

This article is printed:

Levchenko V.F., Khartsiev V.E. (2000). "The Life Demon" and Auto-regulation of Evolutionary Process. *International Journal of Computing Anticipatory Systems*, vol. 10, pp. 31 - 44.

"The Life Demon" and Auto-regulation of Evolutionary Processes

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Abstract

The auto-regulation phenomena are fundamental properties for biological systems of various levels of biological organization (organisms, ecosystems, biosphere). At present, in spite of the brilliant successes in cybernetics, the investigations of the auto-regulation for living systems in context of their development or/and evolution are hampered by essential theoretical and methodological difficulties. In this paper we present several simple approaches which can give some basis to elaborate in the future new quantitative models in above fields. The first approach concerns the management of energy flows, the second one introduces the concept of the so called "the Life Demon". The Demon is specific non-material object which is factually an algorithm and which can propagate by the alike way as it does virus. The third approach results in the simple type of electronic model which describes some features of behaviour for the objects of the first and of the second approaches, in particular, auto-regulation activity, searching activity, anticipatory behavior. We suppose that these approaches can be joined and perfected in the future with use of the balance kinetic models of auto-regulations for the cases of quasi-isolated ecosystems and for biosphere.

Keywords: evolution, ecology, biosphere, bio-energetics, information processes

1 Introduction

The points considered in the paper develops some previous publications of authors (Khartsiev, et al., 2000; Levchenko, 1993, 1994, 1997, 1999). The goal of this article is the building up of some basis to elaborate the models and qualitative approaches in the field of evolutionary biology. Especially, we are interested in auto-regulation processes in different bio-systems of various levels of complexity and of biological organization from organisms to ecosystems and the biosphere. The auto-regulation and, in particular, auto-canalization phenomena determinate the course for many processes in biological systems during the time period of their existence. The same mechanisms are also typical for big class of complicated non biological objects including technical ones with numerous practical applications. Up to now, the investigations of the auto-regulation processes itself for bio-systems are connected with essential theoretical and methodological difficulties. We suggest they can be at least partly solved if to develop the following two directions of studies: (i) development of general theory and methodology of auto-regulation and (ii) elaboration of various particular qualitative and quantitative approaches and models. In this paper, several rather simple approaches along this direction are presented; some of them are developing of the previous authors results in different scientific fields. The given models allow to apply quantitative evaluations and are oriented mainly to schematic description of either aspects of auto-regulation phenomena for different bio-systems.

The first approach presented in the part 2 is devoted to the task which any bio-system has to solve when it feels either shortage of resources (it may be not only catastrophic situation) and, thus, when the bio-system

needs to reestablish vital processes.

In the part 3, the concept of new kind of specific non-material objects which are factually algorithms is introduced. These objects have some traits as viruses, they are named by us “The Life Demons”. The Life Demon is new type of ideal intelligent objects among already known: a) the Maxwell Demon; b) Darwin Demon.

It is not out of place to remind here about that the Maxwell Demon introduced by Maxwell in 1871 is some specific “door” between two vessels which has to allow to accumulate the hot particles of a gas in one of the vessels (see, for instance, Feynman, et al., 1963). The such Demon must work in closed nonequilibrium systems which being receiving some information about the velocities of gas particles from an external sources. The activity of the Demon is to separate hot particles and produce their surplus in one of the vessels. This leads to decrease the total entropy of the all closed system of two vessels. But the paradox is that in order to realize this hypothetical construction it is necessary to open the system to manage the work of the Demon, hence, we have no contradictions with the second thermodynamics law. The so called the Darwin Demon was described by Asimov (see the work of A.Gorban and R.Khlebovross, 1988). It works in living systems and realizes the function of Darwinian natural species selection. The Demon functionates by definition in open systems which exist due to the processes of the entropy decreasing being run in the biosphere. This doesn't also contradict to the second thermodynamics law.

Thus, the Demons are usually considered as ideal intellectual systems, which may realize necessary regulation processes in systems. These theoretical Demons allow to translate the descriptions of various properties of real objects to the language of alternate logic for management processes.

In the part 4 the simple electronic scheme which permits to build theoretic model of heuristic activities and, hence, the model of some bio-system functions is proposed. This scheme realizes, in particular, three functions which characterize any bio-systems: (i) searching, reconnaissance activity; (ii) auto-regulation activity, (iii) anticipatory behavior. This approach permits to apply the balance kinetic model for the cases of auto-regulation in quasi-isolated ecosystems and the biosphere. We hope to use also other mathematical methods which were developed by us (Khartsiev et al., 2000) to continue in the further the elaboration of approaches presented in this article.

2 Physical Evolution of the Biosphere as Development of its Algorithmic Power

In previous works (Levchenko, 1992, 1993, 1997, 1999) the model of physical evolution of the biosphere was elaborated. On the basis of Schroedinger (1955) ideas, it is postulated in the model that each bio-system (for example, organism, ecosystem, biosphere) “strives” to function not to decrease an energy flow through itself. Just the such bio-systems are being self-preserved under being altered environmental conditions. This means that every temporary decrease of energy flow through the bio-system - **interruption** - leads to searching of new ways of energy reception and, eventually after that, either to the appearance of new way for the energy reception or, in the case of failure of the finding, to the death of the bio-system. Thus, every interruption stimulates above bio-system to its physical evolution because the quantity of ways for energy reception grows in reply on the interruptions (Levchenko, 1997, 1999). This approach to physical evolution of biological systems is named by us as **interruptions hypothesis**.

This reasoning gives possibility to deduce very simple formulas of the physical evolution for energy values in the system of co-ordinates of bio-system itself. The model of physical evolution of bio-system is based on the following simple assumption: in the case of “ideal living system”: the decrease of the energy flow by size J (i.e. interruption) through the system leads to compensatory reactions which direct to reestablish the initial flow. This means the interruption by size J provokes the increase of energy flow by J through the ideal system. In general case, the equation has the form:

$$G(N) = J_0 + S_{1,N} J_k \quad (1)$$

where $G(N)$ is the energy flow (in units of energy/time) passing through the bio-system after N interruptions, J_0 is the initial energy flow passing through the bio-system in some first moment of time, J_k is the amount of decrease in already used flow of energy during the interruption with number k (this decrease have to be compensated by appearance of new way of energy reception, according the model), $S_{1,N}$ is the algebric sum of 1 to N and the sign “ J ” is included to consider the behaviour of bio-system in non ideal case.

The importance of consideration of energy flow through sub-systems of the biosphere to describe the biosphere evolution, was discussed in literature repeatedly (see, for example, Abrosov et al, 1982). Within a framework of the model of physical evolution (Levchenko, 1993, 1997) for the biosphere case, the

interruptions are temporary changes of environment when possibilities to receive energy by usual, "traditional" way come down. These interruptions are connected in general with both oscillations of Earth orbit with durations several tens thousands years and with geological processes with period about 200 millions years. It can be shown that for majority of the biosphere interruption the value of interruption (i.e. decrease of "traditional" flow for this time) is proportional to total energy flow which the biosphere receives by means of photosynthesis processes (Levchenko, 1993). Then the physical evolution of the biosphere may be described as:

$$G(N) = J J_0 (1+b)^N \quad (2)$$

where b is the relative decrease in incoming energy flow during interruptions (Levchenko, 1993, 1997).

If to translate the description of above mechanism to biological language then it can say that the physical evolution of the biosphere is connected with compensatory reactions - **adaptations** - in order to save the intensity of the flow in any time domain including interruption. It is important that the bio-system has to have a possibility to experiment (heuristic behaviour, "free will") in order to find new ways of energy reception. In the case of ecosystems and biosphere heuristic processes are provided by mechanism of selection of more suitable genetic lines in every stretch of evolutionary time. In other words, the interruption leads to appearance of new way of reception of energy as one of the consequences of origin of new species or, more exactly, the interruption leads to origin of new kinds of aggregates consisting of surroundings and species populations – **biogeocenosis** - which are to be able to receive energy under new conditions.

It is known any biogeocenosis is ecosystem within a framework of concrete plant communities (Odum 1975, Rautian, 1988). Each biogeocenosis presents itself also as holder, vehicle or **carrier** of specific manner of functioning, in other words, the carrier of some algorithms of the biosphere behaviour for/under concrete, actual kind of conditions in the planet. Hence, the physical evolution of the biosphere is one of results of appearance of new algorithms of behaviour of this super-ecosystem. Simultaneously, it leads to the origin of new canalization factors for subsequent ways of the evolution as a result of unreversible modifications of organisms and their surroundings (Starobogatov, et al., 1993 ; Timofeev-Resovsky, et al., 1977).

The paleontological data confirm the such approach (see in full about different theories of the biosphere changes in Gorshkov, 1994; Levchenko, 1993). After every of the interruptions – in fact, of energy crisis in the reason of the reduction of photosynthesis – new dynamically stable system of the biosphere arises. The every such system has characteristic distinctive producers. Later, on the last stages of the biosphere evolution the informational exchange between different animals promotes to use resources of surroundings more effectively especially during the crisis geological epochs. This exchange begins also to play more and more risen role for the physical evolution of the biosphere after the origin of humans (Levchenko, 1994, 1999). It is possible to say that physically weak interactions between people begin to introduce vital importance in the life evolution (Khartsiev et al, 2000).

Thus, we can see that the physical evolution of the biosphere in reply to different interruptions is connected with complexification of organization of the biosphere and with development of adaptation mechanisms, i.e. with growing of algorithmic complexity of the biosphere system. The development of behavioural algorithms of the biosphere permits to adapt in principle to more broad diapason of conditions. This growing of quantity and quality of above algorithms along evolution means that **algorithmic power** of the biosphere increases along evolutionary time.

How to estimate the evolution of the biosphere as well as other bio-systems in the view of the development of algorithmic power of them? It seems to be naturally to use some quantity $A(t)$ which characterizes potential possibility of bio-system to receive energy flow and which increases with the growing of total energy flow $G_{real}(t)$ being used by the bio-system. Obviously, the value $A(t)$ can be more than $G_{real}(t)$ in the reason of that the potential possibility to receive energy flow can exceed some current real flow. On the other hand, this quantity have to be less than some quantity G_{max} which is proportional to maximal flow through the bio-system in the case of ideal evolutionary way, i.e. when the eq. 1 has equality.

Thus, we come to the following equation:

$$G_{Nreal} < \alpha A_N < G_{Nmax} \quad (3)$$

where A_N is algorithmic power of bio-system after N interruptions, α is some coefficient for normalization, G_{Nreal} is the real energy flow through the bio-system, G_{Nmax} is maximal possible flow in the case of ideal evolution; it is equal to the right part of eq. 1.

What does the such definition mean? If an biological system is able to save some energetic flow through itself in the surroundings with interruptions then it is possible to suppose that this bio-system has necessary totality of algorithms for that. The value A_N characterizes the potential algorithmic possibility to manage energy flow which is received from environment by the bio-system. In the cases of ecosystems and the biosphere, corresponding values A_N characterize their fundamental (i.e. potential) group ecological niches. Similarly, the quantities G_{Nreal} are some characteristics of realized group ecological niches of these bio-systems (Levchenko, 1993, 1997; Starobogatov, et al., 1993).

Of course, we are not able in general case to forecast either concrete details of the above algorithms of the biosphere behaviour, especially in context which is used by programmers to evaluate programs. We can say only (if to watch along biological evolution) these algorithms work and allow to the life to survive along and under evolution.

One of the simple consequences of the such approach is every interruption stimulates to increasing of algorithmic power of the biosphere, in opposite case it had to die finally. This demonstrates the important role of different carriers of biosphere algorithms, i.e. important role of biodiversity in the broad sense including the individual level and super-organism ones (Lovelock, 1991). The high level of biodiversity provides the stability of the biosphere (Gorshkov, 1994; Wilson, 1988)

Another almost evident but interesting consequence concerns the ability of bio-system to find new manners of reception energy from surroundings: the bigger algorithmic power allows to manage bigger energetic flows through the bio-system. In other words this allows to accomplish “big jumps” under switching of the flows. Moreover, when algorithmic power $A(t)$ grows this simplifies the search of new manners of behaviour under the conditions of interruptions which don't destroy the bio-system. Thus, the value $A(t)$ characterizes indirectly the so called “creative power” of the bio-system (Levchenko, 1999).

3 “The Life Demon”

To simplify the further argumentation it is useful to introduce the notion of so called “**the Demon of the Life**” or simpler “**Life Demon**”. As it was mentioned in the part 1, the such theoretical construction is introduced by us by analogy with Maxwell Demon and Darwin Demon. The Life Demon is a convenient manner to formalize the above mechanism of the interruption. This “Demon” becomes apparent when bio-system meets with either difficulties to provide the processes of vital functions, for example when the energy flow through the bio-system (of the such kind which is being used for living processes of course) is diminished. In this case, the Life Demon tries to help to the bio-system to reestablish the energy flow through itself and has to find some new way of reception of both energy and resources. Taking into consideration that the reinforcement of effect of any limiting factor of surroundings leads at last to the decrease of assimilation of energy flow by the bio-system it can suppose that the Life Demon is engaged with energy flows in general. We shall say thereupon about “reducibility” of external factors of different kinds to the energy factors. Not difficult to see that every present Life Demon is some algorithm to function in concrete field of conditions and he (the Demon) lives as the remembrance of the bio-system about correct behaviour under past events in surroundings. By other words, the Life Demon is carrier of some manner of behaviour, he isn't some material object (he is just Demon!) and he can be saved by different signs in different material structures (including the tip of sewing needle). The appearance of new Life Demon is factually some successful but paradoxical reaction of bio-system in reply to dangerous situation for providing of either vital functions.

It is very important to note that the word “algorithm” which is used by us here in explanations about the Life Demon isn't enough exact. The widespread meaning of this word means just hard program of operations, for example, in the case of computer program. Of course, the computer program can be very complicated but, nevertheless, it has some set of predetermined variants of operations and completions. The Life Demon algorithm isn't the such “rigid” as the computer one. If to say more accurately, we have indistinct, **diffuse algorithms** in the case of Demon. These algorithms resemble in many aspects just the tasks which have to be solved when the initial conditions and concrete goals are assigned, posed. By other words, the Demon algorithm can describe only some project of activity, it gives purposefulness of behaviour but it doesn't appoint all concrete steps in order to reach this goal. The tasks of the such type (i.e. the diffuse algorithms to reach either goals) are known for different scientific fields, for example, mathematical programming, physics, psychology. The optimal solving of the such tasks needs the use of the variation methods as a rule.

It is clear, that every Demon algorithm, or simpler every Demon, provides anticipatory activity. The many traits of anticipatory systems are described in the pioneer works of R.Rosen (1985, 1991) and D.Dubois

(1998a,b,c, 2000). At least some of these traits can be translated to the Demon case. Indeed, any goal under the purposefulness activity isn't real result but is only virtual one which can be either happened or not happened after all supposed actions; the producing of goal in order to be going towards it is just anticipatory activity. The living systems are engaged with the such activity because they have to be able both to conjecture different situations in surroundings and to choose optimal "course of life" in order to survive in every instant time (Dubois, 2000; Rosen, 1985). In this context, the discussion about anticipatory properties of non-living substance (Dubois, 2000; Dubois, Sabatier, 2000; Mitchel, 2000) can be transformed to the problem "can non-anticipatory systems exist along time in this Universe in principle?". We suppose that some type of the models of anticipatory behaviour can be developed on the basis of concept of the Life Demon as well as on the basis of another concept proposed by V.Khartsiev about Universal Genius Demon.

Any living bio-system has non-zero quantity of own different Life Demons which appear with every new sort of interruptions. In the language of this **Demon model** the bio-system wakes corresponding Demon from some pool of virtual Demons during the interval of interruption. New Demon begins to work and rescues the bio-system; he plays the role of "Angel-rescuer" of the system. The growing of the quantity of different Life Demons heightens the steadiness of the bio-system to external influences of different kinds. When a bio-system has several Life Demons they can compete for either resource(s) and then some of Demons operate in full power only sometimes. Although waked Demons don't wish to go away independently (this characterizes the irreversibility of the system changes) some of Demons can die if they aren't used absolutely during long time; this means that corresponding algorithms of behavior are forgotten by bio-system. For example, this is mated with disappearance of species populations in ecosystem which are carriers of specific algorithms of the ecosystem behaviour. Nevertheless, the quantity of the Demons of different bio-systems (organisms, ecosystems, biosphere) increases along evolution on the Earth.

In the period of time without interruptions the Life Demons descent from other living Demons: they can be reproduced, transferred, sent and received along space and along time by bio-systems, for instance in the forms of genetical or linguistic information (Korogodin, 1991, Levchenko, 1994, 1999). At that every Demon can be deciphered, decoded i.e. can be correctly understood and effectively used under concrete conditions by only concrete kinds of bio-systems which are tuned, adapted to this kind of Demons. Living Demons aren't universal creatures. By other words, every Demon implies concrete organizations of both bio-system and its environment.

The Demons can also mutate along time, so the "life" and "evolution" of different Demons resemble the analogous processes for real species populations (Rensch,1960). But extra trait of many Demons is they can combine with each other and to engender sometimes different chimera forms; another process of Demon speciation is division.

Thus, summarizing above, the Demons of the life are the diffuse algorithms of bio-system behaviour. These algorithms can have some fragments to allow heuristic behaviour. It is known that the such behaviour together with selection mechanism are necessary conditions for creative activity. The appearance of new Demons changes properties and, hence, some reactions of bio-system in reply to either external signals. Just possibility to function not always along "algorithms" of simple physical laws (in the reason of specific and "paradoxical" reactions of living systems in response to some influences, for example, avoiding of some of eventual harmful events) allows bio-systems to survive in unstable surroundings. Of course, the such reactions request to apply not only algorithms but to use also either additional - external or/and accumulated - sources of energy. The algorithms help to manage energy flow and to decide tasks of behaviour, making bio-systems to be objects of not classical physics and thermodynamics.

After those a little comic but we hope useful reflections, we can also propose else amusing the Life Demons traits:

- every Demon provides anticipatory activity;
- every kind of bio-systems has own varieties of the Demons;
- the Life Demons are neither avatars nor villains, they try only to help to survive (not always competently unfortunately);
- new Demons awake within pool of virtual Demons (something alike to Platon's "world of ideas") but in reply on violation of the such bio-system processes which are perceived by the bio-system as vitally important;
- organisms have pools of virtual Demons (recorded as genetic information, for instance) which can be sleeping till they are called for; some of them are waked automatically along ontogenesis;
- the Demons can descent from each other but
- the Demons are not able to propagate itself independently, they need either material substance for that, for example:

- the Demons can be reproduced and transferred by bio-systems (likewise as books);
- every kind of the Demons can be accepted and used only by corresponding kinds of bio-systems, by other words in some concrete context of situation;
- the Demons can be propagated or/and saved in symbolic form as material records which can be decoded by corresponding kinds of bio-systems;
- the Demon can sometimes carry some heuristic, creative traits of behaviour so the Demon may be the carrier of the “spirit of life”;
- the Demons can combine themselves in chimeras;
- the Demons can be propagated by fission;
- living Demons wish to function always;
- idle Demon can die;
- the Demons can compete with other Demons for resources;
- and others properties...

All these features of the Demons allow to suppose that in functional aspects they are similar to viruses but not only on the basis of use of genetic information. Of course, it is not obligatory that the such viruses are harmful and dangerous as they were presented in known fantastic novel of Colin Wilson "The Mind Parasites" (1967). In connection with this we introduce also the notion about **deleterious Demon** which is not the Life Demon and which is being perceived by bio-system as giving pleasure or/and profit but which is objectively not useful for its survival or population survival. Many above properties of the Life Demons can be appropriate to any Demons but the consideration of this exciting fields (including, of course, associations with different religious ideas) isn't the topic of this work. Any life is some viral substance of the Demons with inherent processes of selection in the point of view which is given in this article; the life origin is conjugate with the origin of first Life Demon which can be not obligatory genetic one. The usual (i.e. “biological”) viruses are the special case of the Demons and, hence, they are also the carriers of diffuse algorithms of own survival.

Not difficult to see that many features of both the origin and propagation of the Life Demon can be described on the basis of the model which was given in the article “Evolution of the Life as Improvement of Management by Energy Flows” (Levchenko, 1999) in the section “Ultra-rate Evolution of Modern Biosphere as Result of Anticipatory Activity. Evaluation Experiment”. The main object of this consideration is “informational message” i.e. some portion of produced or of transferred information which change evolutionary trajectory of system. Obviously, that the Life Demon can perform a role of the such message and therefore the mechanisms which are given in above article are appropriate to the Demon origin and Demon selection. It follows also from consideration in (Levchenko, 1999) that the Demons which are perceived by bio-system to be with a priori the valuable goals have to be more successful in survival.

In order to illustrate the Life Demon model we come back to the part 2 of this article and give brief description of the biosphere evolution (see also Levchenko, 1997). At the earliest stages of life on the Earth, the anaerobic life predominates in the planet. When necessary for that resources were depleted either interruption, for example, temporary decrease of average temperature of the planet leads to decrease of populations of traditional producers of organic matter. They are not able to provide consumers of this matter and, thus, the crisis of the biosphere system arises. This leads to the appearance of the “photosynthesis Life Demon” which tries to rescue the biosphere. This Demon begins to compete very strongly with old “anaerobic Demon” (oxygen blockades many of anaerobic processes, moreover photosynthetic processes need the same as a rule resources which are used by anaerobic ones). New Demon ousts old one to backyard of the biosphere life already about 2 millions years ago. Nevertheless, the anaerobic Demon doesn't die and lives up to now and the biosphere has different manners of energy reception. When the life begins to develop on the dry land, the photosynthesis Demon generates in reply on interruptions the multitude of “kids”: there are different classes of terrestrial plants including superior modern forms. Every such kid is designed for some concrete surroundings of the planet and participates in the common circulation of the biosphere matter.

Returning to the part 2 we can also see that the appearance of new kinds of biosphere along the evolution which have new Demons means the increase of both algorithmic power of the system and ability to manage by bigger energy flows - see eq. 3. Different limiting factors don't allow to reach maximal possible flow of energy through the biosphere but just this circumstance permits to have reserve algorithmic possibilities for stability of the system. New Demons to be waked when traditional energy sources are exhausted.

This simple Demon model can permit to explain some phenomena of evolutionary biology by new way, for example to draw a parallel between equations of population biology and equations describing processes in electronic scheme - see below. On the other hand, this model can be transformed to the model of the so called

“cell automates” which are broadly discussed in new field of computer science “Artificial life” (Merelo, et al., 1997; Spirov, 1996). The regularities of some social processes can be simply described on the language of the Demon idea too. At last, the activity of economical systems includes also the above Demon mechanism. Don't suppose only this approach is renaissance of ancient vitalistic, antropomorphous etc statements or it is some return to dualism between the matter and the spirit about what Doctor Faust liked to ponder. Rather, it is some reflection of more modern dualism when organism can be described as either physical-chemical system or some sensing system which has the will to live. But not only: we believe that any model is only an hint at reality but not the reality itself, hence the Demon model isn't more funny than any mechanical one.

4 The Simple Electronic Model of the Demons Activity

This part is devoted to the building of simple electronic model which illustrates the logic of work of the Demons which provide the life of bio-system and gives the possibility to draw analogy between some properties of this model and the properties of real bio-systems.

The work of living Demons and the logic of appearance of new Demons in the case of interruptions can be understood from the simple electronic scheme in the Fig 1.

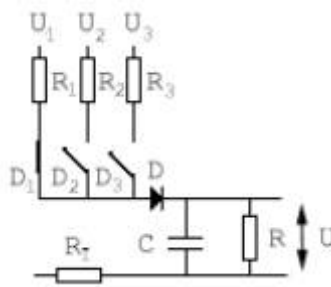


Fig. 1. Simple Electronic Model of the Demons Activity

In this picture, the charge of the capacitor C illustrates the quantity of organic matter which a bio-system contains, the current through the circuit corresponds to the energy flow through a bio-system. This charge is connected with voltage U and capacity C by known equation $Q=UC$ where Q is the charge. The energy can come in the system through the external sources U_1, U_2, U_3, \dots in the left part of this scheme. The resistor R_1 is introduced in order to consider either limiting factors which can reduce voltage U . In general case this resistor has to have nonlinear character of the current stabilizer (then the current can not exceed some value) in order to simulate known fact that the biosphere and ecosystems have natural limitations to use resources of the planet. The electrical keys D_1, D_2, D_3, \dots are the Demons, the diode D doesn't permit for capacitor C to discharge through circuits of external sources of voltage U_1, U_2, U_3, \dots (this may be interpreted as mirror of unidirectional character of many processes in the biosphere).

Within of framework of this analogy, the discharge of capacitor C in RC circuit corresponds to the process of destruction of the bio-system organic matter (time constant $\tau = RC$). The charging of the capacitor is produced through circuit D_1R_1 where electrical key D_1 means the Demon 1. When external source of voltage U_1 gives constant voltage then system is in equilibrium (the speeds of both charging and discharge are equal). The voltage U_1 produces some voltage U on the resistor R and, hence, some charge on the capacitor C . This charge can be interpreted as quantity of accumulated organic matter.

The interruption i.e. some decrease of U_1 leads to the diminution of U . The logic of the Demons work in this case is the following: signal about diminution of U ($dU/dt < 0$) switch on either sleeping Demon. It can be, for example, key D_2 in the picture. Then the voltage U returns to be not less than before interruption (we suppose in this simplified explanation that all sleeping Demons have powers which are not less than the power of D_1 , otherwise we can include several new Demons instead of D_1 only). The waked Demons don't go away, both keys D_1 and D_2 are installed to be switch on and, thus, after the first interruption two sources (U_1 and U_2) are supporting now some new heightened level of voltage on the capacitor C . The same logic of work will be for further interruptions of already used sources. We don't give here possible versions of electronic schemes which may realize the described details of mechanism of switching on of keys D_2, D_3, \dots (i.e. registration of situation when $dU/dt < 0$, turning on of either keys etc) because this can be easy

constructed by any electronics engineer but this gives nothing to comprehension of this Demon model. Nevertheless, it is important to emphasize that intellectual systems which are really able to anticipatory activity have to switch on not any of sleeping Demons but only the such one which can provide permanent (or enough long time at least) existence of these systems.

The reinforcement of action of either limiting factors (for example, the decrease of water quantity, lowering of temperature which are necessary for maintenance of achieved level of the life etc) can be represented also by this model. If to increase the resistance of resistor R_1 then we shall have the same effect of decrease of U which is in the case of interruptions of some group of separated sources (for example, U_1, U_2, U_3, \dots). Moreover, this resistor appoints the competition between Demons especially in situation when R_1 works in nonlinear regime of the current stabilizer (see above).

This simple electronic model is used by us for elaboration of the system of equations which can be applied to the biosphere evolution. This system is special case of the balance kinetic model under the condition of auto-regulation in quasi-isolated ecosystem and biosphere. We hope to present the results in another article.

5 Conclusion

The phenomenon of auto-regulation is typical for many biological processes and non biological ones. In the case of development of organism we can see different successive stages which are strongly ruled by special programs of ontogenesis. Every new stage follows after all previous stages are traversed. This demonstrates simple case of auto-regulation processes. The ecological succession is too characterized by relative strict sequence of stages. The psychical development can be also described as successive replacement of mental statuses. In this case we can especially clearly see not only auto-regulation of this process but the self-canalizing of the way of development: every new step depends on continuum of previous steps. This is the consequence of the following: the mind chooses either decision among some multitude of forecasts of mental models which concern different concrete details of situation when problem of choice arises. Thus, the knowledge determinates directions of development, but on the other hand every such direction leads to getting of new specific knowledge. It can say that the process of self-programming (i.e. particular case of auto-regulation) takes place here.

The alike phenomena take place also in the case of evolutionary processes which are successive too (although we are not able to predict all traits of them). In the broad sense the biosphere evolution is the self-programming of life in order to survive. It is important that the life not only studies the environment to survive but changes this environment. This circumstance leads to typical quanta-mechanical situation: modifications of objects of study along the study. This process had not still any finishing because the such investigation of environment changes both the traits of life and the conditions of survival.

Nevertheless, it is possible to propose important regularity, "the central road" of the biosphere evolution under auto-canalizing condition: only the such objects are being survived finally along the evolution which use the renewable resources of the biosphere (Gore, 1993). This principle can be used as one of variation ones to construct evolutionary equations for the biosphere (Abrosova et al., 1982).

In this context, the important question of life sciences is how and why does the self-programming lead to different consequences in various periods of development? It can suppose that the self-programming of the biosphere along its evolution is the self-study of biosphere to find some state when modifications (which are stimulated by the self-study) are minimal. But the way of description of the such life phenomena in the language of modern natural scientific paradigms when majority of processes is considered as manifestation of mainly physical regularities being understood as unidirectional in time hampers these investigations. We suggest it is necessary to introduce alternate multi-variant logic for description of the life processes at least. The such approach have to put at the head the management processes (but doesn't forget of course about material carriers which provide these processes). We hope that our model of the Life Demon is one of initial attempts to move in this direction

Acknowledgment

We express our thanks to Dr. Daniel Dubois for his attention to this article. Authors thank also Dmitry Yampolskiy (St. Petersburg State University) for the technical assistance.

This work was supported by the following Funds: Russian Fund for Basic Research (2000-01-00482); INTAS (97-30950) and INTAS (97-2142).

References

- Abrosov, N.S., Kovrov B.G., Cherepanov O.A. (1982).** The Ecological Mechanisms of Coexistence and the Species Regulation (in Russian). Nauka: Novosibirsk.
- Dubois, D.M. (1998a).** Introductory to computing Anticipatory System. International Journal of Computing Anticipatory System, vol. 2, pp. 3 – 14.
- Dubois, D.M. (1998b).** Emergence of Chaos in Evolving Volterra Ecosystems. In: Evolutionary Systems, Van de Vijver et al (eds.). Kluwer Academic Publishers: Netherlands, pp. 197 - 214.
- Dubois, D.M. (1998c).** Computing Anticipatory Systems with Incursion and Hyperincursion. In: Computing Anticipatory Systems: CASYS – First International Conference, Dubois D.M. (ed.). AIP Conference Proceedings 437, pp. 3 - 30.
- Dubois, D.M. (2000).** Review of Incurive, Hyperincurive and Anticipatory Systems - Foundation of Anticipation in Electromagnetism. Computing Anticipatory Systems: CASYS'99 – Third International Conference, Dubois D.M. (ed.). The American Institute of Physics, Conference Proc. 517, pp. 3 -30.
- Feynman, R.P., Leighton R.B., Sands M. (1963).** The Feynman Lectures on Physics. Addison-Wesley Publishing Company, INC. Reading, Masschusetts, Palo Alto, London.
- Gorban, A.N., Khlebopross R.G. (1988).** The Darwin Demon: Optimal Idea and Natural Selection (in Russian). Nauka: Moscow.
- Gore, A. (1993).** The Earth in the Balance. Ecology and the Human Spirit. Plenum, NY.
- Gorshkov, V.G. (1994).** Physical and Biological Basis of Life Stability. Springer-Verl.
- Khartsiev, V.E., Shpunt, V.K., Levchenko, V.F. (2000).** Theoretical Models of the Influences of Weak and Super-weak Factors on a Human organisms. In: Weak and Super-weak Fields and Radiation in Biology and Medicine. The International Congress Proceedings, Petersburg, pp. 21-22.
- Korogodin, V.N. (1991).** The Information and Life (in Russian). Joint Institute of Nuclear Research, Puschino.
- Levchenko, V.F. (1992).** Directedness of Biological Evolution as a Consequence of the Biosphere Development (in Russian). Zhurn. obshch. biol., vol. 53, pp. 58-70.
- Levchenko, V.F. (1993).** Models in the Theory of Biological Evolution (monograph in Russian), Nalbandian S.I.(ed.). Nauka: St. Petersburg, 384 pp.
- Levchenko, V.F. (1994).** What is Information in the View of Naturalist? (Some Biological and Evolutionary Aspects). WESS-com (The Journal of the Washington Evolutionary Systems Society), J.Chandler, G.Farre (eds.), Washington, vol. 4, N 1, pp. 41-46.
- Levchenko, V.F. (1997).** Ecological Crises as Ordinary Evolutionary Events Canalised by the Biosphere. International Journal of Computing Anticipatory Systems, vol. 1, pp.105-117.
- Levchenko, V.F. (1999).** Evolution of the Life as Improvement of Management by Energy Flows. International Journal of Computing Anticipatory Systems, vol. 5, pp.199-220.
- Lovelock, J.E. (1991).** Gaia: The Practical Science of Planetary Medicine. Gaia book Limited.
- Merelo, J.J., Mewes, W., Levchenko, V.F., Spirov, A.V. (1997).** Application of new section of evolutionary computations - the Mobile Genetic Elements (MGE) technique in cognitive approaches to registration, classification and segmentation of series of biological and medical images. INTAS project: Intas-97-30950, Brussels. 30 pp.
- Mitchel, E.D. (2000).** Space Flight as Anticipatory Computing System. Computing Anticipatory Systems: CASYS'99 – Third International Conference, Dubois D.M. (ed.). The American Institute of Physics, Conference Proc. 517, pp. 45-49.
- Odum, Yu. (1975).** The Ecology , vol 1,2. Pergamon Press, London.
- Rautian, A.S. (1988).** The Paleontology as Source of Knowledge About Regularities and Factors of Evolution (in Russian). In: Modern Paleontology, vol. 2, Menner V.V., Makridin V.P. (eds.). Nedra: Moscow, pp. 76 - 117.
- Rensch, B. (1960).** Evolution Above the Species Level. Univ. Press. New York, Columbia.
- Rosen, R. (1985).** Anticipatory Systems: Philosophical, Mathematical, and Methodological Foundations. Pergamon Press, NY.
- Rosen, R. (1991).** Life Itself. Comprehensive Inquiry into the Nature, Origin, Fabrication of Life. Columbia Univ. Press, NY.
- Schroedinger, E. (1955).** What is Life? The Physical Aspect of the Living Cell. Dublin.
- Spirov, A.V. (1996).** Self-Assemblage of gene Networks in Evolution via Recruiting of New Netters. In: Lecture Notes in Computer Sciences, 1141. Springer-Verl.: pp. 91-100.

Starobogatov, Ya.I., Levchenko, V.F. (1993). An Ecocentric Concept of Macroevolution (in Russian). Zhurn. obshch. biol., vol. 54, pp. 389 - 407.

Timofeev-Resovsky, H.B., Vorontsov, H.H., Yablokkov, A.V. (1977). The Brief Sketch of the Evolution Theory (in Russian). Nauka: Moscow.

Wilson, C. (1967). The Mind Parasites. London.

Wilson, E.O. (Ed) (1988). Biodiversity. National Acad. Press: Washington.