

Relationships between the content of C, N, P and their stoichiometry in the soils of selected reserves of the Białowieża Primeval Forest



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Purpose of research:

Evaluate the correlation between the content of C, N, P and their stoichiometry in the soils of the Białowieża virgin forest in northeastern Poland.

The study areas were four nature reserves:

- Władysław Szafer Landscape Reserve,
- Dębowy-Grąd Reserve,
- Lipiny Reserve,
- Koryciny Reserve.

The research area is located in the RDLP Białystok.



Field research:

The soil samples were taken from the open pit, from depth 0-0.0-5, 5-10, 10-20, 20-40 cm - a total of 160 soil samples were collected.

Laboratory research:

- dried in an oven at 40°C,
- sieved through a sieve with a mesh size of 2 mm,
- soil reaction (pH) in 0.01 mol / l CaCl₂ by the potentiometric method, according to PN-EN ISO 10390: 1997;
- total nitrogen (TN), by the high temperature combustion method with TCD detection, according to PN-ISO 13878:2002;
- total carbon (TC), by the method of high temperature combustion with TCD detection, according to PN-ISO 10694: 2002;
- phosphorus (TP), by the method of atomic emission spectrometry with excitation in inductively coupled plasma (ICP-OES), according to PN-EN ISO 11885: 2009.

Statistical Analyses:

Stoichiometric ratios were calculated for: C: N and C: P in soils for selected reserves of the Białowieża primeval forest and the correlation of linear Pearson correlations for $\text{pH}_{\text{CaCl}_2}$ and TC, TN, TP and C: N and C: P in forest litter "0" and in soils with layers up to 40 cm deep for the studied objects as a whole. The significance of Pearson's linear correlation coefficients was evaluated at three significance levels p : 0.05; 0.01 and 0.001.

The value of $\text{pH}_{\text{CaCl}_2}$ (1:10) and the content of C, N, P, as well as the stoichiometric ratios of C: N and C:P in the litter and soils to a depth of 0- 40 cm, taken from the Białowieża primeval forest reserves in 2021.

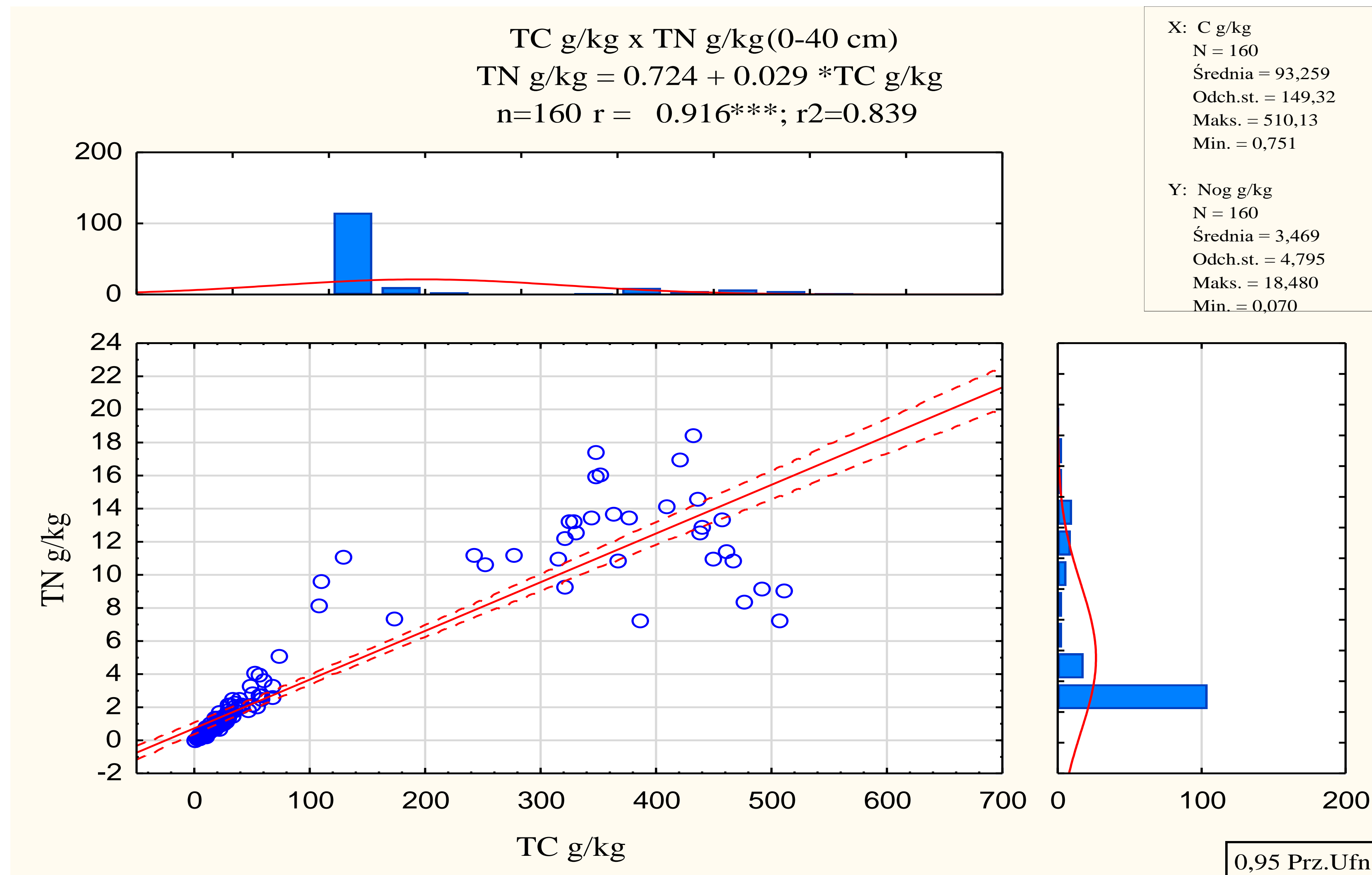
Reserve	N	$\text{pH}_{\text{CaCl}_2}$	TC $\text{g}\cdot\text{kg}^{-1}$ DM	TN $\text{g}\cdot\text{kg}^{-1}$ DM	TP $\text{g}\cdot\text{kg}^{-1}$ DM	C:N	C:P
“KOR”	30	4.32 ± 0.39	72.63 ± 129.3	3.45 ± 6.90	0.405 ± 1.61	17.40 ± 0.58	114.4 ± 143.4
“DG”	30	5.00 ± 0.91	110.0 ± 158.0	4.85 ± 5.42	0.447 ± 0.25	17.70 ± 10.0	180.0 ± 229.7
“WS”	65	4.31 ± 0.66	94.51 ± 154.7	3.19 ± 1.67	0.410 ± 0.21	22.9 ± 7.75	167 ± 267.7
“LP”	30	3.98 ± 0.40	91.59 ± 150.6	2.95 ± 4.45	0.522 ± 0.15	24.5 ± 10.90	150.7 ± 241.7
All objects	160	4.40 ± 0.72	93.26 ± 149.3	3.47 ± 4.80	0.450 ± 0.23	20.91 ± 8.90	157.0 ± 233.2

“KOR” – Koryciny, “DG” - Dębowy Grąd; „WS” – Władysław Szafer; „LP” - Lipiny

Pearson correlations of the $\text{pH}_{\text{CaCl}_2}$ and C, N, P in soils of the Białowieża primeval forest from soil layers 0-40 cm depth in 2021.

Depth (cm)	The number of sample (N)	Parameters	Linear correlation coefficient of Pearson R	Coefficient of determination R^2	Significance level p
"0"	32	$\text{pH}_{\text{CaCl}_2}$ x TP	0.554	0.307	0.001
	32	TC x TP	0.658	0.433	0.001
	32	TC x C:P	0.732	0.536	0.001
0-5 cm	32	$\text{pH}_{\text{CaCl}_2}$ x TC	0,460	0,212	0,008
	32	$\text{pH}_{\text{CaCl}_2}$ x TN	0,534	0,285	0,002
	32	$\text{pH}_{\text{CaCl}_2}$ x TP	0,365	0,133	0,040
	32	$\text{pH}_{\text{CaCl}_2}$ x C:N	-0,459	0,210	0,008
	32	TC x TN	0,965	0,931	0,001
	32	TC x TP	0,362	0,131	0,042
	32	TN x C:N	-0,489	0.239	0,004
	32	TC x C:P	0,781	0,609	0,001
5-40 cm	96	$\text{pH}_{\text{CaCl}_2}$ x TC	0.214	0.046	0.036
	96	$\text{pH}_{\text{CaCl}_2}$ x TN	0.330	0.190	0.010
	96	TC x TN	0.959	0.919	0.001
	96	TC x TP	0.291	0.084	0.004
	96	TC x C:P	0.816	0.666	0.001
	96	TN x C:P	0.746	0.558	0.001

Correlation value between TN and TC in the mineral layers



1. Soils of Białowieża virgin forest reserves and litter were strongly acidic ($\text{pH}_{\text{CaCl}_2}$ 4.40 at SD 0.72) and a weak positive influence of soil pH on the content of TC in litter and TC, TN and TP in soil was demonstrated.
2. A close relationship was demonstrated between the content of TC and TN in the soil, which was confirmed by positive linear relationships for the soil from the 0-5 cm layer ($r = 0.965$ ***, $r^2 = 0.932$) and 5-40 cm depth ($r = 0.959$ ** *, $r^2 = 0.919$).
3. C:N ratio in the soil of the Białowieża primeval forest reserves ranged from 17.40 to 24.5. the largest C:N range was found in the soil of the Lipiny reserve and may indicate slow processes of decomposition and accumulation of organic matter in the soil caused by a very acid soil reaction ($\text{pH}_{\text{CaCl}_2}$ 3.9).
4. Studied soils had a wide range of C:P and ranged from $114.4 \pm 143.4 - 229.7 \pm 229.7$ for Koryciny and Dębowy Grąd reserves, and the mean value for litter was 547.8 ± 269.60 . a significant value of this C: P ratio > 300 may increase the biological sorption of phosphorus in the soil of Lipiny reserve.
5. Forest management in the reserves and especially leaving dead wood in the reserves can significantly contribute to carbon sequestration and be a source of nutrients necessary for maintaining biodiversity in forest ecosystems.

A large, faded, light-green illustration of a multi-story building with a central entrance and a balcony, surrounded by trees, serves as a background for the central text.

Thank you for your attention