CHAPTER 3

Other Natural Factors

CLIMATIC FACTORS

Climate, or the physical state of the aerial environment, is one of the leading natural factors from the standpoint of human health. As Hippocrates said already in 400 B.C.: "*The human organism behaves differently in different seasons. Some people feel better in winter, others in summer. Dry weather is healthier and less dangerous than rainy weather.*" Beyond those general observations, we have today the developed scientific disciplines of *medical climatology* (human bioclimatology) and *medical meteorology*, which study the relationship between the organism and long - term or short - term weather conditions and their direct connection with health and disease.

It can be arbitrarily postulated that a temperate climate represents the norm, and extreme or even moderate deviations of heat or cold and dryness or wetness significantly affect the physiological functions of man and his health. Climate affects the capacity or inclination of human beings for physical activity at different temperatures, reduces salt levels in warm climates, and increases the desire for caloric (fatty) food in cold lands. There are so many different examples that they cannot be enumerated at this time. It is our aim to give a concise review showing the role of this natural factor on human health. For the following discussion, we draw on the work "**Balneoclimatology**" by T. Jovanovic et al. (1977) and other literature.

In the first place, the weather situations to which man is exposed can be simple or complex, the latter having a much more pronounced negative biotropic effect on the human organism than the former. Strong heat waves and cold spells are *simple weather situations*, which also include

sudden changes of barometric pressure, wind, fog, global solar radiation, precipitation, and atmospheric ionization. *Complex weather situations* occur more rarely. They usually are frontal in origin and represent a combination or complex of simple weather situations. So - called *enhanced weather situations* occur even more rarely. They occur when strong air pollution - smog - is superimposed on the complex of meteorological factors. In order to make it easier to study biotropisms of the human organism in response to weather situations, there are a number of classifications of weather states giving rise to certain biotropisms.

Meteorological events on the whole take place in the troposphere, i.e., the envelope of air up to an altitude of 12 - 14 km, and this layer of the atmosphere is popularly called the "*weather kitchen.*" Weather represents the real state of values of meteorological elements and occurrences at a given point in time. For this reason, weather is a concept that is defined by numerical values of meteorological elements and symbols of meteorological occurrences. In contrast to weather, climate represents the set of weather phenomena or atmospheric occurrences characterizing the average physical state of the atmosphere above some region.

Meteorological elements include the following things: solar radiation, terrestrial radiation, day length, horizontal visibility, temperature, pressure, humidity, air streaming, evaporation, snow cover height, and height of precipitation. *Meteorological phenomena* include fog, clouds, rain, snow, hail, sleet, frost, and ice. Greater non - periodic, unexpected, and sudden fluctuations in the values of meteorological elements are of special interest for meteorobiology.

The different climates that occur on the Earth bear witness to the controlling influence of several climatic factors: l) geographic latitude; 2) zones of constant low and high pressure; 3) prevailing winds; 4) storms and interacting air masses; 5) disposal of land and sea; 6) distance from the sea; 7) barriers in the form of mountain ranges; 8) ocean currents; and 9) elevation above sea level. Accordingly, certain large areas of the Earth have a definite climate, which can be polar, tropical, continental, Mediterranean, subtropical, etc. Bioclimatologists, biogeographers, doctors, and other specialists deal with specific complex questions of human life and acclimatization in polar regions, the damp tropics, arid zones, high mountains, and regions with a maritime climate.

With respect to biological effects, the following four meteorological comples can be singled out: thermal, hygric, actinic, and aeric. The *thermal complex* (air temperature, movement of air, and thermal radiation) gives rise to thermoregulatory responses of the organism. The *hygric complex* (concentration of water vapor in the air and air pressure) hinders the thermoregulatory process and imposes considerably greater demands on the thermoregulatory apparatus of man. The *actinic complex* includes solar radiation, and the visible and ultraviolet parts of this radiation are of special significance. The *aeric complex* consists of air pressure

and partial pressures of the individual gases and admixtures of which air is composed.

In addition to studying the numerous physiological reactions of the human organism to the indicated comples, meteorophysiology also monitors physiological reactions brought about by the short - term, intensive, and predominantly dynamic influence of sudden weather changes. Most physiological reactions of the organism occur in response to changes in the surrounding conditions, and their intensity depends on the rate of such changes. We list below several factors and indicate how the organism reacts to them:

1. *Air temperature.* Among other things, the depth and rate of respiration, rate of blood circulation, and provisioning of cells and tissues with oxygen depend on air temperature, as do characteristics of the metabolism of carbohydrates, salts, and fats and work of the muscles;
2. *Relative humidity.* Increased temperature is easier to withstand in the presence of drier air. However, if relative humidity is lower than 20%, then evaporation from the surface of the mucosa lining the respiratory pathways is so great that it begins to dry out. In deserts and mountains, this causes an unpleasant sensation of dryness in the throat and nose, cracking of the lips, and decline in their protective role as factors preventing dust and microbes from entering the organism. On the other hand, high air humidity in cold weather leads to colds and frostbite of the hands, feet, ears, and cheeks due to the prolonged cooling of the organism. Increased humidity in cold weather usually causes aggravation and recurrence of rheumatism and bronchial asthma. This is the case, for example, in the Eastern United States, where the number of acute attacks of rheumatic fever attains a maximum at the end of winter and beginning of spring (Fig. 3.1.);

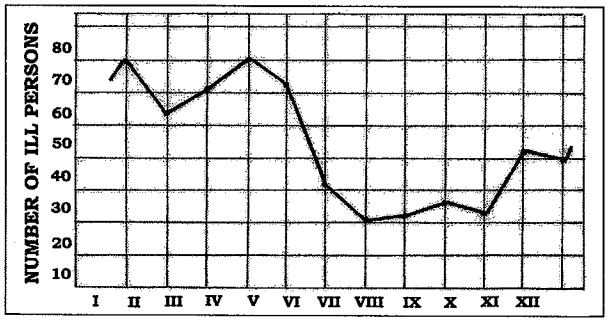

Fig. 3.1. Seasonal variation of number of person's disease of recurrence of rheumatism.

3. *Atmospheric pressure.* Statistics confirm that the number of hypertonic crises is twice as great on days with low atmospheric pressure than on

days with normal values of it. Especially hard to bear is the combination of reduced pressure with high air humidity. It has been established that a decrease in atmospheric pressure by only 10 millibars with a change of weather can cause vascular catastrophes;

4. *Wind.* The influence of wind on man can be either positive or negative, depending on a number of things. For example, the "bura" (a dry cold intermittent wind that blows along the Adriatic seacoast) acts positively on the human organism: sick persons feel better, and there is improvement in the subjective sense of wellbeing of hypochondriacs and asthmatics. On the other hand, the "jugo" (a damp coastal wind) evokes effects opposite to those induced by the "bura." Similarly, the hot dry intermittent winds known as "fens" have a harmful effect on the human organism, especially the psyche.

Adaptation of the organism to changes in the environment is frequently hindered, depending both on the conditions in which it occurs and on the state of adaptability of the people concerned. The mechanism of adaptation is complex and has not been fully clarified.

If a state of equilibrium is not achieved between adaptive responses and changes in the environment, disturbances arise in the organism that fall in the domain of *meteoropathology*, i.e., *meteorotropic diseases.* To be specific, weather conditions can induce the onset of certain diseases, aggravate the state of sick persons, or cause complications of diseases present in the human organism. *Meteorotropisms of certain diseases and states* are discussed below.

Cerebrovascular diseases. Yoshiyuki Ohno established that cerebral hemorrhages can occur with increase of air temperature above 25°C, decline of relative atmospheric humidity below 40%, and decrease of barometric pressure below 1,010 mb. These complications are also often recorded in the course of some physical activity during the cold period of the year. Apoplexy most often occurs after a sudden drop of barometric pressure, with an increase of air temperature, and under conditions of strong wind and cloudiness.

Infarct and *coronary disease.* The greatest incidence of infarcts is recorded in the cold period of the year. Sudden cooling has an unfavorable effect on patients with coronary disease. Decrease of air temperature coupled with increased cloudiness and fog also has an unfavorable biotropic effect on patients with angina pectoris.

Ulcers. Ulcers represent a typical case of poor adaptation. Perforations occur most often during the winter in Western Scotland, but during the summer in Northern Scotland. It is a fact that patients with ulcers respond to sudden changes in the values of many meteorological factors, strong winds especially.

Mental diseases. Psychic patients are subject to meteorological influences. Patients with the clinical pattern of schizophrenia react to the advance of hot air. Many authors attribute a negative biotropic effect to atmospheric ions.

Chronic bronchitis and *bronchial asthma.* Patients experience a worsening of their condition and discomfort with increase of atmospheric humidity and under cloudy conditions. With a decrease of temperature by more than 10°C in a short period of time, asthmatic attacks occur in all patients. Reactions are recorded during passage of meteorological fronts.

Rheumatic diseases. It has been known for a fairly long time that persons who suffer from various rheumatic diseases are "living barometers" and react to sudden weather changes. Discomfort arises with greater fluctuations of temperature and humidity and after a sudden drop of barometric pressure. Atmospheric ions also play a definite role in these reactions.

Traffic accidents. There are many causes of traffic accidents. Apart from factors that make driving conditions worse (fog, slippery roads, heavy rain, snow, and strong wind); there is also the influence of sudden weather changes on the human organism. To be specific, weather changes that occur under unstable cyclonic conditions give rise to exhaustion, apathy, and slowing of reactions in humans. If the driver also suffers from some chronic disease, then significant reduction of driving ability and general concentration is amplified.

As well as risks to the human organism, *meteorological* and *climatic factors* can also ert positive influence. For example, the aim of climatic therapy of asthma and bronchitis patients is to remove the sufferer temporarily from a polluted environment and induce as good and lasting remission as possible by means of exposure to favorable climatic conditions in conjunction with other methods of treatment.

HYDROLOGICAL FACTORS

Water has occupied a position of high priority in the traditions of all peoples and cultures. From time immemorial, man has known that he is inseparably linked with water and can survive only where water also survives. It is therefore understandable that water has erted appreciably greater influence on the development of civilization than all other natural resources, influence such that the entire history of mankind can today be described in terms of our needs for water. Earlier civilizations arose exclusively around great river courses: the Tigris and Euphrates in Mesopotamia, the Nile in Egypt, the Indus in India, and the Yangtze in China. The river - oriented Egyptians constructed complex water - engineering systems, irrigation systems especially, already around 3200 B.C. Thus, for example, the historian Herodotus records that the first pharaoh of Egypt, Pharaoh Min, built a dam on the Nile that altered the river's course. The historian was amazed by the artificial lake, which in his words extended for a length of 450 miles and was almost as long as the whole seacoast of Egypt.

Man marked his holidays and his holy places by regulating water courses and improving springs. He was grateful to the gods for such a valuable gift and feared that the same gods might take it away in punishment for his sins. With the advent of the Industrial Revolution and increasing preoccupation with material values, man removed water from its mythical throne and started to behave toward it as toward every other natural resource. Probably because he believed in the inexhaustible abundance of water on the planet, he subordinated water to uncontrolled industrial development, using it and polluting it without mercy. Only a few decades of such behavior were needed for mankind to be confronted with the *global water problem*, i.e., the *problem of clean drinking water.* Ensuring a supply of clean drinking water and protecting it from pollution and greedy exploitation have thus become one of the most pressing problems facing humanity, and water is today the primary strategic raw material.

Water Resources of the Planet

The distribution of the total volume of water on the Earth is evident. It can be seen that 96.5% (1,338 million km^3) of the world's water resources falls on salt water, i.e., water of the oceans and seas. Only 35 million km^3 or about 2.53% belongs to the category of *low - mineral water*, which is of the greatest interest to mankind. Of this amount of low - mineral water, virtually 70% - or 24 million km^3 to be more precise - is accumulated in *ice* of the Arctic and Antarctica and in glaciers of Asia, North America, and (to some extent) Europe. About 30% of low - mineral water occurs in the form of *groundwater* in water - permeable rocks and soil as very important temporary reservoirs of atmospheric precipitation. Only 0.006% of all low - mineral water falls on terrestrial surface water resources, viz., lakes, reservoirs, swamps, and riverbeds.

Atmospheric precipitation represents the main input element or element of water renewal on the Earth[65]. It can be stated that a layer with average thickness of close to 0.9 m falls annually on the Earth's surface. Renewal of the reserve separates water from practically all other raw materials in nature, which is to it's and man's advantage. Unquestionably, attention must also be called to negative aspects of the situation, namely geographic unevenness in the distribution of precipitation (Fig. 3.2.) and inequality of its regime in terms of time.

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[65] As Solomon observed, all of the rivers run into the sea, yet the sea is not full, even though the rivers flow eternally. Not even the greatest minds, from Aristotle (384-322 B.C.) to Kepler (1571-1630 A.D.), were able to explain this riddle. Measuring of atmospheric precipitation and river drainage in the 17th Century led to formulation of the concept of the *hydrological cycle.* This concept embraces movement of moisture from the sea into the atmosphere, thence to land in the form of precipitation, and then through drainage back into the sea.

A significant portion of precipitation falling on land (approximately 62%) is returned to the atmosphere by means of evapotranspiration. The remainder of precipitation, in the form of surface and underground drainage, is available for use (Fig. 3.3.). Many geographers, hydrologists, and meteorologists have worked out the water balance of the Planet, and the obtained values do not differ very much (by up to 10%). It is calculated that the inhabited part of dry land annually receives an average of 834 mm of precipitation, of which 294 mm is drained or infiltrated into the ground, while 540 mm is evaporated. Water drained on the surface represents the total flow of all rivers, which according to M. M. L'vovich (1974) annually comprises 38,830 km^3 or 1,232,000 m^3/s of water (44,500 km^3 or 1,413,000 m^3/s according to some authors).

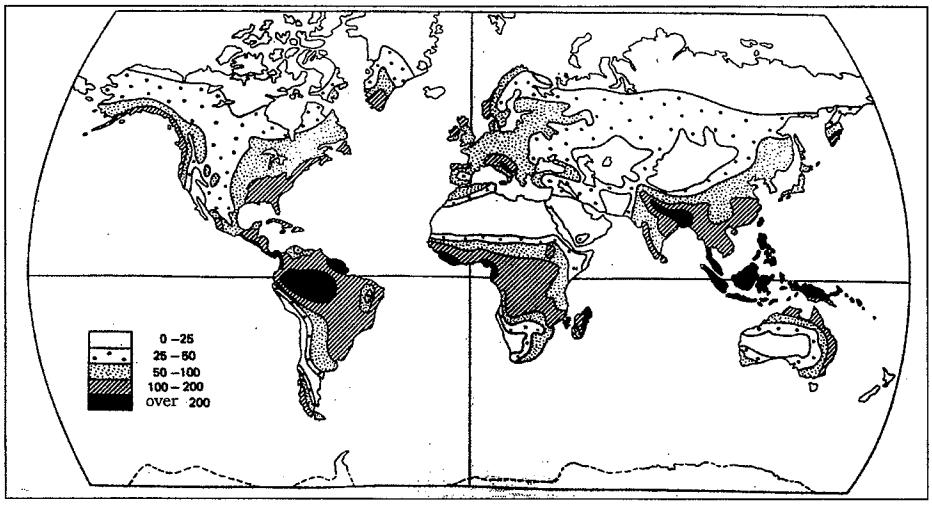

Fig. 3.2. Average distribution of precipitation in the Earth (average values of precipitation height, in cm).

As for individual continents, *South America* has the most intensive water balance (D. Dukic, 1984). The values of all elements (precipitation, evaporation, and drainage) are higher there, and South America is considered to be the wettest continent. The outflow of the Amazon alone is 2.23 times greater than the total outflow of all the river courses in Europe. By way of contrast, *Australia* is the driest continent. The average annual level of precipitation there is 2.2 times lower and the drainage coefficient 3.36 times less than in South America. With an area of 2.68 million km^2, the western plateau of Australia has no surface drainage whatsoever. *North America* has the lowest level of precipitation and the same drainage coefficient as Australia: 0.31. Thus, the average total outflow of all the rivers of North America is less than that of the Amazon, and only seven rivers have an average annual outflow of more than 100 km^3 or 3,170 m^3/s. *Africa* lies largely in the subtropics, and there are vast deserts north and south of the equator. The equatorial zone is where more than 85% of the continent's total annual outflow is

formed. It is also characteristic that enormous reserves of groundwater are present in the wider area of the lower course of the Nile, the middle course of the Niger, and the lower course of the Senegal. A large part of *Asia* (about 30% of its territory) is represented by desert regions, but in spite of this the average drainage coefficient of the largest continent is high: 0.40. Asia has as many as 10 river courses with average annual outflow of more than 350 km³ or 11,100 m³/s. Almost all of *Europe* is under the strong influence of damp air masses from the Atlantic Ocean. For this reason, the average coefficient of water drainage is the greatest among all the continents: 0.43. Still, only nine European rivers have an average annual outflow of more than 50 km³ or 1 - 500 m³/s, among them being the Volga (with 255 km³ or 8,150 m³/s) and the Danube (with 201 km³ or 6,370 m³/s).

Fig. 3.3. Skradinski buk on the river Krka, Croatia.

Rivers are a significant link in the planetary circulation of water. For example, the Amazon has a drainage area of 7.1 million km² and is 80 - 150 km wide at its mouth. Its yellow water can be seen in the ocean at a distance of 300 km from the coast. The Nile is the longest river in the world (6,671 km). Egypt's "Gift from God," it has a number of dams and hydroelectric power plants (the Aswan High Dam has a capacity of 130 billion m³ of water), as well as irrigation canals with a total length of 25,000 km. Larger river courses are navigable over a great part of their length, and some (the Mississippi and Yangtze) are prone to catastrophic flooding.

Lake water also plays a significant part in human life. About 280 thousand km³ of water is accumulated in **lakes**. The Caspian Sea is the

largest lake in the world (with an area of 371 thousand km^2), Lake Baikal the deepest (1,620 m). Lake Horpa in Tibet lies at an elevation of 4,400 m above sea level, while the Dead Sea in Palestine is 392 m below sea level. The chemical composition and degree of mineralization of lake (and river) water is closely dependent on the climatic zone in which it occurs. For example, in regions with a humid climate, lake water usually is weakly mineralized (up to 0.3 - 0.5 g/l) and characterized for the most part by hydrocarbonate magnesium - calcium composition. Widespread in arid zones are saline and brine lakes of varied composition (chloride - sodium, etc.) with significant content of lithium, boron, potassium, rubidium, bromine, strontium, and iodine.

Together with rivers and lakes, enormous areas of land (about 11%) are occupied by **glaciers** (about 15 million km^2 in Antarctica and 1.8 million km^2 on the island of Greenland). Average thickness of the covering glaciers is about 1,500 m (up to 4,000 m in the central part of Antarctica). The Antarctic ice cover represents the largest reservoir of low - mineral water on Earth.

Especially significant for the life of humans and their economic activity, **groundwater** accumulated in permeable rocks and soil on land has already been treated in a separate chapter.

More than 2/3 of the Earth's surface is occupied by **oceans**: the Pacific, Atlantic, Indian, and Arctic Oceans (193.1 thousand km^2). Average depth of the oceans is about 4 km, and their total quantity of water amounts to 1,370 million km^3. The many island archipelagos in the Pacific Ocean occupy an area of about 3.6 million km^2 and represent the most important geographic characteristic of this dominant body of water on the planet. Water salinity usually varies within limits of 3.2 - 3.7%, average salinity at the surface being 3.5%. In seas bordering oceans and land - locked seas, which occupy about a tenth of the World Ocean's area and possess an abundance of water (37 million km^3), salinity ranges from 0.5 - 0.8 to 4.0 - 4.2%. All chemical elements and their isotopes are recorded in water of the oceans. The total content of metals in ocean water is enormous, for example 6 x 10^6 t of gold and 0.5 x 10^9 t of uranium. Kitchen salt (NaCl), magnesium, and bromine are today extracted from seawater. Owing to its enormous amounts of water and the composition of this water, the World Ocean is of exceptionally great significance for life on Earth.

Water and Health

The significance of water for life of plants, animals, and man is very great. Water is as essential a factor as air for human existence in the natural environment, and it makes up approximately the same percentage of the human organism as in composition of the biosphere: about 70%. In

picturesque terms, it can be said that the human organism is essentially an aqueous solution in which all processes of metabolism take place. It is therefore easy to grasp that in order to satisfy the organism's needs, obtaining adequate amounts of water from the natural environment represents a basic biological requirement. Thus, under conditions of the Central European climate, an adult man must take almost three liters of water daily to be able to live; in a desert, on the other hand, he needs as much as 12 l a day. Because of its function, water cannot be replaced by anything else: it is a constant participant in the biochemical processes that transpire in the human organism.

In discussing the more important aspects of water's significance, we rely for the most part on works of V. Jorga (1999) and Cebedzic (1999).

The *significance of water for health* has been known for a very long time. Already Hippocrates recommended bathing as the most effective measure of protection against many diseases. That the ancient Romans well knew the significance of water for health can be seen from the famous Roman aqueducts, public baths, and spas that they built and improved throughout the Roman Empire.

The health significance and role of water is reflected in the fact that a supply of hygienically good water in adequate amounts improves living conditions, raises the level of public health, and reduces mortality (primarily from infectious diseases). In this way, it directly increases the length and quality of life. Classical medical science and practice and current medical postulates based on them indicate unambiguously that the supply of drinking water is closely correlated with the danger of infectious intestinal diseases.

Rest and *active recreation* are important for healthy people. They promote much needed increase in general resistance of the organism, strengthen the body's overall musculature, improve functions of the cardio - respiratory system, and raise the level of general immunity as an expression of the organism's natural strength and ability to defend itself from disease.

Many scientific studies in the area of medical hygiene and modern sports medicine emphasize the great positive effect of different methods and procedures employed in *utilization of water for therapeutic purposes.* Recognition of the health, esthetic, and sport and recreation value of water is constantly growing in keeping with the development of hygiene consciousness of the population and improvement of general health and physical culture.

The *physiological significance of water* is exceptionally great and the role of water so diverse because all vital processes in the organism are linked with its presence. The presence of water in cells ensures all activities of cell metabolism. In the extracellular space, it makes possible

metabolic exchange of cells in tissues and exchange between blood and tissue fluids. Water represents a universal solvent for most organic and inorganic substances and the medium for chemical and physico - chemical reactions linked with commerce of matter and energy in the organism. Nutrients are transported with water. It maintains the normal structure of all tissues in the organism and eliminates the end products of metabolism. Water has a significant if not primary role in maintaining constant body temperature and regulating the course of other vital processes.

The human organism finds it difficult to withstand a *water shortage.* Loss of water amounting to 2 - 3% of body weight already gives rise to the need for re - establishment of the water - mineral balance. Water shortage in the organism increases osmolarity of the intestinal contents and threatens equilibrium of the processes of absorption and secretion of water and fluids from the lumen to the blood vessels. This causes thirst, which of all human instincts is the hardest to deny. If water loss is not compensated in time, all health parameters deteriorate due to disturbance of physiological processes, and death occurs with loss of 10 - 20% of total fluids.

The *hygienic significance of water* is manifested above all in its role in maintaining personal and general hygiene. The hygienic and other every-day needs for water require considerably greater amounts of it than are needed to satisfy basic physiological demands. If consumption of water is limited, the difficulty of maintaining general and personal hygiene unfavorably affects the general health situation and leads to the appearance of lice, supporating and fungal diseases of the skin, intestinal ailments, and other infectious and parasitic diseases.

Water's significance in transmission and spreading of infectious diseases was known already in ancient times. Hippocrates recommended that only boiled water be used. Herodotus wrote that the Persian king rs carried boiled water in barrels with silver bands for the use of his army (the first description anywhere of water disinfection).

The *epidemiological role of water,* i.e., the role of water in transmission and spreading of infectious diseases, today is well - known. We note several infectious diseases below.

Cholera has been known since the time of Hippocrates, when it was given that name. It first occurred in the form of epidemics, but in 1817 appeared in Asia as a pandemic that lasted until 1823. In the course of a second pandemic (1826 - 1837), this dangerous disease embraced all of Europe and was carried by immigrants to the American continent. From that time until 1923, four more pandemics were registered in which hundreds of thousands of people contracted the disease. Imported cases of cholera appeared in Europe in 1989 and 1994. High resistance of the agent (bacteria of the species *Vibrio cholere*) is the reason for

continued existence of endemic foci. The homeland of cholera is India, where the deltas of the great rivers Ganges and Brahmaputra represent the main endemic foci. Discovery of the agent of cholera is linked with the name of Robert Koch.

Typhoid fever is a severely acute infectious disease caused by bacteria of the species *Salmonella typhi.* Great epidemics occur in settlements on large rivers and are most often caused by consumption of water contaminated during floods. *Paratyphoid fever* is similar to typhoid fever and is caused by the bacteria *Salmonella paratyphi* A, B and C.

Bacterial dysentery is caused by bacteria of the genus *Shigella.* Contaminated drinking water is significant in the spreading of this acute infectious disease. Dysentery is widespread throughout the whole world, especially in warm regions with monsoon rains.

The agent of so - called *Legionnaire's disease* (*Legionella pneumophila*) is a very resistant species of bacteria that survives in water for up to a year.

Poliomyelitis (infantile paralysis) is a disease caused by polioviruses. Polioviruses are spread via contaminated objects of general consumption, food, and especially water that are virologically not in order. With introduction and use of the Sabin vaccine, the number of polio sufferers has declined since the 1960's, and it is reckoned that the disease will soon be eradicated.

Coxsakie viruses are the agents of a whole spectrum of diseases such as vascular stomatitis, meningitis, infections of the upper respiratory pathways, myocarditis, etc. The virus is transmitted with contaminated food or drinking water and objects of general use.

Hepatitis A is another viral disease, one that occurs often in children of school age as a result of poor hygiene. The disease in most cases is contracted by consumption of water contaminated with the virus. A clinical picture more serious than that hepatitis A is characteristic of *hepatitis E,* whose endemic focus is in Algeria.

River valleys are especially rich in agents of infectious diseases. As a rule, flatland relief is predisposed to homogeneity of the soil cover, uniformity of vegetation, and a more or less uniform structure of the biocenosis. Lakes with surrounding forests, temporary river courses (*wades*) in desert regions, reservoirs, and irrigation canals can also have great epidemiological significance. An instructive example of this is the rapid multiplication of mosquitoes and other disease - carrying insects that occurred along the 800 - km - long Kara - Kum Canal, which was built between the Amu - Darya River and the city of Ashkhabad in Turkmenia for irrigation of the sandy desert terrain there.

We have already considered the action of geochemical factors under natural conditions, above all the role played by microelements of groundwater and soil in the occurrence of a number of diseases. In arid regions, where the negative action of these factors is amplified by high temperature of the environment, it is possible to single out (among others) regions with increased incidence of fluorosis and goiter as a consequence of elevated fluorine content or iodine deficiency in the water. According to

certain authors, cancer of the esophagus in arid conditions is linked with (among other things) the shortage of good drinking water and use of desalinized water lacking the optimal combination of minerals and microelements.

We see that water is exceptionally important and irreplaceable for two reasons: it is a physiologically essential substance on the one hand, and it can directly or indirectly threaten human life and health on the other. A supply of hygienically good water is an imperative for modern life and a decent standard of living, and it can serve as the best synthetic measure of the prosperity and wellbeing of a population.

In economically developed countries, an adequate amount of good - quality water has been ensured by water - supply systems since the beginning of the 19th Century. Owing to this, the further occurrence and spread of cholera and later typhoid fever was checked already in the course of that century. Unfortunately, these results were spoiled by constantly increasing pollution of water sources in the first half of the 20th Century, and various epidemics have occurred more and more frequently.

The picture is even more unfavorable in developing countries, which are home to 2/3 of the world's population. On an enormous territory, only a third of the urban population is supplied with water from public water mains. If the total population is taken into account, the situation is worse still.

According to data of the World Health Organization (WHO), about 1.3 billion people (predominantly residents of developing countries) in the middle of the 1980's had no communal water supply and 1.8 billion had no system of sewage disposal. The World Health Organization also reports that 80% of all diseases in the world arise from unhygienic water: about 400 million people suffer from gastroenteritis, 160 million from malaria, 30 million from onchocerciasis, and 200 million from schistosomiasis.

BIOLOGICAL FACTORS

The Earth was formed 4.6 billion years ago, and the first rudiments of life (the first biological forms) on it appeared in waters of the World Ocean before more than 3 billion years. Thus, life that arose in the ocean started to develop in exceptionally reductive (anaerobic) conditions. Already about 1 billion years ago, intensive development of aerobic life began in the marine environment, and a new stage in evolution of the biosphere started before about 400 million years with the emergence of life on dry land. Luxurient vegetation and animals then made their appearance.

A million years ago, another miraculous event occurred in the Earth's history, namely the appearance of man. Man became the fruit of evolution

of the living world, the crowning achievement of the biosphere, a thinking being fated to deliberate about his life and perhaps about life of the planet as well (Z. Jovicic, 1997).

The concept of the *biosphere* was introduced in the literature in 1875 by the Viennese geologist Eduard Suess, who used it in a monograph without any interpretation[66]. This term began to be employed in 1911 by V. I. Vernadskii, who in a work entitled "The Biosphere" (1926) explained its essence and geological (geochemical) significance. In Vernadskii's interpretation, the biosphere is an entirely real geological shell inhabited by animals and plant life that determine geochemical characteristics of processes within the shell itself. The biosphere is a truly complex notion, since it signifies the range of life, whose boundaries embrace the troposphere, all of the hydrosphere (including the entire World Ocean), and a considerable part of the lithosphere (to a depth of the order of 3 kilometers).

Discussion of Biological Factors

According to Vernadskii, there are no chemical forces on the Earth's surface that are more constant and more powerful in their final consequences than living organisms taken as a whole. The total effect of the geochemical activity of organisms throughout the entire course of our planet's geological history is very great. For example, A. I. Perelman (1975) states that production of organic substances over the last billion years has been ten times greater than total mass of the Earth's crust, regardless of the fact that the mass of organic substances of the biosphere as living material is constant and comprises only 0.1% of the mass of mineral matter of the Earth's crust. Material of the biosphere is impregnated with mineral material of the Earth's crust, so that today it is often difficult to separate what is mineral material and what is organogenic material of biological origin. The enormous task of destruction of dead organic matter, a kind of unique cleaning of the environment, has been performed predominantly by microorganisms. Mineral compounds formed during decomposition of organic matter are to some extent reabsorbed by plants, and chemical elements once more become part of the bodies of organisms, to be mineralized again in the process of respiration and especially after the death of plants and animals. In this way, *biological circulation of atoms* occurs in nature. Whether tundra, taiga, steppe, or some other kind of landscape arises depends on the amount of organic matter formed in a given place on Earth, the composition of that matter, and the rate at which it decomposes.

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[66]According to A. L. Yanshin (1986), the term biosphere was first used by J. B. Lamarck at the beginning of the 19th Century.

The ocean represents a special area of the biosphere, since water cannot be separated from life, or life from water (O. Gazenko and V. Makarov, 1987). Thus, the greatest production of living mass on Earth is in the oceans, and it is logical to treat them as a very promising food resource. Here microscopic algae synthesize organic matter by means of photosynthesis and bind solar energy to it. Their production serves as food for planktonic animals, which are eaten by more developed organisms, i.e., fish and a number of farther removed consumers including whales, birds, and finally man. The "unconsumed" planktonic mass decomposes and is again transformed into inorganic matter that will be revitalized by algae.

A crucial characteristic of living matter is its ability to perform *photosynthesis*, a unique chemical reaction widespread on the Earth's surface by which organic matter is synthesized from carbon dioxide and water with the aid of solar energy. This reaction is accompanied by evolution of oxygen[67]. The amount of free oxygen in the present - day atmosphere comprises about 280,000 billion tons, and all that oxygen—the product of life on Earth—is a result of photosynthesis. A second important component of air, nitrogen, is created by the activity of microorganisms. On the other hand, green plants have absorbed carbon dioxide from the air over a long period of geological time, with the result that CO_2 content in the present - day atmosphere is low (0.03%). The energy of sunlight needed to decompose water into oxygen and hydrogen is absorbed by plants and preserved in their organic substances. In this way, green plants act as unique accumulators of energy, which animals utilize in nutrition, since they are themselves incapable of creating organic matter from simple mineral bodies (CO_2 and H_2O).

Through their activity, living organisms largely determine the chemical characteristics of landscape components (water, soil, and air). For example, oxygen, carbon dioxide, and organic acids are products of the metabolism of organisms, and a significant part of the calcium, sulfur, magnesium, and other elements in water enters it as a result of decomposition of the dead remains of organisms. Living matter affects the chemical properties of soil in no less measure.

The living world is very rich and diversified[68]. It is estimated that the Earth is inhabited by about 1.5 million different forms of life, which differ among themselves in their relationship with and dependence on the environment, as well as with respect to their development cycles. The

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[67] Plants also require compounds of nitrogen, phosphorus, and many microelements. They can grow and reproduce as long as they don't use up all existing phosphates or nitrates, after which the process of photosynthesis ceases.

[68] Biodiversity or biological diversity has been increasingly discussed of late in scientific circles and wider.

plant kingdom includes about 500 thousand species, the animal kingdom close to a million (I. Radovic and R. Mandic, 1998). Bacteria alone number up to six thousand species, which are for the most part invisible to the naked eye (there are exceptions). While some bacteria cannot survive without oxygen (aerobic species), others live only in media without oxygen (anaerobic species). Disease - causing (pathogenic) species exist among bacteria. In spite of this, plant life is of vital significance to man, and it is logical to devote special attention to plants, which constitute one of the two groups of living organisms (Z. Jovicic, 1997).

Very diverse living communities - *biocenoses* - exist on the Earth[69]. Every such community possesses certain characteristics. The specific characteristics of biocenoses are determined above all by their habitats and by local climate. Typical are large communities: biocenoses of the deciduous forest kind and other types (tropical rain forest, steppe, meadow, desert, tundra, etc.). Plant and animal life is very scarce in zones of permanent ice and snow immediately around the poles. In the spacious areas of arctic tundra just below the zone of the North Pole, biocenoses are characterized by low shrubby vegetation, mosses, and lichens. The zone of the taiga (Canadian, European, and Siberian) is a zone of coniferous forests, which farther south pass over into regions of deciduous forests (Western and Central Europe, East Asia, and Southeastern North America). Various communities of evergreen forests and shrubs are developed in warm subtropical regions, as in the case of Mediterranean regions, while tropical and equatorial vegetation appears farther south.

The plant kingdom has an irreplaceable role in circulation of matter in nature. Thanks to photosynthesis, plants create a special kind of energy - biomass - from inorganic material. About 350 billion tons of oxygen is produced annually on the Earth. Because of oxygen and assimilation of carbon dioxide, the plant kingdom is said to represent the source of life on Earth, and the biological interdependence between plants and man is a special dimension of the biosphere. Plants have other important functions in human life, above all in nutrition, but also in dress and as raw material for industrial processing, including use in the pharmaceutical industry (in the manufacture of medicines). The animal kingdom likewise is greatly dependent on plants, both as food and because plant communities (forests, pastures) provide habitats for animals (Z. Jovicic, 1997).

Forests represent a unique form of plant community, a valuable natural resource of inestimable significance for mankind. They occupy a third of the world's land area. Of the continents, the Americas and Asia

[69] On the territory of Yugoslavia, we encounter practically all of the biomes characteristic of Europe or five of the Planet's total of 12 terrestrial biomes. We note that biomes are biocenoses with mutual similarities.

are the richest in forests, while Europe and Australia are the poorest in this natural treasure. Equatorial and tropical forests stand out with respect to the wealth of species per hectare, number of levels, and height of trees, and they are also of planetary significance as oxygen factories.

The animal kingdom is much diversified, with different divisions. The most widespread types of animal life are unicellular organisms. Amoebas, foraminifera's, radiolarians, and other microorganisms are very widely distributed, but much less so than poriferans, annelids, and arthropods or considerably more organized types such as reptiles, fish, birds, and mammals. It is interesting to note that about 8,600 species of birds exist on the Earth; they live in all meridians and parallels, on rivers and seashores, on high mountains, and in settlements (Z. Jovicic, 1997). Fish make up a goodly part of the human diet, as do many species of domestic animals such as cattle, pigs, sheep, and poultry. Humanoid monkeys live predominantly in tropical regions of Asia and Africa.

Different regions of plant and especially animal life are formed due to the action of biotic and abiotic factors. Although these regions do not coincide in space, interdependence and interconnection between plant and animal life is manifested in each of them.

Six *floristic regions* are singled out on the Earth's surface: Holarctic, Paleotropical, Neotropical, Australian, Kaplan, and Antarctic. The largest of them is the Holarctic floristic region, which encompasses more than half of the globe `and includes temperate and polar zones of the Northern Hemisphere.

There are seven *faunistic regions*: African, Indo - Malaysian, Holarctic, Neotropical, Australian, Polynesian, and Antarctic. In this case also, the Holarctic region occupies the greatest area: Europe, Africa with the Sahara, and a large part of Asia and North America. However, the African and Indo - Malaysian regions have the richest faunas.

According to evolutionists, **man** belongs to the zoological group of primates, whose evolution lasted 50 - 60 million years. The evolution of man proceeded in five phases: Australopithecus, Pithecanthropus, Neanderthal, Homo sapiens, and modern man. As the oldest *fossil man*, Australopithecus (from the end of the Tertiary) has been discovered in South Africa and China, as well as on Java. The Paleolithic (Würm glaciation) began with Homo sapiens, who was succeeded in alluvium by modern man (Homo sapiens recent).

Three separate races - Mongoloid, Europoid, and Negro - Australoid (Equatorial) - developed in the course of human evolution. The *Mongoloid race* numbers about 1.5 billion people and is geographically fairly compact, inhabiting areas of East and Southeast Asia. The *Negroid* or *Equatorial* ("black") *race* inhabits areas of Africa south of the Sahara and considerably smaller parts of Australia and Southeast Asia. With more than 2 bil-

lion people, the *Europoid* (or "white") *race* inhabits Europe, North America, India, North Africa, and other parts of the world. The origin of races is a question that has not been definitively settled, but it is fairly certain that natural factors (especially climatic ones) erted decisive influence.

The history of human influence on nature is divided by I. Radovic and R. Mandic (1998) into four ecological phases: the *Initial Phase*, the *Early Agricultural Phase*, the *Early Urban Phase*, and the *Modern Industrial Phase*.

1. In the *Initial Phase*, the human population probably differed hardly at all in the extent and nature of its ecological activity from populations of other omnivorous mammals. It is possible that the use of fire, beginning more than half a million years ago, caused the first qualitative changes in relations between man and his surroundings.
2. In the *Early Agricultural Phase* (beginning about 12 thousand years ago), man domesticated animals and plants and developed farming technology. Despite all the changes brought about by agriculture, human activities still did not ert any more significant influence the environment, above all meaning natural biogeochemical cycles of the biosphere such as the cycles of carbon, nitrogen, and phosphorus.
3. The *Early Urban Phase* (beginning 5 thousand years ago) brought about a series of fundamental changes in the organization of human society, primarily an increase in the number of people on a limited space and dependence on food produced by surrounding farmers. Due to the uniformity of food, specific diseases such as rickets, scurvy, beriberi, and pellagra appeared and began to spread. However, as in the previous phases, natural biogeochemical cycles remained untouched, and the biosphere as a whole was still essentially in a state of dynamic equilibrium.
4. The *Modern Industrial* or *Technological Phase* (beginning 150 - 200 years ago) introduced many changes in human activities and has erted influence on the biosphere completely out of proportion to duration of the phase. Man's destructiveness will be discussed in a special chapter. Here we note his massive and irreversible destruction of life, which has become a major global biological problem. This can be illustrated by some numerical data: the number of species irreversibly lost every year has climbed to a fantastic figure of 27,000. If extinctions proceed at the present rate, 20% of today's species could disappear in the next 30 years. "*In its scale, this can be compared only with the natural disaster that occurred 65 million years ago, when dinosaurs disappeared from the face of the Earth*" (Radovic and Mandic, 1997).

Plants, Animals, and Health

In certain biogeochemical provinces, all floral and faunal components of the environment are characterized by specific features of chemical element composition. Inseparably linked with this is the concept of biogeochemical microelement endemias, which can occur when soil, water, air, and food of plant and animal origin exhibit an excess or deficiency of microelements

(I, Mn, Co, F) or more complicated forms of imbalance, especially anomalous ratios of their concentrations or an imbalance of micro - and macroelements (P and Mn for instance). For this reason, mechanisms governing the development of certain biogeochemical endemias can be understood only through multiple study of the interconnection and interdependence of links (*rocks— soil—water—plants—animals—man*) in the complex chain of biogeochemical systems (A. A. Keller, O. P. Shchepin, and A. V. Chaklin, 1993). Here both higher and lower plants can be biological indicators of potential dangers to animals (including man) inherent in the biogeochemical situation of a region under study.

The influence of biological factors on human health can be negative or positive. Among these factors of the biosphere, especially dangerous from the standpoint of health are disease agents, animals that are reservoirs or carriers of diseases from their natural foci, and poisonous animals and plants. These things can be the causes of a number of dangerous diseases of humans and animals. Diseases of man caused by contact with poisonous animals or products of their vital activity represent a little studied chapter of geographic pathology. In the work "**Introduction to Geographic Pathology**," A. P. Avtsin (1972) proposes a working classification of local and general pathological processes caused by some form of contact between man and certain poisonous and provisionally pathogenic (nonpoisonous) animals. He also cites Voronov's classification of infections and invasions (A. G. Voronov, 1965).

Many representatives of the **plant kingdom** can possess toxic properties. Such properties are predominantly characteristic of certain parts of plants - fruits, leaves, bark, roots, juice, seeds, etc. For example, it is little known that the very widespread decorative plant black locust possesses poisonous roots and bark. Another very widespread decorative plant, oleander is also poisonous. Opium poppy contains many toxic (and medicinal!) substances. Cases of poisoning by several species of mushrooms are well - known... It is understandable that substances isolated from poisonous plants are often used for purposes of pharmacology and toxicology.

According to the estimates of investigators, there are in nature about a thousand species of plants that under the influence of mechanical processing or specific enzymes are capable of releasing *hydrogen cyanide*, a very poisonous gas which paralyzes breathing. These are the so - called *cyanogenic plants*, and the toxic substances they contain are cyanogenic glycosides. For example, the leaves of wild cherry in the United States can produce 200 mg of hydrogen cyanide per 100 g of mass, and it is estimated that only about 125 mg of such leaves is enough to kill an animal weighing 50 kg (about 150 mg is needed to kill a man of average weight). Sudden death of domestic animals for no apparent reason was most often

caused by hydrogen cyanide released when the animals consumed greater amounts of green mass.

An enormous number of poisonous plants (blind - your - eyes, candelabrum tree, poison ivy, etc.) have been described in the tropics. Contact with these plants can cause fatal poisoning, itching, skin rash, facial swelling, elevated body temperature, headache, etc. On the other hand, many species of useful medicinal plants have been registered in the rich flora of tropical and subtropical regions [70]. For example, the sandalwood tree is used to treat gonorrhea in India, Indonesia, and many other countries; hydnocarpus oil and preparations made from it are used in India, Burma, Thailand, and other countries to treat leprosy, psoriasis, and other skin diseases; croton leaves are used in medicine to treat snakebites... More than 300 species of tropical plants can be used as medicinal raw materials.

Russian scientists have shown that all plants release into the atmosphere especially volatile organic substances called *phytoncides*. Phytoncides ert physiological action on the organism. Many of them possess the ability to destroy microorganisms, including ones that are pathogenic. Certain phytoncides kill microbic agents of disease in animals. It is believed that our organism requires phytoncides, and that their deficiency causes certain lung diseases. To be specific, the existence of phytoncides explains why the air of forests, fields, and pastures has a favorable effect on weak and diseased lungs[71].

The highly diversified **animal kingdom** erts great influence, both positive and negative, on human health. Thus, for example, there are few birds that are not useful as sanitation agents, since they rid fields of various pests such as insects and rodents. On the other hand, many animal species of mountain regions ensure the existence or facilitate the spread of different parasitic and transmissible diseases such as plague, malaria, fevers, etc.

The negative role of animals is especially pronounced in tropical regions. Many representatives of the animal kingdom serve as reservoirs of the agents of infectious diseases: monkeys in the case of yellow fever; rodents and others in the case of plague; mosquitoes of the genera *Anopheles*, *Aedes*, and *Culex* in the case of malaria; etc. Among arachnids, whip scorpions are extremely dangerous; the Malay centipede is the most

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[70] The plant life of mountain massifs is rich in resources of vitamin-containing and medicinal herbs. We mention dog rose, hawthorn, and walnut. The medicinal properties of plants are more pronounced at higher elevations.

[71] "Oxygen factories" are lost with the disappearance of forests. Especially great attention is being devoted to forested zones around urban settlements because suburban forests absorb the carbon dioxide exhaled by man and produced by industry and traffic in great amounts.

dangerous of centipedes; and the most dangerous of poisonous snakes are the black mamba, Egyptian cobra, Gabon viper, etc. Poisonous animals are also very widespread in tropical waters: false coral in the Caribbean Sea and the Pacific and Indian Oceans; the sea wasp and hiropsalmus among medusas; etc. The bite of *Hapalochlaena maculosus* (the most dangerous Australian octopus) can kill a man. The group of poisonous fish numbers about 350 species, most of which live in the Pacific and Indian Oceans...

Food and Health

According to I. Coulier (1986), five of the 12 main causes of death in the United States - atherosclerosis, hypertension, infarct, diabetes, and cirrhosis of the liver - are directly or indirectly linked with nutrition. Thus, about 40% of all of the main causes of death have a link with food. Dietary delusions of all kinds, consumption of risky food, and experimentation with their own bodies have been with people from ancient times to the present day. Whether by reason of ignorance or increasingly due a shortage of food that is safe from the standpoint of health, a smaller part of the world's population feeds itself correctly.

The starvation of hundreds of millions of people on the Planet today can also be attributed to the unjust distribution of food. In addition to this, the race to increase profits has led to growing use of chemical agents, with the result that food is of constantly declining quality and often dangerous to health. Degraded natural conditions for food production are characteristic of agriculturally developed regions such as Western Europe and North America.

The scientific approach to nutrition began in the 18th Century, when Lavoisier clarified the nature of respiration on the basis of heat generation in the living organism. According to Lavoisier, respiration is an oxidative process, and heat liberated in the organism is also a consequence of oxidative processes. After Lavoisier, van Helmout scientifically formulated the theory of *digestion*, i.e., decomposition of food in the digestive organs. Soon to follow were scientific studies on enzymes in the digestive organs and cells, which laid the foundations of modern biochemistry. Improvement of methods in chemistry, physics, physical chemistry, physiology, microbiology, and many other sciences has made a great contribution to further development of the science of nutrition.

Nutrition has three basic functions in the organism. The *first function* is to supply the organism with energy, the *second* is to provide it with plastic or building substances (proteins above all, carbohydrates to a lesser extent), and the *third* is to supply it with biologically active substances needed for regulation of metabolic or vital activities. Thus, the science of nutrition is concerned with processes involved in the metabolism of different kinds of nutritive substances (energetic, structural, and biocatalytic) and their interaction in the maintenance of life.

Maintenance of biological functions of the organism requires constant replacement of consumed substances by means of renewed intake of food and water. The organism needs water, proteins, carbohydrates, lipids (fats), vitamins, minerals, and microelements. Of these substances, proteins, lipids, carbohydrates, and vitamins belong to the category of organic nutrients, while water, minerals, and macro - and microelements are inorganic nutrients. Starvation or malnutrition sets in if the organism does not receive the indicated substances or if it receives them in inadequate amounts. Overnutrition or obesity occurs if the organism takes in more than it needs. It has been calculated that mortality in humans increases by as much as 20% with a 10% increase of body weight and by even more than 40% with a weight increase of 15 - 20%.

Proteins are basic complex organic nutrients that have energetic, structural, and regulatory - catalytic roles in the organism of man and all animals. They constitute the structural and functional basis of every living organism, and the survival of life depends on their activity. In other words, proteins are the most widespread complex organic molecules in the cell. Linked with their activity in the living organism are all manifestations of life: growth, development, active regulation and functioning of the organism, sensitivity, irritability, contraction, adaptability, transmission of inherited traits, etc.

Proteins in foods of plant and animal origin are very similar in elementary chemical composition. However, foods differ significantly in the amount of protein they contain: those of plant origin contain 15 to 18% raw protein, whereas ones of animal origin contain 57 to 84%.

Carbohydrates are basic complex nutrients that have a very important role as a donor of energy in the nutrition of man and nearly all animals. They are divided into sugars (monosaccharides and oligosaccharides) and polysaccharides (starch and cellulose). It is a fortunate circumstance that the organism can convert carbohydrates to fats and partially substitute the former for the latter in food.

Lipids (fats) are basic complex organic nutrients that have energetic, structural, and protective roles in the living organism. About two thirds of the total energy needed by the cell (or the living organism) is satisfied by energy arising from the oxidation of fats. It is calculated that the daily meals of an adult individual should contain at least 70 g of fats. During the summer, this amount can be somewhat reduced, but never below a limit of 40 g; of this amount, 25 g should be of animal origin.

Vitamins are organic compounds of varying chemical structure and molecular weight. They are basic nutrients among biologically active substances. These biocatalysts are essential in small amounts for the health of man and animals. They are needed for health maintenance, growth, development, sustenance of life, etc. A deficiency or surplus of vitamins in food can cause specific and various disturbances in metabolic processes (*hypo* - and *hypervitaminosis*, respectively). About 30 vitamins are known, and nearly all of them have been isolated in crystalline form.

Minerals and *microelements* are an inseparable part of our food. Sodium chloride or kitchen salt is the only mineral that is used in natural form. Other minerals form part of other food components. Minerals are lost every day during cooking of food: 50 - 95% when cooking is done in water, 25 - 59% in oil, 20 - 60% in fat, and 19 - 54% in butter. Loss of minerals also occurs in the human organism through urination and perspiration, so it is necessary to replenish them. Thus, for example, a man on average loses the following amounts of minerals every day: 7 g of sodium, 4.75 g of potassium, 1.25 g of calcium, 1.63 g of phosphorus, 0.5 g of magnesium, 0.05 g of iron, 0.05 g of sulfur, etc. It is believed that of the total number of fatal diseases, microelements are involved in various ways in 70% of the cases. Copper, iron, zinc, manganese, molybdenum, cobalt, iodine, fluorine, selenium, and some other elements are carriers of vital functions of the organism because they participate in the enzyme system, without which necessary biochemical processes could not take place. The role of macro - and microelements in the organism of man and animals was discussed in greater detail in the previous chapter.

According to D.B. Jellife (1967), dietary disturbances represent a pathological state caused by a relative or absolute deficiency or excess of one or several necessary food components. The author divides the given dietary disturbances into four groups: a) malnutrition; b) specific forms of alimentary deficiencies; c) obesity; and d) imbalance.

Food risks are understood to mean the probability that consumption of some food will result in harmful action and cause damage to the organism. Unfortunately, they are very much present today in the world, both in developing countries and in developed ones.

According to a list published in 1973 by the Federal Drug Administration (FDA) of the National Academies of Sciences of the USA, first place among food risks was occupied by naturally present microorganisms and pathogenic microorganisms. In second place was malnutrition, which was followed by soil pollutants, natural toxicants in food, pesticide residues, and (finally) additives (I. Coulier, 1986).

1. It is practically impossible to ensure absolute security from *toxigenic and pathogenic microorganisms* present in food. First on the list of toxigenic agents are bacteria of the genus *Salmonella*, which in food or water cause serious poisoning of humans: salmonollosis. During the period of 1972 - 1974, this agent in the United States alone caused a total of 60 thousand cases of food poisoning in humans, including 12 that were fatal. Serious risks are also posed by mycotoxins, which can contaminate entire harvests of corn, cotton, and other crops[72].

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[72] Among substances of biological origin, *mycotoxins* are today considered to be the most significant. Such mycotoxins are formed as a result of metabolic processes of molds multiplying on products of plant and animal origin rich in proteins and carbohydrates. Toxic substances produced by molds aroused special interest in the world only relatively recently, with appearance of the first more serious disturbances caused by consumption

2. One eighth of the world's population today suffers from *malnutrition.* Data of the World Health Organization indicate that between 30 and 40 million people throughout the world die annually as a result of starvation or malnutrition. Scurvy, rickets, beriberi, goiter, pellagra, and other chronic deficiency diseases in great measure affect health of the Earth's population[73].
3. *Contaminants from the soil* that enter food through plants and drinking water include heavy metals (lead, mercury, and cadmium), arsenic and selenium, halogenic elements (iodine and chlorine), and other components;
4. *Pesticide residues* are strictly controlled, but there still exists a risk of toxic action from food contaminated with them;
5. The risk from food *additives* is slight, but nevertheless cannot be completely excluded.

Investigations of cholesterol and other components have shown the extremely great influence of food on human health. There are many who feel that man dies more often because of food than due to disease.

The group of *alimentary diseases* depends on a number of factors: natural, anthropogenic, socio - economic, and ethnic. Extensive information about the systematic malnutrition of large groups of inhabitants of Latin America was collected some time ago in the now classical book "**The Geography of Hunger**" (J. de Castro, 1954). Problems

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of food contaminated by these agents. To be more precise, the disturbances called *mycotoxicoses* have been known for a long time, but not by that name. In feudal Europe, this disease resulted in thousands of deaths caused by introduction of rye and other grains infected by the mold *Claviceps purpurea* into the organism. Alimentary toxic aleukia was a second mycotoxicosis that attacked humans with tragic consequences. It occurred in Russia in regions where the population ate moldy grain after its overwintering in fields. This disease attracted the attention of experts only in the 60's of the last century, following the deaths of turkeys, ducks, pheasants, and partridges on poultry farms in England and significant losses of a similar kind in Kenya, Uganda, Thailand, and the Philippines. It was established that fungi in corn meal was the cause of death. The isolated toxin was given the name aflatotoxin, and the disease caused by its action was called *aflatotoxicosis* (D. Markovic et al., 1996).

Real danger from micotoxins is hidden in long - term consumption through contaminated food. That is why it is possible formation of carcinogenic, mutagenic and other changes within cells, but also liver malfunctions and other organs.

[73] The cause of starvation and malnutrition lies above all in agro-business, i.e., concentration of political and economic power over agricultural production and trade. In addition to this, the petrochemical industry employs all means to prolong the mass use of chemical agents in agriculture, and a newly created branch of economic activity - production of hybrid seeds - has become a big part of agro-business. The first test of growing from artificial seeds was performed in 1987, and a decade later (at the height of the *transgenetic revolution*) genetically altered agricultural crops were being cultivated on 15 million hectars throughout the world. *It must be asked how all the altered genetic composition of plants and animals will affect the global food chain and above all the health of man and his gene material.*

of protein deficiency and forced uniformity of nutrition affect many regions of developing countries in other parts of the world as well. The very pronounced protein deficiency in the tropics has resulted in extremely high mortality rates among children (30 - 40% in Egypt and nearly 100% in the Belgian Congo). At the same time, a number of diseases are linked with overweight (obesity) of patients.

In the field of nutrition, there have been no scientific or other polemics as numerous as those pertaining to *cholesterol*, above all as to the pathological level of this fatty ingredient of human cells and cell membranes that is introduced into the organism with animal tissues, eggs, cheese, seafood, etc. Worthy of note are the results of 10 - year studies at 12 American research centers, which can be summarized as follows:

- Heart diseases are closely linked with the level of cholesterol in the blood serum;
- Lowering the percentage of cholesterol in the blood significantly reduces the risk of heart attacks (infarcts).

In 1983 - the year in which the results were published - a million Americans suffered a heart attack, and half of them did not survive it. We note that Americans consume as much as 60% more cholesterol in food than is recommended by the American Heart Association and three times more than the Japanese consume (Fig. 3.4.). As the nation that eats the fattiest food, the Finns have the highest cholesterol levels in the blood and the greatest number of heart diseases in the world.

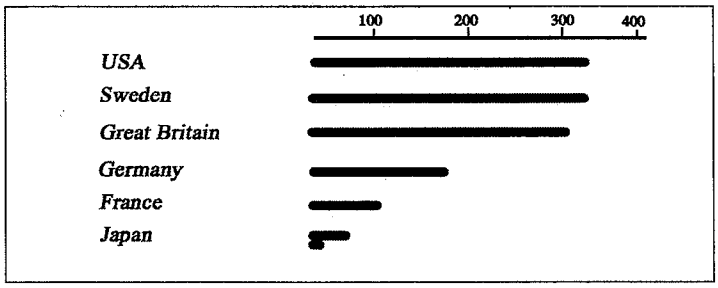

Fig. 3.4. Mortality caused by heart attack per 100,000 persons.

Discovery of the causal link between clogging of the arteries (atherosclerosis) and cholesterol in food was anticipated by the Russian pathologist N. N. Anichkov, who already in 1913 succeeded in artificially creating a fatty deposit on walls of the arteries of experimental mice. A direct correlation between the frequency of atherosclerosis and the nature of nutrition of the population was demonstrated later, although many doctors believe that cholesterol is only one, possibly the most important, of numerous causes of cardiovascular diseases.

In addition to cholesterol as a component of food, the long chain of causes also includes obesity, hypertension, smoking, stress, and inactivity. The American pathologist R. Minick explained the situation as follows: "*Like members of some orchestra, they all play a part in the occurrence of heart diseases.*"

Many indicators support the assertion that modern eating habits, especially in the most highly developed countries, have led to a real explosion of *obesity* and *diabetes*, the diseases of the 20th Century. It is estimated that 15 - 40% of the adult population of developed countries suffers from obesity, as a consequence above all of increased caloric intake (Fig. 3.5.). During the 90's of the past century, obesity took on the character of an epidemic among Americans, and in 1994 71% of the population belonged to the category of *overweight*. Diabetes today ranks third as a cause of death in the United States, and more than 90% of the 5 million American diabetics are overweight (I. Coulier, 1986).

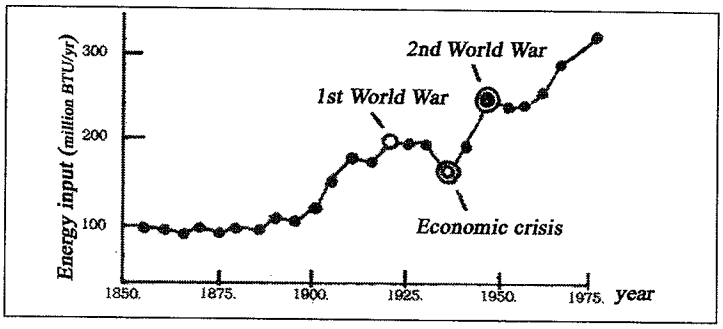

Fig. 3.5. Energy consumption by humans in USA from 1850 to 1975.

High blood pressure (hypertension) affects more than 20% of the world's population. Although the true cause is not known in most cases, there is solid scientific evidence indicating a key role for sodium ions in regulation of blood pressure, and limited salt intake is prescribed for hypertensives.

Microelement deficiency in food is manifested in a whole spectrum of damage to the organism. Contributing to this are various modern technological processes and constantly increasing use of refined food, which deprive man of all traces of minerals.

During the past decades, man has found himself confronted with yet another problem where nutrition is concerned, namely the ever increasing *content of radionuclides* in the food chain. The danger is magnified by the fact that the organisms of some animals accumulate radionuclides in their bodies, whose consumption in the form of meat and other products leads to a dramatic increase in the effects of exposure of the human organism to radioactive radiation.

Study of the relationship between *nutrition* and the incidence of *malignant diseases* has confirmed that some components of food increase the risk of sickness, while others reduce it. Thus, toxic and carcinogenic

action has been established for luteoscirin and cyclochlorotin (products of different species of rice molds). The risk from aflatoxin B - 1 is extremely great, since it is the strongest known carcinogen in food. Benziperen causes cancer of the esophagus and intestine when it is ingested in food and lung cancer when inhaled in smoke. Elevated content of selenium in wheat or corn can cause cirrhosis of the liver and tumor in humans. Cancer of the large intestine is linked with excessive consumption of meat. Esophageal cancer can be caused by vitamin deficiency in food and its uniformity (predominance of fats and carbohydrates). On the other hand, vitamin A protects the organism from different types of cancer... It must be stressed in conclusion that while food is only one of the causes of cancer, it is unquestionably very important[74].

[74] Keller, Shchepin, and Chaklin (1993) assert that dietary and nutritional irregularities make up about 35% of the total number of factors responsible for occurrence of malignant diseases. In the book of I. Coulier (1986), estimates of a group of experts indicate that 40% of cancers in men and 60% in women are linked with food. More comprehensive statistical processing of available data with detection of pertinent correlations will make it possible to establish the share of food-related causes in the incidence of various diseases.