# Lead toxicity in aquatic environments

Mona S. Zaki[1], Samy Shalby[2], Refat A. Yousef [3]and Mostafa H. Osfour[4]

[1]Hydrobiology Department, National Research Centre, Cairo, Egypt
[2]Animal reproduction Department, National Research Centre, Cairo, Egypt
[3]Soil and water use Department, National Research Centre, Cairo, Egypt
[4]Nutrition Department, National Research Centre, Cairo, Egypt
drmonazaki@yahoo.com

**Abstract:** Lead has the highest recycling and reuse rates compared to other major metals and lead batteries, the main application for lead, has a recycling rate of 99% in Europe and North America. Lead batteries also provide cost-effective storage for renewable energy, such as solar and wind power. In addition, most of the world's fixed and mobile phone networks and IT infrastructure relies on lead batteries for back-up emergency power in case of mains power failure in hospitals, public buildings and for the emergency services. Lead also protects underwater cables used to transmit offshore renewable wind and wave power and to keep the world connected. Architectural lead sheet will outlast any other roofing material and is 100% recyclable, while lead sheet is also unrivalled as a barrier to radiation in medical scanning equipment used in hospitals, dental surgeries and laboratories. Like many other metals, lead is found naturally in the environment. Its unique chemical properties, versatile uses and economic values have made it an integral part of our modern society. Natural lead and sources from human activity may enter aquatic environments, but a large proportion of this is ultimately deposited in the sediments of river, estuaries and coastal areas where its availability to harm aquatic organisms is very low. In addition, most lead compounds have low solubility in water and undergo changes to form complexes that are not bioavailable. Concerns regarding lead in surface waters may arise if exposure concentrations increase to a level that is higher than the tolerable effect concentrations of an ecosystem. Such cases are mostly local, originating from a point source, and are controlled by applying proper management measures that are often defined by regulatory standards or operating permits applied to the manufacturing site.

**[**Mona S. Zaki, Samy Shalby, Refat A. Yousef and Mostafa H. Osfour. **Lead toxicity in aquatic environments.** *Stem Cell* 2019;10(3):30-33]. ISSN: 1945-4570 (print); ISSN: 1945-4732 (online). http://www.sciencepub.net/stem. 6. doi:10.7537/marsscj100319.06.

**Keywords:** lead, fish, environment.

## 1. Introduction

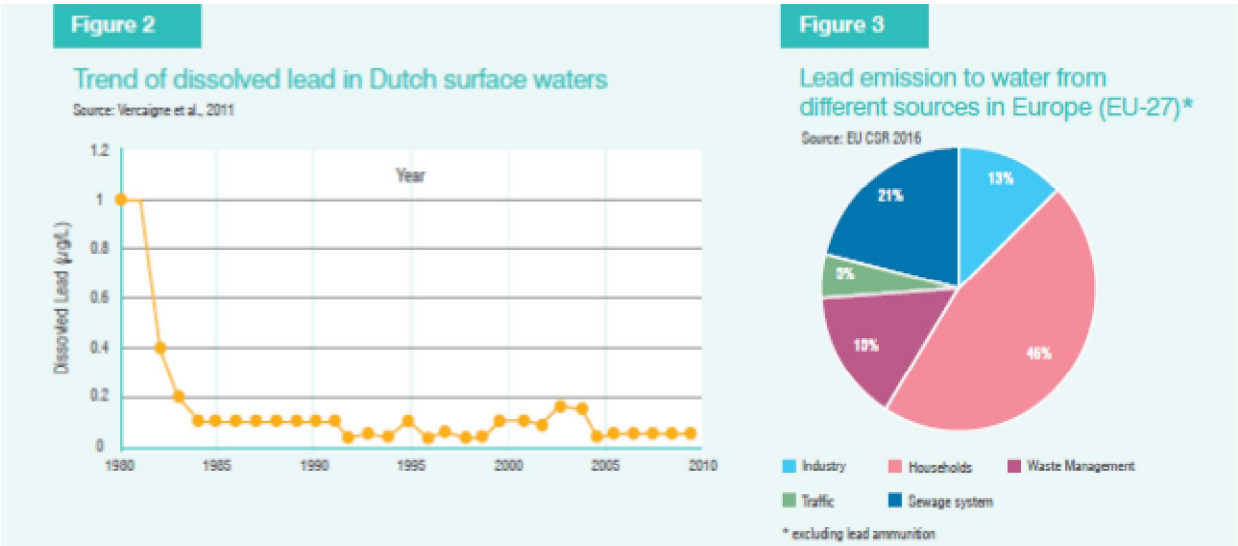
Toxicological and environmental studies have prompted interest in the determination of toxic elements in food. While mercury, cadmium and lead can be tol-erated only at extremely low levels, at certain con- centrations they are exceptionally toxic to humans. Fish accumulate substantial concentrations of mercury in their tissues and thus can represent a major dietary source of this element to humans. With the exception of occupational exposure, fish are acknowledged to be the single largest source of mercury for man. In some instances fish catches were banned for human consumption because their total mercury con- tent exceeded the maximum limits recommended by the Food and Agriculture/World Health Organisation (FAO/WHO, 1972). Takizawa (1979) cited the case where several major incidents of human poisoning in Japan (at Minamata) were implicated in the ingestion of methylmercury-contaminated fish in large quantities. The likelihood of mercury toxicity from fish consumption has been identifed in Peru and some coastal regions of the Mediterranean (Inskip & Piotrowski, 1985; Piotrowski & Inskip, 1981). Tuna was recognised as a predator able to con- centrate large amounts of heavy metals. For example, Enomoto and Uchida (1973) reported mercury con- centrations ranging from 50 to 120 mg gÿ1 in internal organs of Japanese tuna. The ingestion of food is an obvious means of exposure to metals, not only because many metals are natural components of foodstu€s, but also because of environmental contamination and con- tamination during processing. Solder used in the manu- facture of cans is a recognised source of contamination of food by lead during canning. The presence of heavy metals, and particularly mercury, in the environment has been a matter of concern since their toxicity has been clearly documented (Uchida, Hirakawa & Inoue, 1961). The presence of mercury in the environment was reviewed (Holden, 1973; Krenkel, 1973). Extensive surveys have been carried out, in a number of countries, to evaluate the presence of heavy metals in the aquatic

biota, including fish, which can often be considered as indicators of marine pollution. Levels of heavy metals including mercury, lead and cadmium, in fish, have been widely reported (Hellou, Warren, Payne, Belkhode & Lobel, 1992; Joseph & Srivastava, 1993; Kowalewska & Korzeniewski, 1991; Sharif, Mustafa, Mirza & Safiul- lah, 1991; Sharif, Mustafa, Hossain, Amin & Safiullah, 1993; Winchester, 1988). The toxic nature of certain metals and the major contribution made to the total body burden of these metals by food consumption are well documented (Bonner & Bridges, 1983; Browning, 1969; Department of Health and Social Security, DHSS, 1980). Hence the levels of these metals in foodstuffs are under frequent review.

Common carp (Cyprinus carpio L.), rainbow trout (Oncorhynchus mykiss Walbaum), and Siberian surgeon (Acipenser baeri Brandt) are cosmopolitan species found as native or introduced species in rivers of Europe, North America, and Northern Asia. The aquatic environment is characterized by marked temporal and spatial heterogeneity in the oxygen content due to water features such as temperature, salinity, and flows (Lushchak, et.al.,2006 & Lushchak, et.al.,2006. & Lushchak, et. al., 2005). Therefore, aquatic organisms are exposed to oxygen levels with daily and seasonal variation. Various metals can be introduced to the natural environment through human activity. These metals pollute aquatic and terrestrial ecosystems, adversely affecting the environment and inhabiting organisms. High concentrations of metals in fish tissues can lead to redox reactions, generating free radicals, especially reactive oxygen species (ROS), e.g. singlet oxygen; superoxides; peroxides; hydroxyl radical; and hypochlorous acid (Dautremepuits et.al.,2002). These highly reactive compounds, molecules, or ions formed by the incomplete one-electron reduction of oxygen, may induce alterations and change some physiological responses of fish (Paris-Palacios et. al.,2000 & Varanka et. al., 2001). Oxygen is essential for many metabolic processes that are vital to aerobic life. However, dependence on oxygen forces aerobic life to withstand its considerable toxicity, as increased ROS levels can result in significant damage to cell structures (Varanka et. al.,2001).

Natural sources of lead include weathering of soil, forest fires and volcanoes. Sources of lead that come from human activity include the discharge of ammunition, leaded fuel in light aircraft and the combustion of coal and wood, as well as various processes in metal production and manufacturing. In addition, legacy issues such as lead paint, lead water pipes and leaded fuel – all restricted in use in Europe and North America – can be a source of lead.

Lead can also directly enter aquatic environments from urban sources (see Figure 3) including household uses, waste management and sewage treatment plants. Direct emissions to water from industrial sources during mining, manufacturing and recycling is only a small proportion of total European emissions. A recent study reveals a decreasing trend of lead levels in European surface waters (e.g. lakes, rivers, estuaries), indicating that lead emission to water has decreased in the region over the years (Vercaigne et al., 2011). This is typical of many regions around the world (Figure 2).



**Conclusion**

Natural lead and sources from human activity may enter aquatic environments, but a large proportion of this is ultimately deposited in the sediments of river, estuaries and coastal areas where its availability to harm aquatic organisms is very low. In addition, most lead compounds have low solubility in water and undergo changes to form complexes that are not bioavailable.

Concerns regarding lead in surface waters may arise if exposure concentrations increase to a level that is higher than the tolerable effect concentrations of an ecosystem. Such cases are mostly local, originating from a point source, and are controlled by applying proper management measures that are often defined by regulatory standards or operating permits applied to the manufacturing site.

**References**


1. Bonner, F. W., & Bridges, J. W. (1983). Toxicological properties of trace elements. In J. Rose, Trace elements in health (pp. 1±20). London: Butterworth.
2. Browning, E. M. (1969). Toxicity of Industrial Metals (2nd ed.) London: Butterworth.
3. Dautremepuits C., Betoulle S., Vernet, G. Antioxidant response modulated by copper in healthy or parasitized carp (*Cyprinus carpio* L.) by Ptychobothrium sp. (Cestoda). Bioch. Bioph. A. 1573, 4, 2002.
4. DHSS (Department of Health and Social Security) (1980). Lead and health: the report of a DHSS working party on lead in the environment. London: HMSO.
5. Enomoto, N., & Uchida, Y. (1973). Cadmium and other heavy metal contents in marine products from the Ariake Sea and in canned goods on the market. Saga Daigaku Nogaku Iho, 35, 1973, 69±75 [Cited in Chem. Abstr. 18 (1974) 2506].
6. Food and Agriculture/World Health Organisation (FAO/WHO) (1972). Evaluation of certain food additives and the contaminants.
7. Hellou, J., Warren, W. G., Payne, J. F., Belkhode, S., & Lobel, P. (1992). Heavy metals and other elements in three tissues of cod, Gadus morhua from the Northwest Atlantic. Marine Pollution Bul- letin, 24, 452±458.
8. Holden, A. V. (1973). Mercury in ®sh and shell®sh, a review. Journal of Food Technology, 8, 1±25.
9. Inskip, M. J., & Piotrowski, J. K. (1985). Review of the health e€ects of methylmercury. Journal of Applied Toxicology, 5, 113±133.
10. Joseph, K. O., & Srivastava, J. P. (1993). Mercury in the Ennore estuary and in ®sh from Madras coastal waters. Journal of Environmental Biology, 14, 55±62.
11. Kowalewska, M., & Korzeniewski, K. (1991). Trace metals in Gaster-osteus aculeatus L. from the Gdansk Bay. Pol. Arch. Hydrobiology, 38, 475±484.
12. Krenkel, P. A. (1973). Mercury, environmental considerations, Part 1. CRC Crit. Rev. In Environmental Control Saf. Manage. May, 303±73.
13. Lushchak V. I., Bagnyukova T. V. Temperature increase results in oxidative stress in goldfish tissues: 1. Indices of oxidative stress. Comp. Biochem. Physiol. C 143, 30, 2006.
14. Lushchak V. I., Bagnyukova T. V. Temperature increase results in oxidative stress in goldfish tissues: 2. Antioxidant and associated enzymes. Comp. Biochem. Physiol. C 143, 36, 2006.
15. Lushchak V. I., Bagnyukova T. V., Lushchak O. V., Storey J. M., Storey K. B. Hypoxia and recovery perturb free radical processes and antioxidant potential in common carp (*Cyprinus carpio*) tissues. Int. J. Bioch. Cell Biol. 37, 1319, 2005.
16. Mercury, cadmium and lead. WHO Technical Report Series No. 505. Geneva: WHO.
17. Paris-Palacios S., Biagannti-Risbourg S., Vernet G. Biochemical and (ultra) structural hepatic perturbation of *Brachydanio rerio* (Teleostei, Cyprinidae) exposed to two sublethal concentration of copper sulfate. Aquat. Toxicol. 50, 109, 2000.
18. Piotrowski, J. K., & Inskip, M. J. (1981). Health e€ects of methyl- mercury. AMRC Technical Report 24, MARC.
19. Sharif, A. K. M., Mustafa, A. L., Hossain, M. A., Amin, M. N., & Sa®ullah, S. (1993). Lead and cadmium contents in ten species of tropical marine ®sh from the Bay of Bengal. Science of the Total Environment, 113, 193±199.
20. Sharif, A. K. M., Mustafa, A. L., Mirza, A. H., & Sa®ullah, S. (1991). Trace metals in tropical marine ®sh from the Bay of Bengal. Science of the Total Environment, 107, 135±142.
21. Takizawa, Y. (1979). Epidemiology of mercury poisoning. In J. O. Nriagu, The biogeochemistry of mercury in the environment (pp. 325± 365). Amsterdam: Elsevier.
22. Uchida, M., Hirakawa, Y., & Inoue, T. (1961). Biochemical studies on Minamata disease IV. Isolation and chemical identi®cation of the mercury compound in the toxic shell®sh with special reference to the causal agent of the

disease. Kumamoto Medical Journal, 14, 181±184.
23. Varanka Z., Rojik I., Nemcsok J., Abraham M. Biochemical and morphological changes in carp (*Cyprinus carpio* L.) liver following exposure to copper sulfate and tannic acid. Comp. Biochem. Physiol. C 128, 467, 2001.
24. Vercaigne, I, Iaccino, F. and Heijerick, D. 2011 Trend analysis of ambient Pb levels in water, air, sediment and soil samples. ARCHE Consulting, Ghent, Belgium.
25. Winchester, R. V. (1988). Trace metal levels in ®sh from the Manukau Harbour, Auckland, New Zealand, related to a water pollution incident. New Zealand Journal of Marine Freshwater Research, 22, 621±624.

9/25/2019