THE CONGLOMERATE HILLS OF TĂLMACIU-PODU OLT (TRANSYLVANIA, ROMANIA), A REMARKABLE HABITAT COMPLEX OF BIOGEOGRAPHICAL IMPORTANCE

Erika SCHNEIDER-BINDER [1]

KEYWORDS: xerothermic conditions, xero- and thermophilous species, relicts, biogeographical interest, rare species and habitat types.

ABSTRACT

The conglomerate hills of Tălmaciu-Podu Olt demonstrate, as a result of their geomorphological structure and their geographical position on the Southern edge of the Transylvanian Tableland in the contact area with the Southern Carpathians, a mosaic of various xerothermic habitats with many species of biogeographical relevance. Apart from the European floral elements, a remarkable number of Pontic, Pontic-Mediteranean, Pontic-Pannonian, Balkan and Submediterranean elements, as well as endemic species of the area, are present. Some of the rare species are highlighted and discussed in more detail. The characteristic habitat types of the conglomerate hills are presented as well and discussed from the point of view of ecology and nature conservation. Considering the high level of biodiversity present in a relatively small area and its biogeographical relevance, it is proposed that these conglomerate hills be included as a new Site of Community Interest in the Natura 2000 network.

REZUMAT: Conglomeratele de la Tălmaciu-Podu Olt (Transilvania, România), un remarcabil complex de habitate de importanţă biogeografică.

Dealurile de conglomerate de la Tălmaciu-Podu Olt prezintă, datorită stucturii geomorfologice şi a poziţiei lor geografice la marginea sudică a Podişului Transilvaniei în zona de contact cu Carpaţii Meridionali, un mozaic de diferite habitate xeroterme, cu numeroase specii de relevanţă fitogeografică. Pe lângă grupul elementelor floristice europene în aria conglomeratelor este prezent un număr mare de specii pontice, pontic-mediterane, pontic-panonice, specii balcanice, submediterane, precum şi specii endemice. Câteva dintre speciile rare sunt scoase în evidenţă şi discutate mai în detaliu. Prezentate sunt şi tipurile de habitat caracteristice, fiind discutate din punct de vedere ecologic şi al importanţei lor din punct de vedere al conservării mediului. Luându-se în considerare biodiversitatea ridicată şi relevanţa biogeografică a zonei, aceasta este propusă pentru a fi inclusă ca un nou sit de importanţă comunitară în reţeaua Natura 2000.

ZUSAMMENFASSUNG: Die Konglomerate von Talmesch-Podu Olt (Transilvanien, Rumänien) ein bemerkenswerter Komplex an Lebensräumen von biogeographischer Bedeutung.

Die Konglomerate von Tălmaciu/Talmesch-Podu Olt weisen bedingt durch ihre geomorphologische Struktur und ihre Lage am südlichen Rand des Siebenbürgischen Hochlandes im Kontaktgebiet zu den Südkarpaten ein Mosaik an xerothermen Lebensräumen mit einer Vielfalt von Arten von biogeographischer Relevanz auf. Neben den europäischen Arten ist vor allem die Vielzahl der pontischen, pontisch-mediterranen, pontisch-pannonischen, balkanischen, submediterranen und der endemischen Arten hervorzuheben. Einige der seltenen Arten werden ausführlicher dargestellt. Die charakteristischen Habitattypen werden vorgestellt und aus ökologischer und naturschutzfachlicher Sicht besprochen. Unter Berücksichtigung seiner hohen Biodiversität auf relativ kleinem Raum und seiner biogeographischen Relevanz wird das Gebiet zur Aufnahme in das Natura 2000-Netzwerk vorgeschlagen.

INTRODUCTION

The conglomerate hills of Tălmaciu and Podu Olt (Sibiu County) located in the confluence area of the rivers Sadu, Cibin and Olt near to the break-out valley of the Olt through the Southern Carpathians, are of Tortonian age (Curtean-Bănăduc, 2005). The conglomerate forms a layer of a few hundred metres thickness, opened and formed by river erosion (Alexandrescu and Şoigan, 1962). They are exposed in the form of three parts which are: the conglomerate hills on the left river bank of the Cibin River between the locality Tălmaciu, the railway station of Podu Olt (Sibiu County) and upstream a few hundred metres from the station along the Olt River, the Cetate Hill ("Landskrone") of Tălmaciu on the right site of the Sadu and Cibin rivers, and near to Măgura Boiţei ("Wartberg") situated at the mouth of the Cibin into the Olt. They present mostly steep slopes of Western, Southern and South-Eastern aspect and are famous for their xerothermic habitats and numerous xero- and thermophilous species (Fig. 1).

Figure 1: Conglomerate hills near Podu Olt railway station.

The hills with the largest extent on the left side of the Cibin River form the extreme Southern part of the Transylvanian Tableland which separates like a ridge the Cibin Depression from the Olt Depression, the so-called "Ţara Oltului/Olt Land". The Tortonian deposits enter in the Northern part under Bentonitic shale/clay, Dacitic tuff and sandy clay layers, which in their turn are covered by layers of Sarmatian age. The structure of the polygenic conglomerates between Tălmaciu, Podu Olt and Boiţa is given by component elements of different size from a few centimetres to about one m diameter and a diverse petrographical composition originating from crystalline schist, quartzite, chlorite schist, amphibolits, ocular gneiss and pegmatites, and from sedimentary rocks such as limestones similar to those of the Mesozoic era, organogenic limestone, nummulitic limestone, grey micaceous sandstones and grey-blackish marl. The cement is marly, calcareous and sandy and is varying in the vertical and horizontal direction (Alexandrescu and Şoigan, 1962). This diverse geological composition is responsible for the formation of different geomorphological structures such as very steep slopes, shelves, rock prominences and channels as well as particular soil conditions, most of them – in the stony open area – skeletal soils.

Due to these exceptional geomorphological and soil conditions creating varied microhabitats, this relatively small area with steep slopes, in particular those of Southern aspect, has been colonised probably in interglacial ages and the postglacial warm age by different species of Southern, i.e. Mediterranean, Sub-Mediterranean or Balcanic, origin in competition with species of Pontic origin from continental steppes. The interlocking point of species with different origins presents great interest from the phytohistorical, ecological, biocoenological and biogeographical point of view.

This is why from the end of 18th and the beginning of the 19th century onwards the area has been visited by botanists and zoologists from Sibiu/Hermannstadt. First data about the area are included in the plant collection of Joseph V. Lerchenfeld from the end of the 18th and beginning of 19th century that exists at the Museum of Natural Sciences in Sibiu. Also from the conglomerates ("Nagelflue") plants are mentioned by Peter Sigerus in his manuscript "Verzeichnis meiner Pflanzen gesammelt seit 1789" (Index of my plants collected from 1789 ongoing). Further information about the flora of the area is included in the botanical works of Fuss (1866) and Schur (1866).

In its "Plan for research of Hermannstadt County"/"Plan zur Durchforschung des Hermannstädter Stuhles", Reissenberger (1874) recognising the importance of the area, included in his plan the idea of "an exact and comprehensive study" of the conglomerate hills near Tălmaciu/Talmesch. Following this plan, Phleps and Henrich (1894) published the results of their geological and botanical studies in the area. The geological studies resulted in a geological map, but the botanical studies remained at the level of a plant list. From that time no researches have been undertaken in the area until the last decades of the 20th century, when the area came more in the scientific interest from the ecological and phytocoenological point of view (Schneider-Binder, 1970, 1975, 1994; Drăgulescu, 2010 unpublished data), as well as for complex biocoenological studies including vegetation and macroinvertebrates (Weiß, 1980; Ceuca et al., 1983; Schneider unpublished field data and data included in the entomological collection of the Museum of Natural Sciences at Sibiu/Hermannstadt). These complex studies have been conducted with the aim to realise a data base for the area and to show its high biodiversity intended as the basis for a proposal as a protected site. Unfortunately the designation of a protected area was not realised.

For the conglomerate hills one of the most interesting questions from the phytogeographical as well from the zoogeographical point of view is, from which time we can consider the species of different geographical origin being in the area, and which are the ways these species spread into this area. To these questions scientists have tried to find answers, but there still exist many unclear questions.

MATERIAL AND METHODS

During recent field researches and using my own field data from earlier researches, a list of taxa identified in the area of the conglomerate hills has been compiled (Annexe I). As basis for a phytogeographical analysis for each species included in the list the flora element is derived according to Ciocârlan (2009), Sârbu et al. (2013), but also for comparison and clarification of details from Oberdorfer (2001), Ellenberg et al. (2001) and Sanda et al. (1983). The abbreviations for the flora elements included in the alphabetical checklist of the species from the conglomerate hills is used according to the European standards presented in different floristic works (Oberdorfer, 2001; Oprea, 2005; Ciocârlan, 2009; Sârbu et al., 2013). The flora elements have been categorised and represented in a graphical form, showing the different groups and the proportion of each to the other (Fig. 2). Some species of particular biogeographical interest have been analysed and discussed in

more detail. The flora of the whole conglomerate hills area is recorded in the Annexe as an alphabetical checklist, with indication of the flora element, the life form and the family name for each species.

The phytocoenological data from my own unpublished field sampling and publications about the area were analysed and the associations related to the habitat types according to those listed in the EU Habitats Directive and the Manual of European Union habitats (EUR 27, 2007; EUR 28, 2013). The Natura 2000 − related publications including habitat types of Romania also have been taken into account (Doniţă et al., 2005; Schneider and Drăgulescu, 2005; Gafta and Montford, 2008).

RESULTS AND DISCUSSION

The flora elements analysis. The flora of the conglomerate hills of Tălmaciu and Podu Olt presents a manifold spectrum of species of different geographical distribution and origin. The analysis shows a predominance of species belonging to the Euro-Asian flora element group (179), followed by species of European (79) and Central-European (80) flora element. Due to the climate conditions on the edge of the transition from the Central-European-Eastern Carpathian Province to the Balcano-Moesian Province (Borza and Boşcaiu, 1965), as well the special edaphic-microclimatic conditions on the steep slopes of the conglomerate hills, a remarkable number of thermophilous and xero-thermophilous species of Mediterranean, Sub-mediterranean and Balcanic origin and also species from the Pontic flora elements group, are well represented in the area. The concentration of thermophilous elements of Southern and Eastern European origin has been highlighted earlier also for the bordering hills of the Cibin Depression, the conglomerate hills being also included in this area and situated on the Southern edge of the Transylvanian Tableland and the Cibin Depression (Schneider-Binder, 1974, 1979).

In the European flora elements group are included the European (Eur), European – Continental elements (Eur-Ct), European – Submediterranean (Eur-Submed), European-Eastern-Mediterranaen flora elements (Eur-East-Med), European South-Eastern (Eur-S-East) and European-Continental-Sub-Mediterranean (Eur-Ct-S-Med) flora elements (Fig. 2).

The Central-European flora elements group include as main part the Central-European flora element (Ec) and also the Central-European-South-European (Ec-Eur-South), Central-European-Submediterranean (Ec-Submed) and Central-European-Mediterranean (Ec-Med) flora elements (Fig. 2).

From the Euro-Asian flora elements group prevailing are the Euro-Asian elements (Eua), followed by Euro-Asian-Continental (Eua-Ct) flora elements and some Euro-Asiatic-Sub-Mediterranean (Eua-Subm), Euro-Asian-Mediterranean (Eua-Med) and Euro-Asian-Subatlantic (Eua-Subatl-Subm) flora elements (Fig. 2). The Circumpolar species (Cp) are also represented following as species number the European, Central-European and Euro-Asian elements.

The particularity of the area is given by flora element groups represented with a lower number of species, but very characteristic and important from the biogeographical point of view. These are the Pontic, the Balcanic, the Dacic-Balcanic (Dac-Balc) and the Carpathian endemic flora elements group. In the Pontic group are included the Pontic (P), Pontic-Mediterranean (P-Med), Pontic-Mediterranean-Central-European (P-Med-Ec), Pontic-Central-European (P-Ec), Pontic-Balcanic (P-Balc), Pontic-Pannonian (P-Pan) and the Pontic-Pannonian-Balcanic (P-Pan-Balc) flora element. Also have to be mentioned the Balkan flora elements group including Balcanic (Balc), Balcanic-Pannonian (Balc-Pan) and Pannonic-Balcanic (Pan-Balc) flora elements (see Annexe, checklist of species).

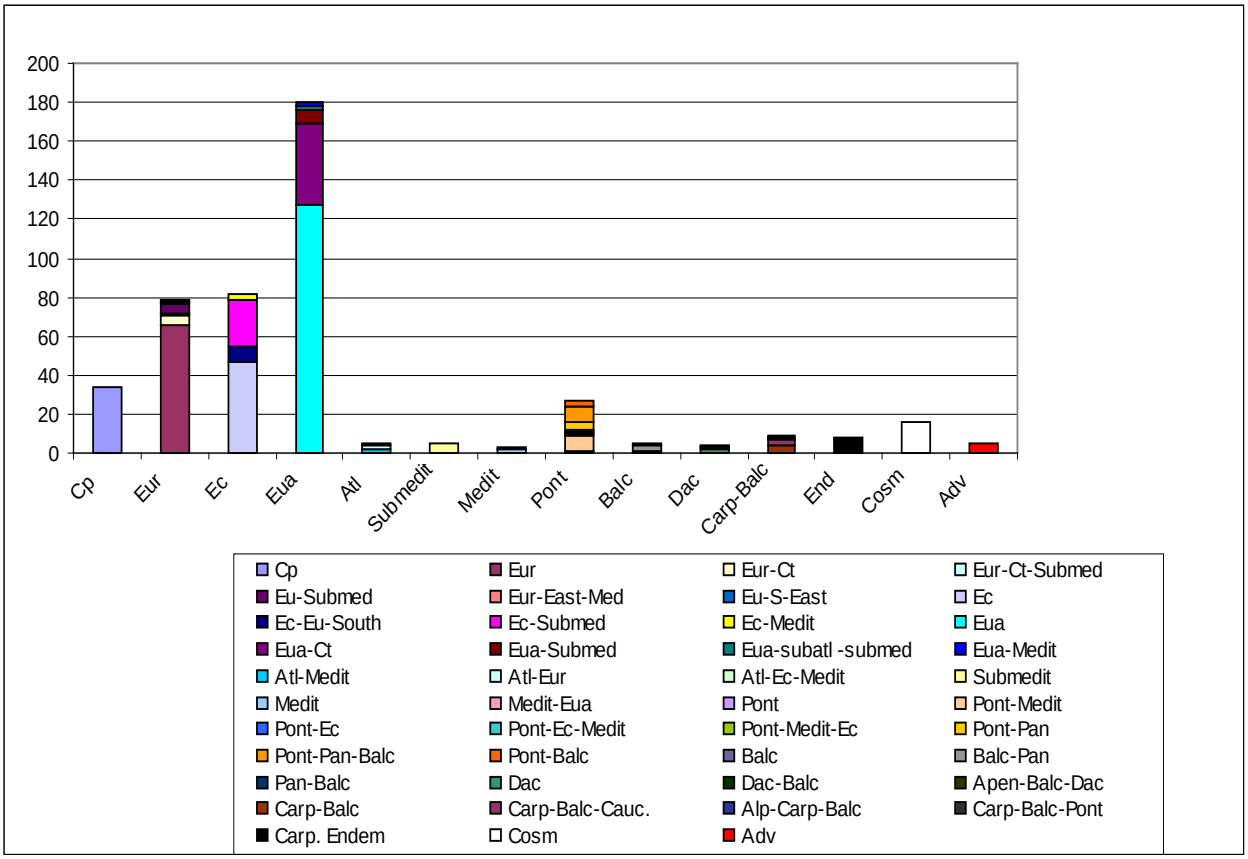

Figure 2: Flora elements of the Conglomerate hills area.

The Dacic endemic element, the Dacic-Balcanic flora element and the Carpathian endemic flora element contribute as well to the particularity of the flora on this crossing point of various macro- and microclimatic influences, which constitutes the base for the high biodiversity of the conglomerate hills. These last are giving, together with the above mentioned flora elements represented as number of species on a smaller scale, but partly with a relatively high abundance, the special characteristics of the flora of the conglomerate hills near Tălmaciu and Podu Olt (Tab. 1, Fig. 2).

Table 1: Flora elements giving the special character of the conglomerate hills.

Pontic P	P-Med	P-Ec	P-Ec-Med	P-Med-Eu	P-Pan	P-Pan-Balc	P-Balc
1	8	1	1	1	4	8	3
Balc	Balc-Pan	Pan-Balc	Apen-Balc-Carp	Carp-Balc	Carp-Balc-P	Carp-Balc-Cauc	Carp-Balc-Anat-Cauc
1	3	1	1	4	1	3	1
Alpin-Carp-Balc	Carp End	Subend-Carp	Dac	Dac-Balc			
1	8	1	3	1			
Med	Atl-Med	Submedit	Central Eu-Submed	Eu-Submed	Ec-South-East Eu	Eua-Submed/ Eua-Med	Eua-Continent
1	2	5	24	5	8	7/ 2	42

The distribution area of many southern xero- and thermophilous species shows in the Southern part of Transylvania a concentration around the valley of the Olt River crossing the Carpathians and suggests a migration, i.e. a geographical expansion, of the species from South to North through the Olt break. The Olt Valley as a possible migration way has been documented by Ciurchea (1968) with detailed distribution studies of some species. Later the problem was also considered for the area with flora and vegetation studies in Southern Transylvania by Schneider-Binder (1970, 1971, 1979 and later observations). A typical example of distribution around the Olt break valley is represented by species such as the Southern Carpathian endemic *Galium bailloni* Brândză, the Carpathian-Balcanic *Galium kitaibelianum* Schultes, the Atlantic-Submediterranean *Dioscorea communis* (L.) Caddick and Wilkin (= *Tamus communis* L.), the sub-Mediterranean Manna or flowering ash *Fraxinus ornus* L., and the Balcanic-Pannonian Silver lime *Tilia tomentosa* Moench and others.

Galium bailloni Brândză, *Galium valantioides* M. B. var. *bailloni* (Brândză, Paucă and Nyárády), found on Piatra Chiorului in the area of conglomerate hills near to Podu Olt (Schneider-Binder, 1971), its unique locality in Transylvania, is a rare endemic species of the Southern Carpathians (Ciocârlan, 2009; Sârbu et at., 2013), being distributed around the Olt break valley and west of the Olt River in some points on the foot of the Mehedinţi Mountains (Schneider-Binder, 1971). The occurrence on the conglomerate hills is the most northern in its distribution area, and the only locality in the inner Carpathian basin from where the species has been mentioned. It is closely related to *Galium valantioides* M. B., an endemic species of the Caucasus Mountains (Pobedimova, 1958). The fact that *Galium bailloni* Brândză is a generic diploid taxon (analysed by Krendl in 1970), indicates its high stability. The two species *Galium valantioides* of Caucasus and *Galium bailloni* from the Carpathians represent disjunct vicariant species, which separated and emerged probably after the time of once-existing connections between Carpathians, Anatolian and Caucasus Mountains.

In the study area the species identifies, together with other thermophilous species such as *Sesleria heufleriana*, *Melittis melissophyllum*, *Galium kitaibelianum*, the herbaceous layer of phytocoenoses of the association Galio kitaibeliani-Fagetum Sanda et al. 1970 (Sanda et al., 1970), included sometime in the assocation Carpino-Fagetum Paucă 1941.

The name-giving species of the above association, *Galium kitaibelianum* Schultes, a Carpathian-Balcanic flora element (Sârbu et al., 2013), is a relatively rare Carpathian-Balcanic species (Oprea, 2005) occurring in beech forests of Southern Carpathians, but it is mentioned also from isolated localities in the Eastern Carpathians area, the most Northern site being Bârgău, followed by the Hăşmaş Mountains (Oprea, 2005; Nechita, 2003). The species is also mentioned from the arc of the Carpathians in the Siriu Mountains (Dihoru, 1975) and Bârsei Mountains at Piatra Mare (Buiculescu, 1971). The species is concentrated around the valleys crossing the Carpathians, in particular the Olt Valley. For many thermophilous Carpathian-Balcanic and Submediterranean species – both plants and animals – it constitutes an expansion route to the Transylvanian basin (Ciurchea, 1968). *Galium kitaibelianum* occurs around the Olt break-out valley (Pasul Turnu Roşu) in the Southern part of the Sibiu Depression, and the surrounding mountains of Sadu Valley and tributaries, for example in the Tălmăcel Valley, a right tributary of the Sadu River (Drăgulescu, 2010; Schneider-Binder, unpublished field data from 2010).

Another remarkable plant species in the studied area from the phytogeographical point of view is *Genista januensis* Viv. var. *spathulata* (Spach) Ciocârlan (considered before as an independent species *Genista spathulata* Spach), an Apenninic-Balcanic-Dacic flora element, the variant *Genista spathulata* being an Carpathian-Balcanic element (Fig. 3). *Genista januensis* var.

spathulata is distributed as well around the Olt Valley break-out growing on a stony, open, dry area, the Southern part of Cibin Depression and the Făgăraş Depression (Schneider-Binder, 1979). As well the species reaches in its distribution area the South-Eastern part of the Apuseni Mountains (Oprea, 2005).

Genista januensis is a characteristic plant species for Dinaric dolomite Scots pine forests (Genisto januensis-Pinetum), habitat type 91R0 of the Natura 2000 network (EUR 28, 2013) in the Illyrian beech forest zone. The variety – formerly *Genista spathulata* Spach – reaches in Southern Transylvanian area the North-Eastern border of its distribution area. On the conglomerate hills it occurs on the open cliff phytocoenoses together with *Teucrium montanum*, *Thymus comosus*, but also in the Feathergrass (*Stipa pulcherrima*) and the *Sesleria heuffleriana* communities (Schneider-Binder, 1970, 1994). In the neighbouring sites north from the conglomerate hills on stony open area near Mohu the species denotes characteristic phytocoenoses included in the association Genisto spathulatae-Agrostietum coarctatae Schneider-Binder, 1975 (Schneider-Binder, 1975).

Figure 3: *Genista januensis* Viv. var. *spathulata* (Spach) Ciocârlan (photo Schneider Eckbert).

The habitat on rendzina soils of the conglomerate hills of Tălmaciu and Podu Olt has similarities with the described Dinaric habitats, occurring in company with species such as *Teucrium chamaedrys*, *Carex humilis*, *Anthericum ramosum*, *Hepatica nobilis*, *Geranium sanguineum* and *Epipactis atrorubens*, which are mentioned also in the Dinaric open Scots pine forest.

Worthy of mention from the biogeographical point of view is the xero-thermophilous species *Onosma heterophylla* Griseb. (= *O. viride* (Borb., Jáv.), a Balcanic flora element, occurring in the area on steep slopes of the locality named “On the stone” (“La Piatra”/“Zum Stein”). This rare species is characteristic of the open phytocoenoses of the association Seseli gracilis-Festucetum pallentis (Soó 1959) Coldea, 1991 (Syn. Festucetum pallentis transsilvanicum (Soó 1950; Gergely 1957) (Schneider-Binder, 1970, 1974).

For *Sesleria heuffleriana* Schur the conglomerate hills constitutes the *locus classicus*, from where this species was first described by Schur (1866). It is a Carpathian species with a predominantly peri-montane distribution (Meusel et al., 1965; Schneider-Binder, 1994), being strongly related to *Sesleria calcaria* from the Alps and Tatra mountains. Indeed, the species is considered to be a vicariant of *S. calcaria* (Deyl, 1946; Meusel et al., 1965). It identifies phytocoenoses included in the association Phleo montani-Seslerietum heufflerianae (Soó 1927) Coldea and Sârbu (2012), described for the conglomerate hills as Seslerietum heufflerianae austro-transsilvanicum Borza 1959 and Stipo-Seslerietum heufflerianae Schneider-Binder 1994.

On the steep slopes of the conglomerate hills in Feathergrass phytocoenoses (Stipetum pulcherrimae) occurs frequently *Iris aphylla* L. ssp. *hungarica*, a Euro-Asian-Continental flora element listed on Annexe II of the EU Habitats Directive.

The plant communities are disposed on the slopes along ecological gradients, being represented in Southern aspect by thermophilous oak forests on the top of the hills, and by tall herbaceous vegetation of Geranion sanguinei type on the edge of the forests in which occur frequently *Anthericum ramosum, Dianthus giganteus, Peucedanum oreoselinum* and *P. cervaria*, interlaced and in contact with shrub and tree vegetation represented by thermophilous species such as *Rhamnus tinctoria, Fraxinus ornus, Sorbus torminalis* and *Staphylea pinnata*. Only at one locality (Crăpătura) also occurs Steppe almond (*Amygdalus nana*), a Euro-Asiatic continental sylvosteppic bush. Different types of xero-thermophilous rocky grasslands form larger or smaller patches, the most representative being the Feathergrass communities identified by *Stipa pulcherrima*. These can be found at Podu Olt on the Piatra Chiorului and as well on the steep slopes of Măgura Boiţei. Characteristic for the area are also the communities of *Festuca pallens* and those of *Sesleria heuffleriana* (Schneider-Binder, 1994).

The plant communities (Schneider-Binder, 1970, 1976, 1994) existing in the area belongs partly to habitat types included in the Annex I (Schneider and Drăgulescu 2005; Doniţă et al., 2005) of the EU Habitats Directive and are of community interest as rare habitat types (EUR 27, 2007; Gafta and Montford, 2008). On Eastern, North-Western and South Western aspects, smaller stands of beech forests of the associations Galio kitaibeliani-Fagetum and Carpino-Fagetum occur.

Habitat types of community interest

40A0* Subcontinental peri-Pannonic scrub

In the area this habitat type is represented by two scrub communities which are of great phytogeographical interest and important for the European network of Natura 2000 habitats. These are on the one hand thermophilous scrubs (and trees) of the Submediterranean Manna or Flowering Ash Ash (*Fraxinus ornus*), which on the steep slopes of the conglomerate hills between Tălmaciu and Podu Olt, on the Piatra Chiorului and on the Măgura Boiţei (Wartberg), identifies characteristic phytoceonoses included in the association **Corno-Fraxinetum orni Pop and Hodişan,** 1964 (Schneider-Binder 2009). On the other hand small relict patches of the Euro-Asian continental Steppe Almond (*Prunus tenella*/*Amygdalus nana*) were found on the border of the "Crăpătura". They identify a characteristic association Prunetum tenellae Soó 1947 (syn.: Prunetum nanae Borza, 1931 **Amygdaletum nanae Soó** 1927 1959).

Manna Ash bushes on the conglomerate hills constitute the characteristic habitat for the Mediterranean Ash Cicada (*Cicada orni* Linné). The nymphs of the species are living on the roots of the ash over several years (observed, studied and monitored by

Mr. Schneider Eckbert). On other species bound to the dry sites with Manna ash of the Măgura Boiţei is the Nightjar (*Caprimulgus europaeus* L.). This bird species is breeding on open, stony areas between the ash bushes and constitutes a rare species for the area.

6110* Rupicolous calcareous or basophile grasslands of the Alysso-Sedion albi

Corresponding to the habitat number R3503 of the Romanian habitats (Doniţă et al., 2005).

Small patches of this habitat type occur in southern aspects on dry rendzinic soils with finer sized gravel on the so-called "Piatra" near Tălmaciu being represented by fragments of the phytocoenoses of the association Saxifrago tridactylitis-Poëtum compressae (Kreh 1951) Géhu and Leriq, 1957 (syn.: Sclerantho-Poëtum compressae Borza, 1959).

On the top of the hills of Piatra and on Bătătura occurs also on dry stony area phytocoenoses of the alliance Thero-Airion Oberd. 1957 represented by the association Filagini-Vulpietum Obrd. 1938 (Tălmaciu, Bătătura) (Schneider, 1975).

6190 Rupicolous Pannonic grasslands (Stipio pulcherrimae-Festucetalia pallentis)

The habitat type is represented in the area by characteristic associations of steep dry xeric slopes with extreme conditions of insolation. The phytocoenoses of the included association **Seseli gracilis-Festucetum pallentis** (Soó 1959) Coldea 1991 (Syn. Festucetum pallentis transsilvanicum Soó 1950) (Gergely, 1957) have their largest extent on the steep slopes of the "Piatra" near to Tălmaciu (Schneider-Binder, 1970, 1975). **Melico-Phleetum montani** Boşcaiu et al. 1966 was monitored with larger extend on the slopes of Piatra Chiorului near Podu-Olt (Schneider-Binder, 1970, 1975 and 2010 unpublished data). The phytocoenoses of the association **Phleo montani-Seslerietum heufflerianae (Soó 1927) Coldea and Sârbu, 2012** (Syn.: Helianthemo cani-Seslerietum heufflerianae Borza 1959) Popescu and Sanda (1992), Seslerietum heufflerianae austro-transsilvanicum Borza 1959, Stipo-Seslerietum heufflerianae Schneider-Binder (1995) is distributed on the Bătătura, Crăpătura and Piatra Chiorului as wall as on the slopes of Măgura Boiţei, where it is interlacing with coenoses of *Stipa pulcherrimae* on the one side and with the bushes of *Fraxinus ornus* in the other side; **Thymio comosi-Festucetum rupicolae** (Csürös and Gergely 1959) Pop and Hodişan 1985 (Syn. Festucetum sulcatae calcicofilum Csürös 1959) occurs on Piatra Chiorului and the coenoses of Feathergrass **Stipetum pulcherrimae calcicolum** Pop and Hodişan 1960 have a large extension on Măgura Boiţei with the characteristic species *Epipactis atrorubens* (unpublished field data) and as well on Piatra Chiorului (Schneider-Binder, 1970). The syntaxonomy of these phytocoenoses have to be clarified as they differ from those included newly under the name of ass. Violo joói-Stipetum eriocaulis (Pop and Hodişan, 1960) Coldea and Sârbu 2012.

6210* Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometea) (*important orchid sites)

This habitat type includes the natural and semi-natural dry grasslands on rendzina soils of the more or less steep slopes of the area. Included are the associations **Thymo comosi-Caricetum humilis** (Zólyomi 1931) Morariu and Danciu 1977 (Syn. Caricetum humilis transsilvanicum Zólyomi 1934) interlaced on Piatra Chiorului with the phytocoenoses of Feathergrass (*Stipa pulcherrima*) and those of Melico-Phleetum, **Brachypodio pinnati-Festucetum rupicolae** Ghişa 1962 occuring near Tălmaciu on the Bătătura; **Carici humilis-Brachypodietum pinnati** Soó 1947.

8120 Calcareous and calcaschist screes of the montane to alpine levels (*Thlaspietea rotundifolii*)

The habitat type is represented in the area only by phytocoenoses of the association **Thymo comosi-Galietum albi** Sanda and Popescu 1999 (syn.: Thymetum comosi Pop and Hodişan 1963, Galietum erecti Pop and Hodişan 1964, Teucrietum Montana Scyros 1958) as pioneer vegetation on open rendzinic soil. *Thymus comosus* is an endemic Carpathian species and occurs on the low mountain level on stony and dry area. On the conglomerate hills *Thymus comosus* frequently forms stands identified only by *Thymus comosus*, or together with *Teucrium montanum*.

8210 Calcareous rocky slopes with chasmophytic vegetation

Small rocky crevices with calcareous conglomerate components are the habitat of typical plant communities well adapted to extreme conditions. The phytocoenoses of these pioneer colonizers, which thanks to the steep slopes remain as a durable open community represents the associations **Asplenio-Cystopteridetum fragilis** Oberd. (1936) 1949 and **Asplenietum trichomanis-rutae-murariae** Kuhn 1937, Tüxen 1937/syn.: *Tortulo-Asplenietum* Tüxen 1937 (Schneider-Binder, 1976).

8230 Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*

The habitat type occurs in the studied area by small patches on open, dry, rounded conglomerate rocks, located on the uppermost part of the slopes. The communities with small degree of cover belong to the associations **Polytricho piliferi-Scleranthetum perennis** Moravec 1967 and **Vulpio-Airetum capillaris** Paucă 1941 described also as Filagini-Vulpietum Oberdorfer 1938 (Schneider-Binder, 1970).

9130 Asperulo-Fagetum beech forests

The habitat type includes different beech forests which in the area are represented by the association Galio kitaibeliani-Fagetum (Sanda et al., 1970) and Carpino-Fagetum Paucă 1941 praemoesicum Vida 1963. Representative and characteristic for the area are the species *Galium kitaibelianum* and *Galium bailonii*. Transition stages can be observed also to the Dacian oak-hornbeam forests (habitat type 91Y0) and the Moesian Silver lime woods (habitat type 91Z0).

91V0 Dacian Beech forests (Symphyto-Fagion)

Smaller stands of the area's beech forests can be considered to be part of the Dacian beech forests which include the association Pulmonario rubrae-Fagetum (Soó 1964) Täuber 1987 Symphyto cordati-Fagetum Vida 1959 and Phyllitidi-Fagetum Vida (1959) 1963. Characteristic stands of these associations are present in the study area.

91Y0 Dacian oak-hornbeam forests

The habitat of Sessile oak (*Quercus petraea*) and Hornbeam (*Carpinus betulus*) is well represented in the area by phytocoenoses of the association **Galio kitaibeliani-Carpinetum** Coldea and Pop, 1988, which includes in the tree layer, apart from *Quercus petraea* and *Carpinus betulus*, some thermophilous species such as *Sorbus torminalis, Tilia tomentosa*, in the shrub layer species such as *Rhamnus tinctoria, Staphylea pinnata*, and in the herb layer at high frequency species such as *Galium kitaibelianum, Melittis melisophyllum* and *Genista ovata*. Well represented in the area as well is the liane-like thermophilous *Dioscorea communis*, an Atlantic-Submediterranean species at the North-Eastern edge of its distribution. Similar phytocoenoses are mentioned from the Olt break valley (Ciurchea, 1966).

CONCLUSIONS

These studies demonstrate the complexity of the habitat conditions and the high biodiversity of species with different geographical origin and ecological requirements. The habitat types of community interest represented in the area as well are showing a high diversity, with changes of habitat types in relatively small area and overlapping of different habitat types in relation with soil conditions and conglomerate composition materials as well the size of the stones included. The conglomerate area presents apart from the European flora elements many Sub-mediterranean, Pontic, Balcanic and endemic elements which all together makes the area of great interest from the biogeographical point of view. Some of the Southern species are well represented along the Olt Valley and reach their limit on the Northern part of the Olt break-out valley in the area of the conglomerate hills of Tălmaciu and Podu Olt. Different studies on the distribution of these species shows, that the Olt Valley is an important point for species migration from south to North.

The basic data for a documentation to declare the conglomerate hills as a protected area i.e. a Natura 2000 site, have been realised with the complex systematic and ecological above mentioned studies. The flora list including Red List species and species as well as important habitats listed in the Annexes of the EU Habitats Directive, underlines the importance of the area. Due to its geomorphological structures with very steep slopes, a basic protection is partly assured. But the protection of the whole area including the plateau and its forests, the slopes with the vegetation disposed along ecological gradients from forests, through scrub to thermophilous fringes and open rocky steppe areas, as well as the foot of the hills, where human intervention occurs, needs more attention from the point of view of nature conservation. More attention is also required for the surrounding area which has to act as a buffer zone to safeguard the conglomerates area with its high conservation value.

ACKNOWLEDGEMENTS

Thanks to Mr. Weiß I. and Mr. Schneider E. for joint field research interesting activities and also for many fruitful discussions concerning the biogeographical importance of this specific area.

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AUTHOR:
[1] *Erika SCHNEIDER-BINDER*
erika.schneider@partner.kit.edu, erika.schb@t-online.de
KIT – University of Land Baden-Württemberg,
National Research Centre of the Helmholtz Society,
Institute for Geography and Geoecology,
Division WWF-Institute for floodplains ecology,
Josefstrasse 1, Rastatt,
Germany, D-76437.

Annex I

Alphabetical checklist for the flora of the conglomerate hills based on own observations and research activities

Acer campestre L., P, Eur, Aceraceae
Acer platanoides L., P, Eur, Aceraceae
Achillea collina J. Becker, H, Eur-cont, Asteraceae
Achillea distans Willd., H, Alp-Carp-Balc, Asteraceae
Achillea millefolium L., H, Euras (Eua), Asteraceae
Acinos arvensis (Lam.) Dandy (*Calamintha acinos* (L.) Clairv.), T-Ht, Eur, Lamiaceae
Actaea spicata L., G, Euras, Ranunculaceae
Adoxa moschatellina L., G, Circ, Adoxaceae
Aegopodium podagraria L., H (G), Euras, Apiaceae
Agrostis capillaris L. (*Agrostis tenuis* Sibth.), H (G), Circ, Poaceae
Agrostis stolonifera L. ssp. stolonifera, H, Circ (Cp)
A. vinealis Schreber (*Agrostis coarctata* Ehrh.), H, Euras, Poaceae
Ajuga genevensis L., H, Euras, Lamiaceae
Ajuga reptans L., H, Eur, Lamiaceae
Alliaria petiolata (M. Bieb.) Cavara and Grande (*Alliaria officinalis* Andrz.), Ht-H, Euras, Brassicaceae
Allium flavum L. ssp. *flavum*, G, Ec-Submedit, Alliaceae
Allium lusitanicum Lam. (*Allium senescens* L. ssp. *montanum* (Pohl) Holub; *A. montanum* Schmidt), G, Ec-Submedit (mont), Alliaceae
Alyssum alyssoides L., T-Ht., Euras Cont (Eua-Ct), Brassicaceae
Anchusa officinalis L., H (Ht), Cont-(Eastmed); Podu Olt, Cetate, Boraginaceae
Anemone nemorosa L., G, Circ, Ranunculaceae
Anemone ranunculoides L., G, Eur, Ranunculaceae
Anthemis tinctoria L., H, Euras-Cont-Smed (Oberdorder, 2001), Asteraceae
Anthericum ramosum L., H, Ec (moderate Cont-Smed), Liliaceae
Anthoxanthum odoratum L., H, Euras, Poaceae
Anthriscus sylvestris (L.) Hoffm., Ht-H, Euras, Apiaceae
Anthriscus cerefolium (L.) Hoffm. ssp. *trichosperma* (Schult.) Arcang., T, Pont-Medit, Apiaceae
Anthyllis vulneraria L., H, Eur, Fabaceae
Aposeris foetida (L.) Less., H, Ec, Asteraceae
Arctium tomentosum Miller, Ht, Euras, Asteraceae
Arenaria serpyllifolia L., T, Circ, Caryophyllaceae
Arrhenatherum elatius (L.) Beauv. ex J. and Presl, H, Euras (Subatl-Smed, acc. to Oberdorfer, 2001), Poaceae
Artemisia campestris L., Ch, Cont Euras, Asteraceae
Artemisia vulgaris L., H, Circ, Asteraceae
Asarum europaeum L., H, Euras, Aristolochiaceae
Asperula cynanchica L., H, Ec-Medit, Rubiaceae
Asperula tenella Heuffel ex Degen in A. Kerner, H, Pont-Balc, Rubiaceae
Asplenium ruta-muraria L., H, Euras, Polypodiaceae
Asplenium scolopendrium L. (*Phyllitis scolopendrium* (L.) Newman), G, Circ, Polypodiaceae
Asplenium trichomanes L., H, Cosm, Polypodiaceae
Aster amellus L., H, Cont Eur, Asteraceae
Astragalus cicer L., H, Eua-Cont, Fabaceae
Astragalus glycyphyllos L., H, Euras-Smed, Fabaceae
Astragalus monspessulanus L., H, Pont-Med, Fabaceae
Astragalus onobrychis L., H, Euras-Cont, Fabaceae
Athyrium filix-femina (L.) Roth, H, Cosm, Polypodiaceae
Ballota nigra L., H, Ec, Lamiaceae
Betula pendula Roth (*Betula verrucosa* Ehrh.), Ph, Eua, Betulaceae
Botriochloa ischaemum (L.) Keng (*Andropogon ischaemum* L., *Dichanthium ischaemum* (L.) Roberty), H, Euras (Submedit), Poaceae
Brachypodium pinnatum (L.) Beauv., H, Euras (Cont), Poaceae
Brachypodium sylvaticum (Hudson) Beauv., H, Euras, Poaceae
Briza media L., H, Euras, Poaceae
Bromus inermis Leysser, H, Cont-Euras, Poaceae
Bromus hordeaceus L. (*Bromus mollis* L.), T-Ht, Euras (Submedit), Poaceae

Bromus sterilis L., T, Euras (Submedit), Poaceae
Bruckenthalia spiculifolia (Salisb.) Reichenb., Ph (Ch), Carp-Balc, Ericaceae
Buglossoides purpurocaerulea (L.) I. M. Johnston (*Lithospermum purpurocaeruleum* L.), H-G, Ec-Submed, Boraginaceae
Bupleurum falcatum L., H, Alp Eur, Apiaceae
Calamagrostis arundinacea (L.) Roth, H, Cont Euras, Poaceae
Campanula abietina Griseb. (*Campanula abietina* Grisebach and Schenk), H, Carp-Balc, Campanulaceae
Campanula cervicaria L., Ht, Cont Euras, Campanulaceae
Campanula moravica (Spitzner) Kovanda, (*Campanula rotundifolia* L. var. *stricta* Schum.), H, Circ, Campanulaceae
Campanula patula L., Ht, Eur, Campanulaceae
Campanula persicifolia L., H, Euras, Campanulaceae
Campanula rapunculoides L., H, Euras, Campanulaceae
Campanula sibirica L., H, Eua-Ct, Campanulaceae
Campanula trachelium L., H, Euras, Campanulaceae
Cardamine impatiens L., Ht, Euras, Brassicaceae
Cardaminopsis arenosa (L.) Hayek, T-Ht, H, Ec, Brassicaceae
Carex caryophyllea Latourr, G, Euras (Submedit), Cyperaceae
Carex digitata L., H, Euras, Cyperaceae
Carex distans L., H, Euras (Subatl-Submedit), Cyperaceae
Carex divulsa Stokes, var. *guestphalica* (Boenn) F. Schultz, H, Circ, Cyperaceae
Carex humilis Leysser, H, Eua-Ct, Cyperaceae
Carex michelii Host, H, Ec, Cyperaceae
Carex montana L. (f. *emarginata* Schur), H, Cont Euras, Cyperaceae
Carex ovalis Good. (*Carex leporina* L.), H, Circ, Cyperaceae
Carex pairei F. W. Schultz, H, Eur, Cyperaceae
Carex pallescens L., H, Circ, Cyperaceae
Carex remota L., H, Circ bor, Cyperaceae
Carex *spicata* Huds., H, Circ, Cyperaceae
Carex *sylvatica* Huds., H, Circ, Cyperaceae
Carex *tomentosa* L., G, Euras, Cyperaceae
Carex vulpina L., H, Euras, Cyperaceae
Carlina biebersteinii Bernh. ex Hornem., Ht, Ec (Mont), Asteraceae
Carlina vulgaris L., Ht, Euras, Asteraceae
Carpinus betulus L., Ph, Ec, Corylaceae
Centaurea phrygia L. ssp. *indurata* (Janka) Stoj. and Acht. (*Centaurea indurata* Janka), H, Dac, Asteraceae
Centaurea scabiosa L. ssp. *scabiosa* H, Eur, ssp. *spinulosa* (Spreng.) Arcang (Rochel) Dostál (*Centaurea spinulosa* Spreng.), H, Ec-SE, Asteraceae
Centaurea stoebe L. ssp. *australis* (A. Kern.) Greuter (C. *biebersteinii* DC.), *Centaurea micranthos* (Griseb.) Hayek, Ht-H, Pont-Pan-Balc, Asteraceae
Centaurium erythraea Rafín. ssp. *erythraea* (C. *umbellatum* auct.) T-Ht, Med, Gentianaceae
Cephalanthera longifollia (L.) Fritsch (*Cephalanthera longifolia* (Huds.) Fritsch), G, Eur, Orchidaceae
Cephalanthera rubra (L.). L. C. Rich., G, Eur, Orchidaceae
Cephalaria uralensis (Murr.) Roem. and Schult., H, Pont.-Balc, Dipscacaceae
Cerastium holosteoides Fries (*C. caespitosum* Gilib.), H-Ch, Cosm, Caryophyllaceae
Cerastium semidecandrum L., T, Eur, Caryophyllaceae
Chaerophyllum temulum L., H, Ec-S, Apiaceae
Chelidonium majus L., H, Euras, Dealul Cetăţii (Landskrone), Papaveraceae
Cichorium intybus L., H, Euras, Asteraceae
Circaea lutetiana L., G, Euras-Medit, Onagraceae
Cirsium pannonicum (L. f.) Lk., H, Pont-Pan, Asteraceae
Clematis recta L., H, Ec, Ranunculaceae
Clematis vitalba L., Ph (liana), Ec, Ranunculaceae
Clinopodium vulgare L. (*Calamintha vulgaris* (L.) Halácsy, *Calamintha clinopodium* Bentham), H, Circ, Lamiaceae
Conium maculatum L. (Cetate/Landskrone), Ht, Euras, Apiaceae
Convallaria majalis L., G, Eur, Liliaceae
Cornus sanguinea L., Ph, Ec, Cornaceae
Coronilla varia L., H, Ec-Submedit, Fabaceae
Corylus avellana L., Ph, Eur, Corylaceae
Crataegus monogyna Jacq., Ph, Eua, Rosaceae

Crataegus pentagyna Waldst. and Kit., Ph, Pont-Pan-Balc, Rosaceae
Crepis praemorsa (L.) F. W. Walther, H, Euras Cont, Asteraceae
Crocus banaticus Gay, G, Subend (Carp). (Cetate Hill), Iridaceae
Cruciata glabra (L.) Ehrend. (*Galium vernum* Scop.), H, Euras, Rubiaceae
Cypripedium calceolus L., G, Euras, Orchidaceae
Cytisus albus (Hacq.) Rothm. (*Chamaecytisus albus* (Hacq.) Rothm.), Ph, Pont-Pan-Balc, var. *pallidus* (Schrad.) Grnt., Fabaceae
Cytisus austriacus L. (*Chamaecytisus austriacus* (L.) Link), Ph, Pont-Pan-Balc, Fabaceae
Cytisus hirsutus L. ssp. *hirsutus* (*C. hirsutissimus* K. Koch, (*Chamaecytisus hirsutus* (L.) Link, ssp. *hirsutus* (L.) Link), Ph, Ec, Fabaceae
Cytisus hirsutus L. ssp. *leucotrichus* (Schur) A. and D. Löve (= *Cytisus leucotrichus* Schur), Ph, Balc-Pan, Fabaceae
Cystopteris fragilis (L.) Bernh., H, Cosm, Polypodiaceae
Cytisus nigricans L. (*Lembotropis nigricans* (L.) Griseb.), Ph, Ec-SE, Fabaceae
Dactylis polygama Horvátovszky, (*Dactylis aschersoniana* Graebner), H, Ec, Poaceae
Dactylis glomerata L., H, Eua, Poaceae
Dactylorhiza maculata (L.) Soó (*Orchis maculata* L.), G, ssp. *transsilvanica* (Schur) Soó, G, Ec-SE, Orchidaceae
Dactylorhiza maculata (L.) Soó ssp. *schurii* (Klinge) Soó (*Dactylorhiza maculata* ssp. *elodes* (Griseb.) Soó, G, End Carp, Orchidaceae
Danthonia decumbens (L.) DC (*Sieglingia decumbens* (L.) Bernh.), H, Eur, Poaceae
Daucus carota L., H, Eua, Apiaceae
Cardamine bulbifera (L.) Crantz, (*Dentaria bulbifera* L.), G, Ec, Brassicaceae
Deschampsia flexuosa (L.) Trin., H, Circ, Poaceae
Dianthus armeria L., T, Eur, Caryophyllaceae
Dianthus carthusianorum L., H, Eur, Caryophyllaceae
Dianthus giganteus D'Urv. ssp. *giganteus*, H, Dac-Balc, Caryophyllaceae
Dictamnus albus L., ssp. *albus*, H, Ec-Med, Rutaceae
Digitalis grandiflora Miller, H, Ec, Scrophulariaceae
Dioscorea communis (L.) Caddick and Wilkin (*Tamus communis* L.), G, Atl-Submedit, Dioscoreaceae
Diplotaxis muralis (L.) D. C., T-H, Ec-Med, Brassicaceae
Dorycnium herbaceum Vill., Ch, Ec-EuSE, Fabaceae
Dryopteris filix mas (L.) Schott, H, Euras, Polypodiaceae
Echinops exaltatus Schrader (*E. commutatus* Jur.), H, Ec, Asteraceae
Elymus hispidus (Opiz) Melderis (*Elytrigia intermedia* (Host) Nevski, *Agropyron intermedium* (Host) Beauv.), G, Cont Euras, Poaceae
Elymus repens (L.) Gould. (*Elytrigia repens* (L.) Nevski), *Agropyron repens* (L.) Beauv.), G, Circ, Poaceae
Epilobium montanum L., H, Euras, Onagraceae
Epipactis atrorubens (Hoffm.) Besser, G, Euras, (Măgura Boiţei/Wartberg), Orchidaceae
Epipactis helleborine (L.) Crantz, G, Euras, Orchidaceae
Equisetum telmateia Ehrh. (E. *maximum* Lam.), G, Circ, Equisetaceae
Erigeron annuus (L.) Pers. ssp. *annuus* (*Stenactis annua* (L.) Less), T, Ht-H, Adv, Asteraceae
Erigeron annuus (L.) Pers ssp. *septentrionalis* (Fernald and Wiegand) Wagenitz *strigosus* (Mühl ex Willd) Wagenitz (*Stenactis ramosa* (Walter) Domin), T, Ht-H, Adv, Asteraceae
Eryngium campestre L., H, Pont-Med, Apiaceae
Erysimum odoratum Ehrh. (*E. pannonicum* Crantz), H, Pont, Brassicaceae
Erysimum virgatum Roth (*E. hieracifolium* Jusl.), Ht-H, Eur, Brassicaceae
Erythronium dens-canis L., G, Eur-Submedit
Euphorbia amygdaloides L., Ch, Ec-Subatl-Submed, Euphorbiaceae
Euphorbia angulata Jacq., H, Pont-Med, Euphorbiaceae
Euphorbia cyparissias L., H, Euras, Euphorbiaceae
Euphorbia platyhyllos L., T, Ec, Euphorbiaceae
Euphorbia epithymoides L (*E. polychroma* Kerner), H, Pan-Balc, Euphorbiaceae
Euphorbia salicifolia Host, H, Pont-Pan, Euphorbiaceae

Euphrasia stricta J. P. Wolff ex. J. F. Lehm, T, Eur, Scrophulariaceae
Evonymus europaeus L., Ph, Eur, Celastraceae
Fagus sylvatica L., Ph, Ec-Atl, Fagaceae
Fallopia dumetorum (L.) Holub. (*Polygonum dumetorum* L.), T, Circ (Cetate Hill, Landskrone)
Ferulago sylvatica (Bess.) Rchb., H, Pont-Med, Apiaceae
Festuca arundinacea Schreb., H, Ec, Poaceae
Festuca drymeja Mert. and Koch, H, Ec-EuSE, Poaceae
Festuca gigantea (L.) Vill., H, Euras, Poaceae
Festuca heterophylla Lam., H, Ec-Submed, Poaceae
Festuca pallens Host, H, Ec (Mont), Poaceae
Festuca pratensis L., H, Euras, Poaceae
Festuca rubra L., H, Circ, Poaceae
Festuca valesiaca Schleich ex Gaudin, H, Ct-Eua, (incl. var. *banatica* (Deg.) Beldie), Poaceae
Festuca stricta Host ssp. *sulcata* (*F. sulcata* (Hack) Nyman, *F. rupicola* Heuff.), H, Ct-Eua, Poaceae
Filago arvensis L., T, S-Euras, Asteraceae
Fragaria vesca L., H, Eua, Rosaceae
Fragaria viridis L. (*F. collina* Ehrh.), H, Eua, Rosaceae
Fraxinus excelsior L., Ph, Eur, Oleaceae
Fraxinus ornus L., Ph, Submed, Oleaceae
Galanthus nivalis L., G, Ec-Submed (Cetate Hill)
Galeopsis speciosa Miller, T, Euras, Lamiaceae
Galium album Mill. ssp. *album* (*Galium mollugo* L. ssp. *erectum* Syme), H, Eur, Rubiaceae
Galium bailloni Brândza (*G. valantioides* Bieb. var *baillonii* (Brândză) Paucă and E. I. Nyár.), Ch, End S Carp, Rubiaceae
Galium mollugo L., H, Euras, Rubiaceae
Galium lucidum All. (*G. mollugo* ssp. *erectum* (Hudson) Briq.), H, Ec-Medit, Rubiaceae
Galium glaucum L. (*Asperula glauca* (L.) Bess.), H, Ec-Submedit, Rubiaceae
Galium kitaibelianum Roem. and Schult. Schultes and Schultes fil., H, Carp-Balc, Rubiaceae
Galium odoratum (L.) Scop. (*Asperula odorata* L.), G, Med-Euras, Rubiaceae
Galium schultesii Vest, G, Ec, Rubiaceae
Galium verum L., H, Euras, Rubiaceae
Genista germanica L., Ch, Ec, Fabaceae
Genista januensis Viv. var. *spathulata* (Spach) Ciocârlan (*Genista spathulata* Spach), Ch, Apen-Balc-Dac, Fabaceae
Genista ovata W. and K., Ch, Ec EuSE, East-Medit (Oberdorfer, 2001), Fabaceae
Genista tinctoria L., Ch, Eur, Fabaceae
Genista sagittalis L., (*Genistella sagittalis* (L.) Gams), Ch, Atl-Ec-Med, Fabaceae
Geranium dissectum L., T, Euras, Geraniaceae
Geranium phaeum L., H, Ec, Geraniaceae
Geranium pratense L., H, Euras-Ct, Geraniaceae
Geranium pussilum L.,T, Eur, Geraniaceae
Geranium robertianum L., T-Ht, Cosm, Geraniaceae
Geranium sanguineum L., H, Eur, Cont-Smed, Geraniaceae
Geum urbanum L., H, Circ, Rosaceae
Glechoma hederacea L., H (Ch), Euras, Lamiaceae
Glechoma hirsuta Waldst. and Kit., H (Ch), Pont-Medit-Ec, Lamiaceae
Glyceria nemoralis (Uechtr.) Uechtr. and Koernicke, H, Ec, Poaceae
Gymnadenia conopsea (L.) R. Br., G, Eur, Orchidaceae
Gypsophila muralis L., T, Eua, Caryophyllaceae
Helianthemum canum (L.) Homem., Ch, Atl-Med, Cistaceae
Helianthemum hirsutum (Thuill.) Mérat., Cistaceae
Helianthemum hirsutum var. *grandiflorum* (Scop) Schinz and Thell
Helianthemum nummularium (L.) Miller, ssp. *nummularium*, Ch, Eur, Cistaceae
Helianthemum nummularium (L.) Miller ssp. *obscurum* (Celak.) Holub (*H. hirsutum* (Thuill.) Mérat), *H. obscurum* Pers., Ch, Ec, Cistaceae
Helianthemum nummularium (L.) Miller ssp. *grandiflorum* (Scop.) Schinz and Thell.
Helianthemum grandiflorum (Scop.) Lam., Ch, Eur Alp, Cistaceae
Helleborus purpurascens Waldst. and Kit., H, Carp-Balc-Pan, Ranunculaceae
Hepatica nobilis Schreber, H, Circ, Ranunculaceae
Heracleum sphondylium L., Ht-H, Eua, Apiaceae
Hieracium murorum L., H, Eur, Asteraceae

Hieracium racemosum W. and K. f. *eriocalycinum* (Hausskn.) Nyár., H, Ec-EuSE, Asteraceae
Hieracium umbellatum L., H, Circ, Asteraceae.
Hierochloe australis (Schhrad.) R. and Schult., H, Ec, Poaceae
Holcus lanatus L., H, Cosm, Poaceae
Humulus lupulus L., H, Eua, Cannabaceae
Hypericum maculatum Crantz, H, Euras, Hypericaceae
Hypericum perforatum L., H, Med-Euras, Hypericaceae
Hypericum richeri Vill., ssp. *transsilvanicum* (Celak.) Ciocârlan (*Hypericum transsilvanicum* Celak.), End. E. and S. Carp, Hypericaceae
Hypochaeris maculata L., H, Euras, Asteraceae
Inula conyza D.C., H, Ec, Asteraceae
Inula ensifolia L., H, Pont-Pan-Balc, Asteraceae
Inula hirta L., H, Euras-Ct (incl. var. *oblongifolia* Beck), Asteraceae
Iris aphylla L. (*I. hungarica* W. and K.), G, Eur-Ct, Iridaceae
Iris ruthenica Ker.-Gawl., G, Euras-Ct, Iridaceae
Isopyrum thalictroides L., H, Ec, Ranunculaceae
Juglans regia L., Ph, subspontaneous, Ec-Balc-Cauc, Juglandaceae
Juncus compressus Jacq., G, Euras, Juncaceae
Juncus tenuis Willd., G, Adv (N Am), Juncaceae
Jurinea glycacantha (Sm.) DC (*J. mollis* (L.) Rchb. ssp. *macrocalathia* (K. Koch) Soó), H, Balc-Pan, Asteraceae
Jurinea mollis (L.) Reichenb., H, Pan-Balc, Asteraceae
Kengia serotina (L.) Packer (*Cleistogenes serotina* (L.) Keng., *Diplachne serotina* (L.) Link), G, Ec-Medit, Poaceae
Knautia arvensis (L.) Coulter, H, Eur, Dipsacaceae
Koeleria macrantha (Ledeb.) Schultes (*K. gracilis* Pers. nom illegit.), H, Circ, Poaceae
Petrorhagia prolifera (L.) P. W. Ball and Heywood (*Kohlrauscjia prolifera* (L.) Kunth, *Tunica prolifera* (L.) Scop.), T, Atl-Med, Caryophyllaceae
Lamium album L., H, Euras, Lamiaceae
Lamium maculatum L., H (Ch), Euras, Lamiaceae
Lapsana communis L., T-H, Euras, Asteraceae
Laserpitium latifolium L., H, Eur (Mont), Apiaceae
Lathyrus niger (L.) Bernh., G, Ec, Fabaceae
Lathyrus pannonicus (Jacq.) Garcke (*Lathyrus lacteus* (M. Bieb.) E. D. Wissjul. var. *versicolor* auct. p.p., *Lathyrus versicolor* auct.), H, Ec, Fabaceae
Lathyrus sylvestris L. var. *platyphyllus* (Retz) Aschers., H, Eur, Fabaceae
Lathyrus tuberosus L., H, Euras, Fabaceae
Lathyrus venetus (Mill.) Wohlf., G, Pont-Medit, Fabaceae
Lathyrus vernus (L.) Bernh., G, Euras, Fabaceae
Leontodon crispus Vill. ssp. *crispus* (*L. asper* (W. and K.) Poir., non Froskal), H, Cont Euras, Asteraceae
Leontodon autumnalis L., H, Euras, Asteraceae
Leontodon hispidus L., H, Euras, Asteraceae
Leonurus cardiaca L., H, Euras, Asteraceae
Leucanthemum vulgare Lam., (*Chrysanthemum leucanthemum* L.), H, Euras (Euras-Subozean acc. to Oberdorfer, 2002), Asteraceae
Ligustrum vulgare L., Ph, Eur (Submed), Oleaceae
Lilium martagon L., G, Euras, Liliaceae
Linaria genistifolia (L.) Miller, H, Cont-Euras, Scrophulariaceae
Linaria vulgaris Miller, H, Euras, Scrophulariaceae
Linum flavum L., H, Pont-Pan-Balc, Linaceae
Listera ovata (L) R. Br., G, Euras, Orchidaceae
Lonicera caprifolium L., Ph, Submedit, Caprifoliaceae
Lotus corniculatus L., H, Euras, Fabaceae
Luzula campestris (L.) Lam. and D.C., H, Circ, Juncaceae
Luzula luzuloides (Lam.) Dandy and Willmott, H, Ec, Juncaceae
Lychnis viscaria L. (*Viscaria vulgaris* Bernh.), Ch (H), Euras, Caryophyllaceae
Lysimachia nummularia L., Ch, Euras, Primulaceae
Lysimachia vulgaris L., H, Euras, Primulaceae
Maianthemum bifolium (L.) F. W. Schmidt, G, Euras, Liliaceae
Malus sylvestris (L.) Mill., Ph, Eur, Rosaceae

Tripleurospermum inodorum (L.) Sch. Bip. (*M. inodora* L., *Matricaria perforata* Mérat), T-Ht, Euras, Asteraceae
Medicago falcata L., H, Eua, Fabaceae
Medicago lupulina L., T-H, Eua, Fabaceae
Medicago minima (L.) L., T, Submedit, Fabaceae
Melampyrum bihariense A. Kerner, T, Dac, Scrophulariaceae
Melampyrum nemorosum L., T, Ec, Scrophulariaceae
Melampyrum sylvaticum L., T, Euras, Scrophulariaceae
Melica ciliata L. ssp. ciliata, H, Ec-Med, var. flavescens Schur, Poaceae
Melica uniflora Retz, H, Centr Eu-Submed, Poaceae
Melilotus albus Medik., Ht, Euras, Fabaceae
Melilotus officinalis Lam., Ht, Euras, Fabaceae
Melittis melissophyllum L., H, Ec, Lamiaceae
Mercurialis perennis L., G (H), Euphorbiaceae
Milium effusum L., H, Circ, Poaceae
Moehringia trinervia (L.) Clairv., T-H, Eua, Caryophyllaceae
Molinia caerulea (L.) Moench., H, Euras, Poaceae
Monotropa hipopitys L., G, Circ, Pyrolaceae
Mycelis muralis (L.) Dumort, (*Cicerbita muralis* (L.) Wallr.), H, Eur, Subatl-Smed (Oberdorfer, 2002)
Myosotis scorpioides L. (*M. palustris* (L.) hill), H, Euras, Boraginaceae
Nardus stricta L., H, Euras (Circ), Poaceae
Neottia nidus avis (L.) Rich., G, Euras, Orchidaceae
Oenothera biennis L., Ht, Adv (N. America), Onagraceae
Onobrychis viciaefolia Scop., H, Eua, Fabaceae
Onopordon acanthium L., Ht, Euras, Asteraceae
Onosma heterophylla Griseb. *O. viride* (Borb.) Jáv., H, Balc, Boraginaceae, La Piatra
Orobanche teucrii Holandre, G, Ec, Orobanchaceae
Oxalis acetosella L., H (G), Circ, Oxalidaceae
Oxytropis pilosa (L.) D.C., H, Eua-Cont, Fabaceae
Pastinaca sativa L. ssp. *pratensis* (Pers.) Celak., Ht, Euras, Apiaceae
Peucedanum carvifolium Vill., H, Ec (Ciocârlan, 2009), Ec Smed (Oberdorfer, 2002), Apiaceae
Peucedanum cervaria (L.) Lapeyr., H, Eu-Ct, Apiaceae
Peucedanum oreoselinum (L.) Moench, H, Eu-Ct, Apiaceae
Phleum montanum C. Koch, H, Carp-Balc-Cauc-Anat, Poaceae
Pilosella cymosa (L.) F. W. Schultz and Sch.-Bip. (*Hieracium cymosum* L.), H, Euras-Ct, Asteraceae
Pilosella officinarum Vaill. (*Hieracium pilosella* L.), H, Euras, Asteraceae
Pilosella piloselloides (Vill.) Sojak ssp. *bauhinii* (Schult.) S. Bräutigam and Greuter (*Hieracium bauhinii*, Besser), H, Eu-Ec, Asteraceae
Pimpinella major (L.) Hudson, H, Eu, Apiaceae
Pimpinella saxifraga L., H, Euras (Submed), Apiaceae
Pinus sylvestris L., Ph, Cult Euras
Plantago altissima L., H, Balc-Pan
Plantago lanceolata L., H, Euras, Plantaginaceae
Plantago major L., H, Euras, Plantaginaceae
Plantago media L., H, Euras, Plantaginaceae
Platanthera bifolia (L.) L. C. M. Richard, G, Euras, Orchidaceae
Poa angustifolia L. (*P. pratensis* L. ssp. *angustifolia* (L.) Gaudin), H, Euras, Poaceae
Poa annua L., T-H, Cosm, Poaceae
Poa compressa L., H, Euras-Ct, Poaceae
Poa nemoralis L., H, Circ, Poaceae
Poa palustris L., H, Circ, Poaceae
Poa pratensis L., H, Circ (Cosm), Poaceae
Poa trivialis L., H, Euras, Poaceae
Polygala comosa Schkuhr, H, Eur, Polygalaceae
Polygala major Jacq., H, P-Med, Polygalaceae
Polygala vulgaris L., H (Ch), Eur, Polygalaceae
Polygonum aviculare L., T, Cosm, Polygonaceae
Polygonum hydropiper L., T, Circ, Polygonaceae
Polygonum lapathifolium L., T, Cosm, Polygonaceae
Polypodium vulgare L., G, Circ, Polypodiaceae
Populus tremula L., Ph, Euras, Salicaceae
Portulaca oleracea L., T, Cosm, Portulacaceae

Potentilla argentea L., H, Eua, Rosaceae
Potentilla erecta (L.) Raeusch, H, Eua, Rosaceae
Potentilla heptaphylla L. (*P. rubens* (Crantz) Zimmeter, non Vill.), H , Eur Cont, Rosaceae
Potentilla cinerea Chaix ex Vill. (*Potentilla arenaria* Borkh.), H, Eur, Rosaceae
Primula veris L., H, Euras, ssp. *veris*
Primula veris L. ssp.*columnae* (Ten.) Lüdi (*Primula columnae* Ten.), H, Medit, Primulaceae
Prunella grandiflora (L.) Jacq., H, Eur, Lamiaceae
Prunella laciniata (L.) L., H, Ec-Med, Lamiaceae
Prunella vulgaris L., H, Cosm, Lamiaceae
Prunus tenella Batsch (*Amygdalus nana* L.), Ph, Euras-Cont, Rosaceae
Prunus avium (L.) L. (*Cerasus avium* (L.) Moench), Ph, Submed, Rosaceae
Prunus spinosa L., Ph, Eur, Rosaceae
Pteridium aquilinum (L.) Kuhn, G, Cosm, Polypodiaceae
Pulmonaria officinalis L., H, Eur, Boraginaceae
Pulmonaria rubra Schott, H, Carp-Balc, Boraginaceae
Pulsatilla montana (Hoppe) Rchb., H, Eur, Ranunculaceae
Pyrus pyraster (L.) Burgsd., Ph, Eur, Rosaceae
Quercus dalechampii Ten., Ph, Eur-Medit-Carp-Balc, Fagaceae
Quercus petraea (Matt.) Liebl., Ph, Eur, Fagaceae
Quercus polycarpa Schur, Ph, Carp-Balc-Cauc, Fagaceae
Quercus robur L., incl. var. glabra (Godr.) Schwz, Ph, Eur, Fagaceae
Ranunculus acris L., H, Eua, Ranunculaceae
Ranunculus auricomus L., H, Eua, Ranunculaceae
Ranunculus ficaria L., H, Eua, Ranunculaceae
Ranunculus polyanthemos L., H, Eur, Ranunculaceae
Ranunculus repens L., H, Eua, Ranunculaceae
Rhamnus catharticus L., Ph, Eua, Rhamnaceae
Rhamnus saxatilis Jacq. ssp. *tinctorius* (W. and K.) Nyman (*Rh. tinctoria* W. and K.) Ph, Ec-Medit, Rhamnaceae
Rhinanthus alectorolophus (Scop.) Pollich (*R. major* L. nom. Ambig.), T, Euras, Scrophulariaceae
Rhinanthus minor L., T, Euras
Rhinanthus rumelicus Velen., T, Pont-Pan-Balc
Robinia pseudoacacia L., Ph, Adv, Fabaceae
Rosa canina L., Ph, Eur, Rosaceae
Rosa micrantha Borrer ex Sm., Ph, Ec-Sud, Rosaceae
Rosa spinosissima L. (*Rosa pimpinellifolia*) L., Ph, Euras, Rosaceae
Rubus caesius L., N, Ph, Eur, Rosaceae
Rumex acetosa L., H, Cosm, Polygonaceae
Rumex acetosella L., H, Eur, Polygonaceae
Rumex sanguineus L., H, Eur, Polygonaceae
Salix caprea L., Ph, Euras, Salicaceae
Salix purpurea L., Ph, Euras, Salicaceae
Salvia glutinosa L., H, Euras (Mont), Lamiaceae
Salvia pratensis L., H, Eur-Submed, Lamiaceae
Salvia verticillata L., H, Ec-Medit, Lamiaceae
Sambucus ebulus L., H, Euras (Submedit), Caprifoliaceae
Sambus nigra L., Ph, Eur, Caprifoliaceae
Sanicula europaea L., H, Euras, Apiaceae
Saponaria officinalis L., H, Eua, Caryophylaceae
Saxifraga tridactylites L., T, Euras, Saxifragaceae
Scabiosa columbaria L. ssp. *columbaria*, H, Eur, Dipsacaceae
Scabiosa ochroleuca L., Ht-H, Euras-Ct, and var. *polymorpha* (Baumg.) Simk., Dipsacaceae
Scilla bifolia L., G, Ec-EurSE, Liliaceae
Scleranthus perennis L., H, Eur, Caryophyllaceae
Scleranthus uncinatus Schur, T, Carp-Balc-Cauc-Anat, Caryophyllaceae
Sedum acre L., Ch, Eua, Crassulaceae
Sedum album L., Ch, Eua, Crassulaceae
Sedum telephium L. ssp. *maximum* (L.) Krock., H, Eur, Crassulaceae
Selaginella helvetica (L.) Spring., Ch, Euras, Selaginellaceae
Senecio ovatus (Gaertner et al.) Willd. (*S. fuchsii* Gmel.), H, Ec-Submed, Asteraceae
Senecio jacobaea L., H, Euras, Asteraceae
S. nemorensis L. ssp. jaquinianus (Rchb.) Celak. (Senecio germanicus Wallr.), H, Euras-Submedit, Asteraceae
Solidago virga-aurea L., H, Circ, Asteraceae

Seseli annuum L., Ht-H, Eur-Ct, Apiaceae
Seseli libanotis (L.) W. D. J. Koch (*Libanotis montana* Crantz), Ht-H, Euras-Ct, var. *major* Hagenb., Apiaceae
Seseli libanotis (L.) Koch ssp. *intermedium* (Rupr.) P. W. Ball (*Seseli libanotis* subsp. *sibiricum* Thell. p.p. non *S. sibiricum* (L.) Garcke), H, Pont-Centr-Eu, Apiaceae
Seseli pallasii Besser (*S. varium* Trevir), Ht-H, Pont-Pan-Balc, Apiaceae
Sesleria heuffleriana Schur, H, End Carp, Poaceae
Setaria viridis (L.) Beauv., T, Euras Cosm, Poaceae
Silene armeria L., T-Ht, Ec, Caryophyllaceae
Silene bupleuroides L. (*Silene longiflora* Ehrh.), H, Pont-Ec-Med, Caryophyllaceae
Silene nutans L. ssp. *dubia* Herb. (*Silene dubia* Herb), H, End Carp, Caryophyllaceae
Silene viridiflora L., H, Ec, Caryophyllaceae
Silene vulgaris (Mnch.) Garcke, H, Eua, Caryophyllaceae
Sorbus torminalis (L.) Crantz, Ph, Eur, Rosaceae
Stachys germanica L., H, Pont-Med, Lamiaceae
Stachys officinalis (L.) Trev. (*Betonica officinalis* L.), H, Euras, Lamiaceae
Stachys recta L., H, Pont-Medit-Ec, Lamiaceae
Stachys sylvatica L., H, Euras, Lamiaceae
Staphylea pinnata L., Ph, Ec-South Eur, Staphyleaceae
Stellaria graminea L., H, Eua, Caryophyllaceae
Stellaria holostea L., H, Eua, Caryophyllaceae
Stellaria media (L.) Vill., T-Ht, Cosm, Caryophyllaceae
Stipa pulcherrima C. Koch, H, Ec-Medit, Poaceae
Succisa pratensis Mnch., H, Euras, Dipscacaceae
Symphytum tuberosum L., ssp. *nodosum* (Schur) Soó, H, Ec-SE, Boraginaceae
Tanacetum corymbosum (L.) Sch. Bip. (*Chrysanthemum corymbosum* L.), H, Euras (Sârbu et al., 2013), Smed-Euras (Oberdorfer, 2002), Asteraceae
Taraxacum officinale Weber ex Wiggers, E, Euras, Asteraceae
Teucrium chamaedrys L., Ch, Ec-Submedit, Lamiaceae
Teucrium montanum L., Ch, Ec-Submedit, Lamiaceae
Thesium linophyllon L., H, Ec, Santalaceae
Thymus comosus Heuff. ex Griseb. and Schenk incl. f. *transsilvanicus* Schur, Ch, End Rom Carp, Lamiaceae
Thymus pannonicus All. (*Th. marschallianus* Willd.), Ch, Pont-Pan, Lamiaceae
Thymus pulegioides L., *Th. pulegioides* ssp. *montanus* (Waldst. and Kit.) Ronniger, Ch, Eur (Mont), Lamiaceae
Tilia cordata Miller, Ph, Eur, Tiliaceae
Tilia platyphyllos Scop., Ph, Ec, Tiliaceae
Tilia tomentosa Mnch., Ph, Balc-Pan, Tiliaceae
Torilis arvensis (Huds.) Lk., T, Ec, Apiaceae
Torilis japonica (Houtt.) DC (*T. rubella* Moench.) Apiaceae
Tragopogon dubius Scop., T-Ht, Ec-Medit, Asteraceae
Tragopogon pratensis L. ssp. *orientalis* (L.) Celak. (*T. orientalis* L.), Ht-H, Ec and East
Trifolium aureum Pollich (= *T. strepens* Crantz), T-H, Eur, Fabaceae
Trifolium alpestre L., H, Ec-EuSE, Fabaceae
Trifolium arvense L., T, Eur, Fabaceae
Trifolium campestre Schreb., T, Eur, Fabaceae
Trifolium hybridum L., H, Atl-Eur, Fabaceae
Trifolium medium L. var. *typicum* A. and G. f. *eriocalycinum* (Hausskn.) Nyár., H, Euras, Fabaceae
Trifolium montanum L., H, Eua-Cont, Fabaceae
Trifolium medium L. var. *typicum* A. and G. f. *eriocalycinum* (Hausskn.) Nyár., H, Euras, Fabaceae
Trifolium ochroleucon Huds., H, Ec, Fabaceae
Trifolium pannonicum Jacq., H, Pont-Med, Fabaceae
Trifolium pratense L., H, Eua, Fabaceae
Trifolium repens L., H, Eua, Fabaceae
Ulmus glabra Hudson (*Ulmus montana* With., *Ulmus scabra* Mill.), Ph, Eua, Ulmaceae
Urtica dioica L., H, Cosm, Urticaceae
Valeriana officinalis L., H, Euras (submedit), Valerianaceae
Verbascum lychnitis L., Ht, Eur, Scrophulariaceae
Verbascum phoeniceum L., H, Euras-Ct, Scrophulariaceae

Veronica chamaedrys L., H-Ch, Euras, Scrophulariaceae
Veronica officinalis L., Ch, Euras, Scrophulariaceae
Veronica spicata L., H, Cont-Euras, Scrophulariaceae
Veronica teucrium L., Ct-Euras, Scrophulariaceae
Veronica urticifolia Jacq., H, Ec-Submedit (mont), Scrophulariaceae
Viburnum opulus L., Ph, Circ, Caprifoliaceae
Vicia angustifolia L., T, Eua, Fabaceae
Vicia cracca L., H, Eua, Fabaceae
Vicia hirsuta (L.) Gray (*V. dumetorum* L.), T, Eua, Fabaceae
Vicia tetrasperma (L.) Schreb., T, Eua, Fabaceae
Vincetoxicum hirundinaria Medikus, (*Cynanchum vincetoxicum* (L.) Pers.), H, Euras-Cont, Asclepiadaceae
Viola alba Bess., H, Ec (Submedit), Violaceae
Viola ambigua W. and K., H, Pont-Pan, Violaceae
Viola canina L., H, Eua, Violaceae
Viola collina Besser, H, Euras, Violaceae
Viola hirta L., H, Euras, Violaceae
Viola reichenbachiana Jordan ex Boreau (*V. sylvestris* Lam.), H, Euras, Violaceae
Vulpia myuros (L.) Gmel., T, Ht, Euras (Cosm), Poaceae
Xeranthemum annuum L., T, Pont-Medit, Asteraceae

CLIMATIC INFLUENCE ON SOME GRAPES VARIETY IN ALBA VINEYARD (TRANSYLVANIA, ROMANIA)

Letiţia OPREAN [1]

KEYWORDS: Alba Vineyard, global heat balance, active heat balance, Transylvania, Romania.

ABSTRACT

This scientific paper aims to analyse important data regarding the climatic framework of the Alba Vineyard through a three-year monitoring of the climatic parameters which contribute to intensifying grape flavours and the accumulation of substantial quantities of carbohydrates.

To this end, a series of parameters were calculated, such as: average annual temperature, global heat balance, annual heat balance, thermic balance in the growth cycle, useful heat balance and useful heat balance during the growth cycle.

The analysed data showed that the year 2013 was the best in regard to the quantity and quality of grapes in the Alba Vineyard, as climatic conditions were most favourable.

REZUMAT: Influenţe climatice asupra unor soiuri de struguri în Podgoria Alba (Transilvania, România).

Prezenta lucrare științifică își propune să analizeze date importante privind elemente de climă al Podgoriei Alba, prin monitorizarea pe o perioadă de trei ani a parametrilor climatici ce concură la potențarea aromelor în struguri și la acumularea de cantități substanțiale de carbohidrați.

În acest scop, au fost considerați o serie de parametri precum: temperatura medie anuală, bilanțul termic global, bilanțul termic anual, bilanțul termic în perioada de vegetație, bilanțul termic util și bilanțul termic util în perioada de vegetație.

Din datele analizate reiese că anul 2013 a fost cel mai benefic în ceea ce privește cantitatea și calitatea strugurilor din Podgoria Alba, condițiile climatice fiind din cele mai favorabile.

ZUSAMMENFASSUNG: Klimatische Einflüsse auf einige Rebsorten in den Weinbergen von Alba Iulia (Transylanien, Rumänien).

Die vorliegende Arbeit, hat zum Ziel, die für die Weinberge von Alba wichtigen Daten betreffend die ökologischen und Hanglage bedingten Klimaelemente zu analysieren und zwar anhand eines dreijährigen Monitorings der Klimaparameter, die zur Verstärkung des Aromas in den Weintrauben sowie die Speicherung bedeutender Mengen von Kohlenhydraten beitragen.

Zu diesem Zweck wurde eine Reihe von Parametern berechnet so wie: durchschnittliche Jahrestemperatur, globale Wärmebilanz, die jährliche Wärmebilanz, die thermische Bilanz während der Vegetationsperiode, die nutzbare Wärmebilanz sowie die nutzbare Wärmebilanz während der Vegetationsperiode.

Aus den analysierten Daten geht hervor, dass das Jahr 2013, das beste bezüglich Menge und Qualität der Weintrauben aus den Weinbergsanlagen von Alba war, da die Klimabedingungen sich am günstigsten erwiesen.

INTRODUCTION

A vineyard is a complex ecosystem, resulting from the association of several biotic and abiotic elements, i.e. soil, climatic conditions, plants (variety and rootstock) and the decisive factor, man (Cotea et al., 1985; Cotea et al., 2010; Tița, 2004). Man contributes to manufacturing superior wines to the same extent as soil, climate and variety (Tița et al., 2006; Pomohaci, 2001).

The Alba Vineyard is situated in the center of Romania (Fig. 1), on the terraces, slopes and glacis on the banks of the Mureș River, near the confluence with Ampoi River (Curtean-Bănăduc et al., 2001). These plantations are situated in at the 46°00' (Vinţu de Jos) and 46°14' (Stremţ) North parallels, as Alba Iulia is situated at the intersection of the 46°04' North latitude parallel with the 23°35' East longitude meridian (Popa et al., 2010; Cotea et al., 2003).

This consists of the Trascău Hills to the West and the Secașelor hills to the East, separated by the Mureș River. Here, we can also find the extensions of the Trascău Hills descending from 600-500 metres to 400-300 metres: the extensions have reduced slopes, wide valleys and are hilly.

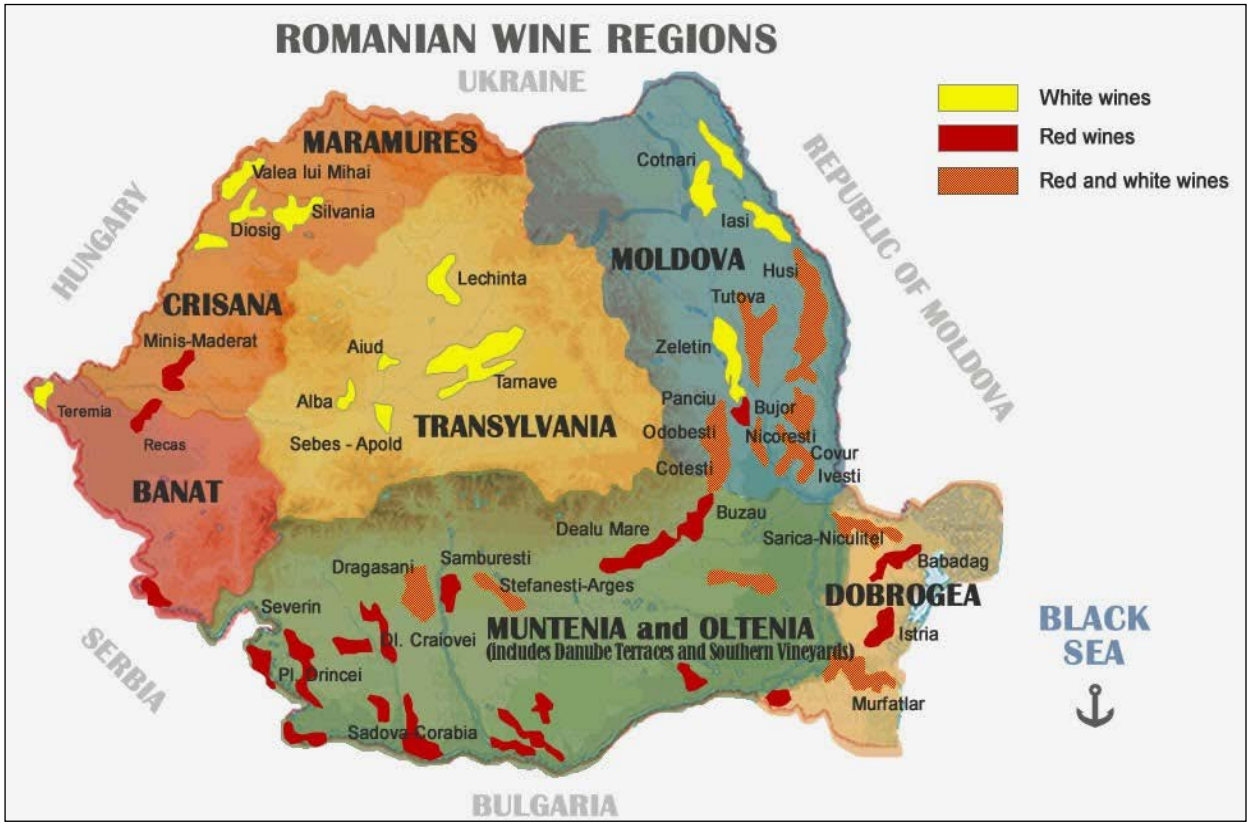

Figure 1: Romanian wine regions (http://vinpenet.blogspot.ro/2014/03/regiunile-viticole-ale-romaniei.html).

The creeks which spring from the Trascău Mountains and the Târnava and Sebeș Rivers flow into the Mureș River. The groundwater in the area provides enough water to cover the grapevines' needs, even though volumes vary over time.

The general climate is moderate continental, with cold winters and relatively warm and humid summers; continued by warm, long autumns lasting until October – favourable for grape ripening. The mist at the end of summer is prolonged until October – November, as a specific fact of the area. This climate is very favourable for the slow ripening of the grapes, as they accumulate a lot of flavours while the medium temperatures are 23°C during the day, which results in an increased content of sugars and constant acidity (Cotea et al., 2006; Pop, 2003; Ţârdea, 2007).

MATERIAL AND METHODS

A series of specific indicators were used in order to characterise the eco-climatic conditions in the experimental period: average annual temperature (Fig. 2), global heat balance (GHB), active heat balance (AHB), and useful heat balance (UHB). During the active growth cycle, the grapevines are much less resistant to low temperatures than during winter season: harmful thresholds differ: – 0.1°C for the tender vines tipes, – 0.2°C for green grapes and adult leaves and 5°C for ripe grapes.

RESULTS AND DISCUSSION

Global heat balance is calculated by adding average temperatures above 0°C. In figure 3, we can see that in the eco-climatic conditions in Alba Vineyard, the global heat balance was 3,798.5°C in 2011, 3,535.2°C in 2012 and 3,902.7°C in 2013. There is an average difference of 200°C between the three years studied. It can be explained through a prolonged autumn and through temperatures over 0°C for a longer period of time.

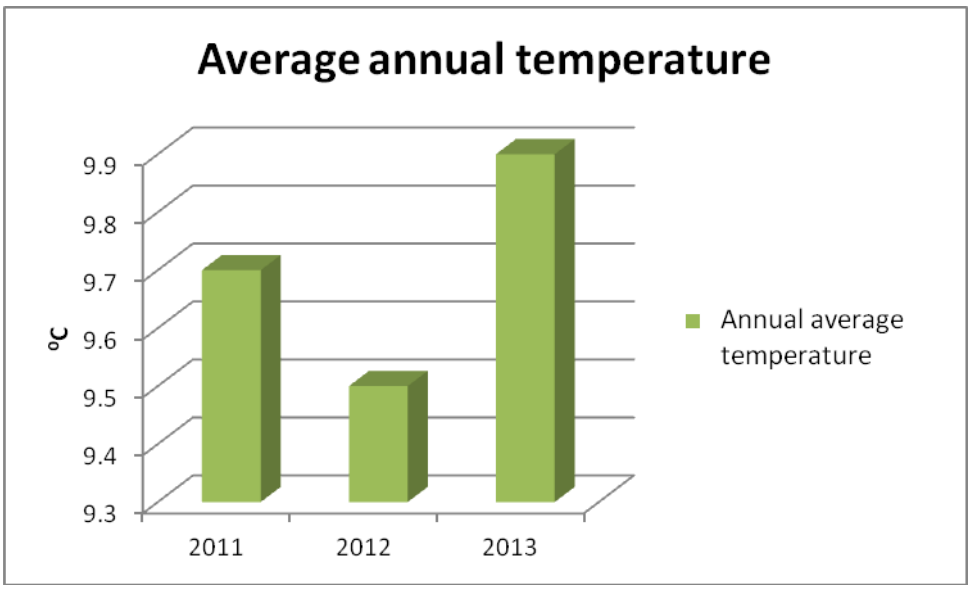

Figure 2: Annual average temperature calculated in the Alba Vineyard in 2011, 2012 and 2013.

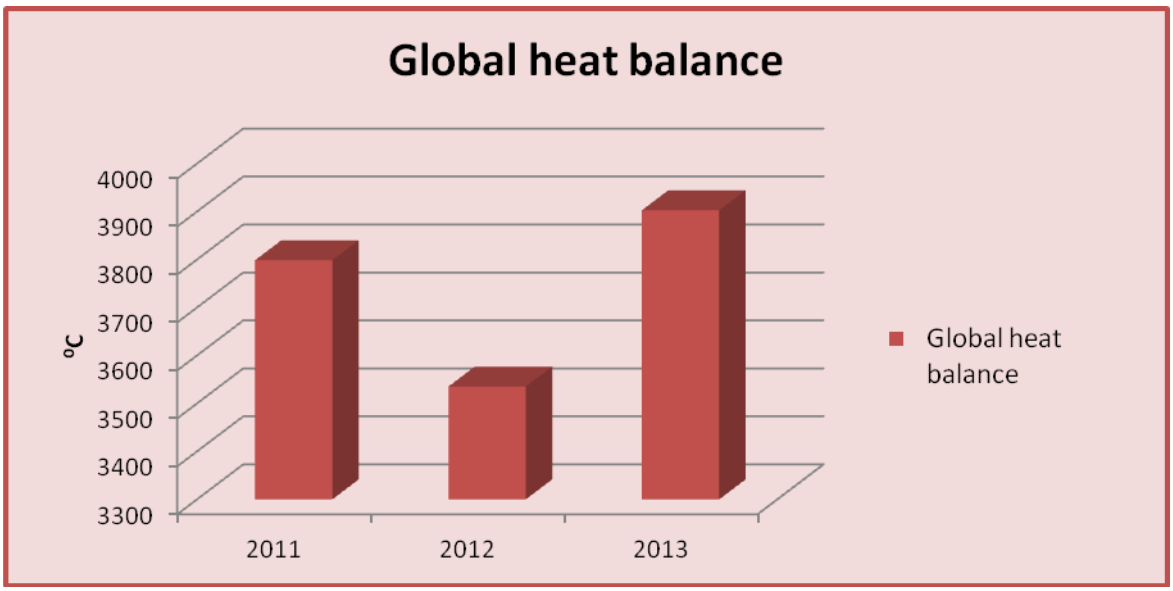

Figure 3: Global heat balance calculated in the Alba Vineyard for the years 2011, 2012, 2013.

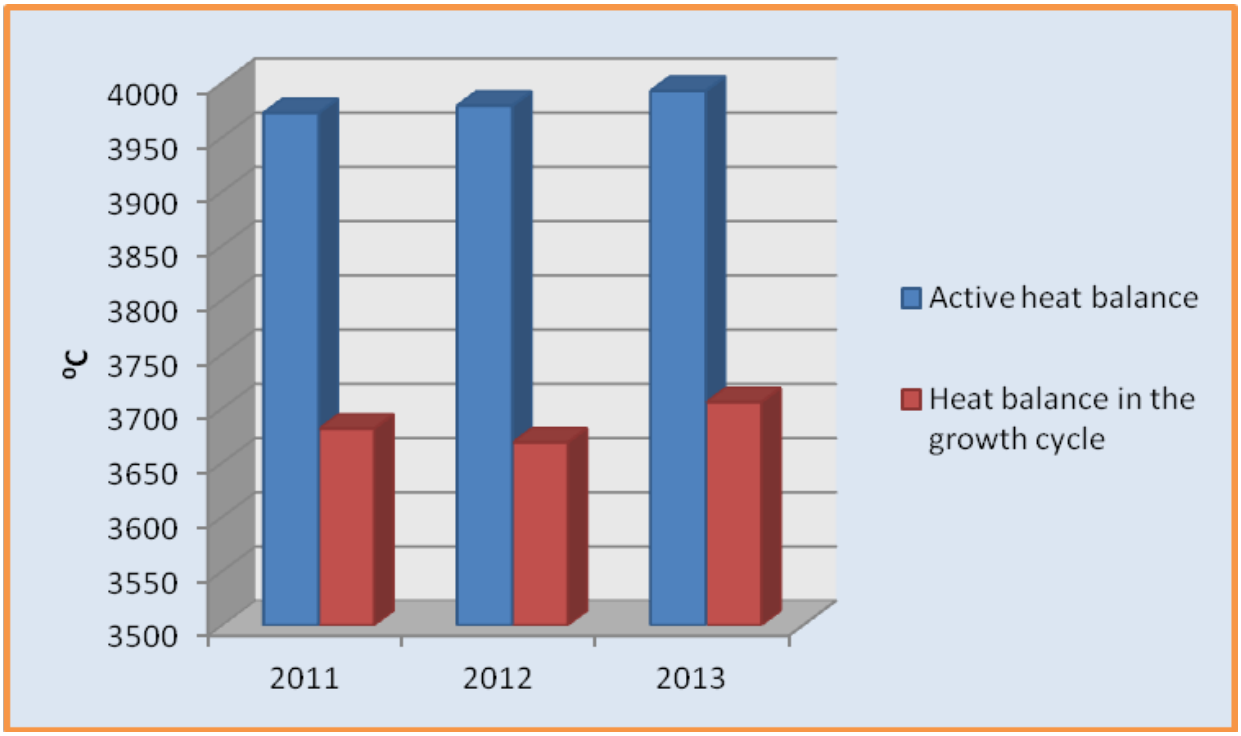

Figure 4: Active heat balance calculated in the Alba Vineyard for the years 2011, 2012, 2013.

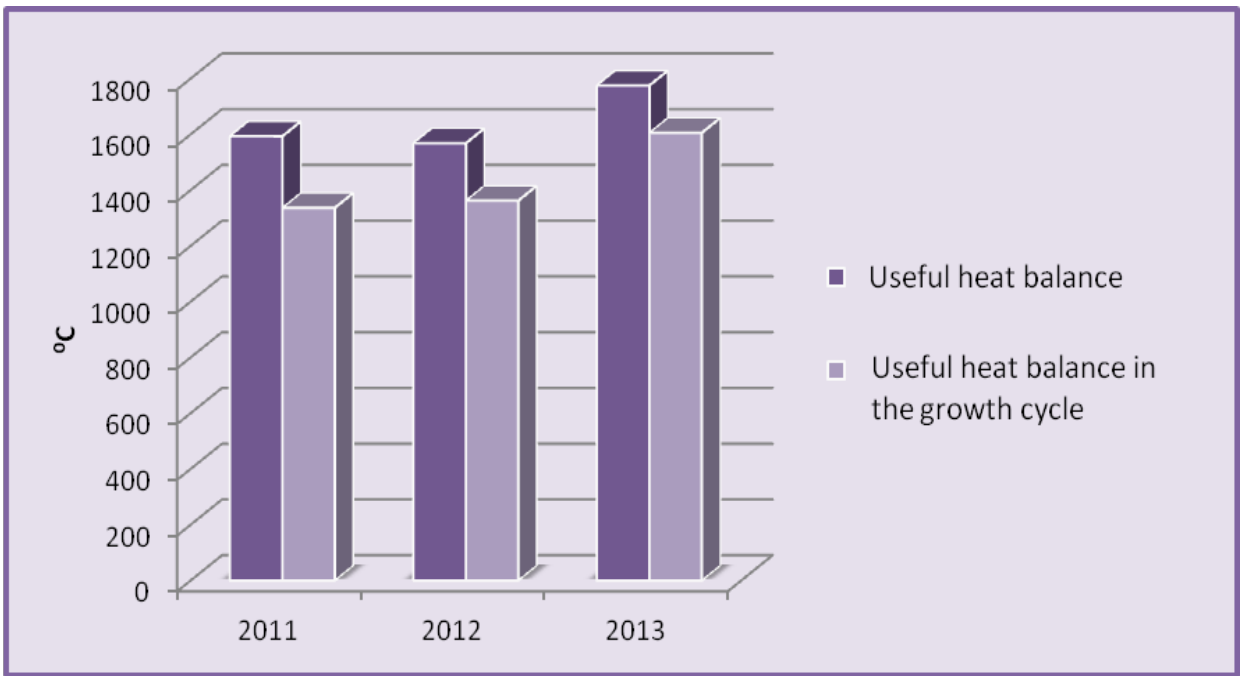

Figure 5: Useful heat balance calculated in the Alba Vineyard for the years 2011, 2012, 2013.

The active heat balance results from adding average daytime temperatures higher than 10°C, which are considered the biological thresholds of grapevine growth (Fig. 4). The lowest biological threshold for biological processes to be triggered in grapevines is over 10°C. Temperatures of 30-36°C represent the upper limit, which cause leaves to wilt.

In 2011, the active heat balance was 3,972.5°C, 3,681.4°C in the growth cycle; lower than in 2012 when the active heat balance was 3,979.1°C, 3,668.7°C in the growth cycle. In 2013, the active heat balance was 3,992.9°C, 3,705.8°C in the growth cycle, this value being 4.5% lower than in 2012.

The useful (efficient) heat balance results from adding average daytime temperatures from which the biological threshold temperature of 10°C (t-10°C) had been subtracted. Figure 5 shows that in 2011 the annual value of useful heat balance was 1,593.2°C, with a value of 1,336.5°C in the growth cycle. In 2012, the sum of annual useful temperatures was 1,568.3°C and 1,362.4°C in the growth cycle. In 2013, the useful heat balance was 1,775.4°C and 1,605.7°C in the growth cycle. We can notice that the year 2012 has the lowest heat balance; it is close to that of 2011, but 11.3 lower than – 2013.

We also established the sugar concentrations in the grapes harvested during the three years under monitoring. The results are as follows:

2011 – total sugars: 197-221g/l;
2012 – total sugars: 182-212g/l;
2013 – total sugars: 198-239g/l.

CONCLUSIONS

The vital process of grapevines takes place under the influence of heat. Each phenomenon is conditioned by a temperature optimum which can be higher or lower, and the phenomenon itself can determine certain physiological and biological thresholds.

During the three years monitored, annual average temperature oscillates by units due to warmer summers and colder winters.

Global heat balance, i.e. the sum of average temperatures higher than 0°C, differs from year to year; the highest was in 2013, which led to a bumper grape crop.

Active heat balance, which is important in the growth cycle, recorded close values during the three years; the most beneficial was that of 2013.

Due to a more balanced climate, slightly higher temperature, and a lack of precipitation at the beginning of autumn, the amount of sugar accumulated in grapes was extremely high in all three years, with minor oscillations, which led to a production of superior wines without the need of corrective interventions.

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AUTHOR:

Letiția OPREAN [1]
letitia.oprean@ulbsibiu.ro
"Lucian Blaga" University of Sibiu
Dr. Ioan Raţiu Street 7-9, Sibiu,
Sibiu County,
Romania,
RO-550012.

HELLENO-BALCANO-CARPATHIAN SILICEOUS CLIFF VEGETATION IN THE SOUTHERN CARPATHIANS

Constantin DRĂGULESCU [1] and *Erika SCHNEIDER-BINDER* [2]

KEYWORDS: rock crevices, pioneer colonisation, chasmophyte vegetation, relict species, regional habitat subtype, vegetation, Silenion lerchenfeldianae, Romanian South-Carpathians.

ABSTRACT

The habitat type of Community Interest 8220 *Siliceous rocky slopes with chasmophytic vegetation* presents many regional sub-types, among them the Helleno-Balcano-Carpathian subtype that includes the plant communities of the Carpathian-Balcanic alliance Silenion lerchenfeldianae Simon 1957. The associations belonging to this alliance are presented with their characteristic species, their distribution area and their ecological requirements. Research results of the authors are presented and discussed in comparison with data published by other authors from the Southern Carpathian area resulting as well in a synthetic table with the associations included in the alliance Silenion lerchenfeldianae, regional subtype of the habitat type 8220 with relevance for the European Natura 2000 network.

REZUMAT: Vegetaţia casmofitică eleno-balcano-carpatică a stâncăriilor silicatice din Carpaţii Meridionali.

Tipul de habitat de importanţă comunitară 8220 *Versanţi stâncoşi silicatici cu vegetaţie casmofitică* prezintă câteva subtipuri regionale între care şi subtipul eleno-balcano-carpatic reprezentat prin alianţa Silenion lerchenfeldianae Simon 1957, având un areal carpato-balcanic. Asociaţiile cuprinse în această alianţă sunt descrise cu speciile lor caracteristice, cu aria de răspândire, precum şi cerinţele lor ecologice. Rezultatele cercetărilor sunt prezentate şi discutate în comparaţie cu informaţiile publicate de alţi autori din Carpaţii Meridionali, sintetizate într-un tabel al asociaţiilor alianţei Silenion lerchenfeldianae, subtip regional al habitatului 8220 relevant pentru reţeaua europeană Natura 2000.

ZUSAMMENFASSUNG: Die Helenisch-Balkanisch-Karpatische Vegetation der Silikatfelsspalten in den SüdKarpaten.

Der Lebensraumtyp von gemeinschaftlichem Interesse 8220 Silikatfelsen und ihre Felsspaltenvegetation umfasst eine Reihe regionaler Sub-Typen zu denen auch der Helenisch-Balkanisch-Karpatische Subtypus gehört, der durch den karpatisch-balkanischen Verband Silenion lerchenfeldianae Simon 1957 vertreten ist. Die Gesellschaften dieses Verbandes werden mit ihren charakteristischen Arten, ihrem Verbreitungsareal und ihren ökologischen Ansprüchen vorgestellt. Die Untersuchungen werden mit denen von anderen Autoren aus den Südkarpaten veröffentlichten Daten verglichen und in einer synthetischen tabelle der Gesellschaften des Silenion lerchenfeldianae Verbandes zusammengefasst, Sub-Typus des Lebensraumtyps 8220, der für das Natura 2000 Netzwerk von Bedeutung ist.

INTRODUCTION

The habitat type 8220 Siliceous rocky slopes with chasmophytic vegetation, including European rocky habitats with "vegetation of fissures of siliceous inland cliffs with many regional subtypes", is represented in the Carpathians area by the regional subtype 62.25 Helleno-Carpathian-Balcanic siliceous cliff vegetation of the alliance Silenion lerchenfeldianae (EUR 28, 2013; Gafta and Mountford, 2008) with a known distribution in the Southern Carpathians area. Characteristic for this habitat subtype is firstly the name-giving species of the alliance Silene lerchenfeldiana Baumg., a Carpathian-Balcan species of rock crevices distributed in the Southern Carpathians of Romania, also the Rila (Horvat et al., 1937) and Pirin mountains (Simon, 1958) of Bulgaria, extending south into northern Greece. Besides *S. lerchenfeldiana* should be mentioned as characteristic for the Helleno-Balcano-Carpathians subtype of the siliceous rocky fissure habitat type – which is congruent with the alliance Silenion lerchenfeldianae – the species *Symphyandra wanneri, Silene dinarica, Potentilla haynaldiana, Saxifraga pedemontana* ssp. *cymosa, Senecio glaberrimus, Jovibarba (Sempervivum) heuffelii, Veronica bachofenii, Dianthus henteri.* To these species should be added *Saxifraga juniperifolia* ssp. *juniperifolia (Saxifraga pseudosancta), Minuartia bulgarica, Haberlea rhodopensis* and *Carex kitaibeliana (Carex laevis)* for Bulgaria (EUR 28, 2013).

Communities included in this alliance are mostly characteristic of the siliceous rock crevices of the montane to the alpine levels, colonising rocks of various gradients and aspects. If crevices are on vertical cliff-faces, without possibilities for a larger accumulation of soil particles and organic matter, they form open communities of high stability, remaining in the state of a durable pioneer vegetation with species well adapted to extreme ecological conditions. In the case of rock crevices on rocks with various slope gradients and possibilities for evolution of skeletal soils, the pioneer communities are developing to grassland communities of small rock belts identified at the alpine level mostly by *Juncus trifidus, Festuca supina* and other rock colonisers. Due to the geographical position, the geomorphology and related climatic conditions, as well as the phytohistorical evolution of the area, some specific Carpathian aspects of the alliance Silenion lerchenfeldianae are emerging.

Considering the particularities of this type of rock crevices vegetation the aim of this paper is to present the Silenion lerchenfeldianae alliance, based on our older and recent research data, to analyse the data in comparison with other published data concerning the alliance in the Carpathian area, and to discuss the different units and regional communities.

MATERIAL AND METHODS

This study is based on observations, field researches and sampling over a longer period of time, complemented by new research in recent years. All the samples together allows an analysis and synthetic view of the different sampled phytocoenoses identified by *Silene lerchenfeldiana, Symphyandra wanneri, Silene dinarica* and other characteristic or differential species for regional units of the communities and for the alliance Silenion lerchenfeldianae. Field samples were taken following the method of Braun-Blanquet (1964) and included in phytocoenological tables with indication of site conditions, degree of cover, number of species in each sample, and locality. The nomenclature used for the species is given according to Oprea (2005) and Sârbu et al. (2013).

The characteristic species of the alliance and the associations are presented with their distribution area in the Carpathians, including the field data of both authors, but also based on literature and plant collection data. The sign "!" indicates that the author observed these plants or

phytocoenoses in the location mentioned. For the overview of associations described, the tables from different authors are given with the number of samples and frequency classes. As well, the characteristic species of the alliance Silenion lerchenfeldianae are analysed from an ecological point of view using the indicator values of Humidity (U), Temperature (T) and pH/soil reaction (R) according to Sanda et al. (1983). The humidity indicator values (U) are: 1: xerophyte, 2: xero-mesophyte, 3: mesophyte, 4: meso-hygrophyte, 5: hygrophyte, 6: hydrophyte, 0 amphitolerant. The indicator values for temperature degrees (T) are: 1: hechistotherm (criophilous), 2: microtherm, 3: mesotherm, 4: moderate thermophilous, 5: thermophilous, 0 amphitolerant. The indicator values for the soil reaction/pH (R) are: 1 pronounced acidophilous species, 2: acidophilous species, 3: acido-neutrophilous species, 4: light acido-neutrophilous species, 5: neutron-basiphilous species, 0: euriionic plant species (amphitolerant). These indicator values gives a general orientation for the ecological requirements of the species, which are strongly related to the geomorphology, aspect, slope gradient and soil conditions as well as climate and microclimate conditions of the particular macro- and microhabitats.

RESULTS AND DISCUSSION

The characteristic species of Silenion lerchenfeldianae and their distribution in the Southern Carpathians.

The distribution area of *Silene lerchenfeldiana* Baumg., as a characteristic species of the Carpathian-Balcanic alliance of siliceous rock crevices *Silenion lerchenfeldianae* covers the siliceous rock massifs of the Southern Carpathians and mountains of Bulgaria (Guşuleac, 1953, Stoianov et al., 1966, 1967; Simon, 1958). In the Carpathians area the species is mentioned for rock crevices from the Făgăraş, Lotru, Parâng, Vâlcan, Retezat, Mehedinţi and Ţarcu-Godeanu mountains (Guşuleac, 1953).

At a detailed level it can be stated that the largest number of localities are mentioned from the Făgăraş Mountains. They are listed with literature and herbaria data for Sibiu County by Drăgulescu (2010) from Arpaş Mountains/Munţii Arpaş (Schur, 1866; Fuss, 1866; Simonkai, 1886; Tuzson, 1934; Herbarium of the Transylvanian Society of Natural Sciences/Sibiu), Bâlea Valley/Valea Bâlea on the Transfăgărăşan at 1,480 m altitude (Drăgulescu, 2010, !), Şerbota Valley (Puşcaru-Soroceanu, 1981), Avrigelului Valley (Schneider-Binder and Voik, 1976), Sărăţii Valley (Schneider-Binder and Voik, 1976; Puşcaru-Soroceanu, 1981; Herbarium Schneider-Binder), Arpaşu Peak (Guşuleac, 1953; Ungar, 1925), Bârcaciu Peak (Fuss, 1846; Simonkai, 1886; Fuss, 1866; Herbarium Fuss; Guşuleac, 1953), Berevoescu (Guşuleac, 1953), Negoiu Peak (Herbarium Schneider-Binder). Recent data about the distribution of *Silene lerchenfeldiana* in the Făgăraş Mountains on the Southern slope of the mountain crest, are mentioned from near to the Vidraru Lake i.e. the Buda – Râiosu mountains (Stancu sampling 2000, published 2005). South of the Făgăraş Mountains near to the Olt break Valley *Silene lerchenfeldiana* is reported from the Cozia Mountains (Guşuleac, 1953; Nyárády, 1955; Oprea, 2005).

For the Cindrel Mountains *Silene lerchenfeldiana* has to be considered a very rare species, being recorded from Mr. Grosu (Drăgulescu, 1980, 1995 and plant collection Drăgulescu in the Herbarium of the Botanical Institute of the University of Cluj-Napoca and Herbarium Drăgulescu at Museum of Natural Sciences Sibiu, !). At the same site var. *lotriensis* (Grec.) Borza has been found (Drăgulescu, 1995; Herbarium Drăgulescu at Museum of Natural Sciences Sibiu, !).

For the Lotru Mountains the species is mentioned from Boarneşu (Buia et al., 1963), Cataractele Lotrului (Drăgulescu, !, 2013, unpublished field data), Câlcescu (Buia et al., 1963 and obs. Schneider-Binder E., 1979), Dengheru-Cioara (Ploaie et al., 2004), Mogoşul (Buia et al., 1963), Mohorul

(Buia et al., 1963), Muntinu Mic (Buia et al., 1963), Găuri Mountain (Ploaie, 1999; Ploaie and Ionescu, 2011), Păpuşa 1,900 m (Pócs, 1961, 1962, 1967), Părăginosu (Buia et al., 1963), Voineasa (Grecescu, 1909; Drăgulescu, !); var. *lotriensis* (Grec.) Borza: Voineasa on V. Jidoaia (Grecescu, 1909; Guşuleac, 1953).

The species is recorded as well from the Parâng Mountains (Guşuleac, 1953; Coldea, 1991), Parâng/Badea rocks and Mândra circus (Simon and Pócs samples from 1956 published in 2012); Vulcan Mountains in the Jiu break valley at Lainici towards Vama Păiuşu on Ciocane (Guşuleac, 1953); Retezat Mountains: at Zănoaga Lake/Lacul Zănoaga and Piciorul Colţului (Guşuleac, 1953), Judelui Valley/Valea Judelui and Muchia Ascuţită (samples Boşcaiu et al., 1970; Boşcaiu et al., 1977), Laboratory house/Casa laborator Gemenele and cliff above Ana Lake/Lacul Ana (samples Boşcaiu et al., 1972; Boşcaiu, et al., 1977), Circus of Gemenele Lake (sample Drăgulescu, 1993); Mehedinţi Mountains: Bulzu Mountain on the Culmea Scăriţii and on the rocks named "Biserici" (Grecescu, 1898; Guşuleac, 1953); Ţarcu-Godeanu Mountains on Ţarcu and Baicu mountains (Guşuleac, 1953; Boşcaiu, 1971), Ţarcu (Jávorka, 1925; Prodan, 1939), Piga and Bulzu (Borza et al., 1967); Ţarcu-Godeanu (Beldie, 1967); Zeicu Mountain (Boşcaiu, Exs. Herbarium University of Cluj, leg. Boşcaiu, 1946), Baicu (leg. Boşcaiu 1946 Delectus Seminum Horti Botanici Cluj).

In Bulgaria *Silene lerchenfeldiana* is recorded from the Stara Planina, Vitosha, Rila, Osogovo and Pirin mountains, as well from the Western and Northern Rodopi Mountains (Stoianov et al., 1966).

The distribution of *Symphyandra wanneri* (Rochel) Heuffel, a Carpathian-Balcanic-Anatolian species (Boşcaiu, 1971), is mentioned in the Romanian flora from the Rodna Mountains (only locality in the Eastern Carpathians), Făgăraş, Parâng, Retezat, Ţarcu, Vulcan, Lotru and Cozia mountains (Ghişa, 1964), the main distribution area being in the Southern Carpathians. At a detailed level, for the Southern Carpathians comprehensive distribution data, including literature and herbaria data, are presented for mountains of Sibiu County (Drăgulescu, 2010) including a large part of the Făgăraş and Cindrel mountains and part of the Lotru Mountains. From the Făgăraş Mountains *Symphyandra wanneri* is known from Muchia Buteanu (Ghişa, 1964), Buteanu Peak (Fuss, 1866; Ungar, 1913; Drăgulescu, 2000; Herbarium Fuss at Museum of Natural Sciences Sibiu), Turnurile Podragului (Botsch, 1991), Arpaş Mountains/Munţii Arpaş (Schur, 1852, 1857; Simonkai, 1886; Ghişa, 1964; Schur, 1857), Arpaş Valley/Valea Arpaşu Mare (Herbarium G. A. Kayser, Museum of Natural Sciences Sibiu), Cârţişoarei Mountains (Ghişa/Flora R. P. R. 1964), Arpaşu Peak/Căldării Valley (Fuss, 1846; Negrean and Drăgulescu, 2005), Arpăşel (Drăgulescu, 1999, Herbarium Drăgulescu at Museum of Natural Sciences Sibiu, !), Căprăreasa (Fuss, 1866), Bâlea (Hayek, 1916; Tuzson, 1934; Ghişa, 1964/Flora R.P.R., Delectus seminum Horti Bot. Univ. Clujensis 1927, Drăgulescu 2000, !), V. Doamnei (Prodan, 1939; Ghişa, 1964), Glăjăria Cârţişoarei (Herbarium of the Transylvanian Society of Natural Sciences Sibiu), Negoiu Mountain (Herbarium Schneider-Binder), Sărăţii Valley (Schneider-Binder and Voik, 1976; Puşcaru-Soroceanu, 1981), Şerbota Valley (Puşcaru-Soroceanu, 1981), Negoiu Peak (Ungar, 1913; Herbarium Barth and Herbarium Ungar at Museum of Natural Sciences Sibiu), Suru Peak (Baumgarten, 1816; Fuss, 1846; Fuss, 1866; Ungar, 1913; Simonkai, 1886; Ghişa, 1964), Tătaru Peak (Ghişa, 1964).

In the Cindrel Mountains the species has been mentioned from the Cibin Gorge/Cheile Cibinului Ungar, 1913; Drăgulescu, 1995; Herbarium Heltmann, Ungar: Herbarium of the Flora of Păltiniş/Hohe Rinne, Drăgulescu own field observation and sampling, !, Caprei Hill (Fuss, 1846; Simonkai, 1886; Fuss, 1866; Ungar, 1913; Herbarium Fuss), Sadu Valley/Valea Sadului (Herbarium G. A.

Kayser at Museum of Natural Sciences Sibiu), Râu Sadului (Drăgulescu, 1995; Herbarium Drăgulescu at Museum of Natural Sciences Sibiu, !).

For Lotru Mountains *Symphyandra wanneri* is mentioned from Sădurel (Drăgulescu, 1995; Herbarium Drăgulescu at Museum of Natural Sciences Sibiu), dowstream the lake Oaşa (Drăgulescu, !), Căprăreţ Valley (Drăgulescu and Benedek, 2005; Herbarium Hermann Schobel, and field observations and sampling Drăgulescu), Lotrioara Valley/Valea Lotrioara (Drăgulescu, 1997, !), at Boarneşu (Buia et al., 1963), from Cataractele Lotrului (Drăgulescu, 2013; unpublished field data, !), Cheile Latoriţei (Drăgulescu, !), Cheile Rudăresei (Drăgulescu, !), amonte Ciungetu (Drăgulescu, !), Coasta lui Rusu 1,700 m (Pócs, 1961, 1962, 1967), Culmea Arsura south of Malaia (Drăgulescu, !), Dengheru-Cioara (Ploaie et al., 2004), Ciocanele Mountain (Grecescu, 1889; Guşuleac, 1953), Cârligele Mountain (Grecescu, 1898; Guşuleac, 1953), Latoriţei Muntains (Delectus seminum 1973), Jidoaia Valley, 1,200 m alt. (Drăgulescu, unpublished field data 2013), Voineşiţa Valley downstream the confluence with Jidoaia Valley (Drăgulescu unpublished field data, !).

In the Bulgarian flora, *Symphyandra wanneri* is mentioned from the Northern and Western part of the Stara Planina, Rila and Northern Rodopi (Smolijansko) Mountains. *Symphyandra wanneri* f. *wanneri* is mentioned from the Western Balkan, at Kom, Togorini kukli Midshur and cliffs at Belogradshik, *Symphyandra wanneri* f. *pumila* Stef. from Karlovski Balkan at Smolijansko and *Symphyandra wanneri* f. *hirsuta* from the Western part of the Rila Mountains, in particular the Valleys of the Rila and Urdina rivers (Stoianov et al., 1967).

Another characteristic species for the alliance Silenion lerchenfeldianae is the Carpathian-Balcanic species *Potentilla haynaldiana* Janka, mentioned from "siliceous rocks in the alpine region of Parâng Mountains between 1,600-2,150 m" and in Mehedinţi Mountains at Gaura Mohorului (Guşuleac, 1956). In Bulgaria the species is mentioned from the Northern and Western Stara Planina, from Rila Mountains, Western and Northern Rodopi Mountains, Osogova and Pirin mountains (Stoianov et al., 1966).

Compared to the above-mentioned species of the alliance Silenion lerchenfeldianae, all Carpathian-Balcanic elements, *Silene dinarica* Spreng., an endemic element of Southern Carpathians has a restricted area in the central part of Făgăraş Mountains. The distribution map of the species well indicates the concentration of the species in the Făgăraş Mountains, with a small area in the Ţarcu-Godeanu Mountains (Schneider-Binder and Voik, 1976). From the Făgăraş Mountains area the following distribution data are recorded:

Breaza Mountains (Schur, 1851, ap. Simonkai, 1886; Andrae, 1853), Colţii Brezei (Guşuleac, 1953); Piscului Peak, alt. 1,800 m (Ghişa, 1940); Zîrna, 1,800 m (Ghişa, 1940; Nyárády, 1941); Trăsnita (Nyárády, 1941); Bîndea (Csató Exsiccata, ap. Szücs 1943); Sâmbăta Valley, alt. 2,000 m (Kotschy, 1853); Viştea Mare (Nyárády, 1911); Tărâţa (Fuss, 1866; Simonkai, 1886; Herbarium Ungar at Museum of Natural Sciences Sibiu, 1906 and Herbarium Barth leg. Ungar 1906, Museum of Natural Sciences Sibiu); Arpaşul Mare (Fuss, 1846; Schur, 1866; Simonkai, 1886; Csató, 1890; Tuzson, 1934; Guşuleac/Flora R. P. R. 1953, Herbarium Fuss leg. Reissenberger 1855 and leg. Schur (without data), Herbarium Ungar, leg. Reissenberger 1855, Exs. Bielz, Csató, Kotschy, Simonkai ap. Szücs 1943, Flora Romaniae Exsiccata no. 1685, leg. Gürtler); Podrăgel (Fuss, 1846; Schur, 1866; Herbarium of the Transylvanian Society of Natural Sciences at Sibiu); Vârtop (Tuzson 1934, Index Horti botanici Budapest, Herbarium Fuss leg. 1861 and Herbarium Ungar leg. Fuss 1861); Capra Budei, including Piciorul Caprei, Faţa Iezerului, Groapa Mieilor (Guşuleac/Flora R.P.R. 1953); Vânătoarea lui Buteanu, 2,508 m (Hayek, 1916; Tuzson, 1934; Guşuleac, 1953); Vârful Netedu 2,351 m (Tuzson, 1934); Căprăreasa (Fuss, 1846; Herbarium

Fuss 1840, Herbarium Ungar at Museum of Natural Sciences at Sibiu); Bâlea Valley/Valea Bâlii (Csató, 1888; Guşuleac, 1953, Herbarium of the Botanical Institute of University Cluj-Napoca: leg. Bielz, without date, leg. Gürtler, 1908, 1912, leg. Richter 1908, leg. Nyárády 1927); leg. Schneider-Binder 1974, Herbarium at Museum of Natural Sciences Sibiu, Exs. Csató, Entz, Kárpáti, Trautmann, Zsák ap. (Szücs, 1943); Paltina (Guşuleac, 1953); Negoi (Fuss, 1862), Herbarium Normale Transsilvanicum no. 98 leg. Reissenberger, Simonkai, 1886; Hayek, 1916; Guşuleac, 1953; Herbarium Fuss and Museum of Natural Sciences Sibiu, leg. Reissenberger 1844, Herbarium of the Transylvanian Society of Natural Sciences leg. Reissenberger, Herbarium of the Botanical Institute of University Cluj-Napoca leg. Reissenberger; Strunga Ciobanului/ Bergerscharte, altitude 2,330 m and 2,348 m (leg. Schneider-B. and Voik 1973); Sărata Valley/Valea Sărata/Drachensteig-Poteca Zmeului, altitude 1,550 m (leg. Schneider-Binder 1971, leg. Schneider-Binder and Voik 1973); Muchia Şerbotei, altitude 1,850 m, 2,050 m, 2,060 m, 2,080 m, 2,100 m, 2,180 m (leg. Schneider-Binder and Voik, 1972); Şerbota Peak, alt. 2,332 m (leg. Schneider-Binder and Voik, 1,073); Mâzgavul/Şerbota Mică, alt. 2,200 m (leg. Schneider-Binder and Voik, 1973); Puha Crest/Creasta Puha, alt. 2,040 m, 2,050 m (leg. Schneider-Binder and Voik, 1972); Gârbova, alt. 2,000 m and Avrigel Valley, alt. 1,520 m, 1,700 m (leg. Schneider and Voik, 1973); Bârcaciu (Fuss 1846); Clăbucet – Muchia Racoviceanu (Csató, 1892); Surul Fuss ap. Grisebach and Schenk, Iter Hung. no. 55, alt. 1,920 m, (leg. Voik 1973).

At the Herbarium of the Museum of Natural Science at Sibiu there are also some samples with the citation "Transylvanian Alps" (meaning Făgăraş Mountains), without any other specification collected by Schur 1851, probably on the Arpaş Mountains, and collected by Kladny 1837 also probably from Arpaş Mountains as botanical researches of these authors are known from this area.

In the Ţarcu-Godeanu Mountains the species is mentioned from Scărişoara below Godeanu (Heuffel, 1858; Grecescu, 1898; Szücs, 1943; Guşuleac, 1953; Boşcaiu, 1971), Godeanu Mountain (Beldie, 1967; Boşcaiu, 1971) and Pârâul Şes (Heuffel, 1858; Guşuleac, 1953; Boşcaiu, 1971).

Distribution according to altitude and ecological requirements of the characteristic species.

Comparing the distribution data for *Silene lerchenfeldiana, Silene dinarica, Symphyndra wanneri* and *Potentilla haynaldiana* in the Southern Carpathians, one can distinguish two species groups, the first with a distribution more at the montane to subalpine level, including *Symphyandra wanneri* and *Silene lerchenfeldiana*, the other with a distribution more at the subalpine and alpine levels of the Carpathians, and including mainly *Silene dinarica*. This last species is present at the alpine level, the highest mentioned occurrence point being on the Vânătoare lui Buteanu at 2,502 m (Hayek, 1916), but this information is not confirmed. The highest registered point during own field researches was on the Negoi at 2,348 m and on the ridge of Şerbota at 2,332 m. But the species also descends to the subalpine level and at least to that of the spruce forests (1,520-1,550 m) as it has been observed on the left side of Sărata Valley on the ridge of Şerbota. These occurrences at high altitude and also at lower levels corresponds for the Făgăraş Mountains, where this differentiation according to altitude, exemplified for *Silene lerchenfeldiana* and *Silene dinarica,* is clearly visible. In this area there exists a small overlap of both species at the altitude of 1,520-1,620 m (Fig. 1, lines I and II), including phytocoenoses with both species (Schneider-Binder and Voik, 1976). From the southern part of Făgăraş Mountains, at Capra Budei and Râiosu Mountains near to the storage lake of Vidraru, *Silene lerchenfeldiana* is mentioned at an altitude of 700-750 m (Stancu, 2005).

On the Cindrel Mountains *Silene lerchenfeldiana* has been observed at Grosu Mountain in the Sadu Valley on the altitude of 970 m (Drăgulescu, 1995, Fig. 1) and in the Lotru Mountains around the altitude of 955 m (Drăgulescu, 2013; unpublished field data, Fig. 1). As one goes further West in the Carpathians to the Parâng, Retezat and Ţarcu-Godeanu mountains, it can be observed that *Silene lerchenfeldiana* is present at the upper montane level, the subalpine and as well the alpine level (Fig. 1, line V, Parâng; line VI Retezat; line VII Ţarcu-Godeanu) reaching altitudes of 2,040 m in the Retezat Mountains (Boşcaiu et al., 1977) and about 2,160 m in the Ţarcu-Godeanu Mountains (Boşcaiu, 1971).

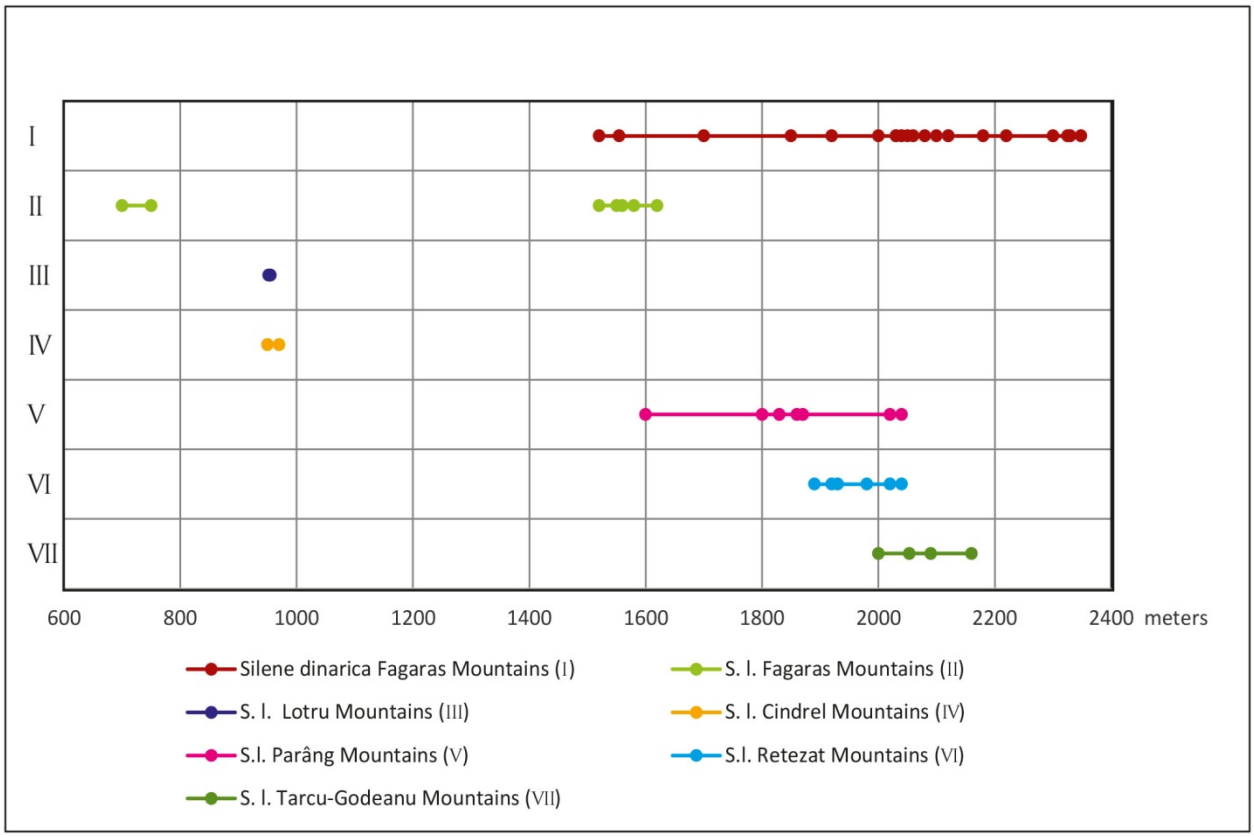

Figure 1: Altitudinal distribution (600-2,400 m) of *Silene dinarica* in the Făgăraş Mountains (I) and *Silene lerchenfeldiana* in Făgăraş- (II), Lotru- (III), Cindrel- (IV), Parâng- (V), Retezat- (VI) and Ţarcu-Godeanu (VII) Mountains.

With regard to the ecological requirement of the main characteristic species of the alliance Silenion lerchenfeldianae, these are almost the same for *Silene lerchenfeldiana* and *Symphyandra wanneri*, and very nearly so also for *Potentilla haynaldiana*, but somewhat different for *Silene dinarica*. Considering temperature, the first three are microtherme species, but the last, *Silene dinarica*, is a typical hechistothermic (criophilous) species adapted to the conditions of the alpine level in the Carpathians. The indicator values for humidity are the same for *Silene lerchenfeldiana*, *Symphyandra wanneri* and *Silene dinarica*, all being xero-mesophytes, and different for *Potentilla haynaldiana*, which is a mesophilous species (Tab. 1). With regard to soil reaction the main characteristic species are those that are acido-neutrophilous. *Dianthus henteri* and *Senecio glaberrimus*, differential species for regional communities have partly also similar ecological requirements concerning humidity and temperature (Tab. 1). Different are the requirements of *Saxifraga pedemontana* subsp. *cymosa*, which denotes also communities included in the alliance

Silenion lerchenfeldianae at the subalpine to alpine level, where the species colonises wet crevices of siliceous rocks together with the bryophytes *Polytrichum juniperinum* and *P. formosum* (Schneider-Binder and Voik, 1977). But the species were found also at the montane and even at the lowest montane level in the Lotru and Cindrel Mountains, in other species combinations (obs. Drăgulescu) having at this level other temperature requirements as at the alpine level of the Carpathians. This fact demonstrates that the ecological amplitude of *Saxifraga pedemontana* ssp. *cymosa* is greater than known at present and further studies are needed to clarify the ecology of the species and subspecies and as well the phytocoenological data.

Table 1: Ecological and distribution data for the main characteristic species of Silenion lerchenfeldianae.

Bioform	Flora element	Name of the species	Ind. value U	Ind. value T	Ind. value R	Altitudinal level
H (Ch)	Carp-Balc	Silene lerchenfeldiana	2	2	3	montan-subalpine
H	Carp-Balc	Symphyandra wanneri	2	2	3	Montan-subalpine
H	Carp-Balc	Potentilla haynaldiana	3	2	3	Montan-subalpine-(alpine)
H	Carp. End	Silene dinarica	2	1	0	Subalpine-alpine
H	Carp. End.	Dianthus henteri	2	3.5	4	montane
H	Carp-Balc	Senecio glaberiimus	3	1.5	4.5	Subalpine-alpine
Ch	Carp-Balc	Saxifraga pedemontana ssp. cymosa	4	1.5	3	(Montane) Subalpine-alpine

Phytocoenological characteristics of the alliance Silenion lerchenfeldianae and their associations.

The alliance including the chasmophytic vegetation of siliceous rocks is limited in its distribution to the Southern Carpathians, the main characteristic species for the alliance Silenion lerchenfeldianae there being *Silene lerchenfeldiana*, *Symphyandra wanneri, Potentilla haynaldiana, Silene dinarica* and, according to *S*imon and Pócs (2012), also *Thymus praecox* Opiz ssp. *polytrichus* (A. Kern ex Borbás) Jalas (= *Thymus balcanus* Borbás) identifying phytocoenoses of different associations. They form "curtain-like" communities, hanging out from the crevices on the perpendicular rock walls, as has been observed in the Parâng Mountains (Simon and Pócs, 2012), Lotru Mountains at Cataractele Lotrului (Drăgulescu, 2013) and Făgăraş Mountains at Sărata Valley on the so called "Drachensteig" area (Schneider-Binder and Voik, 1976).

It is known that from the Southern Carpathians area the following associations of the alliance Silenion lerchenfeldianae have been mentiond in the specific scientific literature (Simon, 1958; Simon and Pócs, 2012; Borza and Boşcaiu, 1965; Schneider-Binder and Voik, 1976, 1977; Boşcaiu et al., 1977; Coldea 1991; Drăgulescu, 1995; Stancu, 2002, 2005; Sanda et al., 2008):

– Sileno lerchenfeldianae-Potentilletum haynaldianae (Horvat et al., 1937) Simon 1958, first mention from Parâng Mountains

(Simon, 1958; Simon and Pócs, 2012 with five samples), below Parângul Mic at Barbu Mountain (Schneider-Binder ap. Heltmann rel. 1970 mscr., Coldea, 1991).

– Senecioni glaberrimi-Silenetum lerchenfeldianae Boşcaiu et al., 1977: Retezat Mountains (Boşcaiu et al., 1977) table with five samples.

– Asplenio septentrionali-Silenetum lerchenfeldianae Horvat 1936; groups of **Silene lerchenfeldiana-Symphyandra wanneri** from Râu Sadului-Dl. Grosu, 670-1,000 m (Drăgulescu, 1995); **symphyandretosum**: Râu Sadului-Fundu Râului and Sădurel (Drăgulescu, 1995)

– Diantho henteri-Silenetum lerchenfeldianae Stancu 2002 (overlapping partially with groupings of Silene lerchenfeldiana-Symphyandra wanneri and Silene lerchenfeldiana-Symphyandra wanneri symphyandretosum).

– Silene lerchenfeldiana-Symphyandra wanneri groupings: Sărata Valley (Schneider-Binder and Voik, 1976 and 1977), Şerbota Valley (Schneider-Binder and Voik, 1976 and 1977).

Coenoses with Silene lerchenfeldiana: Avrigel Valley (Schneider-Binder and Voik, 1976), Sărata Valley (Schneider-Binder and Voik, 1976)

– Silenetum dinaricae Schneider-Binder and Voik, 1976 was first described on the basis of 20 samples taken at altitudes from 1,850-2,400 m in the area of Şerbota and Negoi (Schneider Binder and Voik 1976 and 1977) from the following sites: Strunga Ciobanului (Schneider-Binder and Voik, 1976, 1977; Puşcaru-Soroceanu et al., 1981), Avrigel/Avrig Valley (Schneider-Binder and Voik, 1977; Puşcaru-Soroceanu et al., 1981), Sărata Valley (Schneider-Binder and Voik, 1977, Puşcaru-Soroceanu et al., 1981), Şerbotei Valley (Voik, 1976, with sampling, Schneider-Binder and Voik 1977, Puşcaru-Soroceanu et al., 1981), Ciortea Peak, Gârbova Peak (Schneider-Binder and Voik, 1977; Puşcaru-Soroceanu et al., 1981), Paltinu Peak at 2,380 m (Drăgulescu, !), Suru Peak pe Fruntea Moaşei (Schneider-Binder and Voik, 1977; Puşcaru-Soroceanu et al., 1981), Şerbota Mare Peak and Şerbota Mică Peak (Schneider-Binder and Voik, 1977; Puşcaru-Soroceanu et al., 1981).

Due to the open character of these phytocoenoses, locally being developed only fragmentally and with low degree of cover, the classification and delineation of the phytocoenological units is difficult and possible only through comparison of a large sample of material (Tab. 2).

On the basis of the samples from different mountain massifs of the Southern Carpathians such are Făgăraş, Lotru, Cindrel, Parâng, Retezat and Ţarcu-Godeanu mountains the units can be delineated on the base of characteristic species and as well differential species which are characteristic for some area (Tab. 2). *Silene lerchenfeldiana* occurs in different species combinations and abundance-dominance values. For Lotru, Cindrel and Făgăraş mountains the species combination of *Silene lerchenfeldiana* with *Symphyandra wanneri* is characteristic, in particular at the montane and as well the subalpine level. The two species frequently occur together, but also independent of one another, so that typical symphyandretosum subunits have been delineated (Drăgulescu, 1995). On the lower altitudes of Lotru Mountains and Făgăraş Mountains at Vidraru (Capra Budei and Râiosu mountains) there occurs as a differential species *Dianthus henteri*, a Southern Carpathian endemic species and other species more characteristic of the montane level (Tab. 2, column 1 and 2). This is why an association identified by *Silene lerchenfeldiana* and *Dianthus henteri* has been described (Stancu, 2005). But *Dianthus henteri* occurs as well in phytocoenoses that are classified as part of the association Asplenio septentrionalis-Silenetum lerchenfeldianae, being strongly interlocked (Drăgulescu, 1995).

At the subalpine level of the Făgăraş Mountains a typical combination of *Silene lerchenfeldiana* with *Symphyndra wanneri* occurs (Tab. 2, column 3). This is where also an interlocking with stands of *Silene dinarica* has been observed and described (Schneider-Binder and Voik, 1976). The phytocoenoses of *Silene lerchenfeldiana* and

Sympyhandra wanneri at the subalpine level can be considered as good delineated units which can be considered on the basis of five samples to be an association under the provisional name Symphyandro wanneri-Silenetum lerchenfeldianae. Further material would be needed to confirm this proposal.

At the subalpine, but mainly at the alpine level typical phytocoenoses of Silene dinarica occur. This species takes part of those endemic Carpathian species which are used for the delineation of phytogeographical subunits of the Carpathians (Borza and Boşcaiu, 1965), being recognised already by Pax (1908) as a "Character species of the Transylvanian Alpes". The identifying species can occur together with species of alpine grasslands, if the inclination of the rocks is lower than 80°. As a differential species for the community there occurs *Veronica baumgarteni* (Tab. 2, columns 4 and 5). For the Parâng Mountains is characteristic the association Sileno lerchenfeldianae-Potentilletum haynaldianae (Horvat et al., 1937) Simon 1958, a rare relict community, which occurs in the Carpathians only in the Parâng Mountains (Tab. 2, column 6), other occurences being only in the Bulgarian Rila and Pirin mountains (Simon and Pócs, 2012). From the Retezat Mountains have been described on the base of the species combination of *Silene lerchenfeldiana* and *Senecio glaberrimus*, the association Senecio glaberrimi-Silenetum lerchenfeldianae Boşcaiu et al. 1977 (Boşcaiu et al., 1977). In the studied phytocoenoses *Senecio glaberrimus* occurs with high constancy, together with *Silene lerchenfeldiana* (Tab. 2, column 7).

It seems that *Senecio glaberrimus* is like *Dianthus henteri* a differential species for the association, but it has to be studied and confirmed on the basis of future studies derived from more comprehensive phytocoenological material, whether they can be considerated only as regional variants of the Asplenio septentrionali-Silenetum lerchenfeldianae, or have to be considered as independent phytocoenological units. For a clarification also the area of *Symphyandra wanneri* has to be further studied as a very characteristic species of the alliance which has the same ecological requirements as *Silene lerchenfeldiana*. As *Symphyandra wanneri* occurs on lower altitudes frequently without *Silene lerchenfeldiana*, further researches have to confirm whether or not the delineation of a new phytocoenlogical unit would be justified.

Table 2: Plant communities of the alliance Silenion lerchenfeldianae.

Number of column	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Lo-Ci	Fa	Fa	Fa	Fa	Pa	Re
Number of samples included	8	5	5	20	10	5	6
Silenion lerchenfeldianae							
Silene lerchenfeldiana	III	V	V	II	–	IV	V
Symphyandra wanneri	IV	–	IV	–	–	–	–
Potentilla haynaldiana	–	–	–	–	–	V	–
Silene dinarica	–	–	I	V	V	–	–
Saxifraga pedemontana ssp. *cymosa*	I	–	–	–	–	–	–
Differential species							
Veronica baumgarteni	–	–	–	II	II	–	–
Thymus praecox ssp. *polytrichus*	–	–	–	–	–	V	–
Dianthus tenuifolius	–	–	–	–	–	IV	–
Dianthus henteri	II	V	–	–	–	–	–
Alyssoides utriculata var. graeca	–	I	–	–	–	–	–
Senecio glaberrimus	–	–	–	–	–	–	V

Table 2 (continued): Synthetic presentation of plant communities of the alliance Silenion lerchenfeldianae.

Number of column	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Lo-Ci	Fa	Fa	Fa	Fa	Pa	Re
Number of samples included	8	5	5	20	10	5	6
Asplenietalia septentrionalis							
Asplenium septentrionale	IV	–	–	–	–	–	–
Asplenium trichomanes	II	III	–	–	–	–	–
Asplenium x alternifolium	II	–	–	–	–	–	–
Jovibarba heuffelii	II	–	–	–	–	–	–
Poa nemoralis	IV	II	–	–	–	–	–
Polypodium vulgare	IV	I	–	–	–	–	–
Asplenietea rupestris							
Cystopteris fragilis	II	II	–	–	–	–	–
Asplenium ruta-muraria	-	III	–	–	–	–	–
Thymus comosus	I	III	–	–	–	–	–
Veronica bachofeni	I	IV	–	–	–	–	–
Saxifraga paniculata	I	III	–	–	–	–	–
Valeriana tripteris	–	III	III	–	–	–	–
Alyssum saxatile	I	II	–	–	–	–	–
Silene nutans ssp. *dubia*	II	–	–	–	–	–	–
Sedum hispanicum	II	–	–	–	–	–	–
Saxifraga cuneifolia	–	–	IV	–	–	–	–
Other species							
Juncus trifidus	IV	I	IV	IV	IV	V	V
Festuca airoides	I	–	–	IV	V	V	–
Luzula spicata	–	–	–	–	–	V	–
Polytrichum formosum	II	–	II	I	–	–	–
Huperzia selago	–	I	–	II	III	–	–
Phyteuma nanum	–	I	–	III	III	–	–
Solidago virgaurea	III	–	–	–	–	–	IV
Rhododendron myrtifolium	–	–	–	II	II	–	–
Carex curvula	–	–	–	II	I	–	–
Campanula alpina	–	–	–	II	-	–	–
Primula minima	–	–	–	III	IV	–	–
Grimmia apocarpa	–	–	–	II	-	–	–
Alectoria ochroleuca	–	–	–	II	III	–	–
Thamnolia vermicularis	–	–	–	III	IV	–	–
Oreochloa disticha	–	–	–	–	II	–	–
Vaccinium gaultherioides	–	–	–	–	II	–	–
Vaccinium vitis-idaea	–	–	–	–	II	–	–
Cnidium silaifolium	I	I	–	–	–	–	–
Phegopteris connectilis	II	–	–	–	–	–	–
Sedum telephium ssp. *maximum*	II	–	–	–	–	–	–
Galium kitaibelianum	II	–	–	–	–	–	–

Table 2 (continued): Synthetic presentation of plant communities of the alliance Silenion lerchenfeldianae.

Number of column	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Lo-Ci	Fa	Fa	Fa	Fa	Pa	Re
Number of samples included	8	5	5	20	10	5	6
Spiraea ulmifolia	II	–	–	–	–	–	–
Galium lucidum	–	IV	–	–	–	–	–
Centaurea rhenana	–	III	–	–	–	–	–
Scrophularia heterophylla laciniata	–	III	–	–	–	–	–
Festuca rupicola ssp. *saxatilis*	–	II	–	–	–	–	–
Sempervivum marmoreum	–	II	–	–	–	–	–
Column 1: 5 samples from Lotru Mountains and 3 from Cindrel Mountains (Drăgulescu)							
Column 2: Făgăraş-Mountains: 5 samples Capra Budei-Râiosu/Vidraru (Stancu, 04.08.2005)							
Column 3: Făgăraş Mountains, 5 samples from Valea Sărata (Schneider-Binder and Voik, 1976)							
Column 4: Făgăraş Mountains, 20 samples around Şerbota and Negoi (Schneider-Binder and Voik, 1976)							
Column 5: Făgăraş Mountains, 10 samples from Şerbota area (Voik, 1976)							
Column 6: Parâng Mountains, 5 samples (Simon and Pócs, 2012)							
Column 7: Retezat Mountains, 5 samples (Boşcaiu, Täuber and Coldea, 1977)							
and one sample from Gemenele (Drăgulescu, 1993 unpublished data)							
Species with frequency I in one site: column 1: *Asplenium adiantum-nigrum*							
Campanula glomerata, Epilobium collinum, Melica ciliata, Hieracium sabaudum,							
Veronica urticifolia; column 2: *Inula ensifolia*							
column 5: *Carex sempervirens, Agrostis rupestris, Thymus pulcherrimus*							
column 7: *Asplenium viride, Cystopteris regia, Campanula kladniana, Gentiana punctata*							
Lo-Ci = Lotru and Cindrel Mountains, **Fa** = Făgăraş-Mountains, **Pa** = Parâng Mountains,							
Re = Retezat Mountains.							

As we have stated, there are clear differences between communities denoted by *Silene lerchenfeldiana* at the higher levels of the mountains compared to those of the lower montane levels, descending in the gorges of the rivers to an altitude of 880 m in the Cibin Valley Gorge/Cindrel Mountains or an altitude of only 635 m at Călineşti Valley in the Lotru Mountains (Fig. 1, Tab. 2). Recent researches and sampling in the Lotru Mountains realised in 2013 (Drăgulescu, unpublished data) is showing a species combination of *Silene lerchenfeldiana* with other characteristic species at lower altitude. Species such as *Dianthus henteri*, an endemic species for the Southern Carpathians, but also species of the higher syntaxonomical ranges of the Asplenietalia septentrionalis and Asplenietea rupestris gives a different picture of the phytocoenoses in comparison with those of the higher mountain levels. With high frequency occurs *Asplenium septentrionale, Polypodium vulgare* and *Poa nemoralis*. The interlocking with phytocoenoses identified by the above-mentioned species has also to be studied, as well as the rocky phytoceonoses in which *Veronica bachofeni* occurs.

Table 2 (continued): Phytoceonoses of the Silenion lerchenfeldianae alliance from the Lotru and Cindrel mountains (field sampling by C. Drăgulescu).

Number of sample	1	2	3	4	5	6	7	8	
Cindrel and Lotru mountains	Ci	Lo	Ci	Lo	Lo	Lo	Lo	Ci	
Silenion lerchenfeldianae									
Silene lerchenfeldiana	2	1	1	1	.	.	.	.	III
Symphyandra wanneri	.	.	.	+	2	3	1	2	IV
Saxifraga pedemontana cymosa	.	.	.	.	+	.	.	.	I
Dif. *Dianthus henteri*	.	.	.	+	.	+	1	.	II
Asplenietalia septentrionalis									
Asplenium septentrionale	+	.	1	.	1	+	1	+	IV
Poa nemoralis	+	.	.	1	+	.	1	+	IV
Polypodium vulgare	.	+	.	+	+	.	+	+	IV
Asplenium trichomanes	.	+	.	+	.	.	.	+	II
Asplenium x alternifolium	1	.	1	.	.	.	.	.	II
Asplenium adiantum-nigrum	.	.	.	+	.	.	.	.	I
Jovibarba heuffelii	.	+	.	+	.	+	.	.	II
Asplenietea rupestris									
Cystopteris fragilis	.	+	.	+	.	.	.	+	II
Thymus comosus	.	+	.	.	.	.	.	.	I
Veronica bachofeni	.	.	.	.	.	.	+	.	I
Silene nutans ssp. *dubia*	.	.	+	+	.	.	.	+	II
Sedum hispanicum	.	+	.	+	.	+	.	.	II
Alyssum saxatile	.	.	.	.	.	1	.	.	I
Varia syntaxa									
Juncus trifidus	1	.	+	+	+	+	.	.	IV
Solidago virgaurea	.	.	.	+	+	.	+	+	III
Phegopteris connectilis	.	+	.	+	.	.	.	+	II
Sedum telephium ssp. *maximum*	.	+	.	+	.	.	.	.	II
Veronica urticifolia	.	+	.	.	.	.	.	+	II
Galium kitaibelianum	.	+	.	.	.	.	+	.	II
Spiraea ulmifolia	.	.	1	.	.	.	.	+	II
Cnidium silaifolium	.	.	.	+	.	.	.	.	I
Campanula glomerata	.	.	.	+	.	.	.	.	I
Epilobium collinum	.	.	.	.	.	.	+	.	I
Melica ciliata	.	.	.	.	.	.	+	.	I
Hieracium sabaudum	.	.	.	.	.	.	+	.	I
Festuca airoides	.	.	.	.	.	1	.	.	I
Polytrichum formosum	1	1	.	.	.	+	.	.	II

Locality and date of sampling:

1. Cindrel Mountains, Sadu Valley on Grosu Hill, 970 m alt, aspect E-SE, slope 80°, S. sample 6 m^2, cover 20%, Drăgulescu, 02.08.1978;

2. Lotru Mountains, Cataractele Lotrului, latitude 45°27'38.3" longitude 23°53'36.3, altitude 952 m, asp. SW, slope 90°, S. sample 20 m², cover 35%, Drăgulescu, 01.08.2013;

3. Cindrel Mountains, Sadu Valley on Mr. Grosu 950 m, asp. E, slope 90°, S sample 4 m^2, cover 15%, Drăgulescu, 08.07.1980;

4. Lotru Mountains, Cataractele Lotrului, latitude, 45°27'43.5", longitude (degrees, minutes, seconds) 23°52'30,7", altitude 955 m, asp. SW, slope 85°, S. sample 10 m², cover 20%, Drăgulescu 01.08.2013, Diantho henteri-Silenetum lerchenfeldianae;

5. Lotru Mountains, Sadu River valley at Fundu Râului 670 m alt., asp. N, slope 80-90°, S. sample 6 m^2, cover 20%, Drăgulescu 03.08.1978;

6. Lotru Mountains at Sădurel 770 m alt., asp. NE, slope 85°, S. sample 4 m^2, cover 15%, Drăgulescu, 03.08.1978;

7. Lotru Mountains, Călineşti Valley, 635 m alt., geographical position latitude 45°23'35", longitude 24°13'22", asp. E slope 60°, S. sample 6 m^2, cover 25%, Drăgulescu, 05.04.2014;

8. Cindrel Mountains, gorge of the Cibin River/Cibin Gorge, 880 m alt., latitude 45°42'00", longitude 23°54'00", asp. E, slope 85°, S. sample 9 m^2, cover 20%, Drăgulescu, 26.07.1989.

CONCLUSIONS

The alliance Silenion lerchenfeldianae with all its included associations – most of them relict, rare and with a small distribution area – are of outstanding interest from the phyto-geographical and phyto-historical point of view. There are regional differences between the above-mentioned communities with interlockings between the phytocoenoses, which according to the authors are included in different units. These phytoceonological units and subunits are dependent upon the geo-morphological and climatic conditions, i.e. changing temperature and humidity according to the altitude at which the phytocoenoses occur, but also in relation to phytohistorical aspects laying in the Tertiary, but also in the interglacial ages and the postglacial periods.

With all their aspects the associations integrated into the alliance Silenion lerchenfeldianae form an essential part of the Helleno-Balcano-Carpathian subtype of the habitat type 8220, an important regional contribution for the European Natura 2000 network.

For a larger overview it is of crucial importance to continue the studies with additional sampling which can assure the confirmation of the present association classification, to delineate in detail regional units and subunits within the frame of associations.

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AUTHORS:

[1] *Constantin DRAGULESCU*
constantindragulescu@yahoo.ro
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Ecology and Environmental Protection,
Dr. Ioan Raţiu Street 5-7, Sibiu, Sibiu County,
Romania,
RO-550012.

[2] *Erika SCHNEIDER-BINDER*
erika.schneider@partner.kit.edu, erika.schb@t-online.de
KIT – University of Land Baden-Württemberg,
National Research Centre of the Helmholtz Society,
Institute for Geography and Geoecology,
Division WWF-Institute for Floodplains Ecology,
Josefstrasse 1, Rastatt,
Germany,
D-76437.

ACHIEVEMENT OF REPRODUCTIVE POTENTIAL AND SOME METHODS OF ASSESSMENT OF REPRODUCTIVE CAPACITY IN CILIATES

Elena SILITRARI [1], *Andrei SILITRARI* [2] and *Elena ROŞCOV* [3]

KEYWORDS: ciliates, Infusoria, *Paramaecium caudatum*, Hyflick's, binary division, reproductive potential.

ABSTRACT

This study has been initiated to show the reproductive potential and some methods of assessment of reproductive capacity in Ciliates. The reproductive capacity of unicellular organisms by binary division was determined depending on the age of the population. The reproduction of organisms was made "in vitro" because the observation of some particularities of the Ciliates is impossible to estimate in natural conditions which are complex and vary permanently. The research tried to determine the longevity of Infusoria, the number of bunary division, and the number of generations after the sexuated multiplication process. It was based on the ciliate protozoa model.The basic culture used in investigation is *Paramecium caudatum*.

REZUMAT: Realizarea potențialului reproductiv şi unele metode de cuantificare a capacității de reproducere la ciliate.

Acest studiu a fost elaborat pentru a arăta potențialul reproductiv şi unele metode de cuantificare a capacității de reproducere la ciliate. Astfel, a fost determinată capacitatea de reproducere a unor organisme unicelulare, prin diviziune binară, în funcție de vârsta populației. Reproducerea organismelor a fost făcută „in vitro" deoarece observarea anumitor particularități ale ciliatelor este imposibil a fi estimată în condiții naturale, condiții care sunt complexe şi dinamice în permanență. Cercetările încearcă să determine longevitatea pentru Infusoria, numărul de diviziuni binare şi numărul de generații după procesul de multiplicare sexuată. Studiul este bazat pe modelul protozoarelor ciliate şi cultura de bază utilizată în investigații este constituită din specia *Paramaecium caudatum*.

ZUSAMMENFASSUNG: Die Erzielung des Reproduktionspotentials und einige Methoden zur Quantifizierung der Reproduktionsfähigkeit bei Wimpertieren.

Die vorliegende Untersuchung wurde durchgeführt, um das Reproduktionspotential festzustellen und einige Quantifizierungsmethoden der Reproduktionskapazität bei Wimpertieren aufzuzeigen. Daher wurde die Reproduktionsfähigkeit einiger Einzeller durch binäre Teilung in Abhängigkeit vom Alter der Population bestimmt. Die Vermehrung der Organismen wurde "in vitro" durchgeführt, da die Beobachtung einiger Eigenheiten der Wimpertierchen unter natürlichen, komplexen und ständig dynamischen Bedingungen nicht geschätzt werden kann. Anhand der durchgeführten Forschungen wird versucht, die Langlebigkeit für Infusorien, die Anzahl der binären Teilungen sowie die Zahl der Generationen nach dem Prozess der geschlechtlichen Vermehrung zu bestimmen. Die Untersuchungen beruhen auf dem Modell der einzelligen Wimpertierchen Protozoa Ciliata, wobei die bei den Versuchen verwendete Basiskultur aus Individuen von *Paramaecium caudatum* bestand.

INTRODUCTION

In the study of onthogenesis, some of the aproaches are based on the hypothesis according to which the occurence and the increasing complexity of the individual development during the evolution depended on the number of cells of the organism.

This aproach admits considering all eukariot cells as a unique organisation level. All eukariot cells posess an homologous structure, meaning that all organite classes present in their body are identical and transform in one another through intermediary alterations – all eukariot cells possess a unique spectre of possibilities and are differentiated only by the band width. They can be attributed a biological version of the law of constant composition. Even in the organisation of bacterial cells at the molecular level, many unique principles were conceived and solutions were found, which can be used in further development. Thus, almost all structural genes were created in the prokaryotic cells. Further on the eukariot cell was formed, inside of which the other functions were conceived; organization of the genetic material in a nucleus as chromosomes, mitosis and meiosis, all the organites, and determining versions of their usage in the further evolution as specialised tissues of multicelular plants and animals. The diversity of the cells themselves is relatively small. In humans, 250 different kinds of cells are grouped in four kinds of tissues.

The reproduction of Infusoria may occur in a number of ways; simple or multiple fission, or sporulation. The faith of the reproductive products differs. In some cases they transform directly (or through several development stages) into a vegetative form similar to the mother cell or into sexual individuals and only afterwards into vegetative individuals.

The basic particularity of Infusoria is considered to be the extremely speciphic sexuated process. In so-called "normal" organisms the sexuated process is linked to the merging of two sexual celles with haploid nuclei. In Cilliates, the cells do not merge and the sexuate process is performed on the account of "conjugation" – the exchange of haploid nuclei.

The biological importance of this proces in the life of Infusoria consists in uniting two beginnings in a single organism (maternal and paternal), such as in the case of any other sexual process, in the increase of the hereditary variability and diversity. The increase of the hereditary variability, increases the organism's adaptive possibilities in the actual environmental conditions. The second factor of biological importance in the process of conjugation is represented by the development of the macronucleus out of the divisional products of the synkaryon, as the old one is destroyed. The experimental data showed that the macronucleus plays an exceptionally important role in the life of Infusoria. It directs all basic vital processes and determines the most important process – the protein synthesis that puts together the main part of the living cell protoplasm. The prolongued asexuated reproduction implies a specific process of macronucleus "aging" as well as of the entire cell. The metabolic activity is decreased and the reproductive rate is lowered. After conjugation, in the process of which the old macronucleus is destroyed, the level of the exchange of substances is reestablished, as is the reproductive rate. During conjugation, the process of fertilisation takes place. This process is linked to the reproduction and the engendering of a new generation in the case of most of the other organisms. In Infusoria, the individual is formed as a result of the conjugation which can also be considered as a new sexual generation apperaing, in this case, on the account of the "rejuvenation" of the old one (Jizni, 1987). Until the occurence of a new conjugation, it is necessary to have a certain number of cellular divisions. The cells must reach a certain level of maturity. The experiments showed that the length of the asexuate reproduction phase in Infusoria varies according to the environmental conditions. It was found that starvation or the action of

some salts accelerate the beginning of the conjugation while the abundance of nutrients hold it back. Nevertheless, for most of the Infusoria species, the reorganisation of the nuclear apparatus is absolutely necessary. In the lack of it, Infusoria depress and die. Probably, the renewal of the complicated macronucleus is necessary for the existence of the Cilliates.

Many aspects of the population increase in nature can only be understood according to the way it behaves in vitro. The maintainance of the Cilliates in surveyed conditions allow for the observation of such particularities of the population increase which are impossible to estimate in natural conditions which are complex and vary permanently. A special role is awarded to scientists studying the increase potential of the Cilliates populations.

MATERIAL AND METHODS

Experimental investigations have focused on the ciliated protozoa model which represent a particular evolutionary eukaryotic organisms, because they combined particularities of nature blends cellular and functional integrity bodies. Basic culture used in investigation, *Paramecium caudatum*, was kept in rigurous conditions (of temperature, light, nutritionaly support, etc.) because the reproduction and ciliates growth depends on the nutritional condition, temperature and light.

The investigation was carried in five glasses bottles with a volum of 100 ml, with fresh sustenance in which 100 individuals were placed (Vi = 100 ml, Ni = 1 ind./1 ml). After five days sample individuals were placed in 500 vials, in fresh sustenance. The following metod was used when the culture had 10, 15, 20, 25 and 30 days. Maintenance temperature of samples was 21°C. Data processing was done a day after placing them in vials.

RESULTS AND DISCUSSION

Synthesizing all the experimental data provided, investigation in several priority areas which addresses to the issues of dependence, rate of reproduction action, and intensity number of unicellular animal species were conducted. Cell growth is a characteristic process of living cells that combines, usually, the maturation and cellular differentiation.

Senescence or aging is considered the last stage of this complex development process of all organisms.

Senescence is an inexorably process that relates to a number of changes postaging resulting in decrease of homeostasis and increasing the organism vulnerability.

Senescence is characterized by two important parameters – the average lifetime (which refers to the age by which 50% of the population survives) and their maximum potential for survival (which refers to the maximum lifetime of any member of the population or the species). Over time the average lifetime has increased continuously, but nevertheless full potential survival remains unchanged. Maximum survival potential seems to be specific for each species, which implies an important genetic component in controlling the rate of aging.

In this context, the reproductive capacity of unicellular organisms by binary divisio was determined, depending on the age of the population. The aging cell is represented by cell reduction and decreasing of the organism volume. After decreasing the organism volume, the intensity and aging speed of the cells is determined by their ability to reproduce.

Data included in table 1 illustrates the numerical variation and reproductive parameters of *Paramecium caudatum* clone during 30 days.

Table 1: Reproductive parameters variation of *Paramecium caudatum* at t = 21°C.

τ (days)	Nt. with offs		Nt. without offs		Ln Nt. med.		Cw Nt. med.	
	n	$M \pm m_x$	n	$M \pm m_x$	n	$M \pm m_x$	n	$M \pm m_x$
5	500	21.44 ± 0.55	466	23.09 ± 0.52	466	3.01 ± 0.02	466	1.51 ± 0.01
10	500	23.93 ± 0.47	479	24.98 ± 0.43	479	3.14 ± 0.02	479	1.57 ± 0.01
15	500	23.71 ± 0.51	468	25.32 ± 0.44	468	3.16 ± 0.02	468	1.58 ± 0.01
20	500	13.05 ± 0.31	467	13.71 ± 0.31	476	2.49 ± 0.02	476	1.25 ± 0.01
25	500	29.32 ± 0.61	475	30.86 ± 0.54	475	3.35 ± 0.02	475	1.67 ± 0.01
30	500	12.19 ± 0.37	482	12.60 ± 0.37	482	2.33 ± 0.03	482	1.16 ± 0.01

All these prove that the population has a high reproductive potential. The more complex data regarding the age of the culture, prove the relatively constant value of the specific reproductive ratio (Cw) during the 5-15 days period.

Nevertheless, it was noticed that the binary division in ciliates generates uniformity for all the culture ages, and that it produces huge populations called clones, originating from a single cell. By preserving its multilateralism, the Protozoan cell also preserved its capacity to reach immortality, a feature lost by Metazoan cells due to their unilateral specialization. The Protozoans do not end their life in death, but achieve continuity through repeated division generating new individuals (Fig. 1).

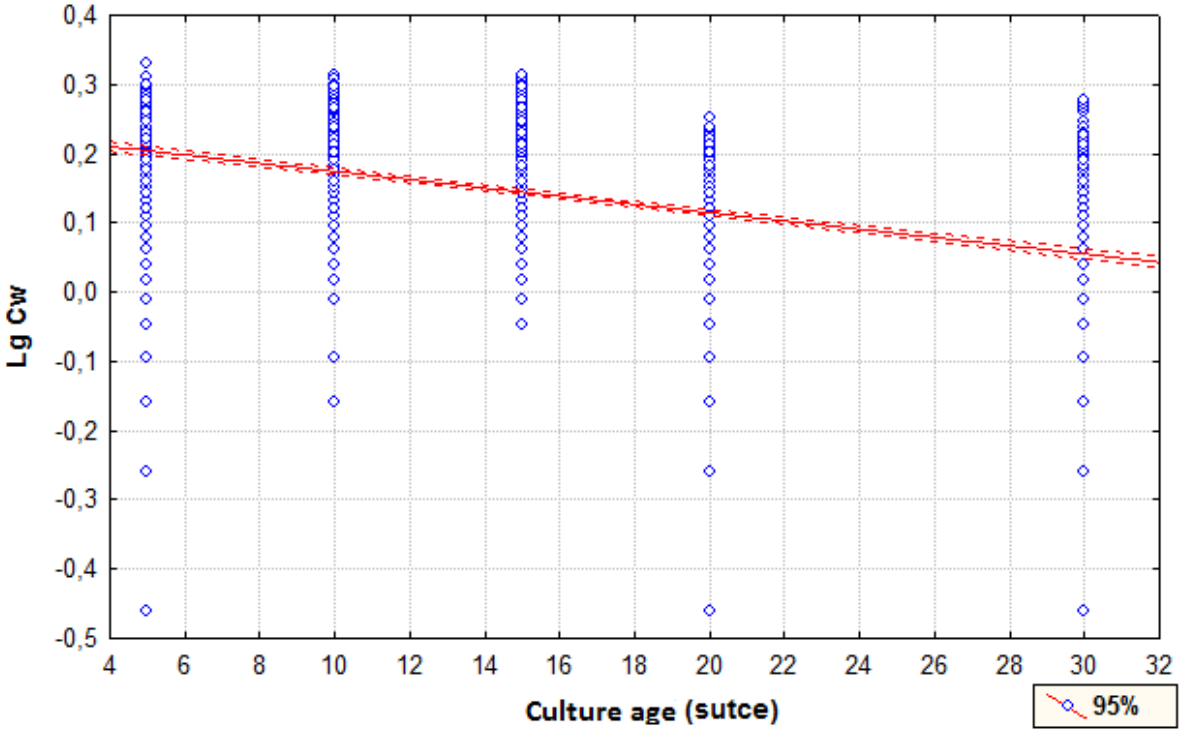

Figure 1: The corelation between reproduction rate (Cw) and culture age (τ) at *Paramaecium caudatum* (n = 2500, $r_{xy} = -0.45$).

Still, during its complete lifetime, as the cell grows, develops and matures, the succession of the binary divisions slows down, the size of the individuals diminishes more and more, even if their aging is hereditary programmed. The occurence of sexuality contributed to the increase of the chances of survival of the organisms.

After a succession of binary divisions, in the ciliates developing cycle, the process of sexuated multiplication occurs – the conjugation. After conjugation, the physiological and reproductive processes

are reestablished within the involved organisms. Thus, the newly formed individual can be considered as a new sexuated generation that appears on the "expence of the rejuvenation" of the old generation.

The cells of the single-cell organisms as well as the cells of the multicellular organisms, have a limited division potential, even in favourable living conditions. For instance, the human cells grown "in vitro", having an advanced divisional age, die after a pre-established and fixed number of divisions called the "Hyflick's limit". The Hyflick theory is concernd with the limit of the cells' division. When reaching this limit, the cells die and the organism is getting old.

He noticed that the human somatic cells grown "in vitro" in favorable conditions are capable to divide only a limited number of times. The division limit depends on the age of the organism from which the cells were harvested (new-born person's cells divided 80-90 times, while a 70 years old person's cells divided only 20-30 times). The maximum number of a cell's divisions was named "Hyflick's limit".

Thus, in a controlled environment, the model-culture has been obtained, for which, by inducing certain abiotic factors variations (temperature, light, starvation), the begining of the conjugation was accelerated. The present study has been initiated in order to determine the longevity of Infusoria, the number of binary divisions, and the number of generations after the sexuated multiplication process. The Hyflick's limit has been studied, most particularly in the case of *Paramecium caudatum* culture, since the Protozoan cell must face multiple problems presented by its environment (the action of ecological factors, either man made or natural), while the cell belonging to a multicellular organism only has to accomplish a limited number of special functions, the rest of them being assumed by otherwise specialized cells.

Eventually, our analysis showed that, compared to human cells (80-90 binary divisions), the number of binary divisions of the ex-conjugators as well as the number of generations increased at least four times. In optimum conditions, the paramecium multiplies very quickly asexuately, dividing two-three times a day. Apparently, high temperature (up to certain limits) speeds up the division, just as certain inorganic and organic substances or radiation can stimulate or slowdown the division. After approximately 201 generations, anomalies were registered, the division slowing down or even coming to a stop (Tab. 2).

As a result of these experiments, we were able to establish a computer model for the prognosis of the modifications of age structure, such as starting point of division, mortality parameters, juvenile periods and conjugation probability. The average and maximum age of the grown individuals was of 43 ± 2 and 140 binary divisions, respectively. The achieved results elucidate the cause of the presence in samples collected in natural habitats of juvenile as well as of adult individuals. The quantitative analysis performed in normal conditions revealed values between 6.5 and 7.9 generations, while for some ex-conjugators, the resulted index showed values of 201 and 235 generations.

Due to the fact that the reproductive parameters of ex-conjugators were differently diminished, we assumed the existence of two systems in a population, each of them reacting in a complex way even when a single factor is changing. For *Paramecium caudatum* populations 235 generations are characteristic. For the forms cultivated in the lab the number of generations cannot be higher then this value. These results demonstrate the model stability which allow us to understand some life particularities of *Paramecium caudatum*.

The sexuate reproduction constitute obviously a priority of the living organisms. It is evident that in such situations, a new system will appear as a result of the circulation and joining information from two different systems and, if they will be more different, the new system will be richer (Fig. 2).

Table 2.1a: Realizing in time of ex-conjugations generations *Paramaecium caudatum*, n = 21, τ (days) = 94, t = 21-22°C.

days	The number of ex-conjugations							
	1	2	3	4	5	6	7	8
1	0.793	0.500	0.500	0.793	1.000	0.500	0.500	0.500
2	2.000	1.000	1.000	1.000	2.082	1.585	1.800	1.000
3	2.788	3.287	2.738	3.514	2.208	1.771	1.560	1.854
4	1.000	1.200	1.293	1.603	0.091	1.000	1.143	1.000
5	1.000	1.000	1.000	1.000	1.000	1.231	1.488	1.000
6	0.000	0.000	0.000	0.000	1.000	1.000	1.000	0.000
7	0.000	0.000	0	0	0.000	1.000	0.000	0.000
8	0.000	1.000			1.250	1.250	1.000	1.125
9	0.000	3.001			2.619	2.792	2.957	3.429
10		2.422			2.539	2.438	2.746	2.484
11		2.221			2.501	2.531	1.974	2.412
12		2.666			2.709	2.247	2.662	2.621
13		2.397			2.578	2.359	1.974	2.655
14		1.438			1.693	1.123	2.662	1.674
15		1.000			1.111	1.084	2.667	1.000
16		1.000			1.000	1.000	1.382	0.000
17		1.783			1.674	1.746	1.000	1.772
18		3.206			3.318	3.056	1.000	3.212
19		3.113			2.985	3.116	1.764	3.579
20		2.508			2.104	2.258	3.436	1.976
21		3.135			3.008	3.046	3.034	3.241
22		3.365			3.311	2.823	2.743	3.189
23		2.107			1.932	2.337	3.060	2.308
24		1.512			1.379	1.342	3.320	1.621
25		2.813			2.999	2.617	2.696	2.593
26		3.096			3.121	3.004	1.251	3.533
27		2.940			2.891	2.711	2.866	2.705
28		3.038			3.342	3.172	3.365	3.392
29		2.441			2.949	2.352	3.324	3.249
30		2.769			3.289	2.914	3.263	3.038
31		2.680			2.769	2.835	2.724	3.249
32		2.684			2.894	2.752	3.159	2.950
33		2.925			3.289	3.182	3.188	3.257
34		1.704			2.663	2.226	3.026	2.437
35		2.426			2.749	2.724	3.307	3.328
36		2.533			2.435	2.608	2.307	2.930
37		2.495			2.613	2.216	2.663	2.566
38		1.831			2.293	1.517	3.131	1.655
39		1.897			1.724	2.143	2.459	2.367
40		1.952			3.001	2.343	1.572	2.716
41		2.751			3.001	2.523	2.631	2.869
42		2.043			2.334	2.939	2.936	2.827
43		2.085			2.390	2.000	2.583	2.569
44		2.270			2.586	2.529	2.997	2.691

Table 2.1a (continued): Realizing in time of ex-conjugations generations *Paramaecium caudatum*, n = 21, τ (days) = 94, t = 21-22°C.

days	The number of ex-conjugations								
	9	10	11	12	13	14	15	16	17
1	0.500	0.500	0.500	0.500	0.500	0.000	0.500	0.500	0.500
2	1.000	2.000	1.000	1.749	1.000	2.000	1.585	2.000	1.455
3	2.000	1.845	1.816	2.071	2.474	1.967	2.000	1.856	2.539
4	1.250	1.000	1.000	1.000	1.000	1.990	1.080	1.000	1.080
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	0.000	1.366	0.000	1.000	1.000	1.000	1.000
7	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000
8	1.000	1.000	0.000	1.000	1.000	1.000	1.000	1.143	1.334
9	2.439	3.224	2.293	3.179	1.379	2.407	3.001	3.303	2.662
10	2.373	2.612	2.612	2.632	2.798	2.506	2.144	2.310	2.545
11	2.857	2.524	2.510	2.544	2.738	2.199	2.795	2.616	2.643
12	2.345	2.564	2.578	2.885	2.915	3.239	2.903	2.433	2.612
13	2.754	2.323	2.533	1.799	3.011	2.767	2.598	2.429	2.552
14	1.963	1.626	1.063	1.000	1.231	1.155	1.200	1.728	1.199
15	1.312	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
16	1.000	1.000	1.335	2.213	0.000	0.000	1.000	0.000	1.000
17	1.759	1.769	1.866	3.719	1.364	1.462	1.264	1.167	1.417
18	3.58	3.486	2.933	3.138	3.288	3.27	3.272	3.560	3.436
19	3.328	3.309	3.367	2.480	3.096	3.181	3.387	3.343	3.386
20	2.14	2.271	2.527	3.074	2.250	1.779	2.049	1.590	2.073
21	2.947	2.83	3.015	3.180	3.066	2.939	3.007	3.125	2.841
22	3.441	3.358	3.559	2.435	3.365	3.357	2.049	3.202	3.142
23	2.053	2.283	2.034	1.073	2.263	2.076	3.001	2.758	2.237
24	1.234	2.518	1.000	2.708	1.559	1.272	3.390	1.342	1.382
25	2.752	2.721	2.553	3.432	2.476	2.802	2.122	2.947	2.648
26	3.571	3.241	3.334	2.920	3.121	3.013	1.111	3.382	3.300
27	2.519	2.881	2.870	2.831	3.170	3.189	2.776	3.288	3.199
28	3.057	3.343	2.677	3.076	2.88	2.638	3.417	2.748	3.074
29	3.128	2.888	2.931	3.111	2.961	2.802	2.873	3.393	3.506
30	3.085	3.014	2.814	3.075	2.915	2.982	3.025	2.980	3.187
31	3.027	3.285	3.010	2.720	3.077	2.740	3.287	3.214	3.280
32	3.109	2.823	3.107	3.593	3.035	2.663	2.811	3.294	2.968
33	3.644	3.179	3.423	2.777	3.274	3.168	3.061	3.450	3.710
34	2.844	2.743	2.642	2.147	2.847	2.942	3.204	2.769	2.613
35	2.927	2.873	2.642	2.000	2.764	2.639	3.347	3.377	2.994
36	2.662	2.329	3.103	2.586	2.485	2.587	2.744	3.034	3.009
37	2.359	2.629	3.022	3.293	2.541	1.394	2.999	2.848	3.135
38	1.635	1.882	1.695	2.662	2.116	2.199	2.741	2.345	1.735
39	2.084	2.180	2.270	2.793	2.343	2.402	2.943	2.248	3.356
40	2.776	2.896	2.778	2.662	2.796	2.524	1.970	2.345	2.973
41	3.084	2.943	2.899	2.565	2.669	2.297	2.068	2.248	3.286
42	2.642	2.796	3.148	2.989	3.241	2.025	2.514	2.745	2.657
43	2.730	2.609	2.499	2.501	2.317	2.499	2.773	2.717	2.340
44	2.987	2.913	2.808	2.586	2.783	2.450	3.506	3.007	2.883

Table 2.2a (continued): Realizing in time of ex-conjugations generations *Paramaecium caudatum*, n = 21, τ (days) = 94, t = 21-22°C.

days	The number of ex-conjugations							
	1	2	3	4	5	6	7	8
45		2.439			1.585	2.390	2.596	2.793
46		1.897			2.793	2.334	2.897	2.557
47		2.667			3.697	2.970	2.995	2.835
48		2.631			2.501	2.057	2.373	2.963
49		2.397			2.293	2.195	2.897	2.200
50		2.147			2.454	2.862	2.558	2.626
51		1.793			2.000	2.000	1.897	2.479
52		2.860			2.586	2.529	2.727	2.743
53		1.897			2.586	2.000	2.293	2.782
54		2.897			2.586	2.905	2.745	2.808
55		2.501			2.586	1.195	2.000	3.230
56		2.179			0	1.500	2.970	2.962
57		2.581				2.197	2.724	2.293
58		2.195				2.293	3.131	2.501
59		2.270				1.661	2.501	2.482
60		2.303				3.323	2.293	2.293
61		1.936				1.585	3.001	2.654
62		2.919				2.000	2.586	2.654
63		2.662				2.000	2.586	2.891
64		2.197				2.586	2.808	2.397
65		2.501				2.000	1.585	2.939
66		1.793				2.322	2.000	3.033
67		2.197				2.586	2.322	2.227
68		2.085				3.001	2.586	2.331
69		1.904				3.171	2.322	2.138
70		4.293				0.000	2.586	3.97
71		1.000				2.000	2.586	1.293
72		2.322				2.000	3.001	2.000
73		1.000				0	1.000	1.661
74		1.000					3.171	1.793
75		1.000					3.586	1.585
76		0					3.001	0.000
77							2.808	
78							3.586	
79							3.001	
80							2.586	
81							2.586	
82							0.000	
83							0.000	
84							2.000	
85							1.585	
86							0	
87								
88								

Table 2.2a (continued): Realizing in time of ex-conjugations generations *Paramaecium caudatum*, n = 21, τ (days) = 94, t = 21-22°C.

days	The number of ex-conjugations							
	1	2	3	4	5	6	7	8
89								
90								
91								
92								
93								
94								
95								
96								
No. of genera-tions	7,581	162,697	6,531	7,91	128,091	157,604	202,796	178,686

Table 2.2b: Realizing in time of ex-conjugations generations *Paramaecium caudatum*, n = 21, τ (days) = 94, t = 21-22°C.

days	The number of ex-conjugations								
	9	10	11	12	13	14	15	16	17
45	2.956	2.724	2.552	2.000	3.189	2.579	2.731	2.577	2.874
46	2.855	2.762	2.977	2.586	3.131	2.593	2.814	2.995	2.798
47	3.007	2.543	2.970	2.808	2.724	2.234	2.865	2.793	3.242
48	2.960	2.745	2.863	2.322	3.067	2.108	3.016	2.000	2.615
49	1.916	1.939	2.043	2.586	2.667	2.594	3.136	2.793	2.234
50	2.786	2.057	2.798	3.001	2.993	2.234	2.896	3.001	2.697
51	2.416	2.252	2.334	2.808	2.724	2.713	2.265	2.501	2.439
52	2.696	2.724	3.498	3.586	2.724	2.679	2.543	2.793	2.397
53	2.729	2.793	3.001	1.585	2.465	2.680	2.043	2.793	2.624
54	2.858	2.793	2.936	2.808	2.775	2.557	2.745	2.586	2.995
55	2.710	2.293	3.057	3.001	2.831	2.846	2.641	2.586	2.891
56	3.434	3.162	2.905	2.808	3.015	1.865	3.043	3.162	3.162
57	2.293	1.793	2.195	3.001	2.586	2.357	3.099	2.697	2.123
58	2.586	1.500	2.862	3.001	2.454	2.465	3.349	3.565	1.897
59	2.586	2.586	2.667	0	2.501	2.752	2.043	1.793	2.897
60	2.586	2.293	2.303		2.404	2.647	2.147	1.500	2.131
61	3.001	3.001	2.539		4.323	2.745	3.196	2.322	2.529
62	0	2.586	2.919		3.586	3.239	2.667	2.808	2.586
63		2.000	2.057		2.586	2.586	2.936	2.454	2.195
64		2.322	2.000		3.001	2.724	2.936	3.501	1.862
65		2.000	2.586		2.808	2.334	2.057	2.586	2.39
66		2.000	2.057		3.586	3.197	2.501	2.586	2.195
67		2.000	2.441		3.001	2.793	2.808	2.565	2.862
68		2.000	2.501		0	2.000	2.197	2.586	2.734
69		3.001	2.586			3.454	2.793	2.662	2.293
70		1.000	2.586			1.000	2.586	2.808	3.46
71		0	1.585			0	2.000	2.586	0
72			2.000				3.808	3.808	
73			2.000				1.000	2.000	

Table 2.2b (continued): Realizing in time of ex-conjugations generations *Paramaecium caudatum*, n = 21, τ (days) = 94, t = 21-22°C.

days	The number of ex-conjugations								
	9	10	11	12	13	14	15	16	17
74			1.000				3.001	2.000	
75			1.000				3.171	2.000	
76			1.585				3.171	2.586	
77			1.000				3.46.	3.001	
78			1.000				4.586	2.586	
79			0				3.001	2.586	
80							3.808	2.586	
81							2.808	2.000	
82							2.000	1.000	
83							2.586	0	
84							2.000		
85							1.000		
86							2.000		
87							0.000		
88							1.585		
89							1.000		
90							3.323		
91							2.586		
92							2.322		
Genera-tions no.	148, 272	164, 079	177, 169	142, 965	165, 249	161, 496	234, 544	200, 536	172, 01

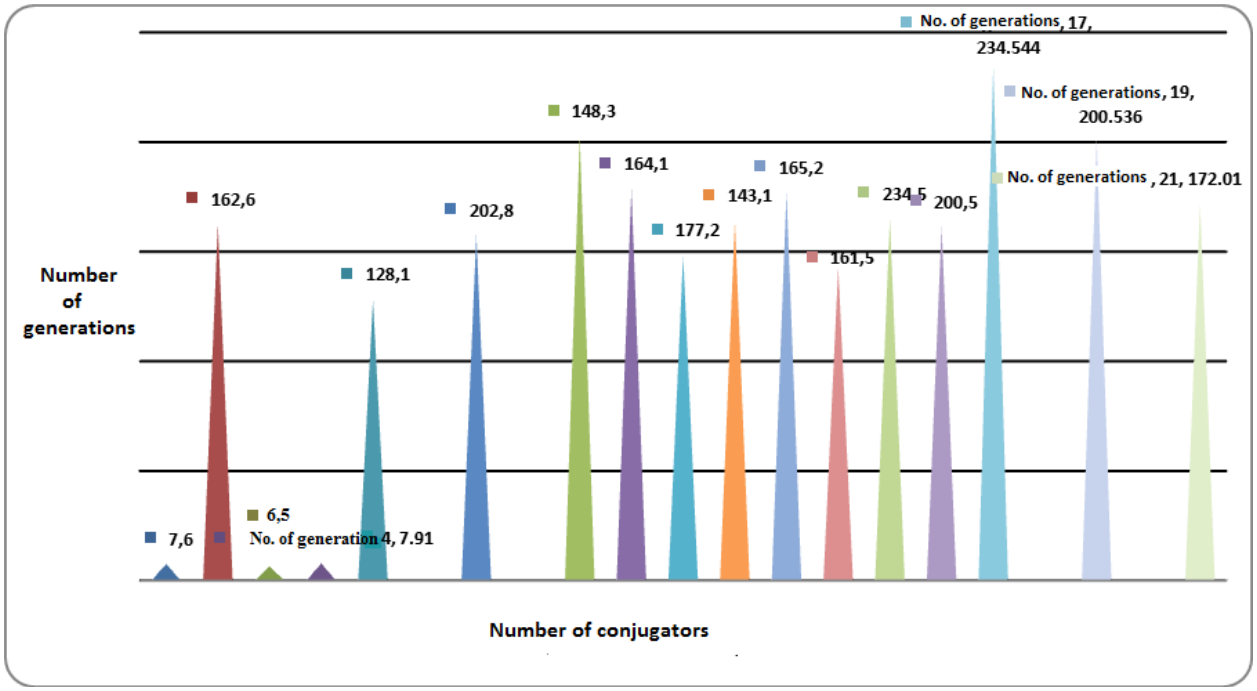

Figure 2: Number of generations and of conjugators.

Additionally, according to general systems theory, fusion information from two or more systems in a single system, not only means a sum of the bouth informational containts, but also their interaction, wich result a new quality, transformed into a special informational content.

CONCLUSIONS

The number of consecutive binary divizions at *Paramecium caudatum* significantly exceed (maximum of four times) "Hyflick's Limit" fixed in average for somatic cells. In exchange of genes and renovation of populational gen pool a limited number of individuals strain are framed. Average and maximum age of individuals in culture after a thousand repeats, represent 43 ± 2 and 140 binary divisions. Quantitative analysis, in normal conditions, showed values between seven and eight generations, while at some cases the index given, varied between 201 and 235.

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AUTHORS:

[1] *Elena SILITRARI*
esilitrari@yahoo.com
Moldova State University,
Faculty of Biology and Pedology,
Mihail Kogălniceanu Street 65A,
Chişinău, Moldavia,
MD-2009.
[2] *Andrei SILITRARI*
asilitrari@yahoo.com
Institute of Zoology,
Academy of Sciences of Moldova,
Academiei Street 1,
Chişinău, Moldavia,
D-2028.
[3] *Elena ROŞCOV*
lenuta_a@mail.ru
Moldova State University,
Faculty of Biology and Pedology,
Mihail Kogălniceanu Street 65A,
Chişinău, Moldavia,
MD-2009.

DIVERSITY OF STONEFLY (INSECTA, PLECOPTERA) COMMUNITIES IN THE GRĂDIŞTE WATERSHED (GRĂDIŞTEA MUNCELULUI-CIOCLOVINA NATURE PARK)

Angela CURTEAN-BĂNĂDUC [1]

KEYWORDS: Romania, Transylvania, Mureș Watershed, Plecoptera, coenology.

ABSTRACT

This paper presents an analysis of the structure and diversity of Plecoptera larvae communities in the Grădiște Watershed.

The results of this study are based on quantitative samples of benthic macroinvertebrates, taken in July-August 2011 from 51 sampling stations of the references area.

17 stonefly species were identified, belonging to 11 genera and six families. The stoneflies have high diversity in the Aninеș Brook and in the upper course of Grădiște River. Low diversity was recorded in the lower part of Grădiște River, downstream of the Grădiștea Muncelului-Cioclovina Nature Park limit, sectors in which the banks line was modified by cutting the bends, by removing arboreal riparian vegetation, by minor riverbed damming or by its location near residential areas. In the lower course of the river, upstream of the Orăștie locality and up to the confluence with the Mureș River, the plecopterans are no more present.

RESUMEN: Diversidad comunitaria de las moscas de roca (Insecta, Plecoptera) en la cuenca Grădiște (Parque Natural Grădiștea Muncelului-Cioclovina).

En este trabajo se presenta un análisis de la estructura y diversidad de las comunidades larvales de plecópteros en la cuenca Grădiște. Los resultados se basan en muestras cuantitativas de macroinvertebrados bénticos, tomadas durante 2011 (Julio-agosto) en 51 estaciones de muestreo. En lo referente a la zona 17, se identificaron 11 géneros y 6 familias de las moscas de roca. Este grupo presentó alta diversidad en Aninеș Brook y en la cabecera del Río Grădiște. Se registró poca diversidad en la parte baja del río, en la vecindad de los límites del Parque Natural Grădiștea Muncelului-Cioclovina; estos sectores, que se encuentran cercanos a áreas residenciales, presentan una línea costera modificada, carecen de vegetación ribereña o bien se han construido presas en sus tributarios. En la cuenca baja, desde la localidad de Orăștie hasta la confluencia con el río Mureș, los plecópteros ya no están presentes.

REZUMAT: Diversitatea comunităților de plecoptere (Insecta, Plecoptera) din bazinul hidrografic Grădiște (Parcul Natural Grădiștea Muncelului-Cioclovina).

Lucrarea prezintă o analiză a structurii și diversității comunităților larvelor de plecoptere din bazinul hidrografic Gădiște.

Rezultatele studiului se bazează pe probe cantitative de bentos prelevate în perioada iulie-august 2011 din 51 stații situate în zona de referință.

Au fost identificate 17 specii de plecoptere aparținând la 11 genuri și 6 familii. Comunitățile cu cea mai mare diversitate sunt prezente în pârâul Aninеș și în cursul superior al râului Grădiște. În cursul inferior al râului Grădiște, comunitățile de plecoptere prezintă diversitate mică, în aceste sectoare aflate în apropierea localităților, albia râului a fost modificată prin tăierea meandrelor și îndiguiri. În cursul inferior al râului, amonte de localitatea Orăștie până la confluența cu Mureșul, plecopterele nu mai sunt prezente.

INTRODUCTION

Due to the habitat needs (lithological substrata, high water velocity, good oxygenation, low organic load) and low resistance to pollution (Cao et al., 1997; Krno, 2007; Sánchez-Montoya et al., 2010; Curtean-Bănăduc and Olosutean, 2013), stonefly are indicators of the favourable ecological state of water courses, especially in the mountain and submountain area (Hilsenhoff, 1981; Lücke and Johnson, 2009; Péru and Dolédec, 2010; Törnblom et al., 2011; Couceiro et al., 2012; Monaghan and Soares, 2012).

This paper presents a specific analysis of the structure and diversity of Plecoptera larvae communities in the Grădiște Watershed, as a basis for establishment of zonation, management measures and future monitoring.

Few faunistic and chorological data concerning stoneflies in the studied area appear in the synthesis work of Kis (1974). Until present, coenological studies regarding stonefly larvae of the Grădiște River basin were not carried out.

Grădiște River is a first order tributary of Mureș River, located in the Central-South-Western part of Romania (Fig. 1). This river has its headwater at 1,659 m altitude, in the Orăștiei Mountains – a subdivision of Șureanu Mountains, Central Meridional Carpathians, and has a 51 km length, 399 km^2 basin surface and a multiannual average flow at the confluence with Mureș River of 2.00 m^3/s (195 m altitude) (Agenția Națională Apele Române – Cadastrul Apelor).

The majority of the Grădiște Watershed area was included in the Grădiștea Muncelului-Cioclovina Nature Park.

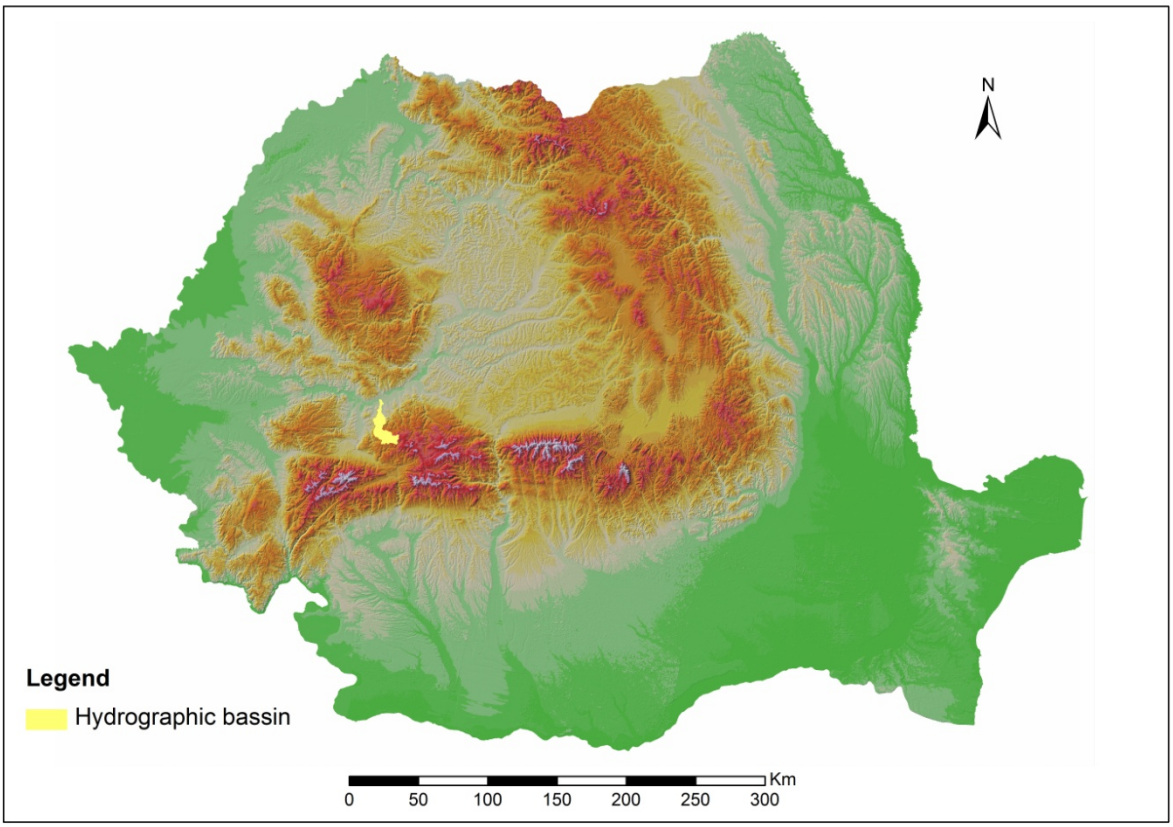

Figure 1: Grădiște River basin localisation on the Romanian map.

MATERIAL AND METHODS

The results of this study are based on quantitative samples of benthic macroinvertebrates (165 samples), taken in 2011 (July – August) from 51 stations situated in the Grădiște Watershed: 11 sampling stations on the Aninеș Brook, seven sampling stations on the Vale Rea Brook and 33 sampling stations on the Grădiște River (Fig. 2). The sampling stations were situated at a distance of approximately two km intervals at Grădiște River and one km intervals for the following river tributaries: Aninеș and Rea Valley. In the case of the Grădiște River, samples were also collected outside the Grădiștea Muncelului-Cioclovina Nature Park, along the whole length of this river to its confluence with Mureș River.

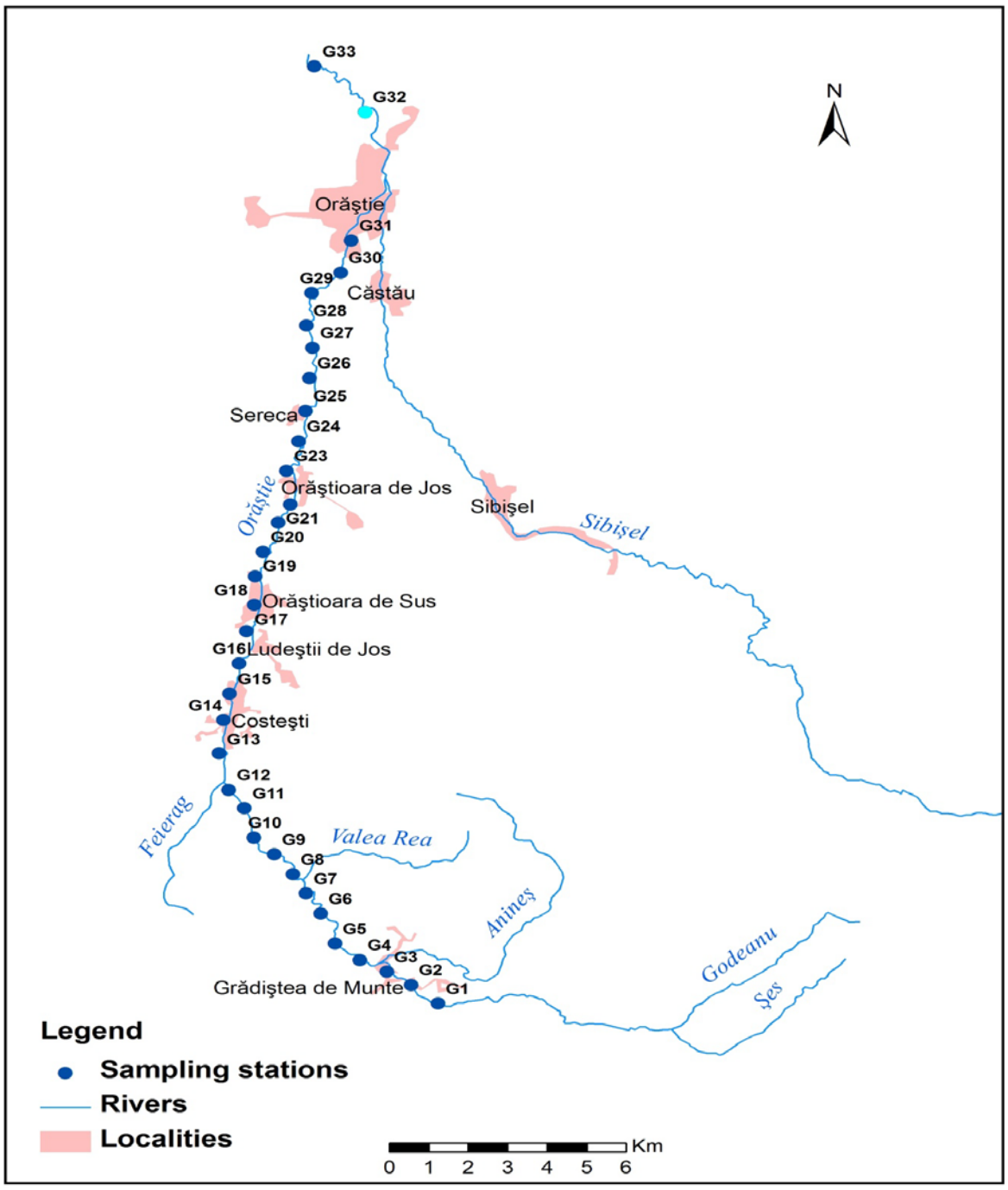

Figure 2: Grădiște River watershed sampling stations.

In each station, quantitative samples were taken from five different points. The sampling was carried out with an 887 cm^2 surface Surber Sampler, with a 250 µm mesh net. The sampled material was fixed in 4% formaldehyde solution ($NaHCO_3$ was added) and was analysed in the laboratory with an Olympus (150X) stereomicroscope.

The analysed Plecoptera larvae were comprised of 1,856 individuals, in life cycle stages which allowed identification to species level.

For quantitative structure description of the stonefly communities we have used relative abundance (A%) and medium density (Ds) of the species. The diversity of the community is expressed through Margalef (Krebs, 1989) and Gini-Simpson indices (Jost, 2007). The assessed biotope variables were: altitude, slope, riverbed width, depth, substratum types (visual evaluation), presence of pools, riffles, runs and bends, bank vegetation, channel modification and riverine land use.

RESULTS AND DISCUSSION

In the reference zone, 17 stonefly species were identified, belonging to 11 genera and six families. The stonefly species identified in Grădişte Watershed, with the specific sampling sites, are presented below:

Fam. Capniidae

Capnia bifrons (Newman 1839) – R1, R2

Fam. Leuctridae

Leuctra fusca (Linnaeus 1758) – A10, A11, R1, R6, R7, G1, G2, G3, G4, G6, G7, G8, G10, G11, G12, G13, G14, G15, G16, G17, G18, G19, G20, G21, G22, G23, G24, G25, G26, G27, G29, G30

Leuctra nigra (Olivier 1811) – A3, A4, A5, A11, R1, R6, R7, G6, G10, G11, G12, G20, G25, G26

Leuctra inermis Kempny 1899 – A2, A3, A4, A5, A7, A8, A9, A10, R1, R5, R7, G19, G25

Fam. Nemouridae

Amphinemura sulcicollis (Stephens 1836) – A4, A6, A8, A9, G6

Amphinemura standfussi (Ris 1902) – A5, A6, A7

Protonemura intricata (Ris 1902) – A1, A2, A3, A4, A5, A6, A8, A9, G1, G2, G3, G4, G5, G6, G9, G13, G17, G20

Nemoura cinerea (Retzius 1783) – A1, A2, A3, A4, A5, A10, A11, G1, G13, G20

Nemoura cambrica Stepens 1836 – A1, A2

Fam. Taeniopterygidae

Brachyptera risi (Morton 1896) – A3, A4, A5, A6

Brachyptera seticornis (Klapalek 1902) – A7, A8, A9

Rhabdiopteryx alpina Kuhtreiber 1934 – A1, A2

Taeniopteryx nebulosa (Linnaeus 1758) – A1, A2

Fam. Perlidae

Perla marginata (Panzer 1799) – R4, R5, R6, R7, G1, G2, G3, G4, G5, G6, G7, G8, G9, G10, G11, G12, G13, G14, G15, G16, G17, G18, G19, G20, G21, G23, G24, G25, G26, G29

Perla pallida Guerin 1838 – G6

Fam. Perlodidae

Isoperla grammatica (Poda 1761) – R3, R4, R5, R6, G14, G15

Perlodes microcephalus (Pictet 1833) – R2, R3, R4

The stonefly species with the widest distribution in the Grădişte Watershed are *Leuctra fusca* (present in 32 of the 48 studied lotic sectors) and *Perla marginata* (present in 30 of the 48 studied lotic sectors). The species with the most restricted distributions are *Perla pallida*, sampled only in one of the 48 studied lotic sectors, and *Rhabdiopteryx alpina*, *Taeniopteryx nebulosa*, *Nemoura cambrica*, *Capnia bifrons*, sampled in two of the 48 studied lotic sectors.

The species which develop populations with highest number of individuals (over 150 individuals/m^2) are *L. fusca* in Grădişte River – G6, G13-G21, G23-G25 and *P. marginata* in Grădişte River – G6, G7, G9 (Tab. 1).

In the reference area, the stoneflies group has the highest number of species (six sps.) and the highest species diversity according with Margalef Index in the Aninеș Brook – A2, A4, A5 and in the Grădiște River – G6 (Tab. 1). The lowest species diversity (one sp.) was recorded in the lower part of Grădiște River, downstream of the Grădiștea Muncelului-Cioclovina Nature Park limit – G22, G27, G30 (Tab. 1) sectors in which the shore line was modified by cutting the bends, removing arboreal riparian vegetation or minor riverbed damming, or was located near residential areas. We have to mention that in the G28 and downstream of G30 to the confluence with Mureș River no stonefly species was found, this sector is in the urban area of Orăștie (17,255 inhabitants).

The stonefly larvae communities with the highest heterogeneity (according to the Gini-Simpson Index) are present on the upper part of the Aninеș Brook (A1-A5) (Tab. 1).

In the reference area, the high diversity of stoneflies is associated with the river sectors with substrata formed by rocks and boulders with big and medium dimensions, with high speed of water, natural riverbed morphodynamic and riparian tree vegetation.

Similarity analysis of the communities of the 48 river sectors considered, based on the relative abundance of the species present, reveals the fact that these can be grouped in 11 classes (Fig. 3):

1. Communities with low specific diversity, in which the species *P. microcephalus* have relative abundances over 45%, are present in Valea Rea Brook – R2, R3 and R4;

2. Communities in which the species *L. fusca*, *L. nigra* and *P. marginata* appear with relative abundances over 15%, present in Valea Rea Brook – R6 and R7;

3. Communities in which the species *P. marginata* is numerical dominant, present in Grădiște River, the sector between G5 and G12;

4. Communities in which the species *L. fusca*, *P. intricata* and *P. marginata* are numerical codominants, present in Grădiște River G1-G4;

5. Communities in which numerical codominants are *P. intricata* and *B. risi*, present in A6;

6. Communities with high heterogeneity, in which numerical codominants are *R. alpina*, *P. intricata* and *N. cinerea*, present in A1;

7. Communities enriched by *L. inermis*, *A. sulcicollis*, *P. intricata* and *B. seticornis*, present in A8 and A9;

8. Communities enriched by *L. inermis*, *A. standfussi* and *B. seticornis*, present in A7;

9. Communities with relatively high heterogeneity, in which the species *L. inermis* appears with abundances over 25%, present in Aninеș Brook A2-A5, A10 and in Valea Rea Brook R1, R5;

10. Communities in which the species *N. cinrea* is numerically dominant, present in A11;

11. Communities with relatively low heterogeneity, in which numerically dominant is the species *L. fusca*, present in the middle and lower Grădiște River G13-G27 and G29-G30.

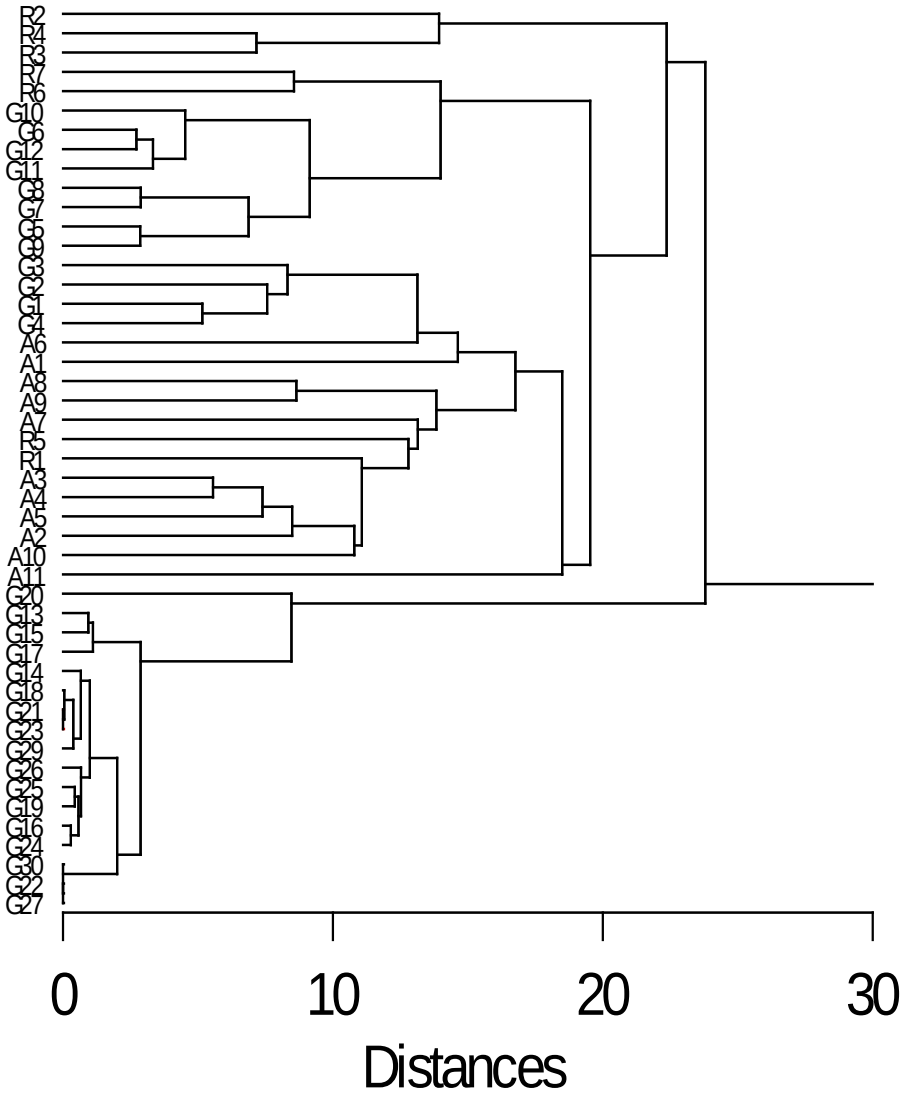

Figure 3: Cluster analysis based on relative abundance of Plecoptera species from each of 48 sampling stations in the Grădiște Watershed (A1-A11, R1-R7, G1-G30 sampling stations, Euclidian distance and average linkage method).

Table 1: Grădiște Watershed Plecoptera communities structure and the Biodiversity Indices values (D – average density, A – relative abundance).

Sampling stations/ GIS position	Plecoptera communities structure			Biodiversity Indices Margalef (M)/ Gini-Simpson (1-l)
	Species	D (ind./m^2)	A (%)	
A1	*Protonemura intricata* *Nemoura cinerea* *Nemoura cambrica* *Rhabdiopteryx alpina* *Taeniopteryx nebulosa*	33.82 33.82 22.55 45.10 11.27	23.08 23.08 15.38 30.77 7.69	M = 3.591/ 1-l = 0.833
A2	*Leuctra inermis* *Protonemura intricata* *Nemoura cinerea* *Nemoura cambrica* *Rhabdiopteryx alpina* *Taeniopteryx nebulosa*	67.64 22.55 33.82 22.55 22.55 22.55	35.29 11.76 17.65 11.76 11.76 11.76	M = 4.064/ 1-l = 0.838
A3	*Leuctra nigra* *Leuctra inermis* *Protonemura intricata* *Nemoura cinerea* *Brachyptera risi*	11.27 45.10 45.10 11.27 22.55	8.33 33.33 33.33 8.33 16.67	M = 3.707/ 1-l = 0.803
A4	*Leuctra nigra* *Leuctra inermis* *Amphinemura sulcicollis* *Protonemura intricata* *Nemoura cinerea* *Brachyptera risi*	22.55 67.64 45.10 56.37 33.82 33.82	8.70 26.09 17.39 21.74 13.04 13.04	M = 3.762/ 1-l = 0.850
A5	*Leuctra nigra* *Leuctra inermis* *Amphinemura standfussi* *Protonemura intricata* *Nemoura cinerea* *Brachyptera risi*	33.82 78.92 22.55 11.27 33.82 45.10	15.00 35.00 10.00 5.00 15.00 20.00	M = 3.843/ 1-l = 0.821
A6	*Amphinemura sulcicollis* *Amphinemura standfussi* *Protonemura intricata* *Brachyptera risi*	33.82 33.82 78.92 56.37	16.67 16.67 38.89 27.78	M = 2.390/ 1-l = 0.758
A7	*Leuctra inermis* *Amphinemura standfussi* *Brachyptera seticornis*	67.64 56.37 22.55	46.15 38.46 15.38	M = 1.795/ 1-l = 0.667
A8	*Leuctra inermis* *Amphinemura sulcicollis* *Protonemura intricata* *Brachyptera seticornis*	11.27 56.37 45.10 45.10	7.14 35.71 28.57 28.57	M = 2.618/ 1-l = 0.758
A9	*Leuctra inermis* *Amphinemura sulcicollis* *Protonemura intricata* *Brachyptera seticornis*	45.10 22.55 22.55 33.82	36.36 18.18 18.18 27.27	M = 2.881/ 1-l = 0.800
A10	*Leuctra fusca* *Leuctra inermis* *Nemoura cinerea*	22.55 67.64 56.37	15.38 46.15 38.46	M = 1.795/ 1-l = 0.667

Table 1 (continued): Grădiște Watershed Plecoptera communities structure and the Biodiversity Indices values (D – average density, A – relative abundance).

Sampling stations/ GIS position	Plecoptera communities structure			Biodiversity Indices Margalef (M)/ Gini-Simpson (1-l)
	Species	D (ind./m^2)	A (%)	
A11	*Leuctra fusca* *Leuctra nigra* *Nemoura cinerea*	45.10 11.27 67.64	36.36 9.09 54.55	M = 1.921/ 1-l = 0.618
R1	*Capnia bifrons* *Leuctra fusca* *Leuctra nigra* *Leuctra inermis*	33.82 33.82 56.37 90.19	15.79 15.79 26.32 42.11	M = 2.346/ 1-l = 0.743
R2	*Capnia bifrons* *Perlodes microcephalus*	45.10 112.74	28.57 71.43	M = 0.873/ 1-l = 0.44
R3	*Isoperla grammatica* *Perlodes microcephalus*	67.64 56.37	54.55 45.45	M = 0.960/ 1-l = 0.545
R4	*Perla marginata* *Isoperla grammatica* *Perlodes microcephalus*	22.55 45.10 78.92	15.38 30.77 53.85	M = 1.795/ 1-l = 0.641
R5	*Leuctra inermis* *Perla marginata* *Isoperla grammatica*	112.74 56.37 22.55	58.82 29.41 11.76	M = 1.625/ 1-l = 0.588
R6	*Leuctra fusca* *Leuctra nigra* *Perla marginata* *Isoperla grammatica*	67.64 45.10 56.37 33.82	33.33 22.22 27.78 16.67	M = 2.390/ 1-l = 0.778
R7	*Leuctra fusca* *Leuctra nigra* *Leuctra inermis* *Perla marginata*	33.82 78.92 45.10 56.37	15.79 36.84 21.05 26.32	M = 2.346/ 1-l = 0.766
G1	*Leuctra fusca* *Protonemura intricata* *Nemoura cinerea* *Perla marginata*	32.87 98.65 32.87 32.87	16.66 50.01 16.66 16.66	M = 2.438/ 1-l = 0.706
G2	*Leuctra fusca* *Protonemura intricata* *Perla marginata*	61.80 72.11 15.45	41.38 48.28 10.34	M = 1.795/ 1-l = 0.615
G3	*Leuctra fusca* *Protonemura intricata* *Perla marginata*	45.46 45.46 51.14	32.00 32.00 36.00	M = 1.795/ 1-l = 0.718
G4	*Leuctra fusca* *Protonemura intricata* *Perla marginata*	23.23 92.95 34.85	15.38 61.54 23.07	M = 1.795/ 1-l = 0.590
G5	*Protonemura intricata* *Perla marginata*	12.40 62.00	16.66 83.34	M = 1.183/ 1-l = 0.286
G6	*Leuctra fusca* *Leuctra nigra* *Amphinemura sulcicollis* *Protonemura intricata* *Perla marginata* *Perla pallida*	170.84 18.95 18.95 37.96 322.67 18.95	29.04 3.22 3.22 6.45 54.85 3.22	M = 2.914/ 1-l = 0.625

Table 1 (continued): Grădiște Watershed Plecoptera communities structure and the Biodiversity Indices values (D – average density, A – relative abundance).

Sampling stations/ GIS position	Plecoptera communities structure			Biodiversity Indices Margalef (M)/ Gini-Simpson (1-l)
	Species	D (ind./m^2)	A (%)	
G7	*Leuctra fusca* *Perla marginata*	26.75 173.91	13.33 86.67	M = 0.797/ 1-l = 0.209
G8	*Leuctra fusca* *Perla marginata*	28.4 102.35	21.73 78.27	M = 0.927/ 1-l = 0.409
G9	*Protonemura intricata* *Perla marginata*	52.99 158.96	25.00 75.00	M = 0.782/ 1-l = 0.409
G10	*Leuctra fusca* *Leuctra nigra* *Perla marginata*	64.49 5.86 76.21	44.00 4.00 52.00	M = 1.795/ 1-l = 0.538
G11	*Leuctra fusca* *Leuctra nigra* *Perla marginata*	43.83 21.92 116.89	24.00 12.00 64.00	M = 1.661/ 1-l = 0.567
G12	*Leuctra fusca* *Leuctra nigra* *Perla marginata*	37.58 6.26 68.90	33.33 5.55 61.12	M = 2.000/ 1-l = 0.600
G13	*Leuctra fusca* *Protonemura intricata* *Nemoura cinerea* *Perla marginata*	491.78 15.36 7.65 69.14	84.22 2.63 1.31 11.84	M = 1.748/ 1-l = 0.275
G14	*Leuctra fusca* *Perla marginata* *Isoperla grammatica*	525.68 46.35 5.14	91.08 8.03 0.89	M = 1.171/ 1-l = 0.18
G15	*Leuctra fusca* *Perla marginata* *Isoperla grammatica*	485.09 70.85 5.45	86.41 12.62 0.97	M = 1.177/ 1-l = 0.251
G16	*Leuctra fusca* *Perla marginata*	267.42 12.18	95.65 4.35	M = 0.715/ 1-l = 0.080
G17	*Leuctra fusca* *Protonemura intricata* *Perla marginata*	498.31 13.42 53.66	88.14 2.37 9.49	M = 1.177/ 1-l = 0.220
G18	*Leuctra fusca* *Perla marginata*	345.70 26.30	92.93 7.07	M = 0.659/ 1-l = 0.117
G19	*Leuctra fusca* *Leuctra inermis* *Perla marginata*	464.95 4.42 22.12	94.60 0.90 4.50	M = 1.217/ 1-l = 0.132
G20	*Leuctra fusca* *Leuctra nigra* *Protonemura intricata* *Nemoura cinerea* *Perla marginata*	171.35 45.07 4.50 13.52 31.56	64.42 16.95 1.69 5.08 11.86	M = 2.898/ 1-l = 0.587
G21	*Leuctra fusca* *Perla marginata*	258.06 19.25	93.06 6.94	M = 0.715/ 1-l = 0.153
G22	*Leuctra fusca*	67.64	100	M = 0/1-l = 0
G23	*Leuctra fusca* *Perla marginata*	190.93 14.24	93.06 6.94	M = 0.797/ 1-l = 0.111

Table 1 (continued): Grădiște Watershed Plecoptera communities structure and the Biodiversity Indices values (D – average density, A – relative abundance).

Sampling stations/ GIS position	Plecoptera communities structure			Biodiversity Indices Margalef (M)/ Gini-Simpson (1-l)
	Species	D (ind./m^2)	A (%)	
G24	*Leuctra fusca* *Perla marginata*	150.12 5.45	96.50 3.50	M = 0.873/ 1-l = 0.143
G25	*Leuctra fusca* *Leuctra nigra* *Leuctra inermis* *Perla marginata*	350.57 2.38 7.14 11.91	94.24 0.64 1.92 3.20	M = 1.976/ 1-l = 0.171
G26	*Leuctra fusca* *Leuctra nigra* *Perla marginata*	118.53 2.58 5.15	93.88 2.04 4.08	M = 1.921/ 1-l = 0.295
G27	*Leuctra fusca*	72.15	100	M = 0/1-l = 0
G29	*Leuctra fusca* *Perla marginata*	53.05 3.31	94.12 5.88	M = 1.431/ 1-l = 0.333
G30	*Leuctra fusca*	4.51	100	M = 0/1-l = 0

CONCLUSIONS

The structure and diversity of stonefly communities reveal the fact that the analysed lotic sectors situated in the Grădiștea Muncelului-Cioclovina Nature Park: Aninеș Brook, Valea Rea Brook, upper course of Grădiște River (G1-G21), and also the sector G23-G26 of the middle course (situated downstream the protected area limit) are in a good ecological status, with adequate lotic habitats for plecopterans, in an almost natural state.

In the sectors G22, G27, G29, G30 the plecopteran communities present a low diversity and density, a fact which indicates the degradation of characteristic lotic habitats. In these sectors are present hidrotechnical works, shore line changes by cutting of bends, embankments, and household and farm wastewater pollution generated by the riverine localities.

Downstream from G30 to the confluence with the Mureș River, plecopterans are not present, a situation which indicates the fact that this river sector is degraded; here anthropogenic impact is significant mainly due to humans cutting the bends, damming, and wastewater organic pollution.

So, in the lower course of Grădiște River, habitats rehabilitation measures and pollution prevention are necessary.

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*** Agenția Națională Apele Române – Cadastrul Apelor. (in Romanian)

AUTHOR:
[1] *Angela CURTEAN-BĂNĂDUC*
angela.banaduc@ulbsibiu.ro, ad.banaduc@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Applied Ecology Research Centre,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County,
Romania,
RO-550012.

DATA ON AQUATIC AND SEMI-AQUATIC HETEROPTERA (NEPOMORPHA, GERROMORPHA) IN THE MERIDIONAL CARPATHIANS (ROMANIA)

Daniela ILIE [1]

KEYWORDS: Nepomorpha, Gerromorpha, community, diversity, Southern Romanian Carpathians, apterous morph of *Gerris thoracicus*.

ABSTRACT

Our findings complement the distribution map of the aquatic and semi-aquatic Heteroptera species within the presented areas (the high mountain groups: Parâng, Făgăraş, Bucegi and the Curvature Carpathians), bringing new data in this regard. Compared to previous studies of the researched area, we have identified a total of 24 species, out of which 13 are reported for the first time. Some are more interesting from the faunistic perspective, for Romanian territory, being less recorded until the present. These are *Gerris costae* and *Gerris lateralis*. The numerical dominance of apterous morph was highly evident in species like *Gerris thoracicus*, within one of the habitats investigated in the Curvature Carpathians. We have also analyzed aquatic and semi-aquatic Heteroptera communities of sampling stations, thus establishing a certain similarity between them, based on quantitative data (the specie's relative abundance).

REZUMAT: Date privind heteropterele acvatice şi semi-acvatice (Heteroptera, Nephomorpha, Gerromorpha) din Carpaţii Meridionali (România).

Cercetările noastre vin să completeze harta distribuţiei speciilor de heteroptere acvatice şi semiacvatice din zonele prezentate (grupele montane mari: Parâng, Făgăraş, Bucegi şi Carpaţii de Curbură), aducând noi date în acest sens. Raportat la studiile realizate anterior, în zona cercetată am identificat un număr de 24 specii, dintre care 13 sunt semnalate în premieră. De remarcat sunt *Gerris costae* şi *Gerris lateralis*, specii cu puţine semnalări în fauna României. A fost evidenţiată dominanţa numerică a morfei aptere la specia *Gerris thoracicus* într-unul din habitatele investigate în Carpaţii de Curbură. Au fost analizate comunităţile de heteroptere acvatice şi semiacvatice din staţiile de colectare, stabilindu-se similaritatea dintre ele, pe baza datelor cantitative (abundenţa relativă a speciilor).

ZUSAMMENFASSUNG: Daten über aquatische und semiaquatische Heteropteren (Heteroptera, Nepomorpha, Gerromorpha) in den Südkarpaten Rumäniens.

Mit den Ergebnissen der vorliegenden Arbeit wird die Verbreitungskarte der aquatischen und semiaquatischen Heteropterenfauna in den Südkarpaten Rumäniens mit neuen Angaben ergänzt. Dabei wurden die folgenden Gebirgsmassive untersucht: Parâng, Făgăraş, Bucegi und der Karpatenbogen. Im Vergleich zu früheren Studien wurden im untersuchten Gebiet 24 Arten festgestellt von denen 13 für die Gebiete neu sind. Erwähnenswert sind die Arten *Gerris costae* und *Gerris lateralis*, für die es in der Fauna Rumäniens wenige Angaben gibt. In einem der im Karpatenbogen untersuchten Habitate wurde eine numerische Dominanz der flügellosen Morphe der Art *Gerris thoracicus* festgestellt. An den jeweiligen Sammelstellen wurden die aquatischen und semiaquatischen Heteropteren-Gemeinschaften untersucht, wobei aufgrund der quantitativen Daten die Ähnlichkeiten zwischen ihnen (relative Häufigkeit der Arten) festgestellt wurde.

INTRODUCTION

The Study on aquatic and semi-aquatic Heteroptera communities in mountain areas of Romania has been a deep concern of research during the recent years (Ilie and Olosutean, 2009; Olosutean and Ilie 2008, 2010). However, the published data only covers the north and west of the Romanian Carpathian mountains. The present study provides an accurate overview, aimed at spotlighting the Heteroptera communities in the Southern Carpathians.

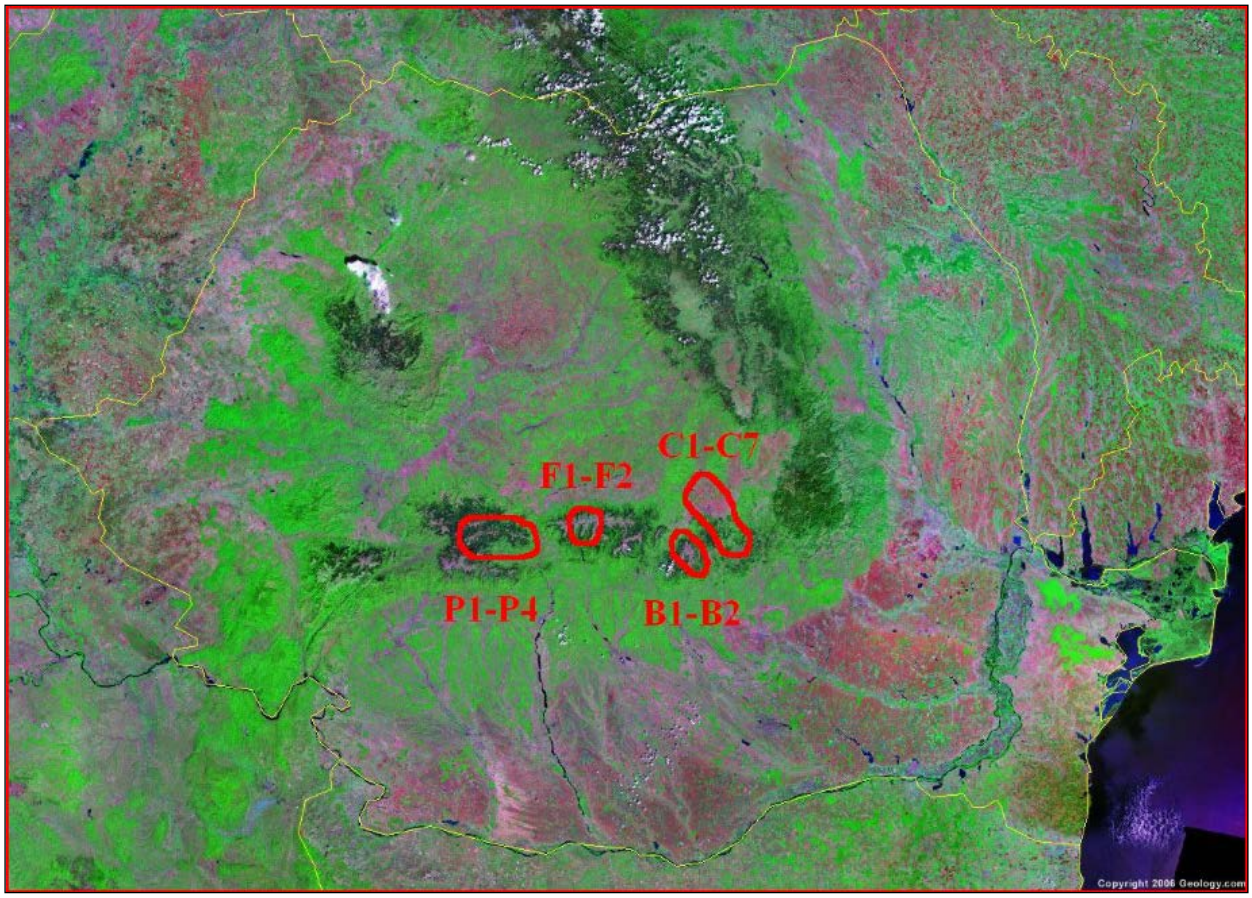

Figure 1: Mountainous areas in which collections were carried out:
P1-P4: Parâng; F1-F2: Făgăraş; B1-B2: Bucegi;
C1-C7: the Curvature Carpathians.

Aquatic and semi-aquatic Heteroptera are included in two infra-orders – Nepomorpha and Gerromorpha – from the Heteroptera (Stys and Kerzhner, 1975). Out of these two Romanian territory infra-orders, 70 species were identified (67 Heteroptera species listed in Ilie, 2009; three new species published by Berchi in 2011, 2012, 2013). These insects are important components of aquatic ecosystemsand fulfill multiple roles in trophic chains.

MATERIAL AND METHODS

The Heteroptera species list was developed based on bibliographic research (Paina, 1975) and based on our own collection. The study was conducted in the Southern part of the Romanian Carpathians, namely in these high mountain groups: Parâng, Făgăraş, Bucegi and the Curvature Carpathians groups (Fig. 1). Our own collections were made in different field campaigns, during September and October 2001, September 2002, August and October 2004 and August, September 2011.

The biological material was collected from 15 stations in different habitats, namely rivers, streams, lakes and ponds (with a permanent or temporary water supply), located from 400 m altitude to 2,000 m.

In Parâng Mountains group, we have collected from four sampling stations, as follows:

Figure 2: P1 sampling station.

Figure 3: P3 sampling station.

P1 (Fig. 2) – the pools are located near Oaşa dam (towards dam tail); which were formed in an anthropic manner, following the work undertaken within the Transalpina road building; the deep pools are about 0.5-1 m; the substrate is oozy and herbaceous vegetation is present on the marshes banks; the human impact is also reduced.

P2 – collection stations are situated in the riverbed of Sadu River, upstream from the village with the same name; the substrate is rocky, vegetation is poorly developed due to soil skeleton and floods. Sadu River's hydrological regime is strongly influenced by hydro technical environment.

P3 (Fig. 3) – the pool is situated on the border of a Sadu Village, formed by the contributions made by spring sources located in the terminal flysch, as well as from the rain accumulations. It has variable levels and has become a pool degraded by running and grazing cattle, making the vegetation difficult to grow.

P4 – the pools are in the Lotrului Gorge, near the confluence with the Olt River. They are located on the right side of the Lotru River, approx. 30 m away from it; they developed from excavations performed around the year of 1990; these pools are supplied from a leaking underground and flysch slope; the maximum depth is 70 cm; the substrate is composed of gravel, over which there is a very thin layer of mud; the vegetation is represented by *Typha latifolia*, *Juncus conglomeratus*, *Cyperus fuscus*; the human impact is also reduced.

Figure 4: F1 sampling station.

Figure 5: B1 sampling station.

In the Făgăraş Mountains group, we collected from two stations, namely:

F1 (Fig. 4) – the sampling station is situated on the Bozghi brook, a tributary of the Sâmbata River (located on the North side of Făgăraş Mountains); the mountain brook has a rich and uniform flow of Carpathian type; there is a bare riparian vegetation, while the banks are covered by specific plants of the forest which is crossing it; there is no human activity in either the specified area, or upstream.

F2 – Bâlea Lake is a typical glacial lake, stuck in the Bâlii pot, near the threshold which separates the former cirque and the glacier valley. It has a mixed collecting process, represented by the Bâlea river origin; the lake has an area of 4.6 ha and a maximum depth of 11.35 m; unfortunately, within the lake, no ecological tourism is practiced.

Within Bucegi Mountain group, we performed collections from two stations:

B1 (Fig. 5) – the sampling station is located on a creek crossed by the road between the villages of Râşnov and Tohanu Nou (three km to Râşnov and five km to Tohanu Nou); the average depth is less than 0.5 m, the substrate is muddy, while the herbaceous vegetation is present along the banks; the human impact on the stream is quite strong.

B2 – the station is situated on the Prahova River, near the Azuga locality; the river's depth in the collection section is under 0.5 m; the substrate consists of gravel, riparian vegetation is present; near the watercourse the gravel is being extracted.

Figure 6: C1 sampling station.

Figure 7: C6 sampling station.

In Curvature Carpathians Group Mountains, we collected from seven stations, namely:

C1 (Fig. 6) – the "Tău fără fund" (bottomless) lake of Mateiaş Village perimeter. The lake is located on the left side of the Olt River, stuck in the terrace deposits, thus, allowing the groundwater to feed the lake; it covers an area of 870 hectares, and is surrounded by *Salix* sp., *Phragmites communis* and *Typha latifolia*; the submerged and natant vegetation occupies over half of the lake, while the human impact is quite reduced.

C2 – the sampling station is situated on the Doftana Ardeleană River (tributary of Târlung River), crossed by the no. 1 National Road; the water depth is less than 0.5 m, the substrate is rocky and rough, and the water is flowing fast; the collection process was conducted in a low speed water area, within a very restricted surface.

C3 – wetland located near Berii Valley, from Ciucaş Mountain, with direct access to the no. 1A National Road Cheia – Braşov (located approximately 29.2 km from Săcel), in a protected area environment, which has been stated in the "Natura 2000 Site".

C4 – a stagnant sector of a stream, which was created by the river crossing under the road (the National Road no. 1A) probably due to the difference of level; the collection sector is located in the forest and is heavily shaded; furthermore, the aquatic vegetation is well developed, and there is also bright water (unfilled aquatic plants areas); the human impact is reduced.

C5 – the sampling station is located on a river crossed by National Road no. 1A, and can be defined by its small stream and rocky substrate; water is shaded by the trees within the forest and has a whitish color, possibly due to the activities of the sheepfolds upstream.

C6 (Fig. 7) – the ponds in the major riverbed of Teleajen River, upstream from the Cheia town, the swamps have small dimensions, of max. 10 m^2; the substrate is muddy; in the banks there are hydrophilic plants and sometimes boulders; in the ponds are numerous pieces of trees' fallen branches, which are present in the area, while the human impact is quite reduced.

C7 – the sampling station is represented by a ditch on the road (National Road no. 1) where there is underground and rain pipe connection; the ditch is about two meters in length and 30-40 cm width.

RESULTS AND DISCUSSION

Sporadic investigations carried out on aquatic and semi-aquatic Heteroptera, in Parâng Mountains groups, Făgăraş, Bucegi and Curvature Carpathians, mentioned in the reference section, have led to the identification of fifteen species, out of which nine are aquatic species and six are semi-aquatic.

In this scientific study, we have identified a total of 24 Heteroptera species, out of which 13 are reported for the first time: *Aquarius paludum, Gerris costae, Gerris lateralis, Microvelia reticulata, Velia caprai, Mesovelia furcata, Mesovelia vittigera, Micronecta (Dichaetonecta)* sp., *Hesperocorixa linnaei, Sigara limitata, Sigara striata, Sigara iactans* and *Notonecta viridis*. Some are more interesting from the faunistic perspective, for the Romanian territory, being less recorded until the present. These are *Gerris costae* and *Gerris lateralis* (Tab. 1). Most widespread Heteroptera species are *Notonecta glauca* (present in ten stations of the four major mountain groups), *Notonecta viridis* and *Gerris lacustris* (present in every one of the eight sampling stations, and which have not been reported in the Făgăraş area).

In the Parâng Mountains group, there were seven Heteroptera species reported, three species in Făgăraş Mountain group, 16 species in Bucegi group and 26 species of aquatic and semi-aquatic Heteroptera, in the Curvature Carpathians. We do consider the number of species identified up to date as being proportionately equal with the favorable habitats number found in these large mountain groups (I personally had seven stations out of which I have collected Heteroptera in Curvature Carpathians, while in Făgăraş I had only two stations), as well as with the accessibility in those areas (in Bucegi group, a greater number of researchers collected, and this is why the access ways are better represented).

The number of Heteroptera species per station varies from one species to 17 species, the best conditions for aquatic and semi-aquatic Heteroptera are to be found in a lake situated in the Perşani Mountains (Curvature Carpathians group) at an altitude of about 520 m (station C1) (Tab. 2a, b).

Table 1: Status of species reported to date in the southern part of Romanian Carpathians, where P, F, B, C – own collections developed in Parâng Mountain area, Făgăraş, Bucegi, namely Curvature Carpathians Mountain Area; P bibl., F bibl., B bibl., C bibl. – bibliographic references from Parâng, Făgăraş, Bucegi namely Curvature Carpathians Mountain Area; (1) – Montandon A. L., 1907; (2) – Soós A., 1959; (3) – Sienkiewicz I., 1960; (4) – Sienkiewicz I., 1964; (5) – Fesci S., 1969. All authors are taken from Paina, 1975.

Taxons	P	P bibl	F	F bibl	B	B bibl	C	C bibl
Infraorder Gerromorpha								
Fam. Gerridae								
Aquarius paludum (Fabricius 1794)					+			
Gerris lateralis Schummel 1832					+			
Gerris (Gerris) thoracicus Schummel 1832						+3	+	
Gerris (Gerris) costae (Herrich-Schaeffer 1850)	+							
Gerris (Gerris) argentatus Schummel 1832						+3	+	
Gerris (Gerris) odontogaster (Zetterstedt 1828)						+3	+	
Gerris (Gerris) lacustris (Linnaeus 1758)	+				+		+	+5
Fam. Veliidae								
Microvelia reticulata (Burmeister 1835)			+				+	
Velia (Plesiovelia) caprai Tamanini 1947			+					
Fam Hebridae								
Hebrus (Hebrusella) ruficeps Thomson 1871						+3.4		
Fam. Hydrometridae								
Hydrometra stagnorum (Linnaeus, 1758)							+	+5
Fam Mesoveliidae								
Mesovelia furcata Mulsant and Rey 1852							+	
Mesovelia vitigera Horváth 1895							+	
Infraorder Nepomorpha								
Fam. Corixidae								
Micronecta (Dichaetonecta) sp. Hitchinson 1940							+	
Corixa punctata (Illiger 1807)						+3	+	
Hesperocorixa linnaei (Fieber 1848)							+	
Hesperocorixa sahlbergi (Fieber 1848)						+1.3		
Hesperocorixa parallela (Fieber 1860)		+2				+1.3		
Sigara nigrolineata (Fieber 1848)	+					+2.3	+	
Sigara (Retrocorixa) limitata (Fieber 1848)							+	
Sigara (Sigara) striata (Linnaeus 1758)							+	
Sigara (Subsigara) iactans Jansson 1983							+	
Fam. Naucoridae								
Ilyocoris cimicoides (Linnaeus 1758)							+	+5
Fam. Nepidae								
Nepa cinerea Linnaeus 1758	+				+		+	+5
Ranatra (Ranatra) linearis (Linnaeus 1758)								+5
Fam. Notonectidae								
Notonecta (Notonecta) viridis Delcourt 1909	+				+		+	
Notonecta (Notonecta) glauca Linnaeus 1758	+		+		+	+3	+	+5
Fam. Pleidae								
Plea minutissima Leach 1817						+3	+	

Table 2a: Structure of aquatic and semi-aquatic Heteroptera communities of sampling stations (relative abundance values).

Species	P1	P2	P3	P4	F1	F2	B1	B2
Aquarius paludum							0.125	
Gerris lateralis								0.048
Gerris costae	0.444							
Gerris lacustris				0.250			0.375	0.048
Microvelia reticulata						0.333		
Velia caprai					1.000			
Sigara nigrolineata			0.654	0.250				
Nepa cinerea		0.500					0.125	
Notonecta viridis	0.222		0.077	0.500				0.238
Notonecta glauca	0.333	0.500	0.269			0.667	0.375	0.667

Table 2b: Structure of aquatic and semi-aquatic Heteroptera communities of sampling stations (relative abundance values).

Species	C1	C2	C3	C4	C5	C6	C7
Gerris thoracicus				0.963			
Gerris argentatus	0.174						
Gerris odontogaster	0.006						
Gerris lacustris	0.003		0.600	0.037		0.141	0.083
Microvelia reticulata	0.208						
Hydrometra stagnorum	0.003						
Mesovelia furcata	0.035						
Mesovelia vitigera	0.016						
Micronecta sp.		1.000					
Corixa punctata	0.013						0.014
Hesperocorixa linnaei	0.006						
Sigara nigrolineata						0.141	0.292
Sigara limitata	0.003						

Table 2b (continued): Structure of aquatic and semi-aquatic Heteroptera communities of sampling stations (relative abundance values).

Species	C1	C2	C3	C4	C5	C6	C7
Sigara striata	0.129						
Sigara iactans	0.060						
Ilyocoris cimicoides	0.271						
Nepa cinerea	0.006		0.400			0.087	0.069
Notonecta viridis	0.006				0.500	0.370	0.083
Notonecta glauca	0.035				0.500	0.261	0.458
Plea minutissima	0.025						

Our previous research has showed that populations of *Gerris thoracicus* are usually monomorphic (macropterous) (Ilie, 2009). At station C4 we found the numerical dominance of apterous morph (12 apter females and 11 apter males, namely two macropter females and one macropterous male). Vepsäläinen (Vepsäläinen, 1974) suggests that, under certain conditions (for example early summer and warm habitats) *Gerris thoracicus* is able to develop a seasonally restricted dimorphism connected with the production of a second generation. The specimens were collected on 08/16/2011, during a very hot summer. It is possible that they helped produce the second generation, macropterous.

The diversity of aquatic and semi-aquatic Heteroptera communities of the investigated habitats, estimated by Shannon Wiener index is maximum in C1 (recorded value 2.05) and minimum in F1 and C2 (recorded value of 0.00 due to collection of a single species in each one) (Fig. 8). It is important to note that the Shannon Wiener's index value for station C6 (where we have identified five species) – namely 1.48 – is greater than for C7 station (where we have identified six species) – namely 1.38. Nevertheless, the values for P1 and P4 (which were identified by three species) – 1.06 namely 1.04 – are higher than in station B2 (although there have been identified four species) – 0.90 – illustrating aquatic and semi-aquatic heteroptera communities more stable for stations with higher values of Shannon Wiener index.

The degree of similarity between the communities of the 15 stations is generally high, except for C1, C4, C2 and F1 (Fig. 9). The group formed by C5 and B2 is featured by flowing water habitats, with vegetation present only on the banks with rocky substrate, strong anthropogenic impact, low depth, at an altitude of over 1,000 m, where there have been identified both species of the *Notonecta* genus, while their relative abundance are larger. F2 joins the group, due to their relative abundance identical value recorded by *Notonecta glauca* species to that of B2.

The group formed by C6 and P4 is featured by stagnant water habitats and by a low anthropogenic impact, with similar species funds (three species in common, including *Notonecta viridis*), similarly represented in the community (proportional values of relative abundance).

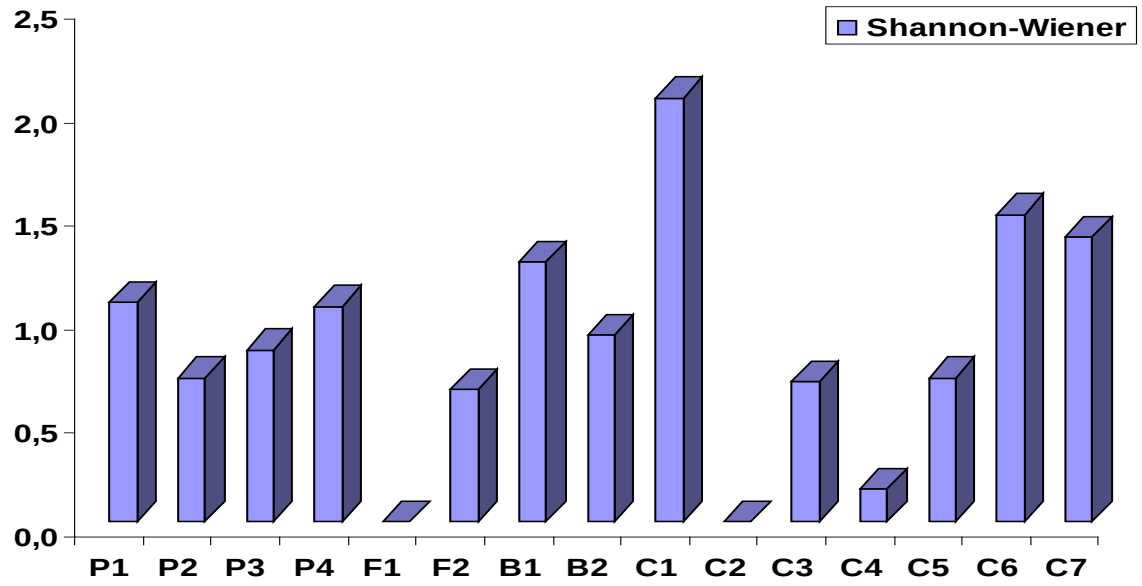

Figure 8: α – Diversity (Shannon-Wiener index)
of aquatic and semi-aquatic Heteroptera, of sampling stations.

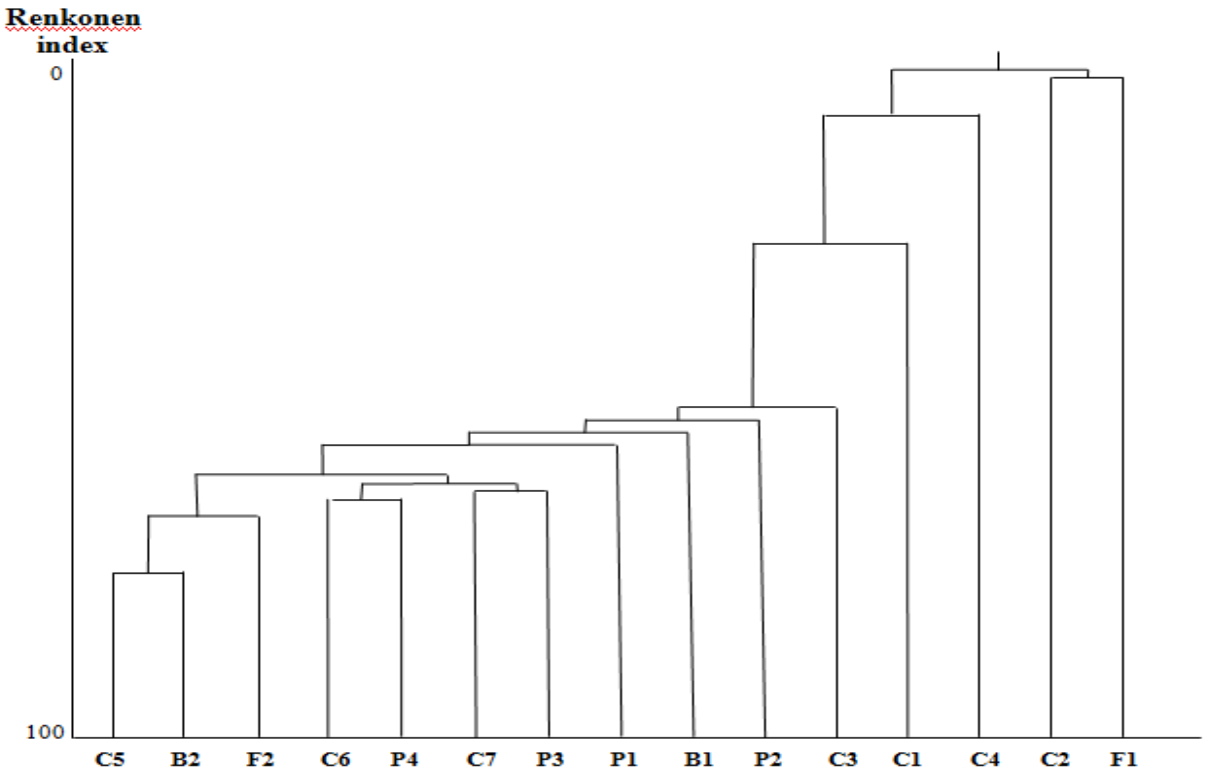

Figure 9: The similarity between aquatic and semi-aquatic Heteroptera communities defined by Renkonen percentage similarity index, clustering method “nearest neighbor”.

Group C7 – P3 is featured by stagnant and shallow water, rich vegetation, anthropogenic impact but not very intense, with direct lighting and similar relative abundance of the notonectide species.

C2 and F1 communities due to the collecting of a single species, are isolated from the others.

CONCLUSIONS

Compared with the fauna of the Northern or Western Romanian Carpathians, aquatic and semi-aquatic Heteroptera fauna which has been identified in the Southern Carpathians investigated areas, is characterized mainly by a high specific diversity.

We do underline the presence of *Gerris lateralis* and *Notonecta viridis* species, stipulated in the mountain groups in Parâng, Bucegi and Curvature Carpathians. The other seven species which have not been identified in the Northern and Western Romanian Carpathians, but are reported during this study, appear in private and very favorable conditions met by one habitat from the Curvature Carpathians (C1).

The differences between large mountain groups in the South of the Carpathians, in terms of Heteroptera fauna, have arised from the different number of favorable habitats identified in these groups.

The aquatic and semi-aquatic Heteroptera communities diversity and the similarity degree between the investigated habitats communities are determined by habitat features (water velocity, water depth, hygrophyte and hydrophilic vegetation, altitude, human impact, etc.).

The *Gerris thoracicus* species' population of station C4 is dominated by the apterous morph, unlike populations from other investigated habitats in the Carpathians or in other areas of the country, where the macropterous morph represents the dominant element.

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AUTHOR:

[1] *Daniela Minodora ILIE*
iliedf@yahoo.com
"Lucian Blaga" University of Sibiu, Faculty of Sciences,
Department of Ecology and Environmental Protection,
Dr. Ioan. Raţiu Street 5-7,
Sibiu, Sibiu County,
Romania, RO-550160.

DOES THE USE OF DIFFERENT BAITS COMPENSATE FOR SHORT TERM SAMPLINGS OF FOREST BEETLES (COLEOPTERA, CARABIDAE, SCARABEIDAE) AND ANTS (HYMENOPTERA, FORMICIDAE)?

Horea OLOSUTEAN [1], *Ioan TĂUŞAN* [2] and *Florin POPESCU* [3]

KEYWORDS: Forest beetles, forest ants, pitfall traps, multiple baits, Grădiștea Muncelului-Cioclovina Nature Park.

ABSTRACT

The forest beetle and forest ant communities from two forest associations in the Grădiștea Muncelului-Cioclovina Nature Park were investigated in the summer of 2012. Pitfall traps with different baits were used in order to find out whether the method can offer a better picture on the community if only a short sampling period is available. The study showed that, besides the obvious differences in community composition between the two forest associations, forest beetle and forest ant species have specific bait preferences, and clear differences are found between the three types of bait used (ethyl alcohol, beer and fruits). The results prove that short-term sampling periods can be compensated by the use of different baits.

REZUMAT: Poate utilizarea momelilor diferite să compenseze colectările pe perioade scurte de timp în cazul coleopterelor forestiere (Coleoptera, Carabidae, Scarabeidae) și a furnicilor (Hymenoptera, Formicidae)?

Coleopterele și furnicile forestiere din două asociații vegetale, din Parcul Natural Grădiștea Muncelului-Cioclovina au fost investigate în vara anului 2012. Capcane Barber cu momeli diferite au fost amplasate cu scopul de a afla dacă metoda poate oferi o imagine mai bună asupra comunităților studiate în condițiile unor colectări de scurtă durată. Studiul a arătat că, pe lângă diferențele evidente dintre comunitățile celor două asociații vegetale studiate, diferitele specii de coleoptere și furnici forestiere capturate au preferințe specifice pentru o anume momeală și diferențe clare au fost observate între cele trei tipuri de momeală folosite (alcool etilic, bere și fructe). Rezultatele demonstrează că o colectare de scurtă durată poate fi compensată de folosirea mai multor momeli.

ZUSAMMENFASSUNG: Kann die Verwendung verschiedener Köder kurze Sammelperioden bei der Erfassung von waldbewohnenden Käfern (Coleoptera, Carabidae, Scarabaeidae) und Ameisen (Hymenoptera, Formicidae) kompensieren?

Während des Sommers 2012 wurden waldbewohnende Käfer und Ameisen aus zwei unterschiedlichen Waldgesellschaften im Naturpark Grădiștea Muncelului-Cioclovina untersucht. Dabei wurden Barberfallen mit verschiedenen Ködern ausgesetzt, um herauszufinden, ob die Anwendung dieser Fangmethode bei kürzeren Sammelzeiten ein besseres Bild über die Artenzusammensetzung der untersuchten Gemeinschaften liefern kann. Die Untersuchungen haben gezeigt, dass außer den offensichtlichen Unterschieden in der Zusammensetzung der Käfer- und Ameisen-Gemeinschaften der beiden Pflanzengesellschaften spezifische Köderpräferenzen bestehen, wobei deutliche Unterschiede zwischen der Annahme der drei verwendeten Köderarten (Ethanol, Bier und Früchte) sichtbar werden. Die Ergebnisse belegen, dass Sammelperioden über eine kurze Zeitspanne durch die Verwendung unterschiedlicher Köder ausgeglichen werden können.

INTRODUCTION

Pitfall trapping is a widespread method used for monitoring ground-dwelling arthropods assemblages (Greenslade and Greenslade, 1971; Southwood and Henderson, 2000). Despite criticism (Topping and Sunderland, 1992; Topping, 1993; Majer, 1997; Missa et al., 2009), pitfall traps yield a wide range of invertebrates; particularly spiders, ground beetles and ants (Weeks and McIntyre, 1997; Ward et al., 2001; Corti et al., 2013).

Every technique has both advantages and disadvantages. However, pitfall traping is a better choice than other methods (e.g. the quadrat method) due to a more efficient capture rate, a higher number of collected taxa and reduced sampling effort (Tisa and Fiedler, 2011; Corti et al., 2013). Moreover, besides being a low cost method, it provides a better overview of the site because it can detect species from surrounding patches (several dozen meters in diameter) (Véle et al., 2009).

Several factors influence pitfall catches: preservative (Koivula et al., 2003; Schmidt et al., 2006; Jud and Schmidt-Entling, 2008; Chen et al., 2011; Tăușan et al., 2012), color (Buchholz et al., 2010), cover of traps (Buchholz and Hannig, 2009), spacing and transect design (Ward et al., 2001; Perner and Schueler, 2004; Larsen and Forsyth, 2005; Sabu and Shiju, 2010) and type of bait (Greenslade and Greenslade, 1971; Marsh et al., 2013). In the latter case, baits are easier to operate and yield faster results, but are prone to disadvantages such as feeding preferences or invertebrate activity (Wang et al., 2001), and are selective and may attract specific species (Greenslade and Greenslade, 1971).

Typical baits consist mainly of sugar (sucrose), syrups (sucrose in water), beer, rotting fruits, meat, dung, carrion and alcohol (Greenslade and Greenslade, 1971; Romero and Jaffe, 1989; Marsh et al., 2013).

The time used for a single experiment is also very flexible, ranging from two days (Greenslade, 1973) to as much as three years (Clarke and Bloom, 1992).

Since the use of different baits could enhance catches of ground-dwelling arthropods with behavioral flexibility (Greenslade and Greenslade, 1971), our main goal was to establish if a short sampling using different baits has the potential of offering sufficient information about the ground-dwelling arthropod community and can be used as an alternative to longer sampling periods.

MATERIAL AND METHODS

Sampling area

The area investigated is located in the central part of the Grădiștea River basin, upstream from its exit from the Grădiștea Muncelului-Cioclovina Nature Park (Fig. 1). Samples were taken from the two versants of the valley. The western versant, covered by a beech forest (Carpino-Fagetum), has sampling points encoded B1 to B4. The eastern versant, covered by a locust tree plantation, has sampling points encoded L1 to L4.

Biological material

Samples were taken using pitfall traps made of 280 ml glass jars. Four sets of traps were installed in each of the two habitats investigated, at 50 meters from each other. Each set consisted of three pitfall traps with three different baits: 96% ethylic alcohol, beer and fruits (we used peaches cut in small chunks). Individuals sampled were preserved in 96% alcohol prior to their identification.

Species identification was conducted using keys provided by Gîdei and Popescu (2012) for forest beetles, and by Czechowski et al. (2012) for forest ants. Biological material was identified using a 65X Kruss Stereomicroscope.

Species nomenclature is presented according to Fauna Europaea (Lopez-Colon, 2013; Radchenko, 2013; Vigna Taglianti, 2013).

Statistical analysis

Cluster analysis (Lance and Williams, 1966) was performed in order to group the sampling stations using the number of sampled individuals. Non Metrical Dimensional Scaling (NMDS – Rabinowitz, 1975) was performed in order to group individual samples, pointing out their contribution to the community sampled from each station. Data processing was conducted in SYSTAT 13 (Systat Software Inc., 2012) and R (R Dev. Core Team).

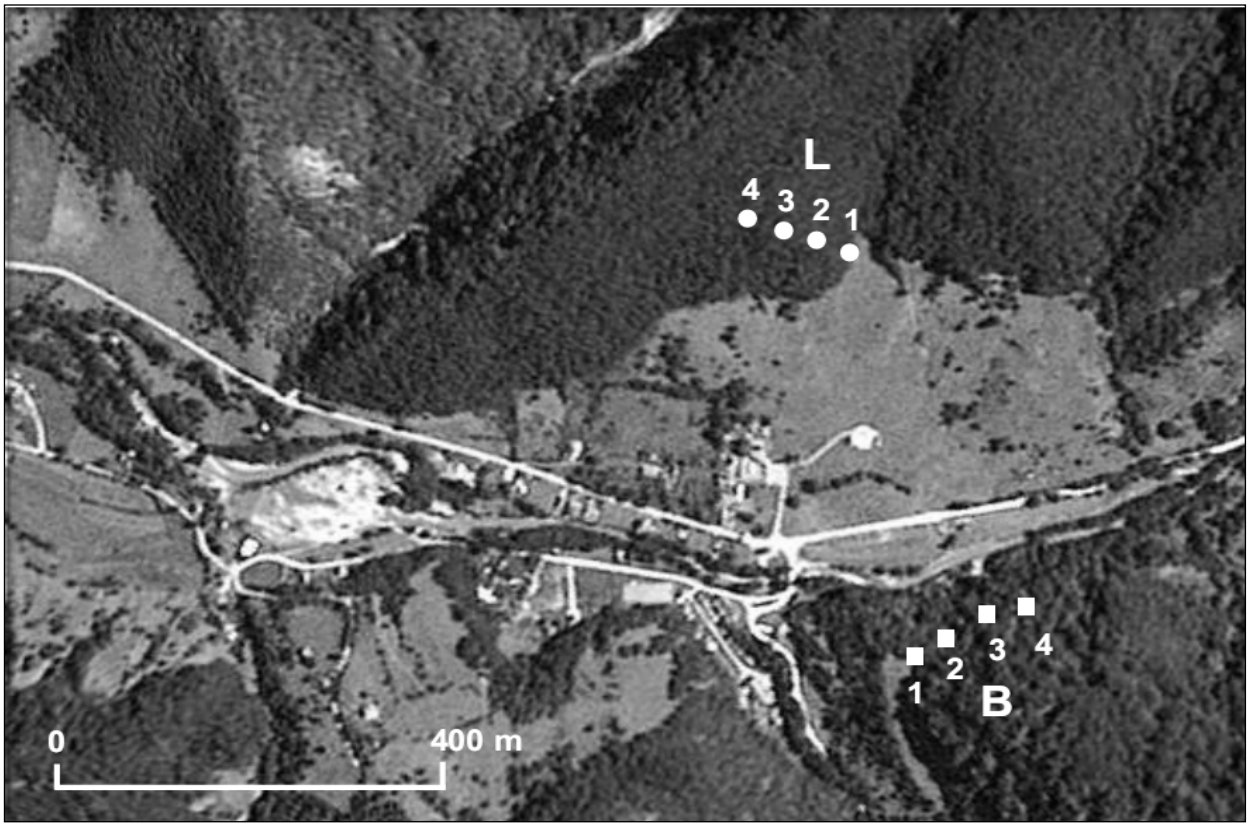

Figure 1: Location of the sampling stations in the Grădiștea River basin (B – beech forest; L – locust tree plantation).

RESULTS AND DISCUSSION

Fourteen species of interest for the 1,194 individuals were sampled from the two investigated habitats (Tab. 1). Six species of forest ants: *Lasius (Lasius) platythorax* Seifert 1991, *Formica (Serviformica) fusca* Linnaeus 1758, *Tetramorium* cf. *caespitum*, *Myrmica ruginodis* Nylander 1846, *Myrmica scabrinodis* Nylander 1846 and *Temnothorax crassispinus* (Karavaiev 1926), and eight species of forest beetles, of which five belong to the Carabidae family: *Carabus (Chrysocarabus) auronitens escheri* Palliardi 1825, *Oodes gracilis* Villa and Villa 1833, *Oodes helopioides* (Fabricius 1792), *Deltomerus* (*Deltomerus*) *carpathicus* (Miller 1868) and *Sphodrus leucophthalmus* (Linnaeus 1758), and three to the Scarabeidae family: *Ceruchus chrysomelinus* (Hochenwart 1785), *Cetonia aurata* (Linnaeus 1761) and *Bolboceras armiger* (Scopoli 1772). Alongside this species, members of the Coleopteran families Anobiidae and Staphylinidae were sampled, but they were not identified at species level.

The two versants and, consequently, the two forest associations sampled seem to have distinct communities of both forest beetles (Fig. 2) and forest ants (Fig. 3). The locust tree plantation hosts higher ant diversity, confirming the findings of B. Seifert (in verbum) and B. Marko (in verbum) about the regularly low ant diversity in pure beech forests. Forest beetles, on the other hand, have a rather similar diversity in the two habitats, with a larger number of individuals sampled in the beech forest.

Table 1: List and presence of forest beetles and ants from the investigated area of this study.

Station / Taxa	S1	S2	S3	S4	F1	F2	F3	F4
Order Coleoptera								
Family Carabide								
Carabus auronitens escheri Palliardi, 1825	✸		✸	✸				
Oodes gracilis Villa and Villa, 1833	✸					★		
Oodes helopioides Fabricius, 1792							★	
Deltomerus carpathicus Miller, 1868						★		
Sphodrus leucophthalmus Linnaeus, 1758					★	★	★	
Family Scarabaeidae								
Ceruchus chrysomelinus (Hochenwart, 1785)	✸							
Cetonia aurata (Linnaeus, 1758)				✸				
Bolboceras armiger (Scopoli, 1772)							★	★
Family Staphylinidae		✸	✸			★		★
Family Anobiidae				✸				
Order Hymenoptera								
Family Formicidae								
Lasius platythorax Seifert, 1991	✸	✸	✸					
Formica fusca Linnaeus, 1758				✸				
Tetramorium cf. *caespitum* (Linnaeus, 1758)				✸				
Myrmica scabrinodis Nylander, 1846		✸	✸	✸				
Myrmica ruginodis Nylander, 1846		✸		✸	★	★	★	★
Temnothorax crassispinus (Karawajew, 1926)							★	★

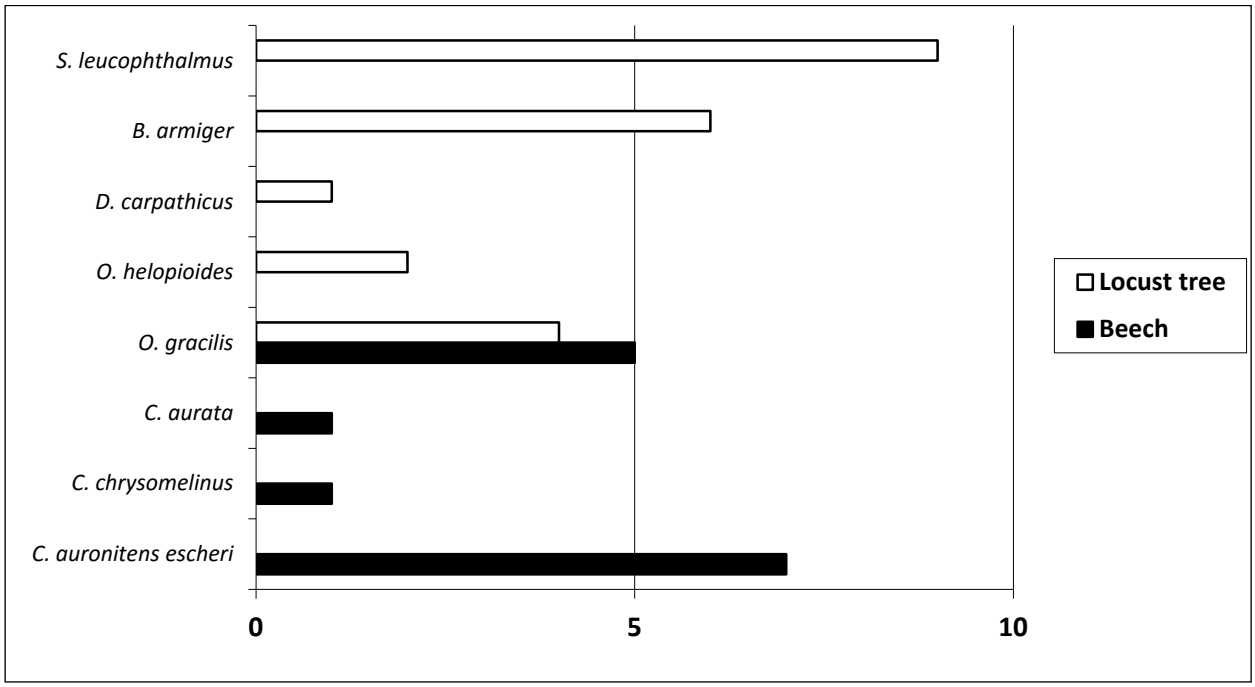

Figure 2: Distribution of forest beetles in the two investigated habitats.

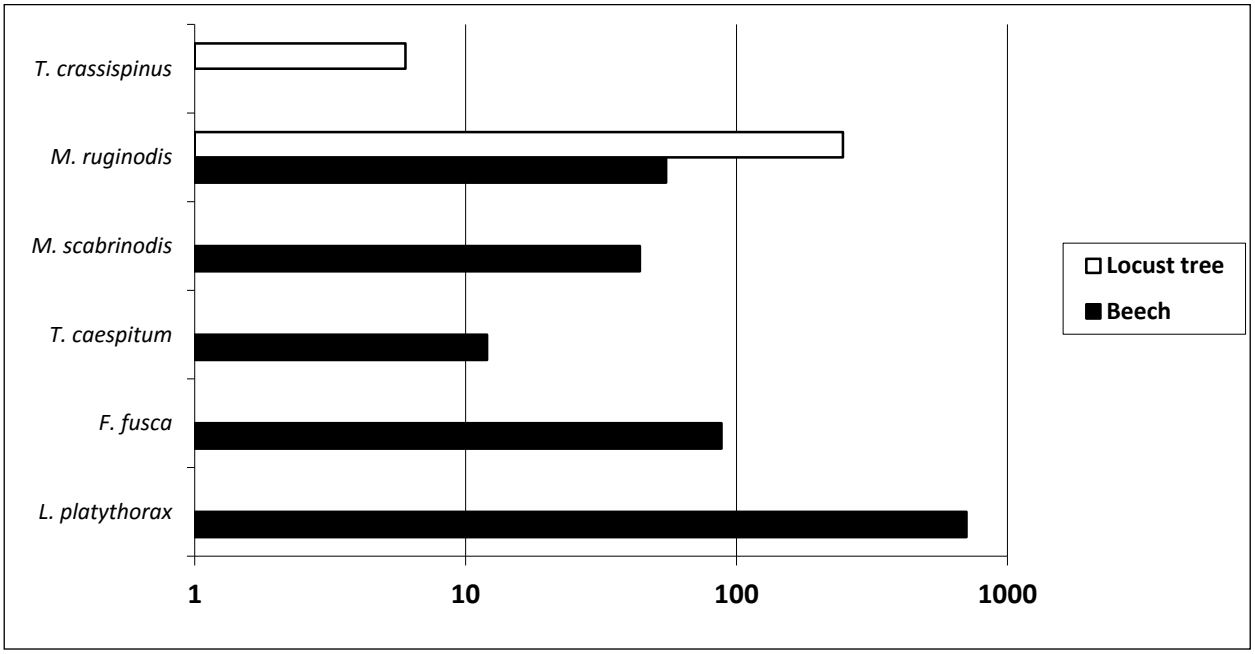

Figure 3: Distribution of forest ants in two investigated habitats (abscissa logarithmically scaled).

The differences of the two communities are also pointed out by the clustering analysis (Figs. 4 and 5). The sampling points are grouped into separate clades for both ants and forest beetles. The difference is that ant communities are closely distanced in the beech forest, due to their lower diversity, as discussed before. The forest beetle communities are closer for the locust tree plantation, due to the lower number of individuals sampled.

The preferences of the individual species for the baits used in this specific experiment are also very clear. The ant species collected, *L. platythorax* and *T. crassispinus*, seem to prefer pitfall traps with chunks of fruit. *M. scabrinodis* and *T.* cf. *caespitum* preferred the ones with just ethylic alcohol. *M. ruginodis* and *F. fusca* are more abundant in traps filled with beer (Fig. 6).

As for the forest beetles, they were trapped only in the pitfall traps with ethylic alcohol and beer, and their preferences are not as clear as those of the ants (Fig. 7). Four species; *D. carpathicus, S. leucophthalmus, B. armiger* and *O. helopioides* seem to prefer beer as bait, while *O. gracilis* is the single species mostly present in pitfall traps with ethylic alcohol. The remaining three species, *C. auronitens escheri, C. chrysomelinus* and *C. aurata* equally prefer the two baits in which forest beetles were trapped.

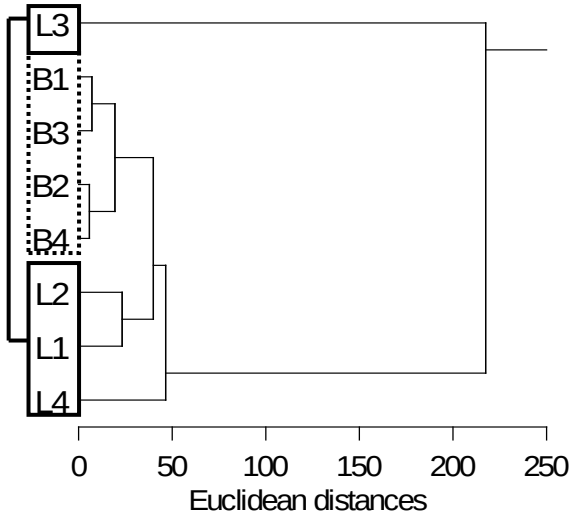

Figure 4: Cluster of sampling points' similarity; forest ants (Euclidean distances, average linkage).

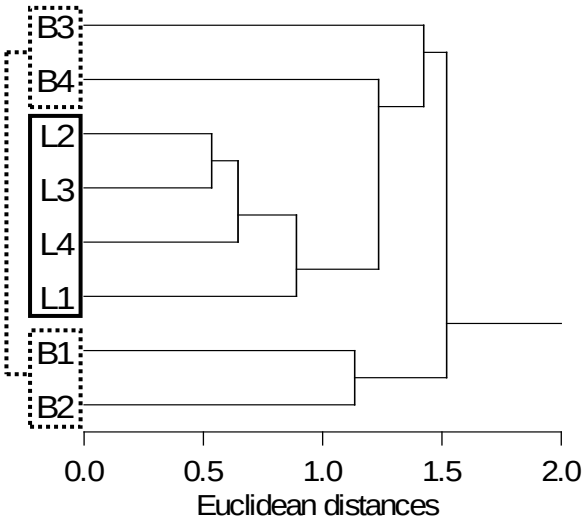

Figure 5: Cluster of sampling points' similarity; forest beetles (Euclidean distances, average linkage).

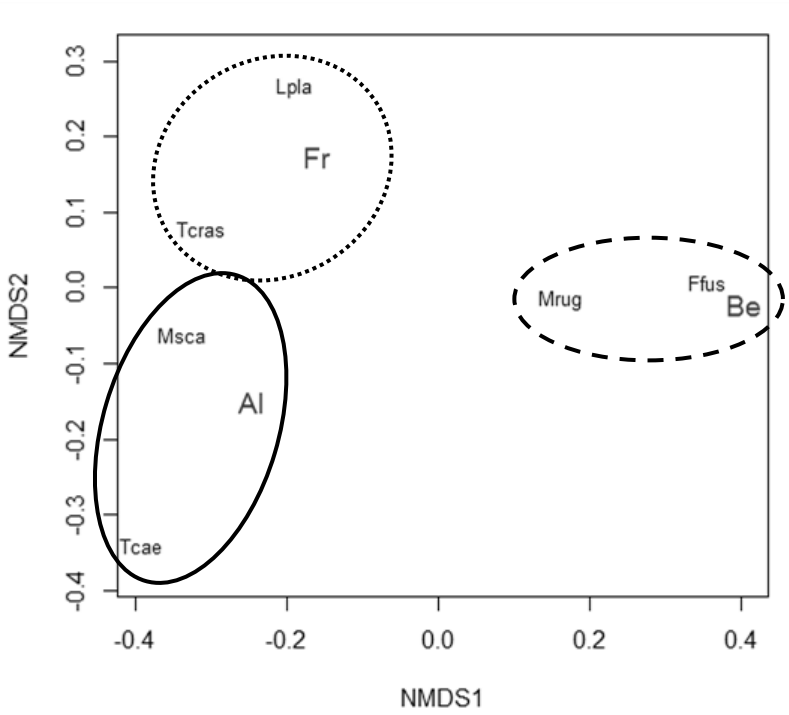

Figure 6: NMDS ordination of forest ant communities from the investigated habitats based on the presence of the most abundant species (Bray-Curtis index of similarity, Stress = 0; Tcras – *T. crassispinus*, Lpla – *L. platythorax*, Msca – *M. scabrinodis*, Mrug – *M. ruginodis*, Ffus – *F. fusca*, Tcae – *T. caespitum*).

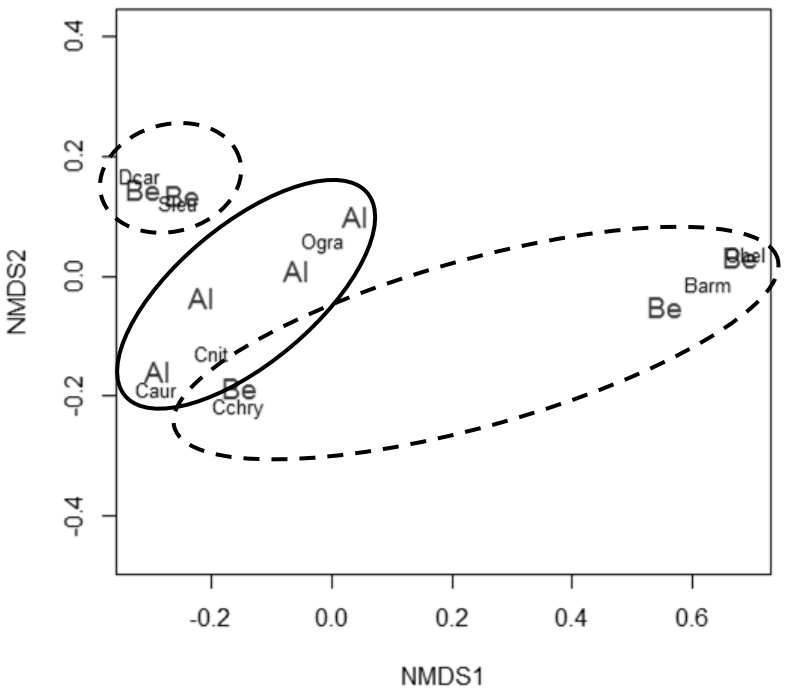

Figure 7: NMDS ordination of forest beetle communities from the investigated habitats based on the presence of the most abundant species (Bray-Curtis index of similarity, Stress = 0; Caur – *C. auronitens escheri*, Ogra – *O. gracilis*, Ohel – *O. helopioides*, Dcar – *D. carpathicus*, Sleu – *S. leucophthalmus*, Cchr – *C. chrysomelinus*, Caur – *C. aurata*, Barm – *B. armiger*).

CONCLUSIONS

The investigated area presents a relatively low diversity of forest beetles and ants, probably due to the short period of sampling.

There are clear differences between the ant and beetle communities of the beech forest, with a low diversity of ants and a higher number of forest beetle individuals, and of the locust tree plantation, where ants are finding better habitat conditions.

Both ant and beetle species seem to have distinct preferences for one of the three baits we used for pitfall traps with a clearer preference in the ant species.

The multiple traps with different baits method is, therefore, suitable for practical use if small periods of sampling time are available because it has the potential to provide a better image of the ground-dwelling insects community.

ACKNOWLEDGEMENTS

The authors would like to thank the administration of the Grădiștea Muncelului-Cioclovina Nature Park for their support during the field campaigns, and Mr. Drăgulescu C., who provided information about the forest associations investigated.

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AUTHORS:

[1] *Horea OLOSUTEAN*
mesaje.facultate@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Applied Ecology Research Center,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

[2] *Ioan TĂUȘAN*
ionut_tausan2007@yahoo.com
Brukenthal National Museum,
Natural History Museum,
Cetății Street 1,
Sibiu, Sibiu County, Romania,
RO-550160.

[3] *Florin POPESCU*
popescu_florinn@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

ROMANOGOBIO KESSLERII (DYBOWSKI, 1862) FISH POPULATIONS MANAGEMENT DECISIONS SUPPORT SYSTEM FOR ROSCI0132 (TRANSYLVANIA, ROMANIA)

Angela CURTEAN-BĂNĂDUC [1], *Ioana-Cristina CISMAŞ* [2] and *Doru BĂNĂDUC* [3]

KEYWORDS: Natura 2000, Kessler's gudgeon, habitats, threats, pressures, management.

ABSTRACT

The ADONIS:CE was used to create a model of *Romanogobio kesslerii* species that presents all the requirements for habitat, the indicators that assure a favorable conservation status – the adequate measures, the species pressures, and threats.

The main threats to *Romanogobio kesslerii* (Dybowski, 1862) populations in ROSCI0132 are: the over sedimentation with mud of the microhabitats due to a wrong soil management in the watersheds, which influence negatively this fish species characteristic substrate for reproduction and it's benthic macroinvertebrate trophic resources, diminishing water flow quantities, appearance and spreading of some competitor fish species, wrong hidrotechnical works in riverbeds, riparian vegetation harm, permanent difuse pollution sources with sinergical effects, poachery, waste dumps near the rivers, and river regulations.

REZUMAT: Sistem suport pentru deciziile de management a populațiilor de pești *Romanogobio kesslerii* (Dybowsky, 1862) pentru ROSCI0132 (Transilvania, Romania).

ADONIS:CE a fost utilizat pentru crearea unui model pentru specia *Romanogobio kesslerii* care prezintă toate cerințele de habitat, indicatorii care asigură starea de conservare favorabilă – măsurile adecvate de management, presiunile și amenințările asupra speciei.

Amenințările principale asupra populațiilor de *Romanogobio kesslerii* (Dybowski, 1862) în ROSCI0132 sunt: sedimentarea excesivă cu nămol a habitatelor, datorită unui management greșit a solului în bazinele hidrografice, ceea ce influențează negativ substratul caracteristic pentru reproducere al acestei specii și resursele trofice de macronevertebrate bentonice, reducerea debitelor lichide a râurilor; apariția și răspândirea unor specii de pești competitoare, construcții hidrotehnice greșite în albiile râurilor, distrugerea vegetației ripariene, sursele de poluare difuze permanente cu efecte sinergice cum sunt depozitele de deșeuri în proximitatea râurilor, braconajul, regularizarea râurilor.

RESUMEN: Sistema de apoyo para decisiones de manejo de poblaciones del pez *Romanogobio kesslerii* (Dybowski, 1862) en ROSCI0132 (Transilvania, Rumania).

El ADONIS:CE se utilizó para crear un modelo para la especie *Romanogobio kesslerii*, la cual presenta tanto los requerimientos concernientes al hábitat, como los indicadores que aseguran un estado favorable de su conservación – medidas adecuadas acerca de las presiones y amenazas que enfrenta esta especie.

Las principales amenazas a las poblaciones de *Romanogobio kesslerii* (Dybowski, 1862) en ROSCI0132 son: sobre-sedimentación de fango en los micorhábitats debido a una mal manejo de suelos en las cuencas hidrológicas, lo cual afecta negativamente el sustrato característico que esta especie necesita para reproducirse; disminución de sus recursos tróficos bentónicos (macroinvertebrados), reducción del flujo de agua, aparición y dispersión de especies de peces competidores, trabajos hidro-técnicos deficientes en los cauces de los ríos, daño a la vegetación riparia, difusión permanente de contaminantes con efectos sinérgicos, pesca furtiva, descarga de aguas negras en zonas cercanas a los ríos y mala regulación de los mismos.

INTRODUCTION

The EU member countries, are obligated to protect all the Habitats Directive (Annex 2) species and they should not permit the decline of ecological status generated by the people activities (*, 1992). The Romanian Natura 2000 sites, including those selected for the conservation of the fish species, were designated for their ecological status preservation. The acceptance of site proposals relied upon specific criteria, such as: well preserved, stable and healthy fish populations, typical natural habitats, favorable geographical position, and relatively low human activities impact. There are a couple of ways, based on which the Natura 2000 European network can ameliorate the European Union member countries' nature conservation: the building of institutional capacity; the broadening of the natural areas aboveground; raising awareness, and last but not least the applying of proper management plans for the natural protected areas (Bănăduc, 2007a, 2010, 2011; Bănăduc et al., 2012; Curtean-Bănăduc and Bănăduc, 2008).

Among the fish species of community interest is *Romanogobio kesslerii* (Dybowski, 1862). These fish are living in the middle course of the relatively big rivers. They prefer a speed of the water of 45-70/90 cm/s, sandy substratum and relatively shallow water sectors. Often many individuals can be found together in groups. The reproduction seems to be in the month of June. They spawn in shallow river sectors over sand or gravel. The dead vegetation debries appeared to be a positive factor for the reproduction areas selection. The eggs are layed down on the substrate and are attached to the substrate. The food consists mainly of diatoms and small psamofilic organisms. Both alevines and adults are active in the day time period. (Bănărescu, 1964; Bănărescu and Bănăduc, 2007)

In Romania, the distribution area of the *Romanogobio kesslerii* is more fragmented than it was half a century ago (Bănărescu, 1964), human impact being the main reason, impact which is dissimilar from one watershed sector to another, even in some nature protected areas (Battes et al., 2005, 2009; Bănăduc, 2005, 2007a, b, 2008; Bănăduc and Curtean-Bănăduc, 2013; Bănăduc et al., 2013; Bănărescu, 1964; Bănărescu and Bănăduc, 2007; Oţel, 2007; Radu et al., 2008; Simalcsik et al., 2004; Telcean and Bănărescu, 2002; Telcean and Cupșa, 2009a, b; Meșter et al., 2003; Ureche, 2008).

The actual structure of the fish communities, which includes *Romanogobio kesslerii* species, in ROSCI0132 (Natura 2000 site Oltul Mijlociu – Cibin – Hârtibaciu) reveal less individual numbers as a consequence of long term human activities impact. The distribution ranges of the fish associations and their relative abundance variation in this Natura 2000 site reflects the relative effect of lotic habitat quality in the Olt River watershed (Bănăduc 1999, 2000, 2005; Curtean-Bănăduc et al., 2007; Curtean-Bănăduc and Bănăduc, 2001, 2004a, b; Curtean et al., 1999).

In the global trend in which the lotic systems become a more and more valuable resource, the human activities impact on them will change its magnitude (Curtean-Bănăduc and Bănăduc, 2012).

If this trend continues in the future, no general "cook book type" management elements are enough to be used in all nature protected areas, because different habitat characteristics should be evaluated. Only after this moment specific management elements should be adjust and proposed for the local habitats' specific conditions.

Lately, the modeling techniques of process are more and more utilized to obtain a so called "big picture" of distinct systems and/or actions of whatever domain. The modeling techniques of process are utilized to ease the interpretion process stages for proper management. The tools of modeling are basically software products, products used to make and/or analyze models of business organizations, and to reveal information about models. Three primary functions are targeted: documenting a present situation, analyzing the effects of

possible changes and documenting plans to switch the present situation in a different direction. As a final result they offer the possibility to make different diagrams which include the needed management elements (Hall and Harmon, 2005).

The purposes of this study are to reveal the present state of the *Romanogobio kesslerii* population in the ROSCI0132 Natura 2000 site, to highlight the present human impact threats and pressures, to propose management measures for the preservation and increase of this species conservation status based on a management model created on specific requirements of this fish species and its specific habitat indicators, as a support system for management decisions.

MATERIAL AND METHODS

The ROSCI0132 area (45.682778 lat., 24.324444 long., 2826.10 ha, between 314 and 568 m altitude) is situated in Braşov, Sibiu and Vâlcea Romania administrative units (county/județ), both in the Alpine and Continental biogeographic regions. This protected area was designated for a number of ten fish species, belonging to the Annex 2 of the Habitats Directive (92/43/EEC), (*Gobio kessleri* code 2511 (*Romanogobio kesslerii*), *Pelecus cultratus* code 2511, *Barbus meridionalis* Natura 2000 code 1138, *Cobitis taenia* code 1149, *Sabanejewia aurata* code 1146, *Rhodeus sericeus amarus* Natura 2000 code 1134, *Zingel streber* code 1160, *Zingel zingel* code 1159, *Aspius aspius* code 1130 and *Gobio uranoscpus* code 1122). (*)

The lotic sectors of the studied area where *Romanogobio kesslerii* were found are revealed in figure 1.

The fish individuals were sampled in 2011-2014, with active and/or passive fishing nets and by electrofishing, followed by on field identification, and release in their habitats.

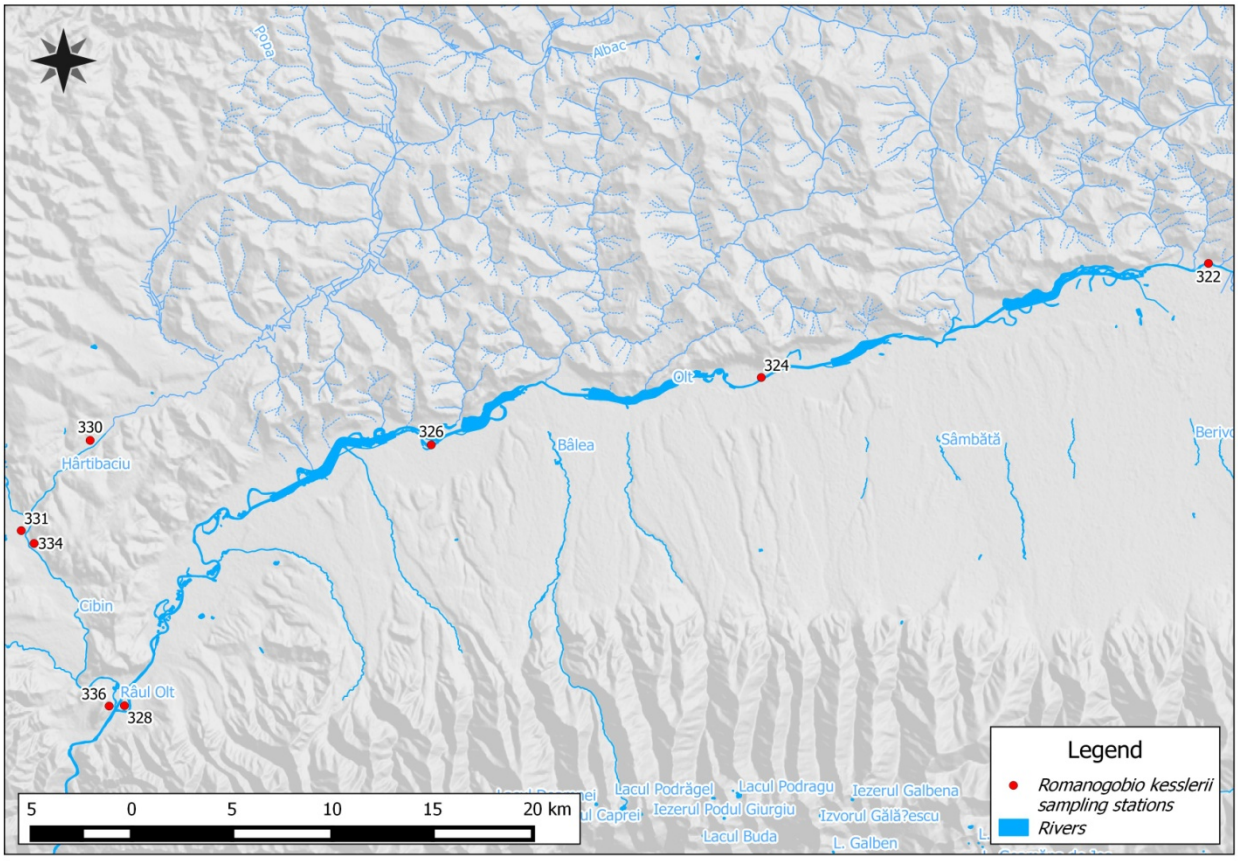

Figure 1: *Romanogobio kesslerii* individuals sampling stations: Hârtibaciu River 330 and 331, Cibin River 334 and 336 and Olt River 322, 324, 326, 328 (Geographic Information System support Mr. Pătrulescu A.).

Romanogobio kesslerii populations were in the study period being monitored and their ecological status was evaluated in relation to the human activities, threats, and pressures identified in this species' habitats.

The fish population's status was evaluated based on balanced distribution of individuals on age classes, size of population, distribution range size, and a high number of individuals of this fish species in the local fish communities.

The *Romanogobio kesslerii* species' specific requirements, threats, and pressures were determined established on their presence or absence of dependence between them and the fish population's ecological status in the studied area.

To determine the management elements needing to be taken to assure this fish species has a favorable conservation status and exemplified process, we used a management model. In this respect we were ADONIS:CE, developed by Business Object Consulting. ADONIS: Community Edition, is a free tool offered by the BOC Group which is useful as a very good entry point to Business Process Management and is the right way to become informed about ADONIS. ADONIS:CE is a useful and feature rich stand-alone version of ADONIS with few limitations if you have to compare it with the commercial edition. BPMN (Business Process Model and Notation) is a multinational standardized modeling language which can be used for processes' illustration. The processes can be quickly, simply, and intuitively modeled based on uniform notation (**).

RESULTS AND DISCUSSION

Romanogobio kesslerii species populations state assessment

Romanogobio kesslerii population ecological state in the **Hârtibaciu** River in the sectors 331 and 330 (Fig. 1) was considered to be low in conformity with: population size, balanced distribution of the individuals on age classes, and a low percentage of this fish species' individuals in the local fish fauna. The habitats, where the sampled individuals of this species were found, are in a medium/low state.

The ecological state of *Romanogobio kesslerii* populations in the **Olt** River sampling sectors 328, 326, 324 and 322 (Fig. 1) is low in conformity with: unbalanced distribution of individuals on age classes, population size and a low percentage of individuals of the species of interest in the structure of the local fish communities. In the Olt River, the habitats of the studied species in the sampling sectors, are in a medium/low ecological condition.

Romanogobio kesslerii individuals sampled in **Cibin** River in 334 and 336 sectors (Fig. 1) is very good based on: balanced distribution of the fish individuals in age classes, population size, and high percentage of the species' individuals in the fish fauna structure. The characteristic habitat is in an average/good state.

Human pressures and threats

During the field research period, in the Hârtibaciu, Olt and Cibin rivers, the next pressures on the fish species of interest populations were found to be: modification/ destruction of characteristic habitats of this species, water pollution, poachery, habitat fragmentation along the lotic systems due to hidrotechnical works, and pollution. The identified threats are: the over sedimentation with mud of the microhabitats due to the wrong soil management in the watersheds, which negatively influenced this fish species' characteristic substrate for reproduction and its benthic macroinvertebrate trophic resources, diminishing water flow quantities, appearance and spreading of some competing fish species, more tolerant ones like *Gobio gobio* (Linnaeus, 1758) or invasive ones like *Pseudorasbora parva* (Temminck and Schlegel, 1846), wrong hidrotechnical works in riverbeds, riparian vegetation harm, permanent difusing of pollution sources with sinergical effects, poaching, pollution, waste dumps near the rivers' control and management, as well as river regulations.

Specific requirements

Romanogobio kesslerii individuals are living in the middle sector of the relatively big rivers. The adults need general river sectors with shallow water, with a majority of substrata needing to be sandy and a water flow at a speed of around 45-70/90 cm/s. Often many individuals can be found together in schools. The reproduction takes place in the period of June, when the adults prefer more speedy water sectors, with pebbles, sand and vegetal debries on the bottom of the water. The juveniles need relatively slow flowing sectors, low depth and with a sandy substratum. The food consists mainly of diatoms and small psamofilic organisms. (Bănărescu and Bănăduc, 2007)

Specific habitat indicators

Relating on *Romanogobio kesslerii* species presence and relative abundance in the studied lotic sectors, the next specific habitat indicators are proposed as follows: areas in the minor riverbed with a depth of the water under 0.5 m (66%); weight sandy substrate (66%); weight pebbles substrate (33%); plant fragments percentage in the substrate/channel (15%); percentage of fast flow-water surface (66%); percentage of slow flow-water surface (33%).

Management measures

Any hidrotechnical work should avoid the realization of new lentic artificial areas or the decreasing of the water flow under the value of 40-65 cm/s., rarely 4-90 cm/s., an appropriate fish leader system should be realised on all the existing dams, the riverbeds' mineral exploitation should be done in sections no closer than three km to each other and without reaching the fixed geological base. In June (the reproduction period) riverbed exploitations and fishing should be banned, and there should be intensive poaching control, riverine natural vegetation protection (minimum 100 m on river sides) with no regulation activities, waste dump control near the rivers, as well as implementation of a seasonal integrated monitoring system.

Site adjusted management model

The basic process for the on site management model is based on activities (squares) and decisions (triangles) (Figs. 3-5a-d).

The main objects used to model *Romanogobio kesslerii* management in ROSCI0132 with ADONIS:CE tool are presented and explained below (from Hall and Harmon, 2005 – Version 1.1, November, 2005, http://mhc-net.com/whitepapers_presentations/2005 Process Trends (040306).pdf):

A process is seen here as a sequence of steps where information is processed/transformed for various models. A process can be modeled through activities, decisions, subprocesses, and documents attached to different activities and notes.

An activity is the smallest part of a process and represents the tasks that are executed during the process. In the modeling process, there are activities that depend on decisions. The decision is an important part of the process because for each decision, it can be assigned a certain probability for achieving the following activities (used in simulation and analysis). Every decision can be assigned a probability condition. For this, there are defined variables (paths can be passed according to the assignment of variables – defined in the transition conditions) and generators (gives values to variables to which they are connected). The generator is directly linked by connectors with decisions and variables.

Model structuring in subprocesses is useful for better process organization and understanding. The subprocess works as a process. It is recommended to use, especially when the model is very elaborate and with their help you "walk" through the process from the highest to the lowest level.
In the next figure, you can see all the processes that are modeled as a table of contents (Fig. 2). You can browse through them by a simple click.

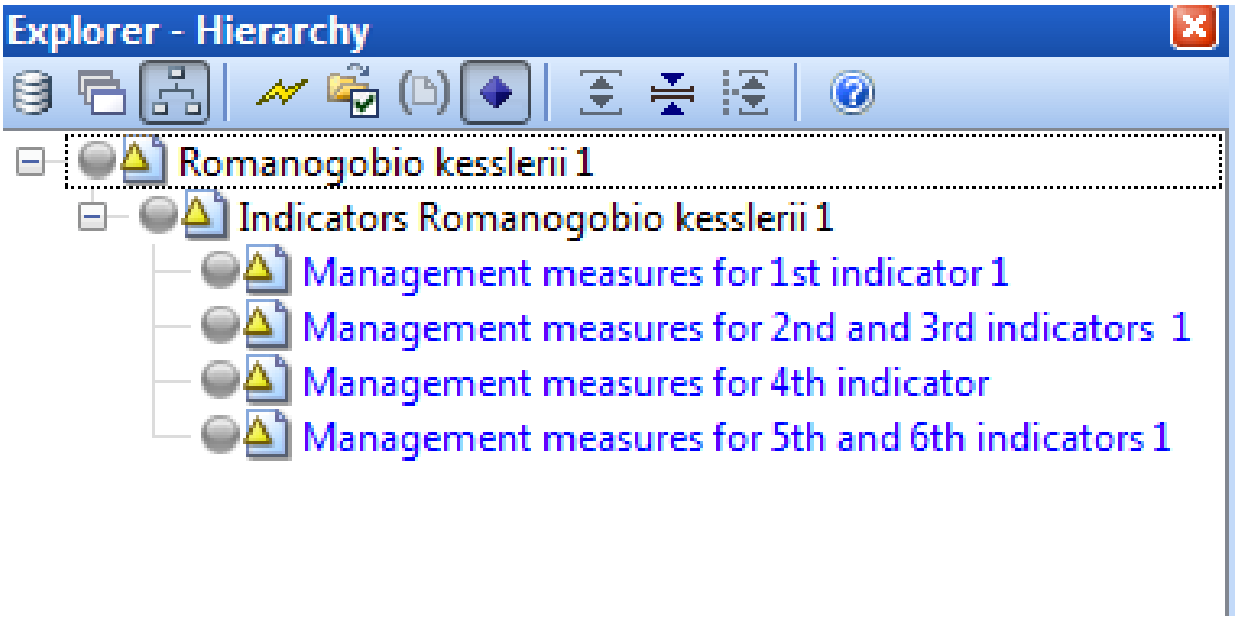

Figure 2: Hierarchy of process modeled.

In the next figure, you can see all the processes that are modeled as a table of contents (Fig. 2). With a simple click, you can browse through subprocesses modeled (e.g. Indicators *Romanogobio kessleri*, Management Measures for the third indicator).

The basic process is called Model of *Romanogobio kessleri* species (Fig. 3) and represents all the characteristics of the species: an *activity* named Specific requirements of habitat – that can be attached by a document which explains these requirements, a *subprocess* called Indicators *Romanogobio kessleri* – containing all the indicators, depending on their percentage, they may or may not ensure the best state of conservation, a *decision* on whether the preservation state is favorable. If the preservation state is in parameters, then the process ends. If the condition is not favorable, then follows the *activity* named Pressures on the species and the process *ends*. For this decision we connect a variable (Preservation_state) and a generator. The generator assigns a discrete variable that represents the probability of the decision (e.g. if Preservation_state = 0.7 we follow the branch "No" of the decision; if Preservation_state = 0.3, we follow the branch "Yes" of the decision).

Figure 4 shows the subprocess Indicators *Romanogobio kessleri* species and here are modeled all the indicators that we should consider for the species conservation. Depending on the probability that they are found, we can take certain management measures. As can be seen in the figure above, the indicators *sandy substrate* and *gravel substrate* have to follow the same management measures. The same happens with indicators *fast flowling surface water* and *slowly flowing surface water* where management measures were combined into a single subprocess (e.g. Management measures for 5th and 6th indicator). After completing each indicator and reaching favorable branches, the last activity is named *Implementation of a integrated monitoring system*. If the condition indicator will not fulfill the standard, then you should follow each subprocess in part. Finally, after going through management measures for each indicator, we still arrived at the last activity (*Implementation of an integrated monitoring system*) and then, the process ends.

Every subprocess that furnishes management measures (Figs. 5a-d) is modeled appling activities to help user-friendly understanding and visualize the phases that must be taken in consideration to guarantee the conservation of the fish species of interest.

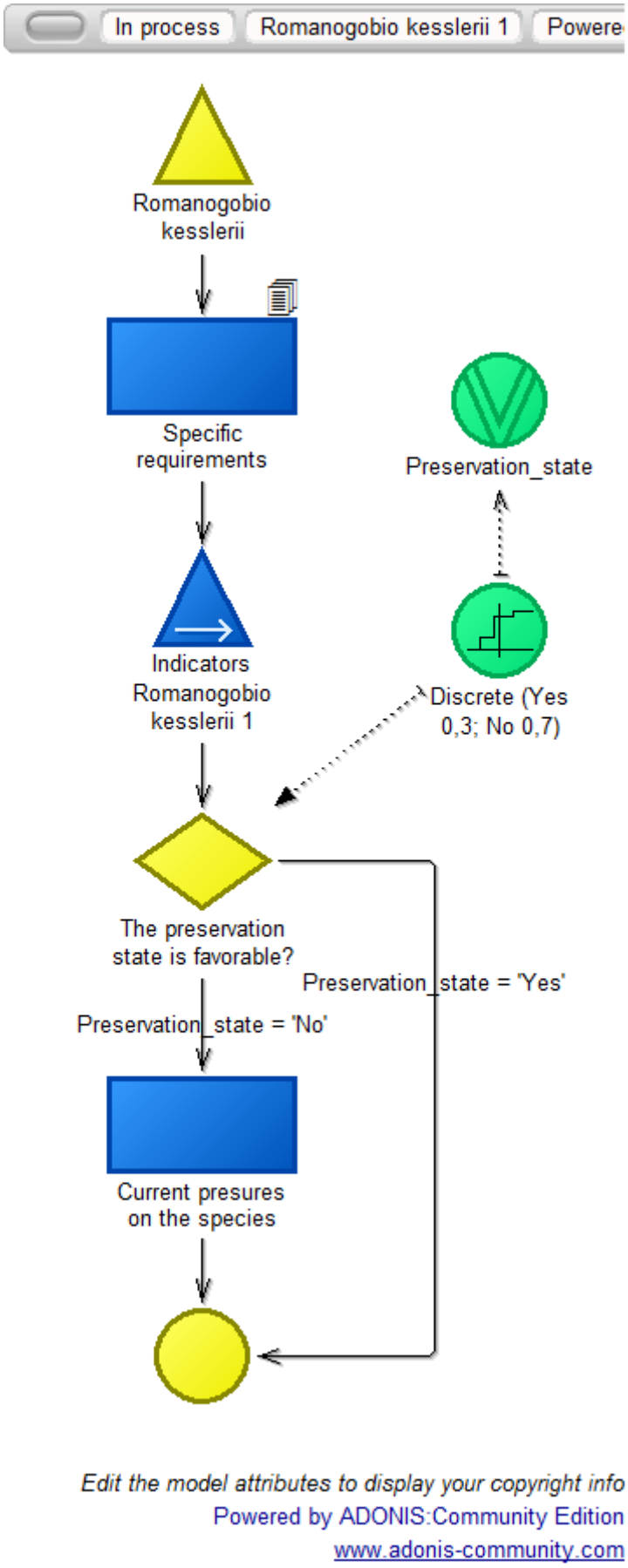

Figure 3: Model of *Romanogobio kesslerii* species management – Main process.

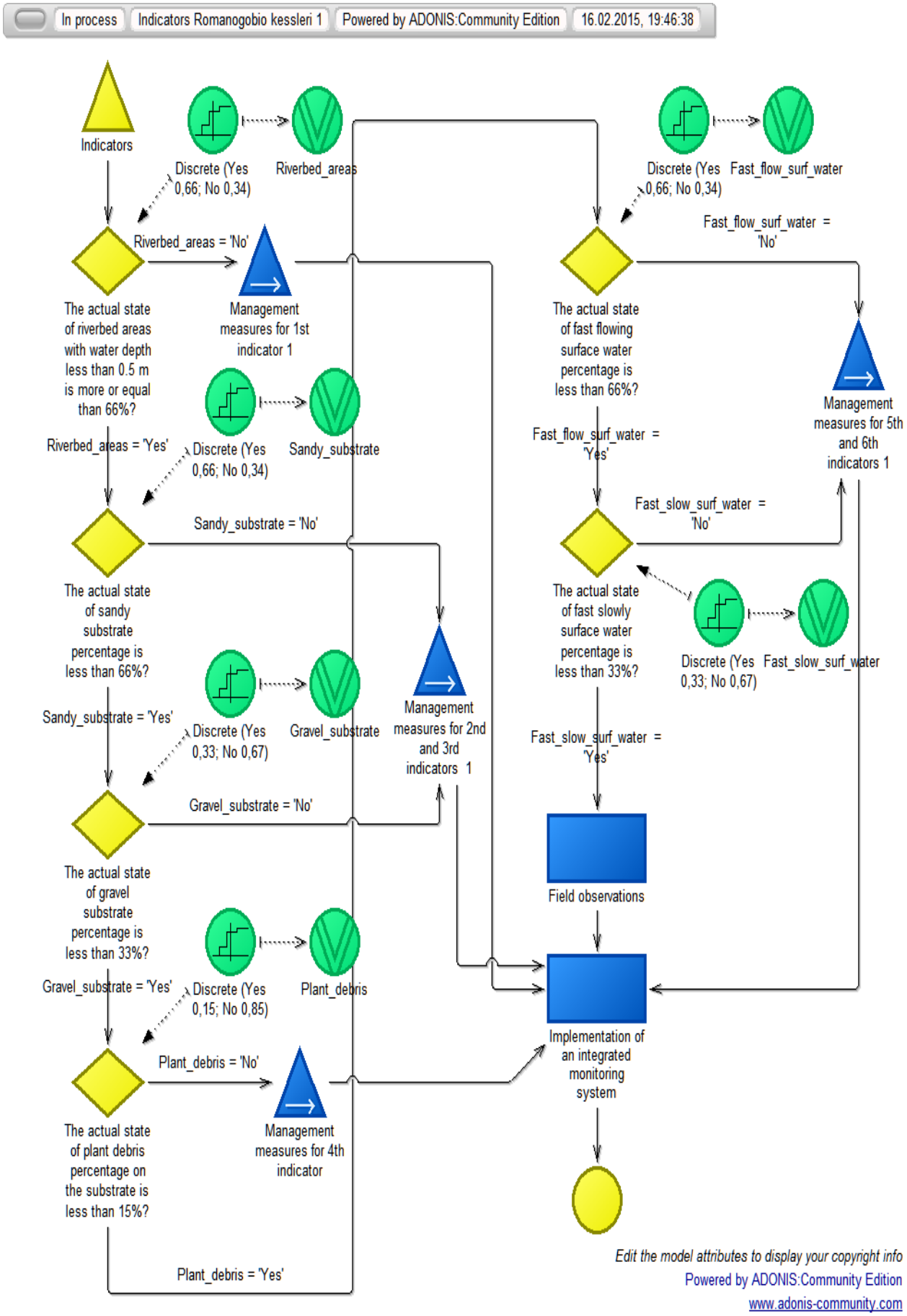

Figure 4: Model of *Romanogobio kesslerii* indicators – actual state versus favourable state.

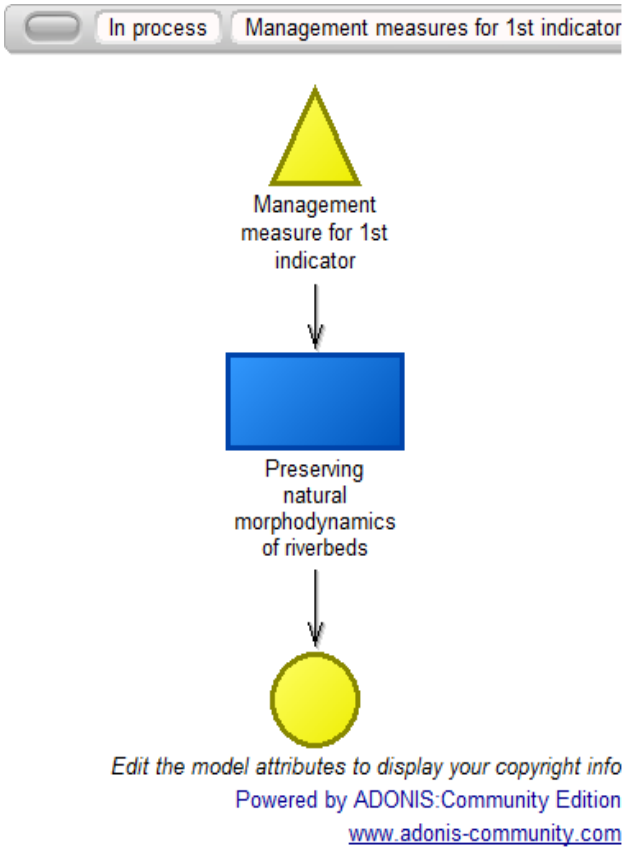

Figure 5a: Model of Management measures for 1st indicator.

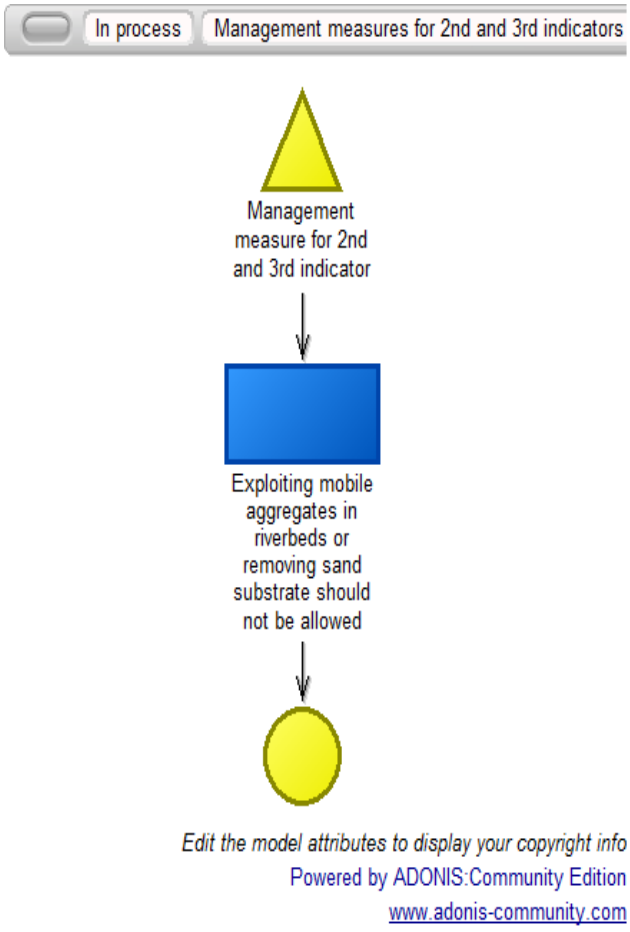

Figure 5b: Model of Management measures for 2nd and 3rd indicator.

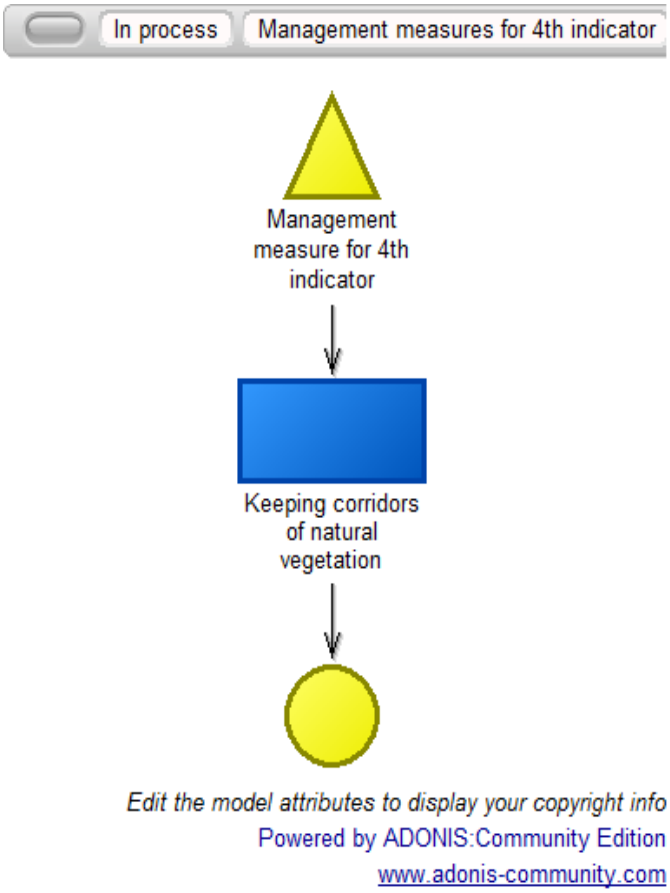

Figure 5c: Model of Management measures for 4th indicator.

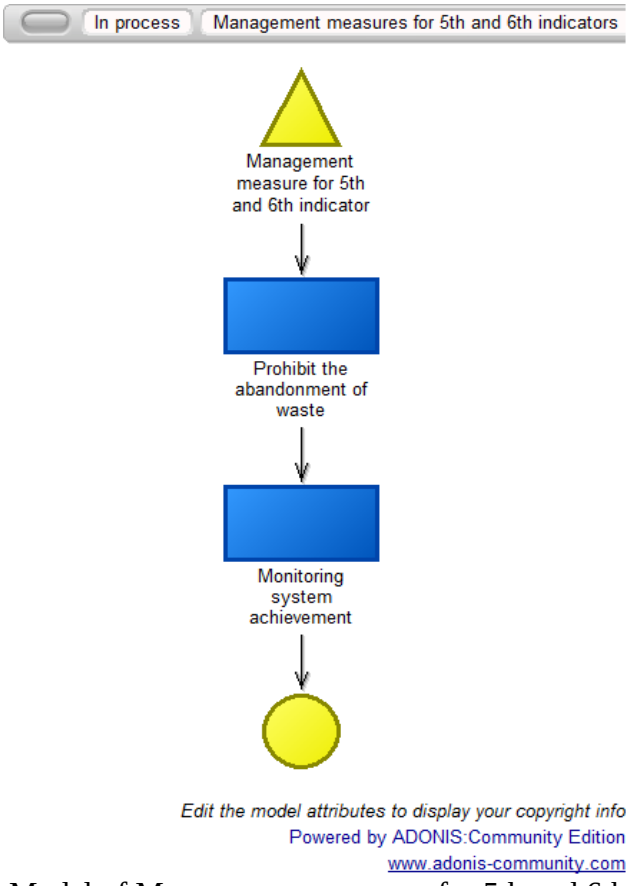

Figure 5d: Model of Management measures for 5th and 6th indicator.

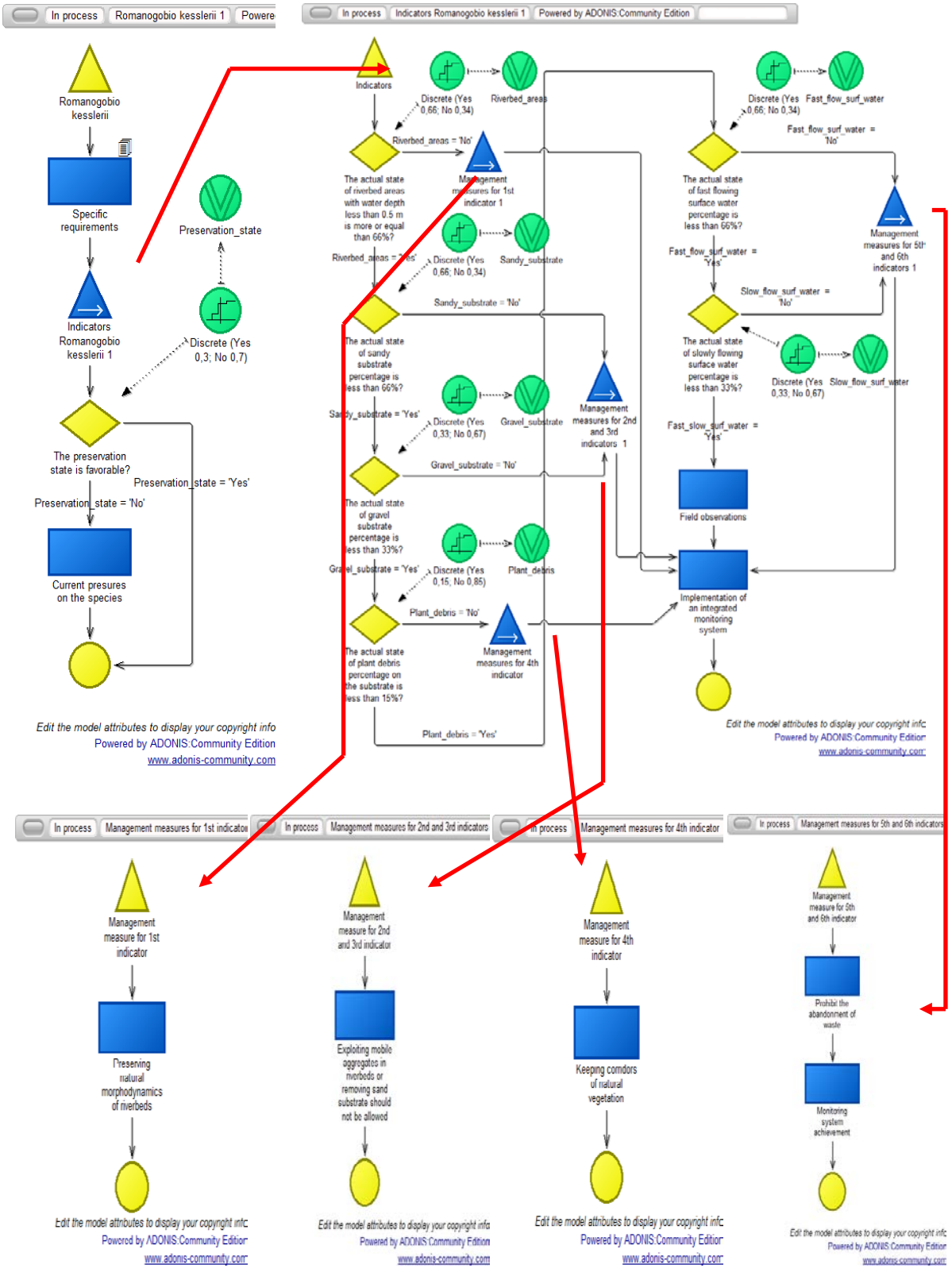

Figure 6: *Romanogobio kesslerii* models framework.

CONCLUSIONS

The present principal threats of the *Romanogobio kesslerii* species populations in the Natura 2000 site ROSCI0132 are the following: the over sedimentation with mud of the microhabitats due to incorrect soil management in the watersheds negatively influence this fish species' characteristic substrate for reproduction and its benthic macroinvertebrate trophic resources, diminishing water flow quantities, appearance and spreading of some competitors' fish species, wrong hidrotechnical works in riverbeds, riparian vegetation harm, permanent difusion of pollution sources with synergical significant effects, poachering, pollution, waste dumps near the rivers' control and management, and river regulations.

The identified pressures on the fish species populations were: modification/destruction of characteristic habitats of this species, water pollution, poachering, habitats fragmentation along the lotic systems due to hidrotechnical works, and pollution.

A highly significant aspect for this species is the actual absence of appropriate fish leaders on all dams and lakes which fragmented the lotic habitats continuity.

The sand overexploitation till the hard massive rocks substrate shouldn't be allowed, thinking about the sandy substrata needs of this species.

In June, the reproduction period of this fish species, the fishing should be restricted.

The poachering is intensive and extensive too; a situation which should be stopped as soon as is possible.

The rivers Cibin, Hârtibaciu and Olt should be managed with the purpose of keeping a good chemical quality of the water.

The extraction of sediments in these rivers should be made in correspondance with their natural rate of refilling and at sites at a distance of a minimum of three km from each other.

The riverine vegetation (herbaceous, shrubs and ligneous) should be protected at a minimum of 100 m on both sides of the river in as long of sectors as is possible.

Seasonal integrated monitoring is needed, including water organic load monitoring.

In this research, the authors "realized" a framework (Fig. 6) of *Romanogobio kesslerii* species. The ADONIS:CE tool is used for modeling business processes, but here it was used in another domain, especially biology/ecology, trying to create a model of *Romanogobio kesslerii* species that presents all the requirements for habitat, the indicators that assure a favorable conservation status – the adequate measures, the species pressures, and threats**.**

For future approaches, it should be realized that such management based systems for other fish species of protection interest the Natura 2000 site ROSCI0132.

AKNOWLEDGEMENTS

Partialy, the results of these data were revealed in the European Union Structural Operational Programme Environment "Pentru Natură şi Comunităţile locale – Bazele unui management integrat Natura 2000 în zona Hârtibaciu-Târnava Mare-Olt" SMIS CSNR 17049 code.

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AUTHORS:

[1] *Angela CURTEAN-BĂNĂDUC*
angela.banaduc@ulbsibiu.ro
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

[2] *Ioana-Cristina CISMAŞ*
cristha_83@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

[3] *Doru BĂNĂDUC*
ad.banaduc@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Applied Ecology Research Center,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

HISTORICAL HUMAN IMPACT ON THE ALPINE CAPRA STREAM MACROINVERTEBRATES AND FISH COMMUNITIES (SOUTHERN ROMANIAN CARPATHIANS)

Angela CURTEAN-BĂNĂDUC [1], *Doru BĂNĂDUC* [2], *Lucia URSU* [3] and *Răzvan RĂCHITĂ* [4]

KEYWORDS: Carpații Meridionali/Meridional Carpathians/Transylvanian Alps, Făgăraș Mountains, alpine stream, human impact, macroinvertebrates and fish communities, assessment.

ABSTRACT

After the analysis of ecological state of the Capra Stream, based on biotic integrity indexes HBI (Hilsenhoff Biotic Index), EPT/C and IBI Carpathian Fish Index, we noticed the present impacts of dams, micro hydro-power plants and pollution on the stream.

The benthic macroinvertebrate and fish communities are directly, and continuously, affected by the lithological substrate change (in conditions of which they and their trophic base depend on the substrate) and by the characteristic changes in the flow regime.

Along the Capra Stream we managed to distinquish three ecological zones: the first ecological zone is characterised by a good ecological state, the second zone is characterised by an unsatisfactory ecological state, and the third zone is better than the second, but not as good as the first, from the ecological point of view.

REZUMAT: Impactul antropic istoric asupra comunităților de macronevertebrate și pești din râul alpin Capra (Carpații Sudici Românești).

Analiza stării ecologice a râului Capra, pe baza indicilor biotici de integritate: HBI, EPT/C și IBI Carpathian Fish Index, a relevat impactul generat în prezent de către baraje, microhidrocentrale și poluare.

Comunitățile de pești și de macronevertebrate au fost direct și continuu afectate de schimbarea structurii substratului litologic al albiei minore (în condițiile, în care aceste comunități sau baza lor trofică sunt dependente de substrat) și de modificarea regimului de curgere caracteristic.

De-a lungul râului Capra, de la izvoare spre vărsare, au fost identificate trei zone ecologice: prima cu stare ecologică bună, a doua cu stare ecologică nesatisfăcătore, a treia cu stare ecologică moderată.

RÉSUMÉN: Impactos humanos históricos sobre las comunidades de peces y macroinvertebrados en el Arroyo Capra Alpina (Cárpatos sureños de Rumanía).

Tras realizar un análisis del estado ecológico del Arroyo Capra, basado en índices de integridad biótica: IBH (índice biótico de Hilsenhoff), EPT/C e IIC (índice de los peces de los Cárpatos) se determinó el impacto actual de las presas, del microhidroeléctricas y de la contaminación.

Las comunidades bentónicas de peces y macroinvertebrados están directa y continuamente afectadas por cambios tanto en el sustrato litológico (condiciones del sustrato que determinan su dinámica trófica) como en las características del régimen de flujo.

Se discernieron tres zonas ecológicas a lo largo del Arroyo Capra: la primera se caracterizó por estar en buen estado ecológico, la segunda zona se caracterizó por mostrar un estado ecológico insatisfactorio, y la tercera representa, en términos ecológicos, un estado intermedio entre las dos zonas mencionadas.

INTRODUCTION

The Carpathian Mountains are part of the Alps-Himalaya mountain system. A system which is extended from the west of Europe to the south of Asia. This system includes mountain ranges such as: Alps, Alborz, Apennine, Atlas, Balkan, Baetic Cordillera, Carpathian, Cantabrian, Caucasus, Dinaric Alps, Hellenides, Himalayas, Hindu Kush, Karakoram, Pamir, Pyrenees, Taurus and Zagros mountains (Moores and Fairbridge, 1998; Schmid et al., 2004). The Romanian Carpathians appeared due to the Alpine orogeny in the active edge of the Euroasian geological plate (Mutihac, 1990).

The Transylvanian Alps (de Martonne, 1907) are mountain ranges that divide the central and southern national territory of Romania. They cover a significant part of the Romanian Carpathian Mountains, part which is located between the Prahova River in the east and the Timiş and Cerna rivers in the west (Posea et al., 1974).

One of the most emblematic alpine relief for the Carpathian Mountains can be found in the Făgăraş Mountains, which stretches between the Olt River to the west and the Rucăr-Bran Passage and Dâmboviţa River to the east. They are characterised by high altitudes of over 2,000 m a.s.l. (e.g. Moldoveanu Peak, 2,544 m, Negoiu Peak, 2,535 m, Viştea Mare Peak, 2,527 m, Lespezi Peak, 2,522 m, Vânătoarea lui Buteanu Peak, 2,506 m), accentuated slopes, massiveness geomorphosites which were formed by the action of the glaciers. (Badea, 1983; Roşu, 1980; Posea, 1982; Florea 1998; Voiculescu, 2002; Niculescu et al., 1960)

The most important targets of the European Union, in the environmental field, are the protection, conservation and the improvement of the environment quality. In context, the intelligent use of the ecosystem's resources and services. In the last few decades, the biodiversity conservation was one of the main objectives of the EU. The action frame at the EU level, to preserve the biodiversity, was mainly established based on the Habitats Directive (92/43/EEC) and Birds Directive (79/409/EEC). Romania is the country with the highest biogeographic diversity, with a total of five biogeographic regions: alpine, continental, pannonic, pontic and stepic. (Curtean-Bănăduc and Florescu, 2007)

There are few important ways through which the Natura 2000 net initiative can improve the protection of nature in Romania: extension of the natural surface, the creation and implementation of correct management plans for protected areas, institutional capacity building, and raising awareness of the problem. This study was created to offer data regarding one very characteristic alpine stream in one of the most representative Natura 2000 sites, in the Romanian alpine biogeographic region, the Făgăraş Mountains Natura 2000 site (administrated together with the Făgăraş Piedmont Natura 2000 site). These two Natura 2000 areas overlap over 27 localities areas, including a total surface area of 243,627.7 ha. This surface area contains a total of 20 natural protected areas (24,205.5 ha), 66 endemic plant species, 326 plant and animal important species of protective interest, etc. (*, 2011).

Historically, the economic activities have had a major destructive impact on aquatic species communities from small streams to large rivers (Antipa, 1909; Bănărescu 1964, 1969). In present the impact is not any different than the past. The main direct or/and indirect effects on fresh water ecosystems are mainly due to the physical and chemical alterations of the habitats (Bănăduc, 2000, 2002, 2005, 2006, 2008; Petts, 2001; Dudgeon, 1992, 1995; Iannuzzi and Ludwig, 2004; Das and Chakrebarty, 2007; Marković et al., 2007; Liogchii, 2008; Kutzenberger, 2008; Yacoub, 2011; Tockner et al., 2009; Yildiz et al., 2010).

The macroinvertebrates and fish communities assessments are commonly used tools for the aquatic habitats ecological assessment (Fausch et al., 1990; Edds, 1993; Harrison and Whitfield, 1995; Schiemer, 2000; Aparicio et al., 2000; Magalhaes et al., 2002; Pont et al., 2007; Kadye et al., 2008; Cao et al., 1997; Clements et al., 1989; Couceiro et al., 2012; Curtean-Bănăduc, 2005, 2008; Hilsenhoff, 1981, 1987; Infante et al., 2009; Jiang et al., 2013; Lücke and Johnson, 2009; Monaghan and Soares, 2012; Park et al., 2007; Péru and Dolédec, 2010; Rosenberg and Resh, 1993; Sánchez-Montoya et al., 2010).

Assessing macroinvertebrates, and fish communities, diversity requires an adaptative scale approach (Levin, 1992; Ciesielka and Bailey, 2007; Heino and Mykrä, 2006; Jiang et al., 2011; Keith et al., 2009; Roth et al., 1996). The river/basin approach is the appropriate assessment.

The need for this type of study is coming from concerns regarding the trend of continuous, and pronounced deterioration of the aquatic ecosystems. A complex and very valuable resource worldwide (Kalinin and Bykov, 1970; Sokolov, 1977; Angradi, 2006; Aldwell, 1977; Arnell, 2004; Lundqvist, 2009). Despite the relatively low to medium human access to these mountainous zones, these areas have lately become an increasingly attractive target for new socio-economic objectives and the Carpathians Mountains is no exception (Dankó, 1993; Costea, 2008; Curtean-Bănăduc et al., 2008; Sandu et al., 2008; Hajdu and Füleky, 2008; Reif et al., 2009; Bănăduc, 2010).

The Făgăraş Mountains alpine lotic ecosystems, especially the relative high altitude sectors due to their relative isolation and difficult access for field work, were rarely studied in comparison with the lower sectors of these rivers with less access. In the present energy crisis, the alternative sources should be quickly adopted and exploited. This includes micro hydro-power plants which are fitting well in alpine areas, but without any negative affects to the environmental elements.

Hydropower generates around 16% of the global electricity consumption and the electricity generated from renewable energy sources, is 86%. After Romania joined the European Union in January 1st 2007, it was clearly stated, at the European Conference for Renewable Energy, that till 2020 it should produce 20% renewable energy. While micro hydro-power plants are a natural option for a Carpathian country like Romania. On the other hand, the degradation of streams due to microhydropower plants unapropriate construction is one of the nine significant problematical cases of thus construction in the world (WWF, 2013).

In Romania aproximatively 411 hidropower plants are in various stages of planning, permitting, construction, or in exploitation. More than a quarter are proposed to be situated inside, or at the limit, of natural protected areas. In this context numerous streams and rivers are already, or can be, negatively affected in the future by micro-hydropower plants in the Făgăraş Mountains Natura 2000 and Făgăraş Piedmont Natura 2000 sites consisting of Capra, Avrig, Bâlea, Cârţişoara, Râu Mare, Viştea, Sâmbăta, Ucea, Dejani, Lupşa, Vişţişoara, Sebeş, Valea Satului, Boia Curpăn, Buda-Otic, Modrogaz, Valea Rea, Zârna, Vâlsan, Valea Doamnei, Topolog, Cumpăna, Cuca, Bârsa, Olt, Pojorta, Brescioara, Valea Satului, etc. All of these are or can be funded from EU funds and green certificates. These funds are acquired and allocated under the national scheme, which is not based on ecologycal criterion (WWF, 2013).

Capra Stream is one of the most representative case of negative human impact on a Carpathian lotic system, situated in a Natura 2000 site (Fig. 1). This is due to a series of micro hydro-power plants conducted without adequate impact studies and needed mitigation measures proposals. Furthermore, in this study it can be explained how the actual state of Capra Stream is a consequence of these micro hydro-power plants and how the human impact on this stream should be taken into consideration.

Despite a few existing species red listed, including the Carpathians basin fish species (IUCN Red List of Threatened Species; Kukuła and Sandor, 2003; Voloscuk, 1996; Bănărescu, 2005), and projects which sugests management elements for macroinvertebates and fish species, and habitats management in the Carpathians area (Curtean-Bănăduc, 2008; Curtean-Bănăduc et al., 2007, 2008, 2011; Curtean-Bănăduc and Bănăduc, 2005; Bănăduc et al., 2012; Galvánek et al., 2014) not much is being done to protect the streams.

One of the most characteristic lotic ecosystem for this exquisite alpine area is the Capra Stream (Fig. 1). This specific study intends to generate data regarding the local macroinvertebrate and fish fauna. Data that is needed for the creation and implementation of a correct management plan for the Făgăraş Mountains Natura 2000 site, and for raising awareness in an alpine environment which has recently become a target for human impact extension and intensification.

The Capra gill flows from Capra glacial lake (located at the altitude of 2,230 m with an area of 18,340 m^2 and a depth of 8 m) to Căpriţa Lake (with an area of 2,190 m^2 and a depth of 1.5 m). These two alpine lakes are positioned beneath the edge of the fifth highest peak of the Făgăraş Mountains (Vânătoarea lui Buteanu, 2,506 m) (Ujvari, 1972; Badea, 1983; Roşu, 1980).

The Capra and Buda gills form together to create the "Argeş hydrographical system" which has an area of 12.521 km^2 and a length of 339,6 km (**, 1971).

This system includes the highest (166,6 m) concrete dam (Vidraru Dam) in Romania. The dam was built in 1965 for the energy production and supply. The Vidraru Lake has a built water volume of 465 millions m^3, a potential surface of 893 ha, a length of 12,3 km, and a circumference of 28 km (Constantinescu and Pâslaru, 1990).

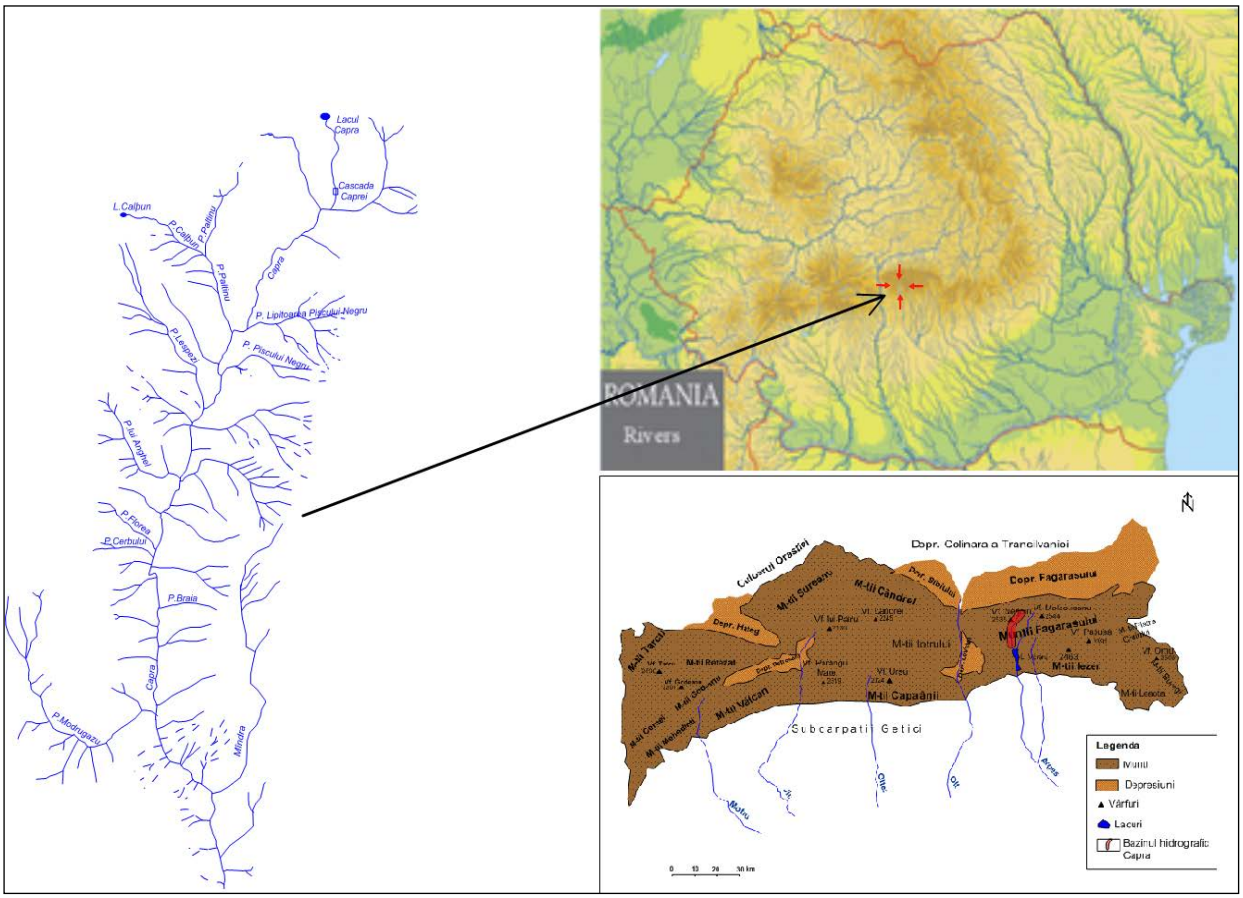

Figure 1: Capra River basin localisation.

The mountain group (Fig. 1), which includes the Capra Stream drainage area, neighbours with Făgăraş depression to the north, Olt Valley to the west, Dâmboviţa Valley to the east, Câmpulung depression, Brădetu, Arefu and Jiblea to the south (Badea, 1983).

The main edge where Capra gill springs from is oriented west-east and Capra River basin is oriented north-east (Ujvari, 1972; Badea, 1983; Roşu, 1980).

The local relief has altitudes of over 2,000 m in the upper part of the basin, which are characteristic of the Făgăraș Mountains. The lowest altitude where the Capra drainage area is located at is about 800 m downstream of Vidraru Lake (Velcea and Savu, 1982).

For the first time in Romania, in the Făgăraș Mountains, was mentioned the glacial relief (Lehmann, 1881). Capra drainage area is characterised by glacial relief, due to its orogeny and geological evolution as was highlighted above.

This area is registered as a cuaternary glaciation mark, reflected by the presence of the glacial cirques and valleys with there steep flanks that are covered by debris and moraines.

The upper Capra drainage area is mainly characterized by river and rainfall processes, caused by high leakage and high slopes (Posea et al., 1982).

The high duration of low temperatures common in elevations upwards of 1,850 m in altitude determined as dominants in the crionival and torrential processes. While at lower altitudes, in the deciduos and coniferous forests, biochemical, river and rain erosion processes have the main role (Posea et al., 1982).

Processes that affect Capra Basin versants are solifuction, gullying, torrential erosion, erosion and transport in river beds, disintegrations, dissolutions and landslides (Posea et al., 1982).

The climatic characteristics of the basin are due to its position in the relief unit; such that it is temperate-continental alpine climate. With short and cool summers and long, cold, snowy winters (Posea et al., 1982).

The Capra River has a length of 20 km and a drainage area of 97 km^2 (Ujvari, 1972). Throughout its length, it receives several tributaries delivering water from the, both left and right sides.

Landforms, that resulted from many years of evolution in the studied Carpathian river basin, have offered various opportunities for several human economic activities such as raising livestock (especially sheep), logging (was practiced logs rafting on the Capra River) tourism, etc. Penetration of human presence, in this relatively isolated area with difficult access, was facilitated after construction of such features as the Transfăgărășan high altitude road.

Both benthic macroinvertebrates and fish are considered to be two of the most important groups of organisms selected in the frame of Water Framework Directive (60/2000/EC) to assess and monitor the integrity of aquatic biological communities, in the process of assessing the ecological status of a river (Rosenberg and Resh, 1993).

Fish are considered an important group of organisms, selected in the frame of Water Framework Directive (60/2000/EC), in order to assess and monitor the integrity of aquatic biological communities in the process of assessing the ecological status of a river. Much more, they are used to assess the ecological status of rivers; as they are composed of species that constitute a large range of trophic levels and pollution tolerances (Rosenberg and Resh, 1993).

MATERIAL AND METHODS

The field campaign of this study was realised in 2012. This studied macroinvertebrates and fish sampling stations were chosen according to: the valley morphology, the type of river substratum, the confluences with the main tributaries and the human impact presence bias (hydro technical works and polution).

For the macroinvertebrates sampling, the Surber Sampler (887 cm^2 surface and 250 µm mesh net) was used (Fig. 2). Ten quantitative samples were taken in each of the 17 sampled river sectors, from near springs area to the stream flow in Vidraru Lake (Fig. 4). The samples were preserved in a 4% formaldehyde solution ($NaHCO_3$ was added). After that, the samples were washed in a 0.2 mm mesh net and analised with a Olympus (150X) stereomicroscope. Identifying individuals was made at orders level, with the exception of Oligochaeta, Araneida and Chironomidae. After the sampled individuals were identified and counted, they were preserved in 70% alcohol and included in the collections of the Hydrobiology Laboratory, Faculty of Sciences, "Lucian Blaga" University of Sibiu.

Figure 2: Surber Sampler benthic macroinvertebrates sampling on Capra Stream.

The indexes used to describe benthic macroinvertebrate communities and analyze stream ecological status are: relative abundance, frequency, ecologycal significance index, Simpson Reversed Index, Margalef Index, Hilsenhoff Index and EPT/C Index. The relative abundance and frequency are used to describe, quantitatively, the structure of comunities. The Hilsenhoff Biotic Index is used to quantify the ecological status of the river. The Simpson Reversed Index and Margalef Index are used to measure biodiversity – as a measure of the river homeostasis.

The Ephemeroptera, Plecoptera, Trichoptera and Chironomidae abundace show the balance among benthic invertebrate communities (EPT/C Index). Ephemeroptera, Plecoptera and Trichoptera are more sensitive to pollution than Chironomidae. The balanced distribution of those groups reveal stream sectors with good ecologycal status. This index reveals the ratio between the sum of sampled individuals, who belong to Ephemeroptera, Plecoptera, Trichoptera orders groups, and the sum of individuals who belong to Chironomidae family group.

Two electrofishing gears were used, the AquaTech IGT600 and the AquaTech IG1300 devices, for fish sampling (Fig. 3) on 100 m river sectors units.

One of the largely accepted integrated approach, in the fish assessment and monitoring respect, is that one based on the biotic integrity using fish communities (Karr, 1981; Leonard and Orth, 1986; Fausch and Schrader, 1987; Lyons et al., 1996; Hughes and Oberdorf, 1998; Goldstein and Simon, 1998; Smathers et al., 1998; Miller et al., 1988; Bramblett and Fausch, 1991; Oberdorff et al., 2002; Sostoa et al., 2003; Bozzetti and Schulz, 2004; Pont et al., 2007; Petesse et al., 2007; Casatti et al., 2009). It is provable that particular adaptations are necessary for each studied river (of the same category in the same biogeographic region). In this manner, a specific adaptation of an integrity biotic index for the Carpathians area basins/rivers was proposed by Bănăduc and Curtean-Bănăduc (2002), its main elements are shortly presented below and were used in this study.

The combination of metrics for this index was created to expose insights of assemblage, community, population and ecosystem perspectives, and to suit local and/or regional patterns in fish ecology. Every such selected metric value should be compared with the estimated categories from similar/comparable sites/sectors with smaller, minimal or no human impact. In general it can be considered that as the adapted/flexible biotic integrity index values decrease, the habitat and lotic ecosystems (as sources of services and resources) quality decrease too. (Bănăduc and Curtean-Bănăduc, 2002)

Figure 3: Electrofishing sampling on Capra Stream.

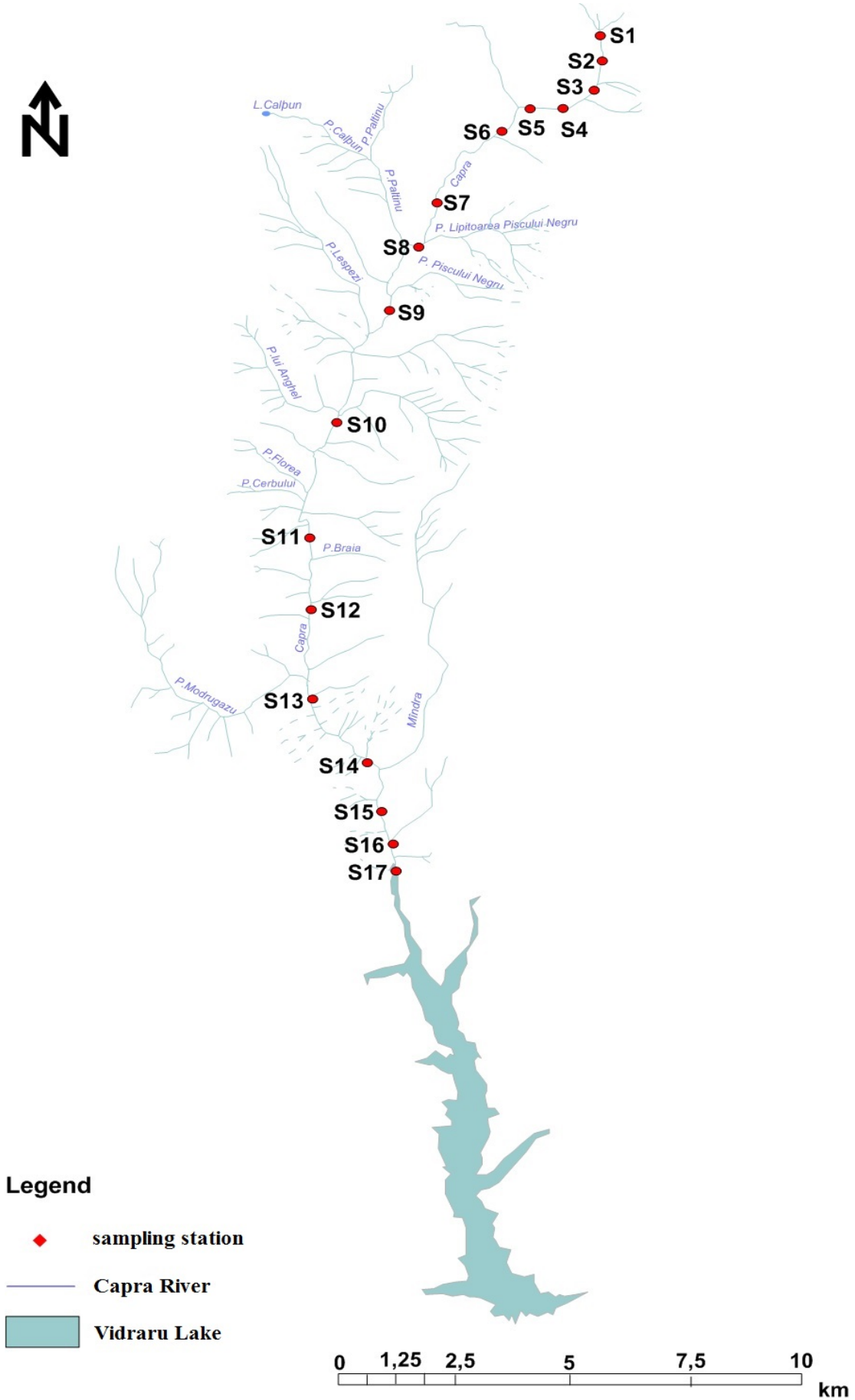

Figure 4: Sampling stations on Capra River.

RESULTS

Sampling station S1 (Fig. 5) is situated on the closest point near the river streams. It is situated at 1,785 m in altitude with coordinates are north latitude 45º35.682' North and longitude 24º38.666' East.

The maximum river width is 3 m, medium width 1.5 m and the minimum 1 m. The substrate is made of rocks, boulders and gravel.

Figure 5: Sampling station 1 on Capra Stream.

The benthic macroinvertebrate community present in this river sector is formed by: Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Trichoptera, Diptera, Turbellaria and Chironomidae (Tab. 1).

From the numerical point of view, Chironomidae are the dominant group (40.75%). From all sistematical groups, the groups with the biggest frequencies are: Oligochaeta, Araneida, Ephemeroptera, Plecoptera, Trichoptera and Chironomidae.

According to calculated ecological semnification index we have: eudominant groups: Chironomidae, Plecoptera and Ephemeroptera; dominant groups: Oligochaeta; subdominant groups: Trichoptera, Araneida and other Diptera; eudominant groups: Collembola and Turbellaria.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index, reflects no fish individuals present. The low water temperature and high content of oxygen reveal an excelent potential habitat for reproduction for *Salmo trutta fario*.

Sampling station S2 (Fig. 6) is situated at the altitude of 1,721 m, and 1 km downstream of the first upstream sampling station. The coordinates are 45º35.419' north latitude and 24º38.672' east longitude.

The maximum width of the stream is 7.5 m and the minimum is 1.5 m. The medium width is 2.5 m.

Figure 6: Sampling station 2 on Capra Stream.

The benthic macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Diptera and Turbellaria (Tab. 1). From the numerical point of view Chironomidae is the dominant group (69.22%). The systematic groups with the highest frequency are: Ephemeroptera, Plecoptera, Trichoptera and Diptera. According to calculated ecological semnification index we have: eudominant groups: Chironomidae, Plecoptera and Ephemeroptera; subdominant groups: other Diptera and Trichoptera; recedent groups: Oligochaeta and Turbellaria; subrecedent group: Collembola.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index in the present circumstances, reflects no fish individuals present in the sector of interest. The low water temperature and high content of oxigen reveal an excelent potential habitat for reproduction for *Salmo trutta fario*.

Sampling station S3 (Fig. 7) is situated at 1,663 m, at 1 km downstream of the sampling station 2. The coordinates are 45º35.130' north latitude and 24º38.534' east longitude.

The maximum width of the river is 4 m, minimum 1 m and medium width of 2.5 m. The maximum depth is 70 cm and the minimum is 8 cm.

Figure 7: Sampling station 3 on Capra Stream.

The benthic macroinvertebrates community from this river sector is formed by Olihochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera and Diptera. (Tab. 1). From the numerical point of view the dominant group is Chironomidae (67.27%). The systematic groups with the highest frequency are Oigochaeta, Araneida, Ephemeroptera, Plecoptera and Chironomidae. According to calculated ecological semnification index we have eudominant groups: Chironomidae, Plecoptera, Ephemeroptera; recedent groups: Oligochaeta, Other Diptera, Araneida, Collembola, Trichoptera and Turbellaria.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index, reflects no fish individuals present. The low water temperature and high content of oxigen reveal an excelent potential habitat for reproduction for *Salmo trutta fario*.

Station S4 (Fig. 8) is situated at 1,541 m altitude and 1 km downstream from sampling station 3 at north latitude 45º35.013' and east longitude 24º37.925'.

The maximum width of the river at this point is 8 m, minimum width is two meters and medium width of 3.5 m. The maximum depth of the river is about 60 cm, and the minimum is 5 cm.

At a distance of arround of 200 m down the stream from this sampling station is situated the first upper micro-hydropower plant (Fig. 9), a first potential bottleneck for fish.

Figure 8: Sampling station 4 on Capra Stream.

Figure 9: Capra Stream – micro hydropower plant Capra I.

The benthic macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Trichoptera, Diptera and Turbellaria (Tab. 1). From the numerical point of view, the dominant groups is Chironomidae (72.66%). The groups with the highest frequencies are Ephemeroptera, Plecoptera and Diptera. According to calculated ecological semnification index we have: eudominant groups Chironomidae and Ephemeroptera; a dominant group: Plecoptera; subdominant group: Other Diptera; recedent groups: Trichoptera, Oligochaeta, Araneida; subrecedent groups: Collembola and Turbellaria.

The Carpathian Fish – Integrity Biotic Index score is 1 – very poor. The missing of trout sprcies in the first four upper sampling stations have natural explanations. This is, related mostly with a big waterfall between the sampling stations 4 and 5, which blockes the potential fish fauna continuum.

The sampling station S5 (Fig. 10) is situated at 1,492 m altitude, 0.9 km downstream of station S4. The coordinates are: 45º34.809' north latitude and 24º37.447' east longitude.

The maximum width of the river is 8.5 m, the minimum 3 m and the medium 4 m. The maximum depth of the river is 50 cm while the minimum is 5 cm.

Figure 10: Sampling station 5 on Capra Stream.

The benthic macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Ostracoda, Ephemeroptera, Plecoptera, Trichoptera, Diptera and Turbellaria (Tab. 1). From the numerical point of view, the dominate group is Chironomidae (55.9%). The groups with the highest frequencies are: Oligochaeta, Ephemeroptera, Plecoptera and Chironomidae. According to calculated ecological semnification index we have eudominant groups: Chironomidae and Ephemeroptera; dominant groups: Trichoptera and Oligochaeta; subdominant groups: Plecoptera other Diptera and Araneida; subrecedent groups: Turbellaria and Ostracoda.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index and reflects no fish individuals in the area.

In this geographic area, in relatively similar lotic sectors of neighbouring streams and similar habitats (e.g. Buda Stream) are good populations of *Salmo trutta fario* and *Cottus gobio* (Bănăduc unpublished data).

The sampling station S6 (Fig. 11) is situated at 1,492 m altitude and 1 km donwstream of sampling station S5. The coordonates are: 45º34.809' north latitude and 24º37.447' east longitude.

The maximum width of the Capra River in this sector is 8.5 m, the minimum is 3 m and medium is 4 m. The maximum depth of the river is 50 cm and minimum is 5 cm.

Figure 11: Sampling station 6 on Capra Stream.

The benthic macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Colembola, Ephemeroptera, Plecoptera and Diptera. (Tab. 1). From the numerical point of view the dominating groups are Chironomidae (91.87%). The groups with the highest frequency are Oligochaeta, Ephemeroptera and Chironomidae. According to calculated ecological semnification index we have eudominant group: Chironomidae; subdominant groups: Ephemeroptera, Oligochaeta and Plectoptera; recedent groups: Araneida, other Diptera and Trichoptera and subrecedent group: Collembola.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index, reflects no fish individuals.

In this geographic area, in similar lotic sectors of neighbouring streams and (e.g. Buda Stream) in similar habitats are good populations of *Salmo trutta fario* and *Cottus gobio*. (Bănăduc unpublished data)

Sampling station S7 (Fig. 12) is situated at 1,249 m altitude and at 3 km downstream of the sampling station S6. The coordinates are: 45º33.726' north latitude, and 24º36.468' east longitude.

The maximum width of the river is 12 m, the minimum is six meters and medium width is 8 m. The maximum depth of the river here is 65 cm and the minimum is 7 cm.

In the downstream part of the sampling station, the lotic habitat is very affected by the micro hydropower plant hidrotechnical works (Fig. 13).

Figure 12: Sampling station 7 on Capra Stream, natural lotic habitat.

Figure 13: Sampling station 7 on Capra Stream, lotic habitat negatively affected by works for micro hydro-power plant Capra II.

The benthic macroinvertebrates community from this river sector is formed by: Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera and Diptera. From the numerical point of view the dominant group is Oligochaeta (63.05%). The benthic macroinvertebrates groups with the highest frequencies are: Oligochaeta, Araneida, Collembola and Chironomidae. According to calculated ecological semnification index we have eudominant groups: Oligochaeta and Chironomidae; dominant group: Araneida; subdominant group: Collembola; recedent groups: Ephemeroptera and other Diptera; subrecedent group: Plecoptera.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor).

The hidrotechnical works human impact is evident on the stream habitat.

Prelevation Station S8 (Fig. 14) is situated at 1 km downstream from the sampling station S7 and at an altitude of 1,242 m. The coordinates are north latitude 45º33.697' and east longitude 24º36.426'.

The maximum width is 9 m long, minimum 1.5 m. Here is located a touristic complex (Fig. 14 and 15), and we can notice direct waste water evacuation and the lack of a treatment plant.

Figure 14: Sampling station 8 on Capra Stream, natural habitat, with polluted tributary.

Figure 15: Touristic complex at sampling station 8 on Capra Stream.

The benthic macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Ostracoda, Ephemeroptera, Plecoptera, Trichoptera and Diptera (Tab. 1). From the numerical point of view the dominant group is Chironomidae (76.46%). The groups with the highest frequencies are Plecoptera and Chironomidae. According to calculated ecological semnification index we have eudominant groups: Chironomidae and Plecoptera; subdominant groups: Oligochaeta, Ephemeroptera, Araneida and Trichoptera; recedent group: other Diptera and subrecedent group: Ostracoda.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor).

In this area in similar lotic sectors of neighbouring streams (e.g. Buda Stream) are proper habitats for good populations of *Salmo trutta fario* and *Cottus gobio* (Bănăduc unpublished data).

The water pollution in the fragmented stream is due to the upstream and downstream micro hydro-power plants represent the local human impacts.

Sampling station S9 (Figs. 16 and 17) is situated at two kilometers downstream from the sampling station S8. This station is positioned at 1.158 m altitude.

The geographical coordinates are: 45º32.925' north latitude and 24º35.920' east longitude. The maximum width of the river course is 14 m and the minimum 10 m.

Figura 16: Sampling station 9 on Capra Stream; hidrotechnical work on th stream bank.

Figure 17: Sampling station 9 on Capra Stream, pipe ready to be buried in the stream bank.

The benthic macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Trichoptera, Diptera, Amfipoda and Turbellaria (Tab. 1). From the numerical point of view the dominant group is Chironomidae (78.89%). The groups with the highest frequencies are: Oligochaeta, Araneida, Ephemeroptera, Plecoptera, Trichoptera and Chironomidae. According to calculated ecological semnification index we have eudominant group: Chironomidae; eudominant group: Plecoptera; subdominant groups: Ephemeroptera, Oligochaeta, Araneida and Trichoptera; recedent groups: other Diptera, Amphipoda and Turbellaria; subrecedent group: Collembola.

The Carpathian Fish – Integrity Biotic Index score (24 – fair), describes some expected species absent (*Cottus gobio*) or rare (*Salmo trutta fario*) only two individuals were sampled in the fishing time unit.

The hidrotechnical works (banks reshaping and riverbed surface diminishing) impact is high.

Sampling station S10 (Fig. 18) is situated at 2.4 km downstream from the prelevation station S9. The station is positioned at an altitude of 1,131 meters. The coordinates are: 45º31.899' north latitude and 24º35.284' east longitude. The maximum width of the river course is 14 m and the minimum 10 m.

The maximum width of the river course is 13 m and a minimum width of 7 m. The maximum depth is 70 cm and the minimum is 15 cm.

Figura 18: Station 10, burried pipe in the stream bank at micro hydro-power plant Capra III.

Figure 19: Sampling station 10 on Capra Stream, near the micro hydro-power plant Capra III.

The macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Trichoptera and Diptera (Tab. 1). From the numerical point of view the dominant group is Chironomidae (64.03%). The groups with the highest frequencies are: Oligochaeta, Ephemeroptera, Plecoptera, Trichoptera and Diptera. According to calculated ecological semnification index we have the following groups: eudominant groups Chironomidae and Plecoptera; dominant group: Ephemeroptera; subdominant groups: Trichoptera, Oligochaeta and other Diptera; recedent group: Araneida; subrecedent group: Collembola.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor). In this area in similar lotic sectors of neighbouring streams (e.g. Buda Stream) are proper habitats for good populations of *Salmo trutta fario* and *Cottus gobio* (Bănăduc unpublished data).

The studied river course is ocupied by human removed river rocks. Downstream it is situated the micro hydro-power plant Capra III (Fig. 19) due to which the lotic and riverine habitats are drastically disturbed.

Sampling station S11 (Fig. 20) is situated at 2.4 km downstream from sampling station S10. The station is positioned at 1,046 m altitude. The coordinates are 45°30.793' north latitude and 24°35.028' east longitude. The maximum width of the river course is 9 m and the minimum 5 m.

Figure 20: Station 11, burried pipes on bank and riverbed surface diminished with 50%.

Figure 21: Near the station 11, remaines of old rocks and loggs dam used for lodgs rafting.

The macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Trichoptera and Diptera (Tab. 1). From the numerical point of view the dominant group is Chironomidae (85.09%). The groups with the highest frequency are: Ephemeroptera, Plecoptera, and Chironomidae. According to calculated ecological semnification index we have eudominant groups: Chironomidae; subdominant group: Ephemeroptera, Plecoptera, Oligochaeta and Araneida; recedent groups: other Diptera, Collembola and Trichoptera.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index, reflects no fish individuals present. In this area in similar lotic sectors of neighbouring streams (e.g. Buda Stream) are proper habitats for good populations of *Salmo trutta fario* and *Cottus gobio* (Bănăduc unpublished data).

The actual human impact on the stream is due to agressive hydrotechnical works (Fig. 20). Older lodges rafting impact has happened here (before the second world war) the lodges rafting barrages remains are still present in this area (Fig. 21).

Sampling station S12 (Fig. 22) is situated 1.7 km downstream from the sampling station S11. The station is positioned at 966 m altitude and its coordinates are: 45º30.124' north latitude and 24º35.011' east longitude. The maximum width of the river course is 8 m and the minimum 1.3 m.

The maximum width of the river course is 13 m and the minimum is 7 m. The maximum depth is 70 cm and the minimum is 15 cm.

Figure 22: Sampling station 12 on Capra Stream.

The macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Trichoptera and Diptera (Tab. 1). From the numerical point of view the dominant group is Chironomidae (88.98%). The groups with the highest frequencies are Plecoptera and Chironomidae. According to calculated ecological semnification index we have eudominant group: Chironomidae; subdominant groups: Ephemeroptera and Plecoptera; recedent groups: Araneida, Oligochaeta, Trichoptera and other Diptera; subrecedent group: Collembola.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index, reflects no fish individuals present. In this area in similar lotic sectors of neighbouring streams (e.g. Buda Stream) we can find proper habitats for good populations of *Salmo trutta fario* and *Cottus gobio* (Bănăduc unpublished data).

The rock filling width which cover the pipes buried in the river banks, represent 50% of the initial river bed width. This station is situated downstream of the michro hydro-power plant Capra IV.

Sampling station S13 (Fig. 23) is situated at 1.5 km downstream from prelevation station S12. This site is also located on the future placement of the Capra V micro hydro-power plant. The station is positioned at 915 meters in altitude.

The registeerd coordinates are: 45º29.289' north latitude and 24º34.998' east longitude.

The maximum width of the river course is seven meters and the minimum four meters. The maximum depth is 130 cm.

Figure 23: Sampling station 13 on Capra Stream, lotic habitat negatively affected by works for microhidropowerplant Capra V underground pipes instalments.

Figure 24: Pipe used for the local hidrotechnical works.

Figure 25: Heavy construction equipment work near the sampling station 13; lotic habitat negatively affected by works for Capra V micro hydro-power plant.

A common situation for the Capra Stream tributaries is that their connections are blocked by some antierosional dams (Fig. 26).

Figure 26: Dam on a tributary in the proximity of sampling station 13.

The macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Ostracoda, Collembola, Ephemeroptera, Plecoptera, Trichoptera and Diptera (Tab. 1). From the numerical point of view the dominant groups are Chironomidae (71.91%). The groups with the highest frequencies are Ephemeroptera, Plecoptera and Chironomidae. According to calculated ecological semnification index we have eudominant groups: Chironomidae and Ephemeroptera; subdominant groups: Collembola, Plecoptera, Araneida, Oligochaeta and other Diptera; recedent group: Trichoptera; subrecedent group: Ostracoda.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor).

To be able to bury the pipes here (Fig. 24) a rad has been developed through the river bed, of one hundred of m length (Fig. 23). The building ground necessary to bury the pipes is wider than the remaining river bed width. The riverbed work is done with heavy construction equipment with no measures to minimize the envirnmental impact (Fig. 25).

Sampling station S14 (Fig. 27) is situated at 1.7 km downstream from the sampling station S13 on the planed future placement of the Capra VI microhidropwerplant. The station is positioned at 890 meters in altitude.

The coordinates are: 45º28.649' north latitude and 24º35.826' east longitude. The maximum width of the river course is 11 m and the minimum 9 m. The maximum depth of the water is about 1 m and the minimum 30 cm.

Figura 27: Sampling station 14 on Capra Stream,
lotic habitat negatively affected by works for Capra VI micro hydro-power plant.

In this sampling station the lateral connection of Capra River with its tributaries is also blocked by anti-sediments dams.

The macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Trichoptera and Diptera. From the numerical point of view the dominant group is Chironomidae (88.89%). The groups with the highest frequencies are Oligochaeta, Plecoptera, Trichoptera and Diptera. According to calculated ecological semnification index we have eudominant group: Chironomidae; subdominant groups: Plecoptera, Trichoptera, Oligochaeta and other Diptera; recedent groups: Ephemeroptera, Araneida and Collembola.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index, reflects no fish individuals present.

In this area, in such lotic sectors of neighbouring streams, (e.g. Buda Stream) are proper habitats and good populations of *Salmo trutta fario* and *Cottus gobio* (Bănăduc unpublished data).

Sampling station S15 (Fig. 28) is situated at 1.5 km downstream from sampling station S14 at 845 meters in altitude. The coordinates are: 45º28.644' north latitude and 24º36.058' east longitude.

The maximum width of the river course is 11 m and the minimum nine meters. The maximum depth is 90 cm, while the minimum is 20 cm.

Figure 28: Sampling station 15 on Capra Stream.

The macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Ostracoda, Collembola, Ephemeroptera, Plecoptera, Trichoptera and Diptera (Tab. 1). From the numerical point of view the dominant group is: Chironomidae (82.73%). The groups with the highest frequencies are Ephemeroptera, Plecoptera, Trichoptera and Diptera. According to calculated ecological semnification index we have eudominant groups: Chironomidae; subdominant groups: Trichoptera, Oligochaeta, other Diptera, Plecoptera and Ephemeroptera; recedent groups: Collembola and Araneida; and subrecedent group: Ostracoda.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index, reflects no fish individuals present. In this area, in similar lotic sectors of neighbouring streams, (e.g. Buda Stream) are proper habitats for good populations of *Salmo trutta fario* and *Cottus gobio* (Bănăduc unpublished data).

Sampling station 16 (Fig. 29) is situated at 500 m downstream the station S15. The coordinates are: 45º27.751' north latitude and 24º36.172' east longitude.

The maximum width of the river course is 18 m, the minimum 13 m and the medium 15 m. The maximum depth is 95 cm while the minimum is 20 cm.

Figure 29: Sampling station 16 on Capra Stream.

The macroinvertebrates community, from this river sector is formed by Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Trichoptera and Diptera (Tab. 1). From the numerical point of view the dominant group is Chironomidae (89.77%). The groups with the highest frequencies are Ephemeroptera, Plecoptera, Trichoptera and Diptera. According to calculated ecological semnification index we have: eudominant group: Chironomidae; subdominant groups: Plecoptera, Trichoptera, other Diptera and Oligochaeta; recedent groups: Ephemeroptera and Araneida; subrecedent group: Collembola.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor), a minimum possible score of this index, reflects no fish individuals present. In this area in similar lotic sectors of neighbouring streams (e.g. Buda Stream) are proper habitats for good populations of *Salmo trutta fario* and *Cottus gobio* (Bănăduc unpublished data).

The last Capra Stream sampling station, S17 is situated upstream the Vidraru Lake (at the edge of the lake), upstream the anti-bottom sediments dam (Figs. 30 and 31). The coordinates are: 45°27.543' north latitude and 24°36.202' east longitude. S17 is situated at 843 m altitude.

The maximum width of the river course is 29 m and the minimum nine meters. Here we can see small sediment particles accumulation (sand and mud), gravel, and vegetation (Fig. 30) that generate the semnificative change of the habitats and microhabitats against their natural state. The maximum depth of the river course is 1 m and the minimum 10 cm.

Figure 30: Sampling station 17 on Capra Stream.

Figure 31: Logs and sediments blocks the dam near the Vidraru Lake during high flows period in S17.

Figure 32: Sampling station 17 on Capra Stream, view from downstream of the concrete anti-bottom sediments dam on the Capra River course at the edge of Vidraru Lake.

The macroinvertebrates community from this river sector is formed by Oligochaeta, Araneida, Collembola, Ephemeroptera, Plecoptera, Trichoptera, Diptera (Tab. 1). From the numerical point of view the dominant group is Chironomidae (86.01%). The groups with the highest frequencies are: Plecoptera and Chironomidae. According to calculated ecological semnification index we have: eudominant group: Chironomidae; subdominant groups: Plecoptera, Ephemeroptera, Oligochaeta, Trichoptera and other Diptera; recedent groups: Araneida and Collembola.

The Carpathian Fish – Integrity Biotic Index score (1 – very poor).

The lotic habitats are transformed here in lentic habitats, upstream and downstream, this is primarily due to the concrete anti-bottom sediments dam on the Capra River course, at the edge of Vidraru Lake. No downstream-upstream fish fauna connection is possible due to the lack of fish passage.

DISCUSSION

Analising the similarities between the benthic macroinvertebrates communities from the Capra Stream, based on the relative abundance of the present taxonomic groups we found out that they can be grouped in eight (I-VIII) classes (Fig. 33, Tab. 1).

I. The communities dominating from the numerical point of view are Chironomidae. These communities are present at 1.6 km downstream from the first micro hydro-power plant (sampling station 6), at 2.4 km downstream of the Capra III microhidropowerplant (which was under construction) (S11), downstream of the Capra IV micro hydro-power plant (in construction during the prelevation period) (S12), in the future emplacement of Capra VI micro hydro-power plant – where during prelevation period the investor was preparing for the construction of Capra VI micro hydro-power plant (S14), downstream of the future emplacement of the Capra VI micro hydro-power plant (S16) and upstream of the Vidraru Lake (S17).

II. Communities that are still dominant (numerically) also consist of Chironomidae, but with a lower relative abundance than the above case. These communities are situated at 1,500 m downstream of the future emplacement of the Capra VI micro hydro-power plant and at 1,500 m downstream of the anti-bottom sendiments dam which blocks the connection of Capra Stream with its tributary.

III. Communities with numerical dominant groups are Chironomidae and Plecoptera. These are present near the touristic area Piscul Negru (S8) and a two kilimeters downstream from this touristic complex (S9).

IV. Communities with the highest relative abundance (between 64.03% and 72.66%) are Ephemeroptera (6.76-15.33%) and Plecoptera (8.4-15.79%). These communities are present in the first 3 km of the river, downstream the first sampling station (S2, S3 and S4) in the place where began the Capra III microhidropowerplant construction during the sampling period (S10) and at 3 km downstream of Capra IV microhidropowerplant which is also in construction (S13).

V. Communities with the highest relative abundance Chironomidae (40.75%), Plecoptera (26.67%), Ephemeroptera (17.61%) and Oligochaeta (7.2%). These communities are situated in the first prelevation station, at the closest point to the headspring (S1).

VI. Communities with numerical dominant groups Chironomidae (55.9%), Trichoptera (15.31%) and Ephemeroptera (12.36%). These communities are present at approximative four kilometers downstream from the first prelevation station (S5).

VII. Communities with numerical dominant groups Oligochaeta (63.05%) and Chironomidae (24.05%). These are present downstream from the Capra II micro hydro-power plant in construction during the sampling period (S7).

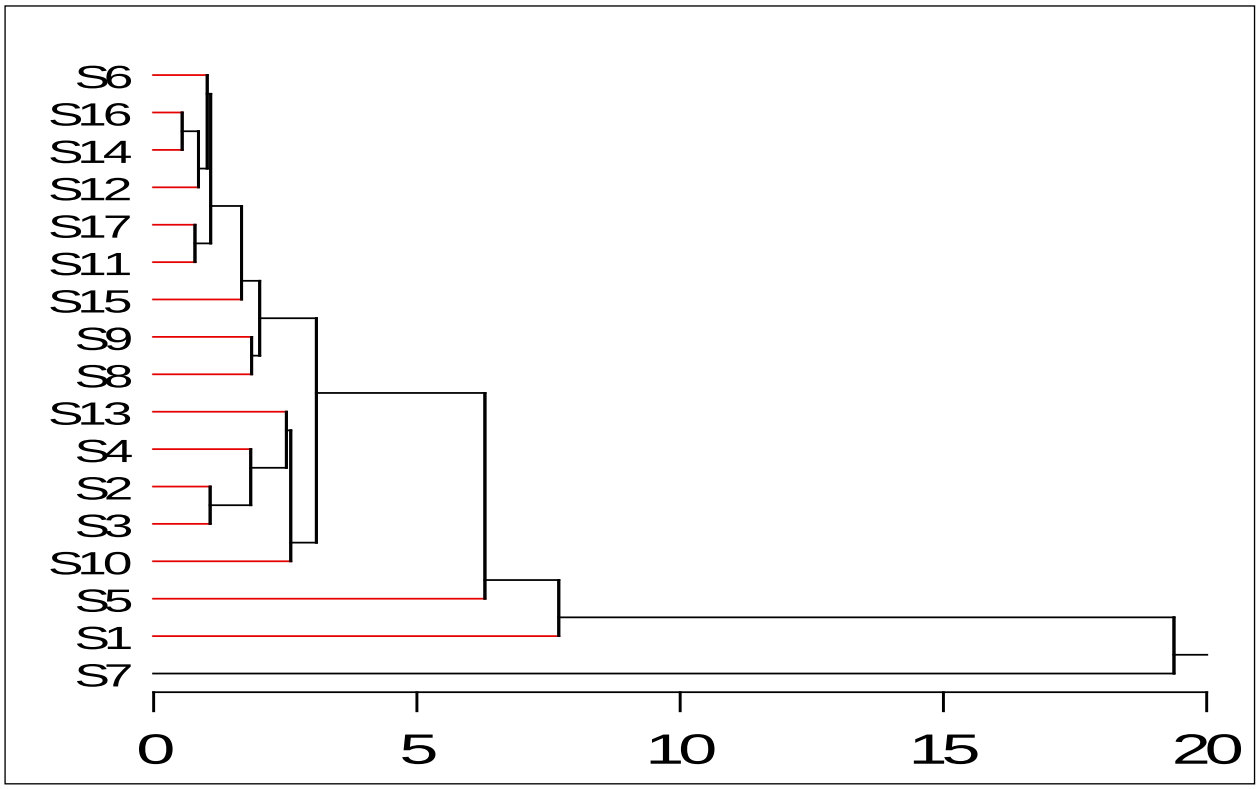

Figura 33: Similarity analysis of benthonic macroinvertebrates from Capra Stream based on relative abundance values of these groups (grouped at euclidean distance S1-S17 prelevation stations).

Table 1: Benthic macroinvertebrates communities structure from the Capra Stream (A – relative abundance, F – frequency and W – ecological significance index).

Station	Sistematic groups	A (%)	F (%)	W
1.	Oligochaeta	6.29	100	6.29
	Turbellaria	1.26	50	0.63
	Araneida	1.64	100	1.64
	Collembola	1.26	75	0.94
	Ephemeroptera	17.61	100	17.61
	Plecoptera	26.67	100	26.67
	Trichoptera	2.52	100	2.52
	Chironomidae	40.75	100	40.75
	Other Diptera	2.01	75	1.51
2.	Oligochaeta	1.04	75	0.78
	Turbellaria	0.4	75	75
	Araneida	0.54	75	0.41
	Collembola	0.1	50	0.05
	Ephemeroptera	12.52	100	12.52
	Plecoptera	12.86	100	12.86
	Trichoptera	1.29	100	1.29
	Hydropsychidae	0.2	75	0.15
	Chironomidae	69.22	100	100
	Other Diptera	1.83	100	100
3.	Oligochaeta	1.03	100	1.03
	Turbellaria	0.6	75	0.45
	Araneida	0.67	100	0.67
	Collembola	0.42	75	0.32
	Ephemeroptera	12.58	100	12.58
	Plecoptera	15.79	100	15.79
	Trichoptera	0.48	75	0.36
	Hydropsychidae	0.12	50	0.06
	Chironomidae	67.27	100	67.27
	Other Diptera	1.03	75	0.77
4.	Oligochaeta	0.71	75	0.53
	Turbellaria	0.06	25	0.01
	Araneida	0.77	50	0.38
	Collembola	0.06	25	0.01
	Ephemeroptera	15.33	100	15.33
	Plecoptera	8.4	100	8.4
	Trichoptera	0.77	75	0.58
	Chironomidae	72.66	100	72.66
	Other Diptera	1.12	100	1.12
5.	Oligochaeta	7.2	100	7.2
	Turbellaria	0.37	25	0.09
	Araneida	1.48	75	1.11
	Ostracoda	0.18	25	0.05
	Ephemeroptera	12.36	100	12.36
	Plecoptera	4.98	100	4.98
	Trichoptera	15.31	50	7.66
	Chironomidae	55.9	100	55.9
	Other Diptera	2.21	75	1.66

Table 1 (continued): Benthic macroinvertebrates communities structure from the Capra Stream (A – relative abundance, F – frequency and W – ecological significance index).

Station	Sistematic group	A (%)	F (%)	W
6.	Oligochaeta	2	100	2
	Araneida	0.71	75	0.53
	Collembola	0.14	25	0.04
	Ephemeroptera	2.14	100	2.14
	Plecoptera	2	75	1.5
	Trichoptera	0.29	50	0.14
	Chironomidae	91.87	100	91.87
	Other Diptera	0.86	50	0.43
7.	Oligochaeta	63.05	100	63.05
	Araneida	6.74	100	6.74
	Collembola	3.52	100	3.52
	Ephemeroptera	1.17	50	0.59
	Plecoptera	0.29	25	0.07
	Chironomidae	24.05	100	24.05
	Other Diptera	1.17	50	0.59
8.	Oligochaeta	5.5	50	2.75
	Araneida	1.55	75	1.16
	Ostracoda	0.17	25	0.04
	Ephemeroptera	3.44	75	2.58
	Plecoptera	10.82	100	10.82
	Trichoptera	1.55	75	1.16
	Hydropsychidae	0.17	25	0.04
	Chironomidae	76.46	100	76.46
	Other Diptera	0.34	50	0.17
9.	Oligochaeta	4.22	100	4.22
	Araneida	2.88	100	2.88
	Collembola	0.19	25	0.05
	Ephemeroptera	4.8	100	4.8
	Plecoptera	5.37	100	5.37
	Trichoptera	1.73	100	1.73
	Hydropsychidae	0.77	50	0.38
	Chironomidae	78.89	100	78.89
	Other Diptera	0.38	50	0.19
	Turbellaria	0.38	25	0.1
	Amphipoda	0.38	25	0.1
10.	Oligochaeta	2.18	100	2.18
	Araneida	0.8	50	0.4
	Collembola	0.11	25	0.03
	Ephemeroptera	6.76	100	6.76
	Plecoptera	21.19	100	21.19
	Trichoptera	2.63	100	2.63
	Hydropsychidae	0.11	25	0.03
	Chironomidae	64.03	100	64.03
	Other Diptera	2.18	75	1.63

Table 1 (continued): Benthic macroinvertebrates communities structure from the Capra Stream (A – relative abundance, F – frequency and W – ecological significance index).

11.	Sistematic group	A (%)	F (%)	W
	Oligochaeta	2.64	75	1.98
	Araneida	2.08	75	1.56
	Collembola	0.75	50	0.38
	Ephemeroptera	4.91	100	4.91
	Plecoptera	3.4	100	3.4
	Trichoptera	0.38	50	0.19
	Chironomidae	85.09	100	85.09
	Other Diptera	0.75	75	0.57
12.	Oligochaeta	1.38	50	0.69
	Araneida	1.38	75	1.03
	Collembola	0.2	25	0.05
	Ephemeroptera	4.33	75	3.25
	Plecoptera	1.97	100	1.97
	Trichoptera	0.79	75	0.59
	Hydropsychidae	0.39	25	0.1
	Chironomidae	88.98	100	88.98
	Other Diptera	0.59	75	0.44
13.	Oligochaeta	2.81	75	2.11
	Araneida	3.37	75	2.53
	Ostracoda	0.28	25	0.07
	Collembola	4.49	75	3.37
	Ephemeroptera	10.96	100	10.96
	Plecoptera	3.37	100	3.37
	Trichoptera	0.84	755	0.63
	Hydropsychidae	0.28	25	0.07
	Chironomidae	71.91	100	71.91
	Other Diptera	1.69	75	1.26
14.	Oligochaeta	1.77	100	1.77
	Araneida	1.06	75	0.8
	Collembola	0.47	50	0.24
	Ephemeroptera	1.77	50	0.89
	Plecoptera	2.48	100	2.48
	Trichoptera	1.89	100	1.89
	Hydropsychidae	0.47	25	0.12
	Chironomidae	88.89	100	88.89
	Other Diptera	1.18	100	1.18
15.	Oligochaeta	4.18	75	3.14
	Araneida	0.55	50	0.27
	Ostracoda	0.18	25	0.05
	Collembola	0.73	50	0.36
	Ephemeroptera	1.45	100	1.45
	Plecoptera	2	100	2
	Trichoptera	4.91	100	4.91
	Hydropsychidae	0.36	50	0.18
	Chironomidae	82.73	100	82.73
	Other Diptera	2.91	100	2.91

Table 1 (continued): Benthic macroinvertebrates communities structure from the Capra Stream (A – relative abundance, F – frequency and W – ecological significance index).

16.	Oligochaeta	1.52	75	1.14
	Araneida	0.58	75	0.44
	Collembola	0.07	25	0.02
	Ephemeroptera	0.51	100	0.51
	Plecoptera	3.12	100	3.12
	Trichoptera	2.25	100	2.25
	Hydropsychidae	0.87	100	0.87
	Chironomidae	89.77	100	89.77
	Other Diptera	1.31	100	1.31
17.	Oligochaeta	2.51	75	1.88
	Araneida	0.42	25	0.1
	Collembola	0.42	50	0.21
	Ephemeroptera	3.76	75	2.82
	Plecoptera	3.34	100	3.34
	Trichoptera	1.67	75	1.25
	Hydropsychidae	0.42	25	0.1
	Chironomidae	86.01	100	86.01
	Other Diptera	1.46	75	1.1

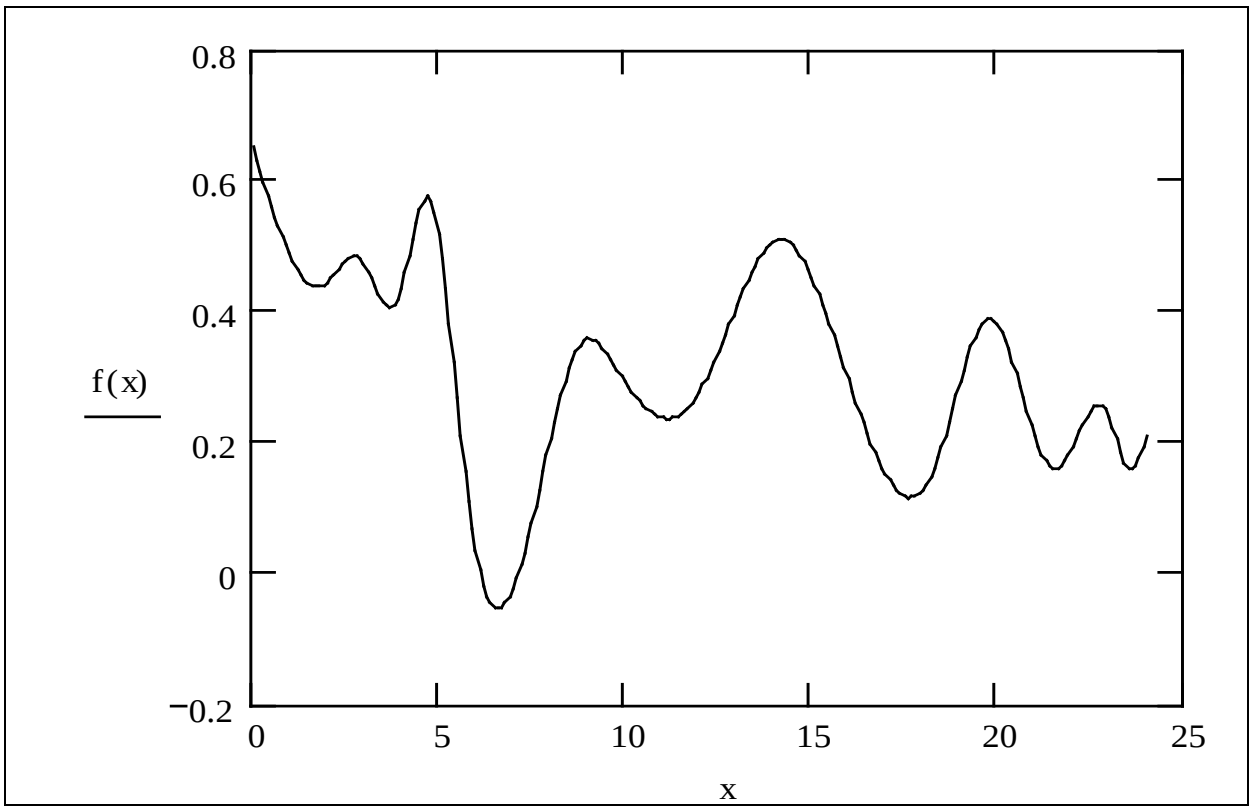

Figure 34: The Reversed Simpson Index values variation for Insecta Class along the Capra Stream (interpolation cubic spline function, ox axis – stream length in km).

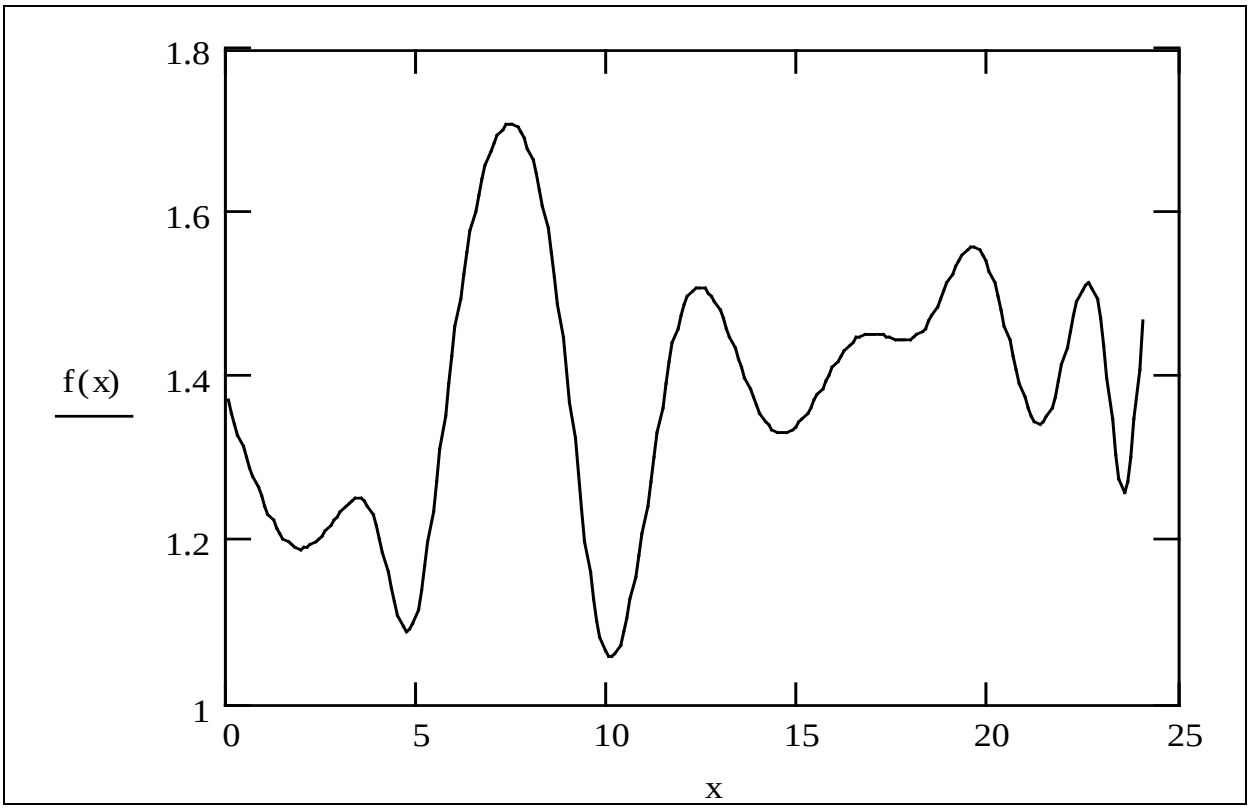

Figure 35: The Margalef Index values variation for Insecta Class along the Capra Stream (interpolation cubic spline function, ox axis – stream length in km).

According to reversed Simpson and Margalef Index values for Insecta Class we recorded that although the diversity is high (Fig. 34) the taxonomic groups distribution in the lotic system is homogenous (Fig. 33).

Capra Stream ecological state based on benthic macroinvertebrates and fish communities

The biotic Hilsenhoff index shows organic charge of the water and, according to registered values, the water quality is good in the sampling stations of the Capra Stream (Tab. 2). This shows that the untreated water resulting from touristic areas along the river, is not strong enough and doesn't have a significant negative impact on the benthonic macroinvertebrates communities.

The EPT/C index reveals that the taxonomic groups structure is sensitive to different types of impact. Systematic groups Ephemeroptera, Plecoptera and Trichoptera, beside the fact that they are sensitive to oxigen concentration, are directly dependent on the lithologic substrate structure and type of flow. The registered value of EPT/C is higher than 1, only in the first sampling station (Tab. 2) which shows that the impact of micro hydro-power plants preparatory works on the other sampling stations is important for the benthic macroinvertebrates of this river.

The benthic macroinvertebrates structure and the biotic integrity values of the Hilsenhoff and EPT/C indexes (Tab. 2, Fig. 35), shows the existance of three ecological zones on the river: **I.** The superior sector of the stream is characterised by a very good state. Here the anthropic impact is insignificant, the aquatic habitats being close from the natural state of the river. **II.** The middle sector of the river reveals an unsatisfactory state because of the Capra II microhidropowerplant construction work and because of the untreated waste water resulting from the Conacul Ursului chalet. Because of the Capra II micro hydro-power plant development work, there have

been observed significant hydrological and morphological changes in the river bed. The river banks have been also modified because of the pipe burial disturbance. **III.** The lower sector of the river (downstream from S8) shows a better ecological state than the previous sector. The good water quality is due to tributaries water which flow directly in the Capra Stream. This river sector is also exposed to anthropic pressures such as river continuum fragmentation, the development of four micro hydro-power plants, buried pipes in the river banks, riverbed surface diminishing untill 50%, hasty set up roads for buring the pipes in the river bed, the building site with heavy equipment in the river bed which do not have any measures to reduce the impact, the side connection block of the river and the untreated waste water ejection from the touristic zone situated near by.

Table 2: The Hilsenhoff index values (with the adequate quality classes), Margalef and reversed Simpson (based on the resulted values for Insecta Class).

	HBI		EPT/C	Margalef Index	Reversed Simpson Index
S1	3.54	Excellent	1.14	1.37	2.89
S2	4.16	Very good	0.38	1.19	1.79
S3	4.09	Very good	0.43	1.23	1.94
S4	4.32	Good	0.33	1.22	1.74
S5	4.15	Very good	0.58	1.09	2.33
S6	4.85	Good	0.04	1.39	1.12
S7	6.29	Unsatisfactory	0.06	1.45	1.54
S8	4.52	Good	0.2	1.08	1.44
S9	4.6	Good	0.16	1.46	1.35
S10	3.87	Very good	0.47	1.34	2.05
S11	4.67	Good	0.1	1.45	1.25
S12	4.75	Good	0.08	1.46	1.19
S13	4.26	Good	0.21	1.55	1.65
S14	4.72	Good	0.07	1.35	1.19
S15	4.64	Good	0.1	1.44	1.31
S16	4.73	Good	0.07	1.26	1.19
S17	4.71	Good	0.1	1.47	1.27

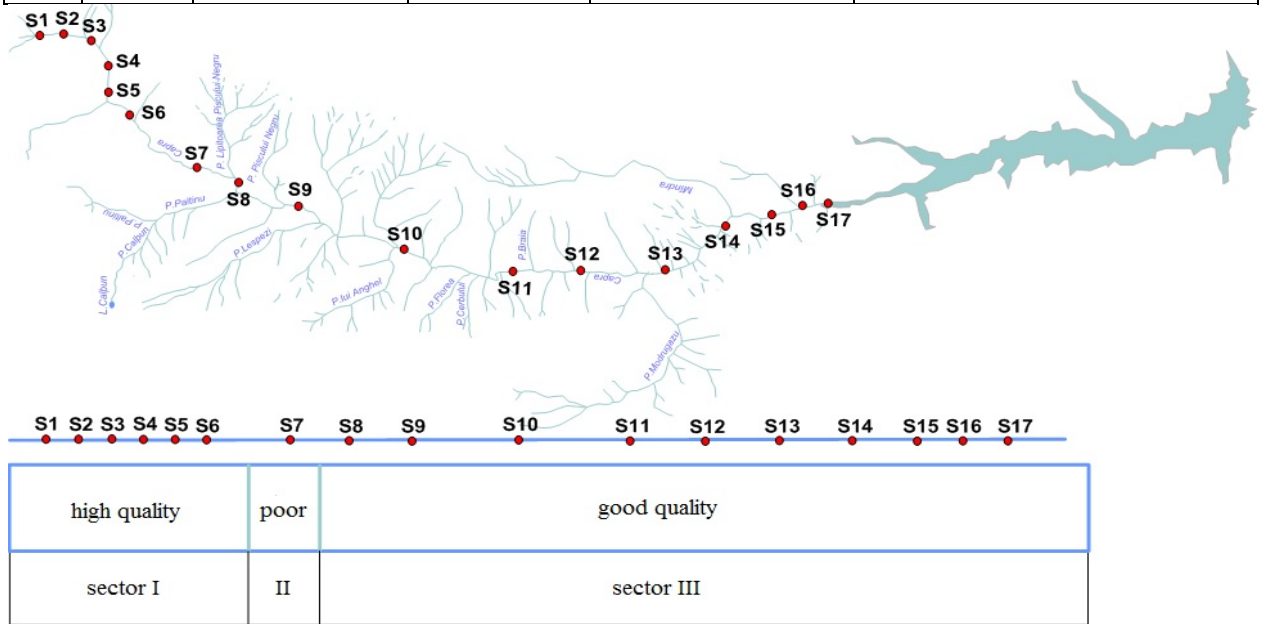

Figure 36: Capra River sectors enframe in quality categories, depend on Hilsenhoff biotic index values (HBI).

CONCLUSIONS

After the analysis of the Capra Stream ecological state based on biotic integrity indexes (HBI and EPT/C) and IBI Carpathian Fish Index we noticed the impacts of dams, micro hydro-power plants development and pollution.

The macroinvertebrate and fish fauna are directly affected by the lithological substrate change (in conditions of which they and their trophic base depend on the substrate) and by the flow regime changes.

Along the Capra Stream we managed to distinquish three main ecological zones.

The first ecological zone is characterised by a good ecological state the anthropic impact being insignificant. Because the lotic habitats are in an appropiate state of the natural one, we recommend the conservation of this status.

The second ecological zone is characterised by an unsatisfactory ecological state mainly because of the Capra III micro hydro-power plant development and because of the untreated wastewaters discharges in the stream. In this river sector have been hidrological and morphological changes which generate stress for the aquatic communities fact which determines changes in their structure. The river banks configuration change also may determine the river bed deepen because of the rotational flow with negative effect on the aquatic communities. We propose the next management measures for this river sector are to reduce/ban the causes which generates hidrological changes, so the analysed lotic communities can benefit by the ecological flow regime (mentioned in water's law no. 107/1996 necessary for the aquatic communities structure maintainance and ecological system well function in natural conditions or appropiate conditions to natural). Then we propose re-establishing measures for the modified river banks and reduction of the river bed erosion.

The third ecological zone is better than the previous one from the ecological point of view because of the left and right tributaries contribution of the Capra Stream. In this sector the anthropic impact is still significant because of the development of micro hydro-power plants, the tributaries connection blocking and the untreated wastewater discharge. The building works simultaneous with the semnificative river bed damage determinated the *Cottus gobio* local extinction and the drastic reduction of *Salmo truta fario* individuals (the presence of *Salmo truta fario* in just one river sector of 17 sampling stations).

After finishing the chain of micro hydro-power plants construction on this stream it's compulsory to repopulate with trout and bullhead species, which before the anthropic impact had stable populations data (Bănăduc, unpublished data). These repopulations are recommended to be done with biologic material prelevated from Buda stream which have similar ecological characteristics with Capra, and also have been in connection with Capra Stream in the past. The extinction of every fish species in all prelevation stations except station 9 area with low abundance though is due to major interventions (as temporal as well as spatial aspect) of the micro hydro-power plants construction team upstream.

This situation resulted because of factors that have accumulated throughout time such as lodges rafting in the first part of the XIX century, fractioning the ichtiofauna connectivity because of the anti-bottom sediments dams without the construction of a fish ladder built on the tributaries (especially the one built on Capra close to the Vidraru Lake edge); aggressive damage of the river bed for pipe burial constructed for the micro hydro-power plants chain in different states of development; the secondary impact of the untreated wastewater discharges of Piscul Negru chalet (in the last two decades).

The management measures for this river sector are prevention measures from developing new roads through the river bed and re-establishing measures where they are needed, re-establishing the tributaries connections and re-establising of past water courses, the adequate treatment of wasterwaters.

ACKNOWLEDGEMENTS

The authors thank the Association Ecotur Sibiu for the support during the field campaign.

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AUTHORS:

[1] *Angela CURTEAN-BĂNĂDUC*
angela.banaduc@ulbsibiu.ro
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Applied Ecology Research Center,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

[2] *Doru BĂNĂDUC*
ad.banaduc@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

[3] *Lucia URSU*
ipcyana@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

[3] *Răzvan RĂCHITĂ*
rachita.razvan@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

RESTORING LONGITUDINAL CONNECTIVITY OF THE SOMEŞUL MIC RIVER NEAR THE DAM IN MĂNĂSTIREA VILLAGE (TRANSYLVANIA, ROMANIA)

Răzvan VOICU[1] and *Doru BĂNĂDUC*[2]

KEYWORDS: dam, river connectivity, lotic ecosystem, Someşul Mic River.

ABSTRACT

Water Framework Directive (60/2000/CE), the National Management Plan approved by Government Decision no. 80/2011, european institutions with competences in environmental protection, faculties of environmental protection, environmental movements and foundations, European Union legislation, etc. bring a substantial contribution to the protection of lotic ecosystems in Europe.

Proposals and implementations, of solutions to restore the longitudinal connectivity of the river in order to reduce the effect of the hydromorphological pressures (cross barring) on watercourses, were introduced.

The solution presented in this paper is relatively complex, but robust, utilizing non-corrosive components that provide a safe transport for fish upstream of the basin. This system, after some resizing, can be successfully used on other dams or discharge sills located along the Someşul Mic River.

REZUMAT: Restabilirea conectivității longitudinale a râului Someșul Mic în apropierea barajului din satul Mănăstirea (Transilvania, România).

Directiva Cadru Apă (60/2000/CE), Planul Național de Gestiune aprobat prin Hotărârea Guvernului Român nr. 80/2011, instituțiile europene cu competențe în protecția mediului, universitățile de profil, ONG-urile de mediu, legislația europeană etc., își aduc o contribuție substanțială la protecția ecosistemelor lotice din Europa și nu numai.

Propunerea și implementarea de soluții pentru restaurarea conectivității longitudinale au ca scop reducerea efectului presiunilor hidromorfologice asupra cursurilor de apă.

Soluția prezentată în acest articol, este relativ complexă, dar robustă și nu conține componente corozive. Pe lângă un sistem de transport în siguranță al peștilor în amonte, acest sistem, după unele reajustări, poate fi utilizat cu succes și în cazul altor baraje și stăvilare situate pe râul Someșul Mic.

RÉSUMÉ: Rétablissement de la connectivité longitudinale de la rivière Someşul Mic à proximité du barrage du village de Mănăstirea (Transylvanie, Roumanie).

La Directive Cadre de l'Eau (60/2000/CE), Le Plan National de Gestion approuvé par la Décision Gouvernementale no. 80/2011, les institutions européennes ayant des compétences dans la protection de l'environnement, l'Université Ecologique, les ONGs de profil, la législation européenne etc. contribuent d'une manière significative à la protection des écosystèmes lotiques d'Europe et pas seulement.

La proposition et la mise en place de solutions pour le rétablissement de la connectivité longitudinale ont pour objectif de réduire l'effet des pressions hydro-morphologiques sur les cours d'eau.

La solution présentée dans le présent article est relativement complexe mais fiable et ne comprend pas de composants corrosifs. En plus de permettre un transport sécurise des poissons en amont du bassin, ce système, après certains réajustements, peut être utilisé avec succès dans le cas d'autres barrages et déversoirs de la rivière Someșul Mic.

INTRODUCTION

The Romanian rivers follow a global trend in which more and more of them are being negatively impacted by human activities that causing damaging concerns like various hidrotechnical works, different types of pollution, eutrophisation, water flow diminishing, mineral substrata overexploitation, watershed clear cutting of forests, poachery, introduction of invasive species, lodges transport on river bed, etc. (Curtean-Bănăduc and Fărcaș, 2013; Curtean-Bănăduc and Olosutean, 2013; Curtean-Bănăduc, 2008, 2005, 2012; Fărcaș et al., 2013; Curtean-Bănăduc et al., 2007).

The Someș River (435 km length, 15,015 km^2 basin), is formed by the merging of the Someșul Mare River (with springs in Rodnei-Suhard Mountains) and the Someșul Mic River (with springs in Apuseni Mountains). Mănăstirea Village is located in the Transylvanian Plateau (Romania) on the right side of the Someşul Mic River (Fig. 1) approximately three km upstream of the confluence between the Someşul Mare and Someşul Mic rivers. (Pădurean, 2007; Posea et al., 1982)

Due to the obvious fragmentation problems (Vannote et al., 1980) in the Someș River basin lotic continuum, different technical sollutions have already been proposed for different sectors of the studied river (Voicu, 2014; Voicu and Bretcan, 2014). This approach should continue due to the degree and complexity of the problems.

In 1920 a five meter high dam was built (*) in Mănăstirea Village (Fig. 1). This dam Hydrotechnical Works (Figs. 2-10) constructed for hydroelectricity purposes, represent a significant obstacle for the fish fauna movements. This is a major fragmentation of the local lotic system sector, with negative effects for the lower Someşul Mic River. All these negative impacs on fish (large scale mortality and also injury) are here due to the mechanical barriers, big drops over the weir, lotic sectors replacement with lenitic sectors, etc.

Figure 1: Someșul Mic at Mănăstirea Village.

Figure 2: Dam location in Mănăstirea Village
(Source: Google Earth).

Proper perceiving of fish biology and ecology is an important ground on which optimum decisions to eliminate rivers fragmentations are made.

The river sector upstream and downstream the Mănăstirea Village, belong from the ichthyological point of view to the Common Nase zone, includes the following two fish species which migrate or have some special relatively small moovements for reproduction and need an unfragmented lotic system: *Vimba vimba* (Linnaeus, 1758) and *Chondrostoma nasus* (Linnaeus, 1758) (Bănărescu, 1964). *Vimba vimba*, a Bern Convention protected fish species (Annex 3), it is a rheophilic species that prefer deep clay or sandy hard substrata with a need for relatively short migrations for reproduction. *Chondrostoma nasus*, also a Bern Convention protected fish species (Annex 3), it is a rheophilic species tha prefers faster water flow sectors with rocky substratum. The mature individuals form big groups which migrate upstream (Oțel, 2007).

Vimba vimba and *Chondrostoma nasus* fish species can be considered needed key indicators for local lotic sector restoration and conservation as well as for the realization for future monitoring/presence upstream and downstream for this sector.

Figure 3: Dam – upstream view (photo: Sofronie C.).

Figure 4: Dam – downstream view and toe basin (photo: Sofronie C.).

Figure 5: Old outlet small hydropower – upstream (photo: Sofronie C.).

Figure 6: Washing opening (dam).

Figure 7: Downstream discharge sill.

Figure 8: Downstream Mănăstirea Dam.

Figure 9: Downstream discharge sill.

Figure 10: Downstream Mănăstirea Dam.

Figure 11: Downstream Mănăstirea Dam.

MATERIAL AND METHODS

The materials used in the system described below, which will give bypassing upstream and downstream of the dam from the village Mănăstirea, are stainless and consist of only a few components that are easily assembled and disassembled. Raising fish vertically gives this solution a wide range of aplicability in terms of positioning (including near dams).

The effective cost savings of this system ranges to the use of all dams under 15 meters that contain flows rates of water downstream of the dam somewhat similar to that of the Mănăstirea Dam. For example, the construction of a Mănăstirea Dam classic fish lift costs at least $ 500,000 which is costs much more than the new system proposed in this article at $ 150,000 minimum. Consumed energy and elevator permanent maintenance for larger fish lifts are more than the electricity consumption and maintenance of the system of winches and vertical cell pool proposed in the article.

Fish entering the concrete basin are free of pressure issues due to the redirection of electric fields generated by low amperage. Doors opening and closing horizontally, and vertically, through the design are positioned in migrating steps so as not hurt the fish. Specific cylinder well finishing and durable plastic materials for migrating fish while the pillars of the cylinder do not affect the size and positioning of vegetation on the banks. Instinctively, and easily, the fish bypass the semicircular metal sheet pile due to low water velocity. Even if the water speed is high, the fish will not be harmed thanks to the design of the metal sheet pile. Minor bed is great, and from this point of view, the placing of the concrete basin will not affect local fish biodiversity. Movement of the water inside the cylinder is caused by the force of gravity and is constrained to a slow velocity as to cause no hurt the fish and other aquatic organims that moving within the cylinder.

RESULTS AND DISCUSSION

Fish fauna migration upstream of Mănăstirea Dam can be achieved by applying solution I. Downstream of the dam, on the water course and on the left bank of the following water flow direction, a concrete basin will be built in the Someşul Mic River bed. A circular metal sheet pile that redirects the water body is fastened to the side (surface) perpendicular to the river (Fig. 4). In the water storage area, the concrete basin will have a height of 2.10 meters, a length of 4 meters and a width of 2.20 m.

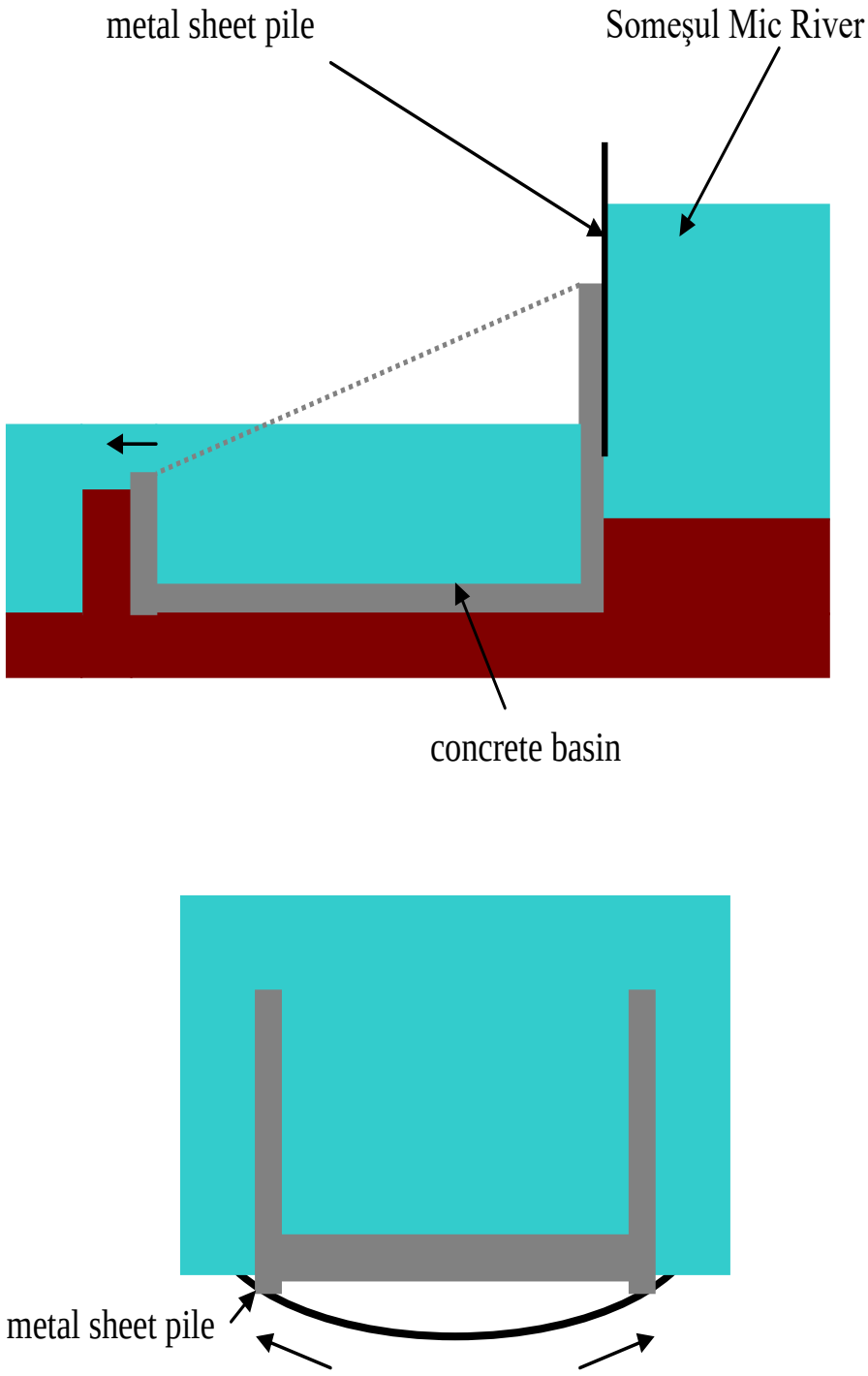

Figure 12: Positioning the metal sheet pile-indicative scheme.

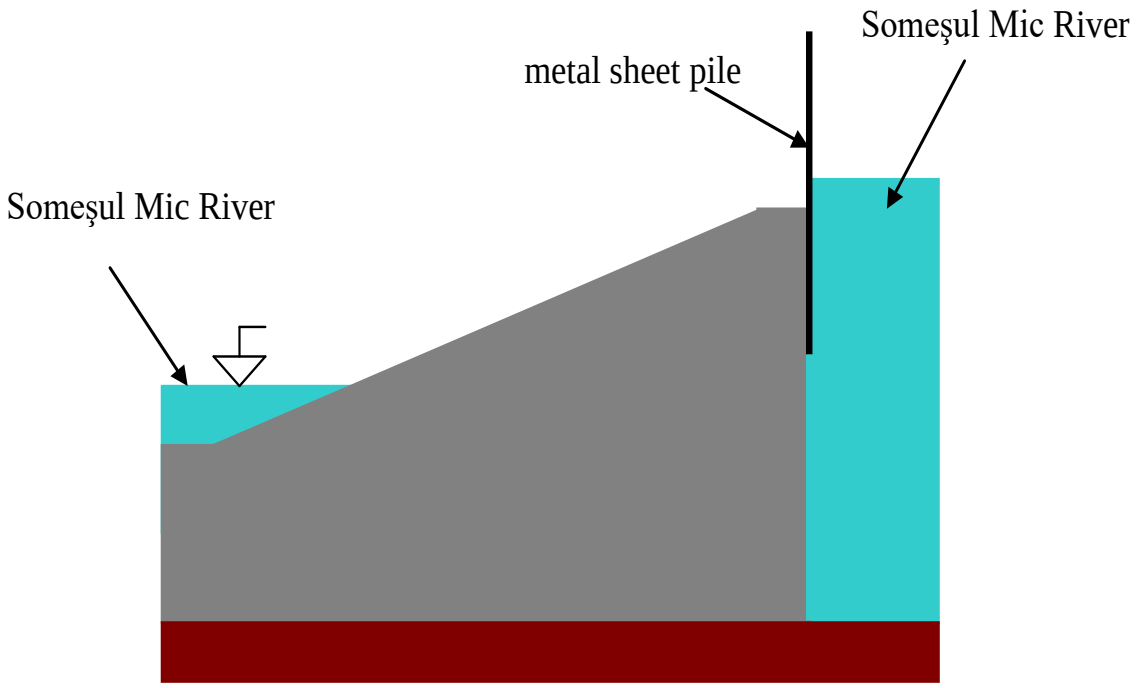

Figure 13: Side cross section of the concrete basin-indicative scheme.

Due to both the lateral surfaces of the concrete basin and metal sheet pile, the river water can only reach the lower side of the basin, but cannot penetrate into the basin. If the water penetrates into the concrete basin, there may still the problem of stationary water. Thus, upstream of this concrete basin a metal pipe with a diameter of about 20 cm will be fixed inside the river bed and capture water by the upstream end which, is equipped with a metal lattice and will discharge water inside the basin through a metal lattice (Fig. 14).

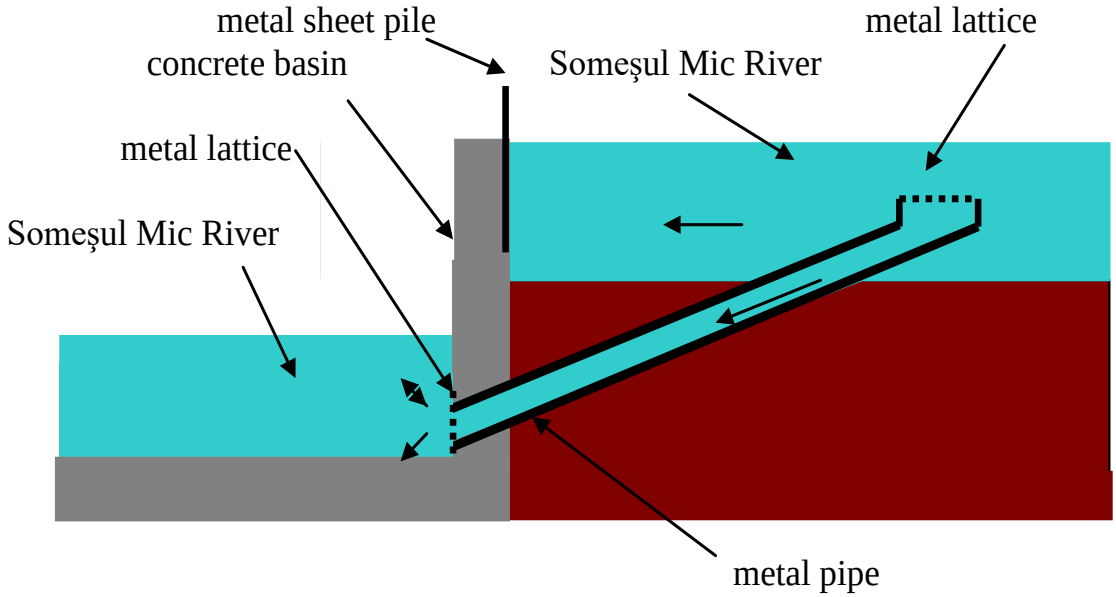

Figure 14: Positioning the metal pipe – indicative scheme.

Because of the metal pipe, water flows inside the concrete basin and maintains a constant water level in the basin; it also represents an attraction to fish. To redirect a system of fish away or towards the basin, we must use metal fences and low amperage electric field generators (Figs. 15a, b, c). The electric generators operate within the metal fence range, facilitating fish migration into the concrete basin.

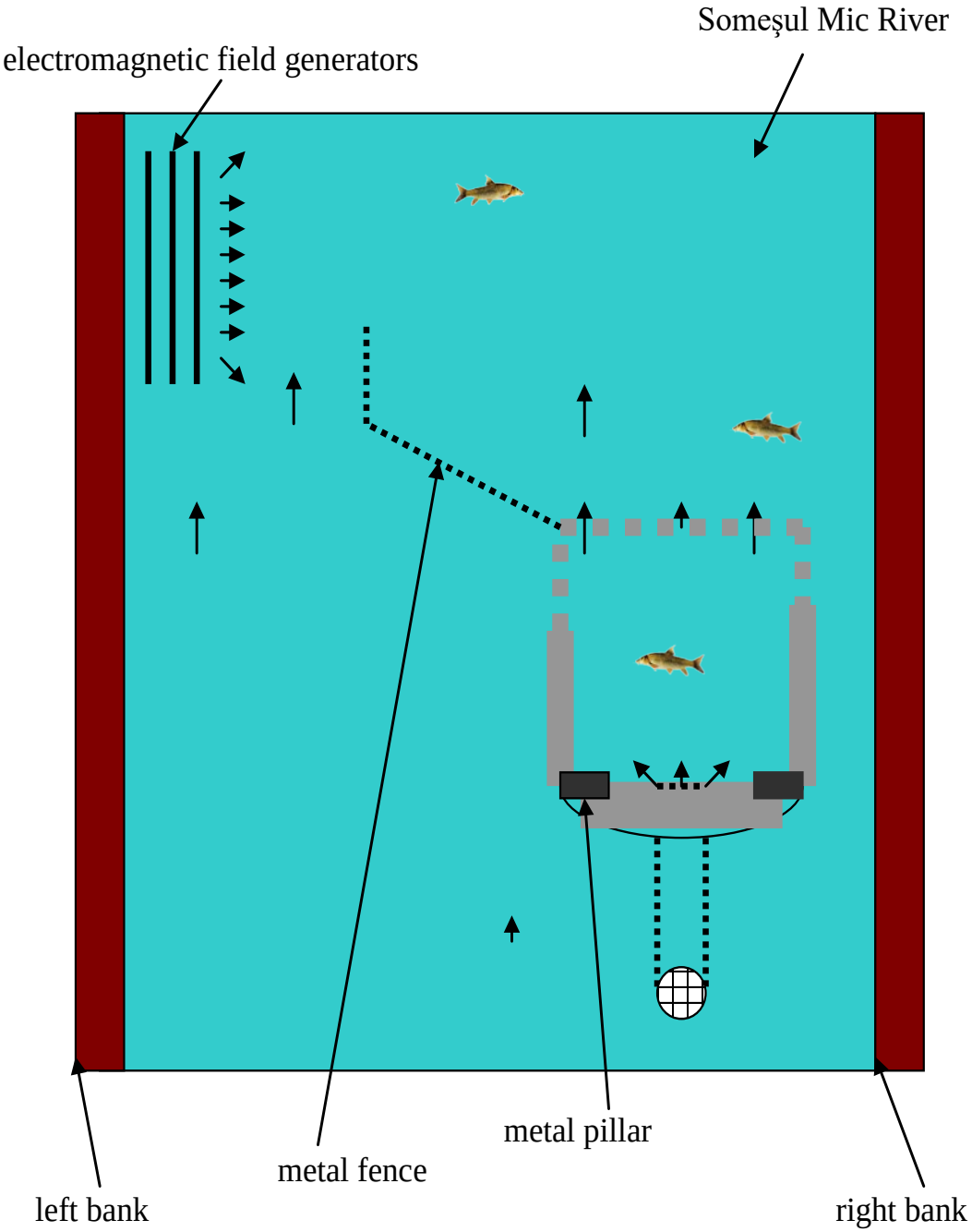

Figure 15a: Positioning the metal fence and electromagnetic field generators – indicative scheme.

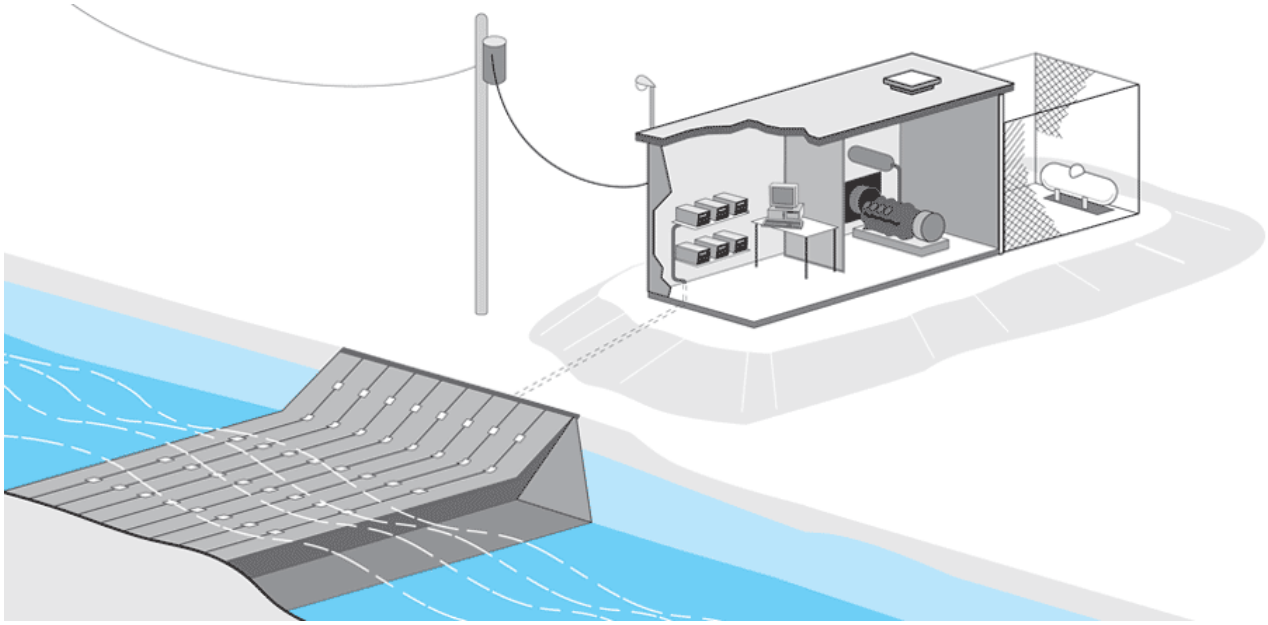

Figure 15b: Electric fields generator for blocking or redirecting the fish positioned before a discharge sill (http://www.smith-root.com/).

Figure 15c: Electric fields generator for blocking or redirecting the fish positioned before a discharge sill (http://www.smith-root.com/).

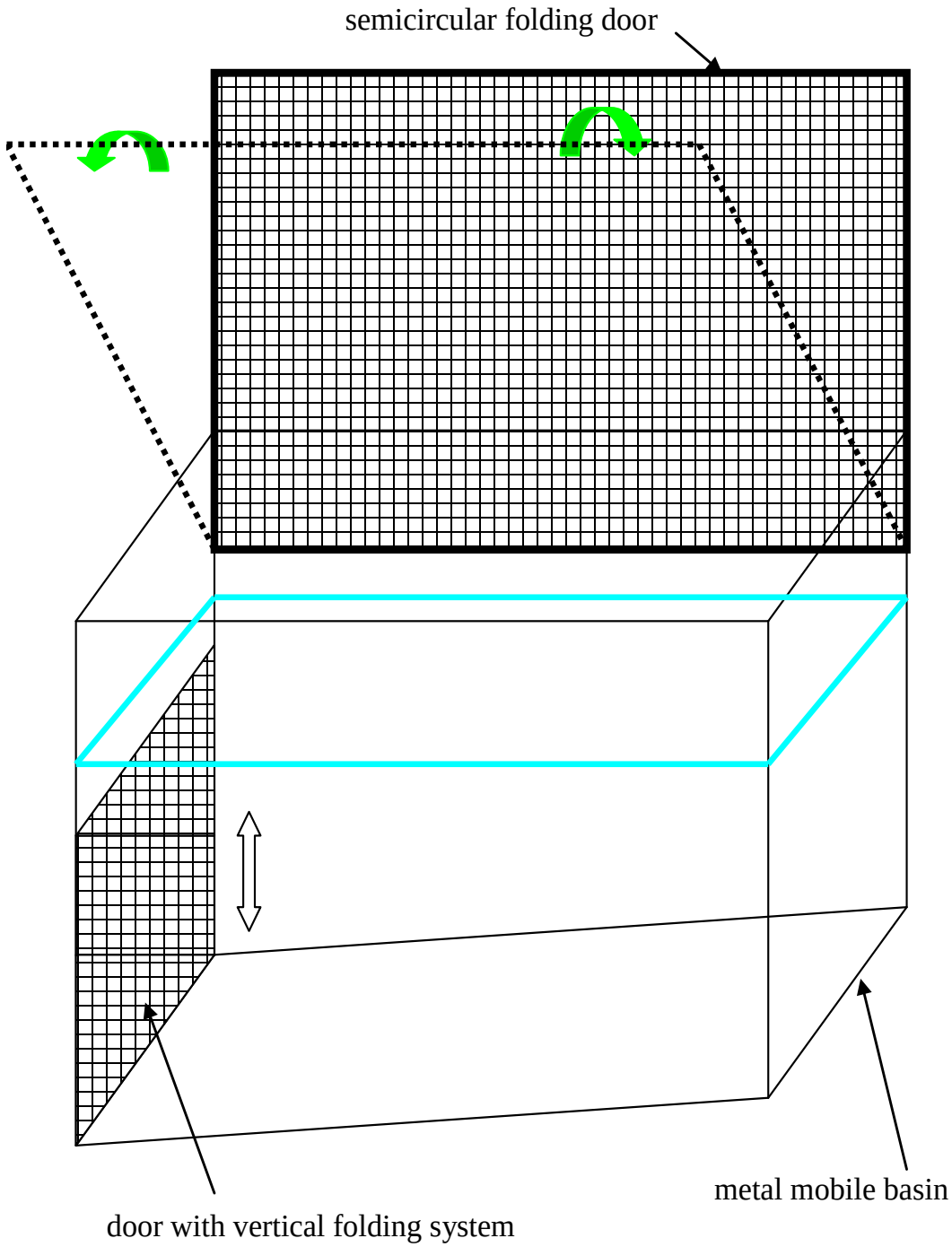

Figure 16: Positioning the two mobile surfaces – indicative scheme.

Fish in the concrete basin must be moved upstream of the dam. Inside the concrete basin, two very durable stainless steel pillars are fixed-both to the horizontal surface and to the surface where the metal sheet pile is attached. A mobile metal basin, that perfectly folds to the shape of the concrete basin, is fixed to the two metal pillars. This basin consists of a metal lattice and has two mobile surfaces where, at the base of the basin, is an inclined plane (Fig. 16). The mobile basin completely enters the concrete basin, where fish are attracted inside due to the water flow coming out of the pipe. The mobile basin is 210 meters height, 3.60 meters length and 2.05 m width.

The mobile metal basin is fixed to the two pillars by the means of four metal collars. Each metal collar contains four bearings which function to allow the basin to move on the metal poles (Fig. 17).

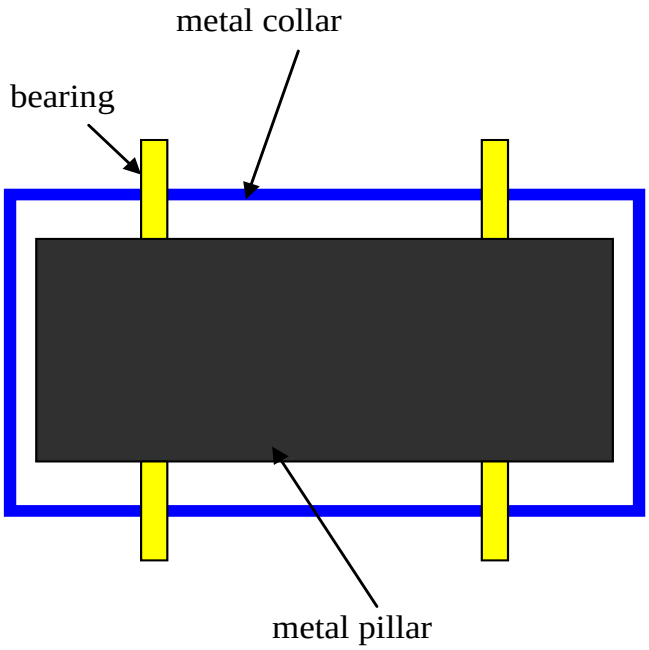

Figure 17: Fixing the collar on the metal pillar – indicative scheme.

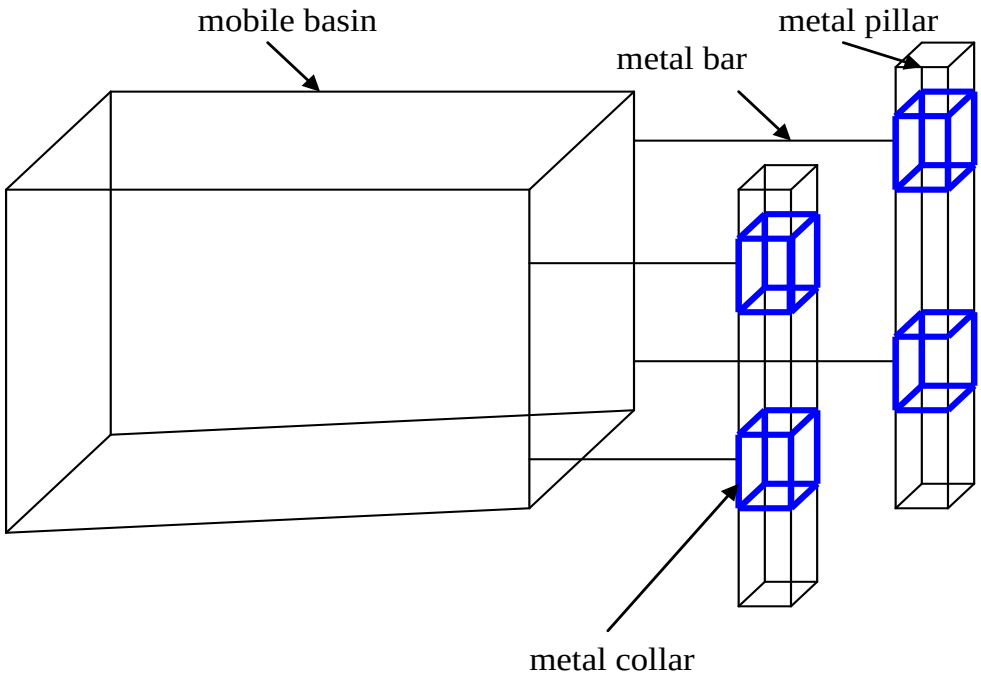

Figure 18: Fixing the mobile basin to the metal pillars – indicative scheme.

The mobile metal basin is fixed to the four collars by the means of four metal bars (Fig. 18).

Two concrete pillars are fixed upstream of the metal sheet pile in the river bed. On these pillars are two winches (Fig. 19a) capable of lifting the mobile basin over 8 m high. Each of the concrete pillars is fixed in the river bed at maximum height of about 8 meters above the multiannual average flow of the river. Electricity is captured from the national network that feeds Mănăstirea Village or directly from the dam hydropower plant. This system can also use solar energy if there is no other source of electricity available.

http://www.edk-pickup.ro
Figure 19a: Electric winch.

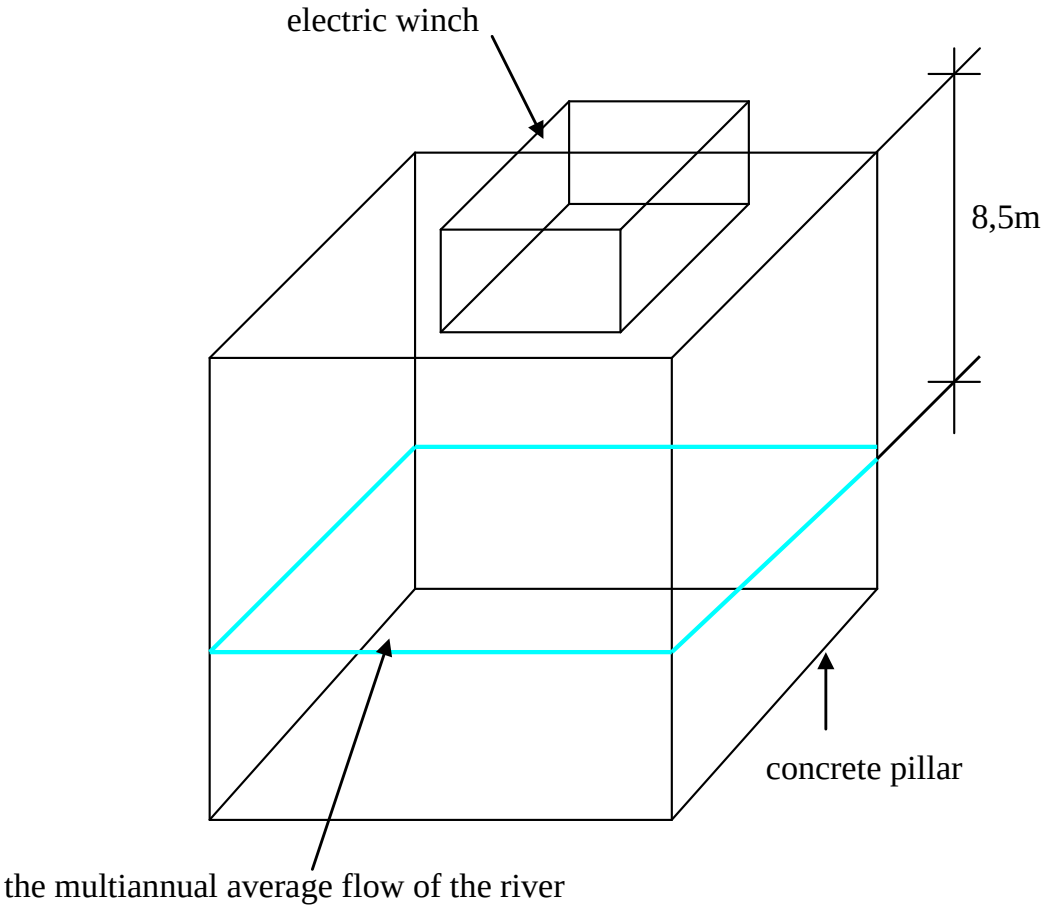

Figure 19b: Positioning the electric winch on the concrete pillar.

The winches are fixed high enough on concrete pillars so that water does not reach them, even during large floods. The circular metal sheet pile is more than 2.5 meters above the multiannual average flow of the river. Each electric winch cable is passed over two pillars and fixed on each metal pillar (Fig. 20).

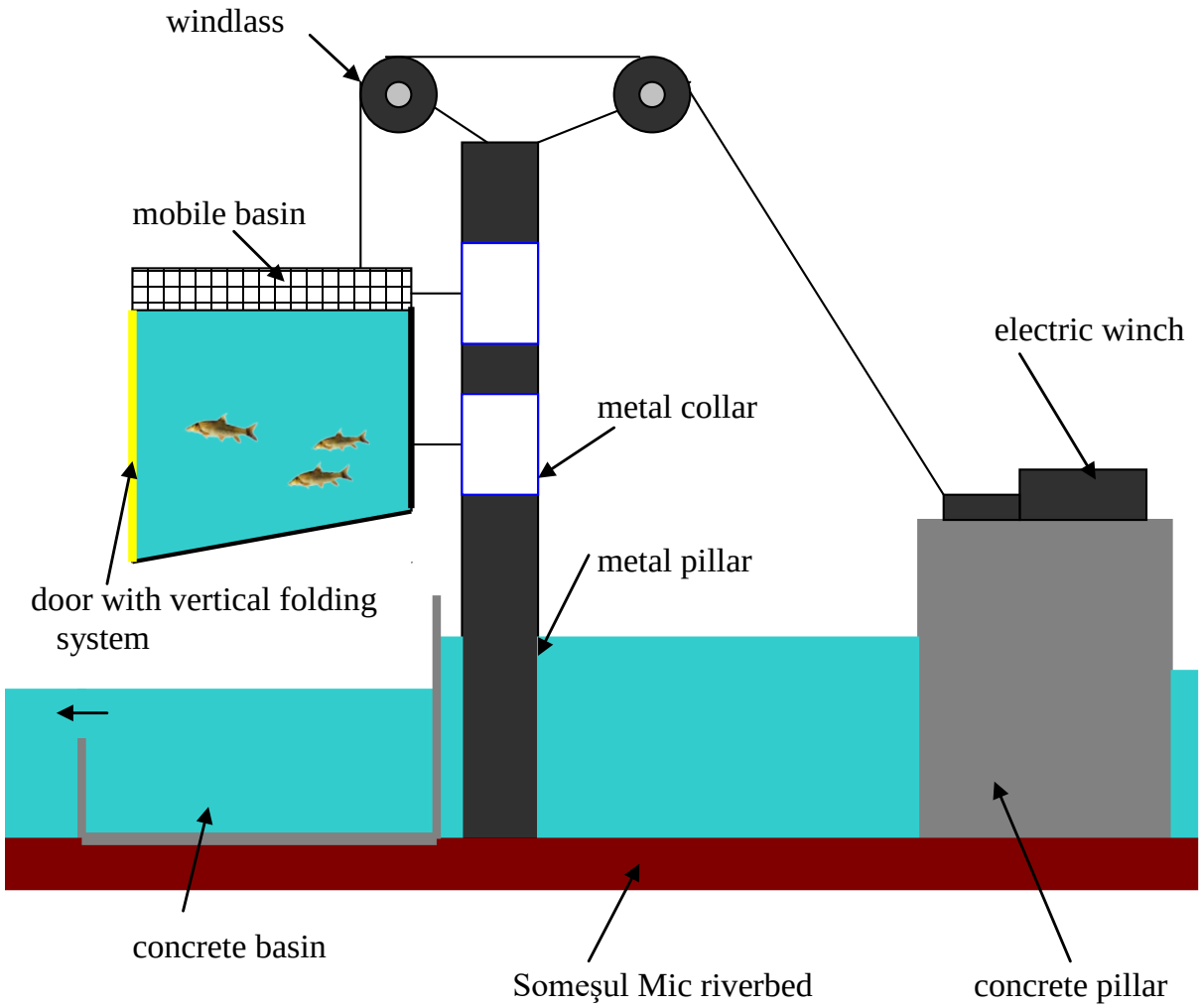

Figure 20: Mobile basin lifting system.

Inside the concrete basin there is a sensor that, when a certain number of passing fish is reached, conveys the automatic shutdown signal to the horizontal flip door. This is done so that the fish fauna are caught inside the mobile basin. When the mobile basin reaches maximum height there is a metal funnel which, after opening the vertical flip door, undertakes all the fish fauna. The base of the mobile basin is an inclined plane and thus allows both the ichthyofauna and the water to reach the metal or durable type plastic funnel (Fig. 21).

The vertical flip door works by the principle of using an electric motor equipped with a cogwheel. An electric generator fixed on the poles provides the energy needed for two telescopic hydraulic pistons that open and close the door with a semicircular flap. The electric motor, which facilitates the opening of the vertical flip door, starts up when reaching the maximum position of the mobile basin. On the outside of all surfaces of the metal basin, including the two flip doors, plastic sheet piles are fixed in order to keep water and the fish fauna in the basin. The funnel is mounted on a stainless steel pole.

A rectangular pipe is properly fixed to the funnel (rectangular parallelepiped) and undertakes the fish fauna that slip on the inclined plane of the mobile basin. The fish fauna are carried upstream of the dam with the water in the basin. The pipe that undertakes the ichthyofauna is fixed on the poles both inside the river and on the right bank of the river. If necessary, metal poles can be fixed to the dam (Fig. 22). The length of pipe that undertakes water and fish fauna is about 60 meters, width of 1 m and height of 1.20 m.

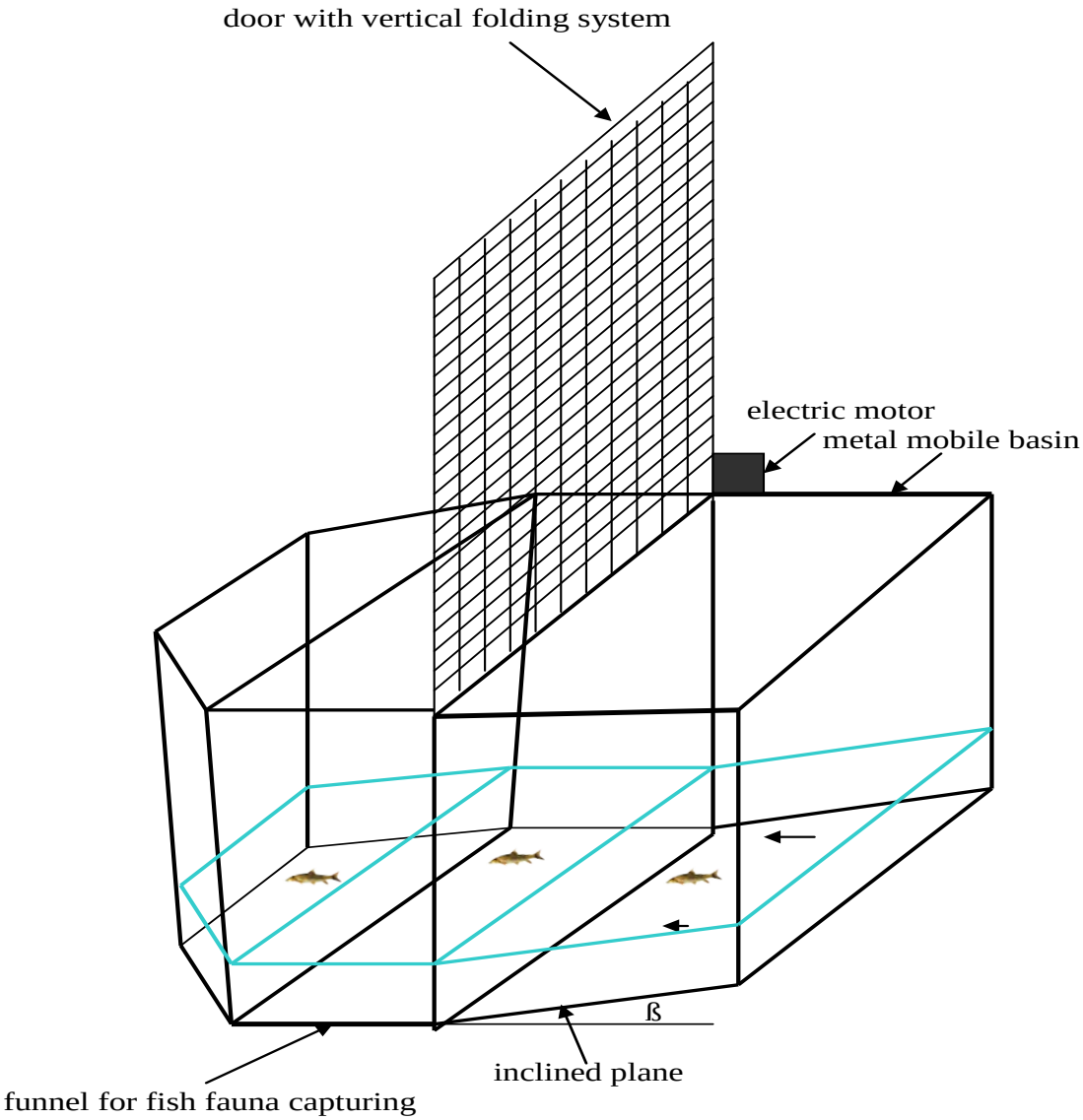

Figure 21: Positioning the funnel for fish fauna capturing.

After the first lift of the mobile basin, the fauna mobile sensor automatically disconnects for a few minutes allowing for the mobile basin to discharge twice the amount of water inside the rectangular pipe so all the fish fauna can reach upstream of the dam. Each winch is scheduled, as previously mentioned, for three ascents and descents of the mobile basin. After all of the water has discharges, the fish fauna will finally reach the lake. The rectangular pipe slope is significantly greater because ichthyofauna must arrive safely in the lake. Between the concrete basin and the minimum level of the mobile basin, there is a space so that the fish caught between the two basins can be safe. All the components of this system are not corrodable. Taking into account the current technology, the fish fauna migration system is not sophisticated. Between two consequtive reproduction periods, April-May and June-July for *Vimba vimba*, and April-May for *Chondrostoma nasus* (Bănărescu, 1964) the mobile basin can be uninstalled and kept in a warehouse without being damaged, and each winch can be protected by the metallic casing. The costs of this system is average and ichthyofauna safety rate is maximized; additionally the dam structure is not affected in any way due to the operation of this system.

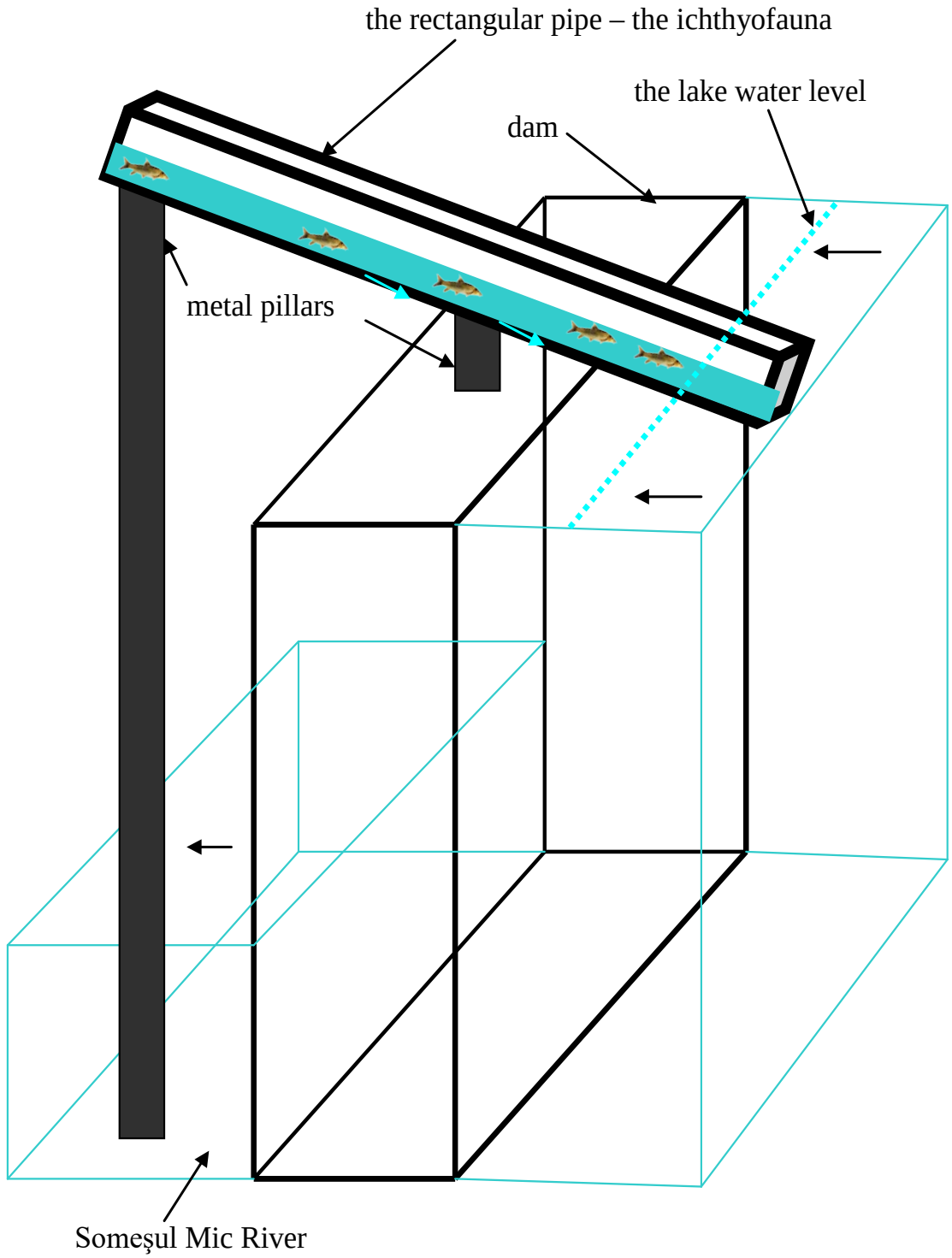

Figure 22: Fixing the rectangular pipe for undertaking fish fauna.

CONCLUSIONS

The presented system, related to the ichthyofauna passage upstream of the dam in Mănăstirea Village, has relatively moderate costs of completion, uses unsophisticated technology, guarantees a long operational time, and requires minimal human presence (though very rare). There is no danger of watercourse blocking on the Someşul Mic River. The effective redirectioning and directioning system of fish fauna towards the mobile basin offers significant chances for the migratory fishes (*Chondrostoma nasus* and *Vimba vimba*) in this river sector to be transported over the dam. These two species have a good chance to recover and not face local extinction.

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*** – http://www.rowater.ro/

AUTHORS:

[1] *Răzvan VOICU*
rzvnvoicu@yahoo.com
"National Institute of Hydrology and Water Management",
Laboratory of Water management and Eco-Hydrology,
București-Ploiești Street 97,
București, Romania,
RO-013686.

[2] *Doru BĂNĂDUC*
ad.banaduc@yahoo.com
"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Department of Environmental Sciences,
Dr. I. Rațiu Street 5-9,
Sibiu, Sibiu County, Romania,
RO-550012.

PHARMACEUTICALS, A CURRENT POLLUTANT OF THE ENVIRONMENT

Maria CISMARU [1] and *Letiția OPREAN* [2]

KEYWORDS: micropollutants, pharmaceuticals, wastewater, surface water, groundwater.

ABSTRACT

Occurrence of pharmaceuticals in the aquatic environment, at low levels of µg/l or ng/l, has become a "hot spot" for researchers in recent years. As a group of micropollutants, pharmaceuticals used by humans and for animals can contaminate surface water, groundwater and drinking water by excretion and disposal of solid waste. Although the adverse health effects caused by indirect consumption of pharmaceutical products at very low concentrations are not clear at present, pharmaceuticals may have a significant disturbing impact on the metabolism of organisms and the ecosystem as a whole. Therefore, based on precautionary principles, pharmaceuticals in the environment are a problem for human health and can have negative effects on the ecosystem.

REZUMAT: Farmaceuticele în mediu, un poluant de actualitate.

Apariţia substanţelor farmaceutice în mediul acvatic, în concentraţii de ordinul µg/l sau ng/l, a devenit un „hot spot" pentru cercetători în ultimii ani. Ca un grup de micropoluanţi, produsele farmaceutice folosite de oameni şi pentru animale, pot contamina apa de suprafaţă, apele subterane, precum şi apa potabilă prin excreţie şi prin eliminarea deşeurilor solide. Deşi, efectele adverse asupra sănătăţii cauzate de consumul indirect de produse farmaceutice, la concentraţii foarte mici, nu sunt clare în prezent, farmaceuticele pot avea un impact semnificativ perturbator asupra metabolismului organismelor şi a ecosistemului ca întreg. Prin urmare, pe baza principiilor de precauţie, produsele farmaceutice din mediul acvatic reprezintă o problemă pentru sănătatea oamenilor şi pot avea efecte negative asupra ecosistemului.

ZUSAMMENFASSUNG: Pharmazeutika, ein laufender Umweltschadstoff.

Das Vorkommen von Arzneimitteln in der aquatischen Umwelt in niedrigen Konzentrationen von µg/l oder ng/l, hat sich in den letzten Jahren zu einem "hot spot" für Forscher entwickelt. Als eine Gruppe von Spurenschadstoffen können die von Menschen und auch für Tiere verwendeten Arzneimittel Oberflächenwasser, Grundwasser und Trinkwasser durch Ausscheidung und Ablagerung von Feststoffabfall verunreinigen. Obwohl die nachteiligen gesundheitlichen Auswirkungen durch indirekten Verbrauch von pharmazeutischen Produkten in sehr geringen Konzentrationen derzeit nicht klar sind, können Arzneimittel signifikant störende Auswirkungen auf den Stoffwechsel von Organismen und das Ökosystem insgesamt haben. Daher sind pharmazeutische Mittel, gestützt auf das Vorsorgeprinzip, in der aquatischen Umwelt ein Problem für die menschliche Gesundheit und können negative Auswirkungen auf das Ökosystem haben.

INTRODUCTION

Drinking water is a basic necessity to maintain a healthy life, but it is also a vehicle for the transmission of diseases by the introduction of pathogenic biological agents or various chemicals into the human body. (Curtean-Bănăduc, 2005; Curtean-Bănăduc and Bucșa, 1998; Curtean-Bănăduc and Bănăduc, 2012a, b)

Special care is attributed to compounds of pharmaceutical origin or those from personal care products, found in the water, which in recent years have become a group of rapidly developing micropollutants.

By their nature, all these specific compounds may produce metabolic and hormonal disorders and can, for example, cause acquired immunity to various antibiotics.

The source of these specific compounds is the high consumption and direct release into the water through drainage, or indirect release through different types of wastes.

Once in the water, these specific micropollutants can have a different behaviour when it comes to stability, permanence and also environmental effects.

Wastewater treatment processes may be ineffective, leading to release of various amounts of micropollutants such as pharmaceuticals in surface water through effluent treatment plant or soil through the application of sludge on agricultural land.

Surface water and groundwater infiltration compounds can reach even into drinking water due to ineffective treatment processes.

Another source of pollution is the direct application of pharmaceutical products in aquaculture or indirectly from manure applied to the soil.

Based on these considerations lies the need to implement effective treatments of wastewater and water treatment especially for human consumption and implementing effective waste management strategies (Fent et al., 2006; Nikolaou et al., 2007).

The responsible authorities worldwide decide the maximum allowable limits of certain contaminants in water intended for human consumption and recreational purposes.

The Environmental Protection Agency of the United States (USEPA), Environmental Protection Agency EU (EEA), the World Health Organization (WOH), to name a few, and government agencies establish standards that differ from each other and reflect expectations and achievement of economic, social and technical standards of which they are addressed.

The selection process of water treatment is taking into account at least several factors: raw water quality, legal regulations and not least the economic factor of budgetary availability.

This specific paper intend to provide an overview of scientific research on the sources and occurrence of pharmaceuticals in the environment (Tabs. 1a, b).

Table 1a: Occurrence of pharmaceuticals found in the environment worldwide: a review of 35 studies published 2005-2014.

Sources	Europe					
	Effluent WWTP/STP	Freshwater - rivers, canals, etc.	Drinking water	Ground water	Sea water	Sediment soil
Location/ Compounds	UK, Ireland, Germany, Finland, Norway, Italy, Spain, Portugal, Serbia, Switzerland	UK, Romania Belgium, Greece Sweden, Germany, Luxemburg Finland, Italy, Spain, Serbia, Portugal	Germany, Italy, UK, Spain, Serbia	Serbia	Ireland, North Sea, Norway	Italy, Spain
Antibiotics						
Trimethoprim	•	•			•	
Ciprofloxacin	•	•				
Sulfamethoxazole	•	•				
Erytromicyn	•	•				
Ofloxacin	•	•				
Lincomycin	•	•				
Amoxycillin	•					
Tetracycllin		•				
Anti-inflammatory drugs/Analgesics						
Naproxen	•	•	•	•		•
Ibuprofen	•	•	•	•	•	•
Acetaminophen	•					
Ketoprofen	•	•	•			
Diclofenac	•	•	•		•	
Mefenamic acid	•	•			•	
Salicylic acid	•	•	•	•		•
Codein	•	•				
Indometacin	•	•				
Phenazone	•	•	•	•		
Aspirin		•				
Paracetamol		•				•
Dextropropoxyphene	•	•				
Anti-epileptic						
Carbamazepine	•	•	•	•	•	
Stimulants						
Caffeine	•	•			•	
Lipid regulators						
Benzafibrate	•	•	•			
Clofibric acid	•	•	•			•
Gemfibrozil	•	•	•		•	
Steroids and related hormones						
17-β-estradiol, estrone	•	•				
17α-ethinyl estradiol		•				
Beta-blockers						
Metoprorol	•	•	•			
Propranolol	•	•	•	•		
Atenolol	•	•				
Sotalol			•			

Table 1a (continued): Occurrence of pharmaceuticals found in the environment worldwide: a review of 35 studies published 2005-2014.

Sources	Europe					
	Effluent WWTP/STP	Freshwater – rivers, canals, etc.	Drinking water	Ground water	Sea water	Sediment soil
Location/ Compounds	UK, Ireland, Germany, Finland, Norway, Italy, Spain, Portugal, Serbia, Switzerland	UK, Romania Belgium, Greece Sweden, Germany, Luxemburg Finland, Italy, Spain, Serbia, Portugal	Germany, Italy, UK, Spain, Serbia	Serbia	Ireland, North Sea, Norway	Italy, Spain
Cancer therapeutics						
Cyclophosphamide		•				
Diuretics						
Furosemide	•	•				
Tranquillisers						
Diazepam		•	•			•
Anti-mycotics						
Clotrimazol		•				
Anti-histamines	•	•				
Illicit drugs	•	•				
Reference	Nikolaou et al., 2007; Baker and Kasprzyk-Hordern, 2013; McEneff et al., 2011; Kosonen Jand Kronberg, 2009; Zuccato et al., 2006; Pedrouzo et al., 2011; Carmora et al, 2014; Páiga et al., 2013; Petrovic et al., 2014; Duan et al. 2013	Roberts and Thomas, 2006, Baker and Kasprzyk-Hordern, 2013; McEneff et al. 2011, Claessens, 2013; Nikolaou et al. 2007; Pailler et al., 2009; Benz et al., 2005; Kosonen and Kronberg, 2009; Zuccato E. et al., 2006; Carmora E. et al, 2014; Boleda M.R. et al., 2014; Paíga et al., 2013; Petrovic et al., 2014; Moldovan, 2006; Stasinakis , 2012	Zweiner, 2007; Zuccato et al., 2006; Carmora et al., 2014; Petrovic et al., 2014	Petrovic et al., 2014	McEneff et al. 2011; Nikolaou et al., 2007;	Zuccato et al., 2006; Aznar et al., 2014

Table 1b: Occurrence of pharmaceuticals found in the environment worldwide – a review of 35 studies published 2005-2014.

Sources	America				Asia		Africa
	Effluent WWTP/ STP	Fresh water – rivers, canals	Drinking water	Sediment soil	Effluent WWTP/ STP	Fresh water – rivers canals	Fresh water – rivers canals
Location/ Compounds	USA, Canada, New Mexico, Argentina	USA, Indiana, New Mexico, Canada	USA, Canada, Brazil	USA	China, Japan, South Korea, Taiwan	China South Korea India, Japan	Kenya
Antibiotics		•					
Trimethoprim	•	•			•		•
Ciprofloxacin	•						
Sulfamethoxazole	•	•			•	•	•
Erytromicyn		•				•	
Ofloxacin	•						
Claritromicycin						•	
Oxytetracyclin		•					
Lincomycin	•	•				•	
Penicillin	•						
Tetracycllin		•					
Doxycycline		•					
Clorotetracycline		•					
Clindamycin						•	
Anti-inflammatory drugs/Analgesics							
Naproxen	•	•			•	•	
Ibuprofen	•	•	•		•	•	•
Acetaminophen		•				•	
Ketoprofen					•	•	
Diclofenac	•	•	•		•	•	
Salicylic acid						•	
Indometacin		•				•	
Phenazone			•				
Paracetamol							•
Anti-epileptic							
Carbamazepine	•	•	•	•	•	•	•
Stimulants							
Caffeine		•			•	•	
Nicotine		•					
Lipid regulators							
Benzafibrate		•	•			•	
Clofibric acid	•	•	•		•		
Gemfibrozil		•	•		•		
Steroids and related hormones		•					
17-β-estradiol, estrone			•			•	
17-α-ethinyl estradiol						•	
Beta-blockers							
Atenolol	•						

Table 1b (continued): Occurrence of pharmaceuticals found in the environment worldwide – a review of 35 studies published 2005-2014.

Sources	America				Asia		Africa
	Effluent WWTP/ STP	Fresh water – rivers, canals	Drinking water	Sediment soil	Effluent, WWTP/ STP	Fresh water – rivers canals	Fresh water – rivers canals
Location/ Compounds	USA, Canada, New Mexico, Argentina	USA, Indiana, New Mexico, Canada	USA, Canada, Brazil	USA	China, Japan, South Korea, Taiwan	China South Korea India, Japan	Kenya
Diuretics							
Furosemide						•	
Antiretroviral drugs							•
Reference	Fent, 2006; Nikolaou et al., 2007; Brown et al., 2006; Elorriaga et al., 2013	Nikolaou et al., 2007, Bunch and Bernot , 2011; Lissemore et al., 2006; Brown et al., 2006; Sodré et al., 2010	Zweiner, 2007	Nikolaou et al., 2007	Du et al., 2013; Duan , et al. 2013; Nikolaou et al., 2007; Fang et al., 2012	Wu et al., 2014; Nikolaou et al., 2007, Shanmugam et al., 2014, Komori et al. 2013	K'oreje et al., 2012

RESULTS AND DISCUSION

Source of pharmaceuticals and occurrence in the environment

There are no data available about the total worldwide use of pharmaceuticals. The consumption and application of pharmaceuticals may vary considerably from country to country, it may happen that some compounds are not used any more or others gain more importance. According to United Nations' figures, 2.3% of Japanese women of reproductive age take a contraceptive pill containing ethinylestradiol as the main active compound, compared to 16% in North America and up to 59% in Europe (United Nations, 2004). Some pharmaceuticals are sold over the counter without prescription in some countries, while in others they are only available by prescription. Some antibiotics such as streptomycins are used in the growing of fruits while others are used in bee-keeping. The heavy use of streptomycins in the growing of fruits in the US is being discussed as a possible reason for the high resistance of pathogenic bacteria against these compounds. In Germany, the use of these antibiotics for this purpose has been banned. Antimicrobials are among the most widely used pharmaceutical compounds in animals.

In 2001 about 50,000 different drugs were registered in Germany, 2,700 of which accounted for 90% of the total consumption and which, in turn, contained about 900 different active substances, corresponding to 38,000 tonnes of active compounds. A total of 6,000-7,000 tonnes per year of active substances are of potential environmental concern in Germany, which is aproximately 0.45 kg per capita and year (Kümmerer, 2009).

China is among the countries that produce and consume large quantities of pharmaceuticals. It has been estimated that the annual usage of raw antibiotic materials is about 180,000 tons – China's per capita consumption of antibiotics is ten times as much as the United States (Dazhong, 2012 cited by Du et al., 2013).

In the European Union, consumption of pharmaceuticals is substantial. About 3,000 different substances are used in human medicine, such as analgesics and anti-inflammatory drugs, contraceptives, antibiotics, beta-blockers, lipid regulators, neuroactive compounds, and many others. Also, a large number of pharmaceuticals are used in veterinary medicine, such as antibiotics and anti-inflammatories. Sales figures are relatively high, as reported for several countries. In England, Germany and Austria the amounts for the most frequently used drugs are in hundreds of tonnes per year (Fent et al., 2006). Non-steroidal anti-inflammatory drugs, including aspirin (836 tonnes in Germany in 2001), paracetamol (622 tonnes in Germany in 2001), ibuprofen (345 tonnes in Germany in 2001), naproxen (35 tonnes in England in 2000) and diclofenac (86 tons in Germany in 2001), the oral antidiabetic metformin (517 tonnes in Germany in 2001) and the antiepileptic carbamazepine (88 tonnes in Germany in 2001) are some examples of the most commonly used pharmaceuticals (Fent et al., 2006).

Drugs are eliminated by persons undergoing treatment, and the compounds removed are either the original substance or its metabolites. Although urine seems to be the most important path in the disposal of the medicines, their excretion in faeces must not be neglected. These compounds are designed to take a specific action in the body and many are persistent, being detected at low levels in many countries for many environmental samples, e.g. in the effluent of sewage treatment plants, surface water, sea water and groundwater. Although the possible development of drug-resistant bacteria as a result of exposure to untreated hospital and domestic sewage effluents, genotoxic effects of some of the drugs, endocrine disruption caused by the administration of synthetic and natural hormones therapeutics were discussed, possible subtle effects on long-term non-target organisms are still unknown.

Of environmental concern is not necessarily a high production volume of a certain pharmaceutical per se, but the environmental persistence and critical biological activity (e.g. high toxicity, high potency for effects on biological key functions such as reproduction). As exemplified by the synthetic steroid hormones in contraceptive pills, such as 17α-ethinylestradiol, the annual production lies in a couple of hundred kilograms per year in the European Union, yet it is extremely potent, quite persistent in the environment and shows oestrogenic activity in fish at concentration of 1-4 ng/l, or lower.

Hence, pharmaceuticals having environmental relevance share the following properties: often, high production volume combined with environmental persistence and biological activity, mainly after long-term exposure (Fent et al., 2006).

Pharmaceuticals and their metabolites in the environment may enter mainly by excretion and waste water disposal. Due to incomplete treatment of wastewater, waste of many toxic organic compounds, including pharmaceuticals, are also found in surface waters. Municipal and hospital wastewaters are the most important sources of human pharmaceuticals, with contributions also from drug manufacturers by removing unused medicines in the environment, wastewater and leachate from waste. In addition, veterinary pharmaceuticals may enter aquatic systems via manure application to fields and subsequent runoff, but also via direct application in aquaculture (Fent et al., 2006).

Dedicated special scientific attention to the environment of pharmaceutical products has led to increasing number of reports on detection of pharmaceutical products in a variety of environmental samples such as river water, sea water, underground water, rivers waste, soil, sediment and sewage sludge. Pharmaceutical products have also been detected in drinking water (Tabs. 1a and 1b).

Examples of compounds detected in drinking water in different countries, such as Germany, Italy, UK, USA and Canada, are clofibric acid (270 ng/l), bezafibrate (27 ng/l) and gemfibrozil (70 ng/l), carbamazepine (258 ng/l), diclofenac (6 ng/l), phenazone (400 ng/l), propilfenazonă (120 ng/l) and ibuprofen (3 ng/l) (Zweiner, 2007).

The occurrence of pharmaceuticals was first reported in 1976 by Garrison et al., who detected clofibric acid in treated wastewater in the USA at concentrations from 0.8 to 2 μg/l (Fent et al., 2006). In the USA, 95 micropollutants, including steroids, caffeine, triclosan, and antibiotics, were detected in samples from 139 streams downstream of urban areas and livestock production (Kolpin et al., 2002 in Nikolaou et al., 2007). Carbamazepine has been detected in 44 rivers across the USA (average 60 ng/l in water and 4.2 ng/mg in sediment) (Thaker, 2005; Nikolaou et al., 2007).

In the Indiana region, during a specific scientific study, abundance and distribution of pharmaceuticals were measured in headwater streams across the whole Upper White River watershed. Four non-prescription pharmaceuticals were found at one or more sites with mean concentrations of 0.038, 0.109, 0.057 and 0.041 μg/l, respectively. Caffeine was measured at trace concentrations at all sites sampled (Aubrey and Bernot, 2011).

In 1985 and 1986 ibuprofen and naproxen were detected in wastewaters in Canada (Richardson and Bowron, 1985; Rogers et al., 1986 in Nikolaou et al., 2007). In southern Ontario, Canada, during a study of the geographical and temporal distribution of pharmaceutical products, they were detected in seven tributaries receiving, primarily, agricultural input in a typical watershed. Of the total of 28 pharmaceuticals surveyed, 14 were detected in the 125 streams (Lissemore et al., 2006).

During a study in New Mexico, 23 samples of wastewater and three samples of Rio Grande water were analyzed for the presence of 11 antibiotics. 58% of samples had at least one antibiotic present while 25% had three or more. Hospital effluent had detections of sulfamethoxazole, trimethoprim, ciprofloxacin, ofloxacin, lincomycin, and penicillin G, with four of five hospital samples having at least one antibiotic detected and three having four or more. At the residential sampling sites, ofloxacin was found in effluent from assisted living and retirement facilities, while the student dormitory had no detects. Only lincomycin was detected in dairy effluent (in two of eight samples, at 700 and 6,600 ng/l). Municipal wastewater had detections of sulfamethoxazole, trimethoprim, ciprofloxacin, and ofloxacin, with four of six samples having at least one antibiotic present and having three or more. At the Albuquerque wastewater treatment plant, both raw wastewater and treated effluent had detections of sulfamethoxazole, trimethoprim, and ofloxacin, at concentrations ranging from 110 to 470 ng/l. However, concentrations in treated effluent were reduced by 20% to 77%. No antibiotics were detected in the Rio Grande upstream of the Albuquerque wastewater treatment plant discharge, and only one antibiotic, sulfamethoxazole, was detected in the Rio Grande (300 ng/l) below the wastewater treatment plant (Brown et. al., 2006).

Sodré et al. investigated the occurrence of emerging contaminants in drinking water of the city of Campinas in Brazil. Tap water samples were analyzed using SPE-GC-MS for 11 contaminants of recent environmental concern. Six emerging contaminants (stigmasterol, cholesterol, bisphenol A, caffeine, estrone, and 17-β-estradiol) were found in the samples. The latter two were detected only during the dry season, with concentrations below quantification limits. Stigmasterol showed the highest average concentration (0.34 ± 0.13 μg/l), followed by cholesterol (0.27 ± 0.07 μg/l), caffeine (0.22 ± 0.06 μg/l), and bisphenol A (0.16 ± 0.03 μg/l). In Campinas, where surface drinking water supplies receive large amounts of raw sewage inputs, the emerging contaminants levels in drinking waters were higher than median values compiled for drinking and finished water samples around the world (Sodré et al., 2010).

For the first time in Argentina the presence of pharmaceutical compounds in sewers discharges from different urban areas was showed in a survey of pharmaceuticals in municipal wastewaters discharging into fresh and estuarine waters from areas with varying degrees of urbanization. Caffeine, ibuprofen, carbamazepine, diclofenac and atenolol were detected in concentrations within the order of μg/l, indicating inputs of these compounds into surface waters of the region (Elorriaga et al., 2013).

In a monitoring study in the UK, propranolol (median level 76 ng/l) was found in all sewage effluents whereas diclofenac (median 424 ng/l) was found in 86%, ibuprofen (median 3,086 ng/l) in 84%, mefenamic acid (median 133 ng/l) in 81%, dextropropoxyphene (median 195 ng/l) in 74%, and trimethoprim (median 70 ng/l) in 65% of samples (Ashton et al., 2004, in Nikolaou et al., 2007). In the Tyne estuary, UK, the concentrations of some of the pharmaceuticals (acetyl-sulfamethoxazole, clofibric acid, clotrimazole, dextropropoxyphene, diclofenac, erythromycin, ibuprofen, mefenamic acid, paracetamol, propranolol, sulfamethoxazole, tamoxifen, and trimethoprim compounds) ranged from four to 2,370 ng/l (Roberts and Thomas, 2006). Spatial and temporal occurrence of a comprehensive set of > 60 pharmaceuticals, illicit drugs and their metabolites in wastewater (seven wastewater treatment plants utilising different treatment technologies) and a major river in the UK, over a 12-month period, was the subject to another study that showed that the concentration of each analyte was largely dependent on rainfall and

the dilution factor of wastewater treatment plant discharge. The results indicate that although the drugs of abuse are not present at very high concentrations in river water (typically low ng/l levels), their occurrence and possible synergic action is of concern (Baker and Kasprzyk-Hordern, 2013).

A year-long study measured the occurrence and relative distribution of five pharmaceuticals (antiepileptic – carbamazepine; anti-inflammatories – diclofenac and mefenamic acid; lipid regulator – gemfibrozil and antibiotic – trimethoprim) in samples of wastewater effluent, marine surface water and marine mussels collected from three sites around the Irish coastline. All five of the selected pharmaceuticals were detected in 85% of effluent samples collected from each exposure site. The pseudo-persistence of pharmaceuticals in the aquatic environment was observed with the continuous detection of pharmaceutical residues in marine surface waters, at slightly lower concentrations than those detected in effluent. Three of the five detected pharmaceuticals in marine surface waters were also found to occur in exposed mussels (*Mytilus* ssp.) with residues of trimethoprim measuring at concentrations up to 9.22 ng/g dry weight. This study has confirmed the uptake of pharmaceuticals in marine bivalves at measurable quantities and also highlights the inability of mussels to act as reliable bioindicators of pharmaceutical pollution due to temporal variations observed in the data (McEneff et al., 2011).

A selection of monitoring studies has been performed previously in European estuarine and marine surface waters. In a study carried out by Thomas and Hilton (2004), 14 pharmaceuticals were monitored in British estuaries of the Thames, the Tyne, the Mersey, the Tees and Belfast Lough. From the targeted list, nine pharmaceuticals were detected in the estuarine water samples collected. Ibuprofen and trimethoprim were determined at the highest concentrations, measuring at 928 ng/1 and 569 ng/l, respectively, and clotrimazole was the most frequently detected pharmaceutical with a median concentration of 7 ng/l. A number of other studies have analysed marine water samples collected from the North Sea, its estuaries and harbours (Buser et al., 1998; Langford and Thomas, 2011; Weigel et al., 2002; Weigel et al., 2004 in McEneff et al., 2011). Eight pharmaceuticals were previously determined in Belgian coastal waters, with salicylic acid and carbamazepine measured most frequently at concentrations up to 860 ng/l (Wille et al., 2010 cited by McEneff et al., 2011). Wille et al. (2010, 2011) studied the occurrence of 13 pharmaceutical compounds in the Belgian coastal zone and reported concentrations of salicylic acid up to 0.855 µg/l within a Belgian coastal harbour, and up to 0.660 µg/1 at open sea stations close to the shore. This compound was still detected at sampling stations located roughly 20 km off shore, at concentrations up to 0.237 µg/l and was also found in the bivalve *Mytilus edulis* at levels up to 490 ng/g dry weight. The neuroactive compound carbamazepine occurred at concentrations up to 12 ng/l at roughly 10 km off shore and was detected regularly in *Mytilus edulis*. The remaining pharmaceuticals were only detected in the coastal harbours with a single occurrence of the b-blocker propranolol (at 1 ng/l) and the lipid regulator bezafibrate (at 8 ng/l) close to the shoreline. Propranolol was sporadically detected in *Mytilus edulis* at levels up to 52 ng/g dry weight (Claessens, 2013).

Thirty-two pharmaceuticals from different medicinal classes have been detected in German municipal sewage treatment plant effluents and river waters (Ternes et al., 1998 in Nikolaou et al., 2007). Anti-inflammatory drugs (salicylic acid, diclofenac, ibuprofen, indometacine, naproxen, and phenazone), lipid regulators (bezafibrate, gemfibrozil, clofibric acid, fenofibric acid), beta-blockers (metoprolol, propranolol), and carbamazepine were found to be ubiquitously present in streams

and river water in the low ng/l range (Miao et al., 2002, in Anastasi Nikolaou et al., 2007). Ibuprofen, diclofenac, carbamazepine, a variety of antibiotics, and lipid regulators have been detected in the river Elbe (range 20-140 ng/l) in a study by S. Wiegel et al., 2004, in Nikolaou et al., 2007.

In a survey on xenobiotic concentrations and the fluxes of dissolved xenobiotics during runoff events in the small rural Mess catchment (35 km^2) in the South-western part of Luxembourg, sulfonamides, tetracyclines, analgesics and hormones, dissolved nutrients, sulphate and chloride were measured to gather information about runoff generation. Typically, the highest values can be found during the first flush mainly in the rising limb of the flood hydrographs. The highest concentrations in eleven flood events are measured for ibuprofen (2,383 ng/l), estrone (27 ng/l and diclofenac (20 ng/l). From the tetracycline group tetracycline (9 ng/1) itself is of relevance, while the sulfonamides are mainly represented by sulfamethoxazole (5 ng/l). The variable patterns of chemographs are attributed to the heterogeneous runoff generation characterised by different reactions of storm overflows from the combined sewer systems. During single flood events, the fluxes of ibuprofen (24,000 mg), 17α-ethinylestradiol (122 mg), 17-β-estradiol (32 mg) or estrone (274 mg) are rather low (Pailler et al., 2009).

Ibuprofen and its metabolites hydroxy-ibuprofen and carboxy-ibuprofen, ketoprofen, naproxen, diclofenac, atenolol, metoprolol, propranolol, trimethoprim, sulfametoxazole, carbamazepine and gemfibrozil were found in the Hoje River, Sweden, and peak concentrations ranged from 0.12 to 2.2 µg/l (Benz et al., 2005).

The occurrence of the anti-histamines cetirizine, acrivastine, fexofenadine, loratadine, desloratadine and ebastine in sewage treatment plants wastewaters was studied in Turku (Finland) and in recipient river waters. The analytical procedure consisted of a solid-phase extraction of the water samples followed by a liquid chromatography separation and detection by a triple-quadrupole mass spectrometer in the multiple reaction mode. Cetirizine, acrivastine and fexofenadine were detected in both influent and effluent wastewater samples at concentration levels ranging from about 80 to 220 ng/l, while loratadine, desloratadine and ebastine could not be detected in any samples. During sewage treatment, the concentration of the antihistamines dropped by an average of 16-36%. Furthermore, elevated concentrations of antihistamines were observed in samples collected during the season of most intensive plant pollen production, in May. In the river water samples, the relative pattern of occurrence of cetirizine, acrivastine and fexofenadine was similar to that in the wastewater samples; although the concentration of the compounds was substantially lower (4-11 ng/l). The highest concentrations of the studied drugs were observed near the discharging point of the sewage treatment plant (Kosonen and Kronberg, 2009).

In the North Sea, the maximum concentrations of clofibric acid and caffeine were 1.3 and 16 ng/1, respectively, whereas diclofenac and ibuprofen were found only in the estuary of the river Elbe (6.2 and 0.6 ng/1, respectively) (Khan and Ongerth, 2002 in Nikolaou et al., 2007). In Norway, analysis of sewage effluents and seawater revealed the presence of the pharmaceuticals caffeine (20-293 µg/l and 7-87 ng/l, respectively), triclosan (0.2-2.4 µg/l), ibuprofen and its major metabolites hydroxy- and carboxy-ibuprofen (0.1-20 µg/l and < 7.7 ng/l). Hydroxy-ibuprofen was the major metabolite in sewage whereas carboxy-ibuprofen was dominant in seawater samples (Wiegel et al., 2004 in Nikolaou et al., 2007).

In Italy, Zuccato et al. (2000), quoted by Zuccato et al. (2007) showed that there are many "priority" pharmaceutical products in the water and sediments of rivers Po and Lambro Adda. Samples of drinking water from the main water supply systems in the cities of Lodi and Varese,

had traces of diazepam, clofibric acid and tylosin. Traces of some pharmaceutical products were also present in the sediment of the same river. The widespread occurrence of pharmaceuticals in the Italian environment was subsequently confirmed by the same authors (Calamari et al., 2003) and by others. Calamari et al. (2003), reports results of an extensive investigation with eight sampling stations along the rivers Po and Lambro. In the first study, 13 pharmaceuticals for human or veterinary use were detected in the 0.1-250 ng/l range, but in this second campaign the method was revised, adding new compounds, selected as previously described, so they could detect 18 pharmaceuticals in significant amounts. Further studies subsequently measured pharmaceuticals for human use in the influents and effluents of urban sewage treatment plant. Effluents of nine sewage treatment plants spread over Italy, namely Cagliari, Latina, Cuneo, Varese, Cosenza, Palermo, Naples and Monza, were analysed, and several pharmaceuticals were found in the microgram range. By comparing sewage treatment plant levels with those previously measured in the Po and Lambro rivers, it was possible to identify a group of environmentally important pollutants in Northern Italy, namely ofloxacin, furosemide, atenolol, hydrochlorothiazide, carbamazepine, ibuprofen, spiramycin, bezafibrate, erythromycin, lincomycin and clarithromycin (Zuccato et al., 2005a cited Zuccato et al., 2006). These pharmaceuticals were detected in high concentrations in sewage treatment plant effluents and were persistent enough to remain in substantial quantities in rivers (Zuccato et al., 2006).

The presence of 33 pharmaceuticals and hormones in waters from two sewage treatment plants situated in Catalonia, in north-eastern Spain was also studied. The target compounds were one psychoactive stimulant, one anti-epileptic, four analgesics and non-steroidal anti-inflammatories, one lipid regulators, two anti-ulcer agents, nine antibiotics (sulfonamides andmacrolides), two beta-blockers, two metabolites, and 11 hormones (free and conjugates). Most of the pharmaceuticals were found in both influent and effluent samples from the two sewage treatment plants. The most frequently detected were caffeine, acetaminophen, carbamazepine, diclofenac, ibuprofen, naproxen, sulfamethoxazole, sulfapyridine, sulfathiazole, ranitidine, omeprazole, estrone 3-sulfate, and estradiol 17-glucuronide. Specifically, the highest concentrations found in influents were 19,850 ng/l (acetaminophen), 9,945 ng/l (caffeine), 4,215 ng/l (ibuprofen), 5,695 ng/l (sulfamethoxazole), and 5,140 ng/l (sulfathiazole). Most of the pharmaceuticals present in influent waters were found in effluents at lower concentrations. The highest concentrations in effluents were 970 ng/l (caffeine), 670 ng/l (sulfamethoxazole), 510 ng/l (bezafibrate), and 1,032 ng/l (diclofenac). The occurrence of these contaminants was studied using a total of seven sample sets in 2007-2008 in both sewage treatment plants (Pedrouzo et al., 2011).

The occurrence of 21 acidic pharmaceuticals, including illicit drugs, and personal care products in waste, surface and drinking water and in sediments of the Turia River basin (Valencia, Spain) was studied. Up to 20 compounds were detected in both influent and effluent wastewaters indicating that conventional treatment processes do not completely remove these polluants. Among them, ibuprofen, naproxen and THCOOH were predominant in influents, whereas THCOOH, triclocarban, gemfibrozil and diclofenac were the major compounds detected in effluents. Important quantities of diclofenac (3,462 ng/l), gemfibrozil (3,735 ng/l), ibuprofen (6,593 ng/1), naproxen (7,189 ng/1) and propylparaben (5,020 ng/1) were detected, which indicates the contamination of this river. Mineral and tap waters also presented significant amounts (approx. 100 ng/1) of ibuprofen, naproxen, propylparaben and butylparaben (Carmora et al., 2014).

The ten most frequently identified compounds in Spanish rivers are ibuprofen, diclofenac, naproxen, clofibric acid, carbamazepine, sulfamethoxazole, trimethoprim, bezafibrate, atenolol, and gemfibrozil with concentration levels ranging from few ng/l to high μg/l. Their maximum levels represent the highest concentrations in river waters reported in the literature except for ibuprofen, naproxen and trimethoprim (Hughes et al., 2013, in Boleda et al., 2014). The most refractory compounds frequently reported in Spanish finished water are ibuprofen, venlafaxine, atenolol and acetaminophen hydrochlorothiazide and carbamazepine, some of them not included in the 75 most studied worldwide (Boleda et al., 2014).

A study on Spanish soils with different farmland uses, describes the analysis of 15 pharmaceutical compounds, belonging to different therapeutic classes (anti-inflammatory/analgesics, lipid regulators, antiepileptics, β-blockers and antidepressants) and with diverse physical–chemical properties. The limits of detection ranged from 0.14 ng/g (naproxen) to 0.65 ng/g (amitriptyline). At least two compounds where detected in all samples, being ibuprofen, salicylic acid, and paracetamol, the most frequently detected compounds. The highest levels found in soil were 47 ng/g for allopurinol and 37 ng/g forsalicylic acid (Aznar et al., 2014).

A total of 42 water samples, including surface waters, landfill leachates, wastewater treatment plant and hospital effluents, were analyzed in order to evaluate the occurrence of ibuprofen in the north of Portugal. In general, the highest concentrations were found in the river mouths and in the estuarine zone. The maximum concentrations found were 48,720 ng/1 in the landfill leachate, 3,868 ng/1 in hospital effluent, 616 ng/1 in wastewater treatment plant effluent, and 723 ng/1 in surface waters (Lima River) (Paíga et al., 2013).

Pharmaceuticals belonging to different therapeutic groups and having different physico-chemical properties were analyzed in different types of waters collected from 25 locations in the northern part of Serbia. The pharmaceuticals were selected based on their very frequent usage and therefore ubiquitous presence in different types of waters. A UPLC-QqLIT-MS/MS method was applied to determine simultaneously 81 pharmaceuticals from different therapeutic classes in extracts of surface, underground, drinking and waste waters (industrial and municipal). Forty seven of 81 pharmaceuticals were found in investigated samples of water collected from Serbia. The highest concentrations of pharmaceuticals were found in sample of municipal waste water, while the lowest occurrence of pharmaceuticals were in waters intended for drinking water supply (untreated and treated), in which the highest concentration was found for carbamazepine metabolite (10.11-epoxycarbamazepine), the predominant compound within the group of psychiatric drugs in all types of water. A widespread occurrence of pharmaceuticals in the analyzed waters was proven, with general levels, when detected, from ng/1 to more than 1 μg/1 as found for some of the drugs such as ibuprofen, diclofenac, codeine, valsartan, acetaminophen, 2-hydroxyl-carbamazepine and 10.11-epoxy-carbamazepine in a sample of municipal waste water. This was the first attempt to assess the occurrence of these 81 pharmaceutical residues in water samples in Serbia (Petrovic et al., 2014).

In Romania, in the Someş River, 15 compounds including stimulants, antirheumatic, antiepileptic, analgesic, antimicrobial, and cytostatic agents were detected with concentrations ranging from 30 ng/l to 10 μg/l. Caffeine and acetylaminophenazone were detected at concentrations between 300 and 10,000 ng/l and pentaoxifilline, ibuprofen, formylaminophenazone, p-chlorophenyl sulfone, N,N-bis(3,3-dimethyl-2-oxetanyl)-3,3-dimethyl-2-oxetanamine between 100 and 300 ng/l; levels of aspirin, triclosan, carbamazepine, codeine, diazepam, and cyclophosphamide were below 100 ng/l (Moldovan, 2006).

Presence of four phenolic endocrine-disrupting compounds (nonylphenol, nonylphenol monoethoxylate, bisphenol A, triclosan) and four nonsteroidal anti-inflammatory drugs (ibuprofen, ketoprofen, naproxen, diclofenac) in a Greek river receiving treated municipal wastewater was investigated in a study that showed that these compounds were frequently detected in river water (Stasinakis, 2012).

The occurrence and removal efficiency of seven pharmaceuticals (norfloxacin, trimethoprim, roxithromycin, sulfamethoxazole, ibuprofen, diclofenac and carbamazepine) were determined in three sewage treatment plants within Xuzhou City, Eastern China. The results showed that seven pharmaceuticals were detected in the influent samples with concentrations ranging from 93 to 2,540 ng/l. The studied pharmaceuticals were found in all influent samples collected over the monitoring period, indicating their high usage in this area. Ibuprofen had the highest concentrations among the pharmaceuticals analyzed (ranging from 1970-2,540 ng/1), followed by diclofenac (860-1,693 ng/1) and carbamazepine (729-1,340 ng/1). Lower levels were detected for norfloxacin (165-273 ng/1), sulfamethoxazole (368-815 ng/1), and trimethoprim (370-612 ng/1). Roxithromycin occurred at the lowest concentrations, ranging from to 93-158 ng/1 (Du et al., 2013).

Five acidic pharmaceuticals were investigated in a municipal wastewater treatment plant in Shanghai, China. Pharmaceuticals were found to vary in mass loadings in the influent, with ibuprofen being the most abundant. During wastewater treatment, all compounds were found to show concentration decline from influent to effluent. These pharmaceuticals were also found both upstream and downstream of the effluent outfall. The results revealed that wastewater from Shanghai is a significant contributor of pharmaceuticals to the Yangtze River and thus the Yangtze River Estuary and the coastal East China Sea (Duan et al., 2013). The occurrence of pharmaceuticals and personal care products in the central and lower Yangtze River, along with four large freshwater lakes within the river basin (Dongting, Poyang, Tai, and Chao), was reported in a study by Wu et al. (2014). Fifteen out of twenty selected pharmaceuticals and personal care products were detected in the collected surface water samples. Caffeine, paraxanthine, sulfamethazine and clindamycin were detected with 100% frequency in the Yangtze River. In the river, the highest average concentration was observed for erythromycin (296 ng/1), followed by caffeine (142 ng/l) and paraxanthine (41 ng/1). In the four lakes, total pharmaceuticals and personal care products concentrations were higher in the Chao (1,547 ng/1) and Tai (1,087 ng/1) compared to the Poyang (108 ng/1) and Dongting (137 ng/1). Lincomycin and clindamycin were most abundant in the lakes, especially in the Tai Lake (Wu et al., 2014).

In South Korea, iopromide, naproxen, carbamazepine and caffeine were observed quite frequently in surface waters and effluents. Iopromide, sulfamethoxazole, carbamazepine were the analytes present at the highest concentrations. The primary oestrogen hormones 17-α-ethynylestradiol and 17-β-estradiol were rarely detected, but oestrone was detected both in surface water and in effluent from wastewater treatment. Elimination of these chemicals during drinking water and wastewater treatment processes at full- and pilot-scale was also investigated. Conventional drinking water treatment methods were relatively inefficient at removing contaminants; efficient removal (99%) was achieved by use of granular activated carbon (Kim et al., 2006 in Nikolaou et al., 2007).

The concentrations of five common non-steroidal anti-inflammatory drugs (diclofenac, ketoprofen, naproxen, ibuprofen, and acetylsalicylic acid) were determined in surface waters from 27 locations of the Kaveri, Vellar, and Tamiraparani Rivers in southern India. The measured concentrations of four of the five drugs in this reconnaissance were relatively

similar to those reported elsewhere (200 ng/l); however, acetylsalicylic acid, the most readily degradable of the investigated drugs, was found at all sites and at considerably higher concentrations (up to 660 ng/l) than reported in European surface waters (Shanmugam et al., 2014).

In Japan there was conducted a nationwide survey to clarify the occurrence of 24 selected pharmaceuticals in major rivers and evaluate their environmental risk to aquatic organisms. There were found a total of 22 substances in river waters at concentrations from several nanograms per litre to several micrograms per litre. The highest was 2.4 μg/l of caffeine, followed by 1.5 μg/l of crotamiton and 1.4 μg/l of sulpiride. The measured environmental concentration values of four substances, caffeine, carbamazepine, clarithromycin, and ketoprofen, exceeded 0.1, with the maximum value of 9.0 for clarithromycin (Komori et al., 2013).

The occurrence and distribution of pharmaceutical compounds in the effluents of a major sewage treatment plant in Northern Taiwan and the receiving coastal waters were determined. The study reports, for the first time, on clofibric acid, diclofenac, ibuprofen and ketoprofen concentrations in the Bali station treatment plant waste water and the adjacent coastal waters of Northern Taiwan. The concentrations of these pharmaceutical compounds in both the influent and effluent could be reliably measured, and were generally higher than those found in coastal seawater. The concentrations found were comparable with those reported in other parts of world, suggesting that the aquatic environment of Taiwan was inevitably contaminated by pharmaceutical compounds. The concentrations of the studied pharmaceutical compounds analyzed in coastal waters in Northern Taiwan ranged from not detected to 60 ng/l (Fang et al., 2012).

The occurrence of at least 10 pharmaceutical residues in a limited number of water samples taken in the Nairobi River basin, Kenya, East Africa. For the first time, the anti-retroviral drug lamivudine has been detected in surface water, and also other scarcely detected pharmaceuticals such as sulfadoxine (antimalarial drug) and two other antiretroviral drugs (nevirapine and zidovudine) were measured in the Nairobi River water, at concentrations clearly higher than what has been reported in the previous analyzed literature. Trimethoprim, sulfamethoxazole, metronidazole, paracetamol, and ibuprofen were reported, and carbamazepine, already reported extensively in other countries, was confirmed for the Nairobi River. Indicative concentrations were in the range 0.1-30 μg/l, with the highest values measured for ibuprofen, paracetamol, sulfamethoxazole and zidovudine (K'oreje et al., 2012).

CONCLUSIONS

In the last 15 years a multitude of studies and reviews have been published on the subject of pharmaceuticals in the environment, the majority of which have reached similar conclusions:

- Pharmaceuticals can now be detected at levels of ng/l in the majority of environmental samples;
- The principal route to the environment is from their excretion by patients, although discharges from manufacturing, hospitals and inappropriate disposal of unused and life expired products can also make an important contribution;
- Concentrations are at a level considered unlikely to have adverse consequences for human beings and acute impacts on other organisms, but there are no sufficient data available to determine whether long-term exposure to these concentrations poses a significant risk to humans and wildlife populations.

Building a comprehensive monitoring programme requires knowledge of contamination, mainly supplemented by detailed information on individual pollutants. Selecting pollutants to be considered in monitoring actions is based mostly on the available information about

their environmental relevance (persistence, bio-accumulation potential, toxicology and ecotoxicology) and their occurrence in the environmentally affected system. On a large scale, for monitoring, contaminants of interest are considered those of highest continuously frequent occurrence, and widely distributed in various riparian systems. Clearly, many organic contaminants have been neglected so far in environmental studies.

A good stategy to reduce the presence of pharmaceuticals in the environment consists of advanced wastewater treatment technology, education of medical professionals to reduce over-prescription, pharmaceutical-return programmes coupled with public education, taking in to account "green pharmacy" – benign compounds and substitution of critical compounds, in order to reduce the environmental impacts of pharmaceuticals. According to the principle of sustainability, the entire life cycle of a compound has to be taken into account to identify opportunities for risk management and risk reduction (Kümmerer, 2009).

We believe much more attention should be paid to these micropollutants, according to their growth in consumption. Scientific studies are still needed for thorough knowledge of the behaviour of these compounds in the environment, in order to propose a good and effective strategy for reduction the input of pharmaceuticals (and other chemicals) into the environment. In Eastern Europe and specifically in Romania this area is still very little explored.

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AUTHORS:

[1] *Maria CISMARU*

University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, RO-400372.

[2] *Letiția OPREAN*

"Lucian Blaga" University of Sibiu, Ioan Raţiu Street 7-9, Sibiu, Sibiu County, RO-550012.

MANAGEMENT OF WASTE DISPOSAL FROM CONSTRUCTIONS AND DEMOLITIONS IN MEDIAŞ CITY (TRANSILVANIA, ROMANIA)

Anamaria SZABO [1]

KEYWORDS: Romania, Transylvania, Mediaş, waste disposals management.

ABSTRACT

Socio-economic development has produced large changes on the Romanian environment as well as how it is managed. The EU determined that Romania was to establish a good management of waste. This is why modern sanitation service security is a priority in the north of Sibiu County. At local and national levels, construction and demolation waste management is poor due to a lack of legislation.

Thus, we realised that scientific studies are important to prove the legislative necessity in construction and demolation waste domain, and also to adopt a local council decision in the Mediaș city domain. All of these studies were conducted in 2012 and have come to support a strategy based on waste production prevention.

REZUMAT: Managementul deşeurilor din construcţii şi demolări la nivelul Municipiului Mediaş (Transilvania, România).

Dezvoltarea socio-economică a produs modificări foarte mari ale mediului. UE a impus României buna gestionare a deșeurilor, tocmai de aceea în regiunea de nord a județului Sibiu asigurarea serviciilor moderne de salubritate este o prioritate. Atât la nivel local cât și la nivel național, managementul deșeurilor din construcții și demolări este precar datorită lacunelor legislative în acest domeniu.

În acest sens, am realizat studii care să ajute la dovedirea necesității legislative în domeniul deșeurilor din construcții și demolări, dar și la adoptarea unei Hotărâri de Consiliu Local privind acest domeniu în municipiul Mediaș. Aceste studii s-au realizat în 2012 și susțin o strategie bazată pe prevenirea producerii deșeurilor.

ZUSAMMENFASSUNG: Management von Abfall aus dem Bauwesen auf dem Gebiet des Munizipiums Mediasch (Transilvanien, Rumänien).

Die sozial-ökonomische Entwicklung hat große Veränderungen in der Umwelt mit sich gebracht. In diesem Zusammenhang hat die EU Rumänien zu einem guten Abfallmanagement verpflichtet. Daher gehört die Sicherung einer modernen Abfallentsorgung im nördlichen Teil des Kreises Sibiu/Hermannstadt zu den vorrangigen Aufgaben. Sowohl auf lokaler, als auch auf nationaler Ebene ist das Management von Abfall aus dem Bauwesen, Bauschutt und Zertrümmerungen, bedingt durch das Fehlen einer entsprechenden gesetzlichen Regelung mangelhaft.

Eine diesbezüglich durchgeführte Studie sollte dazu beitragen, die Notwendigkeit einer rechtlichen Regelung im Bereich der Abfallentsorgung aus Bau und Zertrümmerungen zu belegen und auch zur Annahme eines Beschlusses des Lokalrates der Stadt für diesen Bereich führen. Die während der Jahre 2012 durchgeführten Untersuchungen dienen der Unterstützung einer Strategie, die auf der Verbeugung von Abfallproduktion beruht.

INTRODUCTION

Construction and demolition wastes are identified by the European Union as an important priority waste flow because they represent a source of recycling and reuse in the construction industry (Bănăduc and Curtean-Bănăduc, 2005; Leopold et al., 2011).

This waste results from renovation, rehabilitation, consolidation, the demolition of civil constructions, industrialization, urban structures, transportation infrastructure and also results from dredging and clogging activities (Leopold et al., 2011).

It is necessary to design and manage a database of construction and demolition waste, so that evidence of generated quantities and how to manage them exists.

Generally, construction wastes are stored to household wastes, but this is no longer accepted due to legislative regulations on environmental protection imposed at the Community level. That is why it is very important to develop and deepen route recycling of construction and demolition waste (Leopold et al., 2011).

The main measures that can be applied to manage these types of waste in accordance with active regulations, after specialized literature, are the following (Leopold et al., 2011):

– separate collection from the place of generation, by the type of material and categories of dangerous and hazardous waste;

– the promotion of recycling and reutilization of construction and demolition waste;

– providing treatment of sorting them;

– ensuring controlled disposal of wastes which can not be capitalized.

The local administration authorities must take appropriate measures to control this waste flow in order to maintain evidence of generated, reused, recycled and also removed quantities of waste by conditioning the approval of construction works (clauses relating to storage areas for this types of waste) through ensuring processing capacities and arranging of the stores in accordance with this type of waste.

This type of waste can be a resource for recycling and reuse in construction industries and is identified to be a priority of waste flow in the European Union. Due to huge quantities of construction and demolition waste, they can use valuable spaces inside the landfills. Also, if not separated of source, they may contain traces of hazardous waste. However, they can represent a valuable resource and the technology for the separation and recovery of construction and demolition waste (which is well established) makes the process accessible and generally inexpensive. The most important factor is that there is a market to use the materials resulted from construction and demolition waste in the construction of roads, drainage systems and other constructions.

In the past, people had problems with this type of waste because ecological materials were used: bricks, soil, wood, clay, river stone. The sophisticated constructions of XXI century and the need for facilities (electricity, water supply, gas supply) determinated a diversification of construction materials and waste resulted from construction activities.

In most cases of waste composition there are hidden mixtures of diverse materials: construction debris, chemicals, insulating materials, excavated soil, glass, wood, metal, plastic, cardboard, paper, etc.

The development of construction sectors in Romania has made default construction waste a problem. In the absence of selection and recycling networks, the waste is currently stored at landfills.

The materials that can be recovered, (Leopold et al., 2011):

– paper and cardboard from packaging that can be recycled;

– wood construction can be used for concrete formwork. If untreated, it can be used for heating. If painted or lacquered, it must be incinerated in an incineration plant for toxic products;

– metals can be recycled thus achieving large savings in raw materials and energy;

– plastic materials are recyclable, they must be carefully cleaned before;

– excavated soil can be used for gardening, it must be kept clean and must not be mixed with other construction materials (mortar, cement);

– debris can also be reused and transformed into new building materials.

However, materials exist which can not be recycled, some of them toxic: glue, oils, paints, asbestos and other chemicals. This must be gathered and burned in special spaces designed for hazardous waste.

Reusing construction and demolition waste presents both ecological and economic advantages. The greatest benefits from the ecological points of view are space reduction of allocated authorized landfills and saving natural resources. From the economic point of view, the use of recyclable materials instead of natural resources is a solution with many advantages.

In Romania, for now, there are not deposits for construction and demolition waste. The elimination of this waste is carried out usually on site landfills for municipal waste.

However, there are economical operators who conduct their work with crushers and transform the concrete and bricks into materials that can be used later. S. C. ECO-SAL S. A. from Mediaș holds such a crushing and sorting machine which has a capacity to sort three sizes of waste: 0-8 mm, 8-16 mm and 16-64 mm.

The material resulted from crushing must live up to the quality and cost of raw materials, but in Romania, there are no rules on the quality of the resulting material after treatment, thus preventing its use in applications such as filling material in the construction of transport routes.

RESULTS AND DISCUSSION

Construction and demolition waste are represented by waste resulted from construction activities, maintenance and demolition of buildings and infrastructure.

In the construction waste category are a lot of materials (Leopold et al., 2011): resulting from construction or demolition buildings: bricks, cement, ceramic, rocks, tiles, plaster, metal, plastic, iron, wood, glass, cables, paints, varnishes; resulting from roads constructions: sand, gravel, bitumen, pitch, stone; resulting from excavation: soil, clay, gravel, sand, rocks, plant debris.

In addition to these materials that are considered non-hazardous, dangerous materials in construction and demolition waste are found, such as: asbestos, tar and paint, heavy metals, varnish, adhesives, polyvinyl chloride, solvents, PCBs, resins used for conservation, fireproofing, waterproofing etc., and contaminated materials.

Wastes containing asbestos: ropes, strings, cardboards, paper, cement products, bitumen products, flooring, paints.

Wastes containing polychlorinated biphenyl (PCB): glues, flooring, special adhesives, plasticizers, colorants.

Contaminated soil and gravel: result from construction and demolition, but also from uncovering previously contaminated land.

Usually, non-hazardous waste is generated among with dangerous waste, which requires pre-separation and can be realized on a platform arranged at the site (Leopold et al., 2011).

Construction and demolition waste is classified in category 17 according to European Waste Catalogue, and in Romania it is regulated by Government Decision no. 856/2002 on waste management record which approves the list of waste, including hazardous waste. From the 44 types of construction and demolition waste, 16 are classified as hazardous waste (Leopold et al., 2011).

For efficient management of construction and demolition waste, sustainable management is necessary. This should highlight prevention or reduction of

waste quantities, followed by the reuse of waste, material recovery through recycling, capitalized energetics, and elimination of waste remained by storage.

Using sustainable management in the construction and demolition waste management field not only significantly reduces the quantity of waste storaged, but will drastically reduce the impact generated by storage of waste on the environment.

It is obvious that management improvement of construction and demolition waste is mandatory by the selective collection increase of wastes by holder construction activity, sanitation operators and local public administration.

In this respect, in Mediaș, sanitation society S. C. ECO-SAL S. A. provides individuals and companies with containers for construction and demolition waste which helps the environment by differentiating rates for this type of selectively collected waste, as well as mixed waste.

It is recommended that the reuse of this waste, as well as construction materials or energy recovery be utilized. But the non-recyclable and hazardous need to be removed by storage in landfills or, where applicable, by incineration.

Waste recycling entails conservation of energy and natural resources, and also prevents pollution.

On the environmental side, reuse and recycling of construction and demolition waste reduces the quantities of storage waste and space for deposits, thus achieving an economy of raw materials.

Reuse and recycling of construction and demolition waste presents an economic benefit, thus, the use of recycled materials becomes a solution with more advantages considering the high prices of natural resources.

Framework Directive 2008/98/EC on waste contains previsions in the recycling domain. Thus, the member states shall require that by 2020 to prepare for reuse, recycling (and others filling operations which use waste to substitute other materials), at least 70% by weight of non-hazardous waste will come from construction activities (Leopold, 2011).

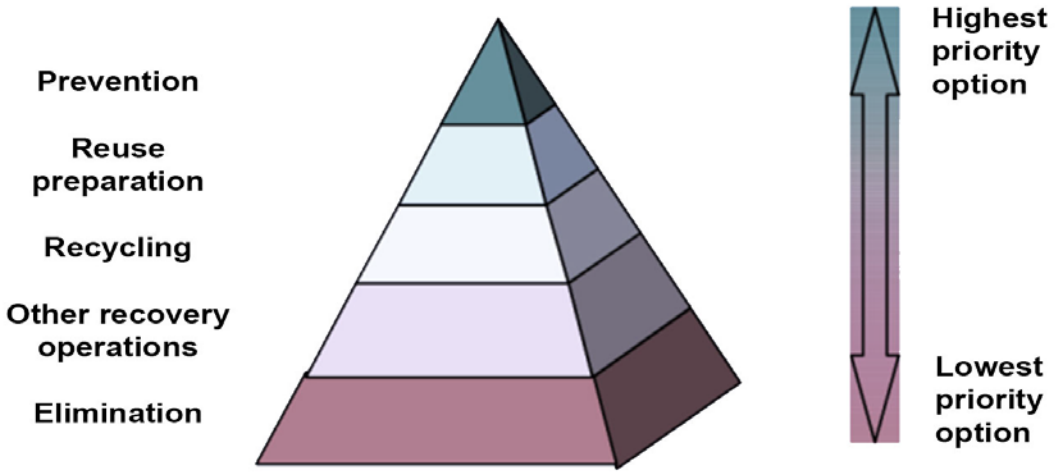

Figure 1: Waste management hierarchy (Leopold et al., 2011).

In the Mediaș municipality, large quantities of waste are gathered annually as shown in table 1.

Household wastes are sorted manually at the reception, processing at capitalization center and are then send to the ecological landfill in Cristian, Sibiu County or at the ecological landfill from Sighișoara, Mureș County.

Recyclable waste such as: paper, cardboard, plastic, and glass are selectively collected or manually sorted from household waste and are capitalized from various collaborators.

Table 1: Quantities (in tones) of waste collected in 2012 in the northern part of Sibiu.

Quantities of waste collected (to) 2012							
	Holdhouse	Recyclable	Energetic	Voluminous	Markets	Vegetable	Constructions
Mediaș	11,135.15	662.844	2.84	452.68	101.05	877.01	1146.38
Copșa Mică	814.78	39.38	14.38	0	0	0	0
Dumbrăveni	1,166.78	26.8	0	0	0	0	0
Localități	5,123.422	53.406	0	0	0	0	0
Total	18,240.132	782.43	17.22	452.68	101.05	877.01	1146.38

Construction waste is the only side which seems to have problems with waste management at the local level and beyond; this is due to the lack of national legislation in this direction.

S. C. ECO-SAL S. A. provides both individuals and companies with containers for selective collection of construction and demolition waste at the request of the holder construction activity, according to tariffs set.

Also, for a fee, it is assured the fact that the handling and transportation of containers will arrive at the reception and processing of construction and demolition waste center.

At the center for reception and processing of construction and demolition waste, the sorted waste is brought with personal transport and received for free by individuals or companies from the North of Sibiu County.

Any generator of this type of waste benefits by sanitation services local operator based on firm order can be completed at the company or sent by fax or e-mail. The standard order form can be downloaded for free from the company's website or can be requested from the company's headquarters.

After completing the standard order form, the company transports the container to the requested address. After that the container is transported to the center for the reception and processing of construction and demolition waste; it is weighed and checked by specialization inspectors to see the composition of waste. After that they are passed throught the cutter and sorted by dimensions of 16-64 mm, 8-16 mm and < 8 mm.

This waste is the subject for recycling and recovery processes, and are used for rearranging roads and other activities.

CONCLUSIONS

Following a study of the construction and demolition waste collected at the center for the reception and processing of the construction and demolition waste from the S. C. ECO-SAL S. A. company, it was proved that most of this waste is represented by concrete at 42%, followed by pitch at 28%.

This result is due to the fact that in our country most buildings were made by concrete, especially in urban areas unlike the rural areas near the mountains where wood and stone are predominating building materials.

Pitch is in a high proportion because at the level of Mediaș it was realised that many repairs/modifications to the road were done in 2012.

After monitoring the construction and demolition waste in 2012 at S. C. ECO-SAL S. A. it was shown that about 45% of waste has dimensions between 16-64 mm.

Processing of waste from construction and demolition began in 2010, at Mediaș, when the storage, sorting and crushing platform was arranged and the necessary equipment was purchased.

The study showed that individuals have produced a smaller amount of waste than in 2012 and the companies' situation is contrary. This may be because 2012 was the year of modernization; business centers and wage declines negatively influenced individuals. But another assumption is that individuals have noticed the lack of legislation in this domain and thus the fear of legislative abuse decreases and they resumed to store construction and demolition waste on the riverbanks or in other forbidden places.

Confronting personal activity from the field requires that the container addressed to the sanitation society from Mediaș is observed by many individuals who perform construction or renovation activities on private domain, but did not require special containers for construction and demolition waste. Certainly due to the lack of legislation, people could not be held responsible because no one has the authority to prove reusing or storage according to the legislation of this waste; and this should be changed.

In 2012, at level of S. C. ECO-SAL S. A., companies registered a total of 129 orders for special containers for collecting construction and demolition waste.

There is evidence that most people which request containers are individuals at 80% and only 20% of the orders are made by companies. This shows that 2012 was not the year for modernized business centers as the analysis took waste quantities into account in 2011 and 2012.

The studies show that in proportion of about 85-90%, companies do not realize selective collection of this waste, while most individuals comply with that. This result may be due to the fact that the rates practiced by different companies presents differences for selective and non-selective collection.

However, it is disappointing that only 70% of cases realised selective collection of this types of waste and the remaining 30% of waste is collected chaotically and uncontrolled.

Upon reviewing the results, it should be taken into account that not everyone uses an ordering fee for the construction and demolition waste speciality container.

As a result of the study, it was realised at the level of 68 people, to the need of Local Council Decision in construction and demolition waste domain, most of them considered that is necessary to implement this legislation.

Although sanitation operator S. C. ECO-SAL S. A. was informing citizens by distributing 21,000 calendars on waste collection in the municipality; calendars showed how to collect construction and demolition waste, equipment by the company, companies' tariffs, rates which vary by type of collection (selective or non-selective). From the study, it was resulted that it really is necessary to implement a regulation on the collection, transport and storage of wastes which results from construction and demolition activities.

Considering that from early 2012 I served as special inspector ecologist in S. C. ECO-SAL S. A., I considered necessary the legislative regulation of construction and demolition waste.

Considering that the entire study is realised at the level of Mediaș municipality, I considered that is necessary to draft a regulation on construction and demolition waste; regulation which includes a plan to eliminate construction and demolition waste and at the same time include the sanctions for those who do not respect the previsions of regulation.

For approval of the Local Council Decision, it is necessary that an Opportunity Report be prepared by the operator which contains the reasons for approving the regulation on the collection, transportation and storage of waste resulting from the construction and/or demolition activities.

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AUTHOR:

[1] *Anamaria Szabo*
anamariasz12@yahoo.com

"Lucian Blaga" University of Sibiu,
Faculty of Sciences,
Dr. Ioan Raţiu Street 7-9, Sibiu,
Sibiu County,
Romania,
RO-550012.

FRESHWATER BIVALVE MOLLUSCS – A SOLUTION FOR ORGANIC WATER TREATMENT?

Cornelia LUNGU [1] and *Letiția OPREAN* [2]

KEYWORDS: Unionidae, *Dreissena polymorpha*, filtration capacity, water treatment.

ABSTRACT

The filter-feeding bivalves have a significant role in the matter and energy flow of freshwaters. The role of bivalves in aquatic ecosystems is crucial due to the fact that these species can filter out a significant amount of matter. The current review paper underlines the role provided by freshwater bivalves, due to their filtration capacity, in water treatment facilities. Moreover, the paper gives an overview of the current state of knowledge about native and invasive bivalves used in water treatment plans. Moreover, the paper highlights the effects of freshwater bivalves on water quality by incorporating them in an on-site filtration facility-biofilters, such as artificial blocks or rigs. However, the benefits must be balanced with the ecological risks associated with the transport of invasive bivalves, such as zebra mussels, to new sites. For this reason, even though invasive bivalves species proved to have higher filtration capacity, it is recommended to develop biofilters within aquatic ecosystems that have already been populated by invasive bivalves species (e.g. *Dreissena polymorpha*).

REZUMAT: Bivalvele de apă dulce – o soluție în epurarea apelor încărcate organic?

Bivalvele au un rol semnificativ în fluxul de energie și materie din apele dulci. Rolul bivalvelor este esențial datorită faptului că aceste specii pot filtra o cantitate semnificativă de materie. Lucrarea de față își propune să scoată în evidență rolul pe care bivalvele de apă dulce îl au, datorită capacității lor de filtrare, în instalațiile de tratare ale apei. De asemenea, lucrarea oferă o privire de ansamblu asupra bivalvelor de apă dulce, native și invazive, utilizate în stațiile de tratare ale apei. Mai mult decât atât, efectul bivalvelor de apă dulce asupra ecosistemelor acvatice ar putea fi sporit prin realizarea unor sisteme artificiale de filtrare in – situ la care să fie folosite specii de bivalve (de exemplu blocuri artificiale, dispozitive etc.). Însă, aceste beneficii trebuie să fie corelate cu riscurile ecologice care pot apărea la transportul unor specii de bivalve invazive în ecosisteme acvative. Din acest motiv, este recomandat să se dezvolte astfel de filtre biologice doar în ecosistemele acvatice unde au fost deja introduse specii invazive (de exemplu *Dreissena polymorpha*).

ZUSAMMENFASSUNG: Die Süßwassermuscheln – eine Lösung für die Reinigung von Abwässern?

Muscheln spielen eine wichtige Rolle im Energie- und Stoffaustausch von Süßwasserlebensräumen, da sie eine beträchtliche Stoffmenge filtern können. Die vorliegende Arbeit hat zum Ziel, die Rolle der Süßwassermuscheln, die sie dank ihrer Filterkapazität besitzen, in den Wasseraufbereitungsanlagen zu untersuchen. Außerdem gibt die Arbeit einen allgemeinen Überblick über die einheimischen und eingeschleppten, imvasiven Süßwassermuscheln, die in Wasseraufbereitungsanlagen verwendet werden. Aus den Untersuchungen wird gefolgert, dass die Auswirkungen der Süßwassermollusken auf aquatische Ökosysteme durch die Einrichtung einiger künstlicher Filtersysteme in situ erhöht werden könnten, wobei dafür Muscheln sowie künstliche Blöcke, Vorrichtungen etc. zu verwenden wären. Diese Vorteile müssen jedoch gegen die ökologischen Risiken abgewogen werden, die durch das Einbringen einiger invasiver Muschelartenn in die aquatischen Ökosysteme entstehen könnten. Aus diesem Grund ist es zu empfehlen, derartige biologische Filter lediglich in solchen aquatischen Ökosystemen anzuwenden, in die bereits invasive Arten eingeführt wurden, wie zum Beispiel *Dreissena polymorpha*.

INTRODUCTION

Water quality management is one of most complex environment issue today (Curtean-Bănăduc and Bănăduc, 2012a, b).

Freshwater bivalves individuals can filter up to half a liter of water per hour, measurements shown (McIvor, 2004), thus the freshwater mussels are known as excellent water filters. The filter-feeding bivalves have a significant role in the matter and energy flow in freshwaters (Bodis et al., 2008). The current paper gives an overview of the state of knowledge concerning the filtration capacity of freshwater bivalves and its application in organic waste water treatment. However, the filtration rate mainly depends on the suspended matter content of the water. Moreover, the high density of bivalves not only removes particulate material from the water column, but they also excrete a large amount of inorganic nutrients back into the water column (Kohata et al., 2003). The main goal of this paper is to give the reader an overview about water treatment facilities using freshwater bivalves and enhacing their on site filtration capacity by using different methods. The research questions that arise from this paper can be summarised as follows: do freshwater bivales (native and invasive) have potential in water treatment plans? Or are freshwater bivalves "engineers" in polluted aquatic systems?

MATERIAL AND METHOD

A systematic scientific literature review has been conducted in order to achieve the objectives of this paper. To minimize the risk of bias, the author attempt to identify papers and articles and to use the research with least bias. A number of 50 articles have been searched and a number of 26 have been included in the current paper.

RESULTS AND DISCUSSION

In freshwater ecosystems, bivalves are dominant filters with many species that have high filtration rates. Invasive species such as *Corbicula fluminea* and *Dreissena polymorpha* (zebra mussel) have very high filtration rates (Strayer et al., 1994), compared with Europe native species such as *Unio crassus* or *Unio pictorum*. Bivalves can filter out a significant amount of organic matter through their filtering activity (Kohat et al., 2003). Filtration behavior of freshwater bivalves can play a very important role in the riparian ecosystem by reducing phytoplankton, increasing water clarity and generating benefits for plants, invertebrates, fish and bird populations (McIvor, 2004).

Freshwater bivalves filter/remove a wide variety of particles in the water column, resulting a decrease of phytoplankton and zooplankton and changes in the plankton community. Bivalve organisms filtration activity has significant consequences on the physical environment and act like "ecosystem engineers". An example in this respect is to increase the clarity of the water, and thereby the penetration of light into the water column, by reducing the concentration of plankton and other particulate matter. Increased water clarity was observed, especially after the introduction of different invasive bivalves species such as *Dreissena polymorpha* or *Corbicula fluminea* (Sousa et al., 2009).

Clearence rate determinations were conducted on a monthly basis from April to October in 1992 and 1993 in lake Huron, Michigan (Fanslow et al, 1995). The mean filtration rate of zebra mussel was 16.2 ml/mg/h (range 4.0 to 40.7 ml/mg/h). The filtration rate was determined by the equation from Coughlan (Coughlan, 1969): $FR = Vol\ [(\ln C_o - \ln C_x) - (\ln C'_o - \ln C'_x)]/t$; FR = filtration rate of zebra mussel cluster (ml/h); vol = volume of lake water in aquaria (ml); t = time (h); C_o = initial chlorophyll concentration in experimental aquaria (µg/l); C_x = final chlorophyll concentration in experimental aquaria (µg/l); C'_o = initial chlorophyll concentration in control aquaria (µg/l); C'_x = final chlorophyll concentration in control aquaria (µg/l).

Zebra mussel play a biodeposition and bioconcentration role of polychlorinated biphenyls (PCBs) as investigation were carried out in Hudson River (USA). The ingestion rate (IR) and assimilation efficency (AE) of PCBs were calculated, according to the following formulas: IR = $(C_o - C_x)F/M$, where: C_o = concentration of algae in control aquaria (mg algae/l); C_x = concentration of algae in experimental aquaria (mg algae/l); AE = P_x/P_a IR t; P_x = the amount of PCB incorporated in the tissue; P_a = the amount of PCB associated with alge (µg PCB/mg algae); t = time.

Zebra mussel ingested arround 46-90% of PCB – contaminated algal cells, depending on the supply rate. Of the total ingested food (therfore PCBs), cca 45-78% was found in biodeposits and 15-35% was recovered in tissues (Cho et al., 2004).

Filtering activity of bivalves as can interact with certain human activities. For example, a species of invasive bivalve did have a positive impact on shrimp farms by removing particulates. However, high density started to prevent invasive shrimp species to feed efficiently, increased water clarity intensified activity of predatory birds, and led to reduced pigmentation shrimp which has reduced their market value (Aldrige et al., 2008). Moreover, individual shells of bivalves and high density can affect the flow of water and sediment infiltration affecting particle transport (Gutierrez et al., 2003).

Dreissena polymorpha has profound ecological effects on aquatic environments. This species can be a major phytoplankton consumer. *Dreissena p*. can reach great densities, and can filter large volumes of water and retain a wide size range of particles (Sprung and Rose, 1988; Silverman et al., 1996). *Dreissena p.* populations are capable of removing over 90% of organic matter from the water (MacIsaac, 1996).

In this regard, *Dreissena polymorpha* has been proposed as an useful tool in the water quality management of lakes (Reeders and Bij de Zaate, 1990). Experiments have shown that zebra mussels can remove huge quantities of organic matter from the water. In addition to organic matter, *Dreissena p.* can also filter bacteria (Silverman et al., 1995) and other particles. The infestation of reservoirs and pipelines by zebra mussels is expected to have similar benefic effects on the quality of the water, which would be of great advantage to the water supply industry if the water is eutrophic polluted (Elliott et al., 2008). Invasive species such as *Dreissena p*. should not be introduced in an aquatic ecosystem for water quality benefits.

Invasive bivalves are being used at the moment, in some countries, in the process of filtering freshwater. For instance, Dutch researchers have developed a method for increasing water quality by using *Dreissena polymorpha* as biological filter. Currently this method is tested in the southern Netherlands. As stated before, *Dreissena polymorpha* filter water to feed. The invasive bivalve remove algae and particles from the medium and deposite them through excretion. In sufficient quantities, these bivalves can prevent water flowering and reduce turbidity. This can also improve the growth conditions for aquatic plants and also contribute to water quality.

The process consists of growing *Dreissena polymorpha* on artificial substrates in blocks which can be used as a biological filter. In this way, low quality water can be improved by using these biological filters. This method was patented by Bureau Waardenburg, Netherlands (Waardenburg, 2013).

Even though, zebra mussels could provide potential benefits to water treatment, they are often perceived as more of a pest than an advantageous biofitering organism. This is happening due to the fact that they produce changes in particle size, the content of organic matter, aggregation, which can affect the porosity characteristics of the interstitial water, the redox potential and distribution, and the survival of other organisms (Vaugh and Hakenkamp, 2001). Through their filtration of some algae, zebra mussels have been proposed to facilitate cyanobacterial blooms (Vanderploeg et al., 1995). *Dreissena polymorpha* causes serious biofouling effects on many industrial systems (Elliot et al., 2005).

Despite all these problems there are many ways in which zebra mussels could be used as a biofilter without causing ecological of biofouling problems. One method is to put them on artificial substrate on bloks as described above. Another method is to incorporate them into a purpose-built filtration facility, much like a rig (Elliot et al., 2008). According to Elliot et al. (2008), *Dreissena polymorpha* could remove around 50% of the suspended chlorophylla in water flowing past by. In their experiment, the mussels had survived for over three weeks without much maintenance; this indicated that there is potential for substantial algal control by zebra mussel. Thus, large beds of zebra mussels could be used to provide an initial stage in water treatment. This can minimize the difficulties of on-site water treatment (Elliot et al., 2008). Moreover, the use of bivalves has been proved to be a simple and inexpensive way to reduce the nutrients in the water. Many ponds/water bodies are full of algae and a cheap method to clean/filter these waters is the one with bivalves species. Mussels are found to play an important role in water purification and river functions, thus "mussel-friendly" approaches to river management should be encouraged (McIvor, 2004). In addition, the mussels have long term benefits for the ecosystems. Most species of mussels live more than ten years (Bauer, 2001) and if can reproduce within the waterbody, they may be able to maintain their populations over a much longer time-scale.

There are environmental factors such as temperature, particle concentration, particle composition, and pollution that have shown to effect the bivalve filtration rates (Riisgard et al., 2003).

Filtration rates increase with the temperature, up to an optimum temperature, above which they decrease (Masilamoni et al., 2002). Filtration rates are highest at medium particle concentrations, and may respond to both the volume and the clorophilla a concentration of particles (Hawkins et al., 2001).

Freshwater unionids are known to retain particles greater than 4 µm in diameter with 100% efficiency (Jorgensen, 1989). Pollution is another factor that can reduce the filtration rates of bivalves and close their valves (Ostroumov, 2001).

Used in an on-site rig at a water treatment facility, zebra mussels would not pose as much of an industrial problem as it might be expected. Firstly, they cannot transfer larvae upstream to cause infestation. Secondly, the ecological treatment method is not worse than pre-existing treatment methods such as ozonantion. Thirdly, if the biofilter is followed by another treatment strategy, downstream infestation is likely to be prevented (Elliot et al., 2005).

To sum up, *Dreissena polymorpha* and other freshwater bivalves probably provide, due to their filtration capacity, a level of biofiltration for water treatment facilities, but their effects could be enhanced by incorporating them in an on-site filtration facility (an artificial block, a rig etc.). Nonetheless, the benefits must be balanced with the ecological risks associated with the transport of live zebra mussels to new sites. For this reason, it is recommended to develop such biofilters within aquatic ecosystems that have already been populated by invasive species (e.g. *Dreissena polymorpha*).

The filtration rates of filter feeding bivalves are measured by different methods and are question to pitfalls. A precondition for studying possible implication of filtration rates in bivalves is the ability to make precise measurments. This was not always the case due to examples pointed out by Riisgard (2001). The different methods used in assasying bivales filtration have often caused troubles. The conflicted data on filtration rates seem partly to be caused due to the incorect use of methods or by differences in experimental conditions (Riisgard, 2001).

CONCLUSIONS

Freshwater bivalves, invasive and native, proved to have good capacity in filtering and purifying waters, thus performing an "auto-adjustment" of aquatic ecosystem.

A number of applications for *Dreissena polymorpha* have been proposed. Firstly, they can remove algae, PCBs and particles from the water by arranging them on artificial substrates in blocks and these blocks can be used as a biological filter. Secondly, the successful removal of algae through rig shows that *Dreissena polymorpha* could be used as an on-site industrial biofilter for water treatment. Thus large beds of zebra mussel could be used to provide an initial stage in water treatment. This can minimize the difficulties of on-site water treatment. Moreover, the use of bivalves has been shown to be a simple and inexpensive way to reduce the nutrients in the water. The studies highlighted the potential of using mussels filtration for the environment and commercial benefits of humans. However, such treatment systems must be used with precaution only in aquatic ecosystems already populated with invasive species and taking into consideration the environmental factors such as temperature, particle concentration and pollution.

ACKNOWLEDGEMENTS

Many thanks are addressed to Mrs. Curtean-Bănăduc A. and Mr. Bănăduc D.

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AUTHORS:

[1] *Cornelia LUNGU*

lungucarmen@yahoo.com, amf.lungu@gmail.com

"Lucian Blaga" University, Sibiu, Victoriei Boulevard 10, Sibiu, Romania, RO-550024.

[2] *Letiția OPREAN*

letitia.oprean@ulbsibiu.ro

"Lucian Blaga" University of Sibiu, Victoriei Boulevard 10, Sibiu, Romania, RO-550024.

HOLISTIC ECOSYSTEMIC APPROACH AND THE HUMAN HEALTH

Alexandra VASU [1]

KEYWORDS: holistic ecosystemic approach, ionic equilibrium, biogeochemical cycle, disfuncionality diagnosis, Eh-pH test for cancer.

ABSTRACT

Human impact, by acting on socio-economic criteria, ignoring the unity of ecosystems function, causes major disturbance in ecosystems. Diagnosis of ecosystem functionality/dysfunctionality is necessary to substantiate the resources management, identifying the disturbing phenomena, acting processes and even their mechanisms. As an image of a sequence in time of the dynamic balance of ecosystems, this paper presents an original multidisciplinary ecosystemic-integrated research methodology that enables interdisciplinary interpretation of results. We report research of ionic equilibrium and stability conditions in bio-geochemical cycles, as an expression of the unity in the terrestrial ecosystems. The methodology is also conceptually applied to the human body, as a subsystem component of terrestrial ecosystems.

REZUMAT: Abordarea ecosistemică holistă și sănătatea omului.

Activitatea umană, prin acționarea pe baza de criterii socioeconomice, ignorând funcționarea unitară a ecosistemelor, determină principalele perturbări în ecosisteme. Pentru fundamentarea utilizării resurselor naturale este necesară diagnoza funcționalității/disfunctionalității ecosistemului, cu identificarea fenomenului perturbator, a proceselor care acționează și chiar a mecanismelor acestora. Ca imagine a unei secvențe în timp a echilibrului dinamic al ecosistemelor, lucrarea prezintă o metodologie originală de cercetare multidisciplinară ecosistemic integrată, care permite interpretarea interdisciplinară a rezultatelor. Se evidențiază cercetarea echilibrelor ionice și a condițiilor de stabilitate în circuitele biogeochimice, ca expresie a unității în ecosistemele terestre. Metodologia este aplicată conceptual și la organismul uman, ca subsistem component al ecosistemelor terestre.

RÉSUMÉ: Concept holistique écosystémique et la santé humaine.

L'impact des activités humaines, agissant avec des critères socioéconomiques, en ignorant l'unité fonctionnelle de l'écosystème, provoque d'importantes perturbations dans les écosystèmes. Pour justifier l'aménagement des ressources naturelles, il est nécessaire de diagnostiquer le fonctionnement/dysfonctionnement des écosystèmes, l'identification des phénomènes perturbateurs, les processus agissant et même leurs mécanismes. Comme l'image d'une séquence dans le temps de l'équilibre dynamique des écosystèmes, l'article présente une méthodologie original de recherche pluridisciplinaire écosystémique intégrée, qui permet l'interprétation interdisciplinaire des résultats. La recherche met en évidence les équilibres ioniques et les conditions de stabilité des cycles biogéochimiques, en tant qu'expression de l'unité dans les écosystèmes terrestres. La méthodologie est appliquée de manière conceptuelle également au corps humain, comme sous-système, composante des écosystèmes terrestres.

INTRODUCTION

Human development, with a high quality of life, is achieved only by the assurance of life persisting in harmonious and fair coexistence between human beings and other species (Huntley et al., 1991), as well as with the environment in which it is structural and functional involved (Vasu, 1983, 1984, 1985, 1986a, 1988, 1989a, 1994a). However, increasing socio-economic requirements for biomass production lead often to ecological unbalance between the vegetation needs and the biotope supply, with consequences on ecosystem stability, associated mostly with lowering of productivity and even with degradation of human health. Therefore, the sustainable development of ecosystems is necessary to harmonize socio-economic needs with the optimization of biomass production. It is possible to be achieved by ensuring, even by anthropogenic intervention, of an advanced correspondence between the ecological needs of the biocenosis and the support ability of the whole biotope, especially of the soil.

Ecological balanced bio-productivity is conditioned by the limiting of land use to the range of compatibility, with the persistence in a restricted variation interval (Trojan, 1984; Vasu, 1989) of the soil fertility and its resistance to the disturbance factors induced by the intensive land use.

The complex changes of the state of the environment in the last 50-60 years, with multiple causes, impose a new concept in the solving of the complex humanity problems, including health problems (Leontopol and Andronescu, 1984; Mogoș, 1975, 1976, 1977, 2002; Mogoș and Brozici, 1973; Mogoș et al., 1980; Mogoș et al., 1971, 1973a; Montagnier 1995, 2012; Montagnier et al., 1998; Montagnier and Gougeon, 1993; Passwater, 1975, 1978, 1983, 1998; Simoncini, 2007; Vasu, 1972, 1973, 1983, 1984, 1985, 1986a, 1986b, 1988, 1989, 1990, 1994a, 1994b, 1994c, 1997a, 1997b, 1998, 2001, 2002, 2006; Vasu and Moga, 2008; Vasile, 2002, 2009a, 2009b).

Montagnier (2012), in his conferences and scientific public dialogues during his scientific visits in Bucharest in September 2012, pointed out some basic ideas in the evolution of medicine, according to environment changes. He appreciated that in new times appear new situations imposing solutions that require another, different, approach in medicine. Medical methods need to move towards a holistic approach. The great challenge of modern medicine is to prevent chronic diseases. So was born the medical concept of the 4P: P1 predictive (anticipatory), P2 preventive, P3 personalized, P4 participative. Man must be careful regarding live style, eating, recreation, avoidance of excessive oxidative stress (Montagnier, 1995, 2012; Passwater, 1975, 1978, 1983; Goodman, 1997; Goodman et al., 1994a; Vasile, 2009a, b; Vasu, 1994a, 2001, 2002, 2006; Vasu and Moga, 2008).

The aim of this paper is to present an original holistic approach and a systemic diagnosis methodology, applied in terrestrial ecosystems for the estimation of their stability and their actual, effective qualitative and quantitative productivity, as well as for the estimation of human health status. Its application aims at the identification of disfunctionalities in the equilibrium and evolution of ecosystems, including the human being (at the equilibrium status in the research moment). Its application includes diagnoses of disturbance processes and their mechanisms, essential for equilibrium in ecosystems and even in the human health. This paper tries to bring also some contributions to the extension of the holistic approach to human medical research, as an answer to the necessity to consider in medicine the human being as a unitary body with unitary functions. We try also to propose a test for precocious cancer identification.

Some case studies illustrate ecosystems disturbance due to ignorance of the natural equilibrium in ecosystems and some experiments are presented concerning human cancer.

MATERIALS AND METHODOLOGY

A. Holistic ecosystemic approach

The studies were carried out using a general ecological systemic approach (von Bertalanfy, 1960; Odum, 1971, 1983, 1993, 1974), and according to specific integrated ecosystemic approach (Ellenberg, 1971, 1986; Chiriță, 1974; Chiriță et al., 1983; Vasu, 1972, 1983, 1984, 1985, 1988, 1989, 1994a, 1997a, 1998, 2001, 2002; Vasu and Nedea, 1978; Ulrich, 1981, 1991; Duchaufour, 1995).

In terrestrial ecosystems, the soil – as edaphotope – is the subsystem which achieves the systemic unity of life with the environment, through the multitude of functional connections with the other subsystems of the biotope and with the biocenosis, including human beings. The connections are achieved in developmental and evolutionary processes and especially in nutritional processes (as structural and functional relationships). Thus, a structural and functional scheme of terrestrial ecosystems was proposed (Fig. 1) (Vasu, 1972, 1983, 1985, 1986a, 1988, 1989, 1994a, b, c, 1998, 2001, 2002; Vasu et al., 1995-1996 modified).

The human being, meeting the general and essential characteristics of a system, namely: integrity, historical and informational nature, self organization, internal heterogeneity, function, hierarchy, can be considered a system. In this holistic approach, it is a subsystem within terrestrial ecosystems. Its systemic structure is connected functionally with other subsystems, especially in the field of nutritional processes, ensuring the psychosomatic equilibrium essential for human health. It is necessary to emphasize that the actual OMS definition of human health is: "a psychic, somatic and social individual good state". Terrestrial ecosystems are open dynamic systems where the aqueous solution (with its ionic activities) is the nutrient conveyer, in the rocks – soil – plant – animal – human being circuits; in rocks (or parent materials) pluviometric hydrolysis products; in soil the soil solution; in plants the sap; in animals the blood; and in the human body also the blood.

Therefore, the concept of the Pourbaix Eh-pH Diagrams (Pourbaix, 1963), elaborated as a thermodynamic frame for the simultaneous chemical and electrochemical reactions in the binary systems element – water – was used as an idealistic model for the study of the speciation level of the element – water systems extended to the terrestrial ecosystems chemistry analyses, including the human being (Vasu, 1973, 1983, 1988, 1989, 2001, 2006; Vasu and Nedea, 1978, 1983; Vasu and Roşu, 1980; Vasu and Moga, 2008).

Constituting a condensate, logical and normalized form, the Eh-pH diagrams indicate the existence and stability domain of the chemical species liable to be formed in one element-water system or the relative relevance in systems which has more elements.

The existence of the stability domain, or relative relevance of different chemical element forms, is conditioned by concentration (potential ionizable elements-water), Eh, pH, temperature.

It is necessary to draw attention to the existence of a high microbiological activity in the whole terrestrial ecosystems and, as consequence, upon the existence of many redox systems, where the biochemical and chemical reactions occur with active participation of e^- and H^+ exchanges, inducing Eh and pH variations.

The Eh, pH, temperature, moisture and potential ionizable elements content in the aqueous solutions are considered condition parameters for thermodynamic stability of the system element-water equilibrium and moving conditions parameters of the nutrients in rock-soil-plant-animal systems (Vasu, 1988, 1989, 1994a, b, c, 1998, 2001, 2002; Vasu et al., 1989; Vasu et al., 1995-1996) and in the human body as well (Vasu, 2006; Vasu and Moga, 2008).

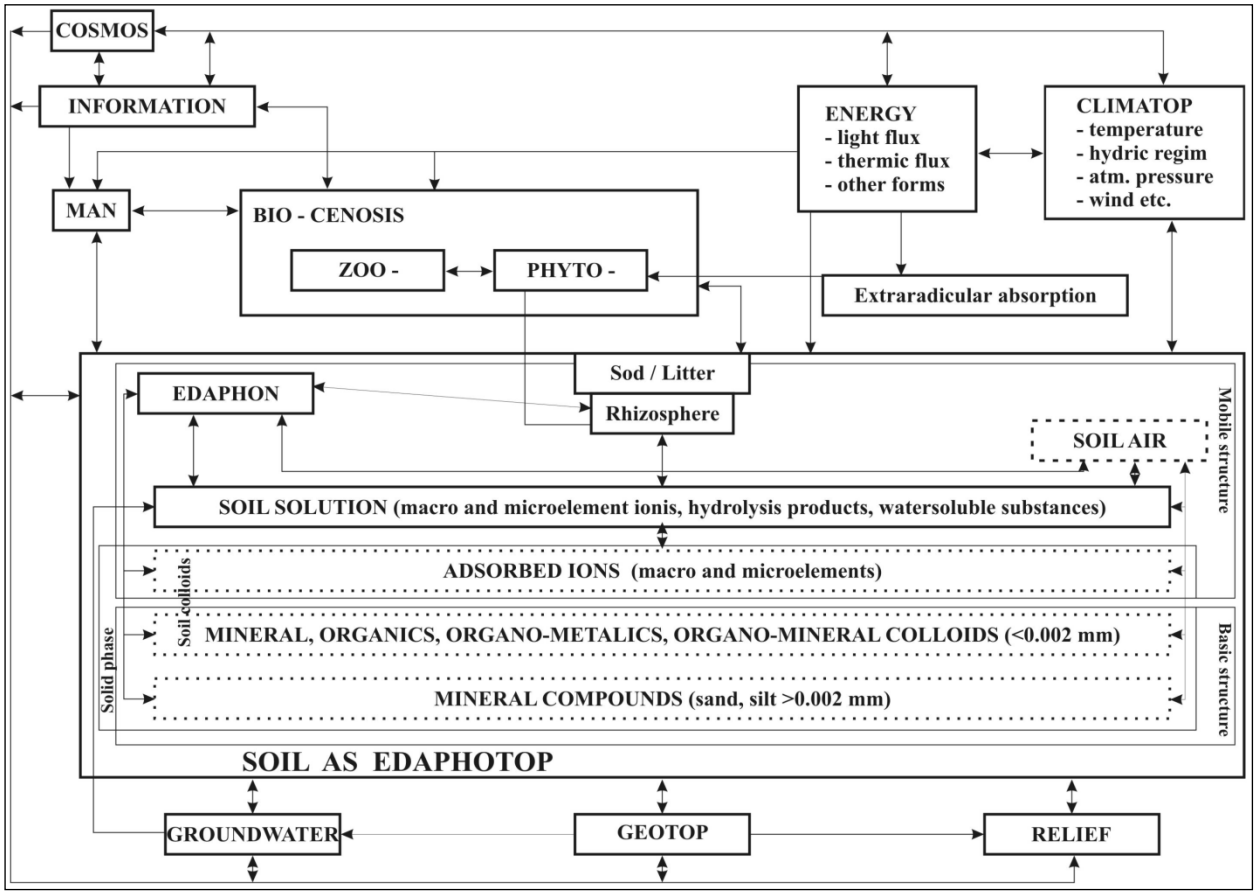

Figure 1: Structure and dynamic equilibria in terrestrial ecosystems.

The experiment in an S-N transect Europe (Vasu et al., 1995-1996) showed the influence of the energy (in field measured temperature and light flux) on the Eh-pH and as consequence on the ionic equilibrium.

That is why the stability conditions accepted for all the subsystems of the ecosystem are legitimately considered valid for the human being too.

The Eh-pH couple, measured at constant temperature, may reflect the thermodynamic stability conditions of general balanced human health.

Therefore, the Eh-pH couple, indicating the existence of some disturbance in the human health equilibrium, seems to be a precocious, rapid cancer test. For the identification of deeper health disturbance processes and their mechanisms (the way it was proved in the behavior of many disturbed terrestrial ecosystems) it is necessary, to analyze the ionic equilibrium in the blood, after finding the Eh-pH disturbance. This means the potential ionizable element quantities (total element content in blood) and the ionized one, as well as compounds like those blocking hemoglobin (blocked as methemoglobin in our experiment – Vasu, 1989). It is important to determine N, P, K, Ca, Mg, Fe, Se, Ge, Zn, Cr, Al, Mn, Cu, Cd and perhaps other elements. The ionic activity of different elements in blood, especially multivalent ones, controlled by the Eh-pH, is important not only as an individual value, but also as ratio between different elements' ionic activities.

In the last 50-60 years, acidic pH, especially in food, is regarded as having a negative role in the equilibrium of human health (Drury-Climent, 2002; Young, Redford-Young, 2005; Simoncini, 2007; Mencinicopschi, 2010; Marinescu, 2012).

It is important to distinguish the effect of changing pH in Tumour Therapy, as a revolutionary approach, proposed by Prof. Dr. Tulio Simoncini, who considered that cancer is a fungus and can be treated with sodium bicarbonate (Simoncini, 2007).

In our modern world it is difficult to know what kind of nutritional ingredients we are getting in our normal daily diets. The mass production of foodstuffs around the world, (packaged with preservatives and processed in for safety), has left many food products lacking in essential nutritional value. Each of us needs to understand more clearly how to supplement our diets to live a long and healthy life.

For this reason more and more authors point out the importance of a balanced lifestyle, with a harmonious balance of time and especially healthy nourishment (Ohsawa, 2002; Valnet, 1981; Goodman, 1991, 1995, 1998, 2001; Goodman et al., 1994; Montagnier, 1995, 2012; Passwater, 1975, 1978, 1983, 1998; Montignac, 2008; Schreiber, 2008; Vasile, 2002; 2009a, b; Mencinicopschi, 2010), including the use of vegetable and fruits with high reducing properties in daily diet.

Richard Passwater has been researching antioxidant nutrients since 1959 and discovered biological antioxidant synergism in 1962. In 1970, at Toronto, he presented his evidence to the Gerontological Society's Annual Scientific Congress that antioxidant nutrients offered a practical means of increasing human lifespan. He was the first to show that practical combinations of antioxidant nutrients increase the lifespan (Chemical and Engineering News, 1970). The reports of Dr. Passwater's research, in 1970, by Ladies Home Journal, and in 1971, by Prevention magazine, may have been the first times that the words "free radical" "antioxidant nutrient" appeared in lay articles. Dr. Passwater was also the first to publish that a synergistic combination of antioxidant nutrients significantly reduces cancer incidence (Cancer: New Directions. American Laboratory, 1973).

Recently, some authors speak of the connection between cancer and oxidants (Leontopold and Antonescu, 1984; Passwater, 1975, 1978, 1983, 1998; Montagnier, 1995, 2012; Montagnier and Gougeon, 1993; Montagnier et al., 1998).

Luc Montagnier – Nobel Prize winner in Physiology and Medicine 2008, for discovering in 1983 of the Virus HIV1 the causative agent of AIDS – considers that (Montagnier, 1995, 2012).

In 2009, Teodor Vasile wrote "Cancer, caused by sadness" (Vasile, 2009b).

In oxidative conditions, or in conditions of sadness, Eh changes occur in the human body, connected with pH changes (thermodynamically proved Pourbaix Diagrams) causing illness, especially cancer, but also disease due to the balance disturbances in the unitary functions of the human body system.

All these researches confirmed the benefit of controlling the modification of Eh-pH as stability parameters in an organism's health.

Montagnier appreciated that one should monitor the markers of oxidative stress, such as lipid peroxides, which increase when opportunistic infection occurs, as well as the carbonyl content of lymphocyte proteins, cytokines and Tumor Necrosis Factor (TNF). Laboratory studies show that the proteins of lymphocytes are very rapidly degraded due to oxidative stress. These parameters will be evaluated and then patient treatment may include several antioxidants such as NAC, beta carotene, vitamins A, C and E, the enzymes superoxide dismutase (SOD) and catalase, proteins such as metallothionine, plant extracts and other nutrients, as indicated. Montagnier appreciated that "Plants have invented many more compounds than we have and we will. Plants are a much richer sources of antioxidants and other useful nutrients or pharmacologically active compounds than man. Let nature help us".

All this encourages the concept that Eh-pH may be a controlling tool for psychosomatic disturbances too (as it was proved in the study of more than 550 terrestrial ecosystems with different kind of disturbances) (Vasu, 1985, 1986a, b, 1988, 1989, 1990, 1994a, b, c, 1997a, b, 1998; Vasu et al., 1989, 1990, 1995-1996).

In terrestrial ecosystems, the soil as edaphotop is the subsystem which achieves the systemic unity of life (living subsystems) and other subsystems of the biotope.

In the soil, the focus of the main connections is the soil solution (Lindsay, 1979; Vasu, 1972, 1983, 1988, 1989, 1998, 2001; Vasu et al., 1989; Vasu et al., 1990; Vasu et al., 1995-1996; Paucă-Comănescu et al., 1989).

The specific ionic activities (Pourbaix, 1963) of the soil solution, directly, easily available to plant roots (effective soil fertility), in dynamic equilibrium with the exchangeable adsorbed ions, potentially available to the plant (potential soil fertility), constitute the mobile systemic structure of the soil. These act as ecological factors in the functioning of the ecosystem and determine directly the actual (effective) ecosystem stability and productivity. The mobile systemic structure of the soil is in dynamic equilibrium with the constitutive elements of the mineral, organic, organic-mineral and organic-metallic compounds – basic systemic structure of the soil – and with the other biotope subsystems. These influences, availability of nutrients, act as ecological determinants in the ecosystem's functions and induces indirect influences on the ecosystem's stability and productivity (Vasu, 1988, 1989, 1994a, 1998, 2001).

Potential productivity is appreciated by the trophicity index (Chiriță, 1974, modified 1987; Vasu, 1997a) and the mezoclimate influences.

For rendering ecosystem stability evident, the actual ecosystems' productivity is estimated as compared to the potential one. The ecosystem disturbances induce actual, effective productivity decrease, as compared to the potential productivity, with negative influences in the ecosystem stability (Vasu, 1994a, 1997a, b, 1998, 2001, 2002, 2006).

For the health evaluation of human beings, classical investigation results must be interpreted in interdisciplinary fashion and in connection with environmental characteristics.

Inorganic compound dynamics research methodology is part of the original interdisciplinary systemic methodology, in the ecosystemic approach, which studies the integrated soil ecosystemic (partially published Vasu, 1972, 1983, 1984, 1994a, 1998, 2001; Vasu et al., 1995-1996; Paucă-Comănescu et al., 1989; Seceleanu et al., 1995).

B. METHODS.

The interdisciplinary methodology connects multidisciplinary investigation methods, which allow the interdisciplinary interrelated interpretation of data. Each discipline works with its own specific methods, but adapted to the ecosystemic purposes and, very importantly, at the same investigation depth level. The methodology using prevalent relative investigation methods is a differential diagnoses methodology, consisting in simultaneous investigation in paired ecosystems, the disturbed ecosystem as compared with a balanced one. For the humans it is necessary to investigate the ill person in respect to the values characterizing healthy persons.

The methodology was verified in more than 550 ecosystems, out of which more than 140 have different kind of human impact. It was verified on a large geographical scale, about 26° latitude, 35° longitude and 1,500 m altitude difference, in Romania, Germany, Spain, France, Sweden. It was applied even in two additional EU Projects, CT 920141 and CT 910043.

The dynamics of inorganic compounds in soil is studied differently depending on the specific purpose, for soil pedogenetic evolution level and evolution direction identification (soil system as natural or transformed body), for soil function as edapho-top, or for the soil used as means of production, with human intervention in the natural equilibria (Fairbridge and Finkl, 1979; Vasu, 1988). The selection of the representative situation for the studied phenomenon is very important.

In the laboratory were determined, selected for different situations, in different specific investigation ways: 5C forms and 3 forms organic-metallic compounds, 3SiO_2 forms, 3H forms, 6Al forms, 6Fe forms, 3N forms, 3P forms. Ionic forms in soil solution were also determined (directly available to the plants), and mobile (adsorbed ions, potential available to the plants) Ca, Mg, K, Na, Fe, Al, Mn, Zn, Cu, Pb, Cd. The same elements were determined in rocks (or parent materials), litter, sod, plants (roots, stems and leaves) in animal blood and hair and in human beings in blood. Thermodynamic stability conditions and moving conditions were determined in the biogeochemical cycle's Eh, pH and exchange capacity, base saturation degree – which allow the estimation of the potential trophicity and fertility of the soil and allow also the estimation of their ecological significance as ecological factors or determinants. In the laboratory the analysis were carried out at 20-22°C and on stabilized soil, plant, blood samples (Vasu, 1972, 2001, 2002; Paucă et al., 1989; Vasu et al., 1990, 1995-1996).

Temperature and humidity were also measured in the field.

The analysis of ecosystem chemistry, as an expression of ecosystem functionality, focused on the soil solution chemistry and on the ionic equilibrium in the biogeochemical cycle, estimating especially the ionization level and the ion ratio in the soil solution, immediately available to the plant roots. This is essential for achievement of stability in terrestrial ecosystems, as well as in emphasizing the disturbance level and its possible reversibility. Similarly to this is functionality of the human body.

Complex chemical investigation allows corroboration of its results with all the results of the other kind of ecosystem investigation, for interrelated interpretation by logical analytic-synthetic analysis. Multivariables analysis was not valid because of more than 70 variables and especially because of the high individuality of the living subsystems. In the interpretation of the complex, high quantity of large interdisciplinary (10-13 discipline) research information was taken into account (minimum 77 parameters and many descriptive elements). By multifunctional analysis unsuitable results were obtained as compared with the logical analysis (Max Planck Institute for Biophysical Chemistry, Gottingen, Germany analysis, 1992; CNRS, Centre d'Ecologie Fonctionelle et Evolutive Montpellier France analysis, 1997; Paucă et al., 1989; Vasu et al., 1995-1996). For this reason, in latest opinions it is necessary to replace the actual models, considering the terrestrial ecosystems and their subsystems as linear dynamic open systems. It is suggested to introduce a new approach based on the recognition and adaptation of non-linear dynamic systems theory for the ecological systems as large and complex systems, with antientropic behavior (Vădineanu, 1998).

For the identification of the main disturbance processes, typical compounds were identified and an interpretation scale was established. For example: for acidification, during acid rains, or degradation processes due to no suitable vegetation changes the active H^+ (Vasu and Roşu, 1982); for alkaline hydrolysis, in irrigation with high water quantities, the hydrolyzed SiO_2 (Vasu et al., 1990); for desertification risk (with active disintegration process) organic-mineral SiO_2 (Vasu, 1997a); for spodosolification – due to the strong acidification of the soil, the active amorphous Fe and Al (Vasu, 1969, 1984, 1986b; Vasu and Nedea, 1983); for andosolification, material amorphous SiO_2 and Al transmitted from parent (Vasu, 1984, 1986b, 1990) i.e.

RESULTS AND DISCUSSION

A. Some cases of disturbances in terrestrial ecosystems:

The complex chemical investigation methodology presented above, by a holistic approach, was applied to the function and disturbances diagnoses of the ecosystems, for the substantiation of sustainable land use development, for environment protection and, in the near future, for human health rehabilitation. The unitary study of the whole ecosystem's chemistry allows also the assessment and justification of the effective productivity in the research moment.

The investigative methodology pointed out the advanced specificity of the litter or soil composition and their influence on the biogeochemical cycle, especially in connection with the vegetal species, but also with the other biotope components (Vasu and Roşu, 1980; Vasu, 1989).

Thus, were studied: the phenomena resulting from deforestation, land use changes, extension of species out from natural zones, plantation of unsuitable species for the biotope conditions (having effects such as forest productivity decrease or even premature forest drying), the desertification risk, the effects of monoculture plantations, spruce wind fell, irrigation with high quantities of water, the use of heavy agricultural equipment, the use of high quantities of fertilizers (especially $N\text{-}NO_3$), pollution by acid rain, heavy metals, concrete, urbanization, etc.

The specific processes were analyzed, mostly even the acting mechanism. Identification criteria were discovered. Disturbance processes were identified, such as acid and alkaline hydrolysis, disintegration weathering, amorphyzation, ionization level disturbance – consequently with unbalance of ionic ratios in the soil solution, or even of the whole mobile systemic structure and disturbance in the biogeochemical cycles, nutritional processes.

The application of complex ecosystem chemical analysis methodology in the diagnosis of terrestrial ecosystem dysfunctions is exemplified by some studied situations, illustrating some of the above mentioned disturbance phenomena, the specific acting processes and their mechanisms.

a. The effect of the stability conditions on the ionisation level and on the ecosystem stability and productivity:

Researches were carried out in two *Fagus silvatica* forests in – O. S. Baia Mare E3 Butin, high productivity (I-II cl.) and O. S. Bretcu E12 Lemnia, medium to low productivity (III-IV cl.) – (Vasu in Paucă et. al., 1989).

E3 has acid brown cryptospodic andic soil on andesite and E12 has typical luvic brown soil on sandstone.

In E3 as compared with E12, the couple Eh/pH is in lives 527/5.08 – 531/5.05, in Au – Ao horizons, 524/4.22 – 544/4.68, in Bv1(s) 533/4.40 – Bt1 534/5.93, in Bv2(s) 540/4.53 – Bt2 522/5.87; as a consequence, the ionization level of the nutrients and the ratio between them is different, explaining the productivity difference, otherwise inexplicable by the usual, classical characterizing parameters. Thus, the potentially ionizable bases characterized by classic parameters SB/Te me/100 g in P3-P12, in the same horizons' succession are in Au-Ao 3/7-4/5, in Bv1(s)-Bt1 1/4-4/5, in Bv2(s)-Bt2 3/9-4/5, respectively Ve/V8.3% are in Au-Ao 46/11-94/53, in Bv1(s)-Bt1 12/2-89/55, in Bv2(s)-Bt2 36/12-95/65; the soil humidity (%) in the same succession is 5.6-3.6, 3.7-1.4, 3.7-1.1. Concerning the effect of the difference of stability conditions on the ionization level of nutrients, one can notice significant differences, as illustrated – aqua soluble/potentially ionizable in ppm in the same horizon, **$N\text{-}NO_3$** aqua soluble/total Au-Ao 1.8/73-2.8/190, Bv1(s)-Bt1 5/110-1.5/150, Bv2(s)-Bt2 7.8/110-2.4/136; aqua soluble/potentially ionizable: **P** Au-Ao 0.7/2-0.5/5, Bv1(s)-Bt1 0.96/1-o.2/2, Bv 2(s)-Bt2 2.2/3-0.3/2, **K** Au-Ao 20/250-38/260, Bv1(s)-Bt1 6/110-12/50, Bv2(s)-Bt2 6/80-12/50, **Ca** Au-Ao 75/320-159/1530, Bv1(s)-Bt1 75/80-38/-750, Bv2(s)-Bt2 75/300-50/3240, **Mg** Au-Ao 3/50-2/4,

Bv1(s)-Bt1 2/19-3/5, Bv2(s)-Bt2 2/10-2/6, **Na** Au-Ao 17/20-8/30, Bv1(s)-Bt1 13/20-7/10, Bv2(s)-Bt2 8/10-3/10, **Al** Au-Ao 26/310-15/630, Bv1(s)-Bt1 43/330-13/-400, Bv2(s)-Bt2 48/600-8/180, **Fe** Au-Ao 4/5-2/4, Bv1(s)-Bt1 1/2-2/3, Bv2(s)-Bt2 1/3-4/7, **Mn** Au-Ao 0.6/2o-0.3/8, Bv1(s)-Bt1 0.7/1.2-0.1/-0.4, Bv2(s)-Bt2 0.7/40-0.1/2, **Zn** Au-Ao 0.9/1-1.5/3, Bv1(s)-Bt1 0.2/0.4-0.1/0.3, Bv2(s)-Bt2 0.8/1.3-0.1/0.4.

The difference of the couple Eh-pH in the two ecosystems is obvious. The high acidity in P3 at the rooting depth is considered restrictive for high productivity in literature, but in corroboration with the Eh level (as in the new methodology) the ionization level of nutrients is highly modified in the two ecosystems. Thus, the ionization level is higher for N, which is maintained in the proper level for normal nutrition. An extremely important factor, and probably the one which ensures the high productivity, is the high ionization level of the small quantities of potentially ionizable **P,** between 70-95%, even more and 95% in the main rooting depth in E3. These, associate with the high ionization of Ca, enough of Mg, K, Na and tolerant for the vegetation of Al, Fe, Mn and Zn, ensure a favorable nutrients ratio in the soil solution explaining the high productivity of E3. This was unaccountable by classical criteria, pH, and base saturation degree, respectively the evaluation of the nutritional level by the individual evaluation of the content of mobile form (potential ionizable) of the nutrients.

b. The effect of deforestation – Copşa Mare, (Vasu and Filip, 1990, unpublished):

Through felling, an oak forest, with high productivity, in natural zone Copşa Mare E1 was spontaneously substituted by meadow surface. In the vicinity, the remaining forest E2 is affected too in about 8-10 years, by premature drying out phenomenon, with consequences in strong lowering the productivity. The ecosystem E2, with premature drying phenomenon is compared with E1, remaining from the former forest (actual meadow), with a very slight slope in the direction of E2. Both ecosystems have luvic brown soils, on silty deposits.

The new meadow ecosystem induces changes in the hydrological regime (active humidity index in vernal > 145-65 in E2, as compared with 80-30 in E1 and in autumnal 50-25-70 in E2, respectively 25-10-30 in E1). These induce a moderate acid hydrolysis (eH/pH, in the soil horizons sequence Oh-Ao-Bt is in E2: 376/5.58-506/5.02-544/4.93, whereas in E1 is: 446/5.61-486/6.58-526/5.38), with increasing of SiO_2 and toxic Al in the soil solution of E2. Thus, hydrolyzed SiO_2 is 40-730 ppm in soil and accumulated in leaves 280,000 ppm in E2 as compared with 15-50 ppm in soil, respectively 13,000 ppm in leaves in E1. The ionized Al in the soil solution, in the same sequence, is: 20-130-1,000 ppm in E2 respectively 35-5-800 ppm in E1. The mobile Ca in E2 has values till 7,000 ppm, is ionized in the soil solution 10-40 ppm and is accumulated 6,800 ppm in leaves (inducing premature ageing through high calcification), as compared with about 2,000 ppm mobile Ca, ionized 18-20 ppm and accumulated 800 ppm in leaves in E1. The disturbance of nutrients ratio has as consequence the premature drying out of the forest, with decreasing productivity.

c. The effect of spruce extension out of its natural belt – South Carpathians, selected data (Vasu and Roşu, 1982):

Through investigation of the advanced specificity of the biogeochemical cycle of spruce ecosystems, with a high amount of Ca and Mg blocking in the litter (Vasu and Roşu, 1980) and as consequence high acidification process, with irreversible soil degradation by spodosolification (occurring with ireversible clay minerals weathering), allowed to identify the effect of spruce extension out from its natural belt (a frequent occurrence due to short-term economic policies).

As an original contribution (Vasu and Roşu, 1982) during this research the potential active H^+ was identified and its diagnostic role defined, associated with different forms of Al and especially with the

active amorphous Al and Fe (specific components for defining the spodosolification level – Vasu, 1969, 1984, 1986b).

Thus, in the beech or oak ecosystems with luvisols, with relative good buffering capacity, the potential active H^+ is < 0.2 ppm and the active amorphous Al is about 0.1% and Fe < 0.02%, both uniform distributed in the soil profile. By the spruce extension, in the broad leaved belt, the potential active H^+ values are graduated in levels, each determining an acidification level. According to the acidification level the active amorphous material has values for Al > 0.1% and for Fe > 0.2%, typical for spodosol and especially with the typical dynamic in the soil profile of those. For instance in Eastern Carpathians, in the Bretcu Depression, by spruce cultivation in the *Fagus* belt, on Luvisol, after 12 years in the eluvial Ea horizon a 12 cm Podsol is formed, with irreversible soil degradation, by acid hydrolysis, acidification and amorphization. In our country H^+ reaches maximum 4 ppm (strong acidification level). In Germany and Sweden, where there exist four to five successive generations of cultivated spruce, respectively Scots pine, values up to 20 ppm were found (expressing extremely strong acidification and high irreversible soil destruction, with low resistance to acid rain).

On this basis, according to the parent material and the bioclimatic belt, three stability levels against the acid degradation of the soil were established (Vasu, 1984).

d. The effect of acid rain on acidified soils – Solling experimental site, Germany, (selected data published – Vasu, 1997a).

In the *Quercus* belt, the former highly productive oak forest is substituted by cultivated spruce (probably at the fourth generation), with high acidification effect in the soil, through potential active H^+ increasing associated with Ca and Mg shutting, in the conifer needles and litter (Vasu and Roşu, 1980). As a consequence the former luvic soil is transformed, by high and continuous acidification, with weathering and spodosolification processes, into Brown Podsol. The potential active H^+ movement disturbs the parent material (continuous increasing), acts continuously to increase the actual effective acidity and lowering the buffering capacity of the actual soil. Thus, the acid rain effect is extremely aggressive on this strongly acidified soil, with low buffering capacity.

The potential active H^+ has values 5.2 ppm in Ahe1 and 1.27 ppm in B and 0.55 ppm even in the deep (at 360 cm) parent material strata (normal till 0.2 ppm without acidification effect and with high acidification effect from > 0.5 ppm). It induces high weathering process with high toxic Al liberation. Al ionized in the soil solution 20 ppm in Ahe and still 6-2 ppm in parent material and with high mobile Al content determining effective total exchange capacity prevalent (> 95%) Al saturate. The high acidification conditions (pH is lowered, from 5.5-6.3 in the former soil, till 2.7 in Ahe, 3.0-3.4 in B and 3.7-4.5 in parent material) induce acid hydrolysis in Ahe and even in the parent material (hydrolyzed SiO_2 285-220 ppm). It induces weathering process, with Fe and Al movement (active amorphous fulvic Fe 1,480 ppm in Ahe2 and 3,110 ppm in Bhvs and active amorphous fulvic Al 6,040 ppm in Ahe2 and 8,060 ppm in Bhvs), with developing the spodosolification till Brown Podsol level (Vasu, 1969, 1984, 1986b, 1987). As a consequence the ecosystem productivity is decreased to low productivity.

e. The effect of monoculture – Vindeln, Sweden (Vasu et al., 1995-1996), EU Project Environment, CT 920141, (selected data published Vasu, 2001):

The disturbed *Pinus silvestris* Ecosystem Vindeln (E4), invaded by the acidophilic *Vaccinium myrtilus* (about 70%), with low stability and productivity (IV cl.) is localized in Sweden, Norland Tableland, 9 km N-NE from town Vindeln, about 100 km S from the Arctic Circle, in temperate cold mesoclimate, transitional to continental subarctic climate, strongly influenced by the Gulf Stream (otherwise it would be much colder).

The ecosystem has a thin soil (Bs up to 21 cm), in FAO/UNESCO Classification a Haplic podsol (respectively podsol aluminum illuvial), with five parental materials strata (till 220 cm), on alluvial deposits originated from Quaternary moraines, which allow the rooting depth up to 60 cm in horizon Cog.

The soil is extremely strongly acidic (pH 3.13-3.60) and high to extremely high oxidizing (Eh 526-574 mV), due to the extreme strong acid and oxidizing litter (pH 3.2 and Eh 524 mV in Oh), which induce extremely strong acid hydrolysis (potential active H^+ 20 ppm) and as consequences an intense weathering process.

The bioaccumulation of the litter is of raw organic matter, with moderate type humification (C/N 58-38) and degree of mineralization (SiO_2/Ct) 0.01-4.7, with corresponding CO_2 release in the atmosphere and N, K in the soil, but with blocking P in Ol layer and low recycling of Ca and Mg, blocked in the needles. The high acidity and the active weathering mobilize, in the humid ecoclimate, a high level of Fe, Al, Mn and even relatively high levels of Pb, Zn and Cu. The degree of nitrification ($N.NO_3$/Nt) is very low in Oh (0.0004), but moderate in Au and Es (0.0020-0.0024). The mineral bio accumulative influences, are mostly in the weathered thin Au horizon, on the ionic activity of N, P, K, Ca, Mg, Al, Fe, Mn, Zn and Cu in the extremely strong acid and extremely high oxidizing soil solution.

In the humid ecoclimate, there occurs (unusual for this soil type) a high illite smectitization (on illitic substratum), respectively 67% smectite (less expanded than normal 1.60-1.65 nm with EG) and 7% illite in Es, with SiO_2(om) and especially high Al, Fe and K release in the soil solution.

The extremely high active and potential active acidity determines the enriching in Al(aq), becoming dominant in the soil solution, with toxic effect for the vegetation. Thus, the disturbance of the nutrients ratio in the soil solution becomes a limitative factor for the ecosystem main producer (*Pinus silvestris*), explaining their low stability and productivity.

f. Desertification risk identification – Mas Bassets – Les Gavares, Gerona, Spain (Vasu in Seceleanu et al., 1995, EU Project PECO 910043, selected data published Vasu, 1997a):

The change of natural *Quercus ilex* forest by cultivated *Quercus suber*, with ecosystem stability disturbance, induces as a consequence the lowering of forest productivity and increasing risk of desertification.

In the actual ecosystem, with high biodiversity, negative acting (about 12 concurrent species, Na, Fe and Al tolerant), which induces acidification, in the high contrasting ecoclimatic conditions (in transition to subtropical mesoclimate with Mediterranean influence). Thus, in the Lithic Cambic Arenosol on leucogranites, occure intense weathering processes. This is ranted out by the high content of active amorphous Al and Fe and especially high content of organic-mineral SiO_2, (identified in the last personal research as quantitative criterion for the evaluation of the desertification risk level – Vasu, 1997a, b). The soil solution has an increased content of potential active H^+ and of Fe and Al ions, disturbing the nutrients ratio in the soil solution and lowering the productivity. Organic-mineral SiO_2 is 10,000 ppm in Au horizon and 73,800 ppm in R(B) horizon (normal values < 1,000 ppm – Vasu, 1997b). In the same horizons, the potential active H^+ is 0.9-0.5 ppm in presence of 8-13 ppm Ca. Ionized Fe is 23-21 ppm and Al is 61-59 ppm. Thus, the nutritive soil solution is highly dominated by Al, Fe, SiO_2 and Na. For example in Au and Bv horizons (the frequent rooting depth 0-25 cm in this ecosystem) the nutritive aqueous soil solution is characterized by the following values: $N\text{-}NO_3$ 2.27-2.0 ppm, P 0.5-2.0 ppm, K 15-13 ppm, Ca 8-13 ppm, Mg 7-3 ppm, Na 18-9 ppm, SiO_2 76-127 ppm, Al 61-41 ppm, Fe 23-20 ppm, Mn 0.6-1.0 ppm. The main producer of the ecosystem (*Quercus suber*) is not able to tolerate this nutritive soil solution and its productivity is extremely low and

continually lowered by the competition with the luxuriant, well-developed accompanying species, such as *Erica arborea, Cystus monspeliensis, Cistus salviifolius, Nardus stricta*, etc. – Na-, Al-, Fe-tolerant species.

g. The effect of high quantity $N.NO_3$ in soil – plant – animal cycle – Jucu experimental site, Cluj, (selected data Vasu et al., 1989):

The effect of fertilization with high quantities of $N.NO_3$ was studied in an experiment carried out in two pasture ecosystems at 360 m altitude, with 600 mm mean rainfall and an average temperature 7.5°C, with Eutric Regosols, on marls. Both were every two years, fertilized with P (50 kg/ha) and yearly with different N quantities. The ecosystem E2, with *Festuca pratensis, Calamagrostis pseudophragmites* (used for calf feeding), fertilized, yearly, with 250 kg N/ha, was compared with a control ecosystem, Ecosystem E1, with *Festuca rupicola, Stipa stenophilla, Dentaria prov.*, (used for calf feeding control), fertilized, yearly, with 60 kg N/ha.

For ensurance the comparison of the analytical results the research were carried out in the substratum – soil – plant (sap) – animal (calf hair and blood) cycle, by an unitary method, possible to be applied for the five material categories (substratum – soil – hay – calf hair and calf blood). It has in view the compounds in equilibrium, meaningful for the substance turnover in the pastures ecosystems, through aqueous solutions as nutrients conveyer (soil solution – cellular sap – blood), The Eh/pH values are changed, in E2 as compared with the control E1, as follows: 420-376 mV/5.50-6.60 in E2 from 382-350 mV -6.10-7.80. As consequence the ionisation level was different for different nutrients. As a result the ionic ratio in the soil solution (aq) is modified and obvious the hay composition. The harmful quality of the hay has direct consequences on the calf blood composition, with significant health disturbances.

The values are changed in E2 as compared with the control E1, (E2-E1), in the sequence blood, hay, sod layer (At), main rooting depth. For all the elements, for blood and hay, the values represents the total content, for soil N total/$N.NO_3$(aq)/$N.NH_4$(aq), Ctotal/-C(aq) and for all the others elements mobile/(aq). All the values are in ppm. Thus, as compared E2-E1 the values are: for N 1260-980, 27800-20570, 7240/2/27, 6580/3/-24, 4190/1.3/22-1960/1/19; for C in blood 43725-41327, 8880/313-460/125, 3210/75-2094/63; for P the values are 16.1-10.7, 19820-18050, 11/4-28/6, 4/3-12/5; for K 39-27, 3200-4200, 280/5-400/9, 160/5-80/3; for Ca 15-9.5, 3000-2200, 8450/43-4480/75, 7450/18-4082/65 (in the soil with marls substratum the roots are able to absorb even the adsorbed Ca from the soil); for Mg 20-18, 1800-1500, 528/6-504/3, 488/-1183/6; for Fe 4.7-6.3, 174-678, 17/2.6-18/3.3 21/8.5-15/2.3.

The ionic equilibrium disturbance in the soil, modify significantly the hay and consequently the blood composition. Thus, the growth of Ca, Mg and surely N content in hay, with strong decreasing of Fe and consequently the same elements modification occurs in the calf blood composition, inducing serious health dysfunction. The high increase of Ca determined frequent tearing of bones after feeding calves (1-2 years) with the hay from E2. But, the most serious health disturbances, up to premature death (after two-three years feeding calves with hay from E2), were determined by the N increase and Fe decrease in hay. These determine an increase of methemoglobin content in blood from 4.4%, normal (by the control calf), to 21-32% by those feeded with high N-fertilized E2 hay and a decrease of Fe content from 6.7 to 4.3 mg/100 ml blood, inducing a grave O_2 shortcoming and death through cancer.

B. Experiments concerning cancer in humans.

The experiments concerning the new proposed rapid test Eh-pH occur with encouraging results.

Some indirect proofs will be presented, such as: a – Health equilibration in the overcoming of cancer using reducing substances (Leontopol and Andronescu, 1984), associated with lifestyle changes including psychotherapy, phytotherapy and apitherapy; b – Overcoming cancer through bioenergetics techniques – using cosmic energies, especially light (Vasile, 2009 a, b), associated with an equilibrate lifestyle using phytotherapy; c – The use of contact thermograph techniques in cancer diagnosis (Mogoș, 1975, 1976, 1977, 2002; Mogoș and Brozoci, 1973b; Mogoș et al., 1971, 1973a).

All this evidence is based on holistic approaches of the human structure and healthy functionality, integrated in the wholly terrestrial ecosystems, controlled by Eh-Ph, temperature (and other energies forms, like light), ionic activities (especially ionic activities ratios) and indirectly by microbiological activities, thermo-dynamically substantiated by the model of Pourbaix Diagrams.

a- Cancer overcome using reducing substances (Leontopol, patent 1984):

In 1971, two sisters were thermografically diagnosed with breast cancer. One of them, 44 years old, after having surgical intervention, chemotherapy and radiotherapy, but without persevering in changing her lifestyle, died in 1975.

The other sister, 36 years old, persevering in changing her lifestyle, especially concerning the ratio between hard work in a toxic environment and relaxation in the open air, and using healthy, preferential, personalized diets, associated with personalized phytotherapy and apitherapy, had two years with slow tumour development (despite the stress caused by intense suffering of losing her sister). After a balneal-climatic cure (with low radio-activity), necessary for articulacy problems, in a few months, the breast tumour grew from two cm to six cm (in less than one year). The blood total Ca decreased to 6.2 mg/100 ml and, in 1974, spinal metastasis appeared, with five herniated discs by apophisis destruction (radiological evidentiated) as following: two located on the cervical spine, two on the lumbar and one lumbar-sacral spine; all these causes persistent paresthesia. Natural therapy was confronted with high aggressiveness.

Thus, in October 1976, she met Mihai Leontopol, who agreed to try to test his treatment (with her agreement), by oral administration of reducing substances. The oncologist accepted to try the treatment (he was the same oncologist who was not able to save her sister using classical treatments). At that experimental time, the treatment was extremely difficult, but efficient. It consisted of a mixture of reducing substances and for few months, with cystein addition. The drug for the treatment of cancer or some other forms of tumours is composed of 10 ... 350 mg of hydroquinone, 30 ... 200 mg of metol, 10 ... 100 mg of amidol; these three active ingredients may be or not associated with 10 ... 100 mg of paraminosalicylic acid; the quantities are expressed per unidose and the association ratio (by weight) between hydroquinone and metol is comprised between 1:3 ... 7:4. The drug is toxicity free in the dosage limits stipulated in the invention.

After one year, the breast tumour disappeared (contact thermographic and mammographic control, Oncological Institute Bucharest). After 30 months, the blood total Ca increased to the hypercalcemic level (13.3 mg/100 ml), the spine was totally remineralized, even presenting small anarchic Ca deposits (radiological and thermographically controlled at the Oncological Institute of Bucharest).

During all this time, she observed the natural recommendations (Aldulescu – communication).

In the summer of 1979, she was considered to be healthy, she was able to walk in the mountains and she resumed her normal laboratory and field activity and is still alive.

The effects of reducing substances are evident, as well as the Eh-pH control in the ionic equilibrium of humans.

She was considered to have overcome cancer, but with a restriction in hard working and especially in going to the seaside.

Nevertheless, she resumed the hard work for updating her research and continuing her PhD Dissertation elaboration.

Moreover, after 1989, she had the chance to work abroad (two EU Projects). Guided by her professional passion she risked using the opportunity to work in Europe, Asia and Australia, working hard in field researches, even in the proximity of the Mediterranean Sea, the Northern Sea, the Atlantic and Pacific Oceans, and in very toxic laboratories. The professional satisfaction was great and the results successful, but they entailled some health hazards.

It is important to mention the effect of reducing substances such as Novocain and Procaine used by Ana Aslan, famous gerontologist. Since 1946 (Parhon and Aslan, 1955, 1957) she introduced (patented in 1952), the internationally accepted Gerovital H1 and even now successfully used Gerovital H3 (Aslan, 1980). In 1961, together with E. Polovraceanu, she created an improved the formula marketed as Aslavital, patented in 1980 (Aslan and Polovrăceanu, 1980), used in gerontology, associated with lifestyle changing. The reducing substance acted with huge performance in chronic degenerative rheumatism, Parkinson's disease, osteoporosis, arthritis, neuromuscular dystrophies, has antidepressant effects, improves memory and attention, visual perception, auditive and olfactive perception, stimulates psychic and neurovegetative balance improvement, growth and hair pigmentation, joint mobility, normalizes blood pressure.

b – Cancer overcome by psycho-somatic integrative therapy (Vasile, 2002, 2009a, b):

In 1999, a woman was diagnosed, by non-invasive imaging, with five malignant tumors: two on the vocal cord, one on the thyroid lobe, one in her left breast, one in the liver and one in the right lobe intracerebral (inoperable). The oncologists hesitated to suggest a treatment protocol. She had the chance to meet Teodor Vasile (Vasile, 2002, 2009a, b), with his integrative psycho-somatic regenerative therapies (associating bioenergy stimulation by cosmic light, psychotherapy, personalized phytotherapy and diet as well as an adequate lifestyle). Five years later, she was declared healthy, is still alive and working.

The cosmic energy, especially the light and cosmic information (Fig. 1), associated with a harmonious functional integration of the human body within all other subsystems of the terrestrial ecosystems, eliminates the oxidative stress, normalizes the Eh-pH in the whole organism and stabilizes the ionic equilibrium in the human body, ensuring the normalization of cellular energymethabolic mechanisms and, as a consequence, the human health.

c – Cancer diagnosis by contact thermography (Mogoș, 1975, 1976, 1977; Mogoș and Brozoci 1973b; Mogoș et al., 1971, 1973a, 1980).

Since 1968, Mogoș has begun his experiments on process and device for determining biological changes in normal and pathological organisms, using tissue thermogenic property (Mogoș et al., 1971, 1973 a; Mogoș and Brozoci 1973b; Mogoș 2002). For more than 35 years, his research tried to promote the tissue thermography as an early cancer detection method, by highlighting even three mm tumors, as well as tumor development during chemotherapy, radiotherapy, or other therapies. Thermographic investigation results were achieved and offer knowledge on cellular energy-metabolic mechanisms in the process of chemical cancerization.

All these results are in accordance with the thermodynamic stability conditions presented above (Eh-pH, temperature, energy, straightly available nutrients) and there are proofs in support of the Eh-pH as a precocious test for cancer, expressing the chemical ionic equilibrium disturbance in the nutrients availability, which allowed the anarchic evolution of the cells.

CONCLUSIONS

The human impact on terrestrial ecosystems, by acting on the production of biomass following only social – economic criteria and using only empirical experiments, ignoring the unitary ecosystems' function and especially the ionic equilibrium in the substance turnover, determines the main disturbances in the ecosystems' structures and also functions, resulting the productivity decrease.

For the substantiation of the soil resources management, for sustainable ecosystem productivity, a correct diagnosis of the ecosystem functionality/ disfunctionality is required.

The Eh, pH, temperature, moisture and potentially ionizable elements content in the aqueous solution are considered thermo-dynamic stability conditions parameters of the element-water system equilibriums and moving conditions parameters of the nutrients in the rock-soil-plant-animal systems and in the human body too.

The identification of the disturbance phenomenon, of the acting processes and even of their mechanism is possible only by a ecosystemic multi-disciplinary structural and functional research of every subsystem and by a holistic interdisciplinary interpretation of the results.

The human body, meeting the general and essential characteristics of a system and having its functional connections with the whole terrestrial ecosystem must be considered in the holistic ecosystemic approach as a structural and functional subsystem, included as a component in the terrestrial ecosystems.

That is why the stability conditions (Eh, pH, temperature, moisture and potentially ionizable elements content in the aqueous solutions) and moving conditions parameters of the nutrients, valid for other subsystems of the terrestrial ecosystems, are also considered valid as thermodynamic stability conditions parameters for human health and moving conditions parameters of the nutrients in the human body.

According to the results of studies of over 500 ecosystems by the holistic approach, the soil-plant-animal cycle studied (where animals died by cancer), the indirect proof of overcoming cancer in humans, and preliminary results of the experimentation of the newly proposed test for precocious cancer screening (Eh-pH and ionic equilibriums), the Eh-pH is proposed as a new test for precocious cancer detection.

This allows the distinguishing of the equilibrium disturbance in the human body, which induce the anarchic grow of cells and, as a consequence, tumour formation.

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AUTHOR:
[1] *Alexandra VASU*
vasualex@yahoo.com

IMPLEMENTATION OF CARPATHIAN CONVENTION STANDARDS ON THE NORTHERN BUKOVINA TERRITORY

Vladimir SOLODKY [1], *Ruslan BESPALKO* [2] and *Ivan KAZIMIR* [3]

KEYWORDS: Northern Bukovina, sustainable development, Carpathian Convention, system approach, biodiversity preservation, Ukrainian-Romanian cooperation.

ABSTRACT

The current paper contemplates the sustainable development of the implementation standards that are reflected in the territory of Northern Bukovina on the basis of the Carpathian Convention principles. In this region the conducted work concerned the implementation of ecological practices for forest, agricultural and water farms on the general watershed-ecosystem basis, and also the achievement of a balanced territorial and functional organization in all sectors of environmental management with special care on the environmental standards for the applied pressures on the natural ecosystems. It is shown, that the result would have positive synergistic effect for a balanced development of the Carpathian region if the protective measures of nature had been carried out synchronously with the help of ecologists from Romania within the territory of Southern Bukovina.

REZUMAT: Aplicarea prevederilor Convenției Carpatice pe teritoriul Bucovinei de Nord.

Lucrarea reflectă situaţia aplicării standardelor de dezvoltare durabilă pe teritoriul Bucovinei de Nord, pe baza principiilor Convenţiei Carpatice. În această regiune se defăşoară o serie de activităţi care îşi propun aducerea la un numitor comun a regimurilor ecologice de funcţionare a unităţilor forestiere, agricole şi piscicole din cadrul sistemului ecologic al bazinului hidrografic unic, precum şi realizarea unei organizări teritoriale şi funcţionale echilibrate în toate sectoarele exploatării naturii, în condiţiile respectării normelor ecologice de reglementare a presiunii exercitate asupra ecosistemelor naturale. Se demonstrează faptul că rezultatele obţinute ar fi contribuit în mod sinergetic la dezvoltarea echilibrată a Regiunii Carpatice, dacă măsurile de protecţie a naturii s-ar fi aplicat sincronic, împreună cu ecologii din România pe teritoriul Bucovinei de Sud.

RÉSUMÉ: La mise en application des Normes de la Convention des carpates sur le territoire de la Bucovine du Nord.

On a éclairci l'état de la mise en application des standards du développement durable sur le territoire de la Bucovine du Nord qui s'appuie sur les principes de la convention des Carpates. On travaille dans la région sur la coordination des régimes écologiques de l'exploitation forestière, agricole et aquacole sur une base commune comprenant l'écosystème et l'accumulation d'eau ainsi que les résultats de l'organisation territoriale équilibrée et fonctionnelle dans tous les secteurs d'utilisation des ressources naturelles en respectant les normes écologiques de l'ajustement des charges sur les écosystèmes naturels. Nous prouvons que le résultat aurait un effet positif synergique dans le développement de la région des Carpates, si les mesures de protection de la nature s'accomplissaient de manière synchrone avec les écologues roumains sur le territoire de la Bucovine du Nord.

INTRODUCTION

Obstacles for norms input and sustainable development standards of Northern Bukovina are a complex of environmental resource problems caused by the complexity of natural productive resources management-both accompanying threats and lack of appropriate resource providing the action programs. Natural threats for the populations' everyday activity and ecosystems become more active in the region: high flow regime of waters, soils changes and windbreaks in a forest stand, seismic influences (Solodky, 2003; Concept, 1997; The Basic Principles of Strategy, 2011). There are demanded effective actions for the stabilization of all environmental conditions, and for the improvement of the natural resources management. Due to overwhelming social, economic and ecological inconsistencies, we proposed to standardize principles of natural resources management, Northern Bukovina thus introduces standards of the balanced development on the basis of the principles of the Framework Convention regarding protection and a sustainable development of the Carpathians (further – the Carpathian Convention) (Furdychko, 2011; Solodky, 2009; Furdychko, 2009; Concept of Ecological Rationing, 1997; The National Plan, 2011). The Carpathian convention plays an outstanding role as the multilateral agreement between Romania, Poland, the Czech Republic, Slovakia, Serbia, Hungary and Ukraine, concerning concentration of joint efforts for preservation, renewal and rational use of natural resources of the Carpathian region of Europe.

Based on the Carpathian convention principles, theoretical bases and the action plans to realize its tasks concerning the introduction of norms and standards of a sustainable development of Northern Bukovina are stated.

MATERIAL AND METHODS

For the achievement of the Carpathian Convention objectives the basic principles of internal national and cross-border cooperation are defined by experts: a) principles of prevention and caution; b) the principle "the pollutant pays"; c) society participation and the involvement of the interested organizations; d) transboundary cooperation; e) the integrated planning of land and water resources management; f) program approach; g) ecosystem approach (Concept of Ecological Rationing, 1997). Strategy of the Carpathian convention in the territory of Northern Bukovina realize by following directions: integrated approach to land resources management; preservation and continuous use of biological and landscape variety; spatial planning; the continuous and integrated water resources and river basins management; constant agriculture and forestry; continuous tourism; an information estimation system about a condition of natural environment, monitoring and early prevention; society participation (Lavrov, 2006; The National Plan, 2011; Solodky, 2012).

According to the specified principles and directions, program and system approaches, a scientific problem is investigated by the algorithm: "principles (tasks) of the Carpathian convention" → "legislative-normatively regulatory base" → "directions of tasks realization of the Carpathian Convention" → "mechanisms of tasks realization" → "legislative, resource or organizational obstacles of tasks realization".

RESULTS AND DISCUSSION

For a number of years (1969, 1998, 2008, 2010), as a result of an intensive precipitation in the Carpathian region, on the river basins of Dniester, Prut and Siret, there were recorded catastrophic water levels, which led to underfloodings and floodings of the Lviv, Ivano-Frankivsk, Chernivtsi, Zakarpattia, Ternopil, Hmelntsky, Vinnytsia regions, and also Romania and Moldova (Figs. 1-3).

Figire 1: Schematic map of territories where catastrophic floods are shown.

Figure 2: Shift of plastic type of 7.6 hectares
(natural landmark Foshky Putyla region, Chernivtsi area, Ukraine, 2008).

Figure 3: Result of destructive action of a flood on the river Cheremosh (Yablunytsia Village, Putyla Region, Chernivtsi area, 2010).

For the environmental resource problems a significant solution of the balance development norms according to Carpathian Convention principles is the sustainable development of the mountain and foothill region on the Chernivtsi territory.

According to the complexity of task solution of legislative and normatively base implementation of the Carpathian Convention, there is a primary plan of actions: the Laws of Ukraine regarding ratification of the Carpathian Convention and the Protocol of biovariety to it, Resolutions of the Cabinet of Ministers about approval of the Carpathian Convention Implementation Strategy, and also Protocols of the Parties of the Carpathian Convention about continuous forest management and continuous tourism (Golubets, 2000; Framework Convention Strategy, 2007; Lavrov, 2006). It offers the chance to work productively over the directions to achieve the Carpathian Convention principles: to improve an ecological situation in the region by controlling the subjects activity of legislation requirements about environment protection; in order to provide the balanced development of productive forces of the region, by taking into account ecological components, intersectoral harmonization of the plans of actions, achievement of the integrated development of mountain and premountain areas; to improve environmental protection by introduction of the ecological standards of anthropogenous loads regulation of ecosystems, decrease of economic influence on environmental risks development.

Developings of bases of the balanced environmental management on the basis of the Carpathian Convention principles realized behind the main directions: scientific and methodical principles, creation of transparent harmonization conditions of

economic and ecological approaches, resource and nature protection strategy. Social and economic features and prospects of the region development, and also actions for the realization of certain tasks are created in the comprehensive program "Bukovina Carpathians". Here, the specified solutions of the problems which hinder harmonizations of social, economic and ecological aspects of a sustainable development are concerned with the preservation of biological and landscape variety, optimization of the nature reserve fund, formation of an eco-network and transition to the watershed and landscape principles of environmental management, etc. The implementation to the provisions of the comprehensive program "Bukovina Carpathians" provides the chance to increase efficiency of environmental management, ecological safety and environmental protection at the expense of introductions towards new methods, technologies, norms of the effective and balanced management, modern forms of control, coordination and regulation of actions, attraction of investments, mechanisms of stimulation of transition to elements of a sustainable development; to introduce nature protection elements in system of silvicultural actions, protection and preservation of the forests, forest exploitation; to provide balanced use of water resources and progressive methods of engineering and biotic protection of waters, soils, coast of the rivers; to create conditions for an intensification of the recreational industry development, the international, "green" and extreme tourism.

Harmonization of departmental subprogrammes of some sectors of economy and environmental protection is carried out according to the principles of continuous environmental management by landscape and watershed principle within certain river basins. Important links of such systems of the coordinated cooperation is ensuring transparent and parity dialogue between the parties of the society relations, including the region population, and also reliable feedback. Feedback is necessary for expeditious tracking of an objects' condition of application of administrative decisions, results of concrete measures and expeditious entering of necessary amendments into processes management, especially in case of emergency manifestations of cataclysms (Golubets, 2000; Framework Convention Strategy, 2007). The mechanism of tasks a realization of the Carpathian Convention takes root on the basis of the thematic plans of actions after the key, problem directions, which are in coordination between leading institutions. According to operating international, national and regional strategies, the developed subprogrammes and offers concerns providing intersectoral coordinated, standard, and their transparent realization on the principles of a sustainable development within certain landscape ecosystems of river basins. Regional programs of continuous usage of land, water, forest resources etc. and also volumes of resource and material requirements and institutional support of the planned actions are created on the basis of the coordinated plans of actions. The priority determined ecologization of environment usage management, development of structural elements of econetworks and biodiversity preservation regarding creation of national natural parks and objects of natural reserve fund, introduction of nature protective technologies, etc. (Golubets, 2000; Framework Convention Strategy, 2007; Furdychko, 2011; Solodky, 2009; Furdychko, 2009; Framework Convention, 2009; Solodky, 2010). The most important principles of the Ukrainian-Romanian cooperation in the sphere of implementation of the Carpathian convention in Bukovina Carpathians and Precarpathians are created with usage of the balanced development experience especialy of Chernivtsi region (Fig. 4).

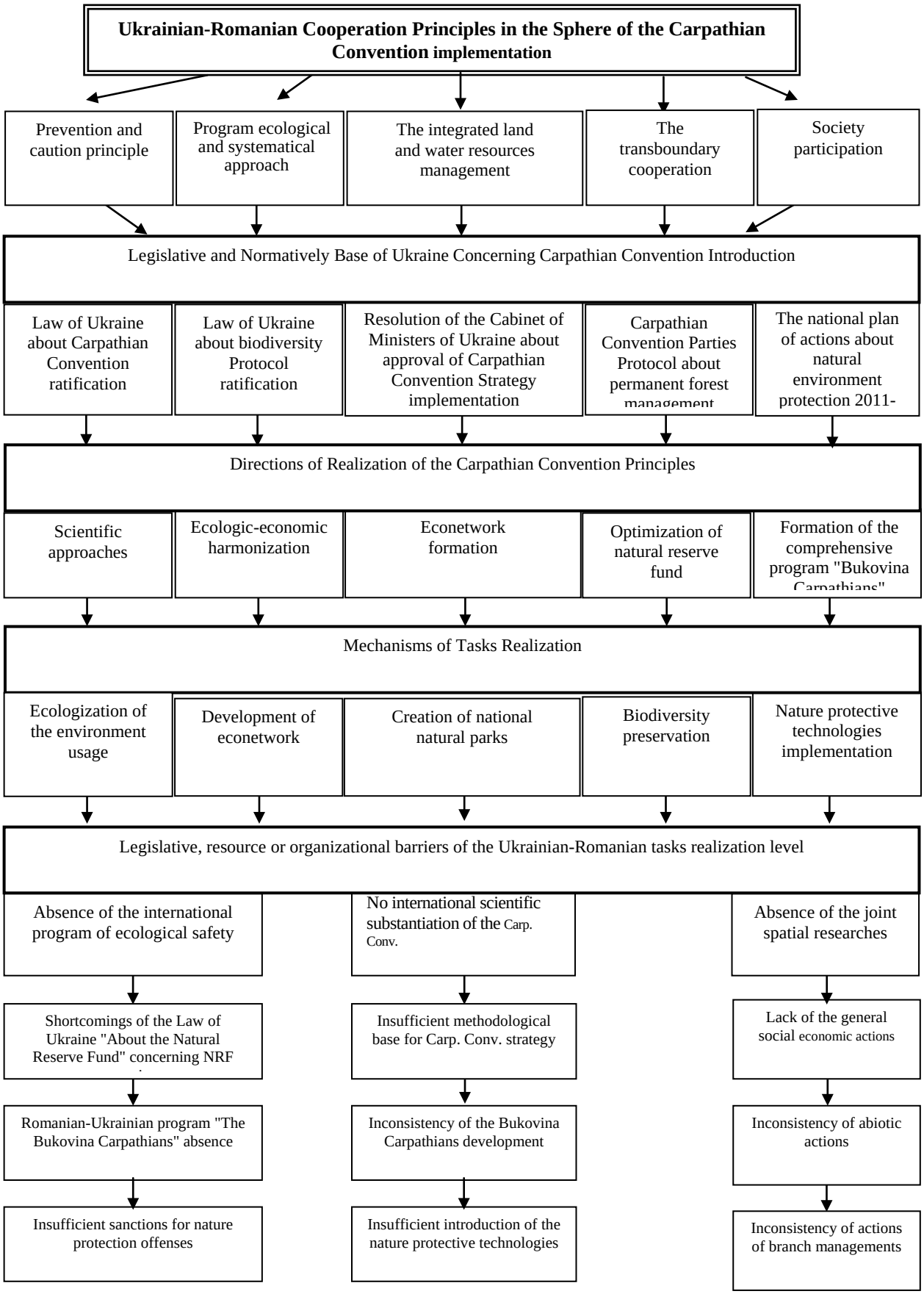

Figure 4: Realization Methodology of the Ukrainian-Romanian cooperation in the sphere of implementation of the Carpathian Convention: legislative regulatory base, resource and organizational support, the directions, mechanisms and barriers of the activity.

For the overcoming of legislative, resource and organizational barriers of the Carpathian Convention tasks realization, it is offered to adjust harmonization mechanisms of existing and perspective target subprogrammes of different aspiration and realization levels, having provided thus a combination of all forms of the state and society management and control. Offers on the approval of the International program of the Carpathians ecological safety are developed, and directed to the corresponding ideas of modifications made to Laws of Ukraine "About Nature and Reserve Fund", "About eco-network Formation". Within the general base of system approach and the coordinated institutional maintenance of implementation of the program an intersector coordination of departmental plan is carried out and the system of interactions at levels of preventive, planned, emergency and perspective actions are developed.

All actions related with the input of the balanced environmental management concerning realization of the Ukrainian-Romanian cooperation in the sphere of Carpathian Convention implementation should be carried out systematically, transparent with involvement of the interested subjects of the society relations. For the solution of contradictions in the changing relations between subjects of environmental management, development of a national econetwork, development of territories and objects of nature and reserve fund, implementation of the general projects which are directed on creation of conditions of appropriate support of nature protection and other valuable economic objects and also the corresponding amendments to normatively legal documents at interstate level and the Carpathian Convention Secretariat are introduced. First of all it concerns the introduction towards the ecosystem approach in the forestry which is now one of the most important ways of preservation of the natural mountain and premountain ecosystems integrity, which are capable of carrying out a role of climate regulation and to resist catastrophic floods and shifts – which are a serious threat of ecological safety of the Carpathian region as forest ecosystems provide dynamic balance of environment.

For the development of bases of the international scientific justification of the Carpathian Convention implementation components on definite sites and territories of the Bukovina Carpathians it is necessary to define leading scientific institutions of Ukraine and Romania.

CONCLUSIONS

The introduction of the balanced development standards of Northern Bukovina on the basis of the Carpathian Convention principles, creates the possibility to applicate a systems approach to the solution of the social, economic and ecological purposes in the region. At the same time tasks of reorientation of an economic complex from the resource dominant which have been created in the conditions of anthropocentrism, are realized on the principles of the biospheric that focused continuous on environmental management.

As a result, in the region, work is conducted for endorsement of intersector ecological modes coordination of maintaining forest, agricultural and water farms at the general watershed and ecosystem base, and also the achievement of the balanced territorial and functional organization in all sectors of environmental management with observance of environmental standards of loads regulation of natural ecosystems. The result would have positive synergistic effects for a sustainable development of the Carpathian region, if conditions have been created for the performance of natures' actions of protection in harmony with ecologists of Romania, in the territory of the Southern Bukovina.

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AUTHORS:

[1] *Vladimir SOLODKY*,
solodkyy_v@mail.com

[2] *Ruslan BESPALKO*,
bespalko.r@gmail.com

[3] *Ivan KAZIMIR*,
ivaznvir@gmail.com

Chernivtsi National University,
Institute of Biology, Chemistry and Biotechnology,
Lesia Street 25, Ukraine, UA-58012.

BOTANICA ROMÂNEASCĂ ÎN SUDUL TRANSILVANIEI/ THE ROMANIAN FOLCK BOTANY OF SOUTHERN TRANSYLVANIA

– REVIEW –

Angela CURTEAN-BĂNĂDUC [1]

Botanica populară românească în sudul Transilvaniei/*The Romanian Folk Botany of Southern Transylvania*, Lucian Blaga University Press 2013, 608 pages is a new study by Romanian botanist Constantin Drăgulescu. The book features: an introduction to the territory under study; the sources and research methods employed; a time-line of Romanian plant-name recording; lists of plants known to and used by South-Transylvania Romanians; an index of local Romanian folk plant names; references used in the study, including Bachelor's and Master's dissertations tackling similar topics.

The country areas under research are Ţara Bîrsei, Ţara Branului, Ţara Făgăraşului, Valea Hârtibaciului, Ţinutul Târnavelor, Mărginimea Sibiului, Ţinutul Şecaşelor, Mărginimea Sebeşului, Valea Mureşului, Ţara Moţilor, Ţinutul Orăştiei, Ţinutul Hunedoarei, Ţara Haţegului, Ţinutul Pădurenilor şi Valea Jiului. The subject matter of the book is Romanians' knowledge about plants – villagers' for the most part but also town-dwellers', of settlements lying in between the Transylvanian Alps (East to West: Bucegi, Piatra Craiului, Făgăraș, Cindrel, Sebeș, Cugir, Retezat Mountains) and the Târnava Valley and the Arieș Valley, respectively. The data were collected from 539 localities in the counties Brașov (114), Sibiu (183), Alba (144), and Hunedoara (98).

The manner of introducing folk botany is the same one encountered in previous works – listing plants in the alphabetical order of their scientific names for superior plants first (cormophytes), followed by inferior plants (thallophytes). For every plant, the following data are given: denomination (with alternate names encountered in other works); author (abbreviated according to established rules) who named the respective plant; Romanian folk names (alphabetized) along with the place where the respective plant name was first given; bibliographic reference. Many entries include the uses of the species (in medicine, or used as food, fodder, adornment, for rituals, in household etc.). Entries for certain species, especially edible ones, include breed names. Plant parts are also mentioned if in some way interesting, or diversified (e.g. conul bradului/fir cone, or amentul salciei/willow ament). The latter part of the book is where Romanian folk names are alphabetized along with their scientific counterparts; plus indices to cormophytes and, respectively, to thallophytes.

There are 1,642 species featured (of which 1,420 are cormophytes/superior plants/flower plants, and 222 are thallophytes/inferior plants/flowerless plants); altogether they bear 5,680 folk names. That number exceeds 52% of the number of plant names included in Alexandru Borza's Dicţionar etnobotanic/ Dictionary of Folk Botany (1968), while half of the names on Drăgulescu's lists are not encountered in the Borza's Dictionary. Therefore, 2,854 plant names are added to Romanian folk plant names, which is 26% up from those in the Dictionary of Folk Botany (with 10,906 phytonyms). In order for the author to conduct this research in southern Transylvania, he made over 450 field trips in which he interviewed about 2,700 people.

The information in the book is suitable for the use of botanists, chemists, and phyto-therapists (human and veterinary), as well as for philologists, ethnographers, sociologists, nutritionists, agronomists, and zoo-technicians.

REVIEWER:

[1] *Angela BĂNĂDUC*
ad.banaduc@yahoo.com
"Lucian Blaga" University of Sibiu, Faculty of Sciences,
Department of Ecology and Environment Protection,
Applied Ecology Research Center,
Dr. Ioan Raţiu Street 5-7,
Sibiu, Sibiu County,
Romania, RO-550012.

TRICHOPTERELE DIN ROMÂNIA (VOL. 1 ŞI 2), CLASA INSECTA, ORDINUL TRICHOPTERA, SUBORDINELE SPICIPALPIA ŞI ANNULIPALPIA (VOL. 1) ŞI INTEGRIPALPIA (VOL. 2) BIOINDICATORI AI APELOR DULCI/ TRICHOPTERANS OF ROMANIA (VOL. 1 AND 2), INSECT CLASS, TRICHOPTERA ORDER, SPICIPALPIA AND ANNULIPALPIA SUBORDERS (VOL. 1) AND INTEGRIPALPIA (VOL. 2) BIOINDICATORS OF FRESH WATERS (IN ROMANIAN)

– REVIEW –

Claudiu TUDORANCEA

Ciubuc C. (2010, 2012) Trichopterele din România (vols. 1 and 2), Clasa Insecta, Ordinul Trichoptera, Subordinele Spicipalpia and Annulipalpia (vol. 1) and Integripalpia (vol. 2) Bioindicators of fresh waters, Edit. MiniEd, ISBN (vol. 1) 978-973-9369-27-5 and (vol. 2) 978-973-9369-26-8, in Romanian.

The Trichoptera, known also as caddisflies, inhabit a large range of freshwater habitats from cold springs, streams, and rivers to the littoral zones of deep lakes and to marshes and temporary pools. Due to their abundance they certainly have a significant role in the transfer of matter and energy through the aquatic systems. More recently, the species of Trichoptera have become a component in the calculation of some biological indices used in water quality assessment. Despite their importance, knowledge of their taxonomy in Romania was restricted to a few taxonomists who have dealt with these insects collected in different regions of the country. Aquatic biologists have always encountered difficulties with the identification of trichopterans.

The publication of an up-dated and comprehensive monograph of this group of insects in two impressive volumes for Romanian ecologists and limnologists by Dr. C. Ciubuc is more than welcome. The two volumes, comprising over 700 pages, are a result of the broad professional experience of the author, in the field of insect taxonomy and aquatic biology.

Although the two volumes deal mainly with the taxonomy of the adults of Romanian Trichoptera, there is more than that. The first volume published in 2010 begins with some introductory notes and a brief presentation of the history of studies conducted on caddisflies in Europe and in Romania in particular. For users which are unfamiliar with the morphology of Trichoptera, there is a general section with a detailed characterization of the external structure (head, thoracic segments, abdomen, wings, legs) of an adult, admirably illustrated and labelled. In a similar way the author describes and illustrates the morphology of trichopteran larvae and pupae. In the same section, important information is presented on a variety of subjects such as feeding habits and diet, adult flight, mating behaviour and life cycle. After a brief discussion on some phylogenetic, paleological and biogeographical aspects, a very useful subsection follows which deals with collecting techniques of both adults and larvae, and procedures for preserving and preparing specimens for micro analysis.

The main body of vol. 1 consists of taxonomic keys of adult Trichoptera species. It begins with a key to the superfamilies, families and genera. Then identification keys are presented for the species of each genus. In this volume there are keys for 110 species belonging to 26 genera, eight families and two suborders (Scilipalpia and Annulipalpia) identified within the Romanian territory. Identification keys are given separately for males and females for two of the richest genera in number of species, *Rhyacophila* and *Hydropsyche*.

Each species is described in detail, clear and with color illustrations, most of them originals, which facilitate the identification of species. A positive side is the addition of synonyms for each taxa and also of ecological notes for each species. Included are also the locations where the species was collected and a statement regarding the geographic distribution of the taxa in the world.

Volume 2 consists of taxonomic keys and description of the adult Trichoptera belonging to the Suborder Integripalpia. 166 species belonging to 12 families and 57 genera are described and illustrated in 415 pages. The format and the presentation of each taxa is similar to those of volume 1. The identification keys are given separately for the males and the females of two genera *Limnephilus* and *Drusus*.

It has been stated that although the various species of Trichoptera are distributed all over the country, most species are found in the prealpine and alpine zones of the Carpathian Mountains in the southern part of Romania. This is because the area comprises a large network of lotic and lentic aquatic systems. Out of 83 genera indentified within the Romanian territory, three are best represented in number of species: *Rhyacophila* (24 species), *Limnophiles* (22 species) and *Hydropsyche* (17 species). Twenty eight genera are each represented by a single species. Based on his own and other Romanian taxonomists' data, the author mentions that 130 species, which is almost half of the total of trichopteran species identified within the Romanian territory, inhabit the western region of the country named Banat. He hypothesizes that this is related to the Mediterranean climate which influences this region. In this zone he also identified two Mediterranean species, *Synagapetus slavorum* and *Polycentropus ieraptera slovenica*, which could not be found in other areas of the country.

Each volume ends with a checklist of taxa belonging to the suborders presented in the respective book, an index of localities where Trichoptera species were collected characterized by geographical coordinates and a map of Romania showing the sampling locations. A rich and diverse list of references and a good taxonomic index conclude each volume as well.

I found a few typographical errors, which is not unusual for such big volumes. Both volumes are hardbound and the quality of the presentation of both text and illustrations is excellent. I am impressed by these two volumes, and both the author and the editor deserve the appreciation of their colleagues working in the field of taxonomy and aquatic biology and of the Romanian scientific institutions for having created such a synthesis of this important group of insects inhabiting the Romanian ecosystems.

The two books would be a most useful addition to Romanian terrestrial and aquatic biologists, and to others as well. These volumes should be in the library of every academic and research institution involved in ecological and limnological studies in Romania. They can also be an educational tool for the universities in which zoology and limnology are part of the curricula.

In spite of the two volumes being written in Romanian, they can also be useful to European taxonomists on Trichoptera due to the clear illustrations of each taxa. This may help them in clarifying some aspects of biogeography related to these organisms. An attempt to translate these two volumes into an international language, although very costly, would be a valuable asset for European taxonomy.

REVIEWER:

[1] *Claudiu TUDORANCEA*

limnos1989@gmail.com

Aquatic Bio-Services, Doon South Drive, 463, Kitchener, Ontario, Canada, CA-N2P 2T6.

ACTA ZOOLOGICA BULGARICA, SUPPLEMENT 7 – INTERNATIONAL ASSOCIATION FOR DANUBE RESEARCH (IAD). LIMNOLOGICAL REPORTS 40. IAD 40TH ANNIVERSARY CONFERENCE "THE DANUBE AND BLACK SEA REGION: UNIQUE ENVIRONMENT AND HUMAN WELL-BEING UNDER CONDITIONS OF GLOBAL CHANGES", 17-20 JUNE 2014, SOFIA, BULGARIA

– REVIEW –

Roumen KALCHEV [1] and *Teodora TRICHKOVA* [2]

The 40th Anniversary Conference of the International Association for Danube Research (IAD), entitled: ***The Danube and Black Sea Region – Unique Environment and Human Well-Being Under Conditions of Global Changes*** was held on 17-20 June, 2014, in Sofia, Bulgaria. It was the fourth conference organised in Bulgaria, after those held in Varna in 1966, in Sofia in 1976 and again in Varna in 1990. Following the established traditions of Bulgarian Danube River limnology, this scientific event was dedicated to the memory of the eminent and highly respected Bulgarian hydrobiologists Prof. Dr. Wesselin Naidenow, Prof. Dr. Boris Russev and Assoc. Prof. Dr. Milen Vassilev, who as IAD leading scientists over many years, devoted much of their efforts and time to the study of the Danube River, and who have made valuable contributions in the fields of the Danube zooplankton, macrozoobenthos and fish community composition and dynamics.

The Conference was co-organised by the Bulgarian Academy of Sciences, the Institute of Biodiversity and Ecosystem Research, the Ministry of Environment and Water of Bulgaria, and the IAD General Secretariat. It was held within the framework of the Bulgarian Presidency of the International Commission for the Protection of the Danube River (ICPDR) in 2014 which also coincides with the 20th anniversary of the Danube River Protection Convention.

The 40th IAD Conference provided a forum for the presentation of long-term multidisciplinary research activities and discussions on various topics highlighting the application of ecosystem and sustainable development approaches, which are essential in order to strike a balance between the economic development of, and the protection of, the unique environment represented by the Danube River basin. The contributions and discussions during the conference covered the following scientific topics:

1. Biodiversity – freshwater, riparian and floodplain flora and fauna, conservation, soil diversity and protection;
2. Protection and rehabilitation of Danube sturgeons;
3. Ecosystem services, wetlands, sustainable use of biological resources;
4. Climate change, habitat change, hydromorphology;
5. Invasive alien species – early warning, priority species and pathways, risk assessment and management;
6. Water quality elements, ecological status, emerging pollutants, microbiology, ecotoxicology, biomonitoring and saprobe systems;
7. Ecological functions and integrated basin management of lotic and lentic ecosystems;
8. Riparian landscapes, land use, flood risk assessment, hydrological modeling and restoration;
9. Sustainable development and public participation in the Danube and Black Sea region.

Supplement 7 of *Acta zoologica bulgariaca* comprises 31 of the contributions presented at the conference, within seven of the initially announced scientific topics, one project review and three papers devoted to the memory of the respected Bulgarian hydrobiologists, including their bibliography related to the Danube River.

Topic 1: Biodiversity – freshwater, riparian and floodplain flora and fauna, conservation, soil diversity and protection.

There are eight contributions on the first topic, which focus on biodiversity of species and habitats belonging to the river and its catchment.

Nikolett Tarjányi and Árpád Berczik investigated the spatial distribution of phytophilous macroinvertebrates in a side arm of the Middle Danube River (Hungarian part) – the Mocskos-Danube side arm and Riha Oxbow in submerged (*Ceratophyllum demersum*) and in emerged (*Trapa natans*) stands. The average abundance of macroinvertebrates in the marginal band of *C. demersum* patches relates to the central parts as 3:1. The habitat diversity in *C. demersum* stands is greater than in *T. natans* patches and as a consequence the latter has a lower number of species.

Dunja Popović, Mihajla Djan, Ljiljana Šašić, Dragana Šnjegota, Dragana Obreht and Ante Vujic studied three populations of *Merodon avidus* species (Diptera: Syrphidae) in the region of Djerdap and Fruska Gora, Serbian Danube River sector, in order to delimitate cryptic taxa within the species complex by means of molecular markers. The morphological characters and the molecular markers of allozymes confirm the occurrence of *M. avidus* Rossi and *M. moenium* Wiedemann, while the mtDNA sequences fail to discriminate these two taxa. Therefore, the authors recommend the integrative usage of allozyme and morphological markers for species identification.

Two papers of Artem Liashenko and Kateryna Zorina-Sakharova are devoted to the study of macroinvertebrates in the Ukrainian part of the Danube Delta. The first one focuses on the variation of species richness in the wide ecotone zone between the riverine freshwater and marine environment in Kyliya branch. The authors report that the mixing zone between fresh and marine water is distinguished by low diversity and abundance, which seems to deviate from the ecotone concept, according to which the abundance and diversity should increase. However, the authors demonstrate that the transition zone is heterogeneous and the extension of the delta into the sea leads to the formation of bays along the coastline, where the stabilisation of abiotic indices increases, which causes also an increase in species richness. The marine environment is distinguished by higher abundances of Polychaeta, Amphipoda and other Crustacea species, while the freshwaters support more abundant Gastropoda, Oligochaeta and Insecta populations. In the second paper, Artem Liashenko and Kateryna Zorina-Sakharova continues their study on macroinvertebrates in the transition zone between the fresh and saline waters in two other branches of the Danube Delta – Bystryi and Vostochnyi. Only 10% of the benthic macroinvertebrates of the drift, mainly euryhaline and eurytopic species transported by the river, mostly Crustacea, manage to survive in the open waters of the marine zone.

The following two papers are related to fish species diversity in the Middle Danube River, Hungarian sector. In his paper “Diurnal changes in fish assemblages in the Danube River section upstream of Budapest and its tributaries” Imre Potyó and Gábor Guti show that standard monitoring of fish abundance and species composition in rivers by electrofishing undergoes considerable fluctuations depending on the day-night cycle, the river size and water regime (low or high water levels). In the Danube River at Szob (rkm 1,709-1,707), the authors recorded the highest species richness at night and during low water levels. However, the day and night difference in species richness and abundance is not significant in a small stream and increases with the size of the watercourses.

András Weiperth in his study on the juvenile fish community in the lower section of the Ipoly River from Ipolytölgyes to the mouth, and five sections along both banks of the Danube River downstream the Ipoly mouth, reports a high species richness, with cyprinids preferring large woody debris and flooded terrestrial vegetation, and with gobies occurring in ripraps. The author concludes that not only the different habitats but also distant spawning and nursing zones of a tributary are of importance for the fish community in the Danube River.

In their paper "Diet composition of the dice snake (*Natrix tessellata* Laurenti, 1768) (Reptilia: Colubridae) in the Danube River catchment area" András Weiperth, Imre Potyó and Miklós Puky present a comprehensive survey of dice snake diet in 10 countries from the Danube River basin. The feeding spectrum includes 38 fish and six amphibian taxa with differences among Lower Danube (Bulgaria, Romania), Middle Danube (Hungary) and Upper Danube River (Austria) countries.

The paper of Sergey Afanasyev, Olena Lietytska and Olena Marushevska presents results of river re-naturalisation in the Tisa River basin, after forest harvesting activities. River re-naturalisation actions, taken by the authors included clearing of the remained timber, restoration of natural conditions by means of building rapids, spits and capes from local stones, and creation of depth drops and areas with different flow velocity. These works were followed by stocking the stream with invertebrates and fish. The observed recovery of benthic and fish communities led the authors to conclude that even little efforts for re-naturalisation might result in fast and considerable improvement and restoration of the river biota and ecological status.

Topic 2: Protection and rehabilitation of Danube sturgeons.

The restoration of the Danube sturgeon in the Danube River has focused the attention of scientists, because of their current high conservation status. In his paper "Can anadromous sturgeon populations be restored in the Middle Danube River?" Gábor Guti makes a review of the major threats to sturgeons: historical over-exploitation, the loss of spawning habitats, interruption of migratory routes between the key habitats and pollution. According to our present knowledge, up- and downstream migrations of sturgeon from the Iron Gates seems to be questionable and of very limited efficiency. The authors conclude that conservation measures should be focused downstream of the Iron Gate dams, where the populations should be restored in order to have individuals able to migrate upstream.

With their paper "Biomonitoring and genetic analysis of sturgeon in Serbia: A contribution to their conservation" Mirjana Lenhardt, Marija Smederevac-Lalić, Vesna Djikanović, Gorčin Cvijanović, Branka Vuković-Gačić, Zoran Gačić, and Ivan Jarić strongly support the general considerations of the previous author by underlining that there is still lack of data on sturgeon spawning, nursing and overwintering habitats in the Serbian Danube River sector. The absence of reliable estimated number of sturgeon migrating upstream of the Iron Gates II dam and their spawning success also hinders protection measures, whose efficiency additionally requires an international cooperation against illegal sturgeon fishing.

Topic 3: Ecosystem services, wetlands, sustainable use of biological resources.

The importance of wetlands is recognised world-wide, as reflected in the significant number of conference contributions. Roumen Kalchev, Maria Dinka, Mihaela Beshkova, Hristina Kalcheva, Árpád Berczik, and Edit Ágoston-Szabó compared and analysed differences and factors that are influencing the nutrient and other chemical variables in the Middle Danube (Hungarian) and Lower Danube (Bulgarian) wetlands. The results indicate that the Bulgarian wetlands have higher TP concentrations than the Hungarian wetlands, which in turn show higher TN concentrations. Wetland morphological connectivity with the river seems to have a

stronger influence on the nutrient dynamics in the Lower Danube River, while flow availability and direction are of significant importance in the Middle Danube wetlands.

Hristina Kalcheva, Roumen Kalchev, and Michaela Beshkova studied "Bacterioplankton of wetlands along the Lower Danube River (Bulgaria) and its relation to environmental factors" and found that the hydrological regime strongly influences bacterial abundance in the pelagial of the Bulgarian wetlands. Their number increased in 2011 when the water level was low and decreased in 2012 after the renewed flooding followed the total drying up of some wetlands. Turbidity, chemical oxygen demand, total nitrogen and wetland depth are positively related, while ammonium and the distance from the Danube River are negatively related to the morphology type and dynamics size of bacterioplankton.

Stefan Kazakov, Károly Schöll, Roumen Kalchev, Luchezar Pehlivanov, and Anita Kiss extended the comparison between the Middle Danube (Hungarian) and Lower Danube (Bulgarian) wetlands with respect to zooplankton species diversity. Fifty and fifty-five rare species were recorded in the Hungarian and Bulgarians wetlands, respectively. The Detrended Correspondence Analysis shows a separation between both Middle and Lower Danube wetlands, as well as within the two sectors according to the wetland connectivity to the river.

The restored hydrological regime was also crucial for the restoration progress of four wetland areas (Babina, Cernovca, Popina and Fortuna) of the Danube Delta Biosphere Reserve in Romania monitored by macrophyte species composition. The results are presented by Erika Schneider in her paper "Aspects of wetland habitat restoration and monitoring in the Danube Delta: Water macrophytes as quality indicators in evaluation processes".

The restoration of large wetland areas in the Lower Danube River aims at preserving the biodiversity and extending the range and efficiency of ecosystem services. However, the results of Luchezar Pehlivanov, Radka Fikova, Nevena Ivanova, Roumen Kalchev, Stefan Kazakov, Milena Pavlova, and Svetla Doncheva, presented in their paper "Analysis of ecosystem services of wetlands along the Bulgarian section of the Danube River" show that not all known past services of the wetlands in Bulgaria can be restored even after implementing rehabilitation, conservation and appropriate management. This mostly concerns the exploitation potential of wetland natural resources (e.g. fishery, reed bed materials, flooded meadows and related cattle breeding, and floodplain forestry).

Topic 4: Climate change, habitat change, hydromorphology.

The hydrological regime of the Danube River and its catchment is in most cases of primary importance for events and biodiversity development, and ecological status is increasingly dependent on global climate changes. Dieter Rank, Stefan Wyhlidal, Katharina Schott, Martin Jung, Gerhard Heiss, and Marian Tudor state in their paper "A 50 years' isotope record of the Danube River water and its relevance for hydrological, climatological and environmental research" that the Danube water's isotope time series as a basic data set are a powerful tool for hydrological investigations as well as for assessing future impacts within the Danube Basin including climatic/hydrological changes (temperature changes, change of precipitation distribution) as well as anthropogenic impacts on the hydrological regime caused by reservoirs changes in land use, etc.

Another useful tool for the determination of the pristine hydrogeomorphologic conditions in the river-floodplain ecosystem is the historical habitat analysis successfully applied by Kinga Farkas-Iványi and Gábor Guti in their study "The effect of hydromorphological changes on habitat composition of the Szigetköz Floodplain". By means of historical maps from the early 19th century in the Szigetköz floodplain of the Danube River the authors show how the effects of canalization has led to a decline in area in

aquatic habitats, changes in river bed load transport, and a decrease in the lateral river-floodplain connectivity.

Ulrich Schwarz Fluvius presents the development of a new method for continuous hydromorphological assessment of the Danube River by subdividing it in 10 km segments. Besides a concise hydromorphological assessment of the navigable Danube River, the 10 km long assessment stretches can be applied for any further interdisciplinary purposes, e.g. sediment and nutrient fluxes, monitoring of habitats and species, floodplain assessments and also such demanding tasks as preparation of hydromorphological reference conditions in large rivers. The latter should present the necessary firm foundation for a successful implementation of the Water Framework Directive of the European Union (EU WFD) in the Danube River. The method was applied during the Joint Danube Survey 3 (2013).

Kateryna Zorina-Sakharova, Artem Liashenko, and Iryna Marchenko present their results on the "Effects of salinity on the zooplankton communities in the fore-delta of Kyliya Branch of the Danube River". The authors report a decrease of species richness linked to increase in salinity. A more pronounced sharp decline in zooplankton is observed at about 2‰. The calculated linear regression equations between salinity and number of zooplankton species indicate that the group of freshwater mesohaline species is the most abundant, followed by freshwater oligohaline species, and only about six freshwater species at zero salinity. The sharpest decline linked to salinity increase is observed in the number of freshwater mesohaline, and the lowest in freshwater species.

Recent modifications of morphology of the Hungarian Danube River sector and the hydrological regime related to it are among the main environmental factors which determine species diversity in the wetlands, including that of zooplankton species studied by Anita Kiss, eds. Ágoston-Szabó, Mária Dinka, Károly Schöll, and Árpád Berczik in the period 2002-2009. The results, presented in their paper, Microcrustacean (Cladocera, Copepoda, Ostracoda) diversity in three side arms in the Gemenc Floodplain (Danube River, Hungary) in different hydrological situations' demonstrate that occurrence of flow as well as connectivity and hydrological distance to the main arm are the main factors that influence the density and diversity patterns of zooplankton assemblages.

Topic 5: Invasive alien species – early warning, priority species and pathways, risk assessment and management.

Although invasive alien species are recently posing a growing threat to the Danube River basin, only one paper focuses on this topic. Miklós Puky reports on an adult form of the spiny-cheek crayfish *Orconectes limosus* (Rafinesque, 1817), which was observed walking from the Szeremle dead arm towards the Danube River in Hungary. It is the first record of *O. limosus* in the Danube River catchment crossing on land from one water body into another. This behaviour definitely helps the colonisation of new water bodies when only small stretches of land separate inhabited and non-inhabited water bodies, or allow the use of terrestrial escape routes in case of desiccation or pollution of the water body.

Topic 6: Water quality elements, ecological status, emerging pollutants, microbiology, ecotoxicology, biomonitoring and saprobic systems.

The ecological status of the target aquatic ecosystems and the water quality elements applied for its specific evaluation are one of the important issues of recent ecological research. The high human impact on the Danube River, such as the considerable hydromorphological changes, very diverse long-lasting pollution and invasive alien species, represents a special challenge for implementation of the requirements of the EU WFD in the Danube River basin.

One of the biological quality elements used in ecological assessment is phytoplankton. The paper of Martin T. Dokulil and Ulrich Donabaum aims at the study of phytoplankton longitudinal long-term variations. The authors note that despite the observed pollution and turbidity decline and the significant increase of nutrients for algal growth, the dominance of diatoms, particularly centric taxa, still persists. Furthermore, the complex hydrological character of the Danube River and the timing variability of phytoplankton seasonal maxima complicate the water quality evaluation according to the EU WFD.

The paper of Melita Mihaljević, Filip Stević, Dubravka Špoljarić, and Tanja Žuna Pfeiffer "Application of morpho-functional classifications in the evaluation of phytoplankton changes in the Danube River" also focuses on the assessment of ecological status of the Danube River by means of phytoplankton, but by application of algal species functional groups. By means of redundancy analysis the authors reveal that the higher percentage of variance is explained when environmental factors are related to algal composition presented by morphology-based functional groups rather than by classical taxonomic classification.

Volodymyr Liashenko presents results on water quality assessment in the Ukrainian part of the Danube Delta by means of biotesting (using *Daphnia magna, Allium cepa* and *Lactuca sativa* as toxicity test organism) and bioindication (using Trent Biotic Index, Belgian Biotic Index, Biological Monitoring Working Party Index, and Goodnight-Whitley Index based on macrozoobenthos). Biotesting shows a decrease in toxic impact level from 2007 to 2012, while biotic indices mostly reveal a *Poor* ecological status for all sampling stations through all years of monitoring. This allowed the author to exclude toxic pollution from the main causes of low water quality in the Ukrainian part of the Danube Delta.

The macrozoobenthos being the most frequently applied biological quality element for the assessment of ecological status of river ecosystems, it was also used in the study of Mila Ihtimanska, Emilia Varadinova, Stefan Kazakov, Radostina Hristova, Svetlana Naumova, and Luchezar Pehlivanov in the Bulgarian sector of the Danube River. The authors compared the macrozoobenthos taxonomic groups using environmental variables and found that most of macrozoobenthic groups had positive correlations with the concentration of nutrients and negative with the concentration of heavy metals. The macrozoobenthos together with physical and chemical parameters of water was also applied for the ecological status assessment of Ogosta River, a Bulgarian tributary of the Danube River, by Teodora Stoyanov and Ivan Traykov. The authors reported a *Bad* ecological status downstream of Montana town and a Moderate status in the remaining stretch further downstream until the inflow into the Danube River.

In their paper "Assessment of fish stocks and elemental pollution in the Danube, Sava and Kolubara rivers on the territory of the city of Belgrade, Serbia" Katarina Jovičić, Mirjana Lenhardt, Željka Višnjić-Jeftić, Vesna Đikanović, Stefan Skorić, Marija Smederevac-Lalić, Milica Jaćimović, Zoran Gačić, Ivan Jarić, and Aleksandar Hegediš made an assessment of the current state of fish resources and elemental pollution in Belgrade fishery waters, in order to establish a good basis for the development of a monitoring system on the state of fish stocks and their exploitation. The tissue's heavy metals content was below the maximum allowable concentrations for many fish species. Thus, the authors recommend fish in the human diet, but only in limited quantities and select pikeperch and freshwater bream for the monitoring of fish meat quality. It is recommended that the implementation of a fishery monitoring program should comprise both economically important fish species and certain nonindigenous species.

Milena Pavlova and Yavor Rabadjiev studied the relation of fish species composition to some environmental variables including nutrients and heavy metals in both water column and sediments, as well as sediment size structure in the Bulgarian Danube River sector. They reveal the bottom substrate as a very important natural environmental factor for the distribution of fish communities along the riparian zone**,** so long as there are no significant hydromorphological changes along the Bulgarian Danube River sector.

Stefan Kazakov, Maria Kerakova, and Mila Ihtimanska assessed the ecological status of stagnant water bodies of four Danube wetlands in Bulgaria using the ECOFRAME approach, which was developed for shallow lakes within the implementation of the EU WFD. The results suggest that the ECOFRAME method needs further verification for the specific conditions of shallow oxbow lakes in the Lower Danube River floodplain. It should be noted, that according to EU WFD, the wetlands have to be considered as part of the surface water body they belong to, when evaluating their ecological status (Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance Documents no. 12, 2003).

Edit Ágoston-Szabó, Károly Schöll, Anita Kiss, Árpád Berczik, and Mária Dinka studied the decomposition dynamics of willow (*Salix alba*) leaf litter in Nyéki Danube Oxbow Lake, Hungarian Danube River sector. The authors report that fungi significantly contribute to the breakdown of willow leaf litter and the main factors that influence the decomposition are the litter quality, pH and the temperature of surrounding water.

Topic 7: Ecological functions and integrated basin management of lotic and lentic ecosystems.

There is one contribution on this topic by Marian Mierlă, Iulian Nichersu, Cristian Trifanov, Iuliana Nichersu, Eugenia Marin, and Florentina Sela, which focuses on flood risk and its effect on environmental parameters, such as soil and land (vegetation) cover types in the area of the Romanian part of the Danube Delta. Different soil and land cover types were affected in different way by floods, which happened within periods of 30, 100 and 1,000 years. The results can be applied in composing flood risk management plans, particularly in areas located close to water bodies (stagnant or running waters).

Project Review

Verena Winiwarter and Gertrud Haidvogl made a review of the project *Danube:* whose future aim is to contribute to sustainable development in the Danube River Basin with particular focus on humanities. The project is a multi-annual program (2013-2020). It consists of two modules: (a) capacity building and (b) sustainability-related research with a long-term socio-ecological component. The capacity-building module started in 2013 with a first series of International Schools to be held annually at least until 2015. However, it is envisaged to establish the International Schools as permanent activity beyond 2015 and 2020, respectively. Further information about the project, its structure, aims and work can be found on www.danubefuture.eu.

The published contributions in this volume show the active participation of scientists from most of the Danube countries. There are 11 scientific papers from Hungary, followed by Bulgaria (8), Ukraine (5), Austria (4) and Serbia (3). Scientists from Germany, Croatia, and Romania published one paper per each country. The current volume demonstrates the great potential of international scientific cooperation within the Danube River basin that should be further developed following the good example of IAD.

REVIEWERS:

[1] *Roumen KALCHEV*
rkalchev@zoology.bas.bg
Bulgarian Academy of Sciences,
Gagarin Street 2,
Sofia, Bulgaria,
BG-1113.

[2] *Teodora Trichkova*
trichkova@zoology.bas.bg
Bulgarian Academy of Sciences,
Gagarin Street 2,
Sofia, Bulgaria,
BG-1113.

TRANSYLVANIAN REVIEW OF SYSTEMATICAL AND ECOLOGICAL RESEARCH 16.1 (2014) – THE WETLANDS DIVERSITY

– REVIEW –

Erika SCHNEIDER-BINDER [1]

Transylvanian Review of Systematical and Ecological Research 16.1 (2014), The Wetlands Diversity, Editors *Angela Curtean-Bănăduc* and *Doru Bănăduc*, Sibiu Romania 2013, "Lucian Blaga" University of Sibiu, Faculty of Sciences, Department of Ecology and Environment Protection, ISSN-L 1841-7051, online ISSN 2344-3219.

With this volume issued recently at the "Lucian Blaga" University of Sibiu/Romania we have again in our hands a very full of content volume from the different fields of Wetlands diversity researches. This volume continues the series of scientific papers issued in the previous volumes including systematic and ecological research from different countries and continents. In this way it is a large, recognised and highly welcomed and appreciated Forum to present, to discuss and to exchange results and experience from the systematic and ecological research in the large field of waters and wetlands around the world.

The recently issued volume of Wetlands Diversity 16.1 presents, like the antecedent volumes, a number of interesting subjects in the field of habitats research, biocoenosis and ecosystems from different countries.

The first paper presented by *Ahmet Öktener* is dedicated to the "Revision of Parasitic Helminths reported in Freshwater Fish from Turkey" including a new checklist for updating the helminths of freshwater fishes known according to new researches from Turkey in the last 10 years. The update includes additional records makes corrections of the errors and omissions that were present in the preceding version from the year 2003. The review of literature indicated the occurrence of 123 parasite species which included 60 monogeneans, 20 digeneans, 20 cestodes, 11 nematodes, seven acanthocephalans and five annelids from 71 different wild fish (64 native, four transitional, three introduced fish) species from freshwaters of Turkey. The Cyprinidae family is dominant with 50 species among the examined fish with regard to species diversity. With all the included information the paper provides a highly welcomed overview of recent knowledge in this field of research, important from a scientific and practical economic point of view.

The "Species composition of the benthic macroinvertebrates on the coastline vegetated rocky substrates of the Southern Caspian Sea" written by *Amir Faraz Ghasemi* is an interesting biocoenological study concerning the benthic macrofauna in strong relation with seagrass beds on rocky substrate on the Southern shore of the Caspian Sea. Research and monitoring were carried out along the coastline during winter and summer of 2013, with registration of 1,286 specimens of the five species *Pontogammarus maeoticus Balanus improvisus, Mytilaster lineatus, Palaemon elegans* and *Alitta succinea*. For these species were also recorded the total abundance as well as the biomass in the winter and the summer season.

The author indicates that from the five collected species only one *Pontogammarus maeoticus* is an indigenous species and concludes that the others are non-indigenous species which potentially could have an effect on native benthic fauna. As an additional food source, they could facilitate the recreation of commercially exploited fish stocks, but in the same time is pointed out, that further studies are required to monitor their potential interacts and impacts on the Caspian Sea fauna.

With their study concerning "Molecular methods for detection of natural hybrids in sturgeon populations" the authors *Alexandru Burcea, Iulia Elena Florescu, Andreea Dudu, Sergiu Emil Georgescu* and *Marieta Costache* present the results of their research with high importance for the conservation of the endangered sturgeon populations of the Danube River. They underscore that due to the construction of Iron Gates dams, the Lower Danube has suffered a decrease of sturgeon populations. This decrease of areal leads to the overlapping of reproduction areas for all sturgeon species and the easiness of hybridization, characteristic to these species, resulting at least in the current situation in an increased number of hybrids. For this reason the authors propose a set of molecular methods for hybrids identification using DNA markers represented by microsatellites and mitochondrial DNA. The obtained data is important for sturgeon farms because of the lack of correctly identifying individuals. In this way it is possible to avoid the difficulties that might appear in the identification of individuals based only on morphological criteria.

The authors *Luiza Florea, Sorin Dorin Strătilă* and *Mioara Costache* refer in their paper "The assessment of community interest fish species from protected area ROSCI0229" to three fish species of the community interest *Gobio uranoscopus frici* Vladykov, 1925, *Barbus meridionalis petenyi* Heckel, 1847 and *Cottus gobio* Linné, 1758 in the Natura 2000 protected site Siriu. During the field research made in the year 2010 in all the three monitored rivers Buzău, Siriu and Crasna, a total number of 193 fish individuals were collected and recorded, 49 individuals of *Barbus meridionalis* and 37 individuals of *Cottus gobio*. According to the analytical indices of population, frequency, numerical abundance and density, the authors assessed a favourable population status for *Barbus meridionalis petenyi* in Buzău River and a medium favourable population status for *Cottus gobio* in Buzău River and its tributaries Crasna and Siriu. The data presents high importance for the management plans of the protected sites of community interest and the proposals of appropriate measures for safeguarding the populations of the mentioned fish species.

Results of a study concerning "The effect of seasonal changes on freshwater fish assemblages and environmental factors in the Bukit Merah Reservoir (Malaysia)" is presented by *Zakeyuddin Mohd Shafiq, Md Sah Amir Shah Ruddin, Hazrin Hashim Zarul, Puteh Khaled, Mohammad Syaiful* and *Wan Omar Wan Maznah*. There are analysed the seasonal changes of freshwater fish assemblages and environmental factors in Bukit Merah Reservoir for the dry season from January-February 2013 and the wet season March-April 2013 by measuring several physico-chemical parameters such as dissolved oxygen (DO), water temperature, pH, water conductivity, total dissolved solids (TDS) and water clarity. From the season difference comparison the authors find out that there are differences in catches between dry and wet season, the mean Catch per Unit Effort (CPUE) for total catch and biomass being significantly different between dry and wet season. Also, based on a T-test analysis, water temperature, pH and conductivity were stated significant differences ($p < 0.05$) between seasons. From all the fish species studied, only mean CPUE for individuals (CPUEn) of *Osteochilus vittatus* and *Oxygaster anomalura* had significant differences between seasons, probably – as the authors conclude- an indicator of their migration season. These results are important from a practical economic point of view.

The paper from *Milca Petrovici* and *Attila N*agy concerning "Structure of bird communities from Cefa Nature Park (Crișana, Romania)" presents the birds communities from the Cefa Nature Park in the North-Western part of Romania on the basis of a long term monitoring (1991-2012), the area being recognised for its bird fauna, especially for water and wetland birds, but also for the birds of the whole habitat mosaic with forests, meadows and agricultural lands with extensive use. From

the identified species, 78 are protected and recorded in the Annex I from Birds Directive 79/409/CEE. In addition to those, 168 species that are not included on the annexes of the Bird Directive were indentified. The total number of 246 species is remarkable for the Cefa area representing 66% of the total bird fauna of Romania.

"Diversity of aquatic ecosystems in urban area – public expectations" is a very actual and needed approach to a social problem related to the aquatic ecosystems in urban areas presented by *Joanna Sender* and *Weronika Maślanko*. The authors underline the difficulties to balance the needs of inhabitants as in cities there are many problems associated with the lack, sometimes the excess, as well as poor water quality. Listing the type of urban aquatic ecosystems, the study was realised according to the aim of the study, which was the determination of public awareness about the role of aquatic ecosystems in cities with different size and number of inhabitants. The need of the water presence in the surroundings was mentioned as a necessary part of the proper functioning of urban life, as well as a place for rest and recreation. In the same time a deficient management and poor ecological status of the waters were noticed.

Genetically modified organisms (GMO) and Biotechnological problems are the subject of the paper with the title "The Nightmare: genetically modified organisms as alien species" presented by *Meliha Merve Hiz* and *Cüneyt Aki*. The authors underline that biotechnological applications in medicine, industry and agriculture allow the economic production of important products, influencing national economy and revenue. But genetically modified organisms also give rise to severe actual debates on aspects of safety and environmental impact of transgenic products. There are also discussed ethical, legal and social acceptance aspects of GMOs, which are strongly influenced by social, economic and political conditions, due to the strong economic impact of high incomes of biotechnology companies. The paper presents a welcomed contribution for the actual problems related to GMO.

Oksana Omelchuk and *Bohdan Prots* are discussing in their paper "Effects of river regulation on plant dispersal and vegetation" a very important problem related to rivers and their importance in plant dispersal and effects of river bank reinforcements for seed bank, plant dispersal and invasion of alien species. This study compares the vegetation and seed deposits of free flowing parts of a river with those regulated by straightening, as well as identifying the correlation between the breadth of the riverbed, existent vegetation and distribution of plant species along the river corridor. The study realised on the rivers in the Ukrainian Carpathians showed that effective distribution of plants had a place in native (non-regulated) river-corridors with a river-bed breadth of 15-30 m. The reduction and straightening of the river-bed decrease the number of species that can be dispersed along rivers leading in the same time to a great increase of the percentage of alien species seeds, in the regulated parts of rivers. Finally the authors conclude that river regulation has a clear negative effect on vegetation by decreasing the resistance of plant communities to alien species, a fact to be taken into account for a sustainable, ecosystem friendly river management and their environment.

The paper "Implementation of a sustainable logistic model of systems for collection of the communal waste in the municipality of Bitola (Macedonia)" by *Ivo Dukoski* and *Nikolche Talevski* presents the problems related to the collection, transport and depositing of the communal waste in the Municipality of Bitola in Macedonia. They present a model for another systematic approach toward the communal waste in the Municipality of Bitola discussing the benefit gain by the implementation of this kind of sustainable logistic model of a system for collection of the communal waste. The authors are summarizing that the obtained benefits would lead to the improvement of living conditions, being important from a social and the environmental point of view.

Continuing from the endangered species *Marsilea quadrifolia* L. the author *Erika Schneider-Binder* presents her paper "The Four Leaf Water clover (*Marsilea quadrifolia* L.) an endangered species. Aspects of conservation and management" problems related to all *Marsilea* species of Europe. Special attention is given to *Marsilea quadrifolia*, the single species occurring in Central and South Eastern Europe. Based on field research made on the Upper Rhine in Germany and the Lower Danube in Romania, the ecological requirements of the species and plant communities where the species is living are analysed and compared with data from other European countries. Due to the decline of the species populations as a consequence of human activities, all European *Marsilea* species are rare, vulnerable, endangered by extinction or extinct in the wild and included in the Red data books of the most European countries. Also all the European water clovers *Marsilea strigosa*, *Marsilea batardae* and *Marsilea quadrifolia* have been included in the Appendix I of the Bern Convention (1979) as strictly protected species and in the Annexe II of the European Flora Fauna Habitat Directive 92/43/1992. After analysis of ecological conditions, the state of conservation and the Red List categories of *Marsilea quadrifolia* following IUCN criteria in the countries of occurrence are presented and discussed possible measures for conservation as well as realised reintroduction in the wild of the species.

The authors *Răzvan Voicu* and *Liliana Voicu* are facing in their paper entitled "Description of an ecotechnical method proposed for Hârtibaciu River along the sector in Agnita, Sibiu County" ecological problems of the Hârtibaciu River, a tributary of the Cibin River. Being canalized and covered by concrete in the sector of the town Agnita, the river represents the source of numerous local pollutions with a negative impact on the environment, both qualitatively and quantitatively. The authors underline, that the lack of riparian vegetation gives the Hârtibaciu River an unpleasant aspect and cannot provide it an efficient filter. The ecotechnical method presented helps both to protect the SPAs into Hartibaciu River basin and to clean the river throughout the city of Agnita. By means of this method the quality of Cibin River can also be improved. The paper can be considered also as a starting point for discussions about the ecological role of natural rivers and their banks and floodplains for the improvement of water quality and in general for a sound environment.

Finally in the series of the papers devoted to protection and conservation subjects the authors *Doru Bănăduc* and *Angela Curtean-Bănăduc* presents "*Rhodeus sericeus amarus* Bloch, 1782; monitoring elements in the new Natura 2000 context in Croatia". There are discussed problems related to the implementation of the Birds Directive (79/409/EEC) and Habitats Directive (92/43/EEC) in Croatia, the principal element being the set up of a Natura 2000 network of protected areas, a network which should be based on a specific monitoring plan at Croatian national level for each species which is considered of community interest. In this general context, the presented study suggests a set of monitoring elements for the fish species *Rhodeus sericeus amarus* for the Croatian Continental Biogeographical Region. The suggestions are based on eight selected criteria: Croatian national borders proximity sectors overlay; very good quality populations of *Rhodeus sericeus amarus* in terms of population density and structure (e.g. protected areas) in characteristic good habitats; habitats which need ecological reconstruction to allow this fish species populations structure ameliorate or natural repopulation; key sectors with importance for connectivity (e.g. lotic sectors between different important sectors, rivers confluence areas, etc.); sectors influenced by human impact like: industrial pollution point sources, sectors influenced by agricultural diffuse sources of pollution, sectors influenced by habitats modifications (watercourses remodelling, watercourses regulation, etc.), geographically extreme

monitoring sections in the most-upstream and most-downstream sections of the rivers, in this species range and in the near outer proximities of these extremes.

All presented scientific papers include maps, tables, demonstrative figures which are completing the written explanation and discussions in the text, rounding up each presentation, which all together constitutes a valuable and diversified volume of 211 pages in the series of Wetlands Diversity.

It is the special merit of the co-editors *Angela Curtean-Bănăduc* and *Doru Bănăduc* to realise this volume which needs much attention for evaluating and reviewing the papers as well as bringing them together in a thematically good structured and assembled volume. As a specific debate platform for the wetlands conservation, as the editors expressed, the data presented in this volume "will develop knowledge and understanding of the ecological status of the wetlands and will continue to evolve".

REVIEWER:

[1] *Erika SCHNEIDER-BINDER*
erika.schneider@partner.kit.edu, erika.schb@t-online.de
KIT – University of Land Baden-Württemberg
and National Research Centre of the Helmholtz Society
Institute for Geography and Geoecology,
Division WWF-Institute for floodplains ecology,
Josefstrasse 1, Rastatt,
Germany,
D-76437.

THE ACADEMIC LIFE OF MR. FRANCO PEDROTTI AND MY PERSONAL EXPERIENCE WITH HIM

Kevin CIANFAGLIONE [1]

– LAUDATIO –

I would like to thank the organizers, for inviting me at this event at the Museo Civico di Zoologia di Roma (Civic Museum of Zoology of Rome), to bear my testimony to and participate in the celebrations of the eightieth anniversary of ***Franco Pedrotti***, as a tribute to his long career as a botanist and conservationist. Entitled "*Una vita per la ricerca e la protezione della natura. Testimonianze per gli ottanta anni di Franco Pedrotti. Martedì 3 aprile 2014" [A Life for the research and for the protection of nature. Testimonies for the eightieth anniversary of Franco Pedrotti. Thursday, April 3, 2014]*.

As the youngest of his students, I feel really under-qualified to describe the complex activity of the Professor, since many others have known him much longer or had the opportunity to spend more time with him than I had. Therefore, I will take advantage of the opportunity to recall my personal experience with him, which has been very fruitful, valuable and intense, and has instilled in me a passion for research.

Those who work in sciences, often seem to forget the conscience of things, working in an automatic, cold, sterile, dogmatic and almost inhuman way. Professor Pedrotti, instead, led me to consider the research not only as scrupulous work, but also to have respect, admiration, and feeling for this work and for the subjects of our studies, encouraging also a certain critical sense and openness to discussion about different ideas.

I met Professor Franco Pedrotti about ten years ago when I was a student in one of his courses at the University of Camerino. I was very interested about his subjects and I was one of those students who had many questions. Not long after, I found myself for a long time as his student and collaborator, until I started my phd with other professors.

Despite our distance and mutual commitments, the friendship and the connection of science and work are still consistent, as normally happens between him and all his past students.

I cannot forget when he brought me and guided me through those sanctuaries of nature that up to then I had only seen in documentaries and studied in books; an experience that all students of the natural sciences, agricultural, landscape ... (*Sensu Latu*) should do.

Today, though I am a doctoral student under the care of other professors, he is always ready to give advices and ideas, always with his almost boy-like passion and spontaneous energy. I had the opportunity to travel with him a few times, although I would have liked to have done this more. Each travel was fruitful and a unique experience, sometimes with light-hearted moments, that I will always remember with fondness. Thus I was able to discover many places, among them Romania, Poland, Peru, Ecuador and the Galapagos Islands, Bolivia, South Africa, Namibia, Lesotho and Madagascar. We conducted many studies together in many parts of the world, and I was involved in many projects, congresses, publications, video documentaries (also for the Italian public television), etc. I came to know many habitats, to recognize many animals and plants and I was introduced to understanding and applying the Phytosociology, the Ecology and how to manage the natural resources and the landscape. On many occasions I had the opportunity to appreciate the vast learning of Franco, with whom it was possible to discuss anything and everything, and in

whom I was able to confide often, as in a brother, mutually. For those who have been near him like me, it was not difficult to experience Professor Pedrotti's attitude for helping the students who came up along his journey. He is always a useful guide and remains a teacher always ready and available for all. For those who have surrounded him so long, like me, it was not difficult to know the man as an institution and at the same time also his more fallible aspects; not only about the work-related aspects, but also concerning his more human side. It was not difficult to know also his noble soul, ready to fight his various battles, near and far, not only in the interests of the environment, but also for philanthropical ends and to the benefit of disadvantaged people.

Finally, I would like to mention Pedrotti as the sincere husband who, to celebrate the memory of Carmela Cortini, his dear wife and colleague of a life, bought a forested holding in the "Monti della Laga" Mts. (Abruzzo Region), so it would never be felled again and could be dedicated to the study of secondary succession, in loving memory of his wife. The forest now named "Bosco Carmela Cortini" is located near the village of Valzo di Valle Castellana.

Now I will offer some biographical details about Professor Pedrotti.

During his high school years Franco Pedrotti spent time in the Museum of Trento, where he had the opportunity to participate in various naturalistic activities and to come into contact with some Italian botanists like Giuseppe Dalla Fior, Benedetto Bonapace and Vittorio Marchesoni, who introduced him to the knowledge about the flora of Trentino region. During these same years he met Professor Renzo Videsott, Director of the Gran Paradiso National Park, who encouraged him to become active in nature conservation. In 1954 Professor Videsott sent him to the conference for nature protection in Hasselfors, Sweden, organized by the IUCN. In 1956 in Salzburg he represented Italy at the foundation of the *Fédération Internationale de la Jeunesse pour l'étude et la conservation de la nature [International Youth Federation for the Study and Conservation of the Nature]*, an organization affiliated with the UICN – International Union for the Protection of Nature (today the IUCN).

His interest in Nature was always wide, ranging from plants to animals, so as to produce a thesis of zoological character. But his university career was launched by Professor Carlo Cappelletti who called him to work as a technician at the Botanical Garden of the University of Padova, on November 1, 1958; few days after Pedrotti's graduation in Natural Sciences. Here he began his research in Phytosociology under the guidance of Professor Sandro Pignatti, on whose advice he stayed in September-October 1960 at the *Station Internationale de Géobotanique Méditerranéenne et Alpine [International station of Mediterranean and Alpine Geobotany]* of Montpellier, where he conducted studies in Phytosociology under the guidance of Josias Braun-Blanquet. In 1961 he moved to the University of Camerino at the proposal of Professor Vittorio Marchesoni; in later years he taught at the University of Milano (1965-66), Catania (1972-73) and Ferrara (1973-77) and in 1977 he returned to the University of Camerino, where he finished his academic career as Professor Emeritus, by Ministerial nomination. In this way he could continue to teach his favourite classes (Nature Conservation and Geobotany Mapping) and to supervise Masters and PhD students.

In addition, he served in prestigious positions, among them as a member of the Commission for Nature Conservation of the *CNR – Centro Nazionale di Ricerca [Italian National Research Council]* from 1973 to 1980. He had a string collaboration also with the *IGM – Istituto di cartografia militare [Italian Militar Institute of Cartography]* and *CFS – Corpo Forestale dello Stato [Italian State Forest Police Corp]*.

He was President of the *SBI- Società Botanica Italiana [Italian Botanical Society]* from 1982 to 1990; President of the *Association Internationale Francophone de Phytosociologie [International Francophone Association of Phytosociology]* (1982-

2005); member of the Board of the Abruzzo National Park starting in 1982, and President of its Scientific Committee since 1988; Vice-President of the Tridentine Museum of Natural Sciences in Trento (since 1991); member of the Scientific Committee of the Center for Alpine Ecology of the Mt. Viotte of Trento (since 1993); President of the Commission for Flora of the Ministry for the Environment (since 1991); Delegate for Italy for the habitat directive at the European Economic Community in Bruxelles (since 1993); Member of the Scientific Committee of the Natural Parks of the Province of Trento (since 1989). He is a member of the *Accademia Italiana di Scienze Forestali [Italian National Academy of Forestry Sciences]*; of the *Accademia Marchigiana di Scienze, Lettere ed Arti [Marchigean Academy of Sciences, Humanities and Arts]*; of the *Accademia degli Agiati* of Rovereto; of the *Accademia degli scrittori di Montagna* and of the *Accademia degli Accesi* of Trento, which he served as President since January 1st, 2014.

His main scientific activity has concerned Phytosociology, Geobotanical Cartography, Forestry, Biogeography, Ecology, Nature conservation and application in the Territory management.

As tireless and enthusiastic worker, Franco Pedrotti has devoted his life to science and dissemination of knowledge. During his long scientifical life, as a teacher and academic researcher, for half a century he passed his knowledge to generations of students. He is an organizer of many scientific events: from 1957 to 2005, he organized 36 conferences, symposia and scientifical society excursions about various themes such nature conservation, phytosociology, geobotany and ecology.

In 1998 he was promoter of the School of Specialization in Management of Natural Environment and Protected Areas, at the University of Camerino. After the abolition of some Schools of Specialization by Ministerial reform, in late 2004 he set up and then directed a new degree, Master in Landscape Planning and Management of Protected Areas at the University of Camerino, successor to the former School of Specialization. He was also the promoter of the first university course in Nature conservation, in Italy, at the University of Camerino.

As an acknowledgement of his scientific prestige, some newly described species, both botanical and zoological (phylum Tardigrada), have been named after him:

– *Protopodocarpoxylon pedrottii* Biondi (a fossil gymnosperm);

– *Taraxacum pedrottii* van Soest (Pedrotti's dandelion);

– *Ranunculus pedrottii* Spinosi ex Dunkel (Pedrotti's buttercup);

– *Hypsibius pedrottii* Bertolani (Pedrotti's water bear).

Outside Italy he has conducted research in Bolivia, (the Bolivian High Plateau, between Titicaca Lake and Isla del Sol, Uru-Uru Lake, Nevado Sajama, mesothermic valleys of Cochabamba and of Tarija), central Siberia (taiga in the zone of Novosibirsk), Poland (Bialowieza Forest), and Romania (the Carpathian Mountains).

In 1970 he obtained for the University of Camerino the donation by Marquis Mario Incisa della Rocchetta, President of the Italian W. W. F., a mountainous tract of 312 hectares, in the municipal territory of Pievetorina and of Montecavallo (in the Umbro-Marchigean Apennines), and in that year he promoted the establishment of the Torricchio Nature Reserve, approved from April 4, 1977 Decree of the Agriculture and Forestry Ministry, and later included in the European network of biogenetic reserves of the Council of Europe. This reserve represent the oldest protected area in Marche Region. He promoted the establishment of the "Museum of the Protected Areas" in a special building of the Camerino Botanical Garden.

In 1990 he founded the *Arboretum Apeninicum* of the University of Camerino, in an 11-hectares area of the Comunità Montana di Camerino (Municipalities Mountain Community of Camerino) near the

village named Tusseggia di Camerino. According to phytosociological criteria, it is composed by groups of trees arranged so that it reconstitute the principal associations of the Apennines.

He belongs to or has participated directly in the scientific committees of numerous and various protected areas and environmental associations, such as the Italian W. W. F. and "Federazione Nazionale Pro-Natura".

His scientific production is very significant, not less than 450 scientific publications between journals, books, and numerous expert reports and summaries in fields of Botanical sciences and Nature conservation.

Franco Pedrotti's editorial activity is fruitful. He is the editor of *Geobotany Studies*, *L'uomo e l'ambiente [Man and the Environment]*, *La Riserva naturale di Torricchio [The Torricchio Nature Reserve series]*, numerous conference proceedings and books, and of the book series "*Natura e Aree Protette*" *[Nature and Protected Areas]*. He is co-editor of: *Colloques Phytosociologiques [Phytosociological symposiums]*, *Documents Phytosociologiques [Phytosociological Documents]* end *Braun-Blanquetia*; journals edited in Camerino for long time. He is a member of the editorial board of 28 scientific journals.

In homage to all the people (employees, students, alumni, visiting scholars and professors) who had studied or worked in the former department of Botany and Ecology of the University of Camerino, Prof. Pedrotti wrote and published a yerabook review that gathered precious and relevant information from 1950 until 2006 and even later.

He received four honorary degrees (*Laurea honoris causa*): the first, in October 1994, in Biology, from the University "Babeş-Bolyai", Cluj-Napoca (Romania); in the December 1998, in Biology, from the University "Al. I. Cuza", Iaşi (Romania); in November 2006, from University of Palermo in Ecology and Biogeography; and the last in Geoarchitecture from the University of the Bretagne Occidentale, in Brest (France) in September 2014.

To his immense pleasure, he is still addressed with respect and friendship as "honored teacher", "esteemed Professor" or "dear President of the centenary of the Italian Botanical Society", by people who in turn have become professors, professionals, and prominent figures.

AUTHOR:

[1] *Kevin CIANFAGLIONE*
cianfaglione@univ-brest.fr
School of Biosciences and Veterinary Medicine,
University of Camerino,
Via Pontoni 5,
Camerino (MC),
Italy,
I-62032.