2.2. The ecological, hydrobiological and nature conservational state of the eustatic dead-arms around the village of Tarpa (NE-Hungary)

Lakatos, Gy., Kovács, B., Kiss, M. K. and Keresztúri, P.

2.2.1. Introduction

Wetlands can be generally characterized by the littoral phytal being always larger than the part of the littoral zone that is dominated by planktonic life forms. Items of specifications and classifications cannot always be arranged hierarchically, but one assumption is completely accepted, wetlands can be either natural wetlands, or constructed wetlands connected to human activities (Lakatos, 1997), such as rice-lands and mine ponds. Naturally, it is also agreed that the individual wetlands differ from each other in their degrees of water circulation, and can represent eustatic, semistatic or astatic water bodies (Dévai, 1994).

Regarding the localisation of the Hungarian wetlands, they can be classified as palustrine (marsh and bog), lacustrine (connected to lakes) or riverine (in river valleys) types, according to the IUCN's recommendation (Dugan, 1990). Dead beds of river are found in the river valleys and flood plains, with this latter case being especially common after the process of the Hungarian river regulations. On the basis of their connection to the main-arm, the actual water flow, these beds can be divided into ox-bow lakes, where the high water level of the river provides flushing in particular periods of the year, and short-cut dead-arms, which either have lost all their connections to the river or can be found in the discharged side (Lakatos, 1998).

Wetlands are often evaluated as theatres of biodiversity. Large-scale morphometric differences and the biochemical variety of the present processes yield a diverse flora that, in turn, gives shelter to a rich kind of fauna, coupled with an abundance of micro-organisms that is less spectacular, but plays an essential role in the life of wetlands (Mitsch, 1996).

During 1998, in the framework of the „Tarpa region environmental state assessment" supported by the Programme Financing Application, examinations have been initiated in order to gain an overall survey on the ecological and hydrobiological ground state, as well as on the local fish fauna of the dead-arms situated in the area of Tarpa. The research work covered the dead-arm of River Tisza at Helmecszeg (H), Vargaszeg (V) and the so-called Kiss Jánosné's dead-arm (K).

2.2.2. Materials and Methods

All the three dead-arms are situated within the right-sided flood plain of River Tisza, and evolved in the time of the river regulations there by cutting off the bends of the flowing river. Their regular water supply is not ensured, and the dead-arms receive fresh water only in periods when the water level of the river is high, reaches up to 290 cm at the watermark post of Rahó.

The northernmost of the three dead-arms is the dead-arm of River Tisza at Helmecszeg that has a relatively steady run-down. Among the examined wetlands, this dead-arm lies in the largest area (12 ha), but has the smallest depth (its deepest point is about 2 m). Today, water can only be found in the upper branch, even when completely filled, while in water deficiency exclusively the deepest site of the upper branch (upper end) contains water. The inlet for the settled communal wastewater of Tarpa is situated in the lower third part of the dead-arm (water sampling site 1). In the upper end (water sampling site 3) there was a small open water spot observed. All along the right bank, except for the section including water sampling site 2, a belt of *Typha angustifolia* runs.

When heading for south one faces the dead-arm at Vargaszeg with its area of 6 ha. This is the deepest one of the three investigated wetlands, therefore has the most balanced hydrobiological character. Its deepest point reaches down to about 6 m. Due to its depth and the introduction of grass carp, its flora is scattered. In the lower end being intermittently dried up (water sampling site 1) there are patches of *Polygonum amphibium* detected. In the middle part of the dead-arm (water sampling site 2), in the inner part of the former bend, *Phragmites australis* appears in patches, as a bordering plant. In the upper end (water sampling site 3) with shallow regions some spears of *Stratiotes alloides* can be found.

Kiss Jánosné's dead-arm lies further to the south. According to the land registry, it has an area of 8 hectares, yet the water surfaces and the depth (4 m) is measured to be smaller than those of the dead-arm at Vargaszeg. Similarly to this latter dead-arm, the flora is scanty, and in the shallow parts at the two ends of the dead-arm, spears of *Potamogeton lucens* grow, while in the lower end (water sampling site 1) it is complemented by stands of *Trapa natans* and *Sagittaria sagittifolia*. In the inner side of the bend some stems of *Nymphaea alba* shoots up, and close to the shore there are patches of *Polygonum amphibium*. Within the section of water sampling site 3, in the right bank, stands of *Schoenoplectus lacustris* can be detected, while in the left bank and the upper end of the dead-arm, *Glyceria maxima* are found.

Water, plankton and plant samples were taken on four occasions – 16/04, 09/06, 21-23/07 and 11-12/09 – during the year of 1998, whereas fish individuals were collected three times with accumulator-generated electric fishing machine. The water samples were processed according to the methods published in Felföldy's handbook (1987). On the basis of the obtained results, the water types, as well as the phyto- and zooplanktonic compositions were established. The species list and nature conservational evaluation of tangles are also detailed (Simon, 1988; Borhidi, 1993).

2.2.3. RESULTS

The particular characters of the wetlands are primarily determined by hydrological factors, the water coverage, water circulation (flooding, drying), water depth and changes in the water level, and at the same time these are the elements that ensure the most essential conditions to aquatic organisms. In this way, the amount of water supply has fundamental importance, however, it is specially the reaction of the organisms through which the significance of water quality is revealed. The physical and chemical properties of water, as well as the factors being responsible for them, do not exercise their effects separately, but through a rather complex system of action mechanisms, and considering the principle of tolerance, the aquatic organisms – with certain limitations – flexibly adopts itself to this system on the level of populations.

All the three dead-arms have relatively low conductivity, and can be grouped to the beta-oligohalobic and beta-alpha-oligohalobic halobity category (Felföldy, 1987), while they – with the exception of the spring water sample collected near the wastewater inlet of the dead-arm at Helmecszeg that is characterized by the Na-HCO_3 ion type – belong to the Ca-HCO_3 ion type, identically with the wetlands of the Tisza valley (Lakatos, 1990).

Small figures for the values of oxygen saturation remaining under 10 % were measured only at water sampling site 1 of the dead-arm at Helmecszeg (near the wastewater inlet, in a flood-free period). The oxygen saturation value generally exceeded 50 %, and accordingly, aerobic conditions prevailed. Furthermore, in areas thickly grown with aquatic plants, saturation values over 100 % were frequently experienced. It can be claimed that the oxygen supply proves to be favourable for the occurrence of natural purification, as well as for the lives of zoo-organisms including fish species.

Regarding the results of measurements on the concentrations of nitrogen and phosphorus forms, the trophity of the dead-arms, that is the nutrient supply, was found to be poor, even in the case of wetlands for fishing, since they reached a mesotrophic state only on two occasions. It is the oligo-mesothrophic type that generally dominates the aquatic sites, and the phosphorus supply is extremely low. The dilute effect of the floods was indicated by the measurements, in these periods the trophity of the investigated dead-arms reduced to an oligotrophic state.

Values for saprobity were detected to be more unfavourable than those of trophity, because – due to the inflowing wastewater – water sampling site 1 of the dead-arm at Helmecszeg showed an alpha-mesosaprobic state that as a consequence of dilution was decreased by two units into beta-mesosaprobity. As compared to this latter state, more favourable water quality conditions were observed only at water sampling site 3. In the case of the dead-arm at Vargaszeg, it ranged between oligo-beta-saprobity and oligosaprobity, therefore the dead-arm could be considered as having fine water quality. The water saprobity of Kiss Jánosné's dead-arm brought values between the data for the two above dead-arms.

The results of phytoplankton analyses correspond to the water chemical data, they can be characterized by relatively small species, as well as individual numbers (30 000 ind/L), the biomass does not reach 0.1 mg/L, and turned out to be remarkably low in the cases of the two dead-arms used for fishing. The most frequent species belong to the *Bacillariaphyceae*, and the most important are *Aulacoseria granulata var. angustissima*, *Nitzschia palea*, *Synedra acus* and *Synedra ulna*. The presence of the *Dinophyta* species, *Peridinium palatinum* at water sampling site 1 of the dead-arm at Helmecszeg being heavily loaded with organic pollutants is worth to be mentioned separately. On the other hand, the infrequency of green algae (*Chlorophyta*) in all the three dead-arms is quite a surprising observation.

The results of zooplanktonic analyses reflect what has been established on the basis of biological-ecological water quality indices about trophity and constructivity, because the entire year brought about small taxon and individual numbers. Favourable conditions were only examined in the September samples from the dead-arm at Vargaszeg, in which the individual number came close to the 30 000 ind/10 L value. In the case of the other dead-arm utilised as fishing water, the individual number remained below 20 000, and about one-third of this amount could be found in the samples of the dead-arm at Helmecszeg. Among zooplankton species, the following rotifers (*Rotatoria*) were detected in larger masses: *Anuraeopsis fissa*, *Brachionus diversicornis*, *Keratella cochlearis* and *Polyarthra dolichoptera*.

In the life of wetlands, plants, respectively their various life forms and connections to the water (their obligate or amphibian nature) have important roles, yet these factors naturally originate from long-term evolutionary processes. The potential vegetation and its structure are primarily defined by the water supply and water quality of the given wetland. Abiotic and biotic parameters work through a series of interrelations that may change dynamically, and thus can develop into more complex interdependencies. Revealing these interdependencies must involve the examination and determination of the sub-processes.

From the three dead-arms, 20 aquatic plant species were identified, and the species list is given in Table 1.

Table 1. Species identified

	H	V	K
Alisma plantago-aquatica	+		
Glyceria maxima	+	+	+
Iris pseudacorus	+		
Lemna minor	+	+	+
Lycopus europaeus	+		
Lysimachia vulgaris	+		
Nymphaea alba	+		
Phragmites australis	+	+	+
Polygonum amphibium	+	+	+
Potamogeton lucens	+		+
Rorippa amphibia	+	+	+
Sagittaria sagittifolia	+		+
Schoenoplectus lacustris	+	+	+
Solanum dulcamara	+		+
Spirodela polyrrhiza	+	+	+
Stratiotes aloides		+	
Trapa natans	+		+
Typha angustifolia	+	+	+
Utricularis vulgaris	+	+	+
Zannichellia palustris	+		
total species number	19	10	13

From the 20 species, 19 were found in the dead-arm at Helmecszeg, and only one, the stratiotes (*Stratiotes aloides*) did not show up. Small stands of the latter species were observed in the dead-arm at Vargaszeg, yet in this site just 10 species could be identified, three species less than in the third dead-arm.

Regarding the distribution of plant species into nature conservation value categories according to Simon (1988), it is the dominance of associative and accompanying species that is characteristic (90 %), while there was one species authorised as protected (*Iris pseudacorus*) and one disturbance tolerant species (*Solanum dulcamara*) also occurred, which indicates degradation. Based on the naturality valuation figures for the Hungarian flora (Borhidi, 1993), the natural competitor species have a determinant role among the social conduct types of natural habitats (45 %), and besides, the generalists or accompanying species, and the natural pioneer plants must be mentioned here. Specialist have only one species, the arrow-head (*Sagittaria sagittifolia*) detected in the area, while on the other hand disturbance tolerant species, which generally belong to interfered habitats, are represented by four species (*Lycopus europaeus*, *Lysimachia vulgaris*, *Polygonum amphibium* and *Solanum dulcamara*).

Apart from the macro-ions, microelements were also subjected to analyses, and particular attention was given to the analysis of heavy metals from the water samples and the fractions of the collected fish species. Quite interestingly, the water analysis carried out with ICP AES could not detect iron in any of the dead-arms, and the manganese concentration remained below 0.1 ppm. It is certainly the aerobic and oxidised conditions that resulted in the deposition of dissolved iron ions and the reduction of the manganese content, though the low level of loading may also contribute to it. Similarly to iron, the concentration of copper did not enter the zone of detectability, because no sample contained this particular element in an observable form. The highest concentration was measured in the case of zinc, the two extreme values were 0.05 and 0.5 ppm. This significant concentration of zinc originates from external loading, still remains well under the value of about 100 ppm obtained from River Túr (Kocsis & Lakatos, 1999). Among heavy metals, every sample bore chromium, and some of the samples had lead and cadmium.

H1	Zn > Cd > Pb > Mn > Cr > Cu
V1	Zn > Pb > Mn > Cr > Cd = Cu
K1	Zn > Pb > Cd > Mn > Cr > Cu

The examination results on fish-biological and faunistic conditions, as well as fish stock structure of the investigated dead-arms near Tarpa have been published in Kovács and Lakatos's survey (1999). Analyses on heavy metals were also performed from the musculature, liver and scales of the fish individuals that belong to the species collected in larger masses in the dead-arm at Vargaszeg. The musculature of the fish individuals did not reveal the presence of cadmium or lead, while the manganese and copper contents were measurable for all the three, examined fish species, though the concentrations remained below 10 ppm. The zinc concentration was detected to be the highest in the roach, the chromium content showed maximal values in the samples from the bream musculature, yet none of the analyses experienced such a limit value that would brought about problems of pernocisiosity (Dévai et al, 1992). In the liver and scale samples of the fish, high zinc and manganese concentrations were measured, while – similarly to the samples from the musculature – no cadmium and lead could be detected.

2.2.4. Discussion

By today, it has been definitely demonstrated that the preservation and protection of the present conditions in nature conservation areas can only be achieved by productive activities of care-taking, supported by thorough and well-founded research work. The preservation of natural values being visible to the naked eye (such as plants and birds) can be virtually achieved by the assistance of thorough and versatile preparatory works that represent essential requirements especially in the case of protecting vulnerable wetlands with small remnants of highly valuable areas.

An important part of the research woks on these wetlands was constituted by investigating the ground ecological state and examining the local water supply and water quality in order to provide adequate information to active nature conservation. Among the examined dead-arms, it is the upper part of the dead-arm at Helmecszeg that is qualified as having a nature conservation value on the basis of its preserved natural state and diversity of the aquatic flora. This particular area represents a remarkable feeding site for the protected black stork (*Ciconia nigra*), and provides shelter for a variety of herons (Ardeidae) and ducks (Anatidae). Due to the hard floods of 1998, the diversity of phyto- and zooplankton could not be verified.

The other two dead-arms primarily serve as fishing water, but since they are presently short of nutrients (oligo-mesotrophic state) and free of organic pollutants (oligo-beta mesosaprobity), they can be considered as approaching the natural state in spite of the local water farming activities. The significance of all three dead-arms are connected to recreation, and the upper part of the Tisza dead-arm at Helmecszeg is utilised as a zone of ecotourism.

The local effects of the mechanically treated wastewater on the receptive dead-arm could be clearly observed and measured, but in a distance from this site, the more favourable, natural purification processes were already functioning, thus the present loading caused by the wastewater could not be particularised, neither modified. When explaining this phenomena, the fact should be considered that in arid periods even the treated or purified water with substandard quality may perform more favourably for the living organisms of wetlands than any dry conditions that ultimately may lead to the destruction of most aquatic organisms.

In the almost one-year period of the application, the research works – in accordance with the preliminary plans – were primarily confined to the dead-arms near Tarpa, in the Szatmár-Bereg Plain, as they contained the selected sampling sites, though the results and experiences are referential to the whole of nature conservation in the Szatmár-Bereg Plain. Consequently, the studies aiming to reveal the basic ecological state of wetlands and the potentialities of nature conservation treatments have not been completed, these first results call for the extended continuation of the examinations.

2.2.5. Summary

An essential task of nature conservation is to reveal the structural and functional state of the remaining natural wetlands. By today, it has been definitely demonstrated that the preservation and conservation of the present conditions in nature restoration areas can only be achieved by productive activities of care-taking, supported by thorough and well-founded research work.

In the framework of the „Tarpa region state assessment" examinations have been initiated in order to gain an overall survey on the ecological and hydrobiological ground state, as well as the local fish fauna of the dead-arms situated in the area of Tarpa. The research work covered the dead-arms of River Tisza at Helmecszeg and Vargaszeg, and the so-called Kiss Jánosné's dead-arm.

In the case of these wetlands, constituent parts of the research work included the observation of the ground ecological state, and the examination of the water supply and water quality so as to provide adequate information for active nature conservation. From

the investigated dead-arms, it is the upper area in the dead-arm of Tisza at Helmecszeg that can be classified as having nature conservational value on the basis of its preserved natural conditions, as well as its diversity in the aquatic flora.

The other two dead-arms offer fine fishing water, yet due to their current state of lacking nutrients (oligo-mesotrophy) and being free of organic pollutants (oligo-beta sabrobity), and in spite of the local water farming are considered to be even more of natural state. The significance of all three dead-arms are connected to recreation, and the upper part of the Tisza dead-arm at Helmecszeg serves the ends of ecotourism.

2.2.6. ACKNOWLEDGEMENT

This study was support by the R+D project of Higher Education (FKFP 2006/97 project) and the Department of Ecology, Kossuth University, Debrecen.

2.2.7. REFERENCES

Borhidi A. (1993): A magyar flóra szociális magatártás tipusa, természetességi és relatív ökológiai értékszámai. KTM TVH, Budapest és JPTE, Pécs. 1-93.

Dévai Gy. (1994): Magyarországi Vizes Élőhelyek (Wetlands) Adatbázisa (Data base of Hungarian wetlands) (MVÉA-Program). KTM Természetvédelmi Hivatala & KLTE Ökológiai Tanszéke, Budapest - Debrecen. 1-24.

Dévai Gy., Dévai I., Felföldy L. and Wittner I. (1992): A vízminőség fogalomrendszerének egy átfogó kocepciója. 3. rész: Az ökológiai vízminőség jellemzésének lehetőségei. (A comprehensive concept of water quality. Part 3: The possibilities of the characterization of the ecological water-quality by water bodies.) – Acta Biol. Debr. Oecol. Hung. 4, 49-185.

Dugan, P.J. (ed.) (1990): Wetland conservation. A review of current issues and required action. IUCN - The World Conservation Union, Gland, 96 pp.

Felföldy L. (1987): A biológiai vízminősítés. (Biological water qualification). VIZDOK, Budapest, Vízügyi Hidrobiológia, 16, 1-258.

Kocsis, G. and Lakatos, G. (1999): Heavy metal loading in a small river (River Túr) in NE-Hungary. Pollution and water resources Columbia University Seminar Series, XXVI. (in press).

Kovács B. and Lakatos Gy. (1999): Tarpa környéki eusztatikus holtágak halállományának szerkezete. (Structure of fish communities in the eustatic dead-arms at Tarpa). Zárójelentés az FKFP 2006/97 sz. programról. (kézirat), Debrecen, 1-10.

Lakatos Gy. (1990): Észak-alföldi védett vízterek hidrobiológiai állapota és természetvédelmi kezelése. (Hydrobiological state and nature conservation treatment of NE-Hungarian protected wetlands) Calandrella IV/l, 90-109.

Lakatos, G. (1997): Restoration of wetlands. Wetlands International Publication, 43, 309-316.

Lakatos Gy. (1998).: Javaslat a hazai vizes élőhelyek osztályozására (Proposal for classification of Hungarian wetlands). Hidrológiai Közlöny, 78, 348-349.

Mitsch, W.J. (1996): Managing the world's wetlands. Preserving and enhancing their ecological functions. Verh. Internat. Verein. Limnol. 26, 139-147.

Simon T. (1988): A hazai edényes flóra természetvédelmi érték-besorolása. (Nature conservation ranks of the Hungarian vascular flora). Abstracta Bot.12, 1-23.