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POLLUTION OF THE ENVIRONMENT
 WITH HEALTH RISK FACTORS

The current paper presents the adverse effects of some pollutants present in the environment on human health. There is described is the influence of heavy metals and pesticides, toxins produced under natural conditions by blue-green algae and moulds, ionizing radiation, pathogenic bacteria and viruses on human being.

1. INTRODUCTION

In natural environment many agents hazardous to people's health, the so-called risk factors, occur. These are mainly pollutants produced by industry, transport, chemicalization of agriculture, etc. They are not only highly toxic, but also widespread in the water, soil, atmospheric air and food products, therefore all people living in the degraded area absorb them unintentionally.

The pollutants are usually different toxic chemical compounds and some of them have also mutagenic, carcinogenic and teratogenic properties. This group includes also numerous allergens and immunosuppressants (compounds lowering immunity).

The mechanisms of pollutant actions on organisms are various and often very complicated, because they take place on the molecular, subcellular and cellular levels of the macroorganism. Therefore it is hard to determine and identify them immediately. It should be also stressed that in some cases, e.g. cancer, their effects are observed a long time after the exposure of living organisms to such agents.

Any organism is exposed to many different agents at the same time, and their actions can be synergistic or antagonistic. Quantitative ratios between macro- and microelements are also important. Not only excess, but also lack of some of them have significant consequences and lead to the so-called deficiencies. This concerns mainly trace elements such as iodine, iron, magnesium, copper, zinc, selenium, fluorine and vanadium. One of the reasons of elimination of, for example, magnesium from the soil and biomass of plants grown on it is the excess of heavy metals, particularly lead, cadmium and mercury [4].

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On this background it must be noted that the human organism does not remain passive in the face of these harmful influences and it launches different non-specific and specific defense mechanisms which allow it to maintain the internal balance. The fight which then takes place may eventually be unsuccessful, but it allows the organism to survive for some time in a fairly good health. Unfortunately, not everybody receives high immunity. Much lower are the chances of children whose immunological systems are not mature, elderly people exhausted by other diseases, undernourished, and also alcoholics, inveterate smokers, drug addicts, etc.

Finally, a very complex set of reasons and results is made up which allows us to identify the cause of the pathological process in each case. It does not mean that one can underestimate environmental exposures; on the contrary, the protection of human health should become the main aim of the environmental protection.

2. MAJOR FACTORS OF THE ENVIRONMENTAL HEALTH RISK

2.1. CHEMICAL COMPOUNDS OF TOXIC AND GENOTOXIC NATURE OF ANTHROPOGENIC ORIGIN

It is not possible yet to give an exact definition of a poison, however, it is known that it is lethal for living organisms when absorbed even in a very small quantity. It is the so-called acute-lethal toxicity. Such effects of environmental exposures are incidental and usually result from accidents.

The other form of toxicity – chronic toxicity – is the result of repeated absorption of very small doses of toxic compounds. Immediate effects are invisible. However, a prolonged exposure leads to the damage of tissues and internal organs which impairs their functions and starts a pathological process. The rates of these alterations depend on the biological activity of the poison measured by its amount needed to reveal certain disorders. The activity of the poison depends on:

- the chemical structure,
- the solubility in water or lipids,
- the ability to react with natural cell compounds,
- the susceptibility of the organism to the poison (species and individual susceptibilities can be distinguished),
 - the age, sex, diet, mode of life, general state of health and physical form,
 - the route of absorption of the poison (respiratory, alimentary, through the skin),
 - the rate of diffusion to blood and the transport to tissues,
 - the transformations in the organism (the metabolites can have increased, decreased or similar activity as the initial compound, or can be inactive),
 - elimination of toxins from the organism,
 - biocumulation in tissues and internal organs.

The poison gives rise to a number of disturbances in the processes integrally associated with maintaining of homeostasis and life of cells, tissues, organs and the whole organism. The disturbances usually concern:

- the disintegration of the cell membrane structure which alters its numerous physiological functions,
- the inhibition of enzymes,
- the inhibition of intracellular respiration,
- the inactivation of hemoglobin and blocking of the oxygen transport to tissues,
- the interference in the DNA structure and change of genetic information (mutation).

These changes are caused only by genotoxic compounds. The sources of the most common toxins present in the environment are shown in table 1.

Table 1

Environmental toxins of anthropogenic origin

Source of pollution	Kinds of poisons
Emission of particulates and industrial gases	heavy metals, pesticides, combustion products
Wastewater treated to a different degree	petrochemicals,
Production and use of crop protection products	PAH-s and their organochlorine derivatives
Dumps and landfills	plastics, dioxins, disinfectants
Sewage sludge	
Secondary products of biodegradation processes	some unidentified products of microbial degradation
Toxic products of fotooxidation	toxic products of reactions induced by ultraviolet radiation

The poisons that are most common in the environment include heavy metals. Their inorganic derivatives exhibit the highest toxicity, since they are soluble in water and therefore can easily penetrate into the cells. Organometallic compounds often cause symptoms of allergy.

Each metal has an affinity to certain tissues, organs and glands which are therefore under a greater threat than other parts of the body. For example, the cardiac muscle disorders are caused by copper (Cu), lead (Pb), cadmium (Cd) and mercury (Hg); cerebral cortex – by lead (Pb) and mercury (Hg); kidneys – by lead (Pb), copper (Cu), mercury (Hg) and cadmium (Cd); liver – by cobalt (Co) and nickel (Ni); erythrocytes – by cadmium (Cd).

It was found that some metals interfere with the functions of endocrine glands. The thyroid gland is at the greatest risk [8]. Some metals such as chromium(VI), nickel, cadmium and arsenic are carcinogenic.

In industrialized regions, heavy metals are constant elements of the environmental pollution and their levels often exceed the permissible limits, particularly in case of

lead and cadmium. Therefore all inhabitants are constantly exposed to these metals. It should be noted that metals are cumulated in tissues. In the Legnica–Głogów copper mining area, an elevated concentration of lead in blood was found even in several year old children [8]. Similarly, in Oława (in the vicinity of a zinc white smelter) the concentration of lead in blood of children was found to exceed the permissible level of 10 $\mu\text{g}\%$ in 34.5% of cases. For comparison, in Wrocław this limit was exceeded in 4.37% of cases [4].

The symptoms of lead poisoning of children manifest themselves as neurological and mental disorders. It is also very important that heavy metals absorbed by pregnant women penetrate through the placental barrier and are toxic to the fetus.

Similarly, pesticides are very widely spread in the environment. However, they differ from the heavy metals in their origin – they are poisons produced intentionally and then used in agriculture and gardening. The idea of the chemical pest and pathogen control was at the beginning the synthesis of such a substance that would have the so-called selective toxicity, i.e. it would be toxic to unwanted species and fully safe for other species, including man. However, such a compound has not been produced so far, despite of great efforts.

After many years of application of DDT extensive studies have lead to the conclusion that this pesticide is a persistent compound, resistant to biodegradation, it remains in an unchanged form in the environment for approximately 11 years, migrates in ecosystems and cumulates in tissues, including human adipose tissue. After finding that DDT is a mutagen and carcinogen and that it penetrates placenta of pregnant women it was phased out all over the world. However, this shows that the introduction of a new product into the environment without a full investigation of its toxicity can have unforeseen health effects.

DDT was replaced with a great number of new crop protection products. Despite the extensive efforts to make them less hazardous to the environment they cannot be considered absolutely safe for our health.

These examples do not exhaust the subject of the environment pollution with the compounds hazardous to health. There is a serious shortage of the studies that control the quality of food products, drinking water, wastewater effluents discharged to the receiving waters, sewage sludge disposal, atmospheric air, etc.

2.2. TOXIC SUBSTANCES OF NATURAL ORIGIN

Many strong poisons are produced by plants, for example, blue-green algae (*Cyanophyceae*) and fungi.

Cyanophyceae are algae which occur in great quantities as the so-called algal bloom in eutrophicated waters, particularly in artificial lakes. This state is reached not only due to a high content of nutrients in the water, especially nitrates and phosphates, but also because of the production of many antibiotics and toxic metabolites by blue-

green algae. In this way, *Cyanophyceae* dominate in the ecosystem and in a short time eliminate other competing species.

Toxins of blue-green algae are released during algal bloom and deteriorate the quantity of raw water uptaken for municipal purposes. These toxins are persistent and resistant to microbial degradation, therefore the water remains contaminated for a long time. They are not efficiently removed by the methods used during water treatment. Moreover, they are resistant to high temperatures, therefore boiling of drinking water does not bring about the expected results. They are not digested by the enzymes in the alimentary canal.

The following species, which produce many toxins, belong to *Cyanophyceae*: *Microcystic aeruginosa*, *Aphanizomenon flos aquae*, *Oscillatoria* sp. and *Anabaena* sp.

Toxins of blue-green algae are not recognized in detail. However, it is known that with respect to their effect on human organism they can be divided in two groups – hepatotoxins and neurotoxins. Hepatotoxins are peptides and cause severe damages of liver, they are mutagenic and carcinogenic. Neurotoxins are alcaloids that paralyze nerve cells, which leads to a neuro-muscular blockade.

The problems of increasing eutrophication and poisoning of water with *Cyanophyceae* toxins, which are produced under uncontrolled conditions, pose a serious threat to health [7].

Fungi are very common in nature. There is a great number of fungal species, including moulds. They exist in soil, sewage sludge, on plants, in food products, fodder and houses [5], [6]. They produce a great variety of compounds, including toxins and antibiotics. Fungi, which synthesize toxins, belong mainly to the *Aspergillus*, *Penicillium* and *Fusarium* genera. They produce cytotoxic, mutagenic, carcinogenic and teratogenic mycotoxins. Some of these poisons after entering the organism exhibit neurotoxic, nephrotoxic or immunosuppressive activity. The aflatoxins B1 and B2 produced by fungi from the *Aspergillus flavus* and *Aspergillus parasiticus* species [7] are considered to be the strongest of all known carcinogenic compounds.

The first known antibiotic, penicillin, discovered by an English scientist Alexander Fleming is produced by moulds from the species of *Penicillium*, *Aspergillus* and *Cephalosporium*.

Moulds propagate very rapidly producing vast numbers of spores spreading around with the slowest air movements. Spores of some genera of fungi cause symptoms of allergy. Moulds form a very broad group of organisms living under different environmental conditions. They include profitable forms with interesting metabolic properties, but toxins produced by some fungi are dangerous and pose a serious health hazard.

2.3. IONIZING RADIATION AS A HEALTH RISK FACTOR

The ionizing radiation, that is X-rays, α , β^+ , β^- and γ rays give rise to a number of adverse effects on a living organism. The sources of such radiation are nuclear explo-

sions, failures of nuclear reactors, production and distribution of isotopes, radioactive waste and radioactive elements present in the lithosphere. The irradiation of a living cell causes its immediate death or alterations leading to the damage of genetic material and other important subcellular structures (table 2).

Table 2

Results of the irradiation of a cell with the ionizing radiation

	Results
Ionizing radiation	ionization of cell components
	atomic excitation
	generation of free hydrogen and hydroxyl radicals
	production of hydrogen peroxide
	gene and chromosome mutations

If the changes take place in somatic cells they will very likely initiate the development of cancer. Gene and chromosome mutations in reproductive cells threaten the next generation with a psychophysical underdevelopment.

2.4. OTHER CAUSES OF ENVIRONMENTAL HAZARDS

Such pathogenic microorganisms as bacteria and viruses are a specific kind of environmental pollutants. They may infect many people at the same time through water, sewage, sewage sludge, atmospheric air, food products and direct contact with a sick person. The infection occurs after invasion of a very small number of microorganisms, the so-called minimum infectious dose.

After colonizing mucous membranes bacteria start to propagate and produce very strong toxins – exo- and endotoxins which cause either acute symptoms of disease or even death. The exotoxin produced by *Clostridium tetani* and botulin produced by *Clostridium botulinum* are the strongest known toxins. Both toxins in trace quantities are lethal for human organism.

Also viruses are infectious but unlike bacteria they do not produce any toxins, since they themselves have cytotoxic properties. Among viruses a group of oncogenic viruses responsible for the initiation of cancer in animals has been identified. Most probably it is also true for man, however, it has not been fully confirmed so far.

Transgenic varieties of plants and animals and genetic modification of microorganisms for wastewater treatment may become an entirely new threat to health in the near future. The use of genetic engineering methods may allow us to obtain some beneficial features of new varieties, but long-term side effects of such methods are not known. The recombinants can reproduce in the environment and may disturb the ecological equilibrium of species. If the hazardous features are identified, their elimi-

nation will be extremely difficult or even impossible. These forms will also have a disturbed metabolism, including the process of protein biosynthesis, and it is not known how it may influence other species.

3. CONCLUDING REMARKS

Nowadays people live in more and more degraded environment and are exposed to a variety of factors hazardous to their health. Therefore a growing proportion of the society suffers from the so-called civilization diseases. In this light, the apprehension for health of future generations is fully justified. Therefore protection of the environment is one of the major scientific and practical tasks. However, its results will not be satisfactory as long as the environmental protection work does not include health protection, sustainable development and harmonious cooperation of man and nature.

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WPLYW ZANIECZYSZCZEŃ OBECNYCH W ŚRODOWISKU NA ZDROWIE CZŁOWIEKA

Przedstawiono szkodliwy wpływ niektórych zanieczyszczeń występujących w środowisku na zdrowie człowieka. Omówiono wpływ metali ciężkich i pestycydów oraz trucizn produkowanych w warunkach naturalnych przez sinice i grzyby pleśniowe, promieniowania jonizującego, a także wpływ bakterii patogennych i wirusów.

