7. Conclusion

The principal statements of this monograph may be summarized as follows. All living things are organized on the basis of most complex internal correlations. All the types of biological correlation are unstable and are subject to constant decay. Both statements have been empirically tested at every level, from genetic to social. Any and all forms of correlation in biology, from cellular to communities, are supported via competitive interaction of individuals in the population, and via the stabilizing selection. (That latter statement has only been tested for some organisms and for some of the simplest communities.) No other means of compensation of continuously occurring decay are known.

Stability of the environment may only be explained as based on biological compensation of all the fluctuations and the directional abiogenic changes in it. This statement is testified to by extensive empirical data. The capability of the communities to keep the matter cycles closed and to extinguish external fluctuations of the environment cannot be supported by the competitive interaction between the individuals in each species comprising the community. The competitive interaction within the species is only capable of supporting the paired correlations between the species, such a correlation containing no information on the necessary interaction of the community as a whole with its environment. That information, contained in the genome of each natural species of the community, may be withheld from decay only via competitive interaction between the different communities. It follows then that all the communities may only exist in populations of competitively interacting communities, similarly to all individuals. The last statement does not contradict any of the empirical data so far known, and enjoys diverse proxy support. The measurements available for the size of communities and for the numbers of their populations are as yet indirect (Gorshkov and Gorshkov, 1992).

Communities are the most complex forms of biological correlation. The formation of the community is only related to the necessity to keep the cycle of matter closed, and to stabilize the environment. There exist many examples of stable existence of populations of separate species outside their natural communities where the cycles of matter are open. There are no grounds to believe that artificial communities may be constructed, which could stabilize the environment at the same level of accuracy that natural communities are capable of providing. Therefore, reducing the natural biota to within a volume smaller than some threshold value robs the environment of its stability, which cannot then be restored by building new cleaning complexes, by proceeding to no-waste industrial cycles, or by using ecologically pure sources of energy.

The level of that threshold was found from certain independent empirical results. It is demonstrated that the share of consumption by large animals in all the known natural communities does not exceed 1 % of the natural biological production. Starting from the analysis of the data on the carbon cycle, it is demonstrated that stabilization of the environment by land biota first failed after the start of the industrial revolution, when the anthropogenic share of consumption of the production from biosphere exceeded 1 %. For all of the several thousand years prior to those times, that part of the biosphere which had remained so far non-perturbed, could compensate for all the perturbations introduced by man's activities, man having already transformed practically all the natural communities of Europe and most of Asia.

The biosphere, consisting of the natural biota formed in the process of natural evolution and interacting with the external and immediate environment, is, by all appearances, the only system capable of supporting the stability of the habitable environment under any perturbations likely to happen.

Referring back to past catastrophes in the history of Earth is of little use. There is still no empirical proof available to show these to have been accompanied by a loss of biological control over the environment on a global scale. The information on such catastrophes has mainly been obtained from paleontological data on the large mobile animals, which have been shown to comprise only a fine superstructure of the natural biota. Extinction of such animals hardly perturbed the normal functioning of the biota in stabilizing the environment.

Let one assume that catastrophes destroying the overall correlation in the biota are still possible. Then, upon the imagined complete destruction of all the communities in the biota, following the single catastrophic event, and the ensuing loss of biological control of the environment on a global scale, two mutually independent processes should start: the process of restoration of the natural biota, and the process of the directional abiotic change of the environment no longer controlled by the biota. Whether life will be preserved after that or not depends on the relative rates of these two processes. The available data apparently indicate these two rates to be of the same order of magnitude. In other words, the perturbed biota, having lost its control of the environment, might have had time enough to regenerate evolutionarily and resume such a control within the time of abiotic changes of the environment to a state unfit for life. The very fact of the evolution of life and of the biological control of the environment testifies to that.

If one assumes that the present anthropogenic perturbation is similar to such a catastrophe destroying the biological stability of the biosphere, then, after the complete loss of correlation in contemporary biota, the stable environment fit for life and its biological control will be regained only after several hundred thousand years. However, during that period of regeneration the environment and the biota may well be in a state unfit for the existence of any mobile animals, man included, and, possibly, multicellular life forms in general. The newly regenerated stable

biota might contain no ecological niches fit for multicellular individuals at all. Thus all those species would irreversibly vanish from the face of the Earth, so in that sense such a catastrophe would not in any way differ from a complete extinction of life for mobile animals and man.

Therefore preserving the natural communities and the existing species of living beings to the extent necessary to satisfy the Le Chatelier principle with respect to global perturbations of the environment, is the principal condition for further life on the planet. To do that it is necessary to preserve the virgin nature of most of the territory of the planet Earth, rather than conserving the biodiversity in gene banks, reservations, and zoos of negligible surface area (Riviere and Marton-Lefevre, 1992). It is necessary to raise the questions of organizing whole reserved continents and oceans. The first step in that direction might be preserving the continent of Antarctica intact, as is being widely discussed all over the world.

Appendix A
Details of Calculations in Sect. 4.11

Consider in detail the task of calculating the increment in production of the dissolved organic carbon (Gorshkov, 1991b, 1993a). Concentrations of radiocarbon vary at an approximately constant gradient from the surface (s) to depth L, less than 1 km, and then at deeper levels (d) remain approximately constant down to the very seabed at depth H. We denote all the surface preindustrial values by the additional subscript "0". Denoting the concentration of isotope $^\nu C$ by the same symbol in italics (and indicating additionally its localization in brackets in either the organic (+) or inorganic (−) reservoir, e.g. $^\nu C(s_0^+)$ or $^\nu C(d^-)$), we arrive at the following equation of mass budget for carbon (either "+" or "−") in the oceanic column of unit area and depth H:

$$H \frac{d\,^\nu C(d)}{dt} = {}^\nu F - \frac{^\nu C(d)H}{^\nu T}, \tag{A.1}$$

where $^\nu F$ is the influx to that reservoir column, $^\nu T$ is the residence time for atoms of carbon isotope $^\nu C$ in the reservoir. The mass of carbon in the oceanic column is assumed equal to $^\nu C(d)H$. Deviation of preindustrial concentration in the surface layer from its value at depths influences the total mass of carbon by only several per cent, see Fig. 4.4.

The influx channel to reservoirs of both organic and inorganic carbon is the same for both ^{12}C and ^{14}C. However, ^{14}C has an additional escape channel from each reservoir, the decay channel. The last term in Eq. (A.1) for ^{14}C actually is a sum of two terms:

$$^{14}C(d)H(^{12}T^{-1} + T_c^{-1}),$$

and the residence time for ^{14}C in the reservoir is determined by the well-known relationship for any two parallel channels:

$$\tau^{-1} = T^{-1} + 1, \quad \tau \equiv {}^{14}T/T_c, \quad T \equiv {}^{12}T/T_c, \tag{A.2}$$

where $T_c = 8267$ years is the average lifetime of ^{14}C (Degens et al., 1984).

The influx $^\nu F$ in both organic and inorganic reservoirs is proportional to surface water concentration of inorganic radiocarbon $^\nu C(s^-)$. The equation $d\,^\nu C/dt = 0$ had held for the stationary preindustrial steady state, and the influxes $^\nu F_0$ into the reservoir coincided with the escape fluxes from the reservoir:

$$^\nu F_0 = {}^\nu C(s_0^-)^\nu v, \tag{A.3}$$