



Substance, Energy, Evolution – The Life of our Earth (What is the Scientific Base of the Sustainable Development?)

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Abstract

In spite of the fact that men are not able to imagine and to know the total Universe, the author deals with not only general philosophical questions connected with it but also the life of our Earth, too. Our Solar System including in our Globe also are the parts of our Galaxy. The life of our Earth can be divided into two basic periods: true abiotic physical life and biological life which was formed on the basis of the physical life. These two periods are the result of the atomic, chemical and biological evolution. Consequences of the life of human beings and farm animals on the biological life of our Planet is discussed.

Keywords: Energy; Substance; Time; Abiotic Physical Life; Evolution; Biological Life; Effect Of Men; Climate Change

Preface

The Universe is endless and timeless substance and energy flow with motion of celestial clusters (e.g. Solar System, Milky Way, Galaxies), bodies (e.g. stars, comets, meteors, meteorites) and cosmic powder on the basis of the law of Nature/God. The celestial clusters, bodies and the cosmic powder are different depending on their type, position, age, size and composition. Even relative time/time unite (which was calculated on the basis of the Earth's rotation around its own axis – day time – and around our Sun – year time – which were divided into smaller unites) as well as relative distance/distance unite (which may be inch, foot or yard but now it is derived from the speed of the light or from the diameter of our Planet) were determined by men the endless and timeless Universe can not be imagine understand and measure.

The relation between substance and energy was studied by A. Einstein who wrote that the energy (E) is aequal with the product of the matter (m) and the square of the light speed (c^2) that is $E=mc^2$. Opinions about the existence of inconceivable time are different. Some of the scientists think that the time does not exist but others consider that it does. On the basis of Einstein's theory the spacetime is a four-dimensional arithmetic model which contains three dimensions of the space and one dimension of the time into a single continuum. He thought that the matter can deform the net of the continuum. Our opinion is that the continuous consecutive changes of the substance and the energy of the Universum have represented/meant the passing time.

It is supposed that our Galaxy was born more than 10 billion years ago and the age of our Solar System and that of our Earth existing in that System may be 5–4.75 and 4.55 billion years, respectively. Since the birth of our Planet it has lived its own life which can be divided into two basic periods: true abiotic physical life and biological life which was formed on the basis of the physical life.

The true abiotic physical life of our Earth (0–3,75/3,8 billion yrs)

True physical life of the abiotic celestial bodies in our Solar System is not unchanged. Different events can be recognized during their life: birth, motion, atomic fusion/atomic evolution, cooling, geological events, regular fluctuation of their temperature (effect of Sun), sterile condition, effects of other celestial bodies, appearance of water and abiotic chemical reactions/chemical evolution but the presence of these happenings depends on the type, position and age of the given celestial body.

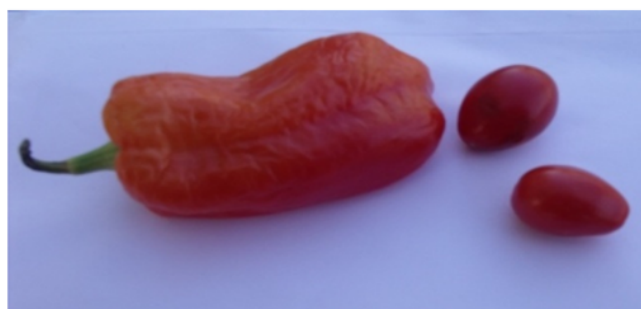
Our Earth was formed as a glowing star which consisted of hydrogen (H_2), helium (He) and atomic fusion and its atmosphere was a solar type one. This early period of its life can be named atomic evolution because different atoms – stable elements and naturally radioactive ones as well as simple molecules – had developed during it. It is probable that solidification of the surface of our Earth started after the end of atomic fusion and the earthly atomic/substantial pool was also evolved by that time. We do not know what

does continuously happen in the depth of our Globe. The mentioned pool is practically constant (except the quantity and quality of naturally radioactive elements) as the atoms are firm and permanent as well as only celestial bodies may bring some substance

from the space on our Earth and nothing can leave it on natural way. Therefore our Planet is a closed system for substance – atoms and molecules – but not for different kinds of energy which can arrive at here freely and our Globe can also emit those.



a.) At the harvest



b.) Two weeks later

Figure 1: Change of colour of yellow pepper and green tomatoes harvested and kept in room.

In contrast with the fact that atoms – except the radioactive ones – are stable the connections among them are changeable. They may change time to time depending on not only the actual energetic, heat, pressure, pH and so on conditions but also on the presence of an atom/a substance which can participate in a chemical reaction. That possibility of the change is the base not only for the abiotic chemical evolution but also for the biological life, biochemical reactions, mutations that is for the biological evolution, too. We think that the change of the colour of yellow pepper and green tomatoes – which were harvested and kept in room with diffuse light or in a box in dark condition even in a refrigerator at 8°C, too – into red one is a good example of the changeableness of the connections between the atoms – see the Figure 1. The process did not need any active natural water (H₂O) and nutriment transport nor the light energy either in the darkness. The lower temperature only reduced the speed of the change.

It is thought that the early solar type atmosphere of our Earth had changed into a new reductive/anaerobic (?) one containing N₂ and inert gases. This condition presumably excluded the presence of oxygen (O₂) and also oxydation that is the probability of physical burning, therefore then carbon dioxide (CO₂) and water might not be present, too.

Importance of carbon (C), O₂ and fluid water

Exact time of the appearance of C and O₂ and that of the process of oxydation – which means that an atom loses electron with an accompanying increase in its positive valence – is an important

unknown question. Carbon dioxide could not be formed without C and H₂O without O₂. On the basis of the data it seems that C and methane were born earlier than O₂ but it is an open question when and how did their birth happen as well as when did CO₂ and H₂O appear and what was their birth order? It is sure that fluid water and/or ice could only be appeared when the Earth's surface was already rigid and its temperature gave the possibility of its condensation and frost. It can be supposed that CO₂ and perhaps water vapour had already existed earlier than fluid water. The water is almost always necessary for chemical processes as a medium. Therefore it was an important base for the early abiotic formation of inorganic and organic compounds which process can be named chemical evolution. Appearance of C, O₂, CO₂ and H₂O had great importance because the first living unite could not be formed without them 0.8 billion years ago. Beside this in the time of their presence the atmosphere might not be reductive although it is thought that it was at the time of appearing of biological life, too. Further importance of the appearance of fluid water was that its presence made possible the start of the water circulation also. We do not know when, how and why did circulation start which process can be influenced by the presence of atmospheric CO₂ as well as by the condition of the surface of our Earth. Water circulation has played important role in regulation of the actual temperature of our Globe that is in its condition of entropy.

The first living unit on our Earth

The physical life of our Earth was sterile and it lasted for 3.75/3.8 billion years long when the first living substantial matrix

that is the biological life appeared. Here we want to tell only that the living unit is a temporary substantial structure which can accept the external – chemical and/or solar – energy and suitable to maintain a life-long continuous electron and ion transport as well as is able to reproduce it self. The start of the life of the first living unit is unknown but it could begin only in fluid water with optimal energetic substantial and environmental conditions including the entropy of our Earth, too.

The first living unit was born about 800–750 million years ago and that fact means that C, O₂, water and different inorganic as well as organic compounds which were needed for its life had appeared earlier. It is supposed that the unite might be a pluripotent archaic type cell without nucleus and other distinct organelles that is it was a procarya. If the theory of the reductive/anaerobic (semiaerobic?) atmosphere – which is supposed – would be true then its metabolism might be chemolithotrophic/autotrophic (perhaps heterotrophic?) one which used chemical energy. As to its metabolism it is important to mention that some of the compounds produced by that unit contained chemically bound energy like an accumulator and during its own metabolism heat, gas and substances were emitted. That accumulator function is a new biological process which first changed the former direct energetic condition of our Earth.

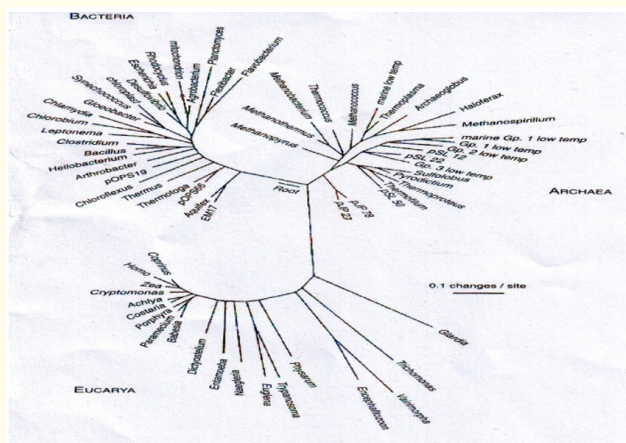


Figure 2: Phylogenetic tree of procarya, bacteria and eucarya cells by M. Dworkin *et al.*

Without procarya there would not be any biological life on our Earth and since its appearance the sterile condition disappeared. That microorganism started to decompose, consume and transform existing substances of our Globe. Its cells became the first organic mud of waters as well as the first complex organic components of ground and they formed the first ecosystem/microbiome

in the environment, too. Without their activity the Earth's surface would be similar to that of the abiotic celestial bodies – for example the Mars and the Moon.

Evolution of different cells

Genetic material of some procarya cells could be changed by mutagenic effects of the environment and in consequence of the environmental selection some of them could exceed the others and they became different new types of cells – bacterial, eucaryal (fungal, plant and animal) – that is the biological evolution has begun. One of the possible ways of phylogenesis can be seen on the Figure 2.

Biological life in a closed system

The closed system is a special environment which has different types. Those parts of the Earth and its surrounding which are suitable for a biological unit to live is named Biosphere. It is natural that the Biosphere – as a part of our Earth – is a closed system and only celestial bodies can bring matter from the space into it and no substance, flora, creature as well as human being can leave it on natural way which fact means that our possibilities are limited. In the same time it is open for arrival of different kinds of energy and it can radiate at least heat, light and the energy of radioactive elements. You can see the light emission of men on our Earth on the Figure 3.



Figure 3: Light emissions on our Earth.

When somebody wants to breed any organism in an artificial closed system – for example in a Roux's bottle or in a closed cultivation tank or in a cage etc. – it is obligatory permanently to ensure the living conditions (water, nutrients, temperature, pH, atmosphere, circulation, elimination of metabolites and over population) which are necessary for the permanent life and reproduction of the given organism. These conditions must be ensured in case of the earthly biological life in our Biosphere, too.

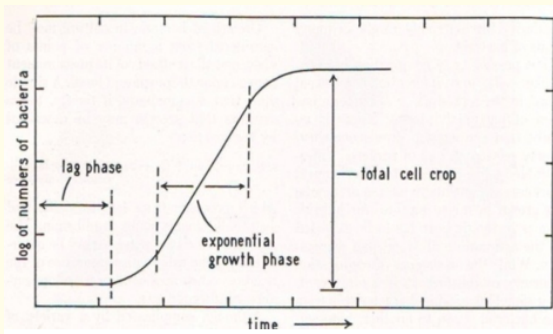


Figure 4: Bacterial growth.

Importance of photosynthetic organisms

In consequence of mutations and of environmental selection the first phototrophic cell appeared and started to consume not only free atmospheric CO_2 and other compounds needed for its life but to use solar energy/photon also for its metabolism as well as to emit free O_2 , heat, other gas and substances. The CO_2 and the solar energy built in the new compounds of the organism which stored them for a shorter or longer time depending on the next events and environmental conditions.

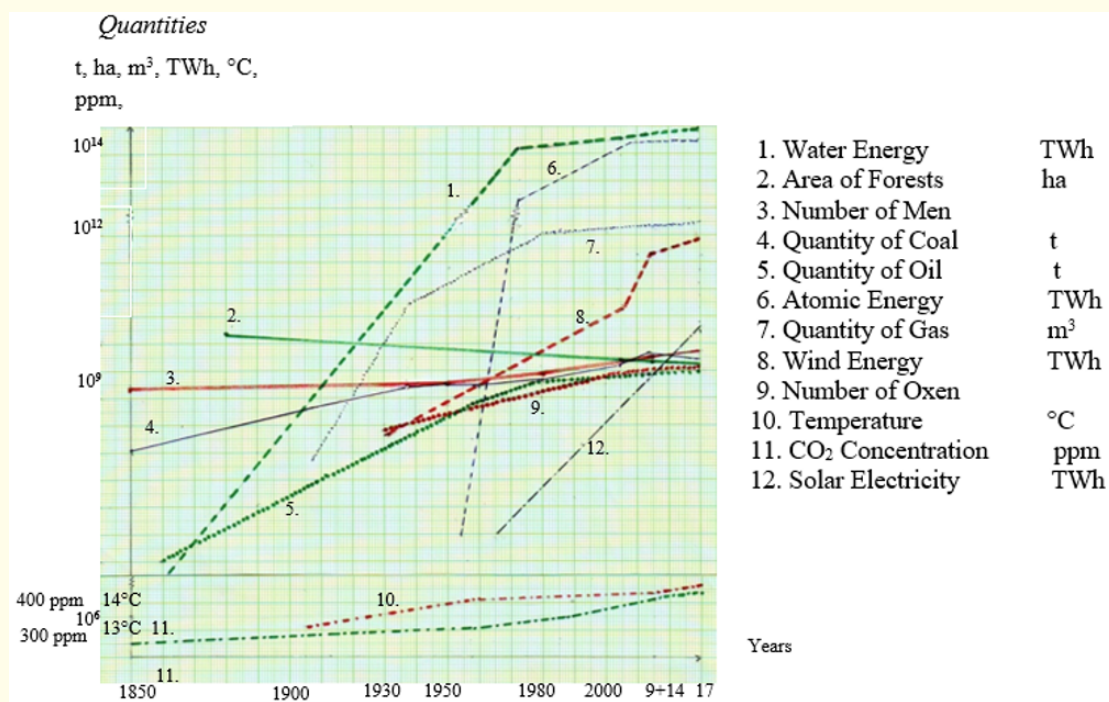


Figure 5: Number of men and oxen; Quantity of energetic raw materials and energies; Dimension of territory of forests; Average temperature of the Earth and CO_2 content of the atmosphere between the years of 1850-2017.

That process is the so called accumulator function mentioned earlier. The carbon and the energy remain bound in the phototrophic cells till their decomposition by a living organism or till their physical combustion. The phototrophic organisms because of their great mass and photosynthetic activity as well as that

they have produced free O_2 have played determinative role in the energetic and substantial processes of our Globe and its environment. Mainly that in the past a lot of living or dead organisms got into the depth of our Earth where they were transformed into different fuels during many millions of years.

Specifications	Mass of fuels as well as their average thermal values and the quantity of CO ₂ liberated from them in Years						
	1860	1935+37	1958	1980	2000+05	2009+14	2017
Oil × 10 ⁶ t	1	279,5	809,8	3059	3590	4117	4365
40,5 MJ/kg	4,05 × 10 ¹⁰	1,13 × 10 ¹³	3,27 × 10 ¹³	1,23 × 10 ¹⁴	1,45 × 10 ¹⁴	1,66 × 10 ¹⁴	
CO ₂ m ³	3,17 × 10 ⁹	8,86 × 10 ¹¹	2,56 × 10 ¹²	9,69 × 10 ¹²	1,13 × 10 ¹³	1,3 × 10 ¹³	
Coal × 10 ⁶ t	136	1280	1762	2805	5878	7823	7549
20,35 MJ/kg	2,76 × 10 ¹²	2,6 × 10 ¹³	3,58 × 10 ¹³	5,7 × 10 ¹³	1,18 × 10 ¹⁴	1,59 × 10 ¹⁴	
CO ₂ m ³	3,12 × 10 ¹¹	2,92 × 10 ¹²	4,05 × 10 ¹²	6,45 × 10 ¹²	1,37 × 10 ¹³	1,72 × 10 ¹³	
Gas × 10 ⁹ m ³	un.	71	400	1531	2778	3479	3768
37 MJ/kg	un.	2,62 × 10 ¹²	1,48 × 10 ¹³	5,66 × 10 ¹³	1,02 × 10 ¹⁴	1,28 × 10 ¹⁴	
CO ₂ m ³	un.	1,37 × 10 ¹¹	7,72 × 10 ¹¹	2,95 × 10 ¹²	5,36 × 10 ¹²	6,72 × 10 ¹²	
All together							
MJ/kg	2,8 × 10 ¹²	3,99 × 10 ¹³	8,33 × 10 ¹³	1,8 × 10 ¹⁴	3,66 × 10 ¹⁴	4,53 × 10 ¹⁴	
CO ₂ m ³	3,15 × 10 ¹¹	3,94 × 10 ¹²	7,38 × 10 ¹²	1,9 × 10 ¹³	3,01 × 10 ¹³	3,69 × 10 ¹³	

Table 1: Data to the Circulation of Energy and CO2 on the Earth.

Abbreviation: un. = datum is unknown

In consequence of the transformation the energy and the carbon bound by the cells had omitted from the usual circulation of the substace and enegry which event could influence the atmospheric concentration of CO₂ and the temperature of our Earth that is the earthly conditions. These environmental changes could result in biological consequences. The recent forced use of the energetic raw materials liberates very fast – only during some 250 years – almost all bound energy and carbon and this process influences on the present energetic and substantial condition of our Biosphere resulting in the recent climate change which has naturally accompanied by biological alterations, too.

Period of time	Animal species and their number × 10 ⁶				
	Oxen	Horse	Pig	Sheep	Hen
1930th	438,9	68,1	193,3	563,0	un.
1999-2000	1351,4	58,2	922,8	1056,1	14860,0
2017	1491,6	60,5	967,3	1202,4	22,8×10 ³

Table 2: Number of farm animals during the last decades.

Abbreviation: un. = datum is unknown

In consequence of photosynthesis concentration of free O₂ increased in the atmosphere causing a new environment which supported not only flowering of aerobic respiration but also formation of animal world the members of which – except carnivorous ones – use plants, O₂, water and so on to get the substances and the energy which are necessary for their life. After about a 720-770 million years long evolution the first two men appeared less than 30 million years ago and the anthropoid term has started. The appearance of men as you will see later has very serious consequences.

The effects of human beings on the Earth

The men since their appearance have continuous determinative effects on the physical, geological and biological condition of our Earth. In that period of time two important turning ponits were: 1778 and the 1940th. Since the first date the industrial revolution has flowed with all its consequences. A small part of those changes which have happened during the last 247 years can be seen on the Figure 5. and in the next tables. We used measured values of twelve parameters to delineate the graphs on the Figure 5. and put some of them in the Table 1, too. The paramererers are: quantity of used energies (water, atomic, wind, solar), that of burnt fuels (coal, gas, oil), number and metabolic effects of men and oxen, territory of forests, average temperature of the Earth and CO₂ concentration in its atmosphere. All values of ten parameters out of the twelve have continuously increased! Beside the ten parameters there are two exceptions, too. The first is the size of the territory of forests and the second is the quantity of coal mined. The territory of forests has continuously decreased which event is not good. As to the quantity of coal it became smaller during the last some years. This is a small result.

As to the CO₂ emission from fuels burnt to produce electricity – 6131 TWh in 1973 and 24973 TWh in 2016 – increased from 15460 Mt (1973) to 32316 Mt (2016) but the rate of the emission decreased from 2,52 to 1,29. This decrease is the result of the change of the ratio of kinds of fuels (oil or gas instead of coal) used and of the more effective cleaning of smokes. These data of CO₂ emission do neither contain for example the metabolic effects of men and oxen which are presented in the Table 4. nor the effect of motorization. The problem mainly is that the total emission of

CO₂ does not decrease and in consequence of that the quantity of this gas has increased continuously in the atmosphere from where it will not suddenly desappeare and all the unpleasant processes have gone on.

Specifications	Animal species and their number x 10 ⁶				
	Goat	Buffalo	Donkey + Mule	Camel	Llama species*
Europe	17,9	0,2	0,8	-	-
Asia	465,2	160,9	18,8	4,2	-
African	218,6	3,4	15,4	15,1	-
N., C. and S. America	35,8	1,1	7,8**	-	5,3***
Óceania	0,7	-	-	-	-
World total 1999-2000	738,2	165,6	42,8	19,3	5,3
2017	1034,4	200,9	55,3	34,8	-

Table 3: Number of domestic animals on the different continents.

Abbreviation:

* = llama, alpaca, vicuna and guanaco together

** = data only from Central America

*** = data only from South America

- = datum is unknown

It is interesting to deal with the domestic animals, too. The Table 2. contains the number of different farm animals in the years of 30th and later. Numbers in the Table 3. give an impression about the existence of different domestic animals over the World. It can be found that all number steadily increased except that of horses. This increase of the number of farm animals has different serious consequences because it is necessary to ensure convenient quantity and quality of fodder, drinking water, animal and sloughter houses further to treat enlarged quantity of sewage water, manure,

hazardous waste materials and other kind of wastes as well as to minimize air pollution, too.

We dealt with the effects of the metabolism of men and oxen, too. As to the emissions some of our calculations can be read in the Table 4. Each value of the emissions has become bigger during the period of observation, which means that the loading of the environment has continuously grown in the result of the increasing number of human beings and oxen [1-14].

Specifications	Years						
	1860	1935 + 37 *2	1958	1980	2000 + 05*2	2009 + 14*2	2016 + 17*2
ENERGY and their quantity							
Water TWh	0	un.	un.	1296	3000	3756	4107
Wind GW		0,3*****	un.	un.	59	318	958
Atomic TWh			5*****	203	2461	un.	2606
Solar electricity TWh			un.	un.	4	un.	328
HUMAN beings	1850	1937	1950	1980	un.	2014	2017
In billion	1,17	2,1	2,5	4.4	un.	7,3	7,5
CO ₂ m ³ /year	3,2x10 ^{8*}	5,75x10 ⁸	6,85x10 ⁸	1,2x10 ⁹	un.	un.	2,05x10 ⁹
When quantity of heat is 25% of metabolism in W/ year	9,39x10 ^{12**}	1,68x10 ¹³	2,0x10 ¹³	3,53x10 ¹³	un.	un.	6,02x10 ¹³
OXEN		Years of 1930th			1999-2000*2		2017
In million		438,9			1351,4		1491,6
CO ₂ m ³ /year		4,98x10 ^{10***}			1,53x10 ^{11****}		
When quantity of heat is 50% of metabolism in W/ year		3,29x10 ^{13****}			1,01x10 ^{14*****}		
Methane liter/year		4,38x10 ¹⁰ - 8,0x10 ^{13*****}			4,93x10 ¹¹ - 2,46x10 ^{14*****}		

Table 4: Data to the Circulation of Energy and CO₂ on the Earth.

Abbreviations: un. = datum is unknown, *= in case of basic metabolism of a person: 270 litre/day, **= in case of basic metabolism of a person: 88 W/day, ***= on the basis of an experimental datum of one calf of 75 kg: 311 litre/day, ****= on the basis of an experimental datum of one calf of 75 kg: 89.16 W/day, *****= data of oxen: 100-500 litre/day/animal, *****=MW

Conclusion

We think that the life of our 4.55 billion years old Earth can be divided into two basic periods which are: abiotic physical life and biological life. Both can be separated into smaller sections which are in case of the physical life: glowing star state with atomic evolution, solidification of the surface, appearance of water and abiotic chemical evolution.

In case of biological life the 1st section started with the appearance of the first living unit and ended by the beginning of photosynthesis. The 2nd one lasted from the start of photosynthesis till the appearance of the first two men some 30 million years ago. The 3rd one began from that point of time and lasted till 1778 and the last one has existed since that date. Some of these periods and sections can be seen on the Figure 6.

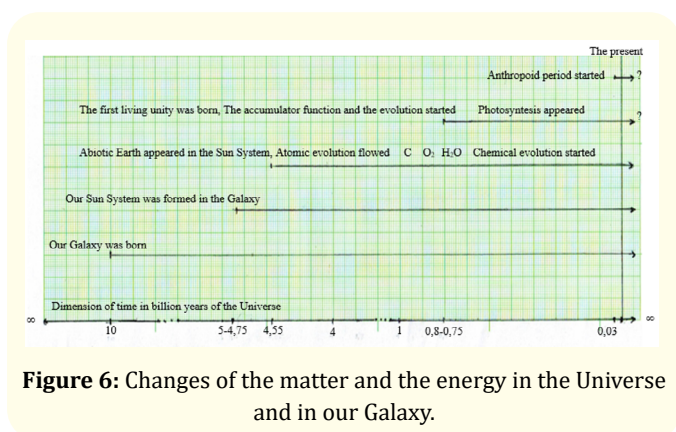


Figure 6: Changes of the matter and the energy in the Universe and in our Galaxy.

Since the appearance of the first living unit biological accumulation of the external energy and C, emission of heat gas and substances, transformation of the earthly environment as well as natural mutation of organisms that is the biological evolution have started. When the photosynthesis begun biological fixation of solar energy and free atmospheric CO₂ as well as production of free O₂ have also started beside the former events and the biological evolution has continued. No unnatural event had happened in these two sections. The fate of the 3rd and the 4th sections – that is the anthropoid ones – has been determined by the unnatural effects of man kind. We decided to study the happenings of the last section, therefore existing data were collected and the missing ones were calculated which were published earlier. All the data can be seen on Figure 5. and in the tables. On the basis of these data it can be concluded that since 1778 and later after 1940 such energetic and substantial processes have happened in our closed earthly environment which are very different from that of the earlier period and sections. Causes and consequences of these changes can roughly be summarized in three points.

The first point contains needs of the increasing number of human beings and farm animals. We list them here in head-words: nutriment, drinking water, energy, housing, clothing etc. To ensure the needs it is necessary to use the fire and to maintain industry, agriculture, transport, communal services, researches institutions and so on which result in production and emission of different kinds of metabolic, artificial, hazardous substances, waste materials, atomic, space as well as gene experiments. Beside these the philosophy of profit, of imperialism and of military force as well as the endless wishes of men are not in accordance with the possibilities of our closed earthly system.

Alterations of the surface of our Globe belong into the second point. The outer part of the Earth has been modified by different kinds of buildings, roads, deforestation, mines, farming lands and animal breeding places, military activities, air ports, ports, reservoirs and contamination of surface waters. These changes have influenced on not only the original possibilities of absorption, adsorption, reflection and utilization of solar energy but also the heat radiation of our Planet as well as movement of waters. Beside these they have great many unpleasant ecological consequences, too.

Atmospheric changes are listed in the 3rd point. These are the effects of CO₂, NO₂, SO₂ etc. which were fixed in the past and are liberated by fire recently as well as other non-inert gases, vapours, dusts and the use of internal combustion engines, aircraft and rockets. These have influenced on the composition and condition of the atmosphere in consequence of which the original way of arrival of solar energy as well as that of leaving of heat and the natural mode of water circulation have been modified. Alterations of the quality of the atmosphere influence directly on the living organisms and change the probability of spontaneous mutations, too.

What can the future bring for us?

"As the unpleasant alterations in our Biosphere have permanently grown the perspective of the human life has continuously got worse". The Nature does not give any base for the existence of different liberal ideas and wishes further it does not bother with the profit. The idea of the "Sustainable Development" in a closed system without the obligatory control of the influencing factors is only a fiction a metal ring made from wood. "Perhaps there is still time enough to save the life of man kind but for that it is necessary to introduce real drastic restrictions immediately".

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