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Heavy Metals as Main Pollutants of the Next Century

S. L. Davydova

(Delivered at XVI Mendeleev Congress in May 1998, St. Petersburg)

The heavy metals appear to be the main pollutants of twentieth century for the following chemical and medical reasons. The big picture of HM danger on a globe scale was given by us recently in Ref. 1. Today you can see the close connection between chemical properties and exposure times with acute toxicity, consequently with health effects for mercury, lead, cadmium, nickel, vanadium, molybdenum, chromium, zinc, copper, cobalt. They penetrate into the human body by inhalation of dust or fume, gases, or

vapors from air, with drinking water, and via food, drugs, and cosmetics¹ (Table 1).

The Conference of Ministers of Environmental Protection from European Committee 1998 (Orhus, Denmark) forwarded the actual problem of biosphere contamination by HM, for example, by leaded gasoline; the last problem is not only well timed but is not postponing business and so-called “White Paper” [“Face out lead from gasoline”] is devoted the influence of Pb on human beings.² On Russian Standards GOST the

TABLE 1

Nickel Ni^{2+}	<ul style="list-style-type: none"> • Respiratory diseases, including asthma and disturbance of protective system for breathing. • Defects of birth and monsters. • Cancer of nose and lungs.
Vanadium $\text{V}^{4+}, \text{V}^{5+}$	<ul style="list-style-type: none"> • Irritation of respiratory ways, asthma. • Nervous disorder. • Blood formula changes.
Lead $\text{Pb}^{2+}, \text{Pb}^{4+}$	<ul style="list-style-type: none"> • Reduction in IQ, hyperactivity, hearing loss and even death for children. • In adult causes increased blood pressure, liver-kidney and fertility damage.

metals refer to (on alphabet): first class of danger — Be, Cd, Hg, Pb, Zn; second class of danger — Co, Cr, Cu, Mo, Ni, V.

The high level of exploration of HM in the environment takes place today everywhere and that situation is the result of wide mining and use of HM in industry and energetics. The high volatility of HM compounds as well influences on contamination. In Table 2 one can see the specific chemical properties of HM as supertoxicants: the property to change their states of oxidation; HM have the possibility to catalyze organic reactions, but that spontaneous catalysis cannot be identified and in many cases is even unknown. HM are the components of a living organisms (Fe, Cu, Zn, Co, and others). Their extravagance in water and atmosphere (V, Ni) interfere with the normal physiological processes.³

Figure 1 schematized the biological response to increasing concentration of an essential metal. The solid curve is an immediate positive response above zero concentration that goes to optimal level; that spans a wide concentration range for many essential metal ions. Finally, at excess concentrations deleterious effects begin to set. The perspective way of description of action of chemi-

cal toxicants can be done by risk coefficients; it can be done as well for HM characterization (Figure 2). One can see on the axis 1–3 not visible (1) or good visible (1) or good visible (3), the same time on the axis 2–4 uncontrollable (2) or easily controllable (4) risks (for example, for mercury and lead contamination).⁵

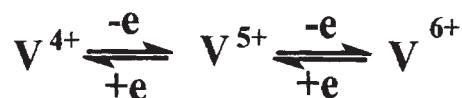
We have to emphasize that many HM have a different influence on the representatives of two sexes — so named “gender influence”, having in mind not biological but social differences between men and women. “Gender influence” by poisoning Pb²⁺ and Pb⁴⁺ containing compounds (for example, by tetra ethyllead Pb(C₂H₅)₄) was discussed in Ref. 6. The temps of decreasing (during last decade) of Pb content in blood are the same, but data are lower for women in comparison for men, maybe because of the possibility of first ones monthly to loose poisoning lead maybe as well and other HM, Figure 3.

The task on evaluation of the contamination by HM is in understanding the spheres of their influences on human being and in recommendations against HM pollution. It is in principle, quite clear and was mentioned in Ref. 7: the assessment HM contamination in definite regions and deter-

TABLE 2

Specific Properties of Heavy Metals as Supertoxicants:

- **Transition of oxydation states , for example**



- **Coordination ability to toxicants as organic ligands and interaction with another metals**
- **Catalytic activity in processes of redox, polymerization, cyclization, hydrogenation, metathesis**
- **Extremely long times of degradation, for example thousands years for Pb**
- **Essentiality for human being**

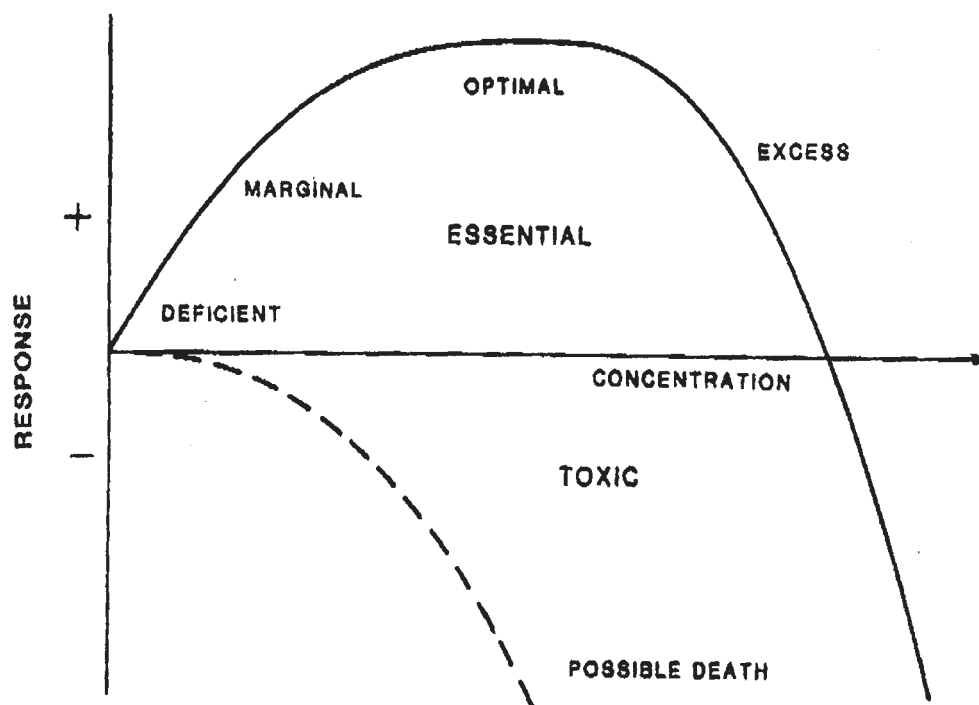


FIGURE 1. Biological response dependence on contraction of HM essential (up) and toxic (below).⁴

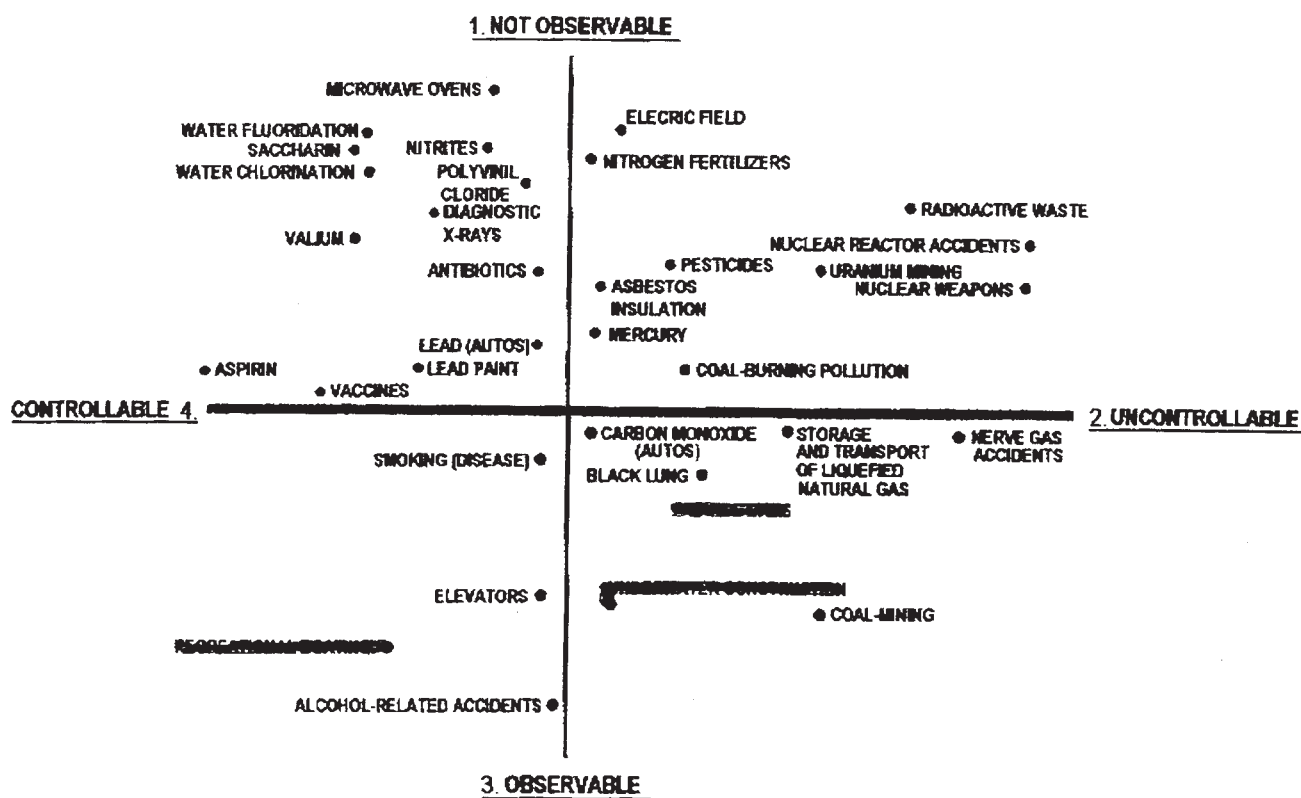


FIGURE 2. Risk space.⁵

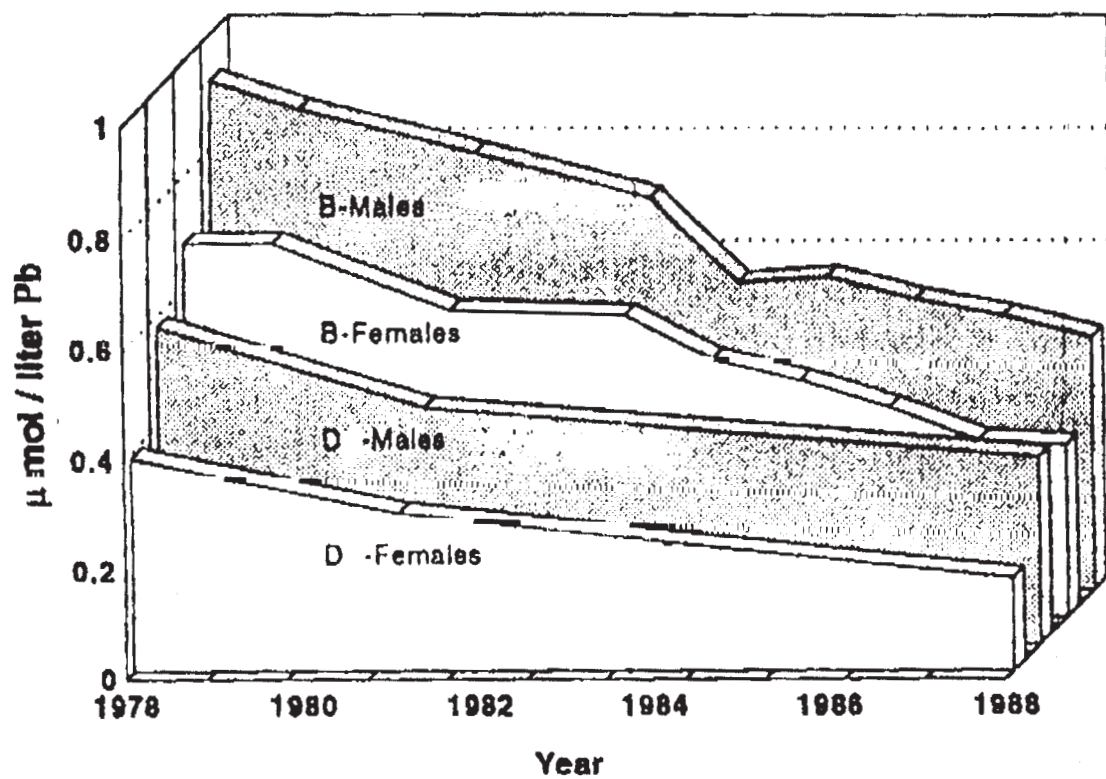


FIGURE 3. Gender influence of lead: B-Belgium, D-Denmark.⁵

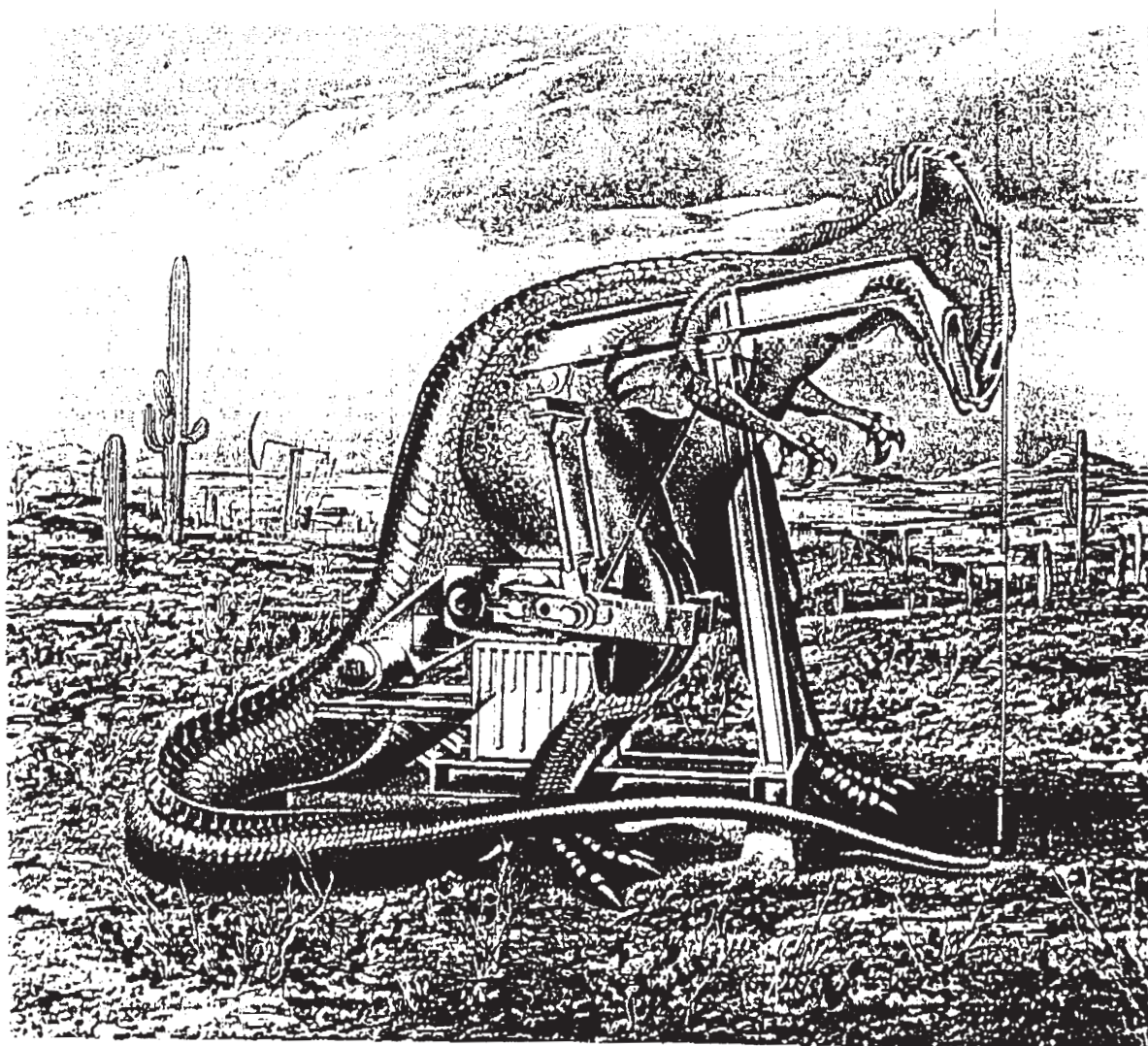


FIGURE 4

mination of industrial HM-sources; accurate analysis in different spheres for definite metal (metals); not only M-concentration (in comparison with maximum permeable concentrations) but as well its (their) oxidation states. Task to be followed medical, ecological, and demographical evaluation of HM impact on workers at metal-making or -using factories as well the whole population of industrial zones in heavy-contaminated regions. We consider what is important is the evaluation of HM influences together with another chemical compounds (N,S,C-oxides, pesticides, and so on).^{3,7}

HM can definitely be, even will be, the main pollutants of the next century⁷ (Figure 4).

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