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Substance, Energy, Evolution: The Life of our Earth

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Abstract

The Universe is endless and timeless substance and energy flow with motion of celestial systems, bodies and cosmic powder on the basis of the low of Nature/God. In spite of the fact that men are not able to imagine and to know the total Universe the author deals with general philosophical questions and the life of our Planet. It is supposed that our Galaxy was born more than 10 billion years ago in consequence of unknown movement of substance and energy. Our Solar System and Earth which has existed in that System are the parts of our Galaxy. In our Solar System celestial bodies get energy mainly from our Sun and they have radiated at least heat. 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 periods are the result of the atomic, chemical and biological evolution. The effect 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, meteorits) and microscopic cosmic powder on the basis of the low of Nature/God. The celestial clusters, bodies and cosmic powder are different depending on their type, position, age, size and composition. The endless and timeless Universe is not imaginable and understandable for men in spite of the fact that arithmetic unsuitableness of the infinity was solved with the determination of relative time (time unite) and relative distance (distance unite). 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 that is $E=mc^2$. When I meditated on the connection of the substance, the energy and the inconceivable time then my opinion was that consecutive change of substance and energy represents/means 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. In our Solar System celestial bodies get energy mainly from our Sun and they have radiated at least heat. 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 Physical Life of our Earth (0-3,75/3,8 billion yrs)

True physical life of the lifeless celestial bodies in our Solar System is not unchanged. They may have some common characteristics: *birth*, *motion*, *atomic evolution*, *cooling*, *geological events*, *regular fluctuation of their*

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temperature (effect of Sun), *sterile condition*, *appearance of water* and *abiotic chemical reactions*/*chemical evolution* and so on.

True physical life of our Earth started as a glowing star consisted of hydrogen (H_2), helium (He) as well as atomic fusion. Its early atmosphere might be a solar type with the same components. That starting process can be named atomic evolution during of which different atoms – nitrogen (N_2), phosphor (P), sulfur (S), ferrum (*Fe*) and the other stable elements and the naturally radioactive ones as well as simple molecules – had been formed. It is probable that the atomic/substantial pool of our Earth evolved by the end of solidification of its surface. This pool is practically constant (except the naturally radioactive elements) as the atoms are firm and permanent and only celestial bodies may bring some substance from the space on our Earth and nothing can leave it on natural way, therefore it is a closed system for substance – atoms and molecules – but not for different kinds of energy. In contrast with the fact that atoms are stable the connections among them are changeable. They may change time to time depending on the actual energetic, heat, pressure and so on conditions and on the presence of 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.

Solidification of the Surface of our Planet

It is probable that the atomic evolution practically ended by the solidification of the surface of our Globe. The substance and structure of the first abiotic solid surface of our Planet is not known but it may be supposed that the composition of its own early laves and that of the surface samples of other lifeless celestial bodies may be similar to that. We do not know what does happen in the depth of our Earth at present.

Change of the Earth's Atmosphere

The first solar type atmosphere of our Globe had also changed. It is supposed that it transformed into a reductive/an anaerobic one containing N_2 and inert gases. This condition spoke against the presence of the oxygen (O_2) and also of the physical burning. The reduction is a process in which a substance gains electron and its positive valence decreases.

The appearance of carbon (C) and O_2 and that of the processe of oxydation – which means that an atom loses electron with an accompanying increase in its positive valence - is an interesting open question. Carbon monoxide (CO), carbon dioxide (CO_2) and water (H_2O) could not be formed without O_2 as well as C. It is a big question-mark when and how did CO, CO_2 and H_2O appear and what was their birth order? It is sure that the appearance of CO, CO_2 and water had happened many 100 million years before and their presence had great importance and had different consequences. Without carbon compounds and fluid water there is not biological life (Figure 1).

Importance of Fluid Water

It is sure that fluid water or ice came into view only when the Earth's surface was already rigid and its temperature as well as the atmospheric pressure gave the possibility of its condensation and/or freeze. It can be supposed that CO, CO_2 and perhaps water vapour had also existed before the presence of fluid water or ice.

Appearance of fluid water was a very important event not only from both chemical and later biological processes - because water is not only a medium for chemical reactions that is for formation of abiotic inorganic and organic compounds which process is the so called chemical evolution as well as later for that of the first living unit - but for the water circulation, too. We do not know when, how and why did circulation start which process together with the atmospheric CO_2 has played important role in regulation of the actual temperature of our Globe that is in its condition of entropy.

Parts of the True Physical Life of our Planet

On the basis of the facts we think that the true physical life of our Earth – which was sterile/abiotic – had three parts.

- The first one can be characterized by atomic, physical and geomorphological events.
- The second part started when the surface of our Earth became massive.
- The third one began with the appearance of water and this part lasted till the birth of the first living unit.

Biological life on our Earth

After the birth of our Earth in consequence of the mentioned sterile physical, geological and chemical processes - which supposedly lasted for 3.75/3.8 billion years - the first living substantial matrix that is the biological life appeared. The biological life is a special energetic and substantial phenomenon of a matrix which formed on the basis of the true physical life of our Globe. Its formation is not known but it is a fact that it

Figure 1: The surface of the Mars as well as that of the Moon and the picture of our Earth.

could form and exist only in fluid water containing the necessary dissolved inorganic as well as organic substances which were already built up in abiosis - chemical evolution. Beside this the temperature and pH of the water as well as the atmospheric conditions had to be optimal and a convenient energetic donor in the environment as well as a suitable energetic acceptor in the matrix had to be also present. It is thought that the biological life is a temporary substanial structure which is suitable to maintain a life-long continuous electron and ion transport – together with the necessary energetic and material background. It would be interesting to list those inorganic and organic compounds which were necessary for the simpliest first living matrix. It seems for us that the abiotic environmental chemistry knew already everything. We do not know what was, what is and what will be the situation in respect of the biological life in the other parts of the endless Universe.

The Living Unit and its Life

The first living unit is a substantial matrix which is bordered by a permeable membrane/wall. Inside that unit and through its membrane/wall a characteristic organized and directed energy and substance transport flows which process requires energy till its own death. The living unit is affected by external energetic, physical and chemical effects and it can accommodate to those only within the borders of its own life requirements. In the same time it influences on its environment, too. The living unit can change and its genetic material can mutate as well as can multiply and its characteristics are bequeathed into its posterities.

The start of the life of the first living unit is unknown, although energetic conditions of the biological life were studied by ***E. Schrödinger*** and ***A. Katsuki***. They stated that the life needed environment of low entropy because consumption of compounds of low entropy (e.g., saccharides and so on) which were essential for it was only possible in such circumstance. Suitable condition of entropy of our Earth has been ensured by the circulation of water and by the composition and condition of its atmosphere as well as its surface.

About the First Living Unit

The first living unit appeared about 800–750 million years ago on our Earth, if the present observations and calculations are exact. As for its characteristics it might be a pluripotent archaic type cell without membrane bound nucleus and other distinct organelles that is it was a procarya/prokaryote/archaea. It is thought that its metabolism – in accordance with the anaerobic (semianaerobic?) condition which is supposed - might be chemolithotrophic/autotrophic (perhaps heterotrophic?) but what was its substantial and energetic background it is unknown for us. We only know that the birth and existance of that unit required an outer energy donor as well as an own operating system which could accept the energy and maintain the metabolism. Besides this it is also fact 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. Therefore the life is a transient organised substance/matrix of the matter together with a continuous flow of electron and ions. Furthermore we know that at present such microorganisms have also lived which can survive a temperature more than 100 °C or a temperature lower than 0 °C, an atmospheric pressure more than 1 bar and the high saline concentration, too. Without procarya there would not be any biological life on our Earth.

Effects of the First Procarya

Since the appearance of the first procarya sterile condition of our Earth disappeared. That microorganism had permanently as well as in a growing degree - in consequence of its multiplication - started to decompose, consume

and transform the already existing abiotic inorganic as well as organic substances and had produced different types of inorganic as well as organic compounds, gas and heat. 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, too. Without their activity the surface of our Globe would be similar to that of the other lifeless celestial bodies – like the Mars or the Moon (Figure 1).

Birth of Different Cells

During the life of procarya cells genetic changes/mutations had also happened in some of them in consequence of which and of the environmental selection different types of microbial cells - bacterial, eucaryal (fungal, plant and animal) - have appeared 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 so called closed system is a special environment which has different types - artificial, natural, energetic, material. Those parts of the Earth and the earthly surrounding all together which are suitable for a living unit at least to survive is named Biosphere. Our Biosphere is a special closed system because only celestial bodies may bring any substance from the space into it and no substance, flora, creature as well as man can leave it on natural way. In the same time, it is open for arrival of different kinds of energy and it can radiate heat, light and the energy of radioactive elements. You can see the light emission of our Earth on the figure 3.

Using an artificial closed system - for example a closed cultivation tank - it is obligatory permanently to ensure those conditions (water, food, temperature, pH, atmosphere, circulation, elimination of metabolites and over population) which are necessary for the continuous life and multiplication of the given organism which is mass cultivated (Figure 4). Our Earth is a closed system not only for the substane but for the biological life, too.

Effects of the Phototrophic Cells

As a result of genetic changes of some archaic microorganisms and of the environmental selection the first phototrophic cell appeared and started to consume not only CO_2 and other compounds needed for its life but solar energy also as well as to emit free O_2. During photosynthesis both CO_2 and solar energy are built in the new organic compounds that is this process results in a shorter or longer fixation of the substance and the energy – accumulator function. 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

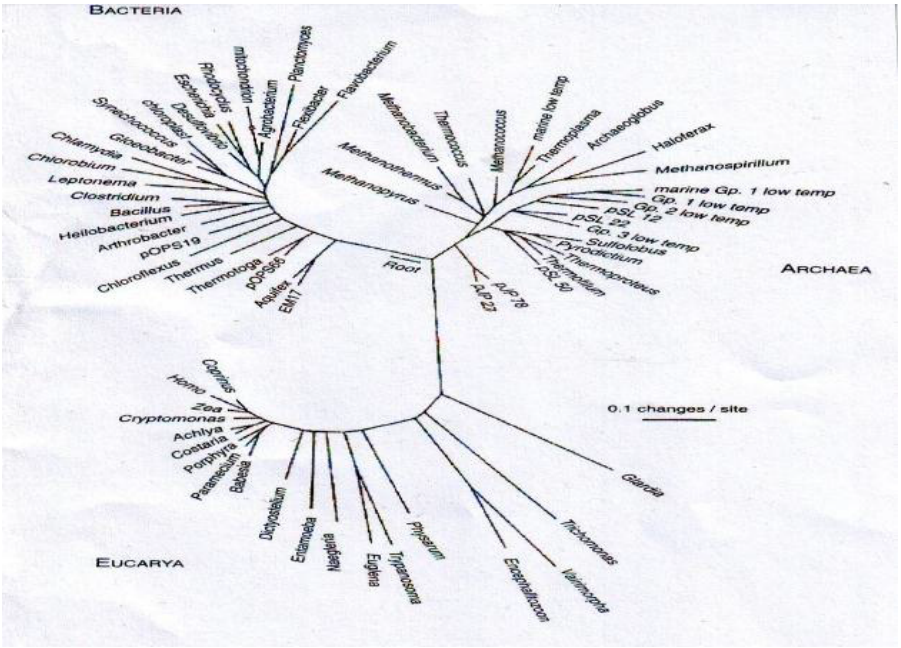

Figure 2: Phylogenetic tree of procarya, bacteria and eucarya cells by M. Dworkin et al.

Figure 3: The light emission of our Earth.

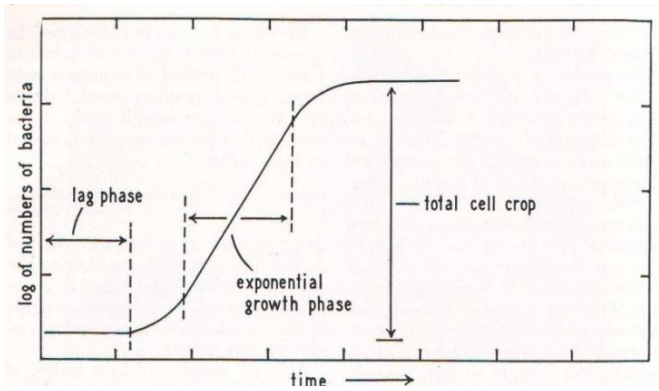

Figure 4: Bacterial growth.

as well as that they produce free O_2 have played determinative role in the energetic and substantial processes of our Earth. Mainly that in the past a lot of living or dead organisms got into the depth of our Globe where they were transformed into oil, coals as well as gas during millions of years. In consequence of these events the energy and the carbon bound by the cells had omitted from the usual circulation which could influence the concentration of atmospheric CO_2 and also the earthly temperature which events went with 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 which process influences on the present energetic and substantial condition of the Biosphere resulting in the recent climate change which has naturally accompanied by biological alterations, too.

Increasing concentration of free O_2 in the Biosphere helped not only flowering of aerobic respiration but also formation of animal world the members of which - except carnivorous ones - consume plants, O_2, 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 biological evolution the first two men appeared less than 30 million years ago and the anthropoid term has started. The appearence of men as you will see later has very serious consequences.

The Effects of Human Beings on the Earth

The men have determinative effects on the physical, geological and biological condition of our Earth. The anthropoid period has an important turning point in 1778. Since that 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 1 and 2.

You can see measured values of twelve parameters on the Figure 5. which are: number of human beings, that of oxen, quantity of energies (water, atomic, wind, solar) used, that of energetic raw materials (coal, gas, oil) burned, territory of forests, average temperature of the Earth and finally CO_2 concentration in the earthly atmosphere. All values of ten parameters out of the twelve have continuously increased! Beside these ten there are two exceptions.

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

Table 1: Number of farm animals during the last decades.

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

Abbreviation: un.=datum is unknown

Table 2: Number of domestic animals on the different continents.

Specifications	Animal species and their number × 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 2017	738.2 1034.4	165.6 200.9	42.8 55.3	19.3 34.8	5.3 -

Abbreviation:
*=llama. alpaca. vicuna and guanaco together; **=data only from Central America
***=data only from South America; -=datum is unknown

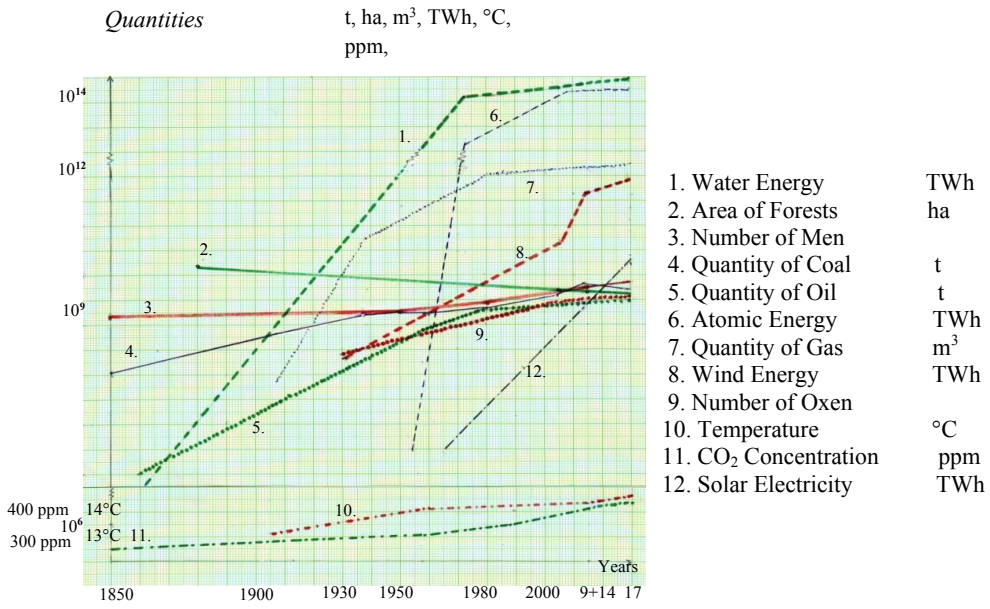

Figure 5: Number of men and oxen; Quantity of energetic raw materials and energies; Dimension of territory of forests; Average temperature of the Earth and CO_2 content of the atmosphere between the years of 1850-2017.

quantity of coal it become smaller during the last some years. This is a small result. As to the CO_2 emission from fuels used 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 process is the result of the change of ratio of kinds of fuels used and that of the more effective cleaning of smokes. These data of CO_2 emission do neither contain the metabolic effects of men and oxen which will be presented in tables 3 and 4. nor for example the effect of motorization. The problem mainly is that the total emission of CO_2 does not decrease and that this gas will not (suddenly) desappeare from the atmosphere and all the unpleasant processes have gone on.

It is interesting to deal with the domestic animals, too. table 1 contains the number of different farm animals in the years of 30th and later. Numbers in table 2 give an impression about the existence of different domestic animals over the world. It can be seen that all number steadily increased except that of horses. But this increase of the number of farm animals has different consequencies. It is necessary to ensure convenient quantity and quality of fodder, drinking water, animal and sloughter houses further to treat sewage water, manure, hazardous waste materials and other kind of wastes as well as to minimize air pollution, too.

As to our calculations some of them are presented in tables 3 and 4. Each calculated value has become bigger during the period of observation. These facts mean that the loading of the environment has continuously grown in consequence of the increasing number of human beings and oxen.

Conclusion

On the basis of the facts we think that the biological life of our Earth can be divided into four periods of time. It is necessary to know about these periods because each of them had/have special

Table 3: Data to the Circulation of Energy and CO_2 on the Earth.

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}	

Abbreviation: un.=datum is unknown

Table 4: Data to the Circulation of Energy and CO_2 on the Earth.

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	3.2 × 10^8*	5.75 × 10^8	6.85 × 10^8	1.2 × 10^9	un.	un.	2.05 × 10^9
When quantity of heat is 25% of metabolism in W/year	9.39 × 10^{12}**	1.68 × 10^{13}	2.0 × 10^{13}	3.53 × 10^{13}	un.	un.	6.02 × 10^{13}
O × EN		Years of 1930th			1999-2000*[2]		2017
In million		438.9			1351.4		1491.6
CO_2 m^3/year		4.98 × 10^{10}***			1.53 × 10^{11}***		
When quantity of heat is 50% of metabolism in W/year		3.29 × 10^{13}****			1.01 × 10^{14}****		
Methane liter/year		4.38 × 10^{10}-8.0 × 10^{13}*****			4.93 × 10^{11}-2.46 × 10^{14}*****		

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

energetic and substantial processes which had/have biological consequences and vice versa.

The first period lasted from the appearance of the first living unit till the beginning of photosynthesis. That part might be an anaerobic (semianaerobic?)

chemolithotrophic section in which biological transformation of earthly environment and the natural mutation of microorganisms that is the biological evolution have started.

The second one lasted from the start of photosynthesis till the appearance of the first two men. During that period of time biological fixation of solar energy as well as free CO_2 and production of free O_2 by phototrophs have started and the biological evolution has continued. These two periods can be described by only natural biological processes and by their consequences besides those lifeless effects which have permanently determined the earlier true physical life of our Planet, too. No unnatural event had happened during these two periods.

The third period ended in 1778 and the fourth one has existed since that point of time. These two periods are the anthropoid ones.

The collected data and our own calculations - which were published earlier - can be seen in Figure 5. and in the Tables. On the basis of these data it can be concluded that during the anthropoid period - especially from 1778 and later after 1940 - such energetic and substantial processes have appeared on our closed Earth and in its atmosphere which are very different from that of the earlier periods - which are: before the appearance of the first living unit or that of the photosynthetic cell or that of the first two men or when the industrial revolution started. Causes and consequences of these changes can roughly be summarized in three points.

The first point contains the effect of increasing number, requirements and activities of human beings and farm animals in a closed system. For example: the environmental effects of fire and the other energies; that of *industry* - mainly by the production and emission of all artificial substances; that of *agriculture* - especially by animal breeding of industrial and by intensive mass-production of plants; that of *transport* and *military activities;* that of *communal processes*; that of *scientific events* - mainly by the synthesis of artificial substances and by the atomic, space as well as the recent gene experiments; that of the *philosophy of profit* and that of the *endless wishes of men*.

Into the second point alterations of the surface of our Earth can be listed. Its natural surface has been modified by buildings, roads, deforestation, mines, farming lands, reservoirs and contamination of surface waters. These changes have modified the original possibilities of absorption, adsorption, reflection and utilization of solar energy, the heat radiation of the Earth as well as movement of waters. Beside these they have great many unpleasant ecological consequences, too.

The third point consisted of CO_2, N_2, SO_2 - which were fixed in the past and are liberated recently - as well as other non-inert gases, vapours, dusts and use of internal combustion engees, aircraft and rockets. They have influenced on the composition and condition of the atmosphere of our Earth in consequence of which 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 quality of the atmosphere have also direct effects on the living organisms and they can influence the probalility of spontaneous mutations, too.

In consequence of the modifications listed above the climate of our Earth has continuously worsend.

What can be Expected from Future?

When somebody thinks about the essence and the aim of the biological life then it can be concluded that it is only a **new life** in a **natural closed environment** on the basis of the **low of Nature** and not on the basis of the **imaginations of men**. The low of Nature does not give any base for the existance of different liberal ideas. This rule ought to have determined the life of human beings all time but it has almost failed all time. Therefore the unpleasant alterations in our closed Biosphere have permanently grown and in consequence of that the condition as well as perspective of the human life have continuously worsend. The idea of 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 human life* but for that it is necessary **to order drastic restrictions immediately**.

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