

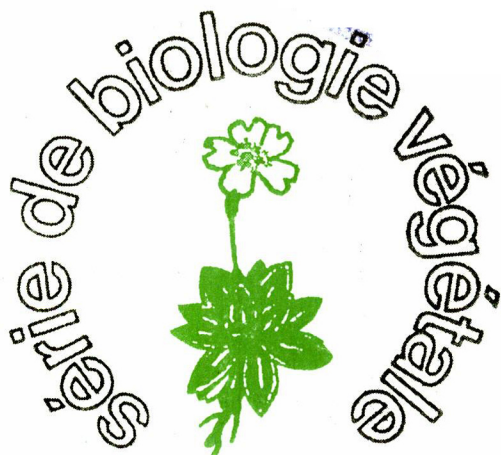
ACADÉMIE ROUMAINE

# REVUE ROUMAINE DE BIOLOGIE

TOME 44

**2** 1999

juillet - décembre



EDITURA ACADEMIEI ROMÂNE



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SÉRIE DE BIOLOGIE VÉGÉTALE

Calea Victoriei 125  
R-79 717, București, România  
Tél. 650 76 80

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Calea 13 Septembrie, nr. 13, sector 5  
R-76 117, București, România  
Tél. 410 32 00; 401-411 90 08  
Tél./Fax. 401-410 39 83

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# TAXONOMY OF THE GENUS *AMARANTHUS* L., SUBGENUS *AMARANTHUS*, IN ROMANIA

MIHAI COSTEA

The present study is an amendment of the genus *Amaranthus* L., subgenus (section) *Amaranthus* based on new morphological and (some) anatomical characters. The taxa *Amaranthus bouchonii* Thellung and *A. quitensis* Kunth are reconsidered, being lowered to subspecific rank.

*Key words:* *Amaranthus*, new combinations, taxonomy.

## MATERIAL AND METHODS

The following Herbaria Collections were examined: BUC (Grădina Botanică, Universitatea București); BUCA (Institutul de Științe Biologice al Academiei Române, București); BUCF (Institutul de Cercetări Forestiere, București); BUCM (Institutul de Științe Biologice, București - Mycology Herbarium); CRA (Universitatea Craiova, Facultatea de Agronomie); CL (Grădina Botanică, Universitatea Cluj Napoca); CLA (Grădina Agrobotanică, Institutul Agronomic, Cluj); I (Facultatea de Biologie, Universitatea "Al. I. Cuza", Iași); IAGB (Grădina Botanică a Universității "Al. I. Cuza", Iași ); IAȘI (Institutul Agronomic, Iași); Herb. Universității de Științe Agronomice București; Herb. Universității de Științe Agronomice, Timișoara; Herb. Facultății de Silvicultură, Brașov; Herb. Muzeului Județean Ploiești; VAB (Facultad de Ciencias Biológicas, Universidad de Valencia); VAL (Jardín Botánico de Valencia, Universidad de Valencia); VALA (Escuela Técnica de Ingenieros Agrónomos, Universidad Politécnica Valencia); VF (Facultad de Farmacia, Universidad Valencia) and WU (Botanischer Garten der Universität Wien). The photos were taken with the Hitachi S-4100 microscope. Herbaria material for all the taxa was introduced in the Herbaria of the University of Agronomical Sciences Bucharest, and in BUCA and BUC Herbaria.

*Characters.* Many species of the genus are greatly affected by environmental factors (nutritional elements, water availability, light conditions, injurious factors, etc.) exhibiting a great morphological variability with little taxonomical significance. An enormous number of such inconsistent states (mostly based on extremely variable characters like: plant height, branching, colour of whole plant or only of stems or petioles, shape of inflorescence etc.) received various taxonomical ranks, increasing thus again artificially the complexity of the genus.



In the present study, besides the recognised characteristics, emphasis is laid on less or unknown characters. Plants should be collected when well developed fruits and seeds are formed. In addition, for a more accurate identification, a range of individuals from the same population and a range of flowers, fruits and seeds belonging to the same plant should be examined.

*The flowers.* Provide the majority diagnostic and easily to be observed characteristics. Because these characters are the best known and frequently used, we shall accentuate on other potential features. Regarding the flowers, less known are the characteristics of bracteoles and tepals venation. The unique vein of bracteoles and tepals may be not ramified (usually) or ramified. Furthermore, it may be gradually narrowed toward the apex (sometimes it disappears completely in this region) or it may be enlarged toward the apex. The colour of the mid-vein may be green or yellowish and it should be examined on dried material.

*The fruits.* a. Morphological characters - as seen under 50 × magnification.

- Fruit circumcissile or indehiscent
- Form of the fruit: spherical, ovoid, ellipsoidal, etc.
- Form of the fruit toward the stigma region: fruit abruptly narrowed toward the stigma region, a short beak being conspicuous and fruit gradually narrowed toward the stigma region with the apex - truncate to rounded or - acute.
- The ratio between the length and the width of the fruit.
- The position of the dehiscence line: in the upper half, at the middle or in the down half of the fruit.
- The general pattern of pericarp wrinkling.
- The ratio between the fruit and the seed: the cavity of the fruit is much larger than the seed opposite to cavity of the fruit only a little larger than the seed.
- Stigma branches: length and width at the base; aspect of stigma branches: erect or recurved.

b. SEM characters - Surface of pericarp observed with the SEM at 300× magnification or more. To describe the patterns of the pericarp surface organisation we slightly modified the classification of Klopper and Robel (1989) as follows:

*Type A (paniculatus* type of Klopper and Robel - 22). - Cells very irregularly shaped and ramified. Principal axis of the cells not more than three times longer than the longest secondary axis. Anticlinal walls irregularly waved.

*Type B (bouchonii* type of Klopper and Robel - 22). - Cells ramified, 4-6 times longer than wide. The anticlinal walls  $\Omega$  or s-waved.

*Type C (patulus* and *deflexus* types of Klopper and Robel - 22). - Cells less ramified or not ramified, 8-12 times longer than wide. Anticlinal walls mostly S-waved.

*Type D (albus* type of Klopper and Robel - 22). - Cells less ramified or not ramified 1.5 - 2 times longer than wide. Anticlinal walls weakly S-waved.



*Type E (lividus* type of Klopfer and Robel - 22) - Cells not ramified, 3-4 times longer than wide with anticlinal walls straight to S-waved.

*The seeds.* The diagnostic features of the seeds were largely neglected due to their small size. Descriptions of seeds were also made by Koval (24) and KLOPPER & Robel (23). The following features (including the sculpture) may be observed under 50× magnification.

- The size is defined by the length of the two diameters and it is constant when the plants grow in the same environmental conditions. Variations of 0.1 - 0.2mm from the average are possible.

- The form: General aspect: as seen from above, the outline of the seeds is variable but constant depending on the species: circular, elliptic, obovate, etc. As seen laterally the seeds usually exhibit a lenticular shape. The seeds are usually differentiated in a central, convex zone and a marginal, plane zone, exceptions from this rule being rare and diagnostic.

- Appearance of the seed basis, namely of the part where the hilum and the radicle are located: the tip of the hilum is above (or at the same level) the tip of the radicle (subgenus *Amaranthus*, exception - *A. hybridus*) or the tip of the hilum is below the tip of the radicle (subgenus *Albersia*).

- The presence between the hilum and the radicle, toward the centre of the seed of: - a furrow; a concavity; a concavity continued by a furrow.

- The shape of the seeds margin observed from the profile may be - acute (usually); - rounded or truncated (rarely).

- The sculpture of the seeds is the result of the concentric distribution of the cells from the exotesta. The following variations are possible: - the sculpture is evident only on the marginal zone, in the central zone being inconspicuous (usually); - both the central and the marginal zone are sculptured; both the central and the marginal zone are almost smooth and - the central zone is sculptured while the marginal one is smooth or distinctly wrinkled.

- The colour of the seeds is commonly darkbrown to blackish, or whitishyellowish with reddish nuances at the species cultivated as cereals. The colour may be uniform or not uniform in the last case the outer zone exhibits a paler nuance.

SEM characters of seeds refer to the ornamentation of the exotesta in the marginal zone of the seeds, as observed under 300×, or more magnification. We used the terminology proposed by Barthlott & Ehler (5). There were noted the aspect of the anticlinal (may be prominent or inconspicuous) and periclinal walls (may be plane, concave or convex with the sculpture of the epicuticular waxes smooth or punctiform).

*The pollen.* It is polyaperturate, apolar, small (with  $D = 18-28\mu$  with echinulate ornamentation. The apertural membrane is slightly sunken. Generally with more than 18 pores having the apertural membrane granulated. Surface of



grains with granules. Characters: - the diameter of the pollen grain; - number and diameter of pores; - density of granules on the surface of the pollen grain: high 20 - 30 granules or more/ $\mu\text{m}^2$ ; medium 10 - 19 granules/ $\mu\text{m}^2$  and low 2-9 granules/ $\mu\text{m}^2$ .

As we have confirmed (13, 14), the division of the genus in three subgenera - *Acnida*, *Amaranthus* and *Albersia* - appears to be, for the moment, the most appropriate. In the subgenus *Amaranthus*, *A. spinosus* and *A. dubius* may probably deserve a separate recognition at the section level. The rest of the common European species of the subgenus *Amaranthus*, section *Amaranthus* are very homogeneous. Therefore, a new division of this group even at the subsection level based on the tepals outline is useless. Within the subgenus *Amaranthus* we sustain the treatment of Sauer (28, 29) in maintaining separate the cultivated species from their supposed wild progenitors. This distinction is supported by important anatomical differences.

#### IDENTIFICATION KEY FOR THE SPECIES OF THE SUBGENUS *AMARANTHUS*

1. Cultivated ornamentals or cereals with coloured inflorescence (rarely ruderals escaped from cultivation). Largest foliar traces in the stem with 11 bundles. Pericarp as seen in crosssections with 4(3) cell layers .....2
  - Weeds with green inflorescence. Largest foliar traces in the stem with 9 bundles. Pericarp as seen in crosssections with 2-3 cell layers .....4
2. Inflorescence tail-like, pendent or trailing. Tepals obovate to spatulate, overlapping each other ..... *A. caudatus*
  - Inflorescence not tail-like. Tepals narrow-ovate, not overlapping each other .....3
3. Fruit abruptly narrowed in the stigma region; bracteoles about as long as the perigon, definitely shorter than the stigma branches; inflorescence with many lax, patent branches ..... *A. cruentus*
  - Fruit gradually narrowed in the stigma region; bracteoles about 1.5× longer than perigon, equalling the spreading stigma branches; inflorescence stiff, ± erect ..... *A. hypochondriacus*
4. Tepals 3-5 very unequal. Leaves elliptic to broad-elliptic. Trichomes multicellular uniseriate present on the stems and leaves ..... *A. powellii*
  - Fruit circumcissible, 2 x longer than wide, irregularly wrinkled above the dehiscence line, with the type pericarp surface A; Seeds with an indistinct furrow prolonged 1/3 to the middle of the seeds, with the marginal zone almost smooth ..... *A. powellii* subsp *powellii*
  - Fruit indehiscent or irregularly dehiscent, 1.5 × longer than wide ± smooth with the type of pericarp surface variable: B to C; seeds with a



concavity above the hilum and the radicle, with the marginal zone evidently sculptured. .... *A. powellii* subsp. *bouchonii*

- Tepals 5, almost equal. Leaves ovate. Trichomes multicellular multiseriate mixed with uniseriate present on the stems and leaves ..... 5

5. Inflorescence lax or with many thin, patent branches. Tepals and bracteoles with dark-green midveins. Seeds broad - elliptical to circular with the tip of the hilum placed below or at the same level with the tip of the radicle ..... *A. hybridus*

- Most of tepals narrowly-ovate to oblong-lanceolate, acute or subacute, erect, shorter than the ..... subsp. *hybridus*

- Most of tepals spatulate to obovate, obtuse or truncated, almost erect or outcurved, longer (rare equal) than the fruit ..... subsp. *quitensis*

- Inflorescence dense, usually with short, rigid, erect, thick branches. Tepals and bracteoles with yellowish brownish mid-veins. Seeds obovate with the hilum above the tip of the radicle ..... *A. retroflexus*

# 1. *Amaranthus caudatus* L., Sp. Pl.: 990 (1753).

Typus: "Habitat in Peru, Persia, Zeylonia"; LINN 1117/26.

Stout erect to arching annual up to 1-1.5(2) m high. Leaves long - petiolate, rhombic-ovate to elliptic. Trichomes on the stems and leaves multicellular uniseriate. Inflorescence large and showy, with the terminal part 10-30(40) cm long, thick and pendent, usually red or purplish, rare white or yellow. Bracteoles 3-4 mm long, about 1.2-1.5  $\times$  longer than the perigon, usually not exceeding stigma branches. Tepals 5, equal, outcurved or erect, 1.9-2.5(3) mm long, obovate to broadly spatulate, mucronate, overlapping each other, with the mid-veins uniform, yellowish - brown. Fruit dehiscent, longer than the perigon, 1.5-2.5 mm long, a little longer than wide, ovoid, weakly longitudinally wrinkled, with the dehiscence line in the down half, gradually or abruptly narrowed toward stigma region. Type of pericarp surface: A. Seeds 1.3-1.5  $\times$  1.25-1.35 mm, round to asymmetrically-round. Between the hilum and the radicle is present a furrow prolonged almost to the middle of the seed. The seeds are differentiated in a central and a marginal zone. Depending on their colour two distinct types of seeds are possible: a) whitish-yellowish - as seen from profile are ovoid, with the marginal zone smooth or irregularly wrinkled, often with reddish stripes, and the central zone conspicuously sculptured. The border of the seed is rounded or truncated. Cells of the exotesta in the marginal zone are elongated (30-50  $\mu$ m length) with prominent anticlinal walls and plane and verrucose periclinal walls b) Dark-brown seeds - lenticular, with the marginal zone sculptured and the central zone smooth; uniformly coloured. Cells of the exotesta like in a. but the periclinal walls are smooth. The border of the seeds is acute. Pollen grains 22-24  $\mu$ m with 30-40 pores of 1.5-1.8  $\mu$ m diameter. Density of granules medium.  $2n = 32$ .

Ancient American cultigen, together<sup>a</sup> with *A. hypochondriacus* and *A. cruentus*, has raised a great interest during recent years as agricultural crops in many regions of the world, due to the exceptionally high nutritional value of seeds. In Europe it is grown as ornamental, and rarely escapes from cultivation in waste places.

2. *Amaranthus cruentus* L., Syst. Nat. ed. 10: 1269 (1759).

Typus: "China"; LINN 117/19.

= *A. paniculatus* L. Sp. Pl. ed. 2: 1406 (1763) = *A. sanguineus* L. p.p., Sp. Pl. ed. 2, 2: 1407 (1763) = *A. hybridus* subsp. *cruentus* (L.) Thell. var. *paniculatus* (L.) Thell., Fl. Adv. Montpell.: 205 (1912) = *A. hybridus* subsp. *cruentus* (L.) Thell. "proles" *paniculatus* (L.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5, 1, 247 (1914) = *A. hybridus* subsp. *paniculatus* (L.) Hejny, Dostal, Kvetevna CSSR: 444 (1950) = *A. hybridus* subsp. *incurvatus* (Tim. ex Gren. & Godr.) Brenan var. *cruentus* Mansf., Die Kulturpflanze, 2: 54 (1959). (? *A. chlorostachys* Willd., Hist. Amaranth.: 34 (1790), nom. ambig.).

Erect annual 0.5-1.5 m, usually reddish throughout. Leaves rhombic-ovate to broadly - lanceolate, 4-15 × 2-18 cm. Trichomes on the stems and leaves multicellular uniseriate. Inflorescence usually with many lateral, patent branches. Bracteoles 2-3 mm long, equalling or scarcely longer than the tepals. Tepals 5, almost equal (one is approximately 0.5 mm longer than the other 4), oblong, acute, with the mid-veins uniform, yellowish-brown. Fruit dehiscent, 2-2.5 mm long abruptly narrowed toward the stigma region, a rostrum being evident. Fruit about 2 × longer than wide, obovoidal to rhombic, 2-2.5 mm long, with the dehiscence line in the upper half. The pericarp is almost smooth or weakly wrinkled around dehiscence zone. Type of pericarp surface variable: A to B. Seeds obovate to elliptic - asymmetrical 1.25-1.6 × 1.1-1.2 mm, whitish or yellowish, rare dark-brown. The pale seeds are very much alike to the ones described for *A. caudatus*. The only differences are that the furrow between the hilum and the radicle is prolonged only about 1/3 through the diameter of the seeds and that the reddish nuances are often absent. The dark seeds exhibit a concavity above the hilum and have both the central and the marginal zone (especially the latter) sculptured. The cells of the exotesta like in *A. hybridus*. The border of the seed is acute. Pollen grains 20-25 μm, with 33-45 pores of 1.9-2.1 μm. Density of granules medium. 2n = 32, 34.

Apparently originated in the Central America from the wild species *A. hybridus*, as a grain crop. Nowadays it is worldwide cultivated mostly as a garden ornamental and sometimes as a potherb or grain culture.



3. *Amaranthus hybridus* L., Sp. Pl.: 990 (1753).

Typus: "Habitat in Virginia"; LINN 1117/19.

Annual to 0.5-1.5(2) m, usually erect. Stems weakly to densely pubescent above, multiseriate hairs are being mixed with uniseriate hairs. Leaves rhombic-ovate to broadly-ovate-lanceolate. Inflorescence dark - green, either with many crowded slender, lateral branches, or lax, with only a few branches (Fig.1).



Fig. 1. - *A. hybridus* subsp. *hybridus* - general aspect.

Bracteoles 2.5-4 mm long, narrow, about 1.2-1.5 to  $2 \times$  longer than the perigon. Tepals 5, almost equal, 1.5-2mm long, with the mid-vein dark-green, with very variable form and length: a) narrowly-ovate to oblong-lanceolate, acute to subacute, erect, shorter than the fruit or b) obovate to spatulate, erect to outcurved, equal to or longer than the fruit. Fruit dehiscent, about as long as wide, with the dehiscence line at the middle or in the upper half, narrowed toward the stigma region and coarsely wrinkled in the dehiscence region. Stigma branches are short, slender, erect (0.9-1.4mm length and 0.1-1.18 mm width at the base).

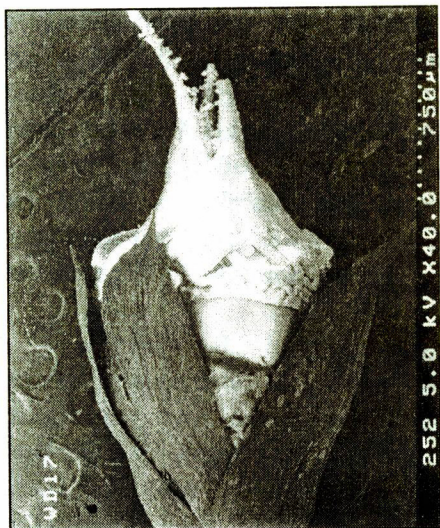


Fig 2. - *A. hybridus* subsp. *hybridus* - fruit and perigon (40×).

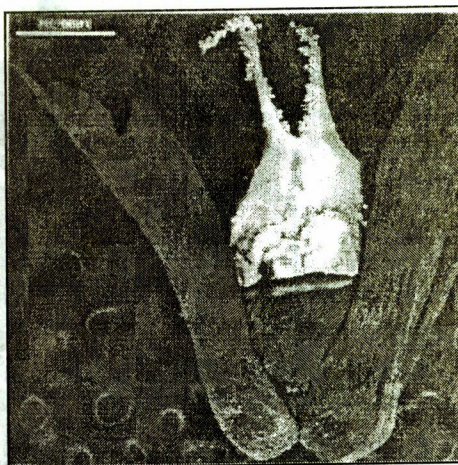


Fig. 3. - *A. hybridus* subsp. *quitensis* - fruit and perigon (40×).

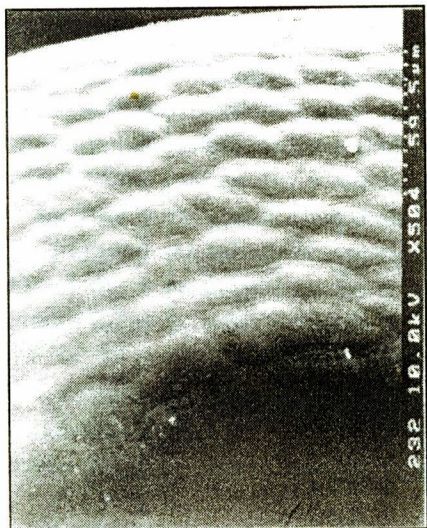


Fig. 4. - *A. hybridus* – sculpture of the seed margin (500×)



Type of pericarp surface variable: B to C. Seeds 1- 1.4 × 1- 1.35mm, broad-elliptical to circular, lenticular. The tip of the hilum is placed below or at the same level with the tip of the radicle. Seeds differentiated in a central zone and a marginal zone, both sculptured. The cells of the exotesta (Fig. 4) are polygonal, 25-35µm, with prominent anticlinal walls and convex, finely sculptured periclinal ones. The border of the seed is acute. Colour dark brown to black, sometimes with the marginal zone having a paler nuance.  $2n = 32$ .

Coons (1978) after a meticulous study of the relationships between *A. hybridus* and *A. quitensis* preferred to include as conspecific the last species into the first. However, she admitted that one character, the inner tepal index may be significant but not correlated with other characters. The description of Kunth (1817) for *A. quitensis*: "calyx quinquepartitus; laciniis lanceolato - oblongis, obtusis" is more a description for *A. hybridus*. Thellung (1914) completed the description for *A. quitensis*: "tepals 5, about 2mm long, spatulate with the apex broad - rounded (with mucro), with a green mid-vein continued into the mucro. Fruit shorter (rarely as long as) than the perianth". These perigon features made Bolos & Vigo (1974) include *A. quitensis* as a subspecies of *A. retroflexus*. However, the real affinities of *A. quitensis* are more with *A. hybridus*, in which we comprehend as a subspecies. The hybrid between subsp. *hybridus* and subsp. *quitensis* has a pollen viability of 60% (Greizerstein & Poggio, 1992) value that shows both the affinity and the dissimilitude between the two taxa. The pollen of the two subspecies of *A. hybridus* is also easily differentiable.

Both subspecies stand apart through their ecology, flowering and setting fruits and seeds in Central and Eastern Europe with about one month later than the other species of the subgenus *Amaranthus*. Native to South America, now a widespread ruderal and segetal weed.

1. Most of tepals narrowly-ovate to oblong-lanceolate, acute or subacute, erect, shorter than the fruit (Fig.2) ..... *A. hybridus* subsp. *hybridus*  
 - Most of tepals spatulate to obovate, obtuse or truncated, almost erect or outcurved, longer (rarely equal) than the fruit (Fig.3) . *A. hybridus* subsp. *quitensis*.

#### a. *A. hybridus* subsp. *hybridus*

Typus: "Habitat in Virginia" ; LINN 1117/19.

= *Amaranthus patulus* Bertol. Comment. Itinere Neapol.: 19 (1837) ≡ *A. hybridus* subsp. *cruentus* (L.) Thell. var. *patulus*. (Bertol.) Thell, Fl. Adventice Montpell. 8 206 (1912) ≡ *A. hybridus* subsp. *hypochondriacus* (L.) Thell. "proles" *cruentus* (L.)Thell. var. *patulus* (Bertol.) Thell., Ascherson & Graebner, Syn. Mitteleur.

Fl.5: 244. (1914)  $\equiv$  *A. hybridus* subsp. *patulus* (Bertol.) Carretero var. *patulus*, Collect. Bot. (Barcelona) 11: 127 (1979).

$\equiv$  *A. incurvatus* Tim. ex Gren. & Godr., Prosp. Fl. France: 8 (1846)  $\equiv$  *A. hybridus* subsp. *incurvatus* (Tim. ex Gren. & Godr.) Brenan var. *incurvatus*, Watsonia 4: 268 (1961). (*A. chlorostachys* auct. non Willdenow).

Cotyledons narrow-elliptic to elliptic, 10-12  $\times$  4mm, with rounded apex. Pollen grains 22-28 $\mu$ m with 25 - 35 pores of 1.4-1.6 $\mu$ m in diameter. Density of granules medium (Fig. 5).

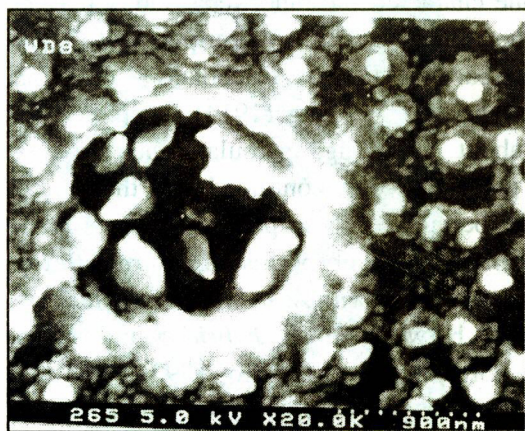


Fig. 5. - *A. hybridus* subsp. *hybridus* - the pollen (20000 $\times$ ).

The name *A. hybridus* was rejected as ambiguous by many authors because it was widely and persistently misapplied to *A. powellii* or *A. hypochondriacus*. As these species were clearly typified, we cannot follow such a view. Another name "*A. chlorostachys*", which was very much used to denominate this taxon, is probably based on a single green plant, within a red-coloured population of cultigens from India (*A. paniculatus* B-WILLD 17521). It seems that Willdenow described this mutation as a separate cultigen, which later authors, ambiguously but constantly synonymized either with *A. hybridus* or with *A. powellii*. In Europe it is scarcely known (Jalas & Suominen, 1980) about the distribution of this taxon, because most of all herbaria and literature references are in fact *A. powellii*.

The length of bracteoles and the inflorescence are very variable, continuous and not correlated. Consequently, an infraspecific separation within subsp. *hybridus* of a var. (subsp.) "hybridus" with bracteoles about 2 $\times$  longer than the perigon; inflorescence dense with many lateral crowded branches and a var.(subsp.) "patulus" with bracteoles about 1-1.5 $\times$  longer than the perigon and inflorescence less ramified, lax, seems for the moment rather arbitrary.



b. *A. hybridus* subsp. *quitensis* (Kunth) Costea & Carretero comb. et stat nov.

Typus: Described from Ecuador: "Crescit in ripa fluvii Guallabambae, alt 1030 hex. (Regno Quitensi), 6 1802, Humboldt & Bonpland 156.

Basionym : *Amaranthus quitensis* Kunth, Humboldt et al., Nov. Gen. Sp.2, ed. folio: 156 (1817)

≡ *A. retroflexus* subsp. *quitensis* (Kunth) O. Bolos & Vigo, Butll. Inst. Catalana Hist. 38: 89 (1974) ≡ *A. hybridus* var. *quitensis* (Kunth) Covas, Darwiniana 5: 329-368 (1941) = *A. caudatus* sensu Greuter & al., Med-Checkl. 1: 46 (1984) p.p., non L. s. str.

Cotyledons lanceolate,  $12 \times 2-2.5\text{mm}$ , with acute apex. Pollen grains  $25-30\mu\text{m}$  with 28 - 35 pores of  $1.2-1.4\mu\text{m}$  in diameter. It is different from subsp *hybridus* mostly in the density of granules, which is high (Fig. 6). This taxon was recorded as a casual from many European countries.

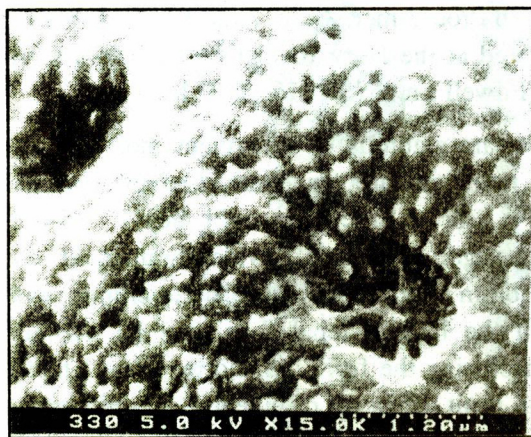


Fig. 6. - *A. hybridus* subsp *quitensis* - the pollen (15000X).

#### 4. *Amaranthus hypochondriacus* L. , Sp. Pl.: 991 (1753).

Typus: "Habitat in Virginia"; LINN 1117/24.

= *A. chlorostachys* var. *erythrostachys* (Moq.) Aellen, Hegi, Illustr. Fl. Mittel.-eur. ed.2, 3(1-2): 482 (1959) ≡ *A. hybridus* subsp. *hybridus* var. *erythrostachys* Moq., DC., Prodr. 13(2): 259 (1849) ≡ *A. hybridus* var. *hypochondriacus* (L.) Robinson, Rhodora 10: 32 (1908) ≡ *A. hybridus* subsp. *hypochondriacus* (L.) Thell. proles *erythrostachys* (Moq.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl.5: 241 (1914).

= *A. flavus* L. Syst. Nat. ed. 10. 2: 1269 (1759) = *A. frumentaceus* Buch. Hamilt. ex Roxb., Fl. Ind. 3: 613 (1832) = *A. anardana* Buch. Hamilt. in Wall. ex Moq.-Tand., DC. Prodr.13(2): 256 (1849) = *A. leucocarpus* S.Wats., Proc. Amer. Acad. Arts. 10: 347 (1875) = *A. leucospermus* S.Wats., Proc. Amer. Acad. Arts. 22: 446 (1887).

Like *A. cruentus*, but inflorescence usually stiff, with only a few thick branches. Bracteoles 3-5 mm long, about 1.5 mm longer than the perigon. Tepals 5, one equal to longer than the fruit, the others 4 shorter, lanceolate, with the mid-vein brown-reddish. Fruit dehiscent, tapering gradually toward the stigma region, 1.5-2mm long, about  $2 \times$  longer than wide, with the dehiscence line in the upper half. Stigma branches about 1.6-1.8mm length and 0.6-0.8mm width at the base. Type of pericarp surface variable: A to B. All the other morphological characteristics of the fruits and of the dark seeds correspond to those of *A. powellii*. The pale seeds are very much alike to those described for *A. caudatus*. They differ in having the cells of the exotesta inconspicuous (because their anticlinal walls are inconspicuous) and the periclinal walls evidently wrinkled. Pollen grains of 18-23  $\mu\text{m}$ , with 32 - 45 pores of 1.3-1.5  $\mu\text{m}$  in diameter. Density of granules medium. The presumed wild progenitor is *A. powellii*.  $2n = 34$ . It is cultivated mostly as a garden ornamental and occasionally escapes from cultivation in ruderal places.

5. *Amaranthus powellii* S.Wats. in Proc. Amer. Acad. Arts. 10:347 (1875).

Typus: Described from a plant cultivated at the Harvard University "from seeds brought from Arizona by Col Powell"(Powell s.n. , US 16163, ISO MO).

Erect annual 0.5-1.5(2)m, with steam glabrous to puberulent mostly in the inflorescence region, with trichomes multicellulare uniseriate. Leaves, broadly-elliptic to rhombic or lanceolate, 3-8  $\times$  2-6cm. Bracteoles rigid, heavy, 4.5-6(8) mm long, about 2-3  $\times$  longer than the perigon. Tepals 3-5, evidently unequal; one tepal is 2.2-3mm long, the others 1.2-1.6mm long, linear-lanceolate to elliptic, with the mid-veins inconspicuous (only in the longest tepal they may be partially visible). The longer (outer) tepal is surpassing the fruit, the shorter (inner) tepals are shorter than (or as long as) the fruit. Fruit dehiscent or indehiscent, elliptical to obovoidal, 1.5 -  $2 \times$  longer than wide, when dehiscent with the dehiscence line in the upper half, gradually narrowed toward the stigma region, the apex of the fruit being truncated. Stigma branches thick, spreading from the base, 1.9 - 2.2 mm long and 0.08-0.01 mm thick at the base. Seeds lenticular, differentiated in a central zone and a marginal zone. Colour black to dark brown, uniform. Pollen grains 18-23  $\mu\text{m}$  with 30 - 45 pores of 1.1-1.3  $\mu\text{m}$  in diameter. Density of granules medium.  $2n = 34$ .

SAUER (1967) and afterwards other authors (Jalas & Suominen 1980; Carretero 1985, 1990; Akeroyd 1993 etc.) considered the European taxon *A. bouchonii*, as conspecific with *A. powellii* on the basis of their evident similarity. The study of isozymes (Wilkin, 1992) failed to prove satisfactory the distinctness of these two taxa. After a close morphological and anatomical examination we found some new characters that support – in our opinion – the subspecies rank.



1. Fruit circumcissible,  $2\times$  longer than wide, irregularly wrinkled above the dehiscence line, with the type pericarp surface A (Fig. 10). Seeds with an indistinct

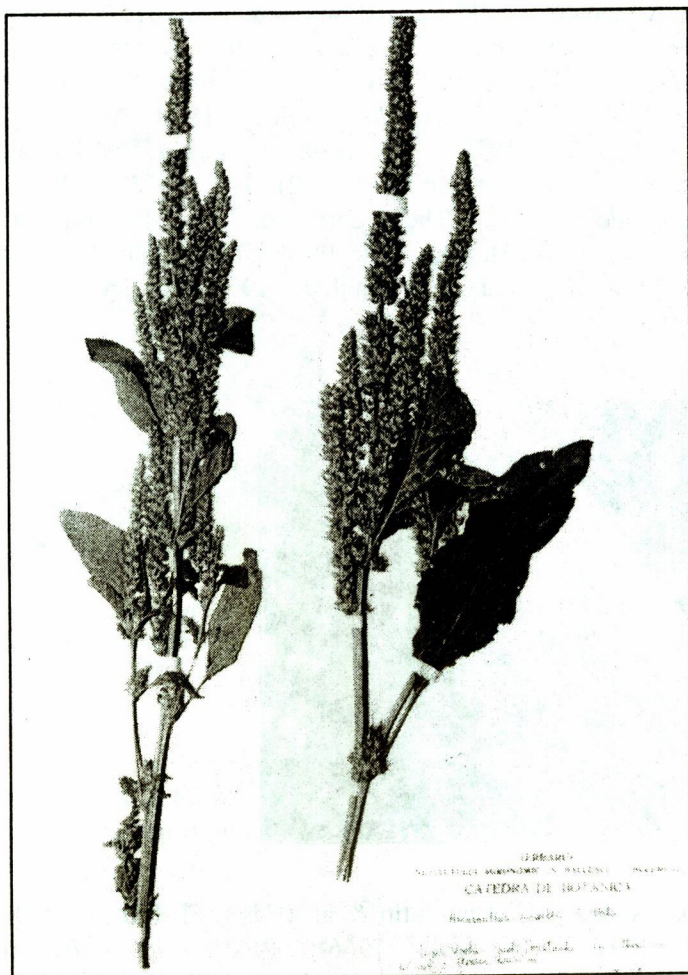


Fig. 7. - *A. powellii* subsp. *powellii* - general aspect.

furrow prolonged  $1/3$  to the middle of the seeds, with the marginal zone almost smooth. .... *A. powellii* subsp. *powellii*

- Fruit indehiscent or irregularly dehiscent,  $1.5\times$  longer than wide  $\pm$  smooth with the type of pericarp surface variable: B to C (Fig. 11). Seeds with a concavity above the hilum and the radicle, with the marginal zone evidently sculptured. .... *A. powellii* subsp. *bouchonii*

a. *A. powellii* subsp *powellii*

Typus: Described from a plant cultivated at the Harvard University "from seeds brought from Arizona by Col Powell"(Powell s.n. , US 16163, ISO MO).

= *A. chlorostachys* var. *pseudo-retroflexus* Thell., Vierteljahrssch. Naturf.Ges. Zurich 52: 443 (1907) ≡ *A. hybridus* subsp. *hypochondriacus* (L.) Thell. var. *chlorostachys* (Willd.) Thell. f. *pseudo-retroflexus* Thell., Ascherson & Graebner, Syn. Mitteleur. Fl.5: 239 (1914) ≡ *A. chlorostachys* var.(subsp.) *powellii* (S.Wats.) Prizter, Ann. Sect. Hort. Vit. Budapest, 2(2): 144 (1953) ≡ *A. hybridus* subsp. *hybridus* var. *pseudo-retroflexus* (Thell.) Carretero, Collect. Bot. 11(4): 125 (1979).

(*A. "chlorostachys"* sensu Hayek, Prodr. Fl. Penins. Balcan. 1: 160 (1927); Davis, Fl. Turkey 2: 341 (1967); Pignatti, Fl. Ital. 1: 179 (1982); Ciocârlan, Fl. României 1: 235 (1988).

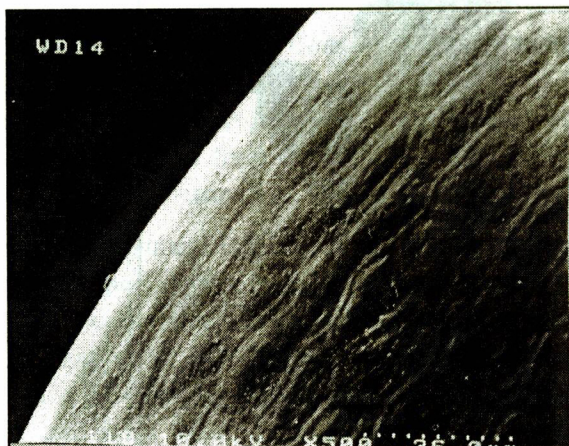


Fig. 8. - *A. powellii* subsp. *powellii* – sculpture of the seed margin (500X).

(*A. "hybridus"* sensu Aellen in Tutin & al. (Eds.), Fl. Eur., ed I, 1: 109 (1964); Zohary, Fl. Palaest. 1: 181 (1966); Beldie, Fl. României 1: 115 (1977)).(*A. "hypochondriacus"* Greuter & al., Med-Checkl. 1: 47 (1984) p.p., non L. s. str.) (*A. "hypochondriacus* var. *chlorostachys"* sensu Morariu, Fl. R.P.R. 1: 586 (1952).

Inflorescence stiff, erect,  $\pm$  unbranched or with a few widely spaced, long branches; the terminal branches are usually much longer than the lateral ones (Fig. 7). The bracteoles are usually 2-2.5(3)  $\times$  longer than the perigon. The fruit 2 $\times$  longer than wide, coarsely wrinkled above the dehiscence line. Seeds elliptic to obovate, 1.25-1.3  $\times$  1-1.1 mm, the marginal zone almost smooth (cells of the exotesta with inconspicuous anticlinal and almost smooth, plane periclinal walls) and the border of the seed acute (Fig. 8).



Worldwide weed native from North and South America. In Europe it is a very frequent ruderal and segetal weed erroneously known until now as "*A chlorostachys*", "*A. hybridus*" or "*A hypochondriacus*".

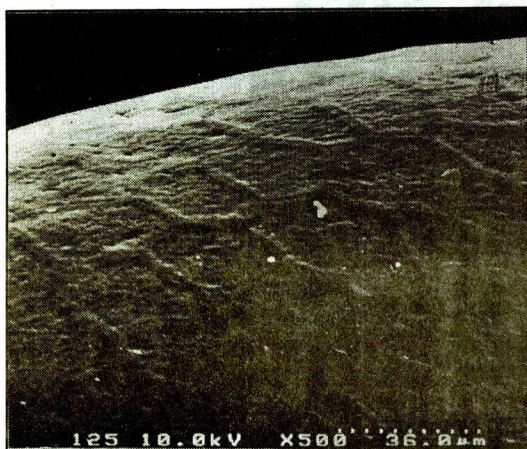


Fig. 9. - *A. powellii* subsp. *bouchonii*-  
sculpture  
of the seed margin (500X).



Fig. 10. - *A. powellii* subsp. *powellii*  
- surface of pericarp  
- type A of organisation (450X).

b. *A. powellii* subsp. *bouchonii* (Thell.) Costea & Carretero comb. et stat. nov.  
Typus: "Bordeaux, Allée du Boutant, Chemin remblaye avec des balayures du port, 25.9.1925, A. Bouchon".

Basionym: *Amaranthus bouchonii* Thell. in Monde Pl. 27 (160): 4 (1926).

≡ *A. hybridus* subsp. *bouchonii* (Thell.) O. Bolos & Vigo in Butl. Inst. Catalana Hist. Nat. 38:89 (1974).

Inflorescence often not strictly erect, more lax. Bracteoles shorter and thinner comparatively subsp. *powellii*, 2-2.3 × longer than the perigon. Fruit indehiscent, about 1.5 × longer than wide, with the pericarp ± smooth. Seeds usually broad-ovate to round (rare obovate), 0.9 × 1-1.2 mm, with the marginal zone sculptured and the margin of the seed usually rounded. Cells of the exotesta (Fig. 9) with prominent anticlinal walls, polygonal, 25 - 30 μm length and the periclinal walls plane, finely sculptured. The origin unknown with certitude; probably an European mutant of *A. powellii*.



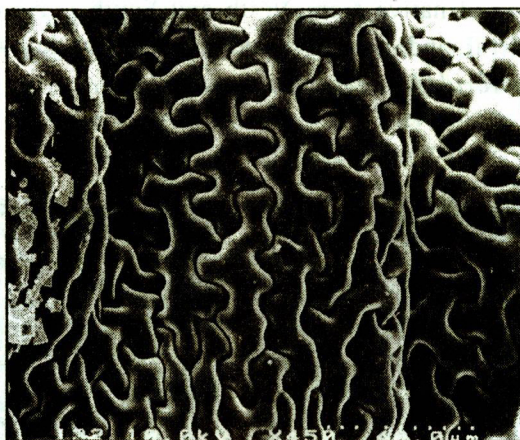


Fig. 11. - *A. powellii* subsp. *bouchonii*  
- surface of pericarp  
- type B of organisation (450 $\times$ ).

***Amaranthus retroflexus* L , Sp. Pl.: 991(1753).**

Typus: "Habitat in Pennsylvania"; LINN 1117/22.

Annual weeds with erect stem, stout, usually branched, up to 1.5(2) m. Plant scurfy villous in and for some distance below the inflorescence, trichomes multiseriate and uniseriate being present. Leaves long-petiolated, ovate or rhombic-ovate, 3-7  $\times$  2-4 cm, usually coarsely pubescent beneath, at least along the veins. Inflorescence usually with many short, thick and crowded branches, the terminal ones about as long as the laterals. Bracteoles (2.5)4-6(8) mm, 1-3  $\times$  longer than the tepals. Tepals 5,  $\pm$  outcurved 2.5- 3 mm long, linear-cuneate to spatulate, rounded, truncated or emarginated, usually mucronated at the tip, often with inconspicuous or pale mid-veins. The perigon is much surpassing the fruit. Fruit dehiscent, about 2 $\times$  longer than wide, obovoidal, gradually narrowed toward the stigma region. Dehiscence line in the upper part coarsely wrinkled above the dehiscence line. Type of pericarp surface variable, A to B. Seeds obovate 1.1-1.25  $\times$  0.8-0.9 mm, lenticular. Between the hilum and the radicle is present a furrow, prolonged almost to the middle of the seed. The seeds are differentiated in a central, smooth zone and a marginal, sculptured zone. Colour dark-brown to black, uniform. Pollen grains 20-27  $\mu$ m, with 30 - 42 pores of 1.1-1.4  $\mu$ m in diameter. Density of granules high.  $2n = 34$ .

**Acknowledgements.** I am very grateful to Dr. Gerold Hügin for his constant help along these years as well as to Prof. dr. Julio Iranzo who kindly made possible the SEM studies. In addition, I am much indebted to Prof. Dr. Jose Luis Carretero for his assistance and the useful discussions over the



problems of the genus. Moreover, I owe thanks to my teachers Prof. Dr. Vasile Ciocârlan, Prof. Dr. Livia Ungurean and Prof. Dr. Constantin Chirilă. Finally, I am obliged to Dr. Gheorghe Dihoru, Dr. Gavril Negrean and Dr. Nicolae Roman for their observations and suggestions.

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Received January 4, 1999

University of Agricultural Sciences  
Department of Botany  
Bd. Mărăști 59, 71331, Bucharest



# NEW AND RARE PLANTS OF ROMANIA'S FLORA

PETRU BURESCU

The author notifies the presence of new infrataxons at form rank recorded in Romanian flora for the first time, a new form: *Typha angustifolia* L. f. *mixtum* f. nova, and two new records for Romanian flora: *Typha angustifolia* L. f. *spathacea* Borb. ex. Géze, *Typha angustifolia* L. f. *Uechtrizii* Kronfeld.

The plants have been identified vegetating in phytocoenoses of some lakes, ponds and marshes of the Romanian North-Western Plain. For identification we will briefly present the diagnosis of the new forms that assess for species variability and the data concerning the ecology and biogeography of these forms.

**Key words:** *Typha angustifolia*, new plant species, Romanian flora.

During the studies on aquatic and marsh vegetation between 1994 and 1998, in the north-western Romania, a new form of the species *Typha angustifolia* L. was discovered, *Typha angustifolia* L. f. *mixtum* f. nova; two new records, previously undescribed for the Romanian Flora are also to be notified: *Typha angustifolia* L. f. *spathacea* Borb. ex. Géze and *Typha angustifolia* L. f. *Uechtrizii* Kronfeld.

The specimens were found vegetating in several aquatic habitats as lakes, ponds and marshes in the North-Western Romanian Plain, as members of phytocoenoses. For identification, several sources were used: *Flora României* (2), *Flora Europaea* (3), works of R. Sáo (1). The specimens were compared with collection material from the Herbarium of Cluj-Napoca University.

*Typha angustifolia* L. was previously described in *Flora României* (2); consequently we give the diagnosis of infrataxonomic rank of newly identified forms. We also present some information about the ecology and biogeography of the forms.

## SPECIES VARIABILITY

Identification key at infrataxonomic rank of *Typha angustifolia* L.

1. *Typha angustifolia* L. f. *spathacea* Borb. ex. Géze. The male and female spikes are at distance one from another. The male inflorescence is provided with a long sword blade (spate) of 15-30 cm. This new record (Fig. 1a) for Romania was found in Bihor county, Diosig commune, Ianca lake; commune Săcuieni, lake Olosig, commune Buduslău, Crestur lake, commune Diosig, lake Fazanilor, commune Curtuișeni, lake Vășad and in Satu Mare county, commune Sanislău, lake Horea.

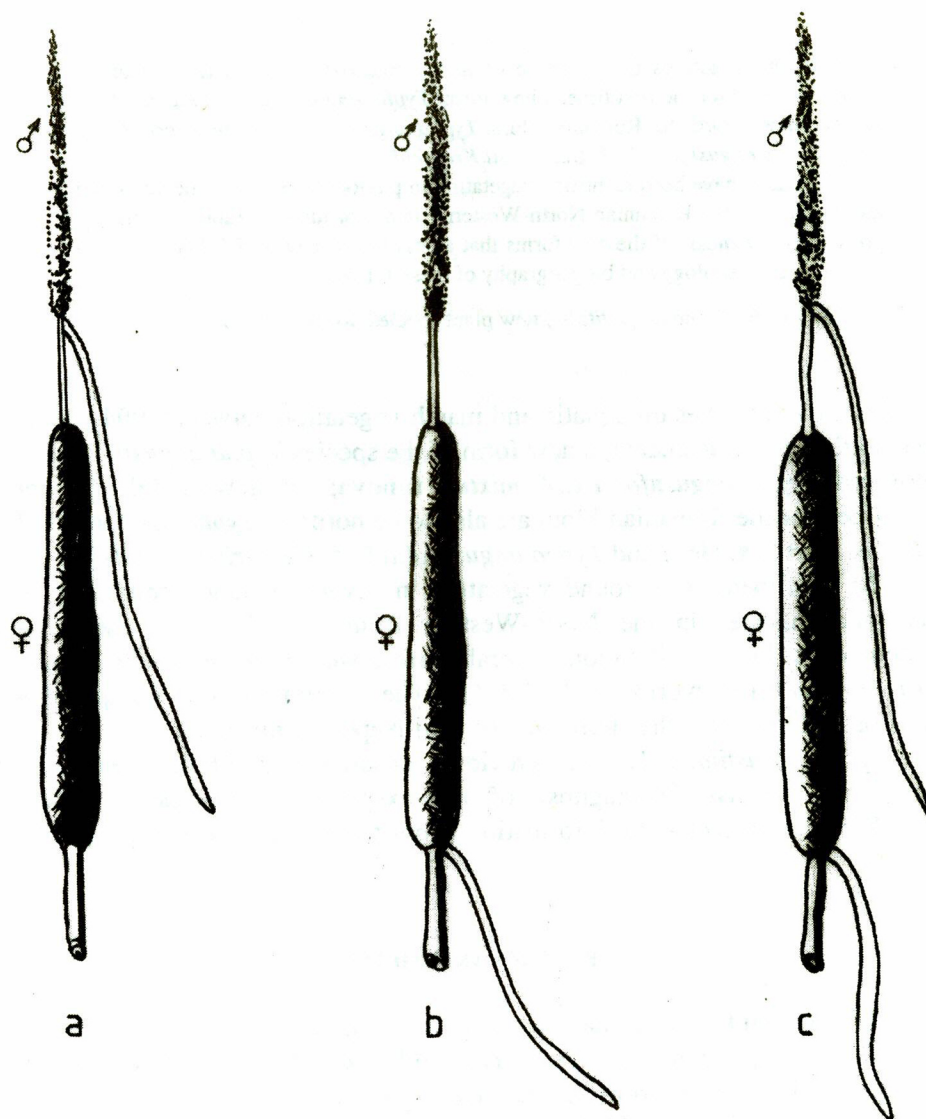


Fig. 1. a - *Typha angustifolia* L. f. *spathacea* Borb. ex. Géze b. *Typha angustifolia* L. f. *Uechtritzii* Kronfeld c. *Typha angustifolia* L. f. *mixtum* f. nova.



2. *Typha angustifolia* L. f. *Uechtritzii* Kronfeld. The male and female spikes are at distance one from another. The female inflorescence is provided with a long sword blade of 15-30 cm. This new record was found in Bihor county (Fig.1b), commune Diosig, lake Ianca, commune Săcuieni, lake Olosig, commune Buduslău, lake Albiș, commune Tarcea, lake Galoșpetreu, commune Curtuișeni, lake Vășad, also in Satu Mare county, commune Sanislău, lake Horea.

3. *Typha angustifolia* L. f. *mixtum* f. nova. The male and female spikes are at distance one from another. At the base of each female and male inflorescence, a long sword blade of 15-30 cm emerges. The specimens of this newly described infrataxon were found in Bihor county (Fig. 1c), commune Diosig, lake Ianca, lake Fazanilor, commune Săcuieni, lake Olosig, commune Buduslău, lake Crestur, also in Satu Mare county, comune Sanislău, lake Horea in the neighbourhood of the village Horea.

*Typha angustifolia* L. f. *mixtum* f. nova, masculi et femini multiflori pediculi basis longa spatula providetur.

*Typha angustifolia* L. f. *mixtum* f. nova, *Typha angustifolia* L. f. *spathacea* Borb. ex Géze, *Typha angustifolia* L. f. *Uechtritzii* Kronfeld vegetates on hydromorphic, halomorphic, gleic and pseudogleic soils, also in shallow waters at the margins of lakes and ponds.

The species and its forms are components of lake and marsh phytocoenoses, in the association *Typhetum angustifoliae* Pignatti 1953 of *Phragmition communis* Koch 1926 alliance.

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Received on April 2, 1999.

University of Oradea  
Faculty of Environmental Protection,  
Gen. Magheru 26,  
3700, Oradea, Romania





# INVASIVE BEHAVIOR OF HIGHLY COMPETITIVE SUBMERGED MACROPHYTES IN EUTROPHIC CONDITIONS

ANCA SÂRBU\*, ANGHELUȚĂ VĂDINEANU\*\*, SERGIU CRISTOFOR\*\*\*

Submerged vegetation was studied in the framework of an integrated research programme, on the assessment of the production and carrying capacity of representative ecosystems of the Lower Danube Floodplain and The Danube Delta, in relation to the rapid eutrophication which occurred in the latest 1.5 decades. Changes induced in the diversity and in the ecological role of this very important compartment of primary producers in shallow lakes were studied in terms of the main characteristics of plant populations (biomass, photosynthetic pigments, nutrient uptake as well as growth responses in experimental conditions) and of the main abiotic factors (hydrology, nutrient load, light regime, alkalinity and pH) throughout successive growth seasons, between 1991 and 1995. The results present a simple species structure, in general dominated by two populations, *Potamogeton pectinatus* L. and/or *Ceratophyllum demersum* L. Structural and functional abilities of different species (tolerance to nutrient toxicity, efficiency in competition for light and inorganic C source and allelopathic relationship) are discussed to explain restructuring of the vegetal communities and the invasive behavior of these two species.

*Key words:* hydrology, nutrients, light, allelopathy, competition, diversity.

## INTRODUCTION

Submerged macrophytes are important and very sensitive primary producers, deeply involved in eutrophication processes and consequences in the structure and functions of the shallow aquatic systems of the Lower Danube River System (LDRS). Important changes of LDRS (including the Lower Danube Floodplain and the Danube Delta) recorded in the last 15 years have resulted from the previous (1965-1987) hydrotechnical works like drainage, damming and canalization (8). About 80% of the floodplain was taken out of the natural flooding regime, reducing the nutrient retention capacity of the floodplain, simultaneously with multiplication of diffuse nutrient sources at the catchment scale, which accelerated the transition towards hypertrophy of most aquatic ecosystems (9). Different effects have been induced in structural, functional and successional reorganization of communities: a general decrease of biodiversity by repression of some compartments (e.g. the macrophytes-epiphytes complex) and a change in species composition and abundance within compartments (e.g. blue-green algae dominance of phytoplankton and *Potamogeton* sp. and *Ceratophyllum* sp. dominance of submerged vegetation). Generally, only few, but highly competitive submerged macrophytes were able to grow under such trophic conditions, leading to a simplification of the communities and to important changes in the strategy of



energy flow maximization (4). Hydrological and nutrient regimes were identified as the major factors directly or indirectly affecting the behavior of aquatic primary producers with different structural responses from lake to lake (5). This paper focused on the identification of the morphological, physiological and behavioral features of the dominant submerged macrophytes and on revealing their significance in qualitative and/or quantitative changes within these communities (6).

## MATERIAL AND METHODS

Nine lakes and two channels from the Danube Delta and two other lakes from the Lower Danube Floodplain were studied between 1991 and 1995. All these lakes are shallow (0.5-3.1 m depth), but are different in size as well as in hydrological and vegetal communities terms (Table 1). Hydrological features of the delta lakes and channels are mainly controlled by the water level regime of the river (lakes Babina, Matița, Băclănești, Bogdaproste, Isac and Uzlina) or by the about stable level of the Black Sea (lakes Puiu and Roșu). Hydrology of the floodplain lakes (L. Gâsca and L. Chiriloaia) is partially controlled by barriers for fish trapping. The research included both field and experimental studies. The selected aquatic systems were studied during five years in terms of main biotic and abiotic parameters: species richness, biomass, assimilatory pigments content, biomass Ca stock, water nutrient load, pH, transparency index (ratio between Secchi and lake depths) and water O<sub>2</sub> content. Monthly 9-15 vegetation sample units (0.16 m<sup>2</sup>) were collected from each lake and channel, from March till November. Species diagnosis accords with Săvulescu (7). The assimilatory pigments chlorophyll *a* and *b* and carotin pigments (spectrophotometric assessment according to Holm, 1954) and Ca content (flame emission photometry  $\lambda=422.7$  nm) in biomass of dominant species were also analyzed monthly. The biomass increase and N & P uptake capacity of the dominant submerged macrophytes were estimated under experimental conditions of nutrient supply (NaNO<sub>3</sub>, KPO<sub>4</sub>H<sub>2</sub>): V1 (10/50  $\mu\text{g P/N l}^{-1}$ ), V2 (25/250  $\mu\text{g P/N l}^{-1}$ ) and V3 (100/1000  $\mu\text{g P/N l}^{-1}$ ) in three replicates. The selection of nutrient concentrations used in experimental studies covers the fluctuation domain of nutrient load recorded in the study sites between 1989 and 1993. For the N and P assessment, the biomass was mineralized with H<sub>2</sub>SO<sub>4</sub> (con. 1.84) and perhydrol 30%, according to the Kjeldahl method. The total nitrogen dosing was made by distillation of the NH<sub>3</sub>, obtained from the mineralization. Phosphorus was determined spectrophotometrically ( $\lambda=420$  nm) using the method of phosphates staining with a mixture of nitric acid, ammonium molybdate and ammonium vanadate.

The allelopathic influences between submerged macrophyte species were assessed in experimental conditions, including a synchronization pretreatment of plants in similar conditions of photoperiod, temperature and water chemistry. Five



alternatives and three replicates were considered by specific filtrates of 2 weeks growth monospecific cultures of studied species, mixed in proportion 1:1 with lake water. Photosynthesis and respiration processes were measured in terms of oxygen consumption and release in clear and black enclosures after 24 hours.

## RESULTS AND DISCUSSION

The structural dynamics of submerged macrophytes, in terms of species richness and biomass density, were related with spatial heterogeneity and with the nutrient and light regime. The contribution of submerged vegetation to the strategy of energy flow maximization was different in space (from lake to lake) and also in time (along the growing season). The studied aquatic ecosystems were divided into three categories: (i) lakes with exclusively phytoplanktonic primary producers (Matița), (ii) lakes or channels dominated by submerged macrophytes, located both in the Danube Delta (Băclănești, Bogdaproste, Uzlina, Șontea, Lopatna) and floodplain (Gâsca, Chiriloaia), (iii) lakes with few submerged vegetation, located in the Delta (Puiu, Roșu, Merhei, Isac, Babina) (Table 1).

Table 1

Main features of the aquatic ecosystems studied in the Danube Delta and Floodplain  
(average annual values)

| Sites            | Surface | Depth | Transparency | pH  | Dominated by                                                  |
|------------------|---------|-------|--------------|-----|---------------------------------------------------------------|
| Delta            | (ha)    | (cm)  | index        |     |                                                               |
| 1                | 2       | 3     | 4            | 5   | 6                                                             |
| Puiu lake        | 865     | 260   | 0.23         | 8.6 | phytoplankton                                                 |
| Roșu lake        | 1445    | 265   | 0.27         | 8.3 | phytoplankton                                                 |
| Matița lake      | 652     | 239   | 0.30         | 8.6 | phytoplankton                                                 |
| Merhei lake      | 1057    | 230   | 0.65         | 8.5 | macrophytes<br>( <i>P. pectinatus</i> )                       |
| Isac lake        | 1101    | 220   | 0.35         | 8.7 | macrophytes<br>( <i>P. pectinatus</i> )<br>phytoplankton      |
| Babina lake      | 432     | 190   | 0.33         | 8.6 | macrophytes<br>( <i>P. lucens</i> L.)<br>phytoplankton        |
| Băclănești lake  | 241     | 140   | 0.97         | 8.0 | macrophytes<br>( <i>C. demersum</i> ,<br>filamentous algae)   |
| Bogdaproste lake | 435     | 120   | 0.60         | 8.2 | macrophytes<br>( <i>C. demersum</i> ,<br><i>N. obtusa</i> *)  |
| Uzlina lake      | 485     | 170   | 0.45         | 8.0 | macrophytes<br>( <i>C. demersum</i><br><i>P. pectinatus</i> ) |

Table 1 (continued)

| 1                 | 2    | 3   | 4    | 5   | 6                                     |
|-------------------|------|-----|------|-----|---------------------------------------|
| Lopatna channel   | 295  | 160 | 0.30 | 7.7 | macrophytes<br>( <i>C. demersum</i> ) |
| Șontea channel    | 225  | 150 | 0.48 | 7.6 | macrophytes<br>( <i>C. demersum</i> ) |
| <b>Floodplain</b> |      |     |      |     |                                       |
| Gâsca lake        | 6.2  | 120 | 0.70 | 7.6 | macrophytes<br>( <i>C. demersum</i> ) |
| Chiriloaia lake   | 11.5 | 130 | 0.80 | 7.6 | macrophytes<br>( <i>C. demersum</i> ) |

\* *Nitellopsis obtusa* (Desv. in Lois) J.Gr.

Only two of the 26 species identified in the aquatic systems populated by submerged macrophytes played a dominant role at the general study scale: (i) *Potamogeton pectinatus*, with vertical growth strategy supporting a single, early biomass peak, in relatively deeper lakes (Puiu, Roșu, Merhei, Isac), with limited species richness and mean water nutrient load, between 250-400  $\mu\text{g N l}^{-1}$  and 25-40  $\mu\text{g P l}^{-1}$ , (ii) *Ceratophyllum demersum*, in the second part of growth season, in relatively shallower lakes (Băclănești, Gâsca, Chiriloaia) and channels (Lopatna, Șontea) with mean water nutrient load, between 400-800  $\mu\text{g N l}^{-1}$  and 50-175  $\mu\text{g P l}^{-1}$ , supporting early higher diversity but low biomass, succeeded by late low diversity but high biomass (Fig. 1).

As a result of the fast eutrophication, competition for nutrients has been replaced by competition for light, as the main mechanism controlling the dynamics and structure of aquatic primary producers. For this reason, *Najas marina* L., *Nitellopsis obtusa* (Desv. in Lois) J.Gr. and *Vallisneria spiralis* L. which dominated these shallow lakes till 1980-1982, being able to compete for both pelagial and benthal nutrient pools, have been replaced by *Potamogeton* sp. (5 species in 1982-1987 increasing to 10 species in 1991-1995). *P. pectinatus* has been especially successful with its vertical growth strategy and efficient photosynthetic pigment structure, able to reach in a limited time the euphotic layers of eutrophicated water bodies. Even in these conditions, *C. demersum* was better represented (in terms of frequency, biomass density and productivity) in the eutrophic aquatic systems as *P. pectinatus* was. *C. demersum* has maintained or even increased its dominance (50-75%) due to its ubiquitous behavior. Other abilities, such as N-tolerance and high capacity to use inorganic carbon source, can be associated with the ability to compete efficiently for light.



A detailed presentation of these mechanisms as responses of submerged macrophytes to accelerated eutrophication by invasive behaviour of few species, as they occurred in LDRS, is given below. Both dominant species (*P. pectinatus* and

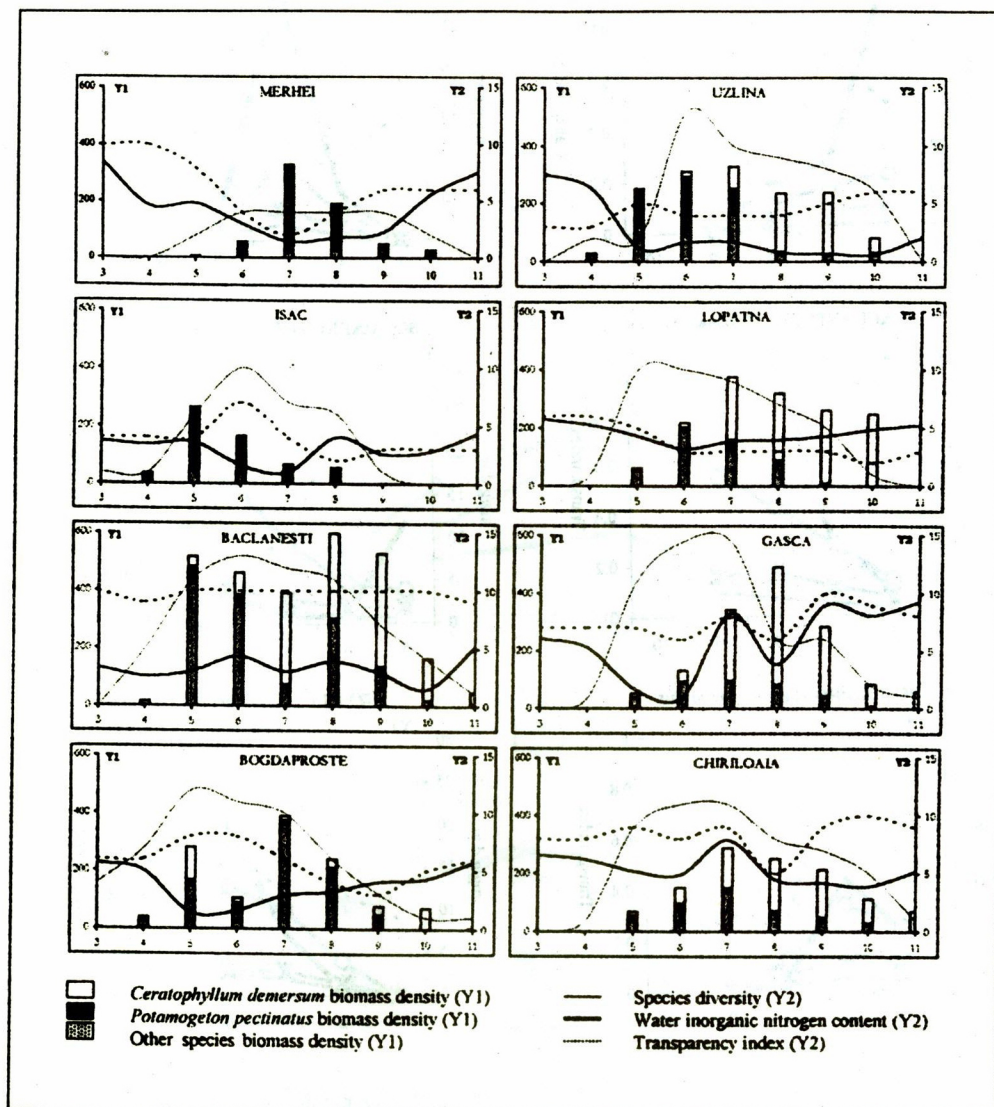


Fig. 1. – Dynamics of biomass density (g d.w. m<sup>-2</sup>), species richness, water inorganic nitrogen (μg l<sup>-1</sup>) content (×10) and transparency index (×10), in selected ecosystems of the Danube Floodplain and Delta (monthly mean values/growth season 1991–1995; months – X axis).

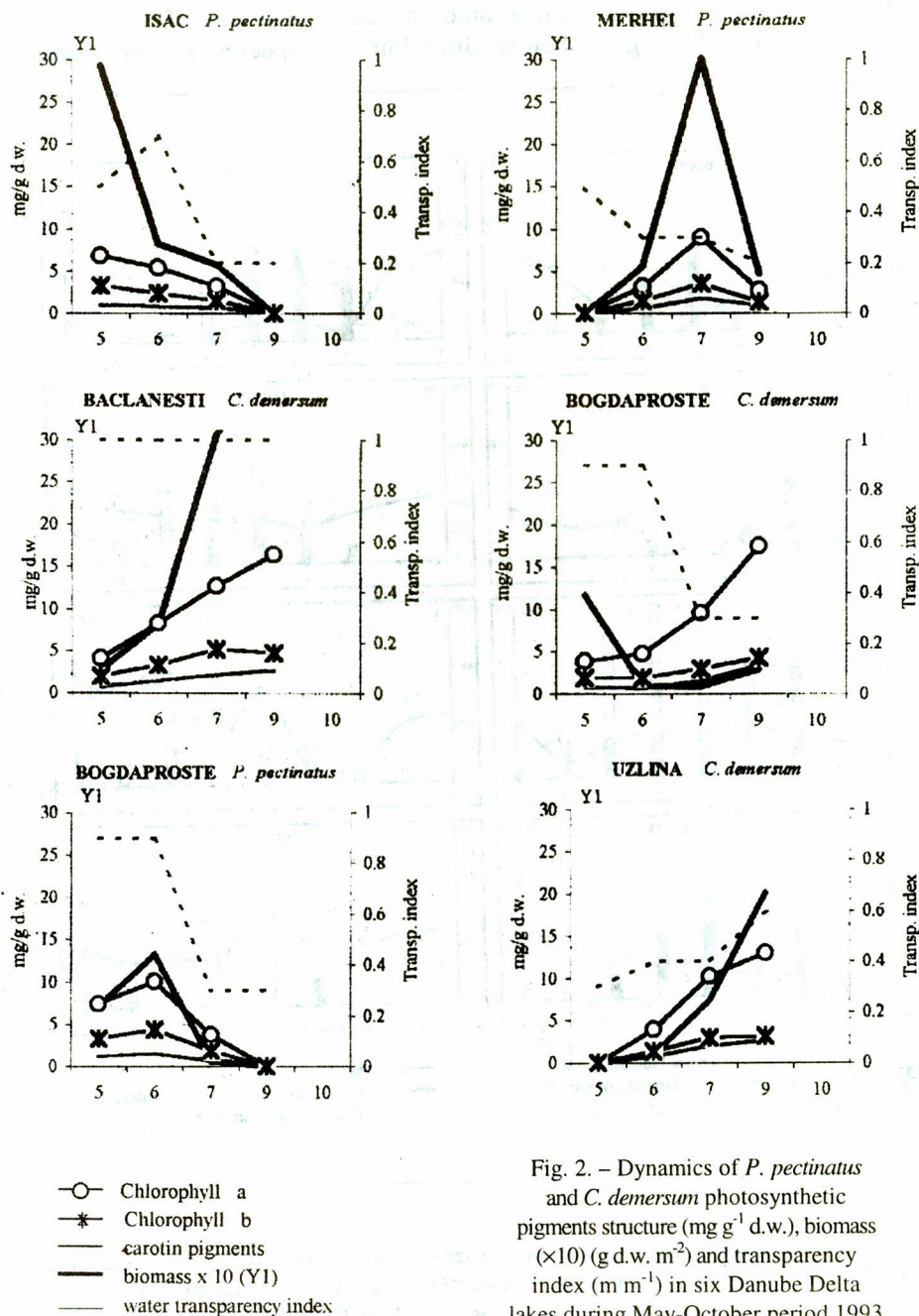


Fig. 2. – Dynamics of *P. pectinatus* and *C. demersum* photosynthetic pigments structure ( $\text{mg g}^{-1} \text{d.w.}$ ), biomass ( $\times 10$ ) ( $\text{g d.w. m}^{-2}$ ) and transparency index ( $\text{m m}^{-1}$ ) in six Danube Delta lakes during May-October period 1993 (months – X axis).



*C. demersum*) seem to have successfully competed for light by specific mechanisms, including both growth strategies and pigmentary dynamics in accordance with their morpho-functional features. Rapid vertical growth in spring and decrease of chlorophyll *a* content (2.5 ‰ d.w.) after a spring/early summer peak (16.8 ‰ d.w.) could be advantageous for *P. pectinatus* (Fig. 2). Development of resistant body (strong cuticula and colenchyma tissue are present) in upper layers of the floating mats and high chlorophyll concentration (up to 25 ‰ d.w.) throughout the entire growing season could be convenient for *C. demersum*. The seasonal dynamics of total photosynthetic pigments content of *C. demersum* showed also a marked and homogeneous increase, not depending on water transparency (Fig. 2).

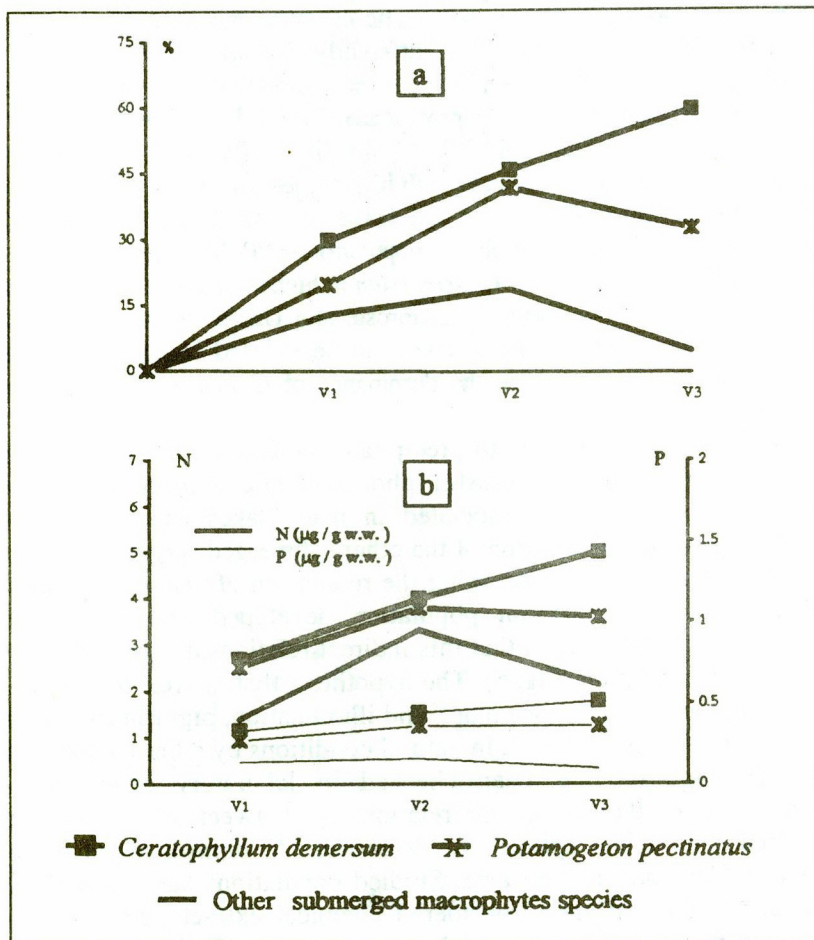


Fig. 3. – (a) Biomass increase and (b) N & P biomass content of submerged macrophytes in experimental conditions of nutrients load: V1 (10/50 µg P/N l<sup>-1</sup>), V2 (25/250 µg P/N l<sup>-1</sup>), V3 (100/1000 µg P/N l<sup>-1</sup>).

Different answers (in terms of biomass increase and nutrient uptake capacity) to high nutrient concentration and to allelopathic influence could explain their different behavior in different trophic stages and water bodies. A comparative analysis of the biomass increase and nutrients (N & P) uptake capacity of *C. demersum*, *P. pectinatus* and other dominant species (*P. perfoliatus* L., *P. trichoides* L., *P. lucens* L., *Elodea canadensis* Rich., filamentous green algae), in the same experimental conditions of nutrient loads (V1, V2, V3), showed a stimulant effect of higher N and P concentration (V3) for *C. demersum* growth, inhibition by 20% of *P. pectinatus* and filamentous green algae, and severe repression (87-96%) of the other considered species (Fig. 3).

Competition for inorganic C seems to be also involved in the regulatory processes in hypertrophicated waters or stages. In aquatic ecosystems with limited CO<sub>2</sub> content, most submerged plants are able to uptake differently C from bicarbonate and to induce associated changes in water alkalinity (1). High uptake ability for inorganic C, assessed in terms of endogenously and exogenously precipitated Ca, has been shown by *C. demersum* (2.40-3.60%) in lower alkalinity (pH 7.2-7.8) conditions (lakes Gâsca, Chiriloaia and channels Șontea and Lopatna) associated with high frequency of CaCO<sub>3</sub> crystals over the epidermal cuticula and inside the cortical cell, compared with *P. pectinatus* (1.66-2.45%) and other present submerged macrophytes populations (1.0-2.18%). A decrease of this value with 20-30% was recorded for *C. demersum* in higher alkalinity circumstances (pH 8.0-8.6), in lakes Babina, Băclănești, Bogdaproste and Uzlina. In these conditions, the water alkalinity variation, from lake to lake, can be induced by the submerged plant communities structure, depending on the dominance of *C. demersum* or *P. pectinatus* populations (Fig. 4).

The ability of *C. demersum* to precipitate the CaCO<sub>3</sub> and to buffer diurnal CO<sub>2</sub> deficit has ensured a successful photosynthetic activity and growth in different eutrophic conditions, associated in many lakes and channels with a decrease of diversity and production of the other submerged species (Fig. 5).

The preliminary results concerning the repression of many other submerged macrophytes when *C. demersum* population developed and water alkalinity decreased suggest the hypothesis that this indirect relationship could be important for interspecific competition (Fig. 5). The hypothesis that the relationship between photosynthesis process, on the one hand, and illumination, pigmentary content and age, on the other hand, is interfered in natural conditions by other factors including chemical interaction (2) has been checked in laboratory conditions. The experimental study on the allelopathic relationships between aquatic macrophytes has considered 5 dominant species: *C. demersum*, *N. obtusa*, *Najas marina*, *P. pectinatus* and filamentous green alga. Studied populations have shown different significant answers to different considered chemical extracts, from hetero- and autostimulation to hetero- and autoinhibition, excepting *C. demersum* which has been generally neutral, both in terms of photosynthesis and respiration processes. On the contrary, *P. pectinatus* has shown the most sensitive behaviour in terms of hetero- and autoinhibition relationship.



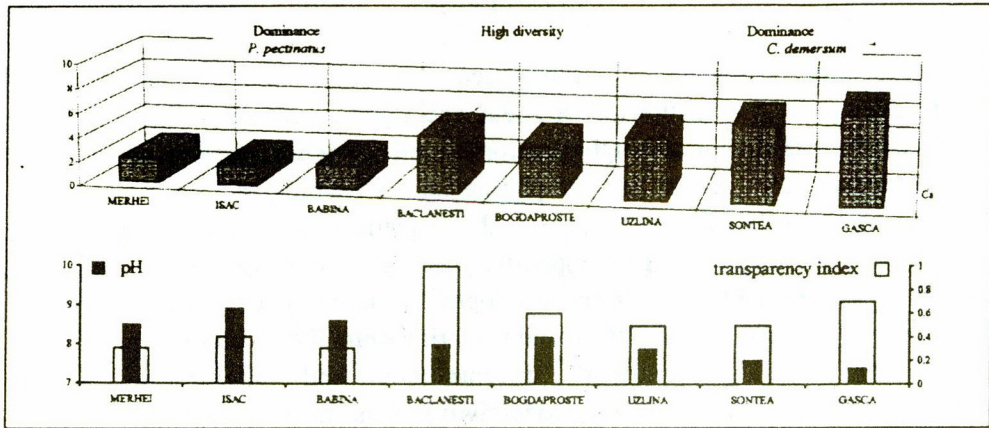


Fig. 4. – Total Ca content in submerged macrophytes biomass (g Ca m<sup>-2</sup>), pH and transparency index (m m<sup>-1</sup>), in selected ecosystems of the Danube Floodplain and Delta (mean values/growth season 1993-1994).

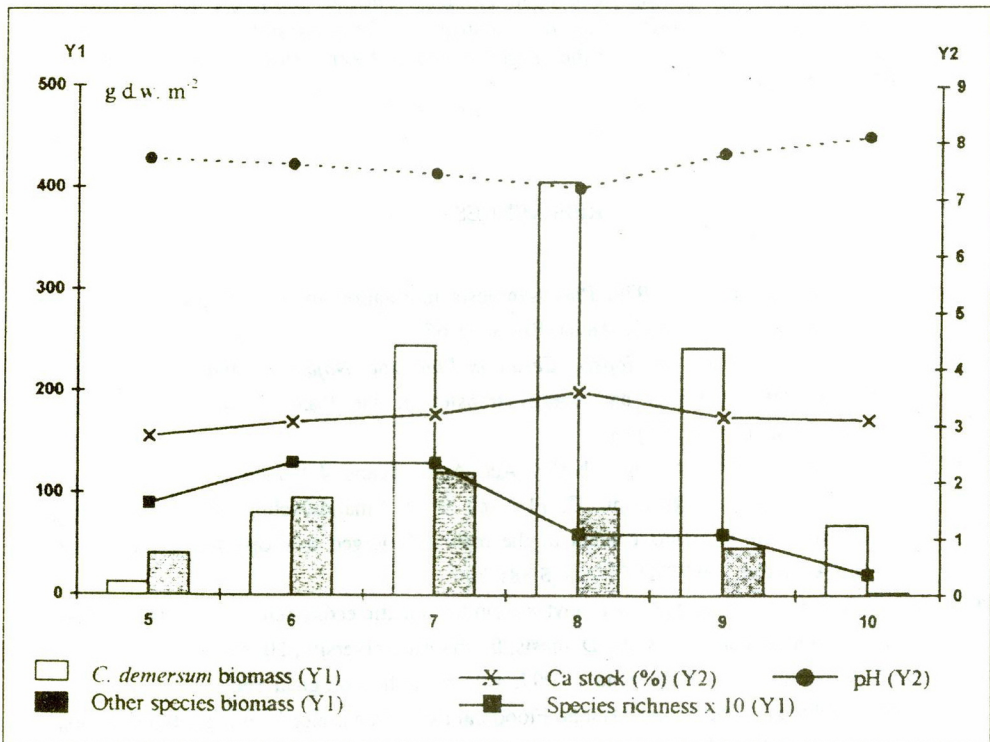


Fig. 5. – Dynamics of *C. demersum* biomass (g d.w. m<sup>-2</sup>) and Ca stock (%), other submerged macrophytes biomass density (g d.w. m<sup>-2</sup>), species richness (x10) and pH, in lake Gásca (monthly mean values/growth season 1992-1995; months – X axis).

## CONCLUSIONS

Structural dynamics of submerged vegetation was related to the heterogeneity and fluctuations of nutrient and light conditions in water bodies. Only two species dominated highly eutrophicated water stages: *P. pectinatus* and *C. demersum*. A series of morphological, physiological and behavioral characteristics explained the changes within aquatic weed communities and the role of these two species: high competitiveness for light (by vertical or floating mats growth strategies and by specific chlorophyll content and dynamics) and for inorganic C (precipitating of  $\text{CaCO}_3$  and buffering diurnal  $\text{CO}_2$  crisis) and different sensitivities to high nutrient concentrations and allelopathic actions (stimulation/inhibition of primary productivity). This invasive behavior seems to be an alternative and unbalanced contribution of primary producers to the energy flow maximization tendency in eutrophic aquatic systems.

*Acknowledgements.* Special thanks to Prof. Dr. Doc. Nicolae Botnariuc for his scientific advice and to our colleagues for direct and indirect contribution. This research was supported by the Ministry of Research & Technology under the program Orizont 2000 (488B/A2, A3, A4/1993) and by the CNCSU (5009-902/1995).

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*Received on May 6, 1999*

*\* Bucharest University, Dept. of Botany,  
Aleea Portocalelor 1-3, RO-77206,  
Bucharest 5, Romania  
Phone: 40 1 638 71 75;  
E-mail: asarbu@botanic.unibuc.ro*

*\*\*Bucharest University, Dept. of System Ecology,  
Spl. Independenței 91-95, RO-76201,  
Bucharest 5, Romania Phone/Fax: 40 1 411 2310;  
E-mail: anvadi@bio.bio.unibuc.ro*

*\*\*\*Bucharest University,  
Brăila Ecological Research Station,  
Ana Aslan 27, RO-6100, Brăila, Romania  
Phone/Fax: 40 39 670 046;  
E-mail: cristof@bio.bio.unibuc.ro*





# THE VEGETATION OF THE PIATRA CRAIULUI MASSIF AND ITS CONNEXIONS WITH OTHER ROMANIAN CARPATHIAN MOUNTAINS

SIMONA MIHĂILESCU

In this paper we showed a comparison between the vegetation of some calcareous massifs or calcareous parts of some massifs from Romanian Carpathian Mountains. This comparison was based on the calculation of the Jaccard qualitative index of similarity. We followed especially, the way by which the vegetation of the Piatra Craiului Massif is integrated in the complex of the Bârsei and the Bucegi Mountains and other massifs of the Carpathian chain. A number of 5 vegetal associations were analysed, whose presentation was done in this study following the ranging of the associations, starting with the associations characterised for the mountain level and finishing with those of the alpine level.

*Key words:* calcareous vegetation, Romanian Carpathians, Jaccard index, cladistics.

## INTRODUCTION

The Carpathian chain is situated at the intersection of continental climate influences and subatlantic and central-european influences, while its southern part is exposed to submediterranean influences (3). Therefore, the alpine meadows vegetation is the result of the climatic conditions determined by the mountain chain with its symmetric and axial position in the centre of the country.

In its assembly the Carpathian chain still keeps the vestiges of a rich autochthonous floristic base, which seems to be of a tertiary age, but this ancestral base so homogeneous at its origin has been very early subjected to allochthonous immigrations of the most different geographic origins.

The comparison that points out the similarity of vegetation from some calcareous mountains or limestone zones of several Romanian Carpathian Mountains is based upon the calculation of the Jaccard similarity index and the obtention of some similarity dendrograms based on cladistics method (11). It was used the quality index of similarity, Jaccard (based on presence / absence criteria) which allows a close examination of data and relèves from the vegetation tables.

It has been emphasized the way by which the Piatra Craiului Massif are integrated in the Bârsei Mountains Complex (which includes Piatra Craiului, Postăvaru and Piatra Mare Mountains) and in the Bucegi Massif, but, in order to follow the differences or the resemblances, other data from the: Cerna-, Retezat-, Rodna Mountains and the Apuseni Mountains (which include the Scărița-Belioara and the Bihor Mountains) have also been taken into account (Fig. 1).

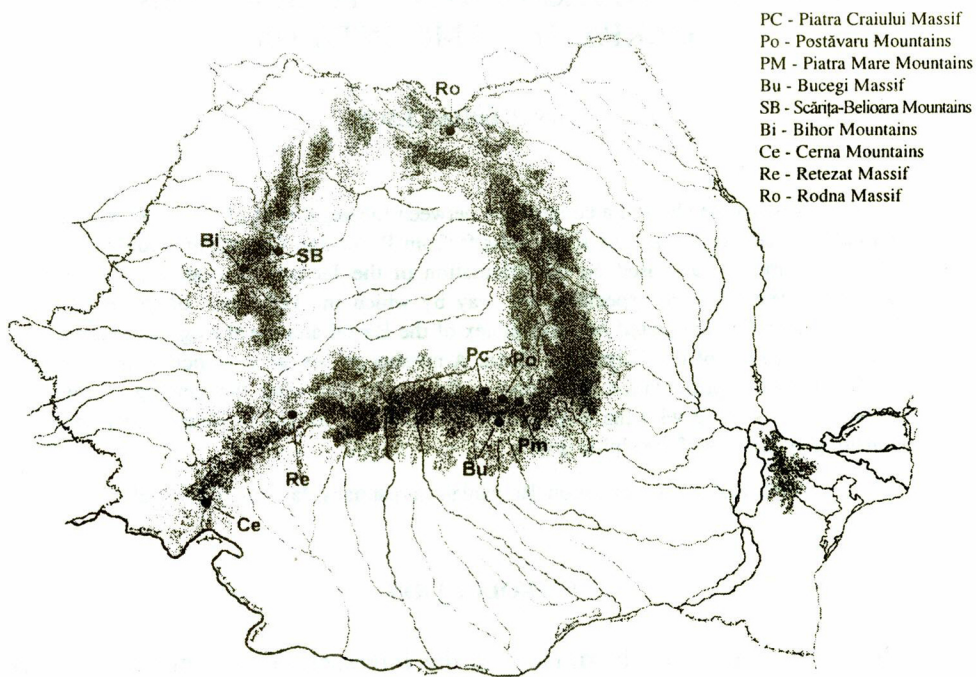


Fig.1. – The geographical position of the Romanian Carpathian Mountains.

## RESULTS AND DISCUSSIONS

The associations have the following syntaxonomical position:

Cl. *Betulo-Adenostyletea* Br.-Bl. & Tx. 1943

Ord. *Adenostyletalia* Br.-Bl. 1931

Al. *Adenostylon alliariae* Br.-Bl. 1925

Subal. *Delphinienion elati* (Hadač 1969) Boșcaiu & Mihăilescu 1997

*Astrantio-Delphinietum elati* Boșcaiu & Mihăilescu 1997

Cl. *Querco-Fagetea* Br.-Bl. & Vlieg. 1937

Ord. *Fagetalia* Pawl. 1928

Al. *Symphyto-Fagion* Vida 1963

Subal. *Moehringio muscosae-Acerenion* Boșcaiu & al. 1982

*Phyllitidi-Fagetum* Vida 1963

(*Asplenio scolopendri-Fagetum* nom. mut. propos.)

Cl. *Asplenietea trichomanis* (Br. Bl. in Meier & Br.-Bl. 1934) Oberd. 1977

Ord. *Potentilletalia caulescentis* Br.-Bl. 1926

All. *Cystopteridion* Rich. 1972

*Asplenio-Cystopteridetum fragilis* Oberd. (1939) 1949

subass. reg. *campanuletosum carpaticae* (Sanda & al. 1977) Coldea 1992

Cl. *Seslerietea albicantis* Br.-Bl. em. Oberd. 1978

Ord. *Seslerietalia albicantis* Br.-Bl. 1926



All. *Seslerion rigidae* Zóly. 1939

*Asperulo capitatae-Seslerietum rigidae* (Zóly. 1939) Coldea 1991

All. *Festuco saxatilis-Seslerion bielzii* (Pawl. & Walas 1949) Coldea 1984

*Seslerio haynaldianae-Caricetum sempervirentis* Puşcaru & al. 1956

The presentation is done in this study following the ranging of the associations, starting with the associations characterised for the mountain level and finishing with those of the alpine level. In general, for the Piatra Craiului Massif we used personal data for relevés.

### ***Phyllitidi-Fagetum* Vida 1963**

In majority of mountain massifs, the vegetation of the forest from the mountain layer is characterised by the presence of different types of beech forests which are spread, in most of the cases, on large areas.

A particular type of beech forest is represented by *Phyllitidi-Fagetum* which grows on calcareous slopes, on rendzina soil, rich in humus, in shadowy places, with a high degree of humidity, as well as on fixed or semifixed screes. This association is an intrazonal type of association situated at a mountain level. Into the tree layer it has *Fagus sylvatica* which is codominant with *Acer pseudoplatanus*.

Compared to the beech forest types which exist in the Romanian Carpathians Vegetation (*Symphyto cordati-Fagetum* Vida 1963, *Pulmonario rubrae-Fagetum* (Soó 1964) Täuber 1987, *Leucanthemo waldsteinii-Fagetum* (Soó 1964) Täuber 1987), *Phyllitidi-Fagetum* depends a lot upon the geological substrate (calcareous), which could be explained by the close grouping of the relevés within the clusters of the dendrogram (Fig. 2).

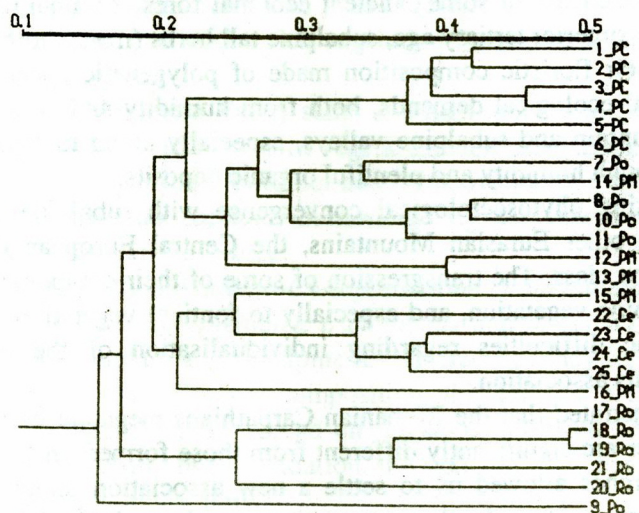


Fig. 2. – Dendrogram of *Phyllitidi-Fagetum* association for the Piatra Craiului (PC), Postăvaru (Po), Piatra Mare (PM), Rodna (Ro) and Cerna (Ce) Mountains.

The dendrogram of *Phyllitidi-Fagetum* associations has resulted from the processing of the original and literature data. For Postăvaru Mountain we used data after H. Fink (8), table 51, relevés 1, 2, 3, 4, 6; for Piatra Mare Mountain we used data after I. Buiculescu (5) table 4, relevés 1, 2, 3, 12, 13 and for Cerna Mountain we used data after N. Boşcaiu (2) table 55, relevés 6, 7, 8, 9. The concentration of the relevés in the cluster dendrogram (Fig. 2) shows clearly the resemblances as far as a floristic composition is concerned between the massifs which belong to the Bârsei Mountains (Piatra Craiului, Postăvaru and Piatra Mare Mountains). The values of the calculated index for this massif are very close to each other. Another branch of the cluster shows that position within the dendrogram of phytocoenosis from the Cerna Valley is quite close to those from the Bârsa Mountain group.

The Rodna Massif (Corongiș, Cormaia and Anieș Valleys) remains more isolated because of its floristic composition properties, which are probably determined by its locations to a different latitude of the massif. At this latitude, the influence determined by the elements of submediterranean origin is very low. For the Rodna Massif we used data of relevés after G. Coldea (6) table 66, relevés 1, 2, 3, 6, 7.

#### *Astrantio-Delphinietum elati* Boşcaiu & Mihăilescu 1997

At the border of the spruce forest zone, near to the slope stones or in regions with huge snow accumulation during the winter, tall herbs are situated.

Being the descendant of some ancient ecotonal forest communities from a moist period of the superior tertiary age, subalpine tall herbs (megaphorbs) become conspicuous by their floristic composition made of polygenetic species at their origin. Their actual ecological demands, both from humidity and soil trophicity, place them in mountain and subalpine valleys, especially along torrents, also on the screes with enough humidity and plentiful organic deposits.

Due to existing phytosociological convergence with subalpine tall herbs' communities from other Eurasian Mountains, the Central European ones were reunited in the same class. The transgression of some of their component species, to shrubs in subalpine vegetation, and especially to fontinal vegetation, continues to raise taxonomic difficulties regarding individualisation of the units with superior rank for this association.

It was demonstrated that the Romanian Carpathians megaphorbs formed on the calcareous layer are significantly different from those formed on the siliceous layer. These researches allowed us to settle a new association under the name *Astrantio-Delphinietum elati*. In this association, we have both the calciphile characteristic species *Delphinium elatum* and the differential species *Astrantia major* at an ecological optimum with high attendance *Astrantio-Delphinietum elati*



association belongs to *Delphinienion elati* suballiance, which include megaphorbs formed on the calcareous layer (4).

The dendrogram has resulted from the processing of relevés of *Astrantio-Delphinietum elati* association described by N. Boşcaiu and S. Mihăilescu (4) table 1, relevés 1-10. At the beginning we can notice the grouping of relevés in very well individualised clusters for all of three massifs which were taken into account: Piatra Craiului Massif, Apuseni Mountains and Lăpuşnicul Mare Valley from the Retezat National Park. The Jaccard index values situate Piatra Craiului Massif on an approximate isolated position to that of the Apuseni Mountains (Cetăţile Ponorului and Cetatea Rădesei) and also that of the Retezat Massif (Lăpuşnicul Mare Valley). We can explain this situation by the different altitude at which the phytocoenoses of the association are situated within those three massifs.

To be able to analyse the saxicole vegetation we made a comparison of associations from gorges and deep valleys situated at the mountain level and also of phytocoenosis spread on the rocks at the subalpine and alpine level.

The composition of the Piatra Craiului Massif is mainly based on Jurassic calcareous rocks, whose layers are folded till vertical, setting up in this way the main ridge of the mountain. In the eastern, south-eastern and southern border the tributary rivers created epigenetic valleys, shaped like gorges: Prăpăstiile Zărneştilor and Dâmbovicioara Gorges, having approximately 10 km length.

The main ridge is divided by Crăpătura Valley in two distinct topographic units called Piatra Craiului Mică and Piatra Craiului Mare. Crăpătura Valley shows the typical vegetation for a gorge, having in some parts an almost vertical slope of walls and on the bottom of it are present massif blocks accumulated in time which are populated with a rich vegetation formed by a large number of rare and even endemic plants.

Because the Crăpătura Valley starts at a high altitude in Şaua Crăpăturii it is possible to meet at 1580-1620 m some vegetal saxicole associations which are also in the other gorges (Prăpăstiile Zărneştilor and Dâmbovicioara), but much more lower, at 800-900 m: *Asperulo capitatae-Seslerietum rigidae*, *Asplenio-Cystopteridetum* subass. *campanuletosum carpatice*.

The subassociation *Asplenio-Cystopteridetum campanuletosum carpatice* is included in the class of *Asplenieta trichomanis* and is spread on the rocks and heavy stones in mountain and subalpine levels. Because they have a small number of plant species in their floristic composition, this kind of plant communities is different between associations spread on the acidic substrate (crystalline schists) and calcareous substrate. In this situation, the saxicole phytocoenoses are grouped in different syntaxonomical units.

For the Piatra Craiului Massif we calculated the Jaccard index values and we realised a comparison between Prăpăstiile Zărneştilor and Dâmbovicioara Gorges and



Crăpătura Valley (9). In this study, we made another comparison between the Piatra Craiului Massif and other Romanian Carpathian Mountains (Fig. 3).

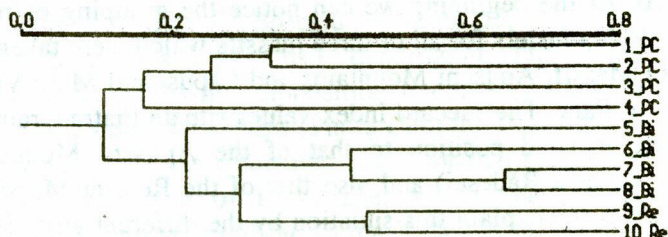


Fig. 3. – Dendrogram of *Astrantio-Delphinietum elati* association for the Piatra Craiului (PC), Bihor (Bi) and the Retezat (Re) Mountains.

***Asplenio-Cystopteridetum fragilis* Oberd. (1939) 1949  
subass. reg. *campanuletosum carpaticae* (Sanda & al. 1977) Coldea 1991**

*Asplenio-Cystopteridetum fragilis* subass. reg. *campanuletosum carpaticae* colonizes the stones clefts and heavy stones from the subalpine and mountain levels. These saxicole phytocoenoses from a limestone substrate comprise a small number of species which make them different from those of acid substrates on the crystalline schist.

Within the phytocoenosis of this association it should be noticed the characteristic species of the class, such as: *Asplenium trichomanes* and *Polypodium vulgare*, and among the differential species with a high constancy: *Poa nemoralis*. The species that characterize this subassociation are: *Campanula carpatica* and *Saxifraga cuneifolia*. In the frame of this association, *Cystopteris fragilis* which is characteristic for the alliance has also shown a high constancy. For the Piatra Craiului Massif we used personal data and data of 4 relevés after V. Sanda & al. (12) table 1 relevés 1, 2, 3 and table 2 relevé 5.

The values obtained after calculating the Jaccard index showed higher similarities between the relevés that belong to Piatra Craiului, compared to other massifs placed at a longer distance (Rodna). In the dendrogram (Fig. 4), the cluster for the Piatra Craiului Massif (1\_PC to 3\_PC belong to Prăpăstiile Zărneștilor Gorges; 4\_PC to 7\_PC belong to Dâmbovicioara Gorges; 8\_PC to 11\_PC belong to Curmătura Valley) is significantly different from Rodna Massif. For the Rodna Massif we used data of relevés after G. Coldea (6) table 4, relevés 1, 3, 4.



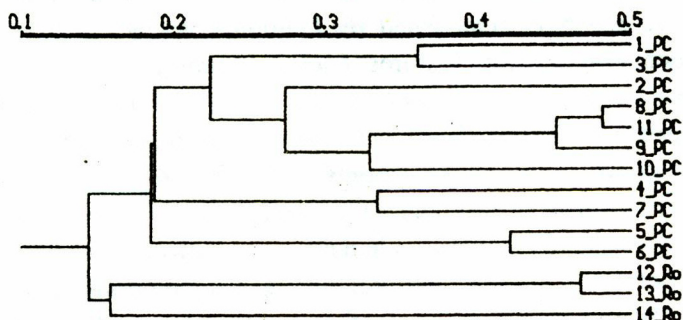


Fig. 4. – Dendrogram of *Asplenio-Cystopteridetum fragilis* subass. reg. *campanuletosum carpaticae* in the Piatra Craiului (PC) and Rodna (Ro) Mountains.

#### *Asperulo capitatae-Seslerietum rigidae* (Zóly. 1939) Coldea 1991

Within rock clefts, even on vertical slopes, a small amount of soil is accumulated allowing the settlement of a chasmophytic species and the formation of certain opened phytocoenoses. The group of associations gathered in the *Seslerion rigidae* alliance which is separated from Zólyomi (13), comprises rocky meadows spread up to 500-2100 m in the calcareous regions of south-eastern Carpathian Mountains. Many species characteristic for a certain class are represented within a phytocoenosis. Among them, *Sesleria rigida* has a wide distribution despite of the verticality of the mountain gorges. The association is very important for the soil formation and fixation on the rocks.

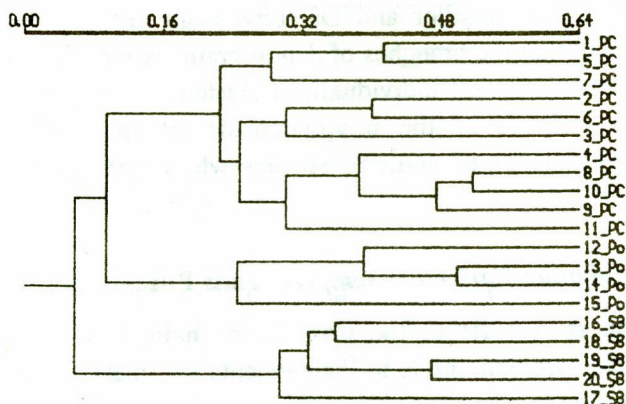


Fig. 5. – Dendrogram of *Asperulo capitatae-Seslerietum rigidae* in the Piatra Craiului (PC), Postăvaru (Po) and Scărița-Belioara (SB) Mountains.

In the Piatra Craiului Massif, the association is represented by rupicole phytocoenosis, which is determined by heliophile species with xerophytic and obvious endemic-preserving features (*Achillea schurii*, *Dianthus spiculifolius*, *Thymus comosus*, etc.).

The dendrogram (Fig. 5) shows that relevés from 1\_PC to 7\_PC which belong to Prăpăstiile Zărneștilor Gorges and 8\_PC to 11\_PC which belong to Crăpătura Valley are grouped in the same cluster.

The values obtained after calculating the Jaccard index showed higher similarities between relevés that belong to neighbouring mountains (Piatra Craiului, Postăvaru), as compared to other mountains placed at a longer distance (Scărița-Belioara). For the Postăvaru Mountains we used data of relevés after H. Fink (8) table 22, relevés 17, 18, 19, 20 and for Scărița-Belioara Mountain we used data of relevés after I. Csűrös (7) table 2, relevés 5, 9, 10, 11, 12.

The differences shown in the dendrograms between relevés from Piatra Craiului are due to the increase of the altitude which triggers the appearance within the association of the species that are usually spread at the subalpine level, and belong to the *Seslerietalia* class. This phenomenon has been especially observed in Șaua Curmăturii where once the stones clefts become enlarged, it appears a competition between the pioneer species and those of the rocks meadows. On the other hand, the presence of a great number of species which belong to this class shows the evolution direction of these association fragments with *Sesleria*.

At the same time the increase of the altitude up to 1620 m surpasses the beech tree level and in relevés appear plants specific to the spruce level explaining the difference between the index values calculated for Șaua Curmăturii.

For the Prăpăstiile Zărneștilor and Dâmbovicioara Gorges, values of the similarity index showed that the branches of dendrogram are more homogeneously grouped in distinct and very well individualized clusters. On the other hand, the differences between relevés of the phytocoenosis situated near the forest include an important number of nemoral species which are characteristic for the *Fagetalia* order.

#### *Seslerio haynaldianae-Caricetum sempervirentis* Pușcaru & al. 1956

The association is specific to the Carpathian chain, therefore, it can be considered an endemic association due to the elements that make it different from association with *Sesleria* from the Alps. The association is stable enough. However, the floristic variations depend on the breadth and inclination of mountain path, the depth of the soil and the thickness of the snow layer. In the



studied relevés, highly frequent carpathian endemic plants can be noticed, such as: *Campanula carpatica*, *Cerastium transsilvanicum*, *Dianthus callizonus*, *D. spiculifolius*, *Onobrychis transsilvanica*, *Saxifraga mutata* ssp. *demissa*, *Thymus comosus*, etc.

In the Piatra Craiului Massif, the meadows of the south-eastern mountainside have a little different floristic composition compared with those of the north-western mountainside, because of their topoclimatic characteristics. They are mostly represented by *Sesleria* association of *Seslerio haynaldianae*-*Caricetum sempervirentis* type, which reveals a very strong conservative character of the flora. For the Bucegi Massif phytocoenosis of this association is especially spread on the mountain paths and on the steep rock faces with southern and eastern position, at the subalpine and alpine level, up to 1800-2400 m. At the same time, for the Rodna Massif, the meso-xerophytic phytocoenosis of this association can be frequently found on the mountains paths and calcareous rocks at the alpine and subalpine levels of the mountain (Piatra Rea, Corongiș).

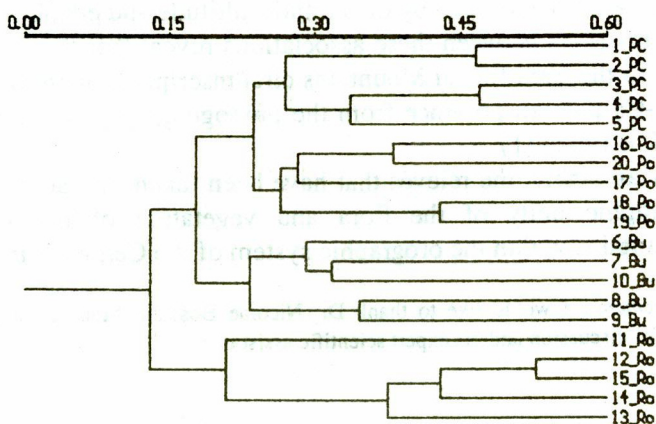


Fig. 6. – Dendrogram of *Seslerio haynaldianae*-*Caricetum sempervirentis* in the Piatra Craiului (PC), Bucegi (Bu), Postăvaru (Po) and Rodna (Ro) Mountains.

With values obtained after calculating the Jaccard index we made a dendrogram (Fig. 6). For the Postăvaru Mountains we used data of relevés after H. Fink (8) table 21, relevés 1, 2, 3, 4, 5; for the Bucegi Massif we used data after D. Pușcaru & al. (11) table 36, relevés 1, 2, 3, 5, 6 and for the Rodna Massif we used data of relevés after G. Coldea (6) table 31, relevés 1, 3, 4, 5, 6.

## CONCLUSIONS

1. As a whole, the dendrograms reveal a homogeneous grouping of the relevés from the mountains that have been compared. The grouping of the relevés as resulted from the dendrograms is in good agreement with the geographic position of the mountains from the south-eastern Carpathian Mountains. Thus, in the case of most association, the most evident similarities (syntaxonomic distances) gather together the relevés that belong to the neighbouring mountains (Piatra Craiului, Postvaru, Piatra Mare and Bucegi Mountains) and the syntaxonomic distances between the groups that have been compared are generally higher for the mountains which are far off each other.

2. The dendrogram obtained after the comparison of the relevés from the Piatra Craiului with those from Rodna shows more reduced similarity among the phytocoenosis of the two mountains, probably because the association of Piatra Craiului is mostly present on rocks of the gorges, while in the Rodna Massif the subassociation settles on the steep rock face at higher altitudes.

3. It was also shown that the flora remains unitary and the differences between relevés were determined by the latitude, altitude and edaphic factors.

4. The similarities between these associations reveal that the Piatra Craiului Massif belongs to the Țara Bârsei Mountains circumscription, namely the Central-European, East-Carpathian province from the phytogeographic arrondissement of A. Borza and N. Boșcaiu (1).

5. In their assembly, the relevés that have been taken into account point out the phytogeographic unity of the flora and vegetation of the south-eastern Carpathian Mountains within the orographic system of the Central Europe.

*Acknowledgements.* I would like to thank Dr. Nicolae Boșcaiu, Member of the Romanian Academy, for helpful discussion and his expert scientific assistance.

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Received December 20, 1998.

Institute of Biology  
Spl. Independenței, 296  
R-79651, Bucharest





# A NEW ASSOCIATION IN THE VEGETATION OF ROMANIA: *PANICO CAPILLARE-KOCHIETUM SIEVERSIAE* NOVA ASS.

ADRIAN OPREA

A new vegetal association is described in this paper: *Panico capillare-Kochietum sieversianae* nova ass.; both of the two characteristic species for this new coenotaxon (*Panicum capillare* and *Kochia sieversiana*) are adventitious in the flora of Romania. Also, some of the companion species in this association are adventitious ones in our flora, e. g.: *Panicum dichotomiflorum*, *Panicum miliaceum*, *Ambrosia artemisiifolia*, *Galinsoga parviflora*, *Brachyactis ciliata*, and so forth.

**Key words:** Romanian vegetation, new association, ruderal plants, adventitious species.

In the period 1993-1998 I also studied, besides the vegetation on the sands from the southern part of Moldavia (Tecuci Plain, particularly) (5), the anthropogenic vegetation from the embankments of the railways in that area. So there were identified besides some new species for our region (Moldavia), e. g. *Panicum dichotomiflorum*, *Lepidium neglectum*, *Cyperus serotinus*, and *Kochia sieversiana* (5), (6) also some interesting new vegetal associations, which are localised for the moment only on the very strong disturbed sites along the railways, especially in the stations, with a heavy traffic of persons and wares.

In some of the railway stations between Hanu Conachi and Rateş-Munteni (Galaţi county), particularly Tecuci Sud station, we had the possibility to identify a new coenotaxon: *Panico capillare-Kochietum sieversianae* nova ass., which is described for the first time (though it was presented in my doctor's degree paper, University of Iaşi-1998 (5)). This new coenotaxon is dominated by the adventitious species *Panicum capillare* (a North-American one) and *Kochia sieversiana* (an Asiatic one); these two species have ruderal features in our country and both of them are accompanied here by other ruderal plants, like: *Hordeum murinum*, *Bromus tectorum*, *Erigeron annuus*, *Tanacetum vulgare*, *Panicum dichotomiflorum*, *Atriplex tatarica*, *Capsella bursa-pastoris*, and so on.

This new association prefers those permanently sunny habitats along the vegetation season, where the humidity is lower too.

The geological substratum is represented by a loessoidic layer and, most of the soils are leached chernozems in the Tecuci Plain, but along the rails these soils are poor in mineral resources. This new association is set down between the rails and nearby. According to V. Jehlik (2) in (3), these kinds of habitats have an obvious anthropogenic character; regularly there are made some maintenance works over the rails, often with soil disturbing processing, adding of broken stones



(of 3-15 cm in diameter), slag, ash, coal, even cement, or slaked lime; the soils formed in these conditions are discontinuous, the ground water is not accessible and the temperature is higher than of the normal soils from the surroundings, because of their dark colour. This fact favoured by circumstances goes to the spread various diaspores of some adventitious or cosmopolitan plants and the vegetation is discontinuous and unstably disturbed.

One could see that phytocoenoses of this association occupy small surfaces (4-20 sq. m.), having a coverage of 40-80 %, even 100 %, on the whole space between the rails.

The analysis of life forms of this synanthropic association indicates that 72 % of species are therophytes (due to the dry steppic climate in this region); the other categories are reduced (T(H)=10 %; H=8 %; T(Ch)3 %; G=3 %; H (G)=3 %). That is why the phytocoenoses have a floristical composition which is inhomogeneous. In the phytogeographical spectrum the adventitious species represent 26 %, most of them having a North-American or Asian origin (as the characteristic species of this association have). This proves the expansion character of the association, on waste places, in this case. One could remark the fact that, though *Kochia sieversiana* has been pointed out lately in our flora (1), it has a great capacity to invade, especially along the lines of communication (railways, highroads, ...); this species was first signalled out in the southern part of Romania in 1991 (1); we discovered it later in Tecuci Sud station (in 1993) and lately in Socola Iași shunting yard station (1997) (4). Other species are cosmopolitan ones (24 %), eurasiatic (17 %), and the other categories are numerically reduced. In this ambience very few mediterranean (3 %) and pontic (3 %) species appear too, this due to the very local climatic conditions. Most of those plants have no higher ecological exigencies and they are easily adaptable at the stony habitats on the rails.

This association was watched for 6 years (1993-1998), and it is obvious the fact that it has a higher constancy along the entire vegetation season, being met each year on the same places comparatively with the previous year; still, one could not find these phytocoenoses occasionally, because of the herbicides used in the cleaning process of the "weeds" along the embankments of the railways.

In the latest few years we have found out some phytocoenoses of this association in other sites far away from the railways, due to the vehicles which collect seeds from the railway stations and spread them out in the territory.

All the localities where this association was identified are situated in the forest steppe zone, with an average annual temperature of 9.8°C and average annual precipitations varying between 400 mm (Hanu Conachi) and 482 mm (Munteni). The altitudes of the localities vary between 20 m. s. l. (Hanu Conachi) and 62.5 m. s. l. (Munteni).

From the coenotaxonomical point of view this new vegetal association was framed out like: Foed. *Sisymbrium officinalis* Tx., Lohm. et Prsg. 1950; Ord.



*Sisymbrietalia* J. Tx. 1961; Cl. *Chenopodietea* Br.-Bl. 1951 emend. Lohm., J. Tx. et Tx. 1961 (6) (Table 1; nomenclatural typus: relevé no 1).

*Acknowledgements.* I'd like to thank Mr. V. Ciocîrlan for his kindness in the determination of the species *Kochia sieversiana*.

Table 1  
*Panico capillare-Kochietum sieversianae* nova ass.

| 1                                                       | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12  | 13  |
|---------------------------------------------------------|----|----|----|----|----|----|----|----|----|----|-----|-----|
| Surface, sq. m <sup>2</sup>                             | 20 | 20 | 20 | 16 | 16 | 10 | 10 | 20 | 16 | 10 | 4   |     |
| Coverage, %                                             | 55 | 80 | 70 | 70 | 60 | 75 | 75 | 70 | 80 | 80 | 100 |     |
| Relevé no.                                              | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11  | K   |
|                                                         | *  |    |    |    |    |    |    |    |    |    |     |     |
| <i>Kochia sieversiana</i>                               | 2  | 3  | 2  | 3  | 2  | 2  | 3  | 3  | 2  | 2  | 3   | V   |
| <i>Panicum capillare</i>                                | 1  | 2  | 2  | 1  | 1  | 2  | 1  | 1  | 2  | 2  | 2   | V   |
| <i>Sisymbrium officinalis</i> et <i>Sisymbrietalia</i>  |    |    |    |    |    |    |    |    |    |    |     |     |
| <i>Atriplex oblongifolia</i>                            | +  | +  | -  | +  | -  | -  | +  | -  | -  | -  | +   | III |
| <i>Hordeum marinum</i>                                  | -  | +  | -  | -  | +  | -  | +  | -  | -  | +  | +   | III |
| <i>Salsola kali</i> ssp. <i>ruthenica</i>               | -  | +  | +  | -  | +  | -  | -  | -  | +  | -  | -   | II  |
| <i>Panicum miliaceum</i>                                | +  | -  | -  | +  | -  | +  | -  | -  | -  | -  | +   | II  |
| <i>Malva sylvestris</i>                                 | -  | -  | -  | +  | -  | -  | -  | +  | +  | -  | -   | II  |
| <i>Lactuca saligna</i>                                  | +  | -  | -  | -  | -  | -  | +  | -  | +  | -  | -   | II  |
| <i>Bromus tectorum</i>                                  | -  | +  | -  | -  | -  | +  | -  | -  | -  | +  | +   | II  |
| <i>Erigeron annuus</i>                                  | +  | -  | +  | -  | +  | -  | -  | -  | +  | +  | -   | II  |
| <i>Ambrosia artemisiifolia</i>                          | +  | +  | -  | -  | -  | -  | -  | -  | -  | -  | -   | I   |
| <i>Panicum dichotomiflorum</i>                          | +  | -  | -  | -  | -  | -  | +  | -  | -  | -  | -   | I   |
| <i>Polygono-Chenopodietalia</i> et <i>Chenopodietea</i> |    |    |    |    |    |    |    |    |    |    |     |     |
| <i>Amaranthus albus</i>                                 | -  | -  | -  | +  | +  | -  | -  | -  | +  | -  | -   | II  |
| <i>Amaranthus blitoides</i>                             | +  | -  | -  | +  | -  | -  | +  | -  | -  | +  | -   | II  |
| <i>Atriplex tatarica</i>                                | -  | +  | +  | -  | -  | +  | -  | -  | -  | +  | -   | II  |
| <i>Setaria lutescens</i>                                | +  | -  | -  | +  | -  | -  | +  | -  | -  | -  | +   | II  |
| <i>Brassica nigra</i>                                   | +  | -  | -  | +  | -  | +  | +  | -  | -  | -  | -   | II  |
| <i>Digitaria sanguinalis</i>                            | +  | -  | -  | +  | -  | -  | -  | +  | -  | -  | -   | II  |
| <i>Bromus arvensis</i>                                  | -  | +  | -  | -  | +  | +  | -  | -  | -  | +  | -   | II  |
| <i>Cirsium arvense</i>                                  | +  | -  | -  | -  | +  | -  | -  | -  | +  | -  | -   | II  |
| <i>Cannabis ruderalis</i>                               | +  | +  | -  | +  | -  | -  | -  | +  | -  | -  | -   | II  |
| <i>Chenopodium album</i>                                | +  | -  | -  | -  | +  | -  | -  | +  | -  | -  | +   | II  |
| <i>Solanum nigrum</i>                                   | +  | +  | +  | -  | -  | +  | -  | -  | -  | -  | -   | II  |
| <i>Capsella bursa-pastoris</i>                          | +  | -  | -  | +  | -  | -  | -  | -  | +  | -  | -   | II  |
| <i>Portulaca oleracea</i>                               | +  | -  | -  | -  | -  | +  | -  | -  | -  | +  | +   | II  |
| <i>Galinsoga parviflora</i>                             | +  | +  | -  | -  | +  | +  | -  | -  | -  | -  | -   | II  |
| <i>Echinochloa crus-galli</i>                           | -  | -  | -  | +  | -  | -  | +  | +  | -  | -  | -   | II  |
| <i>Sonchus oleraceus</i>                                | +  | -  | +  | -  | -  | +  | -  | -  | +  | -  | -   | II  |
| <i>Polygonum persicaria</i>                             | +  | -  | -  | +  | -  | -  | -  | -  | -  | +  | -   | II  |
| <i>Brachyactis ciliata</i>                              | +  | -  | -  | -  | -  | -  | +  | -  | +  | -  | -   | II  |

Table 1  
(continued)

| 1                                             | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13  |
|-----------------------------------------------|---|---|---|---|---|---|---|---|----|----|----|-----|
| Variae syntaxa                                |   |   |   |   |   |   |   |   |    |    |    |     |
| <i>Tanacetum vulgare</i>                      | + | + | - | - | + | - | - | + | -  | +  | -  | III |
| <i>Eragrostis poaeoides</i>                   | + | - | - | + | - | + | - | 1 | -  | -  | 1  | III |
| <i>Gypsophila scorzonae folia</i>             | + | - | - | + | - | - | - | + | -  | -  | -  | II  |
| <i>Brassica elongata</i>                      | + | - | - | - | + | - | - | - | +  | -  | -  | II  |
| <i>Lolium perenne</i>                         | + | - | - | + | - | - | + | - | -  | -  | -  | II  |
| <i>Cynodon dactylon</i>                       | + | + | - | - | - | - | + | - | -  | -  | +  | II  |
| <i>Poa pratensis</i> ssp. <i>angustifolia</i> |   |   |   |   |   |   |   |   |    |    |    |     |
| <i>Torilis arvensis</i>                       | + | + | - | - | + | - | - | + | -  | -  | -  | II  |
| <i>Avena fatua</i>                            | + | - | - | - | - | + | + | - | -  | -  | -  | II  |
|                                               | - | - | - | - | + | - | - | - | -  | -  | -  | I   |

Localization of the relevés: 1-5: August, 17<sup>th</sup>, 1996 - Tecuci Sud railway station; 6-10: August, 10<sup>th</sup>, 1997 - Tecuci Sud railway station; 11: September, 13<sup>th</sup>, 1997 - Tecuci Sud railway station.

\* - a nomenclatural type relevé.

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*Received April 5, 1999.*

*University Botanical Garden of Iaşi,  
7-9, Dumbrava Roşie St.,  
6600-Iaşi*





# L'ASSOCIATION *CARICETUM ROSTRATAE* OSVALD 1923 EM.DIERSSSEN 1982 SOUS-ASS.*CALLETOSUM PALUSTRE* OROIAN 1998 DANS LE DÉFILÉ DU MUREȘ (ROUMANIE)

SILVIA OROIAN

In this study it is presented a new subassociation in the *Caricetum rostratae* Oswald 1923 em.Dierssen 1982 association, which was identified on the basis of the phytosociological researches done in the eutrophic swamp of Ciobotani village, Stînceni commune.

This association was identified in the lower level of the Gurghiu mountains at 687 m height. The characteristic species is *Carex rostrata*, and the differential species *Calla palustris* form a very compact local population. The coenosis is well developed, having a 100% percent cover.

The groups of the characteristic species of order and class allow the obvious syntaxonomical framing. In spite of this, the coenosis is contaminated by species from Phragmitetalia orders (*Lythrum salicaria*, *Cicuta virosa*, *Myosotis scorpioides*, *Phragmites australis*) and from Molinietales order as well (*Caltha palustris*, *Filipendula ulmaria*, *Lysimachia vulgaris*).

This paper deals with 5 samples, the subassociation being ecologically and chorologically analyzed as well as on the basis of the cytological and floristical composition.

**Key words:** phytocoenosis, association, subassociation, swamp, Gurghiu mountains.

Le Défilé du Mureș entre Toplița et Deda, serré entre deux grands appareils volcaniques, Fâncelul au sud et Călimanul au nord, est le plus pittoresque défilé du Mureș, des Carpates Orientales, qui offre des conditions optimales pour le développement d'une flore et d'une végétation extrêmement riches et variées.

Le marais eutrophe de Ciobotani, situé à l'entrée dans le défilé, à 7 km de Toplița et à 3 km de Stînceni, à l'altitude de 687 m abrite l'association *Caricetum rostratae* Oswald 1923 em.Dierssen 1982, subass.*calletosum palustris* S. Oroian 1998, dans laquelle, l'espèce caractéristique est *Carex rostrata* et la différentielle *Calla palustris* forme une population locale très compacte (4). Les groupes des espèces caractéristiques de l'ordre et de la classe permettent l'encadrement syntaxonomique de l'association (2, 3):

*Scheuchzerio-Caricetea fuscae* R.Tx.1937

*Scheuchzerietalia palustris* Nordhagen 1937

*Caricion lasiocarpae* Vanden Berghen in Lebrun et al.1949

*Caricetum rostratae* Oswald 1923 em.Dierssen 1982

*calletosum palustris* Oroian 1998

Les cénoses sont riches, ayant un recouvrement de 100%. Pourtant, les cénoses sont contaminées avec les espèces de l'ordre Phragmitetalia (*Lythrum salicaria*, *Cicuta virosa*, *Myosotis scorpioides*, *Phragmitis australis*) et de l'ordre Molinietales (*Caltha palustris*, *Filipendula ulmaria*, *Lysimachia vulgaris*).

En analysant les phytocénoses de la sous-association selon les principales catégories écologiques (Fig.1) nous voyons que la majorité des espèces sont les hygrophytes (55,55%) suivies par les mesohygrophytes (37,03%). Face au facteur température, le plus grand nombre des espèces sont micro-mésothermes (51,85%), microthermes (25,92%) suivies par les eurythermes (22,22%). Tenant compte de la réaction du sol, la majorité des espèces sont euryioniques (51,85%) suivies par les espèces moins acido-neutrophiles (37,03%).

Le pourcentage des bioformes est présenté dans la figure 2. Selon le spectre des bioformes nous voyons que les hémicryptophytes (51,85%) sont prédominantes, suivies par les hydrophytes (37,04%). Le spectre des éléments floristiques (Fig.3) montre la prépondérance des éléments eurasiatiques (40,47%) suivis par les éléments circumpolaires (37,09%). L'appartenance caryologique (Fig.4) des éléments floristiques met en évidence la dominance des espèces polyploïdes (66,66%) suivies par les diploïdes (25,92%) et par les diplopolyploïdes (7,40%). L'index de diploïdie a la valeur de 0,365.

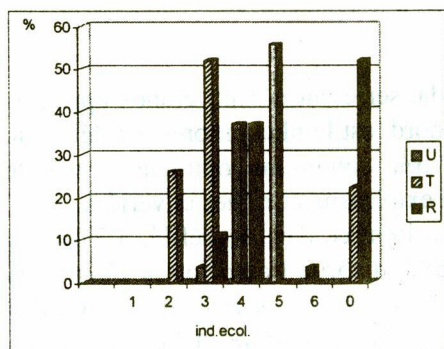


Fig.1.- Le spectre écologique de la sous-ass. *calletosum palustris*.

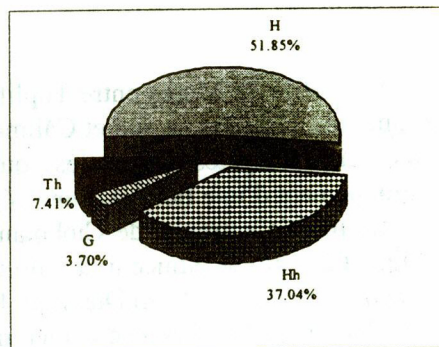


Fig.2.- Les bioformes de la sous-ass. *calletosum palustris*.

En calculant l'indice de similarité Jaccard pour les taxons identifiés dans l'association, résulte la matrice et le dendrogramme de similarité des relevés effectués (Fig.5).

- 1 1.000
- 2 0.500 1.000
- 3 0.280 0.250 1.000



|   |       |       |       |       |       |
|---|-------|-------|-------|-------|-------|
| 4 | 0.476 | 0.450 | 0.609 | 1.000 |       |
| 5 | 0.526 | 0.588 | 0.400 | 0.308 | 1.000 |

Etant donné que *Calla palustris* est comprise dans la Liste rouge (1), nous proposons aux autorités locales que le marais eutrophe du Ciobotani soit déclaré réserve botanique, d'un grand intérêt scientifique, où cette plante rare pour notre pays et pour l'Europe, cette beauté floristique du Défilé du Mureș soit mieux protégée et sauvée.

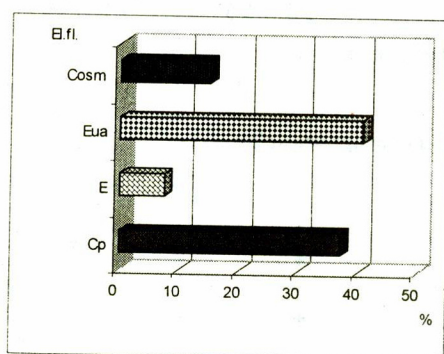


Fig. 3.- Les éléments floristiques de la sous-ass. *calletosum palustre*.

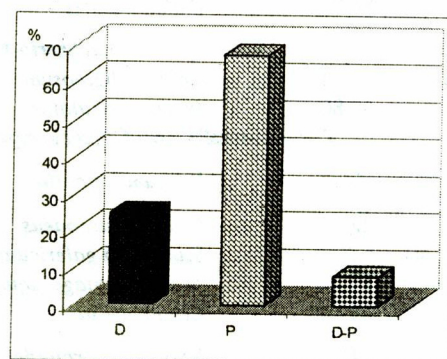


Fig. 4.- Le spectre caryologique de la sous-ass. *calletosum palustre*.

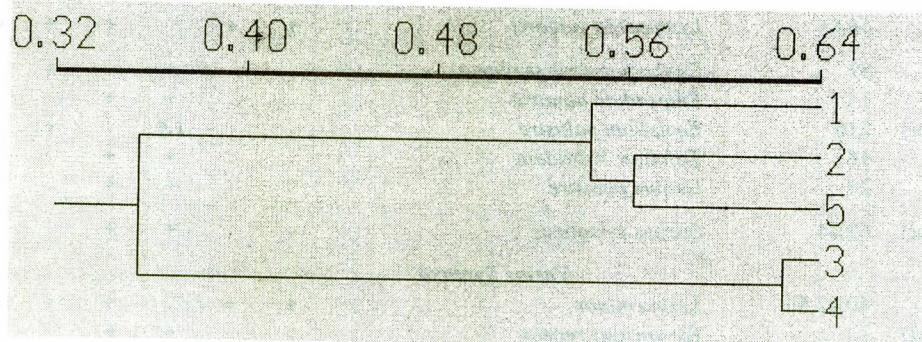


Fig. 5.- La matrix et le dendrogramme de similarité des relevés.

Tableau 1

L'association *Caricetum rostratae* Osvald 1923 em.Dierssen 1982  
subass.*calletosum palustre* Oroian 1998

| Bioforme                                                                 | Géolément | 2n         | Numéro du relevé                  | 1   | 2   | 3   | 4   | 5   |     |
|--------------------------------------------------------------------------|-----------|------------|-----------------------------------|-----|-----|-----|-----|-----|-----|
|                                                                          |           |            | Altitude (m s.m.)                 | 687 | 687 | 687 | 687 | 687 |     |
|                                                                          |           |            | Recouvrement (%)                  | 100 | 100 | 100 | 100 | 100 |     |
|                                                                          |           |            | Surface (m <sup>2</sup> )         | 15  | 25  | 25  | 25  | 25  | K   |
| <b>Opt.ass.</b>                                                          |           |            |                                   |     |     |     |     |     |     |
| Hh Cp                                                                    |           | 60,76,82   | <i>Carex rostrata</i>             | 2.3 | +   | 5.5 | 2.3 | +   | V   |
| Hh Cp(bor)                                                               |           | 36,72      | <i>Calla palustris</i>            | 3.5 | 5.5 | 1.5 | 5.5 | 5.5 | V   |
| <b>Scheuchzerio-Caricetea fuscae</b>                                     |           |            |                                   |     |     |     |     |     |     |
| H Eua                                                                    |           | 22,44      | <i>Galium uliginosum</i>          | .   | +   | +   | +   | .   | III |
| H Cp                                                                     |           | 60,80      | <i>Juncus articulatus</i>         | .   | .   | +   | .   | +   | II  |
| <b>Phragmitetalia (incl.Glycerio-Sparganion et Magnocaricion elatae)</b> |           |            |                                   |     |     |     |     |     |     |
| H-<br>Hh                                                                 | Cosm      | 60         | <i>Lythrum salicaria</i>          | +1  | +   | +   | +   | +   | V   |
| Hh Eua                                                                   |           | 22         | <i>Lycopus europaeus</i>          | +   | +   | +   | +   | +   | V   |
| H Cp(bor)                                                                |           | c.32       | <i>Scutellaria galericulata</i>   | +   | +   | +   | +   | +   | V   |
| Hh Cosm                                                                  |           | 14         | <i>Alisma plantago-aquatica</i>   | +   | +   | .   | +   | +   | IV  |
| Hh Eua                                                                   |           | 22         | <i>Cicuta virosa</i>              | +   | .   | +   | .   | +   | III |
| H-<br>Hh                                                                 | Eua       | 64,66      | <i>Myosotis scorpioides</i>       | +   | .   | +   | +   | .   | III |
| H Eua(M)                                                                 |           | 36         | <i>Epilobium parviflorum</i>      | .   | .   | +   | +   | .   | II  |
| Hh Cp(bor)                                                               |           | c.200      | <i>Rumex aquaticus</i>            | .   | .   | +   | +   | .   | II  |
| H Cp(bor)                                                                |           | 20         | <i>Catabrosa aquatica</i>         | 2.2 | .   | .   | .   | +   | II  |
| Hh<br>-H                                                                 | Cp        | 60         | <i>Glyceria maxima</i>            | .   | +   | .   | .   | 1.2 | II  |
| Hh Cosm                                                                  |           | 42,36,c.90 | <i>Phragmites australis</i>       | 1.2 | .   | .   | .   | .   | I   |
| <b>Molinietalia</b>                                                      |           |            |                                   |     |     |     |     |     |     |
| H-<br>Hh                                                                 | Eua       | 56,84      | <i>Lysimachia vulgaris</i>        | +   | +   | .   | +   | +   | IV  |
| H E                                                                      |           | 32         | <i>Caltha palustris ssp.laeta</i> | .   | .   | +   | .   | +   | II  |
| H Eua                                                                    |           | 14         | <i>Filipendula ulmaria</i>        | .   | .   | +   | +   | .   | II  |
| G Cp(bor)                                                                |           | 216        | <i>Equisetum palustre</i>         | .   | .   | 1.4 | .   | +   | II  |
| H E(M)                                                                   |           | 16         | <i>Trifolium hybridum</i>         | .   | .   | +   | +   | .   | II  |
| H Cp                                                                     |           | 24         | <i>Galium palustre</i>            | .   | .   | +   | +   | .   | II  |
| Hh<br>-G                                                                 | Cp(bor)   | 62,64      | <i>Scirpus sylvaticus</i>         | .   | .   | +   | +   | .   | II  |
| <b>Variae Syntaxa</b>                                                    |           |            |                                   |     |     |     |     |     |     |
| Hh Cosm                                                                  |           | 40,42,50   | <i>Lemna minor</i>                | +   | +   | .   | +   | +   | IV  |
| H Eua(M)                                                                 |           | 32         | <i>Ranunculus repens</i>          | .   | .   | +   | +   | .   | II  |
| Th Eua(M)                                                                |           | 20         | <i>Persicaria hydropiper</i>      | .   | .   | +   | .   | .   | II  |
| Th Eua                                                                   |           | 20         | <i>Impatiens noli-tangere</i>     | +   | .   | .   | +   | .   | II  |
| H Eua                                                                    |           | 28,42      | <i>Alopecurus pratensis</i>       | .   | +   | .   | .   | +   | II  |



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Reçu le 15 avril 1999.

Université de Médecine et Pharmacie,  
Tg.-Mureş





# L'ASSOCIATION *HIERACIO TRANSILVANICI-PICEETUM* PAWLOWSKI ET BR.-BL. 1939 DE LA VALLÉE DU GURGHIU (DÉP. MUREȘ)

MIHAELA SĂMĂRGIȚAN

This study presents the results of phytosociological investigations in spruce fir forests from the Gurghiu Valley. It describes forest communities with *Hieracium rotundatum* (syn. *H. transilvanicum*) and *Picea abies*, which are typically montane, rich in characteristic species to order and alliance (*Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Polygonatum verticillatum*, *Huperzia selago*, *Lycopodium annotinum*, *Orthilia secunda*, *Moneses uniflora*, *Pyrola rotundifolia*, *Streptopus amplexifolius*, etc.).

The paper deals with 18 relevés of species analysed based on a superior degree of syntaxonomic fidelity. The spectra of bioforms and geoelements are also analysed, and the diploidy index after S.Pignatti (1960) formula is calculated.

**Key words:** phytosociology, association, spruce fir forest, mountains, Eastern Carpathians, Gurghiu Valley.

L'une des vallées les plus pittoresques des Carpates Orientales, la Vallée du Gurghiu est flanquée par les monts de Gurghiu au nord et par une forme demi-circulaire à l'est et au sud.

Les plus représentatives hauteurs du bassin du Gurghiu sont: Saca Mare (1777 m), Saca Mică (1733 m), Tătarca (1689 m), Găina (1680 m), Bătrâna (1634) et Frățileasa (1627 m).

Les forêts de pessse groupées dans cette association présentent une large dispersion sur l'étage montagnard supérieur des Carpates roumaines et forment dans la zone forestière la sous-zone de pessière. Les pessses vivent sur des sols bruns acides, riches en humus avec une réaction acide ou modérément acide. Elles préfèrent un climat plus froid et humide, avec des précipitations fréquentes. Dans la zone de montagne de la Vallée du Gurghiu (la station météorologique Bucin, 1282 m altitude), la température annuelle moyenne est de 3,79 °C et les précipitations atmosphériques annuelles atteignent 916,46 mm.

Dans le bassin du Gurghiu les pesssières occupent des surfaces vastes sur les versants et sur les vallées. Les forêts sont étudiées à: Lăpușna, Valea Bătrâna, Valea Creanga Albă, Valea Secuieu, aux altitudes de 800-1300 m. L'espèce dominante est *Picea abies*, avec une couronne dense et elle réalise un recouvrement de 80-90%.

Grâce à l'acidité du sol, dans la synusie herbacée des pesssières, qui a un recouvrement moyen de 30-40%, on rencontre de nombreuses espèces acidophiles caractéristiques à l'alliance et à l'ordre: *Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Polygonatum verticillatum*, *Huperzia selago*, *Lycopodium annotinum*, *Orthilia secunda*, *Moneses uniflora*, *Pyrola rotundifolia*, *Streptopus amplexifolius*, etc., ce qui justifie leur rattachement à ces unités syntaxonomiques (5).

Le contact direct de ces pessières vers leurs limites inférieures de végétation avec les forêts mixtes de hêtres et de pessas fait pénétrer dans leur composition des espèces némorales de l'ordre *Fagetalia* et aussi de la classe *Quercu-Fagetea*. Ainsi nous nous trouvons dans la présence de certaines forêts de *Picea abies* mais avec une flore assez caractéristique pour les hêtraies. Pourtant, on peut encadrer les pessières étudiées dans l'association *Hieracio transsilvanici-Piceetum* Pawlowski et Br.-Bl.1939 (1, 2).

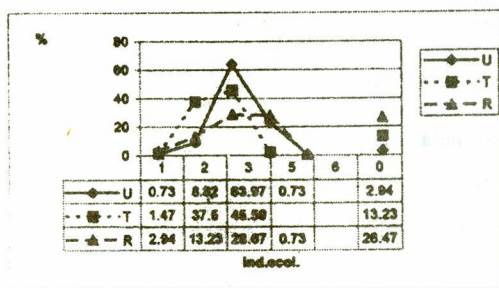


Fig.1. Le spectre écologique de l'ass. *Hieracio transsilvanici-Piceetum*.

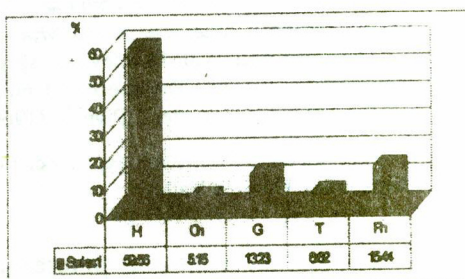


Fig.2. Les bioformes de l'ass. *Hieracio transsilvanici-Piceetum*.

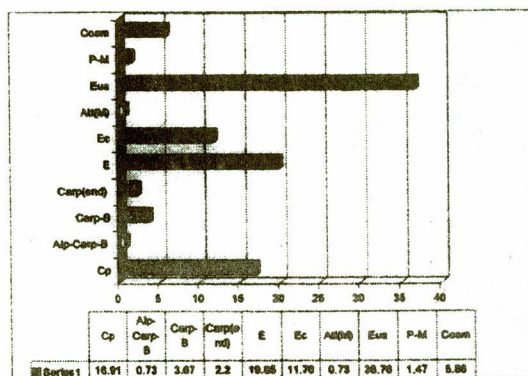


Fig.3. Les éléments floristiques de l'ass. *Hieracio transsilvanici-Piceetum*.

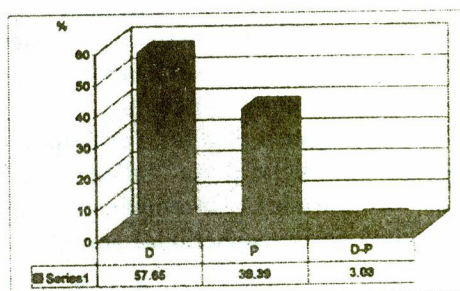


Fig.4. Le spectre caryologique de l'ass. *Hieracio transsilvanici-Piceetum*.

En analysant l'association du point de vue écologique on observe (Fig.1) la dominance des espèces mésophylles (63,97%), micro-mésothermes (45,59%) et microthermes (37,5%), acido-neutrophylles (28,67%) et moins acido-neutrophylles (27,94%). Dans le spectre des formes biologiques (Fig.2) les espèces le mieux représentées sont les hémicryptophytes (59,56%) suivies par les phanérophytes (15,44%) qui sont très diversifiées et par des géophytes (13,23%). Les éléments



phytogéographiques (Fig. 3) qui prédominent sont les espèces eurasiatiques (36,76%), européennes (19,85%) et circumpolaires (16,98%) (6). L'analyse caryologique relève la prédominance d'espèces diploïdes (57,65%). Les polyploïdes ont un pourcentage de 39,39% et les diplo-polyploïdes 2,21% (3, 4). L'index de diploïdie établi selon S.Pignatti (1960) pour cette association a la valeur de 1,466% (Fig.4).

En calculant l'index de similarité Jaccard à l'aide des taxons identifiés dans l'association, résulte la matrix et le dendrogramme de similarité des relevés (Fig.5).

|    |                                                                                                             |
|----|-------------------------------------------------------------------------------------------------------------|
| 1  | 1.000                                                                                                       |
| 2  | 0.617 1.000                                                                                                 |
| 3  | 0.381 0.317 1.000                                                                                           |
| 4  | 0.400 0.383 0.398 1.000                                                                                     |
| 5  | 0.435 0.473 0.344 0.391 1.000                                                                               |
| 6  | 0.339 0.415 0.292 0.364 0.419 1.000                                                                         |
| 7  | 0.380 0.406 0.368 0.346 0.355 0.470 1.000                                                                   |
| 8  | 0.310 0.333 0.271 0.258 0.306 0.364 0.475 1.000                                                             |
| 9  | 0.407 0.447 0.317 0.297 0.446 0.293 0.364 0.388 1.000                                                       |
| 10 | 0.310 0.283 0.271 0.317 0.246 0.389 0.429 0.545 0.333 1.00                                                  |
| 11 | 0.344 0.480 0.267 0.309 0.359 0.373 0.315 0.276 0.370 0.276 1.000                                           |
| 12 | 0.354 0.379 0.348 0.357 0.348 0.403 0.457 0.379 0.290 0.481 0.410 1.000                                     |
| 13 | 0.283 0.395 0.190 0.316 0.377 0.426 0.390 0.364 0.395 0.395 0.375 0.358 1.000                               |
| 14 | 0.323 0.300 0.297 0.348 0.358 0.308 0.429 0.345 0.444 0.345 0.333 0.406 0.373 1.000                         |
| 15 | 0.224 0.260 0.272 0.300 0.188 0.373 0.349 0.313 0.286 0.370 0.278 0.364 0.310 0.304 1.000                   |
| 16 | 0.343 0.323 0.356 0.366 0.319 0.328 0.351 0.302 0.281 0.302 0.375 0.324 0.321 0.278 0.242 1.000             |
| 17 | 0.338 0.361 0.414 0.324 0.412 0.304 0.382 0.339 0.339 0.258 0.348 0.338 0.339 0.310 0.219 0.448 1.000       |
| 18 | 0.333 0.333 0.483 0.372 0.346 0.435 0.481 0.333 0.314 0.373 0.307 0.405 0.273 0.325 0.359 0.359 0.408 1.000 |

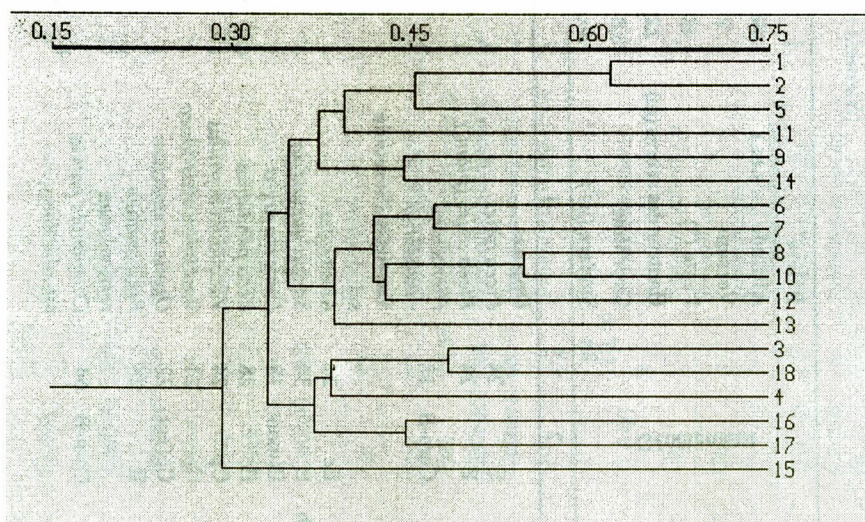


Fig.5. La matrix et le dendrogramme de similarité des relevés.

*Hieracio transilvanici-Piceetum* Pawlowski et Br.-Bl. 1939  
(*Hieracio rotundati-Piceetum* nom. mut. propos Coldea 1991)

[illegible]



| I     | 2        | 3             | 4                               | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23  |
|-------|----------|---------------|---------------------------------|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| G     | Eua(bor) | 36            | <i>Maianthemum bifolium</i>     | + | + | + | + | + | +  | +  | .  | .  | .  | +  | +  | +  | +  | .  | +  | +  | +  | +   |
| Ch    | Cosm     | 68,88,<br>264 | <i>Huperzia selago</i>          | + | + | + | . | 1 | .  | +  | +  | +  | .  | .  | .  | .  | .  | .  | .  | +  | +  | +   |
| Ch    | Cp(bor)  | 68            | <i>Lycopodium annotinum</i>     | 1 | + | + | . | + | .  | +  | .  | 2  | .  | +  | .  | .  | .  | .  | +  | +  | .  | III |
| H(G)  | Cp(bor)  | 26            | <i>Moneses uniflora</i>         | . | + | + | . | . | .  | +  | .  | +  | .  | +  | .  | .  | +  | .  | .  | .  | +  | II  |
| Ch    | Cp(bor)  | 38            | <i>Orthilia secunda</i>         | + | + | + | . | + | .  | +  | .  | .  | .  | +  | +  | .  | .  | .  | .  | .  | .  | II  |
| G     | Carp     | 16            | <i>Ranunculus carpatius</i>     | . | . | . | . | . | .  | .  | .  | .  | .  | +  | +  | .  | +  | .  | +  | +  | .  | II  |
| G     | Cp(bor)  | 160           | <i>Gymnocarpium dryopteris</i>  | + | + | + | + | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | II  |
| G     | Cp       | 32            | <i>Streptopus amplexifolius</i> | . | . | + | + | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | +  | .  | II  |
| H     | Ec       | 12            | <i>Luzula sylvatica</i>         | . | . | . | + | . | .  | .  | .  | .  | +  | +  | .  | +  | .  | .  | .  | .  | .  | II  |
| H     | Eua      | 28,56         | <i>Calamagrostis villosa</i>    | . | . | . | . | . | .  | .  | .  | +  | +  | +  | .  | .  | .  | .  | .  | +  | .  | I   |
| H     | Cp(bor)  | 164           | <i>Dryopteris dilatata</i>      | + | . | . | + | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| H     | Cp(bor)  | 46            | <i>Pyrola rotundifolia</i>      | . | . | . | + | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | I   |
| H     | Ec       | 40            | <i>Soldanella hungarica</i>     | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| H     | (mont)   | 120,14        | <i>ssp. major</i>               | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | I   |
| H     | E(Alp)   | 0             | <i>Homogyne alpina</i>          | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | I   |
| Brr   | Cp       | 10            | <i>Entodon schreberi</i>        | + | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| Brehs | Cp       | ...           | <i>Sphagnum giergensolmi</i>    | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | 2  | .  | I   |
| H     | Carp-B   | 14            | <b>Symphyto-Fagion</b>          | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | V   |
| H-G   | Carp-B   | 18            | <i>Pulmonaria rubra</i>         | + | + | + | + | + | +  | +  | +  | +  | +  | +  | .  | +  | +  | +  | .  | +  | +  | V   |
| H     | Carp     | 18            | <i>Symphytum cordatum</i>       | . | + | + | + | + | +  | +  | +  | +  | .  | +  | .  | +  | +  | +  | +  | +  | +  | V   |
|       | (end)    |               | <i>Leucanthemum waldsteinii</i> | . | + | 1 | . | + | +  | +  | +  | .  | +  | .  | +  | +  | .  | +  | .  | +  | +  | IV  |

|         | 1 | 2        | 3     | 4                              | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23  |
|---------|---|----------|-------|--------------------------------|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| H       |   | Cap(end) | 16    | <i>Aconitum moldavicum</i>     | . | . | + | + | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | 2  | .  | .  | +  | I   |
| H       |   | Ec       | 16    | <i>Euphorbia carniolica</i>    | . | . | + | . | . | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | I   |
|         |   |          |       | <b>Fagetalia sylvaticae</b>    |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
| MPh-mPh |   | E        | 24    | <i>Fagus sylvatica</i>         | . | + | . | + | + | +  | +  | +  | +  | +  | +  | +  | +  | +  | .  | .  | .  | .  | IV  |
| nPh     |   | Eua      | 18    | <i>Daphne mezereum</i>         | + | + | + | . | . | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | V   |
| nPh     |   | E        | 28    | <i>Rubus hirtus</i>            | 1 | . | 2 | . | . | .  | +  | +  | +  | +  | .  | +  | +  | +  | +  | +  | +  | +  | IV  |
| H       |   | E        | 12    | <i>Luzula luzuloides</i>       | + | + | . | + | + | +  | +  | +  | +  | .  | +  | +  | +  | +  | +  | +  | +  | +  | V   |
| H       |   | Eua(M)   | 36    | <i>Epilobium montanum</i>      | + | + | . | + | + | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | IV  |
| H       |   | Eua      | 16    | <i>Salvia glutinosa</i>        | . | . | . | + | + | +  | +  | +  | +  | .  | .  | +  | .  | +  | +  | .  | .  | +  | IV  |
| H       |   | E        | 40    | <i>Senecio ovatus</i>          | . | + | + | + | + | +  | +  | +  | +  | .  | .  | +  | .  | +  | +  | +  | +  | +  | IV  |
| H       |   | E        | 58    | <i>Carex sylvatica</i>         | + | . | + | . | . | .  | +  | +  | +  | .  | .  | +  | .  | +  | .  | +  | +  | +  | III |
| H-G     |   | E        | 64    | <i>Mercurialis perennis</i>    | . | . | + | + | . | +  | +  | +  | +  | .  | .  | +  | .  | +  | +  | .  | .  | +  | III |
| H-Ch    |   | E        | 32    | <i>Ajuga reptans</i>           | . | . | + | + | + | .  | +  | +  | .  | .  | .  | +  | +  | +  | .  | .  | .  | +  | III |
| H       |   | Eua      | 16    | <i>Actaea spicata</i>          | . | . | . | . | . | +  | +  | +  | +  | .  | +  | +  | .  | +  | +  | .  | .  | +  | III |
| G       |   | Eua      | 44    | <i>Galium odoratum</i>         | + | . | + | . | . | +  | +  | +  | +  | .  | +  | +  | .  | +  | +  | .  | .  | +  | III |
| Th      |   | Eua(C)   | 16    | <i>Galeopsis speciosa</i>      | . | . | + | . | . | +  | +  | +  | +  | .  | .  | +  | +  | +  | +  | .  | .  | +  | III |
| H       |   | Eua      | 20    | <i>Paris quadrifolia</i>       | . | . | + | + | . | +  | +  | +  | .  | .  | .  | .  | +  | +  | +  | +  | +  | +  | III |
| Th      |   | Cosm     | 32,64 | <i>Geranium robertianum</i>    | . | . | . | . | . | +  | +  | .  | .  | .  | .  | +  | .  | +  | +  | .  | .  | +  | II  |
| H       |   | Eua      | 40    | <i>Senecio hercynicus</i>      | . | . | . | . | . | .  | .  | .  | .  | .  | +  | +  | +  | +  | +  | .  | .  | .  | II  |
| H       |   | E        | 40,45 | <i>Viola riviniana</i>         | . | . | . | + | + | .  | .  | .  | .  | .  | .  | +  | +  | +  | +  | +  | +  | +  | II  |
| H       |   | Eua      | 18    | <i>Myosotis sylvatica</i>      | . | . | + | . | . | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | +  | +  | +  | II  |
| G       |   | Eua      | 22    | <i>Circaea lutetiana</i>       | . | . | + | + | . | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | II  |
| G       |   | Cp(bor)  | 104   | <i>Phegopteris connectilis</i> | . | . | + | + | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| H       |   | Eua      | 26,40 | <i>Asarum europaeum</i>        | . | . | . | + | + | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | I   |
| H       |   | Ec       | 28    | <i>Geranium phaeum</i>         | . | . | + | . | + | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| Ch      |   | E(M)     | 18    | <i>Euphorbia amygdaloides</i>  | . | . | . | . | . | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| H       |   | At(M)    | 16    | <i>Sanicula europaea</i>       | . | . | . | + | . | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| H       |   | Eua      | 36    | <i>Scrophularia nodosa</i>     | . | . | . | . | . | .  | +  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | .  | I   |



| I       | 2       | 3          | 4                                        | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---------|---------|------------|------------------------------------------|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| H       | Eua(M)  | 34         | <i>Campanula trachelium</i>              | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | +  | I  |
| H       | Ec      | 16         | <i>Aconitum lycoctonum ssp. vulparia</i> | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | .  | I  |
| H(Ch)   | Ec      | 18         | <i>Lamium galeobdolon</i>                | . | . | . | + | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
| H       | Eua     | 66         | <i>Stachys sylvatica</i>                 | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
| H       | Eua     | 34         | <i>Campanula bononiensis</i>             | . | . | . | . | + | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
| H       | Eua(M)  | 34,68, 102 | <i>Campanula rapunculoides</i>           | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | I  |
| G       | Eua(M)  | 38         | <i>Epipactis helleborine</i>             | . | . | . | . | . | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
|         |         |            | <b>Carpin</b>                            |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| MPh-mPh | E       | 64         | <i>Carpinus betulus</i>                  | . | . | . | . | + | 1  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
| H-Ch    | Eua     | 26         | <i>Stellaria holostea</i>                | . | . | . | . | . | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
|         |         |            | <b>Acerion</b>                           |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| MPh     | Ec      | 52         | <i>Acer pseudoplatanus</i>               | + | + | + | + | . | .  | +  | .  | .  | +  | +  | +  | .  | .  | +  | +  | +  | +  | IV |
| nPh     | Eua     | 18,36      | <i>Spiraea chamaedryfolia</i>            | . | . | + | . | + | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | +  | +  | +  | II |
| nPh     | Eua     | 16         | <i>Ribes uva-crispa</i>                  | . | . | . | . | . | +  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | .  | +  | II |
| MPh     | Ec      | 52         | <i>Acer pseudoplatanus (plantules)</i>   | . | . | . | + | . | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | I  |
| H       | Ec      | 60         | <i>Doronicum austriacum</i>              | . | . | + | . | . | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | +  | +  | +  | II |
| H       | Cp(bor) | 164        | <i>Polystichum braunii</i>               | . | . | . | . | . | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | +  | I  |
| H       | Ec      | 16         | <i>Valeriana tripteris</i>               | + | . | + | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
| H       | Cosm    | 168        | <i>Cystopteris fragilis</i>              | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | .  | I  |
| H       | Cosm    | 82         | <i>Polystichum setiferum</i>             | . | . | . | . | . | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
|         |         |            | <b>Alno-Ulmion s.l.</b>                  |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| MPh-mPh | Eua     | 28         | <i>Alnus incana</i>                      | . | . | + | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
| MPh-mPh | Eua     | 28         | <i>Ulmus glabra</i>                      | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I  |
| H       | Cp(bor) | 22         | <i>Circaea alpina</i>                    | . | . | + | + | . | .  | +  | +  | +  | +  | .  | +  | +  | +  | +  | .  | +  | +  | IV |

*Tableau 1 (à suivre)*

[illegible]



|       | 1            | 2              | 3 | 4                                | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23  |
|-------|--------------|----------------|---|----------------------------------|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| H     | E            | 18             |   | <i>Melica uniflora</i>           | . | . | . | . | . | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
|       |              | 28-            |   |                                  |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
| H     | Eua          | 38,42,<br>c.56 |   | <i>Poa nemoralis</i>             | . | . | . | . | . | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| Brche | Cp           | 12             |   | <i>Mnium undulatum</i>           | 2 | . | 1 | + | + | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | 1  | .  | II  |
|       |              |                |   | <b>Epilobion</b>                 |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
| nPh   | Cp(bor)      | 14             |   | <i>angustifolii</i> s. l.        | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | II  |
| mPh   | Eua(bor)     | 36             |   | <i>Rubus idaeus</i>              | + | . | . | 2 | + | +  | .  | .  | .  | .  | +  | .  | +  | .  | .  | .  | +  | .  | I   |
| H     | Eua          | 14             |   | <i>Sambucus racemosa</i>         | + | . | + | . | . | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | V   |
|       |              |                |   | <i>Fragaria vesca</i>            | . | + | + | . | + | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | IV  |
| H     | Cp           | 56             |   | <i>Gnaphalium sylvaticum</i>     | + | + | + | + | + | .  | +  | .  | .  | .  | .  | +  | .  | +  | .  | .  | .  | .  | IV  |
| Th    | Eua          | 32             |   | <i>Galeopsis x tetrahit</i>      | . | . | + | . | . | .  | +  | +  | +  | .  | .  | .  | .  | .  | .  | .  | +  | +  | II  |
| H     | Eua          | 24             |   | <i>Silene dioica</i>             | . | . | + | . | . | .  | +  | +  | .  | +  | .  | .  | .  | .  | .  | .  | +  | .  | II  |
| H(G)  | Eua          | 28             |   | <i>Calamagrostis arundinacea</i> | + | + | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| H     | E            | 56             |   | <i>Digitalis grandiflora</i>     | . | . | . | . | . | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
|       |              |                |   | <b>Adenostylion</b>              |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
| H     | Ec           | 36             |   | <i>Gentiana asclepiadea</i>      | + | . | + | + | + | .  | .  | .  | +  | .  | .  | .  | .  | +  | .  | .  | .  | +  | III |
| H     | E(mont)      | 32             |   | <i>Valeriana montana</i>         | . | . | + | . | 1 | .  | .  | .  | .  | .  | 1  | +  | .  | .  | .  | .  | +  | +  | II  |
| H     | Ec           | 18,22          |   | <i>Carduus personata</i>         | . | . | . | . | + | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | I   |
| H     | Alp-Carp-B   | 16             |   | <i>Aconitum paniculatum</i>      | . | . | + | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | 1  | I   |
|       |              |                |   | <i>Valeriana sambucifolia</i>    | . | . | + | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
| G     | Eua          | 32             |   | <i>Veratrum album</i>            | . | . | + | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | I   |
|       |              |                |   | <b>Variae Syntaxa</b>            |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
| H     | Cp(bor)      | 28             |   | <i>Prunella vulgaris</i>         | . | . | + | . | . | .  | .  | +  | .  | +  | .  | +  | .  | .  | .  | .  | +  | +  | II  |
| H     | Eua          | 16             |   | <i>Hypericum maculatum</i>       | . | . | . | . | + | .  | .  | .  | .  | +  | .  | +  | .  | +  | .  | .  | .  | .  | II  |
| H     | Cp(Aret-alp) | 82             |   | <i>Polystichum lonchitis</i>     | . | . | . | . | . | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | II  |

Tableau I

|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|--|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
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Dates et localités de relevés: 1,4 - Lăpușna 1997.08.18; 2,3 - Valea Bătrâna 1997.08.18; 5 - Lăpușna 1998.08.11; 6,7,8 - Valea Creanga Albă 1998.08.11; 9,10,11,12 - Valea Bătrâna 1998.08.12; 13,14,15 - Valea Gâti 1998.08.13; 16,17,18 - Valea Secuic 1998.08.14.



Les pessières de la Vallée du Gurghiu ont souffert dans les dernières années une dégradation à cause des influences anthropogènes et des rages, qui par leur violence ont provoqué de grands dommages.

Les fûts des arbres n'ont pas été évacués en totalité jusqu'à aujourd'hui à cause de l'accès difficile dans les zones affectées, et des conditions météorologiques défavorables des dernières années. Ce phénomène peut être constaté par la présence dans ce territoire d'un grand nombre d'espèces rudérales.

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Reçu le 15 avril 1999.

Muzeul de Ştiinţe ale Naturii  
Tg.-Mureş  
Str. Horea nr. 24 4300, Mureş





# EXPERIMENTAL RESTORATION OF THE VEGETATION COVER ON THE SPOIL MATERIALS AND ROCK QUARRIES AFTER THE HYDROTECHNICAL WORKS ON THE RÂUL MARE – RETEZAT

MIHAELA PAUCĂ-COMĂNESCU, MARILENA ONETE, RĂZVAN COJOC

The paper presents the experiments of rehabilitation of herbaceous vegetation on the spoil materials and quarries from the montane belt of the Retezat Mountains, in the area where hydrotechnical works were performed on the Râul Mare, on the initial ground, with rough texture, without an addition of soil. Next to the herbaceous species seeded in various proportions (*Festuca rubra*, *Festuca pratensis*, *Festuca arundinacea*, *Agrostis capillaris*, *Lolium perenne*, *Phleum pratense*, *Dactylis glomerata*, *Lotus corniculatus*, *Trifolium repens*, *Trifolium pratense*), which succeeded to cover 30-60% of the ground, only in the vegetation stage, same native ecotypes of the same species developed vigorously and reached the fructification stages.

The essential purpose and ecological result of seeding the grass cover on the spoil materials without soil addition is the self-fixation of organic matter to its surface, alive in the beginning and then as dead matter, which also deposits and encloses the neighboring trees and brush litter.

*Key words:* restoration, rock quarry, spoil materials, grass cover, protected areas, the Retezat Mountains.

The development of the human society, with the whole array of land shaping technologies, led to various degrees of unbalance dangers for the present and particularly for the future. The worldwide awareness of this danger at the top level decision making factors led to the development of a plan for biosphere control in the future, plan synthesized in Agenda 21 of the United Nations as early as 1992, the essence of which is the provision for a "sustainable development" both in the developed and in the developing countries.

The activity of ecological reconstruction at the regional and national level is considered as one of the 9 essential desiderata of Agenda 21, which must be enforced with responsibility, following a plan for research and another for the restoration of the living environment (Hartig, J.H., 1995).

The mining fields and the areas resulted from the hydrotechnical works (quarries, spoil materials) require restoration works because the excavated surface destroyed the superficial living vegetal cover, formed of the solid ground, full of a specific fauna, less visible for those not familiar with it, but which provides, nevertheless, a complex support for the vegetal cover easily visible to anyone, but which has to have a certain plant composition for self-sustainable along the time.

The necessity of restoring is quite well understood by most practitioners, even if some of them consider that "nature can restore by itself" but do not say how long this will take. The manner in which this restoration cycle must be shortened and particularly the manner in which the restoration is sustainable for the vegetal carpet, as the first functional link of ecosystems, much investigated and discussed

during the past period (Harris A.J. *et al.*, 1996; Goldman St. *et al.*, 1997; Jordan III R.W. *et al.*, 1998; Schuman G.E., 1999), with the view of optimizing the processes and costs.

In addition to this general problem of restoring the landscape and ecosystem production, this paper also involves the obligation of restoring these areas as close as possible to the original form, including the specific vegetation composition and structure, because some of them belong to the Retezat National Reservation – the first national park in Romania, patrimony reservation for the whole world, Biosphere Reservation. This contradiction between the interests of the economic development, the interests of the local population and the preservation of the national parks, amply discussed by Nepal S.K. and Weber K. E. (1995), found its practical solution according to the specificity of each country (level of development) and of each area, following ecological case studies.

We shall present subsequently our interest and our actions between 1995-1999, in the basin of the Râul Mare where hydrotechnical works have been performed, in cooperation with the constructors who worked there.

### **Research objectives**

- Determination of the current degree of deterioration of the areas where spoil resulted from underground tunnel excavations for water supply to “Râul Mare” dam were deposited;
- Determination of the speed and quality of the natural restoration of the vegetation cover on the surface of the old spoil materials;
- Experimental determination of solutions for the sustainable ecological restoration of the vegetal cover on the spoil materials from the National Park and outside it.

## **MATERIALS AND METHODS**

The investigations were conducted in two distinct areas:

**1. Netiş valley** – tributary to Râul Mare, passing through the Godeanu – Petreanu mountains, near the confluence. In this area, a rock quarry and spoil materials resulted after the works of water deviation for the accumulation lake, at an altitude of 1000 – 1100 m, in the vegetal belt with beech forests mixed with fir and spruce. The current microrelief is changed, in the rock quarry, several berms resulted as rough ground, consisting of gravel, 2-5 cm in diameter, to rocks of 30-50 cm in diameter, in the higher berm, abandoned some 18 years ago and only 2-5 cm diameter gravel in the lower berm, abandoned about 5-6 years ago. No previous works for plant restoration were conducted here.



On Netiş spoil materials, the gravel has the same dimensions, about 2-5 cm diameter, with no addition of more fine material or soil, the permanent storage being abandoned about 8-9 years ago; several spoil, particularly concrete waste, were dumped here occasionally, particularly on slopes (1:2 slope).

**2. Bârlîi spoil materials** – situated at the confluence of Valereasca valley (Găf) with Bârlîi (at the boundary of the Retezat Reservation), at an altitude of 1100 m, between the secondary pasture of *Festuca rubra* s.l. – *Agrostis capillaris* and the beech forest. The material excavated from the gallery and stored as spoil materials starting with 1993, is rough, 2-5 cm diameter, the total height exceeding 100 m. The slope is 1:2, the basis is in concrete towards Bârlîi valley; the deposit is crossed by a tube through which flows the water of Găf crossing the spoil.

The composition and proportion of the existing wild species were determined both in the area of the spoil materials, in the quarry, in the pasture and in the neighboring forest, in order to observe the initial biodiversity which represents the potential reserve of seeds for these territories (Paucă and Negrean, in press) and the natural restoration on the spoil materials.

The experiments concerning the restoration of the vegetation cover of the spoil materials with grasses had some basic principles:

- Use plant species from the wild flora of the valley;
- Be able to use enough amounts of seeds for the affected areas (seeds produced by units specialized in pasture cultivation);
- Use the primary ground, with no soil addition from other areas, on the one hand to avoid the invasion of foreign species and on the other hand to find least cost solutions with the least effect on the neighbour areas, which are protected areas.

The formulations we used were based on the patents nr. 87764/1985 and 133015/1988 and on the results obtained in the agricultural practice of restoring the pastures and eroded soils (Gh. Anghel et al., 1966), which resemble very much the spoil materials (Table 1). The germinating capacity (60-80%) was assessed in the laboratory. The germination speed in all used species was 4 days for 50% of the seeds and 10 days for all germinated seeds. *Festuca arundinacea* is the most attractive of all used species, being observed on wet, rocky pastures.

The seeds were sown in late spring, to avoid the late freezing, because the soil provides no thermal protection for the young roots, and in order to benefit of the still high moisture of the soil, knowing that the lack of fine and structured materials in the soil leads to a poor water supply (Table 2). The experimental years differed, 1994, 1995 of Netiş spoil materials, 1997, 1998 on the lower berm of Netiş quarries and 1999 for the berm on slope of Bârlîi spoil materials.

The inventory of the seeded plants was done on 25 × 25 cm squares in 15 – 20 replicates, and the nomenclature is according to V. Ciocârlan (1988, 1992).

Table 1  
Species and used rate in experiments

| SITE                                                                                                     |              | VARIANTS<br>(species and %)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Spoil Netiş (flat without vegetation;<br/>slopes 1, 2)</p> <p>Rocky Quarry Netiş<br/>(lower berm)</p> |              | <p><b>Var.1:</b> <i>Phleum pratense</i> 60%,<br/><i>Festuca pratensis</i> 15%,<br/><i>Dactylis glomerata</i> 10%,<br/><i>Lolium perenne</i> 5%,<br/><i>Trifolium pratense</i> 5%,<br/><i>Trifolium repens</i> 5%.</p> <p><b>Var.2:</b> <i>Festuca pratensis</i> 50%,<br/><i>Phleum pratense</i> 20%,<br/><i>Lolium perenne</i> 10%,<br/><i>Festuca arundinacea</i> 10%,<br/><i>Trifolium pratense</i> 5%,<br/><i>Trifolium repens</i> 5%.</p> <p><b>Var.3:</b> <i>Festuca arundinacea</i> 65%,<br/><i>Festuca pratensis</i> 10%,<br/><i>Phleum pratense</i> 5%,<br/><i>Dactylis glomerata</i> 5%,<br/><i>Lolium perenne</i> 5%,<br/><i>Trifolium pratense</i> 5%,<br/><i>Trifolium repens</i> 3%,<br/><i>Lotus corniculatus</i> 2%.</p> <p><b>Var.4:</b> <i>Festuca rubra</i> 25%,<br/><i>Agrostis capillaris</i> 20%,<br/><i>Agrostis gigantea</i> 20%,<br/><i>Lolium perenne</i> 15%,<br/><i>Dactylis glomerata</i> 5%,<br/><i>Festuca pratensis</i> 5%,<br/><i>Lotus corniculatus</i> 5%,<br/><i>Trifolium pratense</i> 3%,<br/><i>Trifolium repens</i> 2%.</p> |
|                                                                                                          |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Bârlui Spoil                                                                                             | On the berm  | <p><b>Var.1.</b> <i>Festuca rubra</i> – monodominated (100%)<br/> <b>Var. 2.</b> <i>Festuca pratensis</i> –monodominated<br/> <b>Var.3.</b> <i>Festuca arundinacea</i> –monodominated<br/> <b>Var.4.</b> <i>Dactylis glomerata</i> – monodominated<br/> <b>Var.5.</b> <i>Festuca rubra</i> 40%;<br/> <i>Festuca pratensis</i> 20%;<br/> <i>Festuca arundinacea</i> 20%,<br/> <i>Dactylis glomerata</i> 20%</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                                                                                                          | On the slope | <i>Dactylis glomerata</i> – monodominated                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |



Table 2  
Ground humidity, 5-11 May 2000

| Depth<br>(cm) | Relative humidity (%) |                 |        |
|---------------|-----------------------|-----------------|--------|
|               | BÂRLII                |                 | NETIŞ  |
|               | Pasture               | Spoil Materials | Quarry |
| 0 – 10        | 36.36                 | 4.81            | 3.32   |
| 10 – 20       | 33.74                 | 4.40            | 2.95   |
| 20 – 30       | 31.82                 | 4.20            | 2.42   |

## RESULTS AND DISCUSSION

The vegetation cover formed experimentally on the spoil materials and rock quarry had a similar evolution in all investigated areas. The main cause of the restrictions in the installation and formation of the vegetation cover is ground texture, which cannot retain the water required by plants (Table 2). As noticed on Bârlui valley, although soil humidity was low on the pasture during the investigated period due to the persistent lack of rain, on spoil materials, humidity was 10 times lower, both at the surface and in depth; compared to Bârlui spoil, situated close to the forest that may protect it from radiation and by its humidity, on the berm from Netiş quarry, humidity is 20% lower. The vegetation seeded artificially started after about 2 months and the composition was variable from one place to another and at different periods (Table 3, 4a, b 5).

The restoration of the vegetation cover in the mountain belt is difficult even of soiled areas because of the rough climate. The vitality of seeded plants is low, only some species succeeded to reach the fertile stage, sporadically. In some variants of Netiş quarry (Table 4b) it was observed that the vegetative part reduced the content of chlorophyll pigments, towards the end of the year, the yellowing being very advanced; the resuming of activity in spring is very delayed.

The cover with vegetation is uniform on all flat areas, while on slopes there are stripes with dense vegetation alternating with bare stripes, the average coverage being 50% or even less in Netiş (Table 3), after a period of more than one season (Tables 3, 4). The density of the vegetal cover is lower and not uniform by unit of area and variable from place to place; we noticed that compared to the high density of the seeded grasses during the early period of the vegetation cover restoration, species density decreased over time (Table 4a), but it diversified with species growing naturally, from the seed reserve of the area.

Table 3

Vegetation cover on spoil materials Netiş – (seeded land, May 1994)

| Species                                    | Frequency % |              |
|--------------------------------------------|-------------|--------------|
|                                            | August 1994 | October 1995 |
| <b>Tree species</b>                        |             |              |
| <i>Betula pendula</i>                      | 23          | 23           |
| <i>Abies alba</i>                          | 4           | 4            |
| <i>Salix capraea</i>                       | 27          | 9            |
| <i>Picea abies</i>                         | 9           | 9            |
| <b>Herbaceous species</b>                  |             |              |
| Gramineous seeded sterile shoots (Table 1) | 91          | 80           |
| <i>Melilotus alba</i>                      | 86          | 27           |
| <i>Achillea stricta</i>                    | 50          | 45           |
| <i>Euphrasia stricta</i>                   | 32          | 27           |
| <i>Agrostis capillaris</i>                 | 18          | 18           |
| <i>Tussilago farfara</i>                   | 18          | 9            |
| <i>Trifolium repens</i>                    | 14          | 4            |
| <i>Poa nemoralis</i>                       | 9           | 9            |
| <i>Taraxacum officinale</i>                | 9           | 4            |
| <i>Erigeron acer</i>                       | 9           | 23           |
| <i>Senecio squalidus</i>                   | 9           | 4            |
| <i>Sonchus arvensis</i>                    | 4           | -            |
| <i>Epilobium montanum</i>                  | 4           | -            |
| <i>Hypericum perforatum</i>                | 4           | 4            |
| <i>Dactylis glomerata</i>                  | 4           | 64           |
| <i>Agrostis stolonifera</i>                | 4           | 31           |
| <i>Calamagrostis arundinacea</i>           | 4           | 4            |
| <i>Campanula sp.</i>                       | 4           | 4            |
| <i>Cardaminopsis arenosa</i>               | 4           | -            |
| <i>Trifolium medium</i>                    | 4           | 4            |
| <i>Daucus carota</i>                       | 4           | -            |
| <i>Origanum vulgare</i>                    | 4           | -            |
| <i>Lotus corniculatus</i>                  | 4           | 4            |
| <i>Trifolium pratense</i>                  | 9           | -            |
| <b>Vegetation cover (%) :</b>              | <b>90%</b>  | <b>50%</b>   |



Although present, many shoots of seeded gramineous reduced their vitality, manifested not only by a deficient synthesis of the assimilating pigments, but also by the shorter period of active vegetation, namely from the later start of vegetation than the surrounding grasses and up to the earlier drying of their aboveground part in autumn, compared to the grasses. The high variability of survival is determined by the period of time of each species; between different seeded species, the density maintained over time, with higher values in *Festuca arundinacea*, while *Dactylis glomerata* developed individuals with higher size and more vigorous, while the synthesis capacity of the pigments and the intensity of the green color did not fade over time in the leaves of this species.

A particular situation was noticed for Netiş spoil materials (Table 3) where seeding was done on the flat area of the plot, but on the spot occupied the previous year by an annual plant with luxurious development, *Melilotus alba*; in the year of seeding (1994) species frequency still was rather high but the size decreased substantially (from 1.5 m height to 10-20 cm), as did plant density, the number of plants being not significant. Our seeding, according to a formulation used on other plots too (Table 1), developed rapidly, after 2 months they were vigorous and already 10 cm in height; the coverage with seeded gramineous was 80%, but shortly, most seedlings turned yellow and many individuals dried. The next year (1995), the frequency and the coverage of all plant cover reduced substantially, *Melilotus* disappearing almost completely. The gramineous species seeded by us still had a high frequency but most of them dried; yet, they favoured the development of local ecotypes of the same species. The next season, the seeded grasses remained just as dead material; an important contribution to this situation was probably due to the allelopathic effect of *Melilotus alba* which, not only preserved its own biomass and enriched the organic matter of the ground, but also had an intoxicating, poisoning effect on other plant species. Thus, the species known or tested as having strong allelopathic effects should be removed from the areas proposed for restoration, even if they cover most of the surface in the beginning.

The life strategy of the species seeded by us under the given conditions on the spoil, to be more precise, of these ecotypes, is a "C-type" strategy according to St. Kitchen, 1996, developed on soils very similar to semi-arid soils; it consists in the prolongation of the life cycle with several years, but with an active life limited strictly for the optimal periods of the year, even accepting broken periods.

The limiting factors for the active life are the dryness and the solar radiation, the very wide temperature amplitude on the same day at the level of the ground; this has a destructive effect on the fine roots of the grasses because there is not protection from the solid particles such as the plants from the surrounding pastures or forests have.

Next to the seeded species, with a coverage degree between 30-60%, with stems 5-10 cm tall, species from the local wild flora develop from the seeds that have germinated in this "protective structure" achieved by seeding. The species number is not large, but these grass species run a complete development cycle (they bloom and produce seeds), both the gramineous (*Dactylis glomerata*, *Poa nemoralis*) and the leguminous (*Lotus corniculatus*) or other dicotyledon plants. They have low density (Tables 3, 4, 5), but their anchorage in the ground and their perennity are already implemented. We may observe that *Dactylis glomerata* and *Lotus corniculatus* are species seeded by us in the experiment but these vigorous plants show the importance of the local provenience of their seeds.

We note particularly the presence of *Poa nemoralis* species, constantly met among the species growing on spoil materials or quarries, proceeding from the local flora, with high frequency for the present wild species of gramineous and with a strong character, of rehabilitation of the vegetation cover in the rocky area of this vegetation belt; unfortunately, the small seeds and the difficulty of producing and harvesting, make it impossible to get them from the agricultural production network, so it may not be recommended for the practical activity of restoration.

Table 4a

Structure indices of plant populations installed on low berm of Quarry Netiş in a seeded area, May 1997 (Measured in August 1999)

| Species                          | Frequency (%) | Density (ind/m <sup>2</sup> ) | Height (cm) |
|----------------------------------|---------------|-------------------------------|-------------|
| <b>Tree species</b>              |               |                               |             |
| <i>Betula pendula</i>            | 100           | 17.11                         | 3-38(117)   |
| <i>Salix capraea</i>             | 58            | 0.85                          | 3-1         |
| <i>Pinus sylvestris</i>          | 46            | 0.61                          | 3-10        |
| <i>Abies alba</i>                | 3,8           | 0.04                          | 3           |
| <b>Herbaceous species</b>        |               |                               |             |
| Gramineous seeded shoots (total) | 69            | 47.69                         |             |
| - fertile                        | 46            | 18.77                         |             |
| - sterile                        | 58            | 28.92                         |             |
| <i>Euphrasia stricta</i>         | 11            | 1.69                          |             |
| <i>Lotus corniculatus</i>        | 8             | 0.46                          |             |
| <i>Trifolium repens</i>          | 3.8           | 0.15                          |             |
| <i>Tussilago farfara</i>         | 3.8           | 1.08                          |             |
| <b>Vegetation cover : 30 %</b>   |               |                               |             |



Table 4b

Structure indices differences between experiments on the Quarry Netiş (October 1999)

| var. 1-2                               |               |                             | var. 3-4      |                             |
|----------------------------------------|---------------|-----------------------------|---------------|-----------------------------|
| Species                                | Frequency (%) | Density ind./m <sup>2</sup> | Frequency (%) | Density ind./m <sup>2</sup> |
| Tree species                           |               |                             |               |                             |
| <i>Betula pendula</i>                  | 40            | 22                          | 27            | 7                           |
| <i>Abies alba</i>                      | -             | -                           | 7             | 8                           |
| Herbaceous Species                     |               |                             |               |                             |
| Gramineous seeds shoots (only sterile) | 100           | 351*                        | 100           | 885                         |
| <i>Euphrasia stricta</i>               | 7             | 1                           | 40            | 22                          |
| <i>Poa nemoralis</i>                   | 13            | 2                           | 20            | 43                          |
| <i>Lotus corniculatus</i>              | -             | -                           | 20 (7%.fer )  | 68 (19 fer. branch)         |
| <i>Cerastium fontanum</i>              | 13            | 2                           | 20            | 8                           |
| <i>Luzula luzuloides</i>               | 7             | 1                           | -             | -                           |
| <i>Epilobium montanum</i>              | -             | -                           | 13            | 2                           |
| <i>Dactylis glomerata</i>              | -             | -                           | 13            | 30                          |
| <i>Convolvulus arvensis</i>            | -             | -                           | (7%. fer)     | (1fer.branch)               |
| <i>Digitalis grandiflora</i>           | -             | -                           | 7             | 2                           |
| <i>Plantago media</i>                  | -             | -                           | 7             | 2                           |
|                                        |               | -                           | 7             | 1                           |
|                                        |               | * 238 dry                   |               |                             |
| Vegetation cover (%) :                 |               |                             |               |                             |
| - mean                                 | 5.27          |                             | 33.67         |                             |
| - amplitude of variation               | 1-15          |                             | 10-85         |                             |

Table 5

Vegetation cover on spoil materials Bârlui (seeded land in May 1999, measured in October 1999)

| Species                             | Frequency (%) | Density ind/m <sup>2</sup> |
|-------------------------------------|---------------|----------------------------|
| <i>Dactylis glomerata</i>           | 30            | 353                        |
| <i>Festuca arundinacea</i>          | 25            | 616                        |
| <i>Festuca rubra</i>                | 20            | 354                        |
| <i>Festuca pratensis</i>            | 20            | 329                        |
| <i>Cardaminopsis arenosa</i>        | 10            | 2                          |
| <i>Epilobium montanum</i>           | 5             | 1                          |
| <i>Coronilla varia</i>              | 5             | 1                          |
| <i>Tussilago farfara</i>            | 5             | 1                          |
| <b>Vegetation cover (%) : 51.83</b> |               |                            |

*Table 6*  
Wood vegetation structure on Quarry Netiş

[illegible]



Table 7  
Wood vegetation structure on the spoil materials Netiş (Superior flat)

[illegible]

The essential role of the grass structure achieved by seeding consists in environment improvement, respectively in the improvement of the ground for the seeds of the wild local plants. This improvement consists in the formation, preservation of a layer of vegetation – live or dead – which stores water during the excess period and saves a higher proportion of water when rainfall is missing; the same effect of protection is also observed for the screening of the intense radiation or of the rapid freezing of the rots developing under ground.

B. Roundy (1996) observed that this system applied for the restoration of the plant cover, for the stimulation of the growth of species with high capacity of vegetative growth (in the case of *Eragrostis lehmanniana* – ruderal species, invading in Arizona) followed by the use of pesticides forms a plant matter anchored in the precarious ground, as a “mulch” that preserves the water required for the growth and development of local wild species germinated naturally and not affected by the pesticide. Therefore, the positive effect of grass seeding may be both the formation of a vegetation cover and the secondary effect of providing a more favorable environment for the other wild species introduced in the cover.

As it can be observed in Tables 3, 4a, b, 5, next to the grass species that cover the spoil materials seeded artificially, several specimens of tree seedlings grow. *Betula pendula* is the most efficient species of seedlings wildy growing on the gravel of Netiş quarry, both on the old, abandoned areas and in the new areas (Table 6) and on Netiş spoil materials (Table 7). Their number and size differ with age, young trees of 15 years growing on the higher berm, while trees of only 4-5 years growing on the lower berm. Although the wood plants are properly anchored, no improvement was noticed in the ground because it cannot retain the litter blown away by the wind from the barren surface of the spoil materials.

Under the conditions of Bârlui spoil materials, situated at the boundary of the Retezat Scientific Reservation, the vegetation cover must reflect the presence of species from the area without technological ingressions; the sown species were similar with the ones from the neighbour pasture. The wild species installed additionally, from the seed reserve of the area, self-selected according to their capacity of adaptation to the rocky, non-solified ground. The future composition of the grass vegetation will diversify gradually with species disseminated from the slopes, at the same time when the ground improves naturally.

The rehabilitation of vegetation in the montane belt – where the spoil materials were deposited and we have made investigations – carries slowly and with a low coverage even under natural conditions, on soils. The results of vegetation restoration that we have obtained, although modest, justify the reparatory intervention of the builders, but correspond to the lower costs obtained by their limitation in the operation of additional seeding of areas, in the absence of ground improvement by addition of fertile soil.



Subsequent investigations for the restoration of spoil mining areas show that the main environmental factors involved in the limitation of the development of the plant cover (temperature and ground moisture) are corrected by the addition of mulches to the ground, obtaining a reduction of their extreme value.

### CONCLUSIONS

Under the soil and climate conditions existing in the mountain area, the spoil materials areas may be restored again in a short period by artificial seeding with certain mixtures of seeds of local growing plant species, but their sustainability is provided by the species disseminated naturally from the local flora.

The absence of fertile soil addition to spoil materials surface, although it makes the operation cheaper, lowers the quality of the plant cover because it has a lower coverage, a lower vitality and a lower productivity compared to the neighbouring conditions.

The essential effect of seeding the vegetation cover on the spoil materials not covered with the soil is the self-fixation of organic matter on their surface, alive in the beginning and then as dead matter, supplemented by the fixation and conservation of neighbouring trees and bush litter and of the one brought by the wind on this ground during its development.

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TATIANA EUGENIA ȘESAN and AURELIA CRIȘAN, *White rot of cropped plants (Sclerotinia sclerotiorum). Prevention and control*, Ceres Publishing House, Bucharest, 288 pp., 39 figs., 20 plates.

The recent issue of the Ceres Publishing House—Bucharest, a monograph appeared in première in the Romanian Plant Pathology literature, but also in the international one, refers to one of the most damaging diseases – White Rot. This disease, caused by the fungus *Sclerotinia sclerotiorum* in a number of cropped plants, can induce losses up to 100%, estimated at millions of dollars.

This work is signed by two personalities of mycology and plant pathology, Ph. D. in Biology Tatiana Eugenia Șesan, awarded Tr. Săvulescu prize of the Academy of Romania, Senior Researcher at the Research Institute for Plant Protection (RIPP) in Bucharest, associate professor at the Faculty of Biology – University of Bucharest, and Ph. D. in biology Aurelia Crișan, awarded Em. Teodorescu prize of the Romanian Academy, reader at the Faculty of Biology of the University Babeș-Bolyai, Cluj-Napoca. The authors succeeded to gather a huge documentary material (more than 1,000 Ph. D. in biology speciality literature titles) and valorized a steady scientific research and didactic activity as well as an impressive personal expertise in the study of this disease, among the most damaging in a wide number of cropped plants.

After the first chapter, including generalities, containing data about the significance and losses caused by White Rot, the area and history of world-wide investigations and also in Romania, the authors treat this subject rigorously and with particular professional competence, using the most modern speciality concepts, taxonomy and ontogeny of the pathogen, the fungus *S. sclerotiorum*.

Morphological, structural and biochemical characters of the fungus *S. sclerotiorum* are further presented, based on data of speciality literature, combined with the results of their own investigations, performed under the pedoclimate conditions prevailing in Romania.

The study of the physiological traits of the fungus *S. sclerotiorum* correlated with practical aspects, resulted in methodologies for selection of resistant cropped plant cultivars, an important way to control the pathogen.

Likewise, the infective mechanism of the pathogen is approached in connexion with the host-plant, the ecological factors influencing this process, by modern methods of electron-microscopy investigation, the whole chapter being based, as well as the entire book, both on foreign and autochthonous quite recent literature, and also on the own data of authors.

Pathogenesis and disease biochemistry are presented as complex and dynamic phenomena of host-pathogen interaction, closely related to environment conditions and the time of their performance. The essential role of enzymes, toxins and other metabolic products in these processes is stressed, their assessments being sustained by the latest and modern researches which offer an answer to many hypotheses.

The chapter containing a description of the symptoms induced by the White Rot revealed in various host-plants, particularly in those cultivated (sunflower, flax, hemp, tobacco, annual pulses, root vegetables, cabbages, cucurbits, solanaceous, cucumbers, endives, medicinal herbs, a. s. o.), and valuable data obtained by synthesis of specialty foreign and Romanian literature, in general, and also of those personal, is particularly useful for specialists and practitioners.



The book also contains hints of biology and ecology of the pathogen, as well as data on epidemiology, spreading of disease, outlining the Romanian contribution to understand requirements of fungal evolution and dynamics of the disease under pedoclimate conditions prevailing in Romania. Likewise, it contains aspects of fungus variability and physiological specialisation, revealed and proved by some researchers, contested and incompletely elucidated yet.

The issue of White Rot prevention and control, of overwhelming significance to agricultural practice is dealt with under the concept of integrated protection, particular stress being laid both on classic well-known methods (technological, physical and mostly chemical), and on the role of non-chemical, unconventional, unpolluting methods, using biological means, such as fungi with antagonistic role in reducing the infective potential and genetic resistance of cropped plants. Of particular interest, mainly to practitioners, is recommendation of fungicide assortment registered in Romania, usable to control White Rot, both by seed dressing and seasonal treatments of various cultivated plants, and also the application to stored products, dose rates and application of timing for these, in various plants and cropping zones in the country, as established by warning and forecast procedures. Likewise, the Romanian contribution to the development of some biological means for protection from White Rot is outlined, such as production at the RIPP Bucharest (Baicu, Şesan and Oancea, 1996) of the first biological fungicide – Trichosemin 25 PTS – registered in 1995. Moreover, recommendations of strategies of integrated protection from White Rot in some outstanding crop types in this country: industrial (sunflower, soybeans, rape), annual pulses (beans), vegetables (lettuce, carrot) and medicinal herbs (fennel), are very useful for the agricultural practice.

The monograph of the fungus *S. sclerotiorum* also includes a chapter taking a more recent challenge, i.e. evaluation of the fungus *S. sclerotiorum* as a potential biological agent for controlling some weed species, most of these belonging to *Asteraceae* family.

The book is based on a comprehensive literature, both foreign and Romanian, to which the authors brought numerous contributions by personal investigation along the years, thus conferring to this book availability to present to readers a complete and irreproachable information on this fungus – *S. sclerotiorum* – and on the disease induced – the White Rot. The text is accompanied by particularly valuable illustrative material from scientific and graphical standpoint, with many photos (39), tables (38), plates (20), mainly original or well-selected from foreign literature, being helped by several, remarkable specialists in the field (Dr. H. C. Huang; Prof. Dr. Linda Kohn, Canada; Dr. G. J. Verkeley, Holland; Dr. M. Gerlagh, Holland et al.). This book issued from a fruitful cooperation exchange with all foreign scientists for studies on the fungus *S. sclerotiorum* as well as from the opportunity of the senior author to benefit, after 1990, of a fellowship at the RIPP – Wageningen (Holland).

We feel that the monographic work on the fungus *S. sclerotiorum*, the causal agent of White Rot, ranks among valuable issues in the field of plant protection, plant pathology and mycology, and presents a real interest by its rich and remarkable content, being useful not only to researchers and practitioners, agronomists and biologists, but also to agriculturists cropping the most diverse plants: agricultural, horticultural, medicinal, a. s. o.

The issue of the book "White Rot of Cropped Plants (*Sclerotinia sclerotiorum*). Prevention and control" could not be a reality without the help of Ceres Publishing House and without the reliability, solicitude and moral support and mainly material backing, generously provided by ALCEDO S.A. by Dr. Al. Al. Alexandri and other renowned plant protection specialists (BASF S.R.L., Dagerty-Gavem S.A., Maktheshim-Agan).

Maria Oprea  
Research Institute for Plant Protection, Bucharest



SIMEON GEORGIEV VANEV, EVTIMIA GEORGIEVA DIMITROVA, ELENA IVANOVA  
ILIEVA, *Fungi Bulgariae*, 2 tomus, ordo *Peronosporales*, red. principali Prof. dr. Ivan  
KOVACHEVSKY, Editit tomum, VIOLETA FAKIROVA, Academia Scientiarum Bulgaria,  
Sofia, 1993, 196 p., 1 fig., 1 tab., 57 pl.

This is the second volume of Cryptogamic Flora of Bulgaria. The editing and printing are similar to those of the first volume dealing with Erysiphaceae. Following a short introduction, a review of studies on downy mildews from Persoon up to now is made.

The systematic part contains elements of the overall morphology of these fungi, a list of taxa treated, the description of orders, families and genera, the table/lists of species belonging to each genus and description of the species. The description of every species is followed by the enumeration of the hosts, the general (world) and Bulgaria distribution. Each species is also illustrated, many of them with the symptoms produced on the hosts. As was the case with the first volume in this series, the book ends with a Bulgarian-Latin vocabulary, indexes, and 6 pages of references. In addition, an English summary of one page is provided. Hundred sixty eight species and four infraspecific taxa belonging to 8 genera and 3 families are described. Thirty of the 168 species have not been found in Bulgaria yet, but their presence is considered as possible.

The illustrations look well at the first sight but the significant details to differentiate the species are missing. This is particularly obvious in the oospores which are depicted as almost identical although their ornamentation varies considerably, particularly in species of *Peronospora* parasitic on Boraginaceae or Fabaceae.

Information about the number of species, especially *Peronospora*, present in Bulgaria, compared with other European countries or the Europe as a whole is presented in Table no 1. This is completely misleading mostly due to differences in the species concept. Except for data from Romania, where a much larger (lumping) concept was used (Constantinescu & Negrean 1983), other lists or monographic studies are based on a sometimes extremely, splitting concept. Thus, if in the study of *Peronosporales* in Romania the same narrow species concept had been used, the number of species of *Peronospora* would not have been 88 but over 270!

The authors were obviously unaware of the description of the genus *Paraperonospora* Constantinescu (1989) which includes both *Peronospora sulphurea* and *P. leptosperma*.

The tables meant to replace the keys for the identification of species are an example of a distressing practice that, unfortunately, is used in many floras of this kind. The data presented in these tables constitute in fact a host-fungus index appended at the end of the volume.

The name *Peronospora knautiae* Fuckel var. *longispora* introduced at page 79 is invalid (arts 36.1 and 37 of ICBN). The use of the name *Plasmopara helianthi* Novot., instead of *Pl. halstedii* for the downy mildew of sunflower should be avoided.

Several names of host taxa or authors are either out of date or simply wrongly spelt:

Thus *Aubrieta* is used instead of *Aubrieta* (p. 26 & 179). *Veronica tryphyllos* instead of *V. triphyllos* (p. 48), *Cephalaria transsylvanica* R. et S. instead of *C. transylvanica* (L.) Roemer & Schultes (p. 56), *Cerastium caespitosum* Gilib. instead of *C. fontanum* Baumg. subsp. *vulgare* (Hartman) Greuter & Burdet (p. 61), *Corydalis slivensis* Vel. instead of *C. solida* (L.) Swartz subsp.

*slivenensis* (Velen.) Hayek (p. 63 & 180), *Veronica urticaefolia* instead of *V. urticifolia* (p. 39 & 76). The correct name of the cultivated strawberry is *Fragaria × magna* Thuill. and not *Fragaria elatior* Ehrh. (p. 142, 146, 151 & 159). As there are four authors whose name is Gmelin, one wonders which one is the author of *Rhinanthus angustifolius*? (p. 124).

The figure at page 44 depicts *Plantago major* rather than *P. media*.

Although the author states that they have examined the herbarium BUCM, several specimens present in this collection are not included like: *Peronospora conglomerata* on *Geranium tuberosum* from NE of Bulgaria (BUCM 70503), *P. echinospermi* on *Lappula marginata* from Balçik (BUCM 49874), *Albugo candida* on *Alyssum alyssoides* from Ecrenè (BUCM 74702). All the three plants are new hosts for Bulgarian micobionta of Peronosporales. In addition, *Peronospora cristata* on *Papaver hybridum* from Caliacra (BUCM 70043) is a new species for the micobionta of Bulgaria.

In spite of these criticisms, which are not diminishing its value as a whole, this volume will be useful not only for the Bulgarian but also for the Romanian mycologists.

Gavril Negrean



## AVIS AUX COLLABORATEURS

La «Revue roumaine de biologie – Série de biologie végétale» publie des articles originaux dans les domaines suivants de la biologie végétale: biologie moléculaire, cytologie, cytogénétique, morphologie, physiologie, génétique, microbiologie, systématique, chorologie, géobotanique, écologie végétale et phytopathologie. Le sommaire est complété des rubriques: 1. La vie scientifique, qui traite des manifestations scientifiques dans le domaine de la biologie (symposiums, conférences, etc.); 2. Comptes rendus des plus récentes parutions dans la littérature.

Les auteurs sont priés de présenter leurs articles en double exemplaire et espacés à double interligne. Le contenu des articles sera introduit sur des disquettes dans un langage connu, préférablement Word 6.0. La composition et la mise en vedette seront faites selon l'usage de la revue: caractères de 11/13 points pour le texte, de 12/14 points pour le titre de l'article et de 9/11 pour les annexes (tableaux, bibliographie, explication des figures, notes, etc.) et le résumé en anglais de 10 lignes au maximum, qui sera placé au début de l'article. Il est obligatoire que sur les disquettes il soit spécifié le nom des fichiers ainsi que le programme utilisé.

Le matériel graphique sera envoyé sur disquette, scanné, avec les mêmes spécifications. En l'absence d'un scanner, le matériel graphique sera exécuté en encre de Chine sur papier calque.

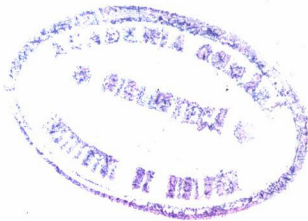
Les tableaux et les illustrations seront numérotés en chiffres arabes dans l'ordre de l'apparition. Les titres des revues seront abrégés conformément aux usages internationaux.

Les textes ne doivent pas dépasser 10 pages (y compris les tableaux, la bibliographie et l'explication des figures).

La responsabilité pour le contenu des articles revient exclusivement aux auteurs.

# TRAVAUX PARUS AUX ÉDITIONS DE L'ACADÉMIE ROUMAINE

CONSTANTIN TOMA, RODICA RUGINĂ, *Anatomia plantelor medicinale (Atlas) (L'anatomie des plantes médicinales. Atlas)*, Editura Academiei Române, 1998, 320 p., 155 pl., ISBN 973-27-0601-5.



ISSN 0035-3914

REV. ROUM. BIOL.-BIOL. VÉGÉT., TOME 44, N° 2, P. 93 – 182, BUCAREST, 1999