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Physical and Biological Bases of Life Stability

Man, Biota, Environment

With 37 Figures

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Preface

It is well known that the biochemical processes of life on Earth are maintained by the external solar radiation and can be reduced to the synthesis and decomposition of organic matter. Man has added the synthesis and decomposition of various industrial products to these natural processes. On one hand, biological synthesis may only be conducted within the rather narrow margins of parameters of the environment, including temperature, humidity, concentrations of the inorganic substances used by life (such as carbon dioxide, oxygen, etc.) On the other hand, the physical and chemical composition of the environment suffers significant changes during those processes of synthesis and decomposition.

The maximum possible rate of such change due to the activity of living beings can exceed the average geophysical rates of change of the environment due to activity of terrestrial depths and cosmic processes by a factor of ten thousand. In the absence of a rigid correlation between the biological synthesis and decomposition, the environment would be greatly disturbed within a decade and driven into a state unfit for life. A lifeless Earth, however would suffer similar changes only after about a hundred thousand years. Preservation of the existing state of the environment is only possible with strict equality between the rates of biological synthesis and decomposition, that is, when the biochemical cycles of matter are virtually closed.

The environment of living beings is regularly subjected to sudden external perturbations such as volcanic eruptions, the fall of large meteorites, and other major geophysical and cosmic fluctuations. Return to the initial state after such perturbations can only be achieved through the compensation of such changes by the living beings, distorting the biochemical cycles from their closed states. The enormous power of synthesis and destruction developed by the Earth biota is necessary to quickly compensate for the various external perturbations.

Numerous different species of living organisms can exist in the present environment, including various domesticated plants and animals. However, an arbitrary set of living things with adequate life capacity cannot maintain the stability of the environment. It is only a strictly defined set of species, forming rigidly correlated communities, which is capable of keeping the environment in a state fit for life. Each species in the community fulfills its precisely prescribed role in stabilizing the environment. There are no "lazybone" species in the community performing no work, and, moreover, there are no villain species that would disrupt the internal

correlation of the community. It is the full set of such natural communities which comprises the Earth biota. Within a time period of several thousand years, only random variations around its stable state could take place and the biota should not have to adapt to any random change in the environment (Sect. 3.9).

The evolutionary transition from one stable state of the biota and its habitat to another takes about a million years; that is the time of species formation.

Thus processes in outer space and in the Earth's core, external with respect to the biosphere, result in a directional change of the environment. Such changes should have brought the terrestrial environment to a state unfit for life, similar to those found on the surface of Mars or Venus, in several million years. Solar radiation by itself does not change the composition of the environment and does not affect the processes in the Earth's core. Using solar radiation as a source of energy, life organizes the processes of transformation of the environment, basing them on the dynamically closed matter cycles, their fluxes exceeding the fluxes of destruction of the environment by the external forces by many orders of magnitude. This is what enables the biota to compensate for practically any adverse changes in the environment by directional change of biochemical cycles from their closed character. This is how life can ensure the stability of an environment fit for its own existence.

It is apparent, however, that there is some threshold level of perturbation of both the natural biota and the environment above which the stability of both is broken. Man's activities during the pre-industrial era did not produce any apparent changes in the natural biota. The biota of non-perturbed natural communities was then capable of compensating for every perturbation of the environment produced by man's activities. There arose no problems of protecting the environment from pollution, and so there was no need for any closed cycle technologies. Such a situation prevailed until the beginning of the industrial era in the last century.

During the present century a significant restructuring of natural biota has occurred, and the rate of pollution of the environment by industrial wastes has drastically increased. As a result the perturbed biota has lost its capacity to compensate for anthropogenic perturbations, and the environment has started to change on a global scale. Any directional change in the existing environment means the loss of its stability and is thus unfavorable for the biota and man.

Escape from the situation thus formed is usually thought to be in a transition to no-waste technologies and to ecologically clean energy sources. However, that is no solution to the task of preserving the environment. Any industrial activity by man is based on energy consumption and involves land use and hence transforming the natural biota. The present-day land biota, perturbed by man, is not only incapable of compensating for anthropogenic perturbations, but perturbs the environment itself at a rate similar in order of magnitude to that generated by the industrial enterprises themselves (Sect. 4.11). Further perturbation of natural biota via ever-increasing industrial activities based on ecologically absolutely clean energy sources may drive the biota into a totally open state. In that case the rate of perturbation of the environment by the perturbed biota will exceed many-fold

that due to activities of modern industrial enterprises. The transition to no-waste technologies will not result in any practical changes in the situation. It will only overcome the apparent local pollution. It is not possible to substitute the natural biota by a technosphere operating, similar to the biota, by the reproducible solar energy: information fluxes in the biota exceed the maximum possible information fluxes in the technosphere by 15 orders of magnitude (Sect. 2.8).

The real breakthrough consists in recovering the natural biota to the extent necessary to support stability of the environment on a global scale. That calls for a reduction in the scope of industrial activities and in the overall human energy consumption on the planet by means of negative population growth.

This book aims to clarify the laws by which the natural biota and man function. That way, the admissible threshold of perturbation disrupting the stability of the biosphere may be estimated, as well as the necessary reductions of contemporary anthropogenic perturbations.

The book is structured as follows: The first chapter briefly describes the contents of the monograph, gives the principal quantitative results and stresses the most important conclusions. The subsequent chapters expound in fine detail on, and produce detailed quantitative arguments and evidence for, the individual claims set forth in the first chapter. The author hopes that the reader will have a clear enough understanding of the message after reading that chapter. As for the more detailed information on any particular question it can be found in one of the follow-up chapters.

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1. Ecological Stability

1.1 Introduction

The aim of all ecological studies is to give a scientific answer to the question: just what are the normal conditions of human existence and how may these be secured for both the present and future generations? Man exists in his environment. Therefore ecological studies should first of all provide for conservation of an environment fit for man's existence.

If the result shows that changes in the environment are mainly controlled by erroneous management of business, the ecological problem would turn into a problem of finding out possible ways of organizing these activities such that they do not alter the environment (Schneider, 1989a). The problems of protecting the wilderness areas and of preserving wild species in both the fauna and flora would then only be secondary, related mainly to catering to the aesthetic tastes of man. Preserving the unique gene pools of the wild species in their natural conditions, as well as in reserves, zoos, and gene banks would then become a purely applied interest, having nothing to do with the ecological task of protecting the environment. Reserves, negligibly small in their areal extent, would serve merely as wild nature memorials, fit only for studies by some narrow circle of dedicated experts. It is apparent that many wild species can only survive if at least 30% of habitable land surface is withdrawn from industrial use (Wilson, 1989). However, mankind will certainly never go to those extremes if all the above is true, and the respective species would be doomed to die out without causing any great concern in the general public.

If, on the other hand, it appears that the communities of natural biospheric species completely control and support the existing state of the environment in which man himself exists, then protection of the wilderness areas, preservation of the natural communities of all the wild species and estimating the threshold of admissible perturbations in the natural biota become the central problem and task of ecology. The restructuring of industry towards a lower level of environmental pollution is then reduced to a local task of second priority which is, strictly speaking, not related to ecology itself.

The task of the present study is to demonstrate that it is impossible to preserve a stable environment fit for man's existence within the prevailing tendencies in restructuring the natural biota and the biosphere.