MORPHOCLIMATIC SIGNIFICANCE OF THE INTRA-MONTANE POSITION OF THE ÎNTORSURA BUZĂULUI DEPRESSION

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KEYWORDS: Romanian Carpathians, Întorsura Buzăului Depression, intra-montane depression, morpho-climatic features, topoclimate.

ABSTRACT

The following study presents a morpho-climatic analysis of the Întorsura Buzăului Depression, with a special look at the enclosed position and the relief characteristics that influence the climatic conditions. In their turn, by a positive feed-back type relation, these features influence other environmental components, including the humans, by restricting certain activities. Several characteristics of the relief are highlighted: the genesis of the depression in the context of the Outer Eastern Carpathians tectonics that led to the concave shape of its surface, the complete enclosure of this depression by mountain ridges, the evolution of the relief of the depression under the pressure of the main hydrographical artery - the Buzău River and the altimetric succession of the relief forms. These aspects, along with the topographical barrier and the particularities of the other active surfaces (water, vegetation), determine differences from the regional climate and are accentuating severe climatic phenomena by increasing their frequency and intensity.

REZUMAT: Semnificaţia morfoclimatică a poziţiei intra-montane a Depresiunii Întorsura Buzăului.

Studiul de faţă prezintă o analiză morfo-climatică a depresiunii Întorsura Buzăului, cu privire specială asupra poziţiei intra-montane şi a caracteristicilor reliefului care se repercutează asupra condiţiilor climatice. Acestea la rândul lor, printr-o relaţie de tip feed-back pozitiv, influenţează celelalte componente de mediu, inclusiv pe cea antropică prin restricţionarea unor activităţi. Sunt accentuate câteva caracteristici ale reliefului: geneza depresiunii în contextul tectonicii Carpaţilor de Curbură care a condus la concavitatea suprafeţei, la închiderea totală a depresiunii de culmi montane, evoluţia reliefului depresiunii sub acţiunea arterei hidrografice principale - Buzăul şi succesiunea altimetrică a formelor. Aceste aspecte, alături de barajul orografic şi particularităţile celorlalte suprafeţe active (ape, vegetaţie), determină diferenţieri faţă de climatul regional şi accentuează fenomenele climatice cu caracter de risc prin creşterea frecvenţei şi intensităţii de producere.

RÉSUMÉ: La significance morpho-climatique de la position fermée de la Dépression Întorsura Buzăului.

L'étude ci-dessous présente une analyse morpho-climatique de la dépression de Întorsura Buzăului, particulièrement de la position fermée entre les montagnes et des caractéristiques du relief qui influencent les conditions climatiques. Celles-ci, par une relation de type feed-back positif, influencent à leur tour les autres composantes de l'environnement, y compris la composante antropique par la restriction de certaines activités. Y sont mises en évidence quelques caractéristiques du relief: la genèse de la dépression dans le contexte de la tectonique de la partie sud des Carpates Orientales Extérieures qui a conduit à la concavité de la surface, à la fermeture totale de la dépression entre des lignes de faîtes, l'évolution du relief de la dépression sous l'action de l'artère hydrographique principale - la rivière de Buzău et la succession altimétrique des formes. Ces aspects, ainsi que la barrière orographique et les particularités des autres surfaces (eaux, végétation), déterminent des différenciations vis à-vis du climat régional et accentuent les phénomènes climatiques à caractère de risque par l'augmentation de la fréquence et de l'intensité à la quelle celles-ci se manifestent.

INTRODUCTION

Usually, the position of a depression in the mountain unit of an upper rank relief and the neighbourhood report with the adjacent mountain units is presented by the intra-montane geographic position. But, the reference to the regional geologic and geomorphologic conditions and the underlining of the local conditions which impose themselves in morphology is significant for the analysis of such a depression. Therefore, the intra-mountainous depressions can be differentiated by size, shape, prevalent relief, altitude, opening degree and genesis (Posea, 2002). Implications of the intra-mountainous position of depressions and of their morphometry are also reflected in their climatic regime, by favouring some extreme phenomena on the basis of a mountain climate, which form habitat conditions. By the typology of its forms, altitude, relief energy and slopes, the relief strongly influences the dynamics of the air masses and the evolution of the weather-climatic phenomena, especially by the obstructing of the air masses, their stagnation above depressions and their canalizing to valleys, producing some strong inversions with effects on all environmental components, on vegetation and fauna, on human organism and human activities.

The selection of Întorsura Buzăului Depression for such a study is not at random. The ratio between the relief and climate is one of the fundamental elements which individualizes this depression (Iancu, 1971; Mihai, 1984). Morpho-climatic issues are extremely complex as a result of the altitudinal position, of the configuration and almost complete enclosure of the depression which develop the weather-climatic phenomena generated mainly during the cold season of the year, and not only then, by the local circulation of the air. They generate the appearance and the intensity of the phenomena of some very important thermal inversions, with serious implication in the relief moulding within thermal regime, in the vegetation (Fărcaş et. al, 1971) and fauna distribution as well as within the development of the anthropic activities.

MATERIALS AND METHODS

The relief, through its morphometric characteristics and particularities induced by its petrographic nature and climate, are the defining elements of the Întorsura Buzăului Depression landscape, which have a direct impact to the whole of environmental conditions. Work methodology was based on the acknowledgment level of specific information and on the geological, geomorphologic and climatic data and procedures. The geomorphologic data needed were derived from topographic and geologic maps (scale 1:100000) and field surveys. Geomorphologic interpretation is based on cartographic material and field observations. The climatic analysis is based on the quantitative statistical-mathematical method of the main climatic parameter registered to the Întorsura Buzăului Climatic Station. The research was made for investigating the geographic aspects regarding the status of geographical position and relief peculiarities that are or may become significant factors of climatic features and processes, emphasising especially the risk aspects in the cold season of year (Bogdan and Marinică, 2007). The results were used to achieve a distinct cartographic material. Morpho-climatic analysis follows some significant issues: the location of Întorsura Buzăului Depression, presentation of regional characteristics of geomorphologic features, summary data on petrography and superficial deposits, some summary data of landform morphometry, especially on the levelling erosion surface, terraces and meadows, forms description and comment on the distribution and typology of the relief and climatic parameters and phenomena. Geomorphologic zoning was the basis for mapping of synthetic cartographic material.

RESULTS AND DISCUSSIONS

Geographical position of Întorsura Buzăului Depression.

Întorsura Buzăului Depression belongs to the Outer Curvature Carpathians unit and it is an intra-mountainous depression at 700 – 800 m altitude, with a tectonic erosive genesis (Posea, 2002). It lies in the northern side of the Buzău Mountains and has a lobate-star-like configuration, almost completely closed by the Întorsura Buzăului Mountains to north (Ielenicz, 1984), Ciucaş Mountains to south-west, Siriu Mountains to south and Podu Calului Mountains to south-east. The depression develops from Sita Buzăului northwards along the upper flow of Buzău River, and from Întorsura Buzăului southwards Crasna. Tectonic and structural oscillation of the level in comparison with the adjacent mountain units (300 – 350 m in comparison with Clăbucetele Întorsurii to north, and 600 – 700 m in comparison with the mountain units to south), developed on Buzău flow and the widening by the lateral erosion in the Întorsura sector give the tectonic erosive character to this depression.

The concave form of the depression, its morphology and the development of the alluvial plain of Buzău and of its tributaries (Fig. 1), the climatic and hydrologic characteristics as well as those bio-pedological-geographical are aspects which consolidate the intra-mountainous character. Morphological limits of the depression are underlined not only by the altitudinal differences with the adjacent mountain units but also by the changes of the other morphometric parameters: slopes, relief energy and fragmentation. They also generate a change of the climatic conditions, bio-pedological-climatic differences and the different utilization of the depression space (Fig. 2).

An important feature of the relief is the presence and the high number of the Carpathian straits and passes, named by Mihăilescu (1963) "pre-hills": Hămaş saddle and Predeluş Pass (1295 m) to Braşov Depression, Buzău Strait in the Buzău Valley (1557 m), Tabla Buţii Strait (1078 m), Zagon Pass (870 m), Zizin Pass in south-west of the Clăbucetele Întorsurii and Hagău Pass. On the one side, they allow the access to Întorsura Buzăului Depression from all directions, as well as the trans-mountain circulation and the habitation of the depression space, and on the other side, they play an important part in the air flowing from high altitudes to the bottom of the depression.

The northern limit is marked by the Clăbucetele Întorsurii which lay between the Târlung Valley, to west, and Zagon Valley, to east. Their low altitude varies between 700 m and 1220 m, due to their position right in the contact area of two regions tectonically labile and with different movement directions (Braşov Depression and Outer Curvature). They are made mainly of marls and Cretaceous schistose-sandstone deposits, occurred also in Întorsura Buzăului Depression, on which a relief with reduced slopes develops.

The south-western limits are marked by the structural abrupt of the Ciucaş Mountains. Because of the high altitudes (Ciucaş Peak, 1954 m), of the high summits which enclose the depression and of the abrupt north-eastern slopes, without vegetation, Ciucaş seems to be the dominant massif in comparison with the other relief units. It distinguishes within the montane landscape by its structural and petrographic relief, and locally by its karstic relief developed on the limy klippen (Ielenicz, 1984). In the conglomerate layer, as a result of the activity of the outer agents, by elementary and complex processes associated with gravitational processes, a ruin-like relief developed, with forms of towers, elevations: Colţii Nitrii, Ţiglăile, Turnul Goliat, Turnul Vulturilor, Sfinxul Ciucaşului, Ciobanul cu oile, etc.

The southern limit is formed of the Siriu Mountains which penetrate as a "belly" between the two gulfs of the depression, axed in the Buzău Valley. It corresponds to a suspended synclinal, directed north-east – south-west whose western side is made of hard sandstones of Siriu which belong to the

Cretaceous flysch, and the eastern one of a succession of sandstones, marls, disodils and menilites of an Oligocene age, which form a ruin-like landscape (Ielenicz, 1984).

Podu Calului Mountains border Întorsura Buzăului Depression to east-south-east. Their maximum altitude is of 1437 m at Podu Calului Peak and they are formed of flysch rocks – a succession of sandstones, marls and clayey schists. This altimetric oscillation of level of the Podu Calului Mountains extended northwards, to Întorsura Buzăului Depression, reflects the direction of the differentiate erosion exercised by the hydrographical branches of different generations, tributaries of Buzău or Bâsca Mare rivers (Orghidan, 1969; Velcea and Savu, 1982).

In the mountains which surround Întorsura Buzăului Depression, developed in a mobile geosyncline, the association of summits and orohydrographic nodes, centred on conglomerates or hard sandstones, raises the problem of the levelling and of the altimetric succession of the interfluves. Polycyclic levelling in the Curvature Carpathians began before the formation of the Braşov Depression, respectively that of the Întorsurii Buzăului, and created some levelling surfaces. Levelling surface identified in the Buzău Mountains at 1650 – 1700 m altitude, under the name of Chiruşca surface (Ielenicz, 1984), is of a Miocene age. It was modelled within the conditions of the subtropical climate, with the alternance of a dry and warm season with a warm and humid one, and has the aspect of a peneplain which later was taken over by the neotectonic movements and deformed. The second levelling surface modelled in the Upper Pliocene, slightly wavy at 1400 – 1450 m altitude, is very well represented in Podu Calului Mountains and represents the general surface of the summits with a middle altitude of the entire groups of the Outer Curvature. Between 750 – 1200 m altitude, there are erosion levels with a transversal valley levelling character (Ielenicz, 1984). They can be recognized in the valley corridors as some valley levels, saddling or at the edge of the depression as glacis. Ielenicz (1984) differentiates three erosion levels, as follows: Buzău level (upper mountain level), placed at 900 – 1250 m altitude, Întorsura Buzăului level (medium mountain level), at 800 – 1000 m and the lower mountain level, at 600 – 700 m altitude. Velcea and Savu (1982) specifies that they gradually go up in valleys, that they pass through saddling from a basin to another, that they form suspended depressions or that they form the high frame of the sub-Carpathians are arguments which plead for a single level, disturbed by the tectonic movements.

Relief particularities

Relief configuration from Întorsura Buzăului Depression and its evolution has to be analyzed within the regional context of the Curvature Carpathians, respectively of the Outer Curvature, being strongly bound by the folding geological structure, by the flysch presence, by the tectonic dislocations, by the swinging post-orogene movements in north-west – south-east direction and, not the least, by the evolution of the base levels of the two areas of subsistence – Braşov Depression – in the Inner Curvature, and Lower Siret Plain – at the Outer Curvature (Roşu, 1973; Velcea and Savu, 1982).

From the **petrographic** point of view, Întorsura Buzăului Depression and a part of the adjacent mountain units (north-west) Siriu Mountains (west) Întorsura Mountains are made of schistose deposits with massive intercalations of curved-cortical sandstones belonging to the Cretaceous inner flysch. The Cretaceous and Palaeogene outer flysch is present in the southern, south-eastern and eastern end of the depression, in the Podu Calului Mountains and Penteleu Mountains, as alternative deposits of sandstones, clayey schists, menilites and disodiles (Posea, 1987). Strong **tectonic mobility** of this studied region generated in the past the strong folding of these deposits and the developing of the normal folds, of those outwards overturned, of the isoclinal and recumbent folds (Săndulescu, 1984; Mutihac, 1990).

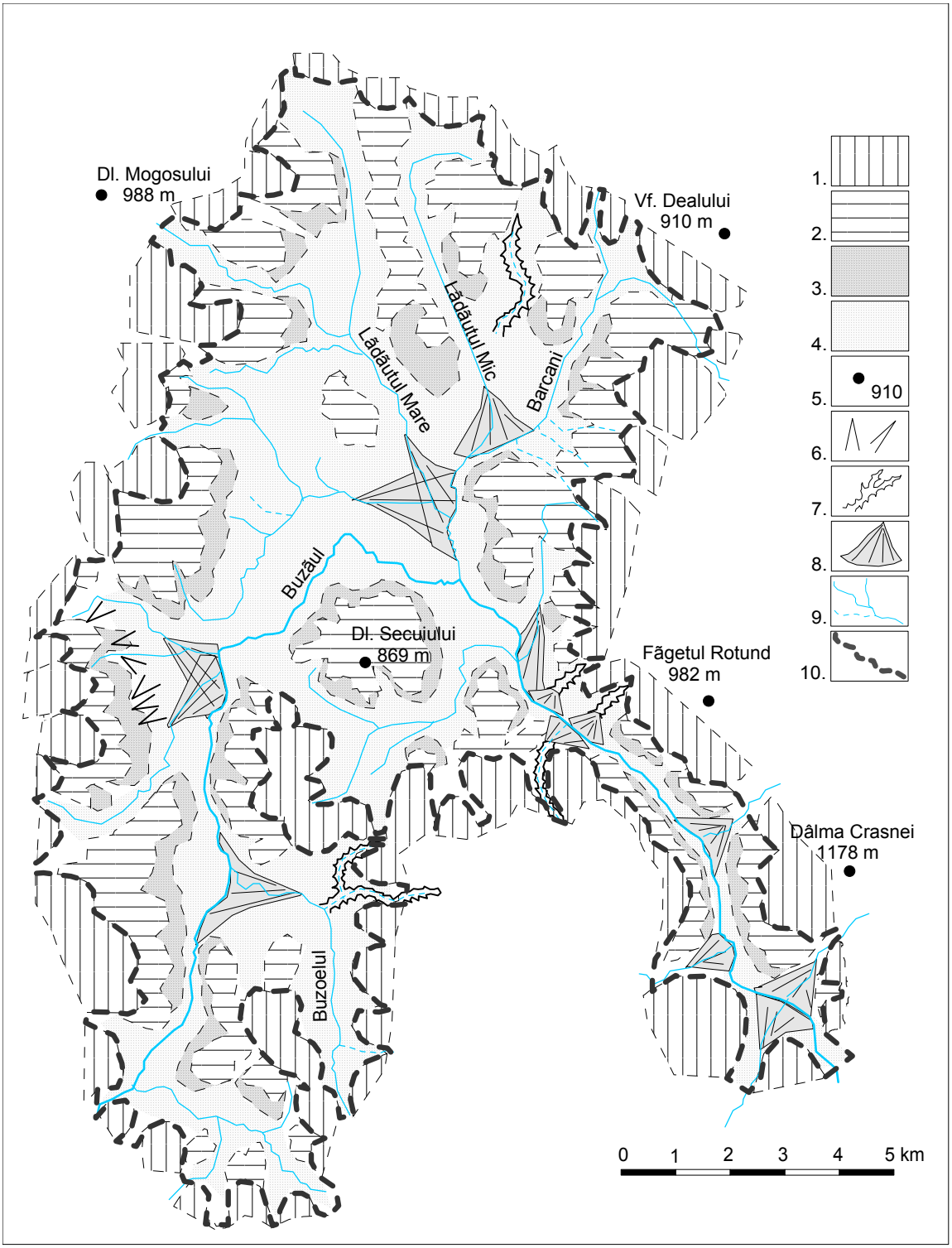

Figure 1: The geomorphologic map of Întorsura Buzăului Depression;
1. upper mountain level (900 – 950 m); 2. middle mountain level (± 850 m);
3. lower mountain level or glacis level (± 750 m); 4. Buzău terraces and meadow (alluvial plane);
5. peaks; 6. gully, ravines; 7. torrents; 8. alluvial cones;
9. hydrographical network; 10. limit of depression.
Dl. – hill; Vf. – peak.

Current tectonic is subordinated to the position of the Buzău Mountains, implicitly of Întorsura Depression, near the seismic area of Vrancea and it is represented by elevating movements (0.5 – 1 mm/year) and intense seismic movements which activate the ample gravitational processes (Orghidan, 1969; Săndulescu, 1984).

Under these tectonic and structural circumstances of Întorsura Buzăului Depression, the evolution stages of the relief can be underlined by the altimetric sequence of the erosion levels, of the Buzău terrace and floodplain (Fig. 1). The **middle mountain level** was shaped within the lower Villafranchian – Middle Pleistocene (Ielenicz, 1984), modelling being influenced by the tectonic conditions (elevations resulted from the Wallachian movements) and climatic ones (the changing of the Mediterranean climate from Pliocene, by cooling). This level is present in the south-eastern margin of the depression at an altitude of ± 850 m, as some level grounds cut in the marl-sandstone deposits, and goes up to 900 – 950 m northwards, at the contact of the depression with the Clăbucetele Întorsurii. Middle mountain level is strongly fragmented by a hydrographical net with high density, the slopes are variable and are covered by deciduous and coniferous forests, secondary lawns and hayfields.

The **lower mountain level** can be identified in the glacis of the edge of the Întorsura Buzăului Depression, at an altitude of ± 750 m. It was shaped in Middle Pleistocene after some elevation movements and a temperate climate action with a large variability. The result was the deepening of the Buzău valley and its tributaries with 100 – 200 m, gravitational modelling of the slopes, enlarging of the river beds and glacis appearance (Ielenicz, 1984).

The two surfaces of levelling, erosion levels identified in valleys, piedmonts and glacis form elements of reference in the relief evolution and represent proves of modelling developed during different evolution stages of the Întorsura Buzăului Depression and of the adjacent mountain units (Sandu and Bălteanu, 2005).

The **alluvial plain** of Buzău River was formed after some accumulations of gravel, sand and mud originating in the erosion of the neighbouring slopes and the soil splash erosion after clearings, and comprises the three terraces of Buzău and its floodplain, used as hayfields and agricultural terrains (Fig. 2). The terraces have relative altitudes of 2 – 3 m, 5 – 6 m and 11 – 12 m in comparison with the Buzău River minor riverbed and it decreasing gradually downstream, losing themselves in the floodplain. The terrace I mainly develops in the curves of the meanders and has the largest extension on the bottom of the depression, in the central area.

The terrace deposits are formed of clay, sand, gravel and even stone blocks. Buzău River floodplain and its tributaries (Barcani, Buzoiel, Lădăuțiul Mare, Lădăuțiul Mic) lays the depression soil and are characterized by intense accumulation, riverbed height increasing, the presence of the deserted old water flows (Sita Mică) or used by tributaries (Floroaia), of the concave areas with humidity and weak drainage surplus as a result of the reduced slopes (4 – 6 m/km). Alluvial deposits from the floodplain are thick (12 – 18 m) and consists of rubble of heterogeneous structure.

Frequent movements of the minor riverbeds, humidity surplus and frequent sediments which influences the elevation of the floodplain level have effect on the manifestation of the soil – genesis processes, on the development of the vegetal surface and on the land use (Fig. 2). Alluvial cones develop at the tributaries confluence with the Buzău River. Their size depends on the solid material, the flow and on the position of the collector riverbed. The greatest alluvial cones are that of the Lădăuțiul Mare and Lădăuțiul Mic valleys, deposited at the confluence with Buzău River, where it fossilizes the floodplain level. Pluvial glacis are frequent at the basis of the terraces (Vama Buzăului) and fossilizes their bridge (Fig. 1).

Climatic characteristics

Being a part of the Curvature Carpathian surface, Întorsura Buzăului Depression has the climatic conditions of the continental temperate regime and of the mountain climate in which diversification elements occur (Bordei, 2008). The climate is cool temperate with 3 – 6 relatively humid cold months (average temperature below 0^oC and frequent frost cycles within the period November-April), with humid intervals (May-July) and dry ones (April, September, October). Multiannual average temperature varies between 6 – 7^oC at Întorsura Buzăului station, the precipitation quantity is altimetric differentiated, having an average of 600 – 700 mm in the bottom of the depression, and 750 – 800 mm to the edge. The climatic differentiation between the adjacent mountain units and depression, but also that from the depression area is the result of several factors. The climate of depression has significant differences in comparison with the regional general climate, generated by the intra-mountain position and the shelter position in front of the air masses, saddling display and of the Buzău Valley in front of the prevalent circulation, degree displaying of the relief forms and the altitudinal levelling (Bâzâc, 1983; Mihai, 1975, 1984).

First of all **the role of orographic barrier** made by the Curvature Carpathians (Bogdan and Niculescu, 1999; Bogdan, 2008), which transpose itself on the depression by changes generated by the height and massiveness of the adjacent mountains, by the relief energy and the pointed out concavity (like a pot) of the depression. Its geographical position, almost right in the centre of the country, leads to the idea that, normally, Întorsura Buzăului Depression may be equally influenced by all air masses which cross the Romanian national territory. In fact, it isn't so. By its southern summits it stops the southwards entrance of the air masses, carried along by the western and north-western circulation, and, at the same time, receives the marine air advections bound by the alternating activity of the Azores anticyclone and of the Icelandic cyclone, of the oceanic cyclones carried along at the edge of the others, which reach here significantly reduced (Bordei, 2008). The moving humid air masses meet the mountains which surround the depression and they diminish their humidity and, implicitly, the precipitation quantity (700 – 750 mm/an). The precipitation fallen on the depression surface were recorded at a maximum of 43% of the annual quantity in summer (June – July) and a minimum in winter (January). June is the rainiest month of the year (an average of 110 mm). In autumn, as a result of the diminishing of the cyclonic activity and intensification of the anticyclonic continental one, the precipitation quantity decreases with 100 – 150 mm in comparison with that fallen in summer (monthly average 30 – 60 mm). Pluviometric regime does not differ very much every year because of the intra-montane position of the depression in the Carpathian, which has a moderating role.

In warm season, frequent föhn processes occur on the north-eastern slope of the Ciucaş Mountains (Bogdan, 1993). By adiabatic processes, the air warms up and loses humidity, this aspect leading to the diminishing of the precipitations in the western side of the depression (below 700 mm/year). In the cold season, under the Scandinavian anticyclone influence, this mountain area is affected by early and late snowing. Especially in the cold season of the year, the Polar and Arctic air masses have the highest frequency, which leads to a great decreasing of the air temperature and to temperature inversions within depression surface. These air masses generate early frost in autumn and late frost, in spring, with consequences on the vegetal layer, agricultural cultures and human activities. As a result of the phenomenon intensity during the cold season and the manifestation period, Întorsura Buzăului Depression is considered the second "Romanian cold Pole" after Joseni locality (Mureş County).

Local circulation of the air in the Întorsura Buzăului Depression manifests as mountain-valley winds, especially at the contact of the depression with the adjacent

mountain units. A thermal and baric contrast occur between these two surfaces. This reverse air movement (cold night air descends on the mountain peaks to valley, and during the day the movement is upward) achieved during summer, a moderation of the air temperature produces in the piedmont strip with about 0.1 – 0.2°C, in comparison with the plain of the depression.

Influence of the morphometric particularities, surface concavity of the depression and the **almost total enclosure** of the depression is reflected in the thermal regime by the appearance of the negative extremes and of the temperature inversions of high intensity (10 – 20°C) as well as in the windy regime with a high frequency of the atmospheric calm (40% of the year).

Appearance and development of the temperature inversions are specific to the cold season of the year, especially to January and February, when the most typical phenomena appear, as a result of the installing of the baric upper limits or of the action of the anticyclonic ridges above our country (Moldovan, 2003). The inversions of advection are amplified in winter by the local conditions, by the air overcooling from the neighbouring topographic surfaces (inversions of radiation). By altitude, relief energy and fragmentation, the depression morphometry conditioning the thickness of the inversion stratum (Bogdan, 2008), its maintaining for a longer period in the cold season (10 – 20 days in winter and 5 – 6 days, in autumn). Data comparison of the daily average temperature between the Întorsura Buzăului and Lăcăuți stations indicates that the inversions can occur along the entire year, due to local conditions, but not with the intensity and frequency of the cold season (January – 16 days; December – 13 days; February – 10 days; June – 2 days; July – 1.5 days; August – 3.5 days).

In the cold season, the temperature inversions associate with a high number of winter days (days with the maximum temperature below 0°C on an average of 40 – 50 days) and with the appearance of the negative extreme temperatures (-31.5°C / 08. II. 1993; -37°C / 08. II. 2005) of the air, recording a large number of frosty days (an average of 30 days) (Bogdan and Dragotă, 2000). Sometimes, the cold days last in March, April, even in May (-25.5°C / 01. III. 1993; -25°C / 26. III. 1996).

Relief fragmentation by Buzău Valley and its tributaries and the saddling presence at the upper limit of the depression leads to the flowing of the cold air from the slopes, canalization along the valleys to the depression hearth, formation of some temperature inversions with lakes of cold, foggy air, fog, white frost. The piedmont frame is thermally moderate and has a higher frequency of the atmospheric calm in comparison with the depression bottom (alluvial plain) (Bâzâc, 1983). The Buzău Valley favorized the canalization of the air currents and maintenance of the air humidity. Along the year, the calm is more frequent in winter (54%), this aspect attracting the creation and maintaining the thermal inversions and fog for a longer period of time; in spring it is much reduced (25%).

Orientation and slope inclination influences directly the climate by differentiations in the receiving of the solar radiation and changes of the climatic parameters: humidity, temperature, frost, hoar frost, precipitations, resistance of the snow layer (Teodoreanu and Mihai, 1982). On the other hand, it cases topoclimatic characteristics influenced by the vegetation type and covering degree of the surfaces and the utilization means of the terrains.

The vegetation and the land use category are the second active surfaces, which through type and height print delivered topoclimatic features. Forest areas are found on the periphery of depression and are characterized through: moderate heat, lack of thermal inversion, high air humidity, high evapotranspiration, atmospheric calm inside and breezes to the periphery area (Fărcaş et al., 1971). Most of the depression surfaces is occupied by pastures and meadows. They, along with agricultural land, causes a higher degree of exposure and frequent and intense thermal inversions production.

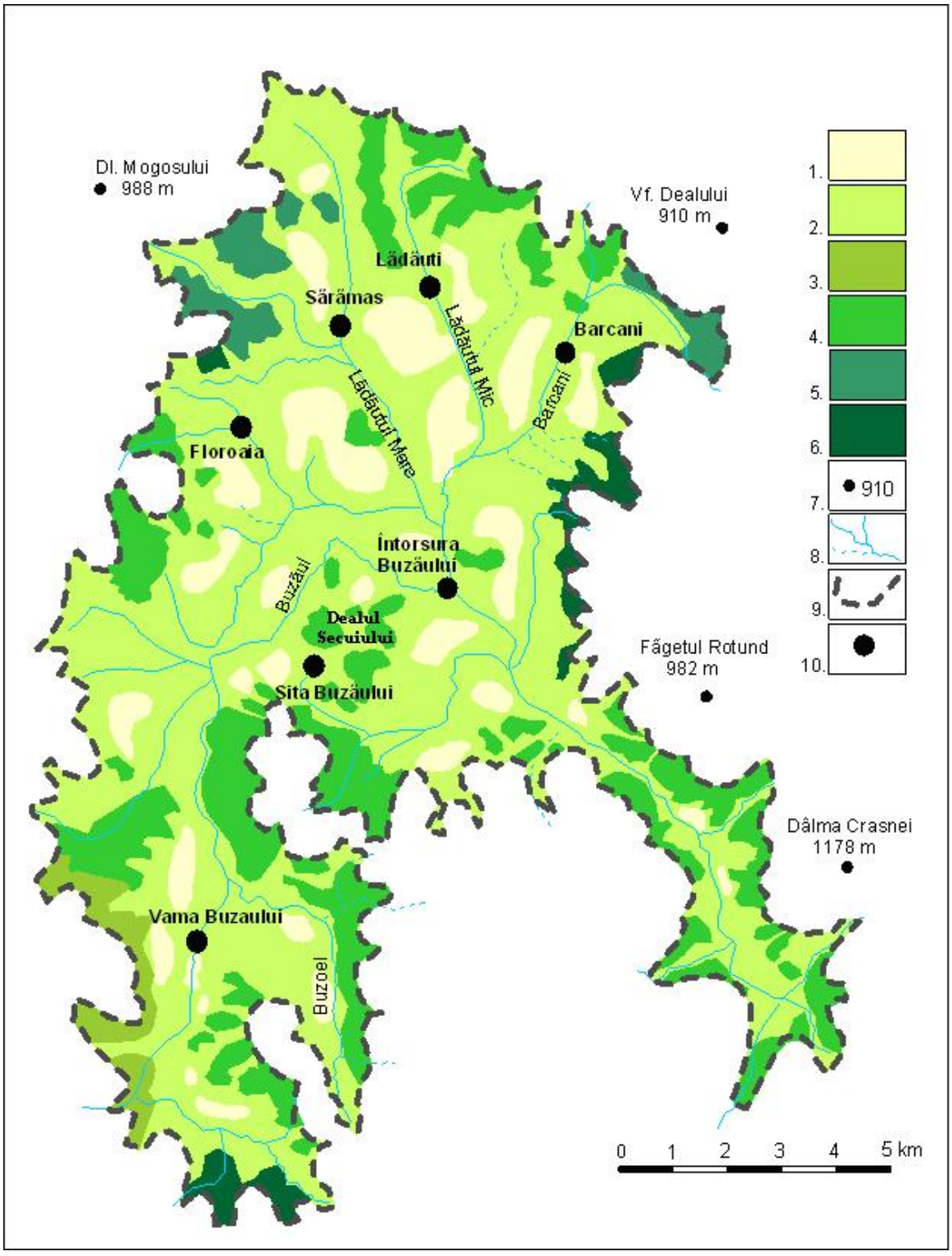

Figure 2: Land use map of Întorsura Buzăului Depression;
1. arable land; 2. hayfield and grassland; 3. oak forest; 4. beech forest;
5. mixed forest; 6. coniferous forest (fir); 7. peaks; 8. hydrographical network;
9. limit of depression; 10. settlements;
Dl. – hill; Vf. – peak.

Influence of the water flows and of lacustrine surfaces manifested by the transfer of humidity between the aquatic units and the floodplain and terraces surfaces. Water caloric capacity influences the values of the climatic parameters in the lower air stratum and generates moderate temperature, high humidity and some evaporation processes. From the distribution of the relative humidity average values it results that for this depression area average values of over 90% are characteristic (95% in January, 98% in February, 105% in December, 85% in June and July) because of the prevalence of the air masses advection from west, north-west and north, of the evaporation sources represented by the water flows of Buzău River and its tributaries, Siriu Lake and forest surfaces. Often, topoclimatic differentiation occurs due to the temperature micro-inversions between the Buzău floodplain and terraces.

Early frost, in autumn – even at the beginning of September and its persistence till the late spring – even in the first decade of the May, affects spontaneous vegetation, agricultural cultures and fruit trees. The climate of the depression is less favourable to the anthropic activities because of low temperatures and high air humidity in the cold season, especially in winter and the beginning of spring. In depression, winter lasts about 4 months (Tab. 1) this aspect leading to the shortening of the vegetation period of plants and agricultural cultures.

Besides frost, hoar-frost also represents a climatic phenomenon of risk in Întorsura Buzăului Depression. Early hoar-frosts occur in the second and the third decade of September (average number of days with hoar-frost in this month being of 3.1 days) and the late hoar-frosts of spring maintain till April (on the average of 4.4 days with hoar-frost) and May (0.9 days with hoar-frost). The highest mean number of days with hoar-frost is in October (on the average 11.5 days) and November (on the average 7.3 days). Late hoar-frost has a disastrous effect on the flower buds, agricultural cultures and fruit trees, as it happened in 1999, on the 8th and 20th of May, or in 2000, on the 3rd, 4th, 5th of May. The presence of the hoar-frost in transition seasons (spring and autumn) is rather frequent in the bottom of the depression and influences the accenting of the temperature inversions. When it is present, it has the role of the snow layer in winter, that one of accenting the air temperature decreasing by a radiative cooling (Mihai, 1984).

Table 1: Characteristics of the climatic phenomena in the cold season of the year in Întorsura Buzăului Depression.

Climatic parameter	Frost	Hoar-frost	Fog	Snowing	Snow layer
Mean date of the first autumn phenomenon	22 IX.			The 2nd decade of November	
Mean date of the last spring phenomenon	18 IV.			The 3rd decade of March	
Mean possible period (days)	165			125	
The earliest date	17 IX.	17 IX.			
The latest date	5 V.	20 V.			
Mean annual no (days)		9 – 10	25 – 35		60
Mean thickness of the snow layer (cm)					2.7 cm the 2nd decade of November. 11.2 cm in January. 8.4 cm in March.

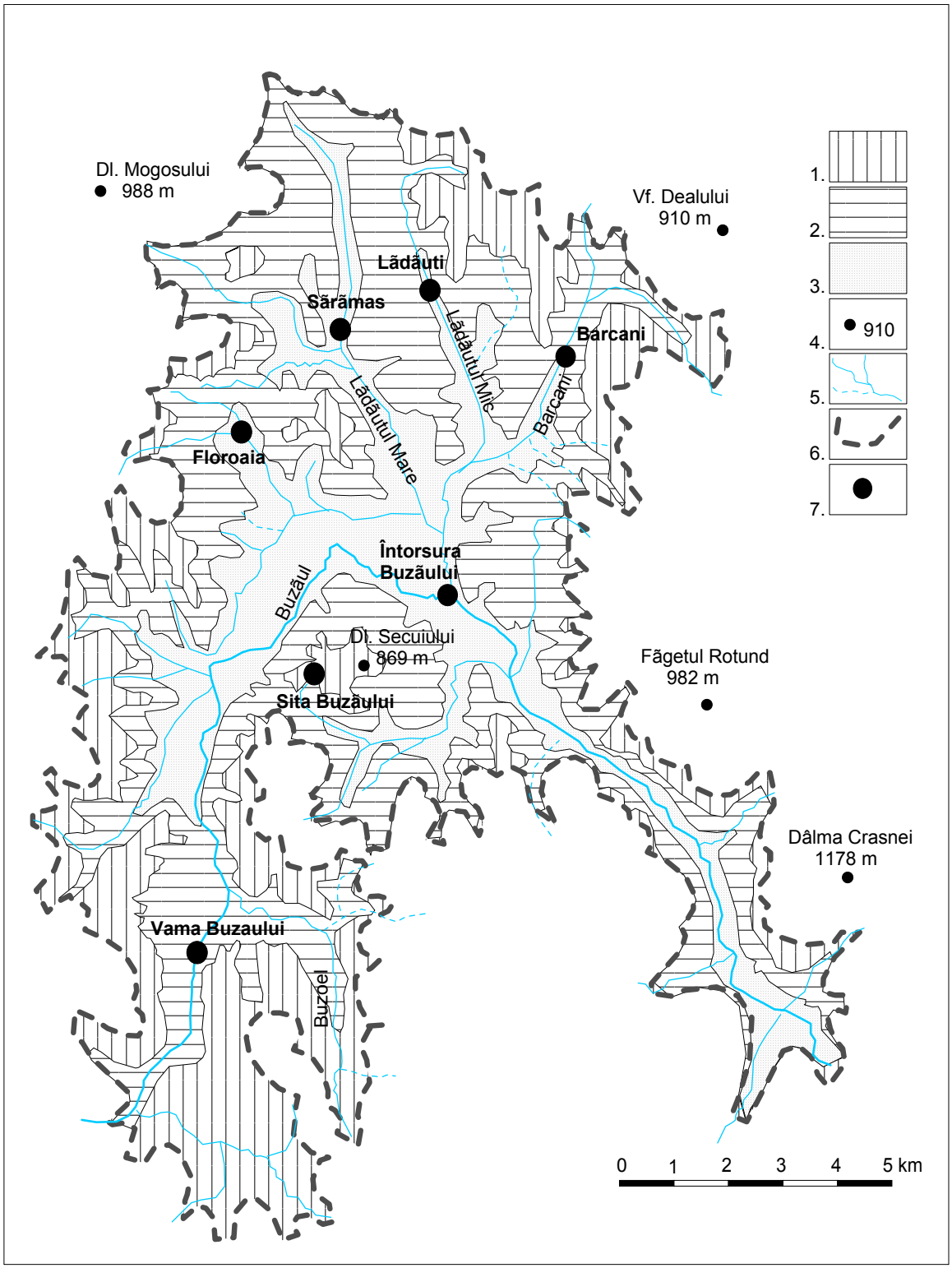

Figure 3: Topoclimates of Întorsura Buzăului Depression;
1. piedmont topoclimate; 2. glacis and terraces topoclimate;
3. floodplain topoclimate; 4. peaks; 5. hydrographical network;
6. limit of depression; 7. settlements;
Dl. - hill; Vf. - peak.

Fog is a common phenomenon in Întorsura Buzăului Depression, mean annual number being between 25 – 35 days. The higher frequency is in winter months (December and January with 4 – 9 days per month), and the lowest frequency, in spring (in March and April). Its effects influences the daily activity, the population's health, exacerbation of respiratory and rheumatic diseases, but also the transport activities by the diminishing of visibility.

From climatic point of view, **altimetric alternance of the relief forms** from the depression (piedmonts, glacis, terraces, floodplain) **generates** a series of **topoclimate complexes** (Bogdan et al., 1977; Neamu et al., 1970).

Terrace and floodplain topoclimate which has strong differences between the climatic elements: higher frequency of the atmospheric calm, temperature inversions with high frequency and variable thickness, minimum temperatures with extreme values, obvious diurnal thermal contrasts, high humidity, higher frequency of the hydrometeors and reduced precipitations (under 700 mm).

Piedmont and glacis topoclimate superposed to the higher border from the feet of the mountain with a climate with moderate manifestation in comparison with the plain of the depression, with temperature inversions with lower frequency and minimum temperatures, with higher values, with reduced diurnal thermal contrasts and rich precipitations (over 750 mm) (Fig. 3).

Each of these complex topoclimates consists of a series of elementary topoclimates, specific to the relief microforms or to the particularities of the active surface which generate them.

CONCLUSIONS

Geographical position and local relief conditions influence the annual frequency and intensity of the weather-climatic phenomena in Întorsura Buzăului Depression.

By its morphometric characteristics, the relief has an important part in the energetic exchange between ground and air, being an active factor in the caloric energy conversion.

Diversity of the relief forms generates a large range of topoclimates and influences the distribution of the climatic parameters and vulnerability degree of the depression surface in comparison with different climatic risks.

Altitude, orographic barrier, slopes exposure, relief fragmentation, Buzău River passage and the hearth of the depression are factors which contributes to the climatic characteristics of the depression and to the accenting of some weather-climatic phenomena of risk as the occurrence of the extreme negative temperatures, of the thermal inversions, of hoar-frost and fog. Phenomena occurred in the cold season of the year had an important impact on vegetal and animal organisms, and implicitly on man. From bioclimatic point of view, the cold period is very stressful for organism by great thermal variations, by the active dynamics of the air, by frost and humidity, processes which generate skin and pulmonary stress and high morbidity (Teodoreanu, 1997).

REFERENCES

Bâzâc G., 1983 – Influența reliefului asupra principalelor caracteristici ale climei României, Ed. Academiei, Bucureşti. (in Romanian)

Bogdan O., 1993 – Föhnul carpatic, *Analele Universității Oradea - seria Geografie*, III, 58-63. (in Romanian)

Bogdan O., 2008 – Carpații Meridionali. Clima. Hazardele meteo-climatice şi impactul lor asupra turismului, Ed. Univ. „Lucian Blaga" din Sibiu. (in Romanian)

Bogdan O., Teodoreanu E., Mihai E. and Neamu G., 1977 – Harta topoclimatică, scara 1:500000, pl. IV, 6, 1, *Atlas R. S. România*, Ed. Academiei, Bucureşti. (in Romanian)

Bogdan O. and Niculescu. E., 1999 – Riscurile climatice din România, Acad. Română Inst. de Geogr. Tipar Sega Internațional. Bucureşti. (in Romanian)

Bogdan O. and Dragotă C., 2000 – Risks of frost occurence in Romania, *Proceedings of Romanian Academy*, B., II, 2, 147-153.

Bogdan O. and Marinică I., 2007 – Hazarde meteo-climatice din zona temperată. Geneză şi vulnerabilitate cu aplicații la Romania, Ed. Univ. „Lucian Blaga" din Sibiu. (in Romanian)

Bordei I. N., 2008 – Fenomene meteo-climatice induse de configurația Carpaților în Câmpia Română, Ed. Acad. Română. (in Romanian)

Fărcaş I., Tudoran P., Tomescu M and Buz V., 1971 – Stratificația microclimatică în topoclimatul de pădure şi influența acesteia asupra componenței şi distribuției unor elemente biocenologice, *Studia Universitatis Babeş-Boliay*, Cluj-Napoca, 43-50. (in Romanian)

Iancu M., 1971 – Depresiunea Întorsura Buzăului. Considerații morfogenetice, în *Geografia județului Buzău şi a împrejurimilor*, Bucureşti. (in Romanian)

Ielenicz M., 1984 – Munții Ciucaş - Buzău. Studiu geomorfologic, Ed. Academiei, Bucureşti. (in Romanian)

Mihai E., 1975 – Depresiunea Braşov. Studiu climatic, Ed. Academiei, Bucureşti. (in Romanian)

Mihai E., 1984 – Particularități climatice ale Depresiunii Întorsura Buzăului, *Studii şi Cercetări de Geografie-geologie* - Geogr. XXII, 2. (in Romanian)

Mihăilescu V, 1963 – Carpații sud-estici de pe teritoriul României, Ed. Ştiințifică şi Enciclopedică, Bucureşti. (in Romanian)

Moldovan F., 2003 – Fenomene climatice de risc, Ed. Echinox. Cluj-Napoca. (in Romanian)

Mutihac V., 1990 - Structura geologică a teritoriului României, Ed. Tehică, Bucureşti. (in Romanian)

Neamu G., Teodoreanu E. and Mihai E., 1970 – L'utilisation des indices quantitatifs et qualitatifs à l'execution de cartes topoclimatiques dans les régions montagneuses (à applications au massif de Bucegi), *Prace Geographia*, CCXLIV, 26, Kracow, 285-293. (in French)

Orghidan N., 1969 – Văile transversale din România. Studiu geomorfologic, Ed. Academiei, Bucureşti. (in Romanian)

Posea G., 1987 – Geografia României, vol. III, Carpații şi Depresiunea Transilvaniei, Ed. Academiei, Bucureşti. (in Romanian)

Posea G., 2002 – Geomorfologia României, Ed. Fundației „România de Mâine", Bucureşti. (in Romanian)

Roşu A., 1973 – Geografia fizică a României, Ed. Didactică şi Pedagogică, Bucureşti. (in Romanian)

Sandu M. and Bălteanu D. (eds.), 2005 – Hazardurile naturale din Carpații şi Subcarpații dintre Trotuş şi Teleajen. Studiu geografic, Ed. Ars Docendi, Bucureşti. (in Romanian)

Săndulescu M., 1984 – Geotectonica României, Ed. Tehnică, Bucureşti. (in Romanian)

Teodoreanu E., 1997 – Bioclimatul din Carpaţii Româneşti şi efectele sale asupra organismului uman, *Studii şi Cercetări de Geografie,* XLIV, 29-38. (in Romanian)

Teodoreanu E. and Mihai E., 1971a – Expoziţia versanţilor, unul dintre factorii determinanţi ai topoclimatului în peisajul geografic, *Buletinul Societăţii de Geografie*, I (LXXI), 133-144. (in Romanian)

Velcea V. and Savu A., 1982 – Geografia Carpaţilor şi a Subcarpaţilor Româneşti, Ed. Didactică şi Pedagogică, Bucureşti. (in Romanian)

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JOINT IMPLEMENTATION AS AN INNOVATIVE MECHANISM TO MITIGATE CLIMATE CHANGE: THE CARPATHIANS CASE STUDY (CZECH REPUBLIC, ROMANIA, SERBIA AND UKRAINE)

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KEYWORDS: Joint Implementation, Kyoto Protocol, market based mechanims, Czech Republic, Romania, Serbia, Ukraine, climate change.

ABSTRACT

At the United Nations Conference on Climate Change in 1997, the Kyoto Protocol was adopted. The flexible mechanisms (clean development, joint implementation, international emissions trading) of the Protocol that were agreed seek to address the most challenging of global environmental problems: climate change. Joint Implementation (JI) is a market based mechanism of the Kyoto Protocol that aims at mitigating global climate change. The rational for JI is to reduce the aggregate costs of greenhouse gases (GHG) mitigation, since the environmental impact of emissions is the same irrespective of the geographic location of the emissions source.

The aim of this research paper is to understand the effectiveness of JI as an innovative governance mechanism in the Carpathian region, with focus on the Czech Republic, Romania, Serbia and Ukraine, and also to provide an insight into knowledge about the opportunities and threats to JI as a tool for global climate governance.

Based on the research performed it can be concluded that for the Carpathian region the effectivness of the JI mechanism is inconsistent, one country (Czech Republic) achieved effectiveness, while in other countries due to the economic and political situation the effectiveness is questionable (Romania, Ukraine) or the mechanism was not implemented at all (Serbia).

REZUMAT: Implementare în Comun ca mecanism inovator pentru diminuarea efectelor schimbărilor climatice: studiu de caz Munţii Carpaţi (Cehia, România, Serbia şi Ucraina).

În cadrul Conferinţei Naţiunilor Unite, privind schimbările climatice din 1997, s-a adoptat Protocolul de la Kyoto. Instrumentele flexibile (mecanismul de dezvoltare curată, implementare în comun, comerţ internaţional cu certificate de emisii), adoptate în cadrul Protocolului au menirea de a lupta împotriva unei probleme globale arzătoare: schimbările climatice. Implementarea în comun (JI) este un mecanism de piaţă al Protocolului de la Kyoto şi are ca scop atenuarea schimbărilor climatice globale. Raţionamentul din spatele mecanismului JI este acela de a reduce costurile totale de atenuare a gazelor cu efect de seră, deoarece impactul emisiilor asupra mediului este acelaşi, indiferent de localizarea georgafică a sursei de emisie.

Scopul acestei lucrări de cercetare este de a înţelege eficacitatea mecanismului JI, ca un mecanism de guvernare inovator, în regiunea Carpaţilor, concentrat pe Republica Cehă, România, Serbia şi Ucraina şi, de asemenea, pentru a oferi o imagine cu privire la oportunităţile şi ameninţările la adresa JI ca un instrument pentru guvernare globală a climei.

În urma studiului, s-a ajuns la concluzia că regiunea Carpaţilor este împărţită între ţări în care mecanismul JI atinge grade înalte de eficacitate (Republica Cehă), în alte ţări, din cauza condiţiilor economice şi politice, eficacitatea este pusă sub semnul întrebării (România, Ucraina), iar în alte ţări mecanismul nu a fost implementat (Serbia).

ZUSAMMENFASSUNG: Gemeinsame Umsetzung - ein neuer Ansatz für die Verringerung der Auswirkungen der Klimaänderungen: Fallstudie im Gebiet der Karpaten (Tschechien, Rumänien, Serbien und Ukraine).

Im Rahmen der Konferenz der Vereinten Nationen von 1997 betreffend die globalen Klimaänderungen, wurde das Kyoto Protokoll angenommen. Die flexiblen Instrumente (Mechanismus der sauberen Entwicklung, gemeinsame Umsetzung, internationaler Handel mit Emissionen) die im Rahmen des Protokolls angenommen wurden, sind dazu bestimmt gegen ein globales, brennendes Problem, die Klimaänderungen zu kämpfen. Die gemeinsame Umsetzung (JI) ist ein Marktmechanismus des Kyoto Protokolls und hat zum Ziel die globalen Klimaänderungen zu mildern. Die Überlegung, die hinter dem JI Mechanismus steht, betrifft die Reduzierung der Gesamtkosten zur Verringerung der Treibhausgase, da der schädliche Einfluss der Emissionen auf die Umwelt der gleiche ist, unabhängig von der geografischen Region des Ausstoßes.

Der Zweck der vorliegenden Arbeit ist, die Wirksamkeit des Mechanismus JI als einen neuen Lenkungsprozess zu verstehen, der sich auf die Karpaten bezieht mit dem Focus auf die Tschechische Republik, Rumänien, Serbien und die Ukraine. Gleichzeitig soll er ein Bild bezüglich der Möglichkeiten und Bedrohungen in Zusammenhang mit JI, als einem Instrument zur globalen Lenkung des Klimas, liefern.

Aus den Untersuchungen kann gefolgert werden, dass die Karpatenregion Länder umfasst, in denen der JI Mechanismus einen hohen Grad an Wirksamkeit (Tschechien) erreicht, in anderen Ländern wiederum ist seine Wirksamkeit in Folge der wirtschaftlichen und politischen Lage in Frage gestellt (Rumänien, Ukraine), während er in anderen Ländern wie Serbien nicht eingesetzt wurde.

INTRODUCTION

The objective of this paper is to better understand the effectiveness of JI as an innovative governance mechanism in the countries situated in the Carpathian region (Austria, Czech Republic, Hungary, Poland Romania, Slovakia, Serbia, Ukraine). This paper will focus on the following countries: Czech Republic, Romania, Serbia and Ukraine. The selection of the countries was based on the development paths of those countries: Czech Republic already an EU member since 2004, Romania member of EU since 2007, Serbia not holding EU membership but preparing for accession and Ukraine not holding EU membership and not intending for the moment to join EU. This paper is also aiming to provide insight in the knowledge about opportunities and threats to JI as a tool for global climate governance in Carpathians area.

In brief the paper argues that effectivness of JI as an innovative mechanism to mitigate climate change is difficult to assess because the process of implementing JI is characterized by a large degree of complexity (Begg et al., 2001) that prevails from the fact that the policy makers are numerous, the long process that takes to implement a JI project, the availability of data etc. Due to the complexity of the mechanism the paper will use the policy evaluation theory of the European Environmental Agency (EEA) to assess JI in Carpathian region. In this regards, the analysis will focus on immediate outputs and outcomes of the JI policy process. For this reason, evaluating the effectiveness of JI will be based upon comparing its effects (institutional capacity, local benefits, compliance with KP) with its objectives. The evaluation proved that effectiveness is understood different in each country in the Carpathian region, varying from countries where the degree of effectiveness reaches high levels to country where JI was not implemented at all due to economical and/or political reasons or of lack of interest from the policy makers.

The objectives of the present paper may thus be formulated in therms of the following two research questions. It is JI working effectively as a tool of global climate governance in the Carpathian region; why or why not? And secondly, what are the most important lessons learnt in the JI process with regards to the Carpathian region?

MATERIALS AND METHODS

In terms of research methods and empirical investigations, the paper employees the triangulation approach (Kumar, 2005). This means that the author used multiple methods (semi-structured interviews) and multiple sources (journals, books, articles, newsletters, reliable internet sources of news, conference papers, etc.) to assess the outputs and outcomes of JI mechanism in the Carpathian region. Literature reviewed helped in gaining information about JI countries in the Carpathian region and their compliance with the institutional requirements of the Kyoto Protocol. In addition to this, qualitative data has been retrieved by means of open face-to-face interviews. The semi-structured interviews were used for all research questions. The interviewers were all directly involved in implementing JI projects in the Carpathian region and included the representative of climate change department of the Ministry of Environment and Sustainable Development in Bucharest.

RESULTS

Joint Implementation (JI) is a market based mechanism in which a "donor" country receives credit for emission reduction investments carried out in a "host" country (Bailey et al., 2001). Joint Implementation has the purpose to reduce the GHGs emissions in order to mitigate global climate change. Joint Implementation allows Parties of the Kyoto Protocol to use GHG credits/certificates from projects that reduce emissions in other countries (Parties of the Protocol as well) to fulfil their Kyoto commitments (Klepper and Peterson, 2006).

The countries in the Carpathian regions are split into "donor" countries (Austria) and "host" countries, the last category being the one well represented. The Carpathian region covers mostly countries with economies in transition (EIT). Although these countries in Central and Eastern Europe (CEE) differ in many ways, they also share a number of similarities. Those similarities frequently result from common communist post-World War II history, social and economic problems specific to the transitional period. One of the characteristics features of the CEE environmental profile is the high GHG emissions. The large emissions of GHG resulted from the structure of the economy, in particular the energy sector shaped under the old communist system.

Most of the countries in CEE that covers also the Carpathian countries are subject to Joint Implementation. For this reason in the following lines we will detail some of the countries in Carpathian region from the point of view of institutional capacity and compliance with KP, thus outputs and outcomes of the Joint Implementation. The structure will offer a view about the effectiveness of Joint Implementation in this region.

Czech Republic

The Czech Republic presented some of the best opportunities to reduce greenhouse gas emissions through joint implementation. In comparison with other former Eastern-European-bloc nations, the Czech Republic has been more popular with investors because of its relatively stable economy and government, and its convenient location. The republic has signed and ratified the Framework Convention on Climate Change and the Czech Ministry of Industry and Trade issued approval for using 1990 as the baseline year for greenhouse gas emissions under the Framework Convention.

The Czech Republic joined the Kyoto Protocol on 23 November 1998 and ratified it by 2001 (UNFCCC, 2009). The Czech Republic joined the European Union in 2004 and this implies that the institutional environment and legal framework with regards to environment and thus climate change is different than in the other Carpathian countries, which entered later (Romania) or are not yet holding EU membership (Serbia, Ukraine). In order for the Czech Republic to be part of EU, compliance with the EU Acquis Communitaire was made. The Acquis sets strict regulations with regards to environmental standards. Thus, one can assume that not a lot of space was left for investments because of the stringent environmental rules. However, Czech Republic has been very attractive for investors. A large portion of the total Western investment in the former Eastern communist bloc since the fall of the Berlin Wall has gone to the Czech Republic. There are several reasons for the Czech Republic's popularity with investors. Its infrastructure and economy are in better shape than those of most of the Carpathian countries. This means that it is easier to conduct business in the Czech Republic than in Hungary, Romania or Poland, for example. Inflation has been relatively stable since the start of market reforms and the government is more stable than in other Carpathian countries. Finally, the Czech Republic is geographically well situated, close to western developed Europe and at the cross roads of Europe (Evans, 1995).

Institutional capacity

In the Czech Republic, the Ministry of the Environment is responsible for the implementation of the Protocol and is simultaneously the supreme control body of the state administration in the area of protection of the environment (DPR, 2006).

Compliance with Kyoto Protocol

The Czech Republic has been very concerned in developing and implementing Joint Implementation project. The country has submitted to the UNFCCC Secretariat all the fifth National Communications Reports (UNFCCC reports, 2009). Due to the fact that Czech Republic complies in time with the UNFCCC Secretariat requirements and also because of the fact that the investment climate is relatively stable comparing with other Carpathian countries (Romania, Ukraine), a research performed by the Finish Climate Initiative for Central and Eastern Europe placed Czech Republic as a country with good investment and institutional climate for Joint Implementation (Finpro, 2005). On the other hand, Czech Republic is confronting with the European Union Emission Trading Scheme (EUETS) double counting problems and is rather reluctant on moving forward with the Joint Implementation and will likely focus its efforts on the Green Investment Scheme (GIS) implementation in the future.

Up to the point, Czech Republic had an impresive very good start in implementing Joint Implementation with good institutional capacity and investment climate. The accreditation of national entities for validation of the Joint Implementation project was also a positive aspect from the point of view of the investors, even though the credibility of these companies can be questionable in a former communist country. However, the entering in EU and the adaptation of its legislation to the Acquis Communitare narrowed its possibilities in implementing Joint Implementation projects. Therefore, the country is closing the window for Joint Implementation and considering in starting GIS implementation.

Romania

Romania, is a country with no stringent regulations concerning environment before 1989 start putting an emphasis on developing environmental policies in order to be integrate in the European Union. Therefore, many pre-accession funds from the European Union were channelled in the field of environmental policies and building institutional capacity. Romania received

financial and technical support also from national Western governments in order to develop this policy sector. Therefore, the climate change policies and thus Joint Implementation development in Romania had experienced two different approaches: a Dutch approach and a Danish approach during 2000 – 2008 (Truşcă, 2009).

Institutional capacity

Given the complexity of a Joint Implementation project, it is perhaps not surprising to say that its success or failure is likely to depend heavily on the institutional framework under which it operates (Begg et al., 2001). The Ministry of Environment and Sustainable Development (MESD) is the government institutions responsible for the implementation of the UNFCCC and the Kyoto Protocol commitments in Romania.

The ministry was busy in undertaken a series of actions related to fulfilling the UNFCCC requirements, organizing trainings and public awareness integrated activities in close cooperation with foreign partners (Dutch and Danish) and also collaborating with national relevant NGOs in the process of Joint Implementation approval (Truşcă, 2009). Next, the government embraced the Joint Implementation mechanism by signing several agreements with the Western countries - Memorandum of Understanding (MoU)- such as Switzerland, Norway, Denmark, Nederland, Sweden, France, Austria, Finland, Italy and also an agreement with the World Bank (MESD, 2007).

Compliance with Kyoto Protocol

Romania was the first country in Annex I (developed and economies in transition countries) to ratify the Kyoto Protocol, committing itself to reduce the GHG emissions by 8%, in the first commitment period (since 2008 to 2012, comparing with the base considered year 1989).

The outputs of the climate change policies in Romania are composed of a series of short, medium and long term strategies for dealing with climate change, scenarios for climate change, inventory reports for GHGs and report on demonstrable progress of Romania under the UNFCCC such as: National Strategy for Climate Change 2005 – 2007, Guidance on adaptation to climate change effects, National Inventory Report for GHGs and so on.

Over 37 Joint Implementation project proposals have been submitted to the ministry (Andrei et al., 2008). From the 37 submitted, 16 received LOA and the rest are in the phase of being approved by the MESD. The projects developed in Romania cover many sectors from energy, renewable, waste to sink. Romania has no preference for developing Joint Implementation projects in a specific sector, even though there is a huge potential in the energy sector due to the economic collapse after 1990 (Fig. 1) (Deaconu, 2009).

The Joint Implementation mechanism in Romania is being undermined by EUETS by restricting the opportunities for Joint Implementation. The sectors covered by Joint Implementation are overlapping with the EU ETS, which covers the carbon emissions. This leaves Joint Implementation suitable for non-carbon projects in the future periods of time (Truşcă, 2009).

Serbia

In comparision with the other countries in CEE, Serbia is not yet subject of Joint Implementation projects due to its status in the Kyoto Protocol. Serbia is a Non-Annex I country, thus has no emission cap under the Protocol. Joint Implementation mechanism involves countries with targets under KP (the so called Annex I countries) (UNFCCC, 2010). This leaves Serbia out of Joint Implementation mecahnism and opens opportunities for other international mechanisms to mitigate climate change such as CDM.

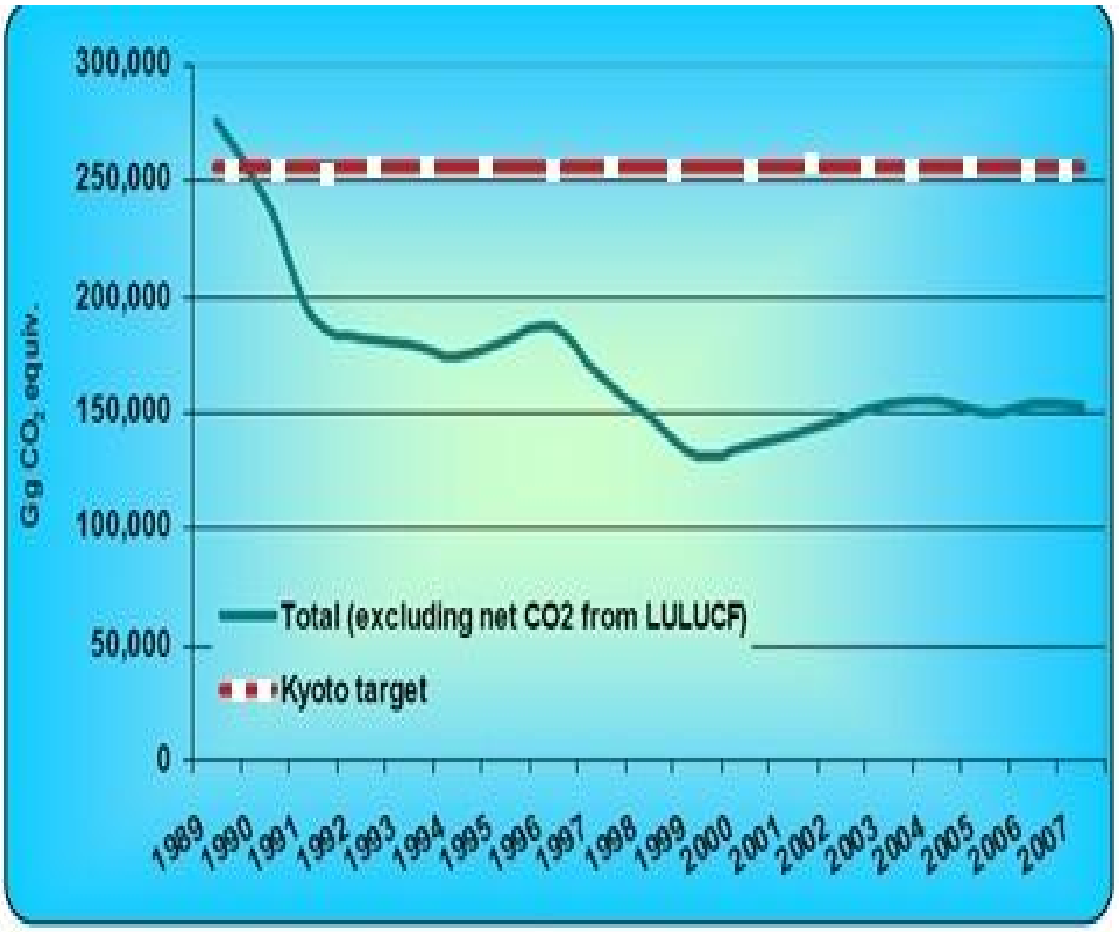

Figure 1: The total GHG emissions in CO_2 equivalent in the period 1989 – 2007; Source National Inventory report of Romania, 2009.

Ukraine

Ukraine is different from the other three named countries, which are dealt within this paper, in the sense that it does not hold EU membership and the Ukraine's prospects of entering the EU within the immediate future are very weak. These circumstances bear significance for the viability of Joint Implementation projects in the Ukraine due to the Acquis Communitaire, which in this context sets stricter minimum environmental standards that limit the room for Joint Implementation investment, which all EU countries have to implement and abide by. The absence of the Acquis Communitaire in Ukraine increases the space for Joint Implementation projects vis-à-vis Czech Republic and also Romania. Thus, from the environmental point of view the developing Joint Implementation projects in Ukraine is not so beneficial, but from the economical aspect is one of the best considered places for implementing Joint Implementation.

Ukraine is the country that ratified the Kyoto Protocol at 12 April 2004. The Kyoto Protocol enters into force on 16 February 2005 (Joint Implementation projects, 2009).

Ukraine has considerable potential for participation in the specific Kyoto mechanism, as the country's emissions remained at 45% of the 1990 base year level in 2007 (Fig. 2) (Joint Implementation database, 2009).

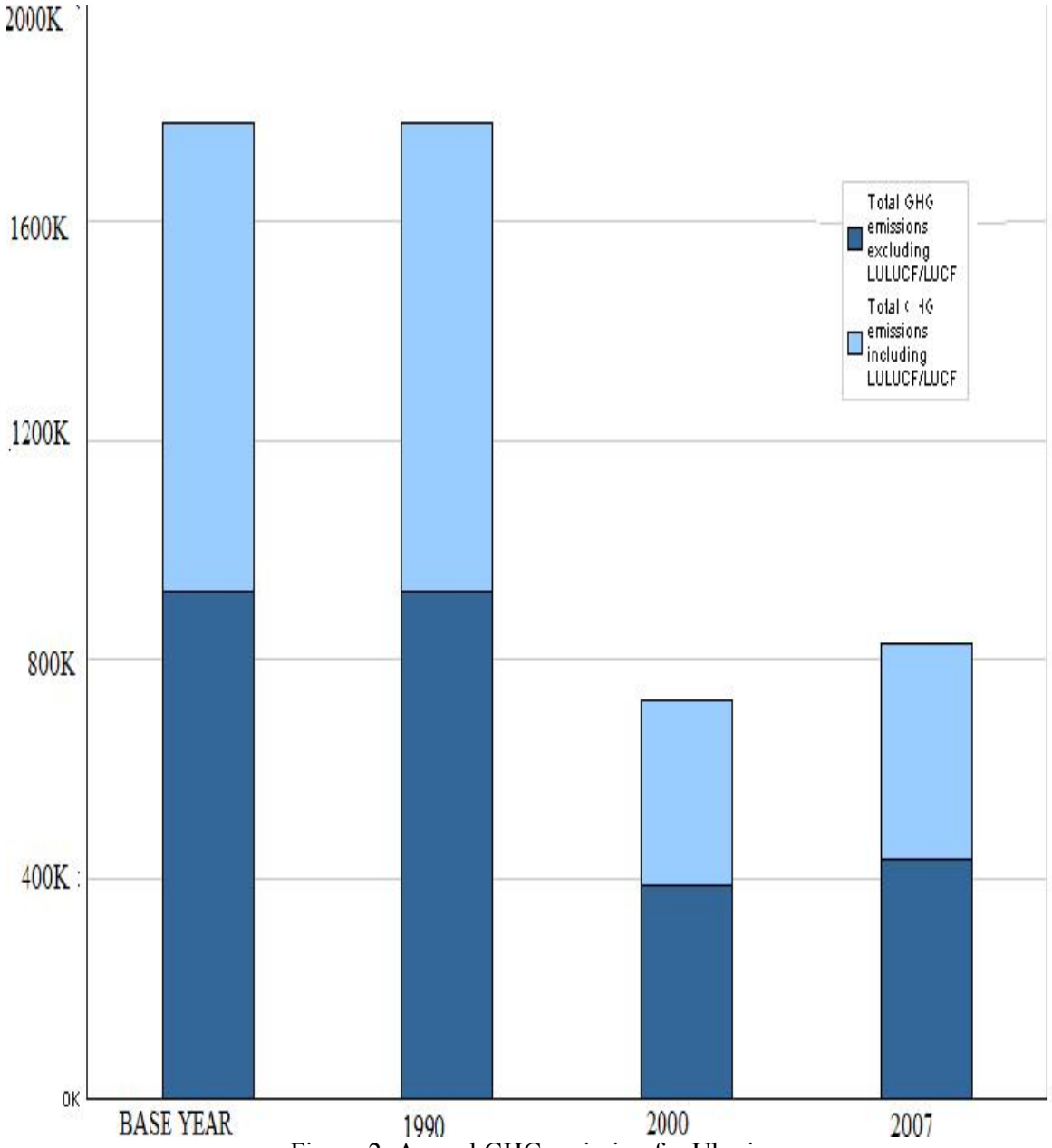

Figure 2: Annual GHG emission for Ukraine,
comparison base year, 1990, 2000 and 2007; source: UNFCCC, Data Interface, 2009.

Institutional capacity

One of the prerequisites for the success of Joint Implementation projects in any given country is the presence of institutions that serve the function of identifying, selecting and coordinating Joint Implementation projects.

In the case of Ukraine, a defining feature of its environmental policy is that there are not a lot of specialists on climate change that are involved in it, and therefore there is little knowledge within the Ukrainian government about Joint Implementation initiative.

Whereas the development of the institutional infrastructure, needed for successful Joint Implementation projects, in the Ukraine has lagged behind those of the other countries discussed in this specific scientific paper, progress has still been made.

The Ministry of Environmental Protection of Ukraine is responsible for development and implementation of climate change policies in Ukraine and implementation of UN FCCC and Kyoto protocol according the Decree of the Ukrainian Government.

The general number of registered Joint Implementation projects in Ukraine is 81, a huge number in comparison with other CEE (for example Romania – 37 projects), (Nigorodoba, 2009). From the 81 Joint Implementation projects only 18 have received Letter of Approval (LOA) and 13 have been approved by Joint Implementation Supervisor Committee (JISC), thus registered by the UNFCCC Secretariat.

Therefore, the Ukrainian Joint Implementation approval system has been regarded as slow. It has been reported that the Ukrainian focal point takes longer to process documents than stipulated in the legislation (Korppo, 2007). In practice it can be a laborious task to get Joint Implementation documentation through the Ukrainian approval system in order to receive a LOA, and this works requires careful attention on the part of the project developer. Without a well known local agent who can maintain close contact with the Ukrainian Joint Implementation focal point, it can be difficult to get projects approved. Papers have gone missing inside the Ministry due to the lack of staff; however, this has not been linked to corruption (Korppo, 2007). More the timelines for the issuance of a LOA as established by law are not followed, due to lack of resources, there are only four staff members working for implementing JI.

Compliance with Kyoto Protocol

Ukraine submitted only two out of five National Communications Reports required by the Kyoto protocol. As emphasised before, this country encounters some problems in fulfilling the Kyoto Protocol requirements because of a lack of specific staff. Because of this the timelines of the Kyoto Protocol are not able to be followed.

However, at international level Ukraine is active when it comes to Joint Implementation mechanism. The 6th Joint Implementation technical workshop and the 17th meeting of the JISC were held in September 2009 in Kiev, Ukraine (UN Ukraine, 2009).

Nonetheless, the Joint Implementation has been established in Ukraine. The Ukrainian government is taking a serious specific approach to the projects approval. The delays caused in LOA issuance are not regarded as a major problem, as the developers recognise the fact that the established project approval process is an ongoing process (Korppo, 2007). However, this lack of human resources in the administration can cause frustration.

Up to this specific point, it's crucial to recognise the fact that the Ukraine`s economy is in possession of some of the most promising economical opportunities for reducing emissions, and that this in itself makes this Carpathian country a very appealing country to conduct Joint Implementation projects in. The main reason for project developers to work with Ukraine is the existence of a functional project approval and that the country is not the subject to the EU restrictions as the other three members of interest for this thesis, which must comply with the Acquis Communitaire level of environmental standards.

DISCUSSIONS AND CONCLUSIONS

The main outcome of this specific analysis is that the author found various similarities while looking at three of the main Carpathian countries: Czech Republic, Romania and Ukraine. A similarity prevails from the fact that in each of the four countries the GHG emissions are far less than the base year set by the Kyoto Protocol, thus a huge surplus of GHG emission for trading with Western countries. Next, the countries are the same in the sense that the Joint Implementation mechanism is coordinated by the ministries of Environment.

However, all these three main Carpathian countries differ significantly also in a number of ways.

The Czech Republic was the first country out of the three to enter the European Union back in 2004. For this complex accession to European Union, the Czech Republic had to comply with the European Union Acquis Communitaire which sets strict environmental rules. Thus, the window for Joint Implementation in Czech Republic was narrowed.

Romania entered in the European Union in 2007, later than Czech Republic did. The country was not completely prepared to enter in 2004 because of lack in implementing the Acquis Communitaire. This might mean that the institutional capacity is weaker in this east European country. Nonetheless, Romania was being active in implementing and complying with Kyoto Protocol requirements and succeeded in fulfilling the eligibility criteria for Joint Implementation specific procedure.

Ukraine is a different country from the other two in the sense that it doesn't hold European Union membership. In addition to this, Ukraine doesn't have to fulfil the requirement for Aquis Communtaire. Therefore, the environmental requirements in Ukraine are less stringent, thus a lot of space for Joint Implementation projects is left. Ukraine is in the possession of some of the most promising economical opportunities for reducing emissions, and that this in itself makes Ukraine a realy very appealing country to conduct Joint Implementation projects in. However, the lack of human resources are slowing down and delaying the Joint Implementation opportunities.

Serbia, on the other hand differs from the other three countries in the Carpathian Mountains region because of the fact that the country is a Non-Annex I country, thus has no cap under the Kyoto Protocol. Serbia is a subject of other international mechanisms to mitigate the climate change, that are not dealt within this paper.

To conclude at the and of this study, there is no single answer when we talk about the effectiveness of Joint Implementation from environmental, economic and social point of view, in a country in Eastern Europe. On one hand, there are countries in the eastern part of the Europe where Joint Implementation mechanism reaches environmental benefits, such as Czech Republic and Romania; on the other hand there are Joint Implementation host countries that provide room for economic opportunities such as Ukraine, but neglect the environmental benefits. It remains at the latitude of the investors in western countries to decide which Joint Implementation host country is the most suitable from their perspective. Moreover, institutions, a stable political arena, an efficient permanent regulatory and consequent framework, a positive economic climate that encourage foreign investment are all crucial for Joint Implementation to become effective in mitigating climate change.

REFERENCES

Andrei L., Ciuta, I., and Teodorescu E., 2008 – The development of JI projects in Romania. Bucharest.

Bailey P. D., Jackson T., Parkinson S. and Begg K. G., 2001 – Searching for baseline constructing joint implementation project emission reductions. Global Environmental Change, 185-192.

Begg K., Jackson T. and Parkinson S., 2001 – Beyond joint implementation-designing flexibility into global climate policy. *Energy Policy*, 17-27.

Deaconu S., 2009 – Romanian's Greenhouse Gas Inventory 1989-2007. National Inventory Report of Romania (NIR). National Protection Agency, Romania.

DPR, 2006 – http://unfccc.int/resource/docs/natc/czenc4.pdf#page=85 visited on 1st December 2009. Prague: Demonstration Progres Report of the Implementation of Kyoto Protocol.

Evans M., 1995 – Joint Implementation in Countries in Transition: an analysis of the potential and barriers. US environmental Protection Agency.

Finpro, 2005 – Finnish Climate Initiative for Central and Eastern Europe. Climbus CEE.

Jidatabase, 2009 – http://unfccc.int/ghg_data/kp_data_unfccc/base_year_data/items/4354.php last visited on 26 November 2009.

Jiprojects, 2009 – http://ji.unfccc.int/JI_Projects/ProjectInfo.html visited on the 27th November 2009.

JISC, 2009 – http://ji.unfccc.int/JI_Projects/ProjectInfo.html last visited on 14th Nov. 2009.

Klepper G. and Peterson S., 2006 – Emissions Trading, CDM, JI, and More: The Climate Strategy of the EU. *The Energy Journal*, vol. 27, no 2.

Korppo A., 2007 – JI approval system in Ukraine: outline and experience. Climate Strategies.

Kumar R., 2005 – Research mehodology. A step by step guide for beginners. 2nd edition. London.

MESD, 2007 – Romania's Initial Report under the Kyoto Protocol. Ministry of Environment and Sustainable Development, Romania.

Nigorodoba S., 2009 – http://unfccc.int/files/meetings/intersessional/awg-lca_1_and_awg-kp_5/presentations/application/vnd.ms-powerpoint/bkk_ukraine_ji_cdm.pps#269,9, Slide 9. Ministry of Environment Ukraine.

Truşcă V., 2009 – Head of Climate Change Department, Ministry of Environment, Romania. July, 2009. Bucharest, Romania - interview.

Truşcă V., 2009 – Joint Implementation: now and post 2012, the Romanian Perspective. Presentation for the 5th Austrian JI/CDM workshop.

UNFCCC, 2009 – http://unfccc.int/parties_and_observers/items/2704.php, visited on 12 august 2009.

UNFCCC, 2010 – http://ji.unfccc.int/JI_Parties/index.html, visited on 30 April 2010.

UNFCCC reports, 2009 – http://unfccc.int/national_reports/annex_i_natcom/status_of_submission_of_natcom_under_the_kp/items/4904.php last visited on 1st December 2009.

UN Ukraine, 2009 – http://www.un.org.ua/en/news/2009-09-10/ last visted on 1st December 2009. United Nations Ukraine.

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HEAVY METAL CONTAMINATION OF LETTUCE FROM BAIA MARE AREA (ROMANIA)

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KEYWORDS: soil contamination, heavy metals in food, metals in soil, metal toxicity, garden soils, human health, environment.

ABSTRACT

The objective of this research was to evaluate the level of garden soil and lettuce contamination with lead, copper and zinc in Baia Mare, a nonferrous metallurgical center located in the North West region of Romania. The soil in the area is affected by the emissions of powders containing metals from metallurgical factories. Previous studies indicated soil contamination with copper, zinc, cadmium and lead, but there are few data about contamination of garden soil in this area and of vegetables cultivated on these soils. The present study highlights that both adults and children consuming vegetables grown in these garden soils ingest significant amount of these metals. Soil and plant samples were collected from four places located at various distances from existing pollution sources within Baia Mare depression: Ferneziu, Tăuții de Sus, Valea Borcutului (Baia Mare), Cicârlău. Sighetu Marmației, a less polluted area, was chosen as reference zone. Heavy metals (Pb, Cu, Zn) content from soil and plant samples were analyzed on a Perkin Elmer Flame AAS. The Cu values in soil are between 32.961 $mg \cdot kg^{-1}$ soil (Cicârlău) and 268.284 $mg \cdot kg^{-1}$ soil (Ferneziu). Cu concentrations in leaves range from a minimum value of 7.526 $mg \cdot kg^{-1}$ (Cicârlău) to a maximum value of 45.340 $mg \cdot kg^{-1}$ (Tăuții de Sus). Values for Pb ranged from a minimum value of 74.933 $mg \cdot kg^{-1}$ soil (Sighet) to a maximum value of 3122.084 $mg \cdot kg^{-1}$ soil (Ferneziu). Pb concentrations in leaves are between minimum value of 6.373 $mg \cdot kg^{-1}$ (Sighet) and a maximum value of 303.816 $mg \cdot kg^{-1}$ (Ferneziu). The minimum value for Zn in soil was 169.325 $mg \cdot kg^{-1}$ (Sighet) and the maximum value was 1865.126 $mg \cdot kg^{-1}$ (Ferneziu). The range of Zn variation in leaves was between 28.759 $mg \cdot kg^{-1}$ (Sighet) and 609.530 $mg \cdot kg^{-1}$ (Ferneziu). This study reveals intense soil and plant pollution in the areas adjacent to sources of pollution (Tăuții de Sus and Ferneziu) and indicates a translocation of these heavy metals in plants. Their consumption makes possible an inevitable transfer of heavy metals in the body, which can have serious consequences on human health.

REZUMAT: Contaminarea salatei verzi cu metale grele din zona Baia Mare (România).

Scopul cercetării a fost evaluarea gradului de contaminare cu plumb, cupru şi zinc a salatei cultivate în grădinile din zona Baia Mare, centru industrial de metalurgie neferoasă situată în regiunea de nord-vest a României. Solurile din depresiunea Baia Mare sunt puternic afectate de emisiile sub formă de pulberi în suspensie ale metalelor grele, provenite din activitățile industriale de metalurgie neferoasă din zonă. Cercetări anterioare au evidențiat poluarea solurilor cu metale grele, dar puține cercetări s-au axat pe determinarea gradului de contaminare a solurilor de grădină şi a legumelor cultivate în aceste soluri poluate. Această lucrare evidențiază riscul ingestiei unor cantități mari de metale grele, prin consumarea legumelor cultivate în aceste grădini cu soluri poluate. Probele de sol şi probele vegetale au fost prelevate din patru grădini, plasate la distanțe variabile față de sursele de poluare existente: Ferneziu, Tăuții de Sus, Valea Borcutului (Baia Mare), Cicârlău. Zona de referință a fost Sighetu Marmației, zonă lipsită de poluare industrială. Decelarea conținutul de metale grele (Pb, Cu, Zn) a fost realizată cu spectrofotometrul cu absorbție Analyst 700,

Perkin Elmer. Domeniul de variaţie pentru Cu, în sol, este cuprins între 32,961 mg·kg^{-1} sol (Cicârlău) şi 268,284 mg·kg^{-1} sol (Ferneziu). Valorile obţinute pentru Cu în frunze sunt mai mici decât cele obţinute în rădăcină, încadrându-se între valoarea minimă de 7,526 mg·kg^{-1} (Cicârlău) şi valoarea maximă de 45,340 mg·kg^{-1} (Tăuţii de Sus). Valorile obţinute pentru Pb se încadrează între valoarea minimă de 74,933 mg·kg^{-1} sol (Sighet) şi valoarea maximă de 3122,084 mg·kg^{-1} sol (Ferneziu). Domeniul de variaţie a Pb-lui în frunza de salată este cuprins între 6,373 mg·kg^{-1} (Sighet) şi 303,816 mg·kg^{-1} (Ferneziu). Valoarea minimă obţinută pentru Zn este de 169,325 mg·kg^{-1} sol (Sighet), iar valoarea maximă obţinută este de 1865,126 mg·kg^{-1} sol (Ferneziu). La frunză, domeniul de variaţie pentru Zn este cuprins între 28,759 mg·kg^{-1} (Sighet) şi 609,530 mg·kg^{-1} (Ferneziu). Din datele prezentate, rezultă un grad ridicat de contaminare al salatei, şi a solurilor aflate în zonele adiacente surselor de poluare (Tăuţii de Sus şi Ferneziu). De asemenea indică existenţa unei translocări ale acestor metale grele în plante şi prin consumarea lor, transferul, inevitabil, al metalelor grele în organismul uman, ceea ce poate avea grave consecinţe asupra sănătăţii omului.

RÉSUMÉ: La contamination aux métaux lourds de la salade verte dans la région de Baia Mare (Roumanie).

Le but de la recherche a été l'évaluation du degré de contamination avec du plomb, cuivre et zinc de la salade cultivée dans les potagers de la région de Baia Mare, un site industriel de la métallurgie non ferreuse situé dans le nord-ouest de la Roumanie. Les sols de la dépression de Baia Mare sont fortement affectés par les émissions sous forme de poussières en suspension chargées de métaux lourds provenant des activités industrielles de métallurgie non ferreuse de la zone. Les recherche précédentes ont mis en évidence la pollution des sols avec des métaux lourds mais peu de recherches se sont concentré sur la détermination du degré de contamination des sols des potagers et des légumes cultivés sur ces sols contaminés. Cet article met en évidence le risque d'ingestion des grandes quantités de métaux lourds par la consommation des légumes cultivés dans des potagers pollués. Les échantillons de sols et de végétation ont été prélevés de quatre potagers situes à une distance variable des sources de pollution existantes: Ferneziu, Tăuţii de Sus, Valea Borcutului (Baia Mare), Cicârlău. La localité de référence a été Sighetu Marmaţiei, localité en dehors de la zone de pollution industrielle. La détection des métaux lourds (Pb, Cu, Zn) a été faite à l'aide du spectrophotomètre d'absorption Analyst 700, Perkin Elmer. Le domaine de variation pour le Cu dans le sol a été compris entre 32,961 mg·kg^{-1} sol (Cicârlău) et 268,284 mg·kg^{-1} sol (Ferneziu). Les valeurs du Cu obtenues pour les échantillons de feuille ont été plus faibles que les valeurs obtenues pour les échantillons de racine, se situant entre une valeur minimale de 7,526 mg·kg^{-1} (Cicârlău) et une valeur maximale de 45,340 mg·kg^{-1} (Tăuţii de Sus). Pour le Pb, les valeurs obtenues sont comprises entre une valeur minimale de 74,933 mg·kg^{-1} sol (Sighet) et une valeur maximale de 3122,084 mg·kg^{-1} sol (Ferneziu). Le domaine de variation du Pb dans la feuille de salade a été compris entre 6,373 mg·kg^{-1} (Sighet) et 303,816 mg·kg^{-1} (Ferneziu). La valeur inférieure obtenue pour le Zn est de 169,325 mg·kg^{-1} sol (Sighet), et la valeur supérieure obtenue est de 1865,126 mg·kg^{-1} sol (Ferneziu). Dans la feuille, le contenu de Zn a été compris entre 28,759 mg·kg^{-1} (Sighet) et 609,530 mg·kg^{-1} (Ferneziu). Les données présentées indiquent un degré élevé de contamination de la salade et des sols des régions adjacentes aux sources de pollution (Tăuţii de Sus et Ferneziu). Egalement, les données indiquent l'existence de l'absorption de ces métaux lourds dans les plantes et, par leur consommation, le transfert inévitable des métaux lourds dans l'organisme, ce qui peut avoir des graves conséquences sur la santé humaine.

INTRODUCTION

The accumulation of heavy metals in agricultural soils is of increasing concern because of food safety issues, potential health risks, and its detrimental effects on soil ecosystems (Cui et al., 2004). Pb is of great concern because of its toxicity to human health and other organisms, whereas Zn and Cu are essential elements for plants and human body. Vegetables take up Pb, Zn, and Cu and accumulate them in their edible and inedible parts in various concentrations. The intake of the edible parts of vegetables is an important path for heavy metals from the soil to harm human health. It is therefore important to control and limit the accumulation of heavy metals in vegetables.

The researches conducted in Baia Mare area have highlighted multiple pollution by heavy metals (Pb, Zn and Cu) in the residential, agricultural and forestry soils, felt at a distance of over 25–30 km around the major pollution sources, as a consequence of the high emission levels and high frequency of exceeding the maximum admissible concentrations of heavy metals in the ambient air (Frentiu et al., 2008, 2009; Cordos et al., 2007; Damian et al., 2010; Oprea et al., 2010).

The most important pollution sources are S.C. Romplumb S.A. and S.C. Cuprom S.A. The location of the two factories inside the urban area, in the east and northeast respectively, on the dominant wind directions and with reduced dispersion of pollutants (slow air circulation, calm atmosphere and frequent thermal inversions) generated by the relief area (depression) causes a high level of pollution emissions across the Baia Mare area.

The total quantities of emissions of metals (Pb, Cd, Zn, Cu, Hg, Ni, Cr, Se and As) resulting from the inventory between 2000 and 2009, based on the CORINAIR emission factors, are presented) (Tab. 1). Emission sources are the primary lead production, traffic, secondary copper production. Highest quantities were recorded for Pb, Zn, Cu and Cd.

Table 1: Annual emissions of heavy metals (t/year); source ANPM.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Annual discharge	101.2	25	18.5	17.5	21.8	20.1	20.6	12.52	2.13	1.82

The contents of Cd, Cu, Pb and Zn in the soils around these pollution sources are sometimes higher than the maximum allowable limits. As a result, the plants, including vegetables, accumulated high quantities of such chemical elements.

The paper presents some results concerning the soil-plant relationships in these areas and the absorption of heavy metals in edible part of vegetables.

Weather factors are contributing to pollutant dispersion in Baia Mare region.

Air temperature is not constant, presenting two types of variations: regular and accidental. Air variation depending on air pressure and height is an important factor involved in the movement of air masses and in the spread of pollutants in the atmosphere.

In Baia Mare region the average annual air temperature for 2009 was 11.1°C. The air temperature annual values are variable. The lowest annual average of 7.9°C was recorded in 1993 and the highest, 11.4°C, was recorded in 1972. The average of annual maximum is 33.7°C and the average of annual minimum is -14.5°C (ANPM).

The greatest considered importance for pollutant dispersion are having the thermal instability and the thermal inversions. In the first case, there is a quickly dispersion, while in the second case the dispersion is almost completely prevented.

Due to the humid air conditions, in this area water vapor quantities vary in relation to physical and geographical conditions, season, daytime and also weather conditions. The relative humidity average in Baia Mare area is 75%. The monthly average values vary between 65-85% (Tab. 2). During the winter the relative air humidity is much higher than in summer. In summer the water vapor pressure, can reach values of 20 mb, while in winter will be under 5 mb.

Table 2: Relative humidity in 2007 (%); source Baia Mare Weather Station, 2008.

Station	Montly values												Annual value
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Baia Mare	87	85	78	72	73	76	76	78	81	82	84	84	80

Under the high humidity, mist is produced, which creates unfavorable conditions for the diffusion of the extreme condensation nucleus resulted from suspended particles. In Baia Mare area every year are registered about 40 days with fog, the frequency of this being higher in winter (Tab. 3). This meteorological phenomenon favors the maintenance of pollutants near the earth's surface and increases their concentration at lower troposphere.

Table 3: Number of days with fog in 2007; source Baia Mare Weather Station, 2008.

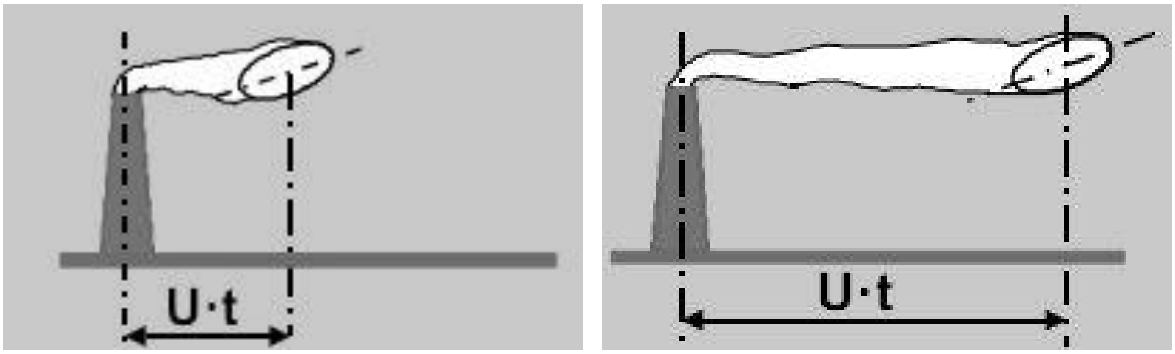
Station		Montly values												Annual value
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Baia Mare	medium	8.0	6.3	2.2	0.9	0.8	0.5	0.3	0.8	2.0	3.9	5.4	9.1	40.2
	maximum	16	12	5	5	3	2	2	2	6	15	10	17	60

The occurrence of rainfall (Tab. 4) is flushing the contaminants of the atmosphere (wash out); the rain makes mainly atmosphere gas flushing, while the snow removes solid particles, increasing the soil pollution. Also possible are chemical reactions between pollutants and water, forming new pollutants more dangerous than the original contaminants.

Table 4: Annual average rainfall between 2005 – 2009 in Baia Mare; source ANPM.

Year	2005	2006	2007	2008	2009
Annual rainfall (l/m^2)	1125	1053.5	870.2	1070.1	965.6

The wind represents horizontal air movement and due to this fact wind is considered the most important factor contributing to the pollutants dispersion in the air. This is the process in which contaminants are moving and creating the phenomenon of diffusion of their air basin. Diffusion is directly proportional to the wind speed. If it is uniform and has a slow speed can maintain high concentrations of pollutants in the air where they have arrived. With the increase of the wind speed the distance where the eliminated pollutants are reaching is longer and longer (Fig. 1).



a) b)

Figure 1: Influence of wind speed on pollutant dispersion;
a) slow; b) speed (Mazzini, 2002).

The atmospheric calm (when wind is below 0.5 km/h) is the most unfavorable weather condition for air pollution, because they accumulate near the source and their concentration gradually increases. In Baia Mare atmospheric calm reaches, in average, up to 45% annual.

The plateau on which the city is located is bordered to the north and partially east by hills of 400 – 600 m height. Gradually, these hills will continue with the Gutâi Mountains, with heights up to 1450 m. This configuration of the land will cause a substantial air movement in the direction V, NV, E and SE.

Climatic characteristics caused by air movements, diurnal cooling and heating are presented as a pie chart that makes up the wind rose. The wind rose shows a more common direction of wind, E direction with a frequency of 15.5%, followed by the V, NV and SE directions with lower frequencies, 8.4%, 5.0% and 4.9%. The 2.4% frequency from SV is due to the barrage influence of the northern mountainous area (Tab. 5, Fig. 2).

Table 5: The average frequency of wind directions and atmospheric calm (%) for the 1961 – 2000 period at the Baia Mare Weather Station; source Baia Mare Weather Station.

Wind direction	Montly values												Annual value
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
N	0.7	1.1	2.4	3.4	3.6	3.2	4.1	4.8	5.5	3.2	1.5	0.8	2.9
NE	1.1	1.6	2.5	2.6	2.2	2.7	2.1	1.9	2.0	1.5	1.1	1.1	1.8
E	12.5	14.4	15.0	14.3	11.1	8.4	8.3	8.1	9.5	13.1	15.3	13.4	11.9
SE	6.6	8.3	9.9	9.6	9.0	6.1	5.8	5.9	7.5	8.6	9.3	6.8	7.8
S	1.2	1.6	2.6	2.7	3.7	3.1	3.5	3.6	2.5	2.3	1.5	1.3	2.5
SV	1.4	1.8	2.7	3.6	4.1	3.5	3.9	3.0	2.9	1.9	1.9	1.5	2.7
V	9.7	10.5	12.8	14.9	14.2	16.9	16.0	13.6	12.1	8.8	10.7	9.5	12.5
NV	4.9	4.6	6.5	7.8	7.9	10.0	9.6	8.4	7.0	4.4	4.9	4.8	6.7
Calm	61.9	56.1	45.6	41.1	44.2	46.1	46.7	50.7	51.0	56.2	53.8	60.8	51.2

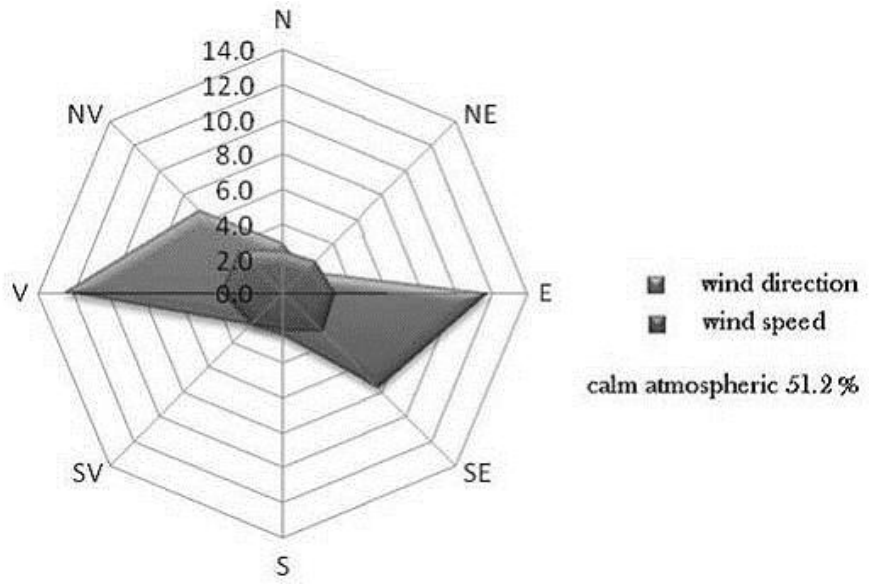


Figure 2: Wind Rose for Baia Mare (Damian et al., 2010).

MATERIALS AND METHODS

Location of the studied area

The soil and plant samples had been collected from four places located at various distances from existing pollution sources from Baia Mare Depression (Fig. 3), where, as shown in previous studies, higher concentrations of heavy metals have been found in the soil, as a consequence of the falling dust which contains metals from direct, diffuse or fugitive emissions from the metallurgical plants from the area (Ivasuc, 2008; Damian et al., 2010). For the comparative analysis of the data, a reference zone had been selected from Sighetu Marmației, area not under the direct impact of the mentioned pollution sources.

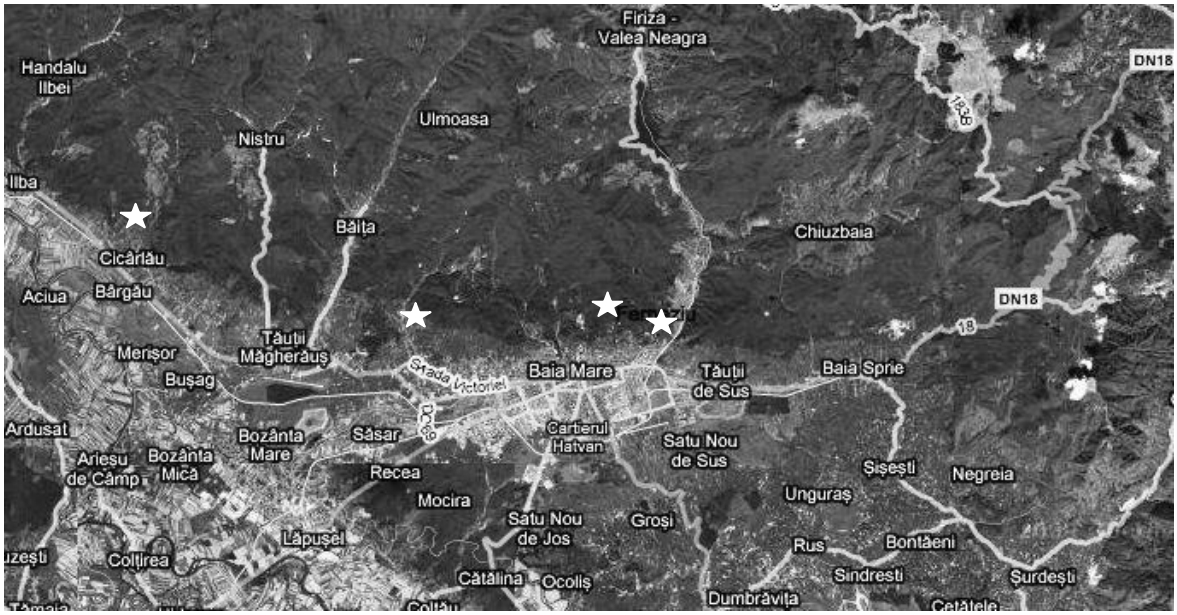


Figure 3: Sampling points of soil and plant from four locations under the impact of pollution.

Soil and plant sampling

Soil and vegetables samples from vegetables gardens within the areas influenced by emissions loaded with heavy metals, were collected in May 2010. The soil samples collected from the 0–20 cm depth of the A horizon, were analyzed for pH values, quantity of humus, quantity of clay and total forms of heavy metals (Cu, Pb and Zn).

The plant samples from the garden soils came from a very common vegetable used in human alimentation: the lettuce (*Lactuca sativa* Linnaeus *var. capitata*). This species was chosen because between vegetables, it has the highest capacity to accumulate heavy metals without manifesting visible phytotoxicity symptoms, which enhances the risk to human health. The plants were taken entirely, in order to determine the content of heavy metals in both roots and leaves.

Samples preparation and analysis

The studied soil reaction (pH values) was determined by potentiometric method in aqueous suspension, using a double glass-calomel electrode. Determinations related to clay and also humus content are part of the Romanian agrochemical system that establishes the heavy metals chemistry (ICPA, 1981). The total content of heavy metals (Cu, Pb and Zn) was measured with flame atomic absorption spectrometer according to the SR ISO 11047: 1999 method.

All the collected plant samples were washed with double distilled water to remove airborne pollutants. Each individual vegetable was separated into root and leaf sub-samples. All sub-samples were weighed and air-dried for a day, to reduce water content. All the samples were then oven-dried in a hot air oven at 70 – 80°C for 24 h, to remove all moisture. Dried samples were powdered using a pestle and mortar and passed through a 0.15 mm sieve. The powdered samples were accurately weighed (0.5 g each) and placed in crucibles. The ash was digested with perchloric acid and nitric acid (1:4) solution. The samples were left to cool and contents were filtered through Whatman filter paper number 42. Each sample solution was made up to a final volume of 25 ml with distilled water and analyzed by atomic absorption spectrophotometry, (Arora et al., 2008).

Standards

The reagents used during the process were of analytical grade. Standard solutions of heavy metals (1,000 mg/l), namely copper (Cu), zinc (Zn) and lead (Pb) were procured from Merck. Solutions of varying concentrations were prepared for all the metals by diluting the standards.

RESULTS AND DISCUSSION

The results reflecting soil chemical characteristics: pH and humus content (%), and physical characteristics: clay content (%), are represented in the table number 6.

In the Baia Mare polluted areas, soils planted with vegetables are predominantly acidic, with small areas neutral or slight alkaline, oligo-mezo-basic.

Table 6: Physical and chemical properties of studied soils.

Soil sampling point	pH	humus	clay
Tauți	6.1500	5.88	28.2
Cicârlău	7.5500	2.3	17.35
Valea Borcutului	6.6500	3.51	23.25
Ferneziu	4.0500	2.18	10.25
Sighet	7.7000	3.03	19.5

The results for soil samples are compared with reference from the Order number 756/1997 of the Ministry of Waters, Forests and Environmental Protection and the results from vegetable samples with reference values in the Order number 975/1998 of the Romanian Ministry of Public Health (Tabs. 7 and 8).

Table 7: The maximum admitted levels (mg/kg) from vegetables according order number 975/1998 of the Romanian Ministry of Public Health.

Food type	As	Cd	Pb	Zn	Cu	Sn	Hg
Fresh vegetables	0.5	0.1	0.5	1	5.0	-	0.05
Leafy vegetables	-	0.2	0.5	-	-	-	0.03

Table 8: Standard normal values, warning threshold and intervention threshold according order number 756/1997 of Ministry of Waters, Forests and Environmental Protection.

Metal	Sensitive type of land			Less sensitive type of land		
	(mg/kg dry mass)					
	Normal values	Warning threshold	Intervention threshold	Normal values	Warning threshold	Intervention threshold
Cu	20	100	200	20	250	500
Pb	20	50	100	20	250	1000
Zn	100	300	600	100	700	1500

The range for Cu values in soil is between 32.961 $mg \cdot kg^{-1}$ soil (Cicârlău) and 268.284 $mg \cdot kg^{-1}$ soil (Ferneziu). The obtained values for Cu in lettuce roots is between a minimum value of 18.346 $mg \cdot kg^{-1}$ (Cicârlău) and a maximum value of 204.889 $mg \cdot kg^{-1}$ (Ferneziu). The Cu concentrations in leaves are lower than in roots, ranging from a minimum value of 7.526 $mg \cdot kg^{-1}$ (Cicârlău) and a maximum value of 45.340 $mg \cdot kg^{-1}$ (Tăuții de Sus) (Tab. 9, Figs. 4 and 5).

Values for soil Pb ranged from a minimum value of 74.933 $mg \cdot kg^{-1}$ (Sighet) and a maximum value of 3122.084 $mg \cdot kg^{-1}$ (Ferneziu). The range of Pb values in roots is between a minimum value of 22.629 $mg \cdot kg^{-1}$ (Sighet) and a maximum value of 964.055 $mg \cdot kg^{-1}$ (Ferneziu). Pb concentrations in leaves are between a minimum value of 6.373 $mg \cdot kg^{-1}$ (Sighet) and a maximum value of 303.816 $mg \cdot kg^{-1}$ (Ferneziu) (Tab. 10, Figs. 6 and 7).

The minimum value for Zn in soil is 169.325 $mg \cdot kg^{-1}$ (Sighet) and the maximum value is 1865.126 $mg \cdot kg^{-1}$ (Ferneziu). The minimum value for Zn in lettuce root is 43.850 $mg \cdot kg^{-1}$ (Sighet) and the maximum value in lettuce root is 1416.247 $mg \cdot kg^{-1}$ (Ferneziu). In leaves the range of variation is between 28.759 $mg \cdot kg^{-1}$ (Sighet) and 609.530 $mg \cdot kg^{-1}$ (Ferneziu) (Tab. 11, Figs. 8 and 9).

For statistical results were performed simple correlations using the Microsoft Excel program, Correl application and graphical representation of linear regression was performed in Curve Expert program (Tab. 12).

The correlation coefficient values were compared with limit values of 5%, 1% and 0.1% transgression probabilities, for degrees of freedom GL = 4 (GL = n-1, n = 5, n - number of samples). It can be observed the fact that between Pb and Zn content in soil and these metals content in root and leaf, there is a direct, distinctly significant connection. Between Cu content in soil and the content in root and leaf there are also direct, significant connections.

Linear regression and Pearson correlation coefficients values can be seen in the figures 10–15.

Table 9: Cu contents in soil and lettuce root and leaf ($mg \cdot kg^{-1}$).

Sampling point	Cu		
	soil	root	leaf
Tăuți	185.245	112.235	45.340
Cicârlău	32.961	18.346	7.526
Valea Borcutului	56.819	32.863	11.945
Ferneziu	268.284	204.889	41.746
Sighet	49.139	12.632	8.794

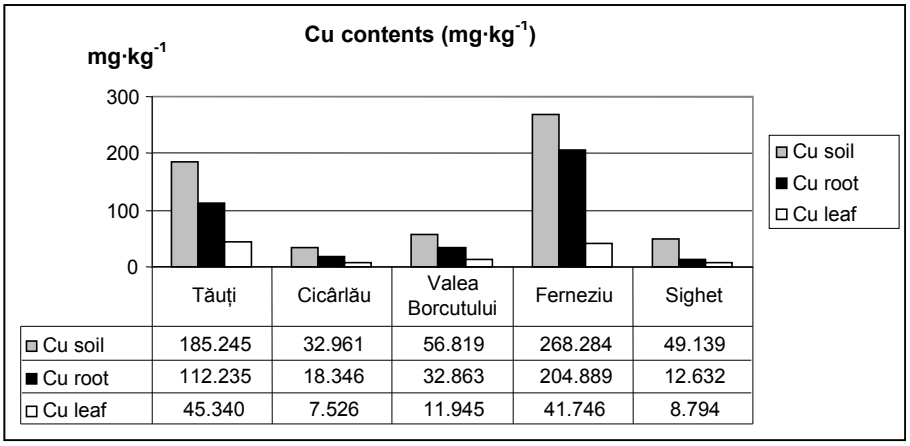


Figure 4: Graphical representation of Cu contents in soil and lettuce root and leaf.

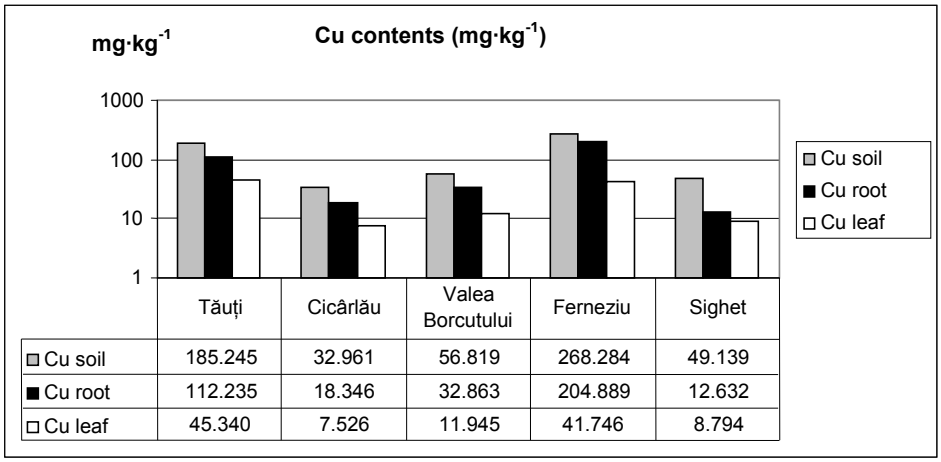


Figure 5: Graphical representation on logarithmic scale of Cu contents in soil and lettuce root and leaf.

Table 10: Pb contents in soil and lettuce root and leaf (mg·kg^{-1}).

Sampling point	Pb		
	soil	root	leaf
Tăuți	2355.950	723.463	204.760
Cicârlău	78.657	26.861	8.497
Valea Borcutului	122.541	39.992	11.459
Ferneziu	3122.084	964.055	303.816
Sighet	74.933	22.629	6.373

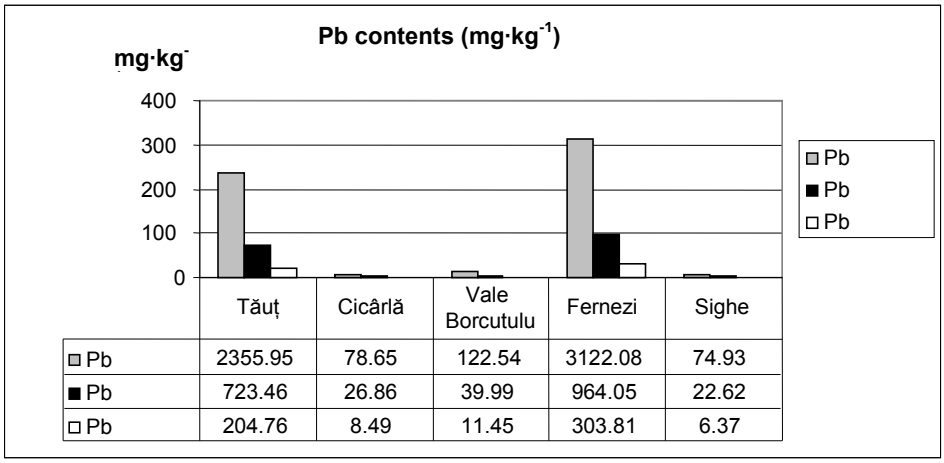


Figure 6: Graphical representation of Pb contents in soil and lettuce root and leaf.

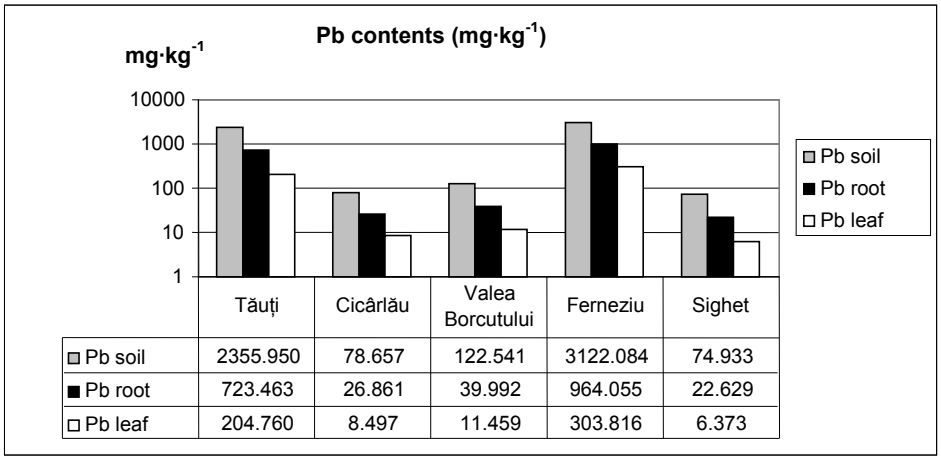
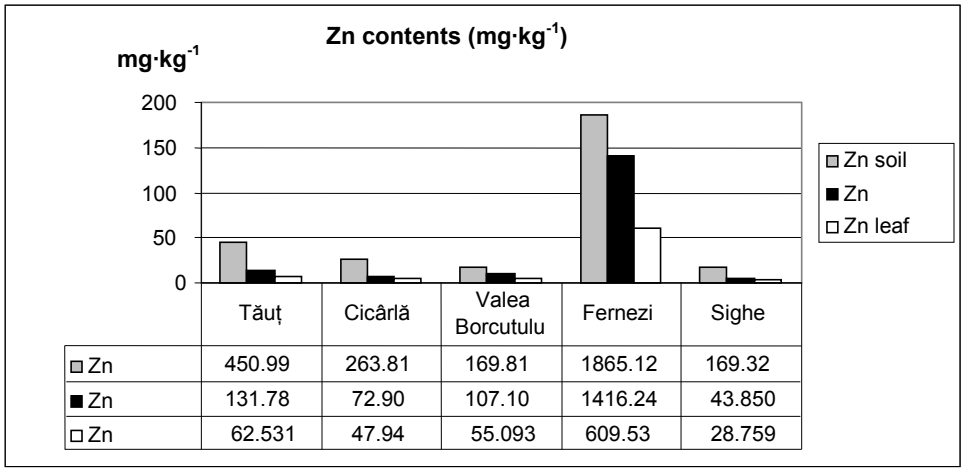


Figure 7: Graphical representation on logarithmic scale of Pb contents in soil and lettuce root and leaf.

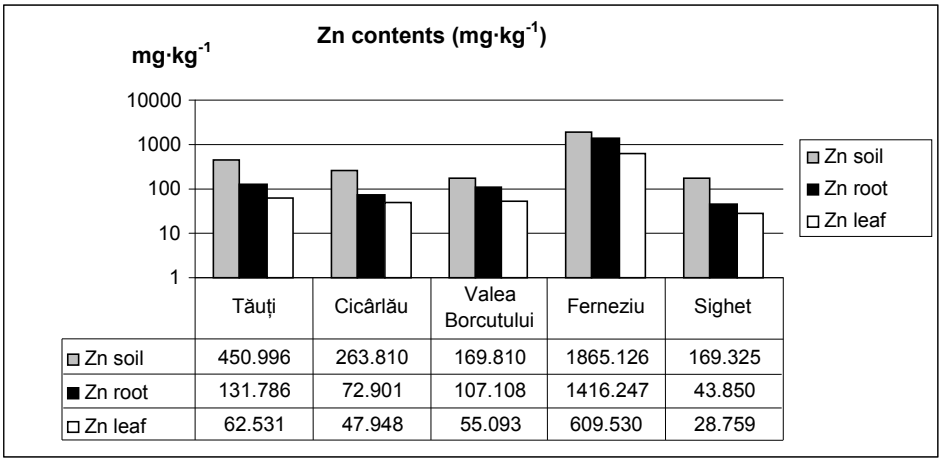
Table 11: Zn contents in soil and lettuce root and leaf (mg·kg^{-1}).

Sampling point	Zn		
	soil	root	leaf
Tăuți	450.996	131.786	62.531
Cicârlău	263.810	72.901	47.948
Valea Borcutului	169.810	107.108	55.093
Ferneziu	1865.126	1416.247	609.530
Sighet	169.325	43.850	28.759



	Tăuț	Cicârlă	Valea Borcutulu	Fernezi	Sighe
Zn	450.99	263.81	169.81	1865.12	169.32
Zn	131.78	72.90	107.10	1416.24	43.850
Zn	62.531	47.94	55.093	609.53	28.759

Figure 8: Graphical representation of Zn contents in soil and lettuce root and leaf.



	Tăuți	Cicârlău	Valea Borcutului	Ferneziu	Sighet
Zn soil	450.996	263.810	169.810	1865.126	169.325
Zn root	131.786	72.901	107.108	1416.247	43.850
Zn leaf	62.531	47.948	55.093	609.530	28.759

Figure 9: Graphical representation on logarithmic scale of Zn contents in soil and lettuce root and leaf.

Table 12: Values for Pearson's correlation coefficients (r) between heavy metal content (Cu, Pb and Zn) in soil and these metals in root, respectively in leaf; n.s. (non-significant), *;° (significant), **;°° (distinctly significant).

Correlations	Root	Leaf
sol-Cu	0.989136 *;°	0.936837 n.s.
sol-Pb	0.999989 **;°°	0.997536 **;°°
sol-Zn	0.99195 **;°°	0.991457 **;°°

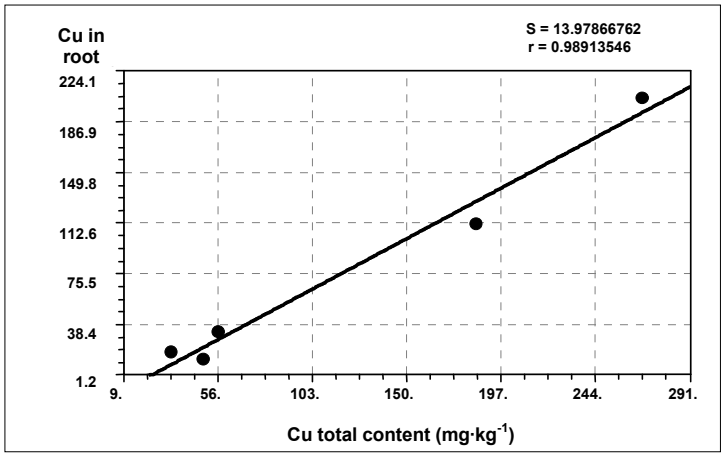


Figure 10: Graphical representation of linear regression between Cu total content in soil - Cu content in lettuce root.

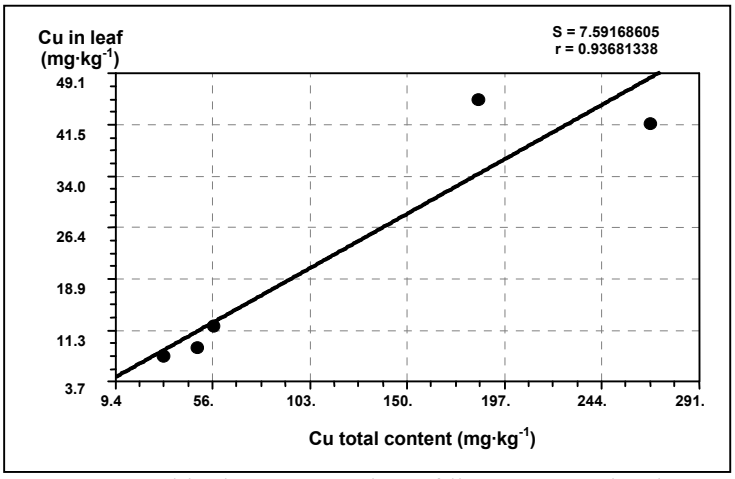


Figure 11: Graphical representation of linear regression between Cu total content in soil - Cu content in lettuce leaf.

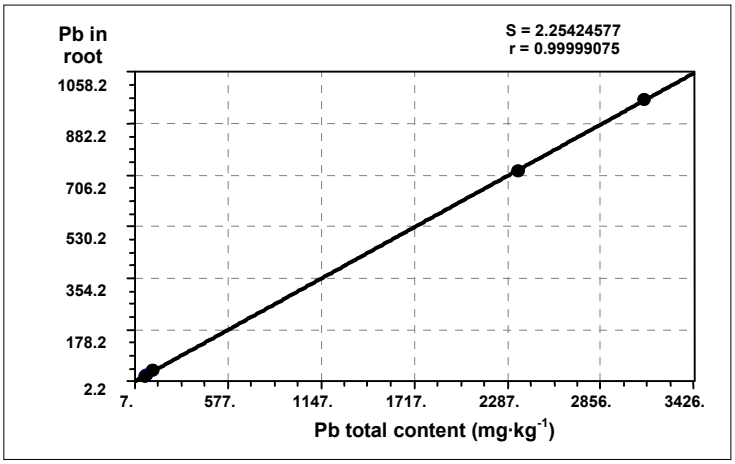


Figure 12: Graphical representation of linear regression between Pb total content in soil - Pb content in lettuce root.

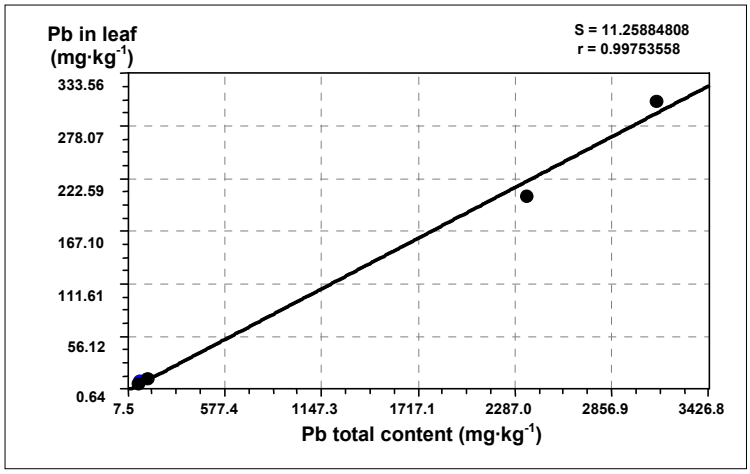


Figure 13: Graphical representation of linear regression between Pb total content in soil - Pb content in lettuce leaf.

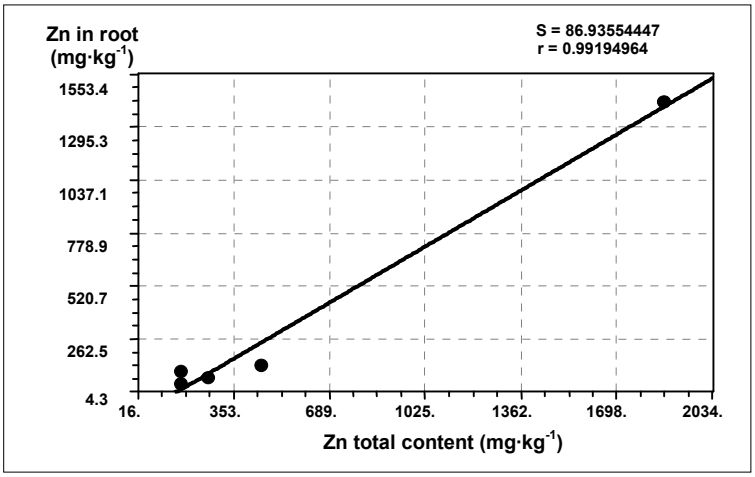


Figure 14: Graphical representation of linear regression between Zn total content in soil - Zn content in lettuce root.

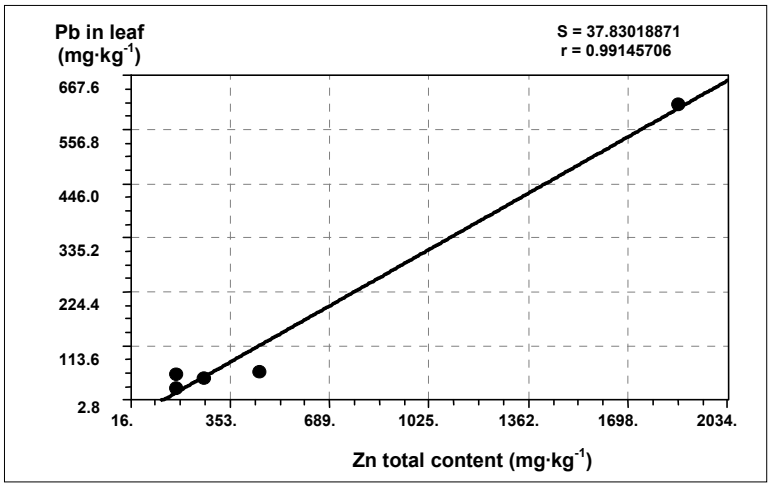


Figure 15: Graphical representation of linear regression between Zn total content in soil - Zn content in lettuce leaf.

CONCLUSIONS

The study presents original results on the soil pollution in Baia Mare area regarding the Cu, Pb and Zn contents in soil and lettuce plants.

If we compare the values obtained with those provided by Romanian legislation for heavy metals in soil (Order number 756/1997 of the Ministry of Waters, Forests and Environmental Protection) and the maximum admitted levels in leafy vegetables (Order number 975/1998 of the Romanian Ministry of Public Health), we can observe that, on the studied gardens, both soil samples and the plant samples have a high content of heavy metals, which exceeds by far the maximum admitted levels.

The results of the present study reveal that the variation of heavy metals content depends very much on the position of sampling site against the sources of pollution. In the areas adjacent to sources of pollution the threshold values for Zn and Cu are exceeded (Tăuții de Sus), and even the intervention threshold for Cu (Ferneziu) and Pb (Tăuții de Sus, Ferneziu and Valea Borcutului).

Higher levels of heavy metals in plants, especially in areas of Ferneziu and Tăuții de Sus, indicate a translocation of these heavy metals in plants and their consumption, an inevitably transfer of heavy metals in the body, which can have serious consequences on human health.

In an overall conclusion, the reduction of pollution will have to start from the source of pollution, that is by industry retechnologization, expanding automatization, improving existing technology, workforce qualification, in other words, pollution prevention, followed by the introduction of technical and organizational systems against pollution.

REFERENCES

Arora M., Kiran B., Rani S., Rani A., Kaur B. and Mittal N., 2008 – Heavy metal accumulation in vegetables irrigated with water from different sources. *Food Chemistry*, 111: 811-815.

Cordos E. A., Roman C., Ponta M., Frenţiu T. and Răuţiu R., 2007 – Evaluation of soil pollution with copper, lead, zinc and cadmium in the mining area Baia Mare. *Rev. Chim.*, Bucharest, 58: 470-474.

Cui L. P., Bai J. F., Shi Y. H., Yan S. L., Huang W. H. and Tang X. Y., 2004 – Heavy metals in soil contaminated by coal mining activity. *Acta Pedologica Sinica*. 41 (6): 896-904.

Damian G., Damian F., Năsui D., Pop C. and Pricop C., 2010 – The soils quality from the southern-eastern part of Baia Mare zone affected by metallurgical industry. *Carpathian Journal of Earth and Environmental Sciences*, 5 (1): 139-147.

Frentiu T., Ponta M., Levei E., Gheorghiu E., Kasler I. and Cordos E., 2008 – Validation of the tessier scheme for speciation of metals in soil using the Bland and Altman test. *Chem. Paper*, 62: 114-122.

Frentiu T., Ponta M., Levei E. and Cordos E. A., 2009 – Study of partitioning and dynamics of metals in contaminated soil using modified four-step BCR sequential extraction procedure. *Chem. Paper*, 63: 239-248.

Ivasuc M., 2008 – Utilizarea spectrometriei de absorbţie atomică în determinarea plumbului şi cadmiului din probe de sol prelevate din zona Baia Mare, MsC. thesis, North University of Baia Mare. (in Romanian)

Mazzini M., 2002 – Dispersione atmosferica degli inquinanti aeriformi, *http://corsiadistanza.polito.it/corsi/pdf/9659A/Presentazione_E.pdf* (in Italian)

Oprea G., Michnea A., Mihali C., Senilă M., Roman C., Jelea S., Butean C. and Barz C., 2010 – Arsenic and Antimony Content in Soil and Plants from Baia Mare Area, Romania. *American Journal of Environmental Sciences*, 6 (1): 33-40.

*** SR ISO 11047:1999 – Calitatea solului. Determinarea Cd, Cr, Co, Cu, Pb, Mn, Ni şi Zn din extracte de apă regală. Metodele prin spectrometrie de absorbţie atomică în flacără şi cu atomizare electrotermică. (in Romanian)

*** Administraţia Română de meteorologie - Staţia meteorologică Baia Mare.

*** APM Maramureş, http://apmmm.anpm.ro/

*** The Order number. 975/1998 of the Romanian Ministry of the Public Health

*** The Order number 756/1997 of the Ministry of Waters, Forests and Environmental Protection.

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THE FLORA AND VEGETATION OF THE DOAMNEI VALLEY (FĂGĂRAŞ MOUNTAINS, ROMANIA)

Constantin DRĂGULESCU [1]

KEYWORDS: Romanian Carpathians, Doamnei Valley, flora, vegetation, species, associations.

ABSTRACT

The Doamnei Valley is 8 km long and lies on the north side of the Carpathian Mountains (Southern Carpathians), between 2398 m and 890 m in altitude.

Crystalline schists dominate and therefore the soils are acidic, "Jgheabul Văros/Văros Gutter" being the only appearance of crystalline limestone in this valley (with a characteristic flora and vegetation).

Based on literature sources, consulted herbaria and personal observations in the field (during 1977–2009), the author has assembled the floristic and phyto-sociological lists presented below.

These include 379 vascular plant species and 33 plant associations.

REZUMAT: Flora şi vegetaţia Văii Doamnei (Munţii Făgăraş, România).

Valea Doamnei are 8 km lungime şi se află pe versantul nordic al Munţilor Făgăraşului (Carpaţii Meridionali), la altitudini cuprinse între 2398 m şi 890 m.

Predomină şisturile cristaline şi, ca urmare, solurile acide, „Jgheabul Văros" fiind singura apariţie de calcar cristalin din vale (cu o floră şi vegetaţie caracteristică).

Având ca surse bibliografia parcursă, herbariile consultate şi propriile observaţii în teren (din perioada 1977–2009), autorul a realizat listele floristică şi fitocenologică de mai jos.

Ele cuprind 379 de specii cormofite şi 33 asociaţii vegetale.

ZUSAMMENFASSUNG: Flora und Vegetation des Doamnei Tales (Fogarascher Gebirge, Rumänien).

Das am Nordabhang des Fogarascher Gebirges in den Südkarpaten gelegene Doamnei Tal (Valea Doamnei) ist 8 km lang und umfasst Höhen zwischen 2398 m und 890 m. Im Gebiet herrschen kristalline Schiefer vor und dementsprechend saure Böden.

Der sogenannte „Jgheabul Văros" ist die einzige kristalline Kalkader des Tales mit einer entsprechenden kalkliebenden Flora und Vegetation.

Die in der Arbeit vorgestellten Listen der Flora und der Pflanzengesellschaften stützen sich auf Literaturrecherchen, Herbarforschung und zwischen 1977 und 2009 durchgeführten eigenen Geländeuntersuchungen.

Sie umfassen 379 Arten von Gefäßpflanzen und 33 Pflanzen-gesellschaften.

INTRODUCTION

Doamnei Valley is located on the northern slopes of the Făgăraş Mountains, bounded on the east side by Muchia/Custura Bâlii, on the west side by Laiţa Ridge, on the south side by Paltinu/Paltina Peak (2398 m), Turnul Paltinei Peak (2345 m) and Laiţa Peak (2398 m). Until the confluence with Bâlii Valley (890 m), Doamnei Valley has a length of about 8 km (average width being about 1 km) and an altitude difference of almost 1510 m. The upper half of the valley is very rough and belongs to alpine and subalpine level (glacial cirques, moraines, exposed rock surfaces, few subalpine shrubs and alpine pastures) and the lower part belongs to middle and upper mountain level (three quarters of coniferous forests, mixed forests and very few beech forests). In the upper valley we can see Doamnei Lake (actually two relatively small adjacent lakes) and Văros Gutter (one of the few crystalline limestones on the north side of Făgăraş Mountains) and in the lower part Mierea Mountain (1596 m). Crystalline schists predominate (therefore, acidic soils with pH from 4.5 to 6.6) and rendzinas. The climate is cold and wet, typical for alpine-subalpine and mountain areas.

Among the researchers of flora and vegetation of this valley we mention: F. Fronius (1856), M. Fuss (1857, 1865, 1866, 1878), J. Csató (1888), L. Fekete, T. Bláttny (1913), T. Ştefureac (1949), Ş. Csűrös (1957), E. I. Nyárády (1957, 1964), E. Szász (1964, 1969, 1970, 1977), M. Ciurchea, V. Codoreanu, (1967), E. Puşcaru- Soroceanu, D. Puşcaru (1971, 1977, 1981), E. Schneider-Binder, W. Voik (1976, 1979), W. Voik, E. Schneider-Binder (1978), G. Coldea, E. Plămadă (1980), M. Boşcaiu, N. Boşcaiu, F. Ehrendorfer (1998).

Based on scientific references, herbaria and field research (between 1977 and 2009) was elaborated the floristic inventory below, inventory comprising of 379 vascular plants species belonging to 61 families.

MATERIALS AND METHODS

For each identified species is specified the scientific name, family, bioform, floristic element, ecological indices, cenotic preferences, sozology (Red List category), chorology and sources of information. The "!" sign indicates that the author saw the plant or plant association in that particular area.

RESULTS

Flora

Lycopodiaceae

Huperzia selago (L.) Martins: Ch, Cosm; U3,5T2R2, Cetrario- Loiseleurion, Vaccinio-Piceetalia, Nt: V./Valley Doamnei (1, 349, 569, 722, HF, !); Mt./Mountain Mierea (1, 722, HF);

Lycopodium alpinum L.: Ch, Cp; U3T1,5R1,5, Nardetalia, Nt: V. Doamnei (858); Vf./Peak Laiţa (1, 858);

Lycopodium annotinum L.: Ch, Cp; U4T2,5R2, Vaccinio-Piceion, Nt: V. Doamnei, 1300 m – 1880 m alt. (269, 569, 858);

Lycopodium clavatum L.: Ch, Cosm; U3T3R1, Nardetalia, Pino-Quercetalia, Nt: Mt. Mierea (485, 722, 858, HF);

Lycopodium complanatum L. ssp. ***chamaecyparissus*** (A. Br.) Doll: Ch, Cp, U3T2R1, Vaccinio - Piceetea, R; V. Doamnei (1, 739, 858); Jgheabul Văros (1, 524, 717, 722, 858, HF);

Selaginellaceae

Selaginella selaginoides (L.) Link.: Ch, Cp; U4T1R4, Elyno-Seslerietea, Nardetalia, Nt: V. Doamnei (661, HSB, !); Vf. Paltinu (251, 804);

Ophioglossaceae

Botrychium lunaria (L.) Sw.: G, Cosm; U2,5T2R0, Nardetalia, Seslerion rigidae, Nt: V. Doamnei (17); Jgheabul Văros (HSB);

Polypodiaceae

Polypodium vulgare L.: G, Cp; U3,5T3R4, Asplenietea rupestris, Nt: V. Doamnei la 1300 – 1400 m (569);

Blechnaceae

Blechnum spicant (L.) Sm.: H, Cp; U3,5T2R1,5, Deschampsio-Fagion, Vaccinio-Piceion, V: Mt. Mierea (1, 524, 722, 779, HF);

Cryptogrammaceae

Cryptogramma crispa (L.) R. Br.: H, Cp; U2,5T1,5R2, Androsacetalia alpinae, Ex: V. Doamnei (1, 152, HU);

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn: G, Cosm; U3T3R0, Quercetea robori-petraeae, Nt: Mt. Mierea (739); f. ***transsilvanica*** Schur: Mt. Mierea (524);

Thelypteridaceae

Thelypteris limbosperma (All.) H. P. Fuchs: G, E; U3,5T2,5R2, Alnion glutinosae, Betulo-Adenostyletea, Vaccinio-Piceion, Nt: Mt. Mierea (1, 524, 717, 722, HF);

Aspleniaceae

Asplenium ruta-muraria L.: H, Cp; U1,5T3R5, Asplenion rutae-murariae, Nt: Jgheabul Văros 2200 m alt. (803, HSB, !); Şaua Laiţa (803);

Asplenium trichomanes L.: H, Cosm; U3T0R4, Asplenietea rupestris, Nt: Jgheabul Văros (803, !);

Asplenium viride Huds.: H, Cp; U4T2R4, Asplenion rutae-murariae, Vaccinio-Piceion, Nt: V. Doamnei (751); Jgheabul Văros (803, HSB, !); Vf. Paltinu 2210 m (803); Şaua Laiţa (803);

Athyriaceae

Athyrium distentifolium Tausch: H, Cp; U3,5T1,5R3, Betulo-Adenostyletea, Vaccinio-Piceion, I: Jgheabul Văros (HF);

Athyrium filix-femina (L.) Roth: H, Cosm; U4T2,5R0, Adenostyletalia, Fagetalia silvaticae, Symphyto-Fagion, Nt: V. Doamnei (569, !);

Cystopteris fragilis (L.) Berhh. ssp. ***fragilis***: Jgheabul Văros (803, !); ssp. ***alpina*** Hartm.: H, Cosm; U3,5T0R0, Asplenietea rupestris, Nt; V. Doamnei (739, 819, HSB); Jgheabul Văros (524, HU); Şaua Laiţa (803);

Cystopteris montana (Lam.) Bernh.: H, Cp; U3,5T2R4,5, Asplenietea rupestris, R: Şaua Laiţa (803);

Aspidiaceae

Dryopteris filix- mas (L.) Schott: H, Cosm; U4T3R0, Fagetalia silvaticae, Querco-Fagetea, Nt: V. Doamnei (349, 363);

Polystichum aculeatum (L.) Roth: H, E; U3,5T3,5R3,5, Acerion pseudoplatani, Fagion, Nt: V. Doamnei (569);

Polystichum lonchitis (L.) Roth: H, Cp; U3T1,5R4,5, Thlaspion rotundifolii, Nt: V. Doamnei (569, 625); Jgheabul Văros (HU); Vf. Paltinu (HIP);

Pinaceae

Picea abies (L.) Karsten: MPh, E; U0T0R0, Vaccinio-Piceion, Nt: V. Doamnei până la 1800 m alt. (569, !);

Pinus cembra L.: MPh, E; U3T1,5R2, Pinion mugi, Vaccinio-Piceetalia, E: Vf. Paltinu (128);

Pinus mugo Turra: mPh, E; U0T2R0, Junipero-Pinetalia mugi, Pinion mugi, Vaccinio-Piceion, Nt: V. Doamnei (569); Vf. Paltinu (418); Vf. Laiţa (349, 418);

Cupressaceae

Juniperus communis L. ssp. ***communis***: mPh, Cp; U2T0R0, Junipero-Bruckenthalion, Junipero-Pinetalia mugi, Nt: V. Doamnei (569); ssp. ***alpina*** (Suter) Celak.: V. Doamnei (277, 569, 661); var intermedia (Schur) Sanio: V. Doamnei (569, 751);

Ranunculaceae

Aconitum anthora L.: H, E; U2T3R5, Seslerietalia coeruleae, V: Jgheabul Văros (174);

Aconitum firmum Rchb.: H, Carp-B-Sud; U2,5T2,5R4,5, Adenostylion alliariae, Junipero-Bruckenthalion, Nt: V. Doamnei (349, 485, 739); Vf. Paltinu (349); ssp. ***multifidum*** (Rchb.) G. Grinț.: Vf. Paltinu (1);

Aconitum moldavicum Hacq. ssp. ***moldavicum***: H, Carp; U3T2R3, Adenostyletalia, Symphyto-Fagion, Nt: V. Doamnei (HS); Mt. Mierea (644, HS); ssp. ***hosteanum*** (Schur) Graebn.: V. Doamnei (664, 727, 739, 771); Vf. Paltinu (305);

Aconitum tauricum Wulf.: H, Alp-Carp; U3T2,5R3,5, Adenostylion alliariae, Deschampsion caespitosae, Junipero-Bruckenthalion, Nt: V. Doamnei (1, 17, 349, 569, 751, !); Şaua Doamnei (269, 661); Lacul Doamnei (234, 256, 267); ssp. ***taurericum*** (Rchb.) Gay.: Jgheabul Văros (1); ssp. ***nanum*** (Baumg.) Gay.: V. Doamnei (HF), Vf. Paltinu (HIP); Jgheabul Văros (739, HF);

Aconitum toxicum Rchb.: H, Carp-B; U4T2,5R4,5, Adenostylion alliariae, Fagion, Nt: V. Doamnei (1);

Anemone narcissiflora L.: G, Cp; U3,5T1,5R4, Caricion curvulae, Seslerietalia coeruleae, V: V. Doamnei (HSB); Vf. Paltinu (751, HIP);

Aquilegia transsilvanica Schur: H, Carp; U2,5T2R4, Seslerietalia coeruleae, R: V. Doamnei (1, 722, 727, 771, HF, HNY, !); Vf. Paltinu (1); Laița (722);

Callianthemum coriandrifolium Rchb.: H, Alp-Carp-B; U2,5T2R4,5, Seslerietalia rigidae, R: Vf. Paltinu (305, HIP);

Caltha palustris L.: ssp. ***laeta*** (Sch., N. et Ky.) Hegi: H, Cp; U4,5T0R0, Calthion palustris, Cardamini-Montion, Molinietalia, Nt: V. Doamnei, 1650 m alt. (25, 811, !); var ***pseudocornuta*** Zap.: V. Doamnei (1);

Clematis alpina (L.) Mill.: H(nPh), Eua; U3T2R2, Symphyto-Fagion, Vaccinio-Piceion, Nt: V. Doamnei (HSB);

Delphinium elatum L.: H, Eua; U4T2R4, Adenostylion alliariae, R: Podul Laiței (HF);

Pulsatilla alba Rchb.: H, Alp-Carp; U3T2R2,5, Caricion curvulae, Potentillo ternatae-Nardion, Vaccinio-Piceetea, Nt: V. Doamnei (1, 739, HU); Lacul Doamnei (HF);

Ranunculus alpestris L.: H, E; U4T1R4,5, Arabidetalia coeruleae, I: Vf. Laița (835);

Ranunculus bulbosus L.: H(G), E; U2,5T3R3, Cynosurion cristati, Nt: V. Doamnei până la 1750 m alt. (569);

Ranunculus carpaticus Herb.: G, Carp; U3,5T2R4, Fagetalia silvaticae, Vaccinio-Piceetalia, R: V. Doamnei (1, 486, 722, 771, HU);

Ranunculus crenatus W. et K.: H, Carp-B; U4T1R4, Salicetea herbaceae, R: V. Doamnei (1, 722, 835, !); Vf. Paltinu (174, 661, 863); Lacul Doamnei (HF);

Ranunculus nemorosus DC.: H, E; U3T0R3,5, Cynosurion cristati, Triseto-Polygonion, Nt: V. Doamnei, 2000 m alt. (485, 739, 751, HF); Mt. Mierea (HF); var ***aureus*** (Schleich.) Jav.: V. Doamnei (661); var ***crantzii*** (Schur) Jav.: V. Doamnei (751);

Ranunculus oreophilus M. B.: H, Alp-Carp-B; U2,5T3R4, Arrhenatheretalia, Elyno-Seslerietea, K: V. Doamnei, 1900–2000 m (1, 17, 739, 751, 880);

Ranunculus pseudomontanus Schur: H, Carp-B; U3,5T2R4,5, Caricion curvulae, Poion alpinae, Triseto-Polygonion, Nt: V. Doamnei (661, !); Vf. Laița (1);

Thalictrum minus L. ssp. ***saxatile*** Schinz et Keller: H, Eua; U2T4R4, Festuco-Brometea, Geranion sanguinei, Nt: V. Doamnei (HF); Jgheabul Văros (717, CHU, HB, HK); Vf. Paltinu (HIP); var ***medium*** (Jacq.) Borza: V. Doamnei (625); var ***flexuosum*** (Bernh.) Schinz et Kell.: Laița (HB);

Trollius europaeus L. ssp. ***europaeus***: H, E; U4T2R4, Calthion palustris, Molinietalia, V: V. Doamnei, până la 1900 m. (1, 722, 751, HSB); Jgheabul Văros (485, 722); ssp. ***transsilvanicus*** (Schur) Simk.: H, Carp-B.; V. Doamnei (HU); f. ***humilis*** (Cr.) A. Nyar.: Lacul Doamnei (739, HF);

Ulmaceae

Ulmus glabra Huds.: mPh-MPh, Eua; U4T3R3, Alno-Padion, Fagetalia silvaticae, Salicetalia purpureae, Nt: V. Doamnei, 1214 m alt. (878);

Urticaceae

Urtica dioica L. ssp. ***dioica***: H(G), Cosm; U3T3R4, Alno-Padion, Epilobietalia angustifolii, Fagetalia silvaticae, Nt: V. Doamnei până la 1900 m alt. (234, 267, 569, 819, !);

Fagaceae

Fagus sylvatica L.: Mph-mPh, E; U3T3R0, Fagetalia silvaticae, Fagion, Nt: V. Doamnei (569); Mt. Mierea (739);

Betulaceae

Alnus viridis (Chaix.) DC.: mPh, Alp-Carp-B; U3,5T2,5R3, Adenostylion alliariae, Betulo-Adenostyletea, Nt: V. Doamnei (878);

Caryophyllaceae

Arenaria biflora L.: H, Cp; U4T1R2, Salicion herbaceae, Nt: V. Doamnei (HBZ); Vf. Paltinu (727, 819, !); Vf. Laița (1);

Arenaria ciliata L. ssp. ***ciliata***: H, Cp; U2T1R0, Elyno-Seslerietea, I: V. Doamnei (1); Vf. Laița (HIP);

Cerastium alpinum L.: Ch, Eua (Cp); U2,5T1R3, Elyno-Seslerietea, Nt: V. Doamnei (1, 156, 880, HBZ, HF); Vf. Laița (HIP); Șaua Doamnei (271, 569); ssp. ***lanatum*** (Lam.) A. et G.: V. Doamnei (156, 642, 722, HBZ, HF, HSB, !); Jgheabul Văros (HU); Vf. Paltinu (804, 819); Vf. Laița (HF); Șaua Laița (803);

Cerastium arvense L.: Ch, Cp; U2,5T0R3,5, Elyno-Seslerietea, Thlaspietea rotundifolii, Nt: ssp. ***ciliatum*** (W. et K.) Rchb.: Ch, DB: V. Doamnei (HF, HU); ssp. ***lercenfeldianum*** (Schur) A. et G.: Ch, Carp, U3,5T1,5R4; V. Doamnei (569, HF, HNY); Vf. Paltinu (751);

Cerastium cerastoides (L.) Britt.: H, Cp; U4T1R2,5, Rumicion alpini, Salicion herbaceae, Nt: V. Doamnei (1, 485, 717, 722, 739, HF); Mt. Mierea (485);

Cerastium transsilvanicum Schur: Ch, Carp; U2,5T1,5R4, Elyno-Seslerietea, R: V. Doamnei (17); Laița (1, 35);

Dianthus barbatus L.: ssp. ***compactus*** (Kit.) Tutin; H, Alp-Carp-B U2 T3.5 R4, Calamagrostidion villosae, R: V. Doamnei (1, 722, 751); Jgheabul Văros (HF);

Dianthus glacialis Haenke ssp. ***gelidus*** (Schott, Nym. et Kotschy.) Nym.: H, Carp; U3,5T1R2, Androsacion alpinae, Thlaspion rotundifolii, R: V. Doamnei (1, 43, 485, 727, 739, 771, 880, HF, HSB, HU, !); Vf. Paltinu (804, 819, 863, HIP); Vf. Laița (771, HF, HIP);
From Doamnei Valley was noted also D. alpinus L. (739) which probably belong to this species (!).

Dianthus petraeus W. et K.: Ch, Carp; U2T3,5R4, Seslerietalia rigidae, R; ssp. ***spiculifolius*** (Schur) Sanda: Jgheabul Văros (174, 863);

Dianthus tenuifolius Schur: H-Ch, Carp; U2T3,5R4, Seslerietalia rigidae, Nt: Jgheabul Văros (174, 863); Laița (351);

Lychnis viscaria L.: H, Eua; U3T4R0, Festucion rupicolae, Nt: Mt. Mierea (485);

Minuartia sedoides (L.) Hiern: Ch, E; U2,5T1,5R0, Androsacion alpinae, Caricetalia curvulae, Nt: Vf. Paltinu (661, 819);

Minuartia setacea (Thuill.) Hay.: H, Ec-B; U1,5T0R4,5, Elyno-Seslerietea, Festucion vaginatae, K: V. Doamnei (HF);

Minuartia verna L. ssp. ***verna***: H-Ch, Cp; U2T0R0, Caricetalia curvulae, Elyno-Seslerietea, Nt; var. ***subnivalis*** (Hegetschw.) Rub.: V. Doamnei (1); ssp. ***gerardi*** (Willd.) Graebn.: Vf. Paltinu (HIP); Vf. Laița (HIP);

Silene acaulis (L.) Jacq. ssp. ***acaulis***: Ch, Cp; U2,5T1R4,5, Androsacion alpinae, Nt: V. Doamnei (880, !); Vf. Paltinu (819); Șaua Doamnei (305, 569);

Silene dinarica Spreng.: H, Carp; U2T1R0, Silenion lerchenfeldianae, Nt: Vf. Paltinu (1, 740);

Silene heuffelii Soo: Th-TH, Carp-B; U3,5T2R0, Adenostylion alliariae, Fagion, Nt: Mt. Mierea (739, HF);

Silene nutans L.: ssp. ***dubia*** (Herb.) Zapal.: H, Carp., U2T3R4, Asplenietalia septentrionalis, Nt: V. Doamnei (17, 661, !); Jgheabul Văros (HU);

Silene pusilla W. et K.: Ch, E; U3,5T2R0, Cratoneurion commutati, Nt: V. Doamnei (485, 739, 811, HF, !); Vf. Laița (HIP);

Silene vulgaris (Mnch.) Garke ssp. ***vulgaris***: H-Ch, Eua; U3T3R4, Molinio-Arrhenatheretea, Nt: V. Doamnei (751); ssp. ***prostrata*** (Gaud.) Chater et Walters: V. Doamnei (739, HF, !);

Stellaria graminea L.: H, Eua; U2,5T3R3, Arrhenatheretalia, Nt: Mt. Mierea (739);

Stellaria nemorum L. ssp. ***nemorum***: H, E; U3,5T3R3, Acerion pseudoplatani, Adenostylion alliariae, Nt: V. Doamnei (343, 569, 722, HF, !);

Polygonaceae

Oxyria digyna (L.) Hill.: H, Cp; U3T1R2, Androsacion alpinae, Nt: V. Doamnei (1, 739, HF, !); Vf. Paltinu (174); Vf. Laița (HIP);

Polygonum alpinum All.: H, Eua; U2,5T2R2,5, Rumicion alpini, R: Vf. Paltinu (HIP, !); Laița (349);

Polygonum bistorta L.: H, Eua; U4T2,5R3, Calthion palustris, Molinietalia, Triseto-Polygonion, Nt: V. Doamnei (485, 661, 739, 751, HF, !); Vf. Paltinu 2200 m (751);

Polygonum viviparum L.: H, Cp; U3T2R3, Caricion curvulae, Nt: V. Doamnei (1, 17, 661, 739, 751, 819, 880, HBZ, HF, HNY, HSB, !); Jgheabul Văros (485, 520); Vf. Paltinu (751, 803, 804, 819, HIP);

Rumex alpinus L.: H, Alp-Carp-B; U3,5T2R0, Adenostylion alliariae, Rumicion alpini, Nt: V. Doamnei (349, 485, 569, 739, !);

Rumex arifolius All.: H, Eua; U3,5T2R3,5, Adenostyletalia, Nt: V. Doamnei (485, 569, 739, HF, !); Vf. Paltinu (HIP); Mt. Mierea (HF);

Rumex scutatus L.: H, Alp-Carp-B; U2,5T0R4, Thlaspietea rotundifolii, R: V. Doamnei (819, HSB);

Crassulaceae

Rhodiola rosea L. ssp. ***rosea***: Ch, Cp; U2T1,5R0, Papavero - Thymion pulcherrimae, Nt: V. Doamnei (751, 880, !); Vf. Paltinu (751); Vf. Laița (1);

Sedum alpestre Vill.: Ch, E; U3T1,5R2,5, Caricion curvulae, Salicetea herbaceae, Nt: V. Doamnei (880, HF); Jgheabul Văros (803, !); Vf. Paltinu (727); Laița (1); Șaua Laița (803);

Sedum annuum L.: Th-TH, Eua; U3T2R0, Asplenion septentrionalis, Nt: V. Doamnei (722); Jgheabul Văros (485);

Sedum atratum L.: Ch, E; U3T1,5R4,5, Seslerion bielzii, Nt: V. Doamnei (1, 17, 722); Jgheabul Văros (1, 485, 722, HU); Lacul Doamnei (HF);

Saxifragaceae

Chrysosplenium alpinum Schur: H, Carp; U4T3R3,5, Androsacion alpinae, Montio-Cardaminetalia, Nt: V. Doamnei (1, 722, 771, HF, !); Vf. Paltinu (251); Lacul Doamnei (485);

Saxifraga adscendens L.: Th, Cp; U1,5T1,5R0, Androsacion alpinae, Seslerion bielzii, Nt: V. Doamnei (722, 819, HBZ, HF); Jgheabul Văros (HFA);

Saxifraga aizoides L.: Ch, Eua (Cp); U4,5T0R4,5, Cratoneurion commutati, Thlaspion rotundifolii, Nt: V. Doamnei (717, 803, HBZ, !); Jgheabul Văros (803, !); Vf. Paltinu 2210 m (174, 251, 305, 803, 804, 819); Vf. Laița (HIP); Șaua Laița (803); f. ***autumnalis*** (L.) Rav.: V. Doamnei (722);

Saxifraga androsacea L.: Ch, Eua (Cp); U4T1R4,5, Androsacion alpinae, Arabidetalia coeruleae, Nt: V. Doamnei (17, 569); Vf. Paltinu (804); Vf. Laița (17); Lacul Doamnei (485, 722, HF);

Saxifraga bryoides L.: Ch, E; U3T1R2, Androsacion alpinae, Nt: V. Doamnei (1, 157, 880, !); Vf. Paltinu (751, HIP); Laița (1, 157, HF); Lacul Doamnei (485, 722);

Saxifraga carpathica Rchb.: H, Carp-B; U3,5T1,5R3, Festucion pictae, Nt: Jgheabul Văros 2200 m alt. (803, !); Laița (1, 75); Șaua Laița (803);

Saxifraga cuneifolia L.: Ch, Ec; U3,5T2R0, Fagion, Nt: V. Doamnei (569, !);

Saxifraga heucherifolia Gris. et Sch.: Ch, Carp-B; U3,5T0R4,5, Adenostylion alliariae, Cardamini-Montion, Nt: V. Doamnei (1, 485, 722, HF); Jgheabul Văros (HF); Vf. Laița (1, HIP); Șaua Doamnei (271, 569, 661);

Saxifraga hieracifolia W. et K.: Ch, Eua; U3,5T1R2,5, Elyno-Seslerietea, Papavero - Thymion pulcherrimae, R: Vf. Paltinu 2100 m – 2200 m (751); Vf. Laița (HIP);

Saxifraga luteoviridis Schott et Kotschy: Ch, Carp-B; U2T1R4,5, Seslerion rigidae, Nt: V. Doamnei (1, 17, 625, 722, 751, 863, HF, HSB); Jgheabul Văros 2200 m alt. (803, HU, !); Laița (1); Șaua Laița (803);

Saxifraga moschata Wulf.: Ch, Eua; U2T1R0, Caricion curvulae, Elyno-Seslerietea, Nt: V. Doamnei (1, 722, 751, 880, HF, HFA); Vf. Paltinu 2200 m (251, 751, 803, 804, 819, !);

Saxifraga oppositifolia L. ssp. ***oppositifolia***: Ch, Cp; U3,5T1,5R4,5, Caricion curvulae, Elyno-Seslerietea, Thlaspietea rotundifolii, Nt: V. Doamnei (880); Vf. Paltinu 2250 m (305, 804, 819);

Saxifraga paniculata Mill: Ch, Eua (Cp); U1,5T1,5R4,5, Caricetalia curvulae, Seslerietalia coeruleae, Thlaspietea rotundifolii, Nt: V. Doamnei (9, 739, 751, HBZ, HF, HSB, !); Jgheabul Văros (HU); Laița (HF); Șaua Laița (803); Lacul Doamnei (485);

Saxifraga pedemontana All. ssp. ***cymosa*** (W. et K.) Engl.: Ch, Carp-B; U4T1,5R3, Androsacion alpinae, Seslerion bielzii, Nt: V. Doamnei (1, 751, HBZ, !); Laița (HF); Lacul Doamnei (485, 722);

Saxifraga retusa Gouan: Ch, E; U2T1R4,5, Androsacion alpinae, I: var ***baumgartenii*** (Schott) Velen.: Vf. Paltinu (305);

Saxifraga stellaris L.: Ch-H, Eua (Cp); U5T1,5R3, Cardamini-Montion, Nt: V. Doamnei (485, 569, 739, HF, HU, !); Vf. Paltinu 2200 m (751); Laița (HF); Lacul Doamnei (569);

Parnassiaceae

Parnassia palustris L.: H, Cp; U4,5T2R4,5, Caricetalia davallianae, Molinion coeruleae, Tofieldietalia, Nt: V. Doamnei (739, HF);
From the Doamnei Valley f. alpina Br. (HF).

Rosaceae

Alchemilla glabra Neygenf.: H, Alp-Carp; U3,5T2,5R0, Potentillo ternatae-Nardion, Rumicion alpini, Nt: V. Doamnei (661);

Alchemilla glaucescens Wallr.: H, Ec; U2,5T2,5R2,5, Caricion curvulae, Potentillo ternatae-Nardion, Nt: V. Doamnei (17, 569);

Alchemilla pyrenaica Dufour: H, Alp-Carp; U3,5T1R1,5, Potentillo ternatae-Nardion, Triseto-Polygonion, R: V. Doamnei (349);

Alchemilla vulgaris L.: H, Ec; U3,5T2R2, Caricion curvulae, Cynosurion cristati, Potentillo ternatae-Nardion, Nt: V. Doamnei, 1650 m alt. (25, 751, !);

Dryas octopetala L.: Ch, Cp; U2,5T0R4,5, Elyno-Seslerietea, R: V. Doamnei (751, HSB, !); Vf. Paltinu (804, 819); Laița (35);

Geum montanum L.: H, E; U2,5T1,5R1,5, Caricion curvulae, Potentillo ternatae-Nardion, Salicion herbaceae, Nt: V. Doamnei (1, 17, 170, 349, 485, 569, 661, 722, 811, !); Vf. Paltinu (1, 170, 349, 661, 804); Laița (1, 170, 349); Șaua Doamnei (271, 569, 661); Lacul Doamnei (170);

Geum reptans L.: H, E; U3T1R1,5, Androsacion alpinae, R: Vf. Laița (1, 170, HIP);

Geum rivale L.: H, Cp; U4,5T0R4,5, Adenostylion alliariae, Calthion palustris, Filipendulo-Petasition, Nt: V. Doamnei până la 1900 m (1, 722, 751, HF);

Geum urbanum L.: H, Eua-M; U3T3R4, Carpinion betuli, Querco-Fagetea, Nt: Mt. Mierea (485, 739);

Potentilla crantzii (Cr.) Beck: H, Eua (Cp); U3T1,5R4,5, Elyno-Seslerietea, R: V. Doamnei 1900 – 2000 m (17, 661, 751, 863); Vf. Laița (863);

Potentilla ternata K. Koch: H, Carp-B; U0T1,5R2, Caricetalia curvulae, Potentillo ternatae-Nardion, Nt: V. Doamnei (1, 17, 25, 267, 269, 349, 569, 661, 739, 880, HF, !); Vf. Paltinu (661); Șaua Doamnei (271, 661); Mt. Mierea (485, 739);

Rubus caesius L.: H(nPh), Eua; U4T3R4, Fagetalia silvaticae, Salicetea purpureae, Nt: V. Doamnei (277, 569);

Rubus idaeus L.: nPh, Cp; U3T3R3, Epilobietalia angustifolii, Fagetalia silvaticae, Nt: V. Doamnei (277, 349, 569, !);

Sorbus aucuparia L.: Mph-mPh, E; U3T2,5R2, Querco-Fagetea, Vaccinio-Piceetea, Nt: V. Doamnei (569);

Spiraea chamaedryfolia L.: nPh-mPh, Eua; U3T2,5R0, Asplenietea rupestris, Nt: V. Doamnei (569, !);

Fabaceae

Anthyllis vulneraria L. ssp. ***alpestris*** (Kit.) A. et G.: H, E; U2 T2 R3 car. Seslerietalia, Nt: V. Doamnei (17, 661, 751, HF, HSB, !); Jgheabul Văros (174, 863); ssp. ***polyphylla*** (Kit.) Nym.: H, P-Pn, U2 T3 R4.5 V. Doamnei (739); f. ***calcicola*** (Schur) A. Nyar.: V. Doamnei (717), Jgheabul Văros (CHU); f. ***picta*** Beck: V. Doamnei (751);

Astragalus australis (L.) Lam.: H, Eua; U3T1R4,5, Elyno-Seslerietea, R: V. Doamnei (1, 2, 17, 717, 722, HF, HNY, HSB, HU, !); Jgheabul Văros (HU); Vf. Paltinu (751);

Genista tinctoria L.: Ch-nPh, Eua; U2,5T3R2, Nardetalia, Nt: ssp. ***oligosperma*** (Andrae) Prod.: Vf. Paltinu (1, 771);

Hedysarum hedysaroides (L.) Schinz et Thell.: H, Cp; U3T1,5R4,5, Elyno-Seslerietea, R: V. Doamnei (1, 17, 751, HNY); Jgheabul Văros (174, 863, !); Vf. Paltinu (751);

Lotus corniculatus L.: H, Eua; U2,5T0R0, Festucion vaginatae, Molinio-Arrhenatheretea, Nt:; var ***alpestris*** Lamotte: V. Doamnei (1, 17, 739, 863, HF, !); Jgheabul Văros (HF, HU);

Onobrychis montana DC. ssp. ***transsilvanica*** (Simk.) Jav.: H, Carp; U2T1,5R4,5, Elyno-Seslerietea, Seslerietalia coeruleae, R: V. Doamnei (1, 17, 661, 722, 751, 771, HF, HNY, HSB, !); Jgheabul Văros (1, 485, 722, 771, HK, HU);

Oxytropis campestris (L.) DC.: H, Cp; U2,5T1,5R4,5, Elyno-Seslerietea, R: Vf. Paltinu 2100 m – 2200 m (751);

Oxytropis halleri Bunge: H, Alp-Carp; U2T1,5R4,5, Seslerion bielzii, R: Jgheabul Văros (174, 863); Vf. Laița (35, 717);

Trifolium badium Schreb.: H, E; U3,5T2R4,5, Arabidetalia coeruleae, Poion alpinae, Nt: V. Doamnei 1843-1900 m (625, 751, 97, HF); Jgheabul Văros (1, 722, HK, HU); Lacul Doamnei (1, 722);

Trifolium pallescens Schreb.: H, Alp-Carp-B; U2T2R4, Elyno-Seslerietea, R: V. Doamnei (751); var ***glareosum*** (Schleich.) A. Nyar.: V. Doamnei (739, HF); Jgheabul Văros (HU);

Trifolium pratense L. ssp. ***pratense***: TH-H, Eua; U3T0R0, Molinio-Arrhenatheretea, Nt: V. Doamnei până la 2000 m alt. (661, 739, 751, !); ssp. ***nivale*** (Sieber) Archang.: V. Doamnei (17, 625); Jgheabul Văros (HU);

Trifolium repens L. ssp. ***repens***: H, Eua; U3,5T0R0, Cynosurion cristati, Molinio-Arrhenatheretea, Plantaginetea majoris, Nt: V. Doamnei, 1850 m alt. (17, 661); ssp. ***alpinum*** (Schur) Rothm.: V. Doamnei (625, !); ssp. ***ochranthum*** (Maly) Nyar.: Vf. Paltinu (804);

Trifolium spadiceum L.: Th, E; U4T3R2, Molinio-Arrhenatheretea, I: V. Doamnei (485);

Onagraceae

Epilobium alpestre (Jacq.) Kroker: H, Alp-Carp; U3,5T2R4, Adenostyletalia, R: V. Doamnei (1, 717, 722);

Epilobium alsinifolium Vill.: H, Eua (Cp); U5T1,5R0, Montio-Cardaminetea, R: V. Doamnei (HF, HU, !);

Epilobium anagalidifolium Lam.: H, Cp; U4T1,5R0, Androsacetalia alpinae, Cardamini-Montion, R: Vf. Paltinu (1); Laița (1);

Epilobium montanum L.: H, Eua; U3T0R3,5, Fagetalia silvaticae, Nt: V. Doamnei (HF, !);

Thymelaeaceae

Daphne mezereum L.: nPh, Eua; U3,5T3R3, Fagetalia silvaticae, Nt: V. Doamnei (625, HNY);

Santalaceae

Thesium alpinum L.: H, E; U2,5T2R2,5, Caricion curvulae, Elyno-Seslerietea, Potentillo ternatae-Nardion, Nt: V. Doamnei (17); Laița (1);

Aceraceae

Acer pseudoplatanus L.: MPh, Ec; U3,5T3R3, Acerion pseudoplatani, Querco-Fagetea, Nt: V. Doamnei (569); Mt. Mierea (485, 722);

Oxalidaceae

Oxalis acetosella L.: H(G), Cp; U4T3R3, Betulo-Adenostyletea, Fagetalia silvaticae, Vaccinio-Piceetea, Nt: V. Doamnei 1500 m alt. (569, !);

Geraniaceae

Geranium caeruleatum Schur: H, Carp-B; U3,5T2,5R4,5, Caricetalia curvulae, R: V. Doamnei (1, 2, HF); Jgheabul Văros (HSB, !);

Geranium sylvaticum L.: H, Eua (Cp); U3T2R0, Betulo-Adenostyletea, Triseto-Polygonion, Nt: var ***alpestre*** Schur: V. Doamnei (1, 661, 722, 751, HU); Şaua Doamnei (661); f. ***eglandulosum*** (Cel.) Borza: V. Doamnei (1, 420); Vf. Paltinu (1);

Linaceae

Linum extraaxillare Kit.: H, Carp-B; U2,5T0R4, Caricion curvulae, Elyno-Seslerietea, Nt: V. Doamnei (1, 17, 661, 722, 751, HF, HNY, !); Jgheabul Văros (HSB, HU); Vf. Paltinu (751);

Balsaminaceae

Impatiens noli- tangere L.: Th, Eua; U4T3R4, Fagetalia silvaticae, Nt: V. Doamnei (569);

Polygalaceae

Polygala alpestris Rchb.: H, Alp-Carp; U2,5T1,5R4, Elyno-Seslerietea, Nardetalia, K: Laița (35);

Apiaceae

Astrantia major L.: H, Ec; U3,5T2,5R4, Fagetalia silvaticae, Trifolion medii, Triseto-Polygonion, Nt: V. Doamnei (17, 625); var ***minor*** Wimm. et Grab.: V. Doamnei (1, 722, 739, 751, HU); Jgheabul Văros (HU);

Chaerophyllum aureum L.: H, E-M; U3T3R4,5, Fagion, R: V. Doamnei, 1900 m alt. (751); Jgheabul Văros (HU);

Chaerophyllum hirsutum L.: H, Ec; U4,5T2R0, Filipendulo-Petasition, Nt: V. Doamnei (1, 722, HF, !);

Conioselinum tataricum Fisch.: H, Eua (Cp); U2,5T2R3, Asplenietea rupestris, Moehringion muscosae, I: V. Doamnei (1, 2, 722, HF);

Heracleum palmatum Baumg.: H, Carp; U4T2,5R0, Adenostylion alliariae, Nt: V. Doamnei (HF);

Laserpitium krapfii Cr.: H, Ec; U0T0R3, Junipero-Bruckenthalion, Seslerion bielzii, R: var ***alpinum*** (W. et K.) Rchb.: Vf. Paltinu (1);

Ligusticum mutellina (L.) Cr.: H, Alp-Carp-B; U3,5T1,5R3, Caricetalia curvulae, Nardetalia, Poion alpinae, Salicion herbaceae, Nt: V. Doamnei (1, 569, 661, 819, 880, HNY, !); Vf. Paltinu (661, !); Şaua Doamnei (661); ssp. ***adonidifolium*** (J. Gay.) Beauverd.: V. Doamnei (1);

Ligusticum mutellioides (Cr.) Vill.: H, Eua (Cp); U3T1R2,5, Androsacion alpinae, R: V. Doamnei (722, HF); Lacul Doamnei (485);

Seseli libanotis (L.) Koch ssp. ***libanotis***: H, Eua-C; U3T0R4, Geranion sanguinei, Nt; var ***humilis*** (Schur) Todor: V. Doamnei (CHU); Vf. Paltinu (HIP);

Hypericaceae

Hypericum humifusum L.: Th, Eua; U4T0R2, Nanocyperion flavescentis, Nt: V. Doamnei (1); Mt. Mierea (1, 485, 722);

Hypericum maculatum Cr.: H, Eua; U4T3R2, Molinion coeruleae, Nardetalia, Nt: V. Doamnei 1700 – 1750 m alt. (17, 25, 569, HNY, !);

Hypericum richeri Vill.: H, Ec; U2,5T2,5R3, Calamagrostidion arundinaceae, Nardetalia, Nt: ssp. ***grisebachii*** (Boiss.) Nym.: V. Doamnei (1, 17, 625, 722, HF, HNY, !); Vf. Laiţa (HIP); Şaua Doamnei (661);

Violaceae

Viola alpina Jacq.: H, Alp-Carp; U2T2R4, Caricion curvulae, Papavero - Thymion pulcherrimae, R: V. Doamnei (803, HBZ, HSB, !); Jgheabul Văros (803); Vf. Paltinu 2210 m (803, 804, 819); Şaua Laiţa (803); Lacul Doamnei (HF, HFA);

Viola biflora L.: H, Cp; U3,5T2R4, Adenostyletalia, Nt: V. Doamnei (880, HNY, HSB, !); Vf. Paltinu (174); Laiţa (1, 739);

Viola declinata W. et K.: H, Carp-B; U3,5T2R2, Cynosurion cristati, Nardetalia, Potentillo ternatae-Nardion, Triseto-Polygonion, Nt: V. Doamnei (661, 739, 751, HF, HNY, !);

Cistaceae

Helianthemum alpestre (Jacq.) DC. ssp. ***alpestre*** (Jacq.) Breistr.: Ch, Alp-Carp; U2,5T1,5R5, Elyno-Seslerietea, R: Doamnei (1, 17, 661, 717, 722); Jgheabul Văros (1, 485, 717, 722, HK, HU); Vf. Laiţa (HIP);

Helianthemum nummularium (L.) Mill. ssp. ***nummularium***: Jgheabul Văros (HU); ssp. ***grandiflorum*** (Scop.) Schinz et Thell: Ch-H, Ec; U2T3R4, Elyno-Seslerietea: V. Doamnei (17, 661, !); ssp. ***tomentosum*** (Scop.) Schinz et Thell.: Laiţa (1, 35);

Helianthemum rupifragum A. Kern.: Ch, Ec; U2,5T1,5R5, Gypsophilion petraeae, R: Vf. Paltinu (751);

Brassicaceae

Alyssum repens Baumg.: H-Ch, Carp-B; U2T2R5, Caricion curvulae, Papavero -Thymion pulcherrimae, Seslerion bielzii, R: V. Doamnei under Vf. Laiţa (17, 863); Laiţa (35);

Arabis alpina L.: H, Cp; U3,5T1,5R5, Thlaspietea rotundifolii, Nt: V. Doamnei (739, 803, HF, !); Vf. Paltinu 2210 m (1, 751, 803, !); Vf. Laiţa (HIP);

Arabis procurrens W. et K.: H, B; U3T3R3, Thlaspietea rotundifolii, R: Lacul Doamnei (486);

Biscutella laevigata L.: H, Ec; U0T0R4, Seslerietalia rigidae, Nt: V. Doamnei (17); Laiţa (35);

Capsella bursa-pastoris (L.) Medik.: Th, Cosm; U3T0R0, Chenopodietea, Chenopodio-Scleranthetea, Nt: V. Doamnei până la 1700 – 1750 m alt. (569); Mt. Mierea (485, 739);

Cardamine pratensis L. ssp. ***rivularis*** (Schur) Simk; H, Cp; U5T3R0, Molinio-Arrhenatheretea, Nt: V. Doamnei (811, HBZ, HF, !);

Cardamine resedifolia L.: H(G), Alp-Carp; U3T1R0, Androsacetalia alpinae, Nt; Lacul Doamnei (485); var ***gelida*** (Schott.) Rouy et Fouc.: V. Doamnei (722);

Cardaminopsis halleri (L.) Hay. ssp. ***halleri***: TH-H, Alp-Carp; U3,5T2,5R2, Potentillo ternatae-Nardion, Seslerion bielzii, Thlaspion rotundifolii, Nt: V. Doamnei (HF, HU); ssp. ***ovirensis*** (Wulf.) Thell.: V. Doamnei (751); Vf. Paltinu (804, !); Vf. Laiţa (717, 722); Lacul Doamnei (739); f. ***dacica*** Heuff.: V. Doamnei (HFA, HKL); Lacul Doamnei (485);

Draba carinthiaca Hoppe: H, Alp-Carp; U1,5T1,5R0, Seslerion bielzii, R: Vf. Paltinu (751);

Draba kotschyi Stur: H, Alp-Carp; U2T1,5R3, Gypsophilion petraeae, R: V. Doamnei, 1920 m alt. (803); Şaua Laiţa (803);

Hutchinsia alpina (L.) R. Br. ssp. ***brevicaulis*** (Hoppe) Arcangeli: H, E; U3,5T0R5, Thlaspion rotundifolii, R: V. Doamnei (739, HF); Lacul Doamnei (485); var ***transsilvanica*** Nyar.: V. Doamnei (1);

Kernera saxatilis (L.) Rchb.: H, E; U2T1,5R0, Asplenietea rupestris, Nt: V. Doamnei (1, 17, 625, 722, 751, HSB); Jgheabul Văros 1920 m – 2200 m alt. (803, HF, HFA, HU, !);

Thlaspi dacicum Heuff.: Th, Carp; U2T1,5R0, Potentillo ternatae-Nardion, R: V. Doamnei 1843 m – 1900 m (17, 751, 771);

Salicaceae

Salix alpina Scop.: nPh, Cp; U4T1,5R2,5, Androsacion alpinae, Salicion retusae, R: Jgheabul Văros (HU); Vf. Paltinu (819);

Salix hastata L.: nPh, Eua (Cp); U3,5T2R4, Salicion retusae, R: Jgheabul Văros (HU); Vf. Paltinu (HIP);
The material from HU from Jgheabul Văros belongs rather to S. hastata than to S. phylicifolia (S. bicolor), as it was originally determined (!).

Salix herbacea L.: Ch, Cp; U3,5T1,5R2, Salicion herbaceae, Nt: Vf. Paltinu 1880 m (157, 174, 804, !);

Salix kitaibeliana Willd.: Ch, Carp; U3,5T1,5R4,5, Salicion retusae, R: Vf. Paltinu (HF);

Salix reticulata L.: nPh, Cp; U3,5T2R5, Salicion retusae, Nt: V. Doamnei, 1863 m alt. (751, HSB, !); Vf. Paltinu (819); Vf. Laiţa (HIP);

Salix retusa L.: Ch, Ec; U3,5T1,5R4,5, Salicion retusae, Nt: V. Doamnei (1); Jgheabul Văros (HU); Vf. Paltinu (804);

Ericaceae

Bruckenthalia spiculifolia (Salisb.) Rchb.: nPh, Carp-B-An; U2,5T2,5R1,5, Junipero-Bruckenthalion, Nt: V. Doamnei (1); Mt. Mierea (1, 485, 722, 739);

Loiseleuria procumbens (L.) Desv.: Ch, Cp; U2T1,5R3, Cetrario- Loiseleurion, Nt: Vf. Laiţa (1);

Rhododendron kotschyi Simk.: nPh, Carp-B; U3T0R2, Rhododendro-Vaccinion, V: V. Doamnei (1, 661, 722, 751, HF); Vf. Paltinu (174, 751, 881, !); Laiţa (1);

Vaccinium gaultherioides Bigelow: nPh, Cp; U3,5T0R1, Cetrario- Loiseleurion, Nt: Laiţa (HSB);

Vaccinium myrtillus L.: Ch-nPh, Cp; U0T2R1, Vaccinio-Piceetalia, Nt: V. Doamnei (277, 569, !); Vf. Paltinu (661, HIP);

Pyrolaceae

Moneses uniflora (L.) A. Gray: H(G), Cp; U3T2R2,5, Vaccinio-Piceetalia, Nt: V. Doamnei (569, !); Mt. Mierea (1, 485, 722);

Monotropa hypopitys L. ssp. ***hypopitys***: G, Cp; U3T2R0, Fagetalia silvaticae, Vaccinio-Piceetalia, Nt: Mt. Mierea (485, 722);

Primulaceae

Androsace chamaejasme Wulfen: H, Cp; U2T1,5R4, Caricion curvulae, Seslerietalia coeruleae, R: Laiţa (35);

Cortusa matthioli L.: H, Eua; U4T2R3, Adenostylion alliariae, Moehringion muscosae, Nt: V. Doamnei (1, 722, 880); Vf. Paltinu (174, 751, !); Şaua Laiţa (803); ssp. ***pubens*** (Schott) Jav.: V. Doamnei (486); Jgheabul Văros (CHU); f. ***subpubens*** Nyar.: V. Doamnei (HF);

Primula elatior (L.) Hill: H, Eua; U3T3R4, Fagion, Seslerio - Festucion pallentis, Nt: V. Doamnei 1900 m – 2000 m (17, 569, 661, 739, 751, !); Jgheabul Văros (485); Vf. Paltinu (HIP); Lacul Doamnei (HF);

Primula halleri J. F. Gmel.: H, Ec; U3T2R4, Seslerion bielzii, R: V. Doamnei (17, 661); Jgheabul Văros (HF);

Primula minima L.: Ch, Ec; U3T1,5R1,5, Caricion curvulae, Salicion herbaceae, Nt: V. Doamnei (1, 172, 739, HBZ); Vf. Paltinu (804, 819, !); Laiţa (1, 172); Lacul Doamnei (172, HF);

Soldanella hungarica Simk. ssp. ***hungarica***: H, Ec; U4T2R1,5, Vaccinio-Piceion, Nt: V. Doamnei (17); Vf. Paltinu (251); ssp. ***major*** (Neilr.) S. Pawl.: V. Doamnei (25, 661, 751);

Soldanella montana Willd.: H, Ec; Junipero-Pinetalia mugi, Seslerion bielzii, Vaccinio-Piceion, K: V. Doamnei (569, 722) U3,5T2R1,5; Mt. Mierea (722);

It is in fact *S. hungarica* ssp. *hungarica* or ssp. *major*, in conformity with the herbarium materials (!). Based on 904 *S. montana* did not grow in the Romanian Carpathians.

Soldanella pusilla Baumg.: H, Ec; U4T2R0, Androsacion alpinae, Caricion curvulae, Salicion herbaceae, Nt: V. Doamnei (162, 661, 727, HF); Vf. Paltinu (174, 661, 863, !); Şaua Doamnei (271, 569, 661); Lacul Doamnei (485, 739);

Gentianaceae

Gentiana frigida Haenke: H, Alp-Carp; U3T1,5R1,5, Arabidetalia coeruleae, Caricion curvulae, Salicion herbaceae, R: V. Doamnei (HSB); Vf. Paltinu (174, 819, 863, !);

Gentiana kochiana Perr. et Song.: H, Alp-Carp; U3T2R1,5, Potentillo ternatae-Nardion, Salicion herbaceae, V: V. Doamnei (1, 158, HF); Vf. Paltinu (174, 863, HIP); Lacul Doamnei (485, 722);

Gentiana punctata L.: H(G), Alp-Carp; U3T1,5R4,5, Elyno-Seslerietea, R: V. Doamnei (1, 349, 722, HF); Vf. Paltinu (1, 661, HIP); Lacul Doamnei (485);

Gentiana utriculosa L.: Th, Alp-Carp; U2,5T2,5R4, Cynosurion cristati, Seslerion rigidae, R: Vf. Paltinu (174);

Gentiana verna L.: H, Eua; U2,5T0R4, Arabidetalia coeruleae, Salicion herbaceae, Seslerietalia coeruleae, Nt: V. Doamnei (1, 722, 751, HSB); Jgheabul Văros (!); Vf. Paltinu 1880 m (751, 804, !); Lacul Doamnei (569); ssp. ***alata*** (Gris.) Lemke: V. Doamnei (HF);

Gentianella austriaca (A. et J. Kern.) J. Holub: TH, Alp-Carp-B; U3T3R3, Cynosurion cristati, Potentillo ternatae-Nardion, Nt: V. Doamnei (HNY); var ***carpatica*** (Wettst.) Jav.: Jgheabul Văros (HU);

Gentianella tenella (Rottb) Borner: Th, Eua (Cp); U3T1R4, Elyno-Seslerietea, Thlaspietea rotundifolii, E: f ***lutescens*** Murr.: Vf. Laiţa (1, HIP);

Swertia punctata Baumg.: H, Carp-B; U5T1,5R0, Adenostylion alliariae, Seslerion bielzii, Nt: Vf. Paltinu (HIP); Laiţa (1, HF, HU);

Boraginaceae

Myosotis alpestris F. W. Schmidt ssp. ***alpestris***: H, Cp; U2T1,5R3, Elyno-Seslerietea, Rumicion alpini, Thlaspietea rotundifolii, Nt: V. Doamnei (722, 751); ssp. ***stenophylla*** (Knaf) I. Grinț. et Nyar.: V. Doamnei (17); Jgheabul Văros (HFA); Vf. Paltinu 2200 m (174, 751); Lacul Doamnei (485, HF);

Myosotis scorpioides L.: H-Hh, Eua; U5T3R0, Calthion palustris, Molinietalia, Nt: Lacul Doamnei (485); var ***elatior*** Opiz: Vf. Paltinu (HIP);

Pulmonaria rubra Schott: H, Carp-B; U3,5T2R3, Fagion, Vaccinio-Piceion, Nt: V. Doamnei (1, 349, !);

Lamiaceae

Ajuga reptans L.: H-Ch, E; U3,5T0R0, Arrhenatheretalia, Fagetalia silvaticae, Nt: var ***alpina*** (Vill.) Koch: V. Doamnei (1, 739);

Ballota nigra L.: H-Ch, Ec-M; U2T3,5R4, Arction lappae, Chenopodietea, Nt: V. Doamnei (569);

Calamintha alpina (L.) Lam. ssp. ***alpina***: H, Ec; U3T0R5, Seslerietalia rigidae, R: V. Doamnei (1, 17, 485, 722, 751, 863, HF, HSB, !); Jgheabul Văros (HSB, HU, !); Vf. Paltinu 2200 m (174, 751); Laița (35);

Lamium galeobdolon (L.) Nath.: H-Ch, Ec; U3T0R4, Fagetalia silvaticae, Nt: V. Doamnei (569);

Lamium maculatum L. ssp. ***maculatum***: H-Ch, E; U3,5T0R4, Fagetalia silvaticae, Nt: V. Doamnei (569, !); ssp. ***cupreum*** (Sch., Nym. et Ky.) Hadac: Laița (1);

Thymus alpestris Tausch: Ch, Ec; U2,5T2R3, Elyno-Seslerietea, Papavero - Thymion pulcherrimae, Nt: V. Doamnei (17);

Thymus balcanus Borb.: Ch, Carp-B; U1,5T3,5R2,5, Elyno-Seslerietea, Festucion rupicolae, Nt: V. Doamnei (569, 661, HF); Șaua Doamnei (271);

Thymus pulcherrimus Schur: Ch, Carp; U2T1,5R3, Papavero - Thymion pulcherrimae, Thlaspion rotundifolii, Nt: V. Doamnei (751, 819, 880); Jgheabul Văros (803, !); Vf. Paltinu (727); Lacul Doamnei (485, 722);

Thymus pulegioides L.: Ch, Ec; U2,5T3R3, Festuco-Brometea, Seslerion bielzii, Nt:; ssp. ***montanus*** (W. et K.) Ronn.: Mt. Mierea (HF);

Thymus x baumgarteni Guşul. f ***schistosus*** (Lyka) Guşul.: V. Doamnei 2100 m alt. (1, 2, 709);

Plantaginaceae

Plantago gentianoides Sibth. et Sm.: H, Carp-B-An; U4T2R3, Salicetea herbaceae, Scheuchzerio-Caricetalia nigrae, Nt: V. Doamnei (1, 569, 811, HSB, !); Lacul Doamnei (485, 739, HF);

Plantago media L. ssp. ***media***: H, Eua; U2,5T0R4, Molinio-Arrhenatheretea, Nt: Mt. Mierea (739);

Scrophulariaceae

Bartsia alpina L.: H, Cp; U4T1,5R4, Seslerietalia coeruleae, Nt: V. Doamnei (1, 164, 17, 722, 751, HF, HSB, !); Jgheabul Văros (164, 717, 722, HF); Vf. Paltinu (164, 751, HIP);

Digitalis grandiflora Mill.: H, E; U3T3R3, Fagion, Geranion sanguinei, Nt: V. Doamnei (349);

Euphrasia minima Lam. et DC. ssp. ***minima***: Th, Eua (Cp); U3T1,5R1,5, Cynosurion cristati, Potentillo ternatae-Nardion, Nt: V. Doamnei (1, 722, 739); ssp. ***tatrae*** (Wettst.) Hayek: V. Doamnei (625, HNY, !);

Euphrasia rostkoviana Hayne ssp. ***rostkoviana***: Th, Ec; U3T3R3, Molinio-Arrhenatheretea, Nt: ssp. ***montana*** (Jord.) Wettst.: V. Doamnei (HU);

Euphrasia salisburgensis Funck: Th, E; U3T1,5R4,5, Elyno-Seslerietea, R: V. Doamnei (17, 625);

Melampyrum sylvaticum L.: Th, Eua; U3T0R1,5, Vaccinio-Piceetea, Nt: V. Doamnei 1843m – 1900 m (751);

Pedicularis hacquetii Graf: H, Alp-Carp; U3T2R0, Calamagrostidion villosae, Potentillo ternatae-Nardion, R: V. Doamnei (1, 722); Jgheabul Văros (1, 722, HF, HU);

Pedicularis limnogena A. Kern.: H, Carp-B; U5T2R2, Scheuchzerio-Caricetea nigrae, I: V. Doamnei (25);

Pedicularis oederi Vahl: H, Eua (Cp); U0T2R4, Cetrario - Loiseleurion, Salicion herbaceae, Nt: V. Doamnei (1, 722, HF, HSB, !); Vf. Paltinu (751, 819);

Pedicularis verticillata L.: H, Cp; U0T2R4,5, Caricion curvulae, Potentillo ternatae-Nardion, Nt: V. Doamnei (1, 485, 722, 751, HF, HSB, !); Vf. Paltinu (751);

Scrophularia heterophylla Willd. ssp. ***laciniata*** (W. et K.) Maire et Petitmengin: H, Carp-B; U2T2,5R0, Elyno-Seslerietea, R: V. Doamnei (661, 739, HF, HNY); Jgheabul Văros (1, 485, 722, HU);

Tozzia alpina L. ssp. ***carpatica*** (Woloszczak) Dostal: G, Carp-B; U3,5T2R4,5, Adenostyletalia, Cardamini-Montion, Nt: Jgheabul Văros (HF); Laiţa (1);

Veronica alpina L.: H, Cp; U3,5T1R0, Potentillo ternatae-Nardion, Salicetea herbaceae, Nt: V. Doamnei (1, 485, 722, HF, HFA); Vf. Paltinu (174, 863, !); Şaua Doamnei (271, 569);

Veronica baumgartenii Roem. et Schult.: H, Carp-B; U2T1,5R3, Androsacion alpinae, Asplenietalia septentrionalis, R: V. Doamnei 1843 – 1900 m (1, 485, 722, 751, 880, HSB, !); Laiţa (HSB);

Veronica officinalis L.: Ch, Eua; U2T2R2, Deschampsio-Fagion, Nardetalia, Potentillo ternatae-Nardion, Vaccinio-Piceion, Nt: V. Doamnei (267, 569, !); Mt. Mierea (485, 722);

Veronica serpyllifolia L. H, Cosm; U3T3R0, Arrhenatheretalia, Cynosurion cristati, Rumicion alpini, Nt: ssp. ***humifusa*** (Dickson) Syme: V. Doamnei (485, 739, HF);

Lentibulariaceae

Pinguicula alpina L.: H, Eua (Cp); U4T0R4, Caricion davallianae, Cratoneurion commutati, Eriophorion latifolii, Seslerietalia coeruleae, Nt: V. Doamnei (751, HSB); Vf. Paltinu 2200 m (751, !);

Pinguicula vulgaris L.: H, Cp; U3T0R4, Caricion canescenti-nigrae, Caricion davallianae, Cratoneurion commutati, Tofieldietalia, Nt: V. Doamnei, 200 m (1, 661, 722, 727, 751, HSB); Jgheabul Văros (HF); Vf. Paltinu (HIP, !); Laiţa (1); Lacul Doamnei (485);

Campanulaceae

Campanula abietina Gris. et Sch.: TH, Carp-B; U3,5T2R2, Junipero-Bruckenthalion, Potentillo ternatae-Nardion, Nt: V. Doamnei (569, !); Mt. Mierea (485, 739, HF); f. ***alpino- pratensis*** Nyar.: Şaua Doamnei (661);

Campanula alpina Jacq.: H, Alp-Carp; U3T1,5R2,5, Caricetalia curvulae, Nt: V. Doamnei (569, 739, HBZ, HF); Jgheabul Văros (485); Vf. Paltinu (1, 661, 804, 819, !); Şaua Doamnei (271);

Campanula rotundifolia L. ssp. ***rotundifolia***: H, Cp; U2T0R3, Asplenietea rupestris, Nardetalia, Seslerietalia rigidae, Nt: Mt. Mierea (485); ssp. ***kladniana*** (Schur) Tacik: H, Carp, U2,5T2R0, Asplenietea, Seslerietalia, Cetrario-Loiseleurion, Nt: V. Doamnei (17, 722); Jgheabul Văros (803); Vf. Paltinu (HIP); Mt. Mierea (722);

Campanula serrata (Kit.) Hendrych: H, Carp-B; U0T2,5R0, Junipero-Bruckenthalion, Potentillo ternatae-Nardion, Nt: V. Doamnei (661, HU, !); Vf. Paltinu (HIP); var ***semiamplexicaulis*** Vlăd. et Săvul.: Jgheabul Văros (HU); var ***alpiniformis*** Nyar. et Moraru: V. Doamnei 2150 m (HNY); ? ***var porcii Săvul***.: V. Doamnei (HNY); var ***stenophylloides*** (Nyar.) Morariu: V. Doamnei (1, 2); Jgheabul Văros (1); f. ***flexuosa*** Hruby: V. Doamnei (1); f. ***scheuchzeriformis*** (Nyar.) Morariu: V. Doamnei (1); f. ***stenophylloides*** (Nyar.) Morariu: V. Doamnei (422, HNY);

Campanula transsilvanica Schur: TH-H, Carp-B; U3T2R5, Caricetalia curvulae, R: V. Doamnei (HK, HU); Vf. Paltinu (HIP);

Phyteuma confusum A. Kerner: H, Alp-Carp-B; U3T2R2, Caricetalia curvulae, Nt: V. Doamnei (17, 661, 739, HBZ); Jgheabul Văros (485); Vf. Paltinu (174, 305, 661, 804, 863, HIP, !); Lacul Doamnei (HF);

Phyteuma orbiculare L.: H, Ec; U0T2R4,5, Asplenietea rupestris, Elyno-Seslerietea, R: V. Doamnei (625, 722); Jgheabul Văros (485, 722, HU);

Phyteuma vagneri A. Kern.: H, Carp; U3T1,5R2,5, Adenostyletalia, Potentillo ternatae-Nardion, R: V. Doamnei (1, 722, HF); Jgheabul Văros (HU); Vf. Laița (HF);

Symphyandra wanneri (Roch.) Heuff.: H, Carp-B-An; U2T2R3, Silenion lerchenfeldianae, R: V. Doamnei (1, 2);

Rubiaceae

Cruciata glabra (L.) Ehrend. ssp. ***glabra***: H, Eua; U3T2R2, Junipero-Bruckenthalion, Potentillo ternatae-Nardion, Quercetea robori-petraeae, Querco-Fagetea, Nt: V. Doamnei (17); ssp. ***alpinum*** (Schur) Simk.: V. Doamnei (722); Jgheabul Văros (HF); Vf. Paltinu (751);

Galium anisophyllum Vill.: Ch-H, Alp-Carp; U2T3R3,5, Elyno-Seslerietea, Papavero - Thymion pulcherrimae, Thlaspion rotundifolii, Nt: V. Doamnei (17, 625, 661, 751, HF, !); Jgheabul Văros (803, !); Vf. Paltinu (803, 804); Șaua Laița (803); var ***sudeticum*** (Tausch) Borza: Lacul Doamnei (739);

Caprifoliaceae

Sambucus racemosa L.: mPh, Eua; U3T2R3, Sambuco-Salicion capreae, Nt: V. Doamnei (277, 569, !);

Valerianaceae

Valeriana tripteris L.: H, Ec; U3T0R4,5, Acerion pseudoplatani, Asplenietea rupestris, Nt: V. Doamnei 1900 m – 2000 m (569, 751);

Dipsacaceae

Knautia longifolia (W. et K.) Koch: H, Alp-Carp; U2T1,5R2, Calamagrostidion villosae, Nt: V. Doamnei (1, 17, 722, HNY); Jgheabul Văros (HU);

Scabiosa lucida Vill. ssp. ***lucida***: H, Alp-Carp; U2,5T2R4,5, Elyno-Seslerietea, Nt: V. Doamnei 2000 m (1, 17, 717, 739); Jgheabul Văros (HF); Vf. Paltinu (1); Laița (HF); ssp. ***barbata*** Nyar.: V. Doamnei (17, HNY);

Asteraceae

Achillea distans W. et K. ssp. ***distans***: H, Ec; U2,5T3R4, Adenostylion alliariae, Junipero-Bruckenthalion, Potentillo ternatae - Nardion, Quercetalia pubescentis, Trifolion medii, Nt: ssp. ***alpina*** (Roch.) Soo: V. Doamnei (1, 485, 739, HBZ, HF, !);

Achillea millefolium L. ssp. ***millefolium***: H, Eua; U3T0R0, Agropyro-Rumicion, Molinio-Arrhenatheretea, Nt: V. Doamnei, 1650 m (25);

Achillea schurii Schultz-Bip.: H, Carp; U3,5T2R2,5, Arabidetalia coeruleae, Cynosurion cristati, Seslerion bielzii, R: V. Doamnei (1, 485, 717, 722, 880, HF, HK, !); Jgheabul Văros (803); Vf. Paltinu (1, 174, 727, 803);

Achillea stricta (Koch) Schleich.: H, Alp-Carp; U2,5T2R3, Junipero-Pinetalia mugi, Nardetalia, Trifolion medii, R: V. Doamnei (HNY);

Anthemis carpatica Kit. ssp. ***carpatica***: H, Ec; U2T1,5R2, Seslerietalia coeruleae, R: V. Doamnei (1, 485, 722, HBZ, HF); Vf. Paltinu (727, HIP);

Artemisia petrosa (Baumg.) Fritsch: H, Alp-Carp-B; U1,5T1R2,5, Asplenietea rupestris, Seslerietalia coeruleae, R: V. Doamnei (717, 722, 739, 751, 880, HSB); Jgheabul Văros (1, 485, 717, 722, HK, HU, !); Vf. Paltinu (751, 804); Vf. Laița (35, 863); ssp. ***carpatica*** Borza: Vf. Paltinu (HIP);

Aster alpinus L.: H, Cp; U2,5T1,5R3, Seslerietalia coeruleae, Nt: V. Doamnei (17, 661, 722, 778, HBZ, HSB, !); Jgheabul Văros (1, 174, 485, 717, 722, 778, HK, HU); Vf. Laița (778); Lacul Doamnei (569);

Carduus kerneri Simk.: TH, Carp-B; U2,5T2R0, Seslerietalia rigidae, R: V. Doamnei 1900 m – 2000 m (1, 4, 17, 569, 661, 722, 751); Vf. Paltinu (727);

Carduus personata (L.) Jacq.: H, Ec; U4,5T2,5R4,5, Adenostylion alliariae, Filipendulo - Petasition, Nt: V. Doamnei (569, !);

Carlina acaulis L.: H, Ec-M; U2,5T0R0, Arrhenatheretalia, Potentillo ternatae-Nardion, Nt: V. Doamnei (625); ssp. ***simplex*** (W. et K.) Arc.: V. Doamnei (1, 17, 722);

Centaurea kotschyana Heuff.: H, Carp-B; U2T2R4,5, Calamagrostidion villosae, Seslerietalia coeruleae, R: V. Doamnei (661, 722, 751); Jgheabul Văros (174, 485, 722, 863, HU);

Centaurea mollis W. et K.: H, Carp-B; U2,5T3R3, Acerion pseudoplatani, Cephalanthero-Fagion, K: Jgheabul Văros (485, 722, HK);

Centaurea nervosa Willd.: H, Alp-Carp; U3T2R2,5, Calamagrostidion villosae, Potentillo ternatae-Nardion, Nt: V. Doamnei (569, 722); Jgheabul Văros (485, 722); Vf. Paltinu (727, HIP, !);

Centaurea triumfetti All. ssp. ***triumfetti***: H, Eua-M; U2T2,5R3, Geranion sanguinei, Seslerietalia rigidae, R: V. Doamnei (661); ssp. ***pinnatifida*** (Schur) Dostal: H, Carp, U2 T4 R4.5, Seslerion bielzii: V. Doamnei (17); Jgheabul Văros (174, 863, HU);

Cicerbita alpina (L.) Wallr.: H, E; U3,5T2R0, Betulo-Adenostyletea, Vaccinio-Piceion, Nt: Mt. Mierea (739);

Cirsium erisithales (Jacq.) Scop.: H, Ec; U3T3R4,5, Fagetalia silvaticae, Filipendulo-Petasition, Nt: V. Doamnei (HNY);

Cirsium waldsteinii Rouy: H, Alp-Carp-B; U4T2R2, Adenostylion alliariae, Caricion curvulae, Filipendulo-Petasition, Nt: V. Doamnei (1, 722, HF);

Crepis conyzifolia (Gou.) D. T.: H, Alp-Carp-B; U3T2R2,5, Potentillo ternatae-Nardion, R: V. Doamnei (625);

Crepis paludosa (L.) ***Mnch***.: H, E; U4,5T0R4,5, Adenostyletalia, Calthion palustris, Montio-Cardaminetea, Nt: V. Doamnei (722, HF); Mt. Mierea (722);

From Doamnei Valley (HU) f. *alpina* Schur.

Crepis viscidula Froel.: H, Carp-B; U3T1R2, Elyno-Seslerietea, Potentillo ternatae-Nardion, I: Mt. Mierea (485);

Doronicum austriacum Jacq.: H, Ec; U3,5T2R3, Acerion pseudoplatani, Adenostylion alliariae, Nt: Mt. Mierea (722, HU);

Doronicum carpaticum (Gris. et Schenk) Nym.: H, Carp-B; U2,5T1,5R0, Asplenietea rupestris, Thlaspietea rotundifolii, R: V. Doamnei (1, 751, HSB, HU, !); Vf. Paltinu (1, 174);

Doronicum columnae Ten.: H, Alp-Carp-B; U3,5T2R3,5, Adenostylion alliariae, Asplenietea rupestris, Elyno-Seslerietea, Papavero - Thymion pulcherrimae, Thlaspietea rotundifolii, Nt: V. Doamnei (1, 722, HF);

Doronicum styriacum (Vill.) D.T.: H, Alp-Carp; U4T1,5R3, Caricion curvulae, I: Lacul Doamnei (1, 485, 717, 722);

Erigeron alpinus L.: H, Eua; U3T1R0, Elyno-Seslerietea, R: V. Doamnei (717, 739, HF, !); Jgheabul Văros (HU);

Erigeron neglectus Kern.: TH-H, E; U3T1R0, Caricetalia curvulae, Elyno-Seslerietea, R: V. Doamnei (1, 661, 722);

Erigeron uniflorus L.: H, Cp; U3T1R3, Androsacion alpinae, Elyno-Seslerietea, R: V. Doamnei (751, HK, HSB, !);

Gnaphalium norvegicum Gunn.: H, Eua (Cp); U3T1,5R1,5, Nardetalia, K: V. Doamnei (1, 722, HF, HU);

Gnaphalium supinum L.: H, Cp; U4T1,5R2, Salicion herbaceae, Nt: V. Doamnei (1, 722, HF, !); Vf. Paltinu (661); Mt. Mierea (485, 722, HF);

Gnaphalium sylvaticum L.: H, Cp; U3T3R3, Epilobietea angustifolii, Nt: V. Doamnei, 1650 m alt. (25); Mt. Mierea (739, HF);

Hieracium acuminatum Jordan: H, E; U2T3R2, Fagetalia silvaticae, K: Mt. Mierea (739);

Hieracium alpinum L. ssp. ***alpinum***: H, Cp; U3T2R1, Caricetalia curvulae, Rhododendro-Vaccinion, Nt: V. Doamnei (739, 880, HBZ, !); Jgheabul Văros (485); Vf. Paltinu (174, 863); var ***gymnogenum*** (Zahn) Nyar.: V. Doamnei (1);

Hieracium aurantiacum L. ssp. ***aurantiacum***: H, Eua (Cp); U3T2R2, Potentillo ternatae-Nardion, Nt: V. Doamnei (HF); Mt. Mierea (485, 739); var ***subaurantiacum*** (N. P.) Nyar.: Mt. Mierea (1, HF);

Hieracium caesium Fries: H, Ec; U3T2R3, Seslerietalia rigidae, R: V. Doamnei (17);

Hieracium murorum L.: H, Eua; U3T0R3, Querco-Fagetea, Vaccinio-Piceetalia, Nt: var. ***alpestre*** Gris.: Jgheabul Văros (HU); Mt. Mierea (739);

Hieracium rotundatum Kit. ex Schultes: H, Carp-B; U3T0R0, Fagetalia silvaticae, Vaccinio-Piceetea, Nt: V. Doamnei (569, !); Mt. Mierea (739, HU);

Hieracium x stoloniflorum W. et K.: Mt. Mierea (1);

Hieracium villosum Jacq.: H, E; U3T1,5R4,5, Seslerion bielzii, K: V. Doamnei (1, 17, 661, 722, 751); Jgheabul Văros (485, 722, HK, HU); Vf. Paltinu (804);

Homogyne alpina (L.) Cass.: H, E; U3,5T2,5R2,5, Junipero - Bruckenthalion, Potentillo ternatae-Nardion, Vaccinio-Piceion, Nt: V. Doamnei (25, 661, !); Vf. Paltinu (661); Şaua Doamnei (661);

Leontodon croceus *Haenke*: H, Alp-Carp; U2,5T1,5R2, Potentillo ternatae-Nardion, R: V. Doamnei (1, 722);

Leontodon x transsilvanicus Nyar., I: Jgheabul Văros (HF);

Leontopodium alpinum Cass.: H, Eua; U2T1,5R4,5, Seslerion rigidae, V: V. Doamnei, 1900 m – 2000 m alt. (17, 385, 722, 751, 880, HSB); Jgheabul Văros (1, 174, 385, 485, 668, 722, 863, HF, HK, HU); Laiţa (35, 385);

Leucanthemum vulgare Lam. ssp. ***vulgare***: H, Eua; U3T0R0, Molinio-Arrhenatheretea, Nt: V. Doamnei, 1650 m alt. (25);

Leucanthemum waldsteinii (Schultz-Bip.) Pouzar: H, Carp; U4T2R3, Adenostylion alliariae, Chrysanthemo-Piceion, Fagion, Nt: V. Doamnei (1, 485, 722, HF); Jgheabul Văros (HK, HU);

Saussurea alpina (L.) DC.: H-Ch, Cp; U3T1R3, Elyno-Seslerietea, R: f. ***albomacrophylla*** Nyar.: V. Doamnei (1, 652);

Scorzonera rosea W. et K.: H, Eua; U2T0R4, Potentillo ternatae-Nardion, Nt: V. Doamnei (1, 661, 751); Jgheabul Văros (HK, HU); Mt. Mierea (485, 722);

Senecio capitatus (Whlbg.) DC.: H, Alp-Carp; U3T1,5R3, Triseto-Polygonion, I: V. Doamnei (HU); Jgheabul Văros (HU); var ***leiocarpus*** (Koch) Cuf.: V. Doamnei (751); Jgheabul Văros (1, 485); Lacul Doamnei (HF);

Senecio carpaticus Herb.: H, Alp-Carp-B; U2,5T1,5R2,5, Caricetalia curvulae, Nt: V. Doamnei (1, 485, 722); Vf. Paltinu (174, 863);

Senecio glaberrimus (Roch.) Simk.: H, Carp-B; U3T1,5R4,5, Caricion curvulae, Seslerion bielzii, Nt: Laița (1, 722);

Senecio nemorensis L. ssp. ***nemorensis***: H, Eua; U3,5T2,5R3, Acerion pseudoplatani, Adenostyletalia, Epilobietea angustifolii, Fagetalia silvaticae, Nt: V. Doamnei (569, !); f. ***octoglossus*** (DC.) Beger: Mt. Mierea (1, 739);

Senecio squalidus L.: TH-H, Alp-Carp-B; U2T0R2,5, Rumicion alpini, Thlaspietea rotundifolii, K: Vf. Paltinu (727);

Senecio subalpinus Koch: H, Alp-Carp-B; U3,5T2R3, Adenostylion alliariae, Montio-Cardaminetalia, Rumicion alpini, Nt: V. Doamnei (HF);

Solidago virgaurea L.: H, Cp; U2,5T3R3, Epilobietalia angustifolii, Nt: ssp. ***alpestris*** (W. et K.) Gaud.: Vf. Paltinu (1);

Taraxacum alpinum (Hoppe) Hegetschw.: H, Eua; U2,5T2,5R2,5, Arabidetalia coeruleae, Rumicion alpini, Nt: V. Doamnei (1, 811); Vf. Paltinu (804, !);

Taraxacum nigricans (Kit.) Rchb.: H, Carp-B-Sud; U3T1,5R2, Androsacion alpinae, Nt: V. Doamnei (819);

Taraxacum officinale Weber: H, Eua; U3T0R0, Arrhenatheretalia, Nt: V. Doamnei, 1750 m alt. (569);

Liliaceae

Allium montanum Schmidt: G, Eua-C; U1,5T3,5R4, Seslerietalia coeruleae, R: V. Doamnei (625, 661);

Allium schoenoprasum L.: G, Cp; U4,5T2R0, Sphagnion fusci, R: ssp. ***sibiricum*** (L.) Hayek-Markg.: V. Doamnei (661); Jgheabul Văros (HU);

Allium victorialis L.: G, E; U3T2R2,5, Calamagrostidion arundinaceae, Fagetalia silvaticae, R: V. Doamnei (661); Vf. Paltinu (751, HIP);

Lloydia serotina (L.) Rchb.: G, Cp; U2T1,5R2,5, Elyno-Seslerietea, Gypsophilion petraeae, R: V. Doamnei (1, !);

Veratrum album L. ssp. ***album***: G, Eua; U4T2,5R4, Adenostyletalia, Molinion coeruleae, Rumicion alpini, Nt: V. Doamnei (349, !);

Iridaceae

Iris ruthenica Ker- Gawl.: G, Eua-C; U2T2,5R0, Elyno-Seslerietea, Nt: Jgheabul Văros (174);

Orchidaceae

Coeloglossum viride (L.) Hartm.: G, Cp; U2,5T0R3, Nardetalia, R: V. Doamnei (751); var ***bracteatum*** (Willd.) Richt.: V. Doamnei (HF); Jgheabul Văros (CHU); Vf. Paltinu (751);

Dactylorhiza cordigera (Fries) Soo: G, Alp-Carp-B; U4,5T2R2, Montio-Cardaminetalia, Scheuchzerio-Caricetalia nigrae, Nt: V. Doamnei 1843 m – 1900 m (25, 722, 751, HF); Jgheabul Văros (HU);

Gymnadenia conopsea (L.) R. Br.: G, Eua; U4T0R4,5, Molinietalia, Nt: V. Doamnei (625, 661, 739, !); Jgheabul Văros (174, 863, HF); var ***alpina*** Turcz.: V. Doamnei (HF);

Nigritella rubra (Wettst.) Richt.: G, E; U2,5T0R4,5, Nardetalia, V: V. Doamnei (17); Jgheabul Văros (174, 650);

Pseudorchis albida (L.) A. Et D. Love: G, Eua (Cp); U2,5T1R4,5, Caricion curvulae, Nt: V. Doamnei (722); Jgheabul Văros (HF); Vf. Paltinu (727);

Juncaceae

Juncus conglomeratus L.: H, Eua; U4,5T3R3, Calthion palustris, Molinietalia, Molinion coeruleae, Scheuchzerio-Caricetalia nigrae, Nt: V. Doamnei, 1650 m alt. (25);

Juncus filiformis L.: H, Cp; U4,5T2,5R2,5, Caricion canescenti-nigrae, R: V. Doamnei (569, 811);

Juncus trifidus L. ssp. ***trifidus***: H, Alp-Carp; U2,5T2R2, Juncetea trifidi, Nt: V. Doamnei (569, 739, 880); Jgheabul Văros (485, 803, !); Vf. Paltinu (174, 751, 863); Şaua Doamnei (661); ssp. ***monanthos*** (Jacq.) A. et G.: Jgheabul Văros (485);

Juncus triglumis L.: H, Cp; U5T1,5R2, Scheuchzerio-Caricetea nigrae, R: V. Doamnei (1, HF, HU); Lacul Doamnei (485, 722);
In HF of Doamnei Valley var. *macrospathus*. M. Fuss (739) noteded from the Doamnei Lake like *J. jacquinii* L.

Luzula alpino- pilosa (Chaix) Breistr.: H, Cp; U2,5T2R2,5, Salicion herbaceae, Nt: V. Doamnei (1, 722, 751, HF, !); Vf. Paltinu (661, 819); Şaua Doamnei (661);

Luzula luzuloides (Lam.) Dandy et Willm. ssp. ***luzuloides***: H, E; U2,5T2,5R2, Betulo-Adenostyletea, Fagetalia silvaticae, Junipero-Bruckenthalion, Nt: V. Doamnei, 1650 m alt. (25); ssp. ***cuprina*** (A. et G.) Chrtek et Krisan: V. Doamnei (17, !);

Luzula silvatica (Huds.) Gaud.: H, Ec; U3,5T2,5R2, Fagion, Vaccinio-Piceetalia, Nt: V. Doamnei (569);

Luzula sudetica (Willd.) DC.: H, Eua; U0T2R2, Sphagnion fusci, Nt: V. Doamnei (25); Vf. Paltinu (1);

Cyperaceae

Carex atrata L. ssp. ***atrata***: H, Cp; U3T1,5R3, Arabidetalia coeruleae, Caricion curvulae, Seslerietalia coeruleae, Nt: V. Doamnei (722, 880, HSB, !); Vf. Paltinu (751); Lacul Doamnei (569, HF);

Carex curta Good.: H, Cp; U5T0R2, Caricion canescenti-nigrae, Nt: V. Doamnei (25);

Carex curvula All.: H, Alp-Carp-B; U2,5T1R1,5, Caricion curvulae, Nt: V. Doamnei (569); Vf. Paltinu (174, 661); Laiţa (317);

Carex firma Host: H, Alp-Carp-B; U2T1,5R5, Seslerietalia coeruleae, I: V. Doamnei 1900 m – 2000 m (751);

Carex flava L.: H, Cp; U4,5T3R0, Calthion palustris, Caricetalia davallianae, Eriophorion latifolii, Tofieldietalia, Nt: V. Doamnei 1650 m alt. (25);

Carex limosa L.: H, Cp; U5T2R1,5, Rhynchosporion albae, R: V. Doamnei 1650 m alt. (25);

Carex nigra (L.) Reichard ssp. ***dacica*** (Heuff.) Şerb. et Nyar.: H, D-B, U0 T2 R2.5, Caricion canescenti - nigrae, Nt: V. Doamnei (811); Vf. Paltinu (HIP);

Carex ovalis Good.: H, Cp; U4T2,5R3, Caricion canescenti-nigrae, Molinietalia, Nardetalia, Nt: V. Doamnei (25); Mt. Mierea (HF);

Carex pallescens L.: H, Cp; U3,5T3R3, Molinio-Arrhenatheretea, Nardetalia, Nt: V. Doamnei 1650 m alt. (25);

Carex pyrenaica Wahlbg.: H, Cp; U2T1,5R4, Androsacion alpinae, Salicetea herbaceae, Nt: V. Doamnei (722, HF); Vf. Paltinu (1, 727, !);

Carex rostrata Stokes: Hh, Cp; U5T2R0, Caricion rostratae, Nt: V. Doamnei (625, 863);

Carex sempervirens Vill.: H, E; U2,5T1,5R4, Elyno-Seslerietea, Nt: V. Doamnei (17, 661, 880, HSB); Jgheabul Văros (174, 863, HF); Vf. Paltinu (174, 751, 819);

Carex vesicaria L.: Hh, Cp; U6T3R4, Magnocaricion elatae, Nt: Lacul Doamnei (863);

Eriophorum latifolium Hoppe: H, Eua; U5T0R4,5, Caricion davallianae, Eriophorion latifolii, Scheuchzerio-Caricetalia nigrae, Tofieldietalia, Nt: Lacul Doamnei (174);

Eriophorum vaginatum L.: H, Cp; U4,5T0R1,5, Sphagnion fusci, Nt: V. Doamnei (25); Lacul Doamnei (174);

Kobresia myosuroides (Vill.) Fiori (Elyna myosuroides (Vill) Fritsch): H, Cp (arct-alp); U2.5T1R4.5, Caricion curvulae, Elyno-Seslerietea, R: Şaua Doamnei (!);

Poaceae

Agrostis capillaris L.: H, Cp; U0T0R0, Molinio-Arrhenatheretea, Nt: V. Doamnei (25, 569); Mt. Mierea (HF);

Agrostis rupestris All.: H, Alp-Carp-B; U2,5T1R1,5, Caricetalia curvulae, Potentillo ternatae-Nardion, Rhododendro-Vaccinion, Nt: V. Doamnei (17, 569, 661, 880, !); Vf. Paltinu (804, !);

Alopecurus laguriformis Schur: H, Carp; U4T1R2, Rumicion alpini, R: V. Doamnei, 2200 m alt. (97, 661, 722, 751, HF, HNY); Jgheabul Văros (1, 485, 722); Vf. Paltinu (HIP);

Anthoxanthum odoratum L.: H, Eua; U0T0R0, Caricion curvulae, Molinio-Arrhenatheretea, Nardetalia, Nt: V. Doamnei (17, 25, 569, 661); Şaua Doamnei (661);

Avenula versicolor (Vill.) Lainz: H, Alp-Carp; U3T1R2, Caricetalia curvulae, Potentillo ternatae - Nardion, Rhododendro-Vaccinion, Nt: V. Doamnei (722); Jgheabul Văros (485, 722); Şaua Doamnei (661);

Calamagrostis arundinacea (L.) Roth: H (G), Eua; U2,5T3R2, Calamagrostidion arundinaceae, Epilobion angustifolii, Nt: V. Doamnei (569, !);

Calamagrostis varia (Schrad.) Host: H, Eua; U3T2R4,5, Fagion, K: Mt. Mierea (722);

Deschampsia caespitosa (L.) P. Beauv.: H, Cosm; U4T0R0, Betulo-Adenostyletea, Molinietalia, Nt: V. Doamnei (569, !); Şaua Doamnei (661); Mt. Mierea (485, 739); var. ***alpina*** (Hoppe) Ducamm.: V. Doamnei (751);

Deschampsia flexuosa (L.) Trin.: H, Cp; U2T0R1, Caricetalia curvulae, Junipero-Pinetalia mugi, Vaccinio-Piceetalia, Veronico officinalis-Quercion, Nt: Mt. Mierea (485, 739);

Festuca airoides Lam.: H, Eua; U2,5T1R2, Caricetalia curvulae, Rhododendro-Vaccinion, Nt: V. Doamnei (17, 661, HNY); Vf. Paltinu (804, 863, !); Şaua Doamnei (271, 569);

Festuca amethystina L.: H, Ec; U2T3R4,5, Seslerietalia coeruleae, R: Doamnei V. 1780 m and under Vf. Laiţa (17, 625, 661, 751, 863);

Festuca bucegiensis Markgr.-Dannenb.: H, Carp; U2T1R2, Androsacion alpinae, R: V. Doamnei (1); Vf. Paltinu (174);

Festuca picta Kit.: H, Alp-Carp-B; U2,5T2R0, Festucion pictae, Nt: Vf. Paltinu (863);

Festuca porcii Hack.: H, Carp-B; U3T1,5R0, Calamagrostidion villosae, R: V. Doamnei, 1600 m alt. (1, 776);

Festuca pratensis Huds.: H, Eua; U3,5T0R0, Adenostylion alliariae, Agrostion stoloniferae, Molinio-Arrhenatheretea, Nt: ssp ***apennina*** (De Not) Beldie: Laiţa (1);

Festuca rubra L. ssp ***rubra***: H, Cp; U3T0R0, Cynosurion cristati, Molinio-Arrhenatheretea, Nardetalia, Nt: V. Doamnei 1650 m (25), Şaua Doamnei 2100 m (661); ssp ***commutata*** Gaud.: V. Doamnei (HNY, !);

Festuca rupicola Heuff. ssp. ***saxatilis*** (Schur) Beldie: H, Carp; U1,5T4R4, Festucion rupicolae, Seslerio-Festucion pallentis, Nt: V. Doamnei (775);

Festuca versicolor Tausch: H, Alp-Carp-S; U2T4R4,5, Seslerion bielzii, R: V. Doamnei (17, 722, 880); Jgheabul Văros (HF, HU); var. ***minor*** (Schur) Kraj.: Laiţa (1); f. ***chrysantha*** (Kraj.) Beldie: Jgheabul Văros (HU);

Festuca violacea Gaud.: H, E; U3T2R0, Papavero -Thymion pulcherrimae, Nt: V. Doamnei (1);

Koeleria macrantha (Ledeb.) Schultes et Schultes fil.: H, Eua; U2T4R5, Festuco-Brometea, Nt: V. Doamnei (17); from Doamnei Valley (17) synonym/syn. *K. transsilvanica* Schur, considered by some authors as good species, H, Carp, U2T2R5, Elyno-Seslerietea.

Nardus stricta L.: H, E; U0T0R1,5, Molinio-Arrhenatheretea, Nardetalia, Nt: V. Doamnei (569, !); Şaua Doamnei (271);

Oreochloa disticha (Wulf.) Link.: H, Alp-Carp; U3T1R1,5, Caricion curvulae, Nt: V. Doamnei, 1850 m alt. (1, 569, HU, !); Vf. Paltinu (174, 863); Vf. Laiţa (1);

Phleum alpinum L.: H, Cp; U3T2R0, Poion alpinae, Rumicion alpini, Nt: V. Doamnei (17, 569, 739, HNY, !); Jgheabul Văros (485);

Poa alpina L.: H, Cp; U3T0R0, Poion alpinae, Rumicion alpini, Nt: V. Doamnei (739, HF); Jgheabul Văros (HF, HU); f. ***vivipara*** (L.) A. et G.: Jgheabul Văros (485); Vf. Paltinu (803, !); Laiţa (HF);

Poa granitica Br.-Bl. ssp. ***disparilis*** (Nyar.) Nyar.: H, Carp; U2,5T1R2,5, Festucion pictae, R: Vf. Paltinu (HIP);

Poa laxa Haenke: H, Eua (Cp); U2,5T1,5R2, Androsacion alpinae, Thlaspion rotundifolii, R: V. Doamnei (1, 722, 819, HU); Vf. Paltinu (1); Lacul Doamnei (HF); var. ***caesio-glauca*** Schur: Vf. Paltinu (174); Lacul Doamnei (174, 305);

Poa media Schur: H, Carp-B; U3T2R0, Juncetea trifidi, Rhododendro-Vaccinion, Nt: V. Doamnei (407, 569, 661, 751, !); Laiţa (HSB); Şaua Doamnei (661);

Poa minor Gaud.: H, Alp-Carp; U2,5T1,5R2, Androsacion alpinae, Thlaspion rotundifolii, Nt: V. Doamnei (HNY);

Poa pratensis L.: H, Cp; U3T0R0, Molinietalia, Molinion coeruleae, Nt: var. ***retezatensis*** (Nyar.) Borza: V. Doamnei (1);

Poa tremula Schur: H, Eua (Cp); U2,5T1,5R2, Salicetea herbaceae, K: V. Doamnei (1);

Poa violacea Bell.: H, Carp-B; U2,5T2R4,5, Poion violaceae, Nt: V. Doamnei (17, 625, 863);

Sesleria coerulans Friv. ssp. ***coerulans***: H, Carp-B; U2,5T2,5R4,5, Seslerion bielzii, Nt: V. Doamnei (661); Jgheabul Văros (174, 863); Vf. Paltinu (174, 661, 881, !); Laiţa (881); ssp. ***bielzii*** (Schur) Gergely et Beldie: V. Doamnei (17, 751, 819, 880); Vf. Paltinu (751, 819);

Sesleria rigida Heuff.: H, Carp-B; U2,5T2R4,5, Seslerion rigidae, K: ssp. ***haynaldiana*** (Schur) Gergely et Beldie: Jgheabul Văros (174);

Trisetum alpestre (Host) B. Beauv.: H, Alp-Carp-B; U2,5T2R0, Gypsophilion petraeae, Seslerion rigidae, R: V. Doamnei (1);

Trisetum fuscum (Kit.) Schultes: H, Carp; U3T1,5R2,5, Salicion retusae, Seslerion bielzii, K: Vf. Paltinu (174).

Vegetation

The vegetation of the Doamnei Valley is specific in general for the Făgăraş Mountains, with the specification that the limestone presence in Jgheabul Văros area, favoured some characteristic coenoses.

There were identified 33 vegetal associations mainly based on talophites and cormophites.

Acarosporetum sinopicae (Hilitzer 1923) Schade 1932: V./Valley Doamnei at 1300 m alt. (211);

Arenarietum biflorae Voik 1976: Vf. Paltinu (!);

Aspicilietum cinereae Frey 1923: V. Doamnei (211);

Asplenio viridis-Cystopteridetum fragilis Oberd. (1936) 1949: Jgheabul Văros (803, !);

Caricetum rostratae Rübel 1912 (*Carex rostrata* and *Carex vesicaria as*.): Lacul Doamnei (863, !);

Carici dacicae- Drepanocladetum exannulatae Boşcaiu et al. 1972: V. Doamnei at 2100 m (811);

Carici-Nardetum strictae (Resmeriţă 1984) Resmeriţă et Pop 1986 (*Hygronardetum strictae* Borza 1934, Puşcaru et al. 1956): Circul Doamnei (881);

Cetrario-Loiseleurietum Br.-Bl. et al. 1939 (Loiseleurietum procumbentis Puşcariu et al. 1956): Vf. Laiţa (!);

Chrysosplenio alpini- Saxifragetum stellaris Pawl. et Walas 1949 (*Philonotio-Saxifragetum stellaris* auct. roman.): V. Doamnei (!);

Diantho tenuifolii - Festucetum amethystinae (Domin 1933) Coldea 1984 *(Festucetum amethystinae* Pawl. 1923): Şaua V. Doamnei - V. Laiţa (17), Jgheabul Văros (17, 807 with Sesleria rigida, 863);

Doronico columnae-Rumicetum scutati Boşcaiu et al. 1977 (*Rumicetum scutati* auct. roman.): V. Doamnei (819);

Dryadetum octopetalae Csürös et al. 1956: Vf. Paltinu at 2250 m (804, !);

Hieracio transsilvanico-Piceetum Pawl. et Br.-Bl. 1939 (*Vaccinio-Piceetum abietis* Brezina et Hadač 1962): V. Doamnei (!);

Juncetum filiformis Tx. 1937 p.p., Csürös 1957: V. Doamnei at 1850 m and 2100 m (569, !);

Juncetum trifidi Szafer et al. 1923 em. Krajina 1933: Piscu Laiţii (881), V. Doamnei at 1880 m (569, !), Vf. Laiţa (!), Vf. Paltinu (863, !); ***oreochloosum*** Borza 1934 (Trifidi-Distichietum Borza 1931 n. n., Pawl. et al. 1938): Vf. Laiţa (!);

Minuartio-Silenetum acaulis Puşcaru et al. 1956 (Silenetum acaulis Krajina 1933): Vf. Paltinu at 2100 m – 2150 m (819);

Phleo alpini - Deschampsietum caespitosae (Morariu 1939) Coldea 1983 (*Rumici-Deschampsietum caespitosae* Csürös et al. 1985): V. Doamnei (!);

Potentillo chrysocraspedae-Festucetum airoidis Boşcaiu 1971: Circul Doamnei (569, !); ***agrostidetosum rupestris*** (Csürös et al. 1956 (*Agrostidetum rupestris* Borza 1934 p.p.): Vf. Paltinu, Vf. Laiţa (!);

Primulo minimae-Caricetum curvulae Br.-Bl. 1926 em. Oberd. 1957: Vf. Paltinu (863);

Pulmonario rubrae -Fagetum (Soó 1964) Täuber 1987 *(Pulmonario rubrae-Abieti-Fagetum* Soó 1964): V. Doamnei (276, !);

Rhododendro myrtifolii-Pinetum mugi Borza 1959 em. Coldea 1985 *(Pinetum mugi* Soó 1928 *rhodoretosum* Puşcaru et al. 1956: Circul Doamnei (!);

Rhododendro myrtifolii-Vaccinietum (Borza 1959) Boşcaiu 1971: V. Doamnei (276), Vf. Paltinul (!);

Salicetum herbaceae Rübel 1911: Vf. Paltinu (804, !);

Salicetum retusae-reticulate Br.-Bl. 1926 (*Salicetum retusae*): Curmătura Paltinului (863, !);

Saxifragetum moschatae-aizoidis Boşcaiu 1972 ***dianthetosum glacialis*** Voik et Schneider 1978: Vf. Paltinu (819);

Saxifrago bryiodis-Silenetum acaulis Boşcaiu et al. 1977: V. Doamnei (880);

Scorzonero roseae-Festucetum nigricantis (Puşcariu et al. 1956) Coldea 1987 (Campanulo abietinae-Festucetum nigricantis G. Anghel et al. 1965 emend. Drg. 1984): V. Doamnei (865);

Seslerio bielzii - Caricetum sempervirentis Puşcaru et al. 1956: Jgheabul Văros (863 syn. *Seslerietum coerulantis alpinum* Csürös 1957), Doamnei V. (880), Vf. Laiţa (881 syn. *Seslerietum coerulantis alpinum* Csürös 1957, !), Paltinu Peak (881 syn. *Seslerietum coerulantis alpinum* Csürös 1957, 863 syn. *Seslerietum bielzii* Domin 1933, with *Carex sempervirens*, !);

Seslerio-Festucetum versicoloris Beldie 1967 (Festucetum versicoloris Pawl. (1923) 1935): Muchia Laiţa (863);

Silenetum dinaricae Schneider-Binder et Voik 1976: Vf. Paltinu at 2380 m (!);

Soldanello pusilae-Ranunculetum crenati (Borza 1931) Boşcaiu 1971: Curmătura Paltinului (863, !);

Urtico dioicae-Rumicetum alpini (Şerbănescu 1939) Todor et Culică 1967 corr. Oltean et Dihoru 1986 (*Rumicetum alpini* auct. roman.): V. Doamnei at 1750 m (569, !);

Violo declinatae-Nardetum Simon 1966 (*Nardetum strictae alpinum* Puşcaru et al. 1956): V. Doamnei (276, 569).

Passing through list it can be seen the existence of eight habitats of Community interest. These are: 4060 Alpine and Boreal heaths; 4070 Bushes with *Pinus mugo* and *Rhododendron myrtifolium* (Mugo-Rhododendro-netum) (prioritar habitat); 6150 Siliceous alpine and boreal grasslands; 6170 Alpine and subalpine calcareous grasslands; 8110 Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsi-detalia ladani); 8210 Calcareous rocky slopes with chasmophytic vegetation; 91V0 Dacian Beech forests (Symphyto-Fagion); 9410 Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea).

HERBARIUMS

HB - Herbarium J. Barth - Brukenthal National Museum of Sibiu, Şt. nat. inventory no. 48.571-58.043.

HBZ - Herbarium J. Bielz, E. Krauss, G. Hergotta, V. Klotz - Brukenthal National Museum of Sibiu, Şt. nat. inv. no. 79.911-81.464 and 81.568-81.687.

HF - Herbarium M. Fuss (incl. Herb. Cryptogam. and Herb. Norm. Transs.) - Brukenthal National Museum of Sibiu, Şt. nat. inv. no. 1-28.983.

HFA- Annex Herbarium M. Fuss – Brukenthal National Museum of Sibiu, Şt. nat. inv. no. 82.435-84.427.

HIP - Herbarium I. Pop - Brukenthal National Museum of Sibiu, Şt. nat. inv. no. 103.407-108.583.

HK - Herbarium E. Kisch - Brukenthal National Museum of Sibiu, Şt. nat. inv. no. 78.026-79.910.

HKL - Herbarium Kladny - Brukenthal National Museum of Sibiu, Şt. nat. inv. no. 84.428-84.607.

HNY - Herbarium E. I. Nyarady - Brukenthal National Museum of Sibiu, Şt. nat. inv. no. 108.584-161.428.

HSB - Herbarium Erika Schneider-Binder - Brukenthal National Museum of Sibiu, Şt. nat. inv. no. 161.429-167.188.

HU - Herbarium K. Ungar - Brukenthal National Museum of Sibiu, Şt. nat. inv. no. 35.520-43.288.

CHU - Catalogue Herbarium Ungar - Manuscris anexat Herbarului K. Ungar.

REFERENCE 1

Antonescu P. G., 1926 – Distribuţia geografică a coniferelor din România, Teză doctorat Fac. şt. nat. Cluj. (in Romanian)

Bojor O., 1963 – Contribuţii la identificarea şi cartarea florei medicinale de pe versantul nordic al munţilor Făgăraşului până la lunca Oltului, Acta Hort. Bot. Univ. Bucureşti, 1961-1962, fasc. II, 585-604. (in Romanian)

Boşcaiu M., Boşcaiu N. and Ehrendorfer F., 1998 – The Cerastium alpinum group (Caryophyllaceae) in the South-Eastern Carpathians, Contr. bot. Cluj-Napoca, II, 1997-1998, 5-38, Bucureşti.

Botsch J. H., 1991 – Flora und Vegetation des Podragu-Tales im Fogorascher Gebirge (Sudkarpaten), Naturwiss. Forsch. u. Siebenburgen, IV, Bohlau Verlag, Koln- Weimar-Wien, 121-176. (in German)

Ciurchea M. and Codoreanu V., 1967 – Contribuţii la cunoaşterea florei şi vegetaţiei lichenologice din Munţii Făgăraşului (Valea Bâlii şi Valea Doamnei), Contr. bot. Cluj, 83-92. (in Romanian)

Coldea G. and Plămadă E., 1980 – Contribuţii la studiul Clasei Scheuchzerio- Caricetea fuscae Nordh. 36 din România III, Hidrobiologia, Bucureşti, 16, 109-117. (in Romanian)

Constantinescu C. and Agopian A., 1973 – Plante medicinale din flora spontană, ed. II-a, Bucureşti. (in Romanian)

Csato J., 1888 – Kirandulas a Bulla volgyen keresztul a Negoj kupjahoz, Mag. Nov. Lap., XII, 81-93. (in Hungarian)

Csüros Ş., 1957 – Adatok a Fogarasi havasok kozponti resze alpin vegetaciojanak ismeretehez, Kulonlenyomat a Koloszvari Victor Babeş es Bolyai egyetemek kozlemenyeibol, Cluj, II, 1-2, 303-310. (in Hungarian)

Fekete L. and Blattny T., 1913 – Az erdeszeti jelentosegu fak es cserjek elterjedese a Magyar allam teruleten, I-II, Selmecsbanya. (in Hungarian)

Fronius F., 1856 – Eine naturhistorische Excursion auf dem Negoiu, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, VII, 119-131. (in German)

Fuss M., 1857 – Zur Flora Siebenburgens, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, VIII, 170-173. (in German)

Fuss M., 1865 – Zur Kryptogamenflora Siebenburgens, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, XVI, 23-35. (in German)

Fuss M., 1866 – Flora Transsilvaniae Excursoria, Sibiu.

Fuss M., 1878 – Systematische Aufzahlungen der in Siebenburgen angegebenen Cryptogamen, Archiv d. Ver. f. siebenb. Landeskunde, NF, Braşov, XIV, 2, 421-474, 3, 627-708. (in German)

Georgescu C. C. and Ciucă M., 1950 – Răspândirea jneapănului sau pinului de munte (Pinus montana Mill.) în R. P. R., Anal. Acad. Bucureşti, ser. geol., geogr., biol., şt. tehn. şi agric., III, 3. (in Romanian)

Lörinczi F. and Szász E., 1967 – Contribuţii la cunoaşterea micromicetelor din solurile zonei Masivului Făgăraş, Contr. bot., Cluj, 191-202. (in Romanian)

Lupşa V., 1977 – Răspândirea speciei Aster alpinus L. în Carpaţii româneşti, St. şi cerc. biol. ser. biol. veget. Bucureşti, XXIX, 1, 21-28. (in Romanian)

Lyka K., 1930 – Nehany ujabb Thymus-alakrol, MBL, XXIX, 1-3. (in Hngarian)

Nyarady A., 1966 – Contribuţii la cunoaşterea răspândirii subunităţilor taxonomice ale microspeciilor Festuca valesiaca Schleich., F. pseudovina Hack. şi F. rupicola Heuff. în România, Notule bot. Inst. agron. Cluj, 59-67. (in Romanian)

Nyarady A., 1966 – Răspândire şi caracteristici ecologico-fitocenologice ale staţiunilor de Festuca porcii Hack., Notule bot. Inst. agron. Cluj, 81-92. (in Romanian)

Nyarady E. I., 1931 – Adnotaţiuni la flora României VI (Die Poa- Arten des Schur-schen Herbariums von Lwow (Lemberg), Bul. Grăd. bot. şi Muz. bot. Univ. Cluj, XI, 1-2, 37-50. (in Romanian)

Nyarady E. I., 1934 – Adnotaţiuni la Flora României IX, Bul. Grăd. bot. şi Muz. bot. Univ. Cluj, XIV, 1-2, 95-99. (in Romanian)

Nyarady E. I., 1940 – Die Gruppe des Saussurea alpina und lapathifolia in den Karpaten, Verh. u. Mitt. d siebenb. Ver. f. Naturwiss. zu Hermannstadt, LXXXXIX-XC, 1939-1940, 231-233. (in German)

Nyarady E. I., 1957 – Noi Carduus-uri din flora Carpaţilor meridionali şi poziţia lor faţă de ceilalţi membri ai grupei C. defloratus, St. şi cerc. biol. Acad. R.P.R. Fil. Cluj, III, 1-2, 179-195. (in Romanian)

Nyarady E. I. and Nyarady A., 1964 – Studiul asupra speciilor secţiei Ovinae Fr. a genului Festuca din R. P. R., I-II, St. şi cerc. biol. ser. bot. Bucureşti, XVI, 2, 105-142, 3, 165-172. (in Romanian)

Nyarady E. I., 1967 – Die subalpinen Holzgewachse des Făgărascher Gebirges und die Mosaikflora des Bâlea-Kessels, Rev. roum. biol. ser. bot. Bucureşti, XII, 5, 335-343. (in German)

Panţu C. Z., 1931 – Geraniaceele din România, Anal. Acad. Bucureşti, Mem. secţ. şt. ser. III. (in Romanian)

Paucă M., 1968 – Răspândirea speciei Saxifraga paniculata Mill. (S. aizoon Jacq.) pe teritoriul României, St. şi cerc. biol. ser. bot. Bucureşti, XX, 3, 231-238. (in Romanian)

Paucă M., 1969 – Răspândirea speciei Saxifraga carpathica Rchb. în România, St. şi cerc. biol. ser. bot. Bucureşti, XXI, 4, 273-275. (in Romanian)

Popescu A. and Sanda V., 1972 – Răspândirea speciilor Geum montanum L. şi Geum reptans L. în România, St .ş cerc. biol. ser. bot. Bucureşti, XXIV, 2, 103-108. (in Romanian)

Popescu A. and Sanda V., 1990 – Vegetaţia grohotişurilor şi bolovănişurilor (Clasa Thlaspietea rotundifolii Br.-Bl. 26) din Carpaţii României, St. şi cerc. biol. ser. biol. veget. Bucureşti, 42, 31-42. (in Romanian)

Popescu A., 1971 – Răspândirea speciilor Bartschia alpina L. şi Gentiana frigida Haenke în Carpaţii româneşti, St. şi cerc. biol. ser. bot. Bucureşti, XXIII, 4, 325-330. (in Romanian)

Porcius F., 1893 – Diagnosele plantelor fanerogame şi criptogame vasculare cari crescu spontaneu. (in Romanian)

Prodan I., 1939 – Flora pentru determinarea şi descrierea plantelor ce cresc în România, I-II, ed. II-a Cluj. (in Romanian)

Prodan I., 1939 – Flora pentru determinarea şi descrierea plantelor ce cresc în România, Cluj, II. (in Romanian)

Puşcaru D., Puşcaru-Soroceanu E. and Dan R. I., 1977 – Perspective of increasing the productivity of Festucetum rubrae commutatum-red Fescue meadows of the Făgăraş Mountains by trophic regime improvement, Com. bot. Bucureşti, 63-79.

Puşcaru-Soroceanu E. and Puşcaru D., 1971 – Excursii în Munţii Făgăraşului, Edit. did. şi pedag. Bucureşti. (in Romanian)

Puşcaru-Soroceanu E. (red.)., 1963 – Păşunile şi fânețele din Republica Populară Română, Edit. Acad. Rom. Bucureşti. (in Romanian)

Puşcaru-Soroceanu E., Csürős S., Puşcaru D. and Popova-Cucu A., 1981 – Die Vegetation der Wiesen und Weiden des Făgăraş-Gebirges in den Sudkarpaten, Phytocoenologia, 9 (3), 257-309. (in German)

Rațiu F., 1982 – Corologia unor specii alpine ale genului Ranunculus în Carpații românești, Contr. bot. Cluj, 143-154. (in Romanian)

Resmeriță I. Csűrös Ş., Lupşa-Drăgan V. and Calancea L., 1963 – Contribuții la studiul fitocenologic şi agrotehnic al nardetelor din Transilvania, Com. bot. Bucureşti, II, p. II-a, 7-62. (in Romanian)

Resmeriță I., Puşcaru-Soroceanu E., and Morariu I., 1977 – Dare de seamă privind organizarea şi desfăşurarea celei de a 10-a consfătuiri naționale de geobotanică, Com. bot. Bucureşti, 5-16. (in Romanian)

Rosler D. and Rosler R., 2000 – Phytoteratologische Beitrage zur Gattung Soldanella in den Karpaten Rumaniens, Naturw. Forsch. u. Siebenburg., VI, Bohlau Verlag Koln-Weimar-Wien, 91-108. (in German)

Sanda V., Ştefan N., Drăgulescu C., Popescu G., Barabaş N., Negrean G., Peicea I. and Ţucra I, 1993 – Răspândirea genului Lycopodium L. în Carpații României I-II, St. şi cerc. de biol. ser. biol. veget., Bucureşti, XLV, 1, 27-46 şi 2, 145-160. (in Romanian)

Sanda V., 1969 – Contribuții la taxonomia şi corologia subsecției Alpini Vierhapper a genului Dianthus L. din flora României, St. şi cer. biol. ser. bot. Bucureşti, XXI, 1, 23-30. (in Romanian)

Sanda V., 1970 – Răspândirea speciilor Cerastium alpinum L. şi Cerastium lanatum Lam. în România, St. şi cerc. biol. ser. bot. Bucureşti, XXII, 5, 401-405. (in Romanian)

Sanda V. and Schneider-Binder E., 1972 – Răspândirea speciei Dianthus tenuifolius Schur în România, Acta Hort. Bot. Univ. Bucurest., 1970-1971, 653-662. (in Romanian)

Sandu-Ville C., 1971 – Pyrenomycetes - sphaeriales ciuperci din România, Edit. Acad. Bucureşti. (in Romanian)

Săvulescu T. (red.), l952-1976 – Flora Republicii Populare Române (Flora Republicii Socialiste România) I-XIII, Edit. Acad. Bucureşti. (in Romanian)

Schneider-Binder E. and Voik W., 1976 – Chorologische und zonologische Untersuchungen uber Silene dinarica Spreng., Linzer biol. Beitr., 8, 23-39. (in German)

Schneider-Binder E., 1980 – Structura asociației Asplenio-Cystopteridetum fragilis Oberd. (1936) 1949 în Carpații sudestici, St. şi com. Muz. Brukenthal Sibiu, Şt. nat., 24, 131-145. (in Romanian)

Schneider-Binder E. and Voik W., 1979 – Asociațiile din clasa Salicetea herbaceae Br.-Bl. 1947 în Carpații Meridionali cu privire specială asupra celor din Munții Făgăraşului, St. şi com. Muz. Brukenthal Sibiu, Şt. nat., 23, 221-237. (in Romanian)

Simonkai L., 1886 – Enumeratio florae transsilvanicae vasculosae critica, Budapest.

Slonovschi V., 1977 – Cartarea speciei Blechnum spicant (L.) Roth în Carpații românești, St. şi cerc. biol. ser. biol. veget. Bucureşti, XXIX, 1, 33-38. (in Romanian)

Szalay B., 1909 – Hermannstadt: Albie. Ein fragwurdiger Gipfelname im Fogorascher Gebirg, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, LIX, 197-200. (in German)

Szasz E., 1964 – Câteva micromicete noi pentru flora R. P. R., recoltate din masivul Făgăraş, Studia Univ. Babeş-Bolyai Cluj ser. biol., 1, 43-46. (in Romanian)

Szasz E., 1968 – Micromicete de pe arbuşti fructiferi spontani din Munţii Făgăraş, Contr. bot. Cluj, 49-58. (in Romanian)

Szasz E., 1964 – Câteva noutăţi micologice din Masivul Făgăraş, Contr. bot. Cluj, 75-80. (in Romanian)

Szasz E., 1969 – Câteva micromicete noi pentru flora micologică a României, Contr. bot. Cluj, 75-82. (in Romanian)

Szasz E., 1970 – Cercetări microfloristice în rezervaţia naturală „Bâlea Lac", Contr. bot. Cluj, 33-44. (in Romanian)

Szasz E., 1977 – Cercetări micofloristice în Valea Doamnei (Munţii Făgăraş), St. şi com. Muz. Brukenthal Sibiu, şt. nat., 21, 25-42. (in Romanian)

Szucs L., 1943 – A Keleti Karpatok endemikus novenyfajai, Acta geobot. Hung. Cluj, 183-240. (in Hungarian)

Şerbănescu G., 1970 – Corologia taxonilor Gentiana clusii Perr. et Song. şi Gentiana excisa Presl. în Carpaţii româneşti, St. şi cerc. biol. ser. bot. Bucureşti, XXII, 6, 475-480. (in Romanian)

Şerbănescu G., 1971 – Corologia speciei Soldanella pusilla Baumg. în Carpaţii româneşti, St. şi cerc. biol. ser. bot Bucureşti, XXIII, 6, 485-490. (in Romanian)

Ştefureac I. T. and Peicea I., 1972 – Corologia speciei Primula minima L. în România, St. şi cerc. biol. ser. bot. Bucureşti, XXIV, 4, 339-343. (in Romanian)

Ştefureac T., 1949 – Bucegia romanica Radian şi alte hepatice eutalice din masivul munţilor Făgăraş, Bul. şt. A. matem., fiz., chim., geol., geogr., biol., şt. tehn. şi agric., Bucureşti, I, 3, 287-290. (in Romanian)

Ştefureac T and Peicea M. I., 1971 – Corologia speciei Saxifraga bryoides L. în Carpaţii româneşti, St. şi cerc. biol. ser. bot. Bucureşti, XXIII, 3, 205-208. (in Romanian)

Tauber F., 1973 – Un monument al naturii: Nigritella rubra în Carpaţii româneşti, Sargetia- Acta mesei Devensis, ser. scient. nat., X, 243-245. (in Romanian)

Tuzson J., 1934 – A Deli Karpatok Novenyfoldrajzi tagolodasa, Index Hort. Bot. Univ. Budapest., II, 5-40. (in Hungarian)

Ungar K., 1913 – Die Alpenflora der Sudkarpathen, Sibiu. (in German)

Ungar K., 1914 – Die siebenburgischen Aconiten, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, LXIV, 1, 1-30. (in German)

Ungar K., 1925 – Die Flora Siebenburgens, Hermannstadt. (in German)

Voik W. and Schneider-Binder E., 1978 – Cercetări asupra asociaţiilor de grohotişuri (Thlaspietea rotundifolii Br.-Bl. 1926) din etajul alpin al Munţilor Făgăraş, St. şi com. Muz. Brukenthal, Şt. nat., 22, 189-202. (in Romanian)

x x x – Schedae ad Floram Exsiccata gramin. et legumin. Romaniae cent. II, Inst. pedag. Piteşti.

x x x – Schedae ad Floram Romaniae Exsiccatam Cent. XXXI, Contr. bot. Cluj, 1968, 511-542.

REFERENCE 2

(ordinated based on the numerical codes used in the conspect)

1. Săvulescu T. (red.), l952-1976 – Flora Republicii Populare Române, I-XIII, Edit. Acad. Bucureşti. (in Romanian)
2. Prodan I., 1939 – Flora pentru determinarea şi descrierea plantelor ce cresc în România, I-II, ed. II-a Cluj. (in Romanian)
4. Nyarady E. I., 1957 – Noi Carduus-uri din flora Carpaților meridionali şi poziția lor față de ceilalți membri ai grupei C. defloratus, St. şi cerc. biol. Acad. R. P. R. Fil. Cluj, III, 1-2, 179-195. (in Romanian)
9. Paucă M., 1968 – Răspândirea speciei Saxifraga paniculata Mill. (S. aizoon Jacq.) pe teritoriul României, St. şi cerc. biol. ser. bot. Bucureşti, XX, 3, 231-238. (in Romanian)
17. Nyarady E. I. and Nyarady A., 1964 – Studiul asupra speciilor secției Ovinae Fr. a genului Festuca din R. P. R., I-II, St. şi cerc. biol. ser. bot. Bucureşti, XVI, 2, 105-142, 3, 165-172. (in Romanian)
25. Resmeriță I. Csűrös Ş., Lupşa-Drăgan V. and Calancea L., 1963 – Contribuții la studiul fitocenologic şi agrotehnic al nardetelor din Transilvania, Com. bot. Bucureşti, II, p. II-a, 7-62. (in Romanian)
35. Puşcaru-Soroceanu E. (red.)., 1963 – Păşunile şi fânețele din Republica Populară Română, Edit. Acad. Bucureşti. (in Romanian)
43. Sanda V., 1969 – Contribuții la taxonomia şi corologia subsecției Alpini Vierhapper a genului Dianthus L. din flora României, St. şi cer. biol. ser. bot. Bucureşti, XXI, 1, 23-30. (in Romanian)
75. Paucă M., 1969 – Răspândirea speciei Saxifraga carpathica Rchb. în România, St. şi cerc. biol. ser. bot. Bucureşti, XXI, 4, 273-275. (in Romanian)
97. x x x – Schedae ad Floram Exsiccata gramin. et legumin. Romaniae cent. II, Inst. pedag. Piteşti.
128. Antonescu P. G., 1926 – Distribuția geografică a coniferelor din România, Teză doctorat Fac. şt. nat. Cluj. (in Romanian)
152. Ungar K., 1925 – Die Flora Siebenburgens, Hermannstadt. (in German)
156. Sanda V., 1970 – Răspândirea speciilor Cerastium alpinum L. şi Cerastium lanatum Lam. în România, St. şi cerc. biol. ser. bot. Bucureşti, XXII, 5, 401-405. (in Romanian)
157. Ştefureac T. and Peicea M. I., 1971 – Corologia speciei Saxifraga bryoides L. în Carpații româneşti, St. şi cerc. biol. ser. bot. Bucureşti, XXIII, 3, 205-208. (in Romanian)
158. Şerbănescu G., 1970 – Corologia taxonilor Gentiana clusii Perr. et Song. şi Gentiana excisa Presl. în Carpații româneşti, St. şi cerc. biol. ser. bot. Bucureşti, XXII, 6, 475-480. (in Romanian)
162. Şerbănescu G., 1971 – Corologia speciei Soldanella pusilla Baumg. în Carpații româneşti, St. şi cerc. biol. ser. bot Bucureşti, XXIII, 6, 485-490. (in Romanian)
164. Popescu A., 1971 – Răspândirea speciilor Bartschia alpina L. şi Gentiana frigida Haenke în Carpații româneşti, St. şi cerc. biol. ser. bot. Bucureşti, XXIII, 4, 325-330. (in Romanian)
170. Popescu A. and Sanda V., 1972 – Răspândirea speciilor Geum montanum L. şi Geum reptans L. în România, St. şi cerc. biol. ser. bot. Bucureşti, XXIV, 2, 103-108. (in Romanian)
172. Ştefureac I. T. and Peicea I., 1972 – Corologia speciei Primula minima L. în România, St. şi cerc. biol. ser. bot. Bucureşti, XXIV, 4, 339-343. (in Romanian)
174. Puşcaru-Soroceanu E. and Puşcaru D., 1971 – Excursii în Munții Făgăraşului, Edit. did. şi pedag. Bucureşti. (in Romanian)

211. Ciurchea M. and Codoreanu V., 1967 – Contribuţii la cunoaşterea florei şi vegetaţiei lichenologice din Munţii Făgăraşului (Valea Bâlii şi Valea Doamnei), Contr. bot. Cluj, 83-92. (in Romanian)
234. Sandu-Ville C., 1971 – Pyrenomycetes-sphaeriales, ciuperci din România, Edit. Acad. Bucureşti. (in Romanian)
251. Ştefureac T., 1949 – Bucegia romanica Radian şi alte hepatice eutalice din masivul munţilor Făgăraş, Bul. şt. A. matem., fiz., chim., geol., geogr., biol., şt. tehn. şi agric., Bucureşti, I, 3, 287-290. (in Romanian)
256. Szasz E., 1964 – Câteva micromicete noi pentru flora R. P. R., recoltate din masivul Făgăraş, Studia Univ. Babeş-Bolyai Cluj ser. biol., 1, 43-46. (in Romanian)
267. Szasz E., 1969 – Câteva micromicete noi pentru flora micologică a României, Contr. bot. Cluj, 75-82. (in Romanian)
269. Szasz E., 1964 – Câteva noutăţi micologice din Masivul Făgăraş, Contr. bot. Cluj, 75-80. (in Romanian)
271. Szasz E., 1970 – Cercetări microfloristice în rezervaţia naturală „Bâlea Lac", Contr. bot. Cluj, 33-44. (in Romanian)
276. Lörinczi F. and Szász E., 1967 – Contribuţii la cunoaşterea micromicetelor din solurile Masivului Făgăraş, Contr. bot., Cluj, 191-202. (in Romanian)
277. Szasz E., 1968 – Micromicete de pe arbuşti fructiferi spontani din Munţii Făgăraş, Contr. bot. Cluj, 49-58. (in Romanian)
305. Nyarady E. I., 1967 – Die subalpinen Holzgewachse des Făgărascher Gebirges und die Mosaikflora des Bâlea-Kessels, Rev. roum. biol. ser. bot., XII, 5, 335-343. (in German)
351. Sanda V. and Schneider-Binder E., 1972 – Răspândirea speciei Dianthus tenuifolius Schur în România, Acta Hort. Bot. Univ. Bucurest., 1970-1971, 653-662. (in Romanian)
343. x x x – Schedae ad Floram Romaniae Exsiccatam Cent. XXXI, Contr. bot. Cluj, 1968, 511-542.
349. Bojor O., 1963 – Contribuţii la identificarea şi cartarea florei medicinale de pe versantul nordic al munţilor Făgăraşului până la lunca Oltului, Acta Hort. Bot. Univ. Bucurest, 1961-1962, fasc. II, 585-604. (in Romanian)
363. Constantinescu C. and Agopian A., 1973 – Plante medicinale din flora spontană, ed. II-a, Bucureşti. (in Romanian)
385. Resmeriţă I., 1973 – Cartarea speciei Leontopodium alpinum Cass. din Carpaţii româneşti, St. şi cer. biol. ser. bot. Bucureşti, XXV, 5, 385-390. (in Romanian)
407. Nyarady E. I., 1931 – Adnotaţiuni la flora României VI (Die Poa- Arten des Schur-schen Herbariums von Lwow (Lemberg), Bul. Grăd. bot. şi Muz. bot. Univ. Cluj, XI, 1-2, 37-50. (in Romanian)
418. Georgescu C. C. and Ciucă M., 1950 – Răspândirea jneapănului sau pinului de munte (Pinus montana Mill.) în R. P. R., Anal. Acad. Bucureşti, ser. geol., geogr., biol., şt. tehn. şi agric., III, 3. (in Romanian)
420. Panţu C. Z., 1931 – Geraniaceele din România, Anal. Acad. Bucureşti, Mem. secţ. şt. ser. III. (in Romanian)
421. Porcius F., 1893 – Diagnosele planteloru fanerogame şi criptogame vasculare cari crescu spontaneu. (in Romanian)
422. Nyarady E. I., 1934 – Adnotaţiuni la Flora României IX, Bul. Grăd. bot. şi Muz. bot. Univ. Cluj, XIV, 1-2, 95-99. (in Romanian)
485. Fronius F., 1856 – Eine naturhistorische Excursion auf dem Negoiu, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, VII, 119-131. (in German)
486. Fuss M., 1857 – Zur Flora Siebenburgens, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, VIII, 170-173. (in German)

520. Fuss M., 1865 – Zur Kryptogamenflora Siebenburgens, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, XVI, 23-35. (in German)

523, 524. Fuss M., 1878 – Systematische Aufzahlungen der in Siebenburgen angegebenen Cryptogamen, Archiv d. Ver. f. siebenb. Landeskunde, NF, XIV, 2, 421-474, 3, 627-708. (in German)

569. Szasz E., 1977 – Cercetări micofloristice în Valea Doamnei (Munţii Făgăraş), St. şi com. Muz. Brukenthal Sibiu, şt. nat., 21, 25-42. (in Romanian)

625. Prodan I., 1939 – Flora pentru determinarea şi descrierea plantelor ce cresc în România, Cluj, II. (in Romanian)

642. Szalay B., 1909 – Hermannstadt: Albie. Ein fragwurdiger Gipfelname im Fogorascher Gebirg, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, LIX, 197-200. (in German)

644. Ungar K., 1914 – Die siebenburgischen Aconiten, Verh. u. Mitt. d. siebenb. Ver. f. Naturwiss. zu Hermannstadt, LXIV, 1, 1-30. (in German)

650. Tauber F., 1973 – Un monument al naturii: Nigritella rubra în Carpaţii româneşti, Sargetia-Acta Devensis, ser. scient. nat., X, 243-245. (in Romanian)

652. Nyarady E. I., 1940 – Die Gruppe des Saussurea alpina und lapathifolia in den Karpaten, Verh. u. Mitt. d siebenb. Ver. f. Naturwiss. zu Hermannstadt, LXXXXIX-XC, 1939-1940, 231-233. (in German)

661. Csuros Ş., 1957 – Adatok a Fogarasi havasok kozponti resze alpin vegetaciojanak ismeretehez, Kulonlenyomat a Koloszvari Victor Babeş es Bolyai egyetemek kozlemenyeibol, Cluj, II, 1-2, 303-310. (in Hungarian)

664. Niedermaier K., 1960 – Contribuţii la cunoaşterea efectului îngrăşămintelor pe pajiştile din Munţii Cibinului, Anal. Inst. de cerc. agron. Bucureşti, ser. A, XXVIII, 163-177. (in Romanian)

709. Lyka K., 1930 – Nehany ujabb Thymus-alakrol, MBL, XXIX, 1-3. (in Hungarian)

717. Ungar K., 1913 – Die Alpenflora der Sudkarpathen, Sibiu. (in German)

722. Simonkai L., 1886 – Enumeratio florae transsilvanicae vasculosae critica, Budapest.

727. Csato J., 1888 – Kirandulas a Bulla volgyen keresztul a Negoj kupjahoz, Nov. Lap., XII, 81-93. (in Hungarian)

739. Fuss M., 1866 – Flora Transsilvaniae Excursoria, Sibiu.

740. Schneider-Binder E. and Voik W., 1976 – Chorologische und zonologische Untersuchungen uber Silene dinarica Spreng., Linzer biol. Beitr., 8, 23-39. (in German)

751. Tuzson J., 1934 – A Deli Karpatok Novenyfoldrajzi tagolodasa, Index Hort. Bot. Univ. Budapest., II, 5-40. (in Hungarian)

771. Szucs L., 1943 – A Keleti Karpatok endemikus novenyfajai, Acta geobot. Hung. Cluj, 183-240. (in Hungarian)

775. Nyarady A., 1966 – Contribuţii la cunoaşterea răspândirii subunităţilor taxonomice ale microspeciilor Festuca valesiaca Schleich., F. pseudovina Hack. şi F. rupicola Heuff. în România, Notule bot. Inst. agron. Cluj, 59-67. (in Romanian)

776. Nyarady A., 1966 – Răspândire şi caracteristici ecologico-fitocenologice ale staţiunilor de Festuca porcii Hack., Notule bot. Inst. agron. Cluj, 81-92. (in Romanian)

778. Lupşa V., 1977 – Răspândirea speciei Aster alpinus L. în Carpaţii româneşti, St. şi cerc. biol. ser. biol. veget. Bucureşti, XXIX, 1, 21-28. (in Romanian)

779. Slonovschi V., 1977 – Cartarea speciei Blechnum spicant (L.) Roth în Carpaţii româneşti, St. şi cerc. biol. ser. biol. veget. Bucureşti, XXIX, 1, 33-38. (in Romanian)

803. Schneider-Binder E., 1980 – Structura asociaţiei Asplenio-Cystopteridetum fragilis Oberd. (1936) 1949 în Carpaţii sudestici, St. şi com. Muz. Brukenthal, Şt. nat., 24, 131-145. (in Romanian)

804. Schneider-Binder E. and Voik W., 1979 – Asociaţiile din clasa Salicetea herbaceae Br.-Bl. 1947 în Carpaţii Meridionali cu privire specială asupra celor din Munţii Făgăraşului, St. şi com. Muz. Brukenthal Sibiu, Şt. nat., 23, 221-237. (in Romanian)

807. Botsch J. H., 1991 – Flora und Vegetation des Podragu-Tales im Fogorascher Gebirge (Sudkarpaten), Naturwiss. Forsch. u. Siebenburgen, IV, Bohlau Verlag, Koln- Weimar-Wien, 121-176. (in German)

808. Popescu A. and Sanda V., 1990 – Vegetaţia grohotişurilor şi bolovănişurilor (Clasa Thlaspietea rotundifolii Br.-Bl. 26) din Carpaţii României, St. şi cerc. biol. ser. biol. veget. Bucureşti, 42, 31-42. (in Romanian)

811. Coldea G. and Plămadă E., 1980 – Contribuţii la studiul Clasei Scheuchzerio- Caricetea fuscae Nordh. 36 din România III, Hidrobiologia, Bucureşti, 16, 109-117. (in Romanian)

819. Voik W. and Schneider-Binder E., 1978 – Asociaţii de grohotişuri (Thlaspietea rotundifolii Br.-Bl. 1926) din etajul alpin al Munţilor Făgăraş, St. şi com. Muz. Brukenthal Sibiu, Şt. nat., 22, 189-202. (in Romanian)

835. Raţiu F., 1982 – Corologia unor specii alpine ale genului Ranunculus în Carpaţii româneşti, Contr. bot. Cluj, 143-154. (in Romanian)

858. Sanda V., Şefan N., Drăgulescu C., Popescu G., Barabaş N., Negrean G., Peicea I. and Ţucra I., 1993 – Răspândirea genului Lycopodium L. în Carpaţii României I-II, St. şi cerc. de biol. ser. biol. veget., Bucureşti, XLV, 1, 27-46 şi 2, 145-160.

863. Resmeriţă I., Puşcaru E. and Morariu I., 1977 – A 10-a consfătuire naţională de geobotanică, Com. bot. Bucureşti, 5-16. 858. (in Romanian)

865. Puşcaru D., Puşcaru-Soroceanu E. and Dan R. I., 1977 – Perspective of increasing the productivity of Festucetum rubrae commutatum- red Fescue meadows of the Făgăraş Mountains by trophic regime improvement, Com. bot. Bucureşti, 63-79.

878. Fekete L. and Blattny T., 1913 – Az erdeszeti jelentosegu fak es cserjek elterjedese a Magyar allam teruleten, I-II, Selmecsbanya. (in Hungarian)

880. Boşcaiu M. and Boşcaiu N. and Ehrendorfer F., 1998 – The Cerastium alpinum group (Caryophyllaceae) in the South-Eastern Carpathians, Contr. bot. Cluj-Napoca, II, 1997-1998, 5-38.

881. Puşcaru-Soroceanu E., Csürős S., Puşcaru D. and Popova-Cucu A., 1981 – Die Vegetation der Wiesen und Weiden des Făgăraş-Gebirges in den Sudkarpaten, Phytocoenologia, 9 (3), 257-309. (in German)

904. Rosler D. and Rosler R., 2000 – Phytoteratologische Beitrage zur Gattung Soldanella in den Karpaten Rumaniens, Naturw. Forsch. u. Siebenburg., VI, Bohlau Verlag Koln-Weimar-Wien, 91-108. (in German)

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TRADITIONAL MANAGEMENT KNOWLEDGE OF GRASSLANDS IN THE SOUTHERN PART OF THE TRANSYLVANIAN TABLELAND (ROMANIA) AS A BASIS FOR CONSERVATION MEASURES

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KEYWORDS: grasslands - meadows and pastures, traditional management, historical information sources, biodiversity, mowing compatibility.

ABSTRACT

The unique landscape of the Transylvanian tableland is characterized by diverse geo-morphological structures which in turn determine the partitioning of vegetation, habitats and species. The natural landscape and vegetation were influenced by human activities through the centuries. Analysis of the site typical grasslands and their biodiversity, underlines that flower rich meadows are of high conservation value, but at the same time they are important for farmers, being their livelihood. The two different groups of interest (conservation and farmers income) must not be in opposition, as it demonstrates the old known practices, the grasslands being used during centuries in a traditional way as pastures and meadows following different models and surviving until present with a high biodiversity. To protect the livelihood of farmers and nature conservation good management is needed, which brings together the different user interests assuring sustainability of grassland use and at the same time conserving ecosystems, habitats and species diversity.

REZUMAT: Cunoaşterea managementului tradiţional al pajiştilor din sudul Podişului Transilvaniei ca bază pentru măsuri de conservare.

Peisajul unic al Podişului Transilvaniei se caracterizează prin structuri geomorfologice diversificate, care la rândul lor sunt determinante pentru distribuţia vegetaţiei, a habitatelor şi speciilor. Peisajul natural şi vegetaţia au fost influenţate de-a lungul secolelor prin activitatea omului. Analizând pajiştile, caracteristice diferitelor staţiuni şi biodiversitatea lor, autoarea subliniază valoarea ridicată din punct de vedere al conservării naturii a pajiştilor bogate în flori şi având o biodiversitate mare, dar în acelaşi timp şi importanţa lor pentru asigurarea bazei de existenţă a fermierilor. Cele două grupe de interese nu trebuie să fie în contradicţie, aşa cum demonstrează practicile vechi ale gospodăririi pajiştilor. De-a lungul secolelor, au fost folosite în mod tradiţional, după diferite modele bine stabilite ca păşuni şi fânețe, păstrându-se astfel cu o biodiversitate ridicată până în prezent. Pentru satisfacerea nevoilor fermierilor şi a conservării naturii este necesar un management adecvat, care întruneşte diferitele interese, asigurând în acelaşi timp atât folosirea durabilă a pajiştilor, cât şi conservarea biodiversităţii ecosistemelor, habitatelor şi a speciilor.

ZUSAMMENFASSUNG: Die Kenntnis der traditionellen Grünlandbewirtschaftung im südlichen Teil des Hochlands von Siebenbürgen als Grundlage für Naturschutzmaßnahmen.

Die einmalige Landschaft des Hochlands von Siebenbürgen kennzeichnet sich durch eine Vielfalt geomorphologischer Strukturen, die ihrerseits für die Verteilung der Vegetation, der Lebensräume und ihrer Arten bestimmend sind. Die Naturlandschaft und ihre Vegetation sind durch die Jahrhunderte lange Bewirtschaftung geprägt worden. Aufgrund einer Analyse der standorttypischen, extensiv genutzten Wiesen und deren Biodiversität stellt die Verfasserin fest, dass diese artenreichen, blumenbunten Wiesen einen hohen Naturschutzwert haben und gleichzeitig auch für die Landwirte und

deren Lebensgrundlage notwendig sind. Diese beiden Interessensgruppen stehen, wie die althergebrachten Nutzungsweisen zeigen, nicht im Gegensatz zueinander, da die Grünlandgebiete über viele Jahrhunderte hinweg auf traditionelle Art entsprechend bestimmten Modellen sowohl zur Beweidung und als auch als Heuwiesen genutzt wurden und auf diese Art und Weise ihre hohe Biodiversität bis heute bewahrt haben. Um die Lebensgrundlage der Landwirte zu sichern und in gleichem Maße den Naturschutz zu berücksichtigen, ist ein gutes Management erforderlich, das die beiderseitigen Nutzerinteressen zusammenführt. Damit ist sowohl die Nachhaltigkeit der Grünlandnutzung als auch der Schutz und Erhalt der Vielfalt der Ökosysteme, Lebensräume und ihrer Arten gewährleistet.

INTRODUCTION

The Transylvanian Tableland is characterized by diversified geo-morphological structures, which on their turn are determinant for the repartition of vegetation, habitats and species. In addition to the natural structures and related site conditions the traditional activities of humans during centuries contributed to the evolution and present state of the landscape diversity with a large variety of habitats, characteristic structure of plant communities and a high species diversity.

The vegetation on the hills in Transylvania is disposed along ecological gradients from the top of the hills to the bottom of the valleys beginning – in particular in the tableland of Southern Transylvania (Podişul Transilvaniei de Sud) – with forests on the top, bushes and tall herbaceous vegetation bordering the forests on the front of the hills and open grasslands – meadows and pastures in dependence of exposition, slope inclination, the related light conditions, temperature and soils (Schneider, 1990, Schneider-Binder 1975, 1977, 1983, 2007). The various conditions create complex macro- and micromosaic structures which are responsible for structural niches and high biodiversity – ecosystems, habitats and species. Such disposition of vegetation can be observed on large hills and as well in smaller hill area such are the slumping hills, the so called "glimee" or "movile" (in the local Saxon dialect "Bächel") in some parts of Southern Transylvania (Schneider-Binder 1996, 2007).

An important part of the smaller and larger hills are covered by grasslands, which have a large extension in the South-Eastern part in the Natura 2000 area (SCI and SPA Sighişoara-Târnava Mare), but also in the other parts of the southern Transylvanian tableland, the whole western area of "Podişul Târnavelor", between Târnava Mare, Visa and Hârtibaciu rivers and also between the last one and the Olt River.

The grassland covers a large range between dry and wet habitats, with xerophilous, meso-xerophilous, mesophilous, meso-hygrophilous and hygrophilous species. Different habitat types of importance for the European Natura 2000 network, each with a large number of different plant communities are present in the area (Oroian 2009, Akeroyd and Page 2011). All these grasslands, in particular meadows are very rich in species of extremely high conservation value. But in the same time these flower-rich grasslands are of high importance for farmers, constituting their livelihood. These two different groups of specific interest for the nature conservation and also for the local farmers must not be in contradiction, because these grasslands were used every time in a traditional way as pastures and meadows following different models, which will be presented below.

Taking into account these aspects, the objective is to answer the question about how to manage at present the grasslands and to conserve their biodiversity. As the present state of the grasslands can not be seen without their past, it is an express need to know how they were managed in the past and how it was possible to preserve their high biodiversity.

MATERIALS AND METHODS

The management of the grasslands in Southern Transylvania has been analysed on the one part on the base of available old bibliographical data concerning traditional grassland use (Schuller, 1895) and information gathered during interviews by people from different villages of Southern Transylvania. On the other part the author used data from own older and new field research by sampling the plant communities on different hills with slopes of various inclination and exposition of the Southern Transylvanian tableland following the method of Braun-Blanquet (1964). The species composition is analysed also following the indicator values of mowing compatibility of grassland plants (in a scale from 1 to 9), this compatibility being an individual morphological-ecophysiological characteristics of the plants which is in strong relation with their regeneration capacity (Briemle and Ellenberg, 1994).

Table 1: Mowing compatibility indicator value (M) according to Briemle and Ellenberg (1994); modified at M6 by the author.

Occurence	M value	Characteristics	Frequency of mowing / year
Succession area, tall herbaceous fringes, old fallow land,	1	Without mowing compatibility (in particular wooden plants without subterranean stolons)	0
straw meadows	2	Between 1 and 3	1
	3	Sensitive to mowing (only autumn mowing compatibility)	1
Extensive to moderate intensive used grasslands	4	Between 3 and 5 (first mowing not before mid of July	1-2
	5	Moderate compatibility (first mowing not before beginning of July)	2
	6	Between 5 and 7 (first mowing not before mid of June)	2- (3)
Intensive grasslands - lawns	7	Good compatible to mowing	3-4
	8	Between 7 and 9 very good compatible to mowing and grazing, i.e. only competitive by frequent mowing or grazing (species of park lawns)	4-6 >6

RESULTS AND DISCUSSIONS

In the large mosaic of structural elements of the near-natural and natural landscape such are forests, hedges, bush groups, vineyards, old field terraces, the grasslands on the hills and the valleys are playing an important role and are still large spread in the tableland. In particular old field terraces are today mostly covered by grasslands – meadows and pastures. These differs one from the other in dependence of exposition, inclination of slopes, related light, temperature conditions and soils. The influence of site factors for the distribution of communities can be examplified by studies of vegetation profiles of hills, with plant communities disposed along ecological gradients, showing the large differences between vegetation of slopes with Southern and Northern exposition and also differences between the front of the slope and the foot of hills. Slopes of Eastern and Western exposition presents a transition of site conditions and also the vegetation include elements with transitional character.

The top of the hills are mostly covered by forests, also the Northern part of hills and plateaus. In South, south-eastern, south-western exposition the forests are

bordered with site typical shrubs vegetation, represented in some places by Small almond (*Amygdalus nana*) and small cerise (*Cerasus fruticosa*), followed by tall herbaceous vegetation represented by communities of the Geranion sanguinei alliance. Frequently is dominating *Dictamnus albus*. In some places (Şeica Mare, Axente Sever, in the past also on Zakelsberg Hill near Şura Mare) a belt of the continental steppe species *Aster villosus* occur (Schneider-Binder 1977, 1983).

The Southern exposed slopes are mostly open, without forest vegetation and covered by grasslands, in particular meadows, but in the last time is visible the appearance of more and more pastures. The former vineyard sites are in large area abandoned and developed to grasslands or colonized by bushes of thermophilous species are developing in their places. On the slopes of the Visa Valley many *Robina pseudoaccacia* bushes extended. They existed on the border of the vineyards beeing introduced as meliferous plants and also for their hard wood, this being used for grape-vines replacing the until that time used oakwood.

Between the upper and the lower part of the slope are large differences in communities and species composition, due to inclination and related sun radiation as well as temperature and underground i.e. soils on quick warming deposits of chalky marl and sandstone (Schneider-Binder, 1977, 1996, 2007). In these condition is possible the high temperatures development, measurements values being between 45-50°C on the southern slope of hills in the Şerbuţa Valley, north of Sibiu (Schneider, 1990).

The following succession of plant communities had been observed from the top of the hills to the bottom of the valley during studies on the southern slopes of Şerbuţa Valley (Schneider, 1990) and the neighbouring Şarba Valley, the steppic reserve of the Dealul Zakel (Schneider-Binder, 1983):

Oak-Hornbeam forest (Querco petraeae-Carpinetum); Small-Almond bush (Amygdaletum nanae) and tall herbaceous vegetation with *Peucedanum cervaria*, *Peucedanum oreoselinum*, *Dictamnus albus*, or with *Aster villosus* a.o.; Feathergrass communities with xerophilous species (*Stipa pulcherrima, Stipa tirsa*, *Salvia nutans, Verbascum phoeniceum, Echium russicum, Astragalus dasyanthus, A. austriacus* and others (Stipetum pulcherrimae, Stipetum tirsae = stenophyllae); grassland with *Festuca valesiaca* (Medicagini-Festucetum valesiacae); xero-mesophilous meadows (Dorycnio-Brachypodietum and Carici-Brachypodietum); Blackthorn bushes, tree hedges; mesophilous hay meadow, wet riverine meadow, tall herbaceous vegetation with *Inula helenium* and riverine Willow-woods. A similar succession have been studied near to Şeica Mare, Agârbiciu, Axente Sever, Micăsasa (Schneider-Binder 1975, 1977, 2007). Other similar successions has been followed on smaller scale on slumping hills (Schneider-Binder, 1996, 2007). All these can be considered as representative for many other hills in the Southern Transylvanian tableland.

In these sites with special conditions, an edaphic steppe vegetation is developing similar to that of eastern European steppes. On these front areas of the upper slope dominates the most extreme conditions, in which can live only species well adapted through special morphological structures. Steppe like meadows with *Stipa* species (*Stipa pulcherrima, S. tirsa = stenophylla*, *S. lessingiana*) and species like *Salvia nutans, Echium russicum*, *Jurinea mollis*, *Vinca herbacea, Cephalaria uralensis*, *Iris pumila, Astragalus dasyanthus, Astragalus austriacus, Verbascum phoeniceum* and many others (Schneider-Binder 1975, 1977, 1996, 2007).

At slope inclination reduction, other communties appears, like communities of Festucion vallesiacae and Cirsio-Brachypodion alliances with communities edified by xero-mesophilous and mesophilous species. These communities are flower rich and represents the highest site typical biodiversity of grasslands on these hills.

From studied communities the highest biodiversity were stated in the xero-mesophilous coummnities edified by

Brachypodium pinnatum, the Carici humilis-Brachypodietum pinnati Sóo (1942) 1947 (Syn: Dorycnio-Brachypodietum pinnati Csürös and Kovács, 1962) and Carici humilis-Chrysopogonetum grylli. It can be stated, that the communities of *Brachypodium pinnatum* of the alliance Cirsio-Brachypodion and those edified by *Chrysopogon gryllus* in the Transylvanian tableland are very closed one to the other (Sanda et al, 2008). In such interference cases from communities near to the more western Mesobromion alliance and Cirsio-Brachypodion alliance are not clarified at all. Both are rich in species, in particular the phytocoenoses of Carici-Brachypodietum have a relatively high number of site typical mostly xero-mesophilous species (Tab. 2). The same high biodiversity in this association with at all 63 species in the frequency classes II-V (based on 15 samples following the method of Braun-Blanquet) were documented during studies in the Southern part of Transylvanian tableland (Schneider-Binder, 1974, 1977) and on the base of recent researches (in 2009 – 2011 period).

Table 2: Examples for the biodiversity of communities on the Southern (incl. SW, SE) exposed hills and on the bottom of the valleys in southern Transylvanian Tableland (Schneider-Binder field research data obtained in 2009 – 2010 period).

Association	Number of species
Stipetum pulcherrimae Soó 1942 (Syn. Salvio nutantis-Stipetum pulcherrimae Boşcaiu et al. 1984)	**34** species (1 sampling Şerbuţa Valley /Şura Mare) and mean number of 43 species represented in the frequency classes II-V and additional species in the class I (25 samples) (Schneider-Binder, 1977);
Thymo pannonici-Stipetum tirsae (= Stipetum stenophyllae Sóo 1946) Sanda et al., 1998	**43** species (1 sampling in the Buia Valley 2009);
Carici humilis-Brachypodietum pinnati Sóo (1942) 1947	**31** species (1 sampling, Ighişu Vechi /Agnita, 20.08.2009); **37** species (1 sampling, Curciu/jud. Sibiu, 4.07.2010); **40** species (1 sampling, Curciu/jud. Sibiu, 4.07.2010)
Thymio pannonici-Chrysopogonetum grylli Doniţă et al. 1992 (Carici humilis-Chrysopogonetum grylli)	**36** species (1 sampling at Ighişu Vechi/Agnita, 20.08.2009); **22, 23, 34** species (3 samples at Zlagna, jud. Sibiu, 20.08.2009); **30** species (1 sampling at Motiş/jud. Sibiu, 25.08.2009); **35** species (1 sampling at Curciu, jud. Sibiu, 4.07.2010);
Botriochloetum (Andropogonetum) ischaemi (Kristiansen 1937) Pop 1977	**19** species (1 sampling at Bîrghiş; used as pasture), **34** species (1 sampling at Bîrghiş, used as meadow); **17** species (1 sampling at Motiş, jud. Sibiu, area used as pasture);
Medicagini-Festucetum valesiacae Wagner 1940	**25** species (1 sampling Dealul Ocnei/Sibiu, 16.06.2011, use for grazing); mean number of 45 species in the frequency classes II-V (on the base of 10 samples, Schneider-Binder 1975)
Diplachneto-Festucetum valesiacae Br.-Bl. 1938	**17** species (1 sampling, Motiş/jud. Sibiu, 25.08.2009, erosion area);
Deschampsietum caespitosae Hayek ex Horvatic 1930 (Syn: Agrostio stoloniferae-Deschampsietum caespitosae Ujvàrosi 1947)	**20** species (1 sampling, Movile/jud. Sibiu, 13.09.2010); **34** species (1 sampling, Beneşti/Agnita, 20.08.2009); **37** species (1 sampling, Ţeline, Hârtibaciu Jud. Sibiu, 3.07.2010);

The large mosaic of communities and species diversity developed through human activities during centuries constitutes a great value for man and nature. But this value is in danger by different practices, which are not taking into account the traditional use and management of grasslands, i.e. hay meadows and the alternation of use in grasslands as hay meadows and as pasture lands. A notable loss is observed in the meadows on the slopes of Gusterița/Fărmăndoala Valley near the Sibiu locality, for the reason, that the grasslands are more used as pastures and less as hay meadows, disappearing many species with low mowing compatibility such as for example *Centaurea atropurpurea* (information from Vonica G.) and sensitive also to eutrophication.

Analysing the site typical biodiversity of grasslands disposed along ecological gradients today it have to take into account - apart from the large area still remained under traditional use of grasslands - tree main aspects, which can be observed in the traditional landscape.

In some area it is obvious an intensification of use (higher frequency of mowing and chemical fertilizer; in others we can observe a change of use by transforming grasslands used in the past by mowing and extensive grazing into permanent pastures with grazing by sheep, the number of animals being frequently higher as can be supported by the vegetation cover. An other problem is, that former grasslands are abandoned entering in succession by appearance and spreading of bushes as a first evolution stage to forests. In each of these cases the biodiversity is not only changing but also decreasing with loss of many important, rare and endangered species which are of great value for the ecosystem and nature conservation. For this reason it should be study, what we can do to conserve the state of existing good meadows or to improve these, which are transformed by not appropriate use.

The analyse of the compatibility to mowing (Briemle and Ellenberg, 1994) can help to identify if and how far the grassland developed from a typical extensively used one and how we can remediate the situation to bring it again in the state of an extensively used meadow following the old traditions.

Analysing the species composition following the mowing compatibility values in a wet meadow of Hârtibaciu Valley, it is clear visible, that the most species are included in the categories 4, 5 and 6 indicating compatibility to extensive use or moderate intensively used grasslands. (Fig. 1). An analyse of species following their main abundance-dominance values on the base of 3 samples from the Hârtibaciu Valley near Beneşti and near to Țeline, the predominance of species of mowing compatibility value 3 and 5 shows the dominance of species sensitive to mowing and supporting only a late mowing as well as species with moderate compatibility to mowing (Fig. 2). This fact demonstrate again the extensive use of this type of meadow.

In the category of mowing compatibility indicator value 4, representing species of extensively used meadows with the first mowing not before mid of July are included *Briza media* (17.6% in 3 samples), *Stachys officinalis, Rhinanthus rumelicus, Lathyrus aphaca, Juncus articulatus, Caltha palustris, Carex distans, Juncus effusus, Galium palustre* and others. The mowing compatibility indicator value 5 is represented by *Deschampsia caespitosa*, as a species with high abundance-dominance values (112.5% in 3 samples), *Galium mollugo, Pastinaca sativa, Lathyrus pratensis, Galium verum, Centaurea jacea, Cirsium oleraceum, Myosotis palustris, Juncus inlflexus, Centaurea Phrygia, Angelica sylvestris, Colchicum autumnale* and others. The mowing compatibility indicator value 6 is represented by *Symphytum officinale, Lotus corniculatus, Trifolium campestre, Ranunculus stevenii, Ranunculus acris, Holcus lanatus, Leucanthemum vulgare, Daucus carota, Equisetum palustre* (35.1% in 3 samples), *Crepis biennis, Odontites serotina, Vicia cracca, Festuca pratensis*.

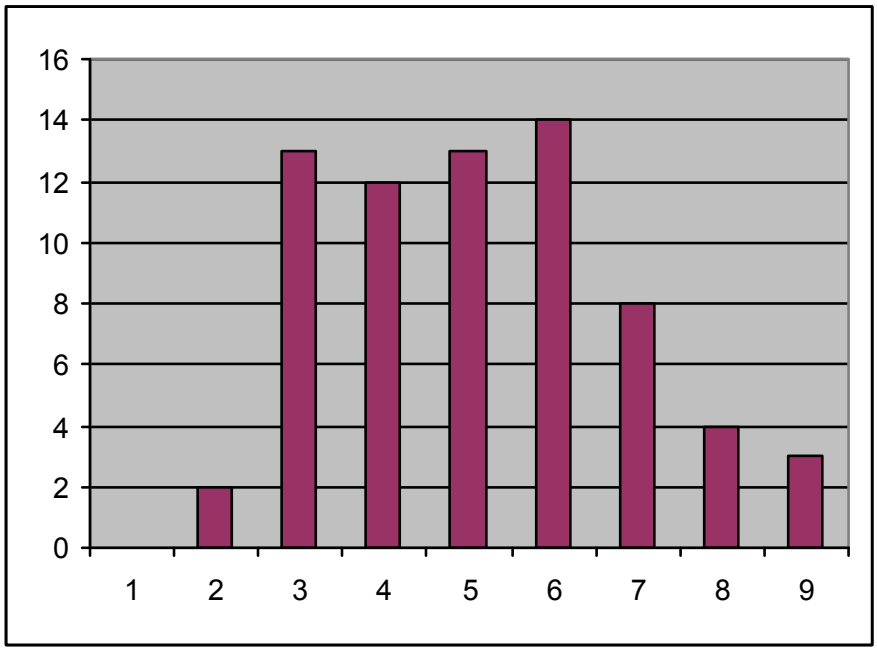

Figure 1: Species number in the different mowing compatibility value categories of a wet meadow (Agrostio-Deschampsietum caespitosae) in the Hârtibaciu Valley (in 2009).

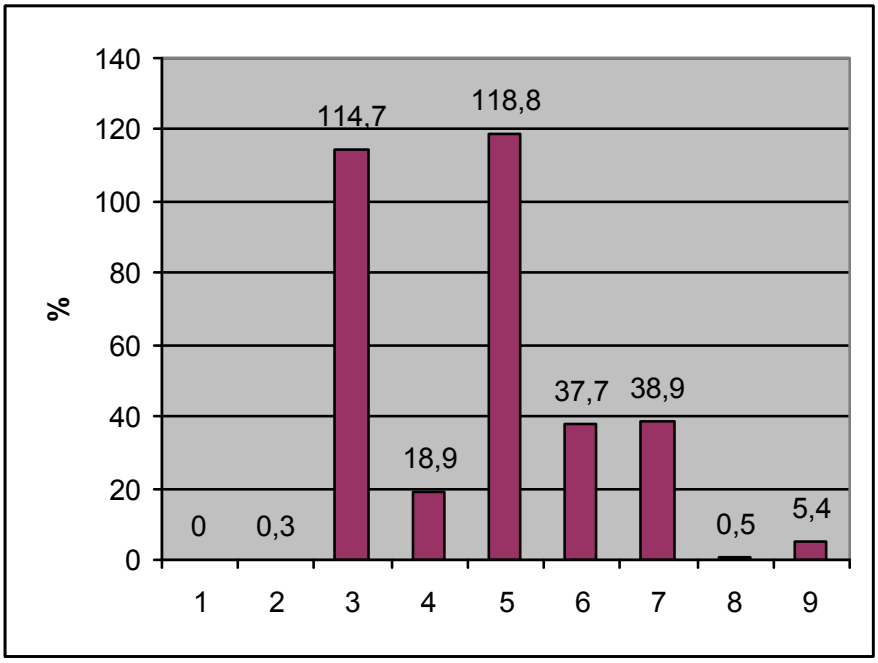

Figure 2: Repartition of species to the different mowing compatibility value categories following their abundance-dominance in a wet meadow (Agrostio-Deschampsietum caespitosae) in the Hârtibaciu Valley (in 2009).

Also the species of the mowing compatibility indicator value 3 is well represented, including species sensitive to mowing and supporting only a late mowing in autumn. These species are *Cirsium canum* (112.5% in 3 samples*), Phragmites australis, Pulicaria vulgaris, Ononis villosa, Selinum carvifolia, Lycopus europaeus, Filipendula ulmaria, Agrimonia eupatoria, Lythrum salicaria, Dactylorhiza incarnate, Orchis laxiflora* ssp. *elegans* and *Thalictrum flavum.*

The category of mowing compatibility indicator value 7 characteristic for the intensively used grasslands is as well represented. Apart from *Trifolium pratense* (37.6% mean value in 3 samples) all the other species are presents with very low abundance-dominance values (only +). To this group counts the species *Trifolium hybridum, Plantago lanceolata, Medicago lupulina, Veronica chamaedrys, Cynosurus cristatus, Trisetum flavescens* and *Trifolium dubium.*

Management

To conserve and use in a sustainable manner the grasslands in the historical landscape of Transylvania (Romania), the management have to be based on the knowledge of the traditional management practices and experience from the past. We have to know how these areas around the villages were used and based on which principles. Following old data about grasslands, it became clear, that existed guidelines and strong indications for their use, which had to be hold by the members of the community. The propriety of each community included forests, pasture lands and water courses.

The community grasslands were part of the Commons ("Allmende"), the pasture opened for the use as grazing place for the villagers livestock. Nearby, first meadows, called "Hewes" were also - for a part of the year - part of the Commons, the communities own pasture lands (Schuller, 1895). In early spring time they were used as part of the Commons for pasture (until end of April), and than used by particulars as hay meadows (until end of august). Data for use as pasture and for mowing were planned and had obliging character for all members of the community (Schuller, 1895). There existed also grasslands used only as pasture and others only as hay meadow.

According to the opinion of Schuller (1895), which consulted many old documents, the management of grasslands in the Transylvanian Saxon villages followed old practices brought from the Mosel and Rhine in the 12th century. These practices included some established roules which are:

- the use of a grassland as pasture in the beginning spring time until first of May (later fixed on Saint George day the 24th April), after that time used as hay meadow by traditional mowing with scythe and up to 24th of August again used as a pasture. During this practice of use (up to the first of May) the beginning of hay harwest was relatively late, i.e. the first Sunday after Saint Margareta/ 12th of July (at that time the seeds were spreaded). Later the Saint John's day (24 June) were fixed with some adaptions following weather condition;

- meadows mowed twice during the vegetation period (1 March to 1 Octomber) (known up to the 13th century) and if long autumn occurred after that time pasturing was allowed. This practice remained usual until present. In some area (Sighişoara, Rupea) only before Saint George day /24 April and after Saint Micheal /29 September was allowed the use as pasture. This practice remained usual until present in the most of villages and assumed also in other villages, were these practices were not used.

Using this methods with strong roules during centuries it has been possible to develop and to have such species and flower rich meadows, with plant well adapted to the rhytm of use. The meadows use in Transylvania was, apart from the fixed periodical mowing almost without other special management. Apart from cleaning the meadows from thistles and other tall herbaceous weeds, special meadow culture like in Western Europe with harrow works and irrigation practices was not usual in the area of the Transylvanian Saxon villages (Schuler, 1895). As it is mentioned on the beginning of the 20th century until that time the farmers "became not friends" with the additional fertilization of hay meadows and of the pastures (Roth, 1911).

According to some old documents mentioned by Schuler (1895) the extension of grasslands, in particular the hay meadows was variable and changed in the course of the centuries. For example in the 18th century in the Laslea/Groß Lasseln community existed 1178 acre arable land and 1188 acre of meadows, which shows that about the same

surface existed for these different uses. Later, on the end of the 19th century (1895), the situation changed in favour of arable lands, these being 1682 acre and meadows together with gardens only 994 acre. Pastures at that time were only the area of the commons (Schuller, 1895).

As pasture were used also the communal forests, in the 15th , 16th and 17th centuries and in some areas it was also usual, even if not agreed by the newer forest legislation, until the end of 19th century (Schuler, 1895). A proof for this type of use are at present the remaind wood pastures as the Breite near Sighişoara, areas near Saschiz, Alţinâ and Caşolţ in the Hârtibaciu Valley and in other places in the tableland.

Grazing was in general usual only on the commons (the community pasture) and with obligation for all the villagers, existing also at present in the most communities. The double utilization as pasture and as meadow was and is allowed only following the above mentioned time specification.

In other type of pasture is related to the arable lands. After their harwesting the stubbles pasture were also usual and can find also at present in some area.

If in the Southern Transylvania have not existed during many centuries the hard work of hay harwesting by traditional mowing with whetted scythes followed by the turn-over for drying, stocking and storing the hay in hayricks and appropriate barns - this hay rich meadows would have never existed. This is also underlined by Niedermaier (1977) for the surroundings of Movile/Hundertbücheln in the Hârtibaciu Valley, from were are know colourful meadows with rich biodiversity and of high conservation value.

CONCLUSIONS

In the traditional landscape of Southern Transylvanian tableland exists large area of high nature value grasslands, which are of great interest for nature conservation as well as for farmers. These grasslands preseserve meadows with high biodiversity of plants and many site characteristic insects. It seems to be different groups of interest for their use, but these groups of interest for nature conservation and for farmers must not be in contradiction, as the historical situation is teaching us, that these grasslands were used every time in a traditional way as pastures and meadows following different models. The question have to be today how to use the grasslands for satisfying livelihood of farmers with flower rich hay of good quality as well as good pastures, and for conserving in the same time sustainably the high site typical biodiversity of interest for nature conservation. For such purposes it is highly needed an optimum/good management plan, which brings together the different user interests.

Taking into account the experience from the past with sustainable practices of use and combining it with new knowledge concerning site conditions and ecological indicator values as well as knowledge about mowing compatibility of plants, we can have both – grasslands/meadows with high conservation value (only hay meadows being with high biodiversity) and grasslands for farmers. Considering the traditional practices in the management plans for Natura 2000 sites, we can conserve the important habitats and species of Community interest and use them in the same time on a sustainable way.

REFERENCES

Akeroyd J. R. and Page J. N., 2011 – Conservation of high nature value (HNV) Grasslands in a farmed landscape in Transylvania, Romania. Contribuţii Botanice, XLVI: 57-71, Cluj-Napoca.

Braun-Blanquet J., 1964 – Pflanzen-soziologie. 3. Aufl., pp. 865, Wien. (in German)

Briemle G. and Ellenberg, H., 1994 – Zur Mahdverträglichkeit von Grünlandpflanzen. Möglichkeiten der praktischen A nwendung von Zeigerwerten. Natur und Landschaft, 69, 4: 139-147. (in German)

Niedermaier, K. 1977, Geheimnisvolle siebenbürgische Landschaft. Naturwissenschaftliche Wanderungen zwischen Alt und Großer Kokel. Siebenbürgisch-sächsischer Hauskalender, 23. Jahrgang, Jahrbuch 1978, München. (in German)

Oroianu S., 2009 – Flora şi Vegetaţia satelor săseşti din sud-estul Transilvaniei, University Press Târgu Mureş, pp. 275. (in Romanian)

Roth C., 1911 – Über Weidewirtschaft. Landwirtschaftliche Blätter, Jg. XXXIX, p. 176-178, p. 213-215, Hermannstadt. (in German)

Sanda V., Öllerer K. and Burescu P., 2008 – Fitocenozele din România. Sintaxonomie, structură, dinamică şi evoluţie. Ars docendi Universitatea din Bucureşti, pp. 570 (in Romanian)

Schneider-Binder E. (1975) – Flora şi vegetaţia Depresiunii Sibiului şi a dealurilor marginale. University Cluj-Napoca, pp. 513. (in Romanian)

Schneider-Binder E., 1975 – Xerothermic grasslands of the Order Festucetalia valesiacae Br.- Bl. Et Tx. 1943 in zone hills area bordering the Depression of Sibiu. Studii şi Comunicări, Ştiinţe Naturale, Muzeul de Istorie Naturală, Sibiu, 19, 95-120, Sibiu.

Schneider-Binder E., 1977 – Despre comunităţile alianţei Stipion lessingianae Soó 1947 în România. Muzeul Brukenthal, Studii şi Comunicări, Ştiinţe Naturale, Muzeul de Istorie Naturală, Sibiu, 21, 91-113, Sibiu. (in Romanian)

Schneider-Binder E., 1983 – Die Flora des Steppenreservates am Zakelsberg (Slimnic, Siebenbürgen). Studii şi Comunicări, Ştiinţe Naturale, Muzeul de Istorie Naturală, Sibiu. 25: 153-176, Sibiu. (in German)

Schneider-Binder E., 1996 – Reliefbedingte Abfolge von Pflanzengesellschaften an Rutschungshügeln in Süd-siebenbürgen (Harbachhochland). Stapfia, 45, 83-93, Linz, Austria. (in German)

Schneider-Binder E., 2007 – Xerophilous and xero-mesophilous grasslands on slumping hills around the Saxon villages Apold and Saschiz (Transylvania, Romania), Transylvanian Review of Systematical and Ecological Researches 4, "The Saxon Villages Region of southeast Transylvania", (eds. Curtean-Bănăduc et al.), pp. 55-64.

Schneider E., 1990 – Entomofauna biocenozelor stepice de pe colinele neogene din nord-estul Depresiunii Sibiului. University Cluj-Napoca, Phd thesis, pp. 214. (in Romanian)

Schuller G. A., 1895 – Aus der Vergangenheit der siebenbürgisch-sächsischen Landwirtschaft From the past of the Transylvanian-Saxon agriculture, Hermannstadt, Buchdruckerei W. Krafft, pp. 130. (in German)

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THE FAUNISTIC AND ECOLOGIC CHARACTERIZATION OF THE TERRESTRIAL ISOPOD SPECIES FOUND IN FOUR MEADOWS OF THE BAIA MARE DEPRESSION (MARAMUREŞ, ROMANIA)

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KEYWORDS: Romania**,** Maramureş, Baia Mare Depression, species, ecological index.

ABSTRACT

We carried out research on the communities of terrestrial isopods found in four meadows in Baia Mare, all grassland ecosystems without woody vegetation. Here we identified 10 species of isopod, of which we collected 2,101 individuals.

Analysing the spread of the 10 species identified, we draw the conclusion that the richest species community, of seven terrestrial isopod species, occurs in the meadow at Dura Hill, Baia Mare. For these species, the numerical abundance value calculated for all the isopod species is the highest ($\overline{X}$ = 135.2). In this meadow there is also a diversity of microhabitats, which enables the existence of some marsh, forest and grassland species that have different ecological demands. Numerical abundance values show the existence of numerous populations: both forest, e.g. *Trachelipus arcuatus* ($\overline{X}$ = 14.9), and grassland species, e.g. *Armadillidium vulgare* ($\overline{X}$ = 36.5).

The distribution of species within the research area is different. The widest distributions are those of *Trachelipus wächtleri* and *T. nodulosus,* found in three of the meadows. Other species are present in one meadow only: *Hyloniscus riparius, Porcellium collicolum, Trachelipus rathkei, Metoponorthus pruinosus.* The first two of these species have extremely reduced populations. We should emphasize that none of the species was found in all the meadows, which suggests that there are important ecological differences between the meadows that we researched.

Hyloniscus riparius, Cylisticus convexus and *Porcellium collicolum* have low numerical abundance in these ecosystems.

In the meadow between the villages of Şişeşti and Dăneşti the ecological conditions are not suitable for terrestrial isopods, as shown by the fact that over a period of a month and a half only two isopod individuals belonging to two different species were captured in five traps. The very high aridity and temperatures here during the summer produces impossible conditions for isopods in this site.

REZUMAT: Caracterizarea faunistică şi ecologică a speciilor de izopode terestre din fânețele studiate din Depresiunea Baia Mare (Maramureş, România).

În Depresiunea Baia Mare, am făcut cercetări asupra comunităților de izopode terestre din 4 fânețe, ecosisteme praticole fără vegetație lemnoasă. În aceste fânețe, am identificat 10 specii de izopode din care am colectat un număr de 2101 indivizi.

Analizând răspândirea celor 10 specii identificate, constatăm că cea mai bogată comunitate în specii se află în fâneața de pe Dealul Dura, din Baia Mare, care cuprinde 7 specii de izopode terestre, pentru care valoarea abundenței numerice calculată pentru toate speciile de izopode este cea mai mare ($\overline{X}$ = 135,2). În această fâneață, există şi o diversitate de microhabitate, care face posibilă existența unor specii paludicole, silvicole şi praticole, cu cerințe ecologice diferite. Valorile abundenței numerice arată existența unor populații numeroase atât la

specii silvicole, ca *Trachelipus arcuatus* ($\overline{X}$ = 14.9), cât şi la speciile praticole, ca *Armadillidium vulgare* ($\overline{X}$ = 36,5).

Răspândirea speciilor în fâneţele studiate este diferită. Cea mai mare răspândire o au speciile *Trachelipus wächtleri* şi *Trachelipus nodulosus,* prezente în câte 3 fâneţe. Alte specii sunt prezente numai în câte o fâneaţă: *Hyloniscus riparius, Porcellium collicolum, Trachelipus rathkei, Metoponorthus pruinosus.* Primele 2 specii au populaţii extrem de reduse. Menţionăm că nici o specie nu a fost capturată în toate fâneţele, constatare care sugerează diferenţe ecologice mari între fâneţele studiate.

Hyloniscus riparius, Cylisticus convexus, Porcellium collicolum, au valori mici ale abundenţei numerice în aceste ecositeme.

În fâneaţa dintre localităţile Şişeşti şi Dăneşti condiţiile ecologice sunt improprii pentru izopodele terestre, deoarece într-o perioadă de o lună şi jumătate au fost capturaţi numai 2 indivizi de izopode care aparţin la 2 specii diferite, în 5 capcane. Ariditatea foarte mare şi temperaturile ridicate în perioada de vară, fac condiţiile imposibile pentru izopode.

ZUSAMMENFASSUNG: Faunistische und ökologische Charakteristik der terrestrischen Isopoden in Wiesen der Senke von Baia Mare (Maramuresch/Rumänien).

In der Senke von Baia Mare wurden Untersuchungen terrestrischer Isopoden-Gemeinschaften in vier unterschiedlichen Heuwiesen, Grünlandökosysteme ohne Gehölzvegetation, durchgeführt. Es wurden zehn Arten von Isopoden festgestellt, von denen die Aufsammlung von 2101 Individuen für die Untersuchungen berücksichtigt wurden.

Bei der Analyse der Verbreitung dieser zehn Arten zeigte sich die artenreichste Gemeinschaft in der Wiese des Dura Bergs bei Baia Mare. Sie umfasst sieben Arten terrestrischer Isopoden, deren für alle Arten errechneter, numerischer Abundanzwert am größten war (= 135,2). Diese Heuwiese beherbergt auch eine Vielfalt von Mikrohabitaten, die das Vorkommen von Sumpf-, Wald- und Wiesenarten mit unterschiedlichen ökologischen Ansprüchen ermöglicht. Die Werte der numerischen Abundanz zeigen das Vorkommen zahlreicher Populationen sowohl von Waldarten, wie beispielsweise *Trachelipus arcuatus* (= 14,9), als auch von Wiesenarten beispielsweise *Armadillidium vulgare* (36, 5).

Die Verbreitung der Arten in den untersuchten Heuwiesen ist unterschiedlich. Die weiteste Verbreitung haben die Arten *Trachelipus wächtleri* und *Trachelipus nodosus*, die beide in dreien der vier untersuchten Wiesen vorkommen. Andere Arten wie: *Hyloniscus riparius*, *Porcellium collicolum, Trachelipus rathkei, Metoponorthus pruinosus* finden sich nur in je einer der untersuchten Heuwiesen. Die ersten beiden der genannten Arten sind nur durch sehr geringe Populationen vertreten. Zu bemerken ist, dass keine einzige der untersuchten Arten in allen vier Heuwiesen anzutreffen ist, was auf die großen ökologischen Unterschiede zwischen den untersuchten Wiesen hinweist.

Hyloniscus riparius, *Cylisticus convexus* und *Porcellium collicolum* haben geringe numerische Abundanzwerte und sind in den Wiesenökosystemen in kleinen Populationen mit geringer Individuenzahl zu finden.

In der Wiese zwischen den Ortschaften Siseşti und Dăneşti sind die ökologischen Bedingungen für terrestrische Isopoden ungünstig, was durch den Fang von nur zwei Individuen zwei verschiedener Arten bei fünf ausgelegten Fallen belegt werden kann. Die große Trockenheit und die hohen Sommertemperaturen machen das Leben der Isopoden an diesem Standort unmöglich.

INTRODUCTION

The Romanian terrestrial isopods have been studied mainly from taxonomic point of view. The taxonomic research made by Radu V., had as a result the printing of two publications with the Romanian fauna (Radu, 1983, 1985). Ecologic researches on terrestrial isopods were made in the second half of the XXth century and the beginning of the XXIth century, when some of Romanian doctoral degree thesis were elaborated (Tomescu, 1973; Accola, 1993; Olariu, 1999; Mureşan, 2004; Hotea, 2006); the results of these researches were published in scientific journals.

Our study on the terestrial isopods in these 4 meadows in Baia Mare Depression, belongs to an ample research theme, which has as the main aim the study of terrestrial isopods in Baia Mare Depression and the sorrounding areas.

MATERIALS AND METHODS

In this research we took samples from four meadows in Baia Mare Depression, which are different when taking into consideration their temperature, altitudine, humidity and vegetation structure. These differences influence the communities of the terrestrial isopods.

Collecting the isopods has been done with soil traps (Barber traps). In the traps we put salty water from Ocna Şugatag (salt mine area). We took the sample after at least a month after placing the traps. The collected biological material was put in separate tubes in alcohol (70%), and analysed in the laboratory. We determined the species and we calculated the ecologic indexes (parameters).

The meadow, situated on Dura Hill in Baia Mare, a plane surface, with a relatively dry soil, situated at 216 m altitudine. In this ecosystem we placed 10 Barber traps, and the samples were taken monthly. From these samples we collected a number of 1352 individuals, belonging to 7 species of isopods: *Hyloniscus riparius* 1 individual, *Cylisticus convexus* 7 individuals, *Trachelipus arcuatus* 299 individuals, *Trachelipus wächtleri* 100 individuals, *Trachelipus nodulosus* 81 individuals, *Trachelipus rathkei* 134 individuals and *Armadillidium vulgare* 730 individuals.

The meadow, situated in Cătălina Village, a plane surface with a relatively low soil humidity, at 164 m altitudine. Here we placed 6 Barber traps. We identified 562 individuals belonging to 5 species of terrestrial isopods: *Trachelipus arcuatus* 22 individuals, *Trachelipus wächtleri* 5 individuals, *Trachelipus nodulosus* 2 individuals, *Porcellio scaber* 1 individual, *Armadillidium vulgare* 532 individuals.

The meadow, situated in Coltău Village, a slightely inclined surface, a soil with a moderate humidity, at 176 m altitudine. In this meadow we placed a number of 7 Barber traps. From the samples taken we collected 185 individuals of isopods belonging to 4 species: *Porcellium collicolum* 2 individuals, *Trachelipus nodulosus* 21 individuals, *Metoponorthus pruinosus* 76 individuals, *Porcellio scaber* 86 individuals.

The meadow, situated between Şişeşti and Dăneşti villages, at 346 m altitudine. From the samples taken from the 5 Barber traps we collected only 2 isopod individuals belonging to the species: *Cylisticus convexus* 1 individual and *Trachelipus wächtleri* 1 individual. In our research on terrestrial isopod communities we took samples from four meadows in Baia Mare Depression, which are different when taking into consideration their temperature, altitudine, humidity and vegetation structure. These differences influence the communities of the terrestrial isopods.

RESULTS

From all the 4 meadows we researched we collected a number of 2101 individuals belonging to 10 species of terrestrial isopods (Tab. 1).

Numeric Abundence ($\overline{X}$). In the meadows where we studied the isopod fauna, the highest numeric abundence (Tab. 1), has been registered at the praticol species *Armadillidium vulgare* ($\overline{X}$ = 88.6) in the meadow from Cătălina Village and ($\overline{X}$ = 36.5) in the meadow on the Dura Hill, Baia Mare. High numeric abundance values were also registered for the following species: *Trachelipus arcuatus* ($\overline{X}$ = 14.9) in the meadow on Dura Hill, eurithopic *Porcellio scaber* ($\overline{X}$ = 12.28) praticol *Metoponorthus pruinosus* ($\overline{X}$ = 10.8) in the meadow in Coltău Village. The high abundance of the forestry species *Trachelipus arcuatus* and *Trachelipus wächtleri* in 2 meadows can be explained by the migration of the individuals of the 2 species from the sorrounding ecosystems.

Analysing the species communities in the meadows, we draw the conclusion that the community with the most numerous species can be found on the meadow on Dura Hill, Baia Mare, consisting of 7 terrestrial isopod species, with the highest numeric abundance value calculated for all the species of isopods ($\overline{X}$ = 135.2). Here, we have also a high diversity of microhabitats, which makes the existence of some marsh, forestry, and praticol species with different ecological demands possible. The numeric abundance values show the existence of a numerous population of forestry species, for example *Trachelipus arcuatus* ($\overline{X}$ = 14.9), and praticol species as well, for example *Armadillidium vulgare* ($\overline{X}$ = 36.5).

The ecologic diversity in this meadow is also marked by the existence of 4 species of *Trachelipus,* 2 forestry, 1 praticol and 1 eurithopic species, situation not yet mentioned in the previous research papers. We also want to underline the absence of the forestry species *Protracheoniscus politus* although the samples contained 2 forestry species. These results indicate significant differences regarding the ecological demands of the species *Protracheoniscus politus politus*, compared with the 2 forestry species present in this meadow. The conditions for the marsh species are extremely poor, in the samples we captured only one individual of *Hyloniscus riparius*.

In the meadow situated in Cătălina Village we identified 5 species of isopods. Two forestry species also live here, but their population number is low. The highest abundance number ($\overline{X}$ = 88.6) was found at the praticol species *Armadillidium vulgare*. The microhabitats favourable for praticol species are dominant here, and they are reprezented by the very numerous population of the species: *Armadillidium vulgare*. The numeric abundance value calculated for all the species of the isopods identified here ($\overline{X}$ = 93.6), is lower in comparison to that calculated on the meadow Dura Hill, but it shows that in this meadow as well, the isopod populations are numerous.

In the meadow situated in Coltău Village, there live praticol, eurithropic, and forestry species; the ecological conditions here do not permit the existence of marsh species. The numeric abundance value calculated for all the species of the identified isopods ($\overline{X}$ = 26.4), show that the number of the individuals in the populations is relatively high, but low compared to other searched meadows.

There are also meadows with harsh conditions for terrestrial isopods, as an example the meadow between Şişeşti and Dăneşti villages, where during a month and a half only two individuals of isopods were captured in 5 traps. The aridity and the very high temperatures during the summer time makes the life conditions for the isopods impossible. In this meadow the numeric abundance value calculated for all the identified species is very low ($\overline{X}$ = 0.4), which sustains what was previously wrote.

The distribution of the species in the searched meadows is different. The largest spreading was for *Trachelipus wächtleri* and *Trachelipus nodulosus,* were founded in 3 meadows. Other species are present only in one meadow: *Hyloniscus riparius, Porcellium collicolum, Metoponorthus pruinosus Trachelipus rathkei.* The first 2 species have very reduced populations. No one species was captured in all meadows, which indicates the fact that there are great ecological differences between them.

The species *Hyloniscus riparius, Cylisticus convexus, Porcellium collicolum,* have low numeric abundance values, being represented by populations with a low number of individuals in these ecosystems.

The relative abundance, the frequency and the index of ecologic significance have been calculated for 3 meadows, where over 20 individuals of 2 or more species were captured.

Table 1: Terrestrial isopod communities in Baia Mare Depression meadows: FD = hay on Dura Hill, Baia Mare; FC = hay in Cătălina Village; FCO = hay in Coltău Village; FSD = hay between Şişeşti and Dăneşti; $\overline{X}$ = numeric abundance (absolute); I = ecologic categories of terrestrial isopods: pa = marsh; s = forestry (sylvan); pr = praticol; eu = eurithope.

No.	Species	I		FD	FC	FCO	FSD	Total
1.	*Hyloniscus riparius*	pa	n	1				1
			$\overline{X}$	0.05				
2.	*Cylisticus convexus*	pr	n	7			1	8
			$\overline{X}$	0.35			0.2	
3.	*Porcellium collicolum*	s	n			2		2
			$\overline{X}$			0.28		
4.	*Trachelipus arcuatus*	s	$\overline{X}$	14.9	3.66			321
			n	299	22			
5.	*Trachelipus wachtleri*	s	n	100	5		1	106
			$\overline{X}$	5	0.83		0.2	
6.	*Trachelipus nodulosus*	pr	n	81	2	21		104
			$\overline{X}$	4.05	0.33	3		
7.	*Trachelipus rathkei*	eu	n	134				134
			$\overline{X}$	6.7				
8.	*Metoponorthus pruinosus*	pr	n			76		76
			$\overline{X}$			10.8		
9.	*Porcellio scaber*	eu	n		1	86		87
			$\overline{X}$		0.16	12.28		
10.	*Armadillidium vulgare*	pr	n	730	532			1262
			$\overline{X}$	36.5	88.6			
Total individuals				1352	562	185	2	2101
Total species				7	5	4	2	10
Numeric abundance/ Total individuals			$\overline{X}$	135.2	93.6	26.4	0.4	

Relative abundance (A). As well as in the numeric abundance, the values of the relative abundance (Tab. 1 and Fig. 1), are different from one species to another species, from one meadow to another meadow, but also within the same species in different meadows, according to the local ecological factors.

In the meadow on Dura Hill, in the Baia Mare area, the high values of relative abundance were registered at the following sampled species: eudominant *Armadillidium vulgare* (**A** = 53.9%) and *Trachelipus arcuatus* (**A** = 22.1%). The dominant species are the following: *Trachelipus rathkei* (**A** = 9.91%), *Trachelipus wächtleri* (**A** = 7.39%), *Trachelipus nodulosus* (**A** = 5.99%). The subrecedent species are: *Hyloniscus riparius* (**A** = 0.073%) and *Cylisticus convexus* (**A** = 0.51%).

In the meadow in Cătălina Village, based on the relative abundance, the isopod species are: eudominant *Armadillidium vulgare* (**A** = 94.6%), subdominant *Trachelipus arcuatus* (**A** = 3.91%) and subrecedent *Trachelipus wächtleri* (**A** = 0.88%), *Trachelipus nodulosus* (**A** = 0.35%), *Porcellio scaber* (**A** = 0.17%).

Table 2: Ecologic index of terrestrial isopods population in the meadows from Baia Mare Depression: FD = meadow on Dura Hill, Baia Mare; FC = meadow in Cătălina Village; FCO = meadow in Coltău Village; A = relativ abundance(%); F = frequency (%); W = index of ecological significance (%).

No.	Species	Ecological index %	FD	FC	FCO
1.	*Hyloniscus riparius*	A	0.073		
		F	5		
		W	0.003		
2.	*Cylisticus convexus*	A	0.51		
3.	*Porcellium collicolum*	A			1.08
		F			14.2
		W			0.1
4.	*Trachelipus arcuatus*	A	22.1	3.91	
		F	75	50	
		W	16.5	1.9	
5.	*Trachelipus wachtleri*	A	7.39	0.88	
		F	45	33.3	
		W	3.3	0.2	
6.	*Trachelipus nodulosus*	A	5.99	0.35	11.35
		F	40	16.6	57.1
		W	2.3	0.05	0.7
7.	*Trachelipu rathkei*	A	9.91		
		F	40		
		W	3.9		
8.	*Metoponorthus pruinosus*	A			41.08
		F			100
		W			41.08
9.	*Porcellio scaber*	A		0.17	46.4
		F		16.6	85.7
		W		0.02	39.7
10.	*Armadillidium vulgare*	A	53.9	94.6	
		F	95	100	
		W	51.2	94.6	
	Total individuals		1352	562	185
	Total species		7	5	4

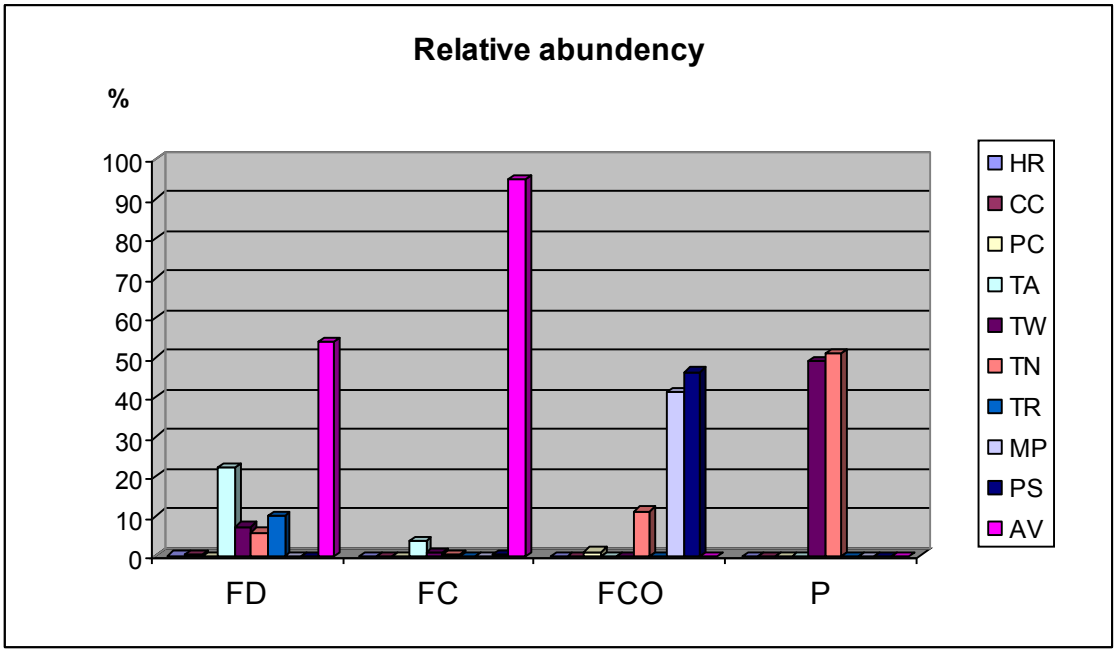

Figure 1: **Relative abundance (A%),** of the terrestrial isopods populations in the meadows from Baia Mare Depression; **FD** = meadow on Dura Hill Baia Mare; **FC** = meadow in Cătălina; **FCO** = meadow in Coltău; **PC** = *Porcellium collicolum*; **TA** = *Trachelipus arcuatus*; **TW** = *Trachelipus wächtleri*; **TN** = *Trachelipus nodulosus*; **TR** = *Trachelipus rathkei*; **MP** = *Metoponorthus pruinosus*; **PS** = *Porcellio scaber*; **AV** = *Armadillidium vulgare.*

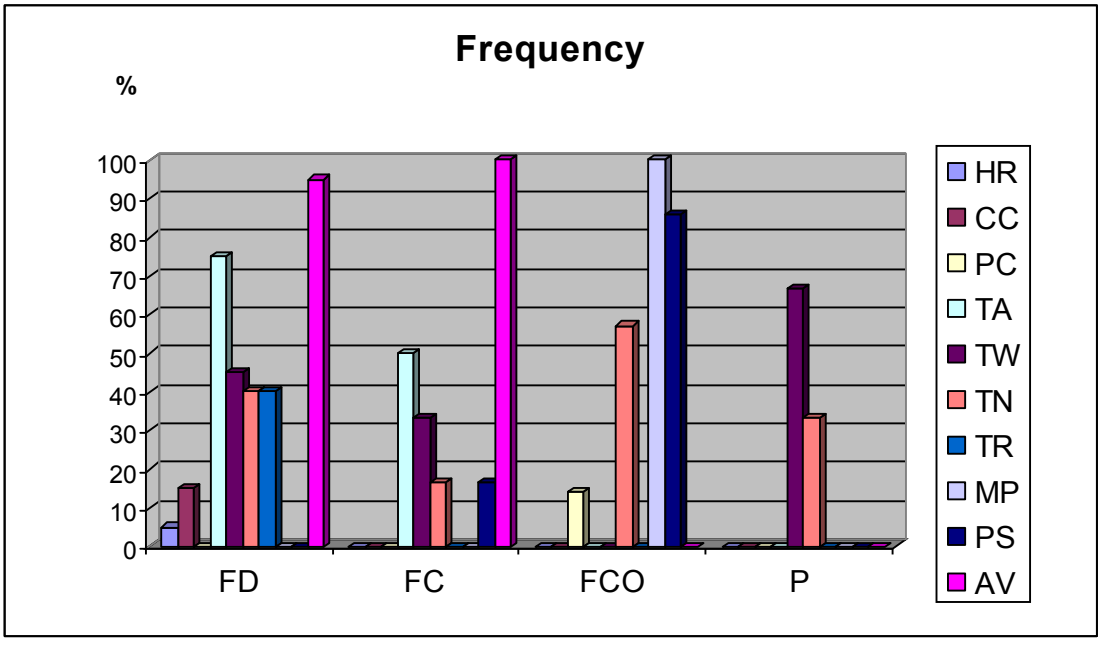

Figure 2: **Frequency (F%),** of terrestrial isopod populations in the meadow from Baia Mare Depression; **FD** = meadow on Dura Hill in Baia Mare; **FC** = meadow in Cătălina; **FCO** = meadow in Coltău; **TA** = *Trachelipus arcuatus*; **TW** = *Trachelipus wächtleri*; **TN** = *Trachelipus nodulosus*; **TR** = *Trachelipus rathkei*; **MP** = *Metoponorthus pruinosus*; **PS** = *Porcellio scaber*; **AV** = *Armadillidium vulgare.*

In the meadow in Coltău Village, some species are eudominant: *Porcellio scaber* (**A** = 46.4%), *Metoponorthus pruinosus* (**A** = 41.08%), *Trachelipus nodulosus* (**A** = 11.35%), and *Porcellium collicolum* (**A** = 1.08%) is subrecedent.

Frequency (F%) of the terrestrial isopods from the samples taken from the meadows, has different values (Tab. 2 and Fig. 2). A high frequency value has been registered for **euconstant and self-evident** species for these meadows, *Metoponorthus pruinosus* (F = 100%) in the meadow from Coltău, *Armadillidium vulgare* (F = 100%) in the meadow from Cătălina, (F = 95%) in the meadow on Dura Hill, *Porcellio scaber* (F = 85.7%) in the meadow from Coltău. High frequency values have been also registered in **constant species** *Trachelipus arcuatus* in the meadow on Dura Hill (F = 75%), *Trachelipus nodulosus* (F = 51.1%) in the meadow from Coltău.

Accessorial species in these ecosystems are: *Trachelipus rathkei* (F = 40%), *Trachelipus nodulosus* (F = 40%), *Trachelipus wächtleri* (F = 45%), all in the meadow on Dura Hill, *Trachelipus arcuatus* (F = 50%), *Trachelipus wächtleri* (F = 33.3%) in the meadow from Cătălina.

Accidental species in these ecosystems are: *Hyloniscus riparius* (F = 5%), *Cylisticus convexus* (F = 15%) in the meadow on Dura Hill, *Porcellio scaber, Trachelipus nodulosus* (F = 16.6%) in the meadow from Cătălina, *Porcellium collicolum* (F = 14.2%) in Coltău meadow.

Index of ecologic significance (W). The index values of ecological significance (Tab. 2), shows that in these meadows from Baia Mare Depression, the significant and characteristic species are: *Trachelipus arcuatus* (W = 16.5%) and *Armadillidium vulgare* (W = 51.2%) in the meadow on Dura Hill, *Armadillidium vulgare* (W = 94.6%) in the meadow situated in the Cătălina Village, *Metoponorthus pruinosus* (W = 41.08%), *Porcellio scaber* (W = 39.7%) in Coltău meadow.

The accessorial species in these ecosystems are: *Trachelipus wächtleri* (W = 3.3%), *Trachelipus nodulosus* (W = 2.3%), *Trachelipus rathkei* (W = 3.9%) in the meadow on Dura Hill, *Trachelipus arcuatus* (W = 1.9%), *Trachelipus wächtleri* (W = 2.2%) in the meadow from Cătălina Village, *Porcellium collicolum* (W = 0.1%), *Trachelipus nodulosus* (W = 0.7%) in the meadow in Coltău.

The accidental species in the searched meadows are the following: *Hyloniscus riparius* (W = 0.003%), *Cylisticus convexus* (W = 0.07%) in the meadow on Dura Hill, *Trachelipus nodulosus* (W = 0.05%), *Porcellio scaber* (W = 0.02%) in the meadow from Cătălina.

Similarity. The values of similarity index (Tab. 3), show that the 4 meadows, do not resemble from the terrestrial isopod faunistic point of view. The highest similarity value has been registered between the meadows on Dura Hill and in Coltău Village, all the other values are very small.

Table 3: The values of similarity index calculated for the meadows in Baia Mare Depression: 1 = hay on Dura Hill, Baia Mare; 2 = hay from Cătălina; 3 = hay from Coltău.

Types of ecosystem	1	2	3
1	*		
2	0.4328	*	
3	1	0.0807	*
4	0.3150	0.0378	0.4455

Coenotic affinity, was calculated for the species identified in each meadow. The results obtained show that, biotope factors: relief, temperature, humidity, soil chemistry of the soil, influences the affinity of the terrestrial isopod species in relation to their ecological demands. Thus, a lot of species live in microhabitats which are not close, which makes the individuals of these species not to show in the same sample.

In the meadow on the Dura Hill, where 7 species of isopods (Fig. 3), the highest values of cenotic affinity has been registered at: *Trachelipus arcuatus* and *Armadillidium vulgare,* which were found together in 79% of the samples. *Trachelipus arcuatus* and *Trachelipus nodulosus, Trachelipus arcuatus* and *Trachelipus rathkei* were found together in 53% of the samples, *Trachelipus arcuatus* and *Trachelipus wächtleri* were found together in 50% of the samples taken. The following species weren`t found together: *Hyloniscus riparius* and *Cylisticus convexus, Cylisticus convexus* and *Trachelipus nodulosus*. Small values of cenotic affinity were registered between the following species, too: *Hyloniscus riparius* and *Armadillidium vulgare, Hyloniscus riparius* and *Trachelipus arcuatus, Hyloniscus riparius* and *Trachelipus wächtleri, Hyloniscus riparius* and *Trachelipus rathkei,* the values between these species are between 5 and 13%; these values suggest that there are big differences between the ecological demands of the species and the lack of close microhabitats, with proper conditions for every species.

It is necessary to underline a few aspects we consider to be new from the scientific point of view, because they haven`t been mentioned before. Cohabitation between *Trachelipus arcuatus* forestry species and *Armadillidium vulgare* praticol species. These 2 species were found together in 79% of our samples.

Cohabitation of 4 species of *Trachelipus*, which were found together in aproximately 50% of the samples, indicates that in this meadow the ecologic conditions generally correspond to the phisiological demands of the 4 species, reprezented by relatively numerous populations.

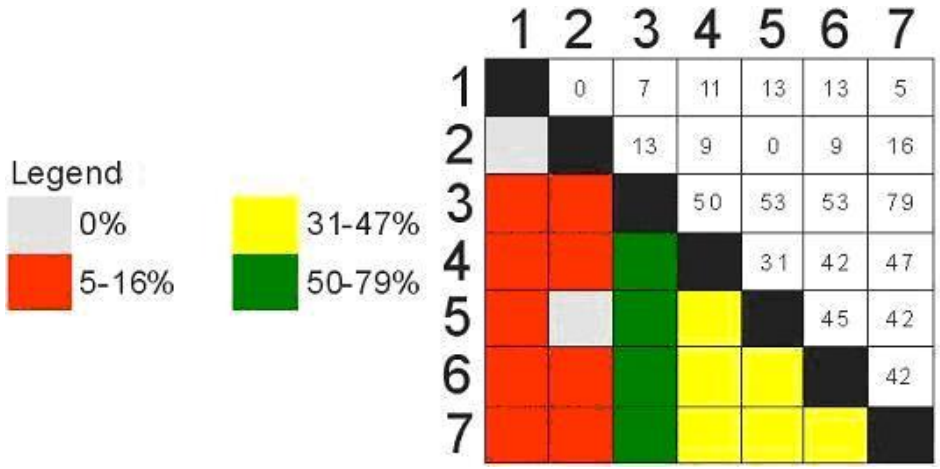

Figure 3: Cenotic affinity of terrestrial isopod species in the meadow on Dura Hill; 1 = *Hyloniscus riparius*; 2 = *Cylisticus convexus*; 3 = *Trachelipus arcuatus*; 4 = *Trachelipus wächtleri*; 5 = *Trachelipus nodulosus*; 6 = *Trachelipus rathkei*; 7 = *Armadillidium vulgare*.

In the meadow of Cătălina Village, where 5 species of terrestrial isopods living, we registered cenotic affinity values of 50% between the species: *Trachelipus arcuatus* and *Armadillidium vulgare, Trachelipus wächtleri* and *Porcellio scaber*, also values of 33% registered between individuals of: *Trachelipus wächtleri* and *Armadillidium vulgare*. In this meadow we didn`t find the following species together: *Trachelipus arcuatus* and *Trachelipus nodulosus, Trachelipus arcuatus* and *Porcellio scaber, Trachelipus wächtleri* and *Trachelipus nodulosus, Trachelipus nodulosus* and *Porcellio scaber* (Fig. 4).

In this hay too, the forestry species cohabit with the praticol species. Unlike the situation of *Trachelipus* in Dura Hill meadow, which cohabit in the same microhabitats, in Cătălina meadow the

forestry species *Trachelipus arcuatus* and *Trachelipus wächtleri* do not cohabit with the praticol *Trachelipus nodulosus*. In no other sample were found together individuals of *Trachelipus nodulosus* with individuals of the 2 forestry species. This is a proof that in this meadow the ecologic conditions determine a complete isolation in certain microhabitats of *T. nodulosus* from the other 2 congeneric species.

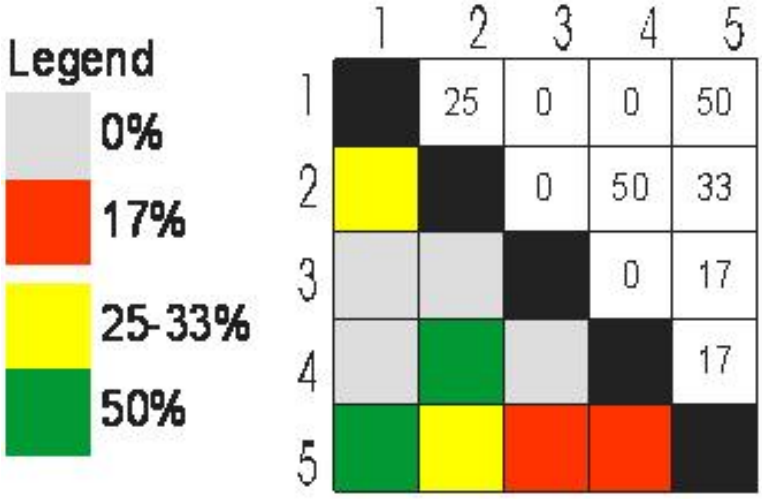

Figure 4: The cenotic affinity of terrestrial isopod species in Cătălina meadow;
1 = *Trachelipus arcuatus*; 2 = *Trachelipus wächtleri*; 3 = *Trachelipus nodulosus*;
4 = *Porcellio scaber*; 5 = *Armadillidium vulgare.*

In the meadow of Coltău Village, from the 4 terrestrial isopod species, the following: *Porcellium collicolum* and *Trachelipus nodulosus* were not identified together. The value of cenotic affinity between the species: *Porcellium collicolum* and *Metoponorthus pruinosus* is 14%, between *Porcellium collicolum* and *Porcellio scaber* 17%, between *Trachelipus nodulosus* and *Metoponorthus pruinosus* 57%, between *Trachelipus nodulosus* and *Porcellio scaber* 43%, but the highest value of cenotic affinity in this meadow was registered between the species: *Metoponorthus pruinosus* and *Porcellio scaber* 86% (Fig. 5).

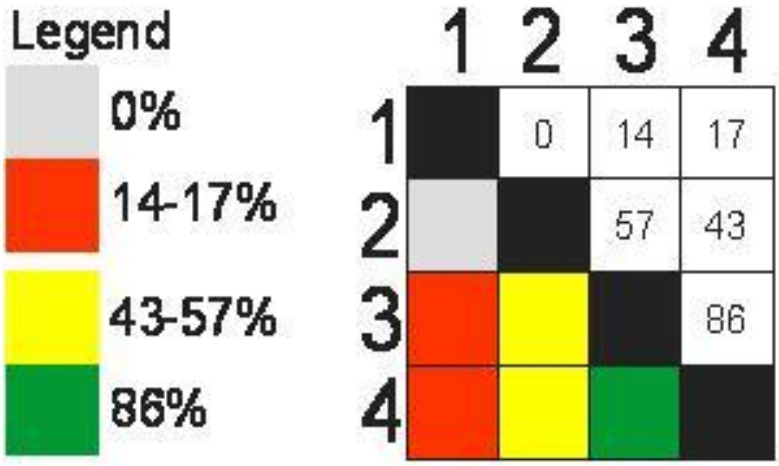

Figure 5: Cenotic affinity of the species of terrestrial isopods in Coltău meadow;
1 = *Porcellium collicolum*; 2 = *Trachelipus nodulosus*;
3 = *Metoponorthus pruinosus*; 4 = *Porcellio scaber.*

Sex proportion. It was calculated for all the isopod populations with a high number of individuals, identified in the meadows, from where a high number of individuals was collected. The values of the sex proportion show that the populations of the forestry species: *Trachelipus arcuatus* from which we collected 321 individuals (m/f = 38/62%), the females dominate with 62%, and the males represent 38%; *Trachelipus wächtleri* from which we collected 130 individuals (m/f = 28/72%), exactly as in the previous species, within the population the females dominate with 72% over the males 28%. The praticol species: *Trachelipus nodulosus* 129 individuals collected (m/f = 28/72%), the sex proportion is identical to that of the forestry species *Trachelipus wächtleri*. The *Metoponorthus pruinosus*: 76 individuals collected: (m/f = 43/57%), the sex proportion is favourable to female, but with a small difference over that of the males. For *Armadillidium vulgare,* 1262 individuals collected, (m/f = 57/43%), the sex proportion indicate a higher number of males over the females in the population. For eurithope species: *Trachelipus rathkei* 134 individuals collected (m/f = 52/48%), the males dominate are dominating, and *Porcellio scaber* 87 individuals collected (m/f = 23/77%), the number of females is dominant (Fig. 6).

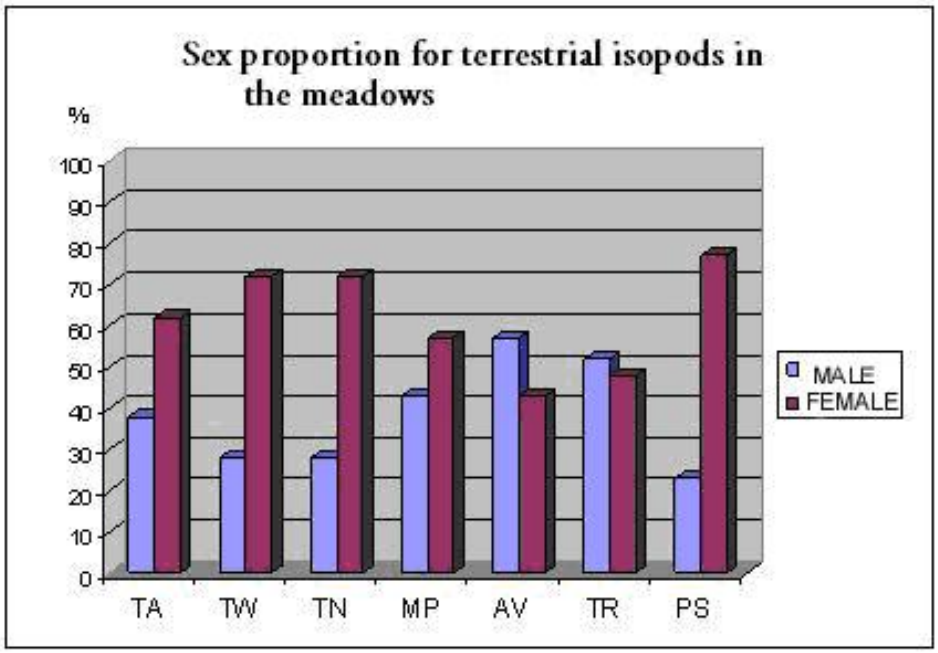

Figure 6: Sex proportion for terrestrial isopods in the meadows;
TA = *Trachelipus arcuatus*; TW = *Trachelipus wächtleri*;
TN = *Trachelipus nodulosus*; MP = *Metoponorthus pruinosus*;
AV = *Armadillidium vulgare*; TR = *Trachelipus rathkei*;
PS = *Porcellio scaber*.

CONCLUSIONS

In the researched meadows, we identified 10 species of terrestrial isopods. The characteristic and most representative species are: *Trachelipus arcuatus* (W = 16.5%) and *Armadillidium vulgare* (W = 51.2%) in the meadow on Dura Hill, *Armadillidium vulgare* (W = 94.6%) in the meadow in Cătălina Village, *Metoponorthus pruinosus* (W = 41.08%), *Porcellio scaber* (W = 39.7%) in the meadow in Coltău Village.

The accesorial species in these ecosystems are: *Trachelipus wächtleri* (W = 3.3%), *Trachelipus nodulosus* (W = 2.3%), *Trachelipus rathkei* (W = 3.9%) in the meadow on Dura Hill, *Trachelipus arcuatus* (W = 1.9%), *Trachelipus wächtleri* (W = 2.2%) in the meadow in Cătălina Village, *Porcellium collicolum* (W = 0.1%), *Trachelipus nodulosus* (W = 0.7%) in the meadow in Coltău Village.

The accidental species in the searched meadows are: *Hyloniscus riparius* (W = 0.003%), *Cylisticus convexus* (W = 0.07%) in the meadow on Dura Hill, *Trachelipus nodulosus* (W = 0.05%), *Porcellio scaber* (W = 0.02) in the meadow in Cătălina Village.

The value of cenotic affinity index shows that in the researched meadows, the isopods species are geographically isolated. The species *Trachelipus nodulosus* is totally isolated from congeneric species in certain microhabitats, because of the ecological conditions. As well, there are relatively important differences in the terrestrial isopods community structure.

In the researched meadows, the female number dominates in the following isopods species: *Trachelipus arcuatus, Trachelipus wächtleri, Trachelipus nodulosus, Metoponorthus pruinosus* and *Porcellio scaber*, and the sex proportion is favourable to males in the following species: *Armadillidium vulgare* and *Trachelipus arcuatus.*

In the meadow on Dura Hill, one single numeric growth has been registered in the isopods population from May to August, included.

REFERENCES

Accola S., 1993 – The Ecology and biology of some terrestrial isopod species - Ph.D., "Babeş-Bolyai" University, Cluj-Napoca, Romania.

Hotea R., 2006 – Faunistic and ecologic research regarding the terrestrial isopods in Baia Mare Depression and the sorrounding areas. Ph.D. thesis. Babeş-Bolyai University, Cluj – Napoca, Romania, pp. 121-130.

Mureşan D., 2004 – Study on terrestrial isopod populations in Arieşului Basin area and the Superior Basin area of the Warm Someş. Ph.D. thesis "Babeş-Bolyai" University, Cluj-Napoca.

Olariu L., 1999 – Faunistic, biologic and ecological study of terrestrial isopod populations in Dornelor area. Ph.D. thesis "Babeş-Bolyai" University, Cluj-Napoca, 1999.

Radu V. G., 1983 – The Fauna of Socialist Republic of Romania, Crustacea vol. IV, Fasc., 13, Ed. Acad., R.S.R., 1983. (in Romanian)

Radu V. G., 1985 – The Fauna of Socialis Republic of Romania, Crustacea vol. IV, Fasc., 14, Ed. Acad., R.S.R. (in Romanian)

Tomescu N., 1973 – Cercetări morfologice, biologice şi ecologice, la izopodele terestre. Ph.D., Univ. „Babeş-Bolyai", Cluj-Napoca. (in Romanian).

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LATEST DATA CONCERNING THE SPREAD OF XYLOPHAGOUS CERAMBYCIDAE COLEOPTERA IN THE TÂRNAVA (TRANSYLVANIA, ROMANIA) GEOGRAPHICAL BASIN

Petru ISTRATE [1]

KEYWORDS: Romania, Transylvania, Cerambycidae, xylophagous, old trees.

ABSTRACT

This paper is a study of the spread of Cerambycidae Coleoptera species in the forests of the Târnava Basin. For this purpose, the deciduous (oak and beech) forests and the conifer forests in the hill and mountain areas of this basin were studied during the adults' flight period. The willow forests growing along the rivers were also visited. Most of the on-site research was carried out in the years 2005 – 2009, although some of the original information dates back to the years 1990 – 2005. The original data were supplemented with information from the few papers published over the last decades concerning the spread of Cerambycidae in the Târnava Basin. Considerable material was collected on 79 species of xylophagous Cerambycidae, by various methods such as: night collection on a screen, close observation, collection by means of fermented baits, collection of wood infested with larvae so that adults were obtained in the laboratory. The material is being kept in the author's personal collection and in the Natural Science Department of Târgu-Mureş County Museum. Most of the species collected develop in Central Europe and they thrive on the wood of deciduous trees, especially on oak-trees. The presence of certain rare species, as shown in the Appendix II of the European Union Habitats Directive, makes us believe that some of the deciduous forests growing in the hilly areas of this basin still favour the survival of these species. These forests exhibit a high biodiversity.

REZUMAT: Date recente privitoare la răspândirea coleopterelor cerambycidae xylofage din Bazinul geografic al Târnavei (Transilvania, România).

În acestă lucrare, este prezentat un studiu al răspândirii speciilor de coleoptere cerambycidae în pădurile din bazinul Târnavei. În acest scop, au fost cercetate în perioada de zbor a adulţilor pădurile de foioase, stejar şi fag, precum şi cele de conifere, din zona colinară şi montană a bazinului. Pădurile de sălcii din lunca râurilor au fost de asemenea cercetate. Majoritatea studiilor în teren s-au realizat în anii 2005 – 2009, dar o serie de date originale provin şi din anii 1990 – 2005. La datele originale, se adaugă cele preluate din puţinele lucrări apărute în ultimele decenii despre răspândirea cerambycidelor în bazinul Târnavei. În urma folosirii unor variate metode de colectare a insectelor: prin observaţie directă, colectare nocturnă la ecran, capcane cu momeli fermentate, prelevare de lemn infestat cu larve şi obţinerea adulţilor în laborator; a fost colectat un material bogat, aparţinând unui număr de 79 specii de cerambycidae xilofage, material depozitat în colecţia personală a autorului, precum şi în cea a Muzeului Judeţean Târgu Mureş, secţia Ştiinţele Naturii. Dintre speciile colectate, majoritatea se dezvoltă în lemnul esenţelor de foioase, în special stejar, şi sunt specii Central Europene. Prezenţa unor specii rare, care au fost incluse în Anexa II a Directivei Habitate a Uniunii Europene, ne fac să considerăm că în unele areale, pădurile de foioase din zona colinară a bazinului mai prezintă un habitat propice dezvoltării speciilor, păduri caracterizate printr-o biodiversitate ridicată.

RÉSUMÉ: Des données récentes concernant la distribution de coléoptères xylophages Cerambycidae dans le bassin géographique Târnava (Transylvanie, Roumanie).

Cet ouvrage est une étude sur la distribution des espèces de coléoptères Cerambycidae dans les forêts du bassin Târnava. Dans ce sens, on a étudié, pendant la période de vol des adultes, les forêts de feuillus (chêne et hêtre) et les forêts de conifères, dans les zones de collinaires et montagneuses de ce bassin. Nous avons visité également les forêts de saules qui poussent le long des rivières. La plupart des recherches sur place ont été réalisés dans les années 2005 – 2009, alors que certaines des informations d'origine remonte aux années 1990 – 2005. Les données initiales ont été complétées par des informations à partir des documents publiés au cours des dernières décennies concernant la distribution des Cerambycidae dans le bassin de Târnava. Un vaste matériel a été recueilli, dont 79 espèces de Cerambycidae xylophages, par différents moyens, tels que: la collecte nocturne sur un écran, après une observation attentive, la collecte au moyen d'appâts fermentés, la collecte de bois infesté de larves, les adultes étant ensuite obtenues dans le laboratoire. Le matériel est conservé dans la collection personnelle de l'auteur et dans le Musée de Târgu-Mureş - le département des sciences naturelles. La plupart des espèces recueillies se développent en Europe centrale et elles prospèrent dans le bois de feuillus, en particulier sur les chênes. La présence de certaines espèces rares, comme indiqué dans l'annexe II de la Directive Habitat, qui nous fait croire que certaines des forêts de feuillus favorisent le développement de ces espèces dans les régions montagneuses de ce bassin. Ces forêts présentent une grande biodiversité.

INTRODUCTION

The Târnava Basin, located in Central Romania, is a complex region, made up of three relief units, i.e.: the plateau unit, the Sub-Carpathians unit and the mountain unit, respectively. The forests cover about 9% of the north-east of the basin, where the rainfall amounts to 500 mm per year, and they extend gradually towards east, covering about 60% of the Gurghiu Mountains, where the rainfall averages 1000 mm per year. The degree of annual precipitation as reported to the height at which the forests grow explains the presence of the oak and hornbeam forests in the east and the presence of the mixed beech or beech and spruce and all-spruce forests in the east and these factors determine the spread of the xylophagous Cerambycidae. Considering the spread of these types of forests, we have tried to identify the xylophagous Cerambycidae groups specific to each type of habitat and we have settled the limits of certain areas of wide entomological biodiversity in these forests.

MATERIALS AND METHODS

Our research on the spread and ecology of the xylophagous Cerambycidae has included a detailed investigation of the forests growing in the east and in the centre of the basin, within the plateau unit, mostly around the town of Târnăveni, where the Dacian oak and hornbeam grow, code Natura 2000: 91Y0*, as well as the Siberian forest steppe vegetation, including *Quercus* spp., code Natura 2000: 91I0*, which however only covers smaller patchy areas, strongly affected by repeated tree cutting.

The second area of interest was the area of the Saxon villages, the Sighişoara-Târnava Mare Natura 2000 site. Various priority habitats have been described there, including the types of deciduous-tree forests, of which we mention the Pannonian forest vegetation, including *Quercus pubescens*, code Natura 2000: 91H0*, forests highly preserved, with high entomological diversity. The evergreen (holm)-oak and beech and hornbeam forests, in various proportion, and the beech forests are the

most widely spread forests in this area of the basin. Quite important are the pastures on which age-old oak-trees are growing, e.g. Breite Plateau, where more than 500 *Quercus pedunculiflora* oaks can be found, or smaller plateaus, such as Brănişte Plateau, Roadeş Plateau, Boian Plateau, etc. These plateaus have been searched and a lot of Cerambycidae have been collected there. The last areas of interest were the beech forests and the beech and spruce forests, as well as the all-spruce forests in the Sovata-Bucin area. We collected here species that develop on *Picea abies* or on various wood essences that can be found along the brooks.

The Cerambycidae sampling was specific. As these species emerge in spring and summer successively, they were collected starting from mid-April in the hilly areas, when species come out to feed on tree and shrub blooms and flowers, till mid-July, when the last species appear. In the mountainous area, where the vegetation emerges later and there is more moisture in the air, insect collection can be done better till mid-August. We chose the places for collection after studying the frequency of older trees, which showed many signs of getting dry and we also looked for those places abounding in tree-stumps and trunks that had fallen on the ground etc.

We collected adults from branches, stumps and trunks, tracing them by sight. The Cerambycidae are thermophile insects, that is why they can be found on branches facing the sun or at least partially exposed to the sunrays. We were also quite successful when inspecting the branches showing signs of attack, such as galleries and the wood dust. The wood stacks set up by rangers on the border of the forest are the ideal place for searching and collecting a lot of species of Cerambycidae that live on wood. The large trees, such as the oaks growing on the pastures and in the meadows in the vicinity of the Saxons villages are often attacked by *Cerambyx cerdo* (Fig. 1), or other species. The adults' which exit galleries are quite large and they can be found easily. A special method of collection is finding the larvae living in the rotten wood of the roots of old trees growing in the meadows at the edge of the forest, as well as looking for branches with emergency holes for adults. We picked up these branches from the soil or broke them off the tree trunks before snowfall and stored them in terrariums covered with iron nets. In winter and early in spring, the adults left the pupae chamber and we could find them lying on the walls of the terrariums.

Inspecting the flower growing by the forests we could collect palynophagous adults, by means of an entomological net.

Many insects hide in daytime under tree bark. The insects living in the forest canopy, especially those that thrive on the wood of small branches, e.g. *Ropalopus macropus* (Fig. 2), are harder to trace and collect. This is why we have used fermented baits hanging from the trees, at a certain height. The traps were checked every week for collecting the adults.

RESULTS AND DISCUSSIONS

On the whole we have examined 708 specimens of Cerambycidae. They belong to 51 genera, with 79 species and 6 subfamilies: Prioninae, Lepturinae, Spondylinae, Necydalinae, Cerambycinae and Lamiinae. Most of them (all the Cerambycidae collected by the author after the year 2000) are being kept in the author's private collection. A part of the material examined comes from the Cerambycidae individuals collection of the Mureş County (Transylvania, Romania) Museum - the Natural Science Department, material that was as well collected by the author of this paper in the year 2001. The material had been previously studied by Florentina Togănel and it was used for compiling a catalogue of the Cerambycidae kept in the Târgu-Mureş Museum. Of all the Cerambycidae the museum had acquired from the author, i.e. 467 specimens, 337 are xylophagous and the author had collected them in the Târnava Basin.

Further information was obtained by studying the private collection of professor Vasile Vicol, Târgu Mureş (unpublished

data) and from Mr. Rozner István's paper. The collecting of the Cerambycidae that allowed us to draw up this paper was done, considering the number of species and their representatives, by: Petru Vasile Istrate - 663 specimens, Florentina Togănel - 19; specimens, Istvan Rozner - 18 specimens, Vasile Vicol - 7 specimens, Szombath Zoltan - 1 specimen. The classification and nomenclature of the longhorn beetles was that suggested by Bense (1995).

Most of the collected Isopod species belong to the Alpine-Carpathian European specific area. Species indications value (Jeniš, 2001) can be low for many of these insects, like common species with high tolerance to changing enviromental conditions. For few of these species, the indications values are high. These species are sensible to the changes in the enviromental conditions, or species with limited range.

Figure 1: *Cerambyx cerdo.*

Figure 2: *Ropalopus macropus*.

Family Cerambycidae
Subfamily Prioninae
Genus *Prionus* Geoffroy, 1762

Prionus coriarius (Linnaeus, 1758) – Cerghid, 15-30.VII.2002, 450 m, IP, 1 ex., evening, on oak trunks and hornbeam trunks. Dâmbău, 19.07.1999, 2 ex., IP; 22.07.2000, IP, evening, on oak trunks., IP. Afternoon and evening, on oak trunks. Gurghiu Mountains, 2-6 VIII, 1999, 2 ex., IP, evening, on coniferus trunks. Sovata, 18.07.1989, 2 ex., FT; 29.07.1999, no. females, IP, on forest path. Târnăveni, 15.07.2000, 8, ex., IP; 12.07.2007, 9 ex., IP, evening, on trunks. Vaidacuta, 07.1997, no. ex. Low indication value. Both, conifers and broadleved trees.

Subfamily Lepturinae
Genus *Rhagium* Fabricius, 1775

Rhagium inquisitor (Linnaeus, 1758) – Gurghiu Mountains, 3 ex., 05.2009, collected by students ! Târnăveni, 05.2009, 1 ex., IP, inside old *Pinus nigra* plantation. Low. Conifers.

Rhagium sycophanta (Schrank, 1781) – Bobohalma, 25.06.2000, 1 ex., IP. Târnăveni, 2.06.1998, 4 ex., IP; 15-20.04.2000, 1 ex., IP; 23.05.2000, 1 ex., IP; 1.05.2002, 1 ex., IP, on old oak trunks with good sun exposure. Viscri, 7.07.2009, 1 ex., IP, dead specimen. High ! Broadleved.

Rhagium mordax (Degeer, 1775) – Gurghiu Mountains, 5.06.2004, 3 ex., IP, on spruce trunks. Harghita Mountains, Harghita-Mădăraşi Peak, 2.VII.1995, 1 ex., RI. Low.

Both conifers and broadleved.

Genus *Stenocorus* Fabricius, 1775

Stenocorus meridianus (Linnaeus, 1758) – Bobohalma, 1 ex., 25.06.2000, IP. Cetatea de Baltă, 25.06.2006, 1 ex., IP, on *Ligustrum vulgare* flowers. Târnăveni, 2 VI.1998, VI,1999, 4 ex., IP. Low. Broadleved.

Stenocorus quercus (Goetz, 1783) – Cerghid, 5.06.2003, 1 ex., 450 m, IP, on fresh cutting hornbeam trees. Târnăveni, 2.06.1998, 4 ex., IP; 06.1999, IP; 1.06.2002, 1 ex., IP, on dead oak branches. Low. Broadleved.

Genus *Pachyta* Dejean, 1821

Pachyta lamed (Linnaeus, 1758) – Gurghiu Mountains, Bucin Plateau, 1280 m, 28.06.1994, 1 ex., RI. High ! Coniferus.

Pachyta quadrimaculata (Linnaeus, 1758) – Gurghiu Mountains, 3.08.1999, no. ex., IP, on the wild withe flowers near secondary rivers; 25-27.07.2005, 8 ex., IP, on the white flowers. Praid, Târnava Mică upper, 1.07.1995, 1 ex., RI. Sovata, 28.07.1998, 1 ex., IP. Low. Coniferus.

Genus *Evodinus* Le Conte, 1850

Evodinus clathratus (Fabricius, 1792) – Harghita – Mădăraşi Peak, 2.07.1995, 1 ex., RI. Low ! Coniferus.

Genus *Dinoptera* Mulsant, 1963

Dinoptera collaris (Linnaeus, 1758) - Cerghid, 05.2002, 1 ex., on the shrub flowers. Cetatea de Baltă, 2.07.2000, 7 ex., IP. Corneşti, 29.04.2001, no. ex., IP, on white flowers. Criş, 14.06.2009, no. ex., IP, on flowers. Saschiz, 14.06.2009, no. ex., IP, on flowers. Târnăveni, 26.04.2000, no. ex., IP. Low. Broadleaved.

Genus *Gaurotes* Le Conte, 1850

Gaurotes virginea (Linnaeus, 1758) – Harghita Mountains, 6.08.1999, no. ex., IP, on white flowers, near secondary rivers; 07.2005, 3 ex., IP. Praid, Bucin Plateau, Târnava Mică upper, 1.07.1995, 1 ex., RI. Sovata, 28.07.1996, 7 ex., FT; 29.07.1998, 4 ex., IP. Low. Coniferus.

Genus *Pidonia* Mulsant, 1863

Pidonia lurida (Fabricius, 1792) – Gurghiu Mountains, 10.06.2003, 3 ex., FT; 7.07.2004, 3 ex., IP, on flowers. Praid, Bucin Plateau, 1.07.1005, 1 ex., RI. Sovata, 26.06.1975, 1 ex., SZ. Low. Both broadleaved and coniferus.

Genus *Grammoptera* Serville, 1835

Grammoptera ruficornis (Fabricius, 1781) – Cetatea de Baltă, 3.06.2001, 2 ex., IP, on dead branches ! Târnăveni, 15-20.04.2000, 4 ex., IP, on *Prunus spinosa* flowers. Low ! Broadleaved.

Genus *Alosterna* Mulsant, 1863

Alosterna tabacicolor (Degeer, 1775) – Cetatea de Baltă, 3.06.2001, 1 ex., IP, on white flowers. Praid, Bucin Plateau, 1.07.1995, 1 ex., RI. Low. Both broadleaved and coniferus.

Genus *Pseudovadonia* Lobanov, Danilevski et Murzin, 1981

Pseudovadonia livida (Fabricius, 1776) – Apold, 3.07.2009, 1 ex., IP, on flowers. Bazna, 26.05.2002, 1 ex., IP, on flowers. Criş, 14.06.2009, 1 ex., IP, on *Achillea millefolium* flowers, 16.06.2009, 1 ex., IP. Roadeş, 16.06.2007, 1 ex., IP.; 4.07.2009, 1 ex., IP, on *Achillea millefolium* flowers. Târnăveni, 22.05.2000, 1 ex., IP; 5.06.2000, 1 ex., IP, on flowers; 27.05.2001, 2 ex., IP, on plants. Low. Larval food is fungi !

Genus *Lepturalia* Reitter, 1912

Lepturalia nigripes (Degeer, 1775) – Bazna, 3.05.2002, 1 ex., IP, on flowers.

High ! Broadleaved.

Genus *Judolia* Mulsant, 1863

Judolia sexmaculata (Linnaeus, 1758) – Cetatea de Baltă, 3.07.1993, 2 ex., VV. Praid, Târnava Mică upper valley, 1.07.1995, 1 ex., RI. Vaidacuţa, 28.06.2002, 6 ex., IP, on white flowers. Velţ, 15.06.2002, 1 ex., IP, on white flowers. High ! Broadleved.

Genus *Pachytodes* Pic, 1891

Pachytodes cerambyciformis (Schracnk, 1781) – Bazna, 3.06.2001, 3 ex., IP, on white flowers, near the edge of forest; 25.05.2002, 1 ex., IP, on white flowers. Gurghiu Mountains, 2-6.08.1999, no. ex., IP, on white flowers near water; 6 ex., IP, on flowers, near secondary rivers. Praid, 1.07.1995, 1 ex., RI. Saschiz, 13.06.2009, no. ex., IP. Stejerenii, 2.07.2009, 1 ex., IP. Sovata, 27-29.07.1998, 7 ex., IP, on white flowers. Low. Broadleaved and coniferus.

Pachytodes erratica (Dalman, 1817) – Bazna, 23.VII.1999, 1 ex., IP, on white flowers. Cetatea de Baltă, 12, 25.07.2000, 4 ex., IP. Roadeş, 15.06.2007, 1 ex., IP. Saschiz, 3.07.2009, 1 ex., IP, on white flowers. Sovata, 28.07.1996, 1 ex., FT. Târnăveni, 2.VI.1998, 4 ex., IP. Vaidacuţa, VI.1997, 3 ex., IP. Low. Both broadleaved and coniferus.

Genus *Anoplodera* Mulsant, 1839

Anoplodera sexguttata (Fabricius, 1775) – Bazna, 2 ex., IP, on the shrubs flowers; 3.06.2001, 25.05.2002, 2 ex., IP, on shrubs white flowers. Cerghid, 06.2002, 1 ex., IP, on shrubs white flowers. Cetatea de Baltă, 3.06.2001, 3 ex., IP. Corneşti, 26.05.2001, 3 ex., IP. Criş, 16.06.2009, 2 ex., IP. Mihai Viteazul, 13.06.2009, 2 ex., IP, on white flowers. Târnăveni, 2-6.06.1998, 17 ex., IP.; 26.05.2000, 2 ex., IP; 1.06.2002, 2 ex., IP, on white flowers. Vaidacuţa, 28.06.2002, 2 ex., IP, on white flowers. Velş, 15.06.2002, 1 ex., IP, forest. Low. Broadleaved.

Anoplodera rufipes (Schaller, 1783) – Târnăveni, 06.2000, 1 ex., IP.

Low. Broadleaved.

Genus *Vadonia* Mulsant, 1863

Vadonia unipunctata (Fabricius, 1787) – Corneşti, 6.06.2003, 2 ex. IP, on *Leucanthemum vulgare* flowers. Crăieşti, 27.06.2009, no. ex., IP, on flowers. Criş, 16.06.2009, 1 ex., IP. Mihai Viteazul, 13.06.2009, 2 ex., IP, on *Leucanthemum vulgare* flowers. Roadeş, 06.2009, 1 ex., IP, dry meadow. Low. Broadleved shrubs, steppe !

Genus *Lepturobosca* Reitter, 1913

Lepturobosca virens (Linnaeus, 1758) – Gurghiu Mountains, Bucin Plateau, 23.08.1976, 2 ex., VV. Gurghiu Mountains, 2 ex., 2.08.1999, IP, on white flowers. Low. Coniferus.

Genus *Anastrangalia* Casey, 1924

Anastrangalia sanguinolenta (Linnaeus, 1761) – Gurghiu Mountains, 24-26.07.2005, 4 ex., IP, on flowers. Bucin Plateau, 1280 m, 28.06.1994, 1 ex., RI. Low. Coniferus.

Anastrangalia dubia (Scopoli, 1763) – Gurghiu Mountains, 8 ex. 24-26.07.2005, IP, on flowers. Bucin Plateau, 23.08.1975, 1 ex., VV. Low. Coniferus.

Anastrangalia reyi (Heyden, 1889), Târnava Mică upper valley, 1.07.1995, 1 ex., RI. Low. Coniferus.

Genus *Corymbia* Des Gozis, 1886

Corymbia scutellata (Fabricius, 1781) – Apold, 3.07.2009, 1 ex., IP, on common beech trunks. Roadeş, 4.07.2009, 1 ex., IP, on *Cirsius* sp. Low. Broadleaved.

Corymbia rubra (Linnaeus, 1758) – Gurghiu Mountains, 2-3.08.1999, 3 ex., IP, on flowers; 07.2005, 1 ex., IP, on flowers. Sovata, 28.07.1996, 2 ex., FT; 28.07.1998, 1 ex., IP. Low. Both broadleaved and coniferus.

Corymbia maculicornis (Degeer, 1775) – Bazna, 3.06.2001, 1 ex., IP, on shrubs flower. Gurghiu Mountains, 6.08, 1999, 2 ex., IP. Low. Both broadleaved and coniferus.

Genus *Leptura* Linnaeus, 1758

Leptura maculata (Poda, 1761) – Bazna, 3.06.2001, 4 ex., IP, edge of forest, on white flowers; 25.05.2002, 1 ex. IP, on white flowers. Criş, 2.07.2009, no. ex., IP, on white flowers. Gurghiu Mountains, 07.2005, 2 ex., IP, on flowers. Romaneşti, 19.05.2002, 1 ex., IP, on flowers. Velţ, 15.06.2002, 3 ex., on flowers. Praid, Târnava Mică upper valley, 1.07.1995, 24.06.2006,1 ex., RI. Saschiz, 13.06.2009, no. ex., IP; 3.07.2009, no. ex., IP. Sovata, 28, 29.07.1998, 4.08.1999, no. ex., IP, on white flowers. Low. Both broadleaved and coniferus.

Leptura annularis (Fabricius, 1801) – Criş, 14.06.2009, 2 ex., IP, on white flowers, near riverside. High ! Both broadleaved and coniferus.

Leptura aurulenta (Fabricius, 1762) – Gurghiu Mountains, 8.08.2004, 1 ex., IP, on dry spruce trunk. Roadeş, 4.07.2009, 1 ex., IP. Sovata, 28.07.1996, 1 ex., FT. High ! Broadleaved.

Leptura quadrifasciata (Linnaeus, 1758) – Cetatea de Baltă, 1.07.2000, 1 ex., IP. Gurghiu Mountains, 2.08.1999, 3 ex., IP. Sovata, 28.07.1998, 3 ex., IP. Bucin Plateau, 18.08.1986. 1 ex., VV. Târnăveni, 23.05.2000, 1 ex., IP, oak forest, on flowers; 10-11.06.2000, 2 ex., IP, inside cemetery; 15, 28.07.2000, 2 ex., Târnava Mică valley, on flowers. Vaidacuţa, 28.06.2002, 1 ex., IP, on white flowers. Low. Both broadleaved and coniferus.

Leptura aethiops (Poda, 1761) – Cerghid, 05.2002, 3 ex., IP, on shrub flowers; 17.05.2002, 2 ex., IP, forest edge, on the shrub flowers. Cetatea de Baltă, 3.06.2001, 1 ex., IP, on white flowers. Romăneşti, 19.05.2002, 1 ex., IP, 450 m. Târnăveni, 23-25.05.2000, 6 ex., IP, oak florest, on white flowers; 06.2000, 1 ex., IP, 400 m. High ! Both broadleaved and coniferus.

Genus *Stenurella* Villiers, 1974

Stenurella nigra (Linnaeus, 1758) – Mihai Viteazul, 13.06.2009, 1 ex., IP, on white flowers. Romăneşti, 19.06.2002, 1 ex. IP, 450 m. Saschiz, 13.06.2009, 2 ex., IP, on white flowers. Târnăveni, 2-6.06.1998, 3 ex., IP; 20.05.2000, 1 ex., IP; 06.2001, 1 ex., IP. Low. Broadleaved.

Stenurella bifasciata (Mueller, 1776) – Sovata, 4.08.1999, 1 ex., IP, on white flowers. Târnăveni, 12.07.1998, 1 ex., IP, on herbal flowers. Low. Both broadleaved and coniferus.

Stenurella melanura (Linnaeus, 1758) – Cetatea de Baltă, 25.06.2006, 1 ex., IP. Cerghid, 27.06.1998, 1 ex., IP; 06.2002, 1 ex., IP, on white flowers. Criş, 2.07.2009, no. ex. IP, forest edge. Criş, 16.06.2009, 1 ex., IP. Mihai Viteazul, 13.06.2009, no. ex., IP, on *Leucanthemum vulgare* flowers. Gurghiu Mountains; 26.06.2000, 6 ex.; 07.2005, 3 ex., IP, on white flowers. Praid, Târnava Mică upper valley, 1.07.1995, 1 ex. RI. Roadeş, 4.07.2009, no. ex., IP. Sovata, 28.07.1996, 1 ex., FT. Târnăveni, 2-6.06.1998, 2 ex., IP, on flowers. Vaidacuţa, 28.06.1998, 1 ex. IP; 28.06.2002, 1 ex. IP, on flowers. Velţ, 15.06.2002, 1 ex., IP, inside forest, on flowers. Low. Both broadleaved and coniferus.

Stenurella septempunctata (Fabricius, 1792) – Cerghid, 06.2002, 1 ex., IP, on white flowers. Criş, 14-16.06.2009, no. ex., IP. Saschiz, 13.06.2009, no. ex., IP, on flowers. Vaidacuţa, 28.06.2002, 2 ex., IP, on white flowers. Low. Broadleaved.

Genus *Strangalia* Serville, 1835

Strangalia attenuata (Linnaeus, 1758) – Cerghid, 06.2002, 4 ex., IP, on white flowers. Cetatea de Baltă, 1.07.2000, 3 ex., IP. Târnăveni, 2, 10, 25.07.1998 şi 10, 25.06.2000, 17 ex., IP; 10.06.2000, no. ex., IP, inside cemetery; 12.06.2000, 1 ex., IP, Târnava Mică riverside; 15.07.2000, 1 ex., IP, Târnava Mică riverside; 18.07.2008, 2 ex. Vaidacuța, 18.07.1998, 1 ex., IP. Velț, 15.06.2002., 1 ex., IP, on white flowers. Low. Both broadleaved and coniferus.

Subfamily Necydalinae

Genus *Necydalis* Linnaeus, 1758

Necydalis major (Chevrolat, 1838) – Apold, 3.07.2009, 2 ex., IP, on dead hornbeam trunk. High ! Broadleved.

Subfamily Spondylinae

Genus *Arhopalus* Serville, 1834

Arhopalus rusticus (Linnaeus, 1758) – Cetatea de Baltă, 27.07.2000, 1 ex., IP, inside railway station, under light lamps. Gurghiu-Bucin Mountains, 13.08.1975, 1 ex. VV. Low. Coniferus.

Genus *Teropium* Kirby, 1837

Teropium castaneum (Linnaeus, 1758) - Praid, Târnava Mică valley, 1.07.1995, 1 ex., RI. Low. Coniferus.

Teropium fuscum (Fabricius, 1787) – Gurghiu Mountains - Liban Plateau, 28.06.2006, 1 ex., RI. Low. Coniferus.

Subfamily Cerambicinae

Genus *Molorchus* Fabricius, 1792

Molorchus minor (Linnaeus, 1758) – Cerghid, 31.04.2002, 1 ex., IP. Low. Coniferus.

Genus *Stenopterus* Illinger, 1804

Stenopterus rufus (Linnaeus, 1767) – Apold, 3.07.2009, 1 ex., IP, on dead branches. Bazna, 3.06.2001, 1 ex., IP, on wild flowers. Criş, 16.06.2009, 1 ex., IP, on wild flowers. Târnăveni, 10.06.1998, 20.05.2000, 9 ex., IP; 14.06.2008, 5 ex., IP, on *Leucanthemum vulgare* flowers, cemetery. Low. Broadleved.

Genus *Callimus* Mulsant, 1846

Callimus angulatus (Schrank, 1789) – Dumbrăveni, 05.2009, 1 ex., IP, on *Ligustrum vulgare* flowers. Low. Broadleved.

Genus *Cerambyx* Linnaeus, 1758

Cerambyx cerdo (Linnaeus, 1758) – Boian, 27.07.2000, 5 ex., IP, on old oak trunks from pasture; 15.06.2002, 5 ex., IP, on old oak trunks from pasture; 25.05.2002, 2 ex., IP, on old oak trunks from pasture. Cetatea de Baltă, 2.06.2001, 3 ex. IP, on old oak trunks near castle, 25.05.2002, 8 ex., IP, castle courtyard. Roadeş, 1 ex., 4.07.2009, IP, on old oak trunks from pasture. Saschiz, 14.06.2009, 1 ex., IP, on old oak trunks from Braniste pasture . High ! Broadleved.

Cerambyx scopolii (Fuesslins, 1775) – Bazna, 3.06.2001, 550 m, IP, 4 ex., on *Daucus carota* flowers, 25.05.2002, 1 ex., IP, on white flowers. Boian, 25.05.2002, 2 ex., IP, evening, on oak trunks. Cerghid, 10.05.2002, 1.06.2002, 450 m, 1 ex., IP, on white flowers from shrubs; 24.05.2002, 3 ex., IP, on *Sambucus nigra* flowers. Corneşti, 16.04.2009, 2 ex., IP, on *Viburnum lantana* flowers. Crăieşti, 18.05.2009, 2 ex., IP, on *Crambe tatarica* flowers. Criş, 14.06.2009, 2 ex., IP, on the fresh cutting oak trees. Romăneşti, 19.05.2002, IP, 1 ex., on white flowers. Sighişoara, Breite Plateau, 2.06.2009, no. ex., on *Crataegus monogyna* flowers, IP. Târnăveni, 15.05.2002, 2 ex., IP, on *Sambucus nigra* flowers. Velț, 15.06.2002, 3 ex., IP, on *Daucus carota* white flowers. High ! Broadleved.

Genus *Purpuricenus* Germar, 1824

Purpuricenus kaehleri (Linnaeus, 1758) - Târnăveni, 8.07.2000, 1 ex., IP, inside cemetery, under old *Juglans regia* trees. High ! Broadleved.

Genus *Aromia* Serville, 1833

Aromia moschata (Linnaeus, 1758) – Gurghiu Mountains, 5.08.1999, 3 ex., IP, on white flowers near riverside. Sovata, 27.07, 1998, 2 ex., IP, on white flowers. Târnăveni, 10.VI.2000, 2 ex., IP, on white flowers. Low. Broadleved.

Genus *Rosalia* Serville, 1833

Rosalia alpina (Linnaeus, 1758) – Gurghiului Mountains, 4, 6.08.1999, 6 ex., 900 m, IP, on fresh cutting common beech trees. High ! Broadleved.

Genus *Hylotrupes* Serville, 1834

Hylotrupes bajulus (Linnaeus, 1758) – Sovata, 9.08.1999, 1 ex., FT. Low. Coniferus.

Genus *Ropalopus* Mulsant, 1839

Ropalopus macropus (Germar, 1824) – Bazna, 25.05.2002, 1 ex., IP, on dry branches inside forest. Cerghid, 25.05.2002, 1 ex., IP, on dry branches inside forest; 5.06.2008, 1 ex., IP, on dry branches of *Acer tataricum*. Low. Broadleved.

Genus *Callidium* Fabricius, 1775

Callidium violaceum (Linnaeus, 1758) – Bobohalma, 7.05.1999, 1 ex., IP, on white flowers. Cerghid, 20.05.2005, 1 ex., IP. Bucin Plateau, 1.07.1995, 1 ex., RI.

Low. Coniferus.

Genus *Phymatodes* Mulsant, 1839

Phymatodes alni (Linnaeus, 1767) – Velț, 7.05.2006, 1 ex., IP, on herb flowers, accidental ! Low. Broadleaved.

Phymatodes rufipes (Fabricius, 1776) – Cerghid, 28.05.2005, 1 ex., IP, on *Tilia cordata* branches, on the soil; 05.2009, 1 ex., on *Urtica dioica*, forest edge. Low. Broadleved.

Genus *Xylotrechus* Chevrolat, 1860

Xylotrechus antilope (Schőnherr, 1817) – Cerghid, 24.05.2002, IP, 2 ex., on dead oak branches. Criț, 14-16.06.2009, 3 ex., IP, on oak trunks. Târnăveni, 1.06.2002, 1 ex., IP, on oak trunks. Low. Broadleved.

Xylotrechus rusticus (Linnaeus, 1758) – Criș, 16.06.2009, 1 ex., IP, on fresh stumps of *Populus nigra*. Târnăveni, 15-25.06.2002, no. ex., IP, on dead *Populus nigra* trunks. Low. Broadleved.

Genus *Clytus* Laicharting, 1784

Clytus tropicus (Panzer, 1795) – Cerghid, 17.05.2002, 1 ex., IP, on herbal plant ! High ! Broadleved.

Clytus rhamni (Germar, 1817) – Gurghiu Mountains, 10.06.2003, 1 ex. FT.

Low. Broadleved.

Genus *Plagionotus* Mulsant, 1824

Plagionotus arcuatus (Linnaeus, 1758) – Bazna, 25.05.2002, 1 ex., 550 m, IP, on dead oak branches. Cerghid, 24.05.2002, 5 ex. IP, on dead oak branches, edge forest. Criț, 14.06.2009, 2 ex., IP, on fresh dead branches, forest edge. Romăneşti, 15.05.2002, 500 m, IP, 1 ex., on dead oak branches inside pasture. Low. Broadleved.

Genus *Chlorophorus* Chevrolat, 1863

Chlorophorus varius (Műller, 1766) – Târnăveni, 08.1996, 17 ex., IP; 15.07.2000, 2 ex.; 07.2002, 2 ex., IP, inside cemetery, on wild white flowers. Vaidacuța, 28.06.2002, 1 ex., IP, on wild white flowers. Low. Broadleved.

Chlorophorus herbsti (Brahm, 1790) – Gurghiu Mountains, 3.08.1999, 2 ex., IP, on wild white flowers. High. Broadleved.

Chlorophorus figuratus (Scopolii, 1763) – Cerghid, 17.05.2002, 1 ex., IP, inside forest, on white flowers; 05.2007, 8 ex., IP, on flowers. Corneşti, 26.05.2001, 3 ex., IP. Târnăveni, 6.06.1998, 11 ex., IP; 25.06.2000, 1 ex., IP, on flowers; 1.06.2002, 2 ex., IP, forest, on shrub flowers. Velț, 15.06.2002, 2 ex., IP, on white flowers. Viscri, 15.06.2009, 1 ex., IP. Low. Broadleved.

Chlorophorus sartor (Műller, 1766) – Târnăveni, 1.06.2002, 1 ex., IP, on white flowers; 07.2002, 4 ex., IP, on white flowers. Vaidacuța, 10.07.2000, 1 ex., IP.

Low. Broadleved.

Genus *Cyrtoclytus* Gangelbauer, 1882

Cyrtoclytus capra (Germar, 1824) – Gurghiu Mountains, 3.08.1999, 1 ex., IP, on white flowers. High ! Broadleved.

Genus *Anaglyptus* Mulsant, 1839

Anaglyptus mysticus (Linnaeus, 1758) – Bazna, 3.06.2001, 1 ex., IP, on shrub flowers. Cerghid, 10.05.2002, 1 ex., IP, on shrub flowers. Corneşti, 29.04.2001, 1 ex., IP; 26.05.2001, 1 ex., IP, on shrub flowers. Dumbrăveni, 01.2010, 1 ex., IP, from dead branches infested with larvas. Târnaveni, 2.06.1998, 8 ex., IP; 26.05.1999, 1 ex., IP; 15-25.04.2000, 2 ex., IP, on *Malus sylvesters* flowers. Low. Broadleved.

Subfamily Lamiinae

Genus *Mesosa* Latreille, 1829

Mesosa nebulosa (Fabricius, 1781) – Cerghid, 24.05.2002, 2 ex., IP, on dead hornbeam branches, edge forest; 06.2003, 1 ex., IP, on hornbeam branches. Cetatea de Baltă, 6.06.2001., 1 ex., IP. Sighişoara – Breite Plateau, 06.2009, 1 ex., IP, on oak dead branches. Low. Broadleaved.

Mesosa curculionides (Linnaeus, 1761) – Bazna, 05.2003, 5 ex., on dead oak branches. Cerghid, 24.05.2002, 12 ex., IP, on dead branches near edge of forest. Cetatea de Baltă, 17.05.2002, 1 ex., IP, on dead oak branch; 12.06.2002, 1 ex., IP, on dead oak branch. Corneşti, 20.06.2002, 2 ex., IP, on dead oak branch. Târnăveni, 1.06.2002, 1 ex., IP, on fresh dead oaks. High ! Broadleaved.

Genus *Monochamus* Dejean, 1821

Monochamus sartor (Fabricius, 1787) – Munții Gurghiu, 2-8.08.1999, no. ex., IP, on spruce stumps. High ! Coniferus.

Monochamus sutor (Linnaeus, 1758) – Bucin Plateau, 1.07.1995, RI. Praid, 1.07.1995, 1 ex., RI. High ! Coniferus.

Genus *Pogonocherus* Dejean, 1821

Pogonocherus hispidus (Linnaeus, 1758) – Cerghid, 5.06.2006, 5 ex., IP, on *Tilia cordata* branchs 6.06.2003, 1 ex., IP, on *Tilia cordata* branchs. Low. Broadleved.

Genus *Oplosia* Mulsant, 1863

Oplosia fennica (Paykull, 1800) – Cerghid, 5.06.2003, 2 ex., IP, on *Tilia cordata* branches; 17.03.2008, 2 ex., IP, rearing from dead infested branches with larvas. High. Broadleved.

Genus *Leiopus* Serville, 1835

Leiopus nebulosus (Linnaeus, 1758) – Cerghid, 06.2003, 1 ex., on dead branches; 01.2010, 3 ex., IP, rearing from dead *Corylus avellana* branches; 20.05.2005, 1 ex., IP. Târnăveni, 21.06.2002, 1 ex., on dead *Corylus avellana* branches stored inside forest. Low. Broadleved.

Genus *Exocentrus* Mulsant, 1846

Exocentrus adspersus (Mulsant, 1846) – Cerghid, 01.2008, 1 ex., IP, rearing from dead wood infested by larvaes; 26.01.2009, 1 ex., IP, rearing from dead wood infested by larvaes. Roadeş, 3.07.2009, 1 ex., IP, on dead hornbeam branches. Low. Broadleved.

Exocentrus lusitanus (Linnaeus, 1767) – Cerghid, 6.06.2003, 1 ex., IP, on dead *Corylus avellana* or *Tilia cordata* branches. Low. Broadleved.

Genus *Stenostola* Mulsant, 1839

Stenostola ferrea (Schrank, 1776) – Bazna, 3.05.2002, 3 ex., IP, on *Acer pseudoplatanus* leaf. Cerghid, 17.05.2002, 2 ex., IP, on *Urtica dioica*, forest edge; 01.2010, 1 ex., IP, rearing from dead branches infested by larvaes. Târnăveni, 2 ex., 20.04.2000, IP, on *Malus sylvestris* flowers; 14.05.2006, 1 ex., IP. Low. Broadleved.

Genus *Oberea* Mulsant, 1839

Oberea linearis (Linaeus, 1761) – Bazna, 26.05.2001, 1 ex., 550 m, IP, on herbal plant inside one young forest. High. Broadleved.

Genus *Tetrops* Kirby, 1826

Tetrops praeusta (Linnaeus, 1758) – Cerghid, 28.04.2001, 1 ex., IP, on shrub flowers. High. Broadleved.

Abbreviations: IP – Istrate Petru, RI – Rozner Istvan, SZ – Szombath Zoltán, TF – Togănel Florentina, VV – Vasile Vicol, no. ex. - number of specimens analyzed, at least five.

The total of 79 xylophagous Cerambycidae we have found in the Târnava Basin area stand for 31.5% of all the Cerambycidae species known in the Romanian national territory, including phytophagous species, and they have been collected in 27 locations in the Târnava Basin and 2 larger areas, i.e. the Gurghiu Mountains and the Upper Târnava Mică area, where we collected them in smaller valleys.

The Cerambycidae individuals which belong to the Lepturinae subfamily are predominant among the 38 species and 410 specimens we have found in this study. The less numerous Cerambycinae subfamily follows, with 24 species and 194 specimens. The Lamiinae subfamily has 12 species and 64 specimens. Less representative are the Spondilinae subfamily, with 3 species and 4 specimens and the Prioninae subfamily with 1 species and 34 specimens and Necydalinae, with 1 species and 2 specimens, (see the figure 3).

Of the species we have found in this study, 47 species thrive on the deciduous trees' wood and 17 species develop on conifers. 15 species develop on both of wood - deciduous and coniferous. 57 species (Fig. 4) develop in the hillside areas and 22 Cerambycidae species can be found in the mountainous areas. Sporadically, one may find mountain species in the hillside areas, if they are carried along together with the cut wood; they can also be found on the plantations of *Pinus sylvestris*, ex. *Rhagium inquisitor, Molorchus minor*, etc. (Fig. 5).

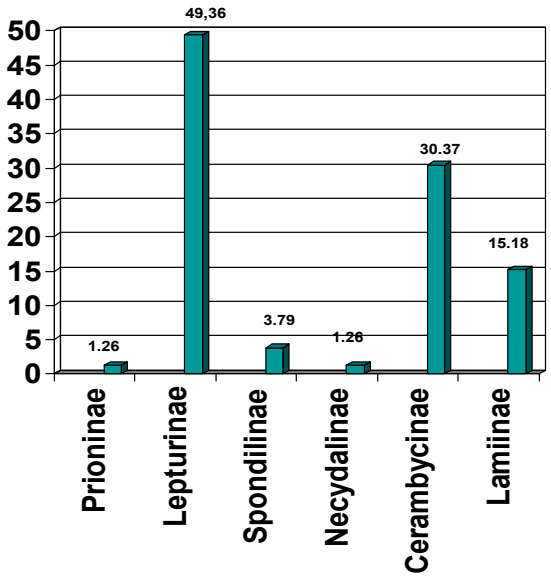

Figure 3: Distribution by subfamilies of the Cerambycidae species collected in the Târnava Basin.

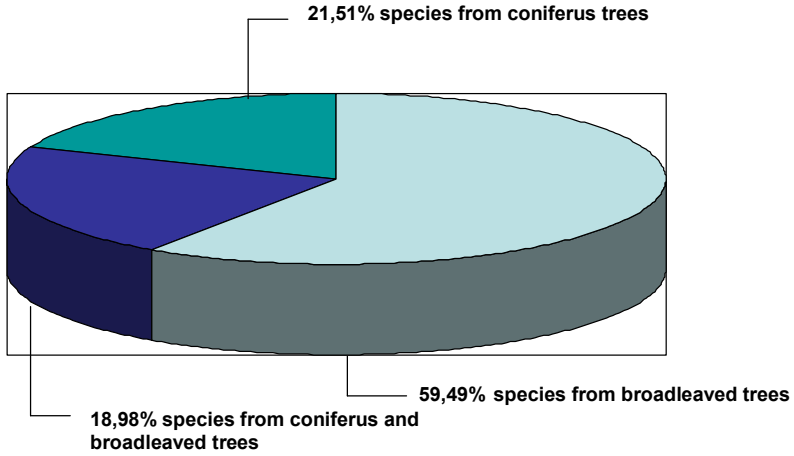

Figure 4: Cerambycidae use different wood type as a food during their larval stage.

Most of the species, i.e. 58 species are little affected by the environment conditions, while 21 species are influenced by the environment conditions.

On the whole, we could say that the forests are quite well preserved even when are exposed to great hazards

Figure 5: *Rhagium inquisitor.*

Figure 6: *Necydalis major*.

Some of the species, i.e. *Cerambyx cerdo* and *Rosalia alpina* are included, as rare species, in the Appendix II of the Habitat Directive, to which several other species can be added, such as: *Pachyta lamed, Leptura annularis, Purpuricenus kaehleri, Chlorophorus herbsti, Cyrtoclytus capra, Necydalis major,* (Fig. 6) *Oplosia fennica, Oberea linearis*.

CONCLUSIONS

By collecting Cerambycidae these years in the Târnava Basin, we were able to identify quite a lot of xylophagous species, mostly in the forests growing in the eastern side of the basin.

About 60% of all the species we discovered develop on the wood of deciduous trees, mostly on oak, and they are species typical in the East and Central Europe. Less than half of all the species discovered, i.e. about 40% are species typical for high relief areas, living in the mountain forests.

Quite a lot of rare species of great importance for the regional fauna have been found, including the two species mentioned in the Appendix 2 of the Habitat Directive of the European Union. One is typical for the old oak forests and the other can usually be found in the mountain beech forests.

Considering the latest data on the Cerambycidae fauna in the Târnava Basin we think it is necessary to ensure a better preservation of the forests growing in the west of the basin, where repeated tree cutting, especially the felling of old trees, has caused the invertebrate fauna to diminish (including the Cerambycidae Coleoptera). In the future, when making an assessment of the xylophagous Cerambycidae fauna we will mainly focus on the eastern mountain areas of the basin, wher we have collected less data so far. Further data can be obtained by inspecting the old tree orchards, as well as the areas covered with shrubs and ligneous vegetation, lying along the rivers. Modern collecting methods could provide new important information concerning the Cerambycidae fauna in the Târnava River Basin.

AKNOWLEDGEMENTS

Cerambycidae collection has been made possible due to the financial support provided over the years by several organizations: PTES (People's Trust for Endangered Species) from Great Britain, ADEPT from Romania and the Dutch Embassy from Bucharest, to which the author wishes to express his whole gratefulness.

REFERENCES

Balogh A., Crişan A. and Ruicănescu A., 1997 – Cercetări faunistice asupra unor familii de coleoptere din zona localității Hotoan, județul Satu Mare (Coleoptera: Scarabaeidae, Cerambycidae, Chrysomelidae), Buletinul Informativ al Societății de Lepideropterologie din România. 8 (3-4), Cluj Napoca. (in Romanian)

Bense U., 1995 – Longhorn beetles, illustrated key to the Cerambycidae and Vesperidae of Europe, 512 p., Margraf (Weikersheim, Germany).

Jeniš I., 2001 – Vesperidae and Cerambycidae of Europe, Atelier Regulus, Zlin.

Istrate P., 2005 – An ecological survey of the Cerambycidae (Coleoptera) in the geografic basin of the Târnava Mică Valley, Transylvanian Review of Systematical and Ecological Research, 2, "The Târnava River Basin", (Curtean-Bănăduc et al., eds.) Sibiu, 99-108.

Panin S. and Săvulescu, N., 1961 – Fauna R. P. R. Insecta Coleoptera. Fam. Cerambycidae. X. F. 5., Ed. Acad. R. P. R., Bucureşti. (in Romanian)

Rozner I., 2007 – Adatok Erdély és a bánság cincérfaunájához (Coleoptera: Cerambycidae), Acta Siculica, 133-141, Sepiszentgyőrgy. (in Hungarian)

Serafim R., 1997 – Contributions to the kmowledge of the Distribution of Coccinelidae and Cerambycidae (Coleoptera) in Maramureş Depression and Rodna Mountains (Romania). Travaux du Museum "Grigore Antipa" XXXVII**,** Bucureşti.

Togănel F., 2004 – Cerambycide (Coleoptera: Cerambycoidea) din Colecția Muzeului de Ştiințele Naturii din Târgu Mureş. Muzeul Olteniei Craiova. Oltenia. Studii şi comunicări. Ştiințele Naturii, vol. XX. (in Romanian)

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INSECTS FROM FORESTRY ZONES OF THE UPPER BASIN OF THE DOAMNEI RIVER (ROMANIAN CARPATHIANS, FĂGĂRAŞ MOUNTAINS)

Romeo RETEVOI [1]

KEYWORDS: Romanian Carpathians, Argeş County, Doamnei River, Stufoasa Forest, harmful insects, *Fagus sylvatica*, *Phyllaphis fagi*.

ABSTRACT

The theme of the scientific project Ecological Researches upon some harmful insects in the forests of the upper basin of the Doamnei River, is fairly broad, offering the possibility of research on harmful insects from different forest types: beech forest, oak forest, false acacia forest, conifer forest and dwarf forest.

As the population of harmful insects determines a fall in annual productivity, a reduction of the working wood percentage, effects of drought on trees, the destruction of their fruits and seeds, and restriction of the protection function, it is necessary to make a thorough investigation of harmful forest insects and of insect-feeders.

Since no ecological studies have been made on harmful insects in the area of the developing project, the main objectives of the research are: to identify the harmful insects from the broadleaved and conifer forests; to monitor and describe the life cycle of harmful insects; to use appropriate methods and techniques to describe the dynamics of their populations; to establish correlations between the life histories of these insects and climatic factors; to study the relationship between harmful insects and insect-feeders; to accomplish some short-term prognosis upon populations of harmful insects; and to identify and describe the ecological effects of insects on the forests.

REZUMAT: Insecte din zone forestiere ale bazinului superior al râului Doamnei (Carpaţii Româneşti, Munţii Făgăraş).

Tema proiectului ştiinţific, Cercetări Ecologice asupra unor insecte dăunătoare în pădurile din bazinul superior al râului Doamnei, este destul de generoasă oferind posibilitatea cercetării dăunătorilor din diferite tipuri de păduri: făgete, cvercete, salcâmete, păduri de amestec, păduri de conifere. Deoarece populaţiile de dăunători determină o scădere a productivităţii anuale, o reducere a procentului de lemn de lucru, uscarea arborilor, distrugerea fructelor şi a seminţelor, limitarea funcţiei de protecţie, este necesară o monitorizare atentă a pădurilor, a insectelor dăunătoare şi a entomofagilor.

Întrucât în zona derulării proiectului nu s-au realizat studii ecologice asupra dăunătorilor forestieri, principalele obiective ale cercetării sunt: identificarea insectelor dăunătoare din pădurile de foioase şi de conifere; urmărirea şi descrierea ciclului de viaţă la aceste insecte dăunătoare; utilizarea unor metode şi tehnici adecvate pentru descrierea dinamicii populaţiilor de insecte dăunătoare; realizarea unor corelaţii între ciclurile de viaţă ale insectelor dăunătoare şi factorii climatici; studierea relaţiilor dintre dăunători şi entomofagi; realizarea unor prognoze pe termen scurt asupra populaţiilor de dăunători; identificarea şi descrierea efectelor ecologice, produse de insecte asupra pădurilor.

ZUSAMMENFASSUNG: Insekten aus Wäldern im oberen Einzugsgebiet des Doamnei Tales (Rumänien Südkarpaten, Fogarascher Gebirge).

Das Thema des wissenschaftlichen Projektes Ökologische Forschungen über einige Insektenschädlinge in den Wäldern im oberen Einzugsgebiet des „Râul Doamnei" Flusses ist entsprechend umfangreich, und bietet die Möglichkeit, die Schädlinge aus unterschiedlichen Wäldern: Buchen-, Traubeneichen-, Robinien-, Misch- und Nadelwälder zu untersuchen.

Da die Schädlinge eine Abnahme der jährlichen Produktivität, eine Verminderung des Anteiles an Arbeitsholz, Abtrocknen der Bäume, Zerstörung der Früchte und der Samen, sowie eine Verringerung der Schutzfunktion verursachen, ist eine genaue Beochachtung bzw. ein Monitoring der Wälder, der schädlichen Insekten sowie der Entomophagen erforderlich

Da in dem Gebiet, in dem das Projekt durchgeführt wird, keine ökologischen Untersuchungen betreffend Forstschädlinge durchgeführt wurden, sind die vorrangigen Forschungsziele:

Erfassung der Insektenschädlinge in den Laub- und Nadelwäldern; Untersuchung und Beschreibung des Lebenszyklus dieser schädlichen Insekten; Anwendung entsprechender Methoden und Techniken zur Beschreibung der Dynamik der Populationen der schädlichen Insekten; Untersuchung der Korrelationen zwischen den Lebenszyklen der Schädlinge und den Klimafaktoren; Untersuchung der Beziehungen zwischen Schädlingen und Entomophagen; Erstellung einer kurzfristigen Prognose betreffend die Entwicklung der Schädlingspopulationen; Identifizierung und Beschreibung der ökologischen Auswirkungen der durch die Insektenschädlinge auf die Wälder

INTRODUCTION

The good condition of the forest breedings and of the trees, prior objective of the forest' protection, depends on the activities attained inside the forest surface. The research of harmful insects from the resinous forest has been performed in two areas: the hilly area of Pietroşani Commune, the Clăbucet mountain area, between 2008-2009. In the two areas there have been identified the following insect species: *Andricus quercuscalicis* galicol wasp of the oak, *Parectopa robiniella* mining moths of the locust tree, *Phyllaphis fagi*-woolly louse of the beech, the big cockroach of the spruce, the small cockroach of the spruce.

Out of these species attentively monitored, was the *Phyllaphis fagi*. It is a species which throghout a year presents an alternation of sex and sexless generations. The attack is powerful at spring, when on the back side of the beech's leaves they form whitish colonies. Because they have an oral system for stinging and sucking, they are fed by the leaves' fluids. In their powerful attacks, the leaves are being deformed which lead to the lowering of productivity. In their summer attacks the leaf is perforated, which result in the reduction of the foliage area, and implicitly of the photosynthesis.

Figure 1: *Phyllaphis fagi*.

MATERIALS AND METHODS

The research of the insects has been done into a beech forest, along a direction that grasped the forest's margins (Stufoasa, Argeş) and also the trees from mountains.

On the agreed direction there have been selected three sampling stations of the specimens. Each sampling surface has been dimensioned at 10 × 10 m. The sample surface marked by the forest edge has a southern exposure and is employed by a young beech forest. The sample surface marked at the middle direction has a southern exposure and is covered by beech trees with mid-dimensions as compared to the ones from the forest edge and the mountains.

The mountainous marked sample surface has a western exposure and is covered by an adult and vigurous beech forest.

The gathering of the samples has been done weekly starting with Mai 15th and ending with September 17th. Out of the marked surface there have been gathered randomly inferior branches with leaves. From each branch there have been counted the insects on the first twenty leaves, and on that data attained, there has been determined: the distribution type, the determination through calculation of the number of sample units, the density, the numerical evolution of the population in those 3 sample surfaces, the multiplication coefficient, the frequency of the attacked leaves referenced to the number of individuals on a leaf.

RESULTS AND DISCUSSIONS

In determining the distribution type there have been used the data obtained on June 15th mid direction (Tab. 1).

The distribution type.

Table 1: Frequency of individuals.

x	0	1	2	3	4	5	6	7	9	10	11	12	14	16	17	18	19	20	22	30	40	42	58
f	27	29	8	3	5	5	5	2	3	1	1	3	1	1	0	3	0	2	1	1	1	1	1

x = number of individuals / sample unit (a leaf)

f = individuals number of units which had 0, 1, 2, 3;

$x = \sum f(x)/n = 524/100 = 5.24$

$S^2 = \sum f(x^2) - x \sum fx / n-1 = 17820-(5.24 \times 524) / 99 = 152$

$S^2 / x = 152 / 5.24 = 29$

Because 29 › 1 results the fact that the distribution is grouped.

$0.2 = 1/X\sqrt{X/n + X2/nK}$

$0.2 = \sqrt{1/nX + 1/nK}$

$n = 1/0.2^2 (1/X + 1/K)$

$n = 25(1/X + 1/K)$

$n = 25(0.19 + 0.86)$

$n = 26.5$

Density

Taking in consideration the surface unit on a leaf we get the following densities (Tab. 2).

Table 2: Density of individuals per leaf.

		Density	
Date	Forest's edge	Middle of the route	Massif
15 May	3.38	6.18	2.73
21 May	3.92	4.34	2.07
28 May	3.70	4.50	2.09
7 June	4.50	5.10	2.20
15 June	7.60	5.24	2.56
21 June	4.76	3.44	1.52
28 June	5.11	6.61	2.15
6 July	4.70	3.60	1.28
13 July	5.88	6.82	1.47
20 July	3.66	2.41	0.31
27 July	1.85	0.74	0.25
2 August	3.43	0.80	0
10 August	3.07	0.46	0
17 August	1.85	0.31	0
24 August	2.01	0.60	0
30 August	1.59	0.34	0
7 September	3.11	0.60	0
17 September	0.86	0.20	0

From the analysis of the table results the fact that the maximum density is found on June, 15th and it is of 7.6. The maximum densities can be found in the forest edge and at the opposite end there is the sample surface from the massif where in the last 2 months the specie hasn't been idetified yet. (Fig. 2)

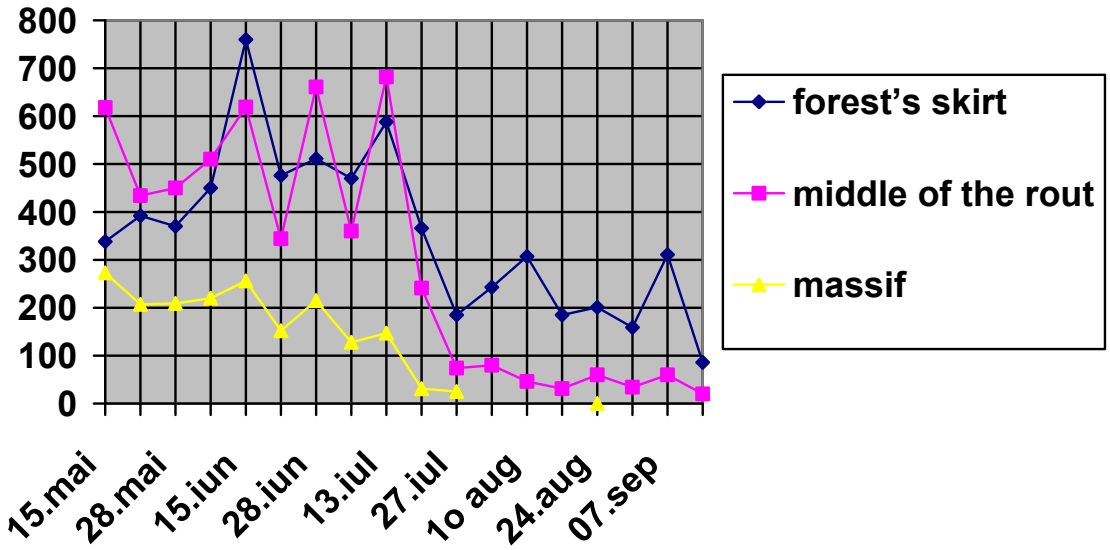

Figure 2: Numerical evolution *Phyllaphis fagi* in 2008 on the three sample surfaces of the route.

The frequency of the atacked leaves by *Phyllaphis fagi* (Figs. 3 and 4), after the number of individuals on a leaf at May 15th 2008 in the 3 points of the route.

On the sample surface limited, by the forest edge, the prelevated samples contained individuals with the below presented frequency (Tab. 3).

Table 3: Frequency of individuals.

x	0	1	2	3	4	5	6	7	8	9	11	13	26	30	31	45
f	26	23	19	8	9	0	6	2	0	1	1	1	1	1	1	1

On the sample surface limited, by middle of the rout, the prelevated leaves presented individuals with the below presented frequency. (Tab. 4)

Table 4: Frequency of individuals.

x	0	1	2	3	4	5	6	7	8	9	10	11	12	14	17	18	22	24	30	31	34
f	41	16	8	3	8	1	4	0	1	0	1	1	1	2	1	3	1	1	1	1	1
x	36	40	46	50																	
f	1	1	1	2																	

On the sample surface limited by the forest's massif, the prelevated leaves presented individuals with the follwing frequency. (Tab. 5, Fig. 3)

Table 5: Frequency of individuals.

x	0	1	2	3	4	5	6	7	8	9	10	11	12	14	15	17	18
f	31	21	13	7	4	5	6	3	4	1	0	0	1	1	1	3	1

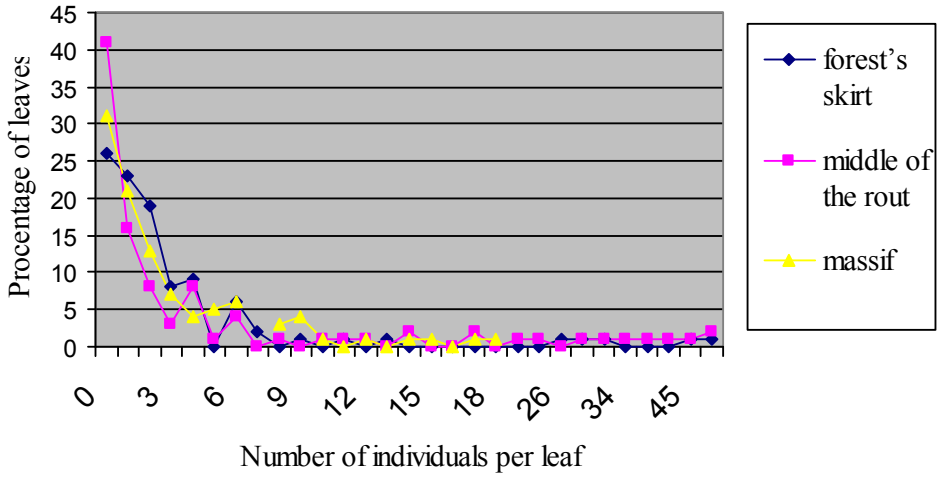

Figure 3: The frequency of the atacked leaves by *Phyllaphis fagi*, according to number of individuals on a leaf at Mai 15th 2008, in the 3 points of the route.

On the sample surface limited by the forest's skirt, the prelevated samples presented individuals with the bellow presented frequency (Tab. 6).

Table 6: Frequency of individuals.

x	0	1	2	3	4	5	6	8	9	11	26
f	34	26	18	10	3	3	2	1	1	1	1

On the sample surface limited by middle of the route, the prelevated samples contained individuals with frequency presented bellow (Tab. 7).

Table 7: Frequency of individuals.

x	0	1	2	14
f	83	15	1	1

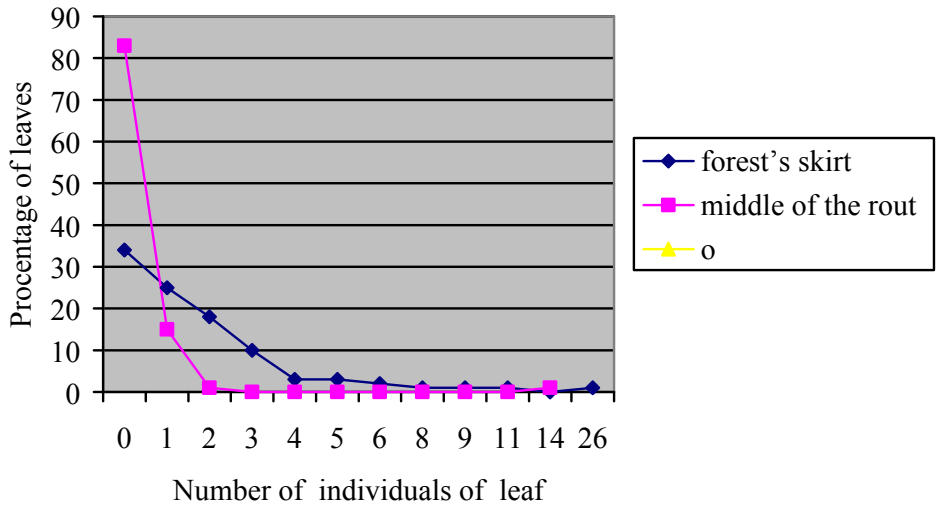

Figure 4: The frequency of the atacked leaves by *Phyllaphis fagi*, after the number of individuals on a leaf at August 17th 2008, in the 3 points of the route.

CONCLUSIONS

Phyllaphis fagi species is a frequently met afid in the beech forests of Romania. This species forms colonies on the inferior face of the beech leaves feeding itself with the fluid contained in leaves. The attack's intensity is maximum on middle of July.

Watching the numerical evolution the author determined 7 peaks apex of 7 generations. The attack is intense on the forest's skirt and in sunny places and at the other end there are beech trees from the montain where the attack is weak. The vigurous trees present unsignificant attack compared to the young ones.

REFERENCES

Iancu I., 1999 – Îndrumarul pădurarului, Ed. Pegas, Bucureşti, ISBN 973-99234-4-5, pp. 574-575. (in Romanian)

Marcu O. and Simon D., 1995 – Entomologie forestieră, Ed. Ceres, Bucureşti, ISBN 973-40-0330-5, pp. 254-260. (in Romanian)

Milescu I., Simionescu A. and Roşianu G., 1997 – Regia națională a pădurilor, Cartea pădurarului, Ed. Muşatini, Suceava, pp. 308-309. (in Romanian)

Roşu C., Chira D., Dănescu F., Chira F., Mihalciuc V., Surdu A. and Nicolaescu N. V., 2003 – Some recent issues regarding the European beech decline in Romania, Annals ICAS, Ed. Tehnică Silvică, pp. 167-176.

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NEW SCIS PROPOSAL REGARDING THE ICHTIOFAUNA AFTER THE PANNONIAN BIOGEOGRAPHIC SEMINAR FOR ROMANIA, SIBIU (TRANSYLVANIA, ROMANIA) 9-12 JUNE 2008

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KEYWORDS: Romania, Pannonian region, Natura 2000, SCIs proposals, *Cobitis taenia, Gobio albipinnatus, Gobio kessleri* and *Misgurnus fossilis*.

ABSTRACT

The principal targets of the European Community in the environment topic are the protection, conservation and amelioration of environment quality, in the context of the judicious use of the resources and services of the ecosystems. In the last few decades the biodiversity protection was one of the principal goal in this respect.

The main aim of the article is to give some data and related arguments for new Natura 2000 sites proposal, for four fish species. At the Pannonian Biogeographic Seminar for the Romanian national teritory (held at the "*Lucian Blaga*" University of Sibiu, Sibiu, 9-12 June 2008), it was concluded that the distribution areas of some fish species are not sufficiently covered with the existing Natura 2000 sites, so additional proposals were requested from the European Union.

As a result this scientific article proposes some new Natura 2000 sites, to be considered at a potential second Pannonian Biogeographic Seminar for the Romanian national area.

The suggested Community interest sites in this article are based on the author's field data using specific criteria (well preserved fish populations; stable fish populations; healthy fish populations; typical natural habitats; relatively low human impact; favorable geographical position). The following fish species of conservative interest were included: *Cobitis taenia, Gobio albipinnatus, Gobio kessleri* and *Misgurnus fossilis*.

REZUMAT: Noi propuneri de SCI-uri, referitoare la ihtiofaună după Seminarul Biogeografic Panonic pentru România, Sibiu (Transylvania, România) 9-12 iunie 2008.

Principalele obiective ale Comunității Europene în domeniul mediului sunt protecția, conservarea şi îmbunătățirea calității mediului, în contextul utilizării raționale a resurselor și de asemenea a serviciilor ecoistemelor. În ultimele decenii, protecția biodiversității a fost unul dintre principalele obiective în această privință.

Scopul principal al acestei lucrări este acela de a oferi date şi argumente în favoarea propunerii unor noi situri Natura 2000 pentru patru specii de peşti. La Seminarul Biogeografic pentru regiunea Panonică, pentru teritoriul național al României (care s-a desfăşurat la Universitatea „*Lucian Blaga*" din Sibiu, în 9-12 iunie 2008) s-a decis faptul că arealele unor specii de peşti sunt insuficient acoperite de situri Natura 2000, astfel noi propuneri au fost cerute de Uniunea Europeană.

Propunerile de Situri de interes comunitar, prezentate în această lucrare, se bazează pe date de teren ale autorului şi criterii specifice (populații de peşti bine menținute, stabile şi sănătoase; habitate naturale tipice; impact antropic relativ scăzut; poziție geografică favorabilă), referitoare la următoarele specii de peşti de interes conservativ: *Cobitis taenia, Gobio albipinnatus, Gobio kessleri* şi *Misgurnus fossilis*

RÉSUMÉ: Propositions pour des nouvelles SCIs concernant l'ichtyofaune à la suite du Séminaire Biogéographique de la zone Pannonian pour la Roumanie, Sibiu (Transylvanie, Roumanie) 9-12 juin 2008.

Les objectifs principaux de la Communauté Européenne dans le domaine de l'environnement sont la protection, la conservation mais aussi l'amélioration de la qualité de l'environnement, dans les conditions de l'utilisation raisonnée des ressources et des services des écosystèmes. Durant les dernières dizaines d'années, la conservation de la biodiversité a été un des principaux objectifs à ce regard.

Le scope de cet article est d'offrir des données et des argument a la faveur de la proposition des nouveaux sites Natura 2000 pour des différentes espèces de poissons. Au Séminaire Biogéographique pour la région Pannonian, pour le territoire national de la Roumanie (qui a eu lieu à l'Université „*Lucian Blaga*" de Sibiu, le 9-12 juin 2008) a été convenu le fait que les habitats de certaines espèces de poissons sont insuffisamment couverts par des sites Natura 2000, donc des nouvelles propositions ont été demandées par les représentants de l'Union Européenne.

Les propositions pour des Sites d'Intérêt Communautaire présentées dans cet article se base sur des données originales de l'auteur et sur des critères scientifiques (des populations de poissons bien maintenues, stables et en bonne santé; des habitats naturels typiques; un impacte anthropique relativement faible; une position géographique favorable), concernant les espèces de poissons protégées ci-dessous: *Cobitis taenia, Gobio albipinnatus, Gobio kessleri* et *Misgurnus fossilis.*

INTRODUCTION

The principal targets of the European Community in the environment topic are the protection, conservation and amelioration of the environment quality, in the context of the judicious use of the resources and services of the ecosystems. In the last decades the biodiversity protection was one of the principal goal in this respect.

The principal targets of the European Community in the environmental topic are the protection, conservation and amelioration of the environment quality, in the context of the judicious use of the resources and services of the ecosystems. The biodiversity protection was a main target of the European Union in the last quarter of century.

To work out its environmental policies the European Community takes in consideration the scientific and technical usable information, the environmental conditions distinctive for dissimilar areas of the Community and the need for a ballanced development of all its component areas, the result welfare and the involved price.

The action frame at the European Community level, to conserve the biodiversity was established based on the Habitats Directive (92/43/EEC) and Birds Directive (79/409/EEC).

These two European Directives have as objective to conserve and suport the biodiversity in the European Union through the realisation of a protected areas network (Natura 2000 net), in which to protect habitats and species characteristic for all the European biogeographic regions.

In the present Romania offers to the European natural heritage an around of: 47% of the national territory covered by natural and semi natural ecosystems; 780 types of habitats; 3700 superior plant species; 33085 invertebrate species and 717 vertebrate species. (Bănăduc, 2001, 2006, 2007a, 2007b)

Romania is the country with the highest biogeographic diversity of all the European Union countries, with a total of five biogeographic regions: Continental, Alpine, Pannonian, Pontic and Stepic.

There are few directions through which the Natura 2000 net initiative in Romania can improve its nature conservation: enlargment of the natural areas surface; the creation and implementation of optimum management plans for all these protected areas; institutional capacity building; raising awareness.

One main element of the implementation of these Directives is the establishment of an optimum Natura 2000 sites network on the Romanian national territory too.

In spite of the fact that the Biogeographic Seminars for the Romanian teritory were done (helded at the *Lucian Blaga* University of Sibiu, in 9–12 June 2008), it was concluded at the end of this very important technical meeting, the fact that the areals of some fish species are not suficiently covered with Natura 2000 sites, so new site proposals were asked by the European Union.

As a result this article deal with some new such Natura 2000 sites proposals, to be accepted at a potential second Pannonian Biogeographic Seminar for the Romanian territory.

The suggested sites of potential Community interest of this paper are based on the field data of the author and some specific criteria (well preserved fish populations; stable fish populations; healthy fish populations; typical natural habitats; relatively low human impact; favorable geographical position), regarding the following protected fish species: *Cobitis taenia, Gobio albipinnatus, Gobio kessleri* and *Misgurnus fossilis*.

MATERIALS AND METHODS

In the European Natura 2000 initiative context the following site selection criteria were used in this specific study: well preserved fish (of Community interest - oCi) populations; stable fish (oCi) populations; healthy fish (oCi) populations; typical natural habitats (oCi); lowest (as possible) human impact presence; favorable geographical position (possibility of species spreading in more than one hydrographic watersheds); best option for species/habitat (oCi) in relation with the needed future Natura 2000 areas specific management.

This article is based on original scientific data, no older than seven years. It should to be stated the fact that no complete data are available to definitely and comprehensively statute and border different local stable fish populations. Further multiannual fish populational field studies are still needed for the needed specific quantitative aspects fulfilment.

This article was centered on the following fish species of conservative interest: *Cobitis taenia, Gobio albipinnatus, Gobio kessleri* and *Misgurnus fossilis*; Annex II fish species.

All the collected fish specimens were caught with specific net tools or through electrofishing, after their identification they were released in their natural habitats for conservative reasons.

RESULTS AND DISCUSSIONS

Cobitis taenia Linnaeus, 1758 - Natura 2000 code 1149 (zvârlugă, fîsă, cîră, zmorlă, rîmbiţar; Dorngrundel, Steinbeisser; Loche de rivière; Spined Loach).

A general fact sheet is presented here due to the fact that some of the Natura 2000 administrations members are not in the position to identify this species and the associated ecological assessments, monitoring and management activities are not possible in this context.

General fact sheet. The dorsal and ventral profiles are almost horizontal. The inter-orbitary space is plain. The two halfs of the inferiour lip are subdivided in 3 – 4 lobes. The third pair of whiskers are the longest. The caudal peduncule in its posteriour part have a dorsal and a ventral streamline, the last one more developed. The

ventral fin insertion is situated a litle backward in comparison with the dorsal fin insertion. The caudal fin is truncated or slightly holed. The pectoral and ventral fins are rounded. The lateral line is short, in general did not overdraw the pectoral fin. The body background is white-yelowish. The dorsal spots are small, rectangular or rounded, in variable number (13 – 24). The lateral pigmentation of the body consist of four zones. At the caudal fin base in the upper corner, is a clear vertical black intense spot. On the head are small spots and an oblique line, from the backhead to the mouth. It can reach 12 centimeters in length. (Bănărescu and Bănăduc, 2007)

Concerning the *Cobitis taenia* species, at the Pannonian Biogeographic Seminar from Sibiu, Transylvania, Romania, 9 – 12 June 2008, there were raised some conclusions about its proposed sites status as insuficient minor. One new site in this respect is proposed below.

Proposed site. The proposed new site for this fish species is the Teuz River, from upstream Şintea Mare locality to this river final confluence.

Gobio albipinnatus (Lukasch, 1933) - Natura 2000 code 1124. (porcuşor de şes; Weißsflossiger Gründling; White-finned gudgeon).

The body and the caudal peduncule of the individuals of this species are relatively high and lateraly compressed. The peduncle hight is a litle higher in comparison with the thickness at the level of the annal fin posteriour edge. 7 exceptional 8 divided rays in the dorsal fin. There are four scales between the lateral line and the ventral fins. In Romania can be found *Gobio albipinnatus vladykovi* Fang 1943. Convex dorsal profile. The maximum heigh is situated at the dorsal fin insertion. The snout is short and obtuse. The eyes are big and close, looking more upward. The wisckhlers reach in general the posterior edge of the eye. The caudal peduncule is slightly lateraly compressed. The caudal fin is profound holed, its superior lobe being longer than the inferior one. The pectoral fins did not reach the ventral fins insertion, the ventral fins outgrow the annus but did not reach the annal fin. The annus is more closer to the ventral fins then the anal fin. The superior part is light yelowish-greyish. The dorsal side of the head is darker greyish, with even darker spots and lines. On flanks in general 7 - 8 round spots. The lateral line scales have two blak spots not very well marked. The ventral face is white. On the dorsal and caudal fins rays are two rows of black spots, also not very well marked. It can reach 13 cm in length. (Bănăduc, 2003; Bănărescu and Bănăduc, 2007)

In Romania has a relatively low spreading area. In the last decades, there were registered reductions in its area of spreading due to the human impact negative effects and of the habitats destructions. The species is protected by: Low 13/1993, Bern Convention and European Directive 92/43. *Gobio albipinnatus* can be considered a moderately endangered species.

About the *Gobio albipinnatus* species, at the Pannonian Biogeographic Seminar from Sibiu 9 – 12 June 2008, there were underlined final conclusions about its proposed sites status as insufficient moderate. Few additional sites were required for this species on the Romanian national territory. One new site in this respect are proposed below.

Proposed site. The new proposed site is the Crişul Alb River from upstream Almaş locality to downstream Şicula locality.

More research can improve this proposal.

Gobio kessleri (Dybowski, 1862) - Natura 2000 code 2511 (porcuşor de nisip; Sandgressling, Kessler Gründling; Kessler's gudgeon).

A general fact sheet is presented due to the fact that this species can be misidentified with other *Gobio* genus species by the European Natura 2000 sites

administrations members and the needed biological assessment, monitoring and management activities are not possible in this circumstance.

General fact sheet. The body is low and thik or relatively high and slightly lateraly compressed. The caudal peduncule is thik and cylindrical, its thikness in general biger than the minimum hight. The eyes have variable dimensions, usualy significant smaller than the interorbitary space. The lateral scales are much higher than longer. The whiskers have a variable length. The caudal lobes are almost equal (excepting *G. k. banaticus*). (Bănăduc, 2003; Bănărescu and Bănăduc, 2007)

In the last decades, there were registered reductions in this species area of spreading due to the human impact negative effects and of the habitats destructions. It is threatened mainly by pollution and habitat destructions. This species is under the protection of the Bern Convention annex 3, Habitats Directive annex 2, IUCN Red List and the Law 462.

Regarding the *Gobio kessleri* species, at the Pannonian Biogeographic Seminar for Romania, from Sibiu 9-12 June 2008, there were underlined specific conclusions about its proposed sites as insufficient minor status. More sites were required for this species on the Romanian national territory. A new site in this respect is proposed below.

Proposed site. The proposed site is on the Western Romanian Plain, on the Crişul Alb River, from upstream the Almaş locality to the downstream Şicula locality.

More scientific researches should improve this proposal with new sites.

Misgurnus fossilis (Linnaeus, 1758) - Natura 2000 code 1145 (ţipar, chişcar, vârlan; Weatherfish; Schlammbeisser; Kerlèche; Wetterfish, Beitzger, Moorgrundel).

General fact sheet. Prolongued and thick body with almost uniform height. The dorsal and the ventral profiles are almost horizontal. The head is thik, slightly compressed lateraly. The nostrils are more closed to the eyes than to the tip of the snout. The anterior nostril is tubular, round, covered by a skiny operculum. The mouth is inferiour and crescent. The upper lip is fleshy and continuous. The lower lip is fleshy with two pairs of flashy lobes; the anteriour pair (and median) short and thick, the posteriour pair long and thin whiskers like. The caudal peduncle is lateraly compressed, mostly in its posteriour part. The caudal dorsal and ventral peduncule edges are straiten and form two faty streamlines which is looking like a elongation of the caudal fin. The dorsal and ventral fins are situated at the same level. Small scales. Hardly visible lateral line. The dorsal side is dark dun, with small sooty spots. This dun area is limited by a narrow longitudinal line, almost black, which lay from the superior corner of the operculum to the caudal fin; in the posterior part this line is interrupted by isolated spots. Under this line, the body is light dun; is following a new sooty line, very broad, continuous from the eye to the caudal fin base. Under this line is yelowish-rusty spoted with brown dots. The head is light-fawn with small dark spots. Smoky fins with dark spots. The females reach 30 cm, the males are smaller. (Bănărescu and Bănăduc, 2007)

This fish species is relatively rare on the Romanian national territory, and can be considered in the last decade as being a species with an decreasing areal here. It is threatened in special by pollution, habitat destructions and water abstraction. The species is protected under: the Bern Convention, Habitats Directive and IUCN Red List.

Regarding the *Misgurnus fossilis* species, at the Pannonian Biogeographic Seminar meeting from Sibiu 9–12 June 2008, there were underlined some final conclusions about its proposed sites as insufficient minor status. More sites were required for this species on the Romanian national territory. One new site in this respect are proposed below.

Proposed site. The Teuz River, in the Adea - Mişca - Tămaşda localities area.

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REFERENCES

Bănăduc D., 2006 – Preinventory for a draft list of Natura 2000 (SCI) sites for fish species, edited by Bureau Waardenburg and Ameco Holand, 62.

Bănăduc D., 2007a – Fish of Natura 2000 network interest in Romania, in Romanian NATURA 2000 NGO Coalition contribution for the SCIs designation, Eds. Curtean-Bănăduc Angela and Florescu Florentina, Ed. Alma Mater Sibiu, ISBN 978-973-632-402 - 4, 147 - 182 pp.

Bănăduc D., 2007b – Alosa pontica; A. tanaica; Aspius aspius; Barbus meridionalis; Cobitis tenia; Gobio albipinntus; G. kessleri; G. uranoscopus; Misgurnus fossilis; in Combroux, I., Thiry, E. and Toia, T. (eds.) Caiet de habitate şi specii, Edit. Balcanic. Timişoara, România, ISBN 978-973-85742-6-7, 57-78 pp.

Bănăduc D., 2003 – Teză de Doctorat, Contribuţii la morfologia şi biologia speciilor genului Gobio (Gobioninae, Cyprinidae, Pisces) în România. Institutul de Biologie al Academiei Române, Bucureşti, pp 225. (in Romanian)

Bănăduc D., 2001 – Specii de peşti dulcicoli şi migratori în mediul dulcicol, de interes comunitar, prezente în România, în Natura 2000 în România, Conservarea speciilor şi habitatelor acvatice, coordonator Curtean-Bănăduc Angela, Editura Alma Mater Sibiu, ISBN 973-632-243-2, 72 - 81. (in Romanian)

Bănărescu M. P. and Bănăduc D., 2007 – Habitats Directive (92/43/EEC) fish species (Osteichthyes) on the Romanian territory, Acta Ichtiologica Romanica II, Bănăduc D. (ed.), 43-78.

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DESCRIPTION OF THE ECOTECHNIC SOLUTION, PROPOSED FOR JIJIA WATERCOURSE SECTOR ON THE IACOBENI VILLAGE TERRITORY

Răzvan VOICU [1] and *Liliana VOICU* [2]

KEYWORDS: reconnecting, meander, ecosystem, watercourses, vegetation.

ABSTRACT

The Jijia River is channelled (without a concrete bed) and not meandered in the village of Iacobeni, a fact which has a negative impact on the dynamics of the water course.

Since they lack the necessary measures, the banks have lost their vegetation and have an artificial appearance, and biotopes that provide food and shelter for aquatic organisms are threatened.

The erosion of these river banks without vegetation will contribute to increasing sludge formation and deposits of clogging materials, therefore blocking the normal development of aquatic life.

The solutions proposed in this specific study are complex, combining engineering and ecological techniques, and aim to remake connections between non-functional tributaries, supplied by groundwater and rainwater, and the water course.

REZUMAT: Descrierea soluției ecotehnice, propusă pentru sectorul râului Jijia pe teritoriul satului Iacobeni.

Râul Jijia este canalizat (nu este betonat) şi nu este meandrat în satul Iacobeni, fapt care are un impact negativ asupra dinamicii cursului de apă.

Fără măsuri corespunzătoare, malurile au pierdut din vegetație, rezultând un aspect artificial şi sunt amenințate biotopurile care oferă hrană şi adăpost pentru organismele acvatice.

Eroziunea malurilor râului, lipsite de vegetație, va contribui la accelerarea formării de nămol şi la creşterea depunerilor de colmatare, prin urmare blocând dezvoltarea normală a vieții acvatice.

Soluțiile propuse în acest studiu specific sunt complexe, combinând tehnici de inginerie şi de ecologie şi propun să refacă legătura brațelor moarte, aprovizionate de apele subterane şi apa de ploaie, la cursul de apă.

RÉSUMÉ: Description de la solution écotechnique, proposée pour le secteur Iacobeni de la rivière de Jijia.

La rivière de Jijia est canalisée (sans être bétonnée) et coule sur un trajet rectiligne sur le territoire du village de Iacobeni, ce qui a un impacte négatif sur la dynamique du cours d'eau.

En manque de mesures appropriées, les berges ont perdu en végétation résultant un aspect artificiel et les biotopes qui nourrissent et abritent les organismes aquatiques sont menacées.

L'érosion des berges sans végétation contribuera a l'accélération de la formation des boues et au volume des dépôts de colmatation, par la suite bloquant le développement normal de la vie aquatique.

Les solutions proposées dans cet étude spécifique sont complexes, combinant des techniques d'ingénierie et d'écologie et proposant la reconstruction des liens de la rivière avec les bras morts de la rivière, alimentées par les eaux souterraines et les précipitations.

INTRODUCTION

The subject of this case study propose an ecotechnical measure consisting of the lateral connectivity creation between an old meander and Jijia River watercourse in the city of Iacobeni. The meander water supply system and the riparian vegetation planting process developed along the banks of Jijia River have been measured in order to create a continuous link between water flow and vegetation, which can revive the local energy flow severely affected by the hydromorphological pressures.

METHODS

There are a variety of channels with standing and flowing water along the rivers. River water quality can quite often be improved through these channels by connecting them to water courses.

In Iacobeni, there is an anthropogenic flowing channel (Fig. 1) and a long-standing water meander (Fig. 2) which is fed by underground water and rain water.

The current situation (before ecological restoration) of the area set (anthropogenic channel Jijia and meander) can be seen in the figure number 3.

The method to be now presented is to establish connectivity between the water course and the standing water channel by combining ecological and engineering methods in order to create wetlands and riparian areas, as basic elements in the local ecosystem functionality.

For the ecological restoration of the river sector in Iacobeni, the following connection method is proposed, namely: the connection is made through a bank of pipe ducts to Jijia River water course, by the first third of the old meander, having as finality, the operation of the new created local ecosystem. The connection with Jijia River will be done at the end of the downstream meander through a breach fitted with a valve duct pipe into the bank that separates the meander and the stagnant water (Fig. 4). The duct pipe will pass under the dam.

Figure 1: The Jijia River water course.

Figure 2: Sector in the first third of the meander (upstream end).

In terms of different ameliorated aspects (rate difference between the meander and water course, the quantity of flow, the soil morphology, etc.) the new situation contribute to this connection between the meander and Jijia water course.

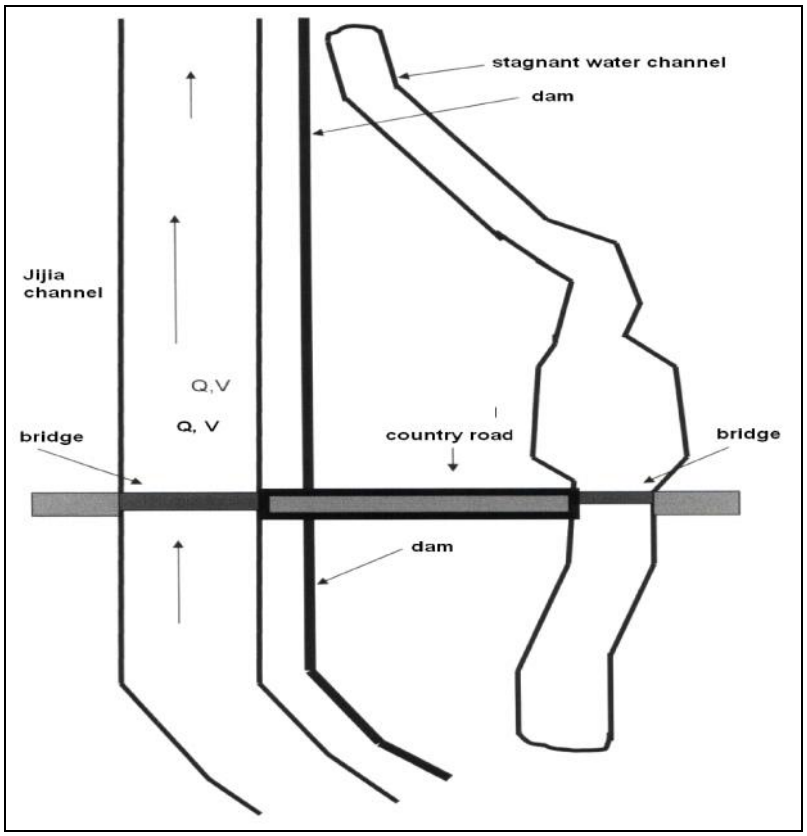

Figure 3: Channel Jijia and the meander before the ecological restoration present situation
- scheme -

Figure 4: Sector in the last two thirds of the old meander (downstream end).

The duct pipes that will supply the old meander with water coming from the Jijia River are arranged in semicircle and in line on the entire surface of the meander's left bank in order to build and maintain the wetland and the riparian area. There are two cases as regards the water outlet through a duct pipe as is following

The duct pipes, even if they are located a few inches below the wet area and open onto the meander's water body, are equipped with holes arranged in line exactly in front of the wetland to keep it functioning.

If the opening takes place directly into the water body near the old meander substrate, the holes arranged in line (first case) are no longer valid. In this case the connecting duct pipes capturing water from Jijia River are continued by other welded duct pipes, through which a lower flow rate will pass, functioning as those in the second solution. Amount of the water flow into the duct pipes should be 1/3 higher than the water flow opened in Jijia River through the duct pipe situated at the downstream old meander's end. (Fig. 5)

Please note that the old meander or actual meander are the same thing. Due to lack of water and aquatic and riparian vegetation on the Jijia water course and on some of its meanders, the erosion is quite pronounced. Erosion supplies the river with materials in suspension. Without appropriate measures, banks have lost vegetation, resulting an artificial-looking and biotopes that provide food and reproduction of fish and aquatic birds are threatened. Erosion of river banks without the vegetation support will contribute to increasing the sludge formation and the amount deposit of clogging, therefore blocking the normal development of underwater life.

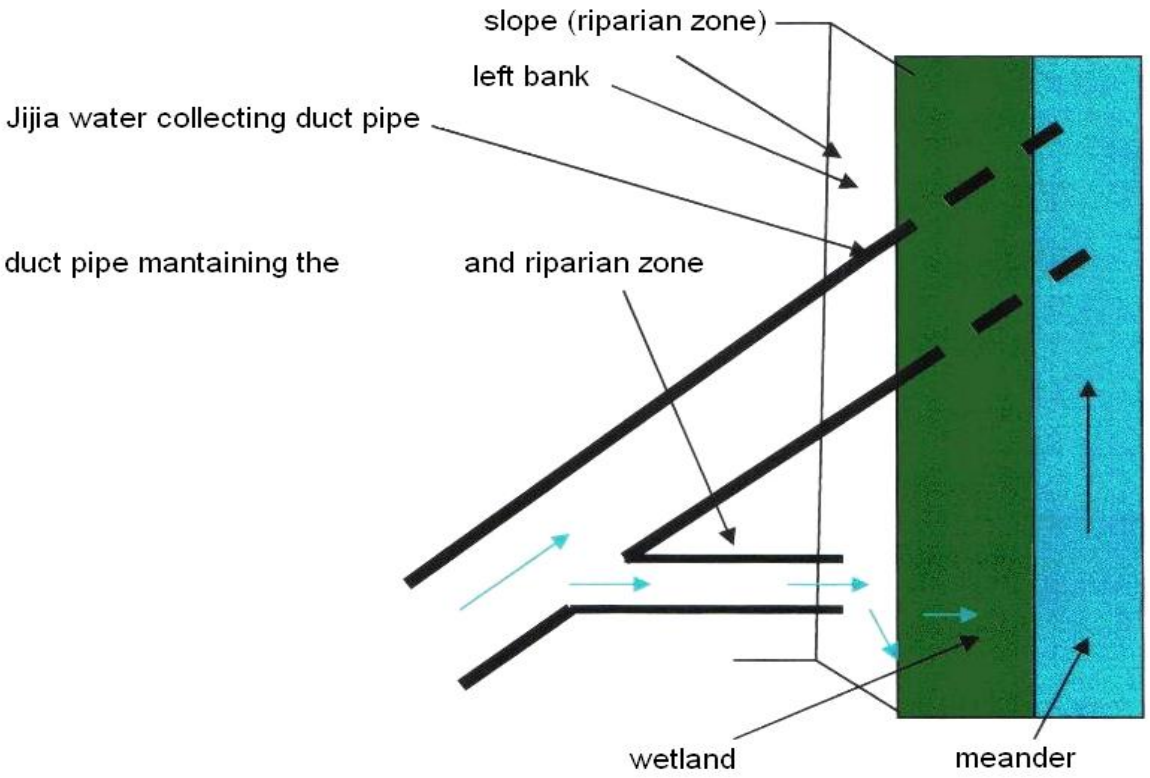

Figure 5: Sector in the first third of the meander
after the ecological restoration longitudinal section.
- scheme -

The left bank of the meander will be leveled up to the bridge, from the point where bank erosion is most pronounced (Fig. 6). This will be done before inserting pipes under the dam. After the bridge that separates the first third of the meander, the left bank leveling (Fig. 7) towards the further water flow direction will be done into the same point where erosion is most advanced.

Planting fast-growing woody species (alder, willow, etc.) is recommended for ground stability; planting higher species is not recommend, as they stagger under the influence of wind causing subsidence cracks in the soil and leading to landfalls. Also, no swing-rooted grass species are recommended, as can ease the slumping; but fascicular rooted grass species can be used (sedge, fescue, etc.). Species that prefer soil moisture and remove large amounts of water through the transpiration process will be used.

Figure 6: Advanced erosion on the right bank of the meander.

Figure 7: Sector in the last two thirds of the meander.

If on the first third of the meander, the left bank becomes uniform with an inclination of 60 degrees, the left bank of meanders, in the direction of water flow, becomes a slope (45 degrees) on the last two thirds, especially for planting and developing root mass of herbaceous and woody plants against the advanced erosion of the bank. On the first half, partly located in the body of water (reed, sedge, bulrush, fescue, etc.), in the inclined plane created, and on the last half of the inclined plane, woody vegetation (silver poplar, alder, willow, etc.) will be planted. (Fig. 8)

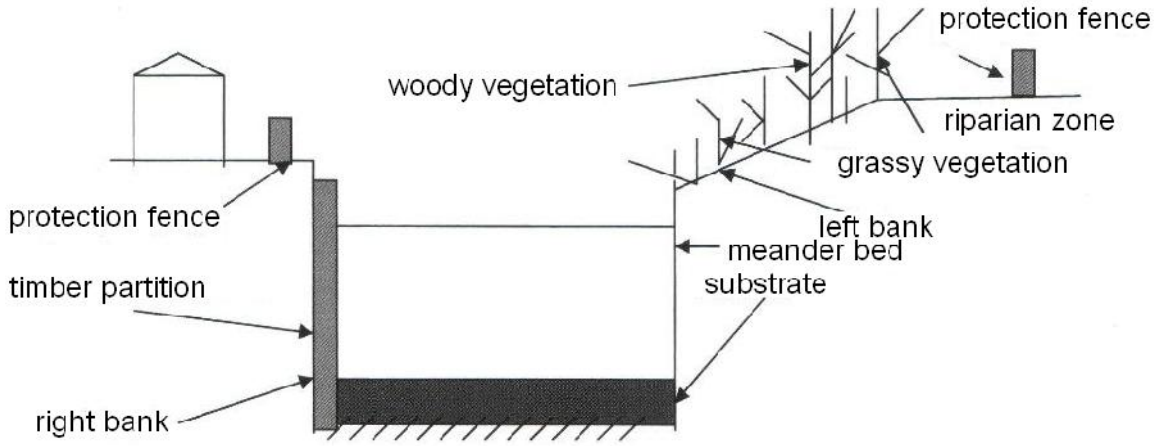

Figure 8: Cross section representing the last two thirds of meanders after the restoration. - scheme -

Two lines will be interconnected on the left bank base, at the first third of the meander and inside the wetland and also on the bank, having an inclination of 60 degrees, where willows and alders will be planted; in the immediate vicinity of the bank, a line of acacia will be planted up to the bridge, at distances of one meter, therefore the bank will be stabilized in two directions through the root mass. (Fig. 9)

Due to erosion and drought, the right bank of the meander's first third must be built in soil steps having about the same size and being similar to gabions and their functions, the height h' and width l'. The first step, entirely positioned within the water must be a few inches below multi-annual average level of water in order to create a linear wetland. The second step, at a height of about $h' \equiv d' \approx 50$ cm from the first sector will be created to support the riparian bush (ex). The average slope is ≈ 1‰. Steps will be built throughout the sector length (≈ 100 m), each step having $h' \approx 50$ cm height and $l' \approx 1.5$ m width (Fig. 9). Vegetation will be planted on such steps, depending on plant water needs, as follows: on the first step, annual and perennial herbaceous vegetation (*Lolium perene*, *Festuca pratensis*, *Agrostis stolonifera*, *Phragmites australis*, etc.) can be planted; on the second step black alders and silver poplars can be planted.

Widths and edges of steps (5 cm) will be surrounded by water impact-resistant plastic material, and the last step should not get beyond the bank height. Steps will be constructed by mechanical equipment but also by metal systems for meander water redirection supported by a plastic material system until over 50% of both herbaceous and woody vegetation (Fig. 9) have been grown. Wetlands should be linked to riparian areas where possible, because, by their multiple features, they greatly improve the effectiveness of newly developed ecosystem, but also the adjacent areas of the riverbed sector especially selected for the method presented.

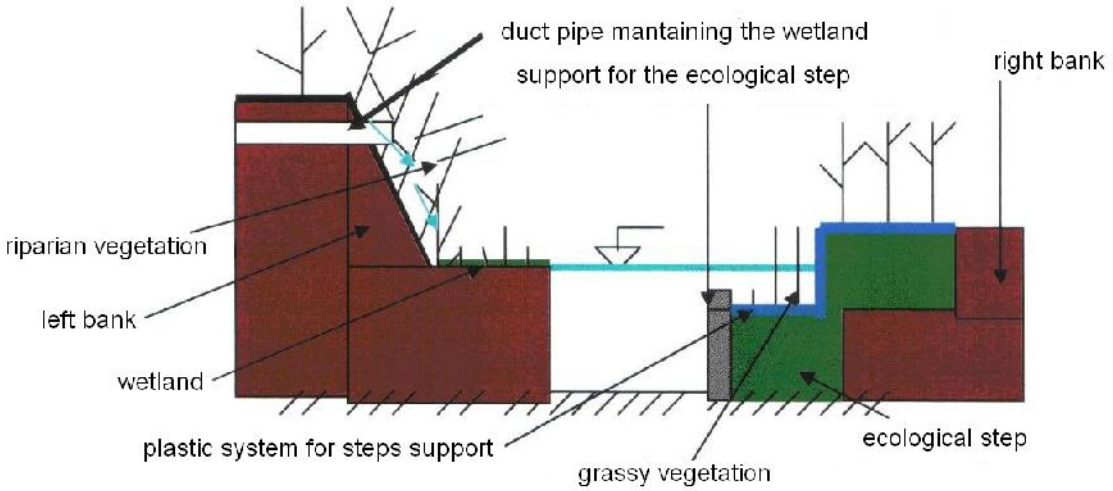

Figure 9: Cross section representing the first third of meanders after the ecological restoration. - scheme -

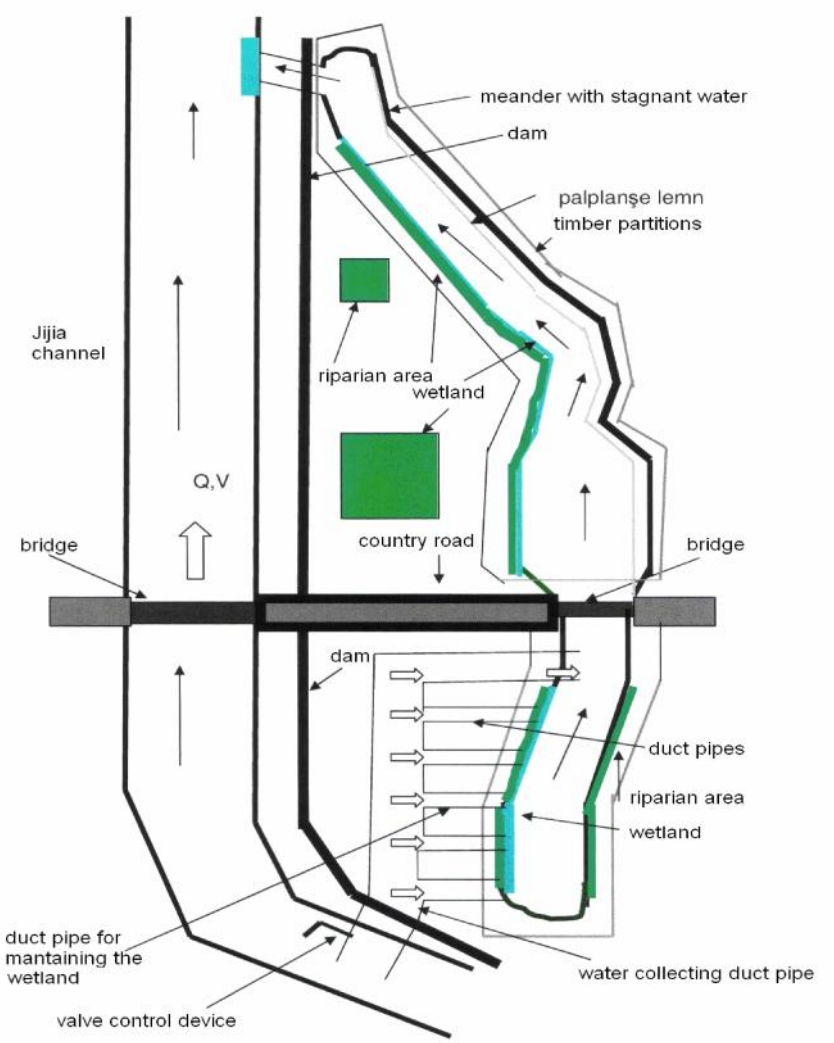

Figure 10: Jijia Rier channel and old meander after the ecological restoration. - scheme -

By the means of some stainless steel or resistant plastic duct pipes (Fig. 10) fixed inside the soil surface, the watercourse (Fig. 1) and the old meander/channel with stagnant water (Fig. 2) will be connected.

It is important to observe the soil morphology and its capability of maintaining water as to create wetlands and riparian areas. Water will penetrate the duct pipes and the breach created into the right bank of Jijia River. After fixing the duct pipes or pipes by the means of some mechanical machines used for drilling in the river bed, and also by using some metal structures in order to redirect the watercourse where the right bank of the Jijia water course will be drilled; grills will be installed at the bottom end of each pipe to protect pipes against a possible obstruction with material in suspension. Flow control will be made by valves, attached to all duct pipes. The right bank of the meander will be protected against erosion by timber partitions set at about 20 m after the bridge (Fig. 11) towards the water flow.

Figure 11: Sector in the last two thirds of the meander.

CONCLUSIONS

This ecotechnical method (of measuring) is performed in order to construct both a functional green oasis and an effective dissipator against the flood.

In cases of accidental pollution, the old meander can be isolated from Jijia River functioning as a refuge for the aquatic and semiaquatic organisms in the area.

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CONSIDERATIONS ON THE AGGRESSIVE BEHAVIOUR OF THE BROWN BEAR (*URSUS ARCTOS ARCTOS*) TOWARDS HUMANS IN THE ROMANIAN CARPATHIANS, IN RELATION TO THE BEAR'S SEX

Nicolae ŞERBAN-PÂRÂU [1]

KEYWORDS: Romanian Carpathians, bear-human conflicts, risk, sex, wildlife management.

ABSTRACT

This work presents the results of an analysis, based on 370 cases, of aggressive behaviour of bears towards humans in the Romanian Carpathians. A total of 350 cases were investigated between 1992 and 2001. This study addresses various aspects of the aggressive behaviour towards humans, in relation to the sex of the animal involved in the attacks. The distribution of the sexes of individuals involved in aggression towards humans, both in cases that ended with the human being chased, and in those with physical aggression, is presented here. Other elements of the analysis were: repeated attacks, multiple attacks, the vertical posture approach, the situation of attacks in human settlements, minimal and maximal altitudes of recorded bear attacks on humans, hours of the attacks, seasons with the highest risk of a bear attack, the aggressiveness of females with cubs, the attack weapons of bears during the aggression, den and hunt as favouring circumstances, factors which directed bear's attention towards the human, causes of the attack and its outcome, the habit of bears to feed on garbage, aggressive behaviour of the "carnivorous" bears, aggressiveness of bears which had a trap (noose) or bullet injury, the role of the mating period on aggressiveness towards humans, examples of man-eating bears, tranquilization accidents in Romania, and the sex of animals involved in accidents that ended with the death of the victim.

REZUMAT: Consideraţii asupra agresivităţii ursului (*Ursus arctos arctos*) în Carpaţii româneşti, în funcţie de sex.

Lucrarea de faţă prezintă rezultatele analizei, privind comportamentul agresiv al ursului faţă de om, în Carpaţii româneşti, pe baza a 370 de cazuri. Un număr de 350 au fost anchetate, în perioada dintre 1992 şi 2001. Studiul abordează diverse aspecte ale comportamentului agresiv faţă de om în funcţie de sexul animalelor, implicate în atacuri. Sunt prezentate distribuţia pe sexe a exemplarelor, implicate în atacuri asupra oamenilor, atât în cazurile soldate cu urmărirea omului, cât şi în cele cu agresiune fizică. Alte elemente analizate au fost: atacurile repetate, atacurile multiple, abordarea posturii verticale, situaţia atacurilor petrecute în interiorul localităţilor, altitudinile minimă şi maximă la care au fost depistate atacuri ale ursului asupra omului, orele la care s-au produs atacurile urşilor asupra oamenilor, anotimpurile, cu risc maxim din punctul de vedere al atacului unui urs asupra omului, agresivitatea femelelor cu pui, armele de atac ale urşilor în cursul agresiunii, bârlogul şi vânătoarea ca circumstanţe favorizante ale atacurilor, factorii care au îndreptat atenţia ursului către om, cauzele atacurilor şi ale opririi atacurilor, obiceiul urşilor de a se hrăni la depozitele cu resturi menajere, comportamentul agresiv al urşilor „carnivori", agresivitatea urşilor care aveau rană produsă de laţ/capcană sau glonţ, rolul perioadei de împerechere asupra agresivităţii asupra omului, cazurile de antropofagie, accidentele de tranchilizare în România şi sexul animalelor implicate în accidente, care s-au soldat cu decesul victimei.

RÉSUMÉ: Considérations sur l'agressivité des ours (*Ursus arctos arctos*) dans les Carpates roumaines, selon le sexe.

Cet ouvrage présent les résultats d'une analyse sur 370 cases de comportement agressif de l'ours vers l'homme, dans les Carpathes Roumains. 350 cases ont été enquetés entre 1992 et 2001. L'étude approche des divers aspects du comportement agressif vers l'homme, en relation avec le sexe de l'animal impliqué dans les attaques. Il y est aussi présentée la distribution sur sexes des individus impliqués dans des agressions vers l'homme, finies par la pourchase de l'homme par l'ours, ou par une agression physique. Des autres éléments de l'analyse sont: les attaques répétés, les attaques multiples, la posture verticale de l'ours, la situation des attaques dans l'interieur des localités, l'altitude minime et maxime des attaques de l'ours vers l'homme, les heures des attaques, les saisons avec le plus grand risque d'attaque de l'ours, l'agressivite des femelles avec des oursons, les armes d'attaque de l'ours pendant l'agression, la tanière et la chasse comme des circonstances favorisantes de l'attaque, les facteurs qui dirigent l'attention de l'ours vers l'homme, les causes de l'attaque et de son arrêt, l'habitude de l'ours de se nourrir au déchets ménagers, le comportement agressive des ours „carnivores", l'agressivité des ours avec des blessures de piège ou fusil, le rôle de la période d'accouplement sur l'agressivité vers l'homme, des cas d'anthropophagie, les accidents de tranquilisation en Roumanie, et le sexe des animaux impliqués dans les accidents engeandrant la mort du victime.

INTRODUCTION

Romania is known as the country with the biggest bear population, and bear density (number reported to area unit) in Europe, excepting Russia. The maximum number of bears was evaluated in the late 90's. Since then, the population started to decrease. We can also presume a de-structuring of the population, in terms of ages and sexes, between 1990 and 2000 period of time.

One of the controversial aspects about the issue of reintroducing the brown bear in several European countries is the risk of accidents in which people could be injured or killed by a bear. The situation of this type of accidents in the Romanian Carpathians is relatively little known. Several accounts, more or less plausible, on this subject, were published, but a rigorous analysis on this phenomenon, on the entire brown bear territory in the Romanian Carpathians, was not done until now. Only in the last decade of 20th century, scientific works about this issue appeared (Şerban-Pârâu, 1994; Şerban-Pârâu and Almăşan, 1995; Şerban-Pârâu and Almăşan, 1997; Micu, 1997, 1998; Ionescu and Iusuf, 1999; Şerban-Pârâu, 1999, 2002, 2004, 2006).

The accounts from the beginning of 19th century, about confrontations between bear and man, are very brief and biased. Those from the end of 19th century and from the first half of 20th century are more and more certain and detailed, showing an increasing progress in the specific knowledge about bear's biology and in information's specificity. In the second half of the 20th century, given the interest of governmental authorities for the bear hunt, the degree of legal protection of the species increased, and more scientific studies appeared. However, all those studies mentioned scarcely the issue of brown bear's aggressiveness towards humans (Almăşan et al., 1963; Almăşan, 1960, 1979, 1990; Neacşu, 1979; Negruțiu and Cazacu, 1979).

This paper integrate the information from older and newer materials, about the bear-human relation, with the data obtained by the author through hundreds of inquiries in the last decade about bear-human conflicts. This is the first rigorous analysis for the Romanian Carpathians, completed on a large number of cases inquired in detail,

which concerns brown bear's aggressivenes towards humans, depending on the sex of the involved animals. This study motivation is that the biology of this species sexes is very different, the female being preoccupied mainly by raising the offspring in 2-year cycles, which makes her entire behavior to be shaped by the existence of cubs.

The aim was to help to a better understanding of bear's biology, in particular its relation with the humans in the conditions of Romania's national territory, and to complete the apprehension on this issue on the entire habitat of the brown bear. Moreover, it offers extremely useful information to a correct management of this species in the Romanian Carpathians area.

MATERIAL AND METHOD

A total of 370 cases were analyzed. From these, 20 accidents took place between 1900 and 1950 and were selected from the bibliography based on the following criteria: the data were published subsequent to a previous inquiry, the richness in details, and the credibility of the authors. The details of the other 350 cases were obtained through author's inquiries between 1992 and 2001 period of time. The information were collected through direct interviewing of persons attacked by the bear, through completion by these persons of a mail-sent questionnaire, through the medical forms from the hospitals where the victims were admitted (where possible), through official forensic and investigation documents for the accidents resulted in the death of the victim. The questionnaire solicited the following information: name of the person, place and time of the accident, occupation, age at the time of the accident, period and place of hospitalization, if the person saw bears before or after the accident and if they behaved aggressively, bear's color, sex, age (approximate - if it was shot), dimensions (approximate), number of cubs, age of cubs, circumstances of the accident, the unfolding of the attack and the reasons why the bear left the victim. Given the lack of official information about the persons attacked by bears in Romania, some of the victims were found through the courtesy of employees from National Forest Office (Romsilva) in a participation percentage of 30% from the units which have bears on their territory, through the courtesy of biology teachers in areas where the species is present, and through the medical registers of the county hospitals (where this was possible). The database was created using Microsoft Access program. The obtained original data was statistically processed with SPSS (Professional Statistics for Social Studies) 8.0. In the statistical data processing were considered only the certain information and/or data, confirmed by victim's declaration or official documents.

RESULTS AND DISCUSSIONS

Distribution on sexes of bears involved in attacks on humans. The distribution on sexes was the following: half males - 50.7% (150 cases) and 38.2% females (113 cases). In 8.8% cases (26) the person had no indication about bear's sex. The lack of information appears also in cases of lethal accidents, if the bear was not found, or there are no auxiliary data to associate the accident with a known bear in the area. This situation appears only in 2.3% (7 cases). The analysis of all 370 cases showed that in 20% of all situations there was no information about the sex of the bear involved in the attack (74 de cases), which underlines the specific difficulty to obtain information about such category of accidents, even in a rigorous inquiry. Considering the rest of 263 cases, there was found a slightly larger number of males than females involved in attacks towards humans.

The chase. A type of aggression of the bear on a person is the chase. For various reasons, it doesn't end up with the physical aggression of the human. Of 35 analyzed cases, in 40.0% were involved males (14), 48.6% females (17) and in 11.4% (4 cases) there was no indication on bear's sex. There

is a slight tendency of females in chasing the human. Taking into account the number of cubs for the females involved in chasing, in 9 cases there were 2 cubs (52.9%), in 6 cases 3 cubs (35.3%), in one case 1 cub and in another their presence was confirmed without knowing their number. We can ascertain an accented tendency of females with 2 or 3 cubs to chase a human. In 10 cases the cubs were from the first year, while only in 2 cases from the second year, which indicates a higher irascibility of females with young cubs. The analysis of causes why the bear abandoned the chase showed on the first place the tendency of females to follow the cubs and stop the chase, when she considers the cubs safe (20.6%). On the second place in causes stopping the chase was the shooting of the bear (14.7%). On the first places for initiating the chase, far from all other motivations, are the fact that the bear was surprised (at close reach, near food, etc.) and the fact that the female considered her cubs in danger.

Thus, the females with cubs of first year, especially when they are many, prove a high maternal anxiety and are likely to get involved in a chase of the human. Also, surprising the animal in any way may result in a chase.

Physical aggression and the length of the attack. Another type of the bears aggression on human is the physical aggression, ended either with the injury (light injury or heavy injury), or the death of the victim. Considering the length of the attacks, we found 3 main types of attacks: short, short-intense (the attaking bear gives more attention to the victim) and long-persevering (the attaking animal interacts longer with the victim). Regardless the sex of bears, we found that the attacks were especially short-intense (40.7%), followed by the short ones (30.7%) and long-persevering (28.6%). Observing the situation on sexes in a total number of 199 studied cases, the ratio between short and long-persevering attacks were 17/28 for bear females and 37/21 for bear males. It results a stronger tendency of females to attack more persevering the victim, given the maternal anxiety. Males seem to have a tendency to aggress the human by shorter attacks.

Repeated attacks. A particularity of bear attacks is the stopping of the physical aggression or the reducing of attack's intensity, giving the impression that the victim will be left. Immediately when the person tries to move after she/he was ignored, or partially ignored, by the bear, the attack may be resumed, or the bear will only display the intention to resume the attack. Many times, the second attack proved to be much more violent, the animal being more irritated than in the first attack. In the case of mother bears with cubs, the anxiety comes from the fact that the movement of the human - after she first considered him annihilated as a danger - makes her consider the human as a still persisting menace. The frequency of the repeated attacks, from the total of 184 cases with enough data for a statistical analysis, was 10.9% (20 cases). In 13 cases the bear attacked once again the victim, in 6 cases twice and in one case in an unknown number of times.

Twice as much females (12) than males (7) had this type of behavior, and in one case the bear's sex was unknown to the victim. In 8 of the 12 repeated attack cases in which females were involved, the cubs were from the first year. In 5 cases there were 2 cubs and in 2 cases one cub. The main motivation of repeated attacks was the maternal concern (29.7%), followed by the taking by surprise of the bear (27.0%) and the situations in which the man could not describe any reason for the attack (16.2%). Taking the animal by surprise and the maternal concern may generate an extremely persevering attack, especially when both factors act simultaneously. Taking by surprise a female represents a bigger risk of a repeated attack (7 cases) than in the case of males (3 cases).

The probability of a repeated attack is small. Both males and females may attack man this way, but this behavior is rather characteristic to females with cubs of one year, for which the maternal concern is

maximal. In order not to provoke a repeated attack, it is recommendable for the victim to stay still and not to move until it is certain that the animal moved off.

Multiple attacks. We considered as multiple attacks if, during the same accident, the attacking bear targeted several persons successively. The animal may come back to the person initially attacked, after he temporarily directed his attention towards another person. In multiple attacks, where bear's sex was known (29 cases), the ratio males/females was 22/7 (3.1/1). Out of 7 cases in which the females attacked several persons, in 6 cases cubs were present. In 5 cases they were cubs of one year.

Attacking several persons seems to be rather a tendency of the males. The explanation resides in the fact that these attacks had as favoring circumstance the hunt or the presence of cattle (sheep, cows, horses, etc.). These circumstances generate bear-human conflicts in which males are mostly involved.

The vertical posture. The analysis of cases in which the bear had taken the vertical posture in front of the man, during the attack, proved that females (19 cases - 73%) more than males (7 cases – 27%) have this tendency. The results showed that 81% of female bears who stood in two paws during the attack had cubs, 61% of females who had taken this posture had 2 or 3 cubs. 93.3% of cubs were cubs of one year, thus inexperienced and demanding great attention and maternal concern.

Also, the bullet wound provokes a standing in two paws to both females and males. The main causes of attacks, when bears had taken this posture, were the fact that the mother bear considered her offspring in danger (30.6%) and the fact that the animal was taken by surprise (30.6%). Victims considered in almost all cases the vertical position as an attack posture. This can be explained by the fact that men have seldom other hints to indicate bear's intention to attack. The qualitative analysis of cases describes the vertical posture as a very efficient approach, the man being rapidly put down and annihilated as a potential danger. In all analyzed attacks, the bear stood only once in two paws.

Attacks in human settlement areas. The analysis of the areas where attacks took place showed that bears of both sexes come near human settlements for food. Most of the times people cannot tell the difference between a male and a female bear who entered in their garden or orchard, except for the cases when they have seen the cubs. The attacks at stables seem to be a preference of males, as they take the risk of a conflict with humans. Female bears probably avoid such conditions because of the risk for cubs.

Considerations on minimal and maximal bear attack altitudes. The accidents at lowest altitudes (3 cases - 300 m in Vâlcan Mountains, Gorj County, on the 8th of November 1992; 521 m, Durducu Forest, Prahova County, on the 25th October 1992; 589 m, Pleşuva Hill near Şoimari Village, Prahova County, on the 12th November) involved females with cubs and took place in autumn, end of October, beginning of November. The cases at highest altitudes (1657 m, Siriu Mountains, Buzău County, in 1962; 1777 m, Vrancei Mountains, Covasna County, Lăcăuți Peak in 1966) involved males and took place in summer, in August and June. In both these studied cases were "carnivorous bears", who had taken animals from the sheepfold.

Considerations on the hours of attacks. The distribution of hours when accidents happened (by analysis of 68 cases for which the exact hour of accident is known) shows that during the night significantly more males (8 cases) are involved in attacks, than females (2 cases). Twilight attacks on humans (19.00 – 22.00) seem to have the same characteristic of distribution on sexes, with a slight increase for females (5 cases). Amazingly, males and females may equally attack between 9.00-16.00, while males are predominant in the total number of attacks analyzed (37 males and 21 females). Female bears have a more pronounced tendency (with 10% higher than males) to attack humans during the day. The explanation comes from the differences in the biology of the sexes. Females, taking

care of the cubs, get seldom involved in conflict situations with humans during the night, which appear mostly when bears come near human settlements or sheepfolds.

Seasons with highest bear attack risk. We considered separately the attack cases with males and with females, to see whether there are any differences of attack frequencies on seasons, or not. Through analysis of 123 cases with males, 9.8% (12 cases) occurred during spring, 51.2% (63 cases) summer, 33.3% (41 cases) autumn and 5.7% (7 cases) winter. In the 95 cases with females, the distribution on seasons was: 11.6% (11 cases) in spring, 45.3% (43 cases) summer, 34.7% (33 cases) autumn and 8.4% (8 cases) winter. Males have a significantly higher frequency of attacks during summer, while females are more likely to attack also during winter and spring. The differences in spring and winter come from the fact that females have a life cycle dependent on cub raising. In January and February female attacks are predominant, because they give birth and nurse cubs, thus they are more alert than males in that period. Following, we find females who attacked because they were disturbed at the den by human activities (hunt, logging, etc.) in January, while there was no attack of male bears in that period.

The aggressiveness of females with cubs. To confirm our supposition that the females with cubs of one year are more aggressive towards humans, because of the dependence of cubs on maternal protection, we have calculated the frequency of females' attacks, considering the age of cubs, for the 59 cases with complete information. In almost 80% of cases (47 cases) there were cubs of one year and in only 11.9% cases (7) yearlings. In only 4 cases the victim could not evaluate the age of the cubs and in one case the mother bear was accompanied both by cubs of one year and yearlings - an extremely rare situation. In many situations, when cubs of one year were present, regardless if the mother bear eventually attacked or not, the female displayed the same behavior pattern: when noticing the human presence, she pushes the cubs with the muzzle to retreat (usually towards the forest). With the yearlings, the female is less vigilant, as they are normally able to retreat by themselves, without mother's impulse.

Another major cause of maternal anxiety is the number of cubs. The habit of small cubs is to stray from the mother, playing and exploring the environment. The more cubs, the more directions they can go to, so that the female is always under tension and with an alert attention. In these cases, female's degree of violence is much bigger if the situation seems to be dangerous for the cubs. To verify this assumption, we checked the frequency of attacks depending on the number of cubs in the 105 cases with available data. The frequency for females with 2 cubs was 43.8% – 46 cases, followed by those with 3 cubs: 12.4% – 13 cases and those with 1 cub: 4.8% – 5 cases. In a large number of cases – 35, meaning 33.3% – the victim could not assess the number of cubs. The results confirm the high degree of risk represented by females with 2 and 3 cubs, compared with those with only one cub. Most female attacks occurred in the forest - a very unfavorable place to meet a female bear, because the human cannot easily retreat, cannot evaluate the position towards the cubs and in many cases may go in the direction of the cubs.

Considerations on the attack's results, depending on the bear's sex. Comparing the outcomes of male and female bears aggression, we found out that males' attacks result more often in the death of the human, with high differences between males and females for the immediate death of the victim. On the other hand, females inflict more serious injuries to humans. This fact can be explained by the correlation with the attack length, as females tend to attack more persevering the victim, and males seem to have a tendency to aggress the human by short and violent attacks.

Considerations on bears' attack weapons. The analysis of the bears' attack weapons during the aggression on the humans proved a preference of females to use both teeth and paws (61.3%), compared to males (38.5%). Males have attacked in

relatively equal number of cases only with the paws (31.3%) or with the teeth (30.2%). Females have a lower tendency to attack only with paws (21%) or teeth (17.7%), probably because they want to be sure that the danger is annihilated. The analysis was done on 96 cases with males and 62 with females.

The den as a favoring circumstance of bear attacks. Most of the cases in which the proximity of the den was a favoring attack circumstance were in February (4 cases), followed by January, March and December with 2 cases each, and April and May with 1 case each. Out of 18 such cases, 13 involved females and only 2 males. In one case the victim did not notice the sex of the bear and in 2 cases the victim was killed and the sex of the bear remained unknown. The existence of cubs was a irascibility motive for the females disturbed at the den, in all 13 cases the females having cubs (2 cases - 2 cubs; 1 case - 3 cubs; 8 cases - there were cubs, but it is uncertain how many) From the 18 cases, 17 resulted in physical aggression and only one in a chase. The fact that 2 people died on the spot and 11 were severely injured, while only 3 people were lightly injured, emphasizes the gravity of accidents at the den. The main motivation of humans to get in the proximity of a bear den was the hunt (5 cases), followed by forestry activities and logging by local inhabitants (3 cases each). Females were disturbed at the den by men (5), dogs (4), forestry activities (1), other human activities (1) and wild boar chase (2). Males were disturbed at the den only in one case by men and in another by forestry activities. It seems that the risk to disturb a female at the den is much higher than for males, as females react more rapidly to any human activity in the proximity of the den, considering it a threat for the cubs.

The hunt as a favoring bear attack circumstance. The analysis of hunt as a favoring bear attack circumstance showed the following distribution on sexes: 69.2% males, 25% females, 5.8% cases without data about bear's sex, because the man was killed or because the victim had no hint about bear's sex. Any type of hunt (chase or stalk, for bear, stag or wild boar, etc.) leads more seldom to accidents with females.

The causes that triggered the attacks at hunt had on the first place the fact that the female considered her cubs in danger (12.2%). On the next places were the chase of wild boars (11.2%), the chase of bear when the animal returned injured from the line of stalls (11.2%) and the stalk hunt that lead to the injury of the bear (10.2%).

Factors that lead bear's attention towards men. The movement of men in the proximity of the bear or a sudden move appear on the first place for both males (38.8%) and females (45.3%), with a higher frequency for the last. If for males the noise made by humans is situated on the second place (21.4%), this stimulus is on the third place for females, although with an equal frequency (21.6%). On the second place for females is the simple presence of the human with 23.0%, while for males it represents the third factor, with 18.3%. This distribution proves that, for a female, the proximity of men is enough to get her attention, due to the concern for cub's safety. The factors on forth and fifth *places - the man tried to take the prey and the man hit the bear* - are reversed between males and females. For females, the fact that the man hit the animal is on the forth place (2.7%). As we mentioned before, females with cubs seldom attack domestic animals, situation that may lead to the attempt of man to take her pray and hit her. Females prefer to get food without putting in danger her cubs and herself by a possible human intervention.

Moreover, females showed a higher degree of irascibility towards persons met on the road, compared to males, attacking in more cases than males in this location.

Attack causes. The analysis of attack causes showed major differences between sexes. For males, a high frequency have, in order: taking the animal by surprise (22.7%), trying to take its prey (14.4%), bear chase (10.8%), trying to chase away the animal (9.8%) and the attacks without any obvious reason (7.2%). Males seem to have more causes for their attacks, thus also being involved in more accidents than females.

Females have two main causes for attacking men: she considered her cubs in danger (41.8%) and she was taken by surprise (33.5%). The frequency of the first attack cause for females is almost double than the first cause for males. Being disturbed at the den is an attack cause mostly for females (5.7%) than males (1%). The reasons for attacking are much clearer for females, more males attacking without any obvious reason - 14 males compared to 5 females. The presence of dogs was disturbing for both females and males (4 cases). The chase provoked especially males (21 males and 3 females). Although taking the bear by surprise is the first cause for males' attacks, this factor acts especially for females, males having also other potential reasons to attack a human.

The cases when males attacked without any obvious reason happened mostly in summer, when the abundant vegetation increases the probability to take the bear by surprise, the rapid attack and retreat, giving the victim little or no information about the attack causes. Accidents caused by bear stalk hunt - injured bear happened in the hunt seasons (spring). Accidents generated by bear or other animals chase occur in autumn. In summer, males attacks are provoked by the attempt of farmers to take back their property (sheep, goats, cows, pigs), to chase away the animal and by the fact that the bear is taken by surprise (explainable also by the existence of high vegetation). The reasons for attacks, which seem to act through the entire year are taking the animal by surprise, the attempt to chase the bear away and shooting the bear before the attack. The first two causes peak during summer.

Two factors generating a female attack act the whole year: the fact that she considered the cubs in danger and taking the bear by surprise. Both have the highest incidence in summer, when human activities in bear's habitat are diverse, the day is long, and the vegetation favors unexpected encounters.

The causes of bear attack stopping. Comparing the reasons for stopping the attack, for males the intervention of dogs is on the first place (20.3%), while for females the main cause is the fact that they went after the cubs (31.4%) with a significantly higher percentage that the main motivation for males. This fact confirms again the tremendous importance of maternal care for both launching the attack and stopping it. On the second place for males is the situation when the motives of retreat are uncertain (14.1%), and for females the intervention of dogs (13.3%).

Both sexes have the tendency to get scared by the noise usually made when men appear. Both males and females tend to leave alone the fainted man (who does not move anymore). The situation when the bear left the man who played dead occurred only with females, probably because when the danger seems to be annihilated, the female considers that she can go back to the cubs. The cases when the bear could not be moved off, involved mostly males.

Considering the correlation between animal's retreat and whether the human opposed resistance to the attack, the results showed that fighting the bear does not influence much the retreat of the animal (many times the resistance may irritate more the bear). Fighting has rather the role to reduce, as much as possible, the seriousness of injuries inflicted to the victim by hits and bites.

The opposition of man proved to be efficient against both males and females (element resulting from the qualitative analysis of accidents), depending in an obvious way on the particular situation and on bear's temperament. This element, bear's temperament, which varies from an individual to another and depends on sex, age etc., appears always when dealing with the issue of bear aggressiveness, in interviews with hunters, forest workers or victims. Although there are clear behavior patterns, found in all investigated cases, each individual's temperament, its way to react in a given situation, make each case unique, from the point of view of its beginning, development, and ending.

Bear's habit to feed at garbage deposits. Between 1992 and 2001 were

found 14 accidents related to bear's habit to feed with human garbage (at garbage dumps, garbage containers near blocks of flats, garbage dumps near mountain chalets, etc.). Braşov is the county with the most numerous accidents favored by the availability of garbage on which bears can feed (78.6% of cases - 11 accidents), the other counties being Prahova (14.3% - 2 accidents) and Sibiu - 1 case. Although the bears feed at garbage in other places as well, such as Tuşnad, in Harghita County, there were no accidents related to this habit. From 12 cases with information about the bear involved in the attack, in more than half (7 cases) were females with cubs, in 3 cases were males and in 2 the man had no hint about bear's sex. All females had cubs (3 females had 2 cubs, one 3 cubs, the other 3 had cubs, but their number is unknown). In 3 cases it is certain that there were cubs of one year and in only one case there were yearlings, but in that case the human directly provoked the animal (the bear was hit). The main causes of these attacks were the fact that the female considered her cubs in danger (41.2%) on the first place, followed by the attacks without an obvious reason (23.5%) and surprising the animal (17.6%). The analysis of these cases showed that the main risk factor is the feeding of females with cubs at garbage, especially in summer and autumn.

Considerations on the aggressive behavior of "carnivorous" bears. The literature considers the brown bear to be an omnivorous animal, which means that it eats almost anything edible, be it of animal or vegetal origin, although it is prevalently herbivorous. Therefore, the expression used to name the bears that have in a given period of time a prevalent carnivorous diet, based on live-stock, and not wild animals (wild boar, stag, deer, etc.), is "carnivorous bear". In Romania, usually when accurate information lacks, the attacks on humans are attributed to this type of bears. From the 370 analyzed cases, only 31.1% - 115 animals could be included in the category of "carnivorous bear". Therefore, it is not justified to blame exclusively these bears for aggressive behavior towards human. Although there are clear data about bear's sex only for 91 individuals out of 115 known as "carnivorous", 78% of them (71 individuals) were males and only 16.5% females (15 individuals). We can presume that in the wilderness the majority of bears with a preponderant carnivorous diet could be males. The attack causes for this category are consistent with the general results. The majority of females attacked because they considered their cubs in danger and because they were taken by surprise, while males because the man tried to take their prey, tried to chase them away or they were taken by surprise.

Both females and males in this cases are likely to stop the attack primarily because of dogs' intervention. The other causes are similar to the general results.

Considerations on wounded (by noose or trap) bears attacks. All bears involved in this type of attacks were males (9 cases – 1.9% of all 370 cases). There were three attack types of bears with noose or trap wounds: 1. captive bears, who attacked while being in the trap/noose (5 cases); 2. released bears, who attacked immediately (2 cases); 3. bears who freed themselves and attacked after a while (2 cases). Almost half of the cases occurred in summer, and all during the day. All bears were shot: 5 during the attack, 4 after it. The qualitative analysis of these cases showed that a trapped bear has an unpredictable behavior, provoked by the tremendous stress on the animal. People who try to free a bear must take good security measures. It is preferable to tranquilize the animal before the release. The analyzed accidents showed a risk for the human to step accidentally into the animal, because the trapped bear is very still after a period of agitation when it tries to break free from the trap or noose, which aggravates the wounds.

Considerations on bullet wounded bears attacks. The bullet wounded bears represented 10.8% of all bears involved in attacks and 63.5% of bears with a physical trauma. To these we can add the bears wounded by small shots – 0.8% of cases and 4.8% of bears with a handicap. Generally, males, more than females, end up having a

physical handicap inflicted by men. The difference between bullet wounded males and females is very high, the ratio being 31/7, 4.4/1). Moreover, male bears are more exposed to other types of traumas, such as injuries from hits with an ax/pitchfork (5 cases of males, 1 female) or small shots (2 cases of males, 1 female). The wounded bear attack is caused mainly during a bear chase (32.8%). Although the rules of such hunts are very strict, a multitude of unpredictable circumstances increase the probability of an accident. Another cause of wounded bear attack is the normal tendency of the animal to attack the one who hurt him (19.0%), followed by the bear stalk hunt (17.2%), which may also generate unpredictable situations, risky for humans - going after the wounded bear, bear recovering after a light commotion, etc. Any other hunt type in bear's habitat may also favor the attack of a bear shot accidentally. The data show that, in general, it is difficult to take off a wounded bear from its victim, except if the animal is being shot to death (extremely risky in such conditions) - this being the first cause for the ending of a wounded bear attack in 31.4% of cases. In 14.3% of cases, all with males, the reasons why the bear stopped the attack are unclear.

Specific considerations about the role of mating season on brown bear's aggressiveness towards humans. The only monograph of brown bear (Couturier, 1954) specifies, as rather a curiosity, the fact that: "During the mating, the couple taken by surprise and disturbed may become exceptionally aggressive". Bear couples may be encountered only in the mating season. Once the female gets out of the heat, bears become solitary again. In areas with high population density, there were found females accompanied by two, three or even more males. My investigations in the last 8 years brought information that indicate the influence of the mating season on the aggressiveness towards humans. Nevertheless, it is difficult to ascertain that an attack is strictly determined by the agitation of animals in that period, since the victim can tell only what happened to him/her and has seldom hints about bear's sex, without the presence of cubs. Of the 4 cases discovered to have been influenced by the mating season, 2 happened in June and one in July, mating period for the Carpathian brown bear. Two bears were present in these cases. In one case both bears attacked, and in the other only one bear. The humans did not provoke the bears, which were especially petulant. In a case occurred in November, there were 5 bears present. Only one attacked, without being provoked by the human. Although in the last autumn month, the aggregation of five bears may be due to the late entry in heat of a female accompanied by 4 mating males, which would explain the excitation of the bear who attacked. The animal left quickly the victim and did not attack again, at the next encounter, after a short while.

Man eating cases. The only case of a man eating bear, a male, in Romania, occurred in Sâncrăieni-Ciuc, Harghita County, in 1954. Several Romanian authors quoted this case (Almăşan et al., 1963; Georgescu, 1970; Şerban-Pârâu, 1994, 2002; Micu, 1997). My analysis of the official documents (forensics report no. 1503/1954 Sâncrăieni-Ciuc) confirmed that the bear ate human flesh. The man eating brown bear cases are rare and considered an effect of the natural food scarcity, in extreme environment conditions, or involving handicapped animals (old bears, with blunt teeth, with no fat reserve). The case in Sâncrăieni-Ciuc, 1954, when the bear acted like a predator towards the man, can be a consequence of scarce food resources in that period (December). In other accidents in Romania, that rise suspicion that the animal ate human flesh, there are no sufficient proves, as no autopsy was undertaken, that the bear actually ate human flesh.

Tranquillization accidents in Romania. The only accident favored by the attempt to tranquilize the animal happened on March 25th, 1977, near Lacul Roşu (Harghita County). The victim was Lucian Manolache, 44, PhD in Biology and researcher within I.C.A.S. (Institute for Forestry Research and Management). In

Romania, during the second part of 20th century, a period of scientific studies on wildlife, tranquillization was rarely used and always with the most affordable methods - one of them used diazepam medicine. Before trying this substance on animals on the wild, the diazepam was tested on the bears from the State Circus. At that time, the dual effect of diazepam on humans and other omnivorous mammals was not known. Presently, it is known that diazepam may first provoke agitation before inducing calm and sleep. The bear, a male, ate a quantity of diazepam, although first he vomited a part of the food with sedative. Initially, the bear unleashed his fury against the man, than against a doghouse, which he destroyed, while chasing other men, then he lied down still with the muzzle on the paws, 4 m from the human corpse. In conclusion, the that sedative first agitated the animal, and then calmed it. Most likely, the bears from the circus, on which the tests were made to establish the diazepam dose, did not show initial agitation (or it was not noticed, as they were captive). Possibly, the animals from the circus were sedated before and showed a degree of adaptation to drug. After this accident, diazepam was more used to tranquilize wild bears in Romania.

Considerations on the sex of bears involved in accidents ended with the death of the victim. Man's death following a bear attack can be considered a particular situation of severe injuries, which eventually lead to victim's death. In the 44 cases of death analyzed, 40 persons (90.9%) were men and 4 women (9.1%). In 60.5% of cases were involved males, in 23.7% females and in 15.8% bear's sex is unknown.

CONCLUSIONS

The analysis of a large number of human-bear conflicts showed that the bear can be a dangerous animal only in some specific circumstances, it's behavior towards humans being dictated by the general biology of the species. The probability of human-bear conflicts may be seriously reduced, even with a high density of bear population, by protecting bear's habitat in the Carpathians and the food potential for this species, along with a minimal human intervention on it. Also, an improvement of people's knowledge (local inhabitants, tourists, hunters, forest workers) about bear's behavior, and especially a real wildlife management - which should protect the interests of both forest administration and local inhabitants - may contribute significantly to avoid the future possible conflicts.

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I thank to the hundreds of persons who were attacked by bears and accepted to relate the circumstances of the attacks. Without their accounts, this study would not have been possible. I thank to the tens of teachers from mountain villages that facilitated the discovery of specific cases and information. I thank to my professor, lamented Mr. H. Almăşan, president of the Romanian Wildlife Society, for the support in beginning this study. I thank to Mr. G. Cahniță, General Director of Romsilva for the cooperation of the institution between 1996 and 1997.

REFERENCES

Almăşan H., 1960 – Ursul, animal insuficient cunoscut, Vânătorul şi Pescarul Sportiv, nr. 10, p. 7-8. (in Romanian)

Almăşan H., Popescu C., Andone G., Babuția T., Nițulescu M., Radu Ş., Radu D. and Scărlătescu G., 1963 – Răspândirea speciilor de vânat în R.P.R., Studii şi cercetări, vol. XXIII-A, Ministerul economiei forestiere, Institutul de cercetări forestiere, Editura agro-silvică, Bucureşti. (in Romanian)

Almăşan H., Babuția T., Cotta V. and Popescu, C., 1963 – Contribuții la cunoaşterea răspândirii şi biologiei ursului (Ursus arctos L.) în R.P.R., Studii şi cercetări, Vol. XXIII-A,

Ministerul economiei forestiere, Institutul de cercetări forestiere, Editura agro-silvică, Bucureşti. (in Romanian)

Almăşan H., 1979 – Bonitatea terenurilor de vânătoare pentru ursul brun (Ursus arctos L.) în România, Consideraţii privind ecologia şi comportarea ursului brun în Carpaţi, Simpozionul internaţional Ursul brun (Ursus arctos) - Braşov (România), 9-12.X.1979, A.G.V.P.S., Bucureşti. (in Romanian)

Almăşan H., 1990 – Expertiză privind situaţia ursului brun în România, Laboratorul de cinegetică, I.C.A.S., Bucureşti. (in Romanian)

Couturier A. and Marcel J., 1954 – L'ours brun, Grenoble. (in French)

Ionescu O. and Isuf C., 1999 – Brown bear (Ursus arctos) - human conflicts in Romania. The 12th International Conference on Bear Research and Management, 14-17 October, Poiana Braşov, România, Book of Abstracts: 48.

Georgescu M., 1970 – Ursul şi lupul în Carpaţii noştrii, A.G.V.P.S., Bucureşti. (in Romanian)

Micu I., 1997 – Teză de doctorat, Universitatea Transilvania, Braşov. (in Romanian)

Micu I., 1997 – Bear-Human Conflicts in Romania, 11th International Conference on Bear Management and Research, European Session, September 1-4, Graz, Austria, p. 45.

Micu I., 1998 – Ursul brun. Aspecte eco-etologice, Editura Ceres, Bucureşti. (in Romanian)

Neacşu A., 1979 – Ursul brun (Ursus arctos L.) în România, Simpozionul internaţional Ursul Brun - Braşov (România), 9-12.X.1979, Bucureşti, 2-12. (in Romanian)

Negruţiu A. and Cazacu I., 1979 – Consideraţii privind ecologia şi comportarea ursului brun în Carpaţi, Simpozionul internaţional URSUL BRUN (Ursus arctos - Braşov - România), 9-12.X.1979, A.G.V.P.S., Bucureşti. (in Romanian)

Şerban-Pârâu N., 1994 – Particularităţi ale biologiei ursului brun (Ursus arctos L.). Thesis, Univ. Bucureşti, Bucureşti, 1-88. (in Romanian)

Şerban-Pârâu N. and Almăşan H., 1995 – Contribuţii la cunoaşterea situaţiei confruntărilor urs-om în România - consideraţii asupra agresivităţii ursului brun. Simpozion C.I.C. „Problema şi gestionarea ursului brun în Palearctic" - Poiana Braşov 29 aprilie - 1 mai, mss. (in Romanian)

Şerban-Pârâu N. and Almăşan H., 1997 – Preliminary results concerning bear-people conflicts in Romania. 11th International Conference on Bear Management and Research, European Session, September 1-4, Graz, Austria, Book of Abstracts: 66.

Şerban-Pârâu N., 1999 – Brown bear - man conflicts at the garbage deposits in Prahova Valley and Braşov, Romania, 12th International Conference on Bear Research and Management, 14-17 October, Poiana Braşov, România, Abstracts: 40.

Şerban-Pârâu N. 2002 – Particularităţi ale biologiei ursului brun în România, Dissertation, Institute of Biology, Romanian Academy, Bucureşti, România. (in Romanian)

Şerban-Pârâu N. 2004 – Considerations on human – bears conflicts correlated with bears feeding at garbage deposits in Romania, Muzeul de Istorie Naturală Sibiu – Studii şi Comunicări – Şt. nat. 29, 241-249.

Şerban-Pârâu N. 2006 – Occupations and professions with increased risk of a brown bear (Ursus arctos arctos) attack in the Romanian Carpathians - short communications, Muzeul de Istorie Naturală Sibiu, Brukenthal Acta Musei I, 3, 235-236.

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A PROGRAMME TO EXAMINE THE EVOLUTION OF ENVIRONMENTAL INDICATORS (THE CORRELATION OF ENVIRONMENTAL FACTORS)

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KEYWORDS: environment, quality, indicators.

ABSTRACT

A program called CEEF-01 has been developed by the author to study the evolution of environmental quality indicators. The program can be used by environmental authorities and economic agencies. Using this program the actual situations encountered in environmental protection activities can better take into account. The program also gives the ability to make a prognosis and risk analyses concerning pollution or the exceedance of an arbitrary designated value.

REZUMAT: Programul pentru examinarea evoluţiei indicatorilor de calitate a mediului (examinarea corelată a factorilor de mediu).

Pentru studiul evoluţiei indicatorilor de calitate a mediului, autorul a proiectat un program denumit CEEF-01, care poate fi utilizat, atât de agenţii economici, cât şi de autoritatea de mediu.

De aceea, situaţiile actuale, întâlnite în activităţile de protecţie a mediului, pot fi mai bine luate în considerare.

Pot fi de asemenea făcute prognoze şi analize de risc, referitoare la poluare sau la depăşirea unei valori desemnate arbitrar.

ZUSAMMENFASSUNG: Programm zur Prüfung der Entwicklung von Umwelt Qualitätsindikatoren (korrelierte Untersuchung der Umweltfaktoren).

Zur Untersuchung der Entwicklung von Umwelt Qualitätsindikatoren hat der Verfasser ein CEEF-01 genanntes Programm entworfen, das sowohl von Wirtschaftsfachleuten, als auch von Umweltbehörden verwendet werden kann. Damit können auch die derzeitig während der Umwelttätigkeiten angetroffenen Situationen besser berücksichtigt werden. Außerdem können Prognosen gemacht und Risikoanalysen in Bezug auf Umweltverschmutzung oder Überschreitung eines ungefähr festgelegten Wertes durchgeführt werden.

INTRODUCTION

For studying the evolution of environment quality indicators, was designed a program called CEEF-01, which can be used both by economical agents and the environmental authority. Therefore, the actual situations encountered in environmental protection activities can be better considered. There can also be made prognosis and risk analysis concerning pollution or the exceeding of an arbitrary designated value.

This program contains:

- a data base;
- a module for determining the total or partial correlation coefficients for the existing data, which can be selected in the program data base;
- a module for determining the probability of encountering an exceeding of the environmental quality indicators.

RESULTS

The data base has the capacity to comprise ten different environment quality indicators. I considered this capacity suitable to cover most of the actual cases of supervising the relevant quality indicators which can have an impact on the major environment factors.

The environment quality indicators to be measured were marked using the symbols: I1, I2, …, I10. For this reason, the data base contains ten columns from I1 to I10. The operator/researcher will arrange the data into these columns by accessing the option "introduce data into the data base" in the programme's dialogue box (Fig. 1). Within an organization, this data is available in the environmental protection department.

I provided the programme data base with three indicators for the level of production, marked as P1, P2, and P3. They will be expressed by a unit of measurement relevant for describing the production volume, such as the functioning hours on metalworking equipments, surfaces covered by galvanic processes. The exact data will be introduced by accessing the option "introduce data into the data base". The production data will be arranged in the columns P1, P2, and P3. The exact data of economical agents can be analyzed in the production department.

The third set of values necessary for making an integrated environment analysis is represented by the indicators for the level of the unit's environment expense, marked as C1 and C2. Within organizations, the precise data concerning the expense are available in the accountant department.

When introducing data, the data regarding the introduced indicators should be also filled in.

A module for determining the total or partial correlation coefficient can be used for the data registered in the program data base. For accessing this section of the program, indicators "I", "P" and "C" have to be selected. After this, press the option "Calculate". This part of the program determines the total and partial correlation coefficients, for a set of data in an "I" column representing an environmental quality indicator, a "P" column representing the production volume, and a "C" column representing the volume of environment expense. The total and partial correlation coefficient values have to be established within the limits [-1, 1]. These values will have to be interpreted. The total correlation coefficients will point out some relevant aspects in environmental performance analysis. The partial correlation coefficients will increase the analysis accuracy and will be relevant for an integrated environmental analysis.

The module for determining the probabilities of encountering an exceeding of the environmental quality indicators function only for the data columns which register the environment quality factors, such as the "I" columns in the program's data base, representing the environment quality indicators. Depending on the registered data, the program will determine the probabilities of encountering 1, 2, …, *n* phenomena of exceeding the maximum allowable concentration (MAC) or other values the researcher established (such as attention levels). According to the Poisson Law, in order to determine several probabilities, we introduce in the dialogue box the following:

- an "I" indicator, without the need to actually introduce the values. For example, we can introduce "15";
- a MAC (maximum allowable concentration) for the quality indicator (for example the MAC for "15"), or another value considered as limit and taken into consideration the possibility of its exceeding;
- the period of time relevant for the data registered in the data base;
- the number of exceeding during the time of the prognosis;
- the period of time of the prognosis.

The user guide of the CEEF-01 program (introducing the data and determining the total and partial correlation coefficients).

1. The data registration is made by accessing the dialogue box in the figure number 1.

Figure 1: The interface of the CEEF-01 program for data registration.

The figure number 2 shows an example of registered data.

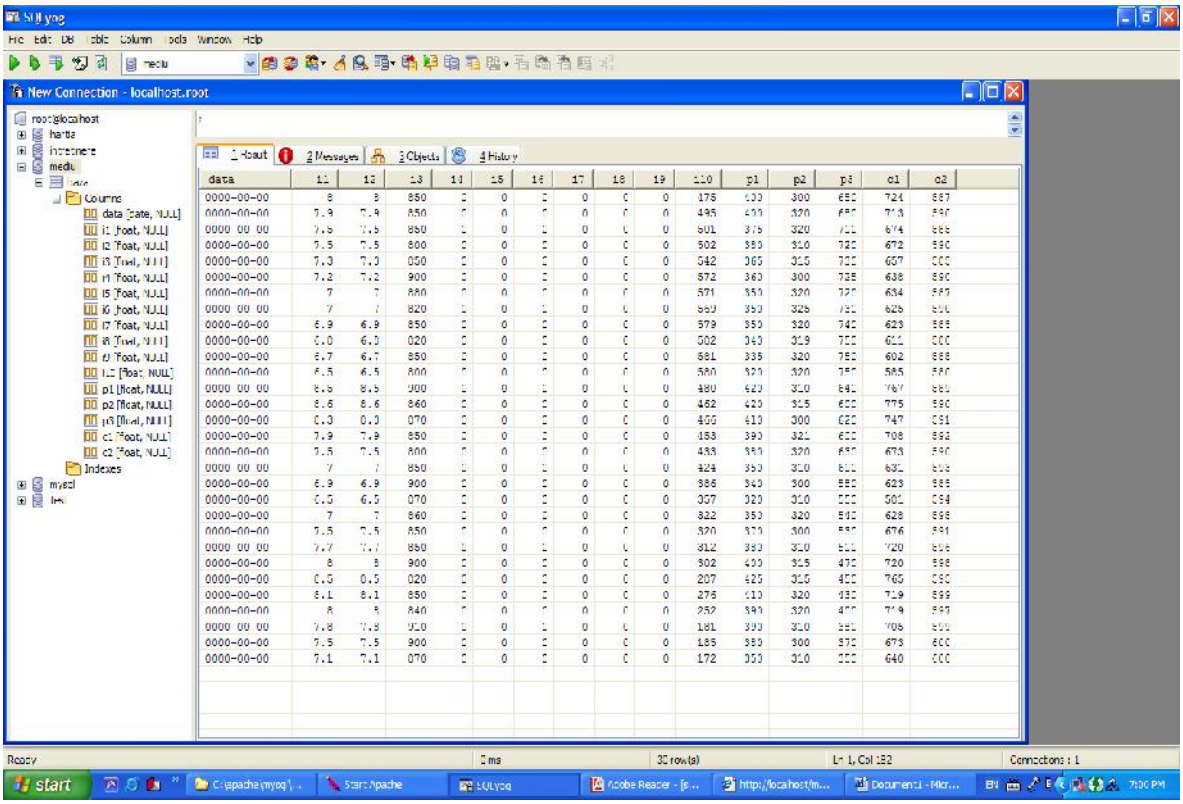

Figure 2: Environment data registered in the CEEF-01 program data base.

After having introduced the data into the program, we can select for the analysis of a correlation an indicator in each of the above mentioned groups, meaning an "I" indicator representing an environment factor, a "P" indicator representing the production level and a "C" indicator representing the volume of environment expense, in the same period of time. By selecting the I, P, C combination (Fig. 3) and accessing the program, the total and partial correlation coefficients for the three I, P, C chosen parameters will be displayed (Fig. 4).

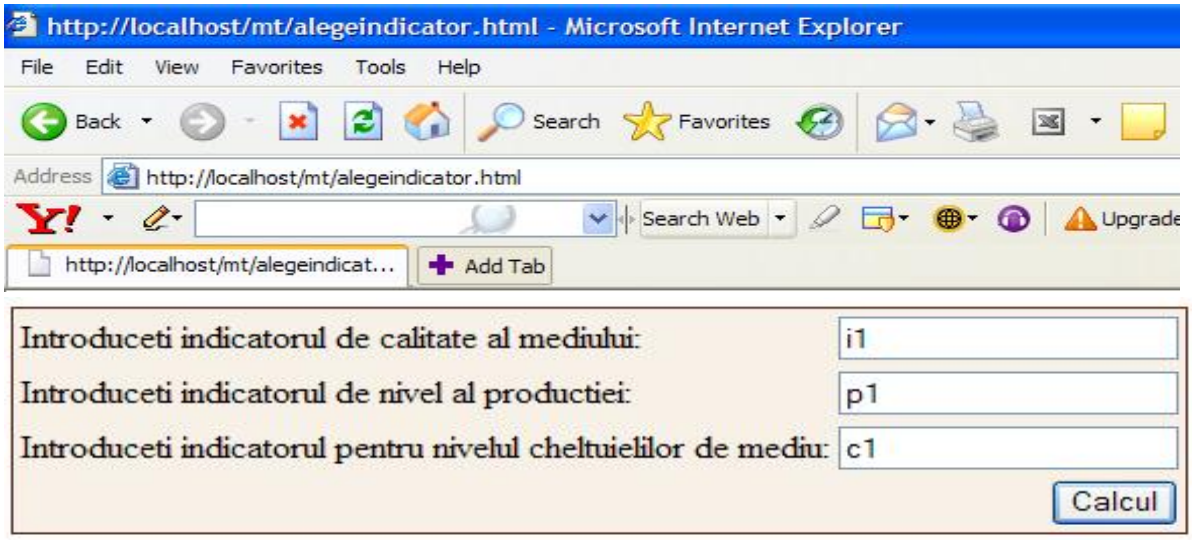

Figure 3: Selecting the indicators for calculating the correlation coefficients.

The data to analyze will be automatically selected from the program data base. The figure 4 shows an example products display.

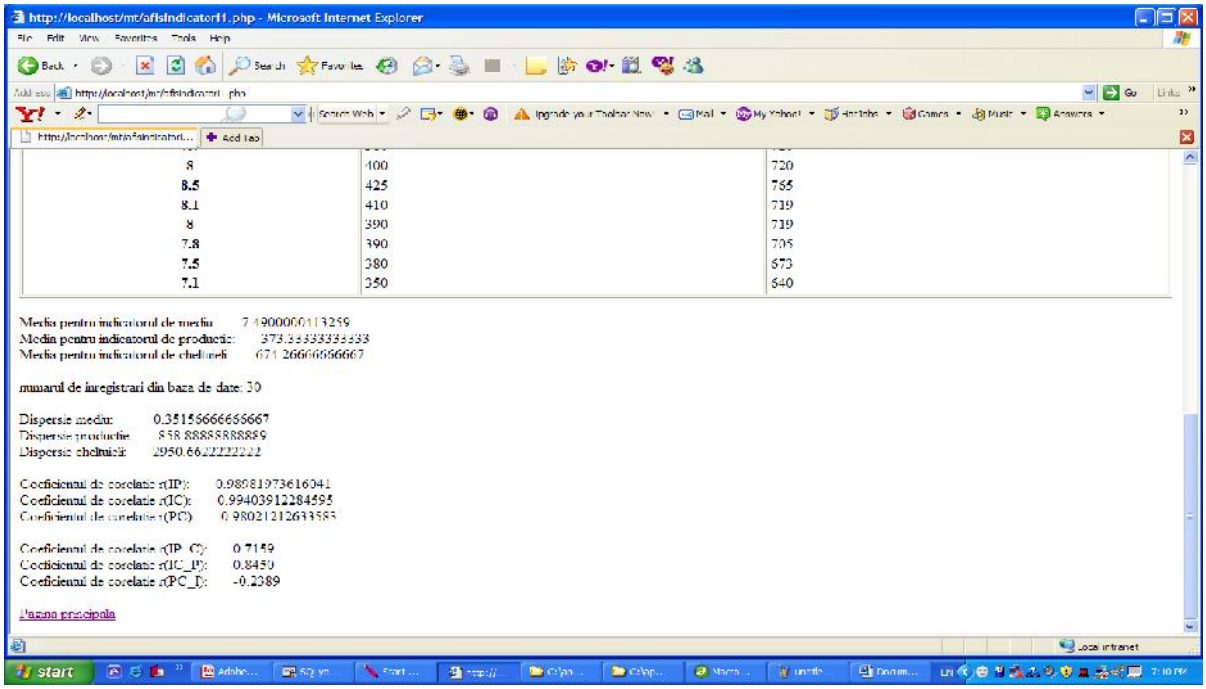

Figure 4: The display of results for correlation coefficients in the CEEF-01 program.

By analyzing these coefficients we can trace the unusual situations and evolutions concerning environmental protection, correlated to the other main parameters specific to the supervised unit, at a certain point in time.

The CEEF-01 program user guide (determining probabilities)

For determining the probabilities of encountering an exceeding of the maximum allowable concentration (MAC) of the environment quality indicators, we have to select the option "calculate probabilities" in the program's main dialogue box.

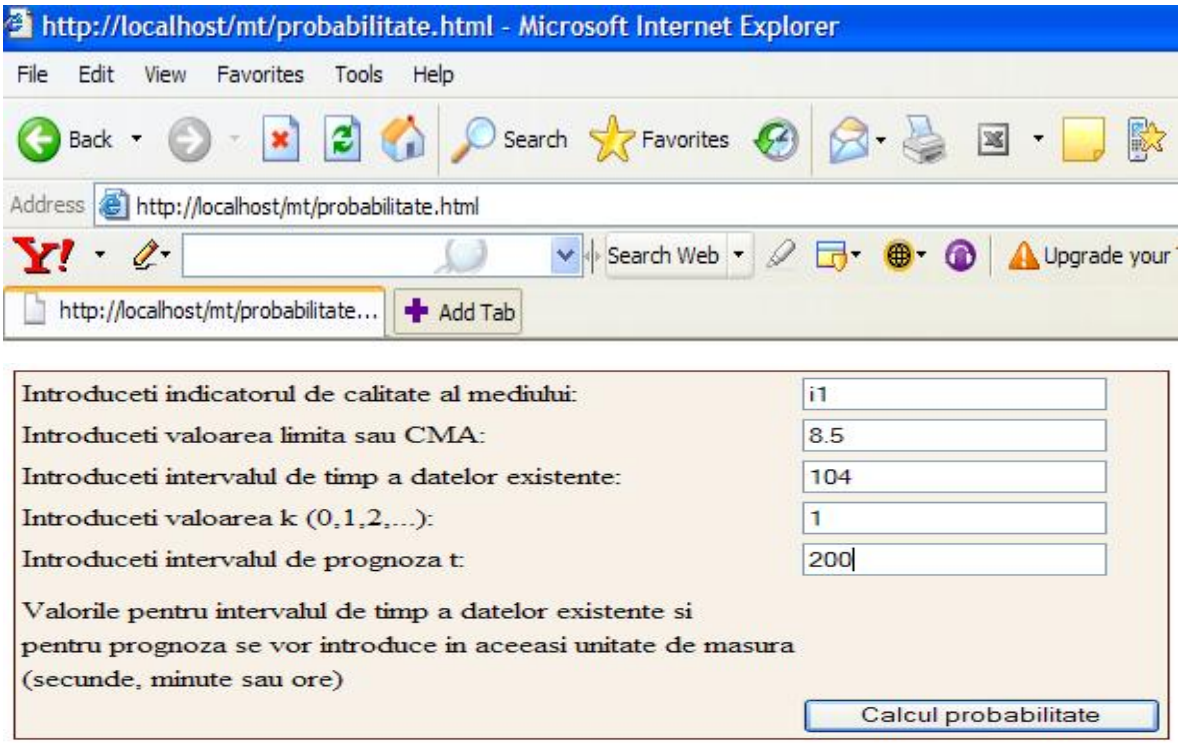

Figure 5: Registering data in the CEEF-01 program probability determination interface.

In the module's dialogue box (Fig. 5) we have to introduce the following data.

- The "I" symbol, n = 1, 2, …, 10. The data to analyze will be automatically selected from the program data base.

- The MAC value for the particular quality indicator. We can replace this value with another one, such as the attention value. The unit of measurement for this value has to be the same as for the "I" value range to study.

- the sequence in time of the available data registered in the data base.

- the prognosis period which will be registered in the program represents the actual functioning hours of the equipment we make the prognosis for.

- the number of exceeding in the prognosis period, that we want to determine the probabilities of appearance for. We introduce a whole positive number in the "Introduce a k value" box. This shows the number of exceeding the MAC value (or of another value registered in the "introduce the prognosis' interval" box) for which we want to establish the appearance probability.

- the period of the prognosis. This is the period of time for which we establish the probability that the MAC value will be exceeded *k* times. For a precise determination, it is necessary that the "period of time t" and the "prognosis period t" be expressed by the same measurement unit. For this purpose, the dialogue box contains a warning text for the users/researchers.

Example: for the data of the figure 2, the CEEF-01 program will calculate the probability to encounter an exceeding of the pH = 8.5 value of the quality indicator "I1" in the next 200 functioning hours. The considered data are registered for the equipment's 104 functioning hours.

After introducing data, the program will display the exact value of the probabilities for the registered conditions.

The figure number 6 shows the manner of result displaying.

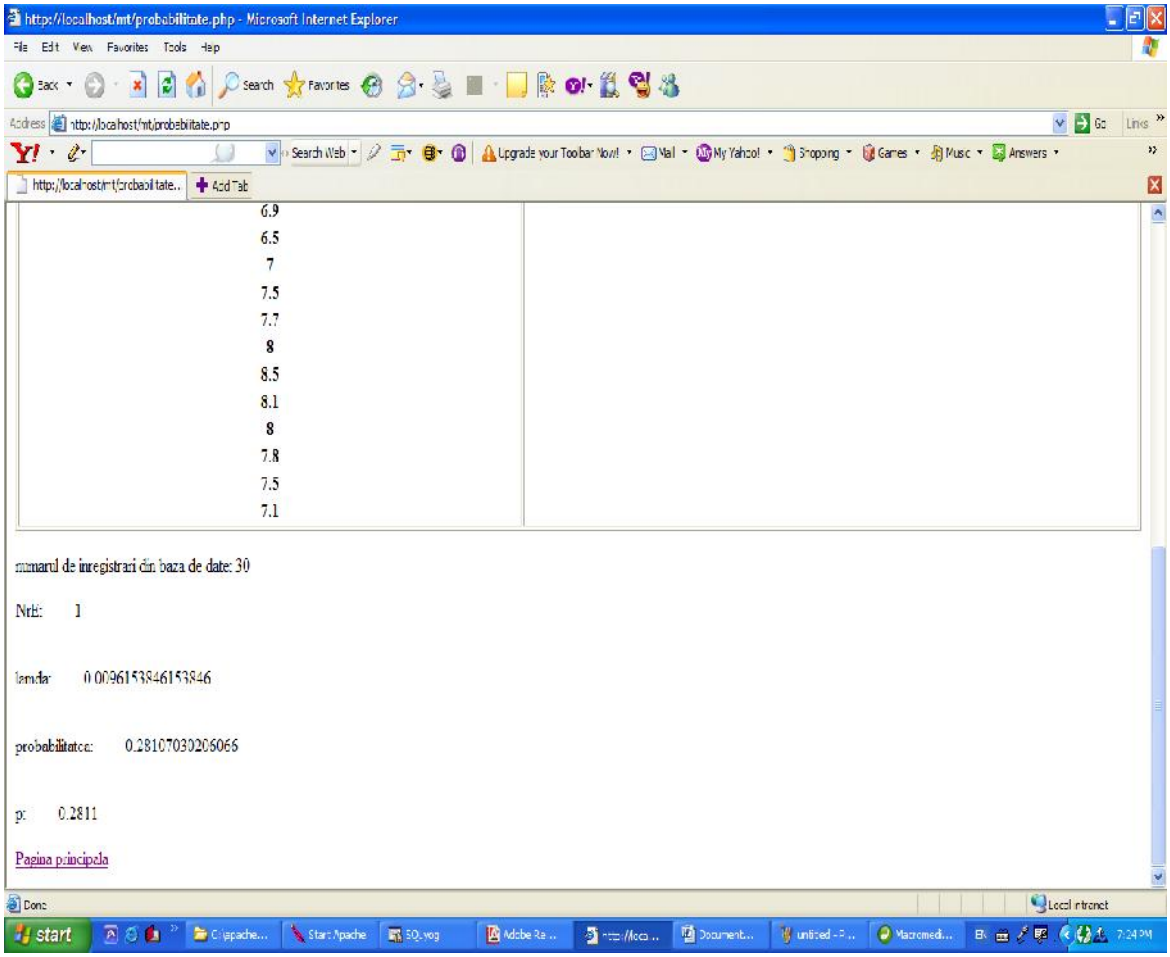

Figure 6: The display of probability determination results using CEEF- 01 program.

The total and also the partial correlation coefficients and the probability to encounter some exceeding of the MAC can improve the organisation's environmental management by an accurate assessment of the diversity of actual situations. Therewith, this program highly improves the quality of environmental performance analysis.

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THE MAIN STAGES OF THE PROCESS OF DIVERSIFICATION OF THE LIVING WORLD

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KEYWORDS: biosphere diversification, biosphere evolution, main steps of biological evolution.

ABSTRACT

Current biodiversity is the result of internal processes specific to the living world – such as biochemical, metabolic and symbiotic, as well as ecological, processes – which, according to the influence they have exerted on the abiotic environment, have stimulated the processes of diversification of the living world. The diversification of biodiversity has taken place over geological eras as an effect of the growing complexity of interspecific relationships and changes in abiotic factors due to the action of living organisms, since these comprise the determining factor behind ecological processes on our planet.

This paper presents the eleven most important stages of the processes underlying the evolution of the living world.

REZUMAT: Etapele procesului de diversificare a biosferei.

Realizarea actualei biodiversități este rezultatul unor procese interne specifice viului – cum sunt cele biochimice, metabolice şi cele simbiotice – dar şi a celor ecologice care, în funcție de influența pe care acestea au exercitat-o asupra mediului abiotic, au stimulat procesele de diversificare a lumii vii. Diversificarea biodiversității s-a desfăşurat de-a lungul erelor geologice ca efect al creşterii complexității relațiilor interspecifice şi al modificării factorilor abiotici sub acțiunea organismelor vii, deoarece tocmai ele sunt factorul determinant al proceselor ecologice de pe planeta noastră.

În lucrare sunt prezentate cele mai importante 11 etape ale procesului care stau la baza evoluției lumii vii.

RÉSUMÉ: Les étapes du procès de diversification de la biosphère.

La présente biodiversité est le résultat des procès spécifiques du monde vivant – tels que les procès biochimiques, métaboliques et symbiotiques – ainsi que les procès ecologiques qui, selon leur influence sur le médium abiotique, ont stimulé les procès de diversification du monde vivant. La diversification de la biodiversité s'est faite durant les âges géologiques comme effet de la complexité des relations interspécifiques et des changements des facteurs abiotiques sous l'action des organismes vivants, parce qu'ils representent le facteur déterminant des procès ecologiques sur notre planète.

L'ouvrage présente les plus importantes 11 étapess du procès qui se trouve à la base de l'évolution du monde vivant.

INTRODUCTION

Modern investigations showed that the variety of the life on our planet is the result of an evolutive process which lasted for about 3.8 billions years (Levine et al., 1994; Purves et al., 1992; Starr et al., 1987; Avise, 2000; Botnariuc, 2005; Fox et al., 1974; May, 2000; Margulis et al., 2000; Neagu et al., 2002). This evolution developed neither uniformly, nor slowly, it being stimulated by several crucial moments which led to the present biodiversity. It was accomplished in spite of some important vicissitudes more or less known, which determined true mass extinction of a lot of living organisms (Fig. 1). These extinctions not only endangered the existence of some living forms at a specific moment, but they determined the course of the subsequent evolution on new ways, that could be considered as progressive ones; they allowed the evolution of the best adapted forms to the environment, of that forms which were more efficient in the utilization of the energy and of the substances needed for their own biosynthesis (Fig. 1).

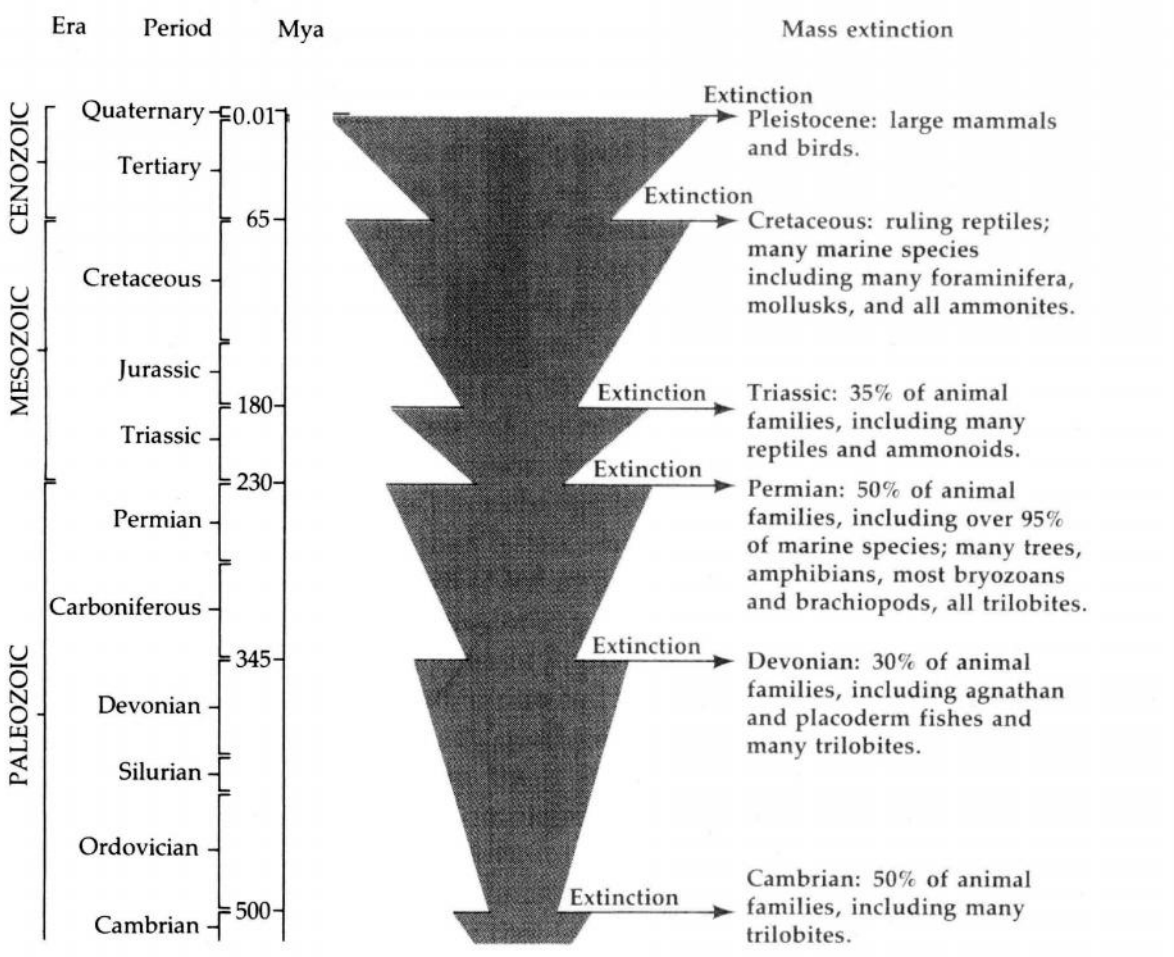

Figure 1: The seven mass extinctions of animals
(Purvis and Orians, 1987, modified).

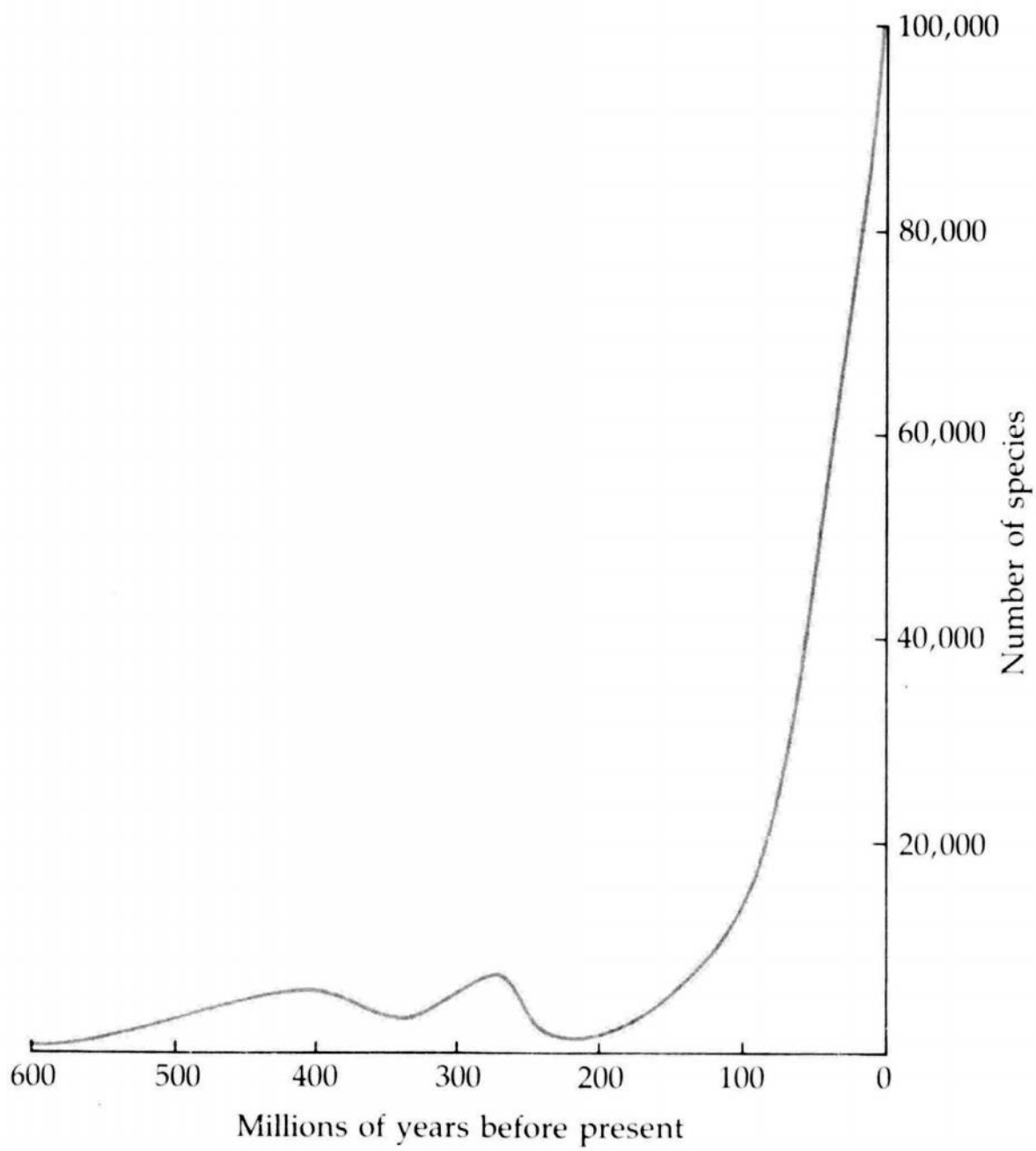

Figure 2: Increase of the number of marine benthic invertebrates species during the last 600 millions years (Purvis and Orians, 1987).

This evolution was not developed "in a vertical sense" only, starting from the simpliest forms to that more and more complex, but also "on horizontal", in the sense of increasing diversity within the phyla, orders, families and genera, as a result of a more efficient use of the resources, i.e. in the sense of a more and more advanced specialization to the new conditions.

Botnariuc (2005) stated 10 moments considered important in the life evolution:

1. appearance and diversification of the Prokaryotes;
2. shift of the metabolic processes from the anaerobic respiration to oxyphillic respiratory reactions;
3. the appearance of symbiosis;
4. the appearance of photosynthesis;
5. the appearance of unicellular eukaryotes;
6. the appearance of sexual process;
7. the appearance of multicellular eukaryotes.
8. diversification of organization levels at the multicellular eukaryotes;
9. the appearance and diversification of living forms in terrestrial environment;
10. trend towards social life.

To these 10 stages, we shall add one more,

11. The appearance of man, and his conquest of the planet.

It is to be pointed out the fact that in present primitive forms coexist with evolved forms, that all the living beings, along the time, adapted to the changes and to the more complex relationships with the biotic and abiotic environment; this fact shows that life can exist in an extraordinary variety of forms which are correlated and, in their turn, act in a synergicall way upon the surroundings (Bavaru et al., 2007; Bisby, 1995; Margulis et al., 2000; Mustață et al., 2004; Purves et al., 1992).

These moments will be presented in detail, emphasizing their implications upon the evolution of life.

1. APPARITION AND DIVERSIFICATION OF PROKARYOTES

Modern studies stated that our Solar System, including Terra, was formed 4.5 billions years ago, and the first forms of life appeared about 3.8 billions years ago (Skelton, 1993; Neagu et al.; 2002, Starr et al., 1987).

As concerns the way of apparition of life, in present there are three major conceptions: A – the life was created by a superior entity; B – the life appeared spontaneously, as a result of self-organization of the molecules occurring in aquatic environment (some scientists consider that it appeared in the terrestrial environment, in the presence of the clay, which acted as a catalyser; C – the life originates in Cosmos, reaching Terra either accidentally, on asteroids or comets, or deliberated, under the control of some rational beings from planets of other solar systems.

Although the origin of life isn't the object of this paper, we have to mention the fact that that we choosed the third hypothesis because, in spite of the huge variety of the present organisms, they all evolved and diversified with no doubt on this planet. There are several elements sustaining this idea, elements showing the presence of some specializations common to all the life forms, which can not be explained by simple hazard. We mean they are all based on a single key chemical element – the carbon; in polarized light, all the organic substances produced by living organisms are levogyr while the organic substances synthetized in laboratory may be either dextrogyr or levogyr; the energy taken from the environment is controlled by a single (unique) substance – adenosine triphosphate (ATP); the present living organisms make permanent exchanges of substances and energy with their environment; they all transmit to their descendents their own charateristics with a high fidelity and, all have the capability of self-organizing, self-perfecting and also of adaptation to the environment.

About the first living organisms there are known very few things, because they leaved no fossil traces. Recognition of their presence is performed through the study of sedimentary and metamorphic rocks; they showed with no doubt the existence of some life forms 3.8 billions of years ago. Since that time until today the presence of the simpliest organisms, that ones without a well defined nucleus (prokaryotic organisms) is mentioned in various geological formations. Similarly to the results of actual investigations on the prokaryotic organisms, we can realize that these living organisms appeared and conquered all living habitats, from the commonest to that characterized by extreme conditions (hot waters exceeding 200°C, waters containing high amounts of mineral substances, or hypersaline waters, or different toxic compounds. They may occur under pressures of thousands atmospheres, in total absence of oxygen, in habitats rich in carbon dioxyde, in ammonia, or in the presence of high concentrations of anorganic acids, etc.).

Until the apparition of the first living forms, along a period of about 2 billions years, the prokaryotes were the unique living organisms on our planet (Margulis et al., 2000; Mustață et al., 2004).

From a morphological point of view, their size and shape diversity is very reduced: there are known only coccoid forms, bacills, spirills and vibrions, and their reproduction is quite exclusively based on simple cell division (some exceptions are reported at several representatives of the Cyanobacteria group). As concerns their metabolic processes, the prokaryotes are very diversified, they being able to "attack" and use every organic matter (alive or not) or anorganic matter existing on Terra (Margulis et al., 2000).

This extraordinary metabolic diversity is not recorded at other types of more evolved organisms, with the exception of several unicellular eukaryotes. They are able to use every natural compound as raw material for the building of their own body, or as a source to obtain the energy needed by their metabolism. Prokaryotes achieve the oxidizing and reduction of sulfur, the nitrification and denitrification, they fix free (atmospheric) nitrogen, they can made the oxidizing of a variety of compunds of various elements, etc. Along the time, different species of prokaryotes were specialised for decompose practically all existing natural organic substances, even the most resistant, as the resins, cellulose, lignine, brute oil, etc., and now they are adapted to attack almost all the synthetized organic substances. In present, almost all the degradation processes of organic substances are achieved by bacterial activity (with some exceptions due to some fungal protoctists). The prokaryotes "specialized" themselves in decomposing and recycling of all chemical products of living organisms, so they became the decomposers of all the organic substances existing on Terra. It may me concluded that in present, without bacteria, the biogeochemical cyclings which allow the life on our planet could not be run.

The prokaryote organisms use all forms of energy they can take from the environment: from anorganic matter (lithotrophic organisms), from organic matter resulted from anaerobic synthesis (through chemosynthesis) or from aerobic processes (through photosynthesis), from living organic substances (by organotrophic organisms) or from dead organic substances (by heterotrophic organisms) (Botnariuc, 2006b).

The prokaryote organisms have in the present an extraordinary range of respiration forms: they can be chemotrophic, chemoautotrophic, also photoheterotrophic and photoautotrophic, obliged or facultative anaerobic, etc. They are able to degrade directly or on successive steps every type of substances, even the most difficult to be degraded, and they are able to synthetize a lot of substances, many of them being of high interest to the mankind.

Due to their diversity and their metabolic mobility, the prokaryotes adapted to all environments, living even in or on all the others living beings, either helping their, or using for their own interest.

2. PASSING OF METABOLIC PROCESSES FROM THE ANAEROBIC RESPIRATION TO THE AEROBIC RESPIRATION

Respiratory processes allow the living organisms to obtain the energy needed for their current activities from organic substances previously synthetized. Generally, respiration has two goals: first to release the electrons needed for the catabolic processes (splitting of the organic substances previously synthetized) and, second, to create molecules of ATP (adenosine triphosphate), compound which is able to store energy and to realize conversion of the energy at cell level, making available the energy needed for normal running of all the metabolic processes (Wikipedia, 2010).

The respiration needs the existence of a terminal acceptor electron. For the large majority of prokaryote organisms, the respiration occurs at the level of cell membrane and consists in the oxydation of the molecule of organic substance in the absence of oxygen, producing simple organic substances (as ethanol and lactic acid) and ATP. Anaerobic respiration is also called fermentative.

Metabolic processes passed in time from the anaerobic respiration, based exclusively on chemical reactions similar to that occuring within Calvin-Benson respiratory cycle, to that running in the presence of a gas – oxygen, through chemical reactions typical for respiratory the Krebs cycle, which produce more molecules of ATP, so that, finally, all the organic substance is reduced at carbon dioxide and water.

Anaerobic respiration runs as follows:

$C_6H_{12}O_6 + 3NO_3 + 3H_2O \rightarrow 6HCO_3 + 3NH_4$ energy production = 2ATP

or

$C_6H_{12}O_6 + 12\ S + 12\ H_2O \rightarrow 6HCO_3 + 12SH + 18H$ energy production = 2ATP

Aerobic respiration runs as follows:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ energy production = 36ATP

Table 1: Energy efficiency of anaerobic and aerobic respirations (Wikipedia, 2010 - modified).

Parameter	Anaerobic respiration	Aerobic respiration
Respiration efficiency	1	19
Total energy exchange (Kcal)	56	686
ATP synthetized starting from glucose	2	36
Energy stored in phosphate links (Kcal)	14	252
Efficiency of the recaptured energy from the whole released energy (%)	25	37

Passing to the aerobic respiration led to a significant increase of the amount of energy available for the functioning of iving organisms (Tab. 1), energy required more and more later, along the evolution of living world (Fig. 3).

The advantages of the aerobic respiration were so important, that even since the apparition of eukaryotes they realized the most important process of acquiring of energy needed for metabolic processes and for locomotion in all the living organisms, although anaerobic processes did not disappear; Calvin-Benson cycle is still present now in all the respiratory processes.

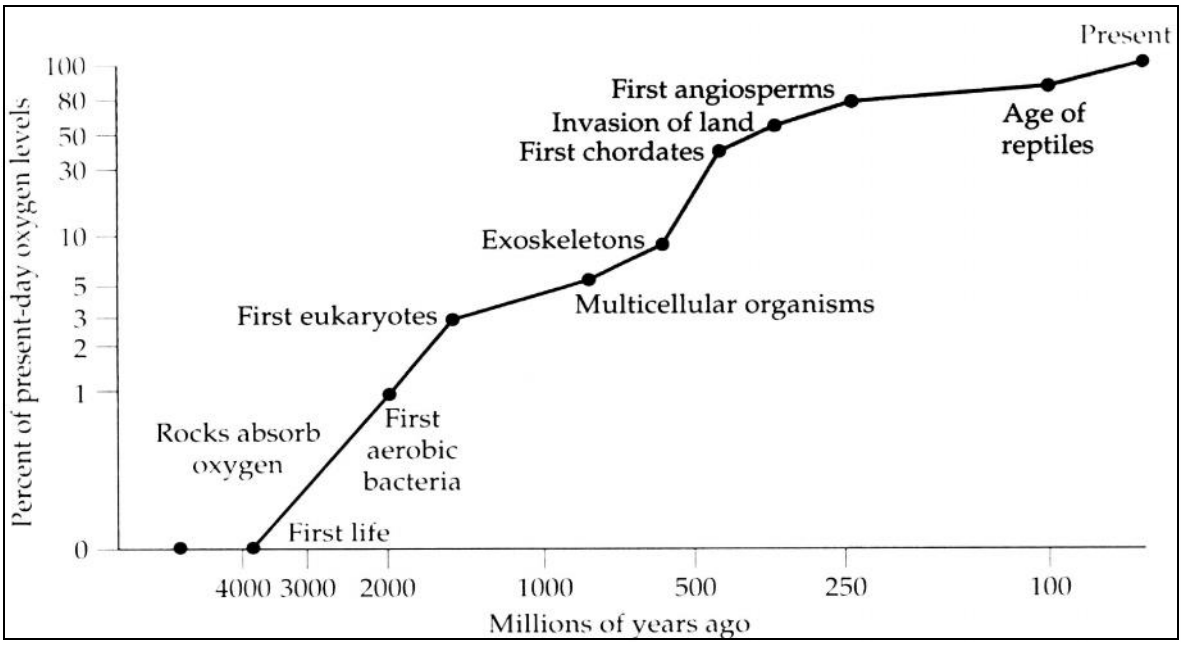

Figure 3: Percent of the oxygen from the atmosphere of the earth at which various living organism appeared (Purves et al., 1992, modified).

3. APPARITION OF THE SYMBIOSIS

During the running of vital processes of different eukaryotes, several of these realized the relational interconnection of some species, process which will facilitate the survival of both partners, each of them depending – more or less evident – of one of the activities of the partner. For instance, a spirochaeta attached on one end to one bacillus or a coccoid cell, allows much more movement of the last, the first partner receiving in turn the necessary substances from that synthetized by the second partner. In other cases, a bigger prokaryote includes by invagination a smaller prokaryote able to produce organic substances through photosynthesis; the bigger partner is supplied with a surplus of organic substances. As a result, the smaller prokaryote is not phagocytized and swallowed, but kept alive in a vacuole of the biggest partner, where it receives necessary nutrients and, also, is protected to be consumed by other prokaryotes. This way, starting from a simple mutual help an advantageous coexistence was reached, favorable to both partners. The symbiosis phenomenon allowed a better utilization of nutrients and energy resources; now it is limited to prokaryotes only. More, it developed and passed to more complex and various forms within all the kingdoms appeared later. According to Margulis (1982) the symbiosis between an eukaryote and different types of prokaryotes (that appearing now as cilia, mitochondria, or chloroplasts, etc.) led to the apparition of eukaryotic multifunctional cells (Margulis et al., 1986).

Today interactions among species belonging to the same kingdom or to different kingdoms are extremely various; they allow the life of both specific partners and stimulate the coevolution. Symbiosis appears at the eukaryote organisms in interspecific relations of (commensalism, mutualism and parasitism). For instance, we mention the presence of some ciliates and of cellulolytic bacteria in the rumen of grass eating ruminant mammals and in the stomach of the termites, or the presence of nitrogen fixing bacteria in the cells of some angiosperms, the presence of the nodules with nitrrogen fixing bacteria on the roots of leguminous plants, the presence of filamentous Fungi which produce the mycorrhiza of absorbant

radicular rhizoids at numerous species of trees, or the relation zooxanthellae – coral reefs, the facilitation of degradative processes in the large intestine at humans and – a final example – the lichens – a distinct taxonomic group resulted from the interaction Fungi to photosynthetic bacteria or green algae. Temporary symbiosis exists between the ants and the Fungi grown in ant hills on vegetal matter carried by ants, between the sharks and the fishes from the genus *Remora*, between the African herbivorous and the insect consuming birds inhabiting their back, between the flowering plants and the pollinating insects (Starr et al., 1987; Soran et al., 1985; Mustață, 2009).

As a consequence of the different symbionts interdependence, appears a new evolutive process, the "lateral evolution", which is the diversification on the same evolutive level. Botnariuc (1992, 2006a) considered the polyphily as being a main characteristic of the life evolutive process, which allowed certain organisms to skip from the horizontal evolution to the vertical evolution and led to new phyletic paths apparition which, during their subsequent evolution determined new anastomosis between the phyletic paths existing previously.

Hence, a process started at the level of prokaryotes developed and become later an important evolutive feature, existing in all eukaryotic kingdoms; it may be considered as a coevolution process.

4. THE APPARITION OF PHOTOSYNTHESIS

The first prokaryote organisms were osmophyllic, then phagotrophic, their food consisting in dissolved and colloidal organic substances, all being produced by simple chemical reactions; at a certain time the amount of organic matter in the aquatic environment became insufficient. So, the uptaking of the food necessary for a good working of metabolic processes was impeded by the lack of primary food. In this "crisis", some of the prokaryote organisms approached a new way to produce their own matter - synthethizing their own organic matter, starting from a common and abundant compound - carbon dioxyde, and a substance in big amounts - water. For this synthesis was necessary a source of energy. Because of that obtainted by chemosynthesis was insufficient, they created a new system, based on the use of light energy, present in huge amounts - solar energy.

The solar energy incident on Terra has a large scale of wave lengths, from several nanometers to kilometers (Purves et al., 1992). Living organisms are able to use only the radiations between 400 and 700 nanometers, i.e. the visible light, between ultraviolet and infrared radiations. These radiations have various colours at small differences of wave lengths (Fig. 4). More, living organisms created a set of photosensitive substances, the chlorophyllic pigments, able to use light energy from specific wave lengths. There are known the following main pigments: chlorophylls, phycocyanins, phycoerythrins, carotenoids, xanthophylls and luteins (Levine et al., 1994, Starr et al., 1987). Their variety is determined by the characteristric of water to hinder – function of water depth – the light from specific wave length, and, by the tendency of organisms to make the photosynthesis more and more efficient. In this sense, for different wave lengths there are specific pigments which offer maximal efficiencies (Fig. 4).

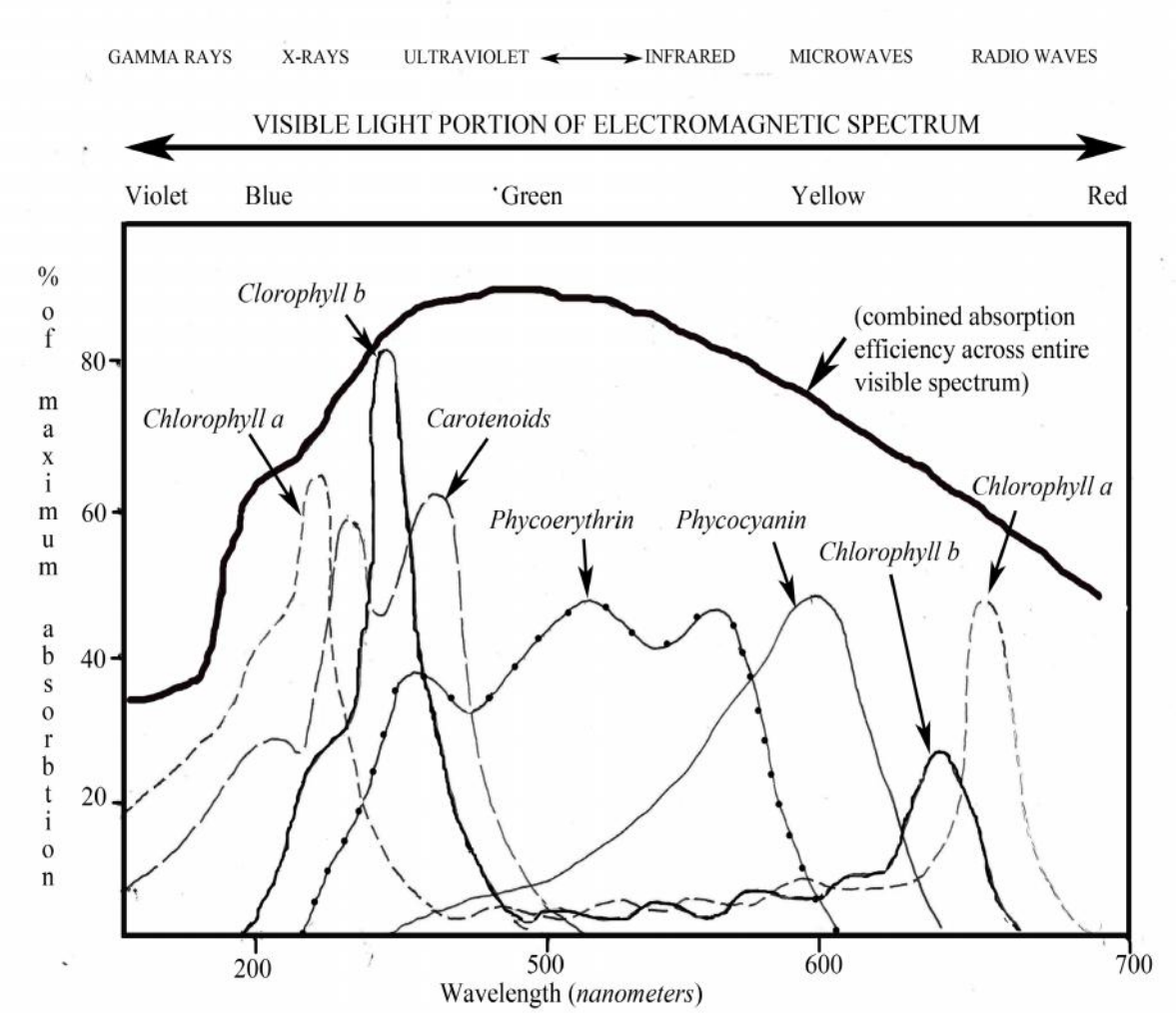

Figure 4: Efficiency of light energy absorption by different clorophilian pigments (Starr and Tagart, 1987; modified).

Because of the fact that the terrestrial photosynthetizing organisms appeared later, they have only two types of chlorophyll pigments, which use the broader band of utilization of light energy, i.e. chlorophyll *a* and chlorophyll *b*, able to work at wave lengths of 400 – 450 nμ and at 650 –700 nμ, (i.e. in blue – green and orange – red light, representing the extreme limits of visible light).

In the planetary ocean, the combination of the activity of different photosynthesizing pigments reaches now an efficiency of 35-85%, maximal efficiency being recorded between 450 and 500 nμ (Fig. 5).

Synthesis of organic substances under the influence of light energy is facilitated by a coenzime appeared in prokaryotes about 3.2 billions years ago: coenzime NADP (nicotinamide adenine diducleotide phosphate) contained in nucleotides. Due to the action of this coenzime, there are synthetized not only simple carbohydrates, which are the base for all the other organic substances, but it allows the production of ADP (adenosine diphosphate) and also ATP (adenosine triphosphate) the last being the most important energy storage feature (Purves et al., 1992).

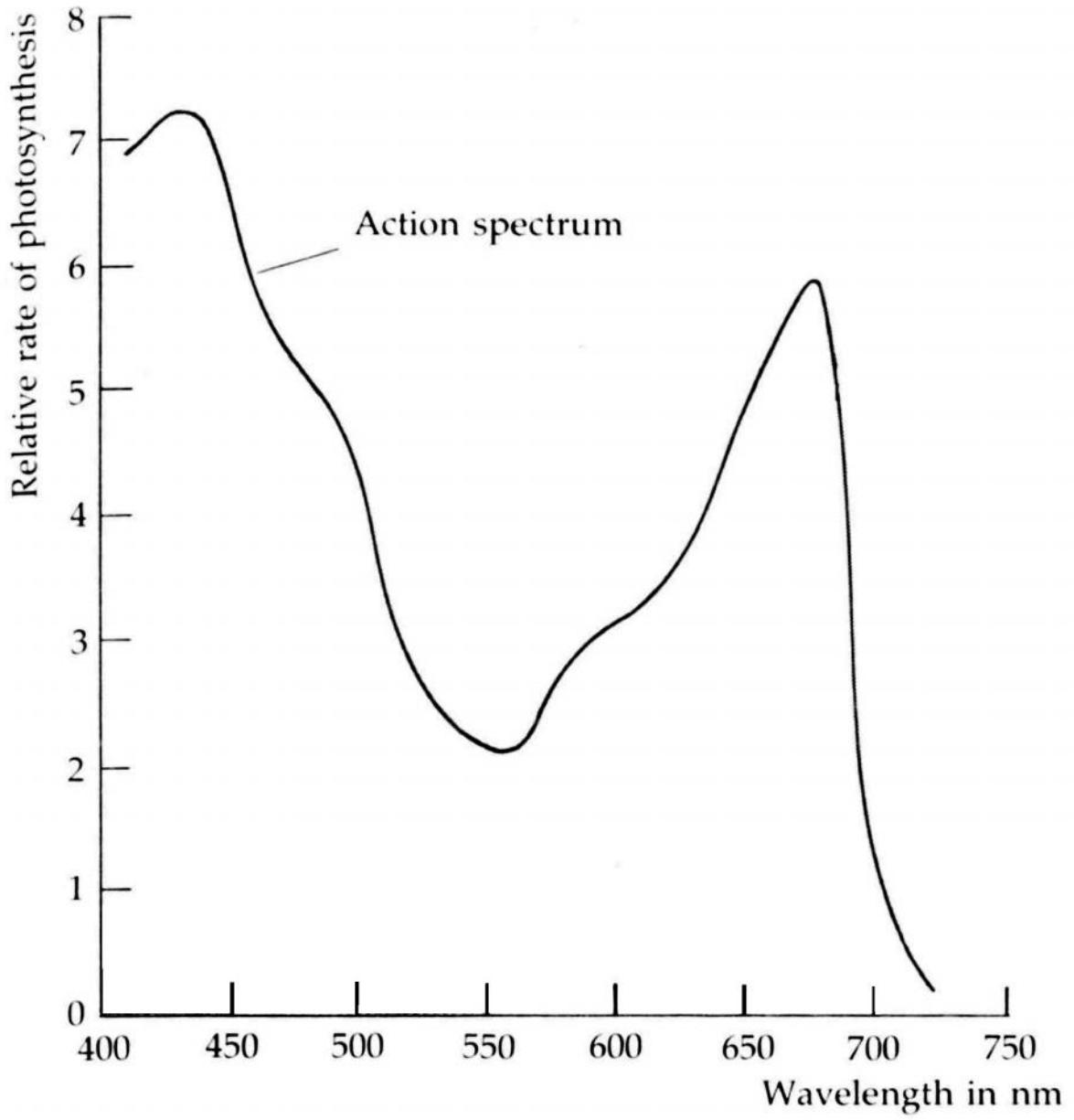

Figure 5: Rate of photosynthesis due to chlorophyll a and b action
(Purves et al., 1992; modified).

As a consequence of the ability to obtain energy – in aquatic environment – at all wave lengths of the visible light, the efficiency of photosynthesis remained low; today it is – as an average – only 0.2 – 6%. This level seems to be very low, but it proves to be sufficient to ensure the necessary energy input for all the photosynthezing organisms. Experiments conducted on algae showed that these, if are maintained under permanent light, photosynthesize more than their needs, the extra organic substances being eliminated in the environment (because biosynthesis in excess is not necessary for the organism). That's why photosynthesizing organisms produce as much as they need, and do not synthetize for others. This explain the apparently reduced photosynthesis efficiency today, it being sufficient that green plants to cover the planet as a rich and diversified vegetal blanket.

The consequences of photosynthesis process are numerous: on one hand the living organisms are no more dependent from chemical production of organic substances, they being able to self-maintenance; on other hand, because the autotrophic prokaryotes multiply easier, they become the main food for a lot of heterotrophic prokaryote organisms. Because the photosynthesizing organisms produce oxygen during the synthesis of organic substances, this is partially used by producers themselves, for running their own aerobic respiration, the excess of oxygen being eliminated in the environment, i.e. in the water of planetary ocean. This extra atomic oxygen led to formation of molecules of oxygen (O_2), which determined the oxygenation of the upper water layers of the ocean, simultaneously with the elimination from water of hydrogen sulfide, of carbon dioxyde and of methane, finally resulting the change of chemical composition of the atmosphere. During the succeeding millenia molecular oxygen became the second gas in the air, as weight (Soran et al., 1985).

An other consequence of increasing amount in the aquatic environment, the organisms that passed to the aerobic respiration became more and more numerous, populating the oxygenated aquatic environment. The organisms keeping the anaerobic respiration retired in the habitats where oxygen concentration is very low, or in that areas where some chemical reactions consumed the oxygen – up to its total lack from water environment. This way, the photosynthesis stimulated the oxyphilic organisms developing.

Under the action of this accelerated gas oxidative chemical processes; part of the molecules of bivalent oxygen, under the action of cosmic rays moved to molecules of ozone, which, in time, created a strong shield against the powerful ultraviolet radiations, which are noxious for the living organisms. As a consequence the amount of UV rays reduced below 5% from the previous level; this feature obviously facilitated the emergence of the living organisms from water to terrestrial environment and, later, the conquest of mainland by them.

The apparition of photosynthesizing organisms determined a more complex structure of the trophic chains, that now have at their base not only osmotrophic and chemotrophic organisms, but, mainly, the photoautotrophic organisms.

5. APPARITION AND DIVERSIFICATION OF THE PROKARYOTES (CONTINUED)

Returning to the examination of the first stage of the process of the diversification of the biosphere, we can see the consequences of the passing to aerobic respiration, of the apparition of symbiosis and of the photosynthesis.

Because there are very few fossils known from the Precambian, and the most part of the rocks than formed were deeply metamorphosed, we only can deduce the consequences of the processes which occurred and to state the way to the level of today diversification of the prokaryotes (Margulis et al, 2000; Neagu et al., 2002).

Prior to the apparition of the eukaryote organisms, the life on Terra was only represented by microscopic organisms inhabiting planetary ocean, possibly the brackish waters or temporary water bodies situated near the ocean. Some of these microscopic organisms consumed organic substances dissolved in water or present under colloidal form through osmosis, other were “predators”, consuming smaller bacteria, and another category were autotrophic, producing themselves the substances necessary for their existence. The prokaryotes developed through the diversification of the way of degrading dead organic matters. This evolution was achieved not by a single bacteria, but by a succession of different bacteria, which decomposed sequentially complex organic substances. The same way were attacked the organic substances synthesized by photosynthesizing bacteria.

Other bacteria consumed smaller bacteria, incorporating them in their cells and then, using the enzymes containted in the digestive vacuoles, digested them: it is the most primitive way of nutrition of predators.

Although the parazitism and the symbiosis exists also in prokaryotes, these two ways of nutrition developed significantly after the apparition of the eukaryotes, which are bigger and easier to approach (Margulis et al., 2000; Mustață et al., 2004).

As concerns the relation between anaerobic and aerobic organisms, they did not mutually excluded, but coexisted, each of them occupying specific ecological niches.

Prokaryotes are not primitive organisms, "living fossils", because they developed permanently, adapting to all the changes of the environmental features, either abiotic or biotic. Even in present the prokaryotes are the most versatile living forms, better adapted to the changes determined by huge variety of human destructive activities.

More, anaerobic bacteria are the main decomposing organisms, which proceed the degrading of dead organic matter, releasing the energy stored in it; they represent a fundamental step in the running of biogeochemical cycling of the matter on our planet.

In the table number 2 there is presented today classification of the phyla of prokaryotes and there are evidenced some of their major peculiarities.

Table 2: Phyla belonging to superkingdom Prokaryotae.

No.	Name of the phylum	Respiration type				Way to aquire organic substances				
		Anaerobic	Microaerophyllic	Facultatively anaerobic	Aerobic	Chemosynthesis	Photosynthesis	Heterotrophy	Symbiotrophy	Parasitism
1.	Euryarchaeota	+			+	+	+			
2.	Crenarchaeota	+				+		+		
3.	Proteobacteria	+			+	+	+	+		
4.	Spirochetae	+			+			+	+	+
5.	Cyanobacteria			+	+		+		+	
6.	Saprospirae	+	+			+		+	+	
7.	Chloroflexa				+		+	+		
8.	Chlorobia	+					+		+	
9.	Aphragmobacteria	+						+	+	+
10.	Endospora	+	+						+	+
11.	Pirellulae				+				+	+
12.	Actinobacteria				+	+		+		+
13.	Deinococci			+	+			+		
14.	Thermotogae	+						+		

5a APARITION AND DIVERSIFICATION OF UNICELLULAR EUKARYOTES

On the basis of fossil records, it is considered that the first eukaryotes, the unicellular ones, appeared about 2 billions years ago, in the primordial ocean, too. They were microscopical and had not a rigid cover; that is why they left few traces in sedimentary strata (Mustață et al., 2004; Barbault et al., 1995; Botnariuc, 2005).

As concerns the passing from prokaryotes to eukaryotes, the theory generally accepted in the present is the symbiotic theory elaborated by Lynn Margulis. The eukaryotic cell originated from a prokaryotic one, through the creation the DNA grouped in central part of the cell a protective membrane and through inclusion by symbiosis a number of small prokaryotes, very specialised, which are now the flagella, mitochondria or chloroplasts; it is possibly that other cell structures to be appeared the same way – as the thylakoids or Golgi apparatus (Fig. 6).

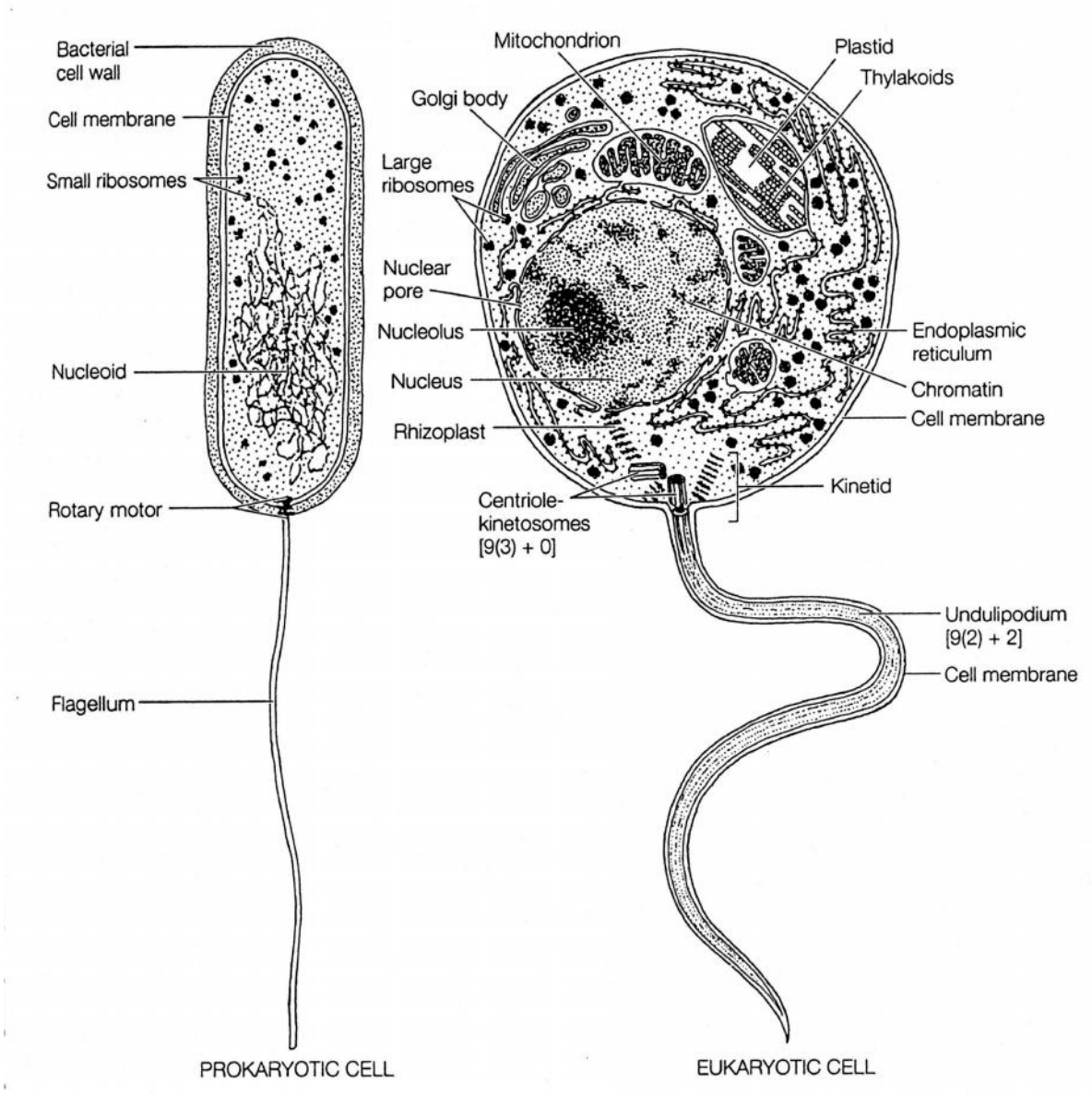

Figure 6: Scheme of a prokaryotic cell and of a eukaryotic cell (Margulis and Schwartz, 2000).

The new organisms represent the very important leap which determined the improving of the information storage system and the improvement of the multiple intercellular symbiotic processes. This way the new organisms acquired new potentialities, very important for their metabolism; same time, they diversified enormously as morphology, nutrition or locomotion characteristics. To these adaptative processes there is added a new mechanism of transmitting the information to descendents through the apparition and diversification of ways of sexual reproduction (this problem will be discussed in section 6 of this paper).

We have to mention the fact that, similarly to prokaryotes, single-cell eukaryotes are inhabiting almost all the possible environments, they modify as a result of their activities and even, often, draw their characteristics (for instance, there is "mud with globigerins", "sand with foraminifera/radiolarians" etc). More, related to the subsequent evolution of living forms, certain unicellular eukaryotes are very specific parasites on plants and animals. Therefore, like the prokaryotes, they developed continuously. We do not know how primitive are actual forms, how much, when and what way they evolved to reach their present developing stage.

As concerning the cells of protoctista (unicellular eukaryotes), they occur today under a multitude of forms, and they present – at a small scale – all the physiological characteristics of the multicellular eukaryotes: inside cells of selected species appear formations specialized for nutrition, for excretion or reproduction, there are very specialized locomotion systems, which are very versatile, there are areas which react at different stimuli (as vibrations, light, movement), there are forms living under aerobic or anaerobic conditions; they may have endo- or exo-skeletons (loricae, testa, plates, thecae, disks, coccoliths, trichocysts, axopodes, microtubules), they develop a large scale of movement forms (through simple or pennate flagella, cirria or cilia and present a high ability to survive and to self-protection against unfavorable environmental features (drought periods, extreme temperatures etc).

6. APPARITION AND DIVERSIFICATION OF SEXUAL PROCESS AT EUKARYOTES

All prokaryotes have an unique reproduction type – through cell division (simple or multiple). Since the separation of intracellular DNA from the rest of cell components through the organization of a nucleus, its role is very well and clear established: the transmission to the descendents of the genetic information of the species.

We have to mention that asexual reproduction continues to exist at the great majority of unicellular eukaryotes. It appears under a lot of forms, as sporulation, binary division, burgeoning and parthenogenesis (Mustață et al., 2004, Matgulis et al., 2000, Purves et al., 1992).

Together with it, 1.1 billions years ago appeared sexual reproduction. The same individual, or two individuals of a species effect recombinations of nuclear DNA, which are transferred to descendents as a mixed DNA, that results in a surplus of information, useful for the survival of the species. The sexual process got a great variety of forms. It was a true explosion of forms of sexual reproduction ((Margulis et al., 1986, Mooney et al., 1996) which is not found at other kingdoms of multicellular eukaryotes – plants, fungi or animals – where later occurred a process of increasing simplicity and specialization.

The most common forms of sexual reproduction at protoctists are: isogamy (at chytridiomycetes, green algae, brown algae, labyrinthulates, granuloreticulates, diatoms, plasmodiophores), anisogamy (at several diatoms, red algae, brown algae), oogamy (at oomycetes, green algae, xenophyophores), apogamy (at some brown algae), heterogamy (at some red algae), conjugation (at ciliates, diatoms and some green algae) (Levine et al., 1994, Purves et al., 1992, Starr et al., 1987).

7a APPARITION AND DIVERSIFICATION OF MULTICELLULAR EUKARYOTES (CONTINUED)

Multicellular eukaryotes organisms appeared about 600 – 570 millions years ago, as a result of the tendency to remain joined a number of unicellular daughter-organisms, either as aggregates, spheres or as filaments. They evolved from representatives of more kingdoms of unicellular eukaryotes, as a continuing and improving of some genetic, morpho-physiological end ecological features (Margulis et al., 2000; Mustață et al., 2004; Botnariuc, 2005).

If at the protoctystes organisms each cell was an organism which fulfilled all the functions necessary for survival and reproduction of its own characteristics, at the multicellular eukaryotes different functions are achieved by specialized organs. Following the phylogeny of the multicellular eukaryotes, it may be observed how, starting with primitive eukaryotes the component cells begin to differentiate for certain functions (as cells with role in reproduction, in digestion, with nervous role, etc.).

At the primitive multicellular eukaryotes a single cell can regenerate a new individual on an asexuate way; at the advanced eukaryotes, the regeneration can be made only at the level of one organ (or a group of well defined specific organs). Embryological studies showed that, gradually, together with cell division, starting from the multiple potentiality of the first cells resulted after divisions, their specialization increases later (Levine, 1994).

The transition to the multicellular organisms is the result of the process of increasing efficiency of the metabolic processes. There is increasing the role of the cells with sensory role and of that which transmit the information (in animals, this role reverts to the nervous system); also, increases the role of protective cells. Appear cells having special functions – producing self-defense substances, stocking nutritive substances or energy, etc. A very important role reverts to the cells which transmit genetic information to the descendents (reproducing cells); in the most advanced forms of plants and animals, these cells are protected and served by specialised cells forming reproductive organs.

From the multitude variety of species belonging to protoctists, passing to multicellular organisms was done on three ways which resulted in present kingdoms of multicellular organisms: Plantae, Fungi and Animalia.

Among photoautotrophic protoctists, several made their way towards the multicellular state through forming thalli very few differentiated morphologically and physiologically, as some representatives of Chlorophyta, Rhodophyta and Phaeophyta; in these forms, sexual reproduction is only at its beninning. All the primitive photoautotrophic eukaryotes are organisms living in water or wet environments (Briggs et al., 1997).

Together with passing to living in wet habitats and, then, on the land, the body of these organisms suffered major changes, which, in part of them determined spectacular evolutions, which resulted in the apparition of the representatives of the kingdom Plantae: the first ferns (Pteridophytae) appeared in Mesozoic age, and flowering plants (Anthophyta) – in Cretaceous and Quaternary. It is presumed that the evolution to the multicellular state was achieved especially by organisms close to the green algae (Margulis et al., 2000; Mustață et al., 2004; Botnariuc, 2005).

From the osmotrophic heterotrophic protoctist organisms (more specific – from the Chitridiomycetes) were developed three actual phyla of Fungi. The differentiation of these new groups of autotrophic organisms was not performed as “explosive” as in the other groups of heterotrophic multicellular eukaryotes – the animals – because the passing to the multicellular state did not result in a huge morphological and physiological diversisty, they remaining motionless.

An other group of heterotrophic organisms which developed towards multicellular state is that having a more active holozoic nutrition and were mobile organisms. This feeding modality implied the differentiation of cells in order to form a distinct digestive apparatus, and the sexual reproduction became specialized only as reproduction through copulation. Most of the specialists consider that the representatives of the kingdom Animalia derived from colonial forms of some protoctists similar to that classified now in phylum Zoomastigota (and especially the representatives of the Choanoflagellata class cases); they were similar to the colonies of *Proterospongia haeckeli* (Margulis et al., 2000). Initially these colonies were homonoms, *Sphaeroteca* type, then cells *Proterospongia* type, which lead to the apparition of Spongiae (Mustață et al., 2004; Margulis et al., 2000). From these colonies having weak specialized cells derived the ancestral planuloid metazoans, with or without coelom, and from the last appeared later protostomes and also deuterostomes. A continuous diversification of the animals was occurred, there appeared parasitic organisms, there were made very many morphological variants, there were appeared organs more and more specialised for different functions, there were recorded also some forms of morphophysiological regression (in several genera and species their affiliation to a certain class or phylum may be determined only following their ontogeny); sexual reproduction, limited only to copulation showing a multitude of forms (there appeared copulatory structures more and more complex and sophisticated, as the copulatory structures in insects and in chelicerates). They were improved by special specific sensorial cells, and – in some cases – the organisms begun to produce attractive compounds for the opposite sex.

Apparition and diversification of the representatives of the kingdom Animalia was performed in the aquatic environment; in the terrestrial environment entered only the most dynamic forms of the phyla Protostomians and also Deuterostomians.

Paleontological records show the fact that the apparition of the multicellular organisms resulted in so called explosion of the biological diversity during the Cambrian period (Purves et al., 1992; Neagu et al., 2002). It appeared after a major extinction of organisms, which took place around 500 millions years ago. At that period of time appeared all the major groups of animals. During the Lower Cambrian period (about 570 – 770 millions years ago) diblastic metazoans appeared, and soon after them (about 540 millions years ago) appeared the triblastic metazoans (Mustață et al., 2004).

8. APPARITION IN THE KINGDOM ANIMALIA OF SOME DIFFERENT STRUCTURE PLANS

Different embryological studies showed that in bilaterally symmetrical animals, which had three embrionic cell layers, the cells which constitute the mesoderm determined three main evolution directions (Purves et al., 1992; Levine et al., 1994).

1 – in one of them, the mesoderm remained as cellular masses, within them internal organs were formed – the digestive apparatus, the excretory apparatus, the reproduction apparatus and the nervous system. They are grouped in acoelomate type of organisms, in which there are Platyhelminthes, Gnatostomulids, Ortonectids and some of the Nemertians (Tab. 3).

Table 3: Phyla belonging to the kingdom Protoctista; A = without mitochondria; CA = mitochondria with flat crista; CT = mitochondria with tubulous crista; CD = mitochondria with discoidal crista.

No.	Name of the phylum	Sp. no.	Way of nutrition				Repro-duction		Mitochondrial[1] type	Type of respiration	
				Heterotrophic							
			Autotrophic	Free iving	Symbiont	Parasite	Asexuate	Sexuate		Anaerobic	Aerobic
1.	Archeprotista				+	+	+		A	+	
2.	Microspora	800				+	+		A	+	
3.	Rhizopoda	2000		+		+	+			+	+
4.	Granuloreticulosa	400		+	+		+	+	CD		+
5.	Xenophyophora	42		+			+	+	CD		+
6.	Myxomycota	500		+			+	+			+
7.	Dinomastigota	4000		+	+				CT		+
8.	Ciliophora	10000		+	+	+	+	+	CT		+
9.	Apicomplexa	4600			+	+	+	+	CT	+	
10.	Haptomonada		+		+		+	+	CA		+
11.	Cryptomonada		+	+			+		CA		+
12.	Discomitochondria	800	+	+	+	+	+				+
13.	Chrysomonada		+				+				+
14.	Xanthophyta	600	+	+			+	+			+
15.	Eustigmatophyta	9 genera	+				+				+
16.	Bacillariophyta/Diatomea	10000	+				+	+			+
17.	Phaeophyta	900	+				+	+			+
18.	Labirinthula	8		+				+			+
19.	Plasmodiophora	29			+	+	+	+		+	
20.	Oomycota	100		+	+	+	+	+			+
21.	Hyphochytridiomycota	23		+		+	+			+	
22.	Haplospora	33				+	+		CA	+	
23.	Paramyxa	6				+	+		CA	+	
24.	Myxospora	1100			+	+	+		CD		+
25.	Rhodophyta	4100	+				+	+			+
26.	Gamophyta	6000	+					+			+
27.	Actinopoda	4000		+	+		+	+			+
28.	Chlorophyta	16000	+				+	+	CT		+
29.	Zoomastigota			+	+	+	+				+
30.	Chytridiomycota	1000		+		+	+	+		+	

2 – in other, mesodermal cells are formed in free spaces (gaps) filled with haemolymph; there are organisms having a schyzocoel. In the case between ectoderm and endoderm appears a cavity filled with haemolymph, in which mesodermal cells develop, we have a pseudocoel, in which there are situated internal organs. Such type of pseudocoelomate organisms are the Nemertians, Nematoda, Nematomorphs, Rotifers and Gastrotrichians, as well the representatives of other smaller phyla. (Tab. 3).

3 – in the case when the mesoderm forms a general cavity in which all the internal organs are included, there is a coelomic cavity. Animals having such a cavity are called Coelomates. The organisms in which the cells forming the coelomic cavity originate from the region of buccal orifice are included in the group of coelomate Protostomians. The organisms in which the cells forming the coelomic cavity were formed from the lateral invaginations of the posterior endotelium, are called Deuterostomians (Tab. 3).

This ontogenetic evolution of the mesoderm determined the evolution of animals on three fundamental organizing (structural) plans which exist today also (Fig. 7).

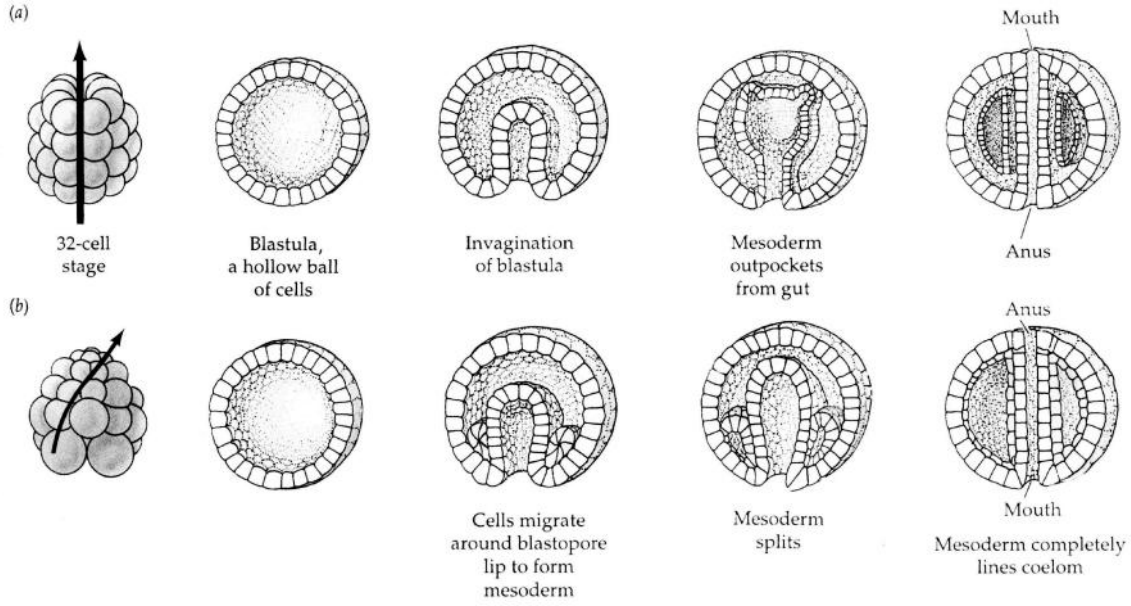

Figure 7: The first stages of primary embryological development in deuterostomians (a) and protostomians (b) (Purves et al., 1992; modified).

7b APPARITION AND DIVERSIFICATION OF MULTICELLULAR EUKARYOTES (3 - CONTINUED)

Today representatives of the kingdom Plantae are imobile forms which posess photoassimilatory pigments of chlorophylic type; they produce starch – as storage compound, and have cellulosic cell walls. The first representatives of this kingdom appeared around 400 millions years ago, when the autotrophic organisms begun to conquer the terrestrial environment (actual aquatic macrophytes returned later in water, most of them in the freshwater environment). As terrestrial organisms, they had to create anti-gravity structures, to emerge from the substrate, structures able to resist against air movements (winds) and to atmospheric precipitations, and protection structures able to face the action of different environmental features.

All the plants form organs for sexuate reproduction gametes in gametangia. The zygote resulted from the fecundation allows the development of the embryo, which is protected by the female gametophyte. In more primitive phylum gametophyte stage is dominant, and in more evoluate phyla sporophyte stage is dominant (Mustaţă et al., 2004; Avise, 2000; Briggs et al., 1997).

In the table number 4 there are presented the main characteristics of actual plant phyla (there were representatives of some phyla which, although at a certain time terrestrial autotrophs were dominant, they disappeared along the evolution (Avise, 2000; Briggs et al., 1997; Neagu et al., 2002).

Table 4: Phyla belonging to the kingdom Plantae.

No.	Name of the phyllum	No. of species	Vascular tissue		Dominant generation		Ovule and seeds		Ovary and fruit		Vegetative body
			Nonvascular	Vascular	Gamophytic	Sporophytic	Present	Absent	Present	Absent	
1.	Anthocerophyta	100	+		+			+		+	Pseudocorm
2.	Hepatophyta	6000	+		+			+		+	Eutal with dorsoventral symetry or cormoid tal
3.	Bryophyta	10000	+		+			+		+	Pseudocorm (cormoid tal)
4.	Lycophyta	1000		+		+		+		+	Complet corm
5.	Psilophyta	10		+		+		+		+	Incomplet corm
6.	Sphenophyta	15		+		+		+		+	Complet corm
7.	Filicinophyta	12000		+		+		+		+	Complet corm
8.	Cycadophyta	185		+		+	+			+	Complet corm
9.	Ginkgophyta	1		+		+	+			+	Complet corm
10.	Coniferophyta	550		+		+	+			+	Complet corm
11.	Gnetophyta	70		+		+	+			+	Complet corm
12.	Anthophyta	270000		+		+	+		+		Complet corm

Actual representatives of the kingdom Fungi are heterotrophic organisms whose nutrition is based on osmosis, consuming organic substances (mainly decaying organic matter, but are also species which utilise organic substances from living organisms parasited by them). Actual Fungi are aerobic organisms, which secrete exoenzymes used for extracellular solving of the food, then uptaking it by osmose. The cell wall of the Fungi contain chitin, and their spores are never flagellated. The cells of Fungi have 2 – n nuclei (there are not uninuclear fungi). The representatives of this kingdom appeared about 500 – 450 millions of years ago, during the Ordovician. The most functionally closed protoctists to fungi are the Myxomycetes, Oomycetes and Hyphochitridiomycetes.

All the fungi organisms reproduce both asexuate and sexuate (through two types of conjugation – either that of the hyphae or through nuclear fusion). In both these cases result spores, which may have either a mitotic origin, or a meiotic origin. From spores appear new hyphae; their aggregation forms a mycelium. During the reproduction period part of these mycelia joined, forming specific fructification organs. All the Fungi have a similar developing cycle, and their descendents have not an embryonic stage (Groombridge and Jenkins, 2000; Margulis et al., 2000; Mustaţă et al, 2004).

In the table number 5 there are presented the three phyla of Fungi, and their main characteristics are also mentioned.

Table 5: Phyla belonging to the kingdom Fungi.

No.	Name of the phylum	Sp. no.	Sporiferous organ	Type of nutrition				Micelia	Dicariotic mycelia
				Saprophytic	Osmotrophic	Symbiotic	Parasite		
1	Zygomycota	1100	Sporangiofor sporocistofor	+			+	Unicelular, sifonal	Absent
2	Ascomycota	30000	Asca	+		+	+	Pluricelular hifae septatae, penata	For a short time
3	Basidiomycota	22250	Bazidia	+	+	+	+	Pluricelular hifae septateae with dolipora structure	For a long time

The oldest heterotrophic multicellular eukaryotes belong to the kingdom Animalia. It is considered that the first animals appeared about 1.5 billion years ago, during the Proterozoic age. The representatives of this kingdom are characterised by a huge diversity of the way of sexual reproduction, by different types of eggs and forms of their segmentation, different modalities of achieving the gastrulation, through varied forms of subsequent evolution of embryonary cell layers, as well as through a great diversity of the ways of embrionary development (this guided to the postulate of Baier, the founder of embryology, that "the ontogeny repeats the phylogeny") (Fig. 8), and the existence in adult individuals of various forms of body symmetry.

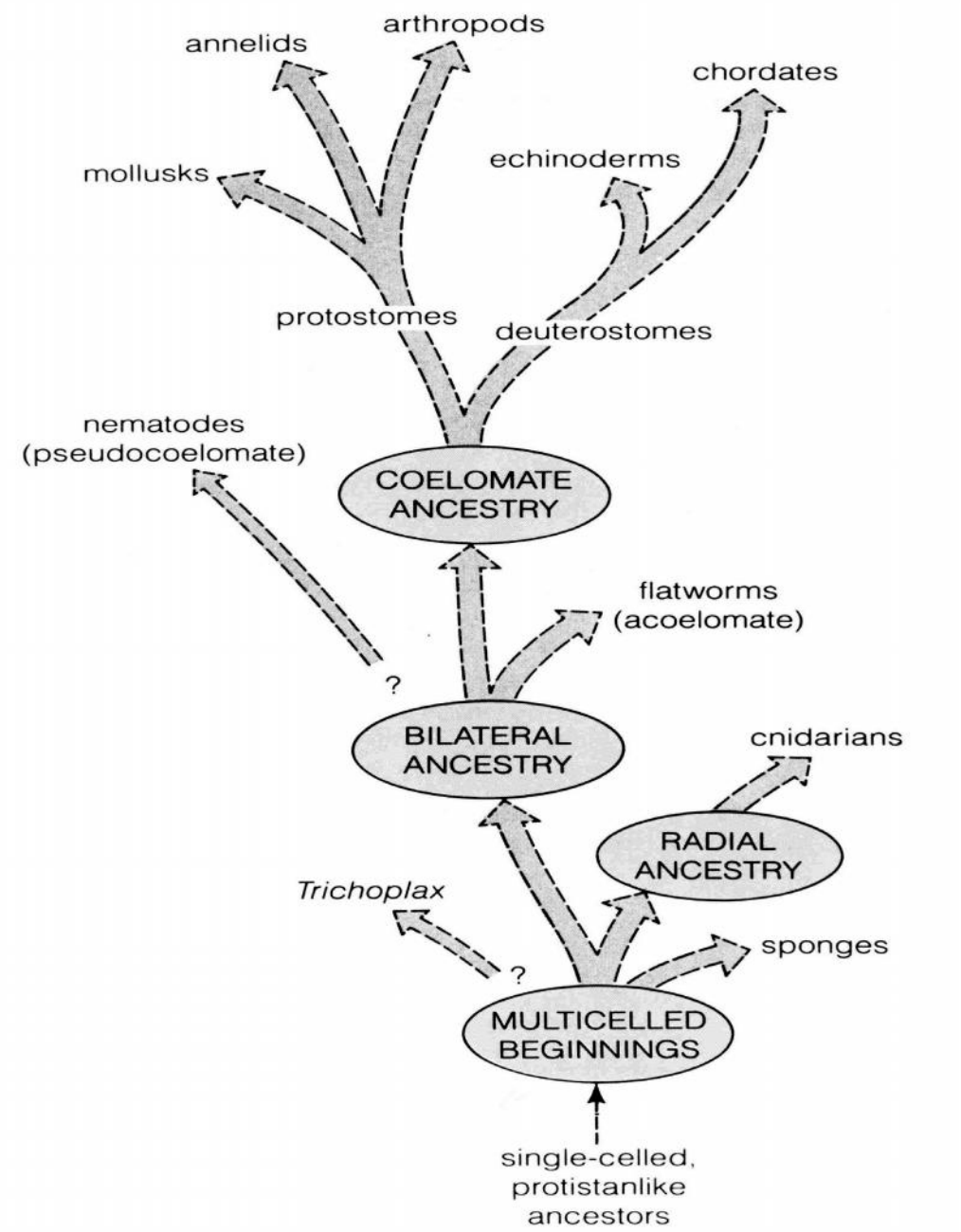

Figure 8: Evolution of the animal kingdom determined by the body simmetry and the specificity of the development of the space between ectoderm and endoderm (Starr and Taggart, 1987).

Examining the modalities of egg segmentation in animals, the following observations re can be make:

- a radial segmentation – in Spongia, Cnidarians and Echinoderms;
- a spiral segmentation – in many worms and molluscs;
- a bilateral segmentation – in Nemertians, Rotifers, Tunicates and Vertebrates;
- a bisymmetric segmentation – in Ctenophores;
- a partial segmentation – in several molluscs, insects and vertebrates.

The gastrulation is produced either through the imigration of cells, or through invagination. As a result of gastrulation produced through invagination embrionary cell layers appear. Function of this there are:

- primitive animals, monoblastic, whose adults possess only one type of cells (representatives of the phylum Monoblastozoa);
- diblastic animals, whose adults have two types of tissues, forming an ectoderm and an endoderm (as in the representatives of the phyla Porifera, Cnidarians and Ctenophora);
- triblastic animals, in which all the tissues originate in three embrionary cell layers - ectoderm, endoderm and mesoderm. Subsequent evolution of triblastic organisms was realized as a result of apparition of different plans of body organization (see the section number 8 in this paper).

Actual animals have three types of symmetry:

- disymmetric – which may be homopolar or heteropolar;
- bilateral – which may be: in sagital plane (dorso – ventral) in lateral plane (left–right) and in transversal plane (antero – posterior),
- radial – which may be pentaradial (in Echinoderms), hexaradial (in Cnidarians), octoradial (in other Cnidarians).

In animals heterotrophy stimulated the diversification of forms of feeding, starting with the apparition of very various way to capture the food, continuing with creation of some different types of digestive apparatus and, sometimes, even the return to the osmotic type of feeding (as in parasite forms of Platyhelminthes, some of Chelicerates or Mandibulates). Together with the digestive apparatus, animals have today a large variety of respiratory apparatus and also excretory apparatus.

The animals possess specialized relationship systems. From these, we have to mention:

- to sense the action of different features from the environment – sensitive organs;
- for transmitting of information – nervous system;
- for achieving the reproduction – the existence of individuals with distinct/separate sexes, or other, which are hermaphrodite;
- for the protection against predators – the existence of an interior skeleton, secretion of repellent substances, etc.

In the table number 6 there are presented the phyla of the kingdom Animalia, with their main characteristics.

Table 6: Phyla belonging to the kingdom Animalia.

No.	Name of the phylum	Sp. no.	Embrionic strata			Organization plan			Body symmetry			Reproduction	
			Monoblastic	Diblastic	Triblastic	Acoelomata	Pseudocoelomata	Coelomata	Disymmetrical	Bilateral	Radial	Asexuate	Sexuate
1.	Monoblastozoa	1	+			+				+		+	
2.	Porifera	10000		+		+			+			+	
3.	Cnidaria	9400		+		+					+	+	+
4.	Ctenophora	100		+		+			+		+		+
5.	Placozoa	2 g.		+		+				+		+	+
6.	Mesozoa	50	+			+				+		+	
7.	Plathelminthes	20000			+	+				+			+
8.	Gnathostomulida	80			+	+				+			+
9.	Orthonectida	20		+		+				+			+
10.	Nemertea	900			+	+	+			+			+
11.	Nematoda	25000		+			+			+			+
12.	Nematomorpha	250		+			+			+			+
13.	Acanthocephala	1000		+			+			+			+
14.	Rhombozoa	65	+			+				+		+	
15.	Rotifera	2000		+			+			+		+	+
16.	Kinorhyncha	150		+			+			+			+
17.	Priapulida	17		+				+		+			+
18.	Gastrotricha	400		+	+		+			+			+
19.	Loricifera	100			+		+			+			+
20.	Cycliophora	1					+						
21.	Entoprocta	150			+		+			+			+
22.	Vestimentifera	20						+P	+				
23.	Pogonophora	120			+			+P		+			+
24.	Phoronida	14			+			+P		+			+
25.	Bryozoa	500			+			+P	+				+
26.	Brachiopoda	350			+			+P	+				+
27.	Annelida	17000			+			+P		+			+
28.	Sipunculida	320			+			+P		+			+
29.	Echiura	140			+			+P		+			+
30.	Mollusca	70000			+			+P		+			+
31.	Tardigrada	750			+			+P		+			+
32.	Onychophora	100			+			+P		+			+
33.	Crustacea	42000			+			+P		+			+
34.	Chelicerata	75000			+			+P		+			+
35.	Mandibulata	<1 mil.			+			+P		+			+
36.	Echinodermata	7000			+			+D			+		+
37.	Chaetognatha	70			+			+D		+			+
38.	Hemichordata	90			+			+D	+				+
39.	Cephalochordata	25			+			+D		+			+
40.	Urochordata	200			+			+D	+				+
41.	Craniata	52000			+			+D		+			+

9. CONQUEST OF THE TERRESTRIAL ENVIRONMENT

Up to 450 – 500 milions of years ago the life was going on only in marine aquatic environment. At a specific time, all the biotopes of marine ecosystems were occupied by different associations of living organisms. In the seas flowed the rivers, their waters had not the salts existing in marine waters, salts indispensable for marine organisms. This absence of mineral salts represented for a long period an osmotic obstacle hard to be surpassed; in time, through the gradual adaptation of several eurioic marine organisms to the life in brackish waters, this obstacle was gradually overpassed, but only by eurioic organisms (Botnariuc, 2005, 2006b; Briggs et al., 1997; Margulis et al., 2000).

An important ecotonic zone was represented by pools and marshes with salt waters. During the tide marine waters entered these habitats and then rested here for a time; at the end tide these waters retired partially back. Water level of these pools and marshes decreased significantly, but not entirely, so that the organisms remained here were obliged to find survival opportunities till to the following tide; they had either to pass to the atmospheric respiration and to protect their body against drying, or to be burried in mud. In the mass of dead vegetal and animal organisms from these shallow water bodies, or from wet habitats, degrading bacteria found favorable conditions to develop; they contributed to the forming of an organic mud and, then, its transformation in an environment favorable to the protection of aquatic organisms against drying and to the avoiding direct solar radiation. Gradually, in these semi-salted marshes it was installed a suitable flora and fauna, characteristic, which, in time, adapted to the terrestrial environment. It is an amphibian biota, which could live in aerial environment for a more or less long period, but always returned, at least in specific periods of their life, in the aquatic environment. This aerial environment imposed to a lot of organisms to pass to atmospheric respiration (which was made either through specialised organs of respiration, or through the skin); as concerns the plants, the aerial environment determined them to create on their surface protection systems against the drying. For plant growing in terrestrial environment it was necessary a differentiation in order to create some antigravitational growth systems: in water it was not needed, the mass of plant body swinging in shallow waters near the banks, together with wave movements. All the organisms which left the aquatic environment have in present the gametes and embryonary and larval stages either in a natural aquatic habitat or created by organisms themselves (in birds' eggs; in mammals; in placenta exists a space filled with amniotic fluid). Plants transformed fixing rhizoids in true roots which allow the fixation of the plant and raising of the body in air. Later, these rhizoids/roots were transformed in supplying organs of the plant with a part of the mineral salts necessary in the process of synthesis of their own organic substances; they, also, can uptake, through osmosis, simple organic substances which, on a metabolic way, are included in their own living matter.

As much the marshes were clogged, organic mud from their bottom lost the water, became more clammy and, mixed with the sand resulted from crumbling of rocks, produced by water or by wind, was transformed in soil. Later, soil formation was improved in terrestrial environment.

As far vegetal organisms adapted to the life under aerial conditions, they extended their capacity to live on soils with less water, but their rhizoids, transformed now in roots, rested dependent of the water in substrate. It is considered that the first colonizing organisms on the terrestrial and semiterrestrial habitats were the plants. As in nature nothing is lost, the plants were followed out of water by their consumers – phytophagous organisms. Among these, an important role was played by leaf-eating and necrophagous Mandibulates, and, also, that consuming products of vegetal genital organs, i.e. pollen and nectar, especially polenizing insects; in time,

between flowering plants and insects established a co-evolution process, which is yet present today. Of course, gradually also emerged from water and semi-aquatic habitat the predators of the phytophagous ones, there were constituted more and more complex biocoenosis, forerunners of the present terrestrial biocoenosis.

The entering in the terrestrial environment determined the followings: morphological and physiological modifications; adaptations to the life in atmosphere (respiration, locomotion, resistence againts air currents and to precipitations); constituting of living associations very diferent from that existing in aquatic habitats; extenstion of life on new areals, characterised by very various environmental conditions, which required from organisms extremely diverse new adaptations; among these is to be mentioned the existence of soil, as substrate and trophic base for plants.

It is important to observe that terrestrial environment was populated by representatives of the most advanced phyla, especially mosses, ferns, conifers and flowering plants, and, among the animals – the Annelids, Molluscs, Chelicerates and Mandibulates (from the Protostomes) and only Craniates (from the Deuterostomes). The Fungi developed only in terrestrial environment.

As it may be observed in the tables numbers 2 to 6, less than 5% from the actual phyla are living in the terrestrial habitat. This terrestrial habitat allowed an extraordinary development of different species, so today, from the 1.9 millions of known species, almost 1.5 millions are terrestrial organisms.

10. TRANSITION FROM THE INDIVIDUAL LIFE TO THE SOCIAL LIFE

From the living organisms, most part of the species are represented by individuals that live entirely as isolated beings, which establish relations with other representative of the same species only during reproduction periods – and not always on a direct way (it may be through water, wind or other organisms).

Researchers observed rudiments of social life in autotrophic colonial protoctists, in some animals – Cnidarians, and, especially, in some Mandibulates and Craniates.

In the last decades there were developed sociobiological investigations; they evidenced very various forms of social life in the representatives of some classes of Mandibulates (only in Insects) and in Craniates (in birds and mammals). This way of life, still poorly known, allows certain work sharing and achievement of a more efficient life, both materially and energetically. Social life creates the opportunities of functional and reproductive differentiation, and favorizes the development of instincts and of intelligence and – in man – of conscience.

This new way of life is considered to offer extraordinary perspectives for the future of life on this planet.

11. APPARITION OF MAN AND CONQUEST OF THE PLANET

During some tens of thousands of years man, this product of our planet, in spite the fact he is not apparently the most well adapted to the environment, because of social life, of the communication abilities (language) and, especially due to his intelligence, conquered and then subdued to his interest the whole planet, in a way which was not made by none of the other living organisms. During a very short period – at a planetary scale – he entered and can live, because external energy sources, all the living habitats – terrestrial, aerial, aquatic and subterranean, and under very diverse climatic conditions (from the equatorial climate to the polar one, from desertic to alpine habitats); as a consequence of the extreme development of the technique, he became one of the most disturbing features of living and non-living processes on the planet. Among the negative impacts of human activities there

should to be mentioned climatical, hydrological and soil changes, the modification of air, water and soil compositions, soil degradation, acceleration of extintion of species, facilitating of the extension of antropophilous species and of that are useful to man, deliberated elimination of the species which are considered as harmful, degradation and replacing of the ecosystems with other, new, modified or created following his interests and, in last decades, even creation of new organisms through genetic manipulations (Baker, 1995; Cogălniceanu, 2003; May et al., 1995; Mooney et al., 1996; Heywood, 1995).

The speed of these impacts is so high, so that their consequences can not be realistically estimated; we think these rapid changes predict a new extinction process for the organisms living now on our planet – this time an anthropogenic one.

It may be mentioned that man realises too things thare are favorable to the life; he determines, voluntarily or not, an increase of eurioic forms, of the cosmopolite ones, creates new organisms, so we think that the presumed anthropogenic extinction will indeed trouble the planetary biota, but will not determine its disappearing, and will result in the evolution of life on new ways, under new conditions.

CONCLUSIONS

From the above presented information there are drawn some main conclusions.

No matter of the ways life appeared on the Earth, it conquered and developed initially only in the primordial planetary ocean.

During almost 4 billions years the forms of life diversified, they have evolved from the simple toward the complex (Fig. 9).

This evolution of life was not going on neither uniformly, nor in the same manner within all its variety of forms; it was determined by a number of internal and external features. From the internal features, the most important were the improvement and increasing the complexity of the biochemical reactions, of that aiming the improvement of metabolic and respiratory processes, the increasing of efficieny of energy utilization (taken by organisms from different sources), the improving of information storage system in specialised organs and gradual passing to the social life.

From the external features there are to be mentioned the change and increasing the complexity of the action of environmental features, either separately, or in their interaction. If at the beginning the abiotic features were dominant, later the biotic features became dominant, they even influencing the effects of abiotic features.

The evolution and diversification of the organisms were stimulated by increasing the efficiency of the way of utilizing the energy, then by the improving of information storage and utilization.

The diversification of living forms was characteristic to the species from each phylum, order, family and genus. In one of them the evolution developed quickly, and then stopped. As a result, that organisms either rested not modified for millenia, or disappeared. In other organisms the evolution was initially slower and, when possible, the species diversified.

The diversification of the biosphere was going on closely related to continuous increasing complexity of interspecific ecological relationships, to the apparition and development of biogeochemical cycles and to the relations between living and non living from the habitats where they lived (Fig. 10).

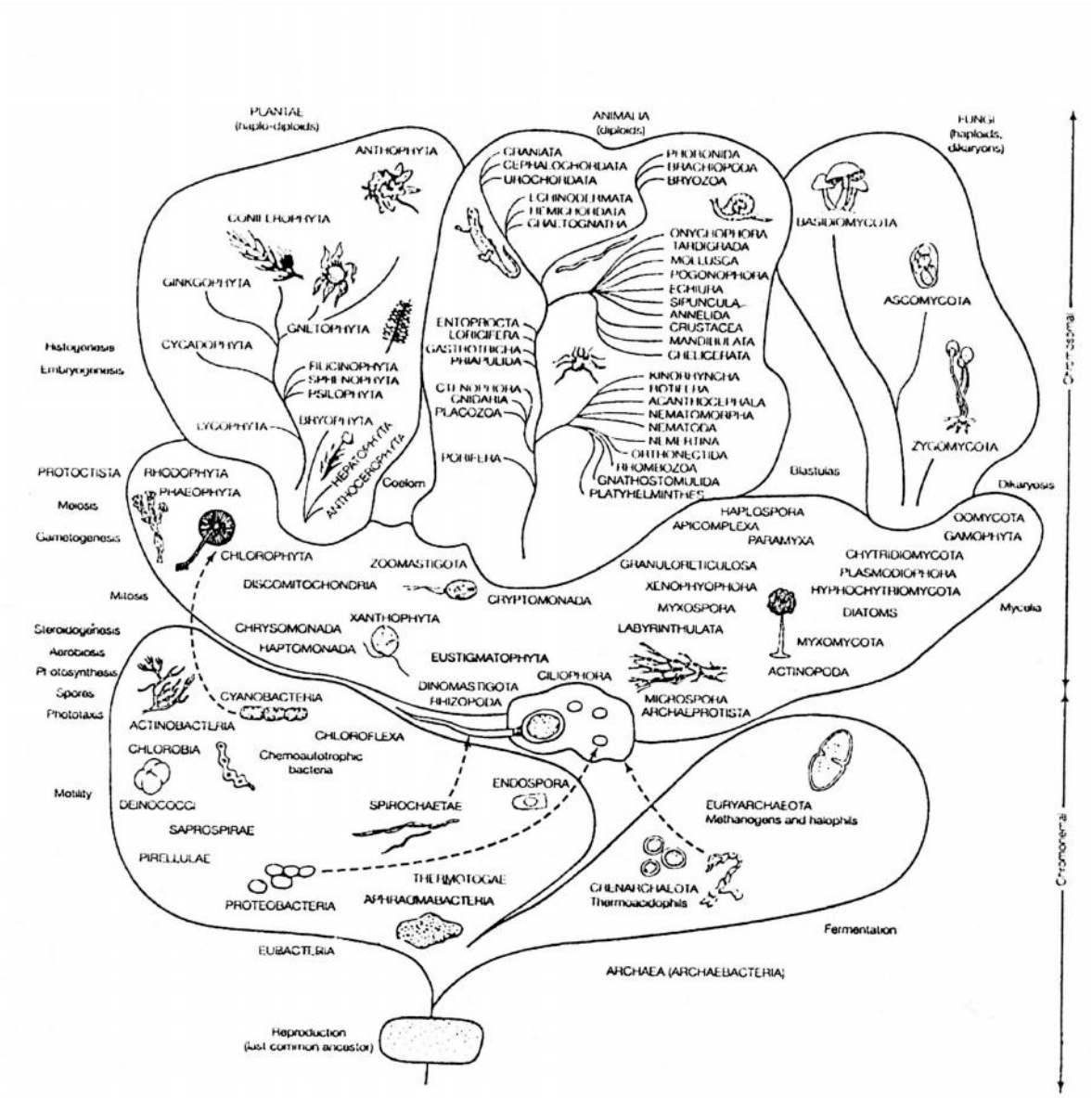

Figure 9: Five kingdoms of the living world; Margulis and Schwartz (Mustață, 2004).

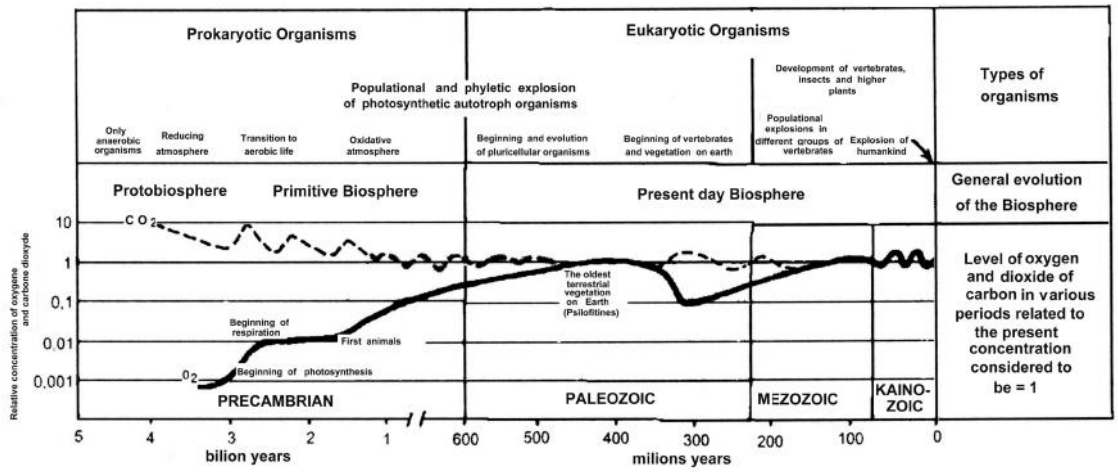

Figure 10: Main points of the biosphere evolution (Soran and Borcea, 1985 – modified).

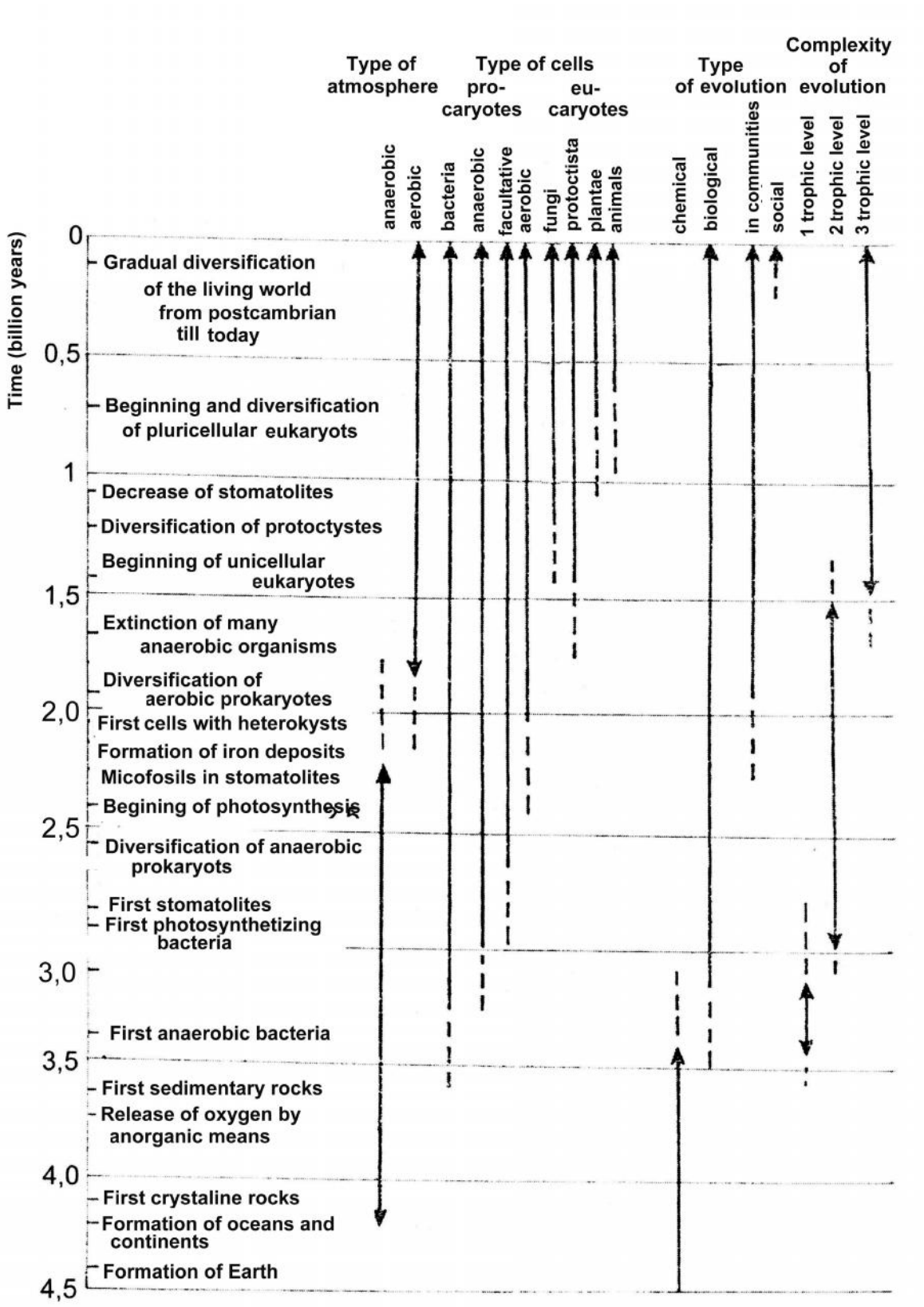

Figure 11: The main cosmic, geophysical and biological events involved in the evolution of life on Earth (Soran and Borcea, 1985); modified.

During the process of diversification of living forms the evolution approached in two ways: either progressively, or regressively. Progressive evolution resulted in specializations and increasing efficiency of the biotic processes. In spite of that overspecializations determined many times the reaching of a treshold from which the adaptation of organisms to the continuous changes of environmental features was not more possible; this situation determined the extinction, or, in better cases, the stopping of evolutive processes of that group of organisms, or, sometimes, the occupying and living in a stable, relictary environment, as the subterranean one. This kind of evolution generates new evolutive ways, which often proceed an other evolutive level.

Regressive evolution, especially in parasitic animals resulted in a high specialization and a more and more close host-parasite interaction, situation that determined only adaptive improvements.

Evolutive process is permanent, both in oldest forms (prokaryotes, protoctists) and in newer forms (in plants and animals) (Fig. 11). This process doesn't appear obligatory in morphology, but is also recorded physiologically, genetically, ethologically and ecologically. It even seems that the organisms that apparently are more primitive have a higher ability to adapt to the changes of the environmental changes.

We consider that the problems concerning the way on which takes place the evolution of life, the way of different processes are yet poorly known, they requiring new future approaches.

REFERENCES

Avise J. C., 2000 – *Phylogeography. The History and Formation of Species*. Cambridge, M. A. Harvard Univ. Press.

BakerY. P. S., 1955 – Human influence on plant evolution. 1971, *Bioscience* 21: 108.

Barbault R. and Sastrapradja S. D., 1995 – Generation, maintenance and loss of biodiversity: 193-273. in Heywood W. H., (ed.), 1995 – *Global Biodiversity Assessment*. Cambridge Univ. Press.

Bavaru A., Godeanu S., Butnaru G. and Bogdan A., 2007 – Biodiversitatea şi ocrotirea naturii. Ed. Academiei Române, Bucureşti. (in Romanian)

Bisby F. A., 1995 – Characterization of biodiversity: 21-105. in: Heywood W. H., (ed.), *Global Biodiversity Assessment*. Cambridge Univ. Press.

Botnariuc N., 1992 – *Evoluționismul în impas.* Ed. Academiei române, Bucureşti. (in Romanian)

Botnariuc N., 2005 – *Evoluția sistemelor biologice supraindividuale.* Ed. Academiei române, Bucureşti. (in Romanian)

Botnariuc N., 2006a – The role of symbiosis in the evolution of the biosphere. *Travaux d'Museum "Grigore Antipa",* XLVIII: 523-530.

Botnariuc N., 2006b – Energy hungry at the problem of progress in the evolution of the biological systems. *Travaux d'Museum "Grigore Antipa",* XLIX: 411-429.

Briggs D. and Walters S. M., 1997 – *Plant Variation and Evolution.* Cambridge Univ. Press.

Cogălniceanu D., 2003 – *Biodiversity*. Dr. Kessel Verlag, Remagen.

Fox S. W. and Dose K., 1974 – M*olecular Evolution and Origin of Life*. W. H. Freeman and Co., San Francisco.

Groombridge B. and Jenkins M. D., 2000 – *Global Biodiversity. Earth's Living Resources in the 21st Century*. World Conservation Press., Cambridge.

Heywood W. H., (Ed.), 1995 – *Global Biodiversity Assessment*. Cambridge Univ. Press.

Levine J. S. and Miller K. R., 1994 – *Biology. Discovering Life*. D. C. Heath & Co., Lexngton, Toronto.

Margulis L., 1982 – *Symbiosis in Cell Evolution. Life and its Environment on the Early Earth.* W. H. Freeman and Co., San Francisco.

Margulis L., 1992 – Biodiversity: molecular biological domains, symbiosys and kingdom origins. *Byosystems*, **27**: 39-51.

Margulis L. and Sagan D., 1986 – *Microcosmos. Four Billion Years of Microbial Evolution.* Touchstone, New York.

Margulis L. and Schvartz K. V., 2000 – *five Kingdoms. An Illustrated Guide of the Phyla of Life on Earth.* 3rd Ed., Freeman Comp., NewYork.

May R. M., 2000 – The Dimensions of Life on Earth. În *Nature and Human Society: the Quest for a Sustainable World*. National Academy of Sciences Press. Washington D.C.

May R. M., Lawton J. H. and Stork N. E., 1995 – Assessing Extinction Rates: 1-24. in J. H. Lawton and May R.M. (ed.), *Extinction Rates*. Oxford University Press.

Mooney H. A., Cushman J. H., Medina E., Sala Q. E. and Schulze E. D., 1996 – *Functional Roles of Biodiversity. A Global Perspective.* John Wiley, Chikester.

Mustață G., 2009 – Evoluția prin asociere şi edificarea organismelor. Ed. Vremea, Bucureşti. (in Romanian)

Mustață G., Mustață M. and Mihai C., 2004 – Regnurile lumii vii. Ed. Venus, Iaşi. (in Romanian)

Neagu T., Lazăr I. and Cârnaru P., 2002 – *Paleozoologia nevertebratelor.* Ed. Universității, Bucureşti. (in Romanian)

Purves W. K., Orians G. H. and Heller C. H., 1992 – *Life: The Science of Biology*. Sinauer Assoc.Inc., Sunderland., V. H. Freeman & Co.

Skelton P., 1993 – *Evolution: A biological and palaeontological Approach.* Addison-Wesley, Wokingham.

Soran V. and Borcea M., 1985 – *Omul şi biosfera*. Ed. Ştiinţ. Enciclop., Bucureşti. (in Romanian)

Starr C. and Taggart R., 1987 – *Biology. The Unity and Diversity of Life.* 4th ed. Wadsworth Publ. Comp., Belmont, California.

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RIVERS OF EUROPE

- REVIEW -

Jürg BLOESCH [1]

Klement Tockner, Christopher T. Robinson and Urs Uehlinger edited under the care of Academic Press as an imprint of Elsevier, London. First Edition 2009, 700 pp. ISBN-13: 978-0-12-369449-2 this exquisite River of Europe publication.

The book on Rivers of North America edited by Arthur C. Benke and Colbert E. Cushing in 2005 was the model for Klement Tockner to publish a comprehensive equivalent book on rivers of Europe. It is the first reference book on running waters that covers all Europe. To compile a compendium on rivers of a continent is an ambitious and laborious task, in particular with respect to basic data search in a biogeographically and politically diverse area. This is exemplified by the fact that comparable information on 165 European rivers had to be collected by more than 130 river experts from 20 countries. Moreover, the doubtful accuracy of data had to be respected: The editors claim that "published data on catchment area varies extremely, even for well-studied rivers such as the Rhine and Danube". The kind reader concludes how difficult it was to compile and harmonize data on hydrology, chemistry and biology. The demanding part of such an attempt is to find a good balance between amount of detail and general concepts of fundamental and applied limnology. The three editors have achieved an excellent compilation in so far as the reader can recognize the concept and strategy behind the structure of the book, which makes the information on rivers and river basins in different chapters comparable.

Each chapter contains a general introduction and several subchapters on human history, bio- and palaeogeography and geology, physiography – climate – land use, geomorphology – hydrology – biogeochemistry – water quality, aquatic and riparian biodiversity (including vegetation, macrophytes, phyto- and zooplankton, macroinvertebrates, amphibians and reptiles, fish, avifauna and mammals), human impact, management and conservation, major tributaries, ending with conclusions and perspectives. These chapters contain highly informative overview maps, a table on river characteristics, instructive diagrams and photos of habitats and river sections, and similar information on major tributaries. The contents are not restricted to scientific state-of-the-art data on abiotic parameters and biota, but also cover applied aspects on human impact, conservation and management. The outstanding alteration and strong fragmentation of most European rivers is shown by the fact that only 17% of the treated catchments are considered as free-flowing. For example, "the greatest single engineering effort in the 19th century was the regulation of the lower Tisza River, the largest tributary of the Danube River, where 12.5 x 10^6 km^2 of floodplain marsh were drained and the river course shortened by 340 km". In a fascinating contrast, the ignorant tourist of these days, who is adapted to channelized rivers, sees in the "Tisza Lakes" an outstanding near-natural riverine landscape of an obviously high richness of fauna and flora. This illustrates the philosophical dimension and dilemma when it comes to rating the lost reference conditions and estimating the value of riverine landscapes.

Hence, the book is an invaluable source of information for limnologists as well as for water managers, politicians and interested non-professionals. The compendium is well suited to support the implementation of the European Water Framework Directive because it helps fostering the awareness of increasing water stress and overuse. It provides up-to-date views on, and rating of, river ecosystems, descriptions of urgent and actual environmental problems and proposals how to solve them.

The following river watersheds are treated in the chapters: "The Volga River Basin, The Danube River Basin, The Iberian Rivers, Continental Atlantic Rivers, The Rhine River Basin, The Rhone River Basin, The Fennoscandian Shield, Arctic Rivers, British and Irish Rivers, Rivers of the Balkans, The Italian Rivers, Western Steppic Rivers, Rivers of the Central European Highlands and Plains, Rivers of the Boreal Upplands, Baltic and Eastern Continental Rivers, Rivers of Turkey, Ural River Basin". This shows that the catchment scale was preferred to the country scale, demonstrating that hydrographic river basins and not national territories provide the ecosystem and scientific unit and, hence, the management unit.

Of course, such a book like that cannot be complete. One may claim that smaller tributaries or other details are missing, some figures may not be exactly congruent in different chapters, and "information on river status, e.g. in the eastern plains of Russia and the Ukraine, is highly limited". However, this should not be considered as a criticism, because this is inherent to any monographic book. The authors have to give main topics priority as space is limited, and they have certainly made the right selection and a thorough data validation. The critical reader can rely on the many key references and websites to pursue further details of interest. For students the compilation of the different river basins is an excellent start on accumulating knowledge about European rivers, inclusively providing a careful and comprehensive selection of secondary literature.

The Rivers of Europe book offers a speciality which I like very much: Apart from the ordinary foreword and editorial preface, the last chapter of this book was entitled "European Rivers: A personal perspective" provides a professional review of this book by Alan G. Hildrew and Bernhard Statzner. It is a real pleasure to read this ingenious analysis of the state of European rivers and the visions of future management strategies. This chapter can be seen as a summary for the "quick" reader who would later find the time and need to search for more details in single chapters of selected river basins of individual interest.

For the Danube people, the chapter on the Danube River Basin is of particular interest. Having myself contributed my share to this overview, particularly the section of protection and management, I can say that it is the only available up-dated Danube "monograph" at present. It provides not only substantial new scientific knowledge complementary to Liepolt's Danube Monograph of 1967, but also adds the applied dimension which is a must nowadays. Although I wished for a long time that Liepolt's Monograph would be updated, providing more details than a single book chapter can cover, the Danube information meets the basic demands of the research community as best as it possibly can.

In summary and conclusion, the Rivers of Europe book definitevely sets an obvious benchmark and should be in the bookshelves of every Danube and large river researcher and manager as an indispensable compendium.

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TRANSYLVANIAN REVIEW OF SYSTEMATICAL AND ECOLOGICAL RESEARCH 5 (2008) - THE MARAMUREŞ MOUNTAINS NATURE PARK

- REVIEW -

Timur Vasile CHIŞ [1]

Angela Curtean-Bănăduc, Doru Bănăduc and Ioan Sirbu, 2008, ***Transylvanian Review of Systematical and Ecological Research, The Maramureş Mountains Nature Park***, vol. 5, 222 pages, "*Lucian Blaga*" University of Sibiu Printinghouse, ISSN 1841-7051.

Research studies conducted in the Maramureş Mountains Nature Park between 1997–2008 are published like a tribute to the Romanian botanist Artemiu Coman (1881-1972), who studied the flora of this area and discovered new species for science.

The 23 valuable papers in this special volume contribute to the increase of the identified species number, the knowledge of their spatial distribution and of the management measures.

The volume begins with the paper "Geographical background elements of the Vişeu River Basin (Maramureş, România)", where T. V. Chiş gives a description of the boundaries, geomorphology and hydrology of the Vişeu River basin and of a part of the Maramureş Mountains Nature Park.

"Analysis of levelled surfaces in Maramureş Mountains (Maramureş, Romania)", by A. Mureşan covers the local nivation surfaces, based on the morphological analysis of the relief, within the framework of GIS programs.

In "The characteristics of the hydrographical basins of the Maramureş Mountains (Maramureş, Romania)", M. Costea presents this massive watershed, based on morphological features, evolution, physical and geographical particularities.

In "Pollen analysis of the sequence from the Peat Bog Tăul Mare - Bardău (Maramureş, Romania)", S. Fărcaş, I. Tanţău, M. Mîndrescu, B. Hurdu, L. Filipaş and T. Ursu highlight the last three classical silvestre phases: *Picea- Quercetum mixtum-Corylus*, *Picea-Carpinus, Picea-fagus-Abies*.

O. V. Danci, in "Conservation and management of the Mountain Pine habitat in the Maramureş Mountains Nature Park (Maramureş, Romania)" offer management measures for the habitat 4070* - *Pinus mugo* and *Rhododendron myrtifolium*.

In "Rare, endangered and endemic species of plants of the Chyvchyny/Civcin Mountains (Carpathians)" by I. Chorney, V. Budzhak and A. Tokaryuk, are presented 134 rare plants identified in this area and the proposal of creating an Ukrainian-Romanian protected area.

I. Sîrbu, V. Gheoca and M. Sîrbu publish data on 12 species of gastropods and three species of bivalve in "Data on aquatic and hygrophilous molluscs from the Maramureş Mountains Nature Park (Maramureş, Romania)".

The scientific study upon terrestrial gastropods made by V. Gheoca, M. Sîrbu and I. Sîrbu led to the identification of 43 species, out of which 24 are reported for the first time in this area, results published in "Data Concerning the fauna of terrestrial gastropods the Maramureş Mountains Nature Park (Maramureş, Romania)".

In "The harvestmen fauna (Arachnida, Opiliones) from the Maramureş Mountains Nature Park (Maramureş, Romania)", R. Plăiaşu and R. Băncilă found 10 species, 2 are endemics in Carpathians.

D. Ilie and H. Olosutean in the paper "Aspects Regarding the diversity of aquatic and semiaquatic Heteroptera from the Maramureş Mountains Nature Park (Maramureş, Romania)" realised a study on the quality of water and the number of aquatic and semi-aquatic Heteroptera species and human impact in the area.

A. Stănescu publishes "The Miridae (Heteroptera) species list of Maramureş (Romania)", collected within Maramureş Depression (Maramureş, Rodna, Ţibleş, Igniş Mountains and Maramureş hills).

The work "Apoid hymenopterans (Melittidae, Megachilidae, Anthophoridae, Apidae) from Maramureş area (Romania)" of C. Ban-Calefariu has 51 species of which two are at their second mention in Romania (*Stelis ornatula* and *Hoplitis ravouxi*).

R. Serafim in "Contributions to the knowledge of the distribution of coccinelids and cerambycids beetles (Coleoptera, Coccinellidae, Cerambycidae) in Maramureş Mountains Nature Park (Maramureş, Romania)" identifies 67 species, 11 listed for the first time in this area.

S. Maican in "The diversity of the leaf beetles (Coleoptera, Chrysomelidae) in the Maramureş Mountains Nature Park and surroundings (Maramureş, Romania)" refers to 94 species among which *Neocrepidodera transsilvanica* is carpathian endemic and *Sclerophaedon carpathicus*, endemic in the Eastern Carpathians.

"The rove beetle fauna (Coleoptera, Staphylinidae) of the Maramureş County (Maramureş, Romania)" by M. Stan describes 413 species of the Maramureş Depression, out of which *Niphetodes semicarinatus*, *N. schoenmanni* and *Tectusa rodnaensis* are endemic in the Rodna Mountains.

"Species' diversity of the beetle fauna, a sensitive parameter for ecologic monitoring. Maramureş Mountains Nature Park (Romania)" is a result of E. Nițu study, in which data on 157 species of beetles collected in different types of habitats (caves, alpine meadows, bogs, streams, lakes, forests) are published.

C. Pârvu publishes in the paper "Diptera (Insecta) of the Maramureş Mountains Nature Park (Maramureş, Romania)", a list of 204 species, out of which 35 are first reported in this area.

"Vişeu River and some tributaries ecological assessment based on macro-invertebrate communities (Maramureş, Romania)", is the first work in this area where a correlation between the communities of macroinvertebrates and habitat conditions was made, by A. Curtean-Bănăduc, and some environmental recovery measures for the basin are also proposed.

D. Bănăduc makes a monitoring of the species *Huco huco*, during the period 1997–2008, highlights the limiting factors and suggests management and protection measures, in "The *Hucho hucho* (Linnaeus, 1758), (Salmoniformes, Salmonidae), species monitoring in the Vişeu River (Maramureş, Romania)".

The paper "The current distribution of herpetofauna in the Maramureş County and the Maramureş Mountains Nature Park, (Maramureş, Romania)", published by D. Cogălniceanu, R. Băncilă, C. Samoilă and T. Hartel shows the current state of 25 species.

I. Kovacs in "Preliminary ornithological survey in the Maramureş Mountains Nature Park (Maramureş, Romania)", identifies 102 species of birds and also tracks down the most significant factor that endangers them - the massive cutting of forests.

"Results of research on the bat (Chiroptera) fauna of the Maramureş Mountains Nature Park (Maramureş, Romania)" by C. Jére, as a result of a study made in 2007–2008 period, presents data on 13 species in the area and their habitat types.

A. M. Gurzău, A. M. Benedek, M. Sîrbu and I. Sîrbu in "Small mammals (Rodentia, Insectivora) from the Maramureş Mountains Nature Park (Maramureş, Romania)", identified 16 species.

The volume reviewed is a very useful publication for researchers, teachers, students, Maramureş Mountains Natural Park Administration, members of the Scientific Council of this park, regarding the management measures of flora and fauna, which should be applied for the biodiversity conservation and management sustainable conservation of this special protected area.

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TRANSYLVANIAN REVIEW OF SYSTEMATICAL AND ECOLOGICAL RESEARCH 7 (2009) - THE ARIEŞ RIVER BASIN

- REVIEW -

Milca PETROVICI [1] and *Mălina DUMBRAVĂ - DODOACĂ* [2]

Angela Curtean-Bănăduc, Doru Bănăduc and Ioan Sîrbu, 2009. ***Transylvanian Review of Systematical and Ecological Research***, ***7 - The Arieş River Basin***, 205 pages, "*Lucian Blaga*" University of Sibiu Printinghouse, ISSN 1841-7051.

Arieş River ("*Aureus*/*Aurarus*" in Latin) is formed from the confluence of the Arieşul Mare River with Arieşul Mic River, springing from the Bihor Mountains (a part of the Apuseni Mountains). With a length of 164 km, flows into Mureş River, downstream of the Luduş City, after which crosses a number of cities (Turda, Baia de Arieş, etc.) and an important mining region (Roşia Montană, Baia de Arieş, Bucium areas), rich in gold, silver and other heavy metals.

The Arieş River watershed is characterized by a varied and a rich landscape and also a great natural beauty. Thus, the 15 papers of the volume 7 of Transylvanian Review of Systematical and Ecological Research dedicated to this basin shows a wide range of areas of interest, addressing different aspects of hydromorphological area, bacteriological and enzymology aspects of the surface water and sediment, management and biodiversity of grasslands, diversity of terrestrial, aquatic and interstitial fauna, parasitological aspects, new breeds of some domestic animals of the area and wood degradation caused by associations of different organisms.

The first paper, realized by M. Costea, presents an analysis of the relief of the Arieş River watershed, with morphostructural conditions and aspects of morpholitology. Also, she identified the disequilibrium tendency in the morpho-hidrographic system of the Arieş River.

The next paper, signed by V. Muntean, A. Livia and R. Carpa, presents an evolution of bacterial and enzymatic activities in water and sediments of this lotic system.

The next contribution, by A. Voicu, M. Ştefănescu and I. Lazăr, presents the results of the laboratory tests in order to reduce the metal ions burden of the waste water, by different bioremediation technologies.

The next three contributions look into biodiversity and management of grasslands. The first, by J. P. Frink, presents the semi-natural grassland vegetation, with 17 associations, 4 subassociations and 10 facieses, highlighting a large diversity of those grasslands.

The second paper, by K. Brinkmann, F. Păcurar and A. Reif, revealed the secondary succession and fluctuations in the meadows of Gheţari area (Apuseni Mountains), under different fertilization regimes for 4 years (2001–2004 period).

The last paper on this topic, discusses the importance of management of oligotrophic grasslands from Gheţari – Poiana Călineasa in Gârda de Sus community, to maintain the current diversity of the phytocenosis; F. Păcurar, I. Rotar, N. Gârda and A. Morea.

In her paper, "Preliminary data upon the aquatic Oligochaeta communities in the upper sector of Arieş River (Transylvania, Romania)", D. Cupşa presents the low diversity and stability of the oligochaeta community (16 species), mainly because of the frequent variations in water level.

D. M. Ilie and H. Olosutean, describe a great diversity of aquatic and semiaquatic Heteroptera fauna in the Arieş River basin. In this article, the authors reported a low value for the α–biodiversity,

counterbalanced by a higher β–biodiversity value for most of the hydrographic basin (using the altitude as gradient).

The diversity of ant fauna of the area, go to 39 species, in the paper signed by I. Tăuşan. The majority of species are common in Romania, with the exception of *Myrmica hellenica* Finzi, 1926 (for which is the third identification in the country).

C. Ciubuc describes in his article, 54 species of trichopterans for the upper Arieş and Someşul Cald catchments. *Hydroptila taurica* Martinov was recorded for the first time in the Romanian fauna. Also, the article presents images of the 6 new trichopterans species for Romania and Apuseni area.

The relationship between the heavy metals and the hyporheic invertebrate community structure was selected by S. Iepure and L. Selescu, to describe environmental changes in the middle basin of the Arieş River. Metal imputs (Cu, Pb, Zn and Mn) from several gold and silver mines affect the abundance, frequency and spatial distribution of the local hyporheic communities.

"Algae, macroinvertebrates and fish communities from the Arieş River catchment area (Transylvania, Romania)", by L. Momeu, K. Battes, K. Battes, I. Stoica, A. Avram, M. Cîmpean, F. Pricope and D. Ureche, presents the results of a complex study. Studies on benthic diatom community confirmed previsions researches in the area and brought new data concerning the qualitative composition. The highest diversity of the macroinvertebrate species community was observed in the upper Arieş River basin. Downstream to human activities (mining and wood industry, tourism, ballast exploitation, discharges of waste waters, etc.), the authors report a decrease in macroinvertebrates fauna diversity. Also, in unaffected areas the values of fish abundance and biomass were good to medium. In contrast, authors report that these ecological parameters decrease drastically in affected areas. In polluted regions, sensitive native species migrated to the clean tributaries.

The paper of I. V. Petrescu-Mag, B. G. and R. M. Petrescu-Mag, presents the first record of myiasis in *Vipera berus* having as agent a member of facultative parasite *Calliphora vormitoria* (Diptera: Calliphoridae).

"Transylvanian giant rabbit originates from Arieş and Someş areas (Transylvania, Romania)", by I. Valentin Petrescu-Mag, R. M. Petrescu-Mag, M. Botha and I. Oroian, describes a new rabbit breed that is in forming. This new breed avoid some inconveniences that have other breeds.

The last paper is an interdisciplinary one dealing with issues of biodiversity and maintenance of the cultural heritage. The autors, L. Bucşa and C. Bucşa, present a case study on biological decay found with the "Avram Iancu" Memorial House and Vidra de Sus Museum. All types of biological attacks are analyzed: their extension and their generating causes. Finally, the authors recommend a set of measures for eradication of the biological attacks.

This diversity of papers reflects the importance of the Arieş River basin, in terms of landscape, biodiversity and many and various human activities which modell the ecosystems of this area.

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TRANSYLVANIAN REVIEW OF SYSTEMATICAL AND ECOLOGICAL RESEARCH 9 (2010) - THE RODNA MOUNTAINS NATIONAL PARK

- REVIEW -

Timur Vasile CHIŞ [1]

Angela Curtean-Bănăduc, Doru Bănăduc and Ioan Sârbu, 2010, ***Transylvanian Review of Systematical and Ecological Research***, ***The Rodna Mountains National Park***, vol. 9, 210 pages, "*Lucian Blaga*" University of Sibiu Printinghouse, ISSN 1841-7051.

This scientific volume presents a high variety of elemnts regarding the Rodna Mountains National Park and Biosphere Reserve, as a homage to the great Romanian botanist *Florian Porcius*, who studied intensively the flora of this excuisite area.

17 high value scientific papers are included in this special volume, most of them contributing to the increase of the species number identified in the Rodna Mountains National Park, as well as to their spatial distribution.

The volume starts with the paper "Geographical introductory characterization of the Rodna Moutains - Rodna Mountains National Park (Eastern Carpathians, Romania)" of T. V. Chiş, which present a description of the position, limits, relief, geology, hydrology, climate and protected areas of the Rodna Mountains.

"Natural cavities in the Piatra Rea - Ştiol area, Gura Fântânii, Borşa (Rodna Mountains) (Transylvania - Maramureş, Romania)", published by D. Iştvan, represents the most complex paper regarding the karst from Piatra Rea area, describing 22 caves and sinkholes.

"Pietrosul Rodnei Reserve typical topoclimatic conditions and the forest vegetation (Maramureş, România)", published by Ş. V. Béreş makes considerations about the topoclimatic conditions for the forest vegetation from the Pietrosu Rodnei Reserve.

The bryophyte related paper "The contributions of the botanists *Artur Coman* and *Adám Boros* to the knowledge of the Rodna Mountains bryophytes (Transylvania-Maramureş, Romania)" presents the bryophyte species inventories of the Maramureş Museum's Natural Sciences Department and the Botanical Museum of Budapest, collected and identified by *Artur Coman* and *Adám Boros*. M. Béreş's paper has a high phytohistorical and also phytogeographical importance, presenting the actual extension of the described species.

In "The Bryophytes of the Rodna Mountains National Park (Transylvania-Maramureş, Romania)", S. Ştefănuţ present the distribution of the bryophytes in the Rodna Mountains National Park based on literature data, collections and field research. The list of the nationally and internationally endangered species it is also presented.

The paper "Alpine wet habitat types of community interest in the Rodna Mountains National Park (Eastern Carpathians, Romania)" by E. Schneider-Binder, is referring to the study of the communitarian interesting wet habitats *7240 of the alpine level of the Rodna Mountains National Park, the author comparing them to similar habitats of other mountain areas of Europe.

The research of V. Gheoca on the Repedea Valley of Rodna Mountains in the study "Terrestrial Gastropod fauna of the Repede River Valley in the Rodna Mountains National Park (Transylvania-Maramureş, Romania)", completes the inventory of the gastropod fauna of this area by the 33 identified species.

S. Maican presents a total of 138 coleopteran species in her scientific paper, "The leaf beetles fauna (Coleoptera, Chrysomelidae) of the Rodna Mountains (Transylvania- Maramureş, Romania)", counting in it also the Carpathian endemic species *Sclerophaedon carpathicus* Weise, *Chrysolina weisei* (Frivaldszky), *Psylliodes frivaldszkyi* Weise and *Neocrepidodera transsilvanica* (Fuss).

The research of A. Curtean-Bănăduc on the mayfly larvae communities published in the scientific paper "Mayfly (Insect, Ephemeroptera) assemblages in the Iza River/Tisa Watershed (Eastern Carpathians, Romania)" represents the most ample research made on the Iza River basin from its sources to its mouth, 21 species and 10 genera being identified here.

The paper "Influence of anthropic impact on aquatic and semi-aquatic Heteroptera distribution from Repede River in the Rodna Mountains National Park (Transylvania- Maramureş, Romania)" presents a study of H. Olosutean and D. Ilie for evaluation of quality of water resources and aquatic and semi-aquatic Heteroptera habitats and human impact on them.

Research about ants, published in "Notes on the ant fauna (Hymenoptera, Formicidae) of the Rodna Mountains National Park and its surroundings (Transylvania-Maramureş, Romania)" by I. Tăuşan led to the identification of 16 species of which 9 (*Camponotus ligniperdus*, *Formica lemani*, *Formica clara*, *Formica sanguinea*, *Leptothorax acervorum*, *Myrmica lobicornis*, *Myrmica rubra*, *Myrmica ruginodis* and *Polyergus rufescens*) are first identified in the Rodna Mountains. With these new data the number of species identified in this area reached at 22.

C. Iuşan, based on a 2004–2008 research, published "Orthoptera fauna of the Rodna Mountains National Park (Transylvania-Maramureş, Romania)" in which he published data on 52 identified species. The paper presents also endemic species in the Carpathians area like: *Isophya brevipennis*, *Miramella ebneri carpathica*, *Odontopodisma carpathica, Isophya pienensis* and *Pholidoptera transsylvanica*.

"Hydrotechnical works impact on Cyclostomata and Cottidae species in the Rodna Mountains and Maramureş Mountains Natura 2000 sites (Eastern Carpathians, Romania), Repede River - a study case", is a study conducted by D. Bănăduc and represents a specific case study about the anthropogenic impact on the hydrological regime and fish diversity due to water extraction and regularization, of Repede River.

"Bat species (Chiroptera) identified in the Rodna Mountains National Park and in adjacent areas (Eastern Carpathians, Romania)", is a complex work on the species identified by T. V. Chiş in field investigations and other authors who conducted such researches in this area.

"New data concerning the small mammal fauna (Insectivora, Rodentia) of the Rodna Mountains National Park (Eastern Carpathians, Romania)" research was done by I. Nae, I. Cobzaru and A. M. Cozma. Eight species were identified and the special species *Sicista betulina* Pallas (1779) presence was reconfirmed.

The research paper "Data on the distribution of *Marmota marmota* (Rodentia, Sciuridae) from the Rodna Mountains National Park (Eastern Carpathians, Romania)" was elaborated by B. M. Szabo and it presents the spatial distribution of marmot, species introduced in 1973 in Pietrosul Rodnei Reservation.

The present volume it is an useful instrument for researchers, students, as well as for the Administration of Rodna Mountains National Park and its Scientific Council members, regarding the management measures that should be applied for conservation and protection objectives.

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ECOLOGICAL AND PHYSIOLOGICAL STUDIES ON *OROBANCHE* SPECIES IN NATURAL ECOSYSTEMS

- REVIEW -

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The main objective of Ms. Ana Höniges Doctoral Thesis (2009) was to find out the reasons, why rare broomrapes (*Orobanche* spp.) in the spontaneous flora are rare and endangered, while weedy broomrapes threat crops in agriculture.

During extensive field work 13 of 22 listed *Orobanche* spp. were found in Romania, namely *Orobanche arenaria, Orobanche caryophyllacea, Orobanche alba, Orobanche coerulescens, Orobanche elatior, Orobanche gracilis, Orobanche lucorum, Orobanche lutea, Orobanche minor, Orobanche purpurea, Orobanche reticulata, Orobanche salviae* and *Orobanche teucrii*. In Baden-Württemberg, Southwest Germany, 11 of 21 listed *Orobanche* spp. were found, namely *Orobanche alsatica, Orobanche arenaria, Orobanche caryophyllacea, Orobanche elatior, Orobanche hederae, Orobanche lutea, Orobanche mayeri, Orobanche minor, Orobanche picridis, Orobanche purpurea* and *Orobanche teucrii.* The finding sites were GPS recorded. The studies result in the statement, that the number of sites, where *Orobanche* occurs, and the number of individuals, where they are found, is in generall in decline.

Climate warming plays a minor role, although it would favour *Orobanche*. Collected local weather data over the past 3-4 years showed a distinct tendency towards warmer and more humid spring months (March-May). The precipitation over the days and months, however, is irregularly distributed and changes from year to year. Dry periods in the spring months are unsuitable for conditioning and germination of *Orobanche* seeds. This explains, why some *Orobanche* spp. were not found in every year.

Rare *Orobanche* spp. compared with the noxious *Orobanche* spp. in agriculture are biologically handicapped. Their seed production is lower, since their flower stands are much smaller than those of noxious species. Due to insect attack the connection to the host plant root is interrupted, stems can dry off early, so that the seed development leads to immature or empty seeds. This was shown by germination tests under standardised laboratory conditions, and was confirmed by electron microscopy. Some *Orobanche* spp. develop only short germination tubes (radicles), which have a very limited chance to come in contact with a host plant root and to form a haustorium.

Due to these biological disadvantages the rare *Orobanche* spp. are not expected to become noxious species endangering the crop plants. The transition to crop damaging pathotypes in rare cases may happen by mutative adaptation (*Orobanche foetida*) or by hybridisation (*Orobanche lavandulacea* x *O. ramosa*).

Series of germination tests were carried out with *Orobanche* seeds, stimulating them with root exudates of their host plants or with the synthetic germination stimulant GR 24, without or with the addition of potential germination inhibitors, and/or gibberellic acid, which could increase elongation growth of the germ tubes. With GR 24 the germination rates of *O. elatior* and *O. lutea* were zero, that of *O. hederae* extremely low. This deserves attention, because GR 24 generally serves as a standard in germination tests. In all the germination test series in this thesis *Orobanche ramosa*, a noxious species in agriculture, was used for comparison.

In order to study allelopathic interactions with the associated flora analyses of root exudates by HPLC with UV/VIS diode array detector, and GC-MS were carried out. Benzoic acid was a significant component in half of the investigated root exudates, including that of the associated flora. Its identity was verified by the retention time in the HPLC chromatograms and by the absorbtion spectrum. Germination inhibitors of the cinnamic acid family were not found. Germination inhibition, shown by standardised germination tests, resulted in significant differences in sensitivity among the *Orobanche* spp.

Suicidal germination could be considered a significant factor in the limitation of rare *Orobanche* spp. Almost all plant roots exude strigolactones, the natural germination stimulants, because these are required for mycorrhiza development. Hence, the exudates of the associated flora stimulates germination, without being parasitised afterwards. Under these circumstances no seed potential is built up in the soil, which during a favorable year could lead to a mass appearance of *Orobanche*.

After the observation during the germination tests that fungi grow out of the seed, these were investigated by transmission electron microscopy. When the presence of endophytic Ascomycetes was discovered, their moleculargenetic identification was carried out. Two fungi have been identified doubtless as *Alternaria tenuissima* strain IA 285 and *Cladosporium* sp.

For the first time strigolactones have been isolated from the root exudates of host plants of rare *Orobanche* spp. and identified by HPLC-Tandem-MS. Known structures have been found, but there are also some indications for related compound, whose structures are not yet revealed. The obtained results show host plant specific qualitative differences in the composition of strigolactones. This supports the hypothesis that host specificity may depend on specific mixtures of strigolactones exuded by the host plant.

The *Orobanche* spp. seed coats surface has been investigated by scanning electron microscopy, in order to prove the suitability for the identification of the *Orobanche* spp. According to the obtained results *Orobanche* and also *Phelipanche* (*Trionychon*) sections can be distinguished, but scarcely the species within these sections.

This Doctoral Thesis can be completely downloaded in German from http://tobias-lib.ub.uni-tuebingen.de/volltexte/3009/3769.

The Romanian version can be obtained contacting its author at a_hoeniges@yahoo.de

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WATER QUALITY ASSESSMENT OF THE CRIŞUL REPEDE RIVER USING MAYFLIES LARVAE AS BIOINDICATORS (INSECTA: EPHEMEROPTERA)

- REVIEW -

Mălina DUMBRAVĂ-DODOACĂ[1]

Milca Petrovici, 2009, Water quality assessment of the Crişul Repede River using mayflies larvae as bioindicators (Insecta: Ephemeroptera), 273 pages, published by Oradea University Press, Bihor, Romania, ISBN 978-973-759-978-0.

This publication subject is located in terms of space in the Crişul Repede River basin, which is one of the main lotic systems in the western part of Romanian national territory.

Overall, it presents the water quality evaluation of Crişul Repede River using benthic invertebrates such as mayflies larvae, as well as their importance for water bodies, resulting in a study conducted over a period of two years. Due to the large diversity of the lotic ecosystems in the temperate regions, mayflies represent an important link of food chains, being located between primary producers and secondary consumers. These organisms are becoming more frequently used as important indicators in studies regarding water quality, due to their sensitivity for various pollutants. In the Romanian scientific literature there are relatively numerous studies regarding the systematics and distribution of the mayflies. However, there are very few studies for analyzing the dynamics of mayflies populations in the lotic systems, of their lifecycle as well as data on secondary production. This new publication gives useful informations regarding the ecology of the mayflies populations, taking a perspective that shows how these specific organisms respond to the changing quality environment.

The present publication is structured in six major sections (introduction, materials and methods, results and discussions, conclusions, abstract and bibliography) and nine chapters.

The first section - introduction - includes the tracked objectives and the main activities also, a number of main aspects regarding mayflies role in the lotic ecosystems, together with the progress on national and international research. This section includes the following chapters: Chapter 1, which provides detailed data on population role and biocoenosis in the hierarchy of biological systems; Chapter 2 describes the secondary production and its significance for the transfer of matter and energy flow through the lotic ecosystems, history studies for the secondary production worldwide and at the national level, the methods used to determine the secondary production like Hynes-Hamilton method and detailed information on the relationship between the production and the biomass (production/biomass ratio for the dominant species); Chapter 3 describes the main features of the investigated aquatic ecosystems: geomorphological structure, network characteristics of Crişul Repede river basin, climatic characterization of the river basin, soil, vegetation and algae communities, location and description of the sample collecting sites). To track the water quality change effects on the structure of biological communities from crossing the river by an urban or/and an industrial center, control points were set in both upstream and downstream of the Oradea locality. To track the effects of hydrological changes, two stations were chosen on the two main tributaries also: Drăganului Valley and Iadului Valley. Finally, to have an overview on the benthic invertebrate diversity, two additional stations have also been chosen as follows: one located at the river source (Saula station) and other located upstream from the entrance of the major tributaries (Drăgan upstream station).

For each of these stations were identified a number of factors, including: altitude, GPS coordinates, riverbed / water average width and depth, type of substrate, water velocity, vegetation cover banks, presence / absence of polluters, or other specific observations.

The second section - materials and methods - includes general aspects of the sample collection program, equipment and methods, the frequency of collection, water physical-chemical parameters, the methods used for processing samples in the laboratory (extraction and identification of benthonic fauna, granulometric analyzes, analyzes of organic substances in the sediment, larval growth experiment under laboratory conditions, assessment of the secondary production, biometry, calculation of the secondary production and size classes) and also the statistical methods (density, abundance, frequency, diversity, equitability, mortality factor and spatial distribution).

The third section - results and discussions - provides information on physical and chemical parameters of water and sediment in the investigated sectors (water velocity and hydrological variations, hydrological regime of the Crişul Repede river and its studied tributaries), benthic macroinvertebrates community (benthic macroinvertebrates community structure and diversity, seasonal and annual dynamics of the benthic groups). There are also included a number of aspects concerning the structure and dynamics of mayflies populations in the investigated area, together with secondary production of the studied populations and life cycle of the mayflies dominant species in the investigated river basin, which details information on structure size classes of identified species.

The fourth section - conclusions - outlines the importance of mayflies larvae in the present study and explains how the diversity modifications regarding this species may produce changes in secondary production for lotic ecosystems.

Finaly, the sections abstract and bibliography summarized the contents and the results obtained throughout the entire study and introduce the literature sources used for this research.

By its subject, this publication is a pioneering work in running water ecology and management in Romania. It offers a wide variety of information on this issue considered to be of international concern. It is based on a two years study, this topic being appreciated both nationally and worldwide. Its applicability and accuracy provide valuable information in the evaluation of the water quality using benthic organisms. Also complements the national and international data regarding the importance of the secondary production, with its significance for matter and energy flow within an aquatic ecosystem.

The results of this work, can be used by specialists in the the field, students or decision makers, government agencies, together with local authorities and communities also.

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