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Concentration of oxygen dissolved in Water Nature Reserve Alúvium Žitavy in the southwestern part of Slovak Republic

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Abstract

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Over the years 2009–2010, the concentrations of dissolved oxygen depending on sampling time and sampling site in the water of the Nature Reserve (NR) Alúvium Žitavy, which is situated in the southwestern part of the Slovak Republic, were evaluated. On the basis of the results we achieved we can state that its mean concentration in the water of the Nature Reserve over the whole monitored period was 5.98 mg O_2 dm^{-3}. Depending on the time of collection, the highest average oxygen concentration for the whole period of study in March (14.36 mg O_2 dm^{-3}) was found, which is probably related to a high flow and due to turbulent stirring of water as well. For the whole period of study the lowest average concentrations in the water of the Alúvium in the summer period were observed with a minimum value being in July (3.36 mg O_2 dm^{-3}). It is supposed that the decrease in oxygen concentration in the summer period with a higher temperature of water and more intensive decomposition of organic matter by microorganisms was linked. Depending on the collection places, the highest average concentrations were in collection sites no. 1 (8.57 mg O_2 dm^{-3}), which being located on the inflow of the river Žitavy to the Alúvium and no. 4 (8.24 mg O_2 dm^{-3}), which was located in the narrowest place of the Alúvium with the fastest water flowing. The lowest average concentrations for the whole period of study in sampling sites of wetland nature (sampling site no. 2, 3, 5 and 6) were discovered, the lowest average value being in the sampling site no. 6 (5.31 mg O_2 dm^{-3}). The calculated value of the 10th percentile of this indicator was lower in all sampling sites when compared with that recommended by order of the Slovak Government No. 269/2010 Coll.

Key words

dissolved oxygen, nature reserve, water quality

Introduction

An important indicator of the purity of surface waters is the concentration of dissolved oxygen (Pitter, 1999). Most biochemical processes are influenced to a great extent by oxygen amount in water, it is a limiting factor for the life of organisms, determining by aerobic or anaerobic processes will be under way in water (Heteša and Kočková, 1997). The main source of oxygen in surface waters is the level transfer from the atmosphere and photosynthesis of aquatic plants (Maidment, 1993; Ambrožová, 2003). As the movement of the water is slowed down, the transfer of oxygen from the atmosphere into the water is decreased too (Metějko, 1981). Its solubility in water depends on the temperature and pressure, to a lesser extent also on the content of salts in water (Šulvová et al., 2009). Water oxygen is consumed by bacteria decomposing organic matter present in the flow (Langhammer, 2002). It is inevitable for fish life and self-cleaning processes in surface waters. If it is depleted from water, environment becomes anoxic (Pitter, 2009).

Material and methods

Research area

The Nature Reserve (NR) Alúvium Žitavy is situated in the cadastral land of the town Hurbanovo and the village Martovce in the southwestern part of the Slovak Republic (*Krajinno-ekologický plán obce Martovce*, 2006). Its area is 32.53 hectares, and it was established as the Nature Reserve in 1993. The Alúvium lies in the interperineal area of the river Žitava, from its present estuary of the river Nitra to the village of Veľký Vék (assumed air line) (Szabóová, 1989). It is closely adjacent surrounding agrocenosis with remainders of meanders of the original water course of the rivers Nitra and Žitava. There is an open water line of the canal with dense bank vegetation in the central part of the Reserve. The northern part is enlarged and there is continuous vegetation of riparian forest. Wetland ecosystems are situated mainly in terrain depression at the edge of the alluvium of the river Žitava (Bridišová et al., 2006).

Its larger part is flooded along the year, but especially in spring. There are different biotopes, aquatic, wetland and riverine vegetation. Riverine forests, particularly willow stands, almost along alluvium provide suitable ecological conditions for nesting and roosting of avifauna. There are more than 76 bird species occurring in this area (*Prírodná rezervácia Alúvium Žitavy*, 2006). Furthermore is very important for conservation of fauna and flora genetic resources (*Štátny zoznam osobitne chránených častí prírody a krajiny Slovenskej republiky*, 2007).

The NR Alúvium Žitavy is a part of the Protected Landscape Area Dunajské luhy (*Krajinno-ekologický plán obce Martovce*, 2006). The aim is to protect biotopes of European importance (riverine willow-poplar and alder wood forests) and the species of European importance (*Proterorhinus* sp., *Rhodeus amarus*, *Gobio albipinnatus*, *Bombina bombina*, *Lutra lutra*, *Citellus citellus*, species of national importance *Microtus oeconomus*) (Bridišová et al., 2006). Concurrently, NR Alúvium Žitavy is a part of the Special Protection Area SKSPA 005 Dolné Považie to which also belongs the proposed habitat of European importance 0159 Alúvium Žitavy (*Krajinno-ekologický plán obce Martovce*, 2006). The rare species of avifauna are for example *Ardea* sp., *Remiz* sp., *Botaurus* sp., *Circus* sp., *Anas* sp., *Acrocephalus* sp., *Charadrius* sp., *Locustella* sp., etc. In term of protected flora, there are *Leucojum aestivum* growing almost over the whole area of the NR and *Nuphar lutea* on water surface. *Ceratophyllum* sp., *Lemna minor* and *Lemna trisulca* form a typical green cover on the water surface. Along the interperineal area of the river Žitava, there is wetland vegetation from which communities of *Phragmites australis*, *Typha latifolia*, *Carex* sp. and *Scirpus* sp. are dominant (*Prírodná rezervácia Alúvium Žitavy*, 2006).

Sampling and processing of the material

Water sampling was carried out from the 6 sampling sites in the NR. The water samples were taken regularly during the years 2009–2010, on the 15th day of each month. The sampling sites were proposed to obtain the best possible data for the evaluation of changes in dissolved oxygen concentrations in water in dependence on the sampling time and site. We have established the following 6 sampling sites:

Sampling site No. 1 (47°51'88" N, 18°09'89" E, 121 m a.s.l.) – inflow of the river Žitava into the Alúvium. *Phragmites australis* and *Salix* sp. grow along the river Žitava. The average depth is 0.32 m.

Sampling site No. 2 (47°51'92" N, 18°09'25" E, 111 m a.s.l.) and **No. 3.** (47°51'83" N, 18°09'25" E, 117 m a.s.l.) – these sampling sites are typical wetland ecosystems. There is a very dense vegetation of *Phragmites australis* and *Salix* sp. in this part of the NR. The water surface is covered by *Lemna minor*. Water in these sites flows very slowly, and the height of its level change is in dependence on weather during the year. The average depth is 0.30 m.

Sampling site No. 4 (47°51'58" N, 18°08'38" E, 129 m a.s.l.) – is situated near a bridge on a road to the village of Martovce. It is also the narrowest part of Alúvium; where the water in the river Žitava flows most rapidly. There is a typical vegetation of *Phragmites australis*, *Salix* sp. and *Alnus* sp. on the banks of the river Žitava. The average depth is 0.40 m.

Sampling site No. 5 (47°51'09" N, 18°07'99" E, 116 m a.s.l.) and **No. 6** (47°50'81" N, 18°07'67" E, 121 m a.s.l.) – typical wetland ecosystems. Here, the river Žitava flows out of its watershed during rapid snow melting in spring and intensive precipitation events in summer. In comparison with the second and the third sampling site, the river floods the whole depression between the two slopes. In dry summer the water level decreases by about a few metres. This part of Alúvium is represented mainly by an open water area. *Typha latifolia*, *Phragmites australis*, *Alnus* sp. and *Salix* sp. grow along the river. The water surface in sampling site No. 6 is covered with *Lemna* sp. forming a typical green cover. Beyond this sampling site, the river Žitava flows into the river Nitra. The average depth in sampling site No. 5 is 0.26 m and 0.39 m in the sampling site No. 6.

Oxygen dissolved concentrations by the galvanic oxygen probe StirrOx (G) using the apparatus inoLab Multi Level 3 were determined in the water samples collected. Evaluation of surface water quality for dissolved oxygen was carried out using a value of the 10th percentile (P10), calculated from the values measured, and by subsequent comparing them with the corresponding system of limit values, which are set out in the Government regulations of the Slovak Republic No. 269/2010 Coll.

Results and discussion

The average values of dissolved oxygen during the period of study ranged from 1.02 (June 2010) to 19.83 mg O_2 dm^{-3} (March 2009). For the whole period of study its value represented 5.98 mg O_2 dm^{-3} (Fig. 1). The highest average concentration for the whole period of study was discovered in March (14.36 mg O_2 dm^{-3}, Fig. 2), which is probably related with a higher flow of water (Fig. 3), in which its turbulence has increased, which according to Langhammer (2002) contributes to a water oxygen saturation. Since the month of March the average oxygen concentration for the whole period of study was decreasing gradually until the month of July, when its minimum value was found (3.36 mg O_2 dm^{-3}). In the following months until the month of October its rise was observed. From the results of the average oxygen concentrations for the whole period of study, depending on the sampling time at the same time it follows that their lowest values were in the summer period. We assume that the low oxygen concentrations in the summer period are related with warmer temperature of water (Fig. 4). An opinion of several authors has, as a result, been confirmed (Ambrožová, 2003; Pitter, 2009; Noskovič et al., 2010) that at higher temperatures the solubility of oxygen in water lowers. In addition, the decrease in oxygen concentration in the summer period may have been related with a more intensive decomposition of organic substances by microorganisms.

Except for the months of February, June, July and August in 2010, with respect to fish life, detected oxygen concentrations in water in the alluvium of Žitava may be considered to be still more satisfactory, because as stated by Lellák and Kubíček (1991) a critical limit for most of the species makes 3–4 mg O_2 dm^{-3}.

The influence of sampling site on dissolved oxygen concentrations is shown in Fig. 5. The highest average concentrations have been measured in sampling sites no. 1 (8.57 mg O_2 dm^{-3}), no. 4 (8.24 mg O_2 dm^{-3}). Lower concentrations were shown in sampling sites. 2, 3, 5 and 6, with the lowest average value for the whole period of study being found in the sampling site no. 6 (5.31 mg O_2 dm^{-3}). We assume that this is related with the nature of these sampling sites. They are wetland habitats with slow-flowing or even stagnant water surface, which facilitated for a thick layer of sediments rich in organic substance from dead macrophytes to be created that form dense growth in these places. Due to this also increased the concentration of organic substances in water, by decomposition of which dissolved oxygen was consumed, which has resulted in its concentration decrease. In similar habitats as were in the locations no. 2, 3, 5 and 6 low oxygen dissolved content was also found out by Sedláková (2004) in nature reserve Parisian swamplands and Beňačková (2007) in nature reserve Žitavský wetland.

In the requirements on the quality of surface water in the Regulations of the Slovak Government No. 269/2010 Coll., the value for dissolved oxygen makes more than 5 mg dm^{-3}. The values calculated of the 10th percentile of this index indicator in all sampling sites were lower than those recommended in the Regulations of the Slovak Government.

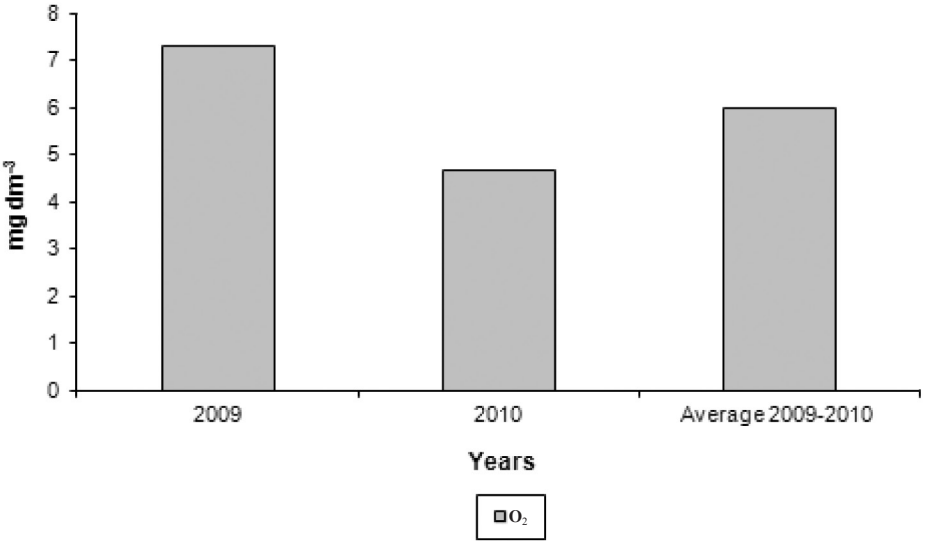

Fig. 1. Mean concentrations of dissolved oxygen in the water of Alúvium Žitavy in years 2009–2010 [mg O_2 dm^{-3}].

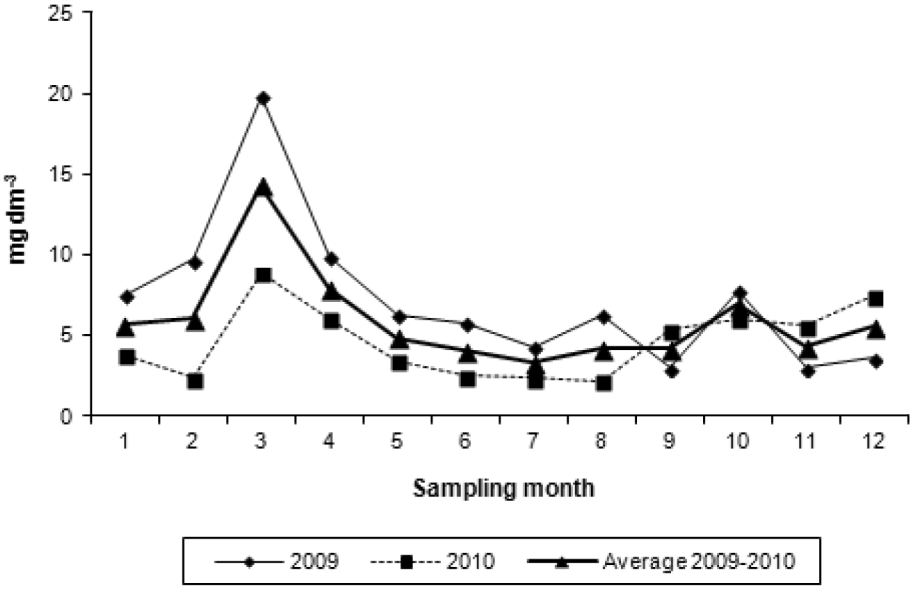

Fig. 2. Mean concentrations of dissolved oxygen in depending on sampling time.

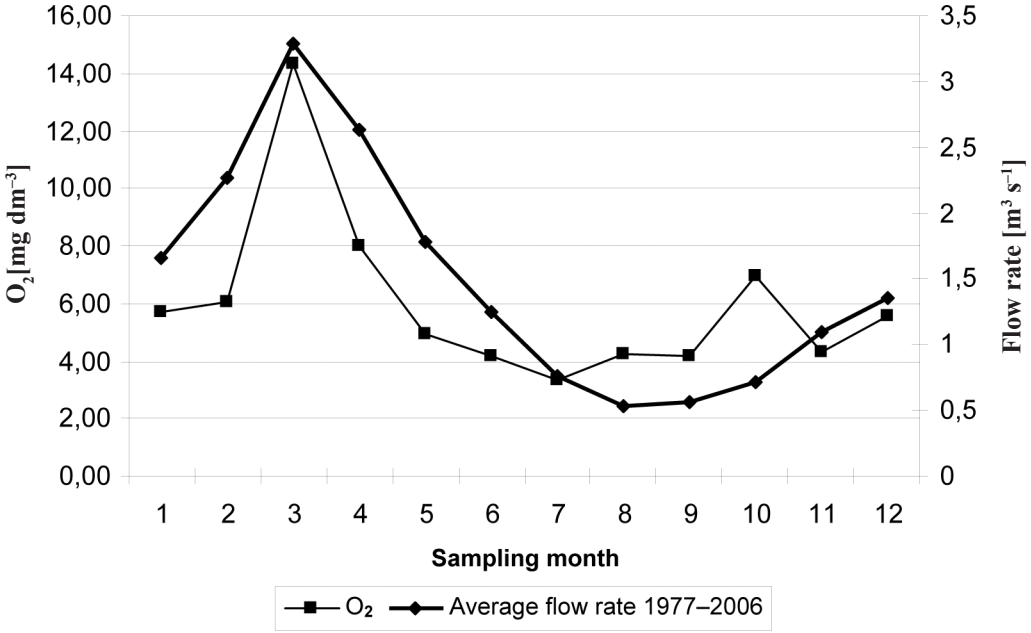

Fig. 3. The relationship between concentration of dissolved oxygen and flow rate (Vieska nad Žitavou gagin station).

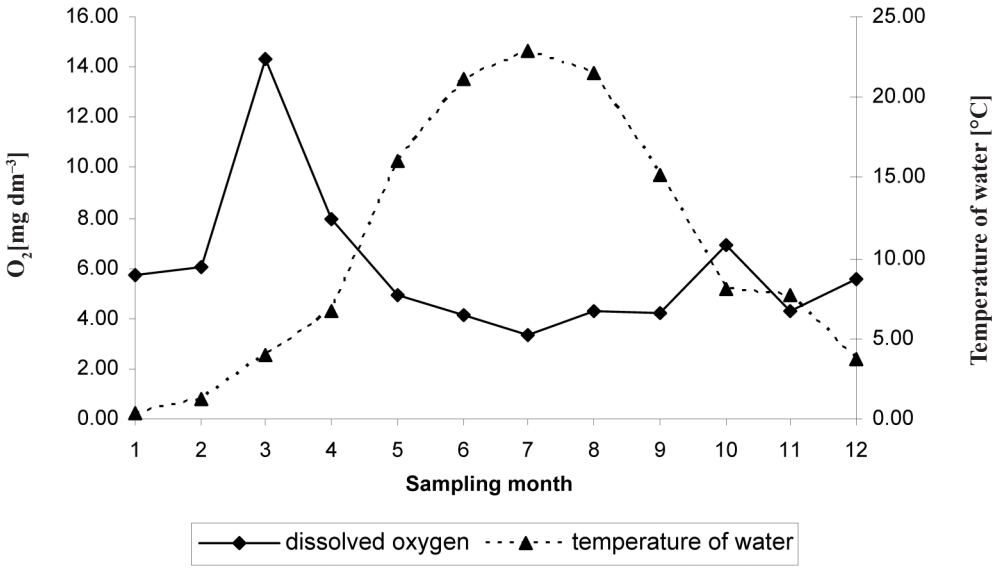

Fig. 4. The relationship between concentration of dissolved oxygen and temperature of water.

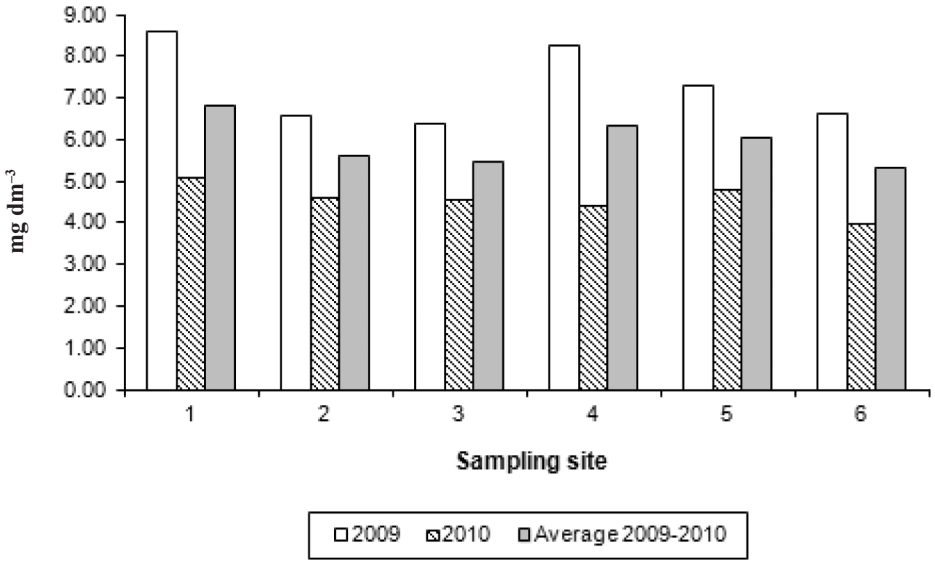

Fig. 5. Mean concentrations of dissolved oxygen in depending on sampling site.

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Koncentrácia rozpusteného kyslíka vo vode Prírodnej rezervácie Alúvium Žitavy, juhozápadné Slovensko

Súhrn

V priebehu rokov 2009 – 2010 sa vo vode Prírodnej rezervácie Alúvium Žitavy, ktorá sa nachádza v juhozápadnej časti Slovenskej republiky, hodnotili koncentrácie rozpusteného kyslíka v závislosti od času a miesta odberu. Na základe získaných výsledkov môžeme konštatovať, že jeho priemerná koncentrácia vo vode PR za celé sledované obdobie bola 5,98 mg O_2 dm^{-3}. V závislosti od času odberu najvyššia priemerná koncentrácia kyslíka za celé sledované obdobie sa zistila v mesiaci marec (14,36 mg O_2 dm^{-3}), čo pravdepodobne súvisí s vysokým prietokom a tým aj turbulentným premiešavaním vody. Najnižšie priemerné koncentrácie za celé sledované obdobie vo vode Alúvia boli v letnom období s minimálnou hodnotou v mesiaci júl (3,36 mg O_2 dm^{-3}). Predpokladáme, že pokles koncentrácie kyslíka v letnom období súvisel s vyššou teplotou vody a intenzívnejšou dekompozíciou organických látok mikroorganizmami. V závislosti od miesta odberu najvyššie priemerné koncentrácie sa namerali v odberových miestach č. 1 (8,57 mg O_2 dm^{-3}), lokalizovanom na vtoku rieky Žitavy do Alúvia a č. 4 (8,24 mg O_2 dm^{-3}), ktoré sa nachádzalo v najužšom mieste Alúvia s najrýchlejším prúdením vody. Nižšie priemerné koncentrácie za celé sledované obdobie boli v odberových miestach mokraďového charakteru (odberové miesto č. 2, 3, 5 a 6) s najnižšou priemernou hodnotou v odberovom mieste č. 6 (5,31 mg O_2 dm^{-3}). Vypočítané hodnoty 10. percentilu tohto ukazovateľa vo všetkých odberových miestach boli nižšie ako odporúčaná hodnota v Nariadení vlády SR č. 269/2010 Z. z.

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