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BIOLOGICAL EFFECT OF NATURAL AND WEAK ARTIFICIAL MAGNETIC FIELDS (On the State of the Art)

Moscow REAKTSIYA BIOLOGICHESKIKH SISTEM NA SLABYYE MAGNITNYYE POLYA (MATERIALY VSESOYUZNOGO SIMPOZIYMA 21-23 SENTYABRYA 1971 GODA) [Reaction of Biological Systems to Weak Magnetic Fields (Materials of the All-Union Symposium 21-23 September, 1971)] in Russian, USSR Academy of Sciences, Scientific Council on the Complex Problem of Cybernetics, USSR Ministry of Public Health 1971, pp 3-6

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[Text] The term "weak magnetic fields" used at the given symposium cannot be considered very appropriate, but nevertheless it is, in our opinion, preferable to the term "magnetic fields close to zero" used by the American researchers (Conley, 1969). Historically this term owes its origin to the first facts about the presence of the biological effects of geomagnetic fields (Brown, 1967) and the threshold effect of constant magnetic fields of about 100 oersteds (Pereira, et al, 1966, Gualtirotti, 1963, Kholodov, 1966). Hence, it was possible to draw the conclusion that with an increase in the intensity of the artificial magnetic field in the reactions of various biochemical systems to the magnetic fields in certain cases a qualitative jump is observed which is reasonably called the "injury threshold." The idea was that with a magnetic field intensity above the indicated value cumulative unfavorable effects are possible. (For the sake of correctness it must be noted that in 1930 P. V. Savostin indicated the high biological effect of weak fields: he stated the proposition of the biological significance of the geomagnetic field as a necessary factor in the normal realization of ontogenesis: however, all of this was soon forgotten). Beginning with what has been stated above, we must propose that the "injury threshold" obviously must exist also for the reduced magnetic field, the effect of which, unfortunately, has been little studied. Thus, the problem of the biological effect of the weak magnetic field must include the study of the biological effect of the

geomagnetic field, the reduced magnetic field and the effect of fields within the limits of two orders exceeding the geomagnetic field (call them augmented magnetic fields).

Considering the problems of the effect of the reduced magnetic field and the augmented magnetic field by comparison with the geomagnetic field it is necessary to note that this comparison is complicated by the conglomerate nature of the geomagnetic field itself, which in addition to the multicomponent nature of its composition is distinguished by fluctuations. The majority of the biological effects of the geomagnetic field apparently are connected with this second feature of the field.

Accordingly, in the experiments with artificial fields, whether they are greater than or less than the geomagnetic fields, its biological effect is still studied in practice with respect to one of these components. The other is more or less ignored.

Obviously, this also determines the difference in the basic areas to which the researcher directs his attention when studying the biological effect of the reduced magnetic fields, geomagnetic fields and augmented magnetic fields. Actually, when studying the effect of geomagnetic fields, attention is concentrated primarily on the following problems:

A. Orientation during movement and migration,

B. Orientation of the organs and systems of organs,

C. Orientation of the biological process in connection with the fluctuations of the geomagnetic field (here the relation to heliobiology is traced clearly),

D. The biological significance of the terrestial magnetic anomalies.

When studying the effects of the reduced magnetic field the following are of primary importance:

A. The relation to space biology (the absence of a factor -- like weightlessness),

B. Ontogenetic problems,

C. Hygienic aspects (hypomagnetic syndrome),

D. Problems of the mechanism of sensitivity to the field.

Finally, when working with the augmented magnetic field we are primarily interested in the field from the point of view of discovering the initial steps in the "hypermagnetic syndrome."

Of course, the problems of the mechanism of the effect of the magnetic field must be studied when working with all forms of magnetic fields, but for the reduced magnetic field they have a special shading bordering on estimation, establishing the biological significance of the magnetic field as a natural factor for life in general. It is no secret that until recently the significance of the terrestial magnetosphere was reduced to its protective (against penetrating radiation) effect, although very important, nevertheless indirect. In the light of what has been stated, our concept of the biological functions of the magnetosphere has been immeasureably expanded. Unfortunately, in the given stage of development of this field of magnetobiology, it is necessary to warn the researcher against excessive, poorly justified reduction of all of the phenomena periodically and aperiodically occurring in the biosphere on various levels to being conditioned only by the external magnetic phenomena. I should like to emphasize in general that when studying the effect of a weak magnetic field the procedural requirements on the statement of the experiment increase immeasurably, and the statement of these experiments itself is seriously complicated.

The lack of equivalence of procedural means of obtaining augmented magnetic fields or reduced magnetic fields by shielding and compensation can be reduced and is reduced to the absence of strict argument from the initial conclusions, which is very dangerous for any young field of science during the fact-gathering period. There are now sufficient facts to issue a serious statement of the problem of the mechanism of the effect of a weak magnetic field.

In addition, the specific problem of the mechanism is central to the overall problem since it only permits us to obtain an answer regarding the biological significance of the magnetic field, that is:

1. Does it help structurally to support the organization of life,

2. Is it the rhythm-setting factor which, in turn, determines the synchrony of the endogenic metabolic processes.

These seemingly similar problems are distinguished by the fact that the variable and constaut component of the geomagnetic field can be means of orientation in space at the same time as the fluctuations alone can be time synchronizers. However, if in the first case we could propose the principle of frequency resonance

as the basis for the orientation mechanism, in the case of a weak constant field this mechanism is still more difficult to imagine. In spite of the general theoretical arguments and hypotheses regarding the presence in a live cell of the integrating electromagnetic field, its controlling function (Sent-D"yerdi, 1954), and the membrane mechanism of sensitivity to a constant field (Gualtirotti, 1966, Dubrov, 1968), no one as yet has succeeded in demonstrating either the presence of the field itself or the presence of these functions, nor have they provided a sufficiently strict theoretical basis for the variation of the membrane permeability in a weak field (the more so in that direct experiments confirming the capacity of the membrane to react to weak magnetic fields have not been performed). Thus, with respect to all items, the question of the mechanism of the perception of weak magnetic fields by animate objects remains open. It is only possible to hope that the further conscientious and unbiased accumulation of new facts and critical evaluation of them will help shed light on the true mechanisms of this sensitivity and its biological significance.