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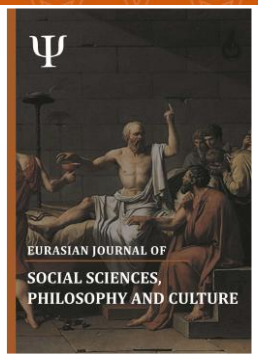

INTEGRITY AND HIERARCHY IN ECOLOGICAL SYSTEMS

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ABSTRACT

This article provides a philosophical analysis of integrity and hierarchy in ecological systems. Ecological systems are considered as a form of unified being in which natural, social, cultural, and human dimensions are inseparably interconnected. The concept of integrity reflects the holistic nature of ecological reality, emphasizing that ecological processes cannot be fully understood in isolation from one another. Any change in a single element influences the system as a whole. Hierarchy, in turn, reveals the multi-level structure of ecological systems, where biological, social, and spiritual factors are organized in a structured and interdependent manner. From a philosophical perspective, ignoring the integrity and hierarchical organization of ecological systems leads to fragmented interpretations of environmental problems. The article argues that a systemic and philosophical approach is essential for understanding ecological being and for developing a harmonious relationship between humans and nature. Such an approach forms a theoretical basis for ecological sustainability.

Introduction. An important aspect of the systematic organization of the ecological world is the dynamic interaction of ecosystems at different levels. As V. I. Danilov-Danilyan noted, self-regulation processes are constantly occurring in natural complexes, aimed at maintaining the stability of the system under changing external factors. These processes may include adaptation mechanisms of individual organisms, changes in the species composition of communities, large-scale ecosystem restructuring as a result of anthropogenic impact or climate change. Here, the principle of feedback plays an important role in the functioning of ecological systems. Integrity and hierarchy in ecological systems

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regulation processes constantly occur in natural complexes, aimed at maintaining the stability of the system under changing external factors. These processes may include adaptation mechanisms of individual organisms, changes in the species composition of communities, large-scale ecosystem restructuring as a result of anthropogenic impact or climate change. Here, the principle of feedback plays an important role in the functioning of ecological systems[1:89]. However, under the influence of anthropogenic factors, such as environmental pollution, destruction of natural biotopes, and excessive use of natural resources, the integrity of ecological systems can be disrupted. In this regard, understanding the limited self-restoration capacity of ecological systems is of particular importance. For example, the destruction of forest ecosystems as a result of felling or fires can lead to soil degradation, biodiversity reduction, and climate change in the region. Restoring such systems is time-consuming and, in some cases, impossible without human intervention[2:54]. In this regard, the concept of sustainable development is of particular importance in the philosophy of ecology. It implies that human intervention in natural processes must be balanced and take into account the limits of ecosystem stability. Systematic analysis of the ecological world allows us to identify critical points where irreversible changes in natural systems begin. Thus, exceeding a certain level of greenhouse gas concentration in the atmosphere will lead to global climate change, which will no longer be covered by natural regulatory mechanisms.

Materials and methods. Ecological reality, considered from the point of view of a systematic approach, has a number of fundamental features, among which integrity and hierarchical organization occupy a central place. These characteristics determine the principles of functioning of natural systems, their stability and adaptability.

Regarding the structural levels of ecological existence, ecological systems are complex, multi-level structures containing various components, the interconnection of which forms a holistic dynamic system. Within the framework of philosophical analysis, several structural levels of ecological existence can be distinguished:

- Molecular-cellular level - includes biochemical interaction processes in living organisms that ensure metabolism, growth, and reproduction.
- The organism level considers individual living organisms as elementary components of ecosystems.
- Population-species level - covers groups of organisms belonging to the same species living in a certain environment.
- Ecosystem level - includes the interaction of various species and abiotic factors in a particular biogeocenosis.
- The biosphere level is a global system that unites all ecosystems of our planet and forms a single ecological space[3:98].

The philosophical significance of this multi-level structure lies in the fact that each level influences others, forming a complex network of interconnections. For example, at the biosphere level, climate change (global warming) affects ecosystems, species populations, and even molecular processes in organisms.

The principles of integrity and hierarchical organization determine the main characteristics of ecological existence, ensuring its stability, self-regulation, and ability to

adapt to changing conditions. The interrelationship of these features is important for understanding the systemic mechanisms of ecology in the context of global environmental problems of the 21st century.

The principle of wholeness and its manifestation. The integrity of ecological systems is expressed in the fact that their elements do not exist separately from each other, but are in constant interaction with each other, forming a single functional structure. This property makes systems resistant to external influences, since the failure of some of them is compensated by the reconstruction of the entire system[4:120]. The manifestation of integrity can be seen in the following phenomena: firstly, the cycle of matter and energy - mechanisms for the redistribution of resources within ecosystems (for example, the carbon or nitrogen cycle); secondly, ecological balance - dynamic equilibrium between different types of the environment and abiotic factors; thirdly, the principle of synergy - strengthening the effect of interaction of ecosystem elements, creating new qualities that do not depend on the properties of individual components[5:78]. Integrity is also manifested in the adaptive mechanisms of ecosystems, which allows maintaining stability even when environmental conditions change. For example, the restoration of forest ecosystems after a fire indicates the ability of natural communities to self-regulate.

Another important aspect of the principle of the integrity of ecological systems is their ability for adaptation and evolutionary development. Ecosystems are not static structures - they are constantly changing under the influence of both internal and external factors. According to the research of A. N. Fomin[6:134], natural systems have a high degree of plasticity, which reflects their ability to adapt to changing environmental conditions. This process involves not only changes in the population structure, but also changes in ecological niches that contribute to the survival and further development of ecosystems.

One of the manifestations of systemic integrity in ecology is the succession mechanism - the sequential change of ecosystems over time. For example, when a water body is overgrown with grass, there is a change of communities from primary hydrobionts to the formation of stable terrestrial biogeocenoses. This process shows that natural systems strive for stability, obeying the laws of self-regulation. V. N. Sukachev[7:98] noted similar patterns in his works, stating that succession is not a disordered process, but a directed change that ensures the stability and integrity of the biogeocenosis.

Results. The integrity of ecological systems is also manifested in the fact that changes in one element are necessarily reflected in other components. This is observed, for example, in agroecosystems, where the introduction of new plant species or changes in agricultural practices lead to changes in soil cover, the number of pollinating insects, and other links in the ecological chain. As V. Kurajkovsky[8:65] noted, interference in complex natural processes without taking into account their systematic organization can lead to disruption of the ecological balance and the occurrence of unforeseen consequences, such as soil degradation or a decrease in biodiversity. The concept of integrity in ecological systems implies that any changes in the natural environment should be considered in terms of their impact on the entire system. A philosophical analysis of this issue allows for a deeper understanding of the interdependence of all

components of the ecological world and the development of scientifically based strategies for managing natural resources. In this regard, the principle of integrity has not only theoretical, but also practical significance and serves as the basis for the formation of environmental policy aimed at sustainable development.

Discussion. Now let's turn to the hierarchy of ecological systems. The hierarchical structure of ecological systems is another important aspect of their organization, which ensures their integrity and stability. The hierarchical structure of ecological reality means that the systems are organized in the form of a hierarchical structure, in which each level plays a specific role, but at the same time is subject to general laws[9:65]. Main features of the ecological hierarchy: subordination of levels - each level of the ecosystem is formed on the basis of lower structures. For example, an ecosystem includes populations, and populations are made up of individual organisms.

Interaction of levels - processes occurring at one level affect all other levels. For example, changes in the biodiversity of populations (species level) affect the stability of the ecosystem.

Heterogeneity of structure - different levels have different rates of change: molecular processes occur faster than evolutionary changes in the biosphere.

The hierarchy of ecological systems allows for their analysis from various positions - from the micro level of biological interactions to global processes of anthropogenic impact on the biosphere. Each of these levels has its own characteristics, but at the same time, they are closely related to other levels and form a complex system of interactions. According to V. I. Vernadsky[10:112], it is this multi-level structure that allows natural systems to maintain their functionality even when the external environment changes.

The lowest level of the hierarchy of ecological systems is organisms, which interact and form populations. Populations combine into biocenoses to form ecosystems, which, in turn, are part of the biosphere, the global system of life on Earth. Dividing into such levels allows us to understand how changes at one level can affect the entire system. For example, a decrease in one species in an ecosystem can lead to cascade effects affecting all subsequent levels, up to changes in the structure of landscapes[11:56].

In the hierarchy of ecological systems, the interaction between abiotic and biotic components plays a special role. Abiotic factors - climate, relief, the chemical composition of soil and water - create the basis for the existence of living organisms, determine their adaptation strategies and evolutionary paths. In turn, biotic elements influence abiotic conditions, forming a new habitat, changing the composition of the atmosphere and soil. For example, forest ecosystems not only depend on climatic conditions, but also regulate air temperature and humidity themselves, forming the local climate[12:73].

The aforementioned complex hierarchical structure manifests itself not only in biological but also in socio-ecological systems, where human interaction with nature reaches a new level of complexity. Economic activity, urbanization, and technological progress can fundamentally change natural systems by introducing new levels of regulation. However, as E. Moren points out, an extreme change in the hierarchy of natural systems under the influence of anthropogenic factors can lead to imbalances that disrupt the natural mechanisms of self-regulation[13:89].

Such a multi-level approach to understanding ecological systems allows not only to determine the patterns of their functioning, but also to develop more precise methods of environmental management. Considering nature as a hierarchical system allows for a deeper understanding of the interconnectedness of processes occurring at different levels of ecological organization.

One of the main aspects of the hierarchical organization of ecological systems is the principle of subordination, according to which each level of the system obeys the laws inherent in the higher level, but at the same time retains relative autonomy. This pattern is especially evident in the study of trophic interactions in ecosystems, where each organism occupies a certain place in the food chain and performs strictly defined functions. For example, a decrease in the number of predators can lead to an excessive increase in the number of herbivorous animals, which in turn leads to the decline of plants and changes in the soil cover[14:192]. It should be noted that hierarchy in ecological systems is not a rigid and unchanging structure. At different stages of system development, individual levels can be interchanged by degree of influence, which indicates the dynamic nature of the hierarchy. For example, in the context of climate change, the role of abiotic factors increases and can determine the dynamics of biocenoses to a greater extent than internal biotic connections. This is confirmed by the research of A. S. Golubev[15: 15], who notes that in global warming, changes in temperature and the level of precipitation become the main factor influencing the structure of ecosystems. In addition, within the framework of the hierarchical organization of natural systems, it is possible to distinguish elements called "node points," through which the largest amount of energy and material flows pass. Such elements play an important role in maintaining the stability of ecosystems. For example, forest areas are the main nodes of the global carbon cycle, regulating the amount of carbon dioxide in the atmosphere. Their removal will lead to imbalances not only on a local, but also on a global scale[16:215].

The hierarchy of natural systems is also manifested in self-regulation mechanisms. Each level of the ecosystem has its own mechanisms for maintaining stability, but at the same time is included in the overall regulatory system. For example, at the population level, this process occurs through natural selection mechanisms that allow organisms to adapt to changing environmental conditions. At the biocenosis level, self-regulation is manifested by establishing a dynamic balance between different species and limiting the number of populations through competition, predation, or symbiotic relationships [17:132].

The hierarchy of ecological systems not only determines the structure of natural interactions, but is also the basis of their stability. Consideration of the ecological world from the point of view of a multi-level organization allows for a deeper understanding of the mechanisms of the functioning of natural systems and the identification of methods for their effective management in the context of modern environmental problems.

Another important aspect of the hierarchical organization of ecological systems is the interaction between levels under conditions of environmental variability. One of the main characteristics of any ecological system is its ability to adapt to external disturbances, redistribute the flow of energy and substances between organizational

levels. This is especially evident in stressful situations, such as sharp climate change, anthropogenic impact, or catastrophic natural phenomena. For example, under arid conditions, the ecosystems of the forest-steppe zone change the structure of the biocenosis: herbaceous plants displace tree plants, which leads to changes in the composition of fauna and the structure of the soil cover[18;89]. It should also be taken into account that at each level of the ecological system, self-regulation mechanisms operate, but at the same time they are subject to the influence of higher levels.

For example, at the biosphere level, climate factors can determine the boundaries of species distribution and the species composition of communities, while at the population level, self-regulation is carried out through natural selection mechanisms and demographic processes. This is also confirmed by the research of V.V. Alekseev[19:146], who notes that in the process of evolution, natural systems developed mechanisms for adaptation to environmental changes through hierarchically organized processes.

Another manifestation of hierarchical structure is the cyclical nature of ecological processes. Cycles can manifest differently at different levels of organization: at the level of individual organisms - these are biorhythms and seasonal changes, at the level of ecosystems - the change of phytocenoses, at the global level - long-term changes in the carbon and water cycles. For example, the water cycle in nature shows the complex interaction of local and global processes: evaporation of water from oceans and land leads to the formation of clouds, precipitation, and subsequent return of moisture to the oceans through rivers and groundwater[20:107].

Furthermore, the hierarchy of natural systems is expressed in succession mechanisms, where changes in environmental conditions lead to sequential changes in the species composition of ecosystems. For example, after deforestation or a forest fire, a primary stage of ecosystem restoration is observed, in which fast-growing herbaceous species and shrubs dominate, then gradual restoration of tree vegetation begins. This process can be considered as a transition from one level of the hierarchical system to another, which is also confirmed by the research of T. G. Gilmanov[21:45].

The principle of hierarchy in ecological systems manifests itself not only in the spatial and organizational structure, but also in the dynamics of time, indicating the complexity of interactions at different levels of natural systems. These regularities must be taken into account when studying ecological reality, as they allow for a deeper understanding of the mechanisms of nature's functioning and the development of effective strategies for its preservation and sustainable development.

Another important aspect of the hierarchy of ecological systems is their fractal structure, which is expressed in the similarity of elements at different levels of the organization. For the first time, ideas about the fractal nature of ecosystems were proposed within the framework of a synergetic approach, which considers nature as a system of interconnected structures with similar properties. For example, the leaves and branches of trees, the river delta, and the river system as a whole have similar configurations, which are due to the unified principles of the structure of matter. Research by scientists shows that such patterns are manifested not only in the physical form of objects, but also in the processes of interaction between the elements of

ecosystems. Here, it is important to emphasize the role of large-scale influences, manifested in the change in the properties of ecosystems during the transition from one level of organization to another. For example, the stability of an individual biogeocenosis may not necessarily mean the stability of the entire ecosystem. This is especially relevant in the context of anthropogenic impact, where local changes (for example, deforestation or pollution of water bodies) can lead to serious disruptions at higher levels of the organization. In the works of such scientists, the importance of taking into account large-scale impacts in the development of environmental policy is emphasized. Furthermore, the hierarchy of ecological systems is crucial for adaptation and evolutionary processes. The interaction between organizational levels leads to the formation of new structures and properties that are not reduced to the sum of the properties of individual elements. This phenomenon, known as emergence, explains why complex ecosystems have unpredictable characteristics based on the analysis of their constituent parts. For example, the biodiversity of tropical forests is associated not only with individual species but also with complex networks of their interactions, making ecosystems resistant to local changes but vulnerable to global factors such as climate change[22:488].

Conclusion. Thus, in conclusion, within the framework of hierarchically organized natural systems, the interaction of biotic and abiotic factors forms a complex dynamic network that ensures the integrity and adaptability of ecosystems. This process plays an important role in the sustainable functioning of the biosphere and requires careful study to develop effective ecological strategies. Analysis of the systemic features of ecological existence shows that the main features of ecosystems are their integrity and hierarchy. These principles determine the laws of operation of natural systems and their ability to self-regulate.

The integrity of ecological systems means that all its components are closely interconnected and form a single self-regulating structure. Within the framework of the systemic approach, ecosystems are considered not as a collection of individual elements, but as whole organisms with new properties arising as a result of the interaction of parts. This principle is confirmed both by empirical observations and by conceptual developments in systems ecology and synergetics.

The hierarchy of ecological existence is manifested in the multi-level organization of natural systems: from molecular and cellular structures to biogeocenoses, the biosphere, and the Earth's global ecosystem. Each level has its own specific operating laws, but at the same time, it is integrated into a wide range of processes, which ensures the stability of the entire system. Understanding the hierarchy of ecosystems is especially important from the perspective of analyzing global ecological crises, since the disruption of connections at one level inevitably affects the entire system.

Analysis of the integrity and hierarchical structure of ecological systems allows a better understanding of the laws of their functioning. The study of the systemic features of ecology has not only theoretical significance, but also serves to provide practical recommendations for maintaining the natural balance, preventing environmental disasters, and developing sustainable development strategies.

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