

# INSIDIOUS LEAD POISONING

especially as revealed by Soviet toxicologists

By D. Stöfen

Thru  
DR. & MRS. S. COLUM GILFILLAN  
1301 Ocean Av., Apt. 403  
Santa Monica, Ca. 90401.

## A. Microtoxicology of lead

When Soviet toxicology has been discussed in Western Germany, criticism has been made of the thesis of RYAZONOV, that the threshold concentration of a poison which induces changes in the conditioned reflexes of the nervous system, is identical with the concentration which causes insidious intoxications from long-time incorporation. While this thesis had won vast publicity in Western countries, the paper of MEDVED on the same matter, convincing by a high discipline of thought, had received hardly any attention. This paper shows that the way of Soviet toxicology is much more realistic than we had thought, since not only conditioned reflexes, but all kinds of tests, including morphologic ones, are applied for the assessment of the toxic data, and are checked in man, if possible. In the case of lead,  $0.0025 \text{ ng Pb/m}^3$  of air had been found to induce disturbances in certain reflexes, and morphologic changes in the brain of animals. In human medicine  $0.001 \text{ ng Pb/m}^3$  of air had induced an increased coproporphyrine excretion in children. In the environment of factories with lead dust emissions ZYKOVA had found multiplication of myocardial damages, stenocardia and mitral diseases, vegetative dystonia, gastritis, colitis, stomach ulcers, likewise affections of liver and gall bladder, in persons between 18 and 50 years of age. The average atmospheric lead concentration had been  $0.0022 \text{ ng/m}^3$ .

For drinking water (CHERKINSKII) the maximum allowable lead concentration had been limited to  $0.1 \text{ ng/liter}$ . This correlates with the maximum lead concentration in the atmosphere ( $0.0007 \text{ ng/m}^3$ ), since both values induce the same lead absorption per day, if the absorption in the gastro-intestinal canal is 1/10 of that in the lungs.

Both limits, which unfortunately have no parallel in the Federal Republic of Germany, can hardly be characterized as being too low. Indeed, a paper by AGOROVA asks if they must not be further reduced, since very small quantities, showing no influence on reflexes or psychologic tests, induce changes in the sperm tests and on the offspring. Unfortunately experiments on animals, with their short pregnancies, are of course not necessarily valid for men too. Since the Soviet investigators shrink back from testing the sperm of man, the few Western institutes, which know not this restraint, have an important task. RAPOPORT has reported that the Institut Khimicheskoi Fiziki in Moscow has already checked the mutagenic effects of hundreds of industrial substances, and found that the mutational rate from some of them exceeds that from the radioactivity which provoked considerable publicity during the A-bomb tests. Whether lead was among those checked substances cannot yet be said. BERSIN has referred to the high frequency of malformations in the lead mining districts of Europe, and asked if the terrifying number of phocomelia cases does not depend on the lead content of our air. In addition, we have the problem of synergesis. Thus also the threshold in the USSR does not give complete safety, especially since other factors are involved, which differ from country to country.

## B. Provisions of the USSR.

The Soviet Union has drawn conclusions from their threshold limits. Ever since 1961-3 the admixture of tetraethyl lead in gasoline has been restricted according to the size of the cities, so that the lead in the cars' exhausts should not exceed the maximum allowable concentration in their atmosphere. The installation of lead water pipe connections to houses

The Public Health Service of the F.R.G. has unfortunately not published the results of the lead dust measurements carried out in recent years. The P.H.S. of Oberhausen/Rhein had found an average concentration of 0.0025 mg/m<sup>3</sup>, which was to be expected. As to the lead concentration in drinking water, KOLLATH had reported in 1942 that he found 0.5 mg Pb/liter in the drinking water of Berlin-Wilmersdorf, where it had stagnated during the night. It has often been asserted that lead pipes cease to contaminate drinking water after about 35 years. But REED et al. say on the basis of ample tests in Britain that this statement has been canceled by the chemization of the environment and esp. of the surface water. In addition the PVC-pipes used since World War II also contain lead for stabilization purposes. In addition to the lead content of the air and drinking water, there are still other sources which contaminate our lives, esp. food, and cigarettes. KLOKE has assessed the average lead intake in food in Western Germany, at the extremely high rate of 1.5 mg per day, without including crops raised near autobahns. PATTERSON considers 0.33 mg/day as the average intake in the USA. Only 1 mg/day is acceptable according to AEBI. According to HOFREUTER and PATTERSON the smoking of cigarettes contributes considerable lead. LERNERT could not confirm an effect of smoking on the lead concentration in the blood of men aged 20-22. Experiments at Zürich and Basel with policemen had also shown that healthy adults have a high lead excretion. But considering the toxicity of drinking water in many places at least 6 decades ago (with effects in present times), and the toxicity of the atmosphere in traffic centers, and of food, one must conclude that the "Zykova diseases" must have much increased. No one will deny they have done so. The statistics which the DAK (Deutsche Angestellten Krankenkasse) in Hamburg have set up for prophylactic purposes on their juvenile members (apprentices in their 2d year, and others with 17-year age), according to the reports of local physicians, are as follows:

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|                               | Male juveniles |       |       |       |       | Female juveniles |       |       |       |       |
|-------------------------------|----------------|-------|-------|-------|-------|------------------|-------|-------|-------|-------|
|                               | 61/62          | 62/63 | 63/64 | 64/65 | 65/66 | 61/62            | 62/63 | 63/64 | 64/65 | 65/66 |
| Announced juveniles           | 15120          | 14882 | 15237 | 16670 | 16835 | 38310            | 41395 | 41114 | 44054 | 45008 |
| Examined juveniles            | 12677          | 12106 | 12803 | 12808 | 14241 | 32296            | 33715 | 34120 | 35877 | 37441 |
| <u>3 with Foot complaints</u> | 21.9           | 22.1  | 21.5  | 22.8  | 22.8  | 24.2             | 25.3  | 21.4  | 23.0  | 23.0  |
| Carriage defects              | 4.8            | 10.8  | 13.5  | 12.6  | 17.0  | 3.5              | 7.3   | 10.2  | 11.3  | 14.1  |
| Tooth damages                 | 11.7           | 11.7  | 11.7  | 11.6  | 12.0  | 11.1             | 10.6  | 10.6  | 10.8  | 11.6  |
| Eye complaints                | 2.1            | 2.1   | 2.2   | 1.8   | 2.1   | 2.2              | 2.5   | 2.3   | 2.2   | 2.1   |
| Neck, nose, ear complaints    | 8.4            | 7.1   | 5.7   | 5.5   | 5.7   | 9.1              | 7.6   | 6.3   | 6.7   | 7.1   |
| Heart complaints              | 3.5            | 4.2   | 3.5   | 3.5   | 3.4   | 3.1              | 2.9   | 2.7   | 2.7   | 2.7   |
| Vascular complaints           | 1.9            | 3.2   | 5.4   | 5.7   | 5.7   | 2.8              | 4.3   | 6.1   | 6.8   | 7.6   |
| Adipositas                    | 0.8            | 1.5   | 1.6   | 2.3   | 2.8   | 0.9              | 1.9   | 2.1   | 2.6   | 3.3   |
| Skin disease                  | 2.4            | 5.4   | 3.3   | 2.8   | 2.8   | 2.1              | 4.1   | 3.0   | 2.6   | 2.7   |
| Anemia                        | 0.5            | 0.7   | 0.5   | 0.6   | 0.5   | 2.0              | 2.2   | 1.9   | 3.0   | 2.1   |
| Renal complaints              | 0.4            | 1.3   | 2.0   | 2.4   | 2.4   | 0.9              | 1.5   | 1.8   | 1.9   | 2.1   |
| Asthma                        | 0.4            | 0.3   | 0.3   | 0.4   | 0.7   | 0.2              | 0.1   | 0.1   | 0.2   | 0.3   |
| Stomach complaints            | 0.9            | 1.0   | 0.7   | 0.7   | 0.9   | 0.9              | 1.5   | 1.3   | 1.3   | 1.6   |
| Vegetative disturbances       | 2.7            | 5.8   | 6.8   | 7.2   | 10.4  | 3.3              | 6.0   | 6.8   | 7.5   | 10.6  |
| Thyropathy                    | 1.0            | 1.8   | 1.4   | 1.2   | 1.2   | 2.2              | 4.3   | 3.7   | 4.1   | 3.4   |
| Nervous disturbances          | 2.4            | 3.3   | 3.4   | 3.8   | 5.9   | 3.1              | 4.4   | 3.8   | 4.9   | 7.4   |
| Retarded development          | 0.7            | 4.4   | 2.4   | 2.2   | 1.7   | 0.6              | 4.3   | 1.8   | 1.9   | 0.9   |
| Danger of tuberculosis        | 0.6            | 0.7   | 0.6   | 0.5   | 0.8   | 0.5              | 0.6   | 0.6   | 0.5   | 0.4   |

So far as I know the causal relation with lead has been examined in Western countries only for one pathological effect on the general population, viz. mental retardation. According to MONCRIEFF et al. 55% of the children who were examined in the Hospital for Sick Children in London had a lead concentration of 0.036 mg/100 cl, or more, in the blood. As a matter of fact the epidemiology of insidious lead intoxication does not need such vast statistical research as, for example, lung cancer from cigarette smoking, since it has become diagnosable, and within certain limits curable, since some years now. I think of the lead mobilization test (see UNSELD; HERNBERG) which, to the best of my knowledge, has been transferred to insidious lead intoxication by Patzer. Perhaps the  $\delta$ -amino levulinic acid test, for which DONSIGNORE has worked out a quick method, has importance for the general population too.

Whereas the determination whether lead is a partial cause of a certain disease, is easy, the high number of diffuse complaints involved offers certain difficulties. For precise scientific researches a judgment, whether a person's parents had been leaded, is necessary, since a lead burden in either parent can damage a person, who may be rather free of lead himself.

#### D. Possible Effects of Insidious Lead Intoxication

1, Anemia; 2, colic; 3, chronic spastic colitis; 4, polyneuritis; 5, encephalopathia; 6, arteriosclerosis, esp. in the brain; 7, atrophy of the nasal mucous membrane; 8, affections of the inner ear; 9, asthma; 10, eczemas; 11, gastritis; 12, hypertonia; 13, myocardial damages; 14, endarteritis obliterans; 15, gangrene; 16, liver diseases; 17, renal diseases, incl. interstitial nephritis and nephrosis; 18, gout, podagra; 19, Basedow's disease; 20, diffuse sclerosis; 21, rickets (at least in cases of maternal lead burden); and 22, visual disturbances.

As lead (mercury too) according to SELYE sensibilizes the body for allergens, the epidemiologic dissemination of insidious lead intoxication can make necessary to include the lead mobilization test in the therapy of allergies and skin diseases, or to find Hg, which might be present in such cases. WEICHARDT confirmed that these metals play a role in skin diseases. In this way spectacular therapeutic successes have already been obtained (not yet published), altho skin tests have been made without any result.

MELTZER of the Presbyterian Hospital in Philadelphia had been able to reduce needed insulin quantities for diabetics to 1/3 by  $\text{Na}_2\text{EDTA}$ -injections. As this result had been accompanied by a heightened excretion of zinc, and in the second place of lead, he presumed zinc to be the main etiological factor for diabetes mellitus. We know however from ROSSI that incorporated lead increased the zinc concentration in blood. (Against this thesis, SOLDATOVIC) That is perhaps the reason why lead could be considered the etiological factor in many diabetes cases, esp. as zinc plays no role as an environmental poison, and Meltzer is aware of the presence of unknown factors in diabetes. Fortunately the Medical Center of Colorado University, in Denver, has included lead in a research program on the causality of trace metals for diabetes mellitus of juveniles.

On the basis of KNICK's paper on the relationship between arteriosclerosis, diabetes mellitus and obesity, investigations regarding the part of lead in obesity may have good chances. Obesity is among the diseases increasing in our civilization.

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CLEGG found osteoporosis after injecting young lambs with lead. An investigation of such matters in the human sphere might have good chances.

The air-cooling system of certain automobiles allows entrance of the exhaust gases with their lead content into the interior of the car. This and the vibration of the car may provoke a lead flush, a mobilization of the body's lead, wh. may be a cause of the disk damages often found in drivers. TELEKY and other authors have described it.

In view of the multiple effects of lead on bones, muscles and ligaments, it must be expected that lead possibly contributes to defective carriage, found increasing rapidly with juveniles.

CAMPBELL has referred to the possibility of lead inducing multiple sclerosis. KOELSCH ascribes to lead an effect on caries; in addition see the

According to SUZUKI lead influences the hair. Scleroderma has often been cured with  $\text{Na}_2\text{EDTA}$ , which eliminated lead ions (WINKELMANN etc.).  $\text{CaNa}_2\text{EDTA}$  reduces the  $\beta$ -lipoproteins in cases of psoriasis (KALZ). A pathogenic influence of Pb on this disease seems to be possible.

Lead is mobilized in pregnancy and then enters the fetus thru the placenta (BAUMANN; BIBILISHVILI). It is possible that numerous pregnancy toxemias have been induced by this fact. Of course the strong link from lead to abortion has been known for a century. The investigators who reported on the influence on births from cigarette smoking by pregnant women, were unfortunately not aware of the lead content of cigarette tobacco, which probably goes to explain their phenomenon. With her milk a mother transfers further lead to the suckling. Like the male sexual organs the female ones too may be easily damaged by a little lead, and in this way also the offspring, apart from the intrauterine incorporation. This might induce a continuous increase of the lead damage to the race, even if the intake from air, water and food did not change. Such process could be one key to the so-called hereditary diseases with uncertain prognosis, whose genetic interpretation is so difficult.

It has been shown that the usual lead concentrations in the centers of city traffic induce morphologic changes in the brain. Cerebral arteriosclerosis by lead is combined with mental deficiencies (TELEKY). The link from lead to mental retardation in children has already been shown. SPIVAK reported delayed answers to questions, and a decrease of logical analysis and synthesis in the early stages of tetraethyl lead poisoning. As the number of victims of insidious lead poisoning must amount to millions, a correlation to the shift of endowment in pupils, from logical-abstract to practical thinking (found by HUTH) is likely. It is known that schools, chambers of commerce, and the armed forces likewise complain of the decay of intelligence in youth. If, nonetheless, able thinkers continue to appear, this does not disprove the relation to lead: it could be the stimulation phase of the intoxication. That lead has also a stimulation phase was proved by DROGOCHINA et al. Lead therapy could have more chance with children who were not removed and backward, than with the mentally retarded ones seen by HARDY.

As to the effect of lead on emotional life, TELEKY reported a lack of sociability, and general disgust! Lead investigations and therapy upon disintegrated people of all kinds, criminals (KOLLSCH), youth in reformatories, isolated people, suicides, may be productive. A comparison of tests with juveniles, 30 years ago and today, shows an increase of calm behavior according to the Jugendbericht (Youth Report) of the Bundesfamilienministerium. I refrain from commenting on the recent political activity of our students.

#### F. General remarks on insidious lead poisoning.

The interrelations between lead and the psyche show also an inversion of the above mentioned effects. A psychical stress, e.g. noise, aggravates a lead intoxication (Prof. Bolezni, KANNER, TICHONOV). This probably illustrates the so-called "manager disease" and similar ailments of students, women piece-workers etc. The occupational stress mobilizes a lead depot. Thus the noise of supersonic planes becomes still more dangerous. When the Russians were able to stand the howling of the German dive bombers far better than Western soldiers, this might have been due to their lower lead burden. The thesis of HARDY that lead aggravates all other diseases, correlates with this statement. The ability to resist infectious diseases is reduced. The lead mobilization test should become a standard institution like tonometry before operations.

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In its therapy the Soviet pharmacology combined vitamin B<sub>12</sub> and iron with the chelating agent CaNa<sub>2</sub>EDTA, probably to replace the excreted cobalt too. CHAIKA reported on the protective effects of pectins in animal lead poisoning, and recommended their adoption in human medicine.

Since lead concentrations in air, drinking water and food have long exceeded the hygienic standards, or did so till a few decades ago, the removal of a lead damaged worker from his occupational exposure has only an incomplete therapeutic value. It is questionable whether the present practice of the public accident insurers can be maintained, of excluding insidious lead poisoning, after this disease has become diagnosable. Attention must be paid also to the non-occupational lead intake. Certainly research on insidious lead intoxications should gain new incitements.

In both world wars occupational lead poisoning disappeared almost completely in Germany, a circumstance which was ascribed to scanty nutrition. Contrary to common opinion WITTGENS et al. have found by tests on rats that milk has an unfavorable influence on the health of the poisoned animals. The solution for the controversy between animal and vegetable fats is perhaps that animal fats are a health risk only for the great number of people with insidious lead poisoning. E.g. caries may be induced by synergetic effects of (intrauterine) lead, sugar and lack of fluorine. According to EICHHOLTZ today already small quantities of alcohol induce dysfunctions, a phenomenon which well agrees with the epidemiologic range of insidious lead.

#### G. The Role of lead in history

The share which has been ascribed to lead by some authors in the decay of ancient civilizations, e.g. by KOBERT, and by GILFILLAN with restriction to the upper class in the Roman Empire, and from STÖFEN by the way, with regard to the psychosociology of that period, will be better understood with the help of Soviet toxicology. The unpublished studies of KNORR on lead in the drinking water of Roman towns, thru the lead pipes and aqueducts often noted, will help illuminate this problem. So far as I know, no study has yet been made as to whether the initial stimulating effect of lead poisoning (DROGOCHINA et al.) has influenced history. One should consider the extremely low lead burden of the African negroes. Causation is possible between the accompanying turn of the Eurasiatic cultures toward spirit, and to abstract-logical thinking, around 1000 B.C., when lead smelting was gaining impetus in Greece, Palestine, Egypt, Persia, India etc. The share of lead in the pathogenesis of genius, and its connection with diffuse diseases and biological decay, becomes transparent in the light of Soviet toxicology. Occidental civilization used lead long before industrialization, e.g. for saving wines from going sour, and making grape sirup for sweetening, and in kitchen utensils, ointments, paint, tickets etc. The secular process of enlarging cranial capacity ("progressive cerebration") and bodily height may have been furthered by lead. In lead mining districts the toxicologists know such phenomena (TARABAEVA). The circumstance that today, when lead's adverse effects strike larger and larger masses of men, abstract-logical thinking is also involved, correlates with this thesis.

#### H. Final observations

There is no doubt that the sanitizing of our biosphere, e.g. the elimination of alkyl lead in gasoline, or a transcontinental water supply from Scandinavia to southern Europe, etc., requires appalling sums. But even these costs will be a trifle when compared with the expenses in the social sphere, which would derive from our present atmospheric lead contamination.

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