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# MERCURY CONTAMINATION IN SOIL, WATER, PLANTS, AND HYDROBIONTS IN KYIV AND THE KYIV REGION

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*Abstract.* In this paper, there was investigated the content of mercury in soil, plant, water, and hydrobionts in Kyiv and in the Obukhiv district of the Kyiv region. Studied territory is characterized by high anthropogenic load. The solid waste landfill in the Obukhiv district of the Kyiv region was characterized by the highest content of Hg in soil. Hg concentration in *Taraxacum officinale* L. was the highest among all studied plants, hence the possibility of recommending this species for phytoremediation of mercury-polluted soils. Mercury bioaccumulation of aquatic organisms (*Blicca bjoerkna* L., *Esox lucius* L., *Ceratophyllum demersum* L.) was much higher than in terrestrial organisms, which indicates the significantly prevailing level of availability and accumulation of mercury for aquatic species in the water environment.

**Keywords:** mercury, bioaccumulation, soil, plants, hydrobionts, water

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## INTRODUCTION

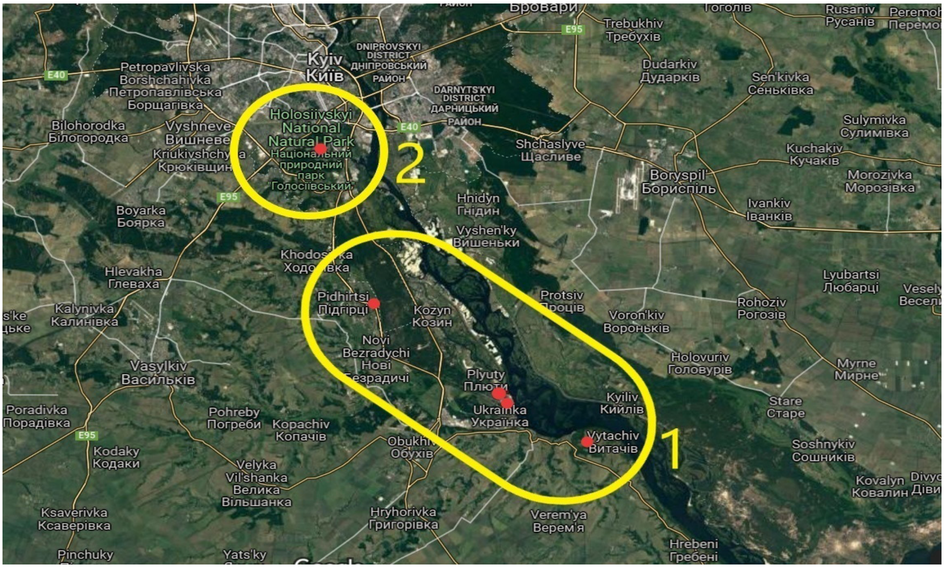
Toxic metals are one of the most dangerous pollutants due to their toxicity, resistance in ecosystem components and bioaccumulative properties. One of the main pollutants is mercury, the compounds of which belong to the first class of danger and are very toxic to biota. Mercury is considered by the WHO as one of the top ten chemicals or groups of chemicals of major public health concern (*Mercury and Health* 2017). It is not among the 15 essential trace elements, but due to environmental pollution, it is determined in all living organisms at the level of 1–100 ppb. Much of mercury gets into the atmosphere and is carried around the globe, entering the world's oceans and soil, water organisms, plants, food, animals and humans, circulating in nature and, thus, acquiring the characteristics and properties of a global anthropogenic pollutant. According to a number of researchers, human activity over the past century has collectively increased the concentration of Hg in the atmosphere by 300–500% (Mason *et al*. 2012, *Technical Background Report…* 2019). The United States Environmental Protection Agency estimated that the global pollution of soil, water and air with mercury due to human activities in 2018 amounted to more than 2 thousand tons (*Mercury Emissions: The…* 2019). In particular, every year, about 260 tons of mercury enter rivers and lakes from contaminated soil. Over the last 100 years, due to human activities, mercury amount in the upper layers of the world's oceans and at depths of up to 100 m has doubled, whereas at great ocean depths, Hg concentration has raised by almost 25% (Trachtenberg *et al.* 2016). The global Hg emissions in the years 2000–2015 increased by 1.8% (Zahir *et al*. 2005, Selander and Svan 2007, Gworek *et al.* 2020).

Like every known toxicant, mercury also has been the cause of numerous environmental disasters, e.g. Minamata disaster (1950), contamination of lake Poopo in Bolivia (2005), contamination of Rhine Basin (1986) and others (Zahir *et al.* 2005, Heise and Förstner 2006, Selander and Svan 2007, Giger 2009). These events highlighted the harmfulness of mercury to human health and biota.

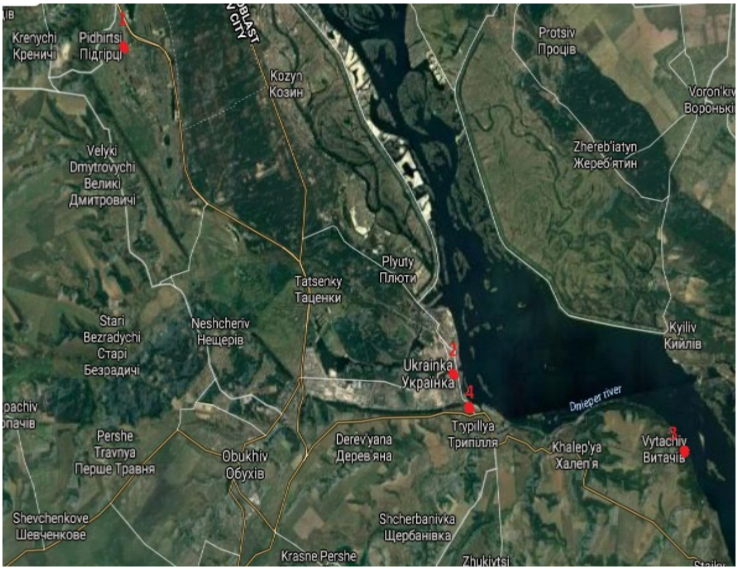
When released into the environment, mercury travels thousands of miles before it is deposited back into the earth (*Bolivia Seeks to…* 2016). Low levels may not be directly lethal to individual organisms, but can lead to food changes and predation risk in case of some wildlife. Special attention should be paid to methyl mercury because of its high bioaccumulation properties. Methyl mercury is absorbed into the body about six times more easily than inorganic mercury, and can migrate through cells which normally form a barrier to toxins (*Mercury in the…* 2020). Environmental assessment of mercury content in the soil-plant and water-aquatic organisms systems allows not only to determine its impact on public health, but to highlight plants species which are sensitive to mercury pollution as well as bioavailability of this metal. The bioavailability of mercury compounds depends on mechanisms of uptake through cell membranes, intracellular distribution, and binding to cellular macromolecules (Raquel and Eleazar 2012, Beyersmann and Hartwig 2008). In recent years, the quality of the environment has worsened in large cities and their surroundings due to significant anthropogenic pressure. Thus, highlighting of mercury migration features in the soil-plant, and water-hydrobiont systems in areas with significant anthropogenic load like, for example, the city of Kyiv and the Obukhiv district of the Kyiv region, will not only solve a number of applied environmental problems, but also predict and eliminate the effects of pollution. The aim of the current study was to investigate the bioaccumulation of $Hg^{2+}$ in plants and hydrobionts for controlling the mercury pollution and forecast the contamination consequences in ecosystems.

## MATERIALS AND METHODS

Two places were studied in order to examine the bioaccumulation of mercury and its content in soil, water, plants, hydrobionts: 1) the Obukhiv district located near the city of Kyiv (Pidhirtsi village, solid waste landfill No. 5; the city of Ukrainka, Kaniv Reservoir; Vytachiv village, landscape reserve "Kalynove protected landscape"; Trypillya village, "Trypillya" Thermal Power Plant; 2) the green park area of the National Natural Park "Holosiyivskyi" in the city of Kyiv (Didorivska and Horikhuvatska location) (Fig. 1).




A)




B)


C)

Fig. 1. Sampling sites: A) Location of studied area: 1. Obukhiv district, Kyiv region; 2. City of Kyiv, Holosiyiv green park area; B) 1. Obukhiv district, Kyiv region (1. Pidhirtsi village, solid waste landfill No. 5; 2. the city of Ukrainka, Kaniv Reservoir; 3. Vytachiv village, landscape reserve of local significance "Kalynove protected landscape", 4. Trypillya village, "Trypillya" Thermal Power Plant); C) 2. City of Kyiv, Holosiyiv green park area (Didorivska and Horikhuvatska locations)

The Obukhiv district is located in the central part of the Kyiv region (with almost 13% of the total population of the Kyiv region) and is characterized by high anthropogenic load. Some of the largest contaminators in the Obukhiv district are the “Trypillya” Thermal Power Plant and solid waste landfill No. 5. These contaminators are included in the list of dangerous objects for Ukraine’s environment (*Program for the*… 2015). “Trypillya” Thermal Power Plant is one of the largest air contaminators. There is an ash dump on its territory, which contains more than 20 million tons of waste from combustion products, which leads to dusting of the surrounding areas of the city of Ukrainka and Trypillya, migration of harmful substances in ecosystems, negative impact on biocenosis and health. According to the WHO data (*Mercury and Health* 2017), burning coal for power and heat is a major source of mercury. Coal contains mercury that is emitted when the coal is burned in coal-fired power plants. Another dangerous object in the Obukhiv district is the solid waste landfill No. 5 in the village of Pidhirtsi which had accumulated near 35.6 million $m^3$ of waste. The landfill was put into operation in 1986, when, as a result of the Chornobyl catastrophe, it was urgent to choose a place for storing leaves that contained radioactive elements. Its area is 63.7 ha. During the exploitation of the landfill since 1986 there were accumulated about 600 thousand $m^3$ of filtrate. The problem of drainage, selection and complete disposal of drainage wastewater generated in solid waste landfills and negatively affecting the quality of surface and groundwater for the Obukhiv district (*Program for the*… 2015). One of the most important and largest rivers in Ukraine is the Dnieper, on the bed of which the Kaniv Reservoir was built, the area of which is 5377.01 ha, with a volume of 376.39 million $m^3$. According to the data of the Ministry of Environment Protection of Ukraine, in the water samples taken in October 2020 from the Dnieper and its tributaries (27 water samples and 5 fish samples), 161 pollutants were detected, including toxic metals (*The First Screening*… 2021). Therefore, it was very important to identify the level of mercury content of soil, water, plants and fish in the immediate area, as well as to compare these results with the samples from green park areas. Holosiyiv green park area is one of the most popular recreation places in the city of Kyiv with significant anthropogenic load. Green parks in big cities are considerably affected by metal contamination. Content of Hg in plants and soil in both green park areas (Holosiyiv and “Kalynove protected landscape”), were compared with the samples of more polluted areas such as cites near solid waste landfill in Pidhirtsi or “Trypillya” Thermal Power Plant. Soil, plants, water and freshwater fish were sampled in 2020–2021.

Mean standard deviations, variance, and minimum, maximum, and standard errors were calculated in four replicates. The total amount of analyzed samples was 148. The experimental results were interpreted using standard statistical methods. Soil and plants were sampled in the phase of plants flowering. We investigated aboveground phytomass of such plant species as: *Taraxacum officinale* L., *Chelidonium majus* L., *Urtica dioica* L., *Impatiens parviflora* DC., *Arctium lappa* L., *Plantago media* L., *Iris pseudacorus* L., *Achillea millefolium* L., *Erigeron annuus* L. Most of these are medicinal, commonly used plants. The investigated soils were:

– grey forest sandy loam on loess loam (grey forest soil): Holosiyiv green park area,

– sod-medium podzolic sandy soil on loess: Pidhirtsi village, solid waste landfill No. 5,

– low humus black soil on loess loam: "Trypillya" Thermal Power Plant; the city of Ukrainka,

– podzolic black soil on loess loam: Vytachiv village, landscape reserve of local significance "Kalynove protected landscape".

Studied soils had the following physicochemical characteristics:

– grey forest sandy loam on loess loam: pH salt 6.2, organic matter determined by the Turin, Walkley-Black methods: 2.5%,

– sod-medium podzolic sandy soil on loess: pH salt 5.5; organic matter determined by the Turin, Walkley-Black methods: 1.5%,

– low humus black soil on loess loam: pH salt 6.4; organic matter determined by the Turin, Walkley-Black methods: 4.3%,

– podzolic black soil on loess loam: pH salt 5.6; organic matter determined by the Turin, Walkley-Black methods: 2.8%.

The analysis of mercury's presence in plants, soil and fish was carried out after wet digestion by $HNO_3$. The analysis of Hg concentration in soil, plants, fish and water was carried out by the method of atomic absorption analysis (AAS) (atomic absorption spectrophotometer Saturn-4; mercury analyzer, RA-915) in the Sanitary and Hygienic Laboratory of the State Institution "Kyiv Regional Laboratory Center of the Ministry of Health of Ukraine" in 2020–2021. Hg concentration levels in soil (0–20 cm) were assessed by existing standards for maximum permissible concentrations (MPC) for Hg in the soil, water, freshwater fish in Ukraine (*Guidelines: Determination of*... 2005).

The biological accumulation factor (BAF) for Hg was calculated as follows:

$$BAF = \frac{C_p}{C_s} \quad (1)$$

where $C_p$ is the concentration in plant, $mg \cdot kg^{-1}$ (dry weight), and $C_s$ is the concentration in soil, $mg \cdot kg^{-1}$.

The bioconcentration factor (BCF) for Hg was calculated as follows:

$$BCF = \frac{C_h}{C_w} \quad (2)$$

where $C_h$ is the concentration in hydrobiont, $mg \cdot kg^{-1}$, and $C_w$ is the concentration in water, $mg \cdot kg^{-1}$.

## RESULTS AND DISCUSSION

### *Hg in soil, plants, water and hydrobionts*

All studied samples did not exceed the MPC (Table 1). Hg concentration of soil samples from "Trypillya" Thermal Power Plant (Ukrainka village) was the lowest among all studied samples. Solid waste landfill (Pidhirtsi village) was characterized by the highest content of Hg in soil. According to Gworek *et al.* (2020), the concentration of Hg in soils depends on the deposition rate and carbon turnover time. The less vegetation, the lower the rate of deposition of pollutants with solid particles from the air. On the top layer soil, Hg deposition is mainly in the oxidized form ($Hg^{2+}$), and its transformations are related mainly with the oxidation–reduction potential and with methylation processes. For soils in which oxidizing conditions predominate, the $Hg^{2+}$ forms dominate, and in soils with reducing conditions, Hg and sulfur compounds are mostly present. Methyl-Hg compounds are most commonly found in soils with transient conditions (Gworek *et al*. 2020). It is considered that the average background concentration of Hg in soils ranges from 0.03 to 0.1 mg $kg^{-1}$ (Kabata-Pendias and Mukherjee 2007, Kabata-Pendias 2010, Li and Jia 2018). In the studied samples, the mercury content in the soil ranged from 0.0028 to 0.0083 mg·$kg^{-1}$. This level is far from the MPC and far from the critical level proposed by Lima *et al*. (2015), who proposed the level of Hg concentration 0.36 mg $kg^{-1}$ in soils as a critical above which plant and soil organisms will be exposed to the harmful impact. Our results coincide, to some extent, with the results of Gray *et al.* (2015) obtained in the USA where the concentrations of Hg in the soil ranged from 0.0038 to 0.011 mg $kg^{-1}$.

Table 1. $Hg_{total}$ in soil, plants, water and hydrobionts

| Sample | Period of studies | MPC, mg $kg^{-1}$ | Concentration, mg·$kg^{-1}$ (soil, plant, fish, bottom sediments); mg·$l^{-1}$ (water) |
|---|---|---|---|
| Territory near "Trypillya" Thermal Power Plant (Ukrainka village, Kyiv region) | | | |
| Soil (0–20 cm) | 2020 | 2.10 | 0.0028±0.001 |
| | 2021 | | 0.0041±0.004 |
| *Taraxacum officinale* L. | 2020 | 0.02* | 0.0040±0.001 |
| | 2021 | | 0.0060±0.002 |
| *Chelidonium majus* L. | 2020 | | 0.0055±0.002 |
| | 2021 | | 0.0060±0.001 |
| Solid waste landfill (Pidhirtsi village, Kyiv region) | | | |
| Soil (0–20 cm) | 2020 | 2.10 | 0.0056±0.001 |
| | 2021 | | 0.0083±0.002 |

| Sample | Period of studies | MPC, mg kg$^{-1}$ | Concentration, mg·kg$^{-1}$ (soil, plant, fish, bottom sediments); mg·l$^{-1}$ (water) |
|---|---|---|---|
| *Taraxacum officinale* L. | 2020 | 0.02* | 0.0051±0.001 |
| | 2021 | | 0.0092±0.003 |
| *Chelidonium majus* L. | 2020 | | 0.0077±0.002 |
| | 2021 | | 0.0080±0.002 |
| Green park area "Kalynove protected landscape" (Vytachiv village, Kyiv region) | | | |
| Soil (0–20 cm) | 2020 | 2.10 | 0.0053±0.0010 |
| | 2021 | | 0.0064±0.0010 |
| *Taraxacum officinale* L. | 2020 | 0.02 | 0.0052±0.0011 |
| | 2021 | | 0.0052±0.0013 |
| *Chelidonium majus* L. | 2020 | | 0.0046±0.0012 |
| | 2021 | | 0.0055±0.0011 |
| Kaniv Reservoir (Ukrainka village, Kyiv region) | | | |
| Surface water | 2020 | 0.00053 | 0.0001149±0.00002 |
| | 2021 | | 0.0002056±0.00015 |
| *Ceratophyllum demersum* L. | 2020 | 0.02* | 0.0074±0.0015 |
| | 2021 | | 0.0065±0.0013 |
| Bottom sediments | 2020 | - | 0.0057±0.001 |
| | 2021 | - | 0.0057±0.0015 |
| *Blicca bjoerkna* L. | 2020 | 0.30 | 0.0055±0.001 |
| | 2021 | | 0.0069±0.0015 |
| *Esox lucius* L. | 2020 | 0.40 | 0.0061±0.002 |
| | 2021 | | 0.0089±0.0033 |
| Green park area of National Nature Park "Holosiyivskyi" (Kyiv) | | | |
| Soil (0–20 cm) | 2020 | 2.10 | 0.0063±0.000315 |
| Bottom sediments | | - | 0.0069±0.000345 |
| *Urtica dioica* L. | | 0.02* | 0.0028±0.0006 |
| *Impatiens parviflora* DC. | | | 0.0027±0.0007 |
| *Arctium lappa* L. | | | 0.0025±0.0007 |
| *Plantago media* L. | | | 0.0026±0.0008 |
| *Iris pseudacorus* L. | | | 0.0008±0.00002 |
| *Achillea millefolium* L. | | | 0.0026±0.0007 |
| *Erigeron annuus* L. | | | 0.0025±0.0009 |

*since in Ukraine there is no MPC for herbal plants (wild plants) we used the value of 0.02 mg·kg (dry matter) which is set as a hygienic standard for fresh vegetables, potatoes, grapes and berries (*Regulation of Maximum*... 2013)

According to Patra and Sharma (2000), Obrist (2007), and Selin *et al*. (2007), in terrestrial plants, Hg in aboveground phytomass comes mainly from the atmosphere, while Hg in the roots comes from soil. Terrestrial plants are normally indifferent to the harmful impact of mercury compounds. Nevertheless, Hg is identified to affect photosynthesis and oxidative metabolism by interfering with electron transport in chloroplasts and mitochondria. Moreover, Hg is also known to inhibit the activity of aquaporins and reduce plant water uptake (Sas-Nowosielska *et al*. 2008). Plant up-taking mechanisms are regulated in nature. Obviously, due to the barrier mechanism, plants do not accumulate trace elements without need (*Summary Report of…* 1994). However, hyper accumulators can take up toxic metal ions at high concentrations. One of the forms in which toxic metal ions are stored in plants is storage in the vacuole (Tangahu *et al.* 2011).

The lowest Hg concentration in plants was for *Iris pseudacorus* L. That is explained by the fact that the plant grows near water environment in such habitats as marshes, shallow waters, or damp banks of rivers and lakes (Fig. 2). Also, low Hg content in *Iris pseudacorus* L. phytomass could be as a result of barrier mechanisms for translocating Hg from soil to plant roots or from plant roots to the top (*Summary report of…* 1994, Czarnowska and Milewska 2000, Dombaiova 2005, Dimitrijevic *et al*. 2016). The concentration of mercury in the *Taraxacum officinale* L. phytomass was highest among all studied plants at the place of growth with the highest content of metal in soil. In the current studies, Hg concentration in *Taraxacum officinale* L. and *Chelidonium majus* L. plants was higher in the samples taken from solid waste landfill No. 5 when compared to those derived from the green park area "Kalynove protected landscape" (the Mann–Whitney *U*-test is 0; the critical value of the Mann–Whitney *U*-test is 13 $(0 \leq 13)$; the differences in the level of the trait in the compared groups are statistically significant, $p < 0.05$). Obviously, the increased content of mercury in the soil affects the rise in metal uptake by plants.

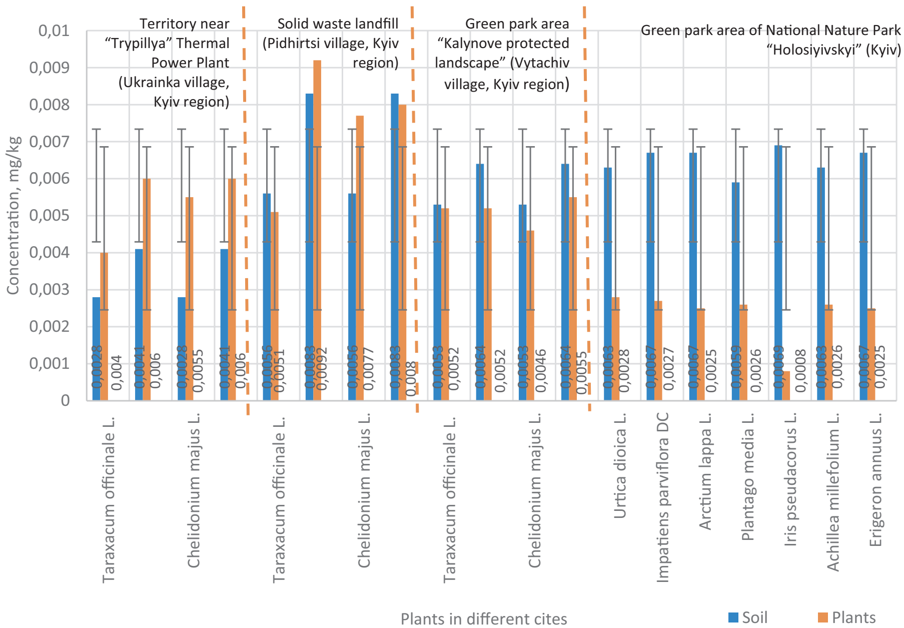



Fig. 2. Hg concentration in terrestrial plants and soil

According to the value of Hg concentration in phytomass, the plants can be ranked in the following descending order: *Taraxacum officinale* L. > *Chelidonium majus* L. > *Urtica dioica* L. > *Impatiens parviflora* DC. > *Plantago media* L. = *Achillea millefolium* L. > *Arctium lappa* L. = *Erigeron annuus* L. > *Iris pseudacorus* L. Our results of Hg in phytomass largely coincide with the results of other researchers, however, the mercury content in plant and soil samples analysed in the studies performed by other researchers is higher than in our investigation. For example, quite high Hg concentrations (0.043±0.03 mg $kg^{-1}$ and 0.025±0.01 mg $kg^{-1}$ in aboveground and underground phytomass, respectively) were found in *Taraxacum officinale* L. by Petrova *et al*. (2013). However, Dombaiova (2005) obtained similar means of Hg concentration (0.000019–0.000528 mg $kg^{-1}$) when compared with our results in terms of phytomass of *Achillea millefolium* L. Many authors proposed to use plants as a biomonitor and an accumulator of toxic metals. Such species as *Taraxacum officinale* L. and *Urtica dioica* L. are often used as a possible biomonitor of toxic metal pollution because they are widely distributed, easy to identify and examine. In addition, they are sensitive to contamination (Kabata-Pendias and Dudka 1991, Edwards *et al*. 1998, Czarnowska and Milewska 2000, Dombaiova 2005, Dimitrijevic *et al*. 2016). Besides, *Taraxacum officinale* L. as well as other studied plants are common species that have been frequently used as medicinal plants in Ukraine.

A number of studies have focused on the mercury content in water, marine and freshwater living organisms because of mercury active accumulation in hydrobionts, and its negative impact on these organisms and the reduction of the value of the hydrobiological resources (*Progress Reports on*… 1987, Atwell *et al*. 1998, Fant *et al*. 2001, Pickhardt *et al*. 2002, Fedyushina 2013). According to Lebedeva *et al*., mercury concentration in the surface layer of the bottom sediments inhabited by benthic organisms varied from 0.0071 to 0.042 mg $kg^{-1}$ dry weight. The concentration of mercury in the thalamus of algae ranged from 0.00124 up to 0.0398 mg $kg^{-1}$ dry weight (Lebedeva *et al*. 2018). In the current study, fresh water of Kaniv Reservoir had the Hg concentration 0.0001149–0.0002056 mg $l^{-1}$. This concentration is almost 5 times lower than the Ukrainian MPC. Hg content in *Ceratophyllum demersum* L. was 0.0074–0.0065 mg $kg^{-1}$, which is in the same range when compared with algae from Grønfjorden, West Spitsbergen (Lebedeva *et al*. 2018). According to the value of Hg concentration in biomass, hydrobionts can be ranked in the following descending order: *Esox lucius* L. > *Ceratophyllum demersum* L. > *Blicca bjoerkna* L.

*Mercury bioaccumulation*

The bioaccumulation of mercury in the soil-plant system depends on many factors: the content of organic matter, the form of the Hg compound, the species characteristics of the plant. Humic acid affects the flow of Hg from the soil to plants, especially for soils with low clay content. Humic acid reduces the amount of available Hg in the soil and prevents mercury from entering plants and its vertical migration in the soil profile (Wang *et al*. 1997). Generally, plant uptake of organic and inorganic Hg from the soil is low, and there are barrier mechanisms for translocating Hg from plant roots to the top. Thus, a significant increase in the level of Hg in the soil leads to only a moderate increase in the level of Hg in the plant by direct absorption from the soil. In terrestrial plants, Hg in aboveground biomass comes mainly from the atmosphere, while Hg in the roots comes from the soil (Selin *et al.* 2007, Obrist 2007, Lomonte *et al*. 2010). Thus, the high variation ($v$, 74%) between the BAFs concerning different species of plants growing in different cities of the studied area may indicate both a barrier mechanism in plants and different paths of taking up mercury by plants (Table 2). According to the value of Hg BAF, the plants can be ranked in the following descending order: *Taraxacum officinale* L. = *Chelidonium majus* L. > *Urtica dioica* L. > *Plantago media* L. > *Impatiens parviflora* DC. = *Arctium lappa* L. = *Erigeron annuus* L. > *Achillea millefolium* L. > *Iris pseudacorus* L.

Table 2. Mercury taken up by plants

| Plant | Site | BAF |
|---|---|---|
| *Taraxacum officinale* L. | Territory near Trypillya Thermal Power Plant (Ukrainka village, Kyiv region) | 1.46 |
| | Solid waste landfill (Pidhirtsi village, Kyiv region) | 1.1 |
| | Green park area "Kalynove protected landscape" (Vytachiv village, Kyiv region) | 0.81 |
| *Chelidonium majus* L. | Territory near Trypillya Thermal Power Plant (Ukrainka village, Kyiv region) | 1.46 |
| | Solid waste landfill (Pidhirtsi village, Kyiv region) | 0.96 |
| | Green park area "Kalynove protected landscape" (Vytachiv village, Kyiv region) | 0.86 |
| *Urtica dioica* L. | Green park area National Nature Park "Holosiyivskyi" (Kyiv) | 0.42 |
| *Impatiens parviflora* DC. | | 0.40 |
| *Arctium lappa* L. | | 0.40 |
| *Plantago media* L. | | 0.41 |
| *Iris pseudacorus* L. | | 0.01 |
| *Achillea millefolium* L. | | 0.39 |
| *Erigeron annuus* L. | | 0.40 |
| $v$, % in green park areas | | 51.98 |
| v, % for all plants and cites | | 74.00 |

BCFs of aquatic organisms were much higher than BAFs in terrestrial plants (Mann–Whitney $U$-test is 0; the critical value of the Mann–Whitney $U$-test is 28; $0 \leq 28$; the differences in the level of the trait in the compared groups are statistically significant, $p < 0.05$) (Fig. 3). This indicates a much higher level of availability and accumulation of mercury for aquatic species in water environment. The level of variation of bioaccumulation of studied hydrobions was low (*v*, 14.07%). According to the value of BCF, the hydrobionts can be ranked in descending order: *Blicca bjoerkna* L. > *Esox lucius* L. > *Ceratophyllum demersum* L.

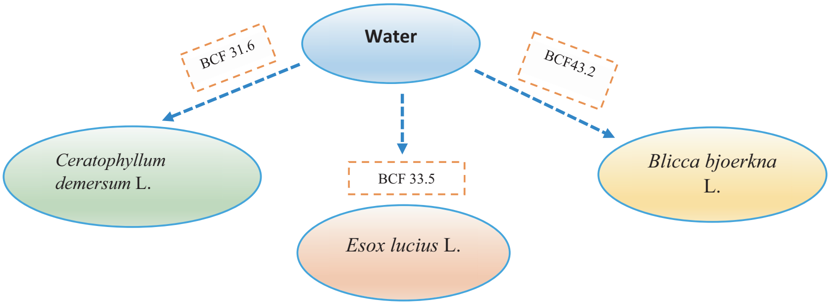



Fig. 3. BCFs for hydrobionts

## CONCLUSIONS

All studied soil and water samples did not exceed the maximum permissible concentration; samples with mercury found in the soil ranged from 0.0028 to 0.0083 mg·kg$^{-1}$, whereas in fresh water of Kaniv Reservoir – 0.0001149–0.0002056 mg l$^{-1}$. The solid waste landfill (Pidhirtsi village) was characterized by the highest content of Hg in soil, whereas the lowest Hg concentration in plants was for *Iris pseudacorus* L. That is obviously explained by plants growing closely to water environment as well as barrier mechanisms for translocating Hg from soil to plant roots or from plant roots to the top. The concentration of mercury in the *Taraxacum officinale* L. phytomass was highest among all studied plants at the place of growth with the highest content of metal in soil. It gives the possibility to recommend this species for phytoremediation of mercury-polluted soils.

BSFs of aquatic organisms were much higher than BAFs for terrestrial plants which indicates a much higher level of availability and accumulation of mercury for aquatic species in a water environment. According to the value of Hg BAF, the terrestrial plants can be ranked in descending order: *Taraxacum officinale* L. = *Chelidonium majus* L. > *Urtica dioica* L. > *Plantago media* L. > *Impatiens parviflora* DC. = *Arctium lappa* L. = *Erigeron annuus* L. > *Achillea millefolium* L. > *Iris pseudacorus* L. The high variation (*v*, 74%) between the terrestrial BAFs for different species growing in different cities of the studied area may indicate both a barrier mechanism in plants and different paths of mercury up-taking to plants. According to the value of Hg BCF, the hydrobionts can be ranked in descending order: *Blicca bjoerkna* L. > *Esox Lucius* L. > *Ceratophyllum demersum* L.

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