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# A CURRENT PROBLEM: MERCURY POLLUTION

**Aurelia Nica [1,*], Adina Popescu [1], Daniela Cristina Ibănescu [1]**

[1] "Dunarea de Jos" University of Galati, 47 Domneasca Street, 800008, Galati-Romania

***Abstract***
*For many years, mercury has been used worldwide for human activities and now the exposure to this metal, both from natural and artificial sources, increases significantly. The set of environmental consequences resulting from mercury biosphere pollution is an alarm signal to end the irresponsible behavior of industrial civilization with regard to water quality. In fact, the harmfulness of water pollution is directly or indirectly reflected on humans, and it is therefore necessary to know better these dangers, including the effects that even small quantities of chemicals from water sources can have on humans. The key points presented in the following pages of this review are: form of mercury exposure, environmental pollution and the effects of mercury pollution. The results described in this paper indicate that mercury is a global pollutant due to persistence, bioaccumulation and environmental toxicity.*

*Keywords: environment, human health, mercury, pollution.*

## 1. INTRODUCTION

Mercury is a natural element found in air, water and soil. It exists in different forms: elemental (or metallic), inorganic and organic. Mercury is an element with unique properties and many uses in the economy, but when its presence in the environment exceeds the normal amount becomes harmful.
Human activity is the main cause of mercury emissions, particularly coal-fired power plants, industrial processes and waste incinerators. Coal power plants are the largest source of mercury emissions in Europe. Mercury is considered by the World Health Organization as one of the top ten chemicals of major concern to public health (http://www.who.int/mediacentre/factsheets/fs361/en/). People can be exposed to mercury in any of its forms under different circumstances, but exposure is mainly by eating contaminated with methylmercury of fish and shellfish and elemental mercury by breathing vapors in the work environment during industrial processes. Methylmercury is efficiently absorbed into the body (more than 95-percent absorption from food) and crosses both the blood brain barrier and the placental barrier (Crinnion, 2000). It is known to be a potent neurotoxin and teratogen. In humans, mercury can have toxic effects on the nervous system, digestive and immune systems, and on the lungs, kidneys, skin and eyes, leading even to death. One of the most serious environmental accidents (Minamata, 1932-1968), which resulted in thousands of deaths, occurred due to mercury poisoning.
The accumulation of mercury in plants is generally much less than for aquatic organisms, concentrations in plants, in general, are significantly lower than those of the ground. It is generally considered that the absorption of mercury concentrations in plants is dictated primarily by the soil. The uptake is limited by the characteristics of the soil, the solubility of the specific compounds and physiology of plant roots. The availability of soil mercury to plants is low, and there is a tendency



*Corresponding author, E-mail address: anica@ugal.ro

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for mercury to accumulate in roots, indicating that the roots serve as a barrier to mercury uptake (Manomita and Archana, 2000).
Concentrations of mercury in plants and animals have been associated with sublethal effects and death. Sublethal effects on plants include growth inhibition, decreased chlorophyll, leaf and root damage. Animal sublethal effects include impaired growth and development, reduced reproduction, liver and kidney damage and behavioral disorders (Moore, 2000).
Despite the unusual characteristics and extensive use of mercury, it presents more problems than solutions for the environment. Mercury poisoned bodies and led to the deaths. Ironically, the most affected was the man, although he is the main cause of rising levels of mercury.
It is very important to investigate and review all available data to contribute to our understanding of the impact of mercury as a global pollutant. Damaging impact of mercury on human health and the environment is discussed in this paper.

## 2. FORMS OF MERCURY EXPOSURE

There are numerous environmental sources of mercury that contribute to global mercury pollution. Some of these industries include the following: (1) the health care sector, in which mercury is used in measuring instruments or as a disinfectant and in dentistry; (2) the mining industry; power plants, crematoria; (3) and the charcoal industry.
Mercury exists in three forms and people are exposed to each in different ways: elemental mercury (the only liquid metal at room temperature), inorganic mercury (has 3 oxidation statuses) and organic mercury (includes compounds with short and long chain).
Elemental mercury is commonly used in the manufacture of medical equipment. Mercury vapors occur through ore processing or accidental spillage. Due to its low absorption, elemental mercury is not toxic in case of ingestion.
Inorganic mercury compounds are water soluble with a bioavailability of 7% to 15% after ingestion; they are also irritants and cause gastrointestinal symptoms. Upon entering the body, inorganic mercury compounds are accumulated mainly in the kidneys and produce kidney damage (Park and Zheng, 2012 ).
Organic mercury is a compound in which the mercury atom is covalently bonded to a carbon atom. The toxicity of the organic compounds is determined by the stability of the covalent bond. Methylmercury and ethylmercury are common organic forms of mercury combined with carbon. Methylmercury is also formed from methylation of inorganic mercury by microorganisms in the environment (Park and Zheng, 2012).

## 3. ENVIRONMENTAL POLLUTION

Emissions in Asian countries, particularly in China and India, dominate the total emissions of Hg. The current estimates of mercury emissions from natural processes (primary mercury emissions and reemissions), including mercury depletion events, were estimated to be 5207 t year, which represents nearly 70 % of the global mercury emission budget. The major conclusion drawn from recent studies on the impacts of mercury on the environment and human health is that there is a need for international action to reduce emissions and human exposure to mercury on a regional and global scale (Pacyna et al., 2016).
When mercury is released into the environment from whatever source, it is highly mobile, cycling between the atmosphere and the earth's surface, where it is deposited in soils, water bodies and bottom sediments. In soil and water, microorganisms convert elemental mercury into the more toxic


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methyl mercury which aquatic plants and animals ingest or absorb. Methyl mercury has the capacity to collect in organisms (bioaccumulate) and to 'biomagnify' as the concentrations increase up each level of the food chain, especially in the aquatic food chain.

The set of environmental consequences resulting from mercury biosphere pollution is an alarm signal to end the irresponsible behavior of industrial civilization with regard to water quality. Mercury is the only metal found in all three major environments: water, soil, atmosphere. It is the metal with the highest toxic potential, although illness incidents are rarer than in the case of lead. Mercury sources are natural from human activity as well. "Quicksilver" is used to separate gold from rock and mud. Gold-mercury amalgam is then heated, usually outdoors, exposing the miner, his children and the whole world to vaporized mercury - a powerful neurotoxic element that causes developmental disorders and affects the central nervous system

Mercury sources can be classified into natural sources and anthropogenic sources (derived from human activity). Natural sources of pollution are considered as volcanic eruptions, geothermal springs, geological deposits (fossil carbons). Mercury is mainly used in the chemical industry for the manufacture of paints, paper, pesticides and fugnicides, pharmaceutical products, disinfectants.

Pollution sources can be of industrial origin, as mercury and its compounds are used in various industries such as cellulose, plastics based on vinyl chlorides, glass, mirrors, etc. In small quantities they are used even in medical practice as purgative, diuretic, antisyphilic, as well as a wide range of unguents such as mercury yellow (HgO), ammonium mercury or mercury metal. They are also found in several types of antiseptic substances. When preparing caustic soda, for example, about 200 grams of mercury are discharged to each tonne of soda. Part of this product remains in soda, which is also used in some branches of the food industry. Another source of mercury pollution is the burning of fossil fuels. Annually, around 5000 tons of mercury per year are generated in the atmosphere. Mercury contamination has a global character and affects both the terrestrial and the aquatic environment. Most of human Hg is released into the atmosphere, through migration and transformation it reaches the aquatic environment, where it accumulates mainly in organisms in the form of very toxic products. Mercury intoxications occur frequently following the use of organomercuric fungicides. Fungicides administered in agricultural work moving through the soil are transported by rainwater or from irrigation to groundwater. Mercury in a pill type battery can pollute 500 liters of water or a square meter of soil over a 50-year period. This in contact with water forms a carcinogen (methyl-mercury) compound that affects the nervous system and the kidneys.

## 4. THE EFFECTS OF MERCURY POLLUTION

Heavy metals contamination of soil has been found to reduce fungal biomass and alter the composition of the fungal community (Muller et al., 2001). It has been reported that, in general, microorganisms are more susceptible to heavy metal stress compared to plants and animals. Many investigations have suggested that mercury inhibits soil microbial activities such as soil respiration, soil enzyme activities and the nitrification process, indicating that the microbial community alters and microbial diversity decreases in a mercury-polluted area.

The response of terrestrial plants to mercury-contaminated soils has been studied over the past decades. These studies have shown that the absorption of mercury in plants through the root is generally low compared to the absorption in the atmosphere through the parts of the plant above the soil (Mahbub et al., 2017).

In soil, forms of inorganic mercury are most available for root absorption. Although fish have been considered the main source of mercury contamination in humans, recent studies indicate that rice could be an equally important source. A number of recent studies have shown that mercury can



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induce oxidative stress in different plant species. Inhibition of root growth, interference in the production of chlorophyll and oxidative enzymes are the causes of mercury oxidative stress observed in various terrestrial plant species such as wheat (*Triticuma estivum*), mint (*Mentha arvensis*), Indian mustard (*Brassica juncea L*), hummingbird (*Sebania grandiflora*), cucumber, tomato (*Lycopersicon esculentum*), lucerne (*Medicago sativa*) and rice (*Oryza sativa*) depending on plant species,the critical Hg content required to exert oxidative stress ranged from 0.05 to 100 mg/l.
Growth and reproduction of invertebrates are sensitive to Hg contamination in the soil environment. Some are more sensitive than others, affecting the diversity of invertebrates in soil ecosystems. Since soil invertebrates are at the start of the food chain, any bio-accumulated Hg will be transferred and eventually enlarged to higher trophic levels. There are only a few studies on acute or chronic Hg in soil invertebrates, where growth, reproduction and mortality measurements have been determined. The most studied invertebrates were different species of earthworms where the accumulated Hg concentrations were compared with the initial levels and forms of Hg from contaminated soils. So far the frames have been considered to be bio-indicators suitable for soil toxicity.
Water pollution with mercury is particularly associated with the possibility of environmental methylation by the inorganic divalent form of the metal, Hg2+ through bacteria and complexation with dissolved organic compounds that enable it to remain in the water column in comparatively high concentrations and seep back into the biota. As methylmercury is liposoluble, it is therefore easily absorbed by biological membranes in general and by the digestive tracts of practically all food chains. These processes help the permanence and diffusion of mercury in the aquatic environment, as well as its dissemination to other ecosystems far removed from the contamination source. The organification of mercury therefore accelerates its bioaccumulation in the food chain and maximizes its threat to natural ecosystems and to human health (Lacerda and Mal, 2008).
At human, the nervous system is very sensitive to all forms of mercury. Methyl mercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems (Azimi and Moghaddam, 2013).

## 5. CONCLUSIONS

Mercury is a heavy and non-essential metal that accumulates in the food chain. Today, mercury is considered to be a key global pollutant due to persistence, bioaccumulation of toxicity to the environment. Mercury is a global and serious threat to human health, including the presence of methyl mercury in fish and seafood.
Many investigations have suggested that mercury inhibits soil microbial activities such as soil respiration, soil enzyme activities and the nitrification process, indicating that the microbial community alters and microbial diversity decreases in a mercury-polluted area.
A number of recent studies have shown that mercury can induce oxidative stress in different plant species. Inhibition of root growth, interferences in the production of chlorophyll and oxidative enzymes are causes of oxidative stress of mercury, observed in different species of terrestrial plants.
At human, the nervous system is very sensitive to all forms of mercury.



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*Corresponding author, E-mail address: anica@ugal.ro