1F) consists of 1-2 layers of cells and the intercostal zone (Fig. 1G) of 8-11 layers of cells. Prickle hairs are present on the leaf border in great numbers (Fig. 1H). The long cells from costal zone are much shorter than those from the intercostal zone. On the adaxial side the costal zone consists of 6-9 layers of cells and the intercostal zone of 8-15 layers of cells. In the right of grooves formed by median rib, two groups of bulliform cells were observed.

Detail qualitative and quantitative differences of characters of leaf epidermis of *S. uliginosa* and *S. heufleriana* are shown in Tab. 1 and Tab. 2.

Tab. 1. Comparative qualitative characters of two *Sesleria* species

Characters	*Sesleria uliginosa*	*Sesleria heufleriana*
ABAXIAL		
SHORT CELL		
Silica cell	Costal paired with cork cell Over the veins spherical or elliptical, between the veins saddle-shaped	Over the veins, spherical or elliptical and between the veins, saddle-shaped
LONG CELL	Rectangular, elongated, with sinuous walls The side-walls parallel, sometimes more or less inflated outwards	Rectangular, elongated, with sinuous walls The side-walls parallel, sometimes are more or less inflated outwards

PRICKLES	Very large, present only on the mid-rib and on the leaf edge	On leaf edge and over the veins . Prickle base size very large
BULLIFORM CELLS	Not observed	Not observed
STOMATA	Rare, 1-2 stomata, just over intercostal zone	Rare, 1-2 stomata, just over intercostal zone
MACROHAIRS	Not observed	Not observed
ADAXIAL		
SHORT CELL		
Silica cell	Costal with irregular shape; intercostal saddle-shaped	Intercostal saddle-shaped and costal with irregular shape
LONG CELL	Rectangular, elongated, with sinuous walls, sometimes more or less inflated outwards	Rectangular, elongated, narrow, width uniform, with sinuous walls, the side one parallel
PRICKLES	Abundant on margin and costal. Prickle base size large	Not seen between the veins and abundant over the veins. Prickle base size very large
BULLIFORM CELLS	On the adaxial surface only. In groups of 8-11 cell	On the adaxial surface only. In groups of 12-13 cells
STOMATA	Abundant, intercostal only. The stomata rows generally adjacent	Abundant, intercostal only. The stomata rows adjacent, not separated by files of intercostal long cells
MACROHAIRS	Just on mid-rib	Not observed

Tab. 2. Comparative quantitative characters of the two species

Characters	*Sesleria uliginosa*	*Sesleria heufleriana*
ABAXIAL		
Intercostal zone		
Long cells - length (μm)	91 - 374	44 - 503
Silica cells - length (μm)	5,2 - 10,6	4,4 - 17,2
Costal zone		
Long cells - length (μm)	55 - 202,2	32 - 100
Silica cells - length (μm)	12,9 - 24	13,1 - 20,8
Prickle hairs - length of base(μm)	62 - 164	40,2 - 65,1

ADAXIAL		
Intercostal zone		
Long cells - length (μm)	40 - 158,5	16 - 152,7
Silica cells - length (μm)	10,7 - 15,3	10,2 - 17,7
Stomata - density (number/visual field)	41- 53	49-85
Costal zone		
Long cells - length (μm)	32 - 254	34 - 232
Silica cells - length (μm)	10,2 - 16,7	8,8 - 18,1
Prickle hairs - length of base(μm)	17,5 - 24	17,2 - 23,5
Macrohairs - length (μm)	23 - 106	-
Number of **bulliform cells**	8 - 11	12 - 13

Conclusion

The present work has shown that two analysed *Sesleria* species (*S. heufleriana* and *S. uliginosa*) exhibit Festucoid type of leaf epidermis: micro-hairs absent; stomata subsidiary cells are parallel-sides [PRAT, 1936; METCALFE, 1960].

The adaxial epidermis (Fig. 2) of both species consists of long cells, short cells, prickles hairs, stomata and bulliform cells. The macrohairs are present just in *S. uliginosa*. Bulliform cells are gradually larger than the rest of the epidermal cells. They are present in two groups on the adaxial side only and their number is different in this two *Sesleria* species.

The stomata are abundant, but are more numerous in *S. heufleriana*.

The abaxial epidermis of both species consists of long cells, short cells, prickles hairs and stomata.

The dimensions of prickles hairs on the leaf margins are much larger in *S. uliginosa* then in *S. heufleriana*.

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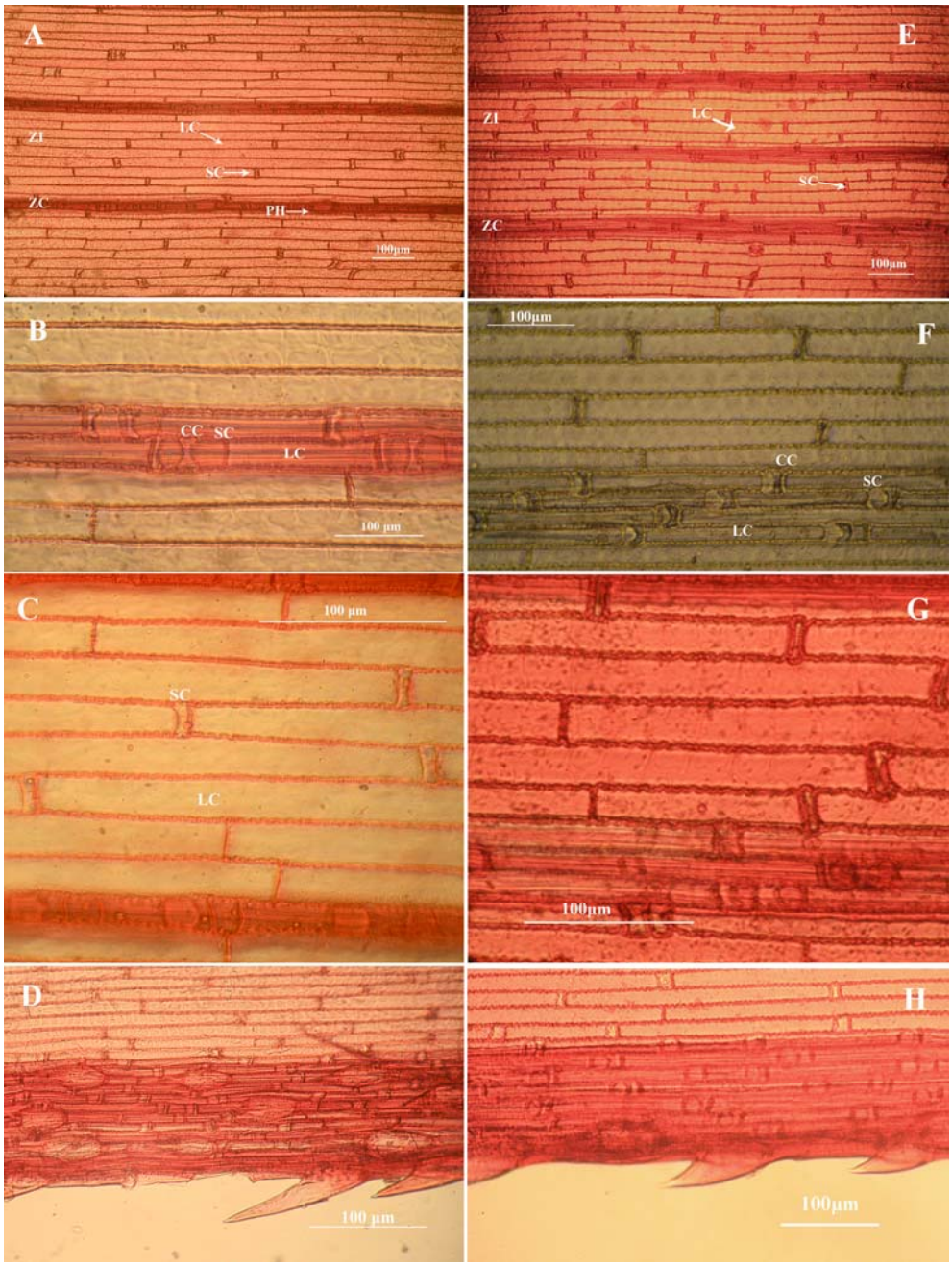

Fig. 1. A – *S. heufleriana* Shur, abaxial epidermis with general aspect; B – costal zone (ZC); C – intercostal zone (ZI); D – Border of the leaf with prickle hairs; E – *S. uliginosa* Opiz, abaxial epidermis with general aspect; F – costal zone (ZC); G – intercostal zone (ZI); H – Border of the leaf with prickle hairs. CC – cork cell, LC – long cell, SC – silica cell, PH – prickle hair.

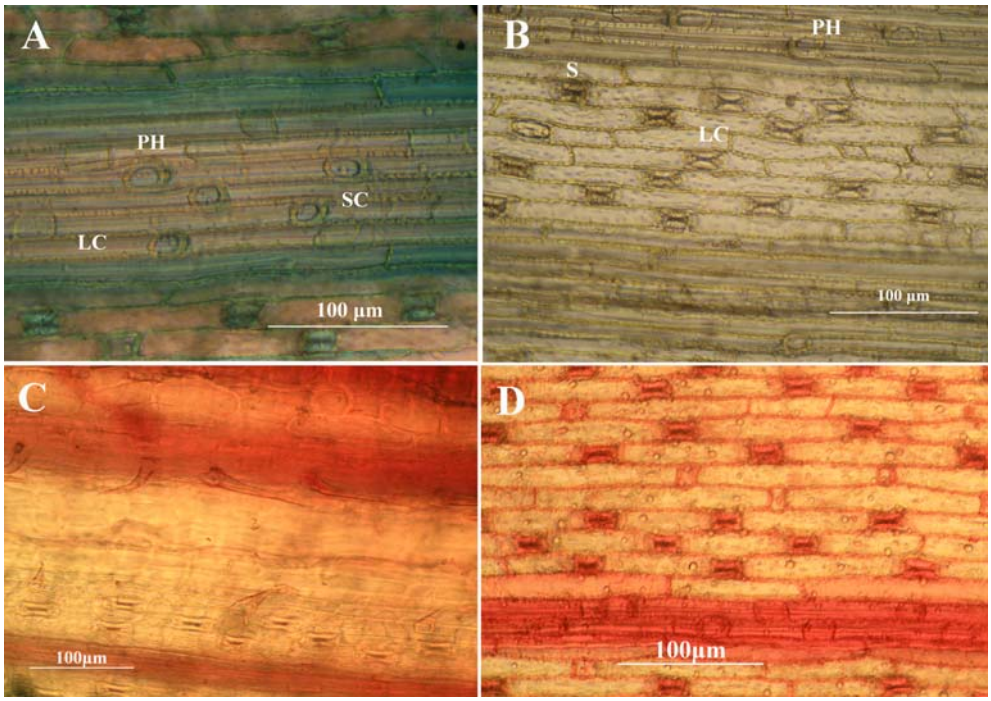

Fig. 2. A – *S. heufleriana* Schur, adaxial epidermis with costal (ZC) zones; B – Adaxial epidermis with intercostal zone (ZI); C – *S. uliginosa* Opiz, middle of adaxial epidermis with bulliform cells; D – Adaxial epidermis with intercostal zone. S – stomata, M – macrohairs, Ph – prickle hair, LC – long cell, SC – silica cell

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MICROMORPHOLOGICAL ASPECTS REGARDING THE LEAVES ON SOME ROSES WITH EMPHASIS ON SECRETORY GLANDS

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Abstracts: The multicellular glands, the epicuticular wax and the tector hairs observed on the leaves are influenced usually by genetic constitution.
The paper investigating 8 genetically related varieties: 'Foc de Tabără', 'Luchian' 'Paprika', 'Coup De Foudre', 'Independence', 'M-me A. Meilland', 'Cocktail', 'Laminuette'.
The micromorphological studies evidencing some characters with a certain value for diagnosis. These may be used in investigation concerning to the identification when the flower is absent.
Our study underlines micromorphology aspects of glands, epicuticular wax and tector hairs. All of them were been examinating through scanning electron microscopy method.

Key words: rose varieties, secretory glands, epicuticular wax, leaves micromorphology

Introduction

Micromorphological aspects on the vegetative shoots of *Rosa* genus have been investigated in the last years preponderant to the botanic species and less to the culture varieties of these species [Adumitresei & al., 2009; Caissard et al., 2006; Hashidoko, 2001; Ritz & Wissemann, 2003; Werlemark et al., 1999; Wissemann, 2000]. Investigations refer especially to the species used in the perfumes industry (*R. damascena, R. moschata, R. gallica, R. rugosa*), and to the species from *Caninae* sub-section that have a special type of meiosis (named equilibrated heterogamy). These species belong to a polyploid series (2n = 28, 35, 42) and have a preponderant maternal heredity [Tackholm, 1920, 1922; Blackburn & Harrisson, 1921 din Krüssmann, 1986]. These facts determined Wissemann to conclude that the epicuticular wax is transmitted by maternal line [Werlemark et al., 1999; Wissemann, 2000].

The studied varieties from our country are in fact introgressive hybrids presenting polyphyletic and heterogeneous origins, characterized by 2n = 28 (x = 7), typical meiosis and characters that are mendelian transmitted [Adumitresei et al., 2009; Cairns et al., 2000; Wagner, 2002; Krüssmann, 1986].

Material and methods

We investigated two romanian types with same genealogy – 'Foc de tabară' and 'Luchian', direct genitors of them ('Paprika' and 'Coup de Foudre'), two representative of their ascending-line up to the fourth generation ('Independence' and 'M-me A. Meilland') and two other types which have common ancestors with these ('Cocktail' and 'Laminuette').

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In fact, all types are introgressive hybrids (fertile hybrids from F1 are crossing for many times either with one of those parents or even with both parents with the view to fix of some characteristics):

- 'Foc de Tabără' (F, ST. Wagner, 1970): Paprika x Coup de Foudre;
- 'Luchian' (F, St.Wagner , R Paloxay, 1972): Paprika x Coup de Foudre;
- 'Paprika' (F, Meilland, 1956): Markenland x Red Favorite;
- 'Coup De Foudre' (F, Hemeray- Aubert, 1956): [(M-me A. Meilland x Independence)] x Oiseau de Feu;
- 'Independence' (F, Kordes, 1951): F2 seedling (Baby Chateau x Crimson Glory);
- 'M-me A. Meilland' (Th, Meilland 1945): (George Dikson x Souv. de Claudius Pernet) x Margaret Mc Gredy;
- 'Cocktail' (Po, Meilland, 1961): [(Independence x Orange Triumph) x Phillis Bide];
- 'Laminuette' (F, Lammerts, 1969): M-Me Meilland x Rumba [4, 14].

The plant material was collected "Anastasie Fătu" Botanical Garden Iasi in June 2009.

Scanning electron microscopy (SEM) investigations – Portions of leaves, rachis and stipules were fixed in FEA in ethanol 50% for 48 hours, stored in 70% ethanol [Johansen, 1940]. After dehydration in a graded ethanol series, the material was critical point dried with CO2, sputter-coated with a thin layer of gold (30 nm) and, finally, examined in a scanning electron microscopy (Tescan Vega II SBH) at an acceleration voltage of 27.88 kV.

Results and discussions

Leaves are odd-pinnate with 5-7 firm leaflets, with individual leaflets broadly elliptic. Leaf edges are serrated, usually with gland-tipped teeth.

'Foc de tabără' and 'Luchian' shows numerousness similarities from micromorphological point of view (Fig 1). The epicuticular wax of the lower epidermis consists in membraneous platlets [Barthlott et al, 1998] or triangular rodlets [Wissemann, 2000] (Fig 1 A, D). Stalked glands occur along the margin of the leaflets and on their mid ribs, on the rachis and at on the stipules margins. The glands have two types of secretory heads – subglobulose and pyriform elongated (Fig. 1 B, C, E). All the glands begin secretion when the leaf is still very young, and secretion continues during leaf expansion (mature gland are observed even on young leaves parts). These glands produce a sticky epicuticular secretion on the leaf surface. In the same time, scattered tector hairs, longs, flexuous, unicellular, could be observed (Fig. 1 B, C, E).

The cuticle which cover the lower epidermis of Paprika leaflets is quite smouth, without specific epicuticular wax (Fig 2A). The glands are of two types: some one long, pyriform elongate shaped secretory part and some one short, with the secretory suglobulose; the last ones appears as basal ramifications of the longest ones (Fig. 2B). The central part of the subglobulose secretory gland is visible proeminent (Fig. 2 C).

The 'Coup de Foudre' cuticle (from the lower leaflet epidermis) show specific epicuticular wax (Fig. 2 D). The glands are short, with globular secretory part (Fig 2 E) or longer, with elongated secretory part (Fig. 2 F). The phenomenon of branching of the gland is still visible, but lower than in 'Paprika'.

The 'Independence's' leaflet shows very rough epicuticular wax on lower epidermis (Fig. 3, A). The same types of glands as in previous cases could be observed (Fig. 3 B).

On the contrary, 'Coktail' leaflets have more smooth epicuticular wax (Fig. 3 C). The all present glands are short, un-branched (Fig. 3 D, F). On the central part of the globular glands visible pores (probably implicated in the release of the secreted products) could be observed (Fig. 3 E).

'Mme Meilland' leaflets show a visible triangular rodlets (Fig. 4 A). The glands have long or short stalk, but only globular secretory parts (Fig. 4 B, C). 'Laminuette' leaflet presents epicuticular waxes to be characterised by a granule wax type (Fig. 4 D). The gland types are very similar with the ones of 'Mme Meilland' (Fig. 4 E, F).

The gland types are usually two: short, with subgobular – globular or pyriform secretory part in 'Foc de tabără', 'Luchian', 'Independence' and 'Coup de foudre'; long, branched with the same two kinds of secretiory parts in 'Independence' and 'Coktail'. In 'Mme Meilland' and 'Laminuette' only glands with globular secretory part could be observed.

The majority of the investigated varieties show rough epicuticular was, with triangular rodlets more or less accentuated. 'Paprika' show smooth epicuticular surface and 'Laminuette' presents granule wax type. In *Rosa* genus – sect. *Caninae* the taxons develop the maternal type of wax structure due to the matroclinal inheritance [Werlemark et al., 1999], excepting 'Laminuette' variety [Ritz & Wissemann, 2003]. The wax type of the roses is influenced usualy by the genetic constitution and not by environmental influences [Wissemann, 2000].

Thus, both types 'Foc de tabară' and 'Luchian' have two times the 'M-me A. Meilland' type in their "short genealogy" both for paternal line and maternal line, and just one time 'Paprika', 'Independence' and 'Coup de Foudre' types.

The glands, present all around the border, are there "by inheritance' from ancestral species and they are more frequent at types which have their genealogy either on *R. foetida* ('M-me A. Meilland', 'Paprika', 'Laminuette', 'Coup de Foudre', 'Luchian' , 'Foc de Tabără' and 'Independence'), or *R. moschata* ('Cocktail', 'Coup de Foudre', 'Independence', 'Laminuette', 'Paprika', 'Luchian' and 'Foc de Tabără').

The glands could have a different morphology because, besides common ancestors which were been already mentioned or not (*R. chinensis*, *R. damascena*, *R. gallica*, *R. multiflora*), some of these types have either *R. roxburgii* ('Laminuette', 'Paprika', 'Foc de Tabără' and 'Luchian') or *R. setigera* ('Laminuette') inside of the ascending line.

Conclusions

'Foc de tabără' and 'Luchian' have many similarities from micromorphological point of view:

1) the epicuticular wax of the lower epidermis consists in membraneous platlets or triangular rodlets;
2) stalked glands occur along the margin of the leaflets and on their mid ribs, on the rachis and at on the stipules margins. The glands have two types of secretory heads – subglobulose and pyriform elongated.
3) All the glands begin secretion when the leaf is still very young, and secretion continues during leaf expansion (mature gland are observed even on young leaves parts).
4) These glands producing a sticky epicuticular secretion on the leaf surface.
5) Scattered tector hairs, longs, flexuous, unicellular, could be observed.

The gland types are usually two: short, with subgobular – globular or pyriform secretory part in 'Foc de tabără', 'Luchian', 'Independence' and 'Coup de foudre'; long, branched with the same two kinds of secretiory parts in 'Independence' and 'Coktail'. In 'Mme Meilland' and 'Laminuette' only glands with globular secretory part could be observed.

The majority of the investigated varieties show rough epicuticular wax, with triangular rodlets more or less accentuated. 'Paprika' shows smooth epicuticular surface and 'Laminuette' presents granule wax type.

'Laminuette' variety develop epicuticular due only through partenal line.

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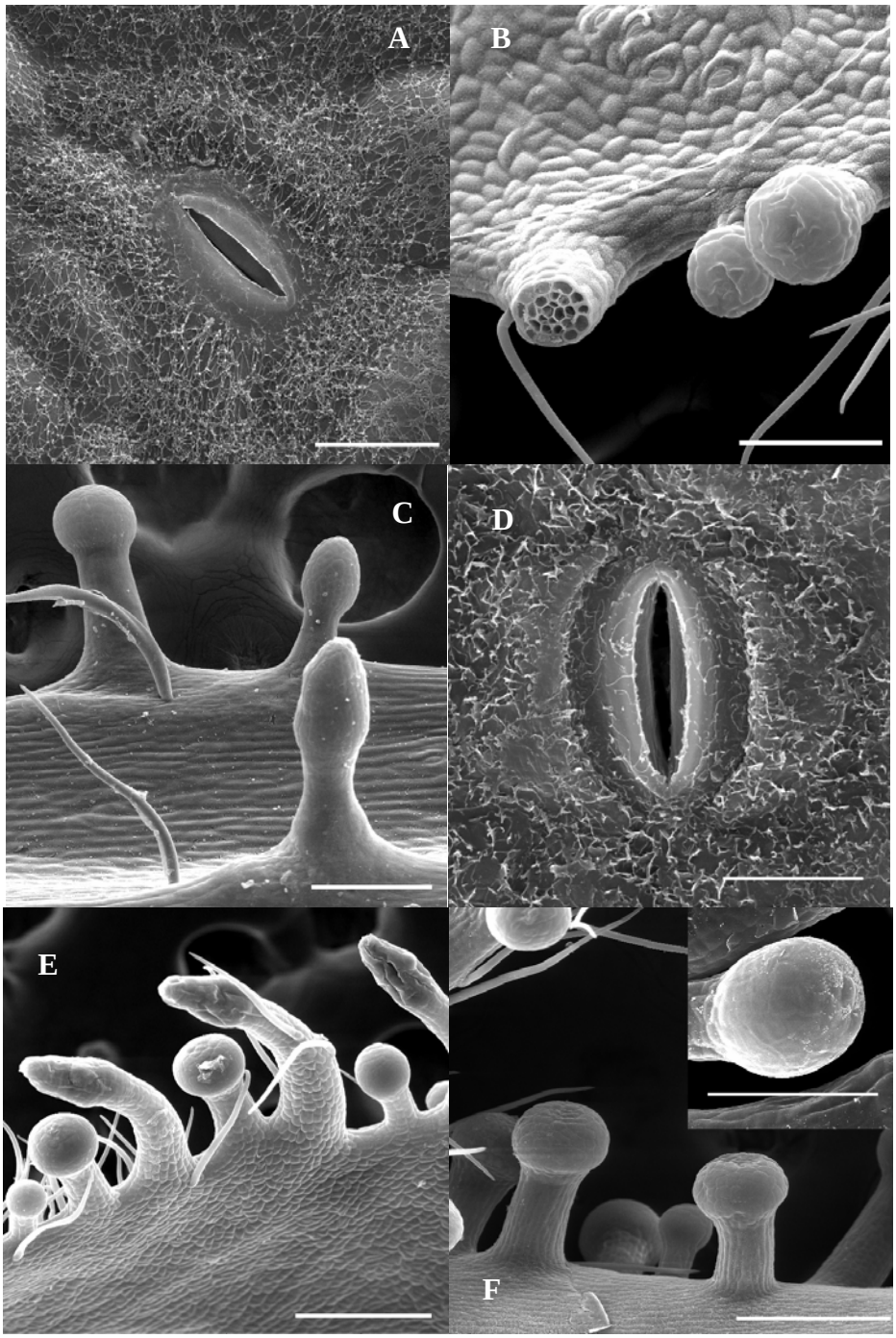

Fig. 1. *Foc de tabara*: A – young leaflet, lower epidermis, scale bar - 20 µm, B – young stipule – 100 µm, C – rachis - 200 µm, ***Luchian***: D – young leaflet, lower epidermis, scale bar - 20 µm, E – young stipule - 200 µm, F – rachis – scale bar - 200 µm (down) - 100 µm (up)

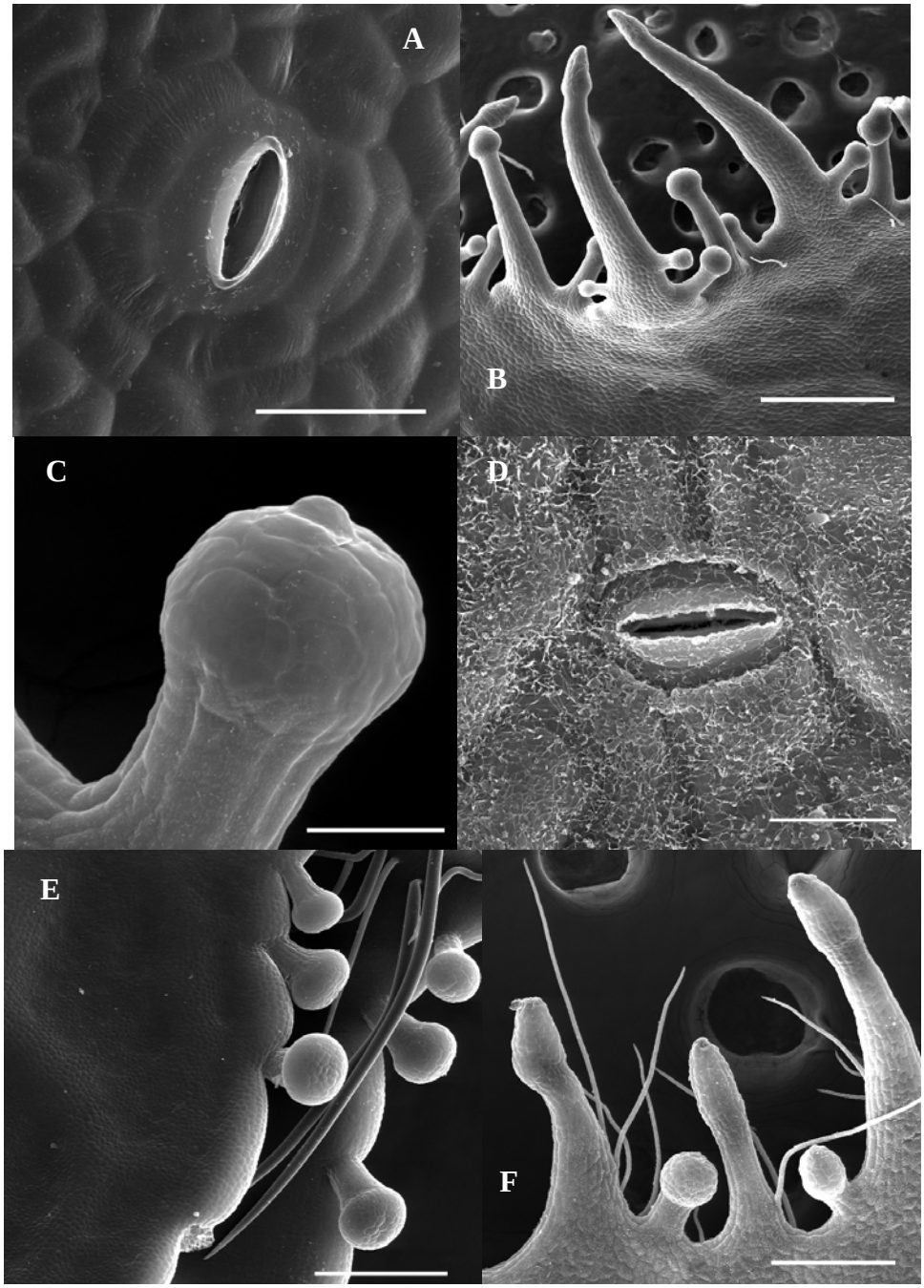

Fig 2. *Paprika*: A – young leaflet, lower epidermis, scale bar - 20 µm, B – young stipule - 500 µm, C – young stipule - 50 µm***, Coup de Foudre***: D – young leaflet, lower epidermis, scale bar – 20 µm, E – margin of the young leaflet, scale bar - 200 µm, F – young stipule - 200 µm

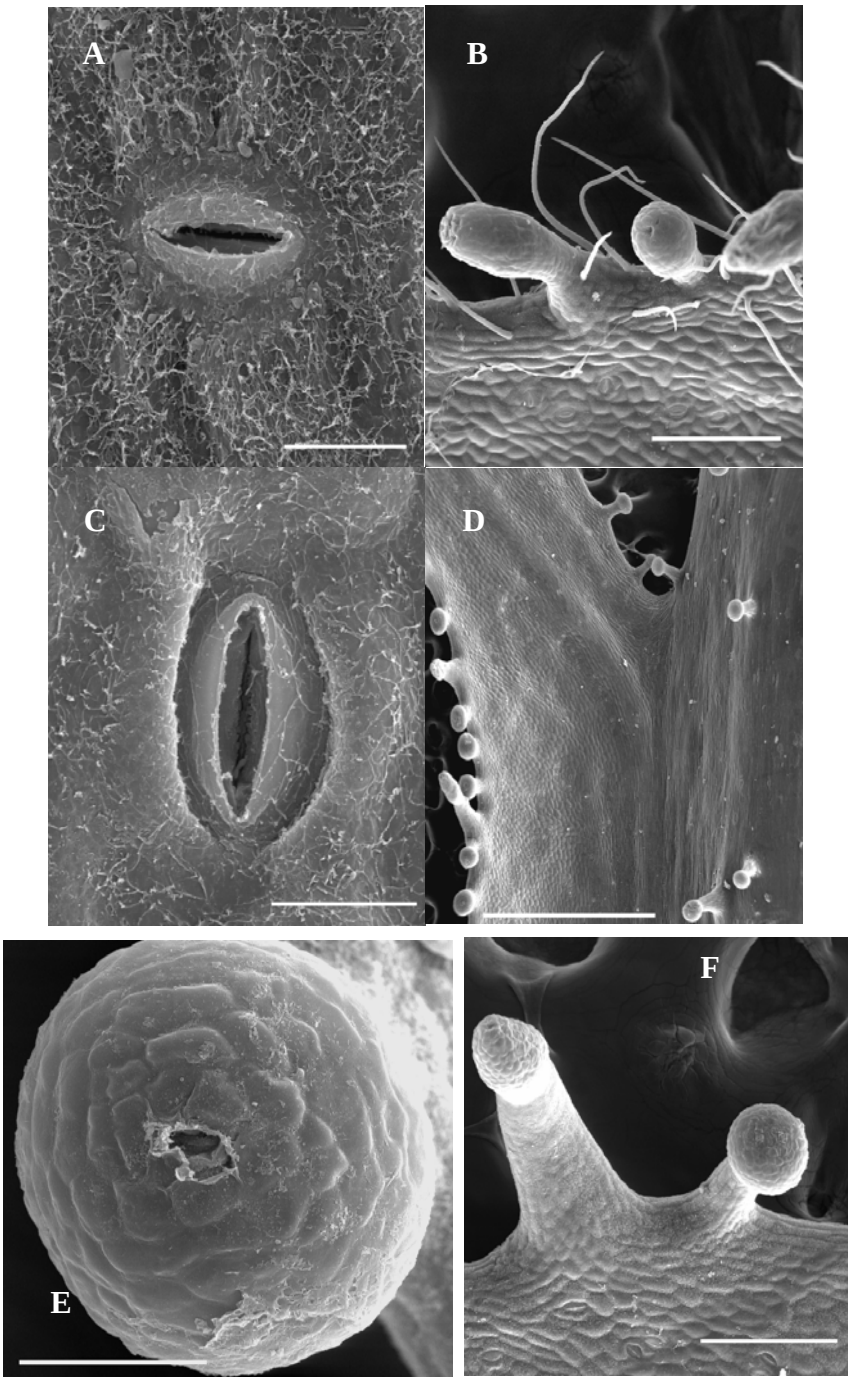

Fig. 3. ***Independence***: A – leaflet, lower epidermis, scale bar - 20 µm, B – stipule - 200 µm, ***Coktail:*** C – leaflet lower epidermis, scale bar - 20 µm, D – mature stipule – 1 mm, E – gland from mature stipule - scale bar - 50 µm, F – two gland types from young stipule - scale bar - 200 µm

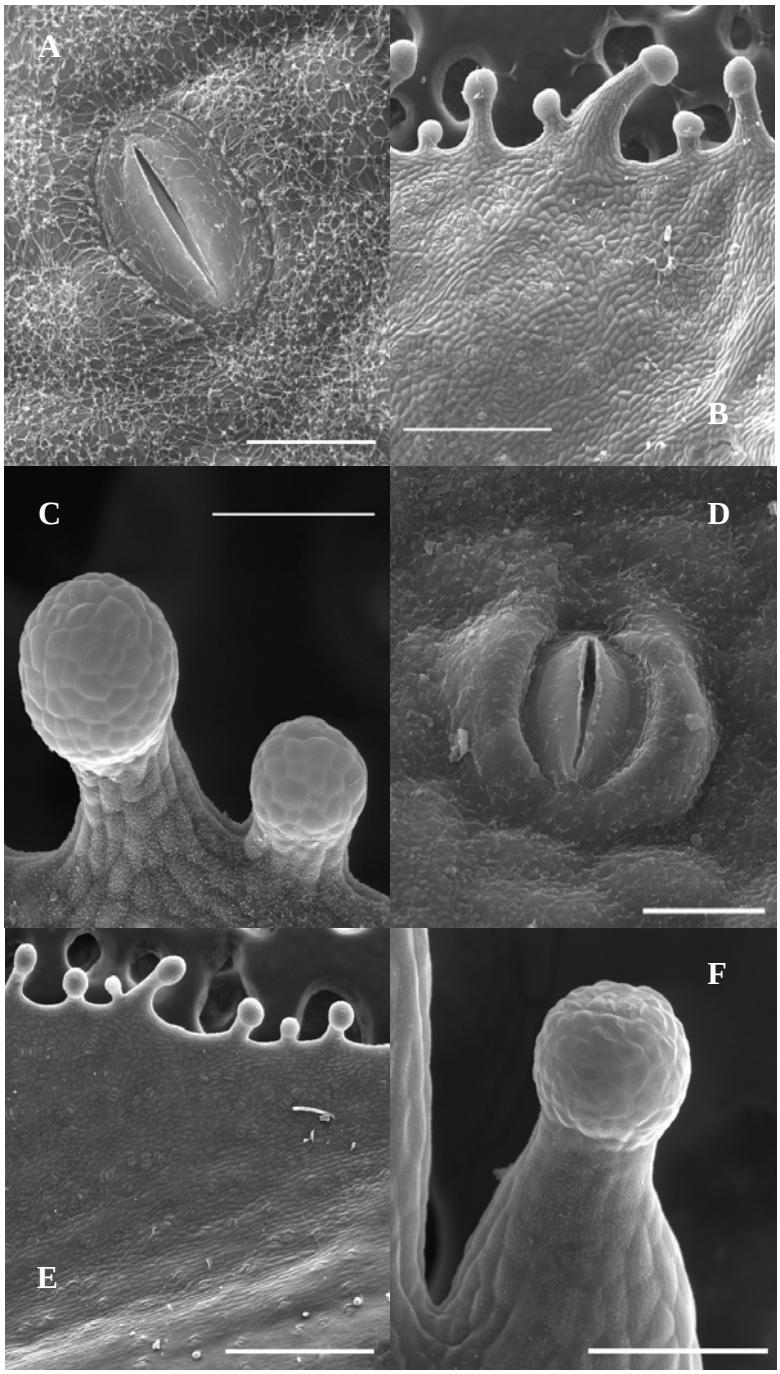

Fig. 4. ***M-me Meillant***: A – leaflet, lower epidermis, scale bar - 20 µm, B – stipule - 400 µm, C - glands from young stipule - scale bar - 200 µm, ***Laminuette***: D – leaflet, lower epidermis, scale bar - 20 µm, E - glands from young stipule - scale bar - 200 µm, F – gland from the margin of the leaflet, scale bar - 50 µm

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EFFICIENT MICROPROPAGATION FROM COTYLEDONARY NODE CULTURES OF *COMMIPHORA WIGHTII* (ARN.) BHANDARI, AN ENDANGERED MEDICINALLY IMPORTANT DESERT PLANT

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Abstract: *Commiphora wightii* (Arn.) Bhandari, is a medicinal important desert species of the family *Burseraceae*. It is a well known for its valuable active principle found in its oleo-gum-resin (guggulsterone E and Z), which are used in drugs preparation for lowering the cholesterol level in human body. Due to its overexploitation, poor natural regeneration this valuable plant is on the verge of extinction and thus a IUCN Red listed species. In the present study we report development of an efficient micropropagation protocol from cotyledonary node of *Commiphora wightii*. Cotyledonary nodes were used as an explants and multiple microshoots were obtained on Murashige & Skoog (MS) medium supplemented with 2.68 μM α-Naphthalene acetic acid (NAA) and 4.44 μM 6-Benzylamino purine (BAP) and on 2.68 μM NAA; 4.44 μM BAP with additives (glutamine 684.2 μM; thiamine 29.65 μM; activated charcoal 0.3%) and various other hormonal combinations. Elongation of microshoot was significantly observed on the 2.46 μM Indole-3-butyric acid (IBA) and 2.22 μM BAP supplemented MS medium. Efficient rooting was obtained on pretreated microshoot (4.92 μM IBA for 24 hours) and followed by transfer to White's medium without Plant Growth Regulators (PGR) and high concentration of activated charcoal (AC). Rooted micro-shoots were transferred to vermiculite and wetted with Hoagland's solution for primary hardening for 4-5 weeks and then finally transferred to plastic cups containing vermiculite, placed in mist chamber. Plantlets were transferred to soil: FYM 1:1 containing poly-bags, then to green shade house for complete acclimatization and finally transplanted to the experimental field.

Keywords: Medicinal plant, *Commiphora wightii*, guggulsterone, budbreak, acclimatization

Introduction

Commiphora wightii (Arn.) Bhandari (*Burseraceae*), a small tree having arid natural habitat grows in North-Western arid tracts of the Thar desert in India and Eastern parts of Pakistan. It is an important medicinal plant of the Indian Ayurvedic system of medicine for over 3000 years and also having a nice status in modern drug system. It is the source of valuable oleo-gum-resin popularly known in the Indian sub-continent as 'guggul gum' or 'guglu', has commercial importance and is extracted through tapping of main stem. Guggul gum is a source of guggulsterones and has many medicinal properties. It lowers hepatic cholesterol levels by acting as an antagonist of the FXR bile acid receptor, important in metabolism of cholesterol [URIZAR, 2002]. It takes 8 to 15 years to become commercially exploitable through tapping and yields 700 to 900 g resin. After which the plant invariably dies [SABINSA CORP., 2000]. Moreover, seeds are a result of apomixes so their formation is very irregular. Apomixis is non-pseudogamous [GUPTA & al. 1996, 1998]. According to one report, the germination rate is as low as 1.4% [YADAV & al. 1999) and it is a slow growing

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species [SONI, 2010]. Hence, natural regeneration rate of this species is very low. Coupled with its commercial importance resulting in over exploitation, its natural population is dwindling fast. It has been listed in the IUCN Red List of threatened species [IUCN, 2010].

Hence tissue culture holds promise to mass-multiply this valuable species which is on the verge of extinction. Here we report the results of a study leading to the development of a micropropagation protocol of *Commiphora wightii* (Arn.) Bhandari, from cotyledonary nodes (Fig. 1).

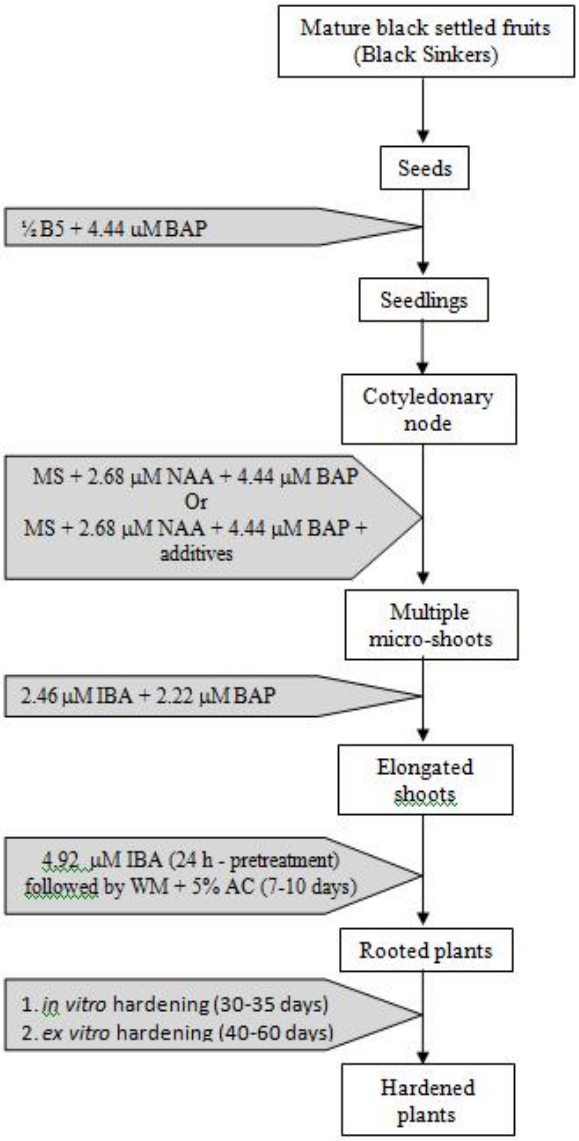

Fig. 1. Complete micropropagation protocol for *Commiphora wightii* from cotyledonary node

Materials and methods

Plant Material.

Commiphora wightii seeds were collected from marked visibly healthy trees growing in the natural population cluster in Kaylana region (Fig. 2A) and plantations growing at the ecology field of JNV University, Jodhpur. The plant flowers twice a year (March and September) and hence fruits (Fig. 2B) were collected twice (summer collection: April-June and winter collection: October-December). Fruits endocarp were either black or white (Fig. 2C). Ripe fruits had red mesocarp.

Fruit selection process. The mature fruits collected (both white and black and from winter and summer season) were subjected to a '*water submergence selection process*'. The fruits either remained submerged or floated and were accordingly classified as sinkers and floaters. Floaters were rejected as they were mostly found to have empty locules with small, improperly developed or no seed. This also explains the reason for their floatation. Sinkers were further categorized into three classes based on their weight. Higher fruit weight is an indicator of healthy and bigger seed. Seeds were isolated from fruits and total number of seeds was counted for all categories.

Surface sterilization. The fruits were de-pulped to remove exo- and mesocarp. The fruit having seeds (category C) were subjected to surface sterilization procedure. The selected fruits were washed in running tap water for 2 minutes to remove dirt and superfluous impurities. They were then shaken in 100 ml. RO water (Millipore RiOS5) having 2 drops of tween-80 for 10 minutes, rinsed 3 times with sRO water (sterilized water from Reverse Osmosis). The cleaned fruits were then treated for 10 minutes with a solution of 200 mg Bavestein and 50 mg streptomycin in 100 ml sRO water with gentle shaking at 50 rpm and rinsed with sRO water once in a laminar flow clean air cabinet. The fruits were finally treated with NaOCl solution (providing 5% available chlorine) for 5 minutes and rinsed with sRO water thrice. The endocarp was now broken open carefully with a sharp sterile scalpel and seeds were scooped out and inoculated on germination medium.

Nutrient Medium. MS, B5 and Whites media were used in various experiments. Media were prepared by re-suspension of readmix nutrient salts (HiMedia Laboratories, India). For germination, full and half strength MS and Gamborg's B5 medium were tested. In one experiment the germination medium was supplemented with BAP (4.44 μM). Different experiments were carried out to test the effect various PGRs on bud break response of the cotyledonary node explants. MS medium supplemented with (4.44, 11.09 and 17.76 μM) BAP alone; MS medium supplemented with Kinetin (4.65, 11.62 and 18.58 μM) alone; MS Medium supplemented with a combination of auxins and cytokinins such that different auxin – NAA (2.68 μM), IAA (2.85 μM), 2,4-D (2.26 μM) and IBA (2.46 μM) was combined with BAP (4.44 and 11.09 μM). To see their effect on bud break response three additives were also tested in the bud break medium. These were glutamine (684.2 μM), thiamine (29.65 μM) and activated charcoal (AC) (0.3% w/v). MS media supplemented with IBA (2.56 μM) + BAP (4.44 μM) and MS media supplemented with IBA (2.46 μM) and BAP (2.22 μM) were used for elongation of micro-shoots.

Root induction. Proliferated shoots were excised from the established cultures and transferred on full strength MS media supplemented with IBA (4.92 μM) for 24 hours treatment. After treatment micro-shoots were subcultured on PGR-free (Plant Growth Regulators free) White's medium, PGR-free White's medium with AC (5% w/v) and PGR-free half strength MS medium for rooting response.

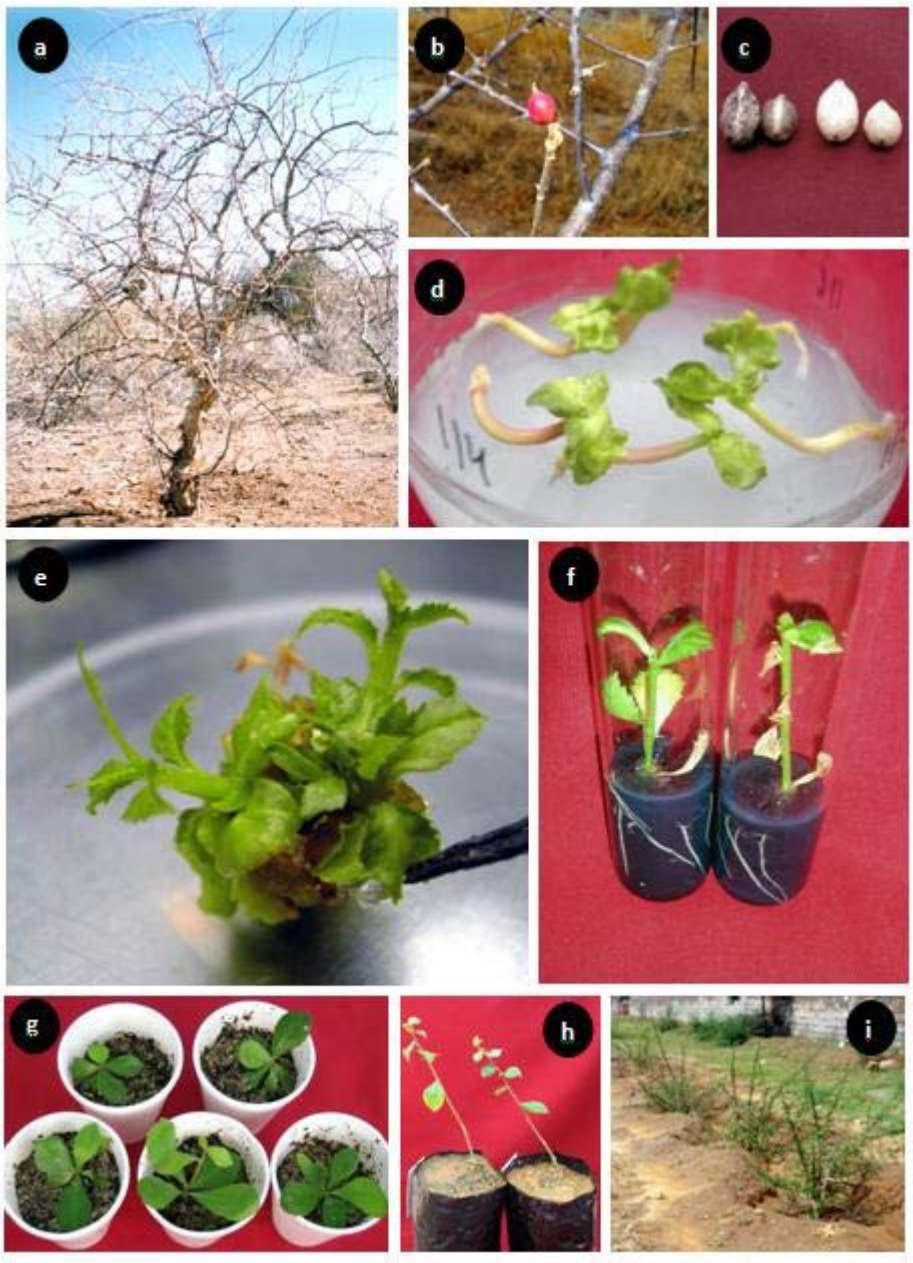

Fig. 2. Cotyledonary node derived micropropagation in *Commiphora wightii*. *A,* a mature tree in May; *B*, mature fruit; *C*, seeds with black and white endocarp; *D*, Germination after BAP pretreatment; *E*, micro-shoot multiplication; *F*, *in vitro* rooting; *G*, *ex vitro* hardening; *H*, hardened plantlets ready for field trial; *I*, plants growing under field conditions (after 1 yr. of transplantation)

Acclimatization and field transfer. Well-rooted plantlets were transferred to glass jam jars filled quarter level with vermiculite and wetted with Hoagland's solution [HOAGLAND, 1950]. After 4-5 weeks when plantlets showed new growth the plastic cap of the glass jar was unscrewed gradually over a period of 2-3 days to reduce relative humidity in the jar, then finally the caps were removed completely from the jars on the third day**.** The plantlets were then transferred to thermocol cups containing vermiculite wetted with Hoagland's solution at one-week interval (Fig. 2G). These plantlets were placed in mist chamber. After two weeks these were then transferred to soil: FYM 1:1 mixture in plastic plantation bags (poly-bags) of size 9x9x36 cm (2916 cm^3). In mist chamber, 90 second misting at ten minutes interval was given to maintain RH between 85 to 95%. The temperature of mist chamber was maintained between 28-30°C. After one month of transfer to poly-bags plantlets were transferred under green-50% agronet shade (Fig. 2H) and after two week transferred to field (Fig. 2I) where they are growing well and have started to flower and set seeds. Growth data of the field grown plants is being collected (data not shown).

*Statistical analysis***.** Experiments were set up in completely randomized design (CRD). Each treatment consisted of 5 replicates and each replicate with five explants. Experiments were repeated thrice. The frequency of bud break and micro-shoot elongation, expressed as percentage, was calculated as the proportion of the number of explants giving positive response. The data were analyzed statistically using SPSS ver 8.0 (SPSS, Chicago, IL). Significance of differences among means was compared using two way analysis of variance and least significant difference at P=0.05.

Results and discussion

Selection of mature fruits for seed isolation. Mature fruits when dipped in water segregate into two types – floaters (F) and sinkers (S). Black fruits collected from different locations during different seasons were dipped in water and it was observed that maximum number of settled black fruits came from winter collection of Kaylana region natural populations. Further selection was based on the weight of the fruits (Tab. 1). Mature fruits could be separated into three categories - floating black fruit, floating white fruit and settled black fruit and were categorized as A, B and C respectively. Settled white fruits were not included in the experiments because their number was very low. Fruits of category C were heavier than other two categories. Therefore, category C fruits were selected to isolate mature seeds. Observations showed no remarkable difference in number of seeds isolated from settled black fruits collected from plantations of JNV University campus and natural plantations of Kaylana region during winter. Further, weight of the isolated seeds from floating and settled fruits was examined**.** No difference was found in weight of the seeds isolated from seed containing floating and settled black fruits collected from Kaylana. Hence, seed present in floating and settled fruits were considered equally good. However, selection was essential to save time and to get maximum seeds in minimum time duration because most of the floating fruits were empty.

Tab. 1. Selection of mature fruits for seed categorization using water dip test

Fruit Category	Fruit colour	Water dip test	Weight (g)
A	White	F	0.02 ± 0.00
B	Black	F	0.04 ± 0.02
C	Black	S	0.07 ± 0.03

Note: F = floater; S = sinker

Seed germination. Isolated seeds from category C fruits, after surface sterilization, were inoculated on full and half strength salt concentrations of MS [MURASHIGE & SKOOG, 1962] and B5 media [GAMBORG'S, 1968]. Half strength B5 media was found to be the most suitable medium for *in vitro* germination of seeds (Tab. 2).

Tab. 2. *In vitro* seed germination response

Treatment	No. of germinated seeds	No. of robust seedlings
MS –fs	10.0 ± 1.92	2.22 ± 1.11
MS –hs	16.5 ± 1.50	16.50 ± 1.41
B5 –fs	19.0 ± 1.0	8.0 ± 0.03
B5 –hs	20.0 ± 0.24	18.0 ± 0.21
MS-hs-1B	21.75 ± 0.93	8.25 ± 1.31
B5-hs-1B	**24.00 ± 0.20**	**17.5 ± 0.32**

Note: fs = full strength; hs = half strength; 1B = 4.44 μM BAP
data scored after 4 weeks of culture inoculation. values indicate Mean ± SE.

Effect of BAP pretreatment. Isolated seeds were treated with BAP during germination. Half strength B5 medium supplemented with BAP (0 and 4.44 μM) was tried. Half strength B5 medium supplemented with BAP (4.44 μM) was found to be best for seed germination and healthy seedling production (Tab. 2). Seed germination was 100% and nearly 72% seedlings were healthy on B5 medium supplemented with BAP (4.44 μM) (Fig. 2D). Positive effect of pretreatment on bud break and multiplication was clearly observed (Tab. 3). Bud multiplication response was also better in BAP treated explants.

Tab. 3. Effect of pretreatment (4.44 μM BAP) on bud break and micro-shoot multiplication through cotyledonary node explants cultured on MS + 2.68 μM NAA + 4.44 μM BAP.

BAP pretreatment (μM)	Percentage explants showing bud break	No. of micro-shoots per sprouted bud (= Fold multiplication)	
		After 20 days	After 45 days
0 ©	58.33 ± 1.10	1 ± 0.32	0
4.44	66.66 ± 1.15	1.75 ± 0.12	**2.25 ± 0.21**

Note: Data scored after 4 weeks of culture inoculation for bud break response.
values indicate Mean ± SE.
© = control

Effect of different hormones on bud break.

1. BAP: Pretreated cotyledonary node exlants were harvested from *in vitro* raised seedlings. These exlants were cultured on MS medium supplemented with BAP (4.44, 11.09 and 17.76 μM). Full strength MS medium supplemented with BAP (4.44 μM) responded best as compare to others (Tab. 4). Increasing concentration of BAP impose

negative effect on bud break and multiplication. Quality of shoot buds was good on BAP (4.44 μM) and BAP (11.09 μM) with very little callusing at the base of cotyledonary node, whereas on higher concentration callusing was more and swelling of micro-shoots was observed. It was also observed that on higher concentration (17.76 μM BAP) proper shoots were not produced.

2. Kinetin: Pretreated cotyledonary node exlants were harvested from *in vitro* raised seedlings. These exlants were cultured on MS medium supplemented with Kinetin (Kn) (4.65, 11.62 and 18.58 μM). Full strength MS medium supplemented with Kinetin (4.65 μM) responded best as compare to others (Tab. 4). Increasing concentration of Kinetin impose negative effect on bud break and multiplication. Quality of shoot buds was good on Kinetin (4.65 μM) but comparatively micro-shoots produced on BAP (4.44 μM) were looking better.

Tab. 4. Effect of BAP and Kn used separately on bud break and micro-shoot multiplication

BAP (μM)	Kn (μM)	Percentage explants showing bud break	No. of micro-shoots per sprouted bud (= Fold multiplication)	
			After 20 days	After 45 days
0 ©	0 ©	11.08 ± 1.33	0	0
4.44	-	**72.25 ± 0.81**	1.19 ± 0.53	**1.49 ± 0.46**
11.09	-	66.66 ± 0.45	**1.29 ± 0.33**	1.42 ± 0.10
17.76	-	63.92 ± 0.34	1.22 ± 0.16	1.35 ± 0.12
-	4.65	69.42 ± 1.17	1.16 ± 0.23	1.20 ± 0.00
-	11.62	63.91 ± 0.72	1.09 ± 0.51	1.13 ± 0.36
-	18.58	58.33 ± 0.85	1.14 ± 0.11	1.19 ± 0.13

Note: Data scored after 4 weeks of culture inoculation for bud break response.
values indicate Mean ± SE.
© = control

3. Auxin and cytokinin: With the aim to study the bud break response on various hormone combinations different auxin NAA (2.68 μM), IAA (2.85 μM), 2,4-D (2.26 μM) and IBA (2.46 μM) were combined with BAP (4.44 and 11.09 μM). On the basis of previous results BAP (4.44 and 11.09 μM) were producing good micro-shoots hence only these were combined here with auxins. Two combinations (2.68 μM NAA + 4.44 μM BAP and 2.26 μM 2,4-D + 11.09 μM BAP) were showing best and similar quantitative results but quality of the microshoot was better on 2.68 μM NAA + 4.44μM BAP (Tab. 5). On 2.26 μM 2,4-D + 11.09 μM BAP, however, microshoot here were not elongating. Later on they turned pale green and died. Qualitatively very nice growth of microshoot was observed on both the BAP combinations with IBA. Micro-shoots were green, shiny and robust on 2.46 μM IBA + 4.44 μM BAP and 2.46 μM IBA + 11.09 μM BAP.

Tab. 5. Effect of auxin and cytokinin used in combination on bud break and micro-shoot multiplication response

Treatment		Percentage explants showing bud break	No. of micro-shoots per sprouted bud (= Fold multiplication)	
Auxin	BAP (μM)		After 20 days	After 45 days
0 ©	0 ©	11.08 ± 1.33	0	0
NAA [2.68 μM]	4.44	**86.7 ± 1.24**	**1.58 ± 1.04**	**2.04 ± 1.22**
	11.09	73.3 ± 1.22	1.36 ± 0.37	1.27 ± 0.67
IAA [2.85 μM]	4.44	76.7 ± 1.89	1.13 ± 0.13	1.09 ± 0.52

	11.09	66.7 ± 2.56	1.29 ± 0.66	1.35 ± 0.39
IBA [2.46 μM]	4.44	73.3 ± 0.89	1.13 ± 0.35	1.68 ± 0.91
	11.09	80.0 ± 1.15	1.17 ± 0.67	1.50 ± 0.72
2,4-D [2.26 μM]	4.44	83.3 ± 1.01	1.28 ± 1.05	1.40 ± 1.04
	11.09	**86.7 ± 1.17**	1.11 ± 0.78	1.19 ± 1.11

Note: Data scored after 4 weeks of culture inoculation for bud break response.
values indicate Mean ± SE.
© = control

Effect of additives on bud break. Glutamine, thiamine and activated charcoal were used as additives. Results show no positive effect of additives. Number of explants showing bud break and number of micro-shoots produced were almost equal in both the experiments (Tab. 5 and 6). Qualitative observation showed that in presence of additives micro-shoots looks healthier with dark green leaves and thick stem.

Tab. 6. Effect of additives on bud break and micro-shoot multiplication response

Treatment (MS Medium + additives)		**Percentage explants showing bud break**	**No. of micro-shoots per sprouted bud (= Fold multiplication)**	
Auxin	**BAP (μM)**		**After 20 days**	**After 45 days**
0 ©	0 ©	73.3 ± 1.26	1.00 ± 0.0	1.00 ± 0.0
0	4.44	80.0 ± 3.15	1.00 ± 0.0	1.00 ± 0.0
0	11.09	80.0 ± 2.11	1.00 ± 0.0	1.00 ± 0.0
NAA [2.68 μM]	4.44	**96.7 ± 1.59**	**1.31 ± 0.51**	**1.69 ± 0.26**
	11.09	90.0 ± 0.66	1.18 ± 0.11	1.15 ± 0.31
IBA [2.46 μM]	4.44	80.0 ± 0.57	1.33 ± 0.23	1.33 ± 0.13
	11.09	83.3 ± 0.89	1.44 ± 0.22	1.44 ± 0.08

Note: Additives (add): glutamine (684.20 μM), thiamine (29.65 μM) and 0.3% (w/v) AC
data scored after 4 weeks of culture inoculation for bud break response.
values indicate Mean ± SE.
© = control

Elongation of micro-shoots.

1. On bud break medium. Observations showed that micro-shoots were showing poor elongation (between 1.5 to 2 cm.) on MS media supplemented with 2.49 μM IBA + 4.44 μM BAP (bud break medium). At the rate of 26.66% after 20 days and 36.66% after 45 days (Tab. 7).

Tab. 7. Elongation of micro-shoots

A. Treatment (bud break medium)	**B. Percentage elongation on bud break medium (A.)**		**C. Percentage elongation of micro-shoots from treatment (A.), upon subculture on EM**
Duration of treatment	**After 20 days**	**After 45 days**	**After 45 days**
Control	0	0	0
MS + add	0	0	0
MS + 4.44 μM BAP	23.33 ± 2.33	23.33 ± 2.33	55.00 ± 2.33
MS + 4.44 μM BAP + add	23.33 ± 1.79	26.66 ± 1.79	55.00 ± 1.79

MS + 11.09 μM BAP	23.33 ± 3.11	20.00 ± 2.84	60.00 ± 1.15
MS + 11.09 μM BAP + add	20.00 ± 1.14	23.33 ± 2.24	55.00 ± 2.88
MS + 2.68 μM NAA +1 BAP	10.00 ± 3.02	10.00 ± 3.02	**75.00 ± 2.56**
MS + 2.68 μM NAA + 4.44 μM BAP + add	13.33 ± 0.89	13.33 ± 0.89	**70.00 ± 1.26**
MS + 2.68 μM NAA +11.09 μM BAP	00.00 ± 0	00.00 ± 0	50.00 ± 3.88
MS + 2.68 μM NAA +11.09 μM BAP + add	13.33 ± 0.78	10.00 ± 0.56	65.00 ± 2.41
MS + 2.46 μM IBA + 4.44μM BAP	**26.66 ± 3.33**	**36.66 ± 3.86**	**70.00 ± 3.23**
MS + 2.46 μM IBA + 4.44μM BAP + add	20.00 ± 2.94	23.33 ± 2.99	75.00 ± 4.18
MS + 2.46 μM IBA + 11.09 μM BAP	20.00 ± 2.13	23.33 ± 2.26	55.00 ± 3.33
MS + 2.46 μM IBA + 11.09 μM + add	20.00 ± 1.68	26.00 ± 2.15	65.00 ± 3.31

Note: EM = elongation medium (MS + 2.46 μM IBA + 2.22 μM BAP)
additives (add): glutamine (684.20 μM), thiamine (29.65 μM) and 0.3% (w/v) AC
values indicate Mean ± SE

2. On elongation media. Since micro-shoot elongation was poor on the bud break medium, BAP concentration was reduced to 2.22 μM. It was also observed in previous experiments that qualitatively better micro-shoots were produced on the medium supplemented with IBA as compare to other tried auxins. Therefore, a new hormonal combination (MS media supplemented with 2.46 μM IBA and 2.22 μM BAP) was tested for elongation of micro-shoots. All the micro-shoots were further subcultured on this medium. Within a period of a month substantial elongation was observed, hence considered as elongation medium (Tab. 7). Best responses was observed on micro-shoot isolated from MS + 2.68 μM NAA + 4.44 μM BAP and MS + 2.46 μM IBA + 4.44 μM BAP + additives followed by MS + 2.46 μM IBA + 4.44 μM BAP and MS + 2.68 μM NAA + 4.44 μM BAP + additives (Fig. 2E).

Rooting of micro-shoots. Low frequency rooting was initiated *sua sponte* on elongation medium. However, White's medium with 5% activated charcoal was found to be best for rooting. A maximum of 43.33% rooting was observed on White's medium with 5% AC (Tab. 8). Positive effect of activated charcoal was clearly visible here (Fig. 2F). In absence of activated charcoal on White's medium, rooting recorded was only 16.67%.

Tab. 8. Rooting response of micro-shoots on different rooting media

Treatment	% Rooting	No. of roots/shoot	Root length (cm)
WM	16.67 ± 3.33	2.5 ± 0.5	2.8 ± 0.1
WM + 5% (w/v) AC	**43.33 ± 3.33**	**5.5 ± 0.5**	**3.7 ± 0.2**
½ MS + 5% (w/v) AC	6.7 ± 0.0	2.0 ± 0.0	1.75 ± 0.05

Note: Data scored after 4 weeks of culture inoculation for rooting response.
values indicate Mean ± SE.

Cotyledonary node explants harvested from BAP-preconditioned seedlings responded better as compare to those without the treatment. Multiple shoots were produced only on preconditioned explants. It showed the necessity of BAP treatment to seeds during germination. Similar observations were recorded in *Pterocarpus marsupium* Roxb. where multiple shoots were induced from cotyledonary nodes derived from 20-d-old axenic seedlings grown on Murashige and Skoog (MS) medium containing 2.22–13.32 μM benzyladenine (BAP) [SINGH & CHAND, 2004]. Better response of explants was observed in *Pithecellobium saman* (Jacq.) Benth, when explants were cultured on half strength MS medium containing 26.63 μM BAP [LISSETTE & al., 1997]. A similar response has been reported in case of *Acacia catechu* Willd. (*Mimosaceae*), [KAUR, 1996]. Best bud break and multiplication was observed on 4.44 μM BAP supplemented medium, while higher concentrations were found to be imposing negative impact in terms of increased callusing and vetrification. Similar observations were also made by JACKSON & HOBBS, 1990 who reported multiple shoots production, from cotyledonary node explants of pea (*Pisum sativum* L., *Fabaceae*) cultured on MS medium containing low concentrations of BAP (4.44 μM).

Excellent growth of micro-shoots was observed on both the BAP combinations with IBA. Micro-shoots were green, shiny and very healthy on 2.46 μM IBA + 4.44 μM BAP and 2.46 μM IBA + 11.09 μM BAP. But overall 2.68 μM NAA + 4.44 μM BAP combination was the best for bud break as well as for multiplication (an average 2-3 shoots per explant) along with good microshoot quality on this combination. A maximum of upto six micro-shoots per cotyledonary node explant was observed. Similarly, 2-3 shoots per explant were obtained in 75% of the cultures of *Commiphora wightii* on MS medium supplemented with 18.58 μM Kn + 17.76 μM BAP [BARVE & MEHTA, 1993].

Shoot buds after bud break showed poor elongation response on same bud break medium. Similar results were reported by BARVE & MEHTA, 1993. It is a known phenomenon in tissue culture that reduction in cytokinin concentration after bud break promotes elongation of micro-shoots. Hence 2.22 μM BAP was used in place of 4.44 μM and 11.09 μM. This also explains the positive responses that were observed by micro-shoots isolated from MS + 2.68 μM NAA + 4.44 μM BAP and MS + 2.46 μM IBA + 4.44 μM BAP + additives followed by MS + 2.46 μM IBA + 4.44 μM BAP and MS + 2.68 μM NAA + 4.44 μM BAP + additives. Positive effect of reduced cytokinin concentration in elongation was also reported by BARVE & MEHTA, 1993 where a maximum of 2-3 cm. elongation was recorded. LI-HUA & al., 2005 also reported that the best shoot production in terms of shoot number and shoot quality was obtained using 4.44 μM BAP and 0.49 μM IBA during the shoot multiplication phase and 1.00 μM BAP and 0.25 μM IBA during the shoot elongation phase.

Pretreatment of IBA with NAA and IAA was also found beneficial in *Commiphora wightii* as reported by BARVE & MEHTA, 1993. Proliferated shoots were excised from the established cultures and cultured on three different media, White's medium [WHITE, 1954], White's medium with 5% AC (w/v) and half strength MS medium with 5% AC (w/v). A maximum of 43.33% rooting was observed on White's medium with 5% activated charcoal. Positive effect of activated charcoal was clearly visible here. In absence of activated charcoal on White's medium rooting recorded was only 16.67%. BARVE & MEHTA, 1993 also reported 40% rooting in *Commiphora wightii* on White's medium.

Glutamine (684.2 μM), thiamine (29.65 μM) and 0.3% AC (w/v) found to be best for *Commiphora wightii* nodal explant and *in vitro* raised shoot apices according to BARVE & MEHTA, 1993. Hence, effects of only these concentrations were studied with cotyledonary node explants in the present study.

Half strength MS and White's root culture media, both with 5% AC were compared and White's root culture media with 5% AC found to be good for rooting. BARVE & MEHTA, 1993 also compared the same media for rooting response and reported 60% rooting on MS half strength with 5% AC. This value greatly differed from present observation. Present study showed only 6.7% rooting on same media. Therefore White's root culture media with 5% AC was selected. Roots were white and produce very few numbers of secondary roots. No callusing was observed with rooting.

Conclusions

Commiphora wightii is on the verge of extinction and need immediate interventions for a sound propagation technology. The protocol described here is suitable to mass multiply the plant from its seeds which are hard to germinate naturally. This can be useful in production of plants that can be utilized in restoration of its degraded habitat and prove helpful in both *in situ* and *ex situ* conservation efforts for this valuable plant.

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TRICHODERMA VIRIDE PERS. – EXPERIMENTAL MODEL FOR BIOLOGICAL AND BIOTECHNOLOGICAL INVESTIGATIONS OF MYCROMYCETA WITH IMPORTANCE IN OBTAINING PLANT PROTECTION BIOPRODUCTS

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Abstract: The technological process for obtaining plant protection bioproducts contains 2 main phases: (i) biomass biosynthesis of microorganisms in a culture medium, available for industrialization and (ii) biomass conditioning of microorganism, the antagonistic micromycetes, respectively. For this type of activities it is essential to establish biological development parameters: (i) the optimum composition of the liquid culture medium for development of the fungus under aerobiotic conditions and (ii) the optimal parameters of biosynthesis in the studied medium. The biomass biosynthesis technology is discontinuous, of cascade type, and develops several phases: (1) preparing of the laboratory inoculum, (2) preparing of the fungal pure culture in Erlenmeyer bottles, (3) industrial (simulated) multiplication in the aired and agitated liquid medium.
This paper presents some experimental aspects referring to: 1 – Characterization of the biologically active *T. viride* isolates, establishing and verifying of their biological thresholds; 2 – Evaluation and experimental verifying of the mass multiplication ability of antagonistic *T. viride* fungi on the culture media in order to select the optimum industrial culture substrate (medium); 3 – Biochimical characterization of *T. viride* isolates by electrophoretic analysis of their protein profile; 4 – Evaluation of the *T. viride* biological activity of *T. viride* isolates against phytopathogenic fungi with high practical importance: *Fusarium graminearum* Schwabe (T. *Gibberella zeae* (Schwein.) Petch), *F. culmorum* (W. G. Sm.) Sacc., *Pythium ultimum* Trow, *Botrytis cinerea* Pers., *Sclerotinia sclerotiorum* (Lib.) de Bary, *Alternaria* spp. [*A. alternata* (Fr.) Keissl., *Alternaria radicina* Meier, Drechsler and E. D. Eddy (*Stemphylium radicinum* (Meier, Drechsler and E. D. Eddy) Neerg.)] etc.; 5 – Processing of technological scheme for obtaining plant protection preparates based on biologically active isolates of *T. viride*.

Key words: antagonistic micromycetes, *Trichoderma viride*, electrophoretic analysis, plant protection bioproducts

Introduction

Trichoderma viride Pers., Neues Mag. Bot. **1**: 92 (1794), syn. *T. lignorum* (Tode) Harz, *Linig. Hyph.* 29 (1871) belonging to *Hypocreaceae* Family, *Hypocreales* Order, *Hypocreomycetidae* Subclass, *Sordariomycetes* Class, *Ascomycota* Phyllum, *Regnum* Fungi [15, 16, 36], is one of the most studied as a fungus with importance in biotechnology [2, 7, 10, 17, 18, 19, 20, 21, 26, 28, 29, 30, 31, 34, 35 a.o.]. It is an appropriate experimental model of mycoparasitic fungus for obtaining bioproducts with plant protection importance [4, 6, 9, 11, 14].

The aim of this paper was the development of the technology for obtaining plant protection bioproducts based on *T. viride* as an experimental model for the autochtonous biotechnology.

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The objectives of the research were the following: 1 – Characterization of the biologically active *T. viride* isolates, establishing and verifying of their biological thresholds; 2 – Evaluation and experimental verifying of the mass multiplication ability of antagonistic *T. viride* fungi on the culture media in order to select the optimum industrial culture substrate (medium); 3 – Biochemical characterization of *T. viride* isolates by electrophoretic analysis of their protein profile; 4 – Evaluation of the biological activity of *T. viride* isolates against phytopathogenic fungi with high practical importance; 5 – Processing of technological phases for obtaining plant protection products based on biologically active isolates of *T. viride*.

Material and methods

As biological material there were used 5 isolates of *T. viride* (Td_5, Td_{35}, Td_{45}, Td_{49},Td_{50}) and isolates of the following 8 phytopathogenic fungi: *Fusarium graminearum* Schwabe (T. *Gibberella zeae* (Schwein.) Petch), *F. culmorum* (W. G. Sm.) Sacc., *Pythium ultimum* Trow, *Botrytis cinerea* Pers., *Sclerotinia sclerotiorum* (Lib.) de Bary, *Alternaria* spp. [*A. alternata* (Fr.) Keissl., *Alternaria radicina* Meier, Drechsler and E. D. Eddy (*Stemphylium radicinum* (Meier, Drechsler and E. D. Eddy) Neerg.), all cultures obtained, isolated and preserved by the first author.

1. For the characterization of the biologically active *T. viride* isolates, 7 different solid culture media (Fig. 1), 17 sources of carbon (Fig. 2) and 18 of nitrogen (Figs. 3-4), 16 initial pH values of culture media (Fig. 5), 19 temperatures have been performed (Fig.6).

Fungal growth have been evaluated by measuring the colony diameter (3-5 replicates/variant) every day and using for graphs the data after 2 and 6 days. The last day of experiment, the 6th day, was the day when the *T. viride* colony covered the whole surface of the Petri plate of 10 cm diameter. The sporulation of tested fungus was appreciated by macroscopical analysis following the microscopical analysis [3, 22, 23, 24, 26, 27, 28, 29, 31].

2. For selecting the optimum submerged culture medium, there were tested 9 media containing intermediate products or residual ones from the food industry (Fig. 7) and and 4 liquid media (a-d) (tables 1-3) [25, 26, 27, 28, 29, 31].

3. For the biochemical characterization of *T. viride* isolates the SDS-PAGE analysis was used to reveal protein bands and to determine protein molecular mass. Investigations have been performed by Laemmli vertical method, in MINI-PROTEAN II (BIO-RAD), using poliacrylamide gel as a migration substrate [5].

4. For the appreciation of biological activity of *T. viride* isolates it was used the method of dual cultures [12]. Evaluation of antagonistic activity of *T. viride* isolates has been done by calculating of x coefficient from the ratio between inner radius (i) and outer radius (e) of the phytopathogenic test-fungi (A) and the antagonistic ones (B) (*T. viride*), after the formula X = iA/iB x eB/eA. When x=1, there is no influence between two fungi; when x<1, the antagonism is as strong as the value is lower, more closed with yero value; when x>1, the tested isolate prove no antagonism [31].

5. Biotechnological parameters for production of the bioproducts based on *T. viride* strain was followed according to the general literature for microbial plant protection products' biosynthesis and formulation [8, 13, 14, 18, 21, 32, 33].

Results and discussion

1 – Characterization of the biologically active *T. viride* isolates, establishing and verifying of their biological thresholds.

1.1. Development of *T. viride* on different solid media. Among the 6 tested solid culture media, the most favourables for the development (growth and sporulation) of *T. viride*, isolate Td_{50}, were: Weindling, Warcup, Malt agar extract and PDA (Fig. 1). The diameter of fungal colony have had values between 2.82-5.2 cm, after 2 days, and between 8.54-9.0 cm, after 6 days, respectivelly. On these media the fungal sporulation was excellent.

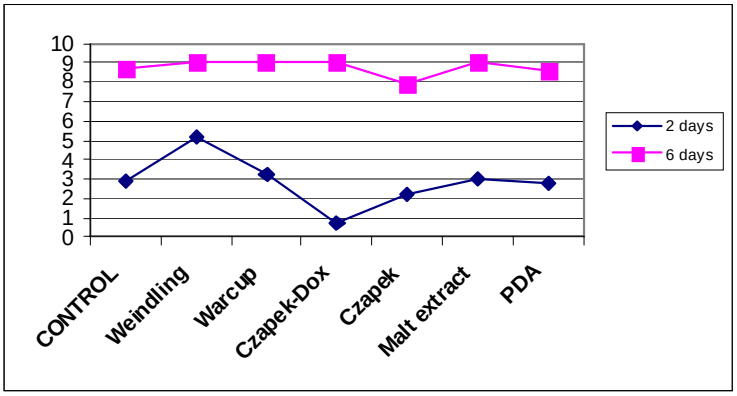

Fig. 1. Growth of *Trichoderma viride*, isolate Td_{50}, on different solid culture media, evaluated by the diameter of fungal colony

1.2. Development of *T. viride* on solid Weindling medium (WG) with different carbon sources. (Fig. 2). Among monosaccharides, the most favourable for growth and sporulation of *T. viride* were: mannite, fructose (levulose), D-ribose, D-galactose, D-mannose, D-dextrose (glucose), the fungal colony having between 4.8-5.833 cm in diameter, after 2 days, and 9.0 cm, after 6 days. Sporulation of *T. viride* was abundant on medium variants containing the mentioned monosaccharides. The poorest development of fungus was found on the medium with D-sorbitol/sorbite, fungal colony having 2.333 cm diameter after 2 days and only 4.433 cm after 6 days.

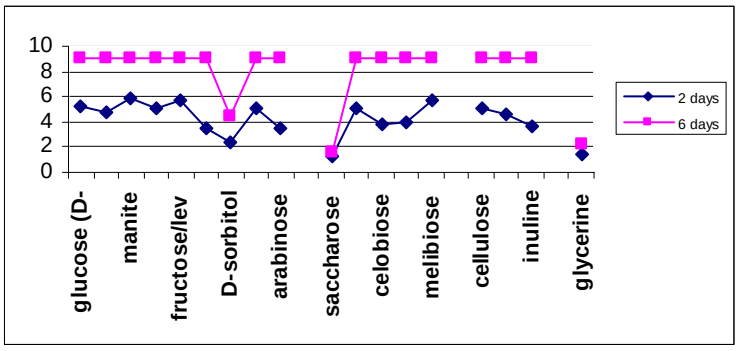

Fig. 2. Growth of *Trichoderma viride*, isolate Td_{50}, on solid culture Weindling medium (WG) containing different carbon sources, evaluated by the diameter of fungal colony

Among disaccharides, the most suitable for the *T. viride* development were melibiose and maltose (diameter of colonies between 5.057 and 5.733 cm after 2 days, and 9.0 cm after 6 days, respectively), followed by lactose and celobiose (diameter between 3.833 and 3.933 cm, after 2 days, and 9.0 cm after 6 days). The most inadequate for the fungal development was saccharose, with the values of 1.2 cm diameter, after 2 days and 1.533 cm, after 6 days.

In the group of polysaccharides, the most favourable was cellulose (5.067 cm diameter after 2 days), followed by starch and inuline (3.633-4.567 cm diameter after 2 days and 9.0 cm after 6 days). The lowest development of *T. viride* has been performed on the medium containing glycerine, fungal colony measuring only 1.4 cm diameter after 2 days and 2.3 cm after 6 days).

1.3. Development of *T. viride* on solid Weindling medium (WG) with different nitrogen sources. The cultivation of *T. viride* on Czapek medium containing different sources of organic and mineral nitrogen (Figs. 3-4) showed that peptone and the aminoacids DL-leucine, L-cystine, DL-citruline, DL-nor-leucine were the most favourable for fungal development (Fig. 3).

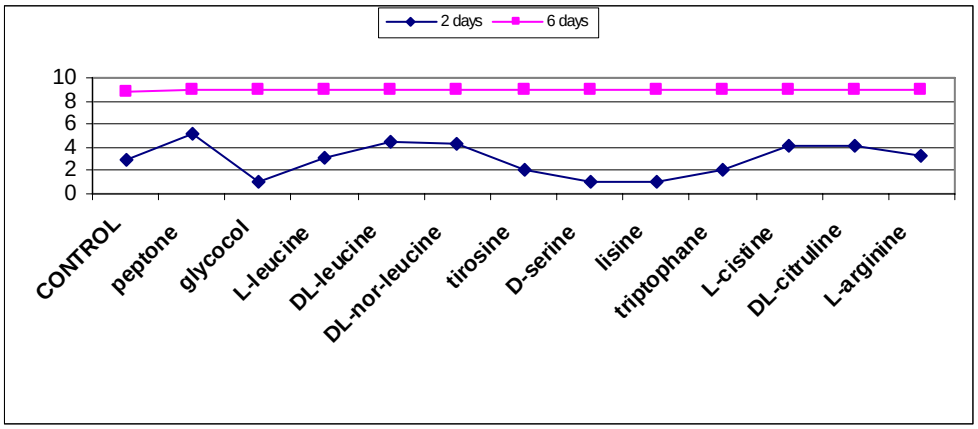

Fig. 3. Growth of *Trichoderma viride*, isolate Td_{50}, on solid Weindling culture medium containing different nitrogen sources (aminoacids), evaluated by the diameter of fungal colony

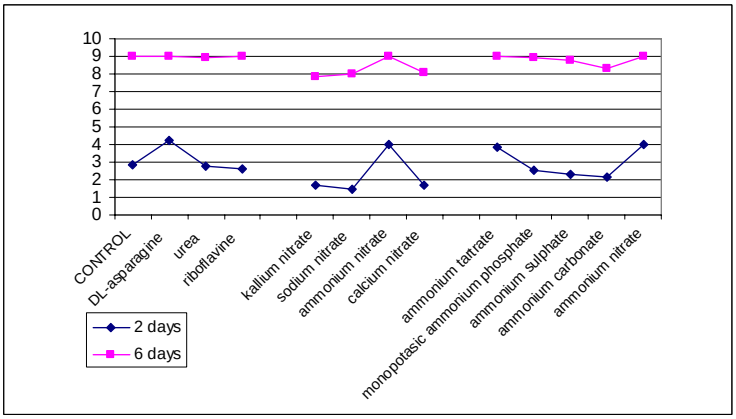

Fig. 4. Growth of *Trichoderma viride*, isolate Td_{50}, on solid culture Weindling medium containing different nitrogen sources (salts, amides, vitamins), evaluated by the diameter of fungal colony

Fungal sporulation was very good on media with: peptone, lysine, tryptophan, DL-asparagine, urea and ammonium salts, and good on media with glycocol, tyrosine, DL-citruline and riboflavin.

1.4. Development of *T. viride* on solid Weindling medium (WG) with different initial values of pH. The best growth of the *T. viride* colonies was recorded in acid medium (pH 4.0-5.5), with a diameter of 6.32 until 7.66 cm after 2 days and 9.0 after 6 days and the poorest one in highly alkaline medium with pH 13.0, and the diameter of the *T. viride* colony of 3.24 cm after 2 days and 5.42 cm after 6 days (Fig. 5).

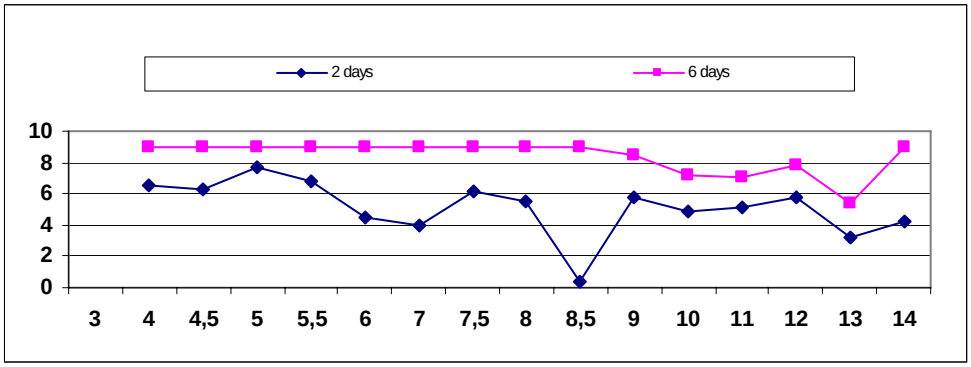

Fig. 5. Growth of *Trichoderma viride*, isolate Td_{50}, on solid Weindling culture medium with different initial values of pH, evaluated by the diameter of fungal colony.

The sporulation of *T. viride* was highest on acid medium, and the poorest on highly alkaline medium (pH 9.0-13.0).

1.5. Development of *T. viride* on solid Weindling (WG) medium under the different temperatures. The optimum growth and sporulation of *T. viride* was the range between 24 and 32ºC (Fig. 6).

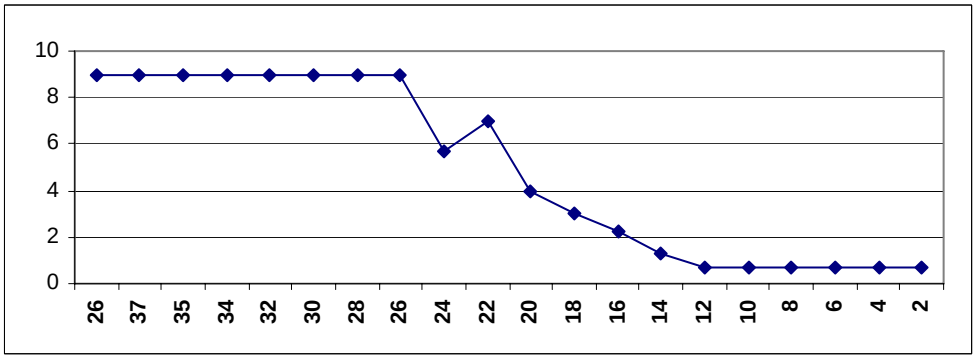

Fig. 6. Growth of *Trichoderma viride*, isolate Td_{50}, on solid Weindling culture medium at different values of temperature, evaluated by the diameter of fungal colony, after 2 days.

The temperatures ranging between 2 and 12ºC do not allow fungal growth and sporulation, between 14 and 18ºC growth but not sporulation was promoted, whereas

between 20-22ºC both growth and sporulation were favoured. At 37ºC the growth and sporulation of the *T. viride*, isolate Td_{50}, were very well.

Based on these investigations, it was possible to be established the optimal biological parameters for the development of *T. viride*, isolate Td_{50}: (i) solid culture media: Weindling, Warcup, Malt extract agar, PDA; (ii) carbon sources: monosaccharides mannite, fructose, ribose, glucose, manose; (iii) nitrogen sources: peptone, aminoacids DL-leucine, L-cistine, DL-citruline, DL-nor-leucine, ammonium nitrate and tartrates salts; (iv) pH initial values of culture media: 4.0-5.5 (for growth), 4.0-8.5 (for biomass); (v) temperatures: optimum 26ºC, for growth 24-32ºC, for sporulation 20-22ºC.

2 – Evaluation and experimental verifying of the mass multiplication ability of antagonistic *T. viride* fungi on the culture media in order to select the optimum industrial culture substrate (medium).

In the submerged cultivation of *T. viride* on nine liquid media, some of which contained intermediate products from the food commodity industry, the best growth was obtained on beer must (mB), on the Weindling medium with the imported chemically pure glucose (WG) or with indigenous food glucose (Wg) and on the MPB medium (Fig. 7.).

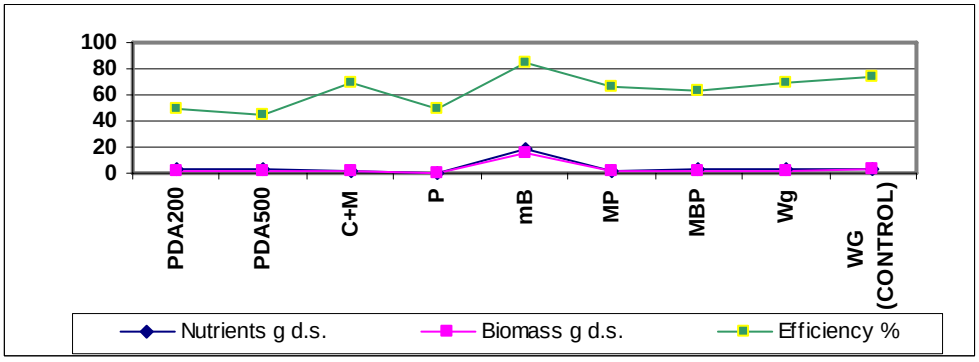

Fig. 7. Accumulation of biomass (g. dry substance/ d.s.) and efficiency (%) of culture liquid media by *Trichoderma viride*, isolate Td_{50}

On these media the sporulation and the titre of conidia and chlamidospores were high. The highest quantity of dry biomass was obtained and a better use (70.0-84.863%) of the nutrients from the medium was recorded. Data of optic density of the *T. viride* liquid cultures confirm this (Fig. 8.).

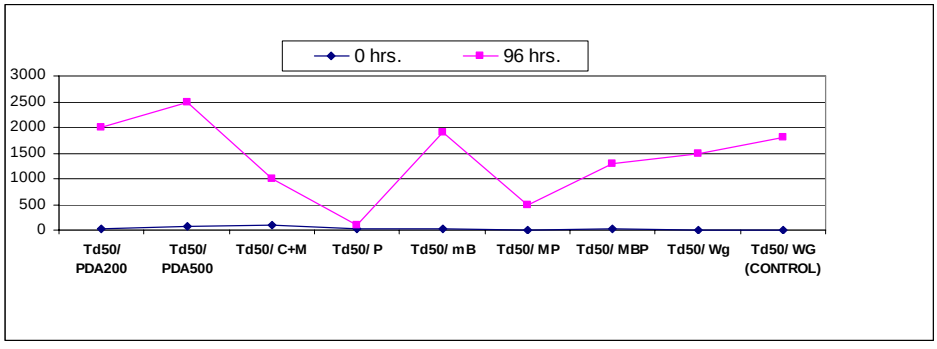

Fig. 8. Optic density of *Trichoderma viride*, isolate Td_{50}, cultivated on different liquid agitated media

Biomass accumulation in the cultures grown in liquid Weindling medium with different initial pH was the highest at pH 4.5-5.5 and the lowest in alkaline (pH 7.5-13.0) and highly acid (pH1.0-2.0) media (Fig. 9.).

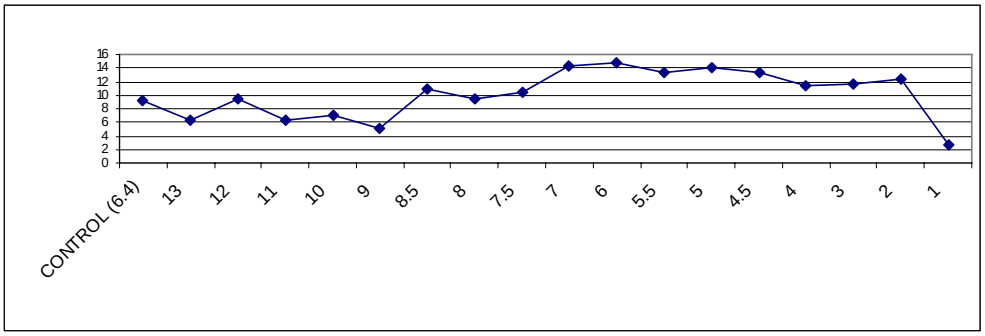

Fig. 9. *Trichoderma viride* biomass (cg) accumulated in Weindling medium with different pH values, after 21 days

A Weindling medium with initial pH between 4.0 and 6.4 and an inoculum rich in conidia ($1x10^8$ – $1x10^5$ conidia/ml) which ensure a fast development of both conidia and chlamidospores in the culture are most favourable for the submerged cultivation of *T. viride*. Based on these investigations we can favour the obtaining of a mixed biological product of phytosanitary utilization containing also conidia and chlamidospores besides mycelium of *T. viride* by maintaining the appropriate cultivation parameters.

From the experiements on submerged cultivation 72 and 96 houres, we have obtained superior results on conidia an chlamidospores titre in the variant of 96 houres of cultivation and at the temperatures between 24 – 30^{o}C.

For the checking of fungal cultivation on the liquid aired medium and aerated with carriers (simulation of industrial process) 4 variant of media have been performed (table 1), the evaluation being based on the efficacy of producing biomass.

Tab. 1. Efficacy expressed by biomass of *Trichoderma viride*, isolate Td_{50}, obtained in different tested liquid media**

Culture media	Wet biomass (g/l)	Dry biomass (g/l)
medium variant a)	9.82 ± 0.54	10.75 ± 0.54
medium variant b)	10.75 ± 1.41	4.04 ± 0.43
medium variant c)	8.64 ± 1.16	2.86 ± 0.37
mediumvariant d)	12.53 ± 0.95	4.88 ± 0.32

* average of least 3 determinations; ** the composition of culture media a), b), c), d) are under the process of a patent

The best results have been performed on the medium with the formula no. 4 (medium d), which is, also, very appropriate being a medium with a low content of ingredients.

These results are in accord with our previous results which mentioned glucose as an optimum carbon source for *T. viride* cultivation [1, 3].

The yeast extract from the medium composition/formula is essential, in general, for the cultivation of microorganisms. This ingredient offers some growing factors, like vitamins and aminoacids, as well as some organic nitrogen compounds with high

bioavailability. Yeast extract is the ingredient which ensure high efficacy in obtaining of *T. viride* biomass.

In the table 2 there were results presenting the influence of temperature on the fungal growth in the medium d) in bioreactor.

Tab. 2. The influence of temperature on the growth of *Trichoderma viride*, isolate Td_{50}, in aired and agitated medium d), evaluated by fungal biomass

Temperature (^{o} C)	Wet biomass* (g/l)	Dry biomasa* (g/l)
22.5	11.47 ± 1.04	4.12 ± 0.39
25.0	12.72 ± 1.66	4.87 ± 0.61
27.5	11.35 ± 0.87	3.39 ± 0.27
30.0	10.75 ± 1.42	3.42 ± 0.46

* average of least 3 determinations

The results showed that *T. viride* is a mesophylous to cryophylous fungus, having the optimum temperature for development at 25^{o}C. These data are in accord with the literature [25].

The effect of aeration on the biosynthesis efficacy of *T. viride* has been performed in the same medium d) and the data are presented in the Tab. 3.

Tab. 3. The effect of airation on the the biosynthesis efficacy of *Trichoderma viride*, isolate Td_{50}, in aired and agitated medium d), evaluated by fungal biomass

Airation rate (l air/l medium/minute)	Wet biomass* (g/l)	Dry biomass* (g/l)
0.50	10.23 ± 1.37	3.42 ± 0.42
0.75	11.35 ± 1.08	3.94 ± 0.37
1.00	12.41 ± 1.67	4.42 ± 0.54
1.25	12.67 ± 1.22	4.58 ± 0.48
1.50	11.88 ± 1.16	3.87 ± 0.35

* average of least 3 determinations

Our results show that a high rate of aeration did not significantly promote the biomass accumulation in the liquid media tested. The optimal rates of aeration are between 0.75 and 1.25 l air/l medium /minute, results which are in accord with similar data from the biosynthesis literature. Based on these results, in practice is recommended the minimal rate of aeration (0.75 l air/l medium/minute), which ensure the efficiency of biosynthesis, due to energy consumption reduction.

For the manufacturing of plant protection bioproducts have been selected strain Td_{49} and Td_{50} of *Trichoderma viride*. On the investigated parameters these strains shown equilibrated characteristics, combining high biological activity with rapid production of biomass on liquid medium (aerated, with carriers) and good survival during the formulation process. These strains were deposited for patent purposes on NCAIM (international depositary authority) and the patent applications were submitted to OSIM.

In conclusion, the parameters for submerged cultivation of *Trichoderma viride* are presented in the Tab. 4.

Tab. 4. Parameters of submerged cultivation of the fungus *Trichoderma viride*

Parameters	Values
Weindling culture medium	variant Wg (indigenous food glucose)
Time of cultivation	4 days (96 houres)
Temperature of culture medium Optimum temperature	$24 – 30^0$ C $24 – 28^0$ C
Reaction of culture medium (pH)	Acid until low acid (pH 4.0 – 6.4)
Titre of inoculum	$1x10^5 – 1x10^8$ conidia/ml medium
Optimal airation	0.75-1.25 l air/l medium/ minute
Viability of biomass	6-7 monthes

3 – Biochemical characterization of *T. viride* isolates by electrophoretic analysis of their protein profile (Tab. 5) reveled that:

3.1. Proteins with MM 7, 8, 10, 12, 14, 35, 56, 60 kD represent characteristics for genus and species, being well differentiated;

3.2. Within the same species the quantitative differences appeared at the level of proteins with MM of 29, 45, 87, 89 kD and are determinated by provenance of various isolates belonging to the same species;

3.3. Isolates Td49 and Td50 proved strong similarities having a common provenance; both isolates proved a high antagonistic capacity against the test-pathogens studied.

Tab. 5 Biochemical characterization of some *Trichoderma viride* isolates based on protein bands separated[z]

MM/kD	7	8	10	12	14	29	35	45	56	60	89	97
Rf	0.98	0.93	0.89	0.84	0.78	0.55	0.49	0.44	0.33	0.31	0.18	0. 15
Td_{35}	++	+	+	++	++	-	++	-	+	+	-	-
Td_{45}	++	++	±	++	++	±	±	±	+	±	±	±
Td_{49}	++	++	++	++	++	±	++	+	+	++	++	++
Td_{50}	++	++	++	++	++	±	++	+	+	++	±	±
Td_5 (ctr)	+	++	++	++	++	-	+	-	+	+	-	-

z = band intensity; '-' = no band; '±' = weak band; '+' = intense band; '++' = very intense band; ctr = control

These results are the first step in a future research conducted to obtain a molecular characterization of our *T. viride* collection of isolates selected as biological control agents of some practically important plant pathogens.

4 – Evaluation of the biological activity of *T. viride* isolates against phytopathogenic fungi with high practical importance has been performed by dual cultures of 7 phytopathogenic fungi (*Fusarium graminearum*, *F. culmorum*, *Pythium ultimum*, *Alternaria alternata*, *Botrytis cinerea*, *Sclerotinia sclerotiorum*, *Stemphylium radicinum*) and 4 antagonistic *T. viride* isolates (Tab. 6).

Tab. 6 Evaluation of the antagonistic activity of some isolates of *Trichoderma viride*, by the x coefficient, calculated after Jouan and others (1964)

Trichoderma viride	*Fusarium graminearum*	*Fusarium culmorum*	*Pythium ultimum*	*Alternaria alternata*
Td_{35}	0.25	0.40	0.24	0.40
Td_{45}	0.78	0.86	0.72	0.86
Td_{49}	0.28	0.38	0.48	0.90
Td_{50}	0.30	0.38	0.36	0.42
Td_5 (control)	0.55	0.39	0.54	0.54
	Botrytis cinerea (Bc.1)	*B. cinerea* (Bc.2)	*Sclerotinia sclerotiorum*	*Stemphylium radicinum*
Td_{35}	0.44	0.42	0.22	0.35
Td_{45}	0.70	0.80	0.48	0.52
Td_{49}	0.62	0.58	0.76	0.90
Td_{50}	0.35	0.38	0.54	0.75
Td_5 (control)	0.89	0.92	0.45	0.30

The antagonistic ability of tested *T. viride* isolates was different against these plant pathogens; the most active was Td_{35}, followed the others: $Td_{35} > Td_{49} > Td_{50} > Td_{45} > Td_5$.

5 – Processing of technological scheme for obtaining plant protection preparates based on biologically active isolates of *T. viride*.

Based on all performed investigations, *T. viride*, isolates Td_{49} and Td_{50}, have been selected for the manufacturing of a bioproduct of plant protection, these isolates being under the procedure for obtaining a patent.

The technological process for obtaining plant protection bioproducts (Fig. 10-11.) contains 2 main phases: (i) biomass biosynthesis of microorganisms in a culture medium, available for industrialization and (ii) biomass conditioning of microorganism, the antagonistic micromycete, respectively. For this type of activities it is essential to establish biological development parameters: (i) the optimum composition of the liquid culture medium for development of the fungus under aerobiotic conditions and (ii) the optimal parameters of biosynthesis in the studied medium.

The biomass biosynthesis technology is discontinuous, of cascade type, and develops several phases: (1) preparing of the laboratory inoculum, (2) preparing of the fungal pure culture in Erlenmeyer bottles, (3) industrial (simulated) multiplication in the aired and agitated liquid medium.

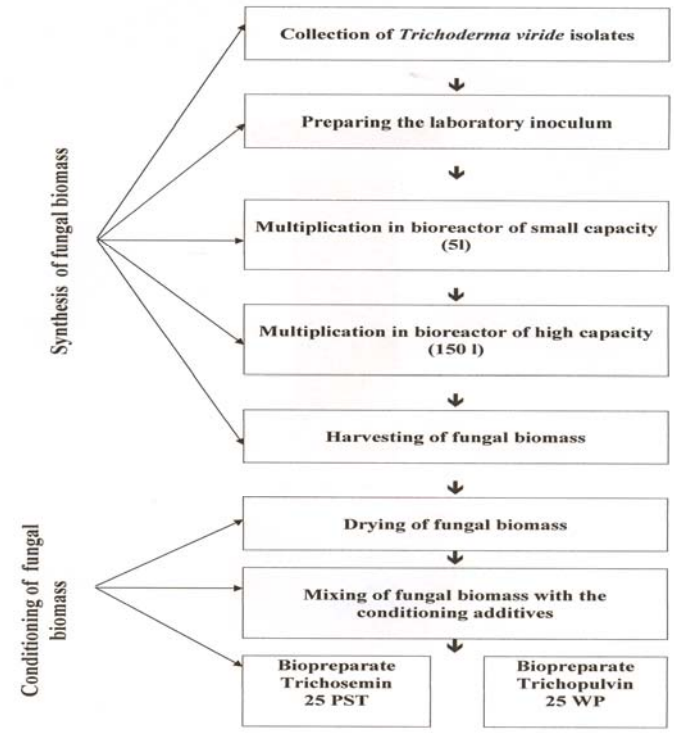

Fig. 10. Technological scheme for obtaining plant protection bioproducts based on *Trichoderma viride* [1, 27, 29]

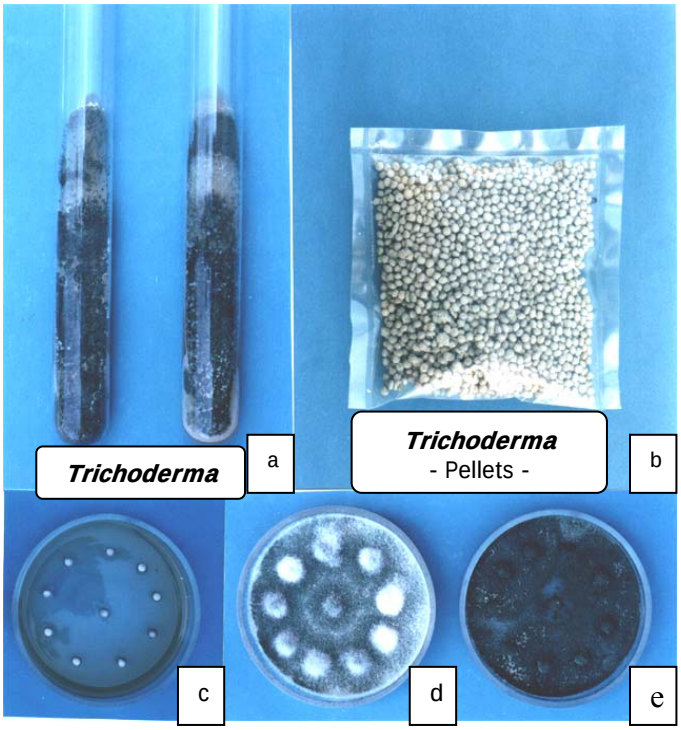

Fig. 11. *Trichoderma viride* bioproduct, in alginate, manufactured at the RIPP Bucharest: a – *T. viride* cultures in tubes on PDA medium (Potato-Dextrose-Agar); b – bioproduct as alginate pellets; c–e – biopreparate/pellets in Petri plates on PDA medium, 0 days (c) and after 3 (d) and 6 days (e) (original)

1. There were established the optimal biological parameters for the development of *T. viride*, isolate Td_{50}: (i) solid culture media: Weindling, Warcup, Malt extract agar, PDA; (ii) carbon sources: monosaccharides mannite, fructose, ribose, glucose, manose; (iii) nitrogen sources: peptone, aminoacids DL-leucine, L-cistine, DL-citruline, DL-nor-leucine, ammonium nitrate and tartrates salts; (iv) pH initial values of culture media: 4.0-5.5 (for growth), 4.0-8.5 (for biomass); (v) temperatures: optimum 26ºC, for growth 24-32ºC, for sporulation 20-22ºC.

2. The parameters for submerged cultivation of *T. viride* are: (i) Weindling medium, variant Wg containing indigenous food glucose; (ii) Period of cultivation – 96 hrs.; (iii) Viability of biomass – 6-7 monthes; (iv) Optimal temperature 25ºC; (v) Optimal pH – 6.0-6.5; (vi) Optimal aeration 0.75-1.25 l air/l medium/ minute, (vii) Viability of biomass – 6-7 monthes.

3. It has been done the first step in a future research conducted to obtain a molecular characterization of our collection of *T. viride* isolates selected as a biological control agents of some practically important plant pathogens. 3.1. Proteins with MM 7, 8, 10, 12, 14, 35, 56, 60 kD represent characteristics for genus and species, being well differentiated; 3.2. Within the same species the quantitative differences appeared at the level of proteins with MM of 29, 45, 87, 89 kD and are determinated by provenance of various isolates belonging to the same species; 3.3. Isolates Td49 and Td50 proved strong similarities having a common provenance; both isolates proved a high antagonistic capacity against the test-pathogens studied.

4. The antagonistic ability of tested *T. viride* isolates was different against plant pathogens; the most active was Td_{35}, followed the others: $Td_{35} > Td_{49} > Td_{50} > Td_{45} > Td_{5}$.

5. It has been established and experimentally verified the technological phases for obtaining plant protection bioproducts based on *T. viride.*

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MACROMYCETES IDENTIFIED ON THE CONSTRUCTION WOOD OF HISTORICAL MONUMENTS FROM MOLDAVIA AND CAUSES OF THEIR DEVELOPMENT

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Abstract: This paper presents a series of observations made at the historical monuments in Moldavia region, where they could show some cases which causes the appearance of macromycetes on wood. We maintained as significant a number of 13 species of macromycetes which were reported with greater frequency on construction wood, but also were included and species which are considered important agents of deterioration for wood: *Gloeophyllum sepiarium* (Wulfen) P. Karst., *Gloeophyllum abietinum* (Bull.) P. Karst., *Schizophyllum commune* Fr., *Trametes versicolor* (L.) Lloyd, *Coniophora puteana* (Schumach.) P. Karst., *Serpula lacrymans* (Wulfen) J. Schröt. etc. In the presence of a source of infection, it was found in some cases favorable conditions to the development of the sporiferous bodies. The number of attacks of macromycetes on historical monuments in Moldavia and the rate of the degradations on wood depend on a number of factors which were presented according to their importance in the overall process of preserving the timber used in construction. There were identified areas where the resistance of wood has been changed due to the destructive action of physical factors (improper humidity, temperature etc.) and especially because of the installation on this type of organic material of a considerable number of bodies from the various groups.

Key words: wood, macromycetes, biodeterioration, historical monuments

Introduction

Knowledge and understanding of the causes that promote the emergence and development of macromycetes on construction wood are of prime importance in determining eradication measures and preventive conservation programs. Specialty papers generally consider these causes, at all types of buildings, but to the historical monuments may have specific circumstances, especially if the constructions have value of outdoor museum exhibits or to a series of obsolete buildings which have specific conservation conditions [COJOCARIU & al., 2005].

Humidity is an important physical parameter, which is one of the main causes of degradation occurring in mobile and immobile heritage [BARBU & MARGINEANU, 1983]. For example, at old buildings, the construction materials used in the walls are generally porous and susceptible to moisture (bricks, porous limestone, lime mortar, wooden beams). Overall, at the historical monuments, wood is present in every building, being a material used in the past for its qualities but also because it is a material readily available in nature and is easy to process them as technology.

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Material and method

Our observations on the deterioration of wood produced by macromycetes, regard the building classify as historical monuments located in Moldavia - area less explored in this regard, as defined under the laws and criteria adopted by the Ministry of Culture by the National Institute of Historical Monuments (2004).

In order to achieve an interpretation on the macromycetes as degradation agents and causes that led to the emergence and development of their sporiferous bodies, were considered a number of 55 historical monuments included in different categories (conventionally labeled A to G). From the seven categories of monuments, have showed interest the wooden churches and monastic ensembles, because of the wood used as construction material, both fully and partially in the main building elements.

Methods for collecting, processing and determination of sporiferous bodies and also the required materials are different, depending on the group of macromycetes [BERNICCHIA & GORJÓN, 2010; BREITENBACH & KRÄNZLIN, 1986; ERIKSSON, 1958; JÜLICH, 1989; JÜLICH & STALPERS, 1980; SESAN & TANASE, 2006; TĂNASE & ŞESAN, 2006]. Worksheet was adapted to include information about the type of wood, local climatic conditions, all macroscopic characters observed in the ground etc.

Following these observations on historical monuments from the territory of Moldavia, we could reveal the causes that gave rise macromycetes on wood. Synthetic data were centralized and analyzed on the basis of tables and graphs drawn according to data recorded in the ground.

Results and discussions

We maintained as significant for our interpretations a number of 13 species of macromycetes which were reported with greater frequency on construction wood. We also take into consideration the species which are considered important agents for deterioration of construction wood. Thus, in order of frequency, the species considered are:

- *Gloeophyllum abietinum* (Bull.) P. Karst. – Photo 1
- *Gloeophyllum sepiarium* (Wulfen) P. Karst.
- *Hymenochaete rubiginosa* (Dicks.) Lév. – Photo 2
- *Dacrymyces stillatus* Nees – Photo 3
- *Schizophyllum commune* Fr.
- *Bjerkandera adusta* (Willd.) P. Karst.
- *Stereum hirsutum* (Willd.) Pers.
- *Daedalea quercina* (L.) Pers.
- *Trametes versicolor* (L.) Lloyd
- *Fibroporia vaillantii* (DC.) Parmasto
- *Coniophora puteana* (Schumach.) P. Karst. – Photo 4
- *Serpula lacrymans* (Wulfen) J. Schröt. – Photo 5
- *Peziza domiciliana* Cooke – Photo 6

Based on field observations, macromycetes have been identified as agents of degradation, which develops on building elements such as roofing (the wood shingle), wooden beams of the exterior walls, bottom beams - foot, beams and elements of wood used to build fences, floor, and annexes represented by stairs, porch, and fence. The frequency of macromycetes species related to category of building elements, indicating a

higher exposure to the attack of macromycetes for structural components located at the bottom, as exterior stairs, foot beams, and exterior walls.

There is a high frequency of occurrence of macromycetes on building elements as exterior walls and bottom beams, where we could see strong infiltration of water, either permanently from the ground, or only during some heavy rains, when water accumulates in areas near the building and the investigated elements are placed in contact with the ground. Sometimes, the stone foundation of the building is affected by the high humidity, the ceiling leaks and inadequate drainage of rain water being factors in the emergence of sporiferous bodies.

In the case of *Serpula lacrymans* species, the attacks mainly be installed within the floor construction and the notations on the type of construction and local conditions, confirm the literature data that this species grows in the presence of calcium sources [BUCSA & BUCSA, 2005]. Thus, in the case of the wooden church "Adormirea Maicii Domnului" from Cerviceşti, Botosani County, the source of calcium was identified in the foundation stone assembled with mortar, cement and lime. The same situation is observed and the Church "Pogorarea Sfantului Duh" from Agafton village, Botosani county.

A higher frequency of occurrence of species *Serpula lacrymans* was identified to the historical monuments that do not have heating systems, or if they exist, are poorly constructed, such as chimneys and such findings related to their poor insulation, allowing the infiltration of large quantities of water. We also observed attacks at the monuments with intermittent or no heating and in addition, there is a lack of ventilation, especially for those monuments out of religious service.

The number of attack of macromycetes at historical monuments in Moldova, and the rate of wood degradation depend on a number of factors as:

- maintaining the same position of exterior wood elements;
- maintaining humidity above 30%;
- infiltration of water from poorly maintained or damaged covers;
- lack of some construction foundation;
- microclimate conditions;
- vegetation in the area, the presence of forest and abandoned wood
- lack of heating in buildings and close them in winter
- arrangement of parts of the structures in direct contact with the ground
- periodic flooding of the lower parts of the building during heavy rains
- placement of leaves and plant debris on different elements of construction
- lack of suitable wood treatments

Moisture in the old building is unequal distributed and affect in different mode the parts of the building, is rarely stationary and often progressive time-related, and also irregular distributed in the masonry elements. Sources of origin of the moisture in walls may be multiple: moisture derived from rainfall that directly infiltrate, association of the wind with the rain, atmospheric moisture, surface or interstitial condensation, moisture in the ground by capillary rise, from surface water (pluvial or accidental leakage) or groundwater [NICOLESCU, 2001].

Moisture derived from rainfall is related to the leaks (roof deterioration, cracks), the failure of collecting devices (gutters, downspouts) and exposure to rain for the horizontal component of the walls. This phenomena is enhanced by maintaining the wet conditions, the lack of proper maintenance (Photo 6).

For the basic building annexes it can be observed a frequent occurrence of the sporiferous bodies. They belong in general to the species that are common in natural

ecosystems of forests on the felled timber, such as the example of species *Daedalea quercina*, *Trametes versicolor*, *Stereum hirsutum* and *Bjerkandera adusta*.

In areas affected by excessive moisture in historic buildings, could reveal a number of species of macromycete with sporiferous body attached on the substrate extending over large areas, which are the main agents of wood decay, such as species *Fibroporia vaillantii*, *Hyphodontia breviseta*, *Phellinus contiguus*, *Radulomyces confluence*.

Conclusions

In the case of species *Serpula lacrymans* (Wulfen) J. Schröt., the attacks are mainly installed on the floor, and we confirm the literature data regarding the development of this species in the presence of a source of calcium.

In some cases, in the presence of a source of infection, was found favorable conditions for sporiferous bodies such as making repairs or replacement during the cold season, use fresh wood, sufficiently dry, use untreated wood, adding filled with a high moisture content, use of paint for walls or floors, which affects ventilation, inadequate use of supplementary materials, as plastic film type by acting as isolator.

There is a high frequency of macromycetes occurrence on construction elements as outer walls and beams below, where is a higher humidity and where we could see the strong infiltration of water, either permanently from the ground, or only in abundant rainfall and water accumulates near the building, and the elements investigated are placed in contact with the ground.

To ensure adequate protection of wood is necessary to know first of all the forms of degradation and the agents involved in the biodegradation of wood to determine the measures of protection based on differential diagnosis and determination of degradation phase.

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Photo 1 – *Gloeophyllum abietinum* (Bull.) P. Karst.

Photo 2 – *Hymenochaete rubiginosa* (Dicks.) Lév.

Photo 3 – *Dacrymyces stillatus* Nees

Photo 4 – *Coniophora puteana* (Schumach.) P. Karst.

Photo 5 – *Serpula lacrymans* (Wulfen) J. Schröt.

Photo 6 – The rapid expansion of mycelium of *Peziza domiciliana* Cooke in the floor, historical house, Stefan cel Mare Street, 75, Targu Neamt

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PERENNIAL *HELIANTHUS* TAXA IN TÂRGU-MUREŞ CITY AND ITS SURROUNDINGS

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Abstract: Although in the neighbouring countries several perennial *Helianthus* taxa have been recorded in the last decade, in Romania only three have been identified so far. The literature and herbaria data of Târgu-Mureş date back to the end of the XIXth century, and only refer to *H.* × *multiflorus* and *H. tuberosus*.
The aim of this study was to identify the perennial *Helianthus* taxa in this region and to prepare their current distribution map. The survey was conducted in Târgu Mureş city and the neighbouring villages: Livezeni, Sântana de Mureş, Sâncraiu de Mureş, Sângeorgiu de Mureş, and Corunca.
Four taxa were identified: *H. pauciflorus* Nutt., *H.* × *laetiflorus* Pers., *H. tuberosus* L. s.str., and *Helianthus tuberosus* L. s.l. The first two taxa are cultivated as ornamental plants, *H. tuberosus* s. str. is cultivated in a few farms, whereas *H. tuberosus* s. l. is an invasive species that spreads along the rivers.

Keywords: *Helianthus tuberosus*, Jerusalem Artichoke, *H. pauciflorus*, *H.* × *laetiflorus,* invasive plants, ornamental plants, Târgu-Mureş

Introduction

12 perennial taxa (out of the 66) belonging to the *Helianthus* genus of American origin are cultivated in Europe for ornamental purpose and for their inulin content. Some of them are invasive. Due to their successful vegetative propagation, allelopathy or shading, they spread aggressively, eliminate other species of the natural habitats, change the structure of plant communities, and even behave as dangerous weeds [BALOGH, 2006]. As a consequence, several works on invasive species have dedicated large chapters to the *Helianthus* taxa [BALOGH, 2006, 2007, 2008].

Another major issue related to the invasive taxa of this genus is that by their getting wild, they earn phenologic plasticity, probably hybridize, so their taxonomic position is uncertain and largely debated [BALOGH, 2006].

The Wild Jerusalem Artichoke (*H. tuberosus* L. s. l.) is one of the 34 invasive taxa of EPPO (European and Mediterranean Plant Protection Organization) [***]. The species is invasive even in its native country, disturbing natural forest communities [BALOGH, 2006]. In Hungary, it is also considered as invasive, whereas the cultivated Jerusalem artichoke (*H. tuberosus* L. s. str.), the Ten-petals sunflower (*H. decapetalus* L.), the Stiff sunflower (*H. pauciflorus* Nutt.) and one of its subspecies (*H. pauciflorus* subsp. *subrhomboideus* (Rydb.) O. Spring et E. Schilling), and the Cheerful sunflower (*H.* × *laetiflorus* Pers.) are known as less aggressive plants [BALOGH, 2006]. Some authors make probable the occurrence of the Paleleaf woodland sunflower (*H. strumosus* L.) too in

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Hungary [BALOGH, 2006]. In the Republic of Moldavia, *H. decapetalus*, *H. tuberosus* and *H. tuberosus* var. *subcanescens* A. Gray are mentioned [MÂRZA, 2010].

In Romania, the Wild Jerusalem Artichoke (*Helianthus tuberosus* L. s. l.) is similarly on the black list of invasive plants [NEGREAN & ANASTASIU, 2004]. Of the other taxa present in the neighboring countries, the literature mentions the Ten-petals sunflower (*H. decapetalus*) as being frequent in Transylvania [CIOCÂRLAN, 2000], but BALOGH [2006] and KOVÁCS [2006] place this taxon in the affinity group of *Helianthus tuberosus* s. l.

The presence of *Helianthus tuberosus* in Transylvania is recorded in different herbaria starting with the end of the XIXth century. Thus, the species occurred in Arad [MITTELMANN – BP, 1889], Deva [MITTELMANN – BP, 1889], and Cluj County - Tăietura turcului [RICHTER – CL, 1903], at early times. *H. decapetalus* were found at Sighişoara [ŢOPA – CL, 1948], at Cipău near the Mureş river and at Cluj-Napoca [ŢOPA – CL, 1962], as well as in Maramureş county, at Şomcuta Mare [ŢOPA – CL, 1965], some times later. The Romanian Flora monography [Săvulescu 1964] mentioned three perennial *Helianthus* species in Romania: *H. tuberosus*, *H. decapetalus* and *H. × multiflorus*.

Further details on the occurrence of different *Helianthus* taxa in Romania are provided by MARIAN [2001/2002], FENESI [2005], KOVÁCS [2004, 2006], OPREA & SÂRBU [2006], FENESI & al. [2009] etc.

The cultivated Jerusalem artichoke can behave to a certain extent as an invasive plant [PÉNTEK & SZABÓ, 1985]. As early as its first mentionings, the plant was known as very difficult to destroy [LIPPAY, 1664]. Formerly it was grown in many places throughout Transylvania, but because of its difficult storage, it didn't become widely cultivated [I'SÓ, 1955]. Today its cultivation ressurrect, as a long-forgotten vegetable with special nutritional values. Despite the fact that the cultivated Jerusalem Artichoke can behave as a weed, its escaped individuals are not thought to be the main founders of the Hungarian invasive populations. Instead, these ones might originate in some other taxon belonging to the group of *H. tuberosus* s. l., that we today name the Wild Jerusalem Artichoke [BALOGH, 2008]. Nevertheless, this hypothesis has yet to be tested.

The wild Jerusalem Artichoke is currently largely spreading along the rivers. Water and small rodents can transport its stolons and tubers to larger distances, whereas moist soils facilitate its establishment. By contrast, *H. pauciflorus* and *H. ×laetiflorus*, when escaped from cultivation, prefer dry weed communities or sandy grasslands, and generally avoid mesic habitats [BALOGH 2006].

Very few literature refer to the perennial sunflower species in Târgu-Mureş city and its surroundings. The last floristic survey of the region belongs to NYÁRÁDY E. I. [1914], who did not register perennial *Helianthus* taxa at the time. Herbaria data point out the presence of *H. tuberosus* at Târgu-Mureş shortly afterwards [Herbarium of NAGY ÖDÖN, Natural History Museum of Târgu-Mureş – OROIAN, 1995]. FENESI & RUPRECHT [2002] report the presence of *H. tuberosus* at Corunca and Târgu-Mureş [pers. comm.]. Two other taxa were recorded in herbaria: *H. decapetalus* at Cipău near Iernut [ŢOPA 1962, CL], and *H. ×multiflorus* at Târgu-Mureş [BARABÁS 1897, CL].

The aim of this work was to prepare a distribution map of the perennial *Helianthus* taxa occurring in Târgu-Mureş city and its surroundings. Our departing points were: a) There are probably several perennial *Helianthus* taxa in the wild or cultivated in this area, some of them being invasive; b) The wild Jerusalem artichoke (*Helianthus tuberosus* s. l.) is present in the studied area, and is currently spreading along the Mureş and other rivers.

Material and method

The research was conducted in Târgu-Mureş city and its surrounding villages: Livezeni, Corunca, Cristeşti, Sântana de Mureş, Sângeorgiu de Mureş, and Sâncraiu de Mureş, during 2007-2009. Perennial *Helianthus* taxa were identified following BALOGH [2006] and GPS-recorded. Herbarium specimens of each taxa were prepared and the surface covered by the plants was approximated. GPS-records were featured on aerial map using ArcView GIS 3.1 [ESRI Inc., New York].

Results

The following *Helianthus*-taxa were identified in Târgu-Mureş and its surroundings (Fig. 1):

- *Helianthus tuberosus* L s. l. (wild Jerusalem Artichoke): is an invasive plant located alongside the Mureş river, and also occurs spontaneously in smaller patches in Târgu-Mureş and Livezeni (in inhabited places), in Corunca and Sântana de Mureş (in inhabited places and cultivated fields), and in Sâncraiu de Mureş (in cultivated fields).
- *Helianthus tuberosus* L. s. str. (cultivated Jerusalem artichoke): is cultivated in the farms of Corunca village, and in smaller groups in Târgu-Mureş, Sâncraiu de Mureş and Sângeorgiu de Mureş.
- *Helianthus pauciflorus* Nutt. (Stiff sunflower): was found only in Târgu-Mureş, Livezeni and Sângeorgiu de Mureş, cultivated as ornamental plant in the green spots of the inhabited places.
- *Helianthus* × *laetiflorus* Pers. (*H. pauciflorus* subsp. *subrhomboideus* × *H. tuberosus* s. l.) (Chererful sunflower): is cultivated as ornamental plant in most of the analyzed localities, being very frequent in Corunca and more rare in Sângeorgiu de Mureş. Because of its hybrid origin, *H.* × *laetiflorus* is difficult to be identified with certainty. It often resembles very much to one of its parental species, *H. pauciflorus*, but it differs from it in its leaves larger than five centimeters and the number of anthodiums higher than six [BALOGH, 2006].

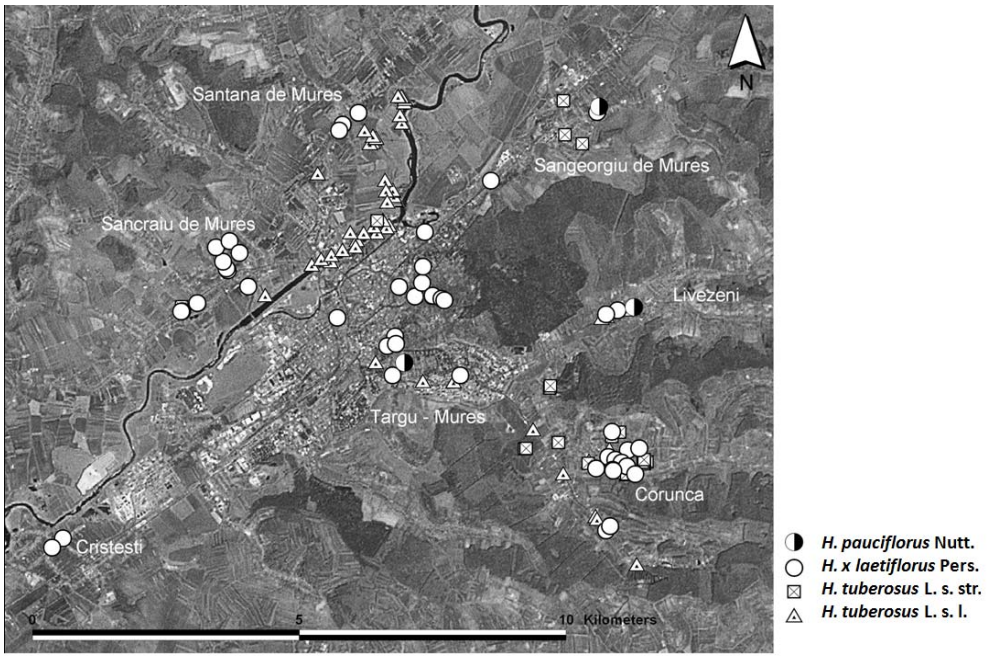

Fig. 1. The distribution map of the perennial *Helianthus*-taxa in Târgu-Mureş and its surroundings

Discussions

The outcome of this study is the first distribution map of the perennial *Helianthus* taxa of Târgu-Mureş and its surroundings. This is the first time that the *H. tuberosus* s. str., *H. pauciflorus* and *H.* × *laetiflorus* are mentioned in this area.

H. tuberosus s. l. is very abundant in this region. It occurs mostly along the Mureş valley, where it can cover several hundreds of square kilometers. Similarly to other regions of Europe, it behaves as an invasive species in the studied region, where it has severely altered the natural habitats along the Mureş and Pocloş rivers. Near the Mureş river, the plant behaves as a weed, as it has invaded the cultivated fields.

H. tuberosus s. str. is much more rare in the area. People started to cultivate it again because of its nutritional properties, being used in the diet of diabetics [FILEP, pers. obs.]. Therefore, new sets of subspontaneous populations can be expected, as inferred by PÉNTEK & SZABÓ [1985].

H. pauciflorus and *H.* × *laetiflorus* occur as ornamental species only in the village gardens or city green spots, but not in the wild. We didn't register escaped or naturalized individuals.

H. × *multiflorus*, mentioned in the region more than a century ago [BARABÁS 1897, CL], was not found, either because more detailed research is needed to discover it, or it has been only sporadically cultivated in Târgu-Mureş during the last century.

Conclusions

So far, four perennial *Helianthus* taxa have been identified in Târgu-Mureş and the surrounding villages. Two of them, *Helianthus pauciflorus* Nutt. and *Helianthus* × *laetiflorus* Pers. (*H. pauciflorus* subsp. *subrhomboideus* × *H. tuberosus* s. l.) are cultivated as ornamentals, and no escaped individuals were registered in the area. *H. tuberosus* s. str. is cultivated in a few places for its nutritional value, but it could escape and naturalize. *H. tuberosus* s. l. is an invasive species which is a serious threat to the local biodiversity and a weed species of the river meadows, very difficult to fight against.

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PHYTOCOENOTIC SURVEYS ON SOME MESOTROPHIC – EUTROPHIC MARSHES IN EASTERN ROMANIA

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Summary: This study is a contribution to the knowledge of the vegetation of some mesotrophic - eutrophic marshes, of topogenic origin, which are located in the hilly area of Neamț county, namely: Unghi, Bahna Mare, Râşcolnița, Borşeni, and Borniş (Dragomireşti commune). The vascular flora of these marshes is characterized by the presence of some fairly rare plant species, into the Romanian flora, e. g.: *Angelica palustris*, *Dactylorhiza incarnata*, *Ligularia sibirica*, and *Menyanthes trifoliata*. Among the plant associations identified in the field, the next ones are rather rare in the region: ass. *Caltho laetae – Ligularietum sibiricae* Ştefan et al. 2000, ass. *Salicetum cinereae* Zólyomi 1931, ass. *Carici flavae – Eriophoretum latifolii* Soó 1944, and so forth. The floristic and phytocoenologic richness of these marshes of Moldavia, their authenticity, their character not yet altered by the human activities, the surprising presence here of some rare relict species into the Romanian flora, are true reasons to promote all of these areas as protected ones, in the near future. Also, for the marshes of "Unghi" and "Bahna Mare", we would like to make proposals as these to be included under the "Natura 2000" European network of protected areas.

Key words: mesotrophic - eutrophic marshes, vegetation, rare plant species, natural habitats, Eastern Romania

Introduction

This study is a new contribution over the vegetation of some marshes from Moldavia, namely: Unghi, Bahna Mare, Râşcolnița, Borşeni, and Borniş (Dragomireşti commune, Neamț county) (Fig. 1). All of these marshes are located at the eastern limit of Neamț sub-Carpathians, in the hilly region of Neamț county, on the nemoral belt of vegetation, in oak and mixed forests altitudinal horizon (Vegetation Unit F 38b, according to [IVAN (coord.)., 1992]).

The geographical coordinates of those investigated marshes are like the next:

- the marshes near Unghi village: N 47º02'14.2"/E 26º33'45.5"/348 m
- the marshes called "Bahna Mare" at Bălăneşti: N 46º58'6.58"/E 26º36'26.24"/254 m
- the marshes called "Râşcolnița" at Ghigoieşti: N 46º57'53.3"/E 26º35'36.5"/322 m
- the marshes near Borşeni village: N 47º05'07.9"/E 26º34'41.4"/301 m
- the marshes near Borniş village: N 47º00'42.5"/E 26º35'59.7"/303 m (Fig. 1).

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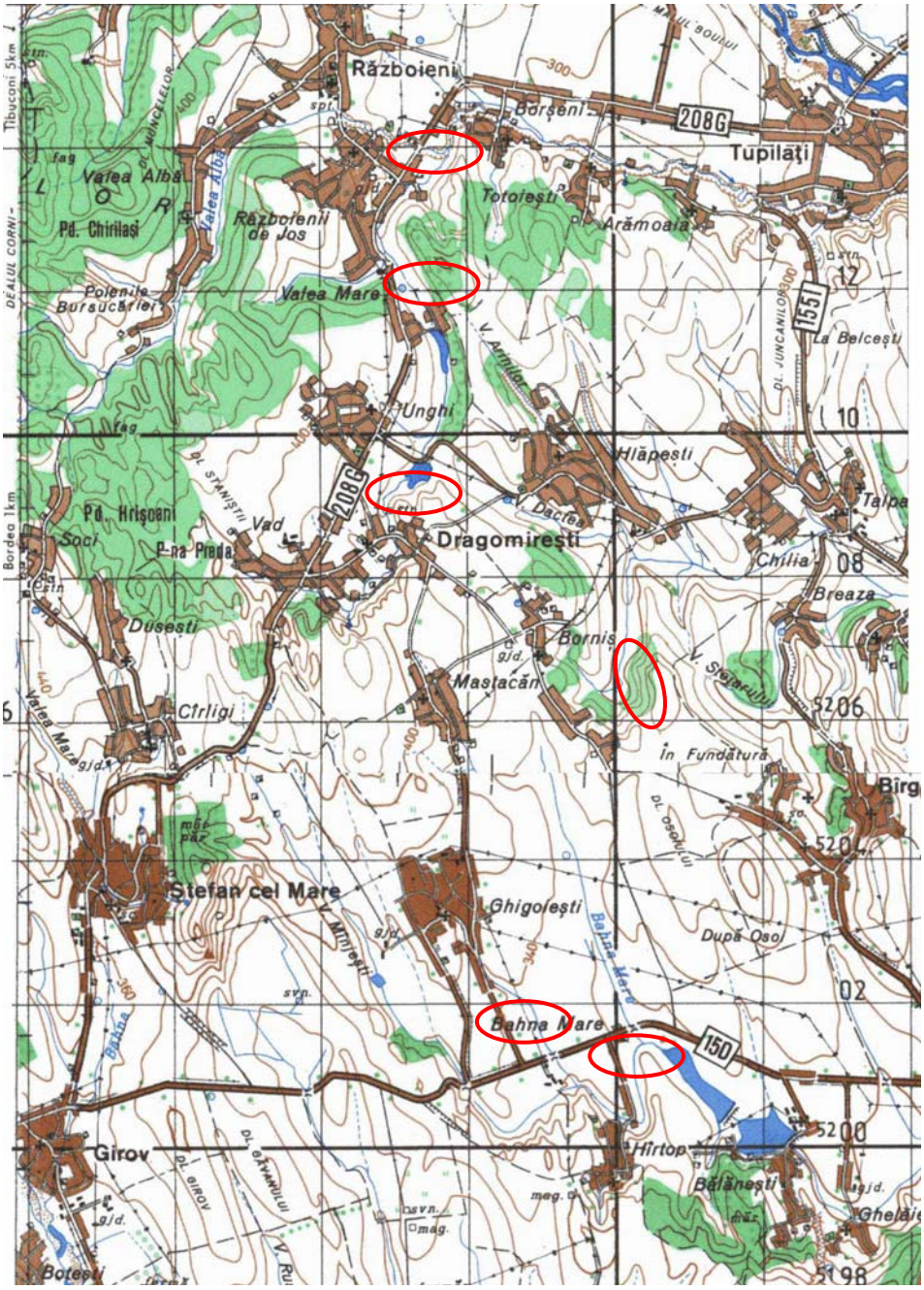

Fig. 1. Geographical location of the surveyed marshes in Neamț county

Among these marshes, the most significant ones are the first two of them, as surface, as well as from floristic and phytocoenotic points of view. The marshes of Unghi is situated in the south of forestry massif "Ghindăoani-Tupilați". It is crossed by a small

stream (called "Valea Albă") in its southern part, which runs toward the east, flowing into Moldova river, in the south of Tupilați village. The hills surrounding the investigated area are between 400 m and 600 m altitudes. Their slopes are affected by landslides, torrents, increased soil erosion, following an intense grazing almost all year around. The marshes of Bahna Mare (called also Bahna Negoieşti) is situated in the north-west of Bălăneşti village, at south of the road between Roman and Piatra Neamț towns; it is fed by a small creek water (called "Bahna").

All of these five marshes have a topogenic origin and from the trophicity point of view all of them are transition mires, of a mesotrophic – eutrophic type. They are linged by a fairly high level of table waters, being situated in the lowest part of relief, occuring in those places where flies sources. They are fed by waters from the water table, meteoric waters (snows, rains), etc., which runs on the nearby slopes, but also with the contribution of small streams, having short courses into the surveyed area (e. g. the marshes of Unghi and Bahna Mare) (Fig. 2 & 3).

Fig. 2. The marshes of Unghi – general view

Fig. 3. The marshes of Bahna Mare – Bălăneşti

This area is located at the limit between two geological units, Miocene (the sub-Carpathian unit in west) and Sarmatian (to east). Miocene is represented by marls mixted

with gypsum, having also some appearances of salts. The Sarmatian consists in sand horizons, having intercalations of clay, alternating with gravels. The soils are of hydromorphic type [BURDUJA & al., 1974].

Climate are moderately continental, with medium yearly precipitations of 550-700 mm, average yearly temperatures between 8.5 ºC and 9 ºC, the dominant winds being from north-west (20%). At the meteo station of Tg. Neamț town, the average yearly temperature is of 8.2 ºC, the medium yearly amplitude is of 23.3 ºC, the medium yearly precipitations being of 672 mm [BURDUJA & al., 1974].

History of botanical research. Some investigations over the marshes on this area have been made by [BURDUJA, 1948, 1954], [CHIFU & al., 1987], [LUPAȘCU, 1999]. Thus, from the marshes of "Bahna Mare" – Bălăneşti there were cited some species, as: *Angelica palustris*, *A. sylvestris*, *Betula pubescens* var. *vulgaris* f. *ovalis*, *B. verrucosa*, *Briza media*, *Caltha palustris*, *Carex distans*, *C. elata*, *C. ovalis* f. *robusta*, *Cirsium canum*, *Cuscuta* sp., *Dianthus superbus*, *Epilobium parviflorum* f. *apricum*, *Eriophorum latifolium, Filipendula ulmaria* subsp. *ulmaria* f. *pubescens, Geranium palustre*, *Holcus lanatus*, *Hypericum tetrapterum*, *Juncus articulatus*, *J. glaucus*, *Leucanthemum vulgare*, *Lotus corniculatus*, *Lycopus europaeus*, *Lythrum salicaria*, *Medicago lupulina* var. *glandulosa*, *Mentha aquatica*, *Odontites verna*, *Ononis arvensis*, *Parnassia palustris*, *Phleum pratense*, *Phragmites australis* subsp. *australis*, *Plantago lanceolata*, *Potentilla erecta*, *Prunella vulgaris*, *Rumex conglomeratus*, *Selinum carvifolia*, *Serratula tinctoria*, *Succisa pratensis*, *Taraxacum officinale*, *Trifolium dubium*, *T. hybridum*, *T. pratense*, *T. repens*, *T. fragiferum* [BURDUJA, 1954].

In an other paper [CHIFU & al., 1987], there are cited few other plant species from Bălăneşti-Bârgăoani, namely: *Lemna gibba*, *Ligularia sibirica*, *Nymphaea alba*, *Menyanthes trifoliata*, *Peucedanum palustre*, *Salix rosmarinifolia* and *Sparganium emersum*.

From the marshes of Ghigoieşti there were cited the next plant species: *Alnus glutinosa*, *Agrostis stolonifera* subsp. *stolonifera*, *Carex vulpina*, *Epilobium parviflorum* f. *apricum*, *Filipendula ulmaria* subsp. *ulmaria*, *Galium palustre*, *Juncus articulatus*, *Leersia oryzoides*, *Mentha aquatica*, *Myosotis scorpioides*, *Odontites verna*, *Phragmites australis* subsp. *australis*, *Ranunculus lingua*, *Sium latifolium*, *Thelypteris palustris*, *Trifolium hybridum*, *T. dubium* [BURDUJA, 1954].

Some of these species are quite rare in the surveyed region, as well as in Moldavian region, namely:

Angelica palustris is a fairly rare glacial relict plant into the Moldavian flora, being cited so far from the Nature Reserve of Lozna – Dersca, Botoşani county [MITITELU & al., 1974], and from the marshes of Bahna Mare – Bălăneşti [BURDUJA, 1948, 1954]. This species has also been cited from other locations from the same Neamț county (but the name of localities are lacking at all in the cited paper [CHIFU & al. 1987]), from Nemira Mountains at "Apa Roşie" marshes [MITITELU & BARABAȘ, 1993], but this last location is not yet confirmed by herbarium sheets; and more than that, this marsh is situated in Harghita county, Transylvania region (!) (Fig. 4).

Fig. 4. *Angelica palustris* in the marshes of Bahna Mare – Bălăneşti

Ligularia sibirica – is also a glacial relict plant, that has been cited from the marshes of Bahna Mare – Bălăneşti, Neamț county [CHIFU & al., 1987]), as well as from Nemira Mountains [MITITELU & BARABAŞ, 1993], and from the Nature Reserve of Lozna – Dersca [MITITELU & al., 1974]; it is more frequent into the mountains region of Suceava county [personal observations]. *Ligularia sibirica* is registered under the Habitat Directive 92/43 of the European Union, having thereby a special protected status inside the "Natura 2000" network of Sites of Community Importance (SCI's) in Europe. In the autumn of 2009 lot of seeds have been collected for the "Index Seminum et Sporarum" edited by the Botanic Garden "Anastasie Fătu" from Iaşi and offered to the international exchange of seeds with other botanic gardens from all over the world [TĂNASE & OPREA, 2009] (Fig. 5).

Fig. 5. *Ligularia sibirica* in the marshes Bahna Mare – Bălăneşti

Menyanthes trifoliata is a glacial relict species into the Romanian flora and it has already cited from the Nature Reserve of Lozna – Dersca, Botoşani county [MITITELU & al., 1974], Osoi lake [GOREA, 2003] and Poiana Uzului – Bacău county [MITITELU & al., 1993], Iaşi city (!) [MITITELU & al., 1995], Vrancea county – frequently (!) [MITITELU & al., 1996], the marshes of Bahna Mare – Bălăneşti [CHIFU & al., 1987], Suceava county – frequently (!) [MITITELU & al., 1989], Cătuşa pool – Galaţi county [MITITELU & al., 1993] (Fig. 6) .

Fig. 6. *Menyanthes trifoliata* – the marshes of Bahna Mare – Bălăneşti

Thelypteris palustris has been previously cited from the marshes of Bahna Mare – Bălăneşti [BURDUJA, 1954], afterwards from the nature reserves Ponoare-Bosanci and "Mlaştina Cristişor" (Suceava county) [MITITELU & al., 1989], as well as from Borşani (Bacău county) [MITITELU & al., 1993], the Nature Reserve of Lozna – Dersca [MITITELU & al., 1974] and Rogojeşti – Mihăileni (Botoşani county) [MITITELU & CHIFU, 1993]). This species has been also cited from the counties of Neamţ [CHIFU & al., 1987], Vrancea [MITITELU & al., 1996] and Iaşi [MITITELU & al., 1995], but the exact locations and cross references are completely absent in the cited papers (Fig. 7) .

Fig. 7. *Thelypteris palustris* in the marshes near the village of Unghi

Concerning the vegetation, only four associations were already cited till now from one of the marshes surveyed by us, namely Bahna Mare – Bălăneşti. These associations are: ass. *Glycerietum maximae*, ass. *Caricetum ripariae*, ass. *Typhetum latifoliae*, and ass. *Typhetum angustifoliae*. The last two associations were reported together in the same phytocoenotic table, both associations being reported also in an other location (Dulceşti – Bozieni), so no one do not know where exactly these associations are present, as a matter of fact [LUPAŞCU, 1999].

Methodology

The vegetation of all five marshes has been surveyed during the summer and fall of 2008 and in the spring and summer of 2009, using the principles of Central-European geobotanical school [BRAUN-BLANQUET, 1964]). The phytocoenologic framing of the vegetation units follow [COLDEA (ed.) & al., 1997] and [SANDA & al., 1997]. The syntaxonomic nomenclature is according to [MUCINA & al., 1993], whereas the nomenclature of vascular plants follows "Flora Europaea" [TUTIN T. G. & al. (eds.), 1964-1980 & 1993; http://rbg-web2.rbge.org.uk/FE/fe.html) and [SĂVULESCU T. & al., 1952-1976]. Conservation value of the identified associations was estimated through the values of Simpson's index of dominance (CRISTEA & al., 2004), considering also the presence of rare and endangered species from a romanian red list of vascular plants [OLTEAN & al., 1994] identified within the analyzed phytocoenoses. The framing of the natural habitats was made using the "Interpretation Manual of European Union Habitat" [*Interpretation Manual of European Union Habitat*/EUR 27/2007].

The geographic coordination of the investigated marshes were recorded using an eTrex Legend HCx GPS system, under the Stereo 70 geographic system.

Results & discussions

As a result of our field works, we can confirm the presence of some rare species as *Angelica palustris, Menyanthes trifoliata*, and *Thelypteris palustris*, in the marshes of Bahna Mare, from Bălăneşti-Bârgăoani. But we can not confirm, in the same marshes, the presence of some other species, as *Lemna gibba, Ligularia sibirica*, and *Nymphaea alba*, which were mentioned in the cited literature [CHIFU & al., 1987]. Instead, we found that *Ligularia sibirica* abundantly grows in the marshes situated near the village of Unghi. *Thelypteris palustris* is also frequently met in some phytocoenoses from these marshes. Other pretty rare plant species in the Romanian flora, and identified in the vegetation of the studied marshes, are the following ones: *Dactylorhiza incarnata* (Unghi and Bahna Mare), *Orchis laxiflora* subsp. *elegans* (Unghi), *Cirsium tuberosum* (Bahna Mare), *Cirsium oleraceum* × *C. tuberosum* (Bahna Mare), *Carex paniculata* (Unghi) etc.

The natural vegetation of the surveyed marshes includes a number of 16 plant associations. In addition, we also identified a type of vegetation of anthropogenic origin, which have the neophyte species *Aster lanceolatus* as a dominant one. All these syntaxa are framed in 11 alliances, 10 orders and 8 classes of vegetation.

The values of Simpson's index of dominance for each association are given into the Tab. 1.

Tab. 1. The values of Simpson's index of dominance (S) for each association

Association	Surface (m^2)	No. of rel.	S
Salicetum cinereae Zólyomi 1931	100	9	0,58
	50	1	0,67
Stellario nemorum–Alnetum glutinosae Lohmeyer 1957	200	2	0,66
Salicetum purpureae Wendelberger-Zelinka 1952	100	2	0,60
Carici flavae–Eriophoretum latifolii Soó 1944	70	3	0,53
	75	2	0,76
	80	3	0,42
	85	1	0,22
	90	2	0,22
Scirpetum sylvatici Ralski 1931	100	3	0,83
Caltho laetae–Ligularietum sibiricae Ştefan et al. 2000	50	4	0,26
	25	3	0,23
Angelico–Cirsietum oleracei R. Tx. 1937	50	3	0,39
Deschampsietum cespitosae Hayek ex Horvatic 1930	25	3	0,58
Pastinaco sativae–Arrhenatheretum elatioris Passarge 1964	25	2	0,75
Caricetum ripariae (Soó 1928) Knapp et Stoffer 1962 *typicum*	50	4	0,57
	25	4	0,70
	20	2	0,54
Caricetum rostratae Rübel 1912	20	2	0,86
Phragmitetum vulgaris Soó 1927	50	2	0,62
	100	1	0,79
Typhetum angustifoliae Pignatti 1953	25	1	0,58
	50	1	0,47
	100	1	0,83
Glycerietum maximae Hueck 1931	4	1	0,92
	25	1	0,73
	50	1	0,90
Galegetum officinalis Dobrescu et Vițalariu 1981	25	1	0,77
Phytocoenoses of *Aster lanceolatus*	50	1	0,72
Callitrichetum polymorphae Soó 1947	1	2	0,90
	2	1	0,85

The species composition of the plant communities is given in the phytocoenotic tables (Tab. 2-9). Most of the identified natural plant communities are well preserved, unmodified or only slightly modified by the human activities.

We used the next framing of the plant communities, from the phytocoenotic point of view:

ALNETEA GLUTINOSAE Br.-Bl. et Tx. 1943
Alnetalia glutinosae Tx. 1937
Salicion cinereae T. Müller et Görs 1958
Salicetum cinereae Zólyomi 1931

QUERCO – FAGETEA Br.-Bl. et Vlieger in Vlieger 1937
Fagetalia sylvaticae Pawlowschi in Pawlowschi et al. 1928
Alno-Ulmion Br.-Bl. et Tx. 1943 em Müller et Görs 1958
Stellario nemorum – Alnetum glutinosae Lohmeyer 1957

SALICETEA PURPUREAE Moor 1958
Salicetalia purpureae Moor 1958
Salicion albae Soó 1930

Salicetum purpureae Wendelberger-Zelinka 1952
SCHEUCHZERIO – CARICETEA FUSCAE R. Tx. 1937
Caricetalia davallianae Br.-Bl. 1949
Caricion davallianae Klika 1934
Carici flavae – Eriophoretum latifolii Soó 1944

MOLINIO – ARRHENATHERETEA R. Tx. 1937
Molinietalia caeruleae Koch 1926
Calthion palustris R. Tx. 1937
Scirpetum sylvatici Ralski 1931
Caltho laetae – Ligularietum sibiricae Ștefan et al. 2000
Angelico – Cirsietum oleracei R. Tx. 1937
Deschampsion Horvatic 1930
Deschampsietum caespitosae Hayek ex Horvatic 1930
Arrhenatheretalia R. Tx. 1931
Arrhenatherion Koch 1926
Arrhenatheretum elatioris Scherrer 1925

PHRAGMITI – MAGNOCARICETEA Klika in Klika et Novák 1941
Magnocaricetalia elatae Pignatti 1953
Magnocaricion elatae Koch 1926
Caricenion gracilis (Neuhäusl 1959) Oberd. et al. 1967
Caricetum ripariae (Soó 1928) Knapp et Stoffer 1962
-typicum
Caricenion rostratae (Bálátová-Tuláčková 1963) Oberd. et al. 1967
Caricetum rostratae Rübel 1912
Phragmitetalia Koch 1926
Phragmition communis Koch 1926
Phragmitetum vulgaris Soó 1927
Typhetum angustifoliae Pignatti 1953
Glycerietum maximae Hueck 1931

GALIO – URTICETEA Passarge ex Kopecky 1969
Convolvuletalia sepium R. Tx. 1950 em. Mucina 1993
Senecion fluviatilis R. Tx. 1950
Galegetum officinalis Dobrescu et Vițalariu 1981
Phytoceonoses of *Aster lanceolatus*

POTAMETEA PECTINATI Klika in Klika et Novák 1941
Callitricho – Batrachietalia Passarge 1964
Ranunculion aquatilis Passarge 1964
Callitrichetum polymorphae Soó 1947

Following, there are discussed each of those 16 associations and phytocoenoses of *Aster lanceolatus*, from chorology and biotope features, as well as from phytocoenotical and ecological point of views.

Ass. ***Salicetum cinereae*** Zólyomi 1931

Chorology and biotope characteristics. In our study only relatively small surfaces of Bahna Mare, Unghi and Borşeni marshes were identified having phytocoenoses of *Salix cinerea*; these are placed either where the water layer does not exceed 15-30 cm in depth or on the wet soils. Grey willow made communities with coverages ranging between 65% and 100% of the ground surface.

Species composition and phytocoenotic structure. The characteristic species, *Salix cinerea*, is the dominant plant in all the phytocoenoses (Fig. 8). The characteristic species for the higher coenotaxa are less represented in all three marshes where it has been identified (Bahna Mare, Unghi, and Borşeni). In exchange, there are well represented some species originating from the marsh vegetation or the mesophyllous meadows nearby, as well as some species from the wet and megatrophic weeds. From *Phragmiti–Magnocaricetea* class there are present: *Carex riparia*, *C. acutiformis, Lythrum salicaria* etc. From the zonal meadows vegetation (*Molinio–Arrhenatheretea*) there are present: *Equisetum arvense*, *Ranunculus repens*, *Angelica sylvestris* subsp. *sylvestris*, *Caltha palustris, Cirsium oleraceum, Filipendula ulmaria* subsp. *ulmaria*, and so on. Finally, the *Galio–Urticetea* class is especially represented by *Eupatorium cannabinum*, *Calystegia sepium*, and *Galium aparine*. Among the rare plant species in our relevés, we can list some of them, as: *Angelica palustris*, *Carex paniculata*, *Ligularia sibirica*, and *Thelypteris palustris* (Tab. 2, rel. 1-10).

The taxonomy of this association has been discused in an other paper of the same authors [OPREA & SÎRBU, 2009].

Fig. 8. Ass. *Salicetum cinereae* Zólyomi 1931 – the marshes of Bahna Mare – Bălăneşti

Ass. ***Stellario nemorum – Alnetum glutinosae*** Lohmeyer 1957

Chorology and biotope characteristics. The phytocoenoses with *Alnus glutinosa* represents those communities situated along the flooded meadows of rivers, on the plain and hilly regions of Romania [MITITELU & al., 1997; SANDA & al., 1997; SANDA & ARCUŞ, 1999 etc.]. The phytocoenoses are located in depressions, with an excess of humidity and the water table just under the soil surface.

Species composition and phytocoenotic structure. In the surveyed areas of Borşeni, Războieni, and Borniş marshes, the coverage of the tree stratum, edified by *Alnus*

glutinosa, vary between 70% and 90% (Fig. 9). The other species has different coverage indices of the soil surface (between 1% and 65%). Among the characteristic species for the higher coenotaxa, besides *Stellaria nemorum* (characteristic for association), there are present other ones, as: *Viburnum opulus*, *Humulus lupulus*, *Cerasus avium*, *Evonymus europaeus*, *Brachypodium sylvaticum*, *Cornus sanguinea*. One can remark the presence of many characteristic species to other classes, which are in nearby, as they are: *Alnetea glutinosae* (*Frangula alnus*, *Lysimachia vulgaris*), *Molinio–Arrhenatheretea* (*Angelica sylvestris* subsp. *sylvestris*, *Equisetum arvense*, *Filipendula ulmaria* subsp. *ulmaria*), *Phragmiti–Magnocaricetea* (*Carex riparia*, *Lycopus europaeus*), *Galio–Urticetea* (*Rubus caesius*, *Aegopodium podagraria*, *Urtica dioica*) etc. (Tab. 2, rel. 11-14).

Tab. 2. Ass. *Salicetum cinereae* Zólyomi 1931 (rel. no. 1-10); Ass. *Stellario nemorum – Alnetum glutinosae* Lohmeyer 1957 (rel. no. 11-14)

Consistency (%)												**0.8**	**0.9**	**0.7**	**0.8**
Tree height (m)												**10**	**10**	**9-10**	**10**
Tree diameter (cm)												**5-20**	**5-25**	**5-25**	**5-25**
Shrub layer coverage (%)	**70**	**80**	**100**	**65**	**75**	**85**	**90**	**90**	**100**	**100**	**K**	**1**	**5**	**65**	**1**
Herbaceous layer coverage (%)	**65**	**50**	**10**	**60**	**60**	**15**	**20**	**20**	**10**	**10**		**40**	**25**	**20**	**15**
Surface of relevé (m^2)	**100**	**100**	**100**	**100**	**100**	**100**	**50**	**100**	**100**	**100**		**200**	**200**	**100**	**400**
No. of relevé	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		**11**	**12**	**13**	**14**
Salicion cinereae, Alnetalia glutinosae & Alnetea glutinosae															
Salix cinerea	4	5	5	4	4	5	5	5	5	5	V	+	-	-	-
Alnus glutinosa	-	-	-	+	+	+	+	+	-	-	III	5	5	4	5
Alnus glutinosa (juv.)	-	-	-	-	-	-	-	-	-	-		+	1	-	-
Lysimachia vulgaris	+	+	-	+	+	-	+	-	+	+	IV	+	+	+	-
Frangula alnus	-	-	-	+	-	+	-	-	-	-	I	+	+	+	+
Solanum dulcamara	-	-	+	-	-	-	-	-	+	-	I	-	-	-	-
Alno–Ulmion, Fagetalia sylvaticae & Querco – Fagetea															
Stellaria nemorum	-	-	-	-	-	-	-	-	-	-		1	1	1	1
Betula pendula (juv.)	-	-	-	-	-	+	-	-	-	-	I	-	-	-	-
Brachypodium sylvaticum	-	-	-	-	-	-	-	-	-	-		-	-	+	+
Cerasus avium (juv.)	-	-	-	-	-	-	-	-	-	-		+	-	+	-
Clematis vitalba	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Cornus sanguinea	-	-	-	-	-	-	-	-	-	-		-	+	-	+
Crataegus monogyna	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Evonymus europaeus	-	-	-	-	-	-	-	-	-	-		+	+	-	-
Fragaria vesca	-	-	-	-	-	-	-	-	-	-		-	-	-	+
Geranium phaeum	-	-	-	-	-	+	+	-	-	-	I	-	-	-	-
Humulus lupulus	-	-	+	-	+	-	-	-	-	-	I	-	+	-	-
Populus tremula (juv.)	-	-	-	-	-	+	-	-	-	-	I	-	-	-	-
Rosa canina	-	-	-	-	-	-	-	-	-	-		+	+	-	-
Viburnum opulus	-	-	-	-	+	-	+	+	+	1	III	+	+	-	-
Molinio – Arrhenatheretea															
Agrostis stolonifera subsp. stolonifera	-	-	-	-	+	-	+	-	-	-	I	+	+	-	+
Angelica palustris	+	-	-	+	-	-	-	-	-	-	I	-	-	-	-
Angelica sylvestris subsp. sylvestris	+	+	-	+	-	+	+	-	+	+	IV	+	+	+	+
Caltha palustris	1	-	+	-	+	-	+	+	+	+	IV	+	+	-	-
Cardamine amara	-	-	-	-	-	-	-	-	-	-		+	-	-	-
Cardamine pratensis	-	-	-	-	-	-	-	-	-	-		+	+	-	-
Carex distans	-	-	-	-	-	-	-	-	-	+	I	-	-	-	-
Carex flava	+	-	-	-	-	-	-	-	-	-	I	-	-	-	-
Carex hirta	-	-	-	-	-	+	+	-	-	-	I	-	-	+	-
Cirsium canum	-	-	+	-	-	-	-	-	-	-	I	-	-	-	-
Cirsium oleraceum	-	-	-	+	+	+	+	-	+	+	III	+	1	-	+
Cirsium palustre	-	-	-	+	+	-	-	-	-	-	I	-	-	-	-
Cirsium rivulare	-	-	-	-	-	+	+	-	-	-	I	-	-	-	-

Cirsium tuberosusm	+	+	-	-	-	-	-	-	-	-	I	-	-	-	-
Dactylorhiza incarnata	-	-	-	-	-	+	+	-	-	-	I	-	-	-	-
Dactylorhiza maculata subsp. fuchsii	+	+	-	-	-	-	-	-	-	-	I	-	-	-	-
Deschampsia cespitosa subsp. cespitosa	+	1	-	-	-	-	-	-	-	-	I	-	-	-	-
Epilobium hirsutum	-	-	-	-	-	-	-	-	+	+	I	-	-	-	-
Equisetum arvense	1	1	+	+	+	+	+	-	+	+	V	1	+	1	-
Eriophorum latifolium	-	-	-	-	-	-	+	-	-	-	I	-	-	-	-
Festuca arundinacea subsp. arundinacea	-	-	-	-	-	-	-	-	-	+	I	-	-	+	-
Filipendula ulmaria subsp. ulmaria	1	-	-	+	1	+	+	-	+	-	III	+	1	+	+
Galium uliginosum	-	-	-	-	-	+	-	+	-	-	I	-	-	-	-
Geranium palustre	-	-	-	+	+	+	-	-	+	+	III	-	+	-	+
Hypericum tetrapterum	+	-	-	-	-	-	-	-	-	-	I	-	-	-	-
Juncus inflexus	+	-	-	-	+	-	-	-	-	-	I	+	-	-	-
Lathyrus pratensis	+	-	-	+	+	+	+	-	-	-	II	+	-	-	-
Ligularia sibirica	-	-	-	+	+	+	1	-	-	-	II	-	-	-	-
Lychnis flos-cuculi	+	-	-	-	-	-	-	-	-	-	I	-	+	-	-
Lysimachia nummularia	+	+	+	+	+	-	-	-	+	-	III	+	-	-	+
Lysimachia punctata	-	-	-	-	-	+	-	-	-	-	I	-	-	-	-
Mentha longifolia	-	+	+	-	+	-	-	-	+	+	II	-	-	-	+
Parnassia palustris	+	-	-	-	-	-	-	-	-	-	I	-	-	-	-
Peucedanum palustre	+	+	-	+	+	-	-	-	-	-	II	-	-	-	-
Plantago major	-	-	-	-	-	-	-	-	-	+	I	-	-	+	-
Poa palustris	-	-	-	-	-	-	-	-	-	-		-	+	+	-
Poa sylvicola	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Potentilla anserina	-	-	-	-	-	-	+	1		+	I	+	-	-	-
Potentilla erecta	+	-	-	+	-	-	+	-	-	-	II	-	-	-	-
Potentilla reptans	+	-	-	+	-	-	-	-	-	+	I	+	-	-	-
Prunella vulgaris	+	-	-	-	-	-	-	-	-	-	I	+	-	+	-
Ranunculus acris	+	-	-	-	-	+	-	-	+	-	II	-	-	-	+
Ranunculus repens	+	+	+	+	+	-	+	+	-	-	IV	+	-	+	+
Rumex stenophyllus	-	-	+	-	-	-	-	-	-	-	I	-	-	-	-
Scirpus sylvaticus	+	-	+	-	-	-	-	+	-	+	II	-	-	-	-
Scrophularia umbrosa subsp. umbrosa	+	-	-	-	-	+	-	-	-	-	I	+	-	-	-
Selinum carvifolia	+	+	-	+	+	-	-	-	-	-	II	-	-	-	-
Succisa pratensis	+	-	-	+	-	-	-	-	-	-	I	-	-	-	-
Symphytum officinale subsp. officinale	+	+	+	-	-	-	-	+	-	-	II	-	-	-	-
Valeriana officinalis	-	-	+	+	-	-	+	-	-	-	II	-	-	-	-
Valeriana sambucifolia	+	+	-	-	-	-	-	-	-	+	II	-	-	-	-
Veronica beccabunga	-	-	-	-	-	-	-	-	-	-		-	-	-	+
Veronica chamaedrys	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Vicia cracca	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Phragmiti – Magnocaricetea															
Berula erecta	-	-	-	-	-	-	-	+	-	-	I	-	-	-	+
Carex acutiformis	1	2	-	1	1	-	+	1	-	-	III	-	-	-	-
Carex paniculata	-	-	-	-	-	-	+	-	-	-	I	-	-	-	-
Carex riparia	3	-	+	3	3	-	+	+	+	+	IV	1	+	+	-
Carex vulpina	+	-	-	-	-	-	+	-	-	-	I	-	-	-	-
Eleocharis palustris	-	-	-	-	-	-	-	+	-	-	I	-	-	-	-
Epilobium parviflorum	+	+	-	-	-	-	-	-	-	-	I	-	-	-	-
Equisetum fluviatile	-	-	+	-	+	+	-	+	-	-	I	+	-	-	-
Lycopus europaeus	+	-	+	-	-	+	+	+	+	+	IV	+	+	+	+
Lythrum salicaria	+	+	+	+	+	+	+	+	-	-	IV	+	-	-	-
Mentha aquatica	+	+	-	+	+	-	-	-	-	-	II	-	-	-	-
Phragmites australis subsp. australis	-	-	-	+	-	-	+	-	-	-	I	+	-	+	-
Scutellaria galericulata	+	-	+	+	+	-	-	-	-	-	II	-	-	-	-

Sium latifolium	-	-	-	-	+	-	-	-	-	-	I	-	-	-	-
Sium sisarum var. lancifolium	-	+	+	-	-	-	-	-	-	-	I	-	+	-	-
Stachys palustris	-	-	+	-	-	-	-	-	-	-	I	-	-	-	-
Thelypteris palustris	-	-	-	+	+	+	+	-	-	-	II	-	-	-	-
Typha angustifolia	-	-	-	+	+	+	-	+	-	-	II	-	-	-	-
Typha latifolia	-	-	-	-	-	-	-	-	+	-	I	+	-	-	-
Galio – Urticetea															
Aegopodium podagraria	-	-	-	-	-	-	-	-	+	+	I	+	+	+	+
Aethusa cynapium	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Calystegia sepium	+	+	+	+	-	-	+	-	-	+	III	+	+	-	-
Chaerophyllum bulbosum	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Eupatorium cannabinum	+	+	+	+	-	+	-	+	+	-	IV	+	+	+	-
Festuca gigantea	-	-	-	-	-	-	-	-	-	-		-	-	-	+
Galeopsis speciosa	-	-	-	-	-	-	-	-	-	-		-	-	-	+
Galium aparine	+	+	-	+	+	+	+	-	-	-	III	-	-	-	-
Geum urbanum	-	-	-	-	-	-	-	-	-	-		-	-	+	+
Glechoma hederacea	-	-	-	-	-	-	-	-	-	-		-	+	-	+
Lamium maculatum	-	-	-	-	-	-	-	-	-	-		-	-	-	+
Lapsana communis	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Rubus caesius	-	-	-	-	-	+	+	1	-	-	I	+	+	4	+
Silene dioica	-	-	-	-	-	-	-	-	+	-	I	-	-	+	-
Tussilago farfara	-	-	-	-	-	-	-	-	+	+	I	+	-	+	-
Urtica dioica	-	-	-	-	-	-	-	-	-	-		+	+	+	1
Salicetea purpureae															
Salix alba	-	-	-	-	-	-	-	-	-	-		-	-	+	
Salix fragilis	-	-	-	-	-	-	-	-	-	-		-	-	+	+
Aliae															
Arctium lappa	-	-	-	-	-	-	-	-	-	-		-	-	-	+
Artemisia vulgaris	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Ballota nigra	-	-	-	-	-	-	-	-	-	-		-	-	-	+
Polygonum lapathifolium	-	-	-	-	-	-	-	-	+	-	I	+	-	-	+
Rumex conglomeratus	-	-	-	-	-	-	-	-	-	-		-	-	+	-
Sambucus nigra	-	-	-	-	-	-	-	-	-	-		+	+	-	+
Torilis arvensis	-	-	-	-	-	-	-	-	-	-		-	-	-	+

Place and data of relevés: 1-3: The marshes of Bahna Mare, September, 21, 2008; 4-8: The marshes of Unghi, on the stream valley "Valea Albă", September, 21, 2008; 9-10: The marshes of Borşeni, July, 18, 2009. 11-12: The marshes of Borşeni, July, 18, 2009; 13: Războieni, along the valley of Tita stream, July, 18, 2009; 14: at south of Borniş, July, 18, 2009

Fig. 9. Ass. *Stellario nemorum – Alnetum glutinosae* Lohmeyer 1957 – the marshes of Borşeni

Ass. ***Salicetum purpureae*** Wendelberger-Zelinka 1952

Chorology and biotope characteristics. The phytocoenoses of red willow, *Salix purpurea* subsp. *purpurea*, are spread along the lower river meadows, from Bahna Mare marshes, being there at the external limit of the Moldavian sub-Carpathians. On that marshes, the soil coverage with red willow is around 90%. This species establish often bushes on various surfaces, on alluvial soils, on minor bed of streams, nearby the surveyed area.

Species composition and phytocoenotic structure. The communities of *Salix purpurea* subsp. *purpurea* are relatively low structured from phytocoenotic point of view. Besides the edificator species, *Salix purpurea* subsp. *purpurea*, among the characteristic species for higher coenotaxa is present *Salix triandra* subsp. *triandra* only. The majority of the species in the species composition are from the wet meadows surrounding these phytocoenoses, namely zonal meadows (*Molinio–Arrhenatheretea*) or the wet vegetation (*Phragmiti–Magnocaricetea*) etc. (Tab. 3).

Tab. 3. Ass. *Salicetum purpureae* Wendelberger-Zelinka 1952

Surface of relevé (m^2)	**100**	**100**
Tree and shrub coverage (%)	**90**	**90**
Herbaceous layer coverage (%)	**15**	**50**
No. of relevée	**1**	**2**
Salicetalia & Salicetea purpureae		
Salix purpurea subsp. purpurea	5	5
Salix triandra susbp. triandra	+	+
Phragmiti – Magnocaricetea		
Berula erecta	+	-
Carex riparia	+	-
Epilobium parviflorum	+	-
Glyceria maxima	-	+
Lycopus europaeus	+	-
Mentha aquatica	-	+
Phragmites australis subsp. australis	-	+
Poa palustris	+	-
Scrophularia umbrosa subsp. umbrosa	+	+
Solanum dulcamara	+	+
Sparganium erectum subsp. erectum	+	-
Molinio – Arrhenatheretea		
Agrostis stolonifera subsp. stolonifera	+	+
Althaea officinalis	-	+
Angelica sylvestris subsp. sylvestris	-	+
Cirsium oleraceum	+	-
Cirsium oleraceum × tuberosum	-	+
Cirsium tuberosum	-	+
Epilobium hirsutum	+	+
Hypericum tetrapterum	+	-
Juncus effusus	+	-
Lysimachia vulgaris	+	-
Lythrum salicaria	+	+
Mentha longifolia	-	+
Potentilla anserina	+	-
Prunella vulgaris	+	-
Ranunculus acris	+	-
Symphytum officinale subsp. officinale	-	+
Taraxacum officinale	+	+
Galio – Urticetea		
Bilderdykia dumetorum	+	-
Calystegia sepium	+	+

Eupatorium cannabinum	+	+
Galium aparine	+	+
Glechoma hederacea	+	-
Urtica dioica	+	3
Artemisietea		
Arctium lappa	-	+
Artemisia vulgaris	-	+
Elymus repens subsp. repens	+	-
Tussilago farfara	+	+
Aliae		
Atriplex patula	+	-
Bidens cernua	+	-
Galeopsis tetrahit	-	+
Polygonum hydropiper	+	+
Rumex conglomeratus	+	-
Sambucus nigra	-	+

Place and data of relevés: 1-2. The marshes of Bahna Mare, September, 21, 2008

Ass. ***Carici flavae – Eriophoretum latifolii*** Soó 1944

Chorology and biotope characteristics. This association has been identified in the marshes of Unghi, Bahna Mare – Bălăneşti (Fig. 10), and Râşcolniţa (Ghigoieşti), on surfaces between 20 m^2 and 100 m^2. The soils are of swampy types, phytocoenoses being situated on flat landes or on slightly slopes, on weak acid toward neutral soils, and variable nutrient contents.

Species composition and phytocoenotic structure. The species composition of this association vary, with herbaceous layer coverages between 70% and 90%. Besides the edificator species (*Eriophorum latifolium*) and the characteristic one (*Carex flava*), the next species are characteristic for the higher coenotaxa (*Scheuchzerio – Caricetea fuscae* class): *Menyanthes trifoliata, Dactylorhiza incarnata, Carex paniculata* etc.

From the vegetation of wet places (*Phragmiti–Magnocaricetea*) there are present some species as: *Thelypteris palustris*, *Phragmites australis* subsp. *australis***,** *Carex acutiformis* etc. Zonal meadows vegetation (*Molinio – Arrhenatheretea*) is present by some species, as they are: *Filipendula ulmaria* subsp. *ulmaria*, *Angelica sylvestris* subsp. *sylvestris*, *Cirsium rivulare*, *Potentilla erecta*, *Equisetum palustre*, *Succisa pratensis*, *Lathyrus pratensis*, *Selinum carvifolia*, *Ranunculus acris* etc.

Fig. 10. Ass. *Carici flavae – Eriophoretum latifolii* Soó 1944 in the marshes of Bahna Mare – Bălăneşti

Some of the phytocoenoses of this association, namely those from the marshes of Bahna Mare – Bălăneşti, are dominated by the glacial relict species into the Romania's flora, *Menyanthes trifoliata* (relevées no. 5-10) (Tab. 4). Other rare species in this association are *Carex paniculata* and *Ligularia sibirica.*

Tab. 4. Ass. *Carici flavae – Eriophoretum latifolii* Soó 1944

Surface of relevé (m^2)	**20**	**20**	**20**	**20**	**100**	**50**	**50**	**50**	**20**	**20**	**25**	
Coverage (%)	**70**	**70**	**75**	**75**	**90**	**80**	**80**	**70**	**90**	**80**	**85**	**K**
No. of relevée	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	
Caricion davalianae, Caricetalia davalianae & Scheuchzerio – Caricetea fuscae												
Eriophorum latifolium	4	4	4	4	3	1	3	2	2	1	3	V
Carex flava	+	+	+	+	+	+	+	+	-	-	+	V
Carex paniculata	-	-	+	-	1	+	+	2	+	1	+	IV
Carex rostrata	-	-	-	-	-	-	-	-	-	-	+	I
Dactylorhiza incarnata	+	-	-	-	+	-	+	+	+	+	-	III
Ligularia sibirica	+	-	+	+	-	-	-	-	-	-	-	II
Menyanthes trifoliata	-	-	-	-	2	3	2	2	2	4	-	III
Phragmiti – Magnocaricetea												
Carex acutiformis	-	+	+	+	+	-	+	1	+	+	-	IV
Carex distans	-	+	-	+	-	-	-	-	-	-	1	II
Carex otrubae	-	-	+	-	-	-	-	-	-	-	-	I
Carex riparia	-	+	+	-	1	5	1	-	+	-	-	III
Eleocharis palustris	-	-	-	-	-	-	-	-	1	-	+	I
Lysimachia punctata	-	+	-	-	-	-	-	-	-	-	+	I
Myosotis scorpioides	-	-	-	-	+	-	-	-	+	-	+	II
Phragmites australis subsp. australis	+	-	+	+	+	2	+	+	1	-	1	V
Symphytum officinale subsp. officinale	-	-	+	-	+	+	1	1	-	-	1	III
Thelypteris palustris	1	+	+	+	+	+	+	+	-	+	-	V
Molinio – Arrhenatheretea												
Agrostis stolonifera subsp. stolonifera	-	-	+	-	-	-	1	+	+	-	+	III
Angelica sylvestris subsp. sylvestris	+	+	-	-	+	+	+	+	+	+	+	V
Caltha palustris	-	-	+	+	+	+	1	-	2	-	1	IV
Carex hirta	-	+	+	+	-	-	+	-	+	-	-	III
Cirsium canum	-	-	-	-	-	+	-	-	+	+	+	II
Cirsium oleraceum	-	+	-	+	-	-	-	+	+	-	-	II
Cirsium rivulare	-	+	+	+	+	-	+	+	+	+	+	V
Dactylorhiza maculata subsp. fuchsii	+	-	-	-	-	-	-	-	-	-	-	I
Equisetum arvense	-	-	-	-	-	-	-	+	-	-	+	I
Equisetum palustre	+	+	+	-	+	+	-	+	1	+	-	IV
Filipendula ulmaria subsp. ulmaria	+	+	-	+	+	+	+	1	1	+	1	V
Galega officinalis	-	-	-	-	+	-	-	-	-	-	-	I
Galium uliginosum	-	+	-	-	-	-	-	-	+	-	+	II
Geranium palustre	-	-	-	+	-	-	+	+	-	-	+	II
Lathyrus pratensis	-	-	-	-	+	-	+	+	+	+	-	III
Linum catharcticum	-	-	-	-	-	-	-	-	-	-	+	I
Lychnis flos-cuculi	-	-	-	-	+	-	+	+	+	+	+	III
Lysimachia nummularia	-	-	-	-	-	-	-	1	-	-	+	I
Lysimachia vulgaris	-	-	-	-	+	+	+	-	+	-	-	II
Peucedanum palustre	-	-	-	-	-	+	+	+	-	+	-	II
Potentilla anserina	-	-	-	-	-	+	1	-	-	-	+	II
Potentilla erecta	+	+	+	+	+	+	-	1	+	-	1	V
Ranunculus acris	-	+	+	-	+	-	-	+	-	+	+	III
Ranunculus repens	-	-	+	-	-	-	-	-	+	-	1	II
Scirpus sylvaticus	-	+	-	-	-	+	-	-	1	-	+	II
Selinum carvifolia	+	+	-	+	+	+	-	-	-	-	+	III
Succisa pratensis	+	+	+	+	+	-	-	-	-	-	+	III
Trifolium pratense	-	-	-	-	-	-	-	+	1	-	+	II

Valeriana officinalis	-	+	-	-	+	+	-	+	-	-	+	III
Aliae												
Eupatorium cannabinum	-	+	-	-	-	-	-	-	+	-	+	II
Geranium phaeum	-	+	+	+	-	-	-	+	+	-	-	III
Salix cinerea (juv.)	+	+	+	+	+	+	+	+	-	-	-	IV
Salix purpurea subsp. purpurea (juv.)	-	-	-	-	-	+	+	-	-	-	-	I

Place and data of relevés: 1-4. The marshes of Unghi, on the stream valley "Valea Albă", September, 21, 2008; 5-10. The marshes of Bahna Mare-Bălăneşti, May, 24, 2009; 11. The marshes of Râşcolniţa (Ghigoieşti), May, 24, 2009

Ass. ***Scirpetum sylvatici*** Ralski 1931 (Syn.: *Scirpetum sylvatici* Schwickerath 1944; *Scirpetum sylvatici* Maloch 1935)

Chorology and biotope characteristics. The phytocoenoses of *Scirpetum sylvatici* association have been identified on the marshes near Borniş village, along the stream valley "Obârşia", and in the marshes near Unghi village. These phytocoenoses are installed along the stream valleys or even on the stream banks in the surveyed area, on alluvial, pseudogleyic and gleyic soils, wet or low flooded.

Species composition and phytocoenotic structure. In species composition , the edificator species is *Scirpus sylvaticus*. From *Molinietalia* et *Molinio – Arrhenatheretea*, there are present about 68% of the total species, as: *Mentha longifolia*, *Angelica sylvestris* subsp. *sylvestris*, *Mentha arvensis*, *Agrostis stolonifera* subsp. *stolonifera*, etc. From the vegetation of wet zones (*Phragmiti – Magnocaricetea*), there are present about 19% of species in the species composition (*Mentha aquatica*, *Carex riparia*, *C. vulpina*, *Glyceria fluitans*, *Symphytum officinale* subsp. *officinale*, etc.) (Tab. 5, rel. 1-3).

Tab. 5. Ass. *Scirpetum sylvatici* Ralski 1931 (rel. 1-3); Ass. *Caltho laetae – Ligularietum sibiricae* Ştefan et al. 2000 (rel. 4-10); Ass. *Angelico – Cirsietum oleracei* R. Tx. 1937 (rel. 11-13); Ass. *Deschampsietum cespitosae* Hayek ex Horvatic 1930 (rel. 14-16); Ass. *Pastinaco sativae – Arrhenatheretum elatioris* Passarge 1964 (rel. 17-18)

Surface of relevé (m^2)	**25**	**25**	**50**	**50**	**25**	**25**	**50**	**50**	**50**	**25**		**50**	**50**	**50**	**25**	**25**	**25**	**25**	**25**
Coverage (%)	**100**	**100**	**100**	**95**	**85**	**90**	**80**	**95**	**85**	**90**	**K**	**95**	**75**	**75**	**100**	**100**	**100**	**100**	**100**
No. of relevée	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Calthion																			
Scirpus sylvaticus	5	5	5	-	-	-	+	-	-	+	II	-	+	-	-	-	-	-	-
Caltha palustris	-	-	+	+	+	-	+	+	+	+	V	-	+	-	-	-	-	-	-
Cirsium oleraceum	-	-	-	+	-	+	-	-	-	-	II	4	3	2	-	-	-	-	-
Juncus articulatus	-	-	-	-	-	-	+	+	-	-	II	-	-	+	-	-	-	-	-
Deschampsion	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Deschampsia cespitosa subsp. cespitosa	-	-	-	-	-	-	-	-	-	-		-	-	-	5	5	5	-	-
Juncus effusus	-	-	-	-	-	-	-	-	-	-		-	-	-	+	-	+	-	-
Molinietalia																			
Angelica palustris	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Angelica sylvestris subsp. sylvestris	+	-	-	+	1	+	+	+	+	+	V	+	+	+	+	+	-	-	-
Cirsium rivulare	-	-	-	-	-	+	+	+	+	+	IV	-	-	-	+	+	+	-	-
Epilobium hirsutum	+	-	-	-	-	-	-	-	-	-		-	+	-	+	-	+	-	-
Equisetum palustre	-	-	+	3	3	2	3	3	2	2	V	+	+	-	-	-	-	-	-
Galium uliginosum	-	-	-	-	-	-	+	+	+	-	III	-	-	-	+	+	+	-	-
Myosotis scorpioides	-	-	+	-	-	-	-	-	-	-		-	-	-	+	+	+	-	-

Arrhenatherion & Arrhenatheretalia																			
Arrhenatherum elatius subsp. elatius	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	5	5
Achillea millefolium	-	-	-	-	-	-	-	-	-	-		-	-	-	+	+	+	+	+
Centaurea phrygia subsp. phrygia	-	-	-	-	-	-	-	-	-	-		-	-	-	+	-	+	-	-
Galium mollugo	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Heracleum sphondylium subsp. sphondylium	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Holcus lanatus	-	-	-	-	-	-	-	-	-	-		+	-	+	-	-	-	-	-
Leontodon autumnalis	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Trifolium pratense	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Trifolium repens	-	-	-	-	-	-	-	-	-	-		-	-	+	-	-	-	+	+
Molinio – Arrhenatheretea																			
Agrostis stolonifera subsp. stolonifera	-	+	-	-	-	-	-	-	-	-		+	+	+	+	+	+	-	-
Alopecurus geniculatus	-	-	-	-	-	-	-	-	-	-		-	-	+	-	-	-	-	-
Carex distans	-	-	+	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Carex hirta	-	+	+	-	-	-	-	-	-	-		+	-	-	+	+	+	-	-
Centaurea jacea	-	-	-	-	-	-	-	-	-	-		-	-	-	+	+	+	-	-
Cerastium fontanum	-	+	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Chaerophyllum hirsutum	-	-	-	-	-	-	-	-	-	-		+	-	-	-	-	-	-	-
Cirsium palustris	-	-	-	-	-	-	-	-	-	+	I	-	-	-	-	-	-	-	-
Cirsium tuberosum	-	-	-	-	-	-	-	-	-	-		-	-	-	+	+	+	+	+
Coronilla varia	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Cuscuta epithymum subsp. trifolii	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Epipactis palustris	-	-	-	-	+	-	+	-	+	+	III	-	-	-	-	-	-	-	-
Equisetum arvense	-	+	-	-	-	-	-	-	-	+	I	+	+	+	+	+	1	+	+
Festuca arundinacea	-	-	-	-	-	-	-	-	-	-		+	-	+	-	-	-	-	-
Festuca pratensis	-	+	-	-	-	-	-	-	-	-		-	-	-	+	+	-	+	-
Filipendula ulmaria subsp. ulmaria	-	-	-	1	+	+	+	+	+	+	V	+	2	3	-	-	-	-	-
Galium palustre	-	-	-	-	+	-	-	-	-	-	I	-	-	-	-	-	-	-	-
Geranium palustre	-	-	-	+	+	+	-	-	+	-	III	+	-	+	-	-	-	+	+
Hypericum tetrapterum	-	-	+	-	-	-	-	-	+	+	II	-	+	-	-	-	-	-	-
Inula britannica	-	-	-	-	-	-	-	-	-	-		-	-	-	+	+	+	-	-
Lathyrus pratensis	-	-	+	-	-	-	1	1	+	-	III	-	-	+	-	-	-	+	+
Leucanthemum vulgare	-	-	-	-	-	-	-	-	-	-		+	-	-	-	-	-	-	-
Lotus corniculatus	+	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Lychnis flos-cuculi	-	-	+	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Lysimachia vulgaris	-	-	-	+	1	1	+	+	+	+	V	+	+	+	-	-	-	-	-
Lythrum salicaria	+	-	-	-	+	-	+	+	-	+	III	+	+	-	-	-	-	-	-
Lythrum virgatum	-	-	-	-	-	-	-	-	-	-		-	-	-	+	-	+	-	-
Mentha arvensis	+	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Mentha longifolia	+	+	1	-	-	-	-	-	-	+	I	1	1	1	+	+	+	+	+
Mentha verticillata	-	-	-	+	-	+	+	+	-	+	IV	-	-	+	-	-	-	-	-
Myosoton aquaticum	-	-	-	-	-	-	-	-	-	-		-	-	+	-	-	-	-	-
Odontites verna subsp. verna	-	-	-	-	-	-	-	-	-	-		-	-	-	+	-	-	-	-
Phleum pratense subsp. nodosum	-	-	-	-	-	-	-	-	-	-		-	-	-	+	+	+	-	-
Plantago major	-	-	+	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Poa hybrida	-	-	+	-	-	-	-	-	-	-		-	-	-	+	+	+	-	-
Potentilla anserina	-	+	+	-	-	-	-	-	-	-		-	-	+	+	+	+	-	-
Potentilla erecta	-	-	-	-	-	-	-	+	-	-	I	-	-	-	-	-	-	-	-
Potentilla reptans	-	-	-	-	-	-	-	-	-	-		+	-	-	+	+	+	+	+
Ranunculus acris	-	+	-	+	+	-	+	+	-	-	III	+	-	+	-	-	-	+	+
Ranunculus repens	-	+	+	-	-	-	-	-	-	+	I	-	+	-	-	-	-	+	+
Rumex crispus	-	-	+	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-

Scutellaria galericulata	-	-	-	-	-	-	+	-	+	-	II	-	-	-	-	-	-	-	-
Selinum carvifolia	-	-	-	+	-	-	+	+	+	+	IV	+	+	-	-	-	-	-	-
Succisa pratensis	-	-	-	-	-	-	+	+	+	+	III	-	-	-	-	-	-	-	-
Taraxacum officinale	-	+	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Valeriana officinalis	-	-	-	+	+	-	+	+	+	+	V	-	-	+	+	+	+	-	-
Scheuchzerio – Caricetea fuscae																			
Ligularia sibirica	-	-	-	2	2	2	2	2	2	2	V	-	-	-	-	-	-	-	-
Carex flava	-	-	-	+	-	-	-	-	+	+	III	-	-	-	-	-	-	-	-
Carex paniculata	-	-	-	+	-	+	+	-	-	-	III	-	-	-	-	-	-	-	-
Dactylorhiza incarnata	-	-	+	+	+	-	-	-	+	+	III	-	-	-	-	-	-	-	-
Eriophorum latifolium	-	-	-	-	-	-	-	-	+	+	II	-	-	-	-	-	-	-	-
Phragmiti – Magnocaricetea																			
Berula erecta	-	-	-	-	-	-	-	-	+	-	I	-	-	-	-	-	-	-	-
Carex acutiformis	-	-	+	-	-	-	-	-	-	+	I	-	-	-	1	1	1	-	-
Carex riparia	-	+	+	2	1	2	-	2	3	3	V	+	+	+	-	-	-	-	-
Carex vulpina	-	+	+	-	-	-	-	+	-	-	I	-	-	-	-	-	-	-	-
Glyceria fluitans	-	+	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Lycopus europaeus	-	-	-	-	-	-	-	-	-	+	I	-	-	-	+	+	+	-	-
Mentha aquatica	+	-	+	-	-	-	-	-	-	-		-	-	-	1	1	1	+	+
Phragmites australis subsp. australis	-	-	-	-	-	+	-	-	+	-	II	-	-	-	-	-	-	-	-
Rumex stenophyllus	-	+	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Scrophularia umbrosa	-	-	-	-	-	-	-	-	-	-		-	+	-	-	-	-	-	-
Sium sisarum var. lancifolium	-	-	-	-	-	-	-	-	-	-		-	-	+	-	-	-	-	-
Symphytum officinale	-	-	+	-	-	-	-	-	-	-		-	-	-	+	-	+	-	-
Thelypteris palustris	-	-	-	1	1	1	1	1	+	1	V	-	-	-	-	-	-	-	-
Typha angustifolia	-	-	-	-	+	-	-	-	-	-	I	-	-	-	-	-	-	-	-
Alnetea glutinosae																			
Alnus glutinosa (juv.)	-	-	-	-	-	-	-	-	-	-		-	+	-	-	-	-	-	-
Frangula alnus	-	-	-	-	-	+	+	-	-	-	II	-	-	-	-	-	-	-	-
Salix cinerea	-	-	-	1	+	+	+	+	+	+	V	-	-	-	+	+	+	-	-
Galio – Urticetea																			
Aegopodium podagraria	-	-	-	-	-	-	-	-	-	+	I	+	-	-	-	-	-	-	-
Bilderdykia dumetorum	-	-	-	-	-	-	-	-	-	-		-	-	-	+	-	-	-	-
Calystegia sepium	+	-	-	+	-	-	-	-	-	-	I	-	-	-	-	-	-	-	-
Eupatorium cannabinum	+	-	-	+	1	2	1	1	+	+	V	2	+	-	1	+	+	-	-
Galium aparine	-			+	+	-	-	-	-	-	II	+	+	+	-	-	-	-	-
Glechoma hederacea	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Urtica dioica	+	-	-	-	-	-	-	-	-	-		+	+	+	-	-	-	-	-
Aliae																			
Arctium tomentosum	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Bidens tripartita	-	-	-	-	-	-	-	-	-	-		+	-	-	-	-	-	-	-
Chaerophyllum aromaticum	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	-
Cirsium arvense	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Cirsium vulgare	-	-	-	-	-	-	-	-	-	-		-	-	-	+	+	+	-	-
Daucus carota	-	-	-	-	-	-	-	-	-	-		-	-	-	+	+	-	-	-
Erigeron annuus subsp. annuus	-	+	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Lavatera thuringiaca	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	-
Plantago lanceolata	-	-	-	-	-	-	-	-	-	-		-	-	-	+	+	+	-	-
Plantago media	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Ranunculus polyanthemos subsp. polyanthemoides	-	-	-	-	-	-	-	-	-	-		-	-	-	+	+	+	+	+
Rosa canina	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	-
Rumex conglomeratus	-	-	-	-	-	-	-	-	-	-		-	-	+	-	-	-	-	-
Rumex obtusifolius subsp. sylvestris	-	-	-	-	-	-	-	-	-	-		-	-	+	-	-	-	-	-
Salix triandra subsp. triandra	-	-	-	-	-	-	-	-	-	-		-	-	-	+	-	+	-	-

Silene alba subsp. alba	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	+
Sonchus arvensis	-	-	-	-	-	-	-	-	-	-		-	-	+	+	+	+	-	-
Stellaria nemorum	-	-	-	-	-	-	-	-	-	-		+	-	-	-	-	-	-	-
Viburnum opulus	-			-	-	+	-	-	-	-	I	-	-	-	-	-	-	-	-

Place and data of relevés: 1: Borniş, on the stream valley "Obârşia", September, 21, 2008; 2-3: The marshes of Unghi, on the stream valley "Valea Albă", September, 21, 2008; 4-10: The marshes of Unghi, on the stream valley "Valea Albă", July, 18, 2009; 11-13: The marshes of Borşeni on the stream valley "Valea Albă", September, 21, 2008; 14-16: The marshes of Bahna Mare, September, 21, 2008; 17-18: The marshes of Bahna Mare, September, 21, 2008

Ass. ***Caltho laetae – Ligularietum sibiricae*** Ştefan et al. 2000

Chorology and biotope characteristics. This association has been described, for the first time, from the vegetation of north-west part of Obcina Mestecănişului (Eastern Carpathians, Romania), along the valley of Cârlibaba river [ŞTEFAN & al., 2000].

The characteristic species of this association, *Ligularia sibirica*, is a pretty rare plant in Moldavian region, being met especially on swampy soils in the Carpathian Mountains. The identification of this plant in the marshes near the village of Unghi (Fig. 2), on a stream valley called "Valea Albă", has been a real surprise for authors, since this locality is situated far enough of the main distribution area of the species into the Eastern Carpathians.

Species composition and phytocoenotic structure. The phytocoenoses of this association, with surfaces of 25-50 m^2, accomplish coverages up to 95% of the soil surfaces. *Ligularia sibirica* has a soil coverage between 15% and 25%, other species having their contribution to the soil coverage, among these being: *Equisetum palustre* (0.5-40%), *Carex riparia* (0.5-40%), *Eupatorium cannabinum* (0.5-20%); a low coverage have other species, as: *Angelica sylvestris* subsp. *sylvestris*, *Lathyrus pratensis*, *Lysimachia vulgaris*, *Thelypteris palustris* or *Salix cinerea* (with a maximum of 5%). *Caltha palustris* (the characteristic species) is constantly met in these phytocoenoses, but its coverage is reduced. The caracteristic species for the higher coenotaxa (*Calthion*, *Molinietalia*, *Molinio – Arrhenatheretea*) are well represented in the floristic structure. There are present other characteristic species for *Scheuchzerio – Caricetea fuscae* or *Phragmiti – Magnocaricetea*. Among these, with a higher constancy besides the above ones, there are others, as: *Cirsium rivulare*, *Filipendula ulmaria* subsp. *ulmaria*, *Valeriana officinalis* etc. (Fig. 11; Tab. 5, rel. 4-10).

Unlike the phytocoenoses with *Ligularia sibirica* and *Caltha palustris* previously described from Cârlibaba valley (Suceava county) [ŞTEFAN & al., 2000], inside the phytocoenoses from the marshes of Unghi village one can remark the lack of some species, as: *Carex nigra*, *Geum rivale*, *Polygonum bistorta*, *Parnassia palustris*, *Valeriana sambucifolia*, *Agrostis capillaris*, *Anacamptis pyramidalis*, *Rumex alpinus*, *Valeriana montana*, etc. This is due to a different altitude and ecology, as well as an other vegetation belt in surroundings in Obcina Mestecănişului Mountains than in the marsh near Unghi village (Neamț county).

Fig. 11. Ass. *Caltho laetae – Ligularietum sibiricae* in marshes near Unghi village

Ass. ***Angelico – Cirsietum oleracei*** R. Tx. 1937

Chorology and biotope characteristics. The higrophyllous phytocoenoses of this association have been identified in the marshes of Borşeni (Fig. 12), along the stream valley called "Valea Albă", on alluvial, pseudogleyic or even brown-acid soils, being wet or excess moistured (flooded sometimes), and rich in nutrients as a rule.

Species composition and phytocoenotic structure. The dominant characteristic species in our phytocoenoses is *Cirsium oleraceum*, while *Angelica sylvestris* subsp. *sylvestris* is only present (+) in those three relevées.

Besides those higro- and meso-higrophyllous species there are present other plants having the same ecological preferances, like the next ones: *Juncus articulatus*, *Mentha longifolia*, *Filipendula ulmaria* subsp. *ulmaria*, *Geranium palustre*, *Scirpus sylvaticus*, *Carex riparia*, and so on.

Fig. 12. Ass. *Angelico – Cirsietum oleracei* R. Tx. 1937 in the marshes of Borşeni

In the phytocoenotic structure of these association one can remark some characteristic species for *Calthion* (*Caltha palustris* and *Juncus articulatus*), *Molinietalia* et *Molinio–Arrhenatheretea* (*Lysimachia vulgaris*, *Agrostis stolonifera*, *Selinum carvifolia,*

Carex hirta etc.) or from *Phragmiti – Magnocaricetea* (*Carex riparia*, *Sium sisarum* var. *lancifolium* etc.). The phytocoenoses are in contact with other plant communities, which explain the presence of species from other coenotaxa, as: *Galium aparine*, *Urtica dioica*, *Aegopodium podagraria* etc. *Eupatorium cannabinum* and *Filipendula ulmaria* subsp. *ulmaria* have important values of soil coverage in some of the phytocoenoses (up to 20%) (Tab. 5, rel. 11-13).

Ass. ***Deschampsietum cespitosae*** Hayek ex Horvatic 1930 (Syn.: *Deschampsietum cespitosae* Rübel 1911)

Chorology and biotope characteristics. Few phytocoenoses of this association have been identified in the marshes of Bahna Mare–Bălăneşti, located on microdepressions, on alluvial or pseudogleyic soils, being wet or excess moistured (flooded sometimes).

Species composition and phytocoenotic structure. The characteristic species, *Deschampsia cespitosa* subsp. *cespitosa*, achieve soil coverages between 75% and 100%, giving a typical aspect of these phytocoenoses.

Besides this, other species are characteristic for *Molinietalia* et *Molinio–Arrhenatheretea* (e. g. *Cirsium rivulare*, *Myosotis scorpioides*, *Galium uliginosum*, *Cirsium tuberosum*, *Equisetum arvense*, *Mentha longifolia* and so on). Other species are from *Phragmiti – Magnocaricetea*, indicating a high moisture or even flooded periods (e. g. *Carex acutiformis*, *Mentha aquatica*, *Lycopus europaeus* etc.), but also from other vegetation classes (Tab. 5, rel. 14-16).

Ass. ***Arrhenatheretum elatioris*** Scherrer 1925

Chorology and biotope characteristics. Two phytocoenoses of this association have been identified on the marshes of Bahna Mare – Bălăneşti, on small surfaces. Those phytocoenoses are installed on wet and fertile, brown soils, neutral to weak acids.

Species composition and phytocoenotic structure. *Arrhenatherum elatius* subsp. *elatius* is both a characteristic and a dominant plant in those two phytocoenoses, having a soil coverage up to 100%. Some of the companion species are from the meso-higrophyllous meadows in surroundings, belonging to *Arrhenatheretalia* order and *Molinio–Arrhenatheretea* class, e. g.: *Achillea millefolium*, *Leontodon autumnalis*, *Trifolium pratense, T. repens, Lathyrus pratensis*, *Angelica palustris*, and so forth. Other species are characteristics for the ruderal vegetation, especially from *Artemisietea* class, e. g.: *Arctium tomentosum*, *Erigeron annuus* subsp. *annuus* etc. The phytocoenoses of this association host some rare plant species in the Moldavia's flora, as *Angelica palustris* and *Cirsium tuberosum* (Tab. 5, rel. 17-18).

Ass. ***Caricetum ripariae*** (Soó 1928) Knapp et Stoffer 1962
– ***typicum***

Chorology and biotope characteristics. This association has been identified in the marshes of Bahna Mare – Bălăneşti and on the marshes near the village of Unghi, on the stream valley "Valea Albă". The phytocoenoses are developed on flat and swampy lands, having a humidity in excess during the spring or in autumn. The soils are weak acid to neutral ones.

Species composition and phytocoenotic structure. The characteristic species of this association, *Carex riparia* and *C. acutiformis*, cover the soil in rates ranging between 50% to 90%, respectively 5% to 20%. Though the number of species is fairly high, almost all of them have low indexes of AD (+ to 2).

Some of the species belong to *Caricenion gracilis* and *Magnocaricion elatae* (*Cirsium canum*, *Lythrum salicaria*, *Galium palustre*, *G. uliginosum*, *Thelypteris palustris*, *Peucedanum palustre*, *Carex rostrata*) indicating the acidity features of the soils. Other species belong to *Phragmiti – Magnocaricetea* class, indicating a humidity in excess of the soils (e. g.: *Lythrum salicaria*, *Phragmites australis* subsp. *australis*, *Mentha aquatica*, *Typha angustifolia*, *Symphytum officinale* subsp. *officinale*, and so on.). From the meso-higrophyllous vegetation in surroundings (*Molinio – Arrhenatheretea* class), often penetrate into these phytocoenoses some species, as: *Filipendula umaria* subsp. *ulmaria*, *Lysimachia vulgaris*, *Valeriana officinalis*, *Angelica sylvestris* subsp. *sylvestris*, *Caltha palustris*, *Selinum carvifolia*, *Cirsium rivulare* etc.). The main rare species into the Moldavia's flora, which are present in these phytocoenoses, are: *Angelica palustris*, *Carex paniculata*, *Ligularia sibirica*, *Menyanthes trifoliata*, *Thelypteris palustris*, and *Salix rosmarinifolia* (Tab. 6, rel. 1-10).

Ass. ***Caricetum rostratae*** Rübel 1912

Chorology and biotope characteristics. This association has been identified by two phytocoenoses only, in the marshes of Unghi, on the stream valley "Valea Albă". Those two phytocoenoses are developed in microdepressions, on swampy places, on soils having a moderately acid pH.

Species composition and phytocoenotic structure. In the phytocoenotic structure there are present few species, the dominant and characteristic one being *Carex rostrata*. Other species, characteristics for wet places (*Magnocaricion elatae* & *Magnocaricetalia and Phragmiti – Magnocaricetea*), are the next ones: *Lythrum salicaria*, *Equisetum palustre*, *Typha angustifolia*, and *Mentha aquatica*. From the higro-mesophyllous meadows in surroundings there are present species belonging to *Molinio – Arrhenatheretea* class (e. g. *Ranunculus acris*, *Caltha palustris*, *Lysimachia vulgaris*, and so on) (Tab. 6, rel. 11-12).

Tab. 6. Ass. *Caricetum ripariae* (Soó 1928) Knapp et Stoffer 1962 *typicum* (rel. 1-10); Ass. *Caricetum rostratae* Rübel 1912 (rel. 11-12)

Surface of relevé (m^2)	**50**	**50**	**50**	**50**	**25**	**25**	**25**	**25**	**20**	**20**		**20**	**20**
Coverage (%)	**75**	**85**	**100**	**100**	**90**	**100**	**100**	**85**	**100**	**70**	**K**	**95**	**85**
No. of relevée	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		**11**	**12**
Magnocaricion elatae & Magnocaricetalia													
Carex riparia	3	4	5	5	5	5	5	4	5	3	V	-	-
Carex acutiformis	-	1	1	+	1	+	+	+	+	2	V	-	-
Carex rostrata	-	-	-	-	-	-	-	-	-	-		5	5
Cirsium canum	2	-	+	+	-	-	-	-	-	+	II	-	-
Galium palustre	-	-	+	-	-	-	-	-	-	-	I	-	-
Galium uliginosum	-	-	-	+	-	+	+	-	-	-	II	-	-
Lythrum salicaria	+	+	+	+	+	+	+	+	+	-	V	+	+
Thelypteris palustris	-	-	-	+	-	-	-	-	+	+	II	-	-
Phragmiti – Magnocaricetea													
Berula erecta	-	-	-	-	-	-	+	-	+	-	I	-	-
Carex vulpina	+	-	+	+	-	+	-	-	-	-	II	-	-
Epilobium parviflorum	+	-	-	-	+	-	-	-	-	-	I	-	-

Equisetum palustre	+	+	+	+	-	+	-	+	-	+	IV	+	+
Lycopus europaeus	-	-	-	-	+	+	+	-	-	-	II	-	-
Mentha aquatica	+	-	+	-	+	+	-	+	+	-	III	+	+
Mentha arvensis	+	-	-	-	-	-	-	-	-	-	I	-	-
Mentha longifolia	+	+	-	-	-	+	+		+	-	III	-	-
Myosotis scorpioides	-	+	-	-	-	+	-	-	+	-	II	-	-
Phragmites australis subsp. australis	-	+	-	+	+	-	-	-	+	+	III	-	-
Sium sisarum var. lancifolium	+	-	-	-	-	-	-	-	-	-	I	-	-
Stachys palustris	-	+	-	+	-	-	-	-	-	-	I	-	-
Symphytum officinale subsp. officinale	-	+	+	-	-	-	-	-	-	-	I	-	-
Typha angustifolia	-	-	-	-	+	-	+	-	+	-	II	+	+
Veronica beccabunga	-	-	-	-	-	-	-	-	+	-	I	-	-
Molinio – Arrhenatheretea													
Agrostis stolonifera subsp. stolonifera	-	+	-	-	+	+	+	+	-	-	III	-	-
Angelica palustris	-	-	-	+	-	-	-	-	-	-	I	-	-
Angelica sylvestris subsp. sylvestris	+	+	+	+	+	-	+	+	-	+	IV		
Caltha palustris	-	-	-	+	-	+	+	+	+	+	III	1	-
Cardamine amara	-	-	-	-	-	+	-	-	-	-	I	-	-
Carex distans	-	-	-	+	-	+	-	-	-	-	I	-	-
Carex echinata	-	-	-	-	-	-	-	-	+	-	I	-	-
Carex flava	-	-	-	+	-	-	-	-	-	-	I	-	-
Carex hirta	-	-	+	-	-	+	-	+	-	+	II	-	-
Carex vesicaria	-	-	-	-	-	-	-	-	+	-	I	-	-
Cirsium oleraceum	-	1	-	-	-	-	+	+	+	-	II	-	-
Cirsium rivulare	-	-	-	+	-	-	+	+	+	+	III	-	-
Cirsium tuberosum	-	+	-	-	-	-	-	-	-	-	I	-	-
Dactylorhiza maculata subsp. fuchsii	-	-	-	-	-	-	-	+	-	+	I	-	-
Deschampia cespitosa subsp. cespitosa	1	-	-	-	-	-	-	-	-	-	I	-	-
Equisetum arvense	-	-	-	-	1	+	+	-	-	-	II	-	-
Eupatorium cannabinum	-	+	-	-	+	+	-	-	-	-	II	-	-
Festuca pratensis	-	-	-	+	-	-	-	-	-	-	I	-	-
Filipendula ulmaria subsp. ulmaria	+	+	+	+	-	-	+	+	+	+	IV	-	-
Galium mollugo	-	+	+	-	-	-	-	-	-	-	I	-	-
Geranium palustre	-	-	-	+	-	-	-	+	-	+	II	-	-
Juncus articulatus	-	-	-	+	-	-	-	-	-	-	I	-	-
Juncus gerardi	-	-	-	+	-	-	-	-	-	-	I	-	-
Lathyrus pratensis	+	-	+	+	-	-	-	+	-	+	III	-	-
Linum catharcticum	-	-	-	-	-	-	-	-	-	+	I	-	-
Lychnis flos-cuculi	-	-	+	-	-	+	+	-	+	+	III	-	-
Lysimachia nummularia	-	-	-	-	-	+	-	-	-	-	I	-	-
Lysimachia punctata	-	-	-	-	-	-	+	-	-	-	I	-	-
Lysimachia vulgaris	+	-	+	-	-	+	+	-	-	-	II	+	+
Molinia caerulea	-	-	-	+	-	-	-	-	-	-	I	-	-
Peucedanum palustre	-	-	-	+	-	-	-	-	+	-	I	-	-
Poa pratensis	-	-	+	-	-	-	-	-	-	-	I	-	-
Potentilla anserina	+	+	+	-	-	+	-	-	-	-	II	-	-
Potentilla erecta	-	-	-	-	-	-	-	-	+	+	I	-	-
Potentilla reptans	-	-	+	-	-	-	-	-	-	-	I	-	-
Ranunculus acris	-	-	-	+	-	+	+	-	+	+	III	+	+
Ranunculus repens	+	-	+	-	-	+	+	+	-	-	III	+	-
Ranunculus sceleratus	-	-	-	-	-	-	-	-	+	-	I	-	-
Rumex acetosa	-	-	+	-	-	-	-	-	-	-	I	-	-
Scirpus sylvaticus	-	+	+	+	-	+	1	-	-	-	III	-	-
Scrophularia umbrosa subsp. umbrosa	-	-	+	+	+	+	-	+	+	-	III	-	-
Selinum carvifolia	+	-	+	+	-	-	-	-	+	+	III	-	-
Serratula tinctoria	-	-	-	+	-	-	-	-	-	-	I	-	-
Succisa pratensis	-	-	-	-	-	-	-	-	+	-	I	-	-
Thalictrum lucidum	-	-	-	+	-	-	-	-	-	-	I	-	-
Trifolium hybridum	+	-	-	+	-	-	-	-	-	-	I	-	-
Valeriana officinalis	+	+	+	-	+	+	+	+	+	+	V	+	+

Valeriana sambucifolia	+	-	-	-	-	-	-	-	-	-	I	-	-
Vicia cracca	-	+	-	-	-	-	-	-	-	-	I	-	-
Vicia sepium	+	-	-	-	-	-	-	-	-	-	I	-	-
Scheuechzerio–Caricetea fuscae													
Carex paniculata	-	-	+	+	-	+	-	+	+	1	III	+	-
Dactylorhiza incarnata	-	-	+	-	-	+	+	+	+	-	III	-	-
Eriophorum latifolium	-	-	-	-	-	-	-	+	+	+	II	-	-
Ligularia sibirica	-	-	-	-	+	+	-	1	-	-	II	-	-
Menyanthes trifoliata	-	-	-	-	-	-	-	-	-	+	I	-	-
Aliae													
Calamagrostis epigejos	-	+	-	-	-	-	-	-	-	-	I	-	-
Calystegia sepium	+	+	-	+	-	-	-	-	-	-	II	-	-
Carex pairaei	-	-	-	+	-	-	-	-	-	-	I	-	-
Erigeron annuus subsp. annuus	-	+	-	-	-	-	-	-	-		I	-	-
Galium aparine	+	+	-	-	+	+	-	+	+	-	III	-	-
Galium verum	-	-	-	+	-	-	-	-	-	-	I	-	-
Polygonum hydropiper	-	+	-	-	-	-	-	-	-	-	I	-	-
Ranunculus polyanthemos subsp. polyanthemoides	+	-	-	-	-	-	-	-	-	-	I	-	-
Salix cinerea (juv.)	-	-	+	+	+	+	+	+	+	+	IV	+	+
Salix purpurea subsp. purpurea (juv.)	-	-	-	-	-	-	-	-	-	+	I	-	-
Salix rosmarinifolia	-	-	-	+	-	-	-	-	-	-	I	-	-

Place and data of relevés: 1-4: The marshes of Bahna Mare, 21.09.2008; 5-10: The marshes of Unghi, on the stream valley "Valea Albă", September, 21, 2008; 11-12: The marshes of Unghi, on the stream valley "Valea Albă", September, 21, 2008

Ass. ***Phragmitetum vulgaris*** Soó 1927 (Syn.: *Scirpo – Phragmitetum* Koch 1926; *Schoenoplecto – Phragmitetum communis* (Koch 1926) Eggler 1961; *Scirpeto – Phragmitetum medioeuropaeum* (Koch 1926) R. Tx. in R. Tx. et Preising 1942; *Scirpo – Phragmitetum phragmitetosum* Soó 1957)

Chorology and biotope characteristics. Some surfaces with reed (*Phragmites australis* subsp. *australis*) are spread out in the marshes of Bahna Mare – Bălăneşti and in the marshes near the village of Unghi, on the stream valley called "Valea Albă", on flat lands, along the stream banks, the lands being most of the time flooded.

Species composition and phytocoenotic structure. The species composition is dominated by the characteristic species, *Phragmites australis* subsp. *australis*, which makes nearly pure stands in the surveyed area, achieving a soil coverage between 80% and 95%. Other caracteristics species for the alliance *Phragmition* and order *Phragmitetalia* are the next ones: *Typha angustifolia, Lycopus europaeus, Berula erecta, Mentha aquatica, Scutellaria galericulata, Alisma plantago-aquatica, Eleocharis palustris, Galium palustre,* and *Stachys palustris*. From *Magnocaricion elatae* & *Magnocaricetalia* one can remark the next species: *Symphytum officinale* subsp. *officinale*, *Carex acutiformis*, but especially *Carex riparia* (this one achieving soil coverages between 5% and 20%). Other species are characteristics for the meso-hygrophillous vegetation in surroundings, *Molinio–Arrhenatheretea* class (e. g.: *Eupatorium cannabinum*, *Valeriana officinalis*, *Angelica sylvestris* subsp. *sylvestris*, *Galega officinalis*, *Filipendula ulmaria* subsp. *ulmaria*, *Caltha palustris*, *Agrostis stolonifera* subsp. *stolonifera* etc.). *Ligularia sibirica* is also present in this association, in a single relevée (Tab. 7, rel. 1-3).

Ass. ***Typhetum angustifoliae*** Pignatti 1953 (Syn.: *Typhetum angustifoliae* Soó 1927; *Typhetum angustifolio – latifoliae* Schmale 1939 p. p.)

Chorology and biotope characteristics. The phytocoenoses of this association are settled down on the marshes of Bahna Mare – Bălăneşti and the marshes near the village of Unghi, on the stream valley "Valea Albă". The water layer has a more or less permanent feature.

Species composition and phytocoenotic structure. The soil coverage of the vegetation are ranging between 90% and 100% in our relevés. The characteristic species, *Typha angustifolia*, is the dominant one in the phytocoenoses, achieving coverage indices between 65% and 75%. Among the characteristics species for the higher coenotaxa one can remark *Carex riparia* and *C. acutiformis* (with coverage of 20-30%), and *Lycopus europaeus* (with a constantly presence into our relevés). The zonal meso-hygrophyllous vegetation of *Molinio – Arrhenatheretea* class is represented by the presence of the next species: *Lythrum salicaria*, *Cirsium oleraceum*, *Equisetum arvense*, *Angelica sylvestris* subsp. *sylvestris*, *Filipendula ulmaria* subsp. *ulmaria*, *Lysimachia vulgaris*, and so on (Tab. 7, rel. 4-6).

Ass. ***Glycerietum maximae*** Hueck 1931

Chorology and biotope characteristics. Some phytocoenoses of this association are installed on the marshes of Bahna Mare – Bălăneşti and the marshes of Unghi, along the stream valley "Valea Albă". These communities are developed in still waters or, seldom, low running waters, rich in nutrients, being situated especially near the edge marshes, or in those soil microdepressions, with a low and fluctuating water level.

Species composition and phytocoenotic structure. The phytocoenotic composition is dominated by *Glyceria maxima*, with a soil coverage ranging between 75% and 95%. Other plant species belong to the wet vegetation (*Phragmiti–Magnocaricetea* class, namely: *Typhoides arundinacea, Alisma plantago-aquatica, Sium sisarum* var. *lancifolium*, *Mentha aquatica*, *Symphytum officinale* subsp. *officinale*, *Poylgonum amphibium* f. *terrestre*, *Myosotis scorpioides* etc.). Some species are from the meso-hygrophyllous vegetation of the zonal meadows, namely *Molinio – Arrhenatheretea* class, e. g.: *Ranunculus repens*, *Dactylis glomerata* subsp. *glomerata*, and so on (Tab. 7, rel. 7-9).

Tab. 7. Ass. *Phragmitetum vulgaris* Soó 1927 (rel. 1-3); Ass. *Typhetum angustifoliae* Pignatti 1953 (rel. 4-6); Ass. *Glycerietum maximae* Hueck 1931 (rel. 7-9)

Surface of relevé (m^2)	**50**	**100**	**50**	**50**	**100**	**25**	**25**	**50**	**4**
Coverage (%)	**90**	**95**	**100**	**90**	**70**	**85**	**95**	**90**	**85**
No. of relevée	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Phragmition									
Phragmites australis subsp. australis	4	5	5	-	-	-	-	-	-
Typha angustifolia	-	+	-	4	4	4	-	-	-
Glyceria maxima	-	-	-	-	-	-	5	5	5
Berula erecta	-	+	-	-	-	-	-	-	-
Lycopus europaeus	+	+	+	+	+	+	-	-	-
Sium sisarum var. lancifolium	-	-	-	+	-	-	+	-	-
Sparganium erectum subsp. erectum	-	-	-	-	-	+	-	-	-

Phragmitetalia									
Alisma plantago-aquatica	-	+	-	-	-	-	-	-	+
Eleocharis palustris	-	+	-	-	-	-	-	-	-
Galium palustre	-	+	-	+	+	-	-	-	-
Mentha aquatica	+	+	+	+	-	-	1	-	-
Scutellaria galericulata	+	-	+	+	-	-	-	-	-
Stachys palustris	-	+	-	-	+	-	-	+	-
Typha latifolia	-	-	-	-	-	-	-	+	-
Typhoides arundinacea	-	-	-	-	-	-	+	-	-
Phragmiti – Magnocaricetea									
Carex acutiformis	+	-	+	2	-	+	-	-	-
Carex riparia	2	-	1	1	+	2	-	-	-
Carex vulpina	+	-	-	-	-	-	-	-	-
Epilobium hirsutum	-	-	-	+	-	-	+	-	-
Myosotis scorpioides	-	-	-	-	-	-	-	-	+
Poa palustris	-	-	-	-	-	-	-	-	+
Polygonum amphibium f. terrestre	-	-	-	+	-	-	+	-	-
Scrophularia umbrosa subsp. umbrosa	-	+	-	+	+	-	+	+	-
Symphytum officinale subsp. officinale	+	+	-	+	+	-	+	+	-
Thelypteris palustris	-	-	+	-	-	-	-	-	-
Veronica beccabunga	-	-	-	-	-	-	-	-	+
Molinio – Arrhenatheretea									
Agrostis stolonifera subsp. stolonifera	-	+	-	-	-	-	-	-	-
Althaea officinalis	-	-	-	+	-	-	+	-	-
Angelica sylvestris subsp. sylvestris	+	-	+	+	-	-	-	-	-
Caltha palustris	-	+	-	-	+	-	-	-	-
Cirsium oleraceum	-	-	-	+	-	-	-	-	-
Cirsium palustre	-	-	+	-	-	-	-	-	-
Cirsium tuberosum	+	-	-	+	-	-	+	-	-
Dactylis glomerata subsp. glomerata	-	-	-	-	-	-	+	-	-
Epipactis palustris	-	-	+	-	-	-	-	-	-
Equisetum arvense	-	+	+	+	-	+	-	-	-
Filipendula ulmaria subsp. ulmaria	-	-	+	-	-	+	-	-	-
Galega officinalis	+	-	-	-	-	-	-	-	-
Geranium palustre	+	-	+	-	-	-	-	-	-
Juncus inflexus	-	-	-	-	-	-	-	-	+
Lysimachia vulgaris	+	+	+	+	+	+	-	-	-
Lythrum salicaria	-	-	-	+	-	+	-	-	-
Mentha arvensis	+	-	-	-	-	-	-	-	-
Mentha longifolia	+	+	+	-	-	-	+	-	-
Peucedanum palustre	-	-	+	-	-	-	-	-	-
Potentilla anserina	-	+	+	-	-	-	+	-	-
Potentilla erecta	-	-	+	-	-	-	-	-	-
Potentilla reptans	-	-	-	-	-	-	-	+	-
Ranunculus repens	-	-	-	-	+	-	-	+	+
Ranunculus sardous	-	-	-	-	-	-	-	-	+
Rorippa sylvestris	-	-	-	-	+	-	-	-	-
Selinum carvifolia	+	-	+	-	-	-	-	-	-
Succisa pratensis	-	-	+	-	-	-	-	-	-
Valeriana officinalis	+	+	-	-	+	-	-	-	-
Valeriana sambucifolia	+	-	-	-	-	-	-	-	-
Galio – Urticetea									
Calystegia sepium	+	+	-	+	-	+	+	+	-
Eupatorium cannabinum	+	+	+	-	-	-	+	-	-
Galeopsis speciosa	-	-	-	-	-	-	+	-	-
Galium aparine	+	+	-	+	-	+	+	-	-
Glechoma hederacea	-	-	-	-	-	-	+	-	-
Solanum dulcamara	-	+	-	+	-	-	-	+	-
Urtica dioica	+	+	-	+	+	-	+	-	-
Aliae									
Alnus glutinosa	-	-	+	-	-	+	-	-	-

Arctium lappa	-	-	-	+	-	-	-	-	-
Ballota nigra	-	-	-	-	-	-	+	-	-
Cirsium arvense	-	-	-	-	-	-	+	-	-
Galium mollugo	-	-	+	-	-	-	-	-	-
Ligularia sibirica	-	-	+	-	-	-	-	-	-
Rumex sanguineus	-	-	-	-	-	-	+	-	-
Salix cinerea	-	-	+	-	-	+	-	-	-
Salix purpurea subsp. purpurea	-	-	-	-	-	-	-	+	-

Place and data of relevés: 1-2: The marshes of Bahna Mare, September, 21, 2008; 3: The marshes of Unghi, on the stream valley "Valea Albă", September, 21, 2008; 4-5: The marshes of Bahna Mare, September, 21, 2008; 6: The marshes of Unghi, on the stream valley "Valea Albă", September, 21, 2008; 7-8: The marshes of Bahna Mare, September, 21, 2008; 9: The marshes of Unghi, on the stream valley "Valea Albă", September, 21, 2008

Ass. ***Galegetum officinalis*** Dobrescu et Vițalariu 1981

Chorology and biotope characteristics. This association has been described, for the first time, from Ciric stream valley (Iaşi county) [DOBRESCU & VIȚALARIU, 1981].

Two phytocoenoses of this association have been identified, also, in the marshes of Bahna Mare – Bălăneşti, on microdepressions, nearby of the reed thickets, on wet and gleyic soils.

Species composition and phytocoenotic structure. The characteristic species of this association is *Galega officinalis*, achieving a soil coverage of over 90%. Besides this species, among the characteristic species for the higher coenotaxa, there are present *Eupatorium cannabinum* and *Calystegia sepium*. Other species belong to *Phragmiti–Magnocaricetea* class, as *Carex vulpina*, *C. riparia*, *C. acutiformis*, *Lythrum salicaria*, *Typha angustifolia*, *Lycopus europaeus* etc. The zonal meso-hygrophyllous meadows from *Molinio – Arrhenatheretea* class are also well represented in the plant composition, by the presence of the next psecies: *Mentha longifolia*, *Juncus effusus*, *Trifolium hybridum*, *Agrostis stolonifera* subsp. *stolonifera*, *Festuca pratensis*, *Lotus corniculatus*, *Succisa pratensis*, and so on (Tab. 8, rel. 1-2).

Phytocoenoses of *Aster lanceolatus*

Chorology and biotope characteristics. Two phytocoenoses edified by *Aster lanceolatus* were identified in the south of Borniş village, along the stream valley called "Obârşia". *Aster lanceolatus* is escaping quite easily from the gardens where is cultivated as an ornamental plant [MORARIU & NYÁRÁDY, 1964, Romania's Flora, t. IX], setting up frequently along the river valleys, where it can make nearly monodominat communities, as it is for instance in the eastern part of Transylvania (e. g. along the Târnava Mare, Târnava Mică, Niraj, Nico Alba, Mureş, Olt, Negru, and Baraolt river valleys) [KOVÁCS, 2004]. Also, along the Tisa river valley, *Aster lanceolatus* is one of the most frequent alien plant in Romania [OPREA & SÎRBU, 2006]. Into the flora of Moldovia, this species has been cited quite recently as an alien plant [SÎRBU & OPREA, 2010].

Species composition and phytocoenotic structure. In the south of Borniş village (Neamț county), *Aster lanceolatus* edify two large phytocoenoses, nearly monodominant, with mesophyllous features, along with other species, as: *Rubus caesius*, *Lapsana communis*, *Inula helenium*, *Eupatorium cannabinum*, *Angelica sylvestris* subsp. *sylvestris*, *Filipendula ulmaria* subsp. *ulmaria*, *Agrostis stolonifera* subsp. *stolonifera*, *Agrimonia eupatoria*, *Clinopodium vulgare*, *Artemisia vulgaris*, *Senecio erucifolius*, and so on. Following the local floristic interferences, into the floristic structure of those phytocoenoses there are present some characteristics species, both for the higher coenotaxa (*Senecion*

fluviatilis, *Convolvuletalia sepium* & *Galio–Urticetea*), but also for mesophyllous meadows in surroundings (*Molinio – Arrhenatheretea*), for the fringe vegetation (*Trifolio – Geranietea*), or for the perennial ruderal vegetation (*Artemisietea vulgaris*), etc., which gives to these phytocoenoses a pretty heterogeneous feature (Tab. 8, rel. 3-4). These phytocoenoses of *Aster lanceolatus* displace the natural communities from *Senecion fluviatilis* R. Tx. 1950, such as *Filipendulo ulmariae – Geranietum palustris* W. Koch 1926 and *Eupatorietum cannabini* R. Tx. 1937, within the investigated area.

Tab. 8. Ass. *Galegetum officinalis* Dobrescu et Vițalariu 1981 (rel. 1-2); Phytocoenoses of *Aster lanceolatus* (rel. 3-4)

Surface of relevé (m^2)	**25**	**25**	**50**	**50**
Coverage (%)	**95**	**95**	**100**	**95**
No. of relevée	**1**	**2**	**3**	**4**
Senecion fluviatilis, Convolvuletalia sepium & Galio – Urticetea				
Galega officinalis	5	5	-	-
Aster lanceolatus	-	-	5	5
Calystegia sepium	-	+	-	-
Eupatorium cannabinum	+	+	+	+
Filipendula ulmaria subsp. ulmaria	-	-	+	+
Inula helenium	-	-	+	+
Lapsana communis	-	-	+	-
Rubus caesius	-	-	+	+
Senecio erucifolium	-	-	-	+
Phragmiti – Magnocaricetea				
Carex acutiformis	-	+	-	-
Carex riparia	-	1	-	-
Carex vulpina	+	-	-	-
Lycopus europaeus	-	+	-	-
Lythrum salicaria	-	+	+	-
Mentha aquatica	-	+	-	-
Typha angustifolia	-	+	-	-
Molinio – Arrhenatheretea				
Achillea millefolium	-	-	+	-
Agrostis stolonifera subsp. stolonifera	+	-	+	+
Angelica sylvestris subsp. sylvestris	-	-	+	+
Arrhenatherum elatius subsp. elatius	+	-	-	-
Bromus commutatus	-	-	+	-
Centaurea phrygia subsp. phrygia	-	-	+	+
Cirsium tuberosum	+	-	-	-
Dactylis glomerata subsp. glomerata	+	-	-	-
Deschampsia cespitosa subsp. cespitosa	-	+	-	-
Equisetum arvense	-	+	-	-
Festuca pratensis	+	-	-	-
Juncus effusus	+	-	-	-
Knautia arvensis	-	-	+	-
Lathyrus pratensis	+	-	-	-
Lotus corniculatus	+	-	-	-
Mentha arvensis	+	-	-	-
Mentha longifolia	+	+	+	+
Odontites verna subsp. verna	+	-	-	-
Poa pratensis	+	-	+	+
Potentilla anserina	+	-	-	-
Ranunculus acris	+	-	-	-
Rorippa sylvestris	+	-	-	-
Succisa pratensis	-	+	-	-
Tragopogon pratensis	-	-	+	+

Trifolium hybridum	+	-	-	-
Valeriana sambucifolia	-	+	-	-
Vicia cracca	-	+	-	-
Artemisietea				
Artemisia vulgaris	-	-	+	+
Carduus acanthoides	-	-	+	+
Cirsium vulgare	+	-	-	-
Daucus carota	+	-	-	-
Elymus repens subsp. repens	+	-	-	-
Erigeron annuus subsp. annuus	+	-	-	-
Salvia verticillata	-	-	+	+
Tussilago farfara	-	-	+	+
Trifolio – Geranietea				
Agrimonia eupatoria	-	-	+	+
Clinopodium vulgare	-	-	+	+
Origanum vulgare	-	-	+	+
Peucedanum alsaticum	-	-	+	+
Aliae				
Achillea collina	+	-	-	-
Anthemis tinctoria	-	-	+	+
Cirsium arvense	-	-	+	-
Clematis vitalba	-	-	+	+
Conyza canadensis	-	-	+	+
Equisetum maximum	-	-	+	+
Euphorbia cyparissias	-	-	+	+
Juncus articulatus	+	-	-	-
Lathyrus tuberosus	-	-	+	+
Plantago lanceolata	+	-	-	-
Potentilla recta	-	-	+	+
Salix cinerea	+	-	+	-
Senecio vernalis	-	-	+	+
Sonchus arvensis	-	-	+	+

Place and data of relevés: 1-2: The marshes of Bahna Mare-Bălăneşti, September, 21, 2008; 3-4: Borniş, along the stream valley "Obârşia", September, 21, 2008

Ass. ***Callitrichetum polymorphae*** Soó 1947

Chorology and biotope characteristics. Three phytocoenoses of this association have been identified in the marshes nearby the village of Unghi, on the stream valley "Valea Albă" (Fig. 13). The phytocoenoses edyfied by *Callitriche cophocarpa* are developed in stagnant or ± running waters, clean and shallow in depth.

Species composition and phytocoenotic structure. The identified phytocoenoses are monostratified, the vegetation being dominated by the species *Callitriche cophocarpa*. The most accompanying species belong to *Phragmiti – Magnocaricetea* class, as: *Alisma plantago-aquatica*, *Typha shuttleworthii*, *Glyceria fluitans*, *Berula erecta*, *Veronica beccabunga*, and so on. Other several species from the neighbouring mesophyllous meadows infiltrate in the species composition of the phytocoenoses (e. g. *Agrostis stolonifera* subsp. *stolonifera* and *Juncus articulatus*) (Tab. 9).

Tab. 9. Ass. *Callitrichetum polymorphae* Soó 1947

Surface of relevé (m^2)	**1**	**1**	**2**
Coverage (%)	**85**	**70**	**90**
No. of relevée	**1**	**2**	**3**
Ranunculion aquatilis, Callitricho–Batrachietalia & Potametea pectinati			
Callitriche cophocarpa	5	4	5
Phragmiti–Magnocaricetea			
Alisma plantago-aquatica	+	+	+
Berula erecta	+	-	+
Carex riparia	-	+	-
Eleocharis palustris	-	+	-
Glyceria fluitans	+	+	-
Leersia oryzoides	-	-	+
Mentha aquatica	-	-	+
Ranunculus repens	+	-	+
Sparganium erectum	-	-	+
Typha shuttleworthii	+	-	+
Veronica beccabunga	-	+	+
Molinio–Arrhenatheretea			
Agrostis stolonifera subsp. stolonifera	-	+	+
Carex hirta	+	-	-
Juncus articulatus	-	-	+
Juncus inflexus	+	-	+
Poa hybrida	-	+	-
Scirpus sylvaticus	+	-	+
Aliae			
Bidens cernua	-	-	+
Cyperus fuscus	-	-	+
Polygonum hydropiper	-	-	+
Ranunculus sceleratus	+	-	-

Place and data of relevés: 1-3: The marshes of Unghi, on the stream valley "Valea Albă", September, 21, 2008

Fig. 13. Ass. *Callitrichetum polymorphae* Soó 1947 in marshes near Unghi village

On the basis of the Simpson's index of dominance values (S) (Tab. 1), the greatest biodiversity is found within the next associations: *Carici flavae – Eriophoretum latifolii* Soó 1944 (S = 0.22-0.76), *Caltho laetae–Ligularietum sibiricae* Ștefan et al. 2000 (S=0.23-0.26) and *Angelico – Cirsietum oleracei* R. Tx. 1937 (S=0.39). The conservation value of

these three associations is also given by the presence of some rare and vulnerable species, such as: *Dactylorhiza incarnata*, *D. maculata* subsp. *fuchsii*, *Carex paniculata*, *Ligularia sibirica*, *Menyanthes trifoliata*, and *Thelypteris palustris*. Other associations include also some endangered plant species, such as: *Salicetum cinereae* Zólyomi 1931 (*Angelica palustris*, *Dactylorhiza maculata* subsp. *fuchsii*, *D. incarnata*, *Thelypteris palustris*), *Caricetum rostratae* Rübel 1912 (*Carex paniculata*), *Pastinaco sativae–Arrhenatheretum elatioris* Passarge 1964 (*Angelica palustris*), *Scirpetum sylvatici* Ralski 1931 (*Dactylorhiza incarnata*), *Caricetum rippariae* (Soó 1928) Knapp et Stoffer 1962 (*Angelica palustris*, *Carex paniculata*, *Dactylorhiza maculata* subsp. *fuchsii*, *D. incarnata*, *Ligularia sibirica*, *Menyanthes trifoliata*, *Thelypteris palustris*), *Phragmitetum vulgaris* Soó 1927 (*Ligularia sibirica*, *Thelypteris palustris*).

These 16 associations, from the surveyed marshes of the Neamț county, could be assigned to the next natural habitats (sensu Habitat Directive 92/43/EEC):

- 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation: ass. ***Callitrichetum polymorphae*** Soó 1947
- 6430 Hygrophilous tall herb fringe communities of plains and of the montane to alpine levels: ass. ***Scirpetum sylvatici*** Ralski 1931; ass. ***Caltho laetae – Ligularietum sibiricae*** Ștefan et al. 2000; ass. ***Angelico – Cirsietum oleracei*** R. Tx. 1937; ***Deschampsietum caespitosae*** Hayek ex Horvatic 1930; ass. ***Caricetum rippariae*** (Soó 1928) Knapp et Stoffer 1962; ass. ***Phragmitetum vulgaris*** Soó 1927; ass. ***Typhetum angustifoliae*** Pignatti 1953; ass. ***Glycerietum maximae*** Hueck 1931
- 6510 Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*): ass. ***Arrhenatheretum elatioris*** Scherrer 1925; ass. ***Galegetum officinalis*** Dobrescu et Vițalariu 1981
- 7140 Transition mires and quaking bogs: ass. ***Caricetum rostratae*** Rübel 1912
- 7230 Alkaline fens: ass. ***Carici flavae – Eriophoretum latifolii*** Soó 1944
- 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*): ass. ***Salicetum cinereae*** Zólyomi 1931; ass. ***Stellario nemorum – Alnetum glutinosae*** Lohmeyer 1957; ass. ***Salicetum purpureae*** Wendelberger-Zelinka 1952.

Given the presence of many rare plant species and some habitats of European Community importance in the marshes of Unghi and Bălăneşti ("Bahna Mare"), they would be proposed, in the near future, as "Natura 2000" sites of community interest (SCI's) and later as nature reserves into the romanian network of protected areas.

Conclusions

- There are described 16 associations, from 11 alliances, 9 orders, and 6 classes of vegetation and other two phytocoenoses of *Aster lanceolatus* into this paper
- Some asssociations include fairly rare plant species into the Moldavian region of Romania, as the next one: *Angelica palustris*, *Carex paniculata*, *Dactylorhiza incarnata*, *Dianthus superbus* subsp. *superbus*, *Ligularia sibirica*, *Menyanthes trifoliata*, *Orchis laxiflora* subsp. *elegans*, *Salix rosmarinifolia*, *Thelypteris palustris*
- Natural habitats which framed the vegetation of the surveyed marshes in Neamț county are represented by phragments of 6 types; among these, one is priority to be preserved into the European Union, namely 91E0*

– It is necessary to protect as nature reserves the marshes nearby the villages of Unghi and Bălăneşti (Bahna Mare) and including these ones into the network of "Natura 2000" sites in Romania.

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ASSOCIATIONS OF *MOLINIETALIA* KOCH 1926 (*MOLINIO-ARRHENATHERETEA* R. Tx. 1937) IDENTIFIED IN NEAGRA BROŞTENILOR BASIN (EASTERN CARPATHIANS)

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Abstract: The paper presents eight vegetal communities (*Junco-Molinietum coeruleae* Preising in R. Tx. et Preising ex Klapp 1954, *Calthetum laetae* Krajina 1933, *Scirpetum sylvatici* Ralski 1931, *Epilobio-Juncetum effusi* Oberd. 1957, *Cirsietum rivularis* Nowinski 1928, *Angelico-Cirsietum oleracei* R. Tx. 1937, *Filipendulo-Geranietum palustris* W. Koch 1926, *Deschampsietum caespitosae* Hayek ex Horvatič 1930) from *Molinietalia* Koch 1926 (*Molinio-Arrhenatheretea* R. Tx. 1937) identified in Neagra Brostenilor hydrographic basin. These are analyzed from the chorology, floristic and phytosociological composition, bio-forms, floristic elements and ecological requests perspectives.

Key words: vegetal associations, *Molinietalia*, Neagra Broştenilor

Introduction

Hydrographic Basin of Neagra Broşteni River includes the central region of Bistriţa Mountains, a part of the eastern slopes of Călimani Mountains and the Drăgoiasa-Glodu Depression (Eastern Carpathians). It is localized in Suceava county and has an area of approximate 350 km^2 [ATLASUL CADASTRULUI APELOR DIN R.S.R, 1972]. The river is about 42 km long, springs from Măgura Mountain (1300 m) and the confluence point with Bistriţa river is at Broşteni (627 m).

Three geo-morphological units represent the relief. *Călimani Mountains*, by volcanic origin, present high altitudes: Căliman Cerbuc peak-2013 m and Căliman Izvor-2030 m, in our study area. *Drăgoiasa-Glodu Depression* (1000 m altitude) is reduced at river's valley. *Bistriţa Mountains*, by tectonic origin, are divided in many massifs: Pietrosul Bistriţei and Budacu with Grinţieşul Mic-1734 m and Budacu-1859 m the highest peaks in our study area [MIHĂILESCU, 1963]. *Eruptive* (Călimani Mountains) and *crystalline* (Munţii Bistriţei) rocks represents geological substratum [MUTIHAC & IONESI, 1974]. The main soils types are *cambisoils* (corresponding to mixed deciduous and coniferous forests), *spodosoils* (corresponding to coniferous forests) and *litho-soils* (corresponding to sub-alpine meadows) [BARBU et al., 1984].

The climate is characterized by average precipitations oscillating between 600-1100 (1200) mm/year, yearly averages of temperatures varying between 0 and 4ºC, western atmospheric circulation, increased nebulosity (6,8-7), increased relative humidity of the atmosphere (over 80%), frequent hydro-meteorological phenomena (dew, frost, hoar-frost, mist) [VELCEA & SAVU, 1982].

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Material and method

Molinietalia caeruleae Koch 1926 (syntax. syn. *Deschampsietalia* Horvatič 1958) order includes herbaceous phytocoenoses that grows on soils characterized by increased humidity (in excess even) and increased fertility, in riversides, valleys and mountainous depressions [CHIFU et al., 2006]. This order is subordinated to *Molinio-Arrhenatheretea* R. Tx. 1937 vegetation class that includes herbaceous, secondary, mesophilous and mesohygrophilous phytocoenoses, representing in fact the grasslands and hays of great economical importance from low hilly areas to high mountainous areas.

The method used for the study of vegetation from *Molietalia* has been elaborated by Central European Phytosociological School. Field data acquiring process has been realized by field trips (on itineraries or in stationeries) in 2006-2009 periods. Identification of vegetal association has been made based on characteristic, dominant and differential species [COLDEA, 1991; SANDA, 2002; CHIFU et al., 2006] and inclusion of the relevèes presenting similar coenotic structures in one phytosociological table. For each vegetal association, chorology, floristic composition, phytosociological composition and proportions of bio-forms, floristic elements and ecological categories have been presented. In this study, the bioforms (life forms) and floristic elements are that presented by Ciocârlan [CIOCÂRLAN, 2000]. Species requirements for light, temperature, humidity, soil pH and soils content in nitrogen (quantified in ecological indices) have been used to analyze the ecological structure of phytocoenoses [ELLENBERG, 1974].

Results and discussion

According to prestigious papers [COLDEA, 1991; SANDA, 2002; CHIFU et al., 2006] on the phytosociological nomenclature and coenotaxa classification, these eight vegetal associations identified by us can be framed in the next coeno-system:

MOLINIO – ARRHENATHERETEA R. Tx. 1937
MOLINIETALIA CAERULEAE Koch 1926
Molinion caeruleae Koch 1926
Junco – Molinietum coeruleae Preising in R. Tx. et Preising ex Klapp 1954
Calthion palustris R. Tx. 1937
Calthetum laetae Krajina 1933
Scirpetum sylvatici Ralski 1931
Epilobio – Juncetum effusi Oberd. 1957
Cirsietum rivularis Nowinski 1928
Angelico – Cirsietum oleracei R. Tx. 1937
Filipendulion Segal 1966
Filipendulo – Geranietum palustris W. Koch 1926
Deschampsion Horvatič
Deschampsietum caespitosae Hayek ex Horvatič 1930

1. As. *Junco – Molinietum coeruleae* Preising in R. Tx. et Preising ex Klapp 1954

Chorology: phytocoenoses of *Junco-Molinietum coeruleae* have a sporadic distribution in Neagra Broştenilor hydrographic basin. They includes communities edified by *Molinia caerulea* (purple moor-grass) having *Juncus effusus* and *Juncus conglomeratus* as characteristic species. These communities are installed on plane or moderate inclined terrains, on humid, moderate acid to neutral and low in nutrients soils. This association has

been mentioned before from Cristişor [LUNGU, 1969] and Neagra Broşteni [POPOVICI et al., 1996]. We identified it in Drăgoiasa village and at the point of confluence of Cristişor rivulet with Neagra Broştenilor river.

Floristic composition and phytocenotic structure: herbaceous layer is homogeneous, presents a covering degree varying between 90% and 100% and includes, besides characteristic and edifying species, numerous other species: *Dactylorhiza maculata, Stachys officinalis, Lysimachia vulgaris, Trifolium spadiceum, Agrostis capillaris, Potentilla erecta* etc. Regarding phytocenological composition, increased constancy indices have been registered for species from: Molinion (*Linum catharticum, Lychnis flos-cuculi* etc.), Calthion (*Myosotis scorpioides, Caltha palustris, Polygonum bistorta* etc.), Filipendulion (*Filipendula ulmaria* etc.), Deschampsion (*Deschampsia caespitosa* etc.), Molinietalia and Molinio-Arrhenatheretea (*Parnassia palustris, Stellaria graminea, Lathyrus pratensis, Trifolium repens* etc.). (Tab. 1).

Bioforms spectrum: H-75%, G-13%, Ht-4%, T-4%, Ch-2%, T-H-2%.

Floristic elements spectrum: Euras.-50%, Circ.-26%, Eur.-15%, Cosm.-7%, Eur. centr.-2%.

Ecological indices spectrum: preponderant light-species (L_7-53% and L_8-20%), eurythermic (T_x-61%) or preferring temperate sub-montane areas (T_5-24%), humid (U_7-23% and U_8-28%) or moderate humid soils (U_5-10% and U_6-12%). Most of the component species are euryionic (R_x-57%) and grows on solis poor in nitrogen (N_2-20%, N_3-20%).

2. As. *Scirpetum sylvatici* Ralski 1931

Chorology: vegetal communities edified by *Scirpus sylvaticus* (wood club-rush) can be frequently met in Neagra Broştenilor basin, both in this river and its affluents valleys. They are installed on plane or moderate inclined terrains, on humid, moderate acid and relative poor in nutrients soils. The association has been mentioned before from Cristişor [LUNGU, 1969] and Păltiniş [MITITELU et al., 1989]. We identified it in Drăgoiasa, Glodu, Neagra Broşteni and Păltiniş villages and Cristişor peat bog.

Floristic composition and phytocenotic structure: floristic composition is variate, herbaceous layer is homogeneous, presents a covering degree varying between 95% and 100% and includes, besides the characteristic and edifying species (*Scirpus sylvaticus*), numerous other species: *Caltha palustris, Lysimachia vulgaris, Juncus effusus, Lychnis flos-cuculi*, *Briza media, Juncus inflexus* etc. (Tab.2). Regarding phytocenological composition, increased constancy indices have been registered for species from: Calthion (*Angelica sylvestris, Cirsium oleraceum* etc.), Filipendulion (*Filipendula ulmaria, Lysimachia vulgaris* etc.), Deschampsion (*Deschampsia caespitosa* etc.), Molinietalia (*Polygonum bistorta*, *Cirsium palustre* etc.), Arrhenatheretalia (*Holcus lanatus, Lysimachia nummularia* etc.), Molinio-Arrhenatheretea (*Trifolium repens, Trollius europaeus* etc.).

Bioforms spectrum: H-84%, G-10%, Ht-4%, Ch-2%.

Floristic elements spectrum: Euras.-47%, Circ.-27%, Cosm.-14%, Eur.-8%, Eur. centr.-2%, Carp.-balc.-cauc.-anat.-2%.

Ecological indices spectrum: preponderant light-species (L_7-51% and L_8-25%), eurythermic (T_x-47%) or preferring temperate sub-montane areas (T_5-35%), humid (U_7-24% and U_8-30%) and poor (to moderate) in nitrogen soils ($N_{1\text{-}6}$-57%). Most of the component species are euryionic (R_x-54%).

3. As. *Epilobio – Juncetum effusi* Oberd. 1957

Chorology: phytocoenoses of *Epilobio-Juncetum effusi* can be frequently met in Neagra Broştenilor basin. They includes vegetal communities edified by *Juncus effusus* (common rush) presenting *Epilobium palustre* (marsh willow herb) as characteristic species and are installed on plane or moderate inclined terrains, on humid and neutral soils, with variable contents of nutrients. This association has been identified before in Drăgoiasa [POP, 1960], Broşteni and Neagra Broşteni [MITITELU et al., 1989], Cristişor [LUNGU, 1969] and in Neagra Broştenilor valley [SEGHEDIN, 1986]. We identified it in Drăgoiasa, Neagra Broşteni, Păltiniş and Dârmoxa localities, on Budacu, Căliman Cerbuc and Cristişor.

Floristic composition and phytocenotic structure: herbaceous layer is very diversified, presents a covering degree varying between 90-95% and includes numerous species: *Caltha palustris, Filipendula ulmaria, Deschampsia caespitosa, Lychnis flos-cuculi*, *Ranunculus repens, Potentilla erecta, Juncus inflexus* etc. (Tab. 8). Regarding phytocenological composition, increased constancy indices have been registered for species from: Calthion (*Myosotis scorpioides, Scirpus sylvaticus, Cirsium oleraceum* etc.), Filipendulion (*Filipendula ulmaria, Lythrum salicaria* etc.), Deschampsion (*Deschampsia caespitosa, Juncus conglomeratus, Carex pallescens* etc.), Molinietalia (*Lychnis flos-cuculi, Juncus articulatus, Cirsium palustre* etc.), Arrhenatheretalia (*Holcus lanatus, Briza media, Cynosurus cristatus* etc.), Molinio-Arrhenatheretea (*Trifolium repens, Alchemilla vulgaris, Agrostis capillaris, Trifolium pratense* etc.), Scheuchzerio-Caricetea nigrae (*Carex nigra, Carex echinata*), Phragmiti-Magnocaricetea (*Galium palustre, Lycopus europaeus* etc.).

Bioforms spectrum: H-84%, G-9%, Ht-3%, T-2%, Ch-2%.

Floristic elements spectrum: Euras.-46%, Circ.-33%, Eur.-9%, Eur. centr.-3%, Cosm.-9%.

Ecological indices spectrum: preponderant light-species (L_7-46% and L_8-26%), eurythermic (T_x-45%) or preferring temperate sub-montane areas (T_5-33%) and humid soils (U_7-26% and U_8-29%). Most of the component species are euryionic (R_x-51%) but a small part preferrs neutral soils (R_7-15% and R_8-12%) characterized by variable contents in nitrogen (can variate from very poor to moderate and rich).

4. As. *Cirsietum rivularis* Nowinski 1928

Chorology: Association *Cirsietum rivularis* includes phytocoenoses edified by *Cirsium rivulare* distributed spodadically (nearby rivulets) in Neagra Broştenilor basin. It has been identified in the proximity of Neagra Broşteni and Dârmoxa villages where it occupies micro-depressions or plane (moderate inclined) terrains with wet and rich in nutrients soils. These vegetal communities were signaled before from Păltiniş [SEGHEDIN, 1986; MITITELU et al., 1989; POPOVICI et al., 1996].

Floristic composition and phytocenotic structure: herbaceous layer presents a covering degree varying betwen 85-95%. It includes, besides characteristic and edifying species, numerous other species: *Angelica sylvestris*, *Carex ovalis*, *Dactylis glomerata*, *Ranunculus repens*, *Geum rivale, Mentha longifolia, Lycopus europaeus* etc. (Tab. 3). From phytosociological point of view, increased constancy indices have been registered for species from: Calthion (*Scirpus sylvaticus, Myosotis scorpioides, Cirsium oleraceum* etc.), Deschampsion (*Juncus effusus, Deschampsia caespitosa* etc.), Filipendulion (*Filipendula ulmaria* etc.), Molinietalia (*Galium palustre, Lychnis flos-cuculi* etc.), Arrhenatheretalia (*Briza media, Stellaria graminea* etc.), Molinio-Arrhenatheretea (*Lathyrus pratensis*, *Trifolium repens, Agrostis capillaris*, *Prunella vulgaris, Cynosurus cristatus* etc.).

Bioforms spectrum: H-87%, G-7%, Ht-H-2%, T-H-2%, Ch-2%.

Floristic elements spectrum: Euras.-54%, Circ.-28%, Eur.-9%, Eur. centr.-2%, Cosm.-7%.

Ecological indices spectrum: preponderant light-species (L_7-53% and L_8-20%), eurythermic (T_x-63%) or preferring temperate sub-montane areas (T_5-24%). Most of the component species are euryionic (R_x-60%) and grows on humid soils (U_7-22% and U_8-23%) characterized by variable contents in nitrogen (can variate from very poor to moderate and rich).

5. As. *Angelico – Cirsietum oleracei* R. Tx. 1937

Chorology: phytocoenoses of *Angelico-Cirsietum oleracei* are frecvently met in Neagra Broştenilor basin (nearby rivulets), including the vegetal communities edified by *Cirsium oleraceum* having in *Angelica sylvestris* the characteristic species. We identified these phytocoenoses in the proximity of Glodu, Neagra Broşteni localities, along many affluents of Neagra Broştenilor (Cristişor rivulet, Arsurii rivulet), growing in places with an exces of humidity, on neutral and rich in nutrients soils. The association has been presented before [SEGHEDIN, 1986] from the valley of Neagra Broştenilor.

Floristic composition and phytocenotic structure: floristic composition is variate, herbaceous layer is homogeneous, presents a covering degree varying between 95-100%, and includes numerous species: *Myosotis scorpioides*, *Lythrum salicaria*, *Ranunculus acris*, *Mentha longifolia, Impatiens noli-tangere, Lycopus europaeus* etc. (Tab. 4). From phytosociological point of view, increased constancy indices have been registered for species from: Calthion (*Caltha palustris, Scirpus sylvaticus* etc.), Filipendulion (*Chaerophyllum hirsutum, Lysimachia vulgaris* etc.), Deschampsion (*Juncus effusus, Deschampsia caespitosa* etc.), Molinietalia (*Cirsium palustre* etc.), Molinio-Arrhenatheretea (*Lathyrus pratensis*, *Prunella vulgaris, Briza media, Trifolium repens, Lysimachia nummularia, Stellaria graminea* etc.).

Bioforms spectrum: H-75%, G-5%, Ht-H-4%, Ch-4%, T-4%, T-Ht-4%, Ht-2%, Ph-2%.

Floristic elements spectrum: Euras-57%, Circ.-20%, Cosm.-13%, Eur.-4%, Eur. centr.-4%, Carp.-balc.-cauc.-anat.-2%.

Ecological indices spectrum: preponderant light-species (L_7-49% and L_8-18%), eurythermic (T_x-58%) or preferring temperate sub-montane areas (T_5-33%). Most of the component species are euryionic (R_x-53%) and grows on humid solis (U_7-20% and U_8-28%), rich in nitrogen (N_7-15%, N_8-18%). Reduced proportions have been registered for shade (L_6-22%), euryhygrous (U_x-15%) and for species prefering neutral soils (R_7-22%, R_8-11%).

6. As. *Calthetum laetae* Krajina 1933

Chorology: vegetal communities edified by *Caltha palustris* (marsh marigold) have a sporadic distribution both in Neagra Broştenilor and its affluents valleys. These phytocoenoses grows on plane or moderate inclined terrains, on humid, neutral and with variable contents in nutrients soils. The association has been presented before [SEGHEDIN, 1986] from the valley of Neagra Broştenilor and Broşteni [MITITELU et al., 1989].

Floristic composition and phytocenotic structure: herbaceous layer is very diversified, presents a covering degree varying between 90-95% including numerous species: *Myosotis scorpioides, Filipendula ulmaria, Juncus effusus, Ranunculus repens, Equisetum palustre, Agrostis stolonifera, Valeriana officinalis* etc. (Tab. 5). From

phytosociological point of view, increased constancy indices have been registered for species from: Calthion (*Scirpus sylvaticus*, *Cirsium oleraceum, Angelica sylvestris, Polygonum bistorta* etc.), Filipendulion (*Lythrum salicaria, Filipendula ulmaria* etc.), Deschampsion (*Deschampsia caespitosa, Juncus conglomeratus* etc.), Molinietalia (*Lychnis flos-cuculi*, *Juncus effusus*, *Cirsium palustre* etc.), Molinio-Arrhenatheretea (*Lathyrus pratensis*, *Trifolium repens*), Phragmiti-Magnocaricetea (*Lycopus europaeus, Galium palustre, Epilobium palustre* etc.).

Bioforms spectrum: H-78%, G-11%, Ht-5%, T-3%, Ch-3%.

Floristic elements spectrum: Euras.-49%, Circ.-32%, Eur.-8%, Cosm.-5%, Eur. centr.-3%, Carp.-balc.-cauc.-anat.-3%.

Ecological indices spectrum: preponderant light-species (L_7-52% and L_8-24%), eurythermic (T_x-55%) or preferring temperate sub-montane areas (T_5-29%). Most of the component species are euryionic (R_x-55%) or preffers neutral soils (R_7-18%) and grows on humid soils (U_7-26% and U_8-37%) characterized by variable contents in nitrogen.

7. As. *Filipendulo – Geranietum palustris* W. Koch 1926

Chorology: phytocoenoses of *Filipendulo-Geranietum palustris* presents a sporadic distribution in Neagra Broştenilor basin, both in this river and its affluents valleys. They occupy plane terrains with humid, moderate acid and relative poor in nutrients soils. This association has not been presented before from this region. We identified it in Glodu, Drăgoiasa, Cristişor and Neagra Broşteni.

Floristic composition and phytocenotic structure: herbaceous layer is very diversified, presents a covering degree up to 100% including numerous species: *Lysimachia vulgaris, Caltha palustris, Juncus effusus, Lychnis flos-cuculi*, *Briza media, Trollius europaeus, Geum rivale, Juncus inflexus, Impatiens noli-tangere* etc. (Tab. 6). From phytosociological point of view, increased constancy indices have been registered for species from: Filipendulion (*Chaerophyllum hirsutum, Polygonum bistorta*, *Lythrum salicaria* etc.), Calthion (*Caltha palustris, Scirpus sylvaticus*, *Myosotis scorpioides* etc.), Deschampsion (*Deschampsia caespitosa, Juncus conglomeratus* etc.), Alopecurion (*Agrostis stolonifera, Phleum pratense*), Molinietalia (*Lychnis flos-cuculi*, *Cirsium palustre*, *Succisa pratensis* etc.), Arrhenatheretalia (*Prunella vulgaris, Dactylis glomerata*, *Briza media* etc.), Molinio-Arrhenatheretea (*Holcus lanatus, Lysimachia nummularia* etc.).

Bioforms spectrum: H-80%, G-10%, Ht-5%, T-2%, Ch-3 %.

Floristic elements spectrum: Euras.-51%, Circ.-27%, Cosm.-8%, Eur. centr.-7%, Eur.-5%, Carp.-balc.-cauc.-anat.-2%.

Ecological indices spectrum: preponderant light-species (L_7-60% and L_8-15%), eurythermic (T_x-47%) or preferring temperate sub-montane areas (T_5-36%). Most of the component species are euryionic (R_x-52%) and grows on humid soils (U_7-24% and U_8-37%), characterized by variable contents in nitrogen. Reduced proportions have been registered for species preferring wet soils (U_9-8%) and neutral soils (R_7-17%, R_8-10%).

8. As. *Deschampsietum caespitosae* Hayek ex Horvatič 1930

Chorology: vegetal communities edified by *Deschampsia caespitosa* can be frequently met in Neagra Broştenilor basin, on plane terrains, with humid, moderate acid-neutral, with variable contents in nutrients soils. In this area, the association was mentioned from Cristişor [LUNGU, 1969] (as *Calliergo cuspidatae-Deschampsietum*

caespitosae) and Păltiniş [SEGHEDIN, 1986]. We identified it in Neagra Broşteni, Păltiniş, Budacu Mountain and Cristişor.

Floristic composition and phytocenotic structure: herbaceous layer is diversified, presents a covering degree varying between 90-100% including numerous species as: *Juncus effusus*, *Myosotis scorpioides, Briza media, Succisa pratensis, Ranunculus repens, Potentilla erecta* etc. From phytosociological point of view, increased constancy indices have been registered for species from: Deschampsion (*Juncus effusus*, *Juncus conglomeratus, Carex pallescens* etc.), Filipendulion (*Filipendula ulmaria, Phleum pratense, Agrostis stolonifera* etc.), Calthion (*Myosotis scorpioides, Caltha palustris*, *Scirpus sylvaticus* etc.), Molinietalia (*Lychnis flos-cuculi*, *Parnassia palustris, Dactylorhiza maculata* etc.), Arrhenatheretalia (*Holcus lanatus, Briza media* etc.), Molinio-Arrhenatheretea (*Lathyrus pratensis*, *Agrostis capillaris, Stellaria graminea, Festuca rubra, Cynosurus cristatus, Trifolium repens, Trifolium pratense* etc.). (Tab. 7).

Bioforms spectrum: H-87%, G-7%, Ht-3%, T-3%.

Floristic elements spectrum: Euras.-53%, Circ.-22%, Eur.-10%, Eur. centr.-3%, Cosm.-12%.

Ecological indices spectrum: preponderant light-species (L_7-49% and L_8-21%), eurythermic (T_x-60%) or preferring temperate sub-montane areas (T_5-24%). Most of the component species are euryionic (R_x-59%) or grows on neutral soils (R_7-12%) and preffers moderat humid (U_5-21%, U_6-16%) and humid (U_7-14%, U_8-16%) soils, characterized by variable contents in nitrogen. Significat proportion has been registered for euryhygrous species (U_x – 21%).

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Tab. 1. As. *Junco – Molinietum coeruleae* Preising in R. Tx. et Preising ex Klapp 1954

Floristic element	Bioform	No. of relevé	1	2	3	4	5	K
		Altitude (m.s.m. x 10)	1060	1060	1000	1000	820	
		Aspect	SE	-	-	-	-	
		Slope (°)	2-3	-	-	-	-	
		Vegetation covering (%)	95	90	95	95	100	
		Plot area (m^2)	25	25	25	25	25	
Car. as.								
Cosm.	H	Juncus effusus	1	-	+	+	1	IV
Circ.	H	Juncus conglomeratus	-	+	-	+	-	II
Molinion et Molinietalia caeruleae								
Euras.	H	Molinia caerulea	4	4	4	4	4	V
Euras.	H	Succisa pratensis	+	-	+	+	+	IV
Eur.	T-H	Linum catharticum	+	+	-	+	+	IV
Circ.	G	Equisetum palustre	+	-	+	-	-	II
Euras.	Ht	Cirsium palustre	+	+	+	+	+	V
Euras.	H	Lychnis flos-cuculi	+	+	+	+	-	IV
Euras.	G	Polygonum bistorta	-	+	-	+	-	II
Eur. centr.	G	Dactylorhiza maculata	-	+	+	+	+	IV
Calthion								
Circ.	G	Scirpus sylvaticus	+	+	-	+	+	IV
Euras.	H	Myosotis scorpioides	+	+	+	+	+	V
Circ.	H	Caltha palustris	-	+	-	+	-	II
Euras.	H	Cirsium oleraceum	-	-	+	-	+	II
Filipendulion								
Euras.	H	Filipendula ulmaria	+	+	-	-	+	III
Deschampsion								
Cosm.	H	Deschampsia caespitosa	+	+	1	+	+	V
Molinio – Arrhenatheretea								
Circ.	H	Parnassia palustris	+	-	+	+	+	IV
Euras.	H	Briza media	+	+	+	+	+	V
Euras.	H	Stellaria graminea	+	-	-	+	+	III
Eur.	T	Trifolium spadiceum	+	-	-	+	-	II
Circ.	H (G)	Agrostis capillaris	1	+	1	1	+	V
Euras.	H	Trifolium repens	+	1	1	+	+	V
Euras.	H	Lathyrus pratensis	-	+	-	+	+	III
Eur.	H	Cynosurus cristatus	-	+	+	+	+	IV
Circ.	H	Festuca rubra	-	-	+	+	1	III
Euras.	H	Phleum pratense	-	-	-	+	+	II
Euras.	H	Anthoxanthum odoratum	-	-	-	+	+	II
Euras.	H	Leucanthemum vulgare	-	-	-	+	+	II
Euras.	H	Trifolium pratense	-	-	-	+	+	II
Variae syntaxa								
Euras.	H	Ranunculus repens	+	-	-	+	-	II
Euras.	H	Potentilla erecta	1	1	+	+	+	V
Eur.	H	Alchemilla vulgaris	-	-	+	1	-	II

Species in one relevé (K-I): Stachys officinalis (Euras., H, rel. 5); Juncus articulatus (Circ., H, rel. 5); Angelica sylvestris (Euras., Ht-H, rel. 4); Lysimachia vulgaris (Euras., H, rel. 5); Lythrum salicaria (Circ., H, rel. 5); Trollius europaeus (Eur., H, rel. 3); Lysimachia nummularia (Euras., Ch, rel. 3); Carex pallescens (Circ., H, rel. 4); Euphrasia officinalis ssp. pratensis (Eur., T, rel. 4); Holcus lanatus (Cosm., H, rel. 5); Prunella vulgaris (Cosm., H, rel. 5); Dactylis glomerata (Euras., H, rel. 5); Taraxacum officinale (Euras., H, rel. 5); Gymnadenia conopsea (Eur., G, rel. 5); Carex nigra (Circ., G, rel. 1); Ligularia sibirica (Euras., H, rel. 1); Eriophorum angustifolium (Circ., G, rel. 2); Carex flava (Eur., H, rel. 3); Carex echinata (Circ., H, rel. 2); Geum rivale (Circ., H, rel. 2); Valeriana officinalis (Euras., H, rel. 4); Lychnis viscaria (Euras., H, rel. 5).
Place and date of relevées: Drăgoiasa (rel. 1-4): 12.07.2008, Cristişor (rel. 5): 3.07.2007.

Tab. 2. As. *Scirpetum sylvatici* Ralski 1931

Floristic element	Bioform	No. of relevé	1	2	3	4	5	6	K
		Altitude (m.s.m. x 10)	1000	950	700	700	800	950	
		Aspect	-	E	-	-	-	-	
		Slope (˚)	-	2-3	-	-	-	-	
		Vegetation covering (%)	90	95	95	100	90	95	
		Plot area (m^2)	25	25	100	100	25	25	
Car. ass.									
Circ.	G	Scirpus sylvaticus	4	5	5	5	5	4	V
Calthion									
Euras.	Ht-H	Angelica sylvestris	+	-	-	+	+	-	III
Euras.	H	Myosotis scorpioides	1	+	+	-	+	+	V
Circ.	H	Caltha palustris	+	-	+	+	+	1	V
Euras.	H	Cirsium oleraceum	-	+	+	+	+	-	IV
Filipendulion									
Euras.	H	Filipendula ulmaria	+	+	+	-	-	+	IV
Circ.	H	Lythrum salicaria	-	-	+	-	+	-	II
Alopecurion									
Circ.	H	Agrostis stolonifera	-	+	-	+	-	-	II
Deschampsion									
Cosm.	H	Juncus effusus	+	-	+	+	-	+	IV
Cosm.	H	Deschampsia caespitosa	-	+	+	-	-	+	III
Molinion et Molinietalia									
Circ.	H	Parnassia palustris	+	+	-	-	-	+	III
Euras.	H	Lychnis flos-cuculi	+	-	-	+	-	-	II
Euras.	G	Polygonum bistorta	+	-	+	+	-	-	III
Euras.	H	Succisa pratensis	+	-	-	-	+	-	II
Euras.	Ht	Cirsium palustre	-	+	+	+	-	-	III
Arrhenatherion et Arrhenatheretalia									
Cosm.	H	Holcus lanatus	-	+	-	-	+	-	II
Euras.	Ch	Lysimachia nummularia	-	+	-	+	+	-	III
Euras.	H	Briza media	-	-	+	+	-	-	II
Euras.	H	Lathyrus pratensis	-	-	+	-	+	-	II
Molinio – Arrhenatheretea									
Euras.	H	Trifolium repens	+	-	+	+	-	+	IV
Circ.	H (G)	Agrostis capillaris	-	-	-	+	+	-	II
Phragmiti – Magnocaricetea									
Circ.	G	Equisetum palustre	+	-	-	-	-	+	II
Circ.	H	Epilobium palustre	-	+	+	-	-	-	II
Euras.	H	Lycopus europaeus	-	-	+	+	-	-	II
Scheuchzerio – Caricetea nigrae									
Circ.	H	Carex echinata	+	-	-	-	+	-	II
Circ.	G	Carex nigra	+	+	-	-	-	-	II
Variae syntaxa									
Euras.	H	Ranunculus repens	+	-	+	-	-	+	III
Euras.	H	Potentilla erecta	+	+	-	-	+	-	III
Euras.	H	Mentha longifolia	-	-	+	+	-	+	III
Circ.	H	Geum rivale	-	-	+	-	+	-	II
Euras.	H	Juncus inflexus	-	-	-	+	-	+	II

Species in one relevé (K-I): Chaerophyllum hirsutum (Eur. centr., H, rel. 2); Lysimachia vulgaris (Euras., H, rel. 4); Geranium palustre (Euras., H, rel. 6); Phleum pratense (Euras., H, rel. 3); Juncus conglomeratus (Circ., H, rel. 3); Carex pallescens (Circ., H, rel. 4); Symphytum officinale (Euras., H, rel. 5); Alchemilla vulgaris (Euras., H, rel. 5); Cynosurus cristatus (Eur., H, rel. 5); Trifolium pratense (Euras., H, rel. 5); Prunella vulgaris (Cosm., H, rel. 5); Poa pratensis (Cosm., H, rel. 5); Trollius europaeus (Eur., H, rel. 6); Glyceria plicata (Circ., H, rel. 5); Eleocharis palustris (Cosm., G, rel. 6); Potentilla anserina (Cosm., H, rel. 4); Telekia speciosa (Carp.-balc.-cauc.-anat., H, rel. 5); Rumex sanguineus (Eur., H, rel. 4); Cirsium heterophyllum (Euras., H, rel. 5); Rumex crispus (Euras., H, rel. 6);
Place and date of relevées: Drăgoiasa (rel. 1): 3.07.2007; Glodu (rel. 2): 3.07.2007; Neagra Broşteni (rel. 3-4): 29.07.2007; Cristişor (rel. 5): 3.09.2007; Păltiniş (rel. 6): 1.08.2008.

Tab. 3. As. *Cirsietum rivularis* Nowinski 1928

Floristic element	Bioform	No. of relevé	1	2	3	4	5	K
		Altitude (m.s.m. x 10)	700	750	700	700	800	
		Aspect	E	SE	-	-	SV	
		Slope (°)	3	5	-	-	2-3	
		Vegetation covering (%)	95	95	85	90	95	
		Plot area (m^2)	10	15	10	20	15	
Car. ass.								
Eur. centr.	H	Cirsium rivulare	4	4	3	4	4	V
Calthion palustris								
Circ.	G	Scirpus sylvaticus	+	1	1	-	+	IV
Circ.	H	Caltha palustris	1	1	-	1	-	III
Euras.	H	Myosotis scorpioides	+	+	1	+	+	V
Euras.	H	Cirsium oleraceum	-	+	-	+	-	II
Euras.	Ht-H	Angelica sylvestris	-	-	+	-	+	II
Deschampsion								
Cosm.	H	Juncus effusus	+	-	+	+	-	III
Cosm.	H	Deschampsia caespitosa	1	+	1	1	+	V
Circ.	H	Carex ovalis	+	-	+	-	-	II
Filipendulion								
Circ.	H	Lythrum salicaria	+	-	+	-	-	II
Euras.	H	Filipendula ulmaria	+	+	+	+	+	V
Molinion et Molinietalia coeruleae								
Circ.	H	Galium palustre	+	-	+	+	-	III
Circ.	H	Parnassia palustris	+	-	+	-	-	II
Euras.	H	Lychnis flos-cuculi	+	+	+	+	+	V
Circ.	H	Juncus articulatus	-	-	+	+	-	II
Arrhenatheretalia								
Euras.	H	Briza media	+	+	+	+	+	V
Euras.	H	Dactylis glomerata	+	-	-	+	+	III
Euras.	H	Stellaria graminea	+	+	+	+	+	V
Molinio – Arrhenatheretea								
Euras.	H	Lathyrus pratensis	+	1	+	+	+	V
Euras.	H	Trifolium repens	+	1	1	+	1	V
Circ.	H (G)	Agrostis capillaris	+	+	+	+	+	V
Circ.	H	Festuca rubra	+	+	-	+	-	III
Cosm.	H	Prunella vulgaris	+	-	+	-	+	III
Euras.	H	Trifolium pratense	+	-	+	+	+	IV
Euras.	H	Ranunculus acris	-	+	+	+	-	III
Eur.	H	Cynosurus cristatus	-	-	-	+	+	II
Variae syntaxa								
Euras.	H	Ranunculus repens	+	-	-	-	1	II
Circ.	H	Geum rivale	+	+	-	+	-	III
Euras.	H	Cruciata glabra	+	-	-	-	+	II
Euras.	H	Mentha longifolia	-	-	+	+	-	II

Species in one relevé (K-I): Polygonum bistorta (Euras., G, rel. 2); Juncus conglomeratus (Circ., H, rel. 5); Lysimachia vulgaris (Euras., H, rel. 3); Succisa pratensis (Euras., H, rel. 2); Linum catharticum (Eur., T-H, rel. 5); Centaurea phrygia (Eur., H, rel. 1); Leucanthemum vulgare (Euras., H, rel. 5); Festuca pratensis (Euras., H, rel. 2); Trollius europaeus (Eur., H, rel. 3); Phleum pratense (Euras., H, rel. 3); Lysimachia nummularia (Euras., Ch, rel. 4); Anthoxanthum odoratum (Euras., H, rel. 5); Equisetum palustre (Circ., G, rel. 2); Epilobium palustre (Circ., H, rel. 3); Potentilla erecta (Euras., H, rel. 3); Lycopus europaeus (Euras., H, rel. 5).

Place and date of relevées: Neagra Broşteni: 5.07.2008 (rel. 1-2); Cristişor: 5.07.2008 (rel. 3); Dârmoxa: 18.07.2009 (rel. 5).

Tab. 4. As. *Angelico – Cirsietum oleracei* R. Tx. 1937

Floristic elements	Bioform	No. of relevé	1	2	3	4	5	6	7	K
		Altitude (m.s.m. x 10)	900	900	800	810	750	800	680	
		Aspect	-	V	-	-	-	SE	E	
		Slope (˚)	-	2-3	-	-	-	5	2-3	
		Vegetation covering (%)	100	100	95	100	95	100	100	
		Plot area (m^2)	20	25	20	20	25	25	25	
Car. ass.										
Euras.	Ht-H	Angelica sylvestris	+	+	-	-	+	-	+	III
Calthion palustris										
Euras.	H	Cirsium oleraceum	5	4	4	5	4	5	4	V
Euras.	H	Myosotis scorpioides	+	+	+	+	+	+	+	V
Circ.	H	Caltha palustris	+	1	+	-	1	+	+	V
Circ.	G	Scirpus sylvaticus	+	1	1	+	+	+	+	V
Filipendulion										
Euras.	H	Filipendula ulmaria	1	+	+	+	1	+	1	V
Eur. centr.	H	Chaerophyllum hirsutum	+	-	+	-	-	+	+	III
Euras.	H	Lysimachia vulgaris	+	-	+	-	-	+	+	III
Circ.	H	Lythrum salicaria	-	+	+	-	-	-	+	III
Deschampsion										
Cosm.	H	Juncus effusus	+	+	+	+	+	+	+	V
Cosm.	H.	Deschampsia caespitosa	+	+	-	-	+	-	-	III
Molinion et Molinietalia caeruleae										
Euras.	Ht	Cirsium palustre	+	-	+	-	-	-	-	II
Circ.	H	Parnassia palustris	-	+	-	-	+	-	-	II
Euras.	H	Lychnis flos-cuculi	-	+	-	-	+	-	-	II
Arrhenatheretalia et Molinio – Arrhenatheretea										
Euras.	H	Lathyrus pratensis	+	+	+	-	-	+	-	III
Cosm.	H	Prunella vulgaris	+	+	-	+	+	+	+	V
Euras.	H	Briza media	+	+	+	-	+	-	-	III
Euras.	Ch	Lysimachia nummularia	+	+	-	+	+	+	+	V
Euras.	H	Trifolium repens	+	+	1	+	+	+	+	V
Euras.	H	Dactylis glomerata	+	-	+	-	-	-	+	III
Euras.	H	Festuca pratensis	-	+	-	-	-	-	+	II
Euras.	H	Phleum pratense	-	+	-	+	-	-	-	II
Cosm.	H	Holcus lanatus	-	-	-	+	+	-	-	II
Euras.	H	Stellaria graminea	-	-	-	+	+	-	+	III
Euras.	Ht-H	Heracleum sphondylium	-	-	-	+	-	+	-	II
Variae syntaxa										
Euras.	H	Ranunculus repens	+	-	+	+	+	-	+	IV
Euras.	G	Petasites hybridus	+	-	-	-	-	+	-	II
Circ.	H	Epilobium palustre	+	+	-	-	+	-	-	III
Euras.	H	Potentilla erecta	+	+	+	-	-	-	+	III
Euras.	H	Mentha longifolia	+	-	+	+	-	+	+	IV
Cosm.	T-Ht	Stellaria media	-	+	-	+	+	+	-	III
Carp.-balc.-cauc.-anat.	H	Telekia speciosa	-	+	+	+	-	+	-	III
Eur.	H	Rumex sanguineus	-	+	-	-	+	-	-	II
Euras.	Ch	Solanum dulcamara	-	-	+	+	+	-	-	III
Euras.	H (HH)	Lycopus europaeus	-	-	+	-	-	+	+	III
Euras.	T	Impatiens noli-tangere	-	-	+	-	-	+	+	III
Euras.	G	Tussilago farfara	-	-	-	+	-	-	+	II
Cosm.	H	Urtica dioica	-	-	-	-	+	+	-	II

Species in one relevé (K-I): Geranium palustre (Euras., H, rel. 2); Ranunculus acris (Euras., H, rel. 2); Carex echinata (Circ., H, rel. 3); Trifolium pratense (Euras., H, rel. 5); Centaurea phrygia (Eur., H, rel. 6); Agrostis capillaris (Circ., H, rel. 7); Equisetum fluviatile (Circ., HH, rel. 1); Juncus articulatus (Circ., H, rel. 2); Valeriana

officinalis (Euras., H, rel. 3); Stachys sylvatica (Euras., H, rel. 3); Cirsium erisithales (Eur. centr., H, rel. 4); Rubus idaeus (Circ., Ph, rel. 5); Eupatorium cannabinum (Euras., H, rel. 5); Glechoma hederacea (Euras., H, rel. 7); Poa pratensis (Circ., H, rel. 7); Geranium robertianum (Cosm., T-Ht, rel. 7); Torilis japonica (Euras., T, rel. 7).
Place and date of relevées: Glodu: 18.07.2009 (rel. 1-2); Cristişor: 2.07.2007 (rel. 3-4); pârâul Arsurii: 19.09.2007 (rel. 5); Budacu: 14.07.2008 (rel. 6); Neagra Broşteni: 13.07.2008 (rel. 7).

Tab. 5. As. *Calthetum laetae* Krajina 1933

Floristic element	Bioform	No. of relevé	1	2	3	4	5	K
		Altitude (m.s.m. x 10)	750	820	820	1000	900	
		Aspect	-	-	-	-	-	
		Slope (˚)	-	-	-	-	-	
		Vegetation covering (%)	90	90	95	95	90	
		Plot area (m^2)	15	15	10	10	20	
Car. as.								
Circ.	H	Caltha palustris	4	4	5	4	5	V
Calthion								
Euras.	H	Myosotis scorpioides	+	+	+	+	+	V
Circ.	G	Scirpus sylvaticus	1	+	+	+	-	IV
Euras.	H	Cirsium oleraceum	+	-	-	+	+	III
Euras.	Ht-H	Angelica sylvestris	+	-	+	-	+	III
Atl.-eur.	H	Trifolium hybridum	-	+	-	+	-	II
Euras.	G	Polygonum bistorta	-	-	+	+	-	II
Filipendulion								
Euras.	H	Filipendula ulmaria	+	-	-	+	+	III
Deschampsion								
Cosm.	H	Deschampsia caespitosa	+	+	+	-	+	IV
Molinietalia								
Euras.	H	Lychnis flos-cuculi	+	-	+	+	-	III
Cosm.	H	Juncus effusus	+	+	-	-	+	III
Euras.	Ht	Cirsium palustre	-	+	+	-	-	II
Circ.	H	Cardamine pratensis	-	+	+	-	-	II
Circ.	H	Parnassia palustris	-	-	+	-	+	II
Euras.	H	Succisa pratensis	-	-	+	+	-	II
Molinio – Arrhenatheretea								
Euras.	Ch	Lysimachia nummularia	+	-	+	+	+	IV
Euras.	H	Ranunculus repens	+	+	+	1	+	V
Euras.	H	Lathyrus pratensis	-	+	-	+	-	II
Euras.	H	Trifolium repens	-	-	-	+	+	II
Phragmiti – Magnocaricetea								
Euras.	H (HH)	Lycopus europaeus	+	-	-	+	-	II
Circ.	H	Epilobium palustre	+	+	-	-	-	II
Euras.	H (HH)	Veronica beccabunga	-	+	+	-	-	II
Variae syntaxa								
Circ.	G	Equisetum palustre	+	+	-	-	-	II
Circ.	H	Agrostis stolonifera	+	+	+	-	-	III
Euras.	H	Potentilla erecta	+	-	-	+	-	II
Circ.	H	Geum rivale	-	+	-	+	-	II
Euras.	T	Bidens tripartita	-	-	+	+	-	II
Circ.	H (HH)	Glyceria notata	-	-	-	+	+	II
Carp.-balc.-cauc.-anat.	H	Telekia speciosa	-	-	-	+	+	II

Species in one relevé (K-I): Lythrum salicaria (Circ., H, rel. 1); Lysimachia vulgaris (Euras., H, rel. 2); Juncus conglomeratus (Circ., H, rel. 2); Dactylorhiza maculata (Eur. centr., G, rel. 4); Symphytum officinale (Euras., H, rel. 5); Galium palustre (Circ., H, rel. 2); Carex flava (Eur., H, rel. 3); Carex echinata (Circ., H, rel. 4); Valeriana officinalis (Euras., H, rel. 5);
Place and date of relevées: Neagra Broşteni (rel. 1): 28.07.2006; Cristişor (rel. 2-3): 3.07.2007; Drăgoiasa (rel. 4): 12.07.2008; Glodu (rel. 5): 13.08.2008.

Tab. 6. As. *Filipendulo – Geranietum palustris* W. Koch 1926

Floristic element	Bioform	No. of relevé	1	2	3	4	5	K
		Altitude (m.s.m. x 10)	850	1000	800	700	680	
		Aspect	-	SE	E	V	-	
		Slope (˚)	-	4-5	3-4	5	-	
		Vegetation covering (%)	95	100	95	100	100	
		Plot area (m^2)	100	100	100	100	100	
		Car. as.						
Euras.	H	Filipendula ulmaria	4	4	4	5	5	V
Euras.	H	Geranium palustre	+	1	+	+	+	V
		Filipendulion						
Eur. centr.	H	Chaerophyllum hirsutum	+	+	-	+	-	III
Circ.	H	Lythrum salicaria	+	-	-	+	+	III
Euras.	H	Lysimachia vulgaris	+	-	+	-	-	II
Euras.	G	Polygonum bistorta	-	+	+	+	-	III
		Calthion						
Circ.	H	Caltha palustris	+	1	1	+	-	IV
Euras.	H	Myosotis scorpioides	+	+	+	+	+	V
Euras.	H	Cirsium oleraceum	1	-	-	+	+	III
Circ.	G	Scirpus sylvaticus	+	+	-	-	-	II
Euras.	Ht-H	Angelica sylvestris	-	-	+	-	+	II
		Deschampsion						
Cosm.	H	Deschampsia caespitosa	+	+	+	+	+	V
Cosm.	H	Juncus effusus	+	+	+	-	-	III
		Alopecurion						
Circ.	H	Agrostis stolonifera	-	-	-	+	+	II
		Molinion et Molinietalia						
Euras.	H	Lychnis flos-cuculi	+	-	+	-	-	II
Circ.	H	Galium palustre	+	+	-	-	-	II
Euras.	Ht	Cirsium palustre	+	-	+	-	+	III
Euras.	H	Symphytum officinale	-	-	+	+	-	II
		Arrhenatherion et Arrhenatheretalia						
Cosm.	H	Prunella vulgaris	+	-	-	-	+	II
Euras.	H	Dactylis glomerata	-	-	+	-	+	II
Euras.	H	Briza media	-	-	+	-	+	II
		Molinio – Arrhenatheretea						
Euras.	H	Lathyrus pratensis	-	+	-	-	+	II
Cosm.	H	Holcus lanatus	-	-	+	-	+	II
Euras.	Ch	Lysimachia nummularia	-	-	+	+	-	II
Euras.	H	Trifolium repens	-	-	-	+	+	II
		Phragmiti – Magnocaricetea						
Circ.	G	Equisetum palustre	+	-	+	-	-	II
Euras.	H	Lycopus europaeus	+	-	+	-	-	II
Circ.	H	Epilobium palustre	+	+	-	-	-	II
		Scheuchzerio – Caricetea nigrae						
Eur. centr.	G	Dactylorhiza maculata	-	-	+	-	+	II

		Variae syntaxa						
Circ.	H	Geum rivale	+	+	-	-	+	III
Euras.	H	Mentha longifolia	+	-	+	+	-	III
Euras.	H	Ranunculus repens	+	+	-	-	+	III
Euras.	H	Potentilla erecta	-	+	+	-	-	II
Euras.	T	Impatiens noli-tangere	-	+	-	+	-	II
Eur.	H	Rumex sanguineus	-	-	+	-	+	II
Euras.	H	Eupatorium cannabinum	-	-	-	+	+	II
Euras.	Ch	Solanum dulcamara	-	-	-	+	+	II
Euras.	G	Petasites hybridus	-	-	-	+	+	II
Euras.	H		-	-	-	-	+	I

Species in one relevé (K-I): Epilobium hirsutum (Euras., H, rel. 4); Juncus conglomeratus (Circ., H, rel. 1); Phleum pratense (Euras., H, rel. 5); Parnassia palustris (Circ., H, rel. 2); Succisa pratensis (Euras., H, rel. 2); Molinia caerulea (Euras., H, rel. 3); Heracleum sphondylium (Euras., Ht-H, rel. 5); Trifolium pratense (Euras., H, rel. 5); Trollius europaeus (Eur., H, rel. 1); Agrostis capillaris (Circ., H, rel. 3); Alchemilla vulgaris (Eur., H, rel. 5); Festuca rubra (Circ., H, rel. 5); Carex nigra (Circ., G, rel. 2); Eriophorum vaginatum (Circ., H, rel. 2); Carex echinata (Circ., H, rel. 2); Cirsium rivulare (Eur. centr., H, rel. 3); Telekia speciosa (Carp.-balc.-cauc.-anat., H, rel. 3); Carex vesicaria (Circ., H, rel. 3); Potentilla anserina (Cosm., H, rel. 4); Carduus personatus ((Eur. centr., H, rel. 4); Valeriana officinalis (Euras., H, rel. 5).

Place and date of relevées: Glodu (rel. 1): 13.07.2008; Drăgoiasa (rel. 2): 13.07.2008; Cristişor (rel. 3): 2.07.2007; Neagra Broşteni (rel. 4-5): 9.07.2007.

Tab. 7. As. *Deschampsietum caespitosae* Hayek ex Horvatič 1930

Floristic element	Bioform	No. of relevé	1	2	3	4	5	6	**K**
		Altitude (m.s.m. x 10)	700	750	800	750	800	700	
		Aspect	SV	-	N	-	-	-	
		Slope (°)	2-3	-	5	-	-	-	
		Vegetation covering (%)	95	100	95	90	95	100	
		Plot area (m^2)	100	100	100	50	50	100	
		Car. as.							
Cosm.	H	Deschampsia caespitosa	4	5	4	4	4	5	V
		Deschampsion							
Cosm.	H	Juncus effusus	+	-	1	-	+	-	III
Euras.	H	Stachys officinalis	+	+	-	-	-	+	III
Circ.	H	Juncus conglomeratus	-	+	+	-	-	-	II
		Filipendulion							
Euras.	H	Filipendula ulmaria	1	-	+	+	+	-	IV
Euras.	H	Phleum pratense	+	-	-	-	+	-	II
Circ.	H	Agrostis stolonifera	-	+	+	-	-	+	III
		Calthion							
Euras.	H	Myosotis scorpioides	+	-	+	+	-	+	IV
Circ.	G	Scirpus sylvaticus	-	+	+	-	1	-	III
Circ.	H	Caltha palustris	-	+	-	+	-	-	II
		Arrhenatherion et Arrhenatheretalia							
Cosm.	H	Holcus lanatus	+	+	+	+	-	-	IV
Euras.	H	Briza media	+	+	-	+	+	+	V
Euras.	Ht-H	Heracleum sphondylium	+	-	-	-	+	-	II
Euras.	H	Leucanthemum vulgare	-	-	+	-	-	+	II

		Molinietalia							
Euras.	H	Lychnis flos-cuculi	+	+	-	+	-	+	IV
Euras.	H	Succisa pratensis	+	+	-	-	+	-	III
Circ.	H	Lythrum salicaria	-	+	-	+	-	-	II
Circ.	H	Parnassia palustris	-	-	+	-	-	+	II
Eur.	T-H	Linum catharticum	-	-	-	+	+	-	II
Eur. centr.	G	Dactylorhiza maculata	-	-	+	-	+	-	II
		Molinio – Arrhenatheretea							
Euras.	H	Lathyrus pratensis	+	+	-	+	+	+	V
Cosm.	H	Prunella vulgaris	+	-	-	-	+	+	III
Circ.	H (G)	Agrostis capillaris	+	-	+	+	+	-	IV
Euras.	H	Stellaria graminea	+	-	+	-	-	+	III
Circ.	H.	Festuca rubra	+	+	-	+	+	+	V
Euras.	H	Trifolium repens	+	+	+	+	+	+	V
Euras.	H	Anthoxanthum odoratum	+	+	-	-	-	+	III
Euras.	H	Ranunculus acris	+	-	-	+	-	-	II
Eur.	H	Cynosurus cristatus	+	-	-	-	+	+	III
Euras.	H	Trifolium pratense	-	+	-	+	-	+	III
Eur.	H	Alchemilla vulgaris	-	+	+	-	+	-	III
Cosm.	H	Poa pratensis	-	+	+	-	-	-	II
Eur.	H (Ch)	Polygala vulgaris	-	+	-	+	-	-	II
Euras.	Ch	Lysimachia nummularia	-	-	+	-	-	+	II
		Variae syntaxa							
Euras.	H	Ranunculus repens	+	-	+	-	-	+	III
Euras.	H	Potentilla erecta	+	+	-	-	+	-	III
Euras.	H	Mentha longifolia	-	+	-	+	-	+	III
Circ.	H	Cirsium oleraceum	-	+	+	-	-	-	II
Euras.	H	Rumex crispus	-	-	+	+	-	-	II

Species in one relevé (K-I): Juncus articulatus (Circ., H, rel. 4); Carex pallescens (Circ., H, rel. 5); Leontodon autumnalis (Euras., H, rel. 1); Campanula glomerata (Euras., H, rel. 3); Taraxacum officinale (Euras., H, rel. 3); Molinia caerulea (Euras., H, rel. 4); Carum carvi (Euras., H, Ht-H); Trollius europaeus (Eur., H, rel. 4); Cerastium fontanum (Euras., Ch, rel. 4); Centaurea phrygia (Eur., H, rel. 4); Cruciata glabra (Euras., H, rel. 1); Carex nigra (Circ., G, rel. 5); Geum rivale (Circ., H, rel. 4); Luzula luzuloides (Eur. centr, H, rel. 5); Pteridium aquilinum (Cosm., G, rel. 6).

Place and date of relevées: Neagra Broşteni: 8.07.2007 (rel. 1-2); Păltiniş: 2.08.2008 (rel. 3); Budacu: 28.06.2006 (rel. 4-5); Cristişor (rel. 6): 29.07.2007.

Tab. 8. As. *Epilobio – Juncetum effusi* Oberd. 1957

Floristic element	Bioform	No. of relevé	1	2	3	4	5	6	7	8	9	10	K
		Altitude (m.s.m. x 10)	1000	980	700	750	1000	900	800	850	800	820	
		Aspect	-	-	SE	-	E	-	V	NV	-	-	
		Slope (˚)	-	-	1-2	-	5	-	3-4	5	-	-	
		Vegetation covering (%)	90	95	90	95	90	95	90	95	95	95	
		Plot area (m^2)	25	20	25	25	25	20	10	10	20	25	
		Car. as.											
Cosm.	H	Juncus effusus	4	4	4	5	4	5	4	4	5	4	V
Circ.	H	Epilobium palustre	-	-	+	+	-	-	+	-	-	+	II
		Calthion											
Circ.	H	Caltha palustris	1	1	+	-	+	+	-	+	+	+	IV
Euras.	H	Myosotis scorpioides	+	+	+	+	+	+	+	+	+	+	V
Circ.	G	Scirpus sylvaticus	+	+	+	+	+	-	+	+	+	1	V
Circ.	H	Cirsium oleraceum	+	-	+	+	-	-	-	+	-	+	III
Euras.	Ht-H	Angelica sylvestris	-	-	+	+	-	-	+	-	-	+	II
		Molinietalia											
Euras.	H	Filipendula ulmaria	+	-	+	+	-	-	-	+	+	+	III
Circ.	H	Lythrum salicaria	-	-	+	+	-	+	-	-	+	+	III
Cosm.	H	Deschampsia caespitosa	+	+	+	-	+	+	+	1	+	+	V
Circ.	H	Juncus conglomeratus	+	-	-	-	+	-	+	-	-	-	II
Euras.	H	Lychnis flos-cuculi	+	+	-	-	+	+	+	-	+	+	IV
Circ.	H	Parnassia palustris	+	-	-	+	+	-	-	-	-	+	II
Euras.	H	Succisa pratensis	-	-	+	-	-	-	+	-	+	+	II
Cosm.	H	Holcus lanatus	+	-	+	+	-	-	-	+	-	-	II
Euras.	H	Briza media	-	-	+	-	+	+	+	+	+	-	III
Euras.	H	Phleum pratense	-	-	+	+	+	-	-	-	+	-	II
Eur.	H	Cynosurus cristatus	-	-	-	-	+	+	-	+	-	+	II
		Molinio – Arrhenatheretea											
Euras.	Ch	Lysimachia nummularia	+	-	-	+	-	-	+	+	-	-	II
Euras.	H	Trifolium repens	+	+	+	+	-	+	-	+	+	-	III
Eur.	H	Alchemilla vulgaris	+	1	+	-	+	+	-	+	+	-	III
Circ.	H	Festuca rubra	+	-	+	+	-	+	+	-	+	+	III

Circ.	H (G)	Agrostis capillaris	-	+	+	-	-	-	-	-	+	-	II
Euras.	H	Lathyrus pratensis	-	-	-	+	+	+	+	+	+	+	III
Variae syntaxa													
Euras.	H	Ranunculus repens	+	+	+	-	-	+	+	-	+	-	III
Euras.	H	Potentilla erecta	+	+	-	-	+	-	-	+	-	+	III
Circ.	H	Geum rivale	-	-	+	+	-	-	+	-	-	-	II

Species in one-two relevées (K-I): Lysimachia vulgaris (Euras., H, rel. 4); Geranium palustre (Euras., H, rel. 5); Carex ovalis (Circ., H, rel. 10); Molinia caerulea (Euras., H, rel. 2); Trollius europaeus (Eur., H, rel. 5); Equisetum palustre (Circ., G, rel. 2); Rumex sanguineus (Eur., H, rel. 1); Juncus inflexus (Euras., H, rel. 4); Eupatorium cannabinum (Euras., H, rel. 6); Equisetum telmateia (Circ., G, rel. 7); Carex flava (Eur., H, rel. 10); Carex pallescens (Circ., H, rel. 5,9); Juncus articulatus (Circ., H, rel. 4,10); Cirsium palustre (Euras., Ht, rel. 4,9); Stachys officinalis (Euras., H, rel. 4,8); Anthoxanthum odoratum (Euras., H, rel. 5,9); Agrostis stolonifera (Circ., H, rel. 4,10); Ranunculus acris (Euras., H, rel. 6,7); Mentha longifolia (Euras., H, rel. 1,5); Potentilla anserina (Cosm., H, rel. 4,6); Veratrum album (Euras., H, rel. 5,8); Impatiens noli-tangere (Euras., T, rel. 6,10); Chaerophyllum hirsutum (Eur. centr., H, rel. 5,7); Dactylorhiza maculata (Eur. centr., G, rel. 6,8); Stellaria graminea (Euras., H, rel. 3,4); Carex nigra (Circ., G, rel. 1,2); Carex echinata (Circ., H, rel. 2,5); Galium palustre (Circ., H, rel. 1,2); Lycopus europaeus (Euras., H, rel. 3,9).

Place and date of relevées:Drăgoiasa (rel. 1-2): 2.08.2007; Neagra Broşteni: 9.07.2007 (rel. 3-4); Păltiniş: 2.08.2008 (rel. 5); Dârmoxa (rel. 6): 11.07.2007; Budacu: 28.06.2006 (rel. 7-8); Căliman Cerbuc: 20.08.2008 (rel. 9); Cristişor (rel. 10): 4.07.2008.

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ECOLOGICAL STATUS AND IMPACT OF DISTURBANCE IN AN ALPINE PASTURE OF GARHWAL HIMALAYA, INDIA

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Abstract: The alpine area in Garhwal Himalaya is highly fragile and is known for its beautiful flora and fauna. The study area was located just below the Gangotri glacier which is the origin of Bhagirathi, a holy river of India. Pilgrimage, tourism, adventure activities and mules are the factors responsible for causing disturbance in this area. There is a remarkable variation in the values of diversity, species richness, dominance, density IVI and biomass production at Bhojbasa Protected (BP) and Bhojbasa Disturbed (BD) sites. The value of liveshoot biomass was highest in August (444 g m^{-2} on BP and 80 g m^{-2} on BD sites). Belowground biomass was also recorded highest for BP site and lowest for BD site. The ANP value at BP site was 363 g m^{-2} y^{-1} and 26 g m^{-2} y^{-1} at BD site.
This area has shown decrease in diversity and productivity, and heavy soil erosion that indicate the consequence of increasing human activities due to pilgrimage, tourism and camping and frequent movement of mules carrying goods. Therefore, this area requires strict measures for biodiversity conservation and disaster mitigation.

Key words: alpine pasture, biomass, primary productivity, compartmental transfer

Introduction

Phytosociological studies incorporate mainly the description of plant composition, floristic communities and the functional aspects. Plants in nature occur in repeating groups of associated plants called communities. The structure of a community is determined mainly by the dominating plant species and not by other characteristics [ODUM, 1971]. The increase in diversity of species in a community shows that the adaptational potential is greater to changing condition of an environment.

The alpine pastures of the Himalaya located above treeline (timberline) are regarded as herbaceous formation governed by many climatic factors [BILLINGS, 1973]. The structure and functioning of the vegetation of any area is affected by the interaction of various factors. The climate and biotic conditions have a remarkable effect on live, standing dead and litter biomass [SIMS and SINGH, 1978a], [MC NAUGHTON, 1985]. Biomass is regarded as the total dry weight of vegetation at any time for a unit area in an ecosystem.

Himalayan alpine vegetation regarding biomass, productivity, conservation, structure, phenology, phytosociology has been studied by Sundriyal & al. (1987), Joshi & al. (1988), Ram & al. (1989), Sundriyal (1992), Rajwar & Dhaulakhandi (1994), Dhaulakhandi & al. (2000), Kala & al. (2002), Kala (2004) and others during last two decades.

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Material and methods

Study area

Two study sites, one protected and other disturbed, were selected at Bhojbasa located four km. down Gangotri glacier in Uttarkashi district of Garhwal Himalaya at an altitude of 3800 m. Protected site was fenced by barbed wire to inhibit any kind of disturbance. The BD site showed disturbance by grazing and trampling by mules used in the transport system and by local people and tourists.

Phytosociology

Data on climate were collected from the Observatory of National Institute of Hydrology, Roorkee at Bhojbasa. Phytosociological analysis was done using 50 x 50 cm quadrats during July and August. On each sampling date 10 randomly placed quadrats were laid down. Basal cover was quantified by selecting ten stems of different sizes for each species. The basal cover was calculated by the method described by Misra (1968).

Plant biomass

Aboveground plant biomass was collected through randomly placed 50 x 50 cm quadrats by harvesting them at ground level. Sampling was done in the concluding week of each month from May to October. Belowground biomass was taken from 3 soil monoliths (25 x 25 x 30 cm depth). The aboveground plants were separated into live shoot, dead shoot and litter, and weighed separately. Belowground monoliths were washed carefully and dried completely at 80^{o}C until constant weight.

Net primary productivity

Aboveground net primary production (ANP) was determined as the sum of positive changes in biomass in successive months plus mortality [SINGH & YADAVA, 1974]. Belowground primary production (BNP) was estimated as the sum of positive increments in belowground biomass (DAHLMAN & KUCERA, 1965). In the present study, the production estimation was made by summing up positive changes in live biomass and mortality [SINGH *et al*., 1975].

Compartmental transfer

The net accumulation and disappearance rates were calculated following the methods given by Singh & Yadava (1974) and Sims and Singh (1978a, b). System transfer function is the quantity by which the system block multiplies the input to generate the output [Golley, 1965].

Accumulation and disappearance rates

Net accumulation and disappearance rates were calculated only for the six month period. The rates were calculated following Singh & Yadava (1974); Sims & Singh (1978 b).

Results

Phytosociological analysis

In the month of August grasses dominated the BP site. Among most dominant four species, *Calamogrostis decora* had the highest importance value index (IVI) of 41.74, followed by *Trisetum clarkei* (28.87), *Stipa roylei* (18.77) and *Poa phagophilla* (18.46). *Potentilla argyrophylla* was dominant among non-graminoids with an IVI of 16.33. The least dominant species was *Astragalus chlorostachys* (Fig. 1).

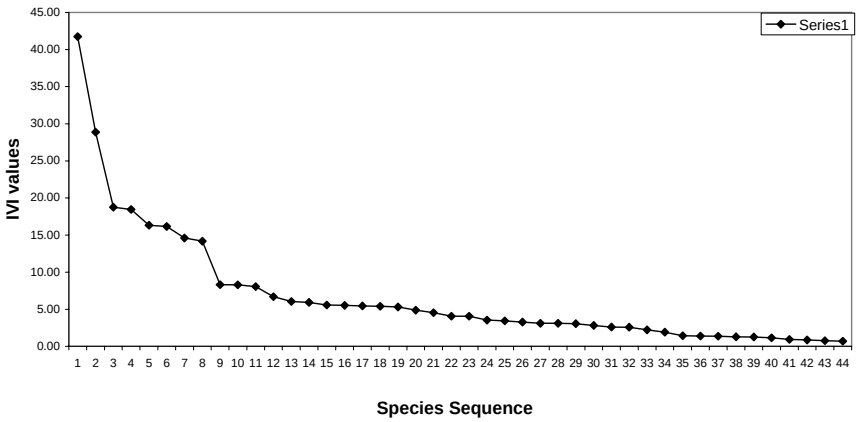


Fig. 1. Dominance-Diversity Curve for August on Bhojbasa Protected site

On BD site, in the month of August *Sibbaldia parviflora* and *Geranium pratense* were recorded as dominant and co-dominant species with IVI values of 34.08 and 28.33 respectively, and with a density of 8.15 and 10.8 plants m^{-2} respectively. Dominant six herb species were non-graminoids, while *Trisetum clarkei* was dominant species among grasses. A total of 28 species was recorded on this site. Total density value was 121.6 plants m^{-2} and total basal cover (TBC) amounted 3.26 cm^2 m^{-2} (Fig. 2). Table 1 depicts comparative data on number of species, density and total basal cover for both the sites.

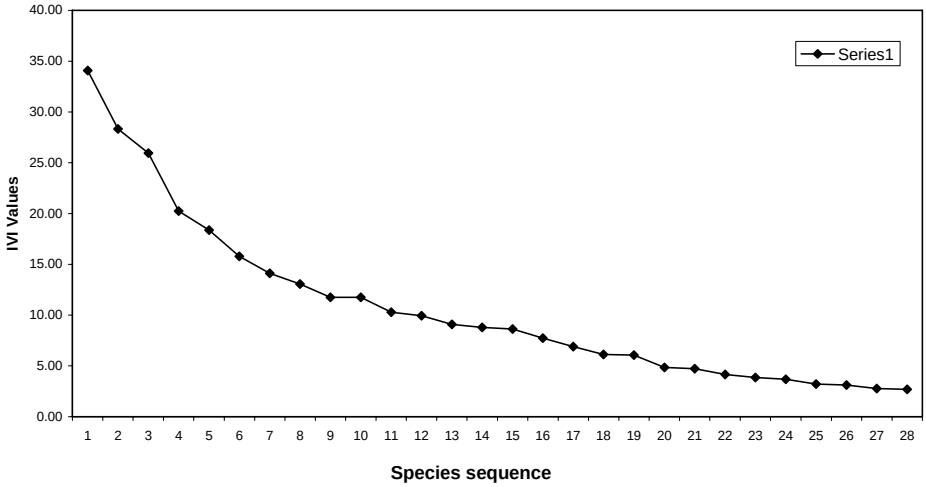


Fig. 2. Dominance-Diversity Curve for August on Bhojbasa Disturbed site

Biomass

On protected site, the maximum liveshoot biomass was recorded in August (444 g m^{-2}) (Fig. 3) and the maximum belowground biomass was observed in May (2101 g m^{-2}) and thereafter, it showed a decreasing trend until August showing least value and then started increasing (Fig. 5). Highest litterfall and standing dead biomass were recorded in October, which have been caused by severe cold (Fig. 4). The liveshoot biomass showed a positive correlationship with temperature and rainfall (r = +0.7198 and +0.4144 respectively).

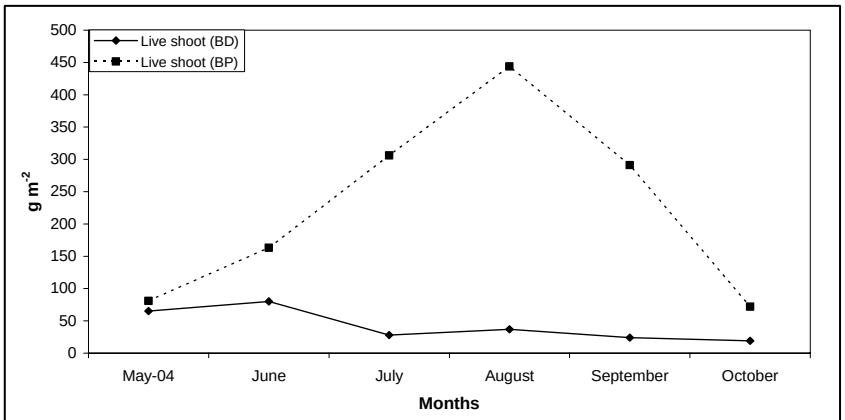


Fig. 3. Liveshoot Biomass Production (g m^{-2}) on BD and BP sites

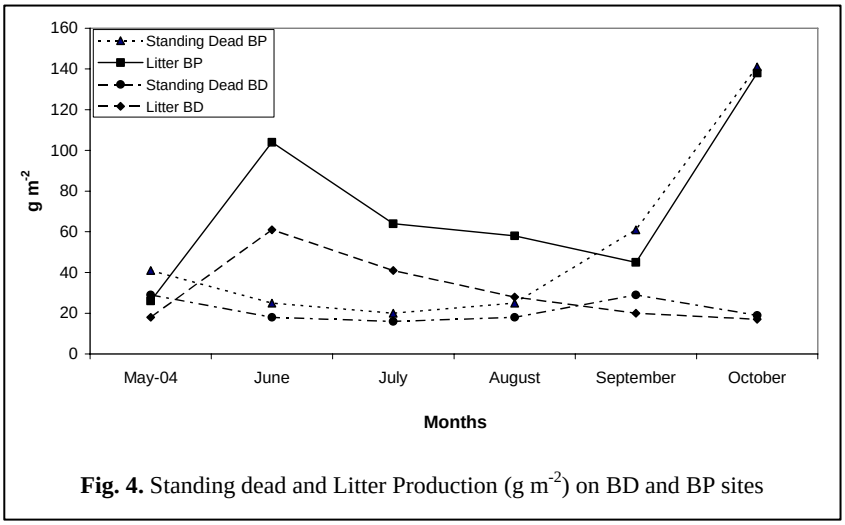


Fig. 4. Standing dead and Litter Production (g m^{-2}) on BD and BP sites

On disturbed site at Bhojbasa the liveshoot biomass decreased continuously from June (80 g m^{-2}) to October (19 g m^{-2}) (Fig. 3). July and August constituted favourable period for the vegetative growth of plants due to favourable conditions of temperature and moisture on this site but the biotic disturbance caused the least production of biomass.

Lowest values for liveshoot, standing dead and litterfall were observed in the month of October (Fig. 3 & 4). Maximum belowground biomass was recorded in October (1160 g m^{-2}) and a decreasing pattern was observed in belowground biomass from May onwards. A positive correlationship was found between mean temperature with liveshoot, standing dead and litter (r = + 0.2041, + 0.4819 and + 0.4658 respectively). Standing dead and litter showed positive correlationship with rainfall (r = + 0.7280 and + 0.0199 respectively).

Productivity

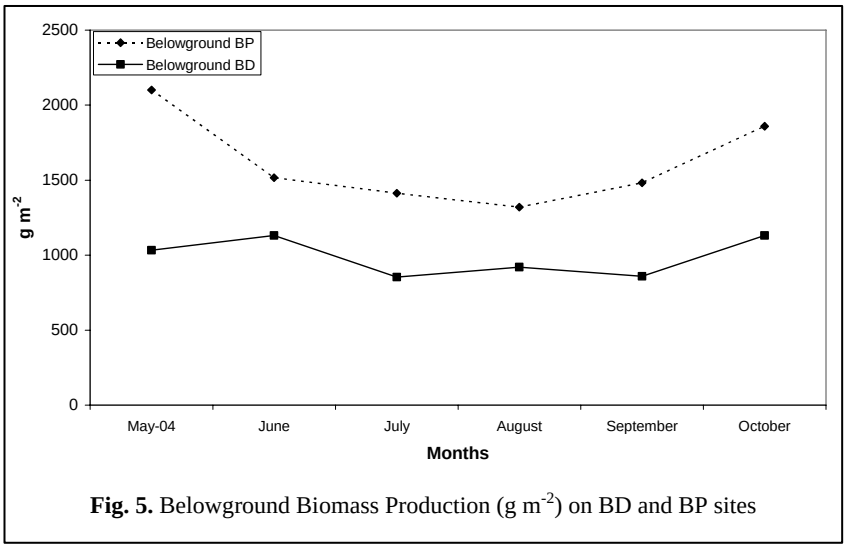


Fig. 5. Belowground Biomass Production (g m^{-2}) on BD and BP sites

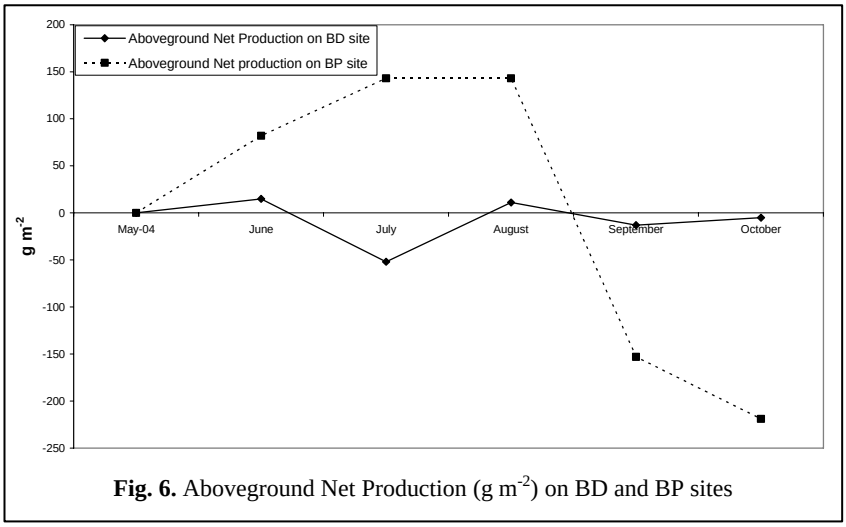


Fig. 6. Aboveground Net Production (g m^{-2}) on BD and BP sites

On Bhojbasa protected site aboveground net production (ANP) was 368 g m^{-2}. Positive values were observed consecutively for three months from June to August.

Maximum value was recorded in July (Fig. 6). On Bhojbasa disturbed site annual net aboveground production was 26 g m^{-2}, while highest value was observed as 15 g m^{-2} in June.

On Bhojbasa protected and Bhojbasa disturbed sites the values of belowground net production were 640 and 466 g m^{-2} respectively (Fig. 7).The TNP is the sum of aboveground and belowground net production (Figs. 8 to 9).

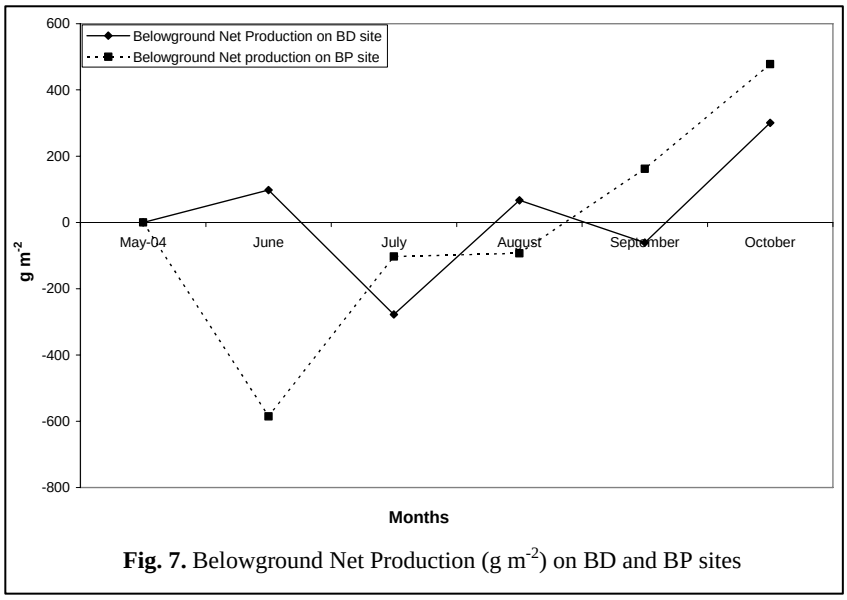


Fig. 7. Belowground Net Production (g m^{-2}) on BD and BP sites

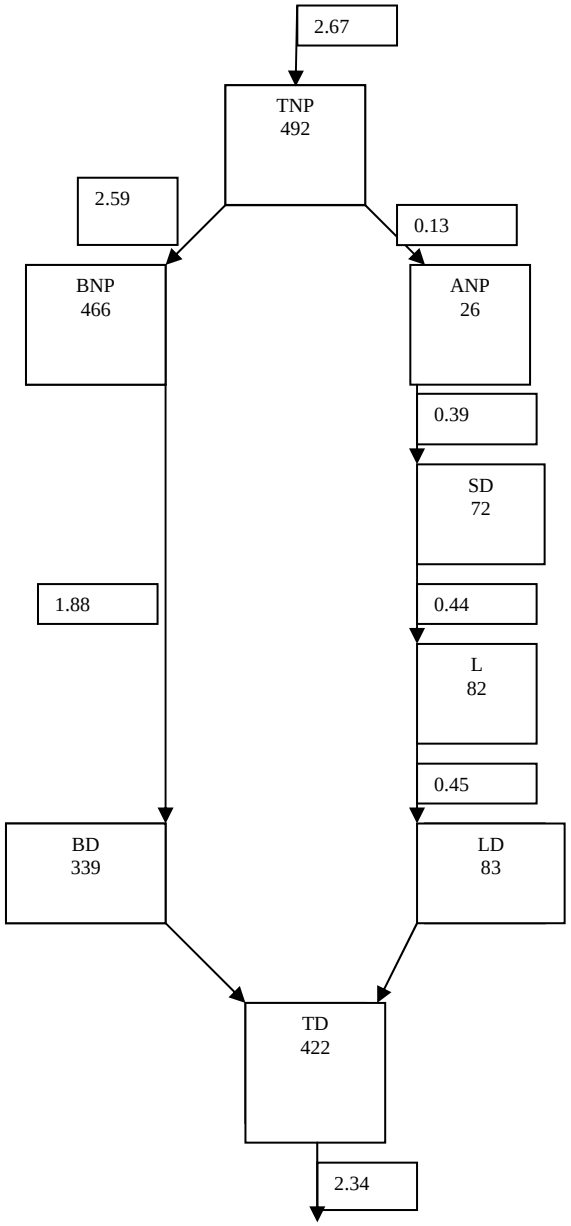
Tab. 1. Comparison of different parameters of Bhojbasa Protected (BP) and Bhojbasa Disturbed (BD) sites at Bhojbasa

Months	**No. of species**		**Total density (plants m^{-2})**		**Total basal cover (cm^2 m^{-2})**	
	BP	BD	BP	BD	BP	BD
May	17	7	206.4	56.7	3.21	0.96
June	28	17	316.9	6.5	4.61	1.11
July	36	21	456.5	72.1	6.29	1.23
August	44	28	358.0	121.6	7.65	3.26
September	26	18	293.7	83.3	5.32	2.0
October	13	9	131.1	46.3	2.79	1.56

Tab. 2. System Transfer Functions on BP and BD sites

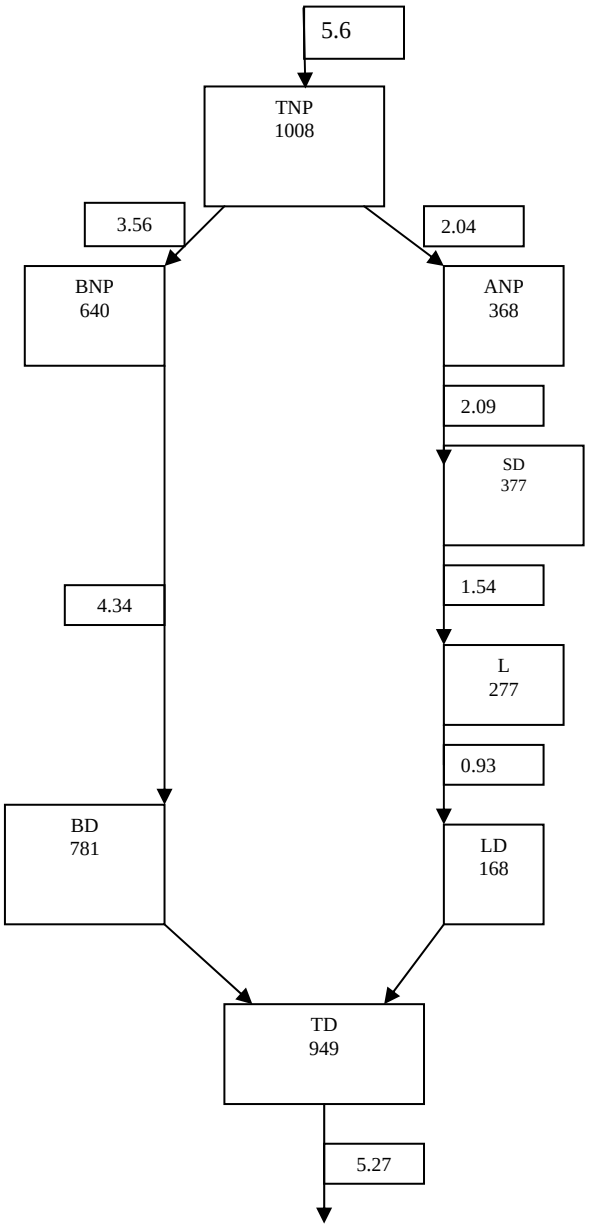
System transfer	**BP**	**BD**
TNP-ANP	0.365	0.053
TNP- BNP	0.635	0.947
ANP-SD	0.024	2.690
SD-L –	0.735	1.139
ANP-L	0.735	3.150
L-LD	0.606	1.012
BNP-BD	0.122	0.727
TNP-TD	0.941	0.858

The Figs. 8 and 9 show a balanced ecological status. The input rate in BP was 5.6 g m^{-2} d^{-1} and the rate of disappearance was 5.27 g m^{-2} d^{-1}. The values for BD sites (Fig. 9) showed input value 2.67 and 2.34 g m^{-2} d^{-1}. The values are comparatively showed low production and accumulation rates than BP site. The system transfer functions for the present study sites have been given in Tab. 2.



Compartments g m^{-2}
Accumulation and Disappearance g m^{-2} d^{-1}

Fig. 8. Net primary production, accumulation and disappearance rates on BD site for 180 days



Compartments g m^{-2}
Accumulation and Disappearance g m^{-2} d^{-1}

Fig. 9. Net primary production, accumulation and disappearance rates onBP site for 180 days

Discussion and conclusion

Plant growth in alpine region starts with onset of summer and snow melting. The growth activity increases with increase in temperature and moisture. Grazing affects the frequency and density of species [SUNDRIYAL et al., 1987, 1992; SUNDRIYAL et al., 1988]. It has been reported that the values of belowground and aboveground biomass also varied with grazing activity. It reduced the green cover over the ground and synthesized low carbohydrate which ultimately assimilated in the belowground parts.

In Bhojbasa on both BP and BD sites a sharp distinction was observed in values of total density and total basal cover. In the month of July and August, on BP site total density values were 456.45 and 358.05 plants m^{-2} respectively, while on BD site these values were 72.1 and 121.6 plants m^{-2} respectively. Similar pattern was observed for TBC on BP site with the values of 6.3 and 7.6 cm^2 m^{-2} in July and August respectively, while on BD site these values were 1.22 (July) and 3.26 cm^2 m^{-2} (August) (Tab. 1).

The structure of biomass of an ecosystem is mainly controlled by climatic conditions and edaphic characteristics, which are closely related to phenology and floristic diversity. The uniformity in increase in biomass showed the favourable conditions of climate from May to August in Bhojbasa disturbed site. During rainy season the biomass was observed less in comparison to the summer season. This season should have shown higher biomass because of favourable growth, but the frequent and unrestricted grazing by animals caused a decrease in these values. At the same time during the rainy season the tourism and pilgrimage activities were at its lowest. In the month of October sharp decline in biomass was recorded due to severe cold in the high altitudes.

On protected site the biomass increased with increasing precipitation. Biomass was highest in August and the total density in July. A sharp decline in temperature after September caused senescence in vegetative parts causing sharp decline in biomass production and number of species. On disturbed site May-June was peak period for herbaceous growth. Due to low pilgrimage and tourism activities in this period the production was low in July and August. Root biomass decreased significantly in grazed site, similar findings were recorded by Vickery (1972) and Weilgolaski (1976).

Billings *& al*. (1977) have reported that roots of tundra plants grow at low temperature below 5^oC and can resume active elongation even after being temporarily frozen. However biomass accumulation in belowground component could be due to retranslocation of organic matter and nutrients from shoot and the accumulation of dead root. Billings (1973) found that several major graminoids of tundra continue primary root elongation throughout the growing season. As the food storage is a prime function of underground part, it seems that high root–shoot ratios are needed just to maintain enough carbohydrate for the early spring shoot growth [BILLINGS, 1973].

On the Bhojbasa disturbed site the peak values were observed in the months of June and July because in late June or early July the pilgrimage and tourism pressure reduced and the animals were free to graze randomly.

Accumulation is the rate of production of dry matter and its transfer through various compartments. Ultimate disappearance from the system for different plots is shown in Figs. 8 to 9. Net rate of accumulation of organic matter in different compartments of the block diagrams was calculated by dividing the production value by the number of days (for present study the days were 180).

A limited amount of dry matter remains after annual cycle which may be required simply to buffer the effect of year to year fluctuations in the environment [RAM &

al., 1988]. The situation is differing from the successional tropical grassland where there is accumulation of surplus organic matter which could result in the advancement of the seral grassland to woodland conditions [GUPTA & SINGH, 1982b].

System transfer function is the quantity by which the system block multiplies the input to generate the output and reflected the orientation of the functioning of an ecosystem in space and time [SIMS & SINGH, 1971c].

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17 (2010): 139-144

ASSESSMENT OF Pb, Cd, Cu AND Zn AVAILABILITY FOR PLANTS IN BAIA MARE MINING REGION

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Abstract. In order to evaluate the mobility of heavy metals in soil from Baia Mare mining region, the total, water and DTPA extractable metal contents were determined. The results showed that despite the high total metals contents and the high percentages of plant available metals only a low percent was water soluble, indicating a potential accumulation of metals in trophic chain and a potential risk for public health. Among the investigated metals, the plant available Pb and Cd species are the most severe contaminants. Significant correlations between total and DTPA extractable metals were found for Cu (r=0.510) and Pb (0.418), and also an affinity between total and water extractable metals were identified for Cu (0.366), Pb (0.502) and Zn (0.597).

Key words: Heavy metals availability, DTPA extraction, soil, mining

Introduction

Heavy metals represent a potential hazard to humans and environment. In industrial areas the heavy metal contents from anthropogenic sources are several times higher than those from natural ones [NRIAGU & PACYNA, 1988]. In addition, areas far from industrial centres also show increasing heavy metal concentrations due to long-range atmospheric transport [CEMEK & KIZILKAYA, 2006]. Mining and ore processing industry is one of the major sources of metals releasing into the environment [CASSELLA & al., 2007; BOUGHRIET & al., 2007; VANDERLINDEN & al., 2006; VANEK & al., 2005; CONESA & al., 2007; MACKLIN & al., 2003, LEVEI & al., 2009, MICLEAN & al., 2009].

Although the total metal concentration is commonly used in soil quality standards, it provides no information regarding the metals chemical nature or mobility [SILVEIRA & al., 2006; WALTER & al., 2006]. To assess the metals availability form soil to plant a great variety of single or sequential extraction schemes have been developed [FUENTES & al., 2004; PEREZ-SANTANA & al., 2007; ABOLLINO & al., 2006]. The DTPA (diethylenetriaminepentaacetic acid) extraction method was initially designed to predict micronutrient deficiencies in neutral to calcareous soils [LINDSAY & NORWELL, 1978], but it has been also employed for the estimation of metal availability for plants [MAIZ & al., 2000]. Water soluble metals represent the most ecotoxicologically relevant fraction in the environment, due to their high contamination potential of the food chain, surface water and groundwater [MEERS & al., 2006].

The objective of this study was to investigate the availability of Cu, Pb, Zn and Cd from soil to plants in Baia Mare mining region using selective extraction in water and DTPA.

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Material and methods

Site description and sampling

In the Baia Mare area, around an industrial complex involved in mining, metallurgical and chemical activities, the environment and particularly the soils are polluted due to the acid rains and heavy metal emissions [LACATUSU & al., 2001]. The region became of international concern after the cyanide spill accident in January 2000 that affected the ecosystem of Tisa and Danube rivers. Despite the fact that the large industrial plants have reduced their activities and some of them were closed, the area is still highly polluted [LEVEI & al., 2009].

A number of 50 surface soil samples were collected in the summer of 2009 from the Baia Mare town, using a stainless steel shovel. Samples were air dried to constant weight, sieved through the 2 mm sieve. The fraction < 2 mm was stored in polyethylene bags until the determination of total, water and DTPA-extractable metal contents.

Chemical analysis

The total metal concentrations in soils were determined after aqua regia digestion. An amount of 1 g soil sample was weighted, introduced into the reaction flask and heated under reflux conditions for 2 h with 21 ml of 12 M HCl and 7 ml of 15.8 M HNO_3. The solution was filtered and diluted to 100 ml with 0.5 M HNO_3. Total heavy metal concentrations were determined by inductively coupled plasma atomic emission spectrometry (ICP-AES) using the scanning spectrometer SPECTROFLAME (Spectro Analytical Instruments, Kleve, Germany).

The plant available metal contents of soils were determined by extraction in water and DTPA. The DTPA extractable metal content was determined using a mixture of 0.005 mol L^{-1} DTPA, 0.01 mol L^{-1} $CaCl_2$, 0.1 mol L^{-1} triethanolamine (TEA) with pH adjusted to 7.3 with 1 mol L^{-1} HCl solution. An amount of 10 g of soil sample was weighted into a 125 mL flask, and shaken for 2 h at room temperature using a magnetic shaker with 20 mL of DTPA extracting solution. The extracts was filtered and diluted to 100 ml with ultrapure water. The water extractable metal content was determined in a 1:10 soil/water mixture. An amount of 5 g of soil sample was shaken with 50 ml water for 2 h at room temperature. The solution was filtered and diluted to 50 ml with ultrapure water. Water and DTPA-extractable metal contents were determined by inductively coupled plasma mass spectrometry (ICP-MS) using the ELAN DRC II-Perkin Elmer, USA).

Soil pH was measured in a suspension of 1:5 soil/water ratio. The suspension was allowed to stand 1 h prior to pH measurement using a Jenway ion-meter.

Results and discussion

The statistic parameters of total, water and DTPA extractable Cu, Pb, Zn and Cd contents are presented in Tab. 1. Due to the fact that soils were sampled from the Baia Mare town the results were compared with the guidelines values for sensitive soil according to Romanian legislation [Ministerial Decree no. 756/1997].

The total contents of all metals were high, exceeding the alert values for sensitive soils (residential and agricultural use) for the most samples. In case of Pb and Zn the 1st quartile is higher and in case of Cu and Cd is around the corresponding alert level for

sensitive soil. For all samples the 3rd quartile was much higher than the action trigger value for all metals. The average total metal content exceeded the action trigger values for sensitive use according to Romanian legislation, 1.5 times in case of Cu and Cd, 3 times in case of Zn and 18 times in case of Pb.

Tab. 1. Descriptive statistics of total, water and DTPA extractable Cu, Pb, Zn and Cd in soil

	Cu			**Pb**		
	Total	**DTPA**	**Water**	**Total**	**DTPA**	**Water**
	(mg kg^{-1})					
Min	38.1	6.5	1.4	87.8	0.1	0.7
Max	1770	187	147	23300	753	16.2
Average	314	58	12.5	1790	153	3.3
Median	168	45.3	6.9	496	87	1.6
Skewness	2.68	1.63	5.39	4.66	2.99	2.32
Kurtosis	9.02	2.32	30.2	23.3	10.4	5.23
1 st quartile	109	25.6	5.5	404	70	1.2
3 rd quartile	367	70.0	11.0	1420	156	3.5
Alert value	100	-	-	50	-	-
Action trigger value	200	-	-	100	-	-
	Zn			**Cd**		
	Total	**DTPA**	**Water**	**Total**	**DTPA**	**Water**
	(mg kg^{-1})					
Min	109	16.3	0.66	1.9	0.28	0.01
Max	11500	351	355	29.9	9.4	2.2
Average	1828	96.9	26.7	7.9	2.3	0.56
Median	737	75.4	6.12	3.5	1.7	0.14
Skewness	2.43	1.94	4.26	1.59	2.30	1.68
Kurtosis	5.67	3.43	19.2	2.00	6.10	2.50
1 st quartile	436	39.6	1.8	3.1	1.2	0.1
3 rd quartile	1705	118	10.9	11.4	2.8	0.9
Alert value	300	-	-	3	-	-
Action trigger value	600	-	-	5	-	-

Total = concentration of metal extracted in aqua regia
DTPA = concentration of metal extracted in DTPA
Water = concentration of metal extracted in water

The total metal contents in soil were, in all cases, higher than those from the vicinity of Pb and Ag processing smelter in the Pribram region in the Czech Republic [VANEK & al., 2005]. The median values of total Pb, Zn and Cd were similar, whilst that of Cu was lower than those from Deer Lodge valley smelter area in Montana, USA [BURT & al., 2003]. The water soluble metal contents and the average percent of DTPA-extractable Cu were higher in our study, while the average total Cu concentration was similar to that found in heavily polluted soils from the vicinity of a deactivated mining site in the Amazon region of Brazil [CASSELLA & al., 2007]. The percentages of water extractable Pb and Zn in our soil samples were similar to those found in soils from a Spanish mining region, but the average percentage of the found DTPA extractable metals was much higher [CONESA & al., 2007].

The content of DTPA-extractable Pb, Cu and Cd from soil exceeded the alert level in 83%, 9% and 17% of samples, respectively. The concentration limits of 20 mg kg^{-1} and

70 mg kg^{-1} DTPA-extractable Pb and Zn respectively, advocated to avoid human risk [WINTER SYDNOR & REDENTE, 2002] were exceeded in 94% and 54% of samples in case of Pb and Zn respectively. In case of Pb the 1st quartile of the DTPA-extractable content exceeded the alert value and the 3rd quartile the action trigger value for sensitive soils. A relatively high fraction of the total metal content was extracted in DTPA. Thus, an average of 22% of the total Pb content was DTPA-extractable and only 0.5% was water-extractable. The corresponding percentages for the other metals were: 11% and 2.3% for Zn, 24% and 4.4% for Cu and 43% and 4.1% for Cd, respectively.

The water soluble content of Cu, Pb and Zn was small compared to the total metal content and that of Cd was below the detection limit (1.4 mg kg^{-1}) of the method in the majority of samples. The average percentages of DTPA and water soluble metals are presented in Fig. 1.

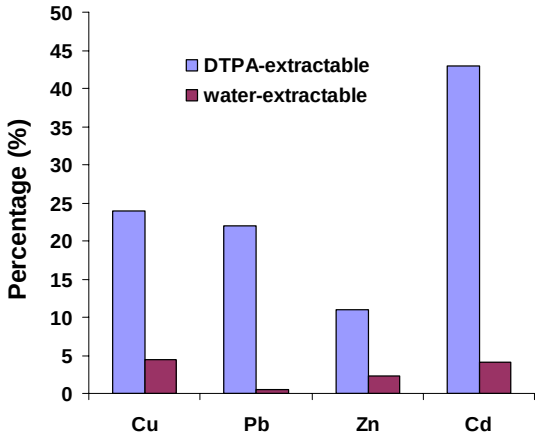

Fig. 1. The average percentage of DTPA and water extractable Cu, Pb, Zn and Cd

Significant correlations between total and DTPA extractable metals were found only for Cu and Pb suggesting that the percent of available metal depends on the nature and mobility of metals species exhausted by polluters. Significant correlations were found between total and water extractable metal content for Cu, Pb and Zn (Tab. 2).

Tab. 2. Correlation coefficients between total-DTPA extractable contents and total-water extractable contents of metals

	Total Cu	Total Pb	Total Zn	Total Cd
DTPA-extr.	0,510**	0,418*	$0,258^{ns}$	$0,260^{ns}$
Water-extr.	0.366*	0.502**	0.597**	0.131^{ns}
ns-not significant;* correlation significant at $p<0.05$; ** correlation significant at $p<0.01$				

The pH values in soil ranged between 3.0-8.23, with average value 6.74, but no statistically significant relationship between pH and available metal content was found. Strong negative correlations were found between water-extractable Cu (r = -0.393), Zn (r =

-0.532), Cd (r = -0.744) and pH. The lack of pH influence on DTPA extractable metal contents is probably due to high buffering capacity of DTPA solution.

Conclusions

The results showed that metal concentrations of polluted soils varied widely, in most cases exceeding the corresponding alert levels, indicating a severe situation, needing urgent measurements of pollution stopping and applying soil decontamination solutions, especially they cannot be degraded or destroyed. The high percentages of DTPA - extractable metals indicate an anthropogenic pollution, and a potential metal accumulation in vegetables, posing a potential risk for public health.

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110 YEARS SINCE THE BIRTH OF BOTANIST DR. EMILIAN TOPA (1900 – 1987)

Abstract: He was born on February 9th 1900, only son of a poor family in the Cuciurul Mic village from the old County named Chernivtsi (today in Ukraine). He did the primary classes in his native village, and the middle and high school in Chernivtsi. He graduated in 1925, the Department of Natural Sciences, University of Chernivtsi. After his graduation Emilian Topa enters into secondary education level, where he worked for the next years (between 1925 and 1943 - at the "Mihai Eminescu" girls High School, the Pedagogic Seminar of University and the School of health officers). Also in this period becomes botany assistant at the University of Chernivtsi, the Chair Professor Guşuleac, where he worked no more than 17 years. During this period he had the responsibility and leadership for the botanical garden from the same city. It then becomes Assistant Botany at Bucharest University (1940-1941), lecturer at Chernivtsi University (1942-1943), lecturer (delegation) for applied botany at the Polytechnic Institute "Gheorghe Asachi" of Iasi (1945-1946), conservator at the Museum of the Botanical Garden in Cluj (1946-1947). Between 1948 and 1953 is geobotany lecturer at University of Cluj and, simultaneously, an associate professor of pharmaceutical botany at the Medico-Pharmaceutical Institute in the same city (1948-1951). From 1952 to 1959, we meet him as director of the Botanical Garden of the University of Cluj, and from 1963 until his retirement in 1970, is director of the Botanical Gardens of Iasi.

Emilian Topa held a prolific and sustainable scientific research, educational or cultural, national or social, during no less than 60 years. Thus, he has published over 200 books, articles, studies and scientific reviews in different areas: plant taxonomy, plant ecology and chorology, phytosociology, phylogeny, phytopathology, phytotherapy, ethnobotanical, nature protection, ornamental flora, Romanian or European botanical histories etc.

His doctoral thesis, titled "Halophile vegetation in northern Romania in relation to the rest of the country", was published in the Bulletin of Faculty of Science from Chernivtsi, in 1939.

He was the main contributor to "Ethnobotanical dictionary", written by Al. Borza, and published by the Romanian Academy in 1968. He participated, along with Eugen Ghisa and Ionel Pop, at the four volumes of "Romanian Encyclopedic Dictionary" (published between 1962 and 1966). He participated in all 10 national conferences of geobotany organized between 1960 and 1970.

In the field of botany has published numerous scientific articles who made valuable contributions to the chorology of vascular plants, first from Bukovina and then from the other parts of Romania. An important contribution is represented by the his collaboration to the monumental work "Flora of Romania", initiated by Traian Savulescu, in his capacity as President of the Romanian Academy in that time (early 50's of last century). So, the botanist Emilian Topa has processed no more than 207 species in 91 genera and 38 botanical families and nine genera of the family *Leguminosae* (working as at 9 of the 13 volumes of the work previously cited).

He made notable contributions in the field of phytosociology, first by studying halophile vegetation in northern Romania (being consecrated as the first European monographer for halophile vegetation in the temperate zone), and then contribute to the knowledge of the other types of vegetation in our country. Thus, his name is linked to the description of some caenotaxa new to science, among which we mention here: Cl. *Puccinellio-Salicornietea* Topa 1939, and several plant associations.

He worked on "*Flora Romaniae Exsiccata*" published in Cluj-Napoca (with more than 5,000 sheets of Herbarium), and "*Herbarium Mycologicum*" (initiated by Traian Savulescu since 1928). His is due the resumption of publication of the prestigious publication "*Bulletin of the Botanical Garden from Cluj*" (founded by Al. Borza and discontinued in 1948), under the new name "*Botanical Contributions*".

He died on February 10, 1987, and was buried beside his wife, Stefania, at the cemetery of „Sfinții Atanasie și Chiril" Church near Botanical Gardens of Iasi.

Born on February 9th 1900, the only son of a poor family in the Ciciurul Mic village of the former county Chernivtsi (now in Ukraine), Emilian Topa will discover in the world of the village since childhood years, the universe surrounding, the plant world, and especially love for nature [Mititelu D., Leocov M., 1987; Morariu I., 1979-1980; Resmerita I. 1980].

Primary school has made in his native village, and on the middle and high school in Chernivtsi. With all the privations imposed by the lowness of his family, especially following the outbreak of the First World War, the young Emilian Topa continue his studies and after military service, he enrolled at the Department of Natural Sciences, University of Chernivtsi. Here, leading teachers will be Eugen Botezat, Constantin Bratescu, Mihail Gusuleac, Fritz Netolitzky, Alfons Peneke, all being models, both for the respect required by their knowledge, but also for the force of conviction with which they expose the scientific ideas in the academic world for its time [Resmerita I., 1982].

After his graduation in 1925, Emilian Topa enters into the secondary school, where he worked for the next years (between 1925 and 1943 - at "Mihai Eminescu" High School girls, Pedagogic seminar of University and School for health officers). Also in this period becomes botanical assistant at the University of Chernivtsi, at the Department of Professor Gusuleac, where he worked no more than 17 years. During this period he also had the responsibility and leadership for the botanical garden in the same city.

The waves of life for the botanist Topa took him further by all the major university centers in Romania. Thus, he becomes Assistant for Botany at University Bucharest (1940-1941), lecturer at University Chernivtsi (1942-1943). Here is called director of the botanical garden (1944). Then he became a lecturer (by delegation) for applied botany at the Polytechnic Institute "Gheorghe Asachi" of Iasi (1945-1946), conservator at the Museum of the Botanical Garden in Cluj (1946-1947). Between 1948 and 1953 is lecturer for Geobotany at University Cluj and, simultaneously, an associate professor for pharmaceutical botany at the Medico-Pharmaceutical Institute from the same city (1948-1951). From 1952 to 1959, we meet him as director of the Botanical Garden of the University Cluj, and from 1963 until his retirement in 1970, is director of the Botanical Gardens of Iasi [Stefureac Tr. et al., 1979].

Emilian Topa held a prolific and sustainable scientific research, educational or cultural, national or social, during no less than 60 years. Thus, he has published over 200 books, articles, studies and scientific reviews in different areas: plant taxonomy, plant ecology and chorology, Phytosociology, sindinamics, phylogeny, phytopathology, phytotherapy, ethnobotanical, nature protection, ornamental flora, Romanian or European botanical histories etc. [Mititelu D. & Leocov M. 1987].

He had a great knowledge on plant use, and their popular names, and he was recruited as a main contributor to "*Ethnobotanical dictionary*", written by Al. Borza, and published by the Romanian Academy in 1968. He participated, along with Eugen Ghisa and Ionel Pop, to the publishing of the four volumes of "*Romanian Encyclopedic Dictionary*" (published between 1962 and 1966). He participated in all 10 national conferences of geobotany organized in country between 1960 and 1970 [Micle F. 1991].

His teaching and educational ideas was synthesized into a large conference with the suggestive title: "Nature as a factor in the formation of the unity of the Romanian nation" (Chernivtsi, 1934), held in several locations over time. He held over 100 conferences on various botanical topics, or apiculture, mineral water, salt and others in many cities in Romania, where he enjoyed a real appreciation of the audience informed.

He has published numerous scientific articles *in the field of botany* and made valuable contributions to chorology of vascular plants, first in Bukovina and then into the other parts of Romania. An important contribution is represented by the his collaboration to the monumental work "Flora of Romania", initiated by Traian Savulescu, in his capacity as President of the Romanian Academy in that time (early 50's of last century). So, the botanist Emilian Topa has processed no more than 207 species in 91 genera and 38 botanical families and nine genera of the family *Leguminosae* (working as at 9 of the 13 volumes of the work previously cited) [Ştefureac Tr., 1979, 1982].

Families processed entirely by Emilian Topa include aquatic and marsh plants or ornamentals, or with other applied properties. Critical and responsible, Emilian Topa describes a number of taxonomic units new to science, all being found in the volumes of the work cited above (ex. *Aesculus x hemiacantha*, *Centaurea tenuiflora* DC. f. *fastigiata*, *Euonymus europaeus* f. *angustata*, *E. nanus ascendens* and *erecta* forms, *Euonymus radicans repens* and *vegeta* f. *robusta* varieties*, Iris pallida „Emil Racovitzae"* variety*, Potamogeton crispus* f. *ecornutus*, *Ribes heteromorphum* Topa = *R. spicatum* Robson, *Sparganium* × *tardivum, Arachys hypogea fastigiata* and *procumbens* varieties*, Elatine alsinastrum semipedunculata* and *sessiliflora* varieties*, Najas graminea f. intermedia* Topa et Zahar.*, Rhododendron kotschyi* f. *oblonga, Scorzonera austriaca* var. *mucronata* etc.). In recognition of the value of the botanist Emilian Topa, the great botanist from Cluj I. Prodan dedicated to his name one species of plant, namely: *Centaurea* × *emilii-ţopae* Prod. (*C. pseudophrygia* × *stenolepis* ssp. *bansagensis*) (prevalent in HD county: Serel on Culmea Peak, IF county: Balteni to Scrovistea). In his itinerations along and across the country, Emilian Topa reported no fewer than 70 new phytotaxons for Romanian flora. From these, we mention here a few, namely: *Aesculus turbinata*, *Aspidium falcatum*, *Calystegia pubescens*, *Crocosmia* × *crocosmiflora*, *Helianthus decapetalus*, *Hosta japonica*, *Lagerstroemia indica*, *Nelumbo nucifera*, *Sagittaria latifolia* and others. Other studies refer of gymnosperms grown in Bucharest and in Oltenia, and a synthetic micromonograph of Romanian *Iris* genus ("*Iris species into the flora of Romania*"), a work published at Firenze in 1963.

Emilian Topa made notable contributions in the field phytosociology, first by studying vegetation in northern Romania halophile vegetation (being consecrated as the first European monographer for halophile vegetation in the temperate zone), and then contribute to knowledge and other types of vegetation in our country. and then contribute to the knowledge of the other types of vegetation in our country. Thus, his name is linked to the description of some caenotaxa new to science, among which we mention here: Cl. *Puccinellio-Salicornietea* Topa 1939, and several plant associations: As. *Camphorosmetum monspeliacae* (Topa 1939) Serbănescu 1965, As. *Leuzeeto-Oenanthetum silaifoliae* (Borza 1931 n. n.) Topa 1939, As. *Triglochineto maritimae-Asteretum pannonici* (Soó 1927) Topa 1939, As. *Staticeto-Artemisietum monogynae* (*santonicum*) Topa 1939, As. *Suaedeto-Kochietum hirsutae* (Br.-Bl. 1928) Topa 1939, As. *Obionetum verruciferae* (Keller 1923) Topa 1939, As. *Halocnemetum strobilacei* (Keller 1923) Topa 1939, As. *Heleochloetum schoenoidis* (Soo 1933) Topa 1939, As. *Lepidietum crasifolii* Topa 1939 etc.

He worked on "*Flora Romaniae Exsiccata*" published in Cluj-Napoca (with more than 5,000 sheets of Herbarium), and "*Herbarium Mycologicum*" (initiated by Traian Savulescu since 1928). His is due the resumption of publication of the prestigious publication "*Bulletin of the Botanical Garden from Cluj*" (founded by Al. Borza and discontinued in 1948), under the new name "*Botanical Contributions*" [Hodişan I., Micle F., 1988].

His work in Iasi. Although still called since 1962 by the leadership of the University of Iasi to organize the new botanical garden, Emilian Topa was appointed director in 1963. In the period while he ruled the destinies of this institution (1963 - 1970) that link the main achievements of his name in the botanical garden are: defining the perimeter of the botanical garden (including all the plans for the future), the distribution and organization of sectors, the complex study of subsoil, soil, climate and flora, administrative buildings and construction of a part of greenhouses, the water, gas, electricity supply, access roads and establishment of circulation, improve degraded lands, maintenance of some enclaves of spontaneous flora and vegetation, ensuring fences, setting plan, appointment of the first botanical garden's scientific council and approved by the Senate, but especially the development and approval of work plans on sectors of botanical garden, making development schemes for sectors etc. Under his leadership, the garden area increased from 8,85 to 67 ha, greenhouse area extends from 300 to 1200 m^2, the number of taxa increases from approx. 2000 to approx. 7500, increase the number of similar units for seeds exchange from approx. 150 to 678 in 130 countries, organize library of the institution (having at that time approx. 3,200 volumes and 655 periodicals), herbarium numbered over 13,200 sheets, many from other herbarium from country or other geographical areas. Also, he donated his full personal library to botanical garden, and even a part of his household furniture was brought into this institution.

During that period Emilian Topa continue the editing of Botanical Gardens seed catalog, enter the editing of an Exsiccate for Moldova and Dobrogea flora (*„Flora Moldaviae et Dobrogeae Exsiccata"*), after the model of Cluj, and edited the first four Centuria (adding up to more than 15,000 sheets of Herbarium). He substantially enriches the collection of plants in greenhouses and outdoors in many taxa of spontaneous or brought under cultivation, from country or abroad [Lazăr Maria, 1982; Leocov M., 1979].

He died on 10 February, 1987, on St. Spiridon hospital beds after a brief suffering, and he was buried beside his wife, Stefania, at the cemetery of „Sfinții Atanasie și Chiril" Church near Botanical Gardens of Iasi.

The botanist Emilian Topa was one of the major Romanian leaders of Botany and he is an example of high professional commitment and attachment to all who knew him. He gained the respect of colleagues through the vastness of his botanical knowledge and the generosity with which provides all energy in the service of one or other ideas. He was treated respectfully by his contemporaries for his knowledge. He was Honorary Professor and Docent Doctor [Diaconescu Florita, 2008].

The botanists from Iasi have entered the name of Professor Emilian Topa on the frontispiece of botanical garden and honor his memory with all gratitude, as otherwise it is necessary for the other great personalities of Romanian science.

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OPREA Adrian, TĂNASE Cătălin, COJOCARIU Ana

PROFESSOR CONSTANTIN TOMA AT HIS 75TH ANNIVERSARY

On November 19th, Iasi academic community, which is joined by leading personalities of the Romanian biology, celebrates and pays tribute to Professor Dr. **Constantin Toma**, member of the Romanian Academy, member of the Moldova Academy of Ecology, Professor Emeritus of the "Alexandru Ioan Cuza" Universit, Doctor Honoris Causa of the Universities from Arad, Bacau and Oradea, member of prestigious scientific societies in the country and abroad.

No doubt that the illustrious name of the professor is among those of the emblematic teachers of the Faculty of Biology, "Alexandru Ioan Cuza" University from Iasi. Testify for this is the results of 52 years of tirelessly toil in the service of plant biology and beyond. The extremely fruitful work of professor includes teaching, science and administrative-management.

Teaching innate talent was constantly enriched through all academic career stages: preparator (1958), assistant (1953), lecturer (1966, 1972), professor (1978), consulting professor (2005). During this time he fully contributed to the preparation of several generations of biologists, shaping their professional destiny, contributing to the edification of students and teachers. Teaching activity was supported by 15 courses, textbooks and academic work (alone or jointly) published by the central and local publishers, totaling over 6300 pages containing over 3500 original images. Three of these volumes are crowned with the "Emanoil Teodorescu" award of the Romanian Academy.

The scientific activity took place mainly in plant morphology and anatomy, drawing with his mentor and then strengthening the foundations of a genuine "school" from Iasi. Among the many directions of research include: blastogeny, morphology, histology, anatomy, xylotomy, phytochemistry, medicinal plants etc. His extensive scientific research has resulted in more than 400 original articles (over 3850 pages) published in specialized journals in the country, 15 foreign journals and volumes of international scientific meetings (29 articles, 184 pages). Testimony for the value of his research is the over 80 references in the international literature.

A special place is occupied by the remembering of contributions of his ancestors, whom he has dedicated over 220 pages in 53 articles of history of biology. He also made over 25 reviews and numerous presentations for papers and books from different specialties of plant biology.

His scientific and teaching work totaling over 10800 pages that have investigated only the morpho-anatomical point of view over 600 species, 200 varieties and hybrids and more than 40 ecotypes of food, fodder, medicinal, honey, textile, toxic, ornamental plants, holoparasite, hemiparasite, carnivores plant, indigenous and exotic plants, useful and harmful, endangered and endemic in Romanian flora.

In the past 15 years has contributed to 11 research projects, at 5 of them being responsible.

At the age of 35 years was named director of the Botanic Garden "Anastasie Fatu" from Iasi, during which time he greatly contributed, along with the young and enthusiastic team, in building the garden sectors on current location, a process that started in 1963 and completed in 1978. Here makes known its managerial values, and he was invested in leadership positions and was appointed as dean of the Faculty of Biology (1975-1977), Head of Department (1977-1985, 1990-1996), Dean (1989-1990, 1996-2001), general chancellor of the University "Alexandru Ioan Cuza" from Iasi (1990-1992), where he worked hard to enhance the prestige of this institution from Iasi.

In the period 1986-1990 has led the Institute of Biological Research as a director. He actively participated in raising the professional prestige, allowing particular attention to broadening the research teams, initiation and training of young researchers.

Over the years he played an important role in various areas related to its basic activities. Thus, since 1992 he is chairman of the Subcommittee of Natural Monuments branch of the Romanian Academy in Iasi, since 2008 he is the honorary president of the Society of Biological Sciences from Romania, since 2001 is secretary of the branch from Iasi of the Romanian Academy.

His work is still tireless, being a member of the editorial board of specialty journals, editor of the *Romanian Journal of Biology - Plant Biology*, *Scientific Annals of "Alexandru Ioan Cuza" University from Iasi - Plant Biology Series*.

His work is still rich as we know it as always, which is underlined by the six articles in press, the daily presence in the laboratory with young researchers, and doctoral students whom he leads.

For all the remarkable achievements mentioned or not, for all the exceptional qualities of teacher and mentor, distinguished, exacting and open, for the strength and firmness with which you have done everything so far, yesterday's students and today colleagues expressing their admiration and gratitude, and heartfelt wishes you a "Happy birthday, Professor!"

We wish for the seventy-fifth anniversary of our distinguished Professor to be a beginning of a long series of fruitful years as those who have passed.

ADUMITRESEI Lidia, COJOCARIU Ana

CHRONICLE

On November 19th 2010 was held in Iasi, the homage session *Human impact on plant diversity. Structural and functional implications*, dedicated to the Professor Dr. Constantin TOMA, a member of the Romanian Academy, commemorating age of 75 years, and over 50 years have been dedicated to the work carried out in university and to promote excellence in plant biology in Romania.

In the first part of the event were presented homage exposures for the personality of Professor Constantin TOMA and messages addressed by representatives of universities and academic institutions in the country.

In the second part of the event was held scientific reports which revealed the results of scientific research on human impact on plant diversity, with some structural and functional implications.

We believe that this event was a soul celebration for botanists from Iasi, attended by over 125 people from the Iasi University Center, University of Bucharest, "George Bacovia" and "Vasile Alecsandri" University of Bacau, "Vasile Goldis" University of Arad and University from Oradea. The Professor receives messages from 54 personalities of biology from almost all university centers of Romania.

At 9.00 o'clock the auditorium B1 of the Faculty of Biology was almost filled with representatives of botany and other branches of biology in Bucharest, Bacau, Arad, University of Agriculture and Veterinary Medicine "Ion Ionescu de la Brad" Iasi, University of Medicine and Pharmacy "Grigore T. Popa", Biological Research Institute, and Gene Bank Suceava. The presence of a large number of former students, now professors or researchers, PhD students and doctors, people whose profession was shaped by the influence of personality of Mr. Constantin Toma, who was for many a model of professional dedication, scientific integrity, humanism and rational requirement.

The opening ceremony was attended by Prof. Dr. Vasile ISAN, Rector of "Alexandru Ioan Cuza" University of Iasi, who praised the teaching, scientific and management activity carried out by Mr. Constantin TOMA, and also the devotion and contribution to the prestige of the University of Iasi. On this occasion, the rector Mr. Vasile Isan offered the Jubilee medal of the Senate Office of the University "Alexandru Ioan Cuza" to celebrate a century and a half from the founding of the first modern university in Romania.

Prof. Dr. Ion MOGLAN, dean of the Faculty of Biology, University "Alexandru Ioan Cuza", was also a student of the celebrated professor, and he highlighted the results achieved in teaching and scientific work.

Mrs. associate professor Dr. Lăcrămioara Ivănescu, Chancellor of the Faculty of Biology, "Alexandru Ioan Cuza" University of Iasi, initiator and organizer of this event, presented a speech on whole activities undertaken by Mr. Constantin TOMA, highlighting the great vocation of teacher, of scientist by contribution to the establishment and development of the modern school of histo-morphology and plant anatomy from Iasi, well recognized in our country and abroad. Into the presentation was underlined the scientific contributions on experimental anatomy, histo-anatomy of reproductive organs, embryology, blastogeny, phytoteratology, *in vitro* culture, cytogenetics, the influence of pesticides, fertilizers and chemical pollutants on plant structure. They also highlighted the contributions of Mr. Constantin TOMA for Nature Conservation and history of biology in

Romania. Scientific research results are stored in 371 articles in journals of specialty in the country, 30 articles are published in foreign journals, 15 books and monographs, 13 synthesis lectures, courses and textbooks, 8 studies published in journals and collective volumes. Also was praised the managerial activity held with competence and professionalism by Mr. Constantin Toma, as scientific secretary of the "Alexandru Ioan Cuza" University, Dean of the Faculty of Biology, Head of Department of Plant Biology, Director of the Botanic Garden "Anastasie Fatu", director of the Institute of Biological Science, many years a member of the Board of the Faculty of Biology and member of the Senate of the "Alexandru Ioan Cuza" University in Iasi.

At present, when almost everything comes down to a continuous chasing after material benefits and easily promotions in the social hierarchy, there are people like Mr. Constantin TOMA, whose concerns are not material benefit to the fore, but perseverance and dedication for Plant Biology future.

Scientific papers and messages dedicated to Mr. Constantin TOMA was included in a volume of over 400 pages entitled "*In Honorem*: to Professor Constantin Toma at his 75th anniversary", published with the support of the GRAPHIS Publishing from Iasi. This edition has been cared by Mrs. Lăcrămioara IVĂNESCU and Maria Magdalena ZAMFIRACHE.

As a member of the Romanian Academy he has always promoted the contributions of plant biology and claimed recognition of these contributions to the development of biological sciences in Romania.

In selecting the collaborators, he sensed at the right time the quality and availability of these and always found the right words of encouragement to each one, in the most difficult moments of the beginning of any research work.

During this event Mr. Constantin TOMA presented the key moments in his career, emphasizing the importance of the work carried out with passion and dedication to academic institution, to students, PhD students and collaborators. He thanked to all participants and those who sent messages, suggesting emotional homage, the number and quality of participants, the flowers that decorated the auditorium.

We consider this event a special moment for Professor Constantin TOMA, but also for the entire academic community from Romania and the edited volume represent pages in the memory of time dedicated to a great personality for plant biology.

Vivat, crescat, floreat !

SÂRBU Ion, TĂNASE Cătălin

REVIEW

TOMESCU Ana and ŞESAN Tatiana Eugenia, *Lumea cunoscută şi mai puţin cunoscută a plantelor. Familia Fabaceae* (*Leguminosae*) [*Known and less known world of plants. The family Fabaceae* (*Leguminosae*)], Ed. Universităţii din Bucureşti (ISBN 978-973-737-831-6): 289 pp.

The work entitled "Known and less known world of plants. The family *Fabaceae* (*Leguminosae*)" by Ana Tomescu and Tatiana Eugenia Sesan, was written with the authors wish to present known plant species of *Fabaceae*, but especially the species more little known in Romania, through their exoticism and the implications for human social life.

For the first category of *Fabaceae* plants, the authors have extended the botanical and ethnobotanical knowledge, focusing in particular on their beneficial or damaging properties.

For the second category, the authors describe new or rare species of plants for our area and, of course, their value as industrial crops, medicinal, foods, spices, honey, ornamental, timber producing, with the role on bioremediation of soils and other uses lesser known so far, offering new alternatives in the developing of life.

The materials submitted for publication at the Bucharest University Press is a paper of biological knowledge, of general and special botanic, of ethnobotanic, plant and environment protection, but also contains a wealth of data from general culture and civilization.

The more extensive data refer to beans, peas, beans, chickpeas, known primarily as food plants. For them, botanical data have been unified with the technological elements of culture and protection of these cultures, data in support of plant lovers and those passionate about gardening and farming.

The book contains four chapters, the first with general knowledge of family *Fabaceae*, and the next three chapters, each covering the three subfamilies of the family *Fabaceae*: *Faboideae* (*Papilionaceae*), with 22 tribes and 71 genera; *Mimosoideae* (3 tribes, 9 genera) and *Cesalpinoideae* (4 tribes, 15 genera). In total, 29 tribes are described, with 95 genera belonging to the family *Fabaceae*.

The proposed publication also contains a valuable index of botanical and medical terms used in text and relies on a rich bibliography consulted, as well as on long personal experience of the two authors.

The paper is addressed mainly to biologists, present or in the making, and also for ecologists, foresters, the fans for applied biology and medicine, especially those involved in ethnobotanical remedies etc.

The volume is completed with professionalism, the authors being researchers and leading academics, passionate for the world of plants and fungi and fill a gap existing in the biological literature in general, and the botany and plant and environment protection, in particular, satisfying the conditions and requirements for publication in book form by the University Publishing House in Bucharest.

It is the first work of this kind that appears in the botanical Romanian literature and hopefully will follow others similar.

Prof. dr. Andrei Marin
Bucharest University – Faculty of Biology

JOURNAL OF PLANT DEVELOPMENT
GUIDE TO AUTHORS

***Types of contributions*:** Original research papers, as well as short communications. Review articles will be published following invitation or by the suggestion of authors. "Journal of Plant Development" also publishes book reviews, as well as conference reports.

Submission of a paper implies that it has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors, and that, if accepted, will not be published elsewhere in the same form, in English or in any other language, without the written consent of the publisher.

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Titles would be written with bold, capital letters, 12 points, centered.

Names and Christian names of the authors would be written with capital letters, 10 points, centered. The names would not be abbreviated; each author name would be accompanied by a complete address, as a footnote on the first page.

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Key Words: few words, the most important ones, after someone could discover your paper on the internet engines.

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The main text would be written at a single space, on A4 format page, Times New Roman, of 10 points.

The scientific names of taxa would be italicized.

Tables should be numbered consecutively in accordance with their appearance in the text and given suitable captions. Be sparing in the use of tables and ensure that the data presented in tables do not duplicate results described elsewhere in the article.

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Examples of papers quotation:

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MEHREGAN I. & KADEREIT J. W. 2008. Taxonomic revision of *Cousinia* sect. *Cynaroideae* (*Asteraceae*, *Cardueae*). *Willdenowia*. **38**(2): 293-362.

References for books:

BOŞCAIU N. 1971. *Flora şi Vegetaţia Munţilor Ţarcu, Godeanu şi Cernei*. Bucureşti: Edit. Acad. Române, 494 pp.
HILLIER J. & COOMBES A. 2004. *The Hillier Manual of Trees & Shrubs*. Newton Abbot, Devon, England: David & Charles, 512 pp.

Serials:

JALAS J. SUOMINEN J. LAMPINEN R. & KURTTO A. (eds). 1999. *Atlas Florae Europaeae*. *Distribution of vascular plants in Europe*. Vol. **12**. *Resedaceae to Platanaceae*. Helsinki: Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo. Maps 2928-3270, 250 pp., ill (maps), ISBN 951-9108.
TUTIN T. G., BURGES N. A., CHATER A. O., EDMONDSON J. R., HEYWOOD V. H., MOORE D. M., VALENTINE D. H., WALTERS S. M. & WEBB D. A. (eds, assist. by J. R. AKEROYD & M. E. NEWTON; appendices ed. by R. R. MILL). 1996. *Flora Europaea*. 2nd ed., 1993, reprinted 1996. Vol. **1**. *Psilotaceae to Platanaceae.* Cambridge: Cambridge University Press, xlvi, 581 pp., illus. ISBN 0-521-41007-X (HB).

Chapters in books:

†TUTIN T. G. 1996. *Helleborus* L. Pp. 249-251. In: †T. G. TUTIN et al. (eds). *Flora Europaea*. 2nd ed., 1993, reprinted 1996. Vol. **1**. *Psilotaceae to Platanaceae.* Cambridge: Cambridge University Press, xlvi, 581 pp., illus. ISBN 0-521-41007-X (HB).

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