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=== IN MEMORIAM ===

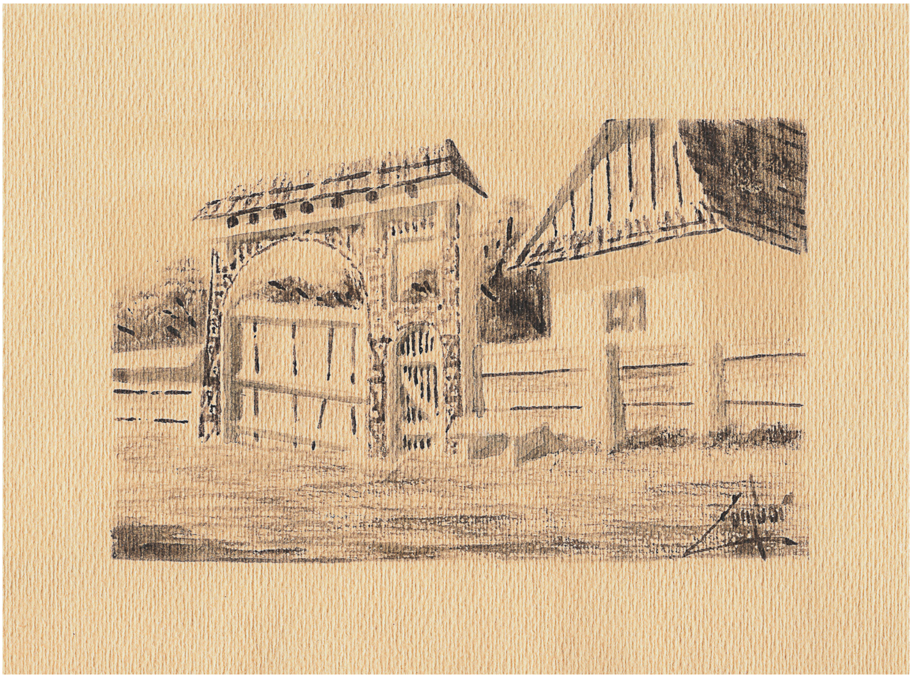
PROFESORUL VASILE GH. RADU (1903 – 1982)

Date biografice şi activitatea didactică

În panteonul dascălilor Universităţii clujene, profesorul Vasile Gh. Radu poate fi considerat ca un caz fericit care întrunea rigoarea cercetării ştiinţifice cu talentul de a transmite cunoştinţele, adică un talent didactic de excepţie. A rămas în memoria a numeroase generaţii de studenţi ca un profesor exigent şi, în acelaşi timp, apropiat sufleteşte de ei.

Profesorul Vasile Gh. Radu s-a născut la 26 iunie 1903 în Pârgăreşti, judeţul Bacău (Imaginea 1), într-o familie numeroasă cu cinci copii (doi băieţi şi trei fete), în care respectul şi dragostea de carte se vede şi din faptul că toţi copiii au făcut şcoală şi s-au realizat ca învăţători, ingineri, profesori (o soră a fost profesoară de matematică la

Universitatea din Iaşi). În perioada liceului (la Bacău) a fost şi învăţător suplinitor în satul natal (probabil şi din cauza greutăţilor materiale ale unei familii atât de numeroase). În perioada 1922 – 1927 a fost student la Facultatea de Ştiinţe a Universităţii din Iaşi. În această perioadă şef al Catedrei de Morfologie animală era profesorul Paul Bujor, pionier al acestui domeniu în ţara noastră. Interesul şi apetitul pentru cercetarea ştiinţifică ale studentului V. Radu au fost observate de către Paul Bujor, care l-a încurajat în cercetare, i-a îndrumat lucrarea de licenţă, apoi i-a fost şi coordonator al tezei de doctorat. Teza de doctorat, susţinută în anul 1931 la Universitatea din Iaşi (redactată în limba franceză), a avut ca temă structura citologică şi histologică a canalului deferent la *Armadillidium vulgare* Latr., adică un domeniu şi un grup taxonomic (Isopoda) de care nu se va despărţi toată viaţa.



Imaginea 1. Casa părintească din Pârgăreşti

Rezultatele acestor cercetări şi tenacitatea doctorului Vasile Radu l-au determinat pe profesorul Paul Bujor să pledeze la Academia Română pentru obţinerea unei burse de cercetare la Universitatea Sorbona din Paris. Astfel, în perioada 1931 – 1932 Vasile Radu efectuează un stagiu de cercetare la Laboratorul de Citologie şi Histologie Comparată de la această universitate, unde are ocazia să intre în circuitul internaţional al elitei ştiinţifice în domeniu (Imaginea 2). Tot în această perioadă face cercetări la Laboratorul de Histologie a Universităţii de Medicină din Paris şi la Staţiunea de Cercetări Marine din Roscoff (Bretagne). Este de remarcat că unele aspecte histologice semnalate în premieră de către profesor în timpul stagiului la Paris, au fost contestate iniţial, dar au fost demonstrate indubitabil ulterior, în urma cercetărilor efectuate după întoarcerea în ţară.

Imaginea 2. Profesorul Vasile Radu în timpul stagiului de la Sorbona

În anul 1935 Vasile Radu a obţinut titlul de conferenţiar la Universitatea din Iaşi iar în 1940 a câştigat concursul pentru titlul de profesor titular la Catedra de Zoologie şi Anatomie Comparată de la Universitatea din Cluj (pe atunci mutată la Timişoara în urma Dictatului de la Viena). De atunci şi până la pensionare (1973), profesorul Vasile Gh. Radu a fost şeful Catedrei de Zoologie de la această universitate, chiar dacă pe parcurs a ocupat şi alte funcţii (director onorific al Institutului de Speologie din Cluj, decan în perioada 1948 – 1951 etc.). Una din preocupările de bază ale profesorului a fost formarea unui colectiv redutabil didactic şi de cercetare la catedră (Imaginea 3), prin care a dezvoltat numeroase discipline zoologice şi direcţii de cercetare (citologie, histologie, taxonomie, ecologie etc.). Pe lângă activitatea la catedră, profesorul a efectuat numeroase stagii de cercetare la Staţiunea Zoologică Marină de la Agigea şi la Staţiunea Zoologică de la Sinaia.

Imaginea 3. Colectivul de cercetare şi administrativ al Catedrei de Zoologie

De-a lungul carierei, Profesorul Radu a predat câteva discipline biologice de bază, printre care Citologie şi Histologie Animală, Anatomia Comparată a Vertebratelor şi, mai ales, Zoologia Nevertebratelor, ultima fiindu-i disciplina de suflet. Ca om la catedră, i-a rămas imaginea exigentă şi aparent rece (ca şi rigoarea didactică şi ştiinţifică ce l-a însoţit în viaţă), o imagine a unui dascăl format într-o altă lume, aşezată pe temeiuri mai trainice şi respectabile. Această imagine inducea studenţilor un respect nu numai faţă de profesor, dar şi faţă de ştiinţa pe care o reprezenta şi faţă de lumea din care venea. Este neîndoios că a avut un talent didactic desăvârşit, prin rigoarea informaţiei, maniera şi eficienţa expunerii şi, la fel de mult, prin talentul de a desena. Desigur, nici un student nu poate uita gestul prin care introducea creta cu mâna stângă între degetele mâinii drepte mutilate şi apoi desena pe tablă fără cusur.

Tot în plan didactic, rămân de referinţă cele două manuale de Zoologia nevertebratelor, editate şi reeditate în perioada 1967 – 1972, în realitate nişte adevărate tratate de zoologie prin bogăţia şi diversitatea informaţiei, pe principiul şcolii franceze de zoologie a lui Grassé, adică a tipului reprezentativ pentru fiecare grup taxonomic. Chiar dacă au dat spaime şi chiar coşmaruri multor studenţi, aceste cursuri s-au dovedit foarte accesibile prin maniera de tratare a aspectelor structurale, biologice, ecologice şi zoogeografice.

Elevii (studenţi, licenţiaţi, doctori) i-au păstrat vie memoria, printre altele fosta Sala de Zoologia Nevertebratelor purtând astăzi numele eminentului profesor.

Contribuţia ştiinţifică a Profesorului dr. doc. Vasile Gh. Radu, membru corespondent al Academiei Române, la cunoaşterea izopodelor terestre (Crustacea, Isopoda) din fauna României

Primele cercetări ale profesorului Vasile Radu referitoare la izopodele terestre au fost făcute în perioada 1927 – 1930, sub îndrumarea mentorului său, profesorul Paul Bujor. Fiind încadrat ca asistent la Catedra de Morfologie animală, profesorul Radu a studiat evoluţia cromatinei în procesul de spermatogeneză la specia de izopod terestru *Armadillidium vulgare*. Rezultatele cercetărilor s-au finalizat prin elaborarea tezei de doctorat, susţinută în 1931. A descris evoluţia celulelor germinale în foliculii testiculari, faza în care are loc diviziunea de maturaţie şi modificările morfologice în urma cărora se formează spermatozoizi. A studiat şi descris cromozomii omologi, organitele citoplasmatice, diviziunile celulare în stadiile prin care trec celulele de la spermatogonii la spematocite şi în final la spermatozoizi. Au fost cercetări de pionerat pentru acea perioadă de timp. Profesorul Radu a abordat şi teme histologice şi anatomice asupra izopodelor terestre. A studiat structura histologică şi citologică a canalului deferent la *Armadillidium vulgare*, glandele coxale ale apendicelor caudale la oniscide, structura tegumentului şi a regiunii stomacale la izopodele terestre. În colaborare cu dr. Constantin Crăciun a făcut cercetări la microscopul electronic referitoare la ciclul anual al fazelor spermatogenetice şi ciclul anual al celulelor glandulare din veziculele seminale la *Armadillidium vulgare*, ultrastructura celulelor glandulare din canalul deferent la *Porcellio scaber*. În colaborare cu dr. Nicolae Tomescu a studiat asimilarea calciului radioactiv din hrană la specii de izopode terestre, temperaturile letale superioare în relaţie cu temperaturile medii din habitatele în care trăiesc specii de izopode terestre, dispoziţia nodulilor laterali şi a câmpurilor glandulare de pe segmentele pereionului la specii din genul *Trachelipus* (*Tracheoniscus*), dezvoltarea ontogenetică postembrionară la *Trachelipus balticus* (= *Trachelipus nodulosus*). Cercetările referitoare la citologia, histologia şi anatomia izopodelor terestre făcute de profesorul Vasile Radu s-au finalizat cu publicarea a 15 articole, în reviste de specialitate din ţară şi străinătate.

După ocuparea postului de profesor de Zoologie la Facultatea de Ştiinţe de la Universitatea din Cluj (1940), profesorul Radu a desfăşurat o activitate de cercetare intensă abordând aspecte de faunistică şi taxonomie referitoare la izopodele terestre din România. A organizat deplasări cu întreg colectivul de zoologi în habitate din diverse unităţi geografice, de unde a colectat izopode terestre pe care le-a studiat şi a descris comunităţile de specii din habitatele cercetate. Asemenea cercetări au fost făcute în Munţii Bucegi, Munţii Apuseni, Munţii Orientali, în diverse habitate din Banat, Transilvania, Moldova, Dobrogea, Muntenia. Materialul colectat, peste 1000 de probe, se găseşte la Muzeul de Zoologie al Facultăţii de Biologie şi Geologie, Departamentul de Taxonomie şi Ecologie, Universitatea „Babeş-Bolyai”, Cluj-Napoca.

În materialul colectat, profesorul Radu a identificat şi descris 25 specii şi 4 subspecii noi pentru ştiinţă (Tabel 1), specii care pot fi considerate endemice pentru fauna României. Dintre speciile descrise ca noi pentru ştiinţă, 6 specii aparţin genului *Haplophthalmus*, 6 specii genului *Trachelipus*, 3 specii genului *Platyarthus*, 2 specii genului *Cylisticus* şi câte o specie genurilor: *Ligidium*, *Trichoniscoides*, *Ropaloniscus*, *Monocyphoniscus*, *Trichorina*, *Haplophiloscia*, *Bifrontonia* şi *Metoponorthus*. Este o contribuţie extrem de valoroasă a profesorului Radu în cunoaşterea izopodelor terestre, ca grup de crustacee în general şi a faunei României în special.

În afara cercetărilor de faunistică şi taxonomie, profesorul Radu, în colaborare cu Nicolae Tomescu, a făcut şi cercetări ecologice cantitative în diferite habitate din împrejurimile Clujului. Rezultatele cercetărilor de taxonomie, faunistică şi ecologie s-au finalizat prin elaborarea a peste 30 articole ştiinţifice publicate în reviste de specialitate. Sinteza cercetărilor taxonomice făcute de profesorul Radu se regăseşte în cele două fascicole de Fauna României, Crustacea, Isopoda, Oniscoidea, volumul IV, fascicula 13 (1983) şi fascicula 14 (1985).

Cercetările profesorului Radu asupra izopodelor terestre din România, reprezintă baza cunoaşterii acestui grup din fauna ţării noastre. Se cuvine să amintim cercetările asupra izopodelor terestre, cu precădere a speciilor cavernicole şi a speciilor acvatice din genul *Asellus*, făcute de profesorul Emil Racoviţă, precum şi cercetările făcute de cercetătorul dr. Ionel Tăbăcaru. În introducerea tezei sale de doctorat, profesorul Radu menţionează susţinerea de care s-a bucurat din partea profesorului Racoviţă, în determinarea unor specii şi în publicarea unor articole ştiinţifice personale. Relaţiile profesionale între cei doi profesori au continuat şi după venirea la Cluj a profesorului Radu. Cu Ionel Tăbăcaru profesorul Radu a colaborat prin schimbul de publicaţii personale.

În concluzie, putem afirma că profesorul Vasile Radu reprezintă o personalitate ştiinţifică care a intrat în istoria cercetărilor referitoare la izopodele terestre din România şi un model privind acurateţea descrierii şi interpretării rezultatelor acestor cercetări.

Tabel 1.

Specii de izopode terestre (Crustacea, Isopoda) noi pentru ştiinţă, descrise de Profesorul dr. doc. Vasile Gh. Radu, din fauna României

Nr. Crt.	Taxa	Punctele de colectare	Distributia
	Familia Ligiidae Brandt 1833		
1.	*Ligidium intermedium* Radu 1950	Sinaia	Sinaia, Poiana Ruscă
	Familia Mesoniscidae Veroeff 1930		
2.	*Mesoniscus graniger graniger* Radu 1977	Munţii Apuseni	Munţii Apuseni
3.	*Mesoniscus graniger moldavicus* Radu 1977	Carpaţii Orientali	Carpaţii Orientali
	Familia Trichoniscidae Sars 1899		
4.	*Trichoniscoides danubianus* Radu 1973	Plavişeviţa	Plavişeviţa, Berzasca (Caraş-Severin)
5.	*Ropaloniscus motasi* Radu 1976	Valea Sâmbra oilor (Maramureş)	Valea Sâmbra oilor (Maramureş)
6.	*Androniscus roseus transsylvanicus* Radu 1960	Cheile Turzii	Cheile Turzii
7.	*Haplophthalmus orientalis* Radu 1955	Atmagea (Jud. Tulcea)	Atmagea (Jud. Tulcea)
8.	*Haplophthalmus napocensis* Radu 1974	Cluj-Napoca	Cluj-Napoca
9.	*Haplophthalmus banaticus* Radu 1979	Orşova	Orşova, Moldova Nouă
10.	*Haplophthalmus medius* Radu 1956	Munţii Perşani	Munţii Perşani
11.	*Haplophthalmus coecus* Radu 1955	Peştera de pe valea Bibarţ – Jud. Alba	Peştera de pe valea Bibarţ – Jud. Alba
12.	*Haplophthalmus ionescui* Radu 1983	Porţile de Fier	Porţile de Fier
13.	*Monocyphoniscus babadagensis* Radu 1965	Babadag	Babadag
	Familia Squamiferidae Vandel 1946		
14.	*Trichorina dobrogica* Radu 1959	Eforie Sud	Eforie Sud
15.	*Platyarthrus dobrogicus* Radu 1951	Slava Cercheză (Jud. Tulcea)	Slava Cercheză (Jud. Tulcea)
16.	*Platyarthrus coronatus* Radu 1959	Eforie Sud	Eforie Sud
17.	*Platyarthrus reticulatus* Radu 1959	Eforie Nord	Eforie Nord şi Eforie Sud

Tabel 1. Continuare

18.	**Familia Oniscidae** Verhoeff 1918 *Haplophiloscia pontica* Radu 1960	Eforie Sud	Ţărmul Mării Negre
	Familia Cylisticidae Verhoeff 1949		
19.	*Cylisticus major* Radu 1951	Localitatea Someşul Rece (Jud. Cluj)	Muntele Rece
20.	*Cylisticus brachycerus* Radu 1951	Munţii Ciucului	Munţii Ciucului
21.	*Bifrontonia feminina* Radu 1960	Serele din Grădina Botanică Cluj	Serele din Grădina Botanică Cluj
22.	*Protracheoniscus politus similis* Radu 1951	Munţii Poiana Ruscăi	Munţii Poiana Ruscăi
23.	*Trachelipus vareae* Radu 1948	Valea Feneş (Jud. Alba)	Valea Feneş (Jud. Alba)
24.	*Trachelipus racovitzai* Radu 1948	Peştera Izvarna	Peştera Izvarna
25.	*Trachelipus bujori* Radu 1950	Munţii Poiana Ruscăi	Munţii Poiana Ruscăi
26.	*Trachelipus spinulatus* Radu 1959	Câmpeni (Jud. Alba)	Câmpeni (Jud. Alba)
27.	*Trachelipus pleonglandulatus* Radu 1950	Munţii Poiana Ruscăi	Munţii Poiana Ruscăi
28.	*Trachelipus difficilis* Radu 1950	Munţii Poiana Ruscăi	Munţii Poiana Ruscăi
29.	*Metoponorthus nitidus* Radu 1951	Tuzla, Eforie Sud	Litoralul Mării Negre

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ANEXA:
Publicaţii ştiinţifice referitoare la izopodele terestre (Crustacea, Isopoda) din fauna României

I. Taxonomie şi ecologie

1. **1939**, **Radu Gh.V.,** Isopodes terrestres de Roumanie I. Isopodes des environs de Sinaia. Ann. Sci. Univ. Iassy, **XXV**, 447 – 462.
2. **1945**, **Radu Gh.V.,** Isopodes terrestres de Roumanie II. Le genre *Armadillidium* en Banat, Acad. Rom., Bull. de la Section Scient., T. **XXVII**, No 6, 381 – 398.
3. **1949**, **Radu Gh.V.,** O nouă specie de izopod terestru: *Porcelio vareae*. Acad. R.P.R., Bull. şt. Secţ. biol., Ser. A, I, 909 – 916.
4. **1950 a**, **Radu Gh.V.,** Izopode terestre recoltate în regiunea Poiana – Ruscă, Hunedoara. Acad. R.P.R., Lucr. ses. Gen. şt. **I – VI**, 1 – 19.
5. **1950 b**, **Radu Gh.V.,** Revizuire critică a speciei de izopod cavernicol *Mesoniscus alpicolus vulgaris* (Choppuis 1944). Acad. R.P.R., Bul. şt. Secţ. şt., II, 159 – 165.
6. **1951 a**, **Radu Gh.V.,** Specii de *Platyarthrus* (Izopode terestre) în fauna R.P.R. – Comunicările Academiei R.P.R., Tom. **I** Nr. 1, 61 – 68.
7. **1951 b**, **Radu Gh.V.,** Specii de de *Cylisticus* (Izopode terestre) în fauna R.P.R. – Bul. Şt. Secţia biol., Tom **III**, Nr. 4, 739 – 749.
8. **1951 c**, **Radu Gh.V.,** Izopode terestre în fauna R.P.R. genul *Metoponorthus*. Studii şi cercetări ştiinţifice, 3 – 4, anul II, 133 – 139.
9. **1955**, **Radu Gh.V.,** *Haplophthalmus caecus*, o nouă specie de izopod terestru în fauna R.P.R. Buletin Ştiinţific, Secţia de Biologie şi Ştiinţe Agricole şi Secţia de Geologie şi Geografie, Tomul **VII**, nr. 3, 803 – 815.
10. **1957**, **Radu Gh.V.,** Species of *Haplophthalmus* (Ground Isopods) in the fauna of the Romanian People's Republic, Revue de Biologie, Tome **II**, No 1, 113 – 136.
11. **1959 a**, **Radu Gh.V.,** Contribuţii la studiul porcelionidelor din R.P.R. *Tracheoniscus spinulatus* n. sp., Omagiul lui Traian Săvulescu cu prilejul împlinirii a 70 de ani, Editura Academiei R.P.R., 641 – 647.
12. **1959 b**, **Radu Gh.V.,** Noi specii de *Platyarthrus* (Izopode terestre) în fauna R.P.R. – Studia Univ. „Babeş-Bolyai", Seria II, fasc. 2, Biologia, 61 – 68.
13. **1960 a**, **Radu Gh.V.,** Un nou gen de Izopode terestre în fauna R.P.R., genul *Trichorina* B. L., – Studia Univ. „Babeş-Bolyai", Seria II, fasc. 2, Biologia, 105 – 109.
14. **1960 b**, **Radu Gh.V.,** *Androniscus roseus* (Crustacea, Isopoda) în fauna R.P.R. reprezentat prin *A. roseus transsylvanicus n. ssp.*, Studii şi cercetări de Biologie, seria Biologie animală, vol. **12**, 3, 231 – 244.
15. **1960 c**, **Radu Gh.V.,** Genul *Ligidium* (Izopode terestre) în fauna R.P.R., Probleme actuale de Biologie şi Ştiinţe Agricole, 187 – 194.
16. **1960 d**, **Radu Gh.V.,** Specii de filosciide (Izopode terestre) în fauna R.P.R. – Studii şi cercetări de Biologie. **11**, 2, 269 – 274.
17. **1961**, **Radu Gh.V.,** *Bifrontonia feminina* N. G. N. sp. (Izopod terestru) în fauna R.P.R. – Studia Univ. „Babeş-Bolyai", Seria II, fasc. 2, 122 – 144.

18. **1962**, **Radu Gh.V.,** Partenogeneza la *Bifrontonia feminina* Radu (Izopod Terestru). Studii şi Cercetări de Biologie – Cluj, T. **XIII**, Fasc. 2, 259 – 271.
19. **1965**, **Radu Gh.V.,** Genul *Cyphoniscus* în fauna R.P.R. *monocyphoniscus babadagensis* – specie nouă (3 ♂, 2 ♀ colectate din Babadag). – Studia Univ. Babeş. Bolyai, Fasc. 2, Biologia, 53 – 57.
20. **1973 a**, **Radu Gh.V.,** *Trichoniscoides danubianus*, nouvelle espéce de *Trichoniscoides* (Isopodes terrestres). Studia Univ. „Babeş-Bolyai", Fasc. 2, 105 – 111.
21. **1973 b**, **Radu Gh.V.,** Un nouveau genre d' isopodes terrestre, *Leptotrichus* B. L. dans la faune de la Roumanie. Rev. Roum. Biol. – Zoologie, tome **18**, No 2, 91 – 102.
22. **1976**, **Radu Gh.V.,** *Ropaloniscus motosi*, noveau genre et nouvelle espece de la famille Trichoniscidae (Isopoda terestria). St. Com. Muz. şt. nat. Bacău, 7 – 13.
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=== IN MEMORIAM ===

110 ANI DE LA NAŞTEREA PROFESORULUI VICTOR POP (1903-1976)

Viaţa şi activitatea didactică

Prof. Victor Pop a fost unul dintre eminenţii profesori ai facultăţii de ştiinţele naturii a Universităţii clujene, în cadrul căreia a desfăşurat, timp de aproape 30 de ani o prodigioasă activitate didactică şi ştiinţifică.

S-a născut în 26 aprilie 1903 în satul Măluţ, comuna Braniştea, judeţul Bistriţa Năsăud, în familia preotului greco-catolic Ioan Pop. A urmat şcoala elementară la Năsăud, iar liceul în continuare la Năsăud şi apoi la Dej, unde şi-a susţinut bacalaureatul în anul 1922. Se înscrie apoi la facultatea de ştiinţe a Universităţii „Regele Ferdinand" din Cluj, pe care o absolvă în anul 1929, lucrarea sa de licenţă având un subiect de fiziologie vegetală. Încă în timpul studenţiei este angajat ca preparator la Institutul de Zoologie din Cluj, apoi la Institutul de Botanică (1925-1928), iar după absolvirea facultăţii este încadrat ca asistent la acelaşi institut de zoologie (1928-1930). Atras şi dăruit activităţii didactice, prof. Victor Pop intră în învăţământul mediu (preuniversitar, în terminologia actuală), pe care îl sluješte timp de 19 ani, între 1930-1949. După cum l-a dus viaţa, a fost profesor la Bistriţa (1931-1939), la Carei (1940/1941) şi la Cluj (1939/1940, 1944-1949), în anumite perioade de timp fiind în acelaşi timp director de şcoală (1947/1948) şi inspector şcolar de specialitate (1945-1946). În pofida eforturilor pe care le impunea activitatea de dascăl de liceu, căreia i s-a dedicat cu dăruire, Victor Pop a găsit timp şi energie să desfăşoare şi o susţinută activitate de cercetare ştiinţifică, materializată în acea etapă prin susţinerea tezei sale de doctorat, la data de 6.11.1945; conducător de doctorat – Emil Racoviţă, cu menţiunea că acesta a fost singurul doctorat susţinut sub îndrumarea ilustrului savant. În anul 1946, Victor Pop revine în învăţământul universitar, iniţial ca şef de lucrări (1946-1949), apoi conferenţiar (1949-1962) şi în continuare ca profesor (1962-1973). Între anii 1950-1960 a fost de asemenea încadrat ca cercetător în cadrul Filialei Cluj a Academiei Române Pensionat la vârsta de 70 de ani, primeşte distincţia statală de Profesor Universitar Emerit şi calitatea de Profesor universitar consultant, pe care o deţine până la decesul său, survenit pe neaşteptate în 1 mai 1976.

Victor Pop şi-a început activitatea didactică universitară prin predarea cursului de biologie (1948-1951), susţinut anterior de Emil Racoviţă. Dar, necesităţile de acoperire a activităţilor prevăzute în programa analitică a facultăţii de ştiinţe naturale l-au pus în situaţia de a prelua cursul de zoologia vertebratelor, cu toate că nu era specialist în acest domeniu. De altfel, situaţii similare se petreceau şi la celelalte două universităţi din acel timp, cea din Bucureşti unde zoologia vertebratelor era predată de prof. Al. V. Grossu, specialist recunoscut în domeniul malacologiei, iar la Iaşi de către prof. Z. Feider, specialist în studiul Acarienilor.

Dar, cu tenacitate şi exigenţă, cu talentu-i pedagogic recunoscut, Victor Pop a reuşit să devină un desăvârşit profesor de zoologia vertebratelor. Cursurile sale, pe lângă bogăţia de informaţii pe care le transmiteau studenţilor, erau clare şi sistematice, elementele constitutive se succedau într-o înlănţuire logică, totul era limpede şi de înţeles. În perioada când pentru studenţi singura cale de a învăţa o anumită materie era luarea de notiţe la cursuri, când la cursurile multor profesori ne pierdeam derutaţi privind când spre catedră, când spre caietele noastre, la cursurile profesorului Victor Pop discerneam cu uşurinţă ce trebuia să punem pe hârtie din cele ce audiam. Mai ales că nu odată profesorul ne sublinia că va urma un aspect de o însemnătate majoră, pe care trebuie să-l înţelegem (insista asupra acestui lucru, „să înţelegem”) şi să-l învăţăm, aşa cum a fost, de exemplu, cazul dezvoltării embrionare la *Amphioxus*, cheia pentru înţelegerea dezvoltării tuturor cordatelor.

Perfecţionându-şi desigur de la un an la altul cursul pe care îl preda, profesorul Victor Pop publică primul volum din Curs de zoologia vertebratelor în anul 1957. Multiplicat prin litografiere (la Litografia Învăţământului Cluj), în format A4, cursul are 608 pagini în care sunt tratate caracterele generale ale cordatelor/ vertebratelor, protocordatele şi peştii. În anul 1959 apare fascicula 1 din volumul II – Reptile şi Păsări (321 pagini), iar în 1962 fascicula 2 a volumului II – Mamifere, 207 pagini (aceasta tipărită la Editura Didactică şi Pedagogică din Bucureşti). Era publicat astfel, în 1.136 pagini, primul curs universitar de zoologia vertebratelor din ţara noastră. La fel ca şi cursul predat în faţa studenţilor, poate chiar mai mult decât acesta, cursul publicat de profesorul Victor Pop se distinge prin amploarea informaţiei şi prin deplina claritate a expunerii. Este de remarcat de asemenea ponderea însemnată pe care profesorul a alocat-o caracterelor anatomice ale diferitelor grupe sistematice (din păcate în prezent subestimate de pretinşi sistematicieni-geneticieni), fapt care a permis studenţilor din acel timp o mai uşoară înţelegere a anatomiei comparate, materie care se preda în anul V.

Pe linia directivelor vremii, a fost pregătit, iar în anul 1964 a fost tipărit un manual unic de zoologia vertebratelor: Zoologia vertebratelor (Editura Didactică şi Pedagogică, Bucureşti, 768 pagini; autori: Z. Feider (amfibieni), Al. V. Grossu (mamifere), Şt. Gyurko (peşti), V. Pop (reptile şi păsări). O a doua ediţie a fost publicată în anul 1976. Capitolele elaborate de profesorul Victor Pop îşi menţin aceleaşi deosebite calităţi, ştiinţifice şi didactice, care au caracterizat cursul „personal” din anii 1957-1962.

În afara zoologiei vertebratelor, prof. Victor Pop a mai predat, cu aceeaşi acurateţe, două cursuri de câte un semestru: Histologie şi Embriologie, materii incluse în programa anului III al facultăţii de ştiinţele naturii.

Profesorul Victor Pop a fost incontestabil unul dintre cei mai îndrăgiţi profesori ai studenţilor biologi din deceniile 6, 7 şi 8 ale veacului anterior. Chiar la catedră fiind, profesorul crea o atmosferă de apropiere şi de încredere profesor-student, astfel încât studenţii veneau la cursul său nu doar din acea obligaţie care domnea în acel timp, ci chiar cu plăcere. Iar în afara sălii de curs, profesorul era oricând abordabil, răspundea oricând solicitărilor sau întrebărilor studenţilor, era totdeauna amabil şi deseori surâzător.

Mai mulţi studenţii şi-au susţinut teza de stat (cum se numea pe atunci lucrarea de licenţă), sub îndrumarea sa, iar pe de altă parte profesorul Victor Pop a fost membru în comisii de doctorat, apoi conducător de doctorat. Mulţi dintre foştii săi studenţi sau doctoranzi, mult timp după terminarea facultăţii, revenind în Cluj, ţineau să-l întâlnească şi să îl salute cu respect pe fostul lor profesor de vertebrate.

Pe de altă parte, trebuie să amintim de articolele adresate publicului larg sau profesorilor de biologie pe care le-a publicat profesorul (de exemplu în revista Natura, care timp de câteva decenii a fost principala sursă de informare pentru cadrele didactice de ştiinţe naturale şi geografie), ca şi de conferinţele pe care le-a susţinut cu diferite ocazii, în diferite cercuri. A fost, de asemenea, unul dintre colaboratorii de specialitate ai Dicţionarului enciclopedic român, publicat sub egida Academiei Române, la Editura Politică, Bucureşti (1962-1966, 4 volume). A activat intens şi în domeniul protecţiei naturii, fiind un timp preşedinte al Consiliului pentru îndrumarea ocrotirii naturii, organism care funcţiona pe lângă administraţia fostei regiuni Cluj, precum şi membru în Subcomisia Monumentelor Naturii pentru Transilvania, de pe lângă Filiala Cluj a Academiei Române.

Profesorul Victor Pop în paralel cu activitatea didactică şi ştiinţifică a desfăşurat şi o importanta activitate social-politică (în deosebi în cadrul Societăţii ASTRA, despărţământul Bistriţa-Năsăud).

Activitatea ştiinţifică

Profesorul Victor Pop a fost un bun om de ştiinţă, cercetător recunoscut pe plan mondial al Oligochetelor viermi inelaţi, în primul rând a râmelor, a cărui aport la dezvoltarea ştiinţei este recunoscut şi la mai bine de 60 ani de la publicare şi la peste 30 ani după moarte.

Victor Pop şi-a dedicat activitatea ştiinţifică studiului viermilor oligocheţi, tereştri şi acvatici. Râmele sunt foarte dificil de studiat din cauza unor structuri morfologice şi anatomice monotone şi greu de observat. Motiv pentru care puţini zoologi se încumetă să studieze acest grup de nevertebrate, aşa de importante în structura şi funcţionarea ecosistemelor terestre.

Activitatea ştiinţifică a Profesorului Victor poate fi împărţită în două mari capitole sau etape, şi anume studiul Lumbricidelor şi studiul Oligochetelor acvatice.

Studiul lumbricidelor. Prof. Victor Pop a publicat un număr relativ mic de lucrări ştiinţifice, dar marea lor majoritate au avut o largă recunoaştere pe plan internaţional. Adept al locuţiunii latine „Non multa, sed multum", Victor Pop, adept al simplificării demersului taxonomic, se încadrează de asemenea în categoria aşa numiţilor zoologi „lumper". Admiţând o variabilitate mare a caracterelor morfologice şi anatomice acest tip de zoologi recunosc mai puţine unităţi taxonomice, spre deosebire de zoologii „spliter", care tind să fărâmiţeze şi să înmulţească categoriile taxonomice de diferite niveluri.

Asadar, Victor Pop a publicat doar 28 lucrări asupra lumbricidelor, dintre care 21 de faunistică şi sistematică, 4 de histologie a peretelui muscular şi a glandelor calcifere şi 3 de fiziologie şi taxonomie biochimică. În afara lucrărilor referitoare la lumbricidele din România, Victor Pop a studiat şi publicat lucrări privind colecţiile de lumbricide din Muzeul de Istorie Naturală din Budapesta (Ungaria), Colecţia Wessely din Linz (Austria), colecţia P. Remy din Nancy (Franţa), colecţia Biospeologica – Emil Racovitza din Cluj, cât şi din alte colecţii mai mici din mai multe ţări din Europa şi Orientul Mijlociu.

Dintre lucrările lui V. Pop asupra lumbricidelor, ne vom referi mai ales la două lucrări de sinteză, care, punând bazele taxonomiei moderne a lumbricidelor, au avut cel mai mare impact internaţional. Aşa-numitul "sistem Pop de clasificare a lumbricidelor" a fost lansat în 1941 în limba germană şi dezvoltat în 1948 în limba română, în lucrările: (1) Pop V. (1941) – Zur Phylogenie und Systematik der Lumbriciden. Zoologische Jahrbücher (Systematik), 74: 487-522; (2) Pop V. (1948) – Lumbricidele din România (cu rezumate în limbile franceză şi rusă). Analele Academiei R.P. Române, Secţiunea Geologie, Geografie şi Biologie, A1, 9: 1-124.

Sistemul Pop de clasificare a lumbricidelor a înlocuit treptat sistemul Rosa-Michaelsen, care devenise prea complicat, greu de utilizat şi cu prea multe excepţii. Notăm că vechiul sistem acorda o prea mare importanţă taxonomică structurii aparatului reproducător, fapt ce a condus la plasarea laolaltă a unor specii evident neînrudite. Reevaluarea variabilităţii caracterelor morfologice, anatomice şi histologice la speciile din România, cât şi din diferite părţi ale Europei, l-au condus pe Pop la elaborarea unei noi ierarhizări a semnificaţiei lor diagnostice.

Astfel, Pop distinge 3 caractere cu valoare diagnostică la nivel de gen (pigmentaţia corpului, distanţele setale şi structura histologică a musculaturii peretelui corpului) şi alte 10-14 caractere cu valoare diagnostică la nivel de specie şi subspecie (poziţia organelor clitelare, tipul prostomiumului, prezenţa sau absenţa ariilor glandulare în jurul porilor masculi, poziţia şi forma glandelor calcifere, şi altele). Pe baza acestor caractere, Pop reuşeşte să distingă linii evolutive şi să plaseze toate speciile de lumbricide cunoscute în doar 7 genuri (Tabel 1).

Tabel 1.

Genurile de lumbricide în sistemul Pop (1941, 1949)

Fără pigment porfirinic	Sete strâns împerechiate	Tericole		***Allolobophora*** Eisen 1874 emend. Pop, 1941
		Acvatice	Organe clitelare bine dezvoltate, ocupă o parte scurtă a corpului	***Eiseniella*** Michaelsen, 1900 emend.Michaelsen1 932
			Organe clitelare slab dezvoltate, ocupă o parte largă a corpului	***Criodrilus*** Hoffmeister, 1845
	Sete larg- sau neîmperechiate			***Octolasium*** Örley, 1885
Cu pigment porfirinic	Sete strâns împerechiate	Cu sac testicular, prostomium epilobic		***Eisenia*** Malm, 1977 emend. Pop 1941
		Fără sac testicular, prostomium tanilobic		***Lumbricus*** Linaeus, 1758 emend. Eisen, 1874
	Sete larg- sau neîmperechiate			***Dendrobaena*** Eisen, 1874, emend Pop, 1941

Pop a modificat conţinutul multor genuri din precedentul sistema Rosa-Michaelsen, a reconsiderat descrierea multor specii, a trecut multe in sinonimie, le-a schimbat diagnozele, le-a regrupat şi relocat în genuri relativ uşor de discriminat, având o unitate morfologică şi filogenetică.

Pop a desfiinţat genurile *Eophila* şi *Bimastos,* a emendat genurile *Allolobophora, Octolasium, Eisenia* şi *Dendrobaena,* lăsând neatinse doar genurile *Eiseniella şi Lumbricus.* Trei dintre aceste genuri şi anume *Eiseniella, Lumbricus, Octolasium* sunt omogene, având o unitate morfologică şi filogenetică, pe când genurile *Allolobophora, Eisenia* şi *Dendrobaena* sunt heterogene. Pop nu le-a putut separa în lipsa de caractere obiective. Pentru acestea a introdus noţiunea de "genuri colective", "Sammengatungen" (în germană), în care a plasat în mod provizoriu specii aparţinând la diverse linii evolutive, dar relativ uşor de determinat.

Cercetări recente prin utilizarea unor noi caractere anatomice şi morfologice au dus la descrierea unor noi genuri de lumbricide. Aceste noi genuri se pot grefa uşor pe sistemul de bază a lui Pop. Astfel. Astfel, Omodeo (1956) divide genul din *Octolasion* subgenurile *Octolasium* şi *Octodriloides*, iar genul *Dendrobaena* în subgenurile *Dendrobaena* şi *Dendrodrilus*. Ulterior sunt ridicate la nivel de genuri. Gates (1975) urmat de mulţi alţii desprind din *Allolobophora* vechiul gen *Aporrectodea* propus încă de Örley (1885) iar Zicsi (1978) genul *Cernosvitovia*. Genul *Criodrilus* este în prezent mutat într-o familie distinctă. Bouché, Qiu, Mrsic şi alţii descriu mulţi taxoni noi, dar a căror validitate nu este suficient susţinută. Sistemul devine din ce în ce mai complicat, dar este clădit pe şi păstrează ideile de bază ale sistemului Pop.

Sistemul Pop de clasificare a lumbricidelor, pe lângă reordonarea genurilor şi speciilor, aduce şi câteva noutăţi teoretice privind stabilirea legăturilor filogenetice în regnul animal. Pop a introdus in filogenia râmelor concepţia seriilor evolutive, sub denumirea de "spiţă", potrivit lui Emil Racovitza de "înrudiri sau origini". În cadrul liniilor evolutive, se pot distinge şi aşa-numite „stadii", fără valoare discriminatorie la nivel de gen (contrar sistemelor anterioare).

Parte distinctă a sistemului Pop de sistematică şi filogenie a lumbricidelor sunt şi ipotezele originale, noi, privind **originea şi răspândirea geografică a lumbricidelor**.

Potrivit ipotezei lui Pop, râmele îşi au originea din strămoşi acvatici, adaptaţi vieţii terestre pe cuprinsul unui areal vast a sistemului Alpino-Carpato-Himalaian, şi nu în leagăne restrânse cum a fost presupus de către Michaelsen. Marea majoritate a speciilor endemice sunt legate de zone montane. Lumbricidele originare din zone altitudinale înalte au dezvoltat ulterior linii evolutive cu valenţe ecologice mai largi, cucerind zonele deluroase, apoi cele de câmpie. Cercetări recente (V.V. Pop 1996 şi V.V. Pop, A.A. Pop, Cs. Csuzdi 2010), aduc noi date în sprijinul ipotezei lui Pop privind originea şi evoluţia faunei de lumbricide din zonele montane.

Un aport însemnat la cunoaşterea lumbricidelor îl reprezintă şi descrierea a 21 specii şi subspecii de lumbricide noi pentru ştiinţă. Este de subliniat pioneratul lui Pop privind ecologia lumbricidelor, şi anume descrierea unor categorii ecologice de lumbricide: (1). râme roşietice (cu pigment porfirinic) care trăiesc şi se nutresc în orizonturile superioare ale solului şi (2) râme fără pigment porfirinic, brune, cenuşii, ce habitează în orizonturile profunde ale solului.

În căutarea de noi caractere discriminatorii la nivel de gen şi/sau specie, cât şi în definirea filiaţiei unor linii evolutive, Victor Pop a făcut studii intense privind structura musculaturii şi a glandelor calcifere, cât şi încercări de utilizare a unor indici biochimici.

Marele avantaj al sistemului Pop este simplitatea lui, permiţând încadrarea rapidă la nivel de gen. “Sistemul Pop” a dominat ştiinţa oligochaetologică mondială mai bine de 50 de ani. Nu există, nici în prezent, lucrare cu pretenţii taxonomice şi filogenetice asupra lumbricidelor care să nu pornească, accepte, sau să dezvolte acest sistem.

În decursul timpului (peste şapte decenii de la emiterea sistemului Pop) pe plan mondial s-a colectat un număr imens de material, din locuri necercetate înainte, şi au fost folosite caractere anatomice noi, dintre care mai important este structura aparatului excretor (T. Perel) sau forma tiflosolisului (Szüts, Zicsi, Mršić). În mod normal, s-au diversificat şi unităţile taxonomice de lumbricide. Însăşi grupul mare „Oligochaeta” are astăzi alt sens. Clase, ordine şi familii nou introduse, specii şi subspecii impropriu descrise, schimbă în mod radical concepţia asupra acestui grup de viermi. Încetul cu încetul, din prea puţine genuri s-a ajuns la o inflaţie de zeci de genuri provocate mai ales de Bouché şi Mršić. În prezent A. A. Pop, V. V.Pop, M. Wink, urmaţi de S. James, încearcă să reordoneze sistematica grupului cu ajutorul taxonomiei moleculare (ADN).

Iată cum sintetizează Stop Bǿvitz (1969) în cartea asupra faunei de lumbricide din Norvegia importanţa sistemului Pop:

“Sistemul Pop ne permite să prezentăm diagnoze generice cu mult mai clare, fără multele excepţii şi rezerve pe care Michaelsen, încetul cu încetul, a fost nevoit să le introducă. Chiar dacă unele genuri sunt încă în mod clar polifiletice (*Allolobophora, Eisenia, Dendrobaena*), sistemul Pop ne permite sesizarea unor trăsături evolutive care iniţial au fost greu de detectat. Este aşadar natural ca autori recenţi să înceapă să adopte sistemul de clasificare propus de Pop, sistem ce va fi utilizat şi în lucrarea prezentă “...şi mai departe....” Trebuie să recunosc că găsesc sistemul propus de Pop mult mai convingător, mai simplu şi mai lucid”.

Astfel, mulţi specialişti au acceptat sistemul Pop, în întregime sau parţial pentru o lungă perioadă de timp: P. Omodeo (Italia), A. Zicsi and Cs. Csuzdi (Ungaria). D.E. Wilcke and O. Graff (Germania), J.D.Plisko (Polonia), M. Avel and M.B. Bouché (Franţa), I.Zajonc (Slovachia), T. Pereli (Rusia), C. Stǿp-Bǿvitz (Norvegia), N. Mrsič, Sapkarev (Slovenia), V.V. Pop, A. A. Pop (România) şi alţii. Unii dintre aceştia şi-au făcut specializarea în studiul lumbricidelor sub îndrumarea lui Victor Pop la Catedra de Zoologie a Universităţii din Cluj, sau prin corespondenţă. Colecţia de lumbricide a lui Pop este si astăzi obiect de iniţiere, studiu şi revizuiri taxonomice.

Activitatea şi moştenirea ştiinţifică a Profesorului Victor Pop arată crearea în Alma Mater a Universităţii din Cluj a unei adevărate şcoli care a dominat multe decenii studiul lumbricidelor. De fapt, din punct de vedere metodologic, se pot distinge trei etape de cercetare cu protagonişti recunoscuţi pe plan internaţional din cadrul a trei generaţii ale familiei Pop. Astfel, Profesorul Victor Pop (1903-1976) a studiat sistematica şi filogenia lumbricidelor cu ajutorul metodelor tradiţionale ale primei jumătăţi a secolului XX, fiul şi continuatorul său Victor V. Pop (n. 1936) a studiat acelaşi grup prin metodele taxonomiei numerice şi ale ecologiei jumătăţii a doua a secolului trecut, iar nepoata Adriana Antonia Pop (n. 1937) a dus mai departe tradiţia familiei studiind oligochetele terestre cu metodele taxonomiei şi filogeniei moleculare din prima jumătate a secolului XI.

Este normal ca trecerea timpului să fi erodat şi sistemul Pop. Totuşi multe dintre ideile lui Pop stau şi în prezent la baza încercărilor de elaborarea unui sistem generic care să permită încadrarea noilor taxoni. S-au făcut progrese însemnate, dar suntem încă departe de a avea o imagine cât de cât unitară asupra sistematicii Lumbricidelor.

Colecţia de Oligochete depusă la Muzeul Zoologic al Universităţii din Cluj. Victor Pop a colectat un mare număr de probe de lumbricide şi a organizat o colecţie valoroasă care cuprinde 1.186 tuburi de sticlă inventariate, din care 1.109 tuburi din România şi 77 din alte ţări. Aceste tuburi cuprind 4.315 indivizi de râme, din care 4.160 din România şi 77 din alte ţări. În total 69 de specii, 13 subspecii repartizate în 11 genuri.

Pentru studiul oligochetelor acvatice a colectat personal un număr mare de probe şi a făcut un mare număr de preparate microscopice fixe. În prezent acestea sunt în fază de organizare şi redactare la Institutul de Cercetări Biologice din Cluj-Napoca.

Material tip pentru speciile nou descrise sunt depozitate în colecţiile de oligochete din Muzeele Naţionale de Istorie Naturala din Bucureşti, Budapesta, Londra şi Hamburg.

Studii asupra oligochetelor acvatice (1965-1976). Am amintit că, din cauza condiţiilor politice de după al doilea război mondial Victor Pop nu a putut face călătorii în străinătate spre a studia materialul din colecţiile Europei Vestice. Astfel Pop, a fost obligat moral, să abandoneze cercetările asupra lumbricidelor. Acest abandon a fost considerat de mulţi specialişti ca o mare pierdere în studiul lumbricidelor.

Din acest motiv, ultimii 10-15 ani din viaţa, Prof. Victor Pop şi-a consacrat studiului oligochetelor acvatice, în vederea elaborării unui volum unitar privind Fauna de Oligochete Terestre şi Acvatice a României.

V. Pop a descris 3 specii noi de Naididae, taxoni noi de Tubificidae şi un Branchiobdelid. De asemenea a publicat o revizuire taxonomică a familiei Branchiobdellidae din Europa.

Volumul „Oligocheata" la care Profesorul Pop a lucrat în ultimii ani, destinat a fi publicat în seria monografică *Fauna României* de către Editura Academiei Române nu a putut fi finalizat. O moarte subită a lăsat în manuscris 9 familii de Annelide acvatice încadrate în prezent în diferite gruprui de Clitellate si Polichete din România şi anume: familiile Aeolosomatidae, Branchiobdellidae, Criodrilidae, Haplotaxidae, Lumbriculidae, Naididae şi Tubificidae, Enchitraeidae şi Lumbricidae. Acest volum este în fază avansată de prelucrare, sarcină preluată de urmaşul său, Victor V. Pop, cercetător principal la Institutul de Cercetări Biologice din Cluj-Napoca.

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Academia Română, Secţia de Ştiinţe Biologice,
Comisia pentru Ocrotirea Monumentelor Naturii

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ANEXA:

Lucrări asupra viermilor oligocheţi

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PRESENT STATUS OF THE *SYRINGA JOSIKAEA* JACQ. EX RCHB., AN ENDEMIC SPECIES WHICH CONTRIBUTES TO THE DIVERSITY OF THE FLORA OF THE CARPATHIANS

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SUMMARY. This paper presents the actual distribution of the Carpathian endemic vascular plant, *Syringa josikaea* Jacq.ex Rchb. in the Apuseni Mountains, Romania. In the less than 200 years from the description of the species in 1830 by Joseph Franz von Jacquin, some of the formerly extant populations have disappeared, and much of the remnant populations have been declined in number. We have managed to identify a quite large population (94 clones) in the Iad Valley (and its affluent, Serenad) and just a few specimens in the valleys of Henţ (3 specimens), Arieş (5 specimens) and Crişul Negru (5 specimens) rivers. The populations from the Drăgan, Someşul Cald and Crişul Repede rivers' valleys have disappeared due to antropic factors.

Keywords: chorology, relict endemic species, the Romanian Carpathians, *Syringa josikaea*

Introduction

*Syringa josikaea (*syn. *Syringa prunifolia* Kit*, Syringa vincetoxifolia* Baumg.*)* (fam. OLEACEAE) is one of the 21-28 (depending on the taxonomic concept, McKelvey, 1928; Fiala, 1988) disjunctly distributed *Syringa* species between southeastern Europe and eastern Asia. It is an endemic species of the Carpathians with disjunctive and fragmented distribution in the north in Ukraine and in the south in the Apuseni Mountains, Romania. It has been long thought as a preglacial relic species, although fossil evidents are missing. Molecular phylogenetic studies (Kim and Jansen, 1998) place it in Series Villosae, sister with *S. wolfii*. Is a microphanerophyte, mezohydrophyte, micro-mesoterm, weakly acid-neutrofil species (Sanda et. al, 1983). Regarding its phytosociological characterization, it belongs to the association *Carici*

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brizoides-Alnetum I. Horvat 1938 em. Oberdorfer 1953, subassociation *syringetosum josikeae* Sanda et Popescu 1999 (syn: *Alno incanae-Syringetosum josikeae* Borza, 1965 n.n.) (Sanda *et al.*, 2008).

The species is listed in Annex II of the Habitats Directive and Appendix I of Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats), mentioned as endangered in the Carpathian List of Endangered Species (Witkowski *et al.*, 2003) and as vulnerable in the Red Book of Ukraine (Gyiduh, 2009).

It appears in various Red Lists of Romania (Boşcaiu *et al.*, 1994; Dihoru and Dihoru, 1994) and mentioned as a species with low risk in the Red Book of Romanian vascular plants (Dihoru *et al.*, 2009). According to the IUCN Red List of Threatened Species there is no information on the population size or trend and potential threats available for Romania. It is therefore classed as Data Deficient, but very probably belongs into a threatened category (Bilz, 2011).

Despite of its rarity we have no data on its Romanian distribution in the last decades. Herbarium specimens from the Alexandru Borza Botanical Garden, Cluj-Napoca (Herbarium CL) collected after 1950 are scarce (8, mainly from the hydrological station from Stâna de Vale), the most recent is from 1977. However, Ukrainian populations were recently studied (Kohut, 2013) and revealed a much more stronger present in the northern enclaves of the Carpathians.

The niche models have good tools to identify the potential distribution areas of the species and to determine the important ecological factors which influence the distribution (Phillipsa *et al.*, 2006, Kumar and Stohlgren, 2009).

The aim of the present paper is to present the distribution and size of the remnant populations of *Syringa josikaea* from Romania and niche modeling the potential distribution areas of the species.

In this study, we investigate the habitats known from literature for *Syringa josikaea* in order to address the following questions: (i) Where the studied species can actually be distributed? (ii) What are the dimensions of the remnant populations? (iii) Which are the causes of the extinction/declining in number of the former populations? and finally (iv) Does the species need any conservation strategy?

Materials and methods

In order to have a clear picture regarding the present distribution of *Syringa josikaea* in Romania, after a systematical documentation of the literature (Simonkai, 1886; Gulyás, 1907; Jávorka, 1925; Nyárády, 1943; Prodan and Buia, 1960; Morariu, 1962; Beldie, 1979; Csűrös, 1981; Raţiu *et al.*, 1984; Molnár, 2003; Ciocârlan, 2009, Lendvay *et al.*, 2013) and Herbarium CL sheets concerning the presence of the studied species in different locations we visit all the mentioned places in the spring and summer/autumn of 2012 and 2013. All the specimens found were marked by GPS (Garmin 62s) and also observations regarding the habitats (biotic and abiotic factors) have been made. For climatic niche modeling the MaxEnt version 3.3.3e software was used. The nineteen bioclimatic variables (BIOCLIN) used in MaxEnt were obtained from WorldClim dataset (http://www.worldclim.org/). The maps were created using DiVa GIS version 7.5.

Results and discussion

We have managed to identify specimens (mainly clones) of *Syringa josikaea* in the valleys of Arieş, Crişuri (Crişul Negru, main affluents of the Crişul Repede: Iad Valley, Stâna de Vale, Henţ Valley) on a total estimated area of 2400 km^2 (Table 1, Fig.1). The total number of the identified specimens/clones is 107. We have not found the species in the wild in the Drăgan, Crişul Repede and Someşul Cald Valleys, although there are data in literature about former populations in these regions.

The *Syringa josikaea* is present with just a few specimens/clones in all the river basins where we have identified it, excepting the Iad Valley, where a population with high number of exemplars (97 clones) still exists. (Table 1).

Table 1.

Coordinates of the identified specimens in different river valleys

No	River Valley	Coordinates
1	Crişul Negru	N46.46116 E22.62666
2	Crişul Negru	N46.46134 E22.62937
3	Crişul Negru	N46.46189 E22.63481
4	Crişul Negru	N46.46148 E22.63350
5	Crişul Negru	N46.45967 E22.62488
6	Arieş	N46.45604 E22.93791
7	Arieş	N46.45703 E22.85047
8	Arieş	N46.46233 E22.77615
9	Arieş	N46.46311 E22.76821
10	Arieş	N46.46383 E22.76807
11	Henţ	N46.84988 E22.86346
12	Henţ	N46.83495 E22.85965
13	Henţ	N46.84241 E22.86069
14	Iad	N46.79164 E22.55788
15	Iad	N46.78973 E22.55639
16	Iad	N46.78425 E22.55377
17	Iad	N46.78247 E22.55367
18	Iad	N46.78194 E22.55371
19	Iad	N46.78144 E22.55395
20	Iad	N46.75226 E22.55503
21	Iad	N46.75382 E22.55564
22	Iad	N46.75434 E22.55582

Table 1. continued

23	Iad	N46.75446 E22.55591
24	Iad	N46.75668 E22.55654
25	Iad	N46.76957 E22.56151
26	Iad	N46.75878 E22.55728
27	Iad	N46.75261 E22.55691
28	Iad	N46.75207 E22.55711
29	Iad	N46.75093 E22.55661
30	Iad	N46.77145 E22.56177
31	Iad	N46.77122 E22.56124
32	Iad	N46.77090 E22.56140
33	Iad	N46.77121 E22.56091
34	Iad	N46.77109 E22.56065
35	Iad	N46.76818 E22.55838
36	Iad	N46.76737 E22.55820
37	Iad	N46.76697 E22.55841
38	Iad	N46.82862 E22.59002
39	Iad	N46.83070 E22.60861
40	Iad	N46.83063 E22.60729
41	Iad	N46.74732 E22.55508
42	Iad	N46.74387 E22.55716
43	Iad	N46.74221 E22.55735
44	Iad	N46.74177 E22.55869
45	Iad	N46.74178 E22.55872
46	Iad	N46.74166 E22.55883
47	Iad	N46.74047 E22.55931
48	Iad	N46.74006 E22.55920
49	Iad	N46.73909 E22.56038
50	Iad	N46.73852 E22.56011
51	Iad	N46.73862 E22.56047
52	Iad	N46.73853 E22.56057
53	Iad	N46.73820 E22.56037
54	Iad	N46.73759 E22.56146
55	Iad	N46.73677 E22.56151
56	Iad	N46.73518 E22.56203
57	Iad	N46.73247 E22.55955
58	Iad	N46.72849 E22.56074
59	Iad	N46.72728 E22.56102
60	Iad	N46.72736 E22.56112
61	Iad	N46.72712 E22.56133
62	Iad	N46.72695 E22.56148
63	Iad	N46.72706 E22.56144
64	Iad	N46.72655 E22.56144

Table 1. continued

65	Iad	N46.72586 E22.56109
66	Iad	N46.72497 E22.56134
67	Iad	N46.72472 E22.56182
68	Iad	N46.72193 E22.56220
69	Iad	N46.72182 E22.56151
70	Iad	N46.72212 E22.56112
71	Iad	N46.72306 E22.56229
72	Iad	N46.72306 E22.56240
73	Iad	N46.72443 E22.56275
74	Iad	N46.72172 E22.56179
75	Iad	N46.72172 E22.56180
76	Iad	N46.72137 E22.56238
77	Iad	N46.72089 E22.56320
78	Iad	N46.72035 E22.56421
79	Iad	N46.72015 E22.56486
80	Iad	N46.72010 E22.56511
81	Iad	N46.71787 E22.56760
82	Iad	N46.71718 E22.56832
83	Iad	N46.71721 E22.56868
84	Iad	N46.71899 E22.57329
85	Iad	N46.71974 E22.57144
86	Iad	N46.71794 E22.57399
87	Iad	N46.71790 E22.57422
88	Iad	N46.71700 E22.57808
89	Iad	N46.71659 E22.57837
90	Iad	N46.71622 E22.57839
91	Iad	N46.71436 E22.58316
92	Iad	N46.71335 E22.58520
93	Iad	N46.71330 E22.59632
94	Serenad	N46.71359 E22.58465
95	Serenad	N46.71324 E22.58521
96	Serenad	N46.71317 E22.58540
97	Serenad	N46.71287 E22.58563
98	Serenad	N46.71269 E22.58539
99	Serenad	N46.71227 E22.58503
100	Serenad	N46.71218 E22.58501
101	Serenad	N46.71164 E22.58479
102	Serenad	N46.71144 E22.58427
103	Serenad	N46.71135 E22.58455
104	Serenad	N46.71123 E22.58444
105	Serenad	N46.71340 E22.58510
106	Stâna de Vale	N46.69034 E22.61460
107	Stâna de Vale	N46.69018 E22.62080

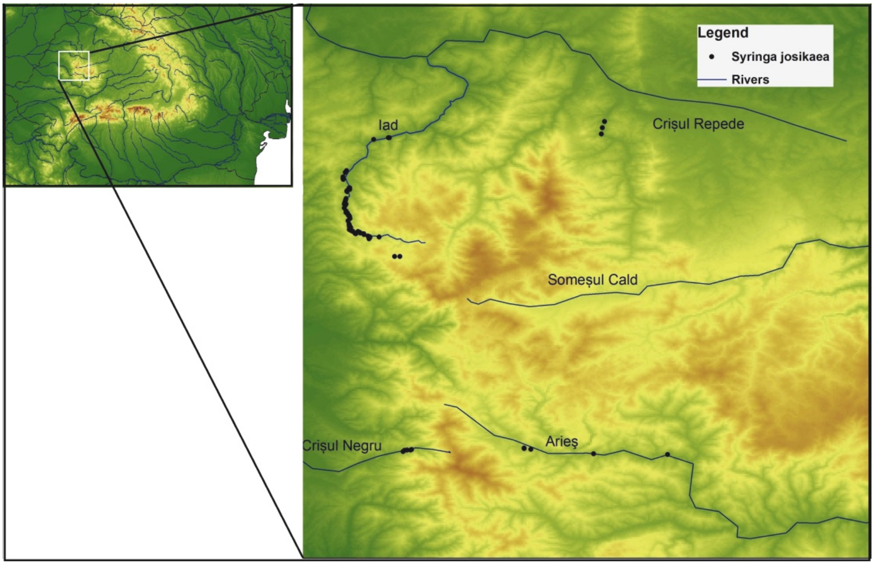

Figure 1. Actual distribution of *Syringa josikaea* in the Apuseni Mountains

The identified specimens are distributed at altitudes ranging between 500–1100 m. As most of them are growing along riversides, the exposition differs according to the direction of the river. The dimensions of clones are variable, maximum sizes are of 1000 m^2**.** Maximum circumference of the trunk (as measured at 50 cm height) is of 24 cm and maximum height of the studied specimens is 4.5m.

The main habitats where we identified the specimens are:

- Alongside mountain rivers, on cliffs and rocky shores
- Alongside mountain rivers, immediately on the shore
- Floodplain of rivers on the hilly zone
- Cultivated in gardens

The causes of the extinction of the former populations and the decrease of extant ones are as follows:

- construction of a reservoir on the Iad Valley
- construction of a reservoir (Beliş) on Someşul Cald Valley
- railway - and road construction on Crişul Repede Valley (Bologa zone)
- road-construction on the Arieş Valley
- development of tourist area in the zone Albac-Arieşeni (Arieş Valley)

- natural modification of the watercourse (in case of Arieş), in such a way, that formerly existed floodplains were disturbed, as a consequence specimens of *Syringa josikaea* were destroyed
- construction of a hydroelectric power plant in the Valley of Crişul Negru
- intensive deforestation

Climatic niche analyses of the species based on actual presence data in Romania tells that the most important factors in the distribution of the species are the humidity, the high level of precipitation evenly distributed during the whole year (precipitation seasonality) and the altitude (the species most probably occurs between 650 and 950 m). The potential distribution area of the species based on the niche modeling is illustrated in fig. 2. The results suggest that the species has a larger potential distribution area (where the bioclimatic factors are appropriate for *S. josikaea*), than it presents know. If we compare the actual climatic niche of the species (Fig. 2) with that during the Last Glacial Maximum (cca. 21000 years ago) (Fig. 3) we can conclude that the species had a potential larger distribution area in the Carpathians. Beside the present distribution areas (the Apuseni Mountains and the Ukrainian Carpathians) it had a potential distribution area in the Southern Carpathians, as well. Based on the niche modeling we can conclude that the *S. josikaea* has a relic status in the Apuseni Mountains.

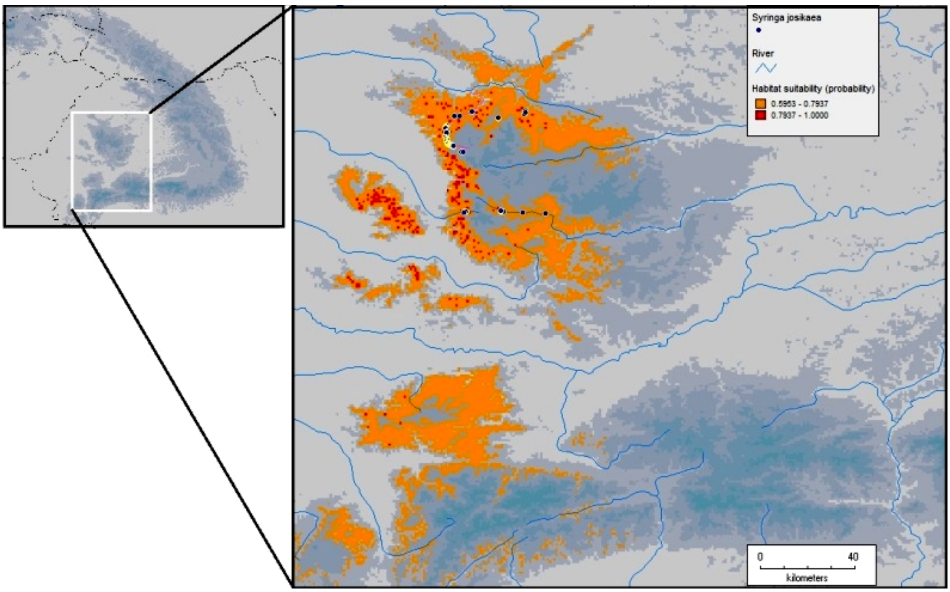

Figure 2. Predicted potential distribution area of *Syringa josikaea* in Romania – actual situation (higher probability than 59%)

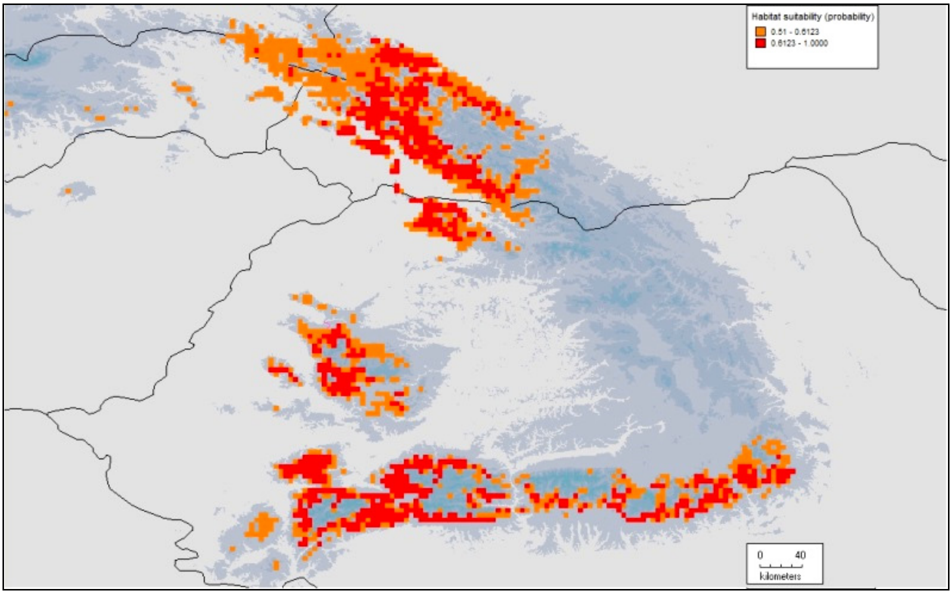

Figure 3. Predicted potential distribution area of *Syringa josikaea* in Romania – situation during the Last Glacial Maximum (higher probability than 51%)

Conclusions

We can conclude that some of the formerly extant populations have disappeared, and those remained have decreased in their number, due mainly to antropogenic factors, but also some climatic extremes as high level of precipitations in summer time can caused the massive decline of the species in Romania. The only population with a high number of specimens (94 clones) is that in Iad Valley, probably because this is the only valley from those studied which presents (at least upstream the reservoir) the smallest human impact on it.

Conservation strategies are needed for the preservation of this species in the Romanian flora. These should be focused on the protection of the Iad Valley's population.

Acknowledgements

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*** The Habitats Directive: EU Council Directive 92/43/EEC
*** Bern Convention - Convention on the Conservation of European Wildlife and Natural Habitats

STUDIA UBB BIOLOGIA, LVIII, 2, 2013 (p. 41-54)

DIVERSITY OF PLANKTON COMMUNITIES FROM LAKE ZORENI (TRANSYLVANIA, ROMANIA)

KARINA PAULA BATTES[1,✉], ROXANA TUDOSĂ[1], LAURA MOMEU[1] and IOANA CRISTEA[1]

SUMMARY. The present paper represents the first record of phytoplankton and microcrustacean taxa from Lake Zoreni, located in the Transylvanian Plateau, Romania. The scarcity of the data about the lake could be explained by the fact that it was formed only about 40 years ago, due to land slides. More than 180 algal taxa and 15 microcrustacean species were identified in May, July and October 2012 in Lake Zoreni, from two sampling sites characterized by different habitat conditions with respect to macrophyte abundance. Species richness and diversity of both phytoplankton and microcrustaceans differed depending on the season and sampling site. Based on indicator values of numerous algal, cladoceran and copepod taxa, the lake can be included in a moderate water quality class, with moderate loads of decomposing organic matter. An on-going process of eutrophication was identified in the lake, caused either by natural processes or by human activities.

Keywords: diversity indices, ecological status, microcrustaceans, phytoplankton, species richness.

Introduction

Planktonic organisms, living suspended in the water, form one of the most important pelagic communities, next to the nekton. Freshwater phytoplankton, as primary producer level, contains cyanobacteria and algae, while zooplanktonic communities can be herbivorous or carnivorous, including protozoans, rotifers, and crustaceans (copepods and cladocerans) (Lampert and Sommer, 2007). Pelagic food webs depend on planktonic communities. On the one hand, phytoplankton represents the most important primary producers in areas where macrophytes cannot survive due to water depth. On the other hand, zooplanktonic primary and secondary consumers

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(filter-feeders and predators) are an essential trophic pathway for the transfer of organic carbon from phytoplankton to fish (Suthers and Rissik, 2009). Moreover, some species of phytoplankton or zooplankton can indicate the health of the environment they live in, showing the trophic state or the amount of decomposing organic matter existing in the system (Zelinka and Marvan, 1961; Sládeček, 1973).

Lake Zoreni is located in the upper Fizeș catchment area, in the center of the Transylvanian Plateau, at 335 m a.s.l. (Floca *et al*., 1998). It is a natural water body, formed in 1975 due to a massive land slide. It has a total surface of 1.5 ha; it is 227 m long and 106 m wide, with a more or less continuous belt of reed and rush along the shore line. A few trees are present on the banks. Human impacts are not severe in Lake Zoreni; they are mostly represented by runoffs from the agricultural and pasture fields near the lake, and probably fish stocking.

The data included in the present paper represent the first study on planktonic communities from Lake Zoreni. No previous species lists of algae or microcrustaceans were found from the area, probably due to the young age of the lake. Thus, the present research represents an important insight on plankton qualitative structure and diversity, but also on the lake's current state of health, in terms of trophicity and saprobity.

Materials and methods

The samples were collected in May, July and October 2012 from two sampling sites located in different areas of the lake (Fig. 1). The first sampling site, Z1 (Fig. 2, left), from the north-western part of the lake (46°47'48.2"N; 24°04'38.7"E), was characterized by poor submerged vegetation in all three sampling seasons, while the second sampling site, Z2 (Fig. 2, right) (46°47'45.9"N; 24°04'44"E) was situated near the eastern bank of the lake, in an area with a rich submerged vegetation. The autumn samples, however, were impossible to collect from the exact location of Z2. The following code is used to denominate the sampling sites for the present paper: Z1-MM.YY, where Z1 is the sampling site, MM is the sampling month and YY is the sampling year. Thus, Z1-05.12 represents the first site, sampled in May 2012.

Qualitative phyto- and zooplankton samples were taken using a 20 µm and a 55 µm mesh net, respectively. All samples were collected from the banks and they were preserved in 4% formaldehyde. Identifications were made to the species level in case of algae (Ettl and Gärtner, 1988; Komárek and Anagnostidis, 2005; Krammer and Lange Bertalot, 1986; Popovsky and Pfiester, 1990; Wolowski, 2005), cladocerans (Negrea, 1983; Negrea, 2002) and copepods (Damian-Georgescu, 1963; Einsle, 1993; Pleşa and Müller, 2002). Several physical and chemical parameters were measured in the field in all sampling occasions, using portable meters (Consort P902 for pH and YSI 52 for dissolved oxygen and water temperature).

Semi-quantitative estimations were carried out for microcrustaceans, by calculating the relative percentage abundance. A number of individuals was counted in each sample and the percentage of the species present was calculated. Based on these data, the Shannon-Wiener diversity and the equitability were estimated for microcrustaceans (Washington, 1984).

Figure 1. Location of Lake Zoreni (in the East part of the Cluj County), with the two sampling sites (Z1 and Z2)

Figure 2. Aspects of the two sampling sites: Z1 on the left and Z2 on the right, in spring 2012

Several trophic and organic pollution indices based on phytoplankton community were considered (Willén, 2000). The first one, the compound index, represents the number of species of Cyanoprokaryota, Chlorococcales, Centrales and Euglenophyta divided by the number of species belonging to Order Desmidiales (Nygaard, 1949). Values below 1 indicate oligotrophic conditions, values between 1 and 3 mesotrophic conditions and values exceeding 3 eutrophic conditions. The β eutrophic index according to Oltean (1977) is calculated as follows: $I_\beta = [(C+Py) \log N] / (Ch+V+T+D+P+E+Cy)$; where N – the total number of taxa; C – Centrales; Py – Pyrophyta

(Dinophyta); Ch – Chrysophyta; V - Volvocales; T - Tetrasporales; D – Desmidiales; P – Chlorococcales; E – Euglenophyta and Cy – Cyanoprokaryota. This index can only be used for ecosystems where water blooms are observed. The I_β values are inverse proportional to the water trophic level. The organic pollution index calculated at the species level (Palmer, 1969) represents the sum of the indicator values of the species tolerant to organic load. Values not exceeding 15 indicate low organic pollution; values between 15 and 19 show moderate pollution and values greater than 20 represent high organic pollution. The biotic index based on cladocerans represents the ratio between large cladocerans (C_l) and the density of all cladoceran species (C_t) (Moss *et al.,* 2003). The values of this index indicate five water quality classes, according to the Water Framework Directive 2000/60/EC of the European Parliament and of the Council: when the values are lower than 0.2, the water quality is bad or poor; when the values vary between 0.2 and 0.5, the water quality is moderate; if they exceed 0.5, the water quality is good or high.

Results and discussion

Physical and chemical parameters measured in Lake Zoreni are presented in Table 1. pH values were neutral in almost all seasons. Water temperatures recorded normal values for the different periods of sampling, while dissolved oxygen saturation ranged from 55% to more than 100% (Table 1).

Table 1.

Physical and chemical parameters measured in the two sampling sites from Lake Zoreni in three different seasons

Sampling date	Sampling site code	pH	Dissolved oxygen (mg/l)	Dissolved oxygen saturation (%)	Water temperature (^{0}C)
19.05.2012	Z1-05.12	7.00	6.50	68.30	17.70
	Z2-05.12	7.00	6.47	70.00	19.20
23.07.2012	Z1-07.12	7.00	3.27	41.20	26.10
	Z2-07.12	7.00	8.60	108.30	27.40
12.10.2012	Z1-10.12	6.50	4.45	55.20	13.90
	Z2-10.12	7.00	4.44	55.10	13.70

A total of 181 phytoplankton taxa was identified in the two sampling sites from Lake Zoreni, belonging to six phyla: Bacillariophyta (34.25% of all taxa); Chlorophyta (33.15%); Euglenophyta (20.44%); Cyanoprokaryota (7.18%); Dinophyta (4.42%) and Chrysophyta (0.55%) (Table 2). Most algal species are true planktonic, and characteristic to shallow ponds: *Aphanocapsa elachista, Oscillatoria tenuis, Acanthosphaera zachariasii, Actinastrum hantzschii, Closterium acutum*, *Coelastrum astroideum*, *Kirchneriella lunaris, Scenedesmus arcuatus*, *Staurastrum chaetoceras, Treubaria schmidlei*, *Lepocinclis steinii, Stephanodiscus neoastraea* etc. There are also several benthic forms, due to the bank sampling: *Caloneis amphisbaena,* *Fragilaria capucina* var. *vaucheriae, Navicula gregaria, Navicula viridula, Nitzschia paleacea*. More than 100 species are cosmopolitan but 20 taxa are halophylous, probably due to the salt diapir fold characteristic to the western Transylvanian Plateau.

Table 2.

List of phytoplankton taxa found in the three sampling seasons from Lake Zoreni

Sampling date → Taxa ↓	19.05.2012	23.07.2012	12.10.2012	Sampling date → Taxa ↓	19.05.2012	23.07.2012	12.10.2012
Phylum Cyanoprokaryota							
Ord. Chroococcales							
Aphanocapsa elachista	-	+	+	*Gomphosphaeria compacta*	+	-	-
Merismopedia elegans	+	+	+	*Snowella lacustris*	-	+	+
Woronichinia compacta	+	+	-				
Ord. Oscillatoriales							
Oscillatoria amphibia	-	+	+	*Oscillatoria lacustris*	+	-	-
Oscillatoria limnetica	-	+	+	*Oscillatoria planctonica*	+	+	+
Oscillatoria tenuis	-	-	+	*Spirulina major*	-	-	+
Ord. Nostocales							
Anabena variabilis	-	+	-	*Cylindrospermum stagnale*	-	+	-
Phylum Chrysophyta							
Ord. Chromalinales							
Chrysococcus rufescens	+	+	+				
Phylum Euglenophyta							
Ord. Euglenales							
Euglena acus	-	+	+	*Euglena agilis*	+	-	-
Euglena caudata	+	+	-	*Euglena deses*	-	+	-
Euglena ehrenbergii	+	-	-	*Euglena geniculata*	-	+	-
Euglena limnophila	+	+	-	*Euglena limnophila* var. *swirenkoi*	-	+	-
Euglena oblonga	+	+	+	*Euglena oxyuris*	+	+	+
Euglena spathirhyncha	-	-	+	*Euglena texta*	+	+	+
Euglena variabilis	+	-	+	*Lepocinclis caudata*	+	-	-
Lepocinclis ovum	+	+	-	*Lepocinclis playfairiana*	+	-	-
Lepocinclis steinii	+	-	-	*Lepocinclis truncata*	-	+	-
Phacus acuminatus	+	+	-	*Phacus agilis*	-	+	-
Phacus curvicauda	-	-	+	*Phacus granum*	-	+	-
Phacus helicoides	+	+	+	*Phacus longicauda*	+	+	+
Phacus orbicularis	+	+	-	*Phacus parvulus*	+	-	-
Phacus pleuronectis	+	+	-	*Phacus pyrum*	-	+	+
Phacus tortus	+	+	+	*Strombomonas acuminatus*	-	+	+
Trachelomonas granulosa	+	+	+	*Trachelomonas hispida*	-	+	+

Table 2. continued

Trachelomonas oblonga	+	-	-	*Trachelomonas planctonica*	-	+	-
Trachelomonas pulcherrima	-	+	-	*Trachelomonas volvocina*	-	+	+
Trachelomonas volvocinopsis	-	+	+				
Phylum Dinophyta							
Ord. Gymnodiniales							
Gymnodinium paradoxum	+	+	+				
Ord. Peridiniales							
Ceratium furcoides	-	+	+	*Peridiniopsis cunningtonii*	+	+	+
Peridiniopsis elpatiewskyi	-	+	-	*Peridinium aciculiferum*	-	+	+
Peridinium bipes	+	+	-	*Peridinium cinctum*	+	+	+
Peridinium umbonatum	+	+	-				
Phylum Bacillariophyta							
Ord. Centrales							
Cyclotella ocellata	+	+	+	*Cyclotella meneghiniana*	-	+	+
Stephanodiscus neoastraea	-	-	+				
Ord. Penales							
Acanthoceras zachariasii	-	-	+	*Achnanthes minutissima*	+	+	+
Amphipleura pellucida	+	+	+	*Amphora libyca*	-	-	+
Amphora montana	-	+	-	*Amphora pediculus*	-	+	+
Bacillaria paradoxa	-	-	+	*Caloneis amphisbaena*	+	-	+
Caloneis silicula	-	+	-	*Cocconeis pediculus*	-	-	+
Cocconeis placentula	+	+	+	*Cylindrotheca gracilis*	-	-	+
Cymatopleura solea	+	+	+	*Cymbella affinis*	-	-	+
Cymbella caespitosa	+	-	-	*Cymbella cistula*	+	-	+
Cymbella cymbiformis	-	-	+	*Cymbella minuta*	+	+	+
Cymbella silesiaca	-	+	-	*Cymbella tumida*	-	+	+
Diatoma tenuis	+	+	+	*Epithemia adnata*	+	+	+
Fragilaria capucina var. *vaucheriae*	+	-	+	*Fragilaria crotonensis*	+	+	+
Fragilaria pulchella	+	-	-	*Fragilaria ulna*	-	+	+
Fragilaria ulna var. *acus*	-	+	+	*Gomphonema parvulum*	-	+	+
Gomphonema truncatum	+	-	+	*Gyrosigma nodiferum*	+	+	+
Mastogloia smithii var. *lacustris*	+	+	+	*Navicula capitata*	-	+	-
Navicula capitatoradiata	-	-	+	*Navicula cincta*	-	+	+
Navicula cuspidata var. *ambigua*	-	-	+	*Navicula cryptocephala*	-	-	+
Navicula gregaria	-	+	-	*Navicula lanceolata*	-	+	-
Navicula radiosa	+	+	+	*Navicula tripunctata*	-	+	-
Navicula viridula	-	+	+	*Nitzschia constricta*	-	+	+
Nitzschia dissipata	-	-	+	*Nitzschia flexa*	+	-	-
Nitzschia fruticosa	-	-	+	*Nitzschia hungarica*	-	+	+
Nitzschia levidensis	-	-	+	*Nitzschia linearis*	+	-	+
Nitzschia littoralis	+	+	-	*Nitzschia palea*	-	+	+

Table 2. continued

Nitzschia paleacea	+	+	+	*Nitzschia reversa*	-	+	+
Nitzschia sigma	-	+	-	*Nitzschia sociabilis*	-	-	+
Nitzschia tryblionella	-	-	+	*Pinnularia viridis*	-	-	+
Rhoicosphenia abbreviata	+	-	-	*Rhopalodia gibba*	+	+	+
Surirella linearis	-	-	+				
Phylum Chlorophyta							
Ord. Chaetophorales							
Elakathrothrix gelatinosa	+	-	-				
Ord. Chlorococcales							
Acanthosphaera zachariasii	-	+	+	*Actinastrum hantzschii*	-	+	+
Botryococcus braunii	+	+	+	*Closteriopsis acicularis*	-	-	+
Closteriopsis longissima	-	-	+	*Coelastrum astroideum*	+	+	+
Coelastrum microporum	+	+	+	*Coelastrum sphaericum*	+	+	+
Crucigenia tetrapedia	-	-	+	*Dictyosphaerium pulchellum*	-	+	+
Kirchneriella lunaris	+	-	-	*Lagerheimia genevensis*	-	-	+
Monoraphidium contortum	+	+	+	*Oocystis borgei*	+	+	-
Oocystis lacustris	+	+	+	*Oocystis marsonii*	+	-	-
Oocystis parva	+	+	-	*Pediastrum boryanum*	+	+	+
Pediastrum boryanum var. *longicorne*	+	+	-	*Pediastrum duplex*	-	+	+
Pediastrum tetras	+	-	-	*Radiococcus planktonicus*	+	+	+
Scenedesmus abundans	-	-	+	*Scenedesmus acutus*	-	+	+
Scenedesmus arcuatus	+	-	+	*Scenedesmus acuminatus*	-	-	+
Scenedesmus communis	+	+	+	*Scenedesmus ellipticus*	+	-	+
Scenedesmus opoliensis	-	+	+	*Tetraëdron caudatum*	+	+	+
Tetraëdron minimum	+	+	+	*Treubaria schmidlei*	-	+	-
Westella botryoides	-	+	+				
Ord. Volvocales							
Chlorogonium elongatum	-	+	-				
Ord. Zygnematales							
Closterium acutum	+	+	+	*Closterium acutum* var. *linea*	-	+	-
Closterium acutum var. *variable*	-	-	+	*Closterium leibleinii*	+	-	-
Closterium moniliferum	+	+	+	*Cosmarium abbreviatum* var. *planctonicum*	+	-	-
Cosmarium bioculatum	-	+	-	*Cosmarium botrytis*	-	+	+
Cosmarium contractum	-	+	+	*Cosmarium pseudopyramidatum*	+	-	-
Cosmarium regnelii	-	-	+	*Cosmarium subcostatum*	-	-	+
Cosmarium subprotumidum	+	-	-	*Mougeotia calcarea*	+	-	-
Mougeotia scalaris	+	-	-	*Mougeotia* sp.	+	+	+
Spirogyra gracilis	+	-	-	*Spirogyra* sp.	+	+	+
Staurastrum chaetoceras	-	-	+	*Staurastrum cingulum*	+	+	-
Staurastrum manfeldtii	-	-	+	*Staurastrum paradoxum*	-	+	+
Staurastrum tetracerum	+	+	+	*Staurastrum tetracerum* var. *triradiata*	-	+	-
Staurodesmus incus	-	+	-				

The microcrustacean community includes only 15 species: 11 cladocerans (Phylum Arthropoda, Subphylum Crustacea, Class Branchiopoda, Subclass Phyllopoda, Ord. Diplostraca, Subord. Cladocera) and 4 cyclopoid copepods (Phylum Arthropoda, Subphylum Crustacea, Class Maxillopoda, Subclass Copepoda, Ord. Cyclopoida), together with copepod immature stages (copepodites and nauplii) (Table 3). Many microcrustaceans are cosmopolitan (like *Chydorus sphaericus* or *Eucyclops serrulatus proximus*). Most species are true planktonic, some are neustonic (*Scapholeberis mucronata*) and some are benthic (*Disparalona rostrata* or *Macrothrix laticornis*). Some species prefer habitats with rich macrophytes, so they are present only in the second sampling site Z2 (*Alona guttata* and *Macrocyclops albidus*). An empirical evaluation of the frequency of appearance was also performed for all microcrustacean taxa identified in the sampling sites, on a ranking scale ranging from *r* (rare) to *d* (dominant) (Table 3).

Table 3.

List of microcrustacean taxa, together with nauplii and copepodites in the two sampling sites from Lake Zoreni (*r* – rare; *s* – sporadic; *c* – common; *d* – dominant; ♀ – females; ♂ – males)

Sampling site codes → / **Taxa ↓**	**Z1-05.12**	**Z2-05.12**	**Z1-07.12**	**Z2-07.12**	**Z1-10.12**	**Z2-10.12**
Cladocera						
Alona guttata Sars 1862	-	*s*,♀	-	*c*,♀	-	-
Alona rectangula Sars 1862	*c*,♀	*s*,♀	*c*,♀	*c*,♀	*c*,♀	*s*,♀
Bosmina longirostris (O.F.Muller 1776)	*c*,♀	*r*,♀	*c*,♀	*s*,♀	*r*,♀	*c*,♀
Ceriodaphnia pulchella Sars 1862	*c*,♀	*c*,♀	*s*,♀	*s*,♀	*r*,♀	*s*,♀
Chydorus sphaericus (O.F.Muller 1776)	*c*,♀	*d*,♀	-	-	*c*,♀	*c*,♀
Daphnia cucullata Sars 1862	-	-	*s*,♀	-	-	*r*,♀
Disparalona rostrata (Koch 1841)	-	-	-	-	-	*s*,♀
Macrothrix laticornis (Jurine 1820)	-	-	-	-	*r*,♀	*s*,♀
Moina micrura Kurz 1875	-	-	*r*,♀	-	-	*r*,♀
Scapholeberis mucronata (O.F.Muller 1776)	-	*d*,♀	*c*,♀	*c*,♀	*s*,♀	-
Simocephalus vetulus (O.F.Muller 1776)	*s*,♀	*c*,♀	-	*s*,♀	*c*,♀	*s*,♀
Copepoda						
Acanthocyclops robustus Sars 1863	*c*,♀♂	*s*,♀	-	-	-	-
Eucyclops serrulatus proximus (Lilljeborg 1901)	-	*s*,♀	-	-	-	-
Macrocyclops albidus (Jurine 1820)	-	*s*,♀	-	*r*,♀	-	-
Thermocyclops oithonoides (Sars 1863)	*r*,♂	-	*s*,♀♂	-	*s*,♀♂	*c*,♀♂
copepodites	*d*	*c*	*c*	*c*	*c*	*d*
nauplii	*d*	*c*	*d*	*d*	*c*	*d*

Other animals were found in the sampling sites: worms (rotifers, nematodes, oligochaets); insect larvae (mayflies, true flies, aquatic butterflies) and other crustaceans (ostracods).

Species richness is a measure of community diversity, and refers to the number of taxa present in the sampling sites considered for the present study. As shown in Fig. 3 and 4, species richness is higher in the first sampling site (Z1) in all three sampling seasons in case of phytoplankton, and in the second sampling site (Z2) for microcrustaceans. The lower number of phytoplankton taxa in Z2 is explained by the massive development of macrophytes, that compete with algae for nutrients and light. In autumn 2012, the smaller difference between the number of taxa from Z1 and Z2 (7, compared to 16 in spring and 24 in summer) is due to the fact that many epiphytic diatoms were identified then in Z2. For microcrustaceans, the presence of macrophytes offer a more heterogeneous habitat, with more hiding places, and thus a higher species richness.

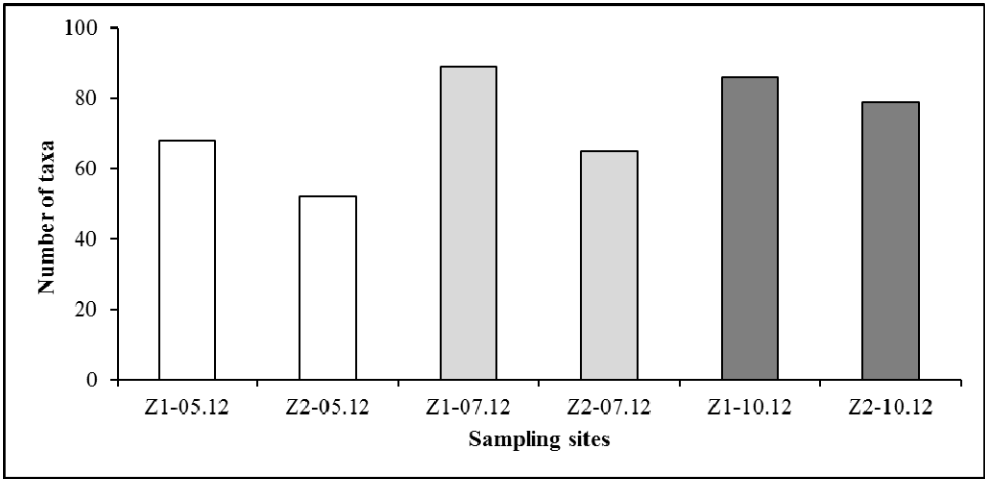

Figure 3. Number of phytoplankton taxa identified in the two sampling sites from Lake Zoreni in 2012

The Shannon – Wiener diversity index and the equitability were calculated for microcrustaceans alone, from the relative abundance estimations (Fig. 5). These indices take into consideration nauplii and copepodites as well, since the development stages of copepods represent a high percentage of the microcrustacean community, ranging from 57% to 94%. However, this high percentage leads to low values of diversity and equitability, showing an unbalanced community. Similar to the species richness, the microcrustacean diversity indices record higher values in the second sampling site (Z2), because of the more heterogeneous habitat created by macrophytes, except for the samples taken in autumn 2012. This can be explained by the high percentage of nauplii and copepodites discussed above, but also by the fact that the location of Z2 was impossible to reach in October 2012, thus no macrophytes were characteristic to the actual sampling location in that season.

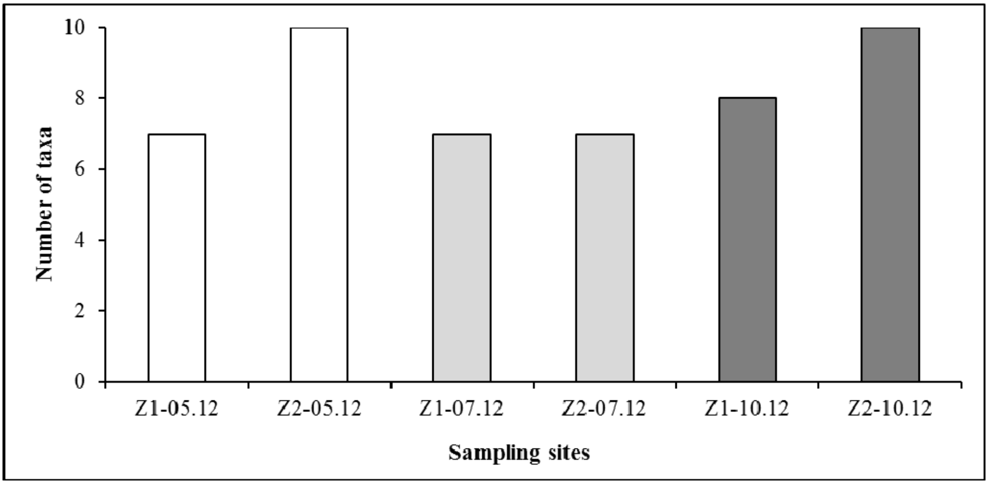

Figure 4. Number of microcrustacean taxa identified in the two sampling sites from Lake Zoreni in 2012 (nauplii and copepodites omitted)

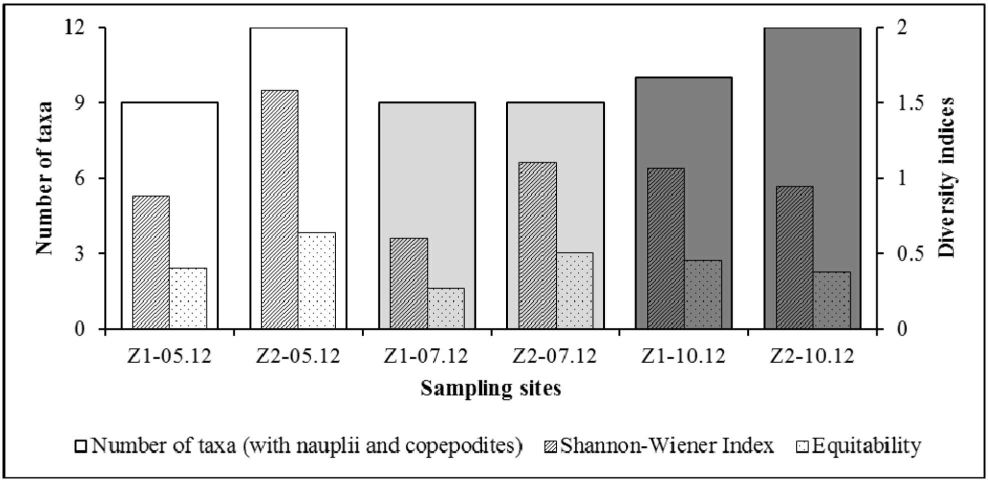

Figure 5. Number of microcrustacean taxa (nauplii and copepodites included) and the diversity indices calculated (the Shannon-Wiener index and the equitability)

The ecological status of Lake Zoreni was assessed based on phytoplankton and microcrustaceans, considering trophicity, saprobity and biotic indices (Table 4). From the 46 algal taxa that have an indicator value for lake trophicity, more than half (25) indicate eutrophic conditions, while 5 microcrustacean species are characteristic to eutrophic waters. The two trophicity indices based on phytoplankton support this: for example, almost all values of the compound index exceeded 3, indicating eutrophic waters. The water blooms in Lake Zoreni were caused by algae belonging to Dinophyta, so the β eutrophic index (Olteanu, 1977) was calculated. The smaller the index values, the higher the trophicity (Table 4). All these data depict Lake Zoreni in an on-going eutrophication process, caused by natural phenomena (soil characteristics, lake morphometry etc.) but also by human pressures (land use around the lake, fish stocking etc.).

As concerns the lake saprobic state, 65 from the total of 181 phytoplankton species; and 13 from the total of 15 microcrustacean species indicate a certain saprobic condition (Sládeček, 1973; Rott, 1997) (Fig. 6). The highest number of phytoplankton and microcrustacean taxa indicated oligosaprobic - β-mesosaprobic waters, showing relatively clean waters, with lower concentrations of decomposing organic matter. The organic pollution index at the species level (Palmer, 1969) (Table 4) recorded higher values for the summer and autumn samples, following the accumulation of organic matter in the lake during the growing season.

Table 4.

The indices used to assess the ecological status of Lake Zoreni based on phytoplankton and microcrustaceans (the two values indicate index figures for the first sampling site, Z1; and for the second one, Z2)

Sampling dates → **Indices ↓**	**19.05.2012**	**23.07.2012**	**12.10.2012**
The compound trophicity index (Nygaard, 1949)	5.4; 2.9	5.4; 5.3	9.3; 3.4
The β eutrophic index (Olteanu, 1977)	0.2; 0.3	0.3; 0.2	0.3; 0.2
The organic pollution index at the species level (Palmer, 1969)	4; 4	24; 23	29; 27
The cladoceran biotic index (Moss *et al.*, 2003)	0.3	0.2	0.5

The biotic index based on the number of large cladocerans versus the total number of cladocerans (Table 4) indicated moderate water quality in all sampling seasons, confirming the findings on lake trophicity and saprobic status.

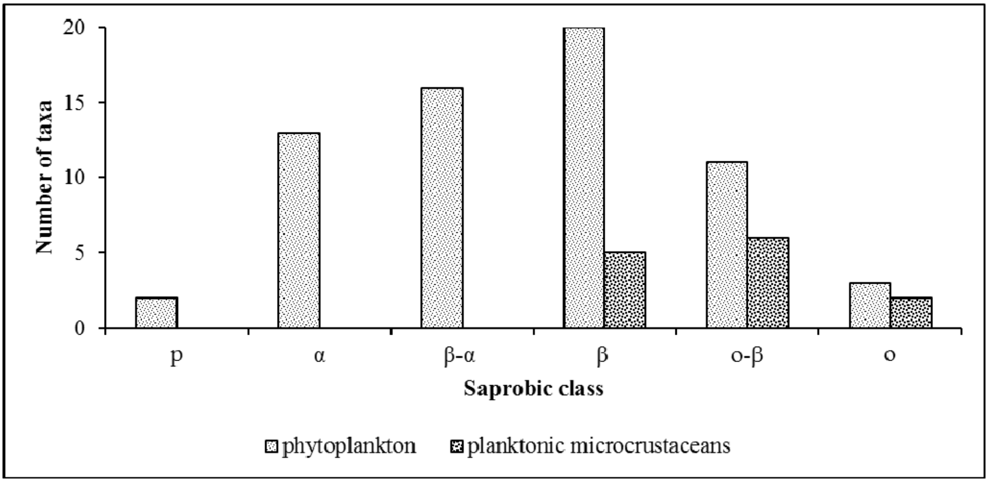

Figure 6. Number of phytoplankton and microcrustacean species, indicators of a certain saprobic condition: polisaprobic (p); α- mesosaprobic (α); β-α mesosaprobic (β-α); β-mesosaprobic (β); oligo- β-mesosaprobic (o-β); oligosaprobic (o)

Conclusions

To conclude, phytoplankton species richness increased in the open water areas, while microcrustaceans recorded a higher number of taxa in regions with rich submerged macrophytes. The diversity of microcrustaceans was generally low, due to the high percentage of nauplii and copepodites present in all sampling seasons. The findings of the present paper show that Lake Zoreni has a moderate water quality, with an on-going process of eutrophication despite its young age. Decomposing organic matter builds up in the ecosystem during the growing season, but the lake has relatively clean waters from this point of view, as shown by saprobic indicator values of phytoplankton and microcrustaceans.

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STUDIA UBB BIOLOGIA, LVIII, 2, 2013 (p. 55-68)

WATER QUALITY ASSESSMENT USING BIOTIC INDICES BASED ON BENTHIC INVERTEBRATES IN THE CARAȘ CATCHMENT AREA

COSMIN IVAȘCU [1,✉], COSMIN BALAUR [1], MIRELA CÎMPEAN[1] and KARINA PAULA BATTES [1]

SUMMARY. The present paper represents a study on benthic invertebrate communities from 9 sampling sites located in the Caraș River catchment area. The data were used to calculate different biotic indices and subsequently to assess the water quality in the area. The following biotic indices were considered: the Extended Biotic Index (E.B.I.), the Biological Monitoring Working Party (B.M.W.P.) and the Average Score Per Taxon (A.S.P.T.), already in use in different European countries. A total number of 75 taxa was found in three sampling seasons in 2012. The water quality from the Caraș River catchment area ranged from very good to moderate (classes I to III).

Keywords: A.S.P.T., B.M.W.P., diversity, E.B.I., similarity

Introduction

The Water Framework Directive 2000/60/EC of the European Parliament stipulates that water quality assessment should rely firstly on biotic communities, with physical and chemical parameters used to complete these data. In the last few years, numerous studies on water quality assessment based on invertebrates were performed in Romania, using European indices (Cîmpean, 2004; Avram *et al*., 2009).

The Caraș is a left tributary of the Danube River that flows in Romania and Serbia. There are numerous protected areas in its catchment area: the National Park Cheile Carașului – Semenic, the scientific reserves Cheile Carașului and Izvoarele Caraşului on its upper course, together with one site of community importance (SCI) ROSCI0226 Semenic – Cheile Caraşului, and one Special Protected Area (SPA) ROSPA0086 Munţii Semenic – Cheile Caraşului (Brînzan, 2013).

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The only previous studies on benthic invertebrates from the Caraș catchment area are Petrucean *et al*. (2009) and Eftenoiu *et al*. (2011), where only five sampling sites were considered. Thus, a systematic study was required in the area, due to its importance and uniqueness.

The major objectives of the present study are: (1) to provide a list of aquatic invertebrates from the investigated area; (2) to assess the water quality using benthic invertebrate communities; and (3) to identify the most drastic human impacts in the Caraș catchment area.

Materials and methods

The study area is represented by the Caraș catchment area. The river has its source in the western part of the Semenicului Mountains at 700 m a.s.l. The total drainage basin area is 1,118 km² and its total length is 110 km, out of which 85 km are in Romania. It flows through three different relief regions: (1) the upper one, located at an altitude ranging from 900 to 400 m a.s.l.; (2) the second one, a calcareous sector 28.5 km long, where the river forms a gorge; and (3) the lower part, a large alluvial plain. The river tributaries are relatively small, but symmetrical (Ujvari, 1972).

Nine sampling sites were considered, out of which three were located on the main river course (C1 – The Caraș River – source; C2 – The Caraș River – gorge; C3 – The Caraș River – Vrani) (Table 1; Fig. 1). C1 was located in the ”Izbucul Carașului”, right at the river source, and represented the first benthic invertebrate sampling location so far. C2 was situated inside the river gorge, near the river exit, while C3 was chosen in the proximity of the Serbian border, in the lowlands.

Table 1.

The nine sampling sites with the codes used for the present paper

Sampling site name	Sampling site code
The Caraș River – source	C1
The Caraș River – gorge	C2
The Nermed River	Ne
The Natra River	Na
The Lișava River – upstream the mine	L1
The Lișava River – downstream the mine	L2
The Lișava River – upstream the junction with the Caraș River	L3
The Ciornovăț River	Ci
The Caraș River – Vrani	C3

One sampling site was located on the Natra River (Na), but only spring samples were collected because in the other two seasons access was not allowed. This sampling location was upstream the uranium mine drained by the river.

Three locations were considered on the Lișava River (L1 – The Lișava River – upstream the mine; L2 – The Lișava River – downstream the mine; L3 – The Lișava River – upstream the junction with the Caraș River) (Fig. 1). L1 replaced the site from the Natra River. L2 was located near the Lișava and Natra Rivers's junction, downstream of the abandoned uranium mine, where the river waters became reddish in color, similar to the substrate.

Two other rivers were sampled, with one sampling location on each one: The Nermed River (Ne) and the Ciornovăț River (Ci) (Table 1; Fig. 1). The samplings from the Nermed River took place downstream of the homonym village, where the riverbed included a high percentage of bricks, tiles and other domestic wastes. The sampling site from the Ciornovăț River was situated downstream the five localities crossed by the river, before its junction with the Caraș River.

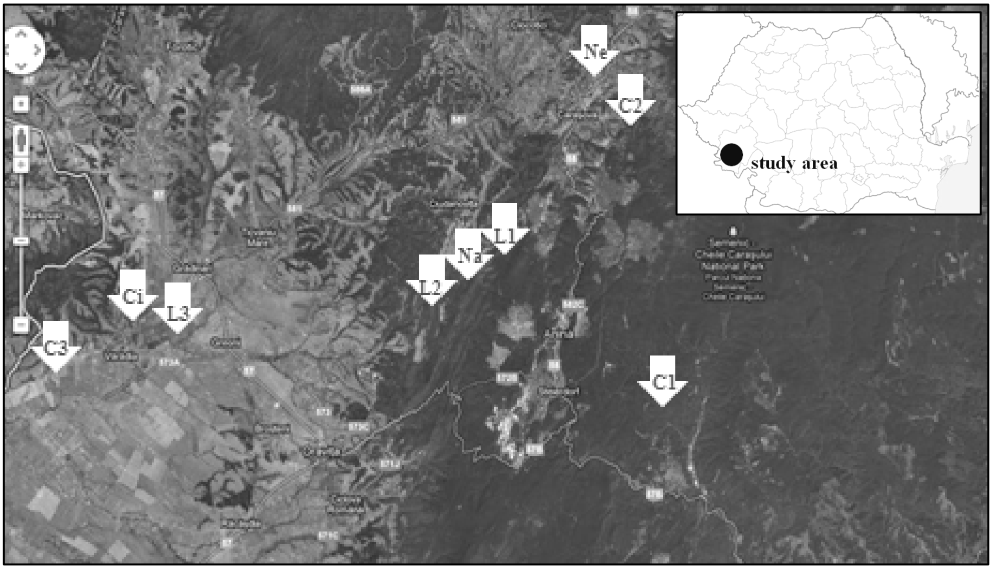

Figure 1. Location of the nine sampling sites from the Caraș catchment area (C1 – The Caraș River – source; C2 – The Caraș River – gorge; Ne – The Nermed River; L1 – The Lișava River – upstream the mine; Na – The Natra River; L2 – The Lișava River – downstream the mine; L3 – The Lișava River – upstream the junction with the Caraș River; Ci – The Ciornovăț River; C3 – The Caraș River – Vrani) (source: GoogleEarth)

Qualitative samples of benthic invertebrates were collected in 2012, in spring (1.05.2012), summer (6.08.2012) and autumn (28.10.2013). The samples were collected with a 250 µm mesh net and in 4% formaldehyde. Invertebrate identifications were made to the genus level for Plecoptera, Ephemeroptera, Turbellaria and Hirudinea; and to the family level for Oligochaeta, Copepoda, Amphipoda, Trichoptera, Diptera, Coleoptera, Odonata and Heteroptera. Based on these identifications, the following biotic indices were calculated: the Extended Biotic Index (E.B.I.), the Biological

Monitoring Working Party (B.M.W.P.) and the Average Score Per Taxon (A.S.P.T.). The E.B.I. (Ghetti, 1997) is used in Italy and it is included in the Italian environmental legislation. The B.M.W.P. was first developed in U.K. (Walley and Hawkes, 1996; 1997) and it was subsequently adapted for Poland. The A.S.P.T. represents the ratio between the B.M.W.P. and the total number of families in the sample. Table 2 presents the GPS coordinates of the nine sampling sites and their most important characteristics (river width and depth).

Table 2.

Location of the nine sampling sites from the Caraș catchment area, with their major characteristics (sp – spring 2012; su – summer 2012; au – autumn 2012)

Sampling site	Altitude (m a.s.l.)	GPS coordinates	Riverbed width (m)			Maximum depth (cm)		
			sp	su	au	sp	su	au
C1	760	N 45º04'40.16" E 21º54'56.52"	6	4.7	5.2	50	50	50
C2	235	N 45º12'03.11" E 21º52'22.30"	13	10.3	11	65	60	60
Ne	229	N 45º13'20.95" E 21º51'07.03"	5	1.8	4	50	30	35
Na	338	N 45º05'45.56" E 21º46'04.12"	2.5	-	-	30	-	-
L1	331	N 45º06'20.69" E 21º46'42.32"	-	2.8	2.5	-	25	20
L2	312	N 45º06'21.71" E 21º45'57.34"	2.7	1.5	1.6	20	15	15
L3	97	N 45º04'54.41" E 21º33'01.93"	6	5.6	5.1	60	40	35
Ci	101	N 45º05'33.01" E 21º33'01.16"	8	7.4	7	50	45	40
C3	88	N 45º02'57.47" E 21º28'49.42"	32	31	30	130	110	120

Results and discussion

Water temperature variation in the nine sampling sites and three seasons is characteristic to rivers having a longitudinal gradient from the water source to the mouth. The river source has a relatively constant water temperature throughout the year, with a few degrees variation, as for the C1 sampling site (The Caraș River – source) (Fig. 2). The water temperature increases from headwaters to mouth, with higher variations during summer (Fig. 2).

Tables 3 and 4 present the list of invertebrate taxa, identified to family or genus level, in accordance with the requirements for the biotic index calculation. The structure of benthic communities is a complex one, including 75 taxa belonging to different groups.

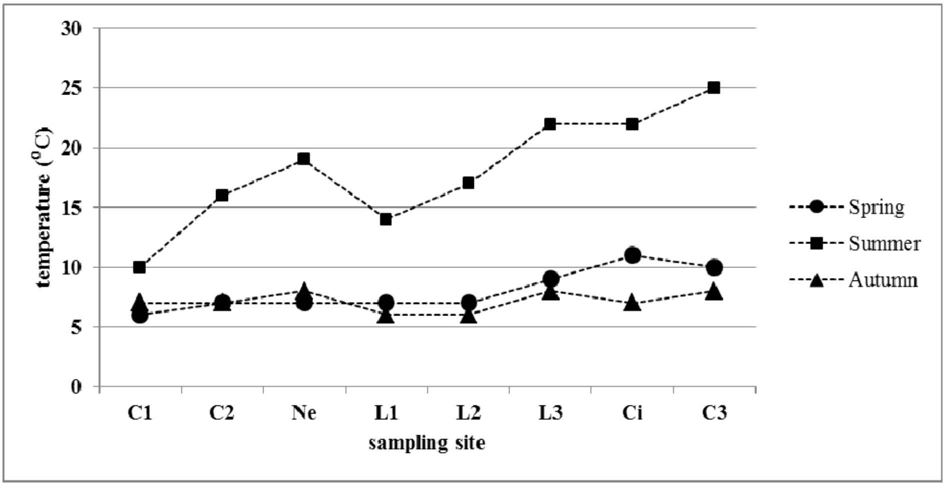

Figure 2. Variation of water temperature (°C) in three seasons during 2012, at the following sampling sites: C1 – The Caraș River – source; C2 – The Caraș River – gorge; Ne – The Nermed River; L1 – The Lișava River – upstream the mine; L2 – The Lișava River – downstream the mine; L3 – The Lișava River – upstream the junction with the Caraș River; Ci – The Ciornovăț River; C3 – The Caraș River – Vrani

Aquatic earthworms (Oligochaeta) appear in all sampling sites, with Family Naididae having the highest frequency of appearance in the sampling locations. Side-swimmers (Amphipoda) are present in all sampling sites, but not in all sampling seasons (Table 3; Table 4). Mayflies (Ephemeroptera) were identified in all sampling sites, but the genera diversity is higher in the headwaters of the Caraș River and its tributaries. At the Caraș River – gorge (C2) seven Mayfly genera were found (*Baetis, Caenis, Ephemera, Habroleptoides, Habrophlebia, Rithrogena* and *Torleya*), besides *Ecdyonurus*, the only genus found by Eftenoiu (2011) (Table 3). In the Nermed River (Ne), the same genus found by Eftenoiu (2011), *Ecdyonurus*, was joined by five others (*Baetis, Caenis, Ephemera, Habroleptoides* and *Serratella*). Similarly, at L1 – The Lișava River – upstream the mine 3 other genera (*Baetis, Habroleptoides* and *Rithrogena*) were identified besides *Ecdyonurus* and *Ephemera*, found by Eftenoiu (2011) (Table 4). The higher number of taxa in the present study is caused by systematic sampling, covering three seasons, which enabled us to find taxa in stages of their life cycles that are impossible to see in only one sampling occasion.

Stoneflies (Plecoptera) were present only in the headwaters: in the Caraș River (C1 – source and C2 – river gorge) and in the The Lișava River (L1 and L2 – upstream and downstream of the mine). Caddisflies include a high number of families in C1, C2 and L1, while in the rest of the sampling sites, no more than three Trichoptera families were present (Table 3; Table 4).

Table 3.

List of benthic invertebrate taxa identified in the three sampling sites located on the main river course (C1 – The Caraș River – source; C2 – The Caraș River – gorge; C3 – The Caraș River – Vrani; sp – spring 2012; su – summer 2012; au – autumn 2012)

Sites; seasons → Taxa↓	**C1 sp**	**C1 su**	**C1 au**	**C2 sp**	**C2 su**	**C2 au**	**C3 sp**	**C3 su**	**C3 au**
Nematoda						+			+
Oligochaeta									
Lumbricidae					+			+	+
Lumbriculidae	+	+	+		+	+			
Naididae		+			+		+	+	+
Copepoda									
Cyclopidae							+		
Ostracoda									+
Amphipoda									
Gammaridae	+	+	+	+	+	+		+	
Hydrachnidia		+	+		+	+			
Ephemeroptera									
Baetis	+	+	+	+	+	+	+	+	+
Caenis					+	+	+	+	+
Ecdyonurus	+	+	+		+	+			
Ephemera				+	+	+	+	+	+
Habroleptoides					+				
Habrophlebia				+	+	+			
Paraleptoflebia							+		
Rhithrogena				+	+				
Torleya					+	+			
Plecoptera									
Isoperla	+	+	+	+					
Leuctra			+		+	+			
Nemoura					+	+			
Trichoptera									
Beraeidae			+		+	+	+		+
Glossosomatidae			+		+				
Hydropsychidae				+	+				
Hydroptilidae			+		+				
Odontoceridae						+			
Philopotamidae	+		+	+	+	+			
Phryganeidae			+		+				
Rhyacophilidae	+	+	+						
Sericostomatidae			+			+			
Diptera									
Athericidae		+	+					+	+
Ceratopogonidae			+	+		+	+		+

Table 3. continued

Chironomidae	+	+	+	+	+	+	+	+	+
Empididae	+		+		+	+			
Limoniidae	+		+	+	+	+			
Psychodidae			+			+			
Ptychopteridae	+	+	+						
Tabanidae					+		+	+	+
Tipulidae									
Coleoptera									
Dryopidae	+		+	+	+	+			
Dytiscidae					+				
Elminthidae	+	+	+	+	+	+			
Others									
Helobdella						+			
Dugesia	+	+	+	+	+	+			
Gastropoda	+					+	+		+
Bivalvia					+	+			+
Asellidae									+
Corixidae					+	+	+	+	
Aeshnidae							+		+
Gomphidae				+		+	+		+
Lestidae					+				
Libellulidae								+	
Megaloptera						+			

Twelve two-winged fly families (Diptera) were identified in the sampling locations, with Family Chironomidae present in all sites and all seasons. Beetles (Coleoptera) recorded a high frequency of appearance in the sampling sites, missing from only one location: C3 – The Caraș River – Vrani. Similarly, the only site with no dragonfly representatives (Odonata) was The Caraș River source (C1).

Nine copepod species were identified in four sampling sites (Table 3; Table 4). Most copepod species are common to benthic and hyporheic habitats: *Acanthocyclops robustus* Sars 1863; *Diacyclops bisetosus* (Rehberg 1880); *Eucyclops serrulatus proximus* (Lilljeborg 1901) or *Paracyclops fimbriatus* (Fischer 1853) (Dole-Olivier *et al*., 2000). Some are benthic crawlers, like *Macrocyclops albidus* (Jurine 1820) or *Macrocyclops fuscus* (Jurine 1820). However, there are cosmopolitan species too, found in all kinds of waters: *Megacyclops viridis* (Jurine 1820) and *Canthocamptus staphylinus* (Jurine 1820). *Diacyclops bicuspidatus* (Claus 1857) is characteristic to springs.

Table 4.

List of benthic invertebrate taxa identified in the main tributaries of the Caraş River (Ne – The Nermed River; Na – The Natra River; L1 – The Lişava River – upstream the mine; L2 – The Lişava River – downstream the mine; L3 – The Lişava River – upstream the junction with the Caraş River; Ci – The Ciornovăţ River; sp – spring 2012; su – summer 2012; au – autumn 2012)

Sites; seasons → Taxa↓	Ne sp	Ne su	Ne au	Na sp	L1 su	L1 au	L2 sp	L2 su	L2 au	L3 sp	L3 su	L3 au	Ci sp	Ci su	Ci au
Nematoda	+		+						+			+			
Oligochaeta															
Haplotaxidae															+
Lumbricidae			+	+		+							+	+	+
Lumbriculidae	+	+	+	+	+										
Naididae		+	+	+			+	+	+	+	+	+	+	+	+
Copepoda															
Cyclopidae			+									+	+		+
Canthocamptidae			+												
Ostracoda			+												
Amphipoda															
Gammaridae		+		+	+	+	+	+	+	+	+	+	+		
Hydrachnidia			+	+	+	+	+	+	+	+		+		+	
Ephemeroptera															
Baetis	+		+		+	+	+		+		+	+	+		
Caenis		+	+							+	+	+	+	+	
Cloeon													+	+	+
Ecdyonurus	+					+	+	+	+						
Ephemera	+	+			+	+		+		+	+	+	+	+	
Habroleptoides	+			+	+	+									
Habrophlebia													+		
Rhithrogena					+		+	+							
Seratella	+														
Plecoptera															
Leuctra					+	+									
Nemoura				+	+	+	+	+	+						
Perla				+											
Siphonoperla				+											
Trichoptera															
Beraeidae	+	+	+		+	+					+	+	+	+	
Glossosomatidae			+			+									
Hydropsychidae				+			+								
Odontoceridae					+										
Philopotamidae				+	+	+		+	+			+			
Phryganeidae						+									
Rhyacophilidae					+	+	+								
Sericostomatidae				+	+	+									

Table 4. continued

Diptera															
Athericidae					+	+			+		+				
Blephariceridae					+										
Ceratopogonidae			+	+			+		+	+		+	+	+	+
Chironomidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Empididae	+					+	+		+	+		+			
Limoniidae			+	+	+	+	+	+				+		+	
Psychodidae			+	+		+									+
Simuliidae			+												
Stratiomidae	+			+		+									
Tabanidae			+									+	+	+	+
Tipulidae			+	+								+			+
Coleoptera															
Dryopidae					+	+			+						
Dytiscidae	+											+			
Elminthidae			+	+	+	+	+	+	+	+		+	+	+	+
Hydraenidae			+												
Others															
Helobdella														+	+
Piscicola													+	+	
Dugesia				+	+	+									
Gastropoda			+	+									+		+
Bivalvia								+	+					+	+
Ligiidae							+								
Trachelopodidae														+	
Corixidae		+								+	+	+		+	
Aeshnidae		+									+	+	+	+	
Calopterygidae							+								
Coenagrionidae														+	
Cordulegasterida										+			+		
Gomphidae	+		+	+		+	+		+	+	+	+			+
Lestidae								+							
Plactynemididae			+						+			+			
Megaloptera							+	+		+					

The total number of taxa varies depending on the sampling site and sampling season, with higher values in autumn 2012. The maximum number of taxa was found in the Caraș River gorge (C2), reaching 32 taxa in summer 2012 (Fig. 3).

Similarity analysis based on the Jaccard index showed the existence of two clusters. The first one includes the benthic communities from L1 and C1 sampling sites (that are 60% similar), together with the biota from C2 (Fig. 4). All these three locations withstand low or no human impacts, because they are included in protected areas (The National Park Cheile Carașului – Semenic, ROSCI0226 Semenic – Cheile Carașului, ROSPA0086 Munții Semenic – Cheile Carașului).

a.

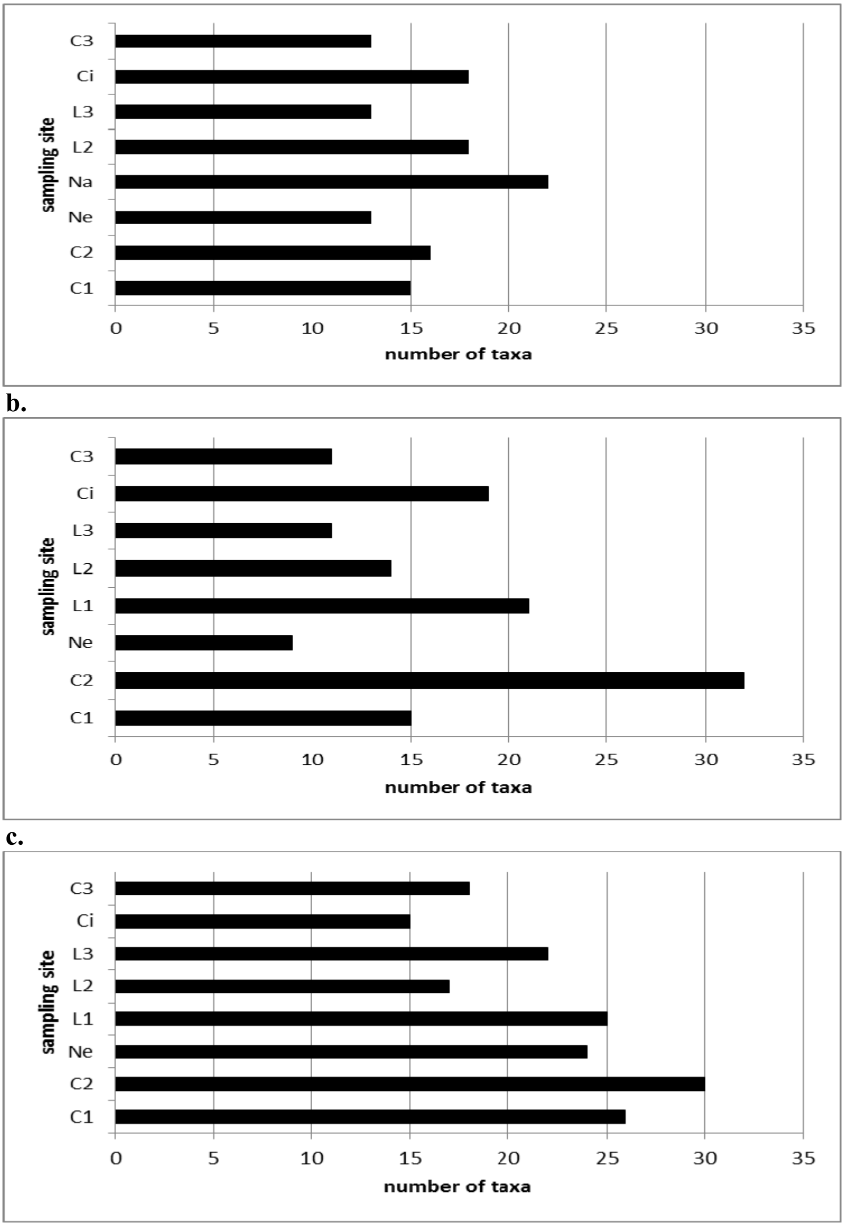

Figure 3. Number of taxa present at the sampling sites from the Caraş catchment area in spring (a), summer (b) and autumn (c)(C1 – The Caraş River – source; C2 – The Caraş River – gorge; Ne – The Nermed River; L1 – The Lişava River – upstream the mine; Na – The Natra River; L2 – The Lişava River – downstream the mine; L3 – The Lişava River – upstream the junction with the Caraş River; Ci – The Ciornovăţ River; C3 – The Caraş River – Vrani)

Benthic communities from The Nermed River (Ne), The Lișava River – upstream the junction with the Caraș River (L3) and The Ciornovăț River (Ci) form the second cluster (50% similarity) probably due to similar human impacts, caused by the presence of human settlements along the rivers. The rest of the three sampling sites differ from the ones presented above: C3, The Caraș River – Vrani, accumulates all the negative effects from the river catchment area, because it is located downstream, near the Serbian border; L2, The Lișava River – downstream the abandoned uranium mine, where the river water has a reddish colour; and finally, Na, The Natra River, where only spring samples were collected (Fig 4.).

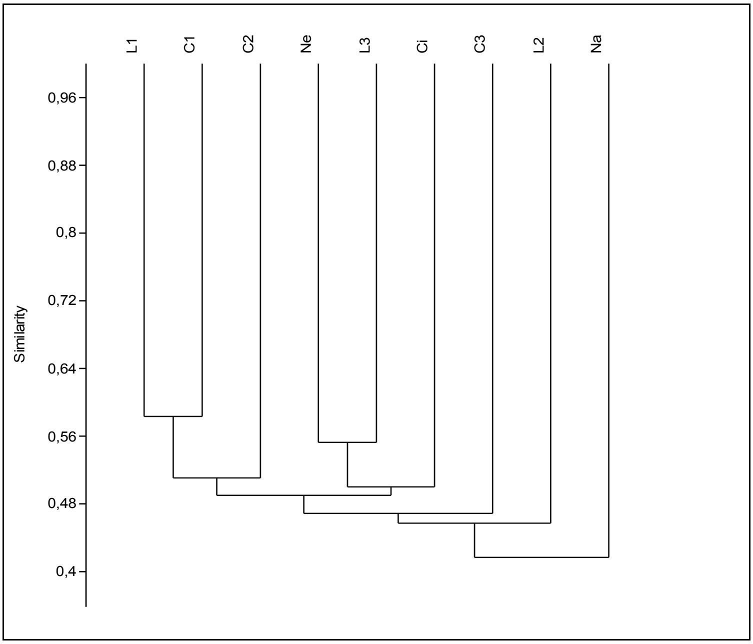

Figure 4. Similarity of benthic communities from the nine sampling sites (C1 – The Caraș River – source; C2 – The Caraș River – gorge; Ne – The Nermed River; L1 – The Lișava River – upstream the mine; Na – The Natra River; L2 – The Lișava River – downstream the mine; L3 – The Lișava River – upstream the junction with the Caraș River; Ci – The Ciornovăț River; C3 – The Caraș River – Vrani) based on the Jaccard index

In order to assess the water quality from the Caraș catchment area, quality classes were estimated based on three biotic indices: E.B.I., B.M.W.P. and A.S.P.T. Since different indices indicated different quality classes in several occasions, only one class was accepted, based on expert judgment (Table 5, Fig. 5).

At the Caraș River source (C1), with no human impacts, the water quality class was II, and not I, as expected. This is due to a series of limiting factors, like constant low water temperatures, variable volume of water depending on precipitations etc. Biotic indices consider the sensitivity of invertebrates to environmental factors, and spring habitats differ from ”true” lotic ones. In case of the Caraș River, Plecoptera and Ephemeroptera genera, known to be sensitive to pollution, are poorly represented in the headwaters, but they were identified downstream. They were replaced by side-swimmers (Amphipoda), considered to be more tolerant to pollution.

Good and very good water quality was found in the Caraș River gorge (C2) and in the Lișava River, upstream the mine (L1), because of the high number of taxa sensitive to pollution. Even if in the Lișava River, downstream the abandoned uranium mine (L2) the water quality decreased (biotic indices showed moderate quality, class III), a clear improvement was seen in L3 (The Lișava River – upstream the junction with the Caraș River) due to the natural cleaning processes, in spite of the agricultural lands and human settlements along the river. The Natra River had a good water quality in spring 2012 (class II); in the other two seasons no samples were collected due to lack of access in the area.

The sampling site from the Nermed River was located downstream of the homonym locality and the good-moderate quality of the water (class II-III) reflected the human impacts caused by the village. Similarly, the water quality from the Ciornovăț River was only moderate (class III) due to intensive farming and the impact of the five rural communities located in the river catchment area of 124 km^2. Finally, the last sampling site, the Caraș River – Vrani (C3), located near the Serbian border, reflected the synergic effects of all impact factors from the river catchment area (agriculture, uranium mine, domestic wastes from human settlements), reaching only the moderate water quality (class III).

Table 5.

The quality classes calculated according to the three biotic indices and accepted quality classes, for the sampling sites considered in the Caraș catchment area (E.B.I. – Extended Biotic Index, B.M.W.P. – Biological Monitoring Working Party, A.S.P.T. – Average Score Per Taxon, C1 – The Caraș River – source; C2 – The Caraș River – gorge; Ne – The Nermed River; L1 – The Lișava River – upstream the mine; Na – The Natra River; L2 – The Lișava River – downstream the mine; L3 – The Lișava River – upstream the junction with the Caraș River; Ci – The Ciornovăț River; C3 – The Caraș River – Vrani)

Sites	E.B.I. quality classes	B.M.W.P. quality classes	A.S.P.T. quality classes	Accepted quality classes
C1	I-II	III	I-II	II
C2	I	I-II	II	I-II
Ne	II	III-IV	II-III	II-III
Na	I	III	III	II
L1	I	II	I-II	I-II
L2	II	III	III	III
L3	I-II	III-IV	II-III	II-III
Ci	II-III	III	III	III
C3	II	III-IV	III	III

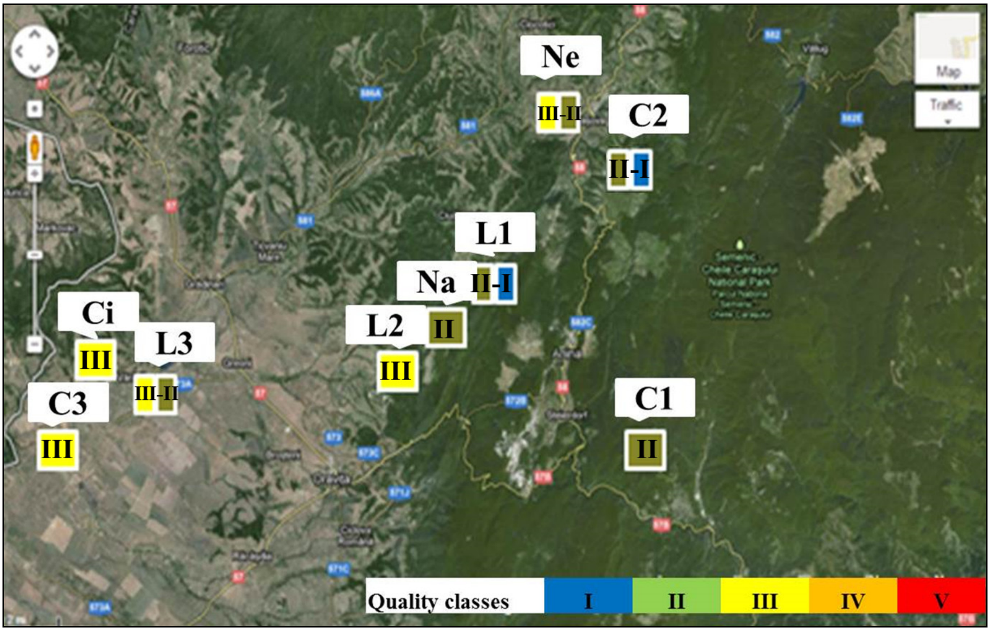

Figure 5. The accepted quality classes according to the considered biotic indices for the nine sampling sites in the Caraș catchment area (C1 – The Caraș River – source; C2 – The Caraș River – gorge; Ne – The Nermed River; L1 – The Lișava River – upstream the mine; Na – The Natra River; L2 – The Lișava River – downstream the mine; L3 – The Lișava River – upstream the junction with the Caraș River; Ci – The Ciornovăț River; C3 – The Caraș River – Vrani)

Conclusions

A total number of 75 taxa was found in the Caraș River catchment area, with the highest number of taxa identified at the Caraș River gorge. Jaccard similarity clearly differentiated the benthic communities characteristic to clean habitats (living in the sampling sites located in the headwaters for example) and those located in impacted environments, like the one from downstream of the abandoned uranium mine or the one situated in the Caraș lower course.

The water quality from the Caraș River catchment area ranged from very good to moderate (classes I to III), however no poor or bad water quality classes (IV and V) were depicted by the biotic indices in the nine sampling sites. This fact could be caused by the lack of major human settlements in the area and the lack of heavy industrial areas. However, the water quality decreased from the headwaters to mouth, since several human impacts were present on the river course and on its tributaries: domestic wastes, intensive agriculture, or the uranium mine.

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DIURNAL LEPIDOPTERA COMMUNITIES FROM NATURA 2000 SITE „DEALURILE CLUJULUI EST"

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SUMMARY. The Natura 2000 Site "Dealurile Clujului Est" is a vast area (24,405 ha) with valuable steppic and forest habitats still very well preserved, but very threatened in the future by real estate development and regional agricultural projects, which will increase because of the proximity of Cluj Napoca metropolitan area. The xeric and mesoxeric steppe meadows harbor a high diversity of plants and animals. In this study we tried to emphasize the importance of this site for the butterfly biodiversity in Transylvanian cultural landscape. We used the transect method, investigating three habitat types: peri-pannonian subcontinental shrubs (40A0*), subpanonnian steppic meadows (6240*) and *Molinia* meadows (6410), identifying a total of 50 butterfly species. Using similarity measures and ANOVA we showed the similarity between habitat types, regarding the species number, their diversity and equitability, and the number of individuals. We also tried to highlight the number of species with different conservation status, and their distribution in the studied habitat types.

Keywords: butterfly, habitat conservation, protected habitats, similarity, traditional landuse.

Introduction

Semi-natural grasslands represent key habitats for maintaining biodiversity in European agricultural areas (Stoate *et al.*, 2009). This grasslands shelter numerous species whose initial habitats have been destroyed on vast areas (Baur *et al.*, 2006). "Dealurile Clujului Est" site is a very important diversity spot, where we can find the largest populations of *Centaurea trinervia* from our country, one of the largest populations of *Goniolimon tataricum* from Romania and Europe, and some very rare species, like *Nepeta ucranica*, *Ranunculus illyricus*, *Astragalus asper* (Bădărău *et al.*, 2000). In this site, Wilson *et al*. (2012) registrated the global richness record for

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semi-dry basiphilous grasslands. Another important aspect of this site is the presence of the *Maculinea* species complex (*M. arion*, *M. alcon*, *M. „rebeli"*, *M. teleius* and *M. nausithous*), this being the only place from Europe where we can find this situation (Vodă *et al.*, 2009). The proximity of Cluj Napoca metropolitan area with all its real estate, industrial and agricultural projects is a real menace for the future conservation of the site, of the habitats and rare population within it. One of the reason they were better preserved in this area is that the most of the site was used until War World Two anly as a meadow for Cluj Napoca and it's, meanwhile other grasslands from Transylvania were turned into agricucltural crops or overgrazed. Nowadays, the establishment of a Natura 2000 site aims to protect habitats and rare species populations in this area from the threat of real estate projects, agricultural farms and the industrialization. The cultural landscape of the mosaic grasslands from "Dealurile Clujului Est" area with its specific structures it's already affected by the changes in the land use (extensive mowing and grazing) (Natura 2000 standard form, 2011). At the same time the terrain abandonment, drainages, industrial plans are other factors that can lead to the loss of this very important site, with its habitats and rare species. In this study we document the diurnal lepidoptera diversity of semi-natural grasslands, and highlight the importance of these habitats in the Natura 2000 Site "Dealurile Clujului Est".

Materials and methods

The site is located at about 30 km from Cluj Napoca city (Fig. 1, red dot), in the geographic unit called "Dealurile Clujului şi Dejului", wich are located south of the Someşan Plateau. The habitats found in the site are the following: sub-pannonian steppic grasslands (6240*), lowland hay meadows (6510), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (6410), pannonian salt steppes and salt marshes (1530*), subcontinental peri-pannonian scrub (40A0) and dacian oak & hornbeam forests (91Y0) (Gafta and Mountford, 2008).

The altitude of the study locations was about 300 m above sea level. We used the transect method, taking the samples with the entomological net. All the butterflies were counted, by species, in an imaginary space of 2.5 m each side, 5 m ahead and 5 m above. The transects were located in 4 sites: Fânaţul Domnesc (46°55.316'N, 23°44.130'E), Fânaţul Sătesc (46°55.518'N, 23°43.660'E), Fânaia (46°53.428'N, 23°42.302'E) and Secheliște (46°53.372'N, 23°42.011'E).

The data were collected from 3 habitat types, each one of them with 3 transects (Fig. 2), 100 m long each: sub-pannonian steppic grasslands (two in Fânaţul Domnesc, one in Fânaia), *Molinia* meadows (two in Fânaţul Domnesc and one in Secheliște) and subcontinental peri-pannonian scrub (one in Fânaţul Sătesc, one in Fânaţul Domnesc, one in Secheliște). The surveys where made in good, sunny weather conditions, with temperatures above 18ºC, wind-speed less than 15 km/h, between 10:00 AM and 16:00 PM, from 21.05.2013 to 05.09.2013, every two weeks. We recorded all species from Rhopalocera and Hesperiidae. The identification of diurnal Lepidoptera was made after Tolman and Lewington (2008).

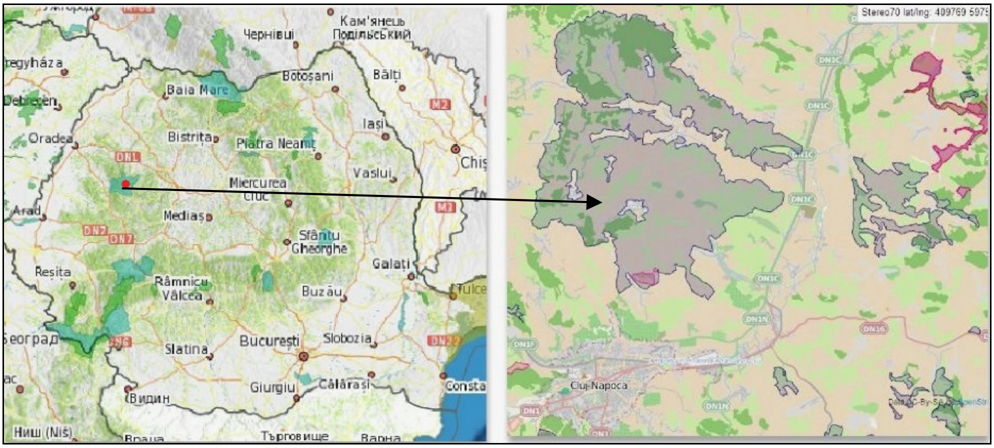

Figure 1. Maps showing the location of Natura 2000 Site “Dealurile Clujului Est” (http://www.natura2000.ro/resurse/harta/arii/)

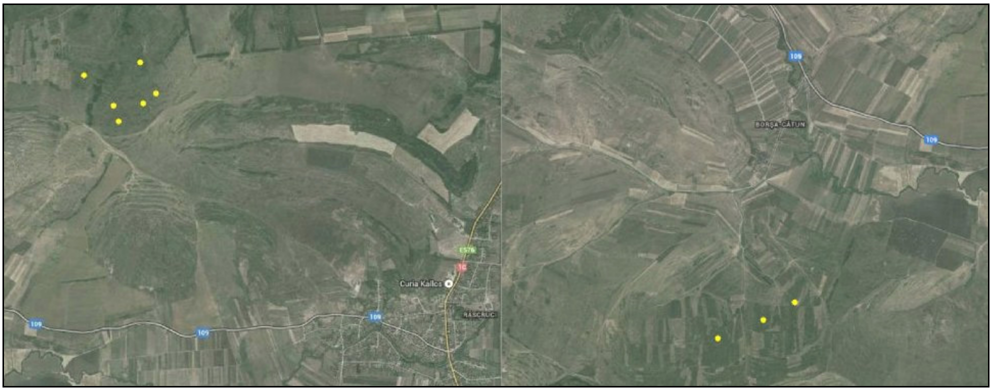

Figure 2. Location of the transects (left image - Fânaţul Domnesc and Fânaţul Sătesc, right image - Sechelişte and Fânaia)

We assessed the species richness and the number of individuals in all sites and habitat types. We computed the Shannon-Wiener diversity index and Pielou evenness index. To compare different types of habitats we used Kruskall-Wallis and one-way ANOVA. In order to compare similarity of the butterfly communities in different sites and habitat types we used single-link clustering method with Morisita’s index of similarity. For data analyses we used Past 2.09 (Hammer and Harper, 2001) and Statview 5.0 (SAS Institute, 1992-1998) statistical programs.

Results and discussion

A total number of 50 species of diurnal Lepidoptera were found in the 5 sampling months, belonging to 5 different families: Nymphalidae (20), Lycaenidae (18), Pieridae (6), Hesperidae (4) Papilionidae (2) (Table 1). The total number of individuals was 2742, found in all 9 transects.

Table 1.

The list of diurnal Lepidoptera from the studied area

TAXON	No. of ind.	Biogeographical profile	Ecological profile	Red list
Hesperiidae				
Ochlodes sylvanus	10	Eua	U	LC
Pyrgus malvae	8	Eua	Mx	LC
Thymelicus lineola	23	Hol	U	LC
Thymelicus sylvestris	36	V.Pal	U	NT
Papilionidae				
Iphiclides podalirius	6	Eua	Xt	VU
Papilio machaon	7	Hol	M	EN
Pieridae				
Aporia crataegi	42	Pal	M	NT
Colias croceus	21	E.Vas.	U	LC
Colyas hyale/alfacariensis	147	E.Vas.	Xt	LC
Leptidea juvernica	163	Eua	M	LC
Pieris brassicae	13	S.Eur.	U	VU
Pieris rapae	7	Pal	U	LC
Lycaenidae				
Callophrys rubi	12	Pal	Mxt	LC
Celastrina argiolus	9	Hol	M	LC
Cupido minimus	9	S.Eur.	Xt	NT
Glaucopsyche alexis	28	S.Eur.	Xt	LC
Lycaena alciphron	1	Eua	Mh	VU
Lycaena dispar	1	S.Eur.	H	VU
Lycaena tytirus	1	Eua	M	NT
Maculinea alcon	10	S.Eur.	Mh	EN
Maculinea nautisthous	8	S.Eur.	Mh	CR
Maculinea "rebeli"	13	S.Eur.	Mx	VU
Maculinea teleius	19	S.Eur.	Mh	EN
Plebejus argus	271	S.Eur.	M	LC
Plebejus argyrognomon	5	S.Eur.	Mx	LC
Polyommatus bellargus	1	Eur	Mxt	NT
Polyommatus coridon	1	E.Vas.	Mxt	NT

Table 1. continued

Polyommatus icarus	135	Pal	U	LC
Satyrium pruni	4	S.Eur.	Xt	NT
Satyrium spini	15	Eur	Xt	NT
Nymphalidae				
Aphantopus hyperanthus	52	S.Eur.	M	LC
Argynnis addipae	5	Pal	Mxt	NT
Argynnis aglaja	8	Pal	M	NT
Argynnis paphia	15	Pal	M	LC
Boloria dia	3	Eua	Mx	LC
Brenthis daphne	1	S.Eur.	M	VU
Brenthis hecate	155	Eua	M	VU
Coenonympha arcania	3	V.Pal	U	LC
Coenonympha glycerion	20	V.Pal	U	NT
Coenonympha pamphilus	112	Pal	M	LC
Erebia medusa	1	S.Eur.	Mxh	NT
Inachis io	2	S.Eur.	U	LC
Lasiommata maera	6	Pal	Xt	LC
Maniola jurtina	702	V.Pal	M	LC
Melanargia galathea	470	E.Vas.	M	LC
Melitaea athalia	8	S.Eur.	U	NT
Melitaea aurelia	8	Eua	Mxt	VU
Melitaea phoebe	16	Pal	Xt	NT
Minois dryas	75	S.Eur.	Xt	NT
Vanessa atalanta	2	Hol	U	LC
Vanessa cardui	11	Cos	U	LC

Abbreviations:

Biogeographical profile: Eur-european, Eua-eurasian, Hol-holarctical, Pal-Palearctical, Cos-Cosmopolitan, S.Eur.- sibero-European, E.Vas.-European-west-asian.
Ecological profile: U-ubicvist, M-mesophilic, Mx-meso-xerophilic, Mt-meso-thermophilic, Mh-meso-hygrophile, Mxt-meso-xero-thermophilic, Xt-xero-thermophilic, H-hygrophilic.
Red list: LC-least concern, NT-near threatened, VU-vulnerable, EN-endangered, CR-critically endangered.

Of all of these species, 25 (50%) have different degrees of endangerment: 13 near threatened, which means 50% of all species found. This demonstrates once again the importance of this site (Rákosy *et al.*, 2003).

From a biogeographical point of view, the Sibero-European species are dominant, followed by the Palearctical and European-Asian ones. The other categories (Cosmopolitan, European-west-asian European, Holartical, West-palearcitcal) are poorly represented (Fig. 3) (Rákosy, 2007). Regarding the ecological profile, we can observe that the dominant species are the mesophilic ones. Species with a high ecological tolerance are also very well represented in the study, as the ones that prefer warmth and dryness (Fig. 3 and 4) (Rákosy, 2007).

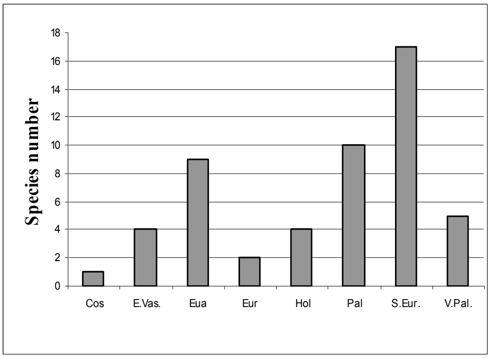

Figure 3. The biogeographical profile of the diurnal Lepidoptera identified species (Eur-european, Eua-eurasian, Hol-holarctical, Pal-Palearctical, Cos-Cosmopolitan, S.Eur.- sibero- EEuropeanEuropean, E.Vas.-European-west-asian)

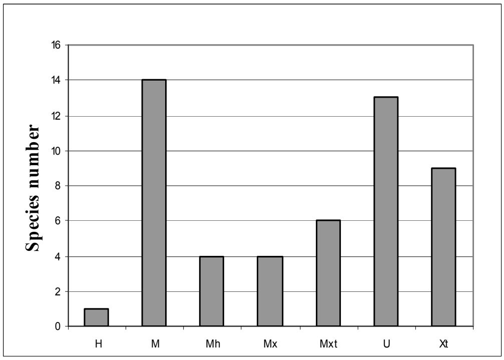

Figure 4. The ecological profile of the diurnal Lepidoptera identified species (U-ubicvist, M-mesophilic, Mx-meso-xerophilic, Mt-meso-thermophilic, Mh-meso-hygrophile, Mxt-meso-xero-thermophilic, Xt-xero-thermophilic, H-hygrophilic)

The average number of species per habitat shows that the subcontinental peri-panonian shrubs have the highest number of species, followed by steppe grasslands and then *Molinia* grasslands (Fig. 5).

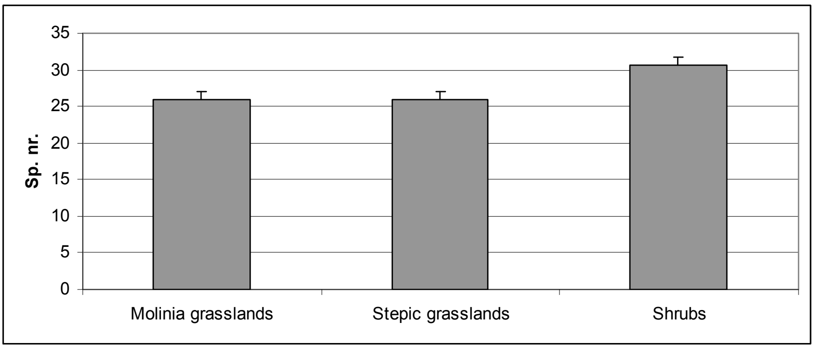

Figure 5. Average number of species by habitat type

The Kruskal-Wallis analysis of variance shows that there are not any major differences between the three habitat types investigated, regarding the species number, their diversity and equitability (Table 2).

The ANOVA similarity test showed significant differences regarding the number of individuals in the different habitat types (F_2=5.87, p=0.049), and post-hoc test showed a higher number of individuals in the *Molinia* compare to the steppe grasslands (Fig. 6).

Table 2.

Kruskal-Wallis one-way analysis of variance

	H	P value	Degrees of freedom DDL
Species Number	4.444	0.1084	2
Equitability	0.250	0.8825	2
Diversity	2.889	0.2359	8

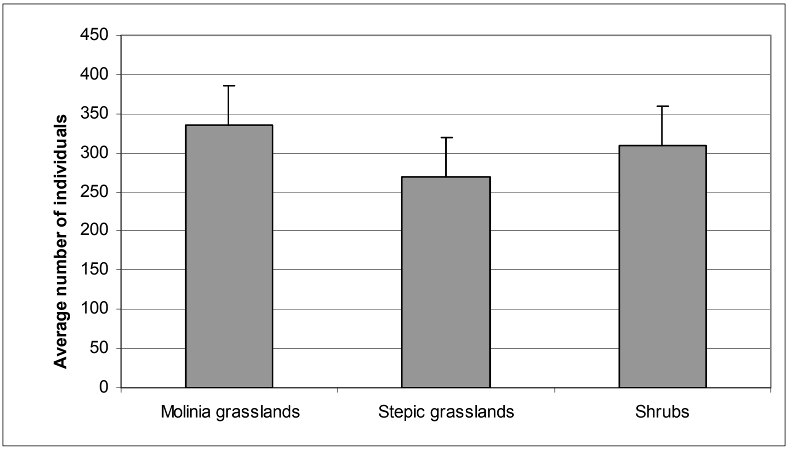

Figure 6. The average number of individuals by habitat type

Looking at the similarity in species composition, the sampled butterfly communities are grouped by locality (Fig. 7). The two transects from Sechelişte are very similar in species composition, even if there are in different habitat types (*Molinia* grasslands and peripanonian shrubs). The communities from the *Molinia* grasslands in Fânaţul Domnesc are as well very similar, like the ones from the steppe grasslands.

Regarding the species from the Red List, the *Molinia* grasslands from “Dealurile Clujului Est” have a significantly higher number of endangered species then the peri-panonian shrubs and the xerophilic grasslands ($F_{\text{degrees of freedom}}$=5.672, p=0.0414) (Fig. 8). Comparing the least concern, near threatened, vulnerable, and critically endangered species, there was no major differences between the three studied habitat types.

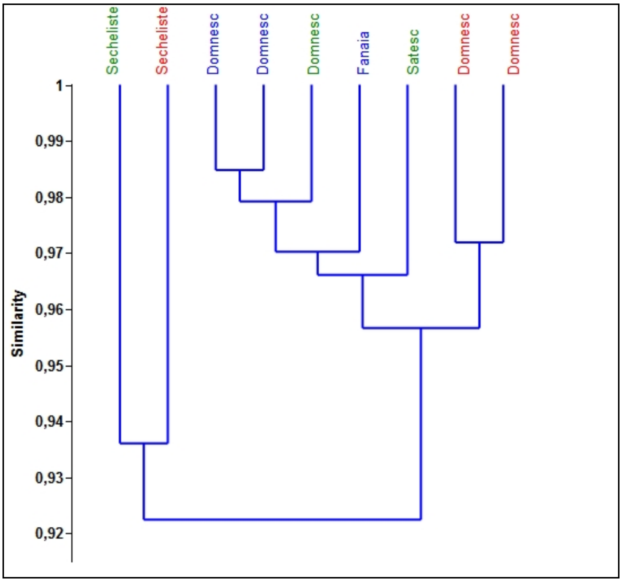

Figure 7. Similarity (Morisita index) in species composition cluster (single-linkage method) (from left to right: the 1st, 5th and 7th habitat type - peripanonnian shrubs; the 2nd, 8th and 9th - *Molinia* grasslands; the 3rd, 4th and 6th - steppe grasslands)

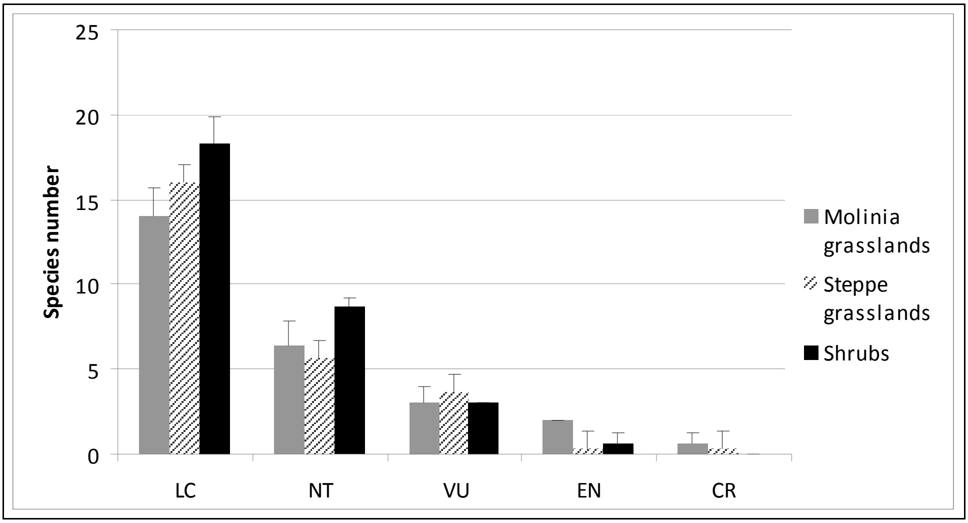

Figure 8. The average number of Red List species in each habitat type (LC-least concern, NT-near threatened, VU-vulnerable, EN-endangered, CR-critically endangered)

Conclusions

A number of 50 diurnal Lepidoptera species was found in the studied habitat types in Natura 2000 Site “Dealurile Clujului Est”, but the total number of species from this site goes up to 80 (Rákosy and Laszloffy, 1997).The average number of species per habitat shows that the highest is in the peri-panonan shrubs areas. Most species are sibero-European and mesophilic There were significant differences between *Molinia* and steppe grasslands, regarding the number of individuals. The sampled butterfly communities are grouped by locality and not by habitat type. Half of the species are on the Red List with different degrees of endangerment, the number of endangered ones being significantly higher in the *Molinia* grasslands compared to the other two habitat types.

There are some necessary measures for the protection of this site in the future: maintaining grassland ecosystems by extensive grazing and traditional mowing, maintaining the mosaic landscape by grazing, alternating shrub areas with grassland areas (Page *et al.*, 2012). From this study we weren’t able to find significant differences in diurnal Lepidoptera fauna between different types of land use (for exemple: grazed and mowed land, or abandoned and grazed/mowed land, etc.), but a curent underway study, using alternative diurnal Lepidoptera evaluation methods, will probably mark out this kind of differences. Information and public awareness actions are very important, too. People in this area need to know about the existence of this site, about the importance of maintaining the current high biodiversity of these cultural landscapes. They also need to be informed about the possibility of accessing agro-environmental founds for the *Maculinea* sp. meadows.

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TEMPORAL PATTERN OF DORMOUSE NESTBOXES USE BY DIFFERENT ANIMAL SPECIES

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SUMMARY. The temporal pattern of artificial nestboxes use by coexisting dormouse (*Gliridae*), passerine bird, amphibian and invertebrate species and the interspecific interaction between them were analyzed in a deciduous forest in the Transylvanian Plain. The active and/or breeding season for several species overlap for at least a time period and competition and predation were observed between them. The fat dormouse *Glis glis* outcompetes and/or predates on bird and other dormouse species, but also peacefully coexists inside the same nestbox with the tree frog *Hyla arborea* and the Copper Underwing moth *Amphipyra pyramidea.* The Great Tit *Parus major* seems to be unaffected by the competition for nest sites or by nest predation.

Keywords: amphibian, interspecific competition, passerine bird, predation, secondary cavity nesters

Introduction

The communities formed by different species that nest in natural tree holes or artificial nestboxes are shaped by the relationships between them. Cavity nesting species interacts with each other through competition for nest sites (Aitken et al., 2002), but also by predation (Brightsmith, 2005). For secondary cavity nesters, the species that do not excavate their own nesting sites, the availability of tree holes can constitute a limiting factor and interspecific competition may appear (Rhodes et al., 2009; Pöysä and Pöysä, 2002; Juškaitis, 1995). In temperate deciduous forest of Europe, dormice and birds use the same nest sites – tree cavities and artificial nestboxes (Adamik and Král, 2008) and interactions between them have been reported, as competition, but also as predation (e.g. Walankiewicz, 2002; Koppmann-Rumpf et al., 2003; Juškaitis, 2006; Adamik and Král, 2008). When the activity and/or breeding periods are distinct in time, interaction can be avoided, but in recent years, due to climate

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change, shifts in phenology of fat dormice and several species of passerine birds have been recorded, leading to temporal overlapping of nestbox use and thus to a negative effect on passerine populations (Adamik and Král, 2008; Koppmann-Rumpf et al., 2003).

The study was initially focused on estimating the abundance and density of dormice species using nestboxes (Sevianu and David, 2011), but during the research we recorded high nestbox occupancy by other animal species. In this paper we analyze i) the temporal pattern of nestboxes use and ii) the interspecific interactions between three species of dormice (fat dormouse *Glis glis*, common dormouse *Muscardinus avellanarius* and forest dormouse *Dryomys nitedula*), two species of Passerine birds (European Starling *Sturnus vulgaris*, Great Tit *Parus major*) and also several other less frequent species.

Materials and methods

The study took place in Ciuașului Forest, a 53 ha hornbeam and sessile oak forest, situated at low altitude (280-430m) in the Transylvanian Plain, Romania (For a detailed description of the study area, see Sevianu, 2009). In this forest, 100 dormouse wooden nestboxes were installed in the spring of 2005, in two parallel line-transects, 20 m apart. The nestboxes were mounted facing the tree trunks, in an attempt to prevent bird species from occupying them.

Data were collected monthly between March and October 2005-2012. One nestbox was considered occupied by a certain species when at least one individual was found inside or when the nest, brood, food remains or other sure signs were detected.

Results and discussion

In the forest analyzed during our study, the dormouse nestboxes were used by mammals, birds, amphibians and invertebrates. We encountered five mammal species: three species of dormice (*G. glis, M. avellanarius* and *D. nitedula*), a murid rodent (*Apodemus flavicollis*), and a microchiropteran bat (*Pipistrellus pipistrellus*); two bird species (*Parus major* and *Sturnus vulgaris*); one amphibian species (*Hyla arborea*) and three invertebrate species: a hornet (*Vespa crabro*), a moth (*Amphipyra pyramidea*) and an ant (*Lasius fuliginosus*). The presence of *P. pipistrellus* was recorded only once (two individuals), inside an empty nestbox, and can be considered an accidental species inside dormouse nestboxes.

European Starling was the first species to visit the nestboxes in the spring, as early as the beginning of March. Male Starlings arrive from migration before females and start building nests between late March and early April (Cramp and Perrins, 1994). Starlings deposited fresh plant material, mainly leaves and flowers of *Corydalis bulbosa* and *Aegopodium podagraria*, together with *Coryllus avellana* catkins, inside the nestboxes, either in empty nestboxes or as an addition to the newly started nests. Starlings have already been reported to carry plant material inside dormice nestboxes (Juškaitis, 2010). This behavior is exhibited only by male starlings and seems to be linked with the pair formation and/or mate attraction (Brouwer and Komdeur, 2004), but the onset time reported varies from a maximum of 5 days before egg laying (Gwinner, 1997) to 18 days, on average 8.7±1.0 days before laying of the first egg (Brouwer and Komdeur, 2004). At our study site we found fresh green material inside nestboxes maximum 28 days before the onset of egg lying, as early as the 11th of March, a much longer period before egg laying that previously reported.

Starlings may have up to three clutches per year, but at our study site we observed only one, laid in the first half of April, reported for central and east Europe as the first clutch (Cramp and Perrins, 1994; Gwinner, 1997), and strongly synchronized, as reported in literature (Meijer *et al.*, 1999). The nestbox usage by Starlings was overlapping with the beginning of the active and breeding season of common and forest dormouse. Starling is a much larger species than either of them, and we did not record any case of predation of those dormice species upon Starling adults, nestlings or eggs, desertion of nests by Starlings due to dormice visits or any take-over by a dormouse of a nestbox already occupied by a Starling. On the contrary, it seemed that by occupying the nestboxes in early spring, Starlings had limited the access to nest sites for the two smaller species of dormouse, which were already active in April (Sevianu, 2009). Starling is an aggressive nest competitor species for other birds (Kerpez and Smith, 1990) that even kills potential competitors for nest sites (Kessel, 1957), and it may defend its nest against the smaller species of dormouse. Our findings are supported by the fact that no Starling nest was reported destroyed by either species of dormice in other studies (Juškaitis, 2006). The adult Starlings and the fledglings of the first brood deserted the nestboxes by the end of May - early June. Other species started to use the nestboxes at this time: *Apodemus flavicollis, Vespa crabro* and *Lasius fuliginosus*, but only to a limited extent. The two invertebrate species continued to use the nestboxes until late summer - early autumn and prevented the use by other species. We recorded no cases of predation upon or taken over of an invertebrate used nestbox by any other species. We also recorded a slight increase in the number of nestboxes used by the common dormouse after the nestboxes were vacated by Starlings, but only for a short period of time, as a massive colonization of nestboxes by the fat dormouse started after the species ended hibernation (Sevianu, 2009). The fat dormouse, a much larger species, outcompeted the smaller dormouse species which were once again driven out of the nestboxes (Sevianu and Filipaş, 2008). In September fat dormouse started hibernation and deserted the nestboxes, some of them being once more occupied by the common dormouse.

The beginning of the active fat dormouse season overlapped with the end of the first clutch rearing by Starlings. The two species interacted inside the nestboxes and we documented two cases of sure predation upon Starling fledglings. The second Starling clutch should have started 40–50 days after the first one, by the end of May, beginning of June (Cramp and Perrins, 1994; Gwinner, 1997). At our study site we could not record a second brood, and the last Starlings, adults and fledglings, deserted the nestboxes in early June. This kind of interaction between fat dormouse and Starling was, as far as we know, reported here for the first time. Predation on Starlings was prior documented only for the garden dormouse *Eliomys quercinus* (Yezerskas, 1961; Airapetyants, 1983, as cited in Juškaitis, 2006), a dormouse species not found at our study site. All species of dormice found in Europe have been reported to kill and/or destroy various species of bird nests, but it seems that those claims could not be supported for the common dormouse (for an extensive analysis, see Juškaitis, 2006). We found no signs of aggression upon Starlings, a much bigger species compared to the common dormouse, but also not on Great Tit, a smaller bird species that used nestboxes at our study site. Great Tit readily breeds in nestboxes when provided, even in small patches of woodland (smaller than 1 ha) (Loman, 2006), but, in contrast with the breeding colonies of Starlings, Great Tits are territorial birds that claim and defend a territory against conspecifics, realizing much lower densities (Kluyver, 1970). Great Tits nested inside the nestboxes during April – July at our study site. Although the time frame partially overlapped with the active season of all three dormouse species, no Great Tit nest was predated by dormice. We found this result rather interesting, as other studies documented quite a significant impact of both fat and forest dormouse on Great Tit populations, while the common dormouse made little impact (Juškaitis, 2006). In at least one occasion Great Tit continued breeding inside the nestbox even after a visit by the common dormouse (droppings found inside nestbox). Birds continuing breeding after common dormouse visits were reported also in Lithuania (Juškaitis, 2006), and other studies showed that Great Tits were able to defend their nests from common dormice, even by killing the intruders (Juškaitis, 1998).

We documented during our research nestbox sharing by different species. In July, August and September the fat dormouse shared some nestboxes with tree frogs and some with the Copper Underwing moth, and also in July the common dormouse shared a nestbox with the tree frog. The association between dormice and the tree frog was not obligate, as we found tree frogs inside empty nestboxes also, but the amphibian presence was perfectly tolerated by the dormice nesting inside. We encounter up to four tree frogs sharing a nestboxes with one or more fat dormice, even females with young. The nestbox sharing with several moth individuals, and the lack of any moth remains, might prove that the species was not eaten by either species of dormouse. As far as we know, there are no other records of nestbox sharing between those species.

Conclusions

The dormouse and bird species whose presence inside nestboxes is analyzed in this study are "secondary cavity nesters" that rely for suitable nest sites on natural cavities or on cavities excavated by "primary cavity excavators" (Aitken *et al*., 2002), but who readily occupy artificial wooden nestboxes provided by humans.

The overlapping between the time periods when two or more species use the nestboxes for breeding and/or shelter triggers interaction between them. Starlings and fat dormice prevent the use of nestboxes by smaller dormouse species (*D. nitedula, M. avellanarius*) by outcompeting them. Fat dormouse also predates on Starlings. Great Tit seems to be unaffected by either species of dormouse or by Starlings. Fat and common dormouse can tolerate the presence of tree frogs and the Copper Underwing moth inside the nestboxes.

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DAM RESERVOIRS – IMPACT UPON THE BIODIVERSITY

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SUMMARY. The increased number of dam reservoirs determined a special interest in order to know their ecological impact. There are generally recognized major impacts of hydrotechnical developments as the integral destruction of terrestrial and aquatic biocoenoses from the flooded area, the breakdown of the river connectivity, with a dramatic impact upon the upstream fish migration. There are also well known the alterations of natural flow pattern and of alluvial transport downstream of dams; many authors emphasize the reduction of biodiversity as a consequence of river damming. In the paper it is discussed mainly a case study – the environmental impact on biodiversity – of hydrotechnical developments on the Bistriţa valley (the Eastern Carpathians, Romania). In fact, the apparition of a new, lacustrine habitat, determined the installation in the new biotope of a lot of lentic organisms, which previously could not occur under stream conditions. The emergence of true phytoplankton and zooplankton communities determines a real increase of biodiversity at the watershed level.

Keywords: biodiversity, dam reservoirs, environmental impact.

Introduction

Today, on the Earth there are 45,000 large dam reservoirs, and about 800,000 smaller dam reservoirs; the total area flooded by all of them reaches 400,000 km^2. The reservoirs are constructed for water supply, flow regulation, water reserve for drought periods, energy production etc. (Cowie, 2002; Sikder and Elahi, 2013; WWF, 2004). In order to produce "green energy" the construction of new dams is going on.

In Romania there are 246 dams recorded in the "*World Register of Great Dams*".

Main environmental impacts of dams

The construction of more and more such hydrotechnical developments turned investigators' attention to their environmental impact, both during their construction and later, for a long term, on the duration of their existence and function (Antoniu,

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1993; Biswas, 2012; McCartney *et al*., 2001; Railsback *et al.,* 1991; Ridley and Steel, 1975; Solacolu, 1993 etc.).

Several aspects of their environmental impact were highlighted, the most important being:

- effective destruction of terrestrial and aquatic biocoenoses, occurring previously on the flooded area;
- breakdown of the river connectivity, respectively its multiple fragmentation in the case of a concatenation of dams, with a direct impact upon the upstream migration of certain fish populations for reproduction;
- alterations of natural flow patterns and of alluvial transport;
- diminishing the quality of wildlife habitat downstream of reservoirs;
- flood control i.e. the reduction of the risk for catastrophic inundations;
- reduction of biodiversity (according to Sayadi *et al*., 2009; Sikder and Elahi, 2013; McAllister *et al*., 2001; McCartney *et al*., 2001).

The first five categories of environmental effects are beyond any doubt, they being obviously manifested for each hydrotechnical development, but the sixth one – concerning the decrease of the biodiversity – has to be analyzed carefully.

Impact on watershed biodiversity

In fact, as a consequence of succeeding from the lotic regime to the lentic one, after the damming of a river, a new biotope appears, with characteristics much different from that of the river.

The water flow regime within the hydrographic basin is modified, it appears a water mass more or less stagnant, with a thermal stratification depending of seasonal climatic changes and, also, a specific light/depth distribution.

The change of the main characteristics of aquatic environment has – as one of the effects – the impossibility of part of stream-adapted biota to survive in the new conditions.

In the new lacustrine biotope appear and are installed, gradually, new populations, able to adapt to the stagnant water conditions; they will constitute, in time, the biocoenoses of a new ecosystem, entirely different as compared to that occurring previously in the flooded area of the hydrographic basin.

So, at the level of the whole watershed, besides of the species occurring previously in water courses, and that continue to exist in the river parts which were not included within the structure of the man-made lake, there are appearing other species of water organisms, which could not live before, in the biotope peculiar to running water. Hence, considering the diversity of living world in aquatic environment – at the scale of the whole hydrographic basin – it may be observed a certain increase of the total number of species. The increase of biodiversity determined by that ecological succession will be the greater the greater will be the difference between the characteristics of the limnic and the lotic, previous environment.

In order to examine the course of the ecologic succession from river to lake, its consequences upon the biodiversity of the watershed, it will be presented here part of some results of the studies carried on within the Bistriţa River (the Eastern Carpathians, Romania) (Cărăuş and Teodorescu, 2006; Miron *et al*., 1983); there are also considered the investigations carried on other impoundments in Romania.

The Bistriţa River was the target of a major hydrotechnical development during the sixth decade of twentieth century. This project resulted in the construction of a great dam at Bicaz and of other seven smaller dam reservoirs downstream; later, a small dam was built upstream Bicaz impoundment.

Before the closing of great concrete dam on the Bistriţa River (July 1st, 1960), the investigations carried on the diatoms in the main river and its tributaries, within the floodable area and adjacent zone, showed 162 taxa; all were benthic species, living on the river bottom. After flooding, most of these species survived, in the same water courses, upstream their flowing into Bicaz dam reservoir. Some of them were identified, after years, in the structure of lacustrine periphytic and microphytobenthonic communities.

The apparition of the new biotope (the maximum volume of the lake is 1.23 billion cubic meters, the maximum depth 90 m) offered conditions for installing of typical plankton algae. It may be emphasized that, previously, in the Bistriţa (a fast flowing river) did not occur any true plankton algae; otherwise, even now, on upstream sectors of the main tributaries, there are no plankton algae.

The first phytoplankton species appeared early after the damming. Later, their number surpassed 200 species, the phytoplankton becoming an important component of the ecosystem, in fact the main primary producer. There were observed even "water bloom" phenomena, - massive developments of certain populations (*Planktothrix rubescens*, *Volvox aureus* etc.), which proved the tendency to reservoir eutrophication.

The other component of plankton biocoenose – the zooplankton –was also missing in the Bistriţa River and its tributaries before the apparition of Bicaz Reservoir; fast water flowing of the river, its turbulence, the presence – sometimes – of large amounts of suspensions hindered the presence of animal plankton.

During the first six years after the closing of the dam, 72 zooplankton species were identified; later, alongside the ecosystem evolution and its relative stabilization, only 51 species remained (e.g. the Rotifers *Asplancha priodonta, Keratella cochlearis, Kellicottia longispina*; Cladocerans *Daphnia longispina, Bosmina longirostris, Leptodora kindti* and Copepods *Acanthocyclops vernalis, Cyclops vicinus, Eudiaptomus gracilis* etc. – according to Rujinschi and Rujinschi, 1983).

In the zoobenthos of the Bistriţa River and its tributaries in the flooded area, 198 species were identified; from these, after the damming, only 18 species survived (Miron, 1983). It is very probably that populations of these species remained in that water courses which were not affected by flooding. In time, in the deep bottom deposits of the reservoir appeared several populations which previously were not found in the Bistriţa River, as *Tubifex tubifex*, *Limnodrilus hoffmeisteri*, *Chironomus plumosus*, *Procladius skuze* etc.

A special attention is to be paid to the situation of fish fauna after the damming.

An early, comprehensive, study on the hydrobiological state of the Bistriţa River, in its whole (Motaş and Anghelescu, 1944) recorded 23 fish species. After the construction of the great dam at Bicaz and the smaller downstream reservoirs the ichthyofauna of the new man-made lakes presented some variations, concerning its composition. 24 fish species were identified (Pricope *et al*., 2010). Eight of the species reported previously weren't identified in the reservoirs, but other nine species were caught (*Eudontomyzon danfordi*, *Esox lucius, Rutilus rutilus, Abramis brama, Gobio kessleri, Carassius carassius, Scardinius erythrophtalmus, Gymnocephalus cernua, Salvelinus namaycush*); some of them were introduced by man.

Similar ecosystem changes were recorded after investigation of ecological situation of other dam reservoirs in Romania. True plankton communities appeared after flooding in dam reservoirs as Vidraru (on the Argeş River), Vidra (on the Lotru River), Tarniţa (on the Someşul Cald River), the reservoirs on the Siret River, partially the dams on the Olt River and others.

In all these cases, the apparition and development of plankton communities resulted in a significant increase of biodiversity at the level of the whole hydrographic basin.

It is to be emphasized that the formation of plankton biocoenose (especially phytoplankton) depends directly on the retention time of the water in a impoundment: short retention times will restrict algal proliferation and, on the contrary, long retention times favor the lacustrine algae. Hence, large, deep reservoirs will have an important phytoplankton community, but smaller impoundments, characterized by fast passage of water, usually have a rather scarce plankton (or no true plankton at all !).

After the construction of the two large dams on the Danube River (Iron Gates 1 and Iron Gates 2), no significant changes of biodiversity due to plankton development were recorded; before damming, the river had complex plankton communities. Most of them are still present now in the two reservoirs. The only increase of biodiversity is determined by mass development of huge macrophyte communities, especially in the downstream impoundment; such large communities of rooted or floating plants were not a common presence before the damming. On the surface of leaves, branches or stalks of water plants, a very abundant periphyton was installed, consisting in fixed algae, various invertebrates (protozoans, worms, crustaceans, mollusks etc.).

A special situation referred to some smaller dam reservoirs. On the Bistriţa valley, downstream of the main power station at Stejaru, there are seven dam reservoirs. They were populated by massive communities of aquatic macrophytes, covering – in several cases – even tens of hectares of water mirror. Dominant species belong to genus *Potamogeton* (*P. crispus, P. pectinatus, P. lucens*); *Elodea nuttallii*, *Myriophyllum spicatum, Ceratophyllum demersum* etc. were also identified.

All these species weren't observed in the middle and lower sectors of the Bistriţa River, before its hydrotechnical development.

The apparition and growth of these communities represent not only an effective increase of biodiversity, but a source of microhabitats constituting supports for periphytic organisms, refuges and food resources for fish fry, for a lot of invertebrates and even for some waterfowl (especially ducks from the genus *Anas*).

The same small reservoirs were/are location for a lot of waterfowl populations, especially in late autumn and winter; there are constantly observed (year by year) hundreds and hundreds of mute swans (*Cygnus olor*), wild ducks (*Anas platyrhynchos*, *Anas crecca, Anas querquedula* etc.). All these birds were not previously an usual presence on the Bistriţa waters; they appeared only after the construction of these reservoirs. It is important that the presence of waterfowl contributed to the introduction into the new habitats of some algae, transported from other water bodies (Munteanu, 2000).

Conclusions

The hydrotechnical developments on inland rivers determine important environmental changes, as effective destruction of flooded terrestrial and aquatic biocoenoses, the interruption of the river connectivity, with direct impact upon upstream migration of fish populations, change of water flow regime.

Some authors consider that one of the negative consequences of dam construction consists in the reduction of biodiversity.

Examining the results of a lot of comprehensive investigations on Romanian dam reservoirs, especially the case study of the Bistriţa River valley, there was stated that, as a result of apparition of a new aquatic habitat, very different from previous river conditions, a lot of new populations are installed. It was impossible for them to occur previously, under running water conditions.

It is obvious that in the new limnic environments, a true phytoplankton appears, also a typical zooplankton and other communities adapted to lacustrine conditions.

The increase of general biodiversity at the level of the whole hydrographic basin is more pronounced in mountain areas, where the environmental differences between river and man-made lake are greater.

Finally, it may be concluded that, the damming of a river determines major environmental impacts, as the ceasing of river connectivity, the breaking of fish migration, associated destruction of riparian biocoenoses, alterations of natural flow patterns on the river downstream the impoundment, modifying the physics, chemistry and biota of the water.

However, in many cases, the new filled impoundment constitutes a new, stagnant habitat, populated, in time, by a lot of new organisms (especially plankton biota) which previously could not live under running water conditions; this represents a contribution to increased biodiversity at the level of the whole watershed.

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PARTICIPATORY MONITORING OF BIODIVERSITY IN THE RODNA MOUNTAINS NATIONAL PARK (BIOSPHERE RESERVE)

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SUMMARY. The Rodna Mountains National Park started an innovative model of biodiversity conservation by involving volunteers as pioneers in Romanian system of protected areas. The participatory monitoring of biodiversity in the Rodna Mountains National Park (the Eastern Carpathians) is a system developed during 9 years and based on involvement of a network formed from 1,000 volunteers, rangers, researchers, experts in flora and fauna, biologists, ecologists which are monitoring 26 flagship species of animals and plants, combining the participatory monitoring with environmental education.

Keywords: biodiversity, flagship, monitoring, participatory.

Case study

The Rodna Mountains National Park is one of the hotspots of biodiversity at the Carpathian level and one of the three Romanian Biosphere Reserves (Iușan, 2011). The Park Administration tried during 9 years (2004-2013) various approaches to develop a combination of environmental, social and economic interventions that conserve biodiversity. The encouraging outcomes of these interventions have led us to pursue the successful approaches over the past 9 years.

The participatory system of monitoring biodiversity created in the Rodna Mountains is offering practical guidance on the key methods and tools that were developed, tested and refined over the years by working with local communities, partners and governmental agencies (Szabo *et. al*, 2008).

The starting point of the system focusing on biodiversity monitoring was set up in 2004 in the framework of an international partnership between the Park Administration of the Rodna Mountains National Park and Environmental Change Institute from Oxford University (UK). Building on these insights, we have been producing a number of field guides, manuals, toolkits and guidelines.

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At the beginning of the Park Administration establishment (2004), a group of experts from Oxford University and Park Administration was involved in working groups for assessment the biodiversity status in the protected area and setting up the steps for developing a participatory monitoring system (Table 1).

Table 1.

Steps for developing a participatory monitoring system for biodiversity in the Rodna Mountains National Park (Biosphere Reserve)

No.	Steps for developing the monitoring system of biodiversity
1	Working groups for assessing the biodiversity conservation status
2	Identifying the needs for nature conservation
3	Identifying the key stakeholders for biodiversity conservation (SWOT analysis)
4	Selecting the set of flagship species for participatory monitoring (25 species of flora and fauna)
5	Selecting the volunteers for participatory monitoring
6	Establishing the monitoring forms and protocols for each flagship species of flora and fauna for standardizing the collecting process of biological data
7	Training the volunteers in methods and techniques for monitoring the flagship species
8	Setting up the electronic database for biodiversity monitoring
9	Collecting biological data from field
10	Supervising the monitoring process of flagship species
11	Analyzing the collected data
12	Validating the biological data
13	Establishing the conservative management measures for flagship species
14	Including the management measures in the Management Plan of the National Park
15	Effectiveness assessment of the monitoring system
16	Improving the effectiveness of participatory monitoring of biodiversity
17	Disseminating and applying the system in other protected areas
18	Financial sustaining the monitoring system

The Park Administration organized a few working groups for assessing the conservation status of biodiversity from the Rodna Mountains. As a result of the working groups focused on biodiversity assessment, more than 1,000 scientific articles, dissertations, books and doctoral thesis were analyzed and a database for biodiversity was created with 6,516 species of flora and fauna, which places the Rodna Mountains on the second place in Romania as the number of inventoried species of flora and fauna (Iușan, 2011).

Identifying the needs for nature conservation was the second step for developing a system of monitoring. Using SWOT analysis, the following entities were identified as key stakeholders: research institutes, faculties of biology and ecology, schools, NGOs, science museums, landowners, land administrators etc.

Volunteers were selected from these different groups which can help the Park Administration in monitoring target species. Having in mind the importance of flagship species and habitats, target species were identified, taking into account their rarity, endemic status, vulnerability and protection status (Table 2).

Table 2.

Set of flagship species taken into account for monitoring in the Rodna Mountains

No.	Flagship species identified for participatory monitoring in the Rodna Mountains	
	Scientific name	**Vernacular name**
1	*Rupicapra rupicapra carpathica*	Chamois
2	*Marmota marmota*	Alpine marmot
3	*Narcissus stellaris*	Daffodils
4	*Pholidoptera transsylvanica*	Transylvanian bush-cricket
5	*Rosalia alpina*	Rosalia longicorn
6	*Microtus nivalis*	Snow vole
7	*Tetrao tetrix*	Black grouse
8	*Erebia sudetica radnaensis*	Sudeten ringlet
9	*Tetrao urogallus*	Capercaillie
10	*Papaver alpinum corona-sancti-stephani*	Glacier poppy
11	*Silene nivalis*	Rodna Mountains rush-light
12	*Gentiana punctata*	Spotted gentian
13	*Dianthus tenuifolius*	Dianthus
14	*Dianthus superbus*	Dianthus
15	*Eriophorum scheuczeri*	Scheuczer´s cotongrass
16	*Lynx lynx*	Eurasian lynx
17	*Leontopodium alpinum*	Edelweiss
18	*Miramella ebneri caprathica*	*Miramella* locust
19	*Muscardinus avellanarius*	Common dormouse
20	*Triturus montandoni*	Carpathian newt
21	*Drosera rotundifolia*	Sundew
22	*Ranunculus crenatus*	Crenate buttercup
23	*Soldanella hungarica*	Snowbell
24	*Inachis io*	Peacock
25	*Pinus cembra*	Swiss pine
26	*Barbastella barbastellus*	Western Barbastelle bat

The monitoring protocols were developed for each species (26) by involving experts in each group of plants and animals, these documents being an important tool for teaching the responsible persons for monitoring (rangers, teachers, students, volunteers) about the biology of flagship species, methods and techniques used for monitoring, period of monitoring, type of biological data collected, abiotic parameters, geographic coordinates.

According to the monitoring protocols, the monitoring forms were elaborated in order to collect the data. During the field monitoring, the persons responsible for monitoring have filled the monitoring forms and after that transposed them in the electronic database of the Rodna Mountains National Park and the information used in management decision process for conserving the target species and habitats.

The field monitoring is involving diverse techniques and methods which are proper for each flagship species: entomological nets for butterflies and grasshoppers, lighting traps with black, white, UV light for moths, Shermann life-traps for small mammals, Barber traps for bugs, binoculars for birds and large mammals, aquatic nets for amphibians, bat detector for bats and locusts, sound recording with the field microphone and analysis of frequency and amplitude (sonograms, oscilograms) for locusts and bats, field guides for all species, sound recorder for birds and call back method, field microscopes for plant seeds, night vision monocular for large mammals and birds, pneumatic boat for glacial lakes and peat bogs, GPS and radio collars for chamois and lynx, video cameras with infrared sensors for large carnivores etc. All the equipment is assured by the Park Administration.

The data collected from field is analyzed, selected and validated by the Scientific Council of the Rodna Mountains National Park, which is composed of 23 members (researchers, university teachers, experts in flora and fauna). The valid biological data are introduced by the supervisors of monitoring system (rangers and IT experts) in the electronic biodiversity database.

Using the new data collected by the network of volunteers regarding the flagship species, the Scientific Council and the Park Administration are deciding and establishing the conservative management measures for preserving the target species. For example, certain vulnerable habitats with flagship species are included in more restricted management zones such as strict protected areas or integral protected areas inside the national park and biosphere reserve. Based on other results, the Park Administration established new scientific reserves such as Corongis, Bila-Lala, Piatra Rea and Pietrosu Mare or banned the access of tourists in hibernation period of bats in different caves, redirected the tourists in the breeding season of large mammals. The daffodil (*Narcissus stellaris*) meadow from the Saca Massif was monitored in last 9 years by volunteers and taking into account the effect of overgrazing identified a few years ago, this activity was established by the management measures of the Park Administration and now the meadow is enlarging. Valuable distribution maps were created using the GIS and remote sensing, finding more information about the flagship species monitored.

The participatory system of monitoring biodiversity is assessed every year for improving its effectiveness by the Park Administration, using questionnaires, interviews, requests from members of the network. For the past 9 years, 10 international exchange programs were organized between volunteers from the Rodna Mountains and Eischfeld-Hanich-Werratal Nature Park from Germany, Pyrenees National Park from France, Gran Paradiso and Abruzzo National Parks from Italy, Hohe Tauer

National Park from Austria, Bayerischer Wald National Park from Germany, Sumava National Park from Czech Republic, High Tatra National Park from Slovakia, Borjomi Karagauli National Park from Georgia, Sooma National Park from Estonia. All these exchanges were focused on transferring the experience regarding the participatory monitoring of flagship species and improving the model developed in the Rodna Mountains.

The participatory monitoring system is sustained from financial point of view by different grants from Darwin Initiative (UK), Netherland Embassy, Rufford Foundation (UK), Alfred Toepfer Academy for Nature Conservation (Germany), Life Natura, Grundtvig, Youth in Action Program, Structural Funds for Environment, GEF Small Grants (USA), EEA – Financial Programs of Iceland, Liechtenstein and Norway in Romania, Erasmus, Partnership Foundation for Environment, Rompetrol Funds.

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