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DISSYMMETRY OF LIVING SYSTEMS

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At the present time, it may be considered as an established fact that chirality substances are preferable for constructing the most important elements of living systems and that homochirality is advantageous since it provides a great kinetic efficiency of stereoselective reactions [Kizel, 1985].

However, the question of a definite sign of chirality observed in nature is up to now the point at issue. It should be remarked that some substances used in living organisms appear to be exclusively right handed, others (e.g. amino acids) are exclusively lefthanded. At any rate, in vitally important structural formations the combination of different signs seems justified but the reason for a distinct choice of one of the alternative combinations remains unclear.

As is known, in the system of chiral molecules of different signs in thermodynamically nonequilibrium systems (living systems belong to them) in the presence of metabolism with the environment, two nonequilibrium but stationary states with an excess of antipodes of this or that kind occur; with an increase of metabolism the excess increases up to the total optical purity. Bifurcation takes place when a certain threshold value of metabolism is achieved.

It is also shown that at the initial stages of originating metabolism and in the region of the bifurcation of a system, a slight excess of one of the antipodes caused by fluctuations or

an outside influence is sufficient for orienting the system along one of the routes [Morozov et al. 1983, Fajszl, 1982] . Thus, three main suppositions appeared:

- 1) An accidental fluctuation in an initially racemic substance at the moment of formation of the first living systems and of the origination of metabolism with the environment, i.e., in the region of bifurcation, and a further development of the systems of only one sign;

- 2) The origination of living systems of different signs in various areas with a subsequent "victory" of one of them when the areas come into contact with each other.

- 3) The influence, especially in the region of bifurcation, of a permanent external dissymmetric factor.

Assumption 1) accounts for dissymmetry most simply and uncontradictorily, provided the living systems originate during one event in a definite small area at a definite time. The calculations of the necessary and permissible range of fluctuations [Morozov et al., 1983] confirm the acceptability of this mechanism though inherently local independent fluctuations of different signs at adjacent points are possible.

However, a great number of such events, which is, apparently, unquestionable, will inevitably result in the areas of right-handed and lefthanded systems (substrates of different signs, if any, may, in principle, be used).

Assumption 2) is, in essence, a development of the first one. It is shown in [Zeldovitch et al., 1986] that in the presence of the contact of two areas of different signs, utilization of an achiral substrate in both of them, possible mutual diffusion and

mutual inhibition, of crucial importance is the geometry of areas - the curvature radius of the interface (i.e., indirectly, the relative dimensions of the areas). If the curvature radius is finite ($\sim 10^4 - 10^{14}$ cm), then there will be the victory of one of the forms the expansion of one area and the contraction of the other.

The velocity of motion of the interface of the areas depends on two independent factors: the ratio of a diffusion coefficient to the radius of curvature and a greater efficiency of self replication of one of the forms as a result of the possible, in principle, influence of an external dissymmetry factor.

Assumption 3. The discussion about the possible influence of a dissymmetrical external factor on the dissymmetry of living systems continues up to now. The search for such a factor in the chiral combinations of electric, magnetic and gravitational fields has failed. Nowadays, the only possible factor is taken to be the effect of weak interactions where "righthanded" and "lefthanded" sides are distinguished.

There are two probabilities: 1) the effect of neutral currents in atoms and 2) the asymmetric radiolysis produced by polarized electrons.

The first one results in the difference of the energy of enantiomers 10^{-17} eV, only for the atoms at the end of the Mendeleev table it can be of the order 10^{-12} ($\sim Z^5$); for the molecules consisting of light atoms the recent estimates give 10^{-18} eV [Tranter, 1985]. This quantity is extremely small, especially, as compared to the influence of the curvature of interface and

of fluctuations. Besides, a very large resource of primary biomass is necessary for producing appreciable influence - such a great, that the fluctuations dispersion could reduce or exclude their influence. However, recent estimates [Morozov et al., 1984] show, that the supposed resource is still sufficient for the effect of weak interactions to manifest itself, and this factor cannot be disregarded.

The possibility of asymmetric radiolysis has been investigated experimentally for a long time (see, e.g., [Bonner et al., 1984]) But all the results were negative; racemization was even observed. According to the estimates the asymmetry of radiolysis must not exceed $10^{-9} - 10^{-11}$; the latter value is more probable. Besides, the electron depolarises gradually.

The advocates of the hypotheses concerning the influence of weak interactions put forward assumptions about the presence of the local powerful sources of polarized electrons - the deposits of ^{235}U , its spontaneous fission, natural "fission reactors", and the availability of ^{26}Al in nature. The assumptions about the role which can play the emission of novae and supernovae were even put forward. It was also pointed out, that, according to Eigen, life could originate at low (up to -20°C) temperatures when fluctuations were essentially suppressed, as well, as the racemisation [Hegström et al., 1985].

We see the problem is not solved yet, it requires the interpretation of some possible events and certainly merits attention.

The final result of discussion disregarding, we must agree, that only living systems, because of their physico-chemical peculiarities, can essentially amplify the initially arisen (or so

far arising) an very insignificant excess of one of chiral forms of them.

So far as the presence of chirality striking manifest itself at all steps of biological hierarchy, the question is of great interest.

References

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