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DISCUSSION

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PROBABILITY OF A "GREENHOUSE DISASTER" AND THE NATURE OF FEEDBACKS*

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The probability of the onset of a "greenhouse disaster" is discussed at theoretical level. In ecological and evolutionary processes of great importance are feedbacks which are always directed against the cause taking the biosystem out of the state of ecological equilibrium. It is more likely that the greenhouse effect will trigger in the biosphere processes aimed at restoring in it the state of ecological equilibrium. The probability of a "greenhouse disaster" is very low. © 1996 Elsevier Science Ltd. All rights reserved.

The expected aftermath of the greenhouse effect in the terrestrial atmosphere is causing much concern to the world community, although its probability and quantitative indices are differently evaluated. Recently, Karnaukhov [1] presented his scenario of the development of events in which a rise in the concentration of carbon dioxide in the terrestrial atmosphere and a corresponding rise in its temperature will turn out, according to the hypothesis of the author quoted, to be part of a self-intensifying process. Karnaukhov is inclined to see in this situation an example of the effect of positive feedback — a concept widely used in publications on biology and ecology [2, 3]. According to the reasoning of the author quoted, the Earth may be threatened by the directivity of evolution, which would make the continued existence of the biosphere impossible and for a number of properties of the atmosphere would make the Earth similar to Venus. The conclusions of the author in themselves and the events predicted by him are undoubtedly of interest. However, theoretical possibilities exist for presenting a different train of future events in the Earth's biosphere.

In my view, in ecology and the theory of the evolution of living systems, any regulatable and self-regulating processes may be understood and characterized by enlisting the concept of signal feedbacks which cannot be "positive" and "negative" since they are always "opposites", i.e. regulating [4]. In accord with the Le Chatelier–Braun principle, feedbacks are always directed against the causes taking the living system out of the state of ecological equilibrium and homeostasis. The ecological results of the operation of feedbacks are ontogenetic adaptations of organisms and just as many adaptive successions of ecosystems. The evolutionary results,

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accordingly, are elaboration of the adaptive features of the organization of any biosystem [5]. All living systems are capable of self-regulation [6]. An example of a grandiose biosystem already preserving for billions of years viability and relative homeostasis (combined with the action of physicochemical factors sometimes extremely potent and destructive and the impressive results of biological evolution) is Gaia itself — the biosphere of the Earth [7], the evolution of which has not been interrupted for about some four billion years [8].

Taking examples from the ecology of communities and populations it is easy to see that the growth of the size of a population of any species, with time, will bring into operation particular mechanisms limiting this process. Harsh climatic conditions, as a rule, will have as their result the formation of adaptations which will enable the renewed species, as before, to perform its own biocenotic role. Extinct species have always been replaced by new ones — their competitors. Saturation of the Earth's atmosphere with oxygen, a destructive factor for the anaerobic forms of life, has promoted the replacement of the dominant forms of life [9, 10] and has not led to its disappearance.

The scenario of the "greenhouse disaster" seems to me unlikely for the reason that the biosphere as a living system will necessarily counteract unfavourable trends worsening the functioning of its subsystems. This may be reflected in many aspects. One may expect quickening of the activity of biosystems (species and ecosystems), effectively utilizing carbon dioxide and methane, and also promoting the release of carbon dioxide from the turnover of matter. An excess of this gas will probably have a depressant action primarily on heterotrophs and saprotrophs, which will slow further rise in the concentration of carbon dioxide. Change in the conditions of life on Earth will be felt by man long before it becomes similar to Venus. As a biological species, man will experience deterioration of the conditions, which will be expressed in reduction of the rates of multiplication, shortening of individual life and so on. Fall in the population with time will weaken pressure on the biosphere. As a highly organized society, mankind will evidently be able to counter in a goal-directed way the worsening of the state of the biosphere. Both these tendencies will diminish the greenhouse effect.

The possible sequelae of the greenhouse effect will prove to be highly diverse and, as is usual in complex systems, each separately considered change in the ecosystems will produce secondary, tertiary and other effects [4], which may be postulated in the most general form. However, there are good grounds for the main conclusion: any uni-directed change in the biosphere acting as a selectogen [11] will trigger the evolutionary mechanism directed against the cause, taking the biosphere out of the state of ecological homeostasis.

Let us imagine that the greenhouse effect, nevertheless, assumes the character of a disaster. In the history of Gaia, there have been more than enough disasters also including severe global cataclysms [12] and yet the biosphere has survived. The hypothetical "greenhouse disaster" at first will be on a local and regional scale, also entailing suppression of the biological and anthropogenic causes augmenting the content of carbon dioxide. In this variant of the greenhouse effect, too, its development into a global cataclysm threatening the existence of living matter appears highly dubious.

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