Mechanism of hyperaccumulation of heavy metals by *Verbascum thapsus* from soil (EGU21-12848)

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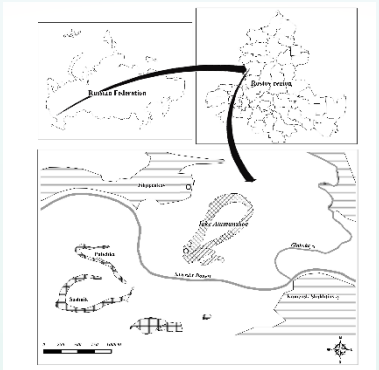
INTRODUCTION

Verbascum thapsus L. (genus *Verbascum*, family *Scrophulariaceae*) rise the particular interest for the analysis of the effect of technogenic pollution with heavy metals (HM), since these are able to grow even in extreme technogenically polluted areas.This species is a widespread in studied anthropogenically transformed territory - lake Atamanskoe. This lake has been used for 40 years as a reservoir for the discharge of industrial waste water from chemical production. The aim of the study is

METHODS

The ecological conditions of the soils were assessed by the value of the total content of HM (X-ray fluorescence analysis) and their mobile compounds (extraction with ammonium acetate buffer using atomic absorption spectroscopy) in soils.

HM were extracted from plant ash by dissolution in 20% HCl solution followed by AAS analysis. Anatomical and morphological features in the tissues of the plants affected by HM were analyzed using light-optical and electron-microscopic methods.



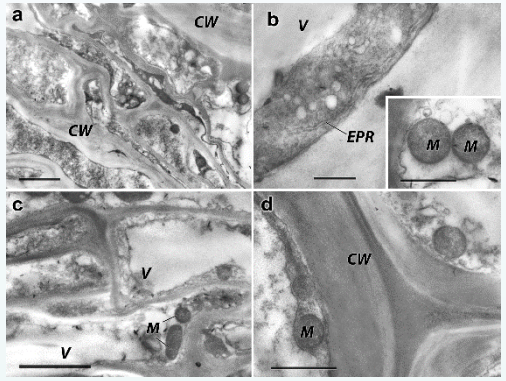
RESULTS

The soil pollution degree is characterized as very high for Zn, high for Pb, and moderate for Cu, Ni, Cr and Mn. The average concentrations of mobile forms of HMs can be represented as a decreasing row: Zn > Mn > Cr > Pb > Ni > Cu > Cd.

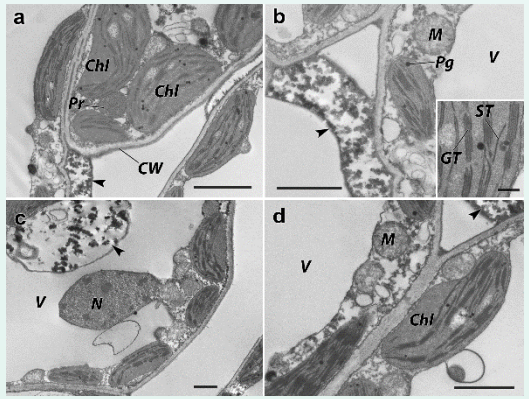
	Mn	Cr	Cu	Zn	Pb	Cd	Ni
				Total content			
	1970±207	134±16	409±36	65243±6010	128±11	5±0.3	165±16
Clarkes	1000	83	47	83	16	–	58
MPC	1500	90	55	100	32	0.5	85
				Weakly bond forms			
	129.3±15.2	**9.1±1.0**	0.8±0.1	**9858±1135**	**7.5±0.9**	0.01±0.001	**7.1±0.7**
MPC	700	6	3	23	6	0.05	4

Exceedances of the Clarkes in soils (Vinogradov, 1957), MPC (Maximum…,1990) are typed in bold.

HM are ranked in the following order in terms of the absolute content in plants: Zn > Cr > Pb > Cu > Mn > Ni > Cd. There is a dependence of the content of metals in plants on the level of technogenic burden on soil by the gross content in general and the level of mobile (exchangeable) forms of metals.



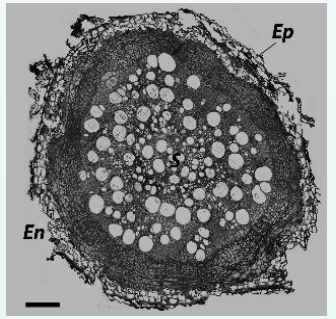
The light-optical observations of *V. thapsus* showed that the accumulation of HM in organs caused degradation of the epidermis and insignificant increase of the root diameter. However, no significant changes in the ultrastructure of cell membranes and major cytoplasmic organelles have been found.

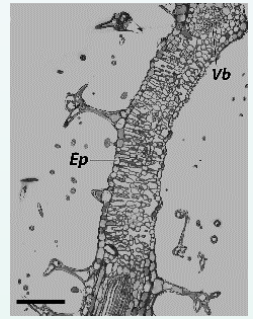


Part of the plant	Mn	Cr	Cu	Zn	Pb	Cd	Ni
Generative organs	1.5±0.1	**3.7±0.4**	5.2±0.3	**343.5±29.8**	3.9±0.4	**0.4±0.02**	2.0±0.3
Stems and leaves	2.5±0.2	**12.0±1.3**	3.8±0.3	**791.2±72.3**	**6.1±5.5**	**0.6±0.08**	1.6±0.3
Roots	0.9±0.1	7.5±0.6	4.3±0.1	1996.0±205.4	4.0±0.4	0.9±0.01	1.7±0.2
MPL	-	0.5	30	50	5	0.3	3

Exceedance of MPL for grasses is typed in bold (Provisional …. 1987)

The lower level of HM content in the inflorescences of mullein plants in comparison with the root system, stems and leaves indicates the resistance of generative organs to technogenic pollution.





The decrease of the size of starch grains and number of plastoglobules in chloroplasts of *V. thapsus* leaves occurs, probably due to changes of the membrane structure of plastids.

Conclusion

Thus, it can be assumed that the disruption of the lamellar system and the internal order of chloroplasts, changes in the structure of plastoglobules and starch grains is a protective mechanism against damage to the photosynthetic apparatus under conditions of HM pollution.

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