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IONIC COMPOSITION OF LOW SEDGE EUTROPHIC MAJERZ FEN WATERS IN THE PIENINY NATIONAL PARK

SKŁAD JONOWY WÓD NISKOTURZYCOWEJ EUTROFICZNEJ MŁAKI MAJERZ W PIENIŃSKIM PARKU NARODOWYM

Abstract: Ionic composition of the analyzed fen waters was variable over the study period and depended on climatic and anthropogenic factors, such as temperature and precipitation and also on the use of land situated on a slope above the analyzed fen. On the basis of ionic composition Majerz fen water, according to the Szczukariew-Prikłoński classification, may be classified in the 18th hydrochemical class of hydrogen carbonate-calcium-magnesium waters.

Keywords: ionic composition, eutrophic fen

Hydrogenic habitats, in which fens may be included, fulfill very important environmental functions. They play a crucial role in surface fresh waters retention, their purification and accumulation of carbon and nitrogen compounds. They also provide a habitat of many stenotypic plant and animal species including protected species [1, 2]. Specific conditions in these habitats are connected with the type of their hydrological feeding together with chemical composition and physical properties of waters. A high level of surface waters stimulates the process of organic matter accumulation, whereas water feeding these habitats enriches them in minerals at the same time shaping their trophicity. However, the state of dynamic balance in fens may be easily disturbed because of their drainage or a change of ionic composition of their feeding waters. Stenotypic species, characterized by specific habitat requirements are particularly sensitive to changes [3, 4].

The aim of the research was to determine the impact of climatic conditions and the way of land use on chemical and physical properties of waters and soils of low sedge slope eutrophic fen.

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Materials and methods

The research comprised the soil and waters of Majerz slope fen covered by vegetation characteristic for *Valeriano-Caricetum flavae* alliance and situated on the Majerz glade in the Pieniny National Park. The analyzed fen developed on the andesite matrix [5]. Two soil pits, situated in its upper and lower part, were made in order to determine soil properties of the analyzed fen. On the basis of the organic carbon content, depth of organic horizons, degree of organic matter decomposition (Table 1) and the type of hydrological feeding, the analyzed fen soils may be counted to Rheic Histosols (Eutric) according to the WRB taxonomy [6].

Piezometres were installed in the places where the soil pits were made and water samples were collected from them from March to November 2005. In the analyzed fen soils the mineral content, pH and degree of organic matter decomposition were determined using the methodology suggested by Sapek and Sapek [7] for organic soils. The temperature, pH, electroconductivity, mineralization, oxygenation and ionic composition were determined using the methodology suggested by Dojlido [8] in the waters sampled from the piezometers placed in the fen soils.

Dependencies between the selected water properties were assessed using Spearman's rank simple correlation coefficient for non-parametric statistics.

Results and discussion

The analyzed fen was characterized by a soligenous type of hydrological feeding. In conditions of high moisture, the bog process of organic material accumulation was in progress in the investigated fen surface horizon. The surface horizons of the investigated soils revealed a high degree of organic material decomposition characteristic for low peats with amorphous-lump structure (Table 1).

Table 1

Essential properties of analyzed fen soils

Profile	Depth [cm]	Horizon symbol	Decomposition degree	Mineral content [%]	WRB 2007
Location: Majerz Glen, 640 m.a.s.l, land slope 8^{o}					
Majerz I	0–20	Ha	H_6	35,0	Rheic Sapric Histosols (Eutric)
	20–45	He1	H_3	52,5	
	45–58	He2	H_3	53,0	
	58–(68)	Cl	—	—	
Majerz II	0–24	Ha	H_6	34,6	Rheic Sapric Histosols (Eutric)
	24–43	He1	H_3	52,3	
	43–65	He2	H_3	59,7	
	65–(75)	Cl	—	—	

The high level of decomposition should be attributed to a considerable oxygen content in the fen feeding waters, which stimulated the organic matter decomposition process. Similar dependencies between the degree of organic matter decomposition and oxygenation of fen feeding waters were registered by Nicia and Miechówka [9] in the waters of eutrophic fens developed on the lime rock matrix.

On the basic of the ionic composition the Majerz fen waters may placed in the 18th hydrochemical class of hydrogen carbonate-calcium-magnesium waters according to Szczukariew-Prikłoński classification [10]. However, ionic composition of the studied fen waters was variable throughout the research period, the state of dynamic balance was observed in them. Changes in the analyzed fen water chemistry observed during the period of research were caused by the factors such as: precipitation, temperature and the presence of animals grazed on a slope above the researched fen.

On the basis of their mineralization, the examined fen waters may be classified after Pazdro [11], to fresh waters with mineralization from 100 to 500 mg $\cdot$ dm^{-3}. The analyzed fen waters were characterized by variable values of total mineralization over the period of research. The highest concentrations of mineral substance were assessed in May over the period of between two and three-weeks of rainless weather (Table 2). The mineral substance content, electroconductivity values and concentrations of Ca^{2+}, Mg^{2+} and HCO_3^- were decreasing in the periods of intensified rainfall as a result of the so-called "dilution effect". Allan [12] described a similar relationship between substance concentrations in river waters and precipitation, whereas Nicia and Miechówka [13] observed it in fen waters. The mineral content is connected with the value of electroconductivity [14]. A statistical analysis of the obtained results revealed a significant dependence between the mineral substance content and the value of electroconductivity (simple correlation coefficient $r = 0.9500$ at $p < 0.01$) (Table 3).

The other factor which apparently affected ionic composition of the examined fen water was the temperature. Changes of temperature cause a change of intensity of processes influencing water chemistry shaping. These processes include, among others, nitrification and biological sorption. Because the intensity of nitrification increases with temperature [15], the concentration of NO_3^- ions was also growing in the analyzed fen water with increasing temperature. Statistical analysis showed a significant relationship between nitrate(V) ion concentration and temperature of the studied fen waters described by a simple correlation coefficient $r = 0.6024$ at $p < 0.1$. The increase in temperature was accompanied by biological sorption involving the incorporation of biogenic components into plant and animal organisms [16]. This process may explain the phosphorus content in the investigated fen waters decreasing with raising temperature.

Changes of phosphate ion concentrations may also be connected with human activity and the presence of wild animals. In June a flock of about 800 sheep was kept on a slope above the fen and the animals left a considerable amount of excrements. Intensive rainfall in June caused leaching phosphate ions from the sheep and wild animal excrements, which enriched the fen waters.

Table 2

Properties of analyzed fen waters

Properties*		Month of sampling										
		III	IV	V	VI	VII	VIII	IX	X	XI	$\overline{X}$**	A***
Temperature	^{o}C	5.7	10.9	12.3	13.7	13.9	15.3	14.5	11.7	6.1	11.6	3.5
pH		6.95	7.02	7.07	7.39	7.11	7.29	7.52	7.8	7.48	7.3	0.3
Conductivity	$\mu S \cdot cm^{-1}$	448	592	675	378	590	488	511	410	436	503.1	98.2
Mineraliztion	$mg \cdot dm^{-3}$	344	470	512	329	423	389	397	345	342	394.6	63.6
O_2		2.3	0.3	0.3	0.5	0.9	1.4	1.4	2.2	1.9	1.2	0.8
HCO_3^-		234.9	300.1	323.4	105.4	211.2	289.3	270.7	256.7	265.7	250.8	64.0
SO_4^{2-}		28.43	37.08	37.8	20.69	52.65	4.75	7.09	15.16	14.31	24.2	16.0
Cl^-		6.06	4.06	4.38	5.01	3.81	3.87	3.38	3.08	3.1	4.1	1.0
NO_3^-		0.93	11.98	13.68	42.79	57.2	23.17	26.8	28.8	23.75	25.5	16.8
NH_4^+		0.04	0.04	0.04	0.27	0.02	0.04	0.03	0.01	0.01	0.1	0.1
PO_4^{3-}		23.1	44.5	46	42.75	5.6	2.67	2.31	2.05	2.05	19.0	20.2
Ca^{2+}		62.05	77.42	84.93	43.51	66.31	69.45	66.03	55.73	57.21	64.7	12.2
Mg^{2+}		18.1	29.1	31.45	14.52	17.35	21.75	25.44	15.65	16.67	21.1	6.2
Na^+		6.03	4.72	4.47	4.54	6.88	6.67	6.74	6.87	6.76	6.0	1.1
K^+		5.53	3.39	2.37	0.8	4.37	1.98	1.92	0.91	0.88	2.5	1.7

* mean value from two piezometres; ** $\overline{X}$ – mean value; ***A – standard deviation.

Table 3

Correlation table

	T	pH	Conductivity	Mineralization	O_2	HCO_3^-	SO_4^{2-}	Cl^-	NO_3^-	NH_4^-	PO_4^{3-}	Ca^{2+}	Mg^{2+}	Na^+	K^+
T	1.0000	0.3333*	0.1667	0.2500*	–0.3109*	0.0667	–0.3000*	–0.1667	0.5000*	0.1399	–0.0669	0.2167	0.1167	0.1167	–0.1667
pH	0.3333*	1.0000	–0.5333*	–0.3667*	0.3025*	–0.1833	–0.6167**	–0.7833**	0.6500**	–0.5509*	–0.7699**	–0.5667*	–0.5000*	0.5000*	**–0.8000*****
Conductivity	0.1667	–0.5333*	1.0000	**0.9500*****	–0.5883**	0.6833**	0.4833*	0.1500	–0.3667*	0.0962	0.5272*	**0.9500*****	**0.9000*****	–0.2167	0.6500**
Mineralization	0.2500	–0.3667*	**0.9500*****	1.0000	–0.5883**	0.6833**	0.4667*	0.0000	–0.2333	0.0087	0.4519*	**0.9000*****	**0.8333*****	–0.1333	0.5667*
O_2	–0.3109*	0.3025*	–0.5883**	–0.5883**	1.0000	–0.3866	–0.4706*	–0.3109*	–0.0420	–0.4894*	–0.7342**	–0.5630*	–0.4538*	0.5462*	–0.0336
HCO_3^-	0.0667	–0.1833	0.6833**	0.6833**	–0.3866*	1.0000	–0.1000	–0.0667	–0.6000**	0.0525	0.2427	0.7833**	**0.8500*****	–0.3667*	0.1667
SO_4^{2-}	–0.3000*	–0.6167**	0.4833*	0.4667*	–0.4706*	–0.1000	1.0000	0.4000*	–0.0167	0.1486	0.6611**	0.3333*	0.1833	–0.1833	0.5667*
Cl^-	–0.1667	–0.7833**	0.1500	0.0000	–0.3109*	–0.0667	0.4000*	1.0000	–0.4667*	**0.8919*****	**0.8285*****	0.2000	0.2333	–0.7833**	0.4000*
NO_3^-	0.6024**	0.6500**	–0.3667*	–0.2333	–0.0420	–0.6000**	–0.0167	–0.4667*	1.0000	–0.3323*	–0.3849*	–0.4833*	–0.6333**	0.5333*	–0.4833*
NH_4^-	0.1399	–0.5509*	0.0962	0.0087	–0.4894*	0.0525	0.1486	**0.8919*****	–0.3323*	1.0000	0.7902**	0.2011	0.2361	**–0.8569*****	0.1224
PO_4^{3-}	–0.0669	–0.7699**	0.5272*	0.4519*	–0.7342**	0.2427	0.6611**	**0.8285*****	–0.3849*	0.7902**	1.0000	0.5272*	0.4937*	**–0.8117*****	0.4268
Ca^{2+}	0.2167	–0.5667*	**0.9500*****	**0.9000*****	–0.5630*	0.7833**	0.3333*	0.2000	–0.4833*	0.2011	0.5272*	1.0000	**0.9167*****	–0.3000*	0.6167**
Mg^{2+}	0.1167	–0.5000*	**0.9000*****	**0.8333*****	–0.4538*	**0.8500*****	0.1833	0.2333	–0.6333**	0.2361	0.4937*	**0.9167*****	1.0000	–0.4167*	0.5500*
Na^+	0.1167	0.5000*	–0.2167	–0.1333	0.5462*	–0.3667	–0.1833	–0.7833**	0.5333*	**–0.8569*****	**–0.8117*****	–0.3000*	–0.4167*	1.0000	–0.0167
K^+	–0.1667	**–0.8000*****	0.6500**	0.5667*	–0.0336	0.1667	0.5667*	0.4000*	–0.4833*	0.1224	0.4268*	0.6167**	0.5500*	–0.0167	1.0000

* significance level p = 0.5; ** significance level p = 0.1; *** significance level p = 0.01.

Conclusions

1. A high level of groundwaters of the analyzed fen, their mineralization and oxygenation affected the direction of the pedogenic process and the degree of organic matter decomposition in the studied fen soils,

2. On the basis of their mineralization the examined fen waters may be classified to the 18th hydrochemical class of fresh hydrogen carbonate – calcium-magnesium waters.

3. Both anthropogenic and climatic factors affected the chemistry of the analyzed fen waters.

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SKŁAD JONOWY WÓD NISKOTURZYCOWEJ EUTROFICZNEJ MŁAKI MAJERZ W PIENIŃSKIM PARKU NARODOWYM

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Abstrakt: Skład jonowy wód badanej młaki był zmienny w okresie badań i zależał od czynników klimatycznych i antropogennych. Na podstawie składu jonowego, według klasyfikacji hydrochemicznej Szczukariewa-Prikłońskiego można je zaliczyć do 18 klasy hydrochemicznej wód wodorowęglanowo--wapniowo-magnezowych.

Słowa kluczowe: skład jonowy, młaki eutroficzne