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Chemical and biochemical characteristics of soils in the catchments of Čertovo and Plešné lakes (Bohemian Forest) in 2010

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Abstract
Basic chemical and biochemical properties of mountain forest soils were determined in the catchments of Čertovo (CT) and Plešné (PL) lakes in 2010. The soil pH was generally low, with the pH_{CaCl2} values being 3.1–4.3 in O horizons, 3–4 in A horizons, and 3.3–4.9 in the first mineral (M) soil horizon below the A horizon. The average element pools in organic-rich horizons (O+A) in the CT and PL catchments were respectively: C, 126+356 and 144+366 mol.m^{-2}; N, 4.7+14.4 and 5.3+13.6 mol.m^{-2}; and P, 0.10+0.53 and 0.10+0.33 mol.m^{-2}. The average effective cation exchange capacity of the O+A horizons was 821+3610 and 1170+3530 meq.m^{-2} in the CT and PL catchments, respectively, with the base saturation of 20% and 36%. The base saturation was primarily based on exchangeable Ca^{2+}. The average C:N ratio was 26 in O and A horizons, and 24 in mineral horizons in both catchments. Average concentrations of C, N, and P in microbial biomass were higher in the CT than PL soils with the respective averages of 300, 40 and 4.9 versus 162, 12, and 2.6 mmol.kg^{-1} for the O horizons, and 186, 22, and 2.3 versus 101, 9.5, and 1.7 mmol.kg^{-1} for the A horizons. Soil microbial biomass represented 0.3–0.8%, 0.8–2.6%, and 1.7–15% of the total C, N, and P concentrations in the CT and PL soils, respectively. The O horizons exhibited ~3 times higher nitrogen mineralization, while ~30% lower nitrification in the CT than PL soils. The most important change of soil chemistry since 1997–2001 was an increase of base cations (and the base saturation) in PL soils, probably due to decomposition of elevated litterfall caused by bark beetle infestation.

Key words: Soil nitrogen, phosphorus, cation exchange capacity, nitrification, mineralization

Introduction

The catchments of Čertovo (CT) and Plešné (PL) lakes in the Bohemian Forest have been intensively studied for last two decades, because they represent rare central European localities, with only limited direct anthropogenic effects, except for long-term atmospheric acidification (Vrba et al. 2003, Šantrůčková et al. 2007). In such areas, the soil composition and pools, together with bedrock mineralogy, vegetation and catchment morphology, represent the main factors controlling water chemistry (Kamenik et al. 2001, Kopáček et al. 2004). Properties of catchment soils play important role in the terrestrial export of nutrients to surface waters (e.g., Baron et al. 1994, Kopáček et al. 2004, Kaňa & Kopáček 2006). Uppermost organic-rich soil layer also represent significant proportion of nutrient pool of coniferous forest sites (Prescott et al. 2000). The understanding of mechanisms responsible for the C, N, and P retention in and/or export from the soils requires knowledge of soil pools, chemistry, and biochemistry. In addition, data on soil chemical properties are necessary for the simulation of future development of soil chemistry under changing rates of acidic deposition (e.g., Cosby et al. 2001, Majer et al. 2003). Such relevant and detailed data on the Bohemian Forest soils were obtained in years 2000 and 2001 (Kopáček et al 2002a,b). It has been already documented that differences in soil chemistry and biochemistry (Kopáček et al 2002a,b, Šantrůčková et al. 2002, Skopcová & Šantrůčková 2006) reflected different bedrock compositions in the CT and PL catchments (Veselý 1994).

The Bohemian Forest ecosystems are, however, recovering from acidification due to reduced sulphur and nitrogen emissions into the atmosphere in central Europe and the consequent decline in acidic deposition in the Bohemian Forest, and their chemistry is assumed to recover (Majer et al. 2003, Kopáček & Hruška 2010). In addition, the PL catchment has been affected by a large-scale bark beetle (*Ips typographus*) infestation since 2004, followed by dieback of trees. Both the decreased acidic deposition and elevated litter fall after forest infestation have been affecting chemistry of the Bohemian Forest soils (Kaňa et al. 2013). The aim of this study is to evaluate differences in soil chemistry between samples taken during the years of 1997–2001 (Kopáček et al. 2002a,b), and in 2010 for both PL and CT catchments, and between these catchments in 2010. Because we assume that major changes in soil chemistry associated with the atmospheric deposition and bark beetle outbreak mostly occur in upper soil horizons, we focus on the uppermost organic-rich horizons and on the underlying 10-cm layer of mineral soil horizons.

Materials and methods

Study site description

The Čertovo (CT) and Plešné (PL) lakes are situated at 49° 10' N, 13° 11' E, and 48° 47' N, 13° 52' E, at elevations of 1030 m and 1090 m in the massives of Jezerní Hora Mt. (1343 m), and Plechý (1378 m), respectively. The CT catchment covers an area of 89 ha (including lake area of 10.7 ha), and is east oriented. The PL catchment covers an area of 67 ha (including the lake area of 7.6 ha), and is north-east oriented (Janský et al. 2005). Both catchments are steep with the maximum local relief of 313 m (CT) and 288 m (PL). Their bedrock is predominantly made up of mica-schist (muscovite gneiss) with quartzite intrusions in the CT catchment, and of granites in the PL catchment (Veselý 1994). Soils at both plots are cambisols and haplic podzols (Kopáček et al. 2002a,b). The soil cover in the CT catchment is dominated (58%) by the cambisol, which is 0.49±0.20 m deep (average ± standard deviation). Podzol (0.49±0.24 m deep) covers 21% of the catchment and the undeveloped organic rich soil (O and A horizons on the rocks) is 0.23±0.13 m deep and covers 17% of the CT catchment (Kopáček et al. 2002 b). The soil cover in the PL catchment is dominated (38%) by the undeveloped thin organic rich soil (O and A horizons), covering the rocks and being 0.20±0.13 m deep. Podzol and cambisol cover 29% and 27% of the catchment, respectively, and are both ~0.45±0.25 m deep. Wetlands and bare rocks cover ~1% and 5% of the PL catchment, respectively (Kopáček et al 2002a).

The unmanaged forests in the PL and CT catchments are 100–160 and on average ~160 years old, respectively, and are dominated by Norway spruce (Svoboda et al. 2006, Kopáček et al. 2010). The details on the dominant understory vegetation are given by Svoboda et al. (2006). Details on the land use history and forest composition of the study catchments are given by Veselý et al. (1993). In 2000, the dead forest occupied <3% of the PL catchment in small patches distributed over the whole catchment. The PL forest has been damaged by a bark beetle outbreak since the summer of 2004 (northwest part) and 2006 (the rest of the catchment), and most of trees died within 2–3 years of the plot infestation. The trees lost most needles during first several months after the outbreak. Then, they had been continuously losing twigs, bark, and branches until the end of this study. Dead trees were continuously broken by winds, and >35% of the original trees was already broken in 2011. In the same year, 93% of the PL forest lost >80% of its original healthy trees. All dead biomass was left in the PL catchment (Kopáček et al. 2013). The CT forest was almost intact in 2000 and was affected by windthrows in 2007 and 2008, which broke most of the trees along the southwestern ridge of the catchment. The only forest management practice used to deal with the damaged stands was bark removing from dead trees, and the most of dead biomass remained in the catchment. Other relatively small patches with broken trees and the following bark beetle outbreak occurred in the northern part and throughout the whole CT catchment in 2007–2011. Altogether, the total area of damaged forest (with >50% dead trees) in the CT catchment increased from ~4% to 18% during 2000–2011 (Kopáček et al. 2013).

Sampling and analyses

Soil profiles

Soils were sampled at elevations between 1028 and 1320 m at 20 and 21 plots distributed evenly in the CT and PL catchments, respectively, from May to June 2010 (Fig. 1). The list of samples is given in Appendices 1 and 2. Soil samples were taken from ~0.25 m^2 pits (ca. 50×50 cm**),** excavated to the first mineral horizon. All stones of the diameter >2–5 cm were removed and weighted separately. Soil from each horizon was taken separately, weighted, and mixed and a representative (1–2 kg) sample was taken and put in a plastic bag for chemical analyses. In the cases where the pit was not a regular quadrangular prism, the area for individual horizon was measured. The thickness of horizons was measured in every corner and in the middle of every side of the pit and the average value was calculated. Number of samples, which were taken from the pit, depended on the soil profile characteristics. For the purpose of this study, we use the following classification of horizons: organic litter layer consisting predominantly of decaying spruce needles, branches, and bark (O horizon), the uppermost mineral horizon with accumulated humified organic matter (A horizon), and if present, the upper 10-cm layer of mineral soil horizon below the A horizon. Those mineral horizons were classified as eluvial horizon E (in podzol profiles) or B horizons (without further detailed classification; Appendix 1 and 2). All the mineral horizons are further denoted together as M horizon.

Physical, chemical, and biochemical analyses

In the laboratory, samples were passed through a 5-mm stainless-steel sieve to remove coarse particles. Then, the samples were divided into two parts. One part was air dried between two sheets of filter paper for 14–21 days at laboratory temperature, sieved through a stainless-steel <2-mm sieve, and used for chemical analyses. The other part was stored (<1 month) wet in a plastic bag at 4°C in the dark until analyzed for water extractable compounds and biochemical parameters.

Water extracts (1:10 by weight, field moist soil, 1 h shaking on a horizontal shaker) were analyzed for dissolved organic carbon (DOC), water extractable total nitrogen (TN_{H2O}), water-extractable total phosphorus (TP_{H2O}), soluble reactive P (SRP_{H2O}), NO_3-N, NH_4-N, and water-extractable aluminium (Al_{H2O}). Concentrations of NH_4-N, NO_3-N and SRP were measured colorimetrically, using a flow injection analyzer consisting of a FIA Star 5027 Sampler, 5012 Analyzer, and 5042 Detector (Foss Tecator, Hoganas, Sweden) (Shaw et al., 1988) after filtration of the samples through Whatman GF/C filters. The gas diffusion method was used

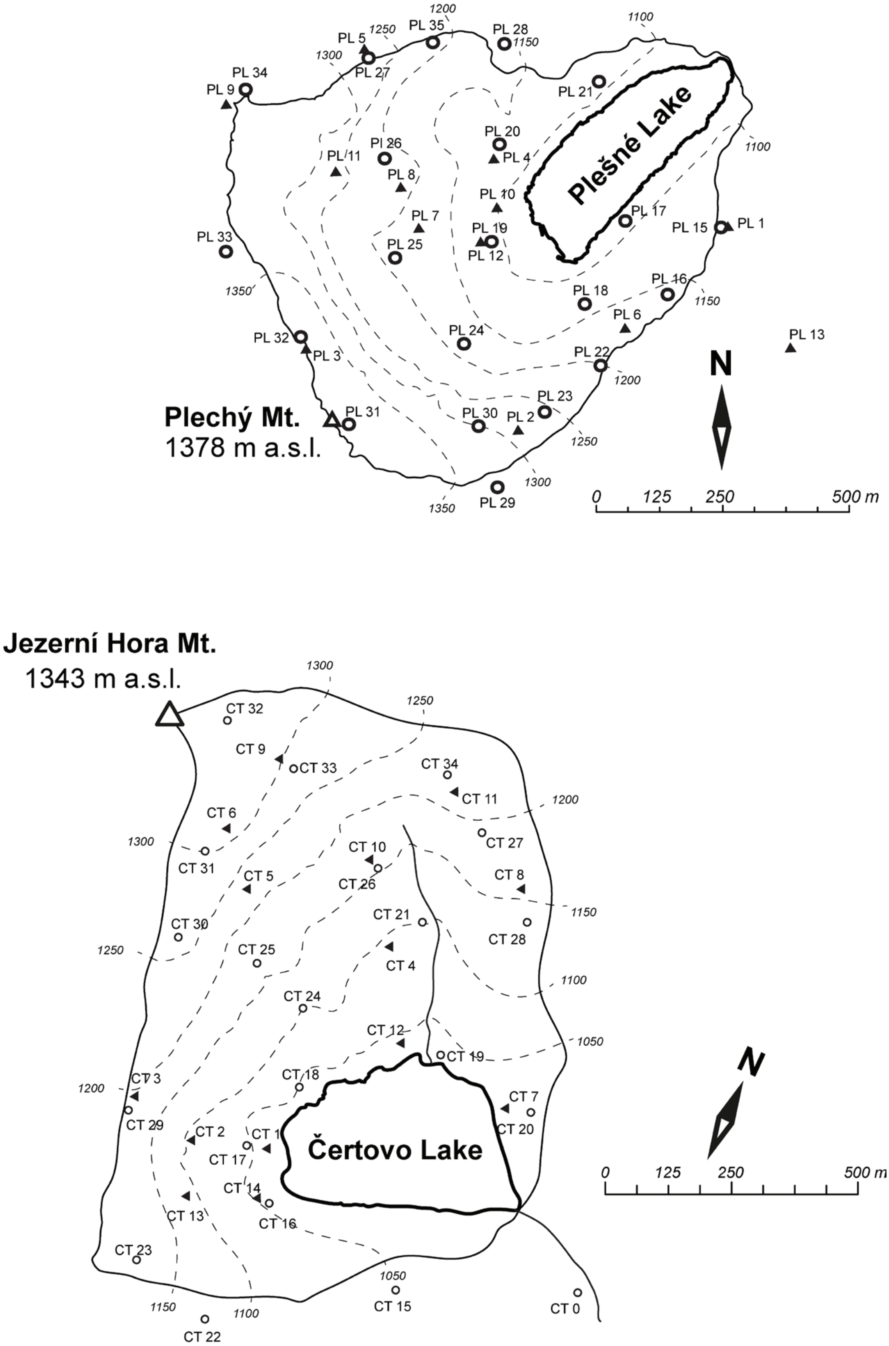

Fig. 1. Map of the catchments of Čertovo and Plešné lakes with the location of sampling pits. Black triangles – pits sampled in 1997–2001, circles – pits sampled in this study.

for the determination of NH_4-N (Karlberg & Twengström 1983). NO_3-N was determined after reduction to nitrite. The standard phosphomolybdenum-blue complex method was used for the SRP analysis (Parsons et al. 1984).

Concentrations of TP_{H2O}, DOC, and TN_{H2O} were analyzed in filtered (Macherey-Nagel glass-fiber filters, 0.4 µm porosity) extracts. TP_{H2O}, was determined by perchloric acid digestion and the molybdate method (Kopáček & Hejzlar 1993), and DOC and TN_{H2O} by IR spectrometry with a TOC/TN analyzer VarioTOC (Elementar, Germany). Aluminium in H_2O extracts (Al_{H2O}) was determined colorimetrically according to Dougan & Wilson (1974).

Subsamples of the air-dried <2-mm soil fraction (further referred to as the AD soil) were used for the following analyses:

Dry weight and loss on ignition (LOI) were obtained by sample drying at 105°C for 2 hours and by igniting at 550°C for 2 hours, respectively.

Subsamples of the AD soils for elemental analyses were finely ground to pass through a 100-µm sieve and homogenized. These samples were analyzed for total concentrations of P, C, and N. The P concentrations were determined colorimetrically after nitric and perchloric acid digestion (Kopáček et al. 2001) and C and N were analyzed using a CN analyzer (ThermoQuest, Italy). The total content of metals was analyzed by the flame atomic absorption spectrometry (Ca, Mg, Na, K, Fe, Mn, Li, and Ti) and/or volumetric titration (Al) after mineralization of finely ground AD soil with H_2SO_4, HNO_3, and HF (200°C, 2 hours). Concentration of Si was calculated from the concentration of SiO_2, calculated as the difference between dry weight and LOI and concentration of metal oxides (CaO, MgO, Na_2O, K_2O, Al_2O_3, Fe_2O_3, MnO, Li_2O and TiO_2).

Oxalate-extractable Fe (Fe_{ox}), Al (Al_{ox}), P (P_{ox}) and soluble reactive P (SRP_{ox}) were determined by extraction of 0.5 g of the AD soil with 50 ml of acid ammonium oxalate solution (0.2 M $H_2C_2O_4$ + 0.2 M $(NH_4)_2C_2O_4$ at pH 3) according to Cappo et al. (1987). The original method was modified as follows: the extraction process was carried out in three successive steps, each with a fresh extracting solution, lasting 17 hours in total (for details see Kopáček et al. 2004). Fe_{ox}, Al_{ox}, and P_{ox} concentrations were determined from the combined extracts using the method of Kopáček et al. (2001), and SRP_{ox} colorimetrically according to Wolf & Baker (1990).

Soluble reactive phosphorus in Mehlich-3 extract (P_{M3}) was determined by extraction (1:10; 5 minutes) of AD soil with Mehlich-3 solution (0.2 M CH_3COOH, 0.25 M NH_4NO_3, 0.013 M HNO_3, 0.015 M NH_4F, 0.001 M EDTA) according to Mehlich (1984).

The pH was measured in distilled water (pH_{H2O}), and in a 0.01M $CaCl_2$ solution (pH_{CaCl2}), with a mass ratio of the AD soil to liquid phase of 1:5 after a 2.5-hour extraction (horizontal shaker).

Exchangeable base cations (BC_{ex} = sum of Ca^{2+}, Mg^{2+}, Na^+, K^+) and exchangeable acidity (the sum of Al^{3+}_{ex} and H^+_{ex}) were determined at natural soil pH by extracting 2.5 g of the AD soil with 50 ml of 1M NH_4Cl and 1M KCl, respectively, in three successive steps (Kopáček et al. 2004). Base cation concentrations were measured by atomic absorption spectrometry (Varian, Australia), and Al^{3+}_{ex} and H^+_{ex} were determined by titration (phenolphthalein, 0.1M NaOH and 0.1M HCl) according to Thomas (1982). The effective cation exchange capacity (CEC) was the sum of BC_{ex}, Al^{3+}_{ex} and H^+_{ex}, and all concentrations were expressed on an equivalent basis (meq.kg^{-1}; 1 equivalent is 1 mole of charge). Base saturation (BS) was calculated as the percentage of BC_{ex} in CEC.

Concentrations of C, N, and P in soil microbial biomass (C_{mic}, N_{mic}, P_{mic}) were measured by chloroform fumigation method (Vance et al. 1987, Brookes et al., 1982). Wet samples (<5 mm, 10 g), were divided into two parts; one part was fumigated and then extracted, the other was directly extracted with 40 ml of 0.5M K_2SO_4 (C_{mic} and N_{mic}) or with 200 ml of 0.5M $NaHCO_3$ (P_{mic}), and filtrated (Whatman, No 42). In the filtrate, concentrations of C and N, were determined with a TOC/TN analyzer Formacs (Skalar, Netherlands) and P with alkaline persulfate oxidation (Cabrera & Beare 1993), followed by phosphomolybdate blue method (Brookes et al. 1982).

Net nitrification (N_{nitr}) and net N mineralization (ammonification) (N_{min}) were determined according to Šantrůčková et al. (2002) by incubation of the wet soil samples (<5 mm, 20 g) under oxic conditions for 1 and 3 weeks. The NH_4^+ and NO_3^- concentrations in 2M KCl extract were analyzed by flow injection analyzer (Tecator FIAStar 5020) after 1 and 3 weeks of incubation. Daily net nitrification and N mineralization rates were calculated as the difference between final and initial NO_3^- and NH_4^+ concentration, respectively, divided by the number of days.

Carbon mineralization rate (C_{min}) was measured as CO_2 release from soil samples (<5 mm, 10 g soil, 55% water holding capacity) after 24 hours incubation in hermetically sealed bottles (100 ml) at 10°C. Evolved CO_2 was determined using a gas chromatograph (Hewlett Packard, TCD).

Concentrations of C_{mic}, N_{mic}, P_{mic}, and rates of C_{min} N_{min} and N_{nitr} were determined in representative mixed samples. The mixed samples were prepared by mixing of proportional amounts (by weight) of fresh soil (<5 mm fraction) from the individual horizons. The origin of mixed samples is in detail shown in Appendices 3 and 4.

All chemical and biochemical results further reported in this paper are given on a dry weight (105 °C) basis. All abbreviations of soil constituents and analytical methods are summarized in Table 1.

Average element pools (mol.m^{-2}) of upper organic soil horizons were calculated as the arithmetical means of individual element pools found in all sampling pits for O and A horizons as C_OM_O and C_AM_A, respectively, where C is concentration of a component (mol.kg^{-1}) in the individual soil horizon and M is the amount (kg.m^{-2}) of the dry weight <2 mm (or <5 mm for biochemical analyses) soil fraction in the respective horizon.

The differences in soil parameters between the catchments, as well as between years 1997–2000 (data from Kopáček et al. 2002a,b), and 2010 were tested by non-parametric Mann-Whitney U test, using STATSTICA™ 9 software.

Results and discussion

Physical and chemical soil characteristics

The characteristics of individual soil horizons are given in Tables 2 and 3, for the characteristics of individual samples see Appendices 1 and 2. Despite the large spatial variability, we found significant between-catchment differences in soil composition – the significantly differing parameters are listed in Table 4.

The O and A horizons were on average (± standard deviation) 5.3±1.8 and 12±6 cm deep and contained 3.4±1.8 and 13±11 kg m^{-2} of dry weight <2 mm soil fraction, respectively, with no significant differences between the CT and PL catchments (for details see Table 2).

Soils from the CT and PL catchments were acidic, with pH_{H2O} varying from 3.1 to 4.3 in O horizons, 3–3.9 in A horizons, and 3.3–4.9 in M horizons. Values of pH_{CaCl2} varied similarly in ranges by 0.5–1 pH unit lower than pH_{H2O} values (Table 2). The soil pH did not statistically significantly differ between the PL and CT catchments.

Concentrations of C were similar in the CT and PL soils and varied between 29.9–43.9, 17.9–40.8, and 2.7–24.3 mol.kg^{-1} in O, A, and M horizons, respectively. The N concentrations varied from 1.2 to 1.7 mol.kg^{-1} in O horizons (with significantly higher concentrations

Table 1. List of abbreviations of chemical and biochemical methods used in this study.

LOI	Loss on ignition (550°C, 2 hours)
C	Total carbon (dry matter; CN analyzer)
N	Total nitrogen (dry matter; CN analyzer)
P	Total phosphorus (dry matter; acid digestion and molybdate method; Kopáček & Hejzlar 1993)
$\mathbf{P_{ox}}$	Total phosphorus in oxalate extract (Cappo et al. 1987)
$\mathbf{SRP_{ox}}$	Soluble reactive phosphorus in oxalate extract (Cappo et al. 1987)
$\mathbf{P_{M3}}$	Soluble reactive phosphorus in Mehlich III extract (Mehlich 1984)
$\mathbf{TP_{H2O}}$	Total phosphorus in H_2O extract from fresh soil (Kopáček & Hejzlar 1993)
$\mathbf{SRP_{H2O}}$	Soluble reactive phosphorus in H_2O extract from fresh soil (FIA)
DOC	Dissolved organic carbon in H_2O extract from fresh soil (IR spectroscopy)
$\mathbf{TN_{H2O}}$	Total nitrogen in H_2O extract from fresh soil (IR spectroscopy)
$\mathbf{NH_4}$**-N**	Ammonium nitrogen in H_2O extract from fresh soil (FIA)
$\mathbf{NO_3}$**-N**	Nitrite nitrogen in H_2O extract from fresh soil (FIA)
$\mathbf{Al_T}$	Total aluminum (FAAS method)
$\mathbf{Al_{ox}}$	Aluminum in oxalate extract (Cappo et al. 1987)
$\mathbf{Al_{EX}}$	Exchangeable aluminum (KCl extraction; Thomas 1989)
$\mathbf{Al_{H2O}}$	Aluminum in H_2O extract from fresh soil (Dougan & Wilson 1974)
$\mathbf{Fe_T}$	Total iron (FAAS method)
$\mathbf{Fe_{ox}}$	Iron in oxalate extract (Cappo et al. 1987)
$\mathbf{H^+_{EX}}$	Exchangeable hydrogen (KCl extraction; Thomas 1989)
$\mathbf{K^+_{EX}}$	Exchangeable potassium (NH_4Cl extraction; AAS)
$\mathbf{Na^+_{EX}}$	Exchangeable sodium (NH_4Cl extraction; AAS)
$\mathbf{Ca^{2+}_{EX}}$	Exchangeable calcium (NH_4Cl extraction; AAS)
$\mathbf{Mg^{2+}_{EX}}$	Exchangeable magnesium (NH_4Cl extraction; AAS)
$\mathbf{BC_{EX}}$	Sum of exchangeable base cations (NH_4Cl extraction; AAS)
CEC	Effective cation exchange capacity (sum of BC_{EX}, Al_{EX}, and H^+_{EX})
BS	Base saturation (percentage of BC_{ex} in CEC)
$\mathbf{C_{mic}}$	Carbon in microbial biomass (chloroform fumigation method; Vance et al. 1987, Brookes et al. 1985)
$\mathbf{N_{mic}}$	Nitrogen in microbial biomass (chloroform fumigation method; Vance et al. 1987, Brookes et al. 1985)
$\mathbf{P_{mic}}$	Phosphorus in microbial biomass (chloroform fumigation method; Vance et al. 1987, Brookes et al. 1985)
$\mathbf{C_{min}}$	C mineralization (gas chromatography)
$\mathbf{N_{nitr}}$	Net nitrification (Šantrůčková et al. 2002)
$\mathbf{N_{min}}$	Net mineralization (ammonification) (Šantrůčková et al. 2002)

Table 2. Average (± standard deviation) characteristics of O, A, and M soil horizon in the catchments of Čertovo (CT) and Plešné (PL) lakes in 2010. Data are related to <2mm dry weight soil fraction; nd – not determined. For the M horizons, total depths are given, but analyses were done for the uppermost 10 cm.

	CT-O	CT-A	CT-M	PL-O	PL-A	PL-M
LOI (%)	87±6.5	67±6.5	23±14.1	87±6.3	65±15.5	17.7±10.7
Depth (cm)	4.8±1.8	11.4±2.2	36±22.2	5.8±1.8	12.8±6.0	27.2±14.8
Soil < 2mm ($kg.m^{-2}$)	3.2±1.5	12.4±3.9	nd	3.7±2.1	13.2±10.8	nd
pH_{H2O}	3.7±0.2	3.6±0.2	3.9±0.1	3.7±0.2	3.5±0.2	3.9±0.4
pH_{CaCl2}	3.1±0.3	3.0±0.3	3.4±0.2	3.2±0.2	2.9±0.2	3.1±0.2
pH_{KCl}	2.8±0.2	3.0±0.2	3.4±0.2	2.9±0.2	2.8±0.2	3.1±0.4
C ($mol.kg^{-1}$)	39.8±3.3	30.1±3.3	9.7±6.5	39.1±3.5	29.7±7.1	7.8±5.0
N ($mol.kg^{-1}$)	1.5±0.1	1.2±0.1	0.4±0.3	1.4±0.1	1.1±0.2	0.3±0.2
P ($mmol.kg^{-1}$)	32.3±4.1	39.9±4.0	33.4±17.7	29.9±8.4	24.9±7.1	12.4±7.7
$\mathbf{P_{ox}}$ ($mmol.kg^{-1}$)	8.5±2.4	16.7±2.6	19.6±13.2	8.7±3.0	9.0±6.2	6.6±5.4
$\mathbf{SRP_{ox}}$ ($mmol.kg^{-1}$)	4.2±0.7	3.6±0.9	4.4±5.0	4.2±1.2	2.9±1.2	1.5±1.5
$\mathbf{P_{M-3}}$ ($mmol.kg^{-1}$)	2.0±0.5	0.7±0.6	nd	2.5±0.8	1.1±0.3	nd
$\mathbf{TP_{H2O}}$ ($mmol.kg^{-1}$)	0.5±0.8	0.3±0.8	0.1±0.1	1.4±1.2	0.6±0.4	0.1±0.2
$\mathbf{SRP_{H2O}}$ ($mmol.kg^{-1}$)	0.34±0.61	0.11±0.6	0.02±0.03	1.3±1.23	0.53±0.35	0.08±0.06
DOC ($mmol.kg^{-1}$)	97±59	80±58	25±33	94±36	82±39.5	24.6±12.7
$\mathbf{TN_{H2O}}$ ($mmol.kg^{-1}$)	17.6±13.8	14.9±13.7	3.7±2.5	22.6±16.3	13±6.6	2.9±1.8
$\mathbf{NH_4}$**-N** ($mmol.kg^{-1}$)	8.1±7.4	3.0±7.3	0.3±0.4	8.7±7.9	2.4±1.7	0.5±0.4
$\mathbf{NO_3}$**-N** ($mmol.kg^{-1}$)	7.5±8.8	7.6±8.6	1.6±1.2	11.4±10.2	7.6±5.2	1.6±1.5
$\mathbf{Al_T}$ ($mmol.kg^{-1}$)	353±252	906±252	2197±504	293±211	898±404	2058±312
$\mathbf{Al_{ox}}$ ($mmol.kg^{-1}$)	75±45	180±44	134±78	63±75	114±89	63±64
$\mathbf{Al_{EX}}$ ($mmol.kg^{-1}$)	20.7±11.3	46.2±11	27.8±13.6	15.8±15.3	26.7±9.3	18.8±13
$\mathbf{Al_{H2O}}$ ($mmol.kg^{-1}$)	0.07±0.07	0.15±0.07	0.09±0.12	0.08±0.08	0.12±0.11	0.07±0.06
$\mathbf{Fe_T}$ ($mmol.kg^{-1}$)	81±36.2	193±35.4	382±265	59±17.8	78±18	89±36.7
$\mathbf{Fe_{ox}}$ ($mmol.kg^{-1}$)	32±13.1	96±12.8	187±164	28.4±8.7	35.0±16.5	34±28.7
$\mathbf{H^+_{EX}}$ ($meq.kg^{-1}$)	95±27	115±29.3	87±23.1	87±19.9	111±22.1	72±31.4
$\mathbf{K^+_{EX}}$ ($meq.kg^{-1}$)	13.2±3.4	7.4±3.8	1.9±1.1	11.5±3.7	6.8±2.2	2.2±1.9
$\mathbf{Na^+_{EX}}$ ($meq.kg^{-1}$)	1.6±0.7	1.3±0.6	0.5±0.2	1.4±0.3	1.4±0.9	0.6±0.4
$\mathbf{Ca^{2+}_{EX}}$ ($meq.kg^{-1}$)	71±35	23±34	3.9±2.7	136±53	63±38	12.6±11
$\mathbf{Mg^{2+}_{EX}}$ ($meq.kg^{-1}$)	18.4±4.3	8.9±4.3	2.0±1.1	23.5±8.7	12.1±4.9	2.4±1.7
$\mathbf{BC_{EX}}$ ($meq.kg^{-1}$)	104±38	40±38	8.2±4.7	173±60	83±43	17.8±14.4
CEC ($meq.kg^{-1}$)	261±38	294±40	178±45	308±45	274±55	146±64
BS (%)	40±13	13±13	5±3	56±17	29±11	13±10

Table 3. Average (± standard deviation) concentrations of mineral constituents of O, A, and M soil horizons in the catchments of Čertovo (CT) and Plešné (PL) lakes in 2010. Data are related to <2mm dry weight soil fraction.

	CT-O	CT-A	CT-M	PL-O	PL-A	PL-M
	mmol.kg^{-1}			mmol.kg^{-1}		
Ca	45±14	29±14	30±12	77±24	48±18	32±7
K	97±134	172±88	449±119	83±68	295±169	793±118
Mg	29±11	43±20	97±55	26±5	29±7	42±10
Mn	1.94±0.77	1.49±0.69	2.73±1.33	2.65±1.21	1.52±0.50	1.84±0.55
Na	33±26	89±54	211±88	55±50	185±109	494±108
Ti	15.8±8.5	42.5±18.8	106±26.6	9.3±4.0	20.5±6.4	38.7±10.1
Si	1288±731	3678±1875	9176±2141	1298±749	3990±1935	10523±1422
Li	0.48±0.18	0.87±0.31	1.82±0.79	0.96±0.39	2.20±1.18	6.02±1.56

in the CT soils; Table 4), and from 0.7 to 1.6 and from 0.1 to 1.2 mol.kg^{-1} in A and M horizons, respectively, with no significant difference between the catchments.

The C:N ratios varied from 19.7 to 32.5 and differed neither between O and A soil horizons nor between the catchments.

The concentrations of inorganic nitrogen forms in the PL and CT soils exhibited large spatial variability within catchments, exceeding one order in magnitude (e.g., NO_3-N concentrations varied from 0.3 to 37.5 mmol.kg^{-1} in O horizons, and from 0.4 to 35 mmol.kg^{-1} in A horizons; Appendices 1 and 2). As a result of this variability, no significant differences between catchments were observed. But the PL soils exhibited higher medians of concentrations of mineral N forms than the CT soils (10.6 vs. 4.8 and 6.5 vs. 4.1 mmol.kg^{-1} of NO_3-N, and 19.9 vs. 11.6 and 12.2 vs. 9.6 mmol.kg^{-1} of NH_4-N in the O and A horizons, respectively). Similar forest disturbances usually lead to transient increase in soil and soil water concentrations of NH_4-N and NO_3-N for ~5–8 years (e.g., Huber et al. 2004, 2005; McHale et al. 2007; Kaňa et al., 2013). Actually, Kopáček et al. (2013) observed a rapid and significant increase in NO_3-N concentrations in all four streams draining the PL catchment after the forest dieback, while the NO_3-N concentrations remained more-or-less stable in streams draining intact CT sub-catchments during 1998–2012. The relatively small between-catchment differences in concentrations of soil inorganic nitrogen observed in 2010 also coincides with results of our more detailed long-term study performed at permanent research plots located in the lower parts of the CT and PL catchments. There we found significantly increasing annual average soil NO_3-N concentrations from ~0.2 to ~3 mmol.kg^{-1} at the PL plot, while relatively stable values (~0.4–1 mmol.kg^{-1}) at the CT plot during 2008–2012 (Kaňa et al., unpubl.).

The CT soils had significantly higher content of total Fe, Mg and Ti, while lower content of total K and Li in all horizons (Table 3). These differences undoubtedly resulted from differences in bedrock composition (Kopáček et al. 2002a,b). Also concentrations of all other Fe forms (besides total Fe) and also of most Al forms were higher in the CT than PL soils (Tables 2 and 4). For example, Fe_{ox} concentrations were almost three-times higher in the CT than PL A horizons (96 vs. 35 mmol.kg^{-1}) and six-times higher in M horizons (187 vs. 34 mmol.kg^{-1}). Similarly, concentrations of Al_{ox} were significantly higher in all CT than PL soil horizons (Tables 2 and 4). These differences in concentrations of metal oxides are probably given by higher liberation of Fe and Al from mica schist in the CT bedrock than from granite in the PL bedrock (Kaňa & Kopáček 2006). Concentrations of Al_{ox} and Fe_{ox} are usually used as a measure of concentration of Al and Fe oxyhydroxides and represent the main factor controlling P retention in acidic mountain soils (Kaňa & Kopáček 2006, Kaňa et al. 2011).

The concentrations of Al_{H2O} were generally low, ~0.01 mmol.kg^{-1} in all the investigated soil horizons (Table 2), and did not differ among the catchments. This mobile form represented only a negligible part of the total soil Al.

The catchments differed significantly in soil P concentrations, with both P and P_{ox} concentrations significantly higher in A and M horizons in the CT than PL catchment (Tables 2 and 4). In contrast, concentrations of SRP_{H2O} were higher in the PL than CT soils (on average 1.3 vs. 0.3 and 0.5 vs. 0.1 mmol.kg^{-1} in O and A horizon, respectively. Similarly, we observed significantly higher P_{M3} concentrations in the PL than CT A horizons (1.1 vs. 0.7 mmol.kg^{-1}). The SRP_{H2O} obviously represents the most mobile readily available P form. Concentrations of SRP in Mehlich-3 extract (P_{M3}) is generally used as a measure of P availability for plants (Cassagne et al. 2000), especially in agricultural soils (Sharpley et al. 2001). The higher concentrations of mobile P forms (SRP_{H2O} and P_{M3}) in the PL soils suggest higher P availability in the PL catchment, despite lower total P and P_{ox} concentrations than in the CT catchment. The P mobility could be partly enhanced by decomposition of fresh litter rich in nutrients after bark beetle infestation in the PL catchment. Kaňa et al. (2013) observed an increase of one order of magnitude in SRP_{H2O} concentrations in the PL catchment during 2008 to 2010.

Concentrations of P forms exhibited different distribution within soil profiles of the CT and PL catchments. While the P concentrations were significantly lower in O than A horizons in the CT catchment (32.3 vs. 39.9 mmol.kg^{-1}), they were significantly higher in the O than A horizons in the PL catchment (29.9 vs. 24.9 mmol.kg^{-1}; Table 2). The catchments did not differ in P_{ox} concentrations in O horizons, but the P_{ox} concentrations in A horizon were ~2 times higher in the CT than PL catchment, due probably to higher concentrations of Al and Fe oxyhydroxides.

In both catchments, the soil CEC ranged between 190–453, 177–374, and 60–324 meq.kg^{-1}

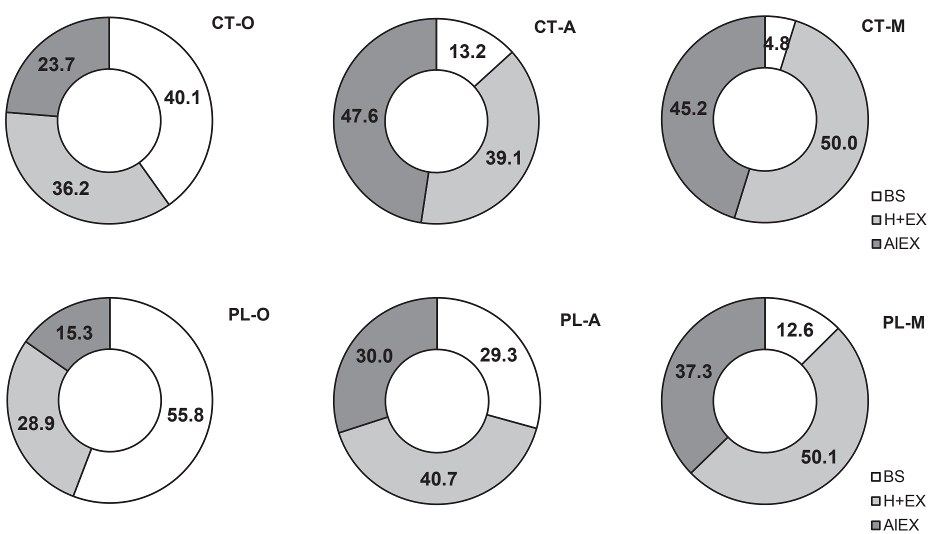

Fig. 2. Percentage of base saturation (BS), exchangeable H^+ (H^+_{EX}) and exchangeable Al (Al_{EX}) in cation exchange capacity in soils from Plešné (PL) and Čertovo (CT) catchments. O, A, and M indicate the respective soil horizons.

Table 4. Statistically significant differences between chemical composition of O, A, and M soil horizons in the catchments of Čertovo (CT) and Plešné (PL) lakes in 2010. Significances are marked by asterisks as follows: * $p<0.05$, ** $p<0.01$, *** $p<0.001$; ns – not significant; the lake code refers to the catchment with significantly higher value of the parameter.

	O	A	M
N	*, CT	ns	ns
P	ns	***, CT	***, CT
P_{ox}	ns	**, CT	***, CT
SRP_{ox}	ns	ns	*, CT
P_{M-3}	ns	**, PL	ns
TP_{H2O}	**, PL	***, PL	**, PL
SRP_{H2O}	***, PL	***, PL	***, PL
NH_4-N	ns	ns	**, PL
Al_{min}	ns	***, CT	***, CT
Al_{ox}	*, CT	*, CT	**, CT
Al_{EX}	*, CT	***, CT	*, CT
Fe_T	*, CT	***, CT	***, CT
Fe_{min}	**, CT	***, CT	***, CT
Fe_{ox}	ns	***, CT	***, CT
Ca^{2+}_{EX}	***, PL	***, PL	**, PL
Mg^{2+}_{EX}	ns	*, PL	ns
BC_{EX}	***, PL	***, PL	ns
CEC	**, PL	ns	ns
C_{mic}	**, CT	***, CT	ns
N_{mic}	***, CT	***, CT	ns
P_{mic}	*, CT	ns	ns

in the O, A, and M horizons, respectively. The average CEC values were significantly higher in O horizons of the PL than CT catchments (308 vs. 261 meq.kg^{-1}), but were similar in both catchments in A and M horizons (Tables 2 and 4).

The catchments differed in proportion of individual cations contributing to CEC. Except for the O horizon in the PL catchment, CEC was dominated by Al_{EX} and H_{EX} (exchangeable acidity) in both catchments (Fig. 2). The Al_{EX} concentrations were significantly lower in the PL than CT soils (Table 4). In contrast, the PL soils had generally higher concentrations of base cations than the CT soils, with the average BC_{EX} values of 173 vs. 104, 83 vs. 41, and 18 vs. 8 meq.kg^{-1} in the O, A, and M horizons, respectively. This difference was caused by ~2–3times higher Ca^{2+}_{EX} concentrations in the PL than CT soils (Table 2) and bedrock (Kopáček et al. 2002a,b). The higher BC_{EX} concentrations, together with lower Al_{EX} concentrations (Fig. 2) resulted in significantly higher base saturation of the PL than CT soils, with the averages of 56% vs. 40%, 29% vs. 13%, and 13% vs. 5% in the O, A, and M horizons, respectively (Fig. 2). The exchangeable Al was probably replaced from the soil sorption complex in the PL soils by elevated inputs of BC_{EX} from mineralization of elevated litter fall after bark beetle infestation (Kaňa et al. 2013). The lower Al_{EX} concentrations in the PL soils thus may denote a lower risk of Al toxicity for plants and soil biota in the PL than CT catchment, as observed elsewhere (e.g., Kochian 1995, Poschenrieder et al. 2008).

Concentrations of total Ca followed a different pattern along the soil profiles than other base elements. The Ca concentrations were highest in the O horizons (on average 45 and 70 mmol.kg^{-1} in the CT and PL catchment, respectively) and lowest in the M horizons (~30 mmol.kg^{-1} in both catchments), while concentrations of total Mg, Na, and K generally increased with the soil depth (Table 3). The Ca enrichment of the upper soil horizons resulted predominantly from relatively high contribution of Ca^{2+}_{EX} to the total Ca concentrations, which was ~80% (CT) to 90% (PL) for O horizons and 35% (CT) to 60% (PL) in A horizons, while only 8% (CT) to 21% (PL) in M horizons. This pattern suggests that Ca originates predominantly from the litter decomposition and atmospheric deposition in the upper horizons, rather than from bedrock weathering. For example, the annual input of Ca via litter fall was 33±14 mmol.m^{-2}.yr^{-1} in the Bohemian Forest prior to bark beetle infestation (Kopáček et al. 2010), and then 179 and 28 mmol.m^{-2}.yr^{-1} in the PL and CT catchments, respectively, during 2006–2010 (Kaňa et al. 2013). In addition, 14–20 mmol.m^{-2}.yr^{-1} Ca^{2+} was deposited on the soils via throughfall deposition in both catchments (Kopáček et al. 2011).

Biochemical soil characteristics

The contents of C_{mic}, N_{mic}, and P_{mic} were generally higher in O and A horizons in the CT than PL catchment. The average C_{mic} values were 299 and 186 mmol.kg^{-1} in the CT O and A horizons, respectively, while similar values were almost 50% lower in the PL soils (Table 5). Similarly, the average N_{mic} concentrations were 40 and 22 mmol.kg^{-1} in the CT O and A horizons, respectively, but only 12 and 9 mmol.kg^{-1} in the respective PL soils horizons. These between-catchment differences in C_{mic} and N_{mic} contents were statistically significant ($p<0.01$), suggesting higher microbial biomass in the CT soils. In the case of P_{mic}, significant ($p<0.05$) between-catchment differences were observed only in the O horizons, with higher concentrations in the CT than PL soils (4.9 vs. 2.6 mmol.kg^{-1} on average). The C_{mic}, N_{mic}, and P_{mic} concentrations were similar in the M horizons in both catchments (Table 4 and 5, Appendix 3).

The molar C_{mic}:N_{mic} ratio in the CT soils was 7.5 and 8.4 in O and A horizon, respectively, while 13.8 and 10.6 in respective soil horizons in the PL catchment. Higher microbial C:N ratio in the PL catchment may indicate higher proportion of fungi in microbial community in the PL soils (reviewed by Cleveland & Liptzin 2007).

The soil microbial activity (C mineralization, net N mineralization and nitrification) generally decreased with soil depth, with the highest values occurring in O horizons and the lowest values in M horizons (Table 5). The average C_{min} rates were 0.45 and 0.36 mmol.kg^{-1}.h^{-1} in the CT and PL O horizons, respectively, but this difference was not statistically significant ($p<0.08$). The average C_{min} rates in A horizons were similar in both the catchments (0.11–13 mmol.kg^{-1}.h^{-1}; Table 6). The C_{min} rates were an order of magnitude lower in M than in O horizons, and ranged only little between 0.02 and 0.03 mmol.kg^{-1}.h^{-1}.

The N_{nitr} rates were highly variable (0.00–0.43 mmol.kg^{-1}.d^{-1}; Appendices 3 and 4), decreased with soil depth, and their averages for individual horizons were similar in the PL and CT catchments (Table 5). The average net N_{min} rates were insignificantly higher ($p = 0.07$) in O horizons of the CT than PL catchment, with averages of 0.21 and 0.07 mmol.kg^{-1}.d^{-1}, respectively. The average net N_{min} rates were close to zero in A and M horizons of both the catchments (Appendices 3 and 4). The data on net N_{min} and N_{nitr} exhibited larger spatial variability than other characteristics. Moreover, they exhibited high variability also in a time scale during the whole growing seasons 2008–2013 in both catchments (Kaňa et al., unpubl.). This high variability limits the interpretation and generalization of the N_{min} and N_{nitr}

Table 5. Average (± standard deviation) biochemical characteristics of the O, A, and M horizons in the Čertovo (CT) and Plešné (PL) catchments. N_{min} – net mineralization (ammonification), N_{nitr} – net nitrification, C_{min} – net C mineralization (respiration).

	CT-O	CT-A	CT-M	PL-O	PL-A	PL-M
C_{mic} (mmol.kg^{-1})	299±64	186±36	52±16	162±52	101±30	47±21
N_{mic} (mmol.kg^{-1})	40±8	22±5	5.5±2	11.8±8.5	9.5±5.7	7±2.3
P_{mic} (mmol.kg^{-1})	4.9±2.1	2.3±1	0.54±0.64	2.6±2.1	1.7±1.3	0.32±0.18
N_{min} (mmol.kg^{-1}.d^{-1})	0.21±0.15	0.02±0.01	0.01±0.01	0.07±0.18	0.02±0.01	0±0.01
N_{nitr} (mmol.kg^{-1}.d^{-1})	0.14±0.14	0.08±0.02	0.04±0.02	0.21±0.12	0.08±0.01	0.02±0.01
C_{min} (mmol.kg^{-1}.h^{-1})	0.45±0.17	0.13±0.05	0.02±0.01	0.36±0.11	0.11±0.04	0.03±0.02

data collected during a single sampling period. Consequently, it is hard to evaluate ecological reasons and consequences of their differences. Nevertheless, N mineralization (sum of N_{min} and N_{nitr}) displayed the same trend as C_{min} and microbial biomass did, indicating no important shift in the pattern of microbial transformations.

Element pools in upper soil horizons

The between-catchment differences in element pools (Table 6) reflected differences in soil composition, because amounts of <2mm soil fraction were similar in both catchments (Table 2). The upper ~16 cm of soil (O+A horizons) in the PL and CT catchments represented important pools of mobile nutrients. For example, the O and A horizons contained ~50 mmol.m^{-2} of NH_4-N, and ~80–130 mmol.m^{-2} of NO_3-N. The pool of SRP_{H2O} in these horizons was on average 10 mmol.m^{-2} in the PL catchment, which was ~2% of the P pool there. In the CT catchment, the pool of SRP_{H2O} was lower (1.3 mmol.m^{-2}) and represented only ~0.2% of the P pool there. Such difference in P availability (Fig. 3) probably resulted from two main factors: (1) Decomposition of elevated litter fall after bark beetle infestation increased SRP_{H2O} concentrations in the PL soils (Kaňa et al. 2013), and (2) ~3-times lower Fe_{ox} pools in the PL than CT soils (550 vs. 1900 mmol.m^{-2}) caused less effectively phosphate retention in the PL soils (Kaňa & Kopáček 2006). The higher phosphate retention in the CT soils was also indicated by higher P_{ox} pools in the CT than PL catchment (270 vs. 150 mmol.m^{-2}).

The pools of CEC in uppermost (O+A) soil horizons were 4400 meq.m^{-2} in the CT catchment, and 4700 meq.m^{-2} in the PL catchment. The pool of exchangeable acidity was similar in both catchments (~1700 meq.m^{-2}) and the Al_{EX} pool was insignificantly ($p>0.05$) higher in the CT than PL soils (650 vs. 420 meq.m^{-2}). The between-catchment difference in CEC thus resulted from the BC_{EX} pool, which was ~2 times higher in the PL than CT catchment (1700 vs. 760 meq.m^{-2}). This difference resulted mostly from ~3-times higher Ca^{2+}_{EX} pool in the PL than CT soils (1300 vs. 460 meq.m^{-2}). The pools of other base cations did not significantly differ between the catchments (Table 4). The higher BC_{EX} concentrations (Table 2) and pools (Table 6) in the PL soils resulted in substantially higher base saturation in O and A horizons in the PL than CT catchment (36% vs. 20%).

Pools of C, N and P in microbial biomass in the upper soil layer were substantially higher in the CT than PL catchment (Table 6). The respective C_{mic}, N_{mic} and P_{mic} pools were 3400, 420 and 48 mmol.m^{-2} in the CT O+A horizons, but only 1850, 150 and 25 mmol.m^{-2} in the PL catchment. Microbial pool represents available nutrient source with a short turnover time, which is sensitive to seasonal fluctuation (Paul & Clark 1996).

Microbes build up nutrients into the cell components, keep them over the lifespan and the nutrients are released back into the soil after death. In this way they retain nutrients and

Table 6. Average (± standard deviation) pools of soil constituents in the O and A horizons in the Čertovo (CT) and Plešné (PL) catchments in 2010.

	CT-O	CT-A	PL-O	PL-A
C ($mol.m^{-2}$)	126±60	356±310	144±80	366±212
N ($mol.m^{-2}$)	4.7±2.3	14.4±2.6	5.3±2.9	13.6±8.1
P ($mmol.m^{-2}$)	101±49	534±667	104±65	333±262
$\mathbf{P_{ox}}$ ($mmol.m^{-2}$)	26.2±14.1	245±428	31.1±20.8	122±147
$\mathbf{SRP_{ox}}$ ($mmol.m^{-2}$)	12.7±5.3	55±102	14.8±7.8	41.5±45
$\mathbf{P_{M3}}$ ($mmol.m^{-2}$)	6.1±3.1	8.5±8.3	8.6±4.3	15±16
$\mathbf{TP_{H2O}}$ ($mmol.m^{-2}$)	1.1±1.3	1.8±3	4.3±3.5	7.2±6.6
$\mathbf{SRP_{H2O}}$ ($mmol.m^{-2}$)	0.6±1	0.7±1.1	3.8±3.3	6.2±5.5
DOC ($mmol.m^{-2}$)	285±184	788±539	321±191	958±643
$\mathbf{TN_{H2O}}$ ($mmol.m^{-2}$)	42±16	132±82	68±36	151±101
$\mathbf{NH_4\text{-}N}$ ($mmol.m^{-2}$)	18.8±9.2	32±28	24.8±17	29±23
$\mathbf{NO_3\text{-}N}$ ($mmol.m^{-2}$)	16.3±12.4	65±56	36±31	94±90
$\mathbf{Al_T}$ ($mol.m^{-2}$)	1.14±1.23	12.7±15.9	1.2±1.67	13.7±19
$\mathbf{Al_{ox}}$ ($mmol.m^{-2}$)	236±228	2530±3940	244±341	1625±1970
$\mathbf{Al_{EX}}$ ($mmol.m^{-2}$)	65.5±59	588±657	65.2±94	359±316
$\mathbf{Al_{H2O}}$ ($mmol.m^{-2}$)	0.2±0.1	1.9±2.2	0.2±0.2	1.9±3.1
$\mathbf{Fe_T}$ ($mmol.m^{-2}$)	262±216	3126±5622	208±127	1023±921
$\mathbf{Fe_{ox}}$ ($mmol.m^{-2}$)	106±83	1765±4000	100±54	449±376
$\mathbf{H^+_{EX}}$ ($meq.m^{-2}$)	291±136	1420±1300	325±208	1410±1050
$\mathbf{Ca^{2+}_{EX}}$ ($meq.m^{-2}$)	231±219	227±265	516±360	783±635
$\mathbf{Mg^{2+}_{EX}}$ ($meq.m^{-2}$)	58±35	100±75	88±61	155±128
$\mathbf{K^+_{EX}}$ ($meq.m^{-2}$)	39±17	89±81	41±25	84±50
$\mathbf{Na^+_{EX}}$ ($meq.m^{-2}$)	5.1±3.4	14.1±9.9	5.1±3.3	15.7±10.2
$\mathbf{BC_{EX}}$ ($meq.m^{-2}$)	333±263	430±352	650±435	1038±800
CEC ($meq.m^{-2}$)	821±441	3610±3440	1170±751	3530±2580
$\mathbf{C_{mic}}$ ($mmol.m^{-2}$)	976±443	2455±1916	645±310	1204±677
$\mathbf{N_{mic}}$ ($mmol.m^{-2}$)	129±57	291±239	45±27	105±61
$\mathbf{P_{mic}}$ ($mmol.m^{-2}$)	18.9±13.9	29.1±24.1	6.4±3.9	18.1±11.5
$\mathbf{N_{min}}$ ($mmol.m^{-2}.d^{-1}$)	0.7±0.5	0±0.8	0.3±0.6	-0.2±0.7
$\mathbf{N_{nitr}}$ ($mmol.m^{-2}.d^{-1}$)	0.3±0.2	0.9±0.7	0.6±0.4	0.8±0.5

prevent them either from leaching (N) or from bounding to unavailable forms (P). Thus, microbes represented important pool of available P, which was of importance especially in the CT soils (see also Fig. 3).

Differences in soil composition between years 1997–2001 and 2010

The contents of total C, N, and P did not change between 1997–2001 and 2010. We expected changes in chemistry of uppermost soil layers ten years after the last soil sampling, mainly

Table 7. Chemical and biochemical parameters of O, and A horizons in the catchments of Čertovo (CT) and Plešné (PL) lakes, which were significantly different between samplings in 1997–2001 (Kopáček et al. 2002a,b) and 2010. Symbols ↑ and ↓ indicate significant higher and lower values, respectively, in 2010 than in 1997–2001. Significances are marked by asterisks as follows: * $p<0.05$, ** $p<0.01$, *** $p<0.001$; ns – not significant.

	PL-O	PL-A	CT-O	CT-A
Ca^{2+}_{EX}	↑*	↑**	ns	ns
Mg^{2+}_{EX}	↑*	↑*	ns	ns
H^{+}_{EX}	↓*	↑*	ns	ns
CEC	↑*	↑**	ns	↑*
BC_{EX}	↑*	↑**	ns	ns
BS	↑*	↑**	ns	ns
Fe_{ox}	↑*	ns	ns	ns
LOI	↓**	ns	ns	ns
pH_{CaCl2}	↑**	↑***	ns	ns
Ca	↑*	ns	ns	ns
Mg	↑***	ns	ns	ns
Si	ns	ns	ns	↓*
Mn	ns	ns	↓**	↓***
Ti	↑*	↑*	ns	ns
C_{mic}	na	↓***	na	↑***
$N_{mi}c$	na	↓**	na	ns
C_{min}	↓***	↓**	↓**	↓***
N_{min}	↓*	↓**	ns	ns
N_{nitr}	↑**	ns	ns	ns

due to ecosystem recovery from acidification (Majer et al. 2003) and decreasing acidic deposition (Kopáček et al. 2010), and due to forest dieback after bark beetle infestation in the PL catchment.

Probably the most important changed parameter, interpretable as a consequence of forest dieback, was the increase in concentrations of base cations in the PL soils. While the BC_{EX} concentrations (and BS) did not change significantly in the CT soils, the concentration of BC_{EX} significantly increased in the PL soils – from to 124 to 173 meq.kg^{-1} in O horizon, and from 45 to 83 meq.kg^{-1} in A horizon. The overall BC_{EX} increased mainly due to Ca^{2+}_{EX} increase – from 95 to 136 meq.kg^{-1} in O horizon, and from 31 to 63 meq.kg^{-1} in A horizon. Higher concentrations of BC_{EX} resulted in a significant increase of BS in PL soils – from 46% to 56% in O horizon ($p<0.05$), and from 20% to 29% in A horizon ($p<0.01$) (Table 7). The Al_{EX} concentrations did not significantly differ from those found in the previous study in the PL soils, but were significantly higher in CT A horizon (129 meq.kg^{-1} in 2010 compared to 95 meq.kg^{-1} in previous study). The CEC values were significantly higher in all PL soil horizons in 2010 than in the previous soil sampling in 1997–2001 (Kopáček et al. 2002; Table 7), probably as a result of increased amounts of Ca originated from decomposition of elevated litterfall.

However, some important parameters (NO_3-N, NH_4-N, SRP_{H2O}), shown as sensitive to forest dieback (Kaňa et al. 2013), were not measured during soil sampling in 1997–2001. Other parameters, especially biochemical, exhibited huge temporal variability, which strongly limited interpretation of differences found between two samplings only.

Conclusions

The soil amounts of the upper soil layers (O+A horizon) did not significantly differ between the catchments.

The CT and PL soils were acidic with the pH_{H2O} of 3.1–4.9, and pH_{CaCl2} 2.1–3.8. Despite the similar CEC values, base saturation was higher in the PL than CT soils (56% vs. 40% in O horizons, and 29% vs. 13% in A horizons), due to almost two times higher BC_{EX} concentrations.

The higher P_{mic} pool in the CT than PL catchment, together with lower pools of mobile P forms (SRP_{H2O}, P_{M3}) showed that microbes are able to consume P more efficiently in the CT soil and immobilize more P in cellular material and release it as easy available material after decease. It suggests important role of microbes as an available P pool in the CT soils, where more P is bounded on Al and Fe oxyhydroxides. The P mobility was higher in the PL than

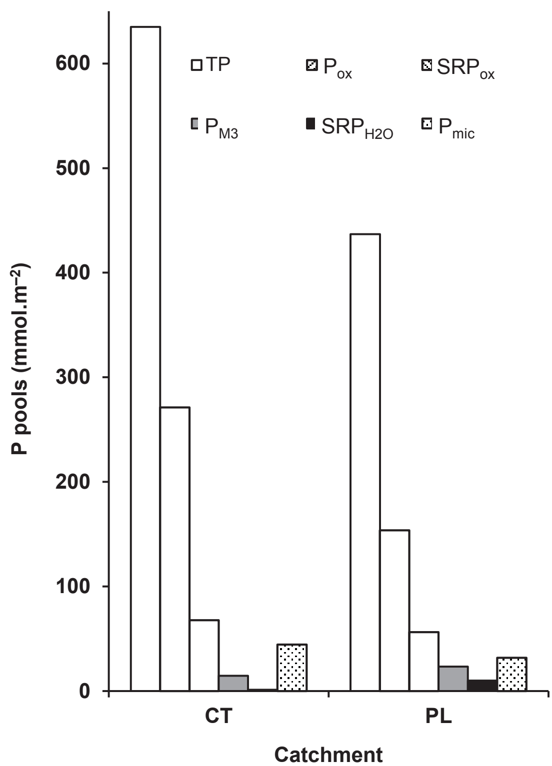

Fig. 3. Pools of individual P forms in the upper (O+A) soil horizons in catchments of Plešné (PL) and Čertovo (CT) lakes.

CT soils, despite the lower concentrations of total P. This was probably the result of decomposition of elevated litter fall after forest dieback (Kaňa et al. 2013) in the PL catchment, and of higher phosphate retention capacity of the CT soils (Kaňa & Kopáček 2006).

The CT soils exhibited significantly higher concentrations of Fe and Al forms than the PL soils.

The catchments did not significantly differ in C and N mineralization and net nitrification rates, despite the forest dieback in the PL catchment. Concentrations of C, N and P in microbial biomass were higher in the CT than PL soils.

Compared to soil sampling in 1997–2001, the PL soils had higher BC_{EX} concentrations, higher BS, and higher pH_{CaCl2} in 2010; this increase was probably a result of ecosystem changes caused by bark beetle infestation there.

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Appendix 1a. Physical and chemical properties of individual O horizon soil samples (dry-weight fraction <2 mm) from the catchment of Plešné lake (PL).

Sample	**Soil**	**LOI**	**pH_{H2O}**	**pH_{CaCl2}**	**TC**	**TN**	**C:N**	**TP**	**P_{ox}**	**SRP_{ox}**	**P_{M-3}**	**TP_{H2O}**	**SRP_{H2O}**	**TC_{H2O}**	**TN_{H2O}**
code	$kg.m^{-2}$	%			$mol.kg^{-1}$		ratio	$mmol.kg^{-1}$							
PL-15-O	6.0	89.5	3.77	3.00	36.4	1.7	21.6	28.0	5.8	3.4	2.07	1.53	1.24	139	14.5
PL-16-O	3.8	89.7	3.56	2.91	42.5	1.5	29.0	27.7	5.3	3.1	1.53	0.09	0.04	123	8.7
PL-17-O	3.7	73.2	3.77	3.26	43.0	1.4	30.6	32.1	7.5	4.3	3.54	3.46	3.36	119	46.5
PL-18-O	3.5	85.0	3.74	3.22	42.1	1.5	28.6	29.7	7.0	4.1	2.81	2.48	2.30	111	15.8
PL-19-O	8.5	91.8	3.51	3.10	43.7	1.4	30.6	19.5	4.8	2.5	1.65	0.53	0.41	40.6	12.1
PL-20-O	3.0	92.0	3.65	3.20	40.2	1.5	27.4	30.5	6.3	3.5	2.29	0.26	0.22	38.4	13.5
PL-21-O	3.1	90.4	3.96	3.43	41.9	1.7	24.3	38.5	9.0	5.4	3.21	0.18	0.13	64.2	10.2
PL-22-O	6.7	91.7	3.41	2.96	37.5	1.5	25.3	41.3	14.8	5.0	2.57	0.64	0.56	40.4	12.2
PL-23-O	8.5	87.9	3.64	3.11	32.5	1.2	28.0	29.3	8.5	3.6	1.46	0.12	0.05	84.8	5.3
PL-24-O	4.3	85.6	4.28	3.76	40.4	1.4	28.1	34.2	10.1	6.3	3.93	1.14	1.06	128	24.9
PL-25-O	1.5	67.4	3.70	3.20	31.5	1.2	26.9	26.1	9.0	4.4	2.94	1.68	0.92	128	19.9
PL-26-O	3.2	86.9	3.60	3.27	41.6	1.4	30.5	25.6	5.1	3.0	2.11	1.11	1.02	52.4	24.1
PL-27-O	1.9	90.5	3.30	2.75	40.0	1.5	26.9	30.2	7.7	3.0	1.74	0.50	0.43	130	22.1
PL-28-O	3.0	94.6	3.64	3.20	39.4	1.4	27.8	30.3	9.0	3.2	1.73	0.41	0.35	64.5	9.8
PL-29-O	2.0	92.8	3.46	3.14	41.8	1.5	27.9	32.3	9.6	5.2	3.53	1.98	2.03	64.9	33.7
PL-30-O	2.9	87.3	3.48	3.02	42.1	1.4	29.2	29.1	8.8	4.6	3.11	2.81	2.78	94.7	40.8
PL-31-O	2.1	90.3	3.65	3.13	38.3	1.5	24.8	33.2	11.1	4.7	2.25	1.77	1.64	142	22.6
PL-32-O	3.0	88.8	3.72	3.23	37.6	1.4	27.2	26.2	8.1	3.8	2.64	3.12	2.46	94.1	16.3
PL-33-O	1.1	83.1	3.92	3.40	39.1	1.5	26.6	30.9	10.3	6.0	3.86	4.27	4.52	138	77.1
PL-34-O	2.8	86.5	3.78	3.23	38.1	1.4	26.6	27.3	8.3	3.2	1.57	1.79	1.59	106	25.0
PL-35-O	2.7	87.5	4.10	3.53	32.6	1.4	23.3	44.6	17.1	6.5	1.59	0.11	0.19	63.6	20.2

Appendix 1a. Continued.

Sample	NO_3-N	NH_4-N	Al_T	Al_{ox}	Al_{EX}	Al_{H2O}	Fe_T	Fe_{ox}	H^+_{EX}	Na^+_{EX}	Ca^{2+}_{EX}	K^+_{EX}	Mg^{2+}_{EX}	BC_{EX}	CEC	BS
code	mmol.kg^{-1}								meq.kg^{-1}							%
PL-15-O	1.89	6.2	428	36	13	0.05	65	28	118	2.2	118	15.8	35.6	171	327	52
PL-16-O	0.48	4.4	139	33	12	0.05	49	21	121	1.8	96	7.8	17.0	123	280	44
PL-17-O	26.9	18.9	90	14	7	0.06	35	21	71	1.2	180	13.0	32.5	227	318	71
PL-18-O	4.92	5.8	146	28	6	0.06	52	31	76	1.1	207	15.6	31.9	256	350	73
PL-19-O	11.3	1.0	117	16	5	0.03	43	20	83	1.0	174	7.6	19.0	201	298	68
PL-20-O	10.9	3.2	257	25	6	0.03	56	27	73	1.0	189	8.4	31.9	230	322	71
PL-21-O	3.89	5.2	147	17	2	0.02	40	15	73	1.0	204	13.2	29.8	248	327	76
PL-22-O	11.4	1.9	622	135	35	0.08	92	33	109	1.5	188	15.8	34.6	240	453	53
PL-23-O	0.26	2.8	976	147	46	0.04	65	26	87	1.5	66	7.1	11.3	85.7	313	27
PL-24-O	12.03	15.0	242	20	3	0.03	50	21	54	1.4	187	15.0	40.4	244	309	79
PL-25-O	4.64	10.2	772	43	12	0.05	107	47	88	1.8	76	15.4	16.8	110	235	47
PL-26-O	20.9	5.4	163	13	5	0.04	58	19	55	1.0	205	6.6	18.0	230	300	77
PL-27-O	10.6	10.0	274	55	21	0.08	79	31	122	1.4	67	9.3	19.9	98	284	34
PL-28-O	4.29	3.0	341	157	40	0.19	62	33	82	1.6	101	7.4	14.9	125	328	38
PL-29-O	25.9	7.2	160	51	10	0.07	52	21	100	1.5	172	12.4	26.1	212	343	62
PL-30-O	25.6	12.9	185	31	10	0.05	62	26	109	1.4	141	9.4	20.1	172	311	55
PL-31-O	4.87	9.6	458	64	20	0.09	99	48	101	1.4	87	10.7	21.0	120	280	43
PL-32-O	6.19	9.0	198	25	8	0.05	76	34	84	1.1	106	10.1	23.2	140	248	56
PL-33-O	37.6	37.0	265	28	5	0.05	58	25	74	1.4	123	19.8	24.7	169	259	65
PL-34-O	4.23	4.3	304	47	9	0.08	73	35	83	0.8	135	10.5	15.7	163	274	59
PL-35-O	11.7	10.5	470	329	56	0.40	79	35	73	1.7	42	9.7	8.6	61.7	302	20

Appendix 1b. Physical and chemical properties of individual A horizon soil samples (dry-weight fraction <2 mm) from the catchment of Plešné Lake (PL).

Sample	**Soil**	**LOI**	**pH$_{H2O}$**	**pH$_{CaCl2}$**	**TC**	**TN**	**C:N**	**TP**	**P$_{ox}$**	**SRP$_{ox}$**	**P$_{M-3}$**	**TP$_{H2O}$**	**SRP$_{H2O}$**	**TC$_{H2O}$**	**TN$_{H2O}$**
code	kg.m^{-2}	%			mol.kg^{-1}		ratio	mmol.kg^{-1}							
PL-15-A	13.1	66.5	3.79	2.91	29.7	1.1	27.9	23.5	5.7	2.3	1.05	0.52	0.49	90	5.8
PL-16-A	9.1	77.7	3.54	2.74	36.0	1.2	30.7	15.9	3.1	1.7	0.58	0.08	0.05	125	8.4
PL-17-A	11.4	75.3	3.49	2.86	34.4	1.3	27.4	30.9	9.1	4.2	1.35	0.78	0.65	59.3	17.8
PL-18-A	13.3	84.8	3.56	2.77	38.2	1.2	32.3	18.3	5.0	2.0	0.72	0.76	0.62	171	10.9
PL-19-A	11.4	82.2	3.28	2.70	38.1	1.2	31.7	19.5	3.5	1.7	0.98	0.59	0.49	88.5	11.3
PL-20-A	26.1	56.0	3.60	3.00	25.3	1.0	26.6	20.8	4.7	2.3	1.30	0.83	0.70	38.3	12.2
PL-21-A	18.2	47.0	3.61	2.89	21.5	1.0	22.2	24.2	6.9	2.1	0.97	0.03	0.01	31.3	4.6
PL-22-A	12.1	40.0	3.67	3.06	17.9	0.8	21.9	21.1	9.1	3.9	1.55	0.26	0.21	19.7	5.4
PL-23-A	54.9	42.6	3.60	3.08	18.9	0.7	25.5	25.8	12.4	3.9	1.41	0.38	0.31	50.1	7.3
PL-24-A	11.4	81.5	3.70	2.92	37.0	1.3	28.8	19.7	6.1	2.5	1.50	1.08	0.92	116	14.3
PL-25-A	6.3	51.4	3.60	2.88	23.0	1.1	21.8	22.3	5.8	2.4	0.91	0.69	0.64	56.8	12.2
PL-26-A	7.8	71.3	3.46	2.87	32.6	1.1	29.9	19.2	3.9	1.4	0.79	0.32	0.29	51.3	5.3
PL-27-A	11.5	58.5	3.05	2.84	27.4	1.0	27.1	19.0	5.5	2.0	0.66	0.15	0.13	62.5	7.7
PL-28-A	9.1	87.7	3.00	3.07	39.6	1.4	29.0	35.2	11.5	4.2	0.71	0.76	0.66	110	16.0
PL-29-A	13.6	71.5	3.53	3.07	32.6	1.2	26.2	46.6	7.1	6.6	1.53	0.73	0.61	99.0	22.5
PL-30-A	12.6	87.6	3.62	3.17	39.2	1.3	29.1	29.3	25.9	4.0	0.76	1.57	1.38	126	21.6
PL-31-A	4.7	64.4	3.47	2.91	30.0	1.2	25.4	26.0	24.2	2.6	1.60	0.60	0.58	71.6	17.5
PL-32-A	7.2	73.8	3.46	2.86	33.5	1.3	26.7	29.1	9.3	3.2	1.02	0.43	0.50	90.6	8.9
PL-33-A	4.4	51.2	3.48	2.88	23.3	0.9	25.5	19.6	6.7	2.5	1.18	1.02	1.05	82	28.8
PL-34-A	3.3	56.2	3.65	3.10	25.7	1.0	26.0	24.3	8.6	2.6	0.87	0.83	0.81	145	20.4
PL-35-A	13.1	66.5	3.79	2.91	29.7	1.1	27.9	23.5	5.7	2.3	1.05	0.52	0.49	90	5.8

Appendix 1b. Continued.

Sample	NO_3-N	NH_4-N	Al_T	Al_{ox}	Al_{EX}	Al_{H2O}	Fe_T	Fe_{ox}	H^+_{EX}	Na^+_{EX}	Ca^{2+}_{EX}	K^+_{EX}	Mg^{2+}_{EX}	BC_{EX}	CEC	BS
code	$mmol.kg^{-1}$								$meq.kg^{-1}$							%
PL-15-A	0.39	2.7	856	66	20	0.06	60	16	105	1.3	53	8.2	18.0	80.4	246	33
PL-16-A	0.77	3.0	440	48	18	0.06	52	21	127	2.1	95	7.3	15.3	119.9	300	40
PL-17-A	13.99	2.1	761	176	52	0.14	69	35	118	1.3	25	8.2	7.0	41.6	314	13
PL-18-A	4.29	2.4	441	81	28	0.10	75	41	133	1.0	131	9.4	25.2	166.6	384	43
PL-19-A	8.57	0.9	384	32	19	0.03	57	20	134	1.6	105	8.9	13.1	128.7	320	40
PL-20-A	8.91	2.5	1284	42	17	0.03	66	20	82	1.4	70	8.1	19.4	98.8	233	42
PL-21-A	2.29	1.4	1277	57	21	0.05	85	29	72	0.8	28	5.0	7.1	41.3	177	23
PL-22-A	4.52	0.5	1632	131	33	0.09	88	22	115	1.1	92	8.7	12.5	114.7	328	35
PL-23-A	6.37	0.8	1705	153	28	0.25	88	30	100	0.9	45	3.4	8.2	57.3	241	24
PL-24-A	4.10	6.5	502	56	16	0.04	64	27	169	2.0	95	11.8	12.7	121.6	340	36
PL-25-A	7.93	3.7	1307	63	25	0.04	77	21	105	1.0	21	5.0	6.6	33.9	213	16
PL-26-A	3.19	0.7	753	48	21	0.03	79	28	121	0.7	163	4.3	16.4	184.5	369	50
PL-27-A	3.38	2.0	1085	60	23	0.04	79	30	104	0.7	39	3.9	6.3	49.8	222	22
PL-28-A	6.53	5.0	541	348	40	0.22	93	53	102	1.7	65	5.7	10.9	83.2	305	27
PL-29-A	16.03	1.4	992	260	40	0.44	131	55	105	0.9	49	6.5	11.5	68.0	294	23
PL-30-A	15.37	1.8	450	173	31	0.17	83	89	123	1.2	32	7.5	11.0	51.9	268	19
PL-31-A	12.75	1.8	929	74	22	0.09	94	34	122	1.1	52	7.7	13.3	74.3	263	28
PL-32-A	2.71	1.3	750	96	25	0.06	112	45	127	0.7	51	7.7	12.3	71.3	274	26
PL-33-A	18.39	4.2	1113	56	22	0.06	91	36	89	2.0	52	7.5	10.8	72.5	227	32
PL-34-A	8.60	1.0	1256	80	21	0.30	105	38	89	4.7	53	4.8	12.3	74.8	226	33
PL-35-A	9.54	5.4	1572	287	39	0.29	97	45	85	0.8	8	4.3	4.1	16.9	219	8

Appendix 1c. Physical and chemical properties of individual mineral horizon soil samples (dry-weight fraction <2 mm) from the catchment of Plešné Lake (PL). The last letter in sample code refers to soil horizon (E or B); na – not analyzed.

Sample	**Soil**	**LOI**	**pH$_{H2O}$**	**pH$_{CaCl2}$**	**TC**	**TN**	**C:N**	**TP**	**P$_{ox}$**	**SRP$_{ox}$**	**P$_{M-3}$**	**TP$_{H2O}$**	**SRP$_{H2O}$**	**TC$_{H2O}$**	**TN$_{H2O}$**
code	kg.m^{-2}	%			mol.kg^{-1}		ratio	mmol.kg^{-1}							
PL-15-B	na	21.6	3.97	3.00	8.9	0.35	25.2	12.2	6.7	2.0	na	0.07	0.06	41.9	2.6
PL-16-E	na	20.3	3.87	2.86	9.2	0.30	30.8	4.8	1.8	0.3	na	0.08	0.01	29.7	1.5
PL-17-B	na	14.0	3.87	3.22	5.9	0.24	25.2	13.6	10.7	2.7	na	0.08	0.06	15.4	1.7
PL-18-B	na	50.4	3.71	3.00	18.6	0.64	29.3	22.3	13.2	2.9	na	0.29	0.25	54.7	4.4
PL-20-B	na	9.7	3.88	3.00	4.2	0.16	26.3	9.6	3.3	0.6	na	0.14	0.11	9.6	2.3
PL-21-E	na	10.1	3.70	3.10	4.3	0.17	26.0	7.0	3.1	0.6	na	0.04	0.07	18.3	1.2
PL-23-B	na	17.2	4.28	3.60	7.4	0.29	25.1	22.6	18.4	5.2	na	0.67	0.04	18.7	2.4
PL-25-E	na	7.2	3.28	3.37	2.9	0.12	23.8	5.3	2.2	0.3	na	0.03	0.03	12.3	1.4
PL-26-E	na	15.3	3.81	2.99	6.4	0.21	30.6	5.9	2.2	0.5	na	0.14	0.12	40.3	2.2
PL-27-B	na	16.5	3.65	2.98	7.0	0.27	25.7	11.4	7.2	2.0	na	0.05	0.03	27.3	1.7
PL-29-B	na	24.3	3.83	3.10	10.3	0.42	24.4	23.8	5.1	1.2	na	0.12	0.11	25.7	6.3
PL-31-B	na	17.0	3.84	3.00	7.3	0.29	25.1	8.6	3.5	0.6	na	0.17	0.08	15.8	3.0
PL-33-B	na	9.5	3.95	3.10	3.8	0.13	29.3	5.2	2.7	0.3	na	0.20	0.10	13.6	2.2
PL-34-B	na	8.5	4.17	3.14	3.3	0.13	26.7	6.3	2.7	0.6	na	0.15	0.15	26.1	3.6
PL-35-B	na	24.6	4.92	3.31	10.4	0.46	22.7	18.4	10.3	2.4	na	0.02	0.04	19.3	7.2

Appendix 1c. Continued.

Sample	NO_3-N	NH_4-N	Al_T	Al_{ox}	Al_{EX}	Al_{H2O}	Fe_T	Fe_{ox}	H^+_{EX}	Na^+_{EX}	Ca^{2+}_{EX}	K^+_{EX}	Mg^{2+}_{EX}	BC_{EX}	CEC	BS
code	mmol.kg^{-1}								meq.kg^{-1}							%
PL-15-B	0.26	1.24	1968	77	23	0.092	138	84	79	0.7	11.7	3.8	3.8	20.0	188	11
PL-16-E	0.13	0.41	1573	22	12	0.022	53	11	109	0.7	21.4	1.6	2.9	26.5	174	15
PL-17-B	1.09	0.23	2422	66	30	0.091	163	65	78	0.4	6.1	1.4	1.3	9.1	179	5
PL-18-B	2.79	0.70	1552	191	45	0.233	80	45	95	1.0	27.5	3.9	4.4	36.9	324	11
PL-20-B	1.63	0.43	2320	26	13	0.011	59	9	93	0.8	4.5	1.6	1.5	8.3	141	6
PL-21-E	0.65	0.68	2190	30	13	0.057	84	24	114	0.4	4.0	1.1	1.2	6.7	160	4
PL-23-B	1.68	0.18	2433	151	25	0.017	126	58	30	0.3	3.4	0.7	0.9	5.3	113	5
PL-25-E	0.50	0.26	2449	14	10	0.040	55	13	69	0.5	1.1	0.9	0.8	3.2	104	3
PL-26-E	0.37	0.30	1722	26	13	0.044	56	14	27	0.7	32.3	1.5	4.2	38.8	104	37
PL-27-B	0.67	0.26	1987	48	9	0.067	139	73	52	0.4	8.9	1.5	1.9	12.6	93	14
PL-29-B	4.43	0.33	2320	18	13	0.161	101	29	57	0.2	8.7	0.9	1.4	11.2	109	10
PL-31-B	2.38	0.29	1969	34	8	0.015	68	10	22	0.4	9.4	2.2	2.2	14.1	60	24
PL-33-B	1.19	0.24	1851	28	13	0.010	51	7	61	0.2	5.6	1.4	1.3	8.5	108	8
PL-34-B	0.59	0.20	2295	16	10	0.114	66	6	90	0.4	9.3	1.5	2.2	13.4	133	10
PL-35-B	5.11	1.30	1817	126	30	0.103	90	34	56	1.7	35.4	8.2	6.6	51.9	203	26

Appendix 2a. Physical and chemical properties of individual O horizon soil samples (dry-weight fraction <2 mm) from the catchment of Čertovo Lake (CT).

Sample	Soil	LOI	pH_{H2O}	pH_{CaCl2}	TC	TN	C:N	TP	P_{ox}	SRP_{ox}	P_{M-3}	TP_{H2O}	SRP_{H2O}	TC_{H2O}	TN_{H2O}
code	$kg.m^{-2}$	%			$mol.kg^{-1}$		ratio	$mmol.kg^{-1}$							
CT-15-O	4.6	89.5	3.48	2.87	41.3	1.5	26.8	30.6	6.4	3.6	1.85	0.08	0.08	58.1	12.4
CT-16-O	2.3	89.7	3.70	3.10	41.4	1.5	27.8	32.0	7.3	3.7	1.98	0.07	0.02	99.9	8.2
CT-17-O	1.8	73.2	3.83	3.29	33.4	1.4	23.2	40.7	13.3	5.4	1.87	0.06	0.04	57.8	24.9
CT-18-O	5.1	85.0	3.57	2.97	39.0	1.5	25.3	31.0	7.9	3.3	1.15	0.72	0.06	67.6	5.0
CT-19-O	2.2	91.8	3.85	3.27	41.7	1.5	27.7	24.2	5.8	3.9	1.76	0.04	0.01	107	9.6
CT-20-O	3.4	92.0	3.64	3.00	42.5	1.5	28.2	30.2	7.1	4.3	2.01	0.07	0.01	89.1	8.6
CT-21-O	4.2	90.4	3.45	2.88	41.5	1.5	27.0	31.3	7.7	3.7	1.93	0.04	0.01	64.5	6.9
CT-22-O	5.0	91.7	3.67	3.10	40.6	1.6	25.9	35.2	9.5	4.5	2.58	0.06	0.02	96.6	7.6
CT-23-O	2.9	87.9	3.54	2.92	38.5	1.4	26.9	33.7	9.0	4.3	2.33	0.18	0.16	33.4	10.9
CT-24-O	2.0	85.6	3.79	3.22	37.8	1.4	27.8	27.9	7.5	3.6	1.30	0.68	0.02	240	22.9
CT-25-O	5.2	67.4	3.89	3.25	29.9	1.2	24.6	30.8	11.3	3.7	0.96	0.03	0.01	47.2	9.0
CT-26-O	3.0	86.9	3.53	2.05	43.9	1.4	30.8	26.9	4.6	3.6	1.74	0.07	0.02	130	25.9
CT-27-O	6.3	90.5	3.76	3.30	39.9	1.5	26.1	30.4	6.6	3.6	2.22	0.06	0.03	63.1	8.2
CT-28-O	3.4	94.6	3.87	3.23	42.3	1.4	29.6	29.9	6.2	4.7	2.36	0.11	0.05	253	19.3
CT-29-O	1.8	92.8	3.75	3.22	42.9	1.6	26.5	30.9	7.3	4.4	2.78	2.20	1.86	140	22.6
CT-30-O	0.7	87.3	4.00	3.55	40.1	1.6	25.4	36.9	10.2	5.6	2.51	2.36	1.57	130	65.5
CT-31-O	2.1	90.3	3.49	3.10	41.6	1.6	26.7	33.5	8.8	4.5	2.77	1.91	1.61	96.1	30.9
CT-32-O	1.3	88.8	3.07	3.10	40.5	1.5	26.8	34.5	9.3	4.6	2.60	0.68	0.43	48.3	17.8
CT-33-O	1.5	83.1	3.65	3.10	37.9	1.6	23.6	39.9	14.0	5.7	2.49	1.06	0.67	67.1	25.4
CT-34-O	4.5	86.5	3.95	2.93	39.7	1.6	24.9	36.1	10.6	3.8	1.66	0.16	0.03	59.6	9.6

Appendix 2a. Continued.

Sample	NO_3-N	NH_4-N	Al_T	Al_{ox}	Al_{EX}	Al_{H2O}	Fe_T	Fe_{ox}	H^+_{EX}	Na^+_{EX}	Ca^{2+}_{EX}	K^+_{EX}	Mg^{2+}_{EX}	BC_{EX}	CEC	BS
code	mmol.kg^{-1}								meq.kg^{-1}							%
CT-15-O	4.81	5.5	197	35	12	0.02	65	30	107	1.4	71.3	8.3	18.8	99.8	243	41
CT-16-O	0.66	4.2	269	55	15	0.04	71	31	124	0.8	76.6	8.0	16.5	101.9	272	37
CT-17-O	14.92	10.7	953	81	23	0.07	153	44	110	0.9	67.2	13.6	21.7	103.5	282	37
CT-18-O	0.49	2.3	603	208	56	0.03	86	31	92	3.2	17.1	11.7	13.0	45.0	304	15
CT-19-O	0.30	5.5	231	75	25	0.06	58	16	63	3.2	61.9	20.1	19.9	105.0	244	43
CT-20-O	0.54	4.9	167	31	10	0.02	56	17	72	1.5	59.2	10.9	15.8	87.4	191	46
CT-21-O	2.07	2.9	246	46	20	0.02	80	28	98	1.4	61.9	12.5	18.1	94.0	251	37
CT-22-O	0.35	3.4	229	96	23	0.04	77	33	67	1.7	56.8	11.4	17.3	87.2	223	39
CT-23-O	8.55	1.9	340	78	24	0.14	78	27	76	1.4	31.6	14.1	22.6	69.6	218	32
CT-24-O	3.78	14.3	463	89	32	0.23	70	29	124	1.4	37.5	13.9	13.7	66.5	287	23
CT-25-O	4.70	2.9	1146	81	22	0.08	201	70	84	0.6	64.9	8.8	10.5	84.8	235	36
CT-26-O	11.98	10.4	452	20	12	0.04	72	10	134	1.0	94.9	9.9	18.1	123.9	293	42
CT-27-O	4.34	2.5	214	33	9	0.02	85	34	83	1.5	170.8	11.2	28.6	212.2	323	66
CT-28-O	0.65	12.7	76	86	7	0.04	27	29	63	1.8	70.0	19.0	16.2	107.0	190	56
CT-29-O	7.44	12.1	160	25	7	0.03	66	25	66	2.1	149.1	15.5	27.2	193.9	281	69
CT-30-O	36.47	33.9	436	145	32	0.28	93	27	66	1.7	61.2	16.3	17.0	96.2	260	37
CT-31-O	18.31	12.4	211	33	13	0.03	77	29	121	1.9	76.5	14.4	19.5	112.3	274	41
CT-32-O	10.22	5.2	332	73	22	0.11	86	33	100	2.2	75.8	18.0	20.0	116.1	283	41
CT-33-O	14.35	11.8	518	107	25	0.06	128	51	157	1.3	60.6	13.5	17.5	92.9	325	29
CT-34-O	5.15	3.3	422	93	25	0.05	118	47	91	1.3	57.0	12.7	17.0	88.0	253	35

Appendix 2b. Physical and chemical properties of individual A horizon soil samples (dry-weight fraction <2 mm) from the catchment of Čertovo Lake (CT).

Sample	Soil	LOI	pH_{H2O}	pH_{CaCl2}	TC	TN	C:N	TP	P_{ox}	SRP_{ox}	P_{M-3}	TP_{H2O}	SRP_{H2O}	TC_{H2O}	TN_{H2O}
code	$kg.m^{-2}$	%			$mol.kg^{-1}$		ratio	$mmol.kg^{-1}$							
CT-15-A	19.5	80.6	3.34	2.63	37.1	1.2	29.9	29.5	3.8	1.6	0.71	0.04	0.01	55.8	5.8
CT-16-A	10.4	64.6	3.58	2.94	29.3	1.1	25.5	28.0	7.9	2.7	0.62	0.14	0.01	73.8	10.1
CT-17-A	3.8	43.9	3.70	3.15	20.0	0.9	23.4	40.4	25.3	4.1	0.66	0.12	0.02	29.5	14.1
CT-18-A	8.5	62.9	3.71	3.21	28.3	1.2	23.1	39.3	17.8	2.8	0.38	0.06	0.00	49.4	7.5
CT-19-A	8.1	76.9	3.82	3.25	34.6	1.4	24.5	37.5	14.9	2.9	0.44	0.03	0.04	86.7	9.5
CT-20-A	11.0	60.6	3.54	2.86	27.4	1.0	26.4	30.1	9.2	2.6	0.60	0.04	0.02	94.2	7.5
CT-21-A	16.1	51.3	3.52	2.83	23.1	1.0	23.9	27.9	11.4	1.9	0.60	0.03	0.01	51.5	5.6
CT-22-A	58.4	61.8	3.77	3.16	26.4	1.1	24.4	55.0	34.2	8.2	0.69	0.02	0.01	39.9	5.7
CT-23-A	12.5	41.1	3.67	2.21	18.1	0.7	25.7	42.3	12.0	2.6	0.97	0.02	0.01	35.9	4.1
CT-24-A	7.3	82.9	3.75	3.20	36.0	1.5	23.9	43.1	17.8	5.3	0.41	0.12	0.05	193.9	21.8
CT-25-A	22.1	49.7	3.82	3.35	21.0	1.0	21.7	47.0	24.7	3.8	0.26	0.04	0.00	32.6	9.6
CT-26-A	6.0	91.4	3.23	2.72	40.8	1.3	32.5	18.5	4.3	2.1	0.90	0.22	0.15	273.9	48.9
CT-27-A	8.4	69.3	3.45	2.83	30.2	1.2	25.6	34.3	7.7	2.7	0.98	0.03	0.02	50.2	7.2
CT-28-A	10.3	75.3	3.63	3.10	32.7	1.5	21.5	35.8	14.6	3.1	0.57	0.10	0.01	120.5	9.5
CT-29-A	3.2	70.8	3.92	3.27	32.9	1.2	26.5	22.6	24.4	2.3	0.40	1.15	0.60	145.6	22.6
CT-30-A	5.2	77.6	3.26	2.80	35.5	1.6	22.6	52.9	8.6	4.1	1.84	0.32	0.28	79.7	46.5
CT-31-A	10.9	78.4	3.53	3.30	35.4	1.5	23.4	65.4	26.6	6.6	1.04	0.40	0.21	51.7	16.7
CT-32-A	6.5	80.3	3.44	2.86	40.7	1.5	26.9	55.2	26.7	4.3	0.90	2.12	0.69	85.8	25.2
CT-33-A	9.6	67.5	3.60	3.10	30.5	1.4	21.8	53.7	23.0	4.8	1.03	0.10	0.08	26.5	12.7
CT-34-A	10.9	47.3	3.62	3.00	21.5	0.9	23.2	40.2	19.8	3.6	0.55	0.07	0.02	31.2	6.5

Appendix 2b. Continued.

Sample	NO_3-N	NH_4-N	Al_T	Al_{ox}	Al_{EX}	Al_{H2O}	Fe_T	Fe_{ox}	H^+_{EX}	Na^+_{EX}	Ca^{2+}_{EX}	K^+_{EX}	Mg^{2+}_{EX}	BC_{EX}	CEC	BS
code	mmol.kg^{-1}								meq.kg^{-1}							%
CT-15-A	2.13	1.5	87	74	32	0.02	101	33	153	1.6	61.8	4.7	14.4	82.5	333	25
CT-16-A	4.05	3.4	965	126	49	0.13	232	63	124	0.8	21.7	6.1	9.3	37.9	310	12
CT-17-A	9.41	1.5	875	197	37	0.04	239	124	64	0.4	13.4	5.3	7.2	26.3	202	13
CT-18-A	3.43	2.1	1543	321	62	0.20	200	92	115	2.9	7.2	9.0	7.8	26.9	328	8
CT-19-A	2.16	5.0	870	362	67	0.32	146	66	102	2.3	12.5	11.3	9.2	35.3	339	10
CT-20-A	1.13	3.1	1117	128	39	0.09	197	83	119	2.0	19.8	6.0	7.7	35.5	272	13
CT-21-A	2.22	1.5	1601	103	29	0.04	181	81	107	1.3	11.5	5.6	6.8	25.2	220	11
CT-22-A	2.16	2.3	1250	315	55	0.15	468	316	108	0.7	4.4	7.0	5.6	17.7	292	6
CT-23-A	0.48	1.0	1059	88	27	0.04	180	50	94	0.9	5.2	7.2	7.4	20.7	197	11
CT-24-A	1.99	8.3	776	271	57	0.38	257	199	157	1.2	14.8	10.7	10.2	36.9	367	10
CT-25-A	6.92	1.0	1764	265	51	0.29	377	170	96	0.6	7.6	5.5	4.9	18.6	267	7
CT-26-A	27.67	2.9	263	68	26	0.10	67	28	153	1.0	101.1	5.1	20.3	127.4	359	35
CT-27-A	3.48	1.9	923	18	49	0.05	157	16	115	1.1	19.6	7.0	9.2	36.9	300	12
CT-28-A	4.06	4.8	816	236	55	0.30	210	121	115	1.7	12.4	11.3	7.9	33.3	315	11
CT-29-A	7.44	2.3	580	175	42	0.06	114	51	90	1.1	8.0	8.1	3.9	21.1	237	9
CT-30-A	35.07	4.2	605	128	40	0.37	169	38	133	1.2	71.8	7.1	14.4	94.5	349	27
CT-31-A	12.19	1.4	736	171	55	0.20	206	90	120	1.5	22.3	9.0	10.0	42.7	327	13
CT-32-A	12.57	7.8	679	199	54	0.07	183	105	135	1.1	22.6	6.9	9.4	40.1	338	12
CT-33-A	9.11	2.5	1142	219	53	0.10	204	90	107	0.8	13.8	8.1	8.0	30.7	297	10
CT-34-A	4.08	1.4	1651	144	40	0.10	232	115	84	0.8	6.5	7.2	4.5	19.0	221	9

Appendix 2c. Physical and chemical properties of individual mineral horizon soil samples (dry-weight fraction <2 mm) from the catchment of Čertovo Lake (CT). The last letter in sample code refers to soil horizon (E or B); na – not analyzed.

Sample	**Soil**	**LOI**	**pH_{H2O}**	**pH_{CaCl2}**	**TC**	**TN**	**C:N**	**TP**	**P_{ox}**	**SRP_{ox}**	**P_{M-3}**	**TP_{H2O}**	**SRP_{H2O}**	**TC_{H2O}**	**TN_{H2O}**
code	$kg.m^{-2}$	%			$mol.kg^{-1}$		ratio	$mmol.kg^{-1}$							
CT-15-B	na	17.6	3.85	3.14	7.1	0.25	28.1	40.4	5.1	2.6	na	0.02	0.01	20.8	1.6
CT-16-B	na	19.9	3.96	3.32	7.9	0.35	22.5	28.6	15.8	2.5	na	0.01	0.00	10.3	2.4
CT-17-E	na	15.2	4.17	3.57	6.0	0.28	21.2	34.8	29.3	6.4	na	0.01	0.00	5.9	2.7
CT-18-E	na	17.5	3.85	3.41	7.0	0.34	20.5	20.1	11.7	1.5	na	0.01	0.00	10.3	1.9
CT-19-B	na	16.4	4.10	3.54	6.8	0.28	24.0	19.6	12.4	1.2	na	0.01	0.00	6.7	2.3
CT-20-E	na	58.5	3.95	3.37	24.3	1.20	20.2	49.7	24.1	0.0	na	0.03	0.01	14.8	2.3
CT-21-B	na	14.3	3.82	3.22	5.7	0.25	22.5	15.9	9.0	1.4	na	0.02	0.00	16.4	1.9
CT-22-B	na	16.5	4.24	3.66	5.1	0.21	24.4	42.0	32.1	11.5	na	0.02	0.00	7.4	1.5
CT-23-E	na	7.3	3.99	3.25	2.7	0.13	21.3	14.6	8.4	3.0	na	0.05	0.02	18.4	2.6
CT-24-B	na	30.0	3.85	3.25	12.2	0.56	21.9	31.4	22.5	2.1	na	0.02	0.01	11.9	4.1
CT-26-E	na	10.9	3.77	3.10	4.5	0.17	26.7	10.9	5.8	0.8	na	0.48	0.10	148.2	8.6
CT-27-B	na	20.8	3.81	3.77	8.9	0.34	26.4	19.4	11.5	1.9	na	0.03	0.01	38.5	4.1
CT-29-E	na	10.2	3.96	3.36	4.3	0.16	27.0	11.0	14.5	3.9	na	0.28	0.07	36.5	2.9
CT-30-B	na	52.1	4.12	3.39	21.7	1.10	19.7	46.0	3.1	0.6	na	0.12	0.05	37.3	9.0
CT-31-B	na	27.9	3.89	3.34	11.5	0.54	21.3	70.1	46.2	19.6	na	0.06	0.02	14.7	3.8
CT-32-B	na	39.2	3.82	3.16	17.1	0.67	25.7	55.0	42.2	6.0	na	0.19	0.09	34.4	8.7
CT-33-B	na	23.1	3.96	3.43	9.7	0.46	20.9	43.6	29.6	6.6	na	0.03	0.01	9.0	3.9
CT-34-E	na	15.3	3.95	3.32	6.1	0.26	23.4	27.7	18.0	5.7	na	0.05	0.00	10.6	2.1

Appendix 2c. Continued.

Sample	NO_3-N	NH_4-N	Al_T	Al_{ox}	Al_{EX}	Al_{H2O}	Fe_T	Fe_{ox}	H^+_{EX}	Na^+_{EX}	Ca^{2+}_{EX}	K^+_{EX}	Mg^{2+}_{EX}	BC_{EX}	CEC	BS
code	mmol.kg^{-1}								meq.kg^{-1}							%
CT-15-B	0.17	0.3	1962	160	32	0.07	625	349	60	0.4	3.5	0.9	1.8	6.6	167	4
CT-16-B	1.23	0.1	1924	145	27	0.04	596	242	91	0.3	2.8	1.6	2.0	6.7	184	4
CT-17- E	1.37	0.1	2779	167	24	0.04	381	198	99	0.3	2.5	1.0	1.0	4.8	180	3
CT-18-E	0.86	0.1	2841	170	30	0.00	418	144	95	0.7	1.4	2.0	2.6	6.8	198	3
CT-19-B	1.28	0.2	2501	166	29	0.05	248	72	78	0.6	3.9	2.1	2.1	8.6	175	5
CT-20-E	0.74	0.2	1206	258	62	0.04	103	40	90	0.0	0.0	0.0	0.0	0.0	297	0
CT-21-B	0.79	0.2	2187	63	16	0.03	358	160	97	0.7	1.9	1.9	1.7	6.2	152	4
CT-22-B	0.70	0.1	2870	311	48	0.08	1200	610	62	0.3	2.2	1.5	1.4	5.5	217	3
CT-23-E	0.87	0.3	1670	45	10	0.06	303	66	56	0.2	1.0	1.1	1.2	3.6	91	4
CT-24-B	1.79	0.2	2405	145	38	0.06	229	135	34	0.6	5.1	3.3	3.5	12.6	164	8
CT-26-E	0.77	0.6	2711	41	15	0.57	124	27	65	0.7	7.9	1.2	1.4	11.2	121	9
CT-27-B	1.45	0.1	2366	64	19	0.07	258	76	66	0.8	2.9	1.6	1.5	6.8	132	5
CT-29-E	0.67	0.1	1622	119	30	0.06	152	37	114	0.5	6.8	1.8	1.7	10.8	217	5
CT-30-B	3.17	1.6	1381	29	13	0.12	101	35	93	0.3	1.8	0.8	0.8	3.6	142	3
CT-31-B	2.62	0.1	2075	171	27	0.06	646	471	103	0.8	7.8	3.9	3.6	16.1	209	8
CT-32-B	5.37	0.3	1972	98	21	0.07	302	201	93	0.7	10.3	3.9	4.2	19.2	182	11
CT-33-B	2.80	0.1	2498	126	25	0.08	415	190	109	0.6	4.6	3.2	3.3	11.7	203	6
CT-34-E	1.30	0.1	2566	69	19	0.04	408	217	109	0.4	3.0	1.9	1.8	7.1	176	4

Appendix 3. Biochemical parameters of mixed soil samples from soils from the Čertovo Lake (CT) catchment. O, A, and M are soil horizons; the numbers in "mixed from" represent the code numbers of sampling sites in 2010 (Fig. 1).

Code	**mixed from**	P_{mic}	C_{mic}	N_{mic}	N_{min}	N_{nitr}
		mmol.kg^{-1}			mmol.kg^{-1} d^{-1}	
CT-O1	CT-O-(15+16)	4.27	277	38.5	0.27	0.08
CT-O2	CT-O-(17+18)	2.62	293	42.7	0.28	0.04
CT-O3	CT-O-(19+20+21)	2.17	338	47.7	0.46	0.02
CT-O4	CT-O-(22+23)	8.01	374	51.2	0.07	0.00
CT-O5	CT-O-(24+25)	3.65	281	34.6	0.27	0.12
CT-O6	CT-O-(26+27+28)	8.04	387	48.4	0.21	0.08
CT-O7	CT-O-(29+30)	4.05	190	30.2	−0.09	0.43
CT-O8	CT-O-(31+32)	6.23	227	34.6	0.15	0.29
CT-O9	CT-O-(33+34)	5.18	322	31.1	0.22	0.16
CT-A1	CT-A-(15+16)	0.83	246	23.9	0.05	0.04
CT-A2	CT-A-(17+18)	0.67	211	27.6	0.02	0.09
CT-A3	CT-A-(19+20+21)	2.17	218	30.9	−0.03	0.06
CT-A4	CT-A-(22+23)	2.48	197	24.8	0.04	0.01
CT-A5	CT-A-(24+25)	2.96	157	16.7	−0.09	0.18
CT-A6	CT-A-(26+27+28)	3.64	148	20.5	−0.03	0.12
CT-A7	CT-A-(29+30)	3.58	133	18.6	−0.10	0.04
CT-A8	CT-A-(31+32)	2.41	186	18.3	−0.08	0.12
CT-A9	CT-A-(33+34)	2.15	184	19.2	0.05	0.08
CT-M1	CT-M-(15+16)	0.07	59	6.1	0.00	0.02
CT-M2	CT-M-(17+18)	0.02	59	8.5	0.03	0.03
CT-M3	CT-M-(19+20+21)	0.21	35	4.2	0.01	0.02
CT-M4	CT-M-(22+23)	0.19	39	4.2	0.01	0.02
CT-M5	CT-M-(24+25)	1.50	72	7.0	0.03	0.09
CT-M6	CT-M-(26+27+28)	0.17	24	2.4	0.01	0.04
CT-M7	CT-M-(29+30)	1.74	50	3.7	0.00	0.06
CT-M8	CT-M-(31+32)	0.48	72	7.6	0.01	0.05
CT-M9	CT-M-(33+34)	0.43	56	5.8	−0.01	0.04

Appendix 4. Biochemical parameters of mixed soil samples from soils from the Plešné Lake (PL) catchment. O, A, and M are soil horizons; the numbers in "mixed from" represent the code numbers of sampling in 2010 (Fig. 1).

Code	**mixed from**	P_{mic}	C_{mic}	N_{mic}	N_{min}	N_{nitr}
		$mmol.kg^{-1}$			$mmol.kg^{-1}\ d^{-1}$	
PL-O1	PL-O-(15+16)	2.19	203	16.1	0.21	0.04
PL-O2	PL-O-(17+18)	2.64	129	4.2	−0.10	0.30
PL-O3	PL-O-(19+20+21)	0.99	175	8.6	0.19	0.13
PL-O4	PL-O-(22+23)	0.74	149	6.2	0.09	0.13
PL-O5	PL-O-(24+25)	1.65	282	32.5	0.38	0.22
PL-O6	PL-O-(26+27+28)	1.36	131	8.0	0.04	0.24
PL-O7	PL-O-(29+30)	5.62	144	8.1	0.06	0.09
PL-O8	PL-O-(31+32)	6.68	130	10.2	−0.03	0.40
PL-O9	PL-O-(33+34+35)	1.32	116	12.2	−0.24	0.33
PL-A1	PL-A-(15+16)	1.06	131	14.4	0.06	0.01
PL-A2	PL-A-(17+18)	1.74	92	8.7	−0.13	0.03
PL-A3	PL-A-(19+20+21)	0.50	96	10.7	−0.01	0.04
PL-A4	PL-A-(22+23)	0.83	78	4.0	0.02	0.04
PL-A5	PL-A-(24+25)	1.00	97	17.5	−0.07	0.06
PL-A6	PL-A-(26+27+28)	1.35	56	2.8	−0.01	0.09
PL-A7	PL-A-(29+30)	3.00	97	5.2	−0.01	0.13
PL-A8	PL-A-(31+32)	4.56	98	5.0	−0.01	0.14
PL-A9	PL-A-(33+34+35)	1.13	161	16.8	−0.04	0.19
PL-M1	PL-M-(15+16)	0.38	51	10.4	−0.03	0.00
PL-M2	PL-M-(17+18)	0.49	42	8.1	0.00	0.00
PL-M3	PL-M-(20+21)	0.18	41	7.1	0.01	0.01
PL-M4	PL-M-(22+23)	0.24	38	6.8	0.00	0.03
PL-M5	PL-M-(24+25)	0.18	37	6.1	0.00	0.01
PL-M6	PL-M-(26+27)	0.65	36	6.8	0.01	0.02
PL-M7	PL-M-(29+30)	0.07	66	10.2	0.00	0.03
PL-M8	PL-M-(31+32)	0.41	22	3.4	0.00	0.01
PL-M9	PL-M-(33+34+35)	0.27	94	4.3	−0.01	0.02

Poznámky / Notes