Lakes, reservoirs and ponds, vol. **4**(2): 119-130, 2010

WATER QUALITY AND ECOLOGY OF THE IEZER AND BOLĂTĂU LAKES

Marcel MÎNDRESCU, Ionuţ Alexandru CRISTEA, Gabriela FLORESCU
University of Suceava, Suceava, Romania
marcel.mindrescu@gmail.com

Abstract

Having been in existence for over 400 years, the natural dammed lakes formed by landslide movements, Iezer and Bolătău, enjoy a high level of biodiversity, far above the average of the nearby land area covered with spruce tree forests. Belonging, from the very beginning of their existence, to a land property of Humor Monastery (1495) in Suceava County, the lakes were, for a while, ponds stocked with fish by the monks of that time. Both lakes hold waters situated in the first two water quality categories, the first for Bolătău, and the second for Iezer respectively. A very good quality of water, together with the slightly alkaline pH, allowed the formation of favourable conditions for salmonids (trout). In 1960 there has been a trout stocking action, with eastern brook trout (Salvelinus fontinalis Mitchell), but nine years later (1969), a new species, less vulnerable to these altitude conditions had to be introduced, the native trout (Salmo trutta fario) respectively. Stocking actions continued in 1979 from the same source, namely Putna Valley, this time with rainbow trout (Salmo gairdneri Richardson). Excessive proliferation of trout, because of the abundance of food, led to the necessity to also introduce specimens of common minnow (Phoxinus Phoxinus), for the purpose of serving as food for salmonids. The high pressure exerted by the fish species was reflected in the development, extinction and variety of microorganisms such as Cladocera. Thus, there are plenty of reasons for the two lacustrine units to become strict protected areas.
Keywords: water quality, ecology, fish, microorganisms, Obcinele Bucovinei

1. Introduction

In the midst of a century-old woodland, which was part of the former property of Humor Monastery, there are two lakes located on the course of two streams, tributaries of the Sadova river. With an area of about one hectare, there is Iezer lake, also called by the locals the Eye of Hell. Located somewhere deep in the woods, away from the main roads, one can find its younger brother, Bolătău Lake.

Despite the fact that Bolătău and Iezer lakes were not mentioned at all in the Romanian hydro-limnological literature, they are well defined water bodies, as

well as a thickness of the sediment layers over 4 meters, significantly higher than those of the well known Red Lake (Begy *et. al,* 2009; Pandi, 2004).

In the present study, we relate the data concerning the size of the two lacustrine basins, including bathymetric maps and apparent profiles, ensued by the analysis of water quality, of vegetation, fauna and micro-vertebrates from the sampled lacustrine sediments, which allows us to assess the ecological status of the two lake basins.

2. Study area

Bolătău and Iezer landslide lakes are located in the north of Romanian Carpathians i.e. the subunit called Obcinele Bucovinei, Obcina Feredeului respectively (Fig. 1).

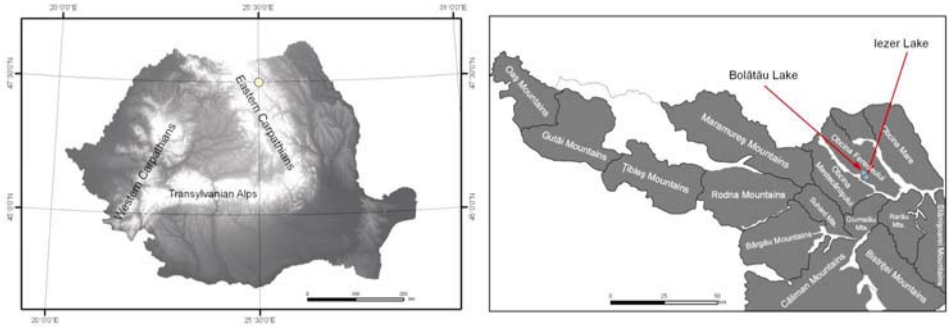

Figure 1. Geographic location of Iezer and Bolătău lakes in the Romanian territory and the Romanian Carpathians

In detail, the two lakes are located in the south-western extremity of Obcina Feredeului under the alignment Obcina Feredeului Peak (1364 m) - Poiana Prislop saddle (1102 m) in Sadova drainage basin (left tributary of Moldova river). Administratively speaking, the lakes belong to the Sadova Comune, about 14.5 kilometers of the Cîmpulung Moldovenesc town, limitary of Suceava County. More specifically, the lake Iezer - Feredeu (930 m alt.) is located on the upper stream of one of Sadova river's left tributaries, who has lent its name (so the correct form of the hydronym should be the genitive - Iezerului Stream, and not Iezer Stream - the nominative, as written on topographic maps), while Bolătău - Feredeu lake (1137 m alt.) is on the next left tributary of Sadova river, also named Bolătău (the upper course is known under the name Holohoşca).

3. Bathymetry and water quality

Bolătău and Iezer lakes are the largest natural lakes in the Suceava County. Formed as a result of landslide movements which took place over 400 years ago (Mîndrescu *et. al,* 2010), they still have notable sizes. Thus, Iezer Lake has an area of 7500 m² and a depth of 4.47 m, while its younger brother, Bolătău, has an area of 2350 m² area and 5 m depth, respectively (Fig. 2). To these impressive dimensions, comparable to those of glacial lakes of Rodna Masiff, we must add those about 4 m of sediments for Iezer and those over 5.5 m for Bolătău.

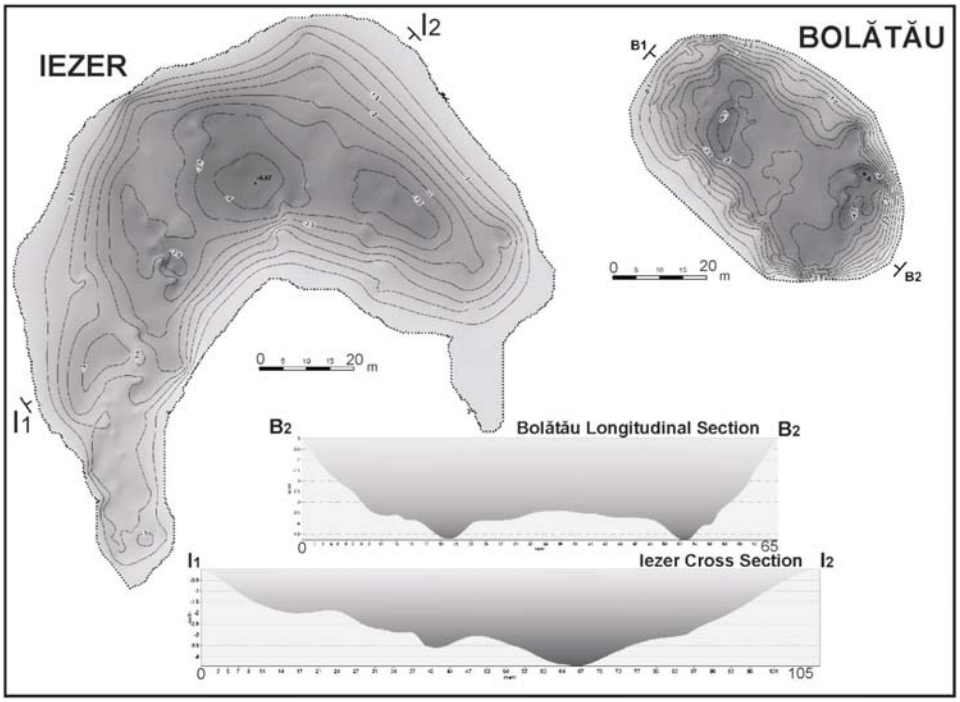

Figure 2. Bathymetrc maps of Iezer and Bolătău

The results interpretation of the determinations which appear in the table below (Tab. 1) was made in accordance with the Order 161/2006 - Normative of elements and standards of biological, chemical and physico-chemical quality, in order to determine the ecological status of surface waters.

But from the perspective of other laws and normatives (surface water for drinking and underground drinking water), the conductivity and hardness values for both samples indicate a low level of mineralization, and the low values of turbidity and suspension indicate that the sampling was done on the background of atmospheric calm (no rain or wind).

Because of a slightly increased concentration of nitrates and phosphates (which are part of the group of nutrients), Iezer Lake falls into **quality grade II**, which means water of good quality.

Bolătău Lake, according to the values of the determined indicators, is positioned within the **quality grade I**, which means a very good water quality.

Table 1. Water quality of the Iezer and Bolătău

INDICATORS	UNIT OF MEASURE	BOLATAU LAKE	QUALITY GRADE	IEZER LAKE	QUALITY GRADE
Suspensions *	mg/l	4	-	2	-
pH	pH units	7,11	in-grade	7,45	in-grade
Conductivity *	µs/cm	157	-	187,4	-
Total Dissolved Solids *(TDS)*	mg/l	110	I	130	I
Mg_2^+	mg/l	3,32	I	4,94	I
Ca_2^+	mg/l	17,63	I	24,08	I
NH_4^+- N	mg/l	0,129	I	0,019	I
NO_2^- - N	mg/l	0,003	I	0,002	I
NO_3^- - N	mg/l	0,901	I	1,179	II
Na^+	mg/l	9,2	I	7,5	I
Total hardness*	mg/l	6,283	-	4,937	-
PO_4^- - P	mg/l	0,014	I	0,153	II
Total alkalinity	mg/l	1,1	I	1,4	I
Turbidity*	NTU units	3,43	-	2,02	-
SO_4^{2-}	mg/l	35,59	I	34,45	I
O_2	mg/l	9,98	I	10,99	I
Detergents	mg/l	0,023	I	0,018	I
Cl^-	mg/l	2,263	I	2,41	I
Total Iron	mg/l	0,073	I	0,051	I

* these indicators are not normed according to the Order 161/2001 for surface waters.

4. Ecology of the lakes

Crustaceans leave some morphological remains in sediments (Frey, 1964), but certainly the chitinized body parts of Cladocera are more common and have been the most widely used (Korhola&Rautio, 2001). Cladoceran species are rearely larger than 1 mm in length, but still play pivotal roles in the functioning of many freshwater systems like Iezer and Bolătău. Depending on ambient conditions, they can exert intense graizing pressures, and so can influence the abundance and composition of algal communities. Equally, the abundance, species composition, and even morphology (Kerfoot, 1974) of cladocerans can be influenced by predation from other animals, such as larger invertebrates and fish (Carpenter *et al.,* 1985).

Thus, given that the two lakes were part of the property of a monastery, they were most probably stocked with various species of fish, even since the sixteenth century. So the more the fish population grows, the less are the remains of crustacean kept in lake sediments (fish pressure). Referring to Iezer lake, several ecological distinctive periods can be identified by analyzing the remains of Cladocera family, genus *Pleuroxus truncatus* (Fig. 3). Moreover, the extinction or expansion of some *Cladocera genera* (eg. *Daphnia ephippium, Pleuroxus truncatus, Alona affinis, Alona guttata*) could provide important information on wáter level changes in the lakes, as some genera are adapted to deeper waters while others feel better in shallow waters.

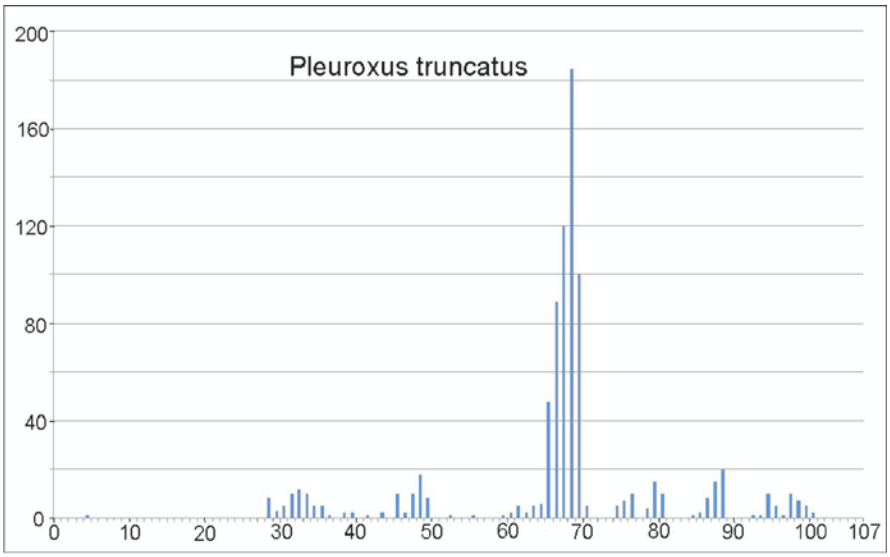

Figure 3. Genus *Pleuroxus truncatus* (*Cladocera* family) from the sediments of Iezerul Feredeu (0-107 cm) (data supplied by A. Brancelj)

Korhola and Rauttio (2001) have summarized the current techniques used to study Cladocera in paleolimnological research, and Jeppesen *et. al.* (2001) have reviewed some recent applications of fossil Cladocera to the reconstruction of anthropogenic impacts. Most studies have been related to trophic dynamics and eutrophication issues, but Cladocera have also been used in assessments of lake acidification, metal contamination, salinity changes, shifts in water levels, and exotic species invasions, as well as in other applications.

Hygrophile vegetation (Fig. 4) along the perimeter of the Iezer consists of sedges (*Carex acutiforium, Carex curvula*) and other plants such as: water plantain (*Alisma aquatica*), bulrush (*Typha latifolia*), Dutch rash (*Bolbosschoenus sp*), creeping buttercup (*Ranunculus repens*), meadow grass (*Poa palustris*), sorrel

(*Rumaex confertus*), forget-me-not (*Myosotis alpestris*), cuckoo flower (*Lichnis flos cuculi*) (Forgaci, 2010).

Figure 4. The vegetation of Iezerul Feredeu (June, 2010)

The aquatic fauna is a rich one, consisting of several families of wild ducks (*Anas crecca*) that seasonally inhabit this surface of water; moreover, around its banks white wagtails (*Motacilla alba*) pop up, looking for Trichoptera larvae.

Among mammals, water shrew (Neomys fodies) has been reported, but in relatively small number. The ichthyofauna, although it has a domestic origin, is very diverse, due to the stocking actions held over time under the initiative of rangers and fishermen living in the area. After a chemical analysis of the water, which proved quite favorable to salmonids, pH 6.0 to 6.5 and with an oxygen concentration of 9.72 mgl (Decei, 1981) (these conditions have been kept the same so far, with some small changes: pH 7.11-7.45 and 9.98-10.99 O_2 in March 2010 - the data are presented in Tab. 1) the decision taken was to populate the lake with species of Eastern brook trout (*Salvelinus fontinalis Mitchell*). The action was completed in 1960, with trout coming from Putna Valley trout farm (Suceava), but nine years later (1969), a new species, less vulnerable to these altitude conditions had to be introduced, the native trout (*Salmo trutta fario*) (Fig. 5). Stocking actions continued in 1979 from the same source, namely Putna Valley, this time with rainbow trout (*Salmo gairdneri Richardson*), mixed with native trout. The specimens were adults and therefore the action had the desired success, trouts reaching in a short time an

appreciable size, due to the abundance of food (specimens of common minnow (*Phoxinus Phoxinus*) were placed here, serving as food for salmonids).

Figure 5. Specimens of native trout *Salmo trutta fario* of lezerul Feredeu, October, 2009 (note the characteristics of the lake trout, the lack of red points respectively)

Over time, the fishermen who were attracted by the fame of this place promising big catches, also introduced - as a compensation for periods when trout was fussy, species less common for this altitude, such as the crucian carp (*Carasius carasius*) - in 1998, with specimens coming from Hăneşti Pond (Botoşani) - which, however, even though have survived and multiplied pretty well, do not reach a significant size ; then the chub (*Leuciscus cephalus*) and later on, even the pike (*Esox lucius*) (Fig. 6) which seems to have adapted quite well, especially since its favourite food, the crucian carp, can also be found in the lake. Regarding the presence of the crucian carp in the lake, one can say that is a very timely appearance, if we are to report it to the habitat which it currently occupies, that is partially invaded by aquatic vegetation, a habitat unpopular for the trout; in addition to this, as a result of its semi-phytophagous characteristics, this cyprinide has an important role of biocontrol, limiting invasive vegetation. The extent to which the trout population of the lake can be adversely affected by the crucian carp population is yet to be seen, knowing the fact that salmonids are quite vulnerable to diseases transmitted by cyprinids, especially by those species with which they don't

cohabitate naturally, such as in this case.

Figure 6. Specimen of pike (*Esox lucius*) in Iezerul Feredeu (June 2010)

Another thing to note about the fish population, is that the indigenous trout achieved here, in time, due to the lake conditions, the features of the lake trout (*Salmo trutta morfa lacustris*), being shorter but much thicker than that found in rivers, with its head smaller reported to the rest of the body, even disproportionately. The color of its back and head is olive green and its flanks and belly are silvery. Flanks are covered, near the belly, with large rough stains, usually X-shaped, and black colored. Stains don't have blue and white rings, as in the case of indigenous or salvelinus species of trout. What is interesting about the coloring is the lack of red spots, so characteristic of common trout, these occurring only incidentally and being almost completely drab in the case of some young specimens. The largest trout caught in this lake exceeded 6 kilos, which is pretty impressive given the relatively small size of the lake.

Along with the fish fauna, this lake basin is also home to various species of amphibians, such as the mountain frog (*Rana temporaria*) and the newt (*Triturus alpestris*), as well as species of water mammals such as the water shrew (*Neomys fodies*); among invertebrates, one can mention the great silver water beetle *Hidrophilus piceus*, the great diving beetle *Ditiscus marginalis*, *Piscia geometra*, the water flea *Daphnia daphnia*, camarons *Gammarus fosarum*, caddisflies *Tricoptera hydropsychidae*, *Plecoptera cupida*, and among the most common dragonflies found

here there is the devil's horse *Cordulegaster Heros*, together with *Crocothemis Erythraea* and *Erythrommana viridulum*.

The vegetation of Bolătău Lake is less rich than that of its older brother, Iezer, but no less spectacular, due to a deep lake basin starting from the sides, which makes vegetation form an unitary whole with the lacustrine area, the trees surrounding it perfectly like a protective mantle (Fig. 7). The basic species are coniferous (spruce and fir), to which we may add the goat's willow (*Salix caprea*), the alder tree (*Alnus incana*), the trembling poplar (Populus tremula), the birch tree (*Betula pendula*) among species of trees, and among water-loving herbaceous plants the rush (*Bolbosschoenus sp*) occurs, but in a lesser extent than in Lake Iezer.

The fauna of Bolătău is less abundant or rich compared to its larger counterpart, as mentioned previosly. Regarding the fish fauna, there are no official data to support previous stocking actions organized by the authorities or even by amateur fishermen, but the presence of fish is undoubted, because it was shown using our sonar (November 2009). To this we may add the assertions of fishermen who have pointed the existence of native trout in the lake. Also, there are traces of amateur fishing activities, such as various artificial baits or even monofilament hung nets on the fallen trunks.

In addition, the presence of the water shrew (a mouse with a sharp nose or the water mouse) was reported here, which can be parallelled with the presence of its favorite food, specifically one made up of specimens of young fish or adult weakened fish. We could also admit the presence of a second species of fish living here, that of the chub rspectively, which we can assume from the appearance on the sonar, at an average depth (between waters) of a species different in shape from that living in the bottom waters (a species we assumed to be salmonids – by excluding from the list the crucian carp, which would be eligible as reported to the area of activity but not when considering the size and shape of the fish species shown by the sonar), which fits the ethology of the chub. We can carry this assumption further on - this time from the viewpoint of the origin of these species of fish in the lake - and agree upon the other explanation, according to which the lake was naturally populated with fish, by means of the incidental intermediance of wild ducks stopping here, which made this area a secondary destination after Iezer, which is a more suitable habitat for them from the perspective of size, shelter opportunities and food abundance (this explanation was given by an engineer at ICAS (Institutul de cercetari si amenajari silvice/The institute of forestry research and management) Cîmpulung Moldovenesc, who has good knowledge of the lake evolution, which gives him more credibility in accepting this idea of the lake being naturally populated).

Figure 7. Bolătău Lake

5. Conclusion

Iezer and Bolătău lakes are the largest natural lakes in the County of Suceava. Formed by landsliding more than 400 years ago, they still hold impressive dimensions for some lakes born as a result of landslide. Both lakes hold waters situated in the first two water quality categories, the first for Bolătău, and the second for Iezer respectively. A very good quality of water, together with the slightly alkaline pH, allowed the formation of significantly favourable conditions for salmonids (trout) and other species of fish.

Thus, ecologically speaking, these two lakes are presently in a state of high trophicity, which makes possible the existence of various species of plants and other organisms specific to lacustrine environments, among which the most important being the species of fish, which, at least for Iezer Lake, represent a complex inter-species cohabitation (cyprinids – the common minnow, the chub, the crucian carp; salmonids - the indigenous trout; esocidae – the pike). Although there is no sign of any accentuated or accelerated degradation of the effective water surface of these lacustrine ecosystems as a result of anthropic or natural influences, still a progressive silting can be observed in the case of Iezer, upstream to downstream, but also from side-left, caused by the input of seasonal alluvia that facilitate the proliferation of hygrophilic vegetation - the rush (*Bolbosschoenus sp*) as invasive species, as well as others, among which we mention the sedges (*Carex acutiforium,*

Carex curvula), the water plantain (*Colonialism aquatica*), the common bulrush (*Typha latifolia*), the creeping buttercup (*Ranunculus repens*), the meadow grass (*Poa palustris*), belonging to the category of secondary species.

After completing our analyses on traces of Cladocera, we can assert that the ecology of the lake had a very long and varied history, depending on the natural, but also anthropic factors. Given the fact that the two lakes became part of the property of a monastery, they were most probably stocked with various species of fish, for short periods of time, since the sixteenth century, thus influencing the development and variety of micro-vertebrates (Cladocera).

Finally, as an aesthetically attractive element, one can speak of a breaking in the monotony of the landscape, the complex vegetation of this lacustrine unit being in contrast with the surrounding landscape which is typical of mountain mid-altitudes and consists only of coniferous species. We therefore propose the establishment of a fully protected scientific reserve consisting of these two landslide-dammed lakes.

Acknowledges

We would like to thank Dr. Simon Hutchinson our collaborator at the University of Salford, UK and Dr. Anton Brancelj from the National Institute of Biology, Department of Freshwater and Terrestrial Ecosystems Research, Ljubljana, Slovenia) and PhD-student Forgaci Daniel, and all students of the Department of Geography, University of Suceava, who participated in the field trips.

References

Begy R., Cosma C., Timar A. (2009), Recent changes in Red Lake (Romania) sedimentation rate determined from depth profiles of 210Pb and 137Cs radioisotopes, *Journal of Environmental Radioactivity*, 100: 644–648.

Carpenter, S.R., Kitchell, J.F., Hodgson, J.R., (1985), Cascading trophic interactions and lake productivity. *BioScience* 35: 634-639.

Decei, P. (1981), *Lacuri de munte: Drumeţii şi pescuit,* Edit. Sport-Turism, Bucureşti.

Forgaci, D., (2010), *Perspective turistice în cadrul potenţialului natural al comunei Sadova*, Lucrare de disertaţie, Suceava, 2010.

Frey, D. G., (1964), Remains of animals in Quaternary lake and bog sediments and their interpretation, *Archiv für Hydrobiologie, Erge bnisse der Limnologie* 2: 1-114.

Jeppesen, E, Leavitt, P., DeMeester, L. Jensen, J.P. (2001), Functional ecology and palaeolimnology: using cladoceran remains to reconstruct anthropogenic impacts. *Trends in Ecology and Evolution* 16, 191-198.

Kerfoot, W.C., (1974), Net accumulation rates and history of cladocerean communities. *Ecology* 55, 51-61.

Korhola, A., Rautio, M., (2001), Cladocera and other branchiopod crustaceans. In *Smol, J. P., Birks, H.J.B. and Last, W.M. (eds.), Tracking Environmental Change Using Lake Sediments*, Volume 4, Zoological Ibdicators. Kluwer Academic Publishers, Dordrecht, 5-41.

Mîndrescu, M., Iosep, I., Cristea I.A., Forgaci, D., Popescu, D.A. (2010), Iezer and Bolătău lakes (Feredeului Mts). The oldest landslide-dammed lakes, in *Romania,* în Gastescu, P., Bretcan, P. (eds.) *Resursele de apă. Vulnerabilitate la presiunea activitatilor antropice cu referire si la ecosistemele lacustre*, Volumul Simpozionului National, Targoviste, 11-13 iunie 2010: 272-282.

Pandi, G. (2004), *Lacul Roşu. Studiu de hidrogeografie*, Ed. Casa Cărţii de Ştiinţă, Cluj.