The heavy metals in the macrophytes of the mining tailing impoundments

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Man-made lakes are formed in the places of mining industry waste preserving. These lakes make on principle a new habitat of the aquatic biota as compared with the environmental habitat of aquatic biota under a high antropogeneous load.

The Salagaev tailing impoundment and the Settler, the collection ponds of the Salair Mining, were chosen as the research objects. Water drainage of these collection ponds is flow into the river M.Tolmovaja. The Salagaev tailing impoundment is environmental hollow in which barite polymetalic ore flotation waste is preserved. The Settler is man-made dam in the river beside the factory. It was made for accident throwing out of the technological water of the factory.

The following macrophytes were studied: *Typha latifolia, Carex, Ceratophyllum demersum L.* The average aquatic plant samples were taken from the places of macrophytes growth. The aboveground and underground parts of the water plants were washed, dried up and crushed very small. The macrophytes samples were decomposed by the mixture of sulphuric and nitrogen acids (1:4). The volume of the mixture was more than the mass of the sample (grams) in 20 times. The concentration of the metals (Cu, Pb, Cd, Zn) was determined in aboveground and underground parts of the macrophytes with the aid of the AAS – method, in water – with the aid of the ICP-MS and the AAS, in sediments – with the aid of the RFA.

Results and discussion

According to the obtained chemical analysis results the aquatic plant habitat is saturated by heavy metals very high as compared with the background point. The toxic components concentration in water and sediments of technogeneous lakes more than its concentration in the background point in 100–1000 times (Table 1, 2). The metal content in the macrophytes more than the background content on 2–3 orders.

Let us see the metal concentration in water and sediments of Salagaev tailing impoundment (Table 1, 2).

Despite of the high antropogeneous load the concentration of the metals in water of the tailing impoundment is lower than the MAC for drinking water. However this factor is not reassuring. Cd concentration in in water of the Salagaev collection

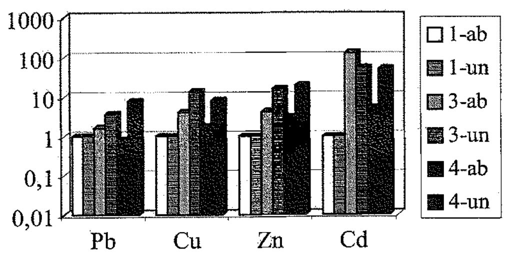

FIG. 1. Relative accumulation of the heavy metals in Typha latifolia. Ab–aboveground part of plant, un - underground part of plant.

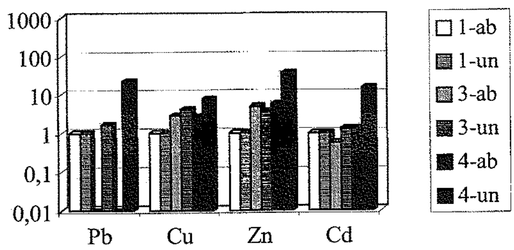

FIG. 2. Relative accumulation of the heavy metals in Carex. Ab - aboveground part of plant, un - underground part of plant.

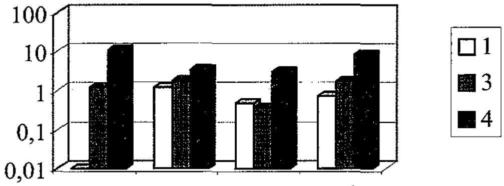

FIG. 3. AC for Carex.

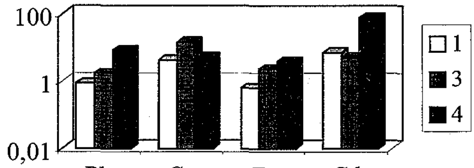

FIG. 4. AC for Typha latifolia.

pond is 1.7μg/l (0.0017 ppm), in pore water of sediments is 18.3 μg/l (0.0183 ppm), in sediments is 0.0015% (15.0000 ppm). Because of it the part of Cd in water of the lake as the follows:

$$\alpha = 0.0017/(0.0017 + 0.0183 + 15.0000) = 1.13 \times 10^{-4}$$

Similarly, the part of the Cd in water of background point is

$$\alpha_0 = 0.00014/(0.00014 + 0.00008 + 0.30000) = 4.66 \times 10^{-4}$$

So, α is lower than α_0 in 4.12 times. However, in the Salagaev lake the average relative accumulation ($[metal]/[metal]_{background}$) of Cd in the aboveground part of *Typha latifolia* is 129 and in the underground part – is 53.57 (Fig. 1).

Consequently, the form of Cd in water is very mobile. Because of it this metal is appropriated easily by aboveground part of this plant. The other metals (Cu, Pb and Zn) are less accessible for *Typha latifolia* than Cd. *Carex* and *Typha latifolia* are growing in the same tailing impoundment. The relative accumulation of Zn in the aboveground part of *Carex* is higher than it in the underground part of the plant (Fig. 2). Consequently, the form of Zn in the tailing impoundment is very mobile and bioavalable in relation to *Carex* also.

Almost all biogeneous elements become toxic for the plant when its concentration (C_{crit}) is very high in the habitat of the given plant. However, C_{crit} for an element is various in dependence on the plant species.

The AC (Zn) (accropetal coefficient is the proportion of the metal concentration in the underground part of the plant and its concentration in the aboveground part) for *Carex* is 0.48 and less than 1 in the upper reach of the river and is 0.37 and less than 1 also in the lake of the Salagaev hollow (Fig. 3). The AC (Zn) for *Typha latifolia* is more than 1 in the Salagaev hollow lake (Fig. 4). Since the concentration of the metals is more in the habitat of the Salagaev tailing impoundment than in the upper reaches of the river, so the C_{crit} (Zn) for the *Carex* is more than the C_{crit} (Zn) for *Typha latifolia* .

Despite of the macrophyte habitat is saturated very much by the heavy metals, the plant – hypoaccumulator was found. It is *Ceratophyllum demersum L.* that grow in the Settler. This plant is accumulator of Cd, Cu and Zn (concentration of Cd, Cu and Zn in *Ceratophyllum demersum L.* more than it in the tailing impoundment water in 500, 20 100 and 4182 times, correspondingly, table 3). The ability of this plant to accumulate big amount of the toxic components and an absent of the roots are make this macrophyte unique in the purification of tailing lakes – ponds water.

TABLE 1. Metal concentration in sediments, %

	1	2	3	4
Pb	0.0025	0.09	0.3	0.51
Cu	0.0015	0.26	0.21	0.23
Zn	0.004	0.80	0.54	1.45
Cd, ppm	0.30	5.00	15.00	46.00

TABLE 2. Metal concentration in water, μg/l

	1	2	3	4
Pb	0.6	100.0	0.7	170.0
Cu	1.9	30.0	25.0	130.0
Zn	10.0	500.0	310.0	2000.0
Cd	0.14	10.0	1.7	80.0

Note: 1–upper reaches of the river, 2-Settler, 3-Salagaev tailing impoundment, 4-lower reaches of the river.

TABLE 3. Metal concentration in the *Ceratophyllum demersum L.* (numerator), μg/g and in water of the Settler (denominator) mg/l.

	Pb	Cu	Zn	Cd
Settler	–/0.10	603/0.03	2091/0.50	5/0.01