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## GENERAL CHARACTERISTIC OF MODERN ECOLOGY STRUCTURE

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Initially ecology was understood by E. Haeckel as a general science about the relations of organisms with the environment. Subsequently the definition of ecology as a science about the relations of organisms or groups of organisms to the environment surrounding them became traditional. Modern ecology is closely connected not only with various biological disciplines but also with geography, chemistry, geology, i.e. it became the cross-disciplinary science. Modern ecology is subdivided into six directions. Bioecology is characterized as classical ecology, and global ecology is characterized as geographical ecology. The prerogative of regional ecology is the studying of specific features of the specific region. Applied ecology includes: engineering, nature protection, construction, radiation, agricultural ecology, etc. Physiological ecology, ecotoxicology, ecoparasitology, production ecology (sanitary ecology), adaptation ecology, etc. are related to the ecology of person. Social ecology studies ecological features of interaction of society with the nature. Some researchers consider modern science ecology, according to ecological biocentrism as a branching of biological science representing, according to them, the system of sciences. There is also a compromise point of view according to which ecology considers the developed conditions of dwelling of the person and other organisms (the biological direction), and hygiene studies influence of the habitat on human health (the medical direction). According to our opinion, the ecology of the person, in particular its section "sanitary ecology" can be a link between ecology and hygiene. We believe that in the researches within this section of ecology it is possible to apply medical and biological approaches and indicators. According to the physical and ecological concept of evolution of ecosystems the researchers allow prebiological evolutionary change of these systems from preecosystems to primitive ecosystems. The ecology as an industry of knowledge, evolves in the process of learning of ecosystems in the aspect of a scientific picture of the World from the simplest physical and ecological concept of evolution of ecosystems to the globalization of ecology in the form of cross-disciplinary area of knowledge about the device and functioning of multilevel systems in nature and society in their interrelation.

Key words: ecology, structure of ecology, directions of ecology, ecological systems.

### **[В.М. Евстропов, Е.А. Трушкова, Ю.Н. Егорова Общая характеристика структуры современной экологии]**

Изначально экология понималась Э. Геккелем как общая наука об отношениях организмов с окружающей средой. Впоследствии традиционным стало определение экологии как науки об отношениях организмов или групп организмов к окружающей их среде. Современная экология тесно связана не только с различными биологическими дисциплинами, а также географией, химией, геологией, т.е. она стала междисциплинарной наукой. Современную экологию подразделяют на шесть направлений. Биоэкологию характеризуют как классическую экологию, а глобальную экологию – как географическую экологию. Прерогатива региональной экологии – изучение специфических особенностей конкретного региона. Прикладная экология включает: инженерную, природоохранную, строительную, радиационную, сельскохозяйственную экологию и т.д. К экологии человека относят; физиологическую экологию, экотоксикологию, экопаразитологию, производственную экологию (санитарную экологию), адаптационную экологию и т.д. Социальная экология изучает экологические особенности взаимодействия социума с природой. Некоторые исследователи рассматривают современную науку экологию, в соответствии с экологическим биологоцентризмом, как разветвление биологической науки, представляющей, по их мнению, сейчас уже систему наук. Существует и компромиссная точка зрения, согласно которой экология рассматривает сложившиеся условия обитания человека и иных организмов (биологическое направление), а гигиена изучает влияние среды обитания на здоровье человека (медицинское направление). По нашему мнению, связующим звеном между экологией и гигиеной может быть экология человека, в частности ее раздел «санитарная экология». Мы полагаем, что в исследованиях в рамках данного раздела экологии можно применять медико-биологические подходы и показатели. В соответствии с физико-экологической концепцией

эволюции экосистем исследователи допускают добиологическое эволюционное изменение этих систем – от преэкосистем к примитивным экосистемам. Экология, как отрасль знаний, эволюционирует по мере познания экосистем в аспекте научной картины мира от простейшей физико-экологической концепции эволюции экосистем до глобализации экологии в форме междисциплинарной области знания об устройстве и функционировании многоуровневых систем в природе и обществе в их взаимосвязи.

Ключевые слова: экология, структура экологии, направления экологии, экологические системы.

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E. Haeckel (1886) understood ecology as "the general science about the relations of organisms with the environment (living conditions of partially organic, partially inorganic nature) [35]. In this regard for a long time the main objective of ecology was the studying of adaptation of organisms to the changing environment conditions. However, with the emergence of the concepts "ecosystem" and "biogeocenosis" there was synecology studying regularities of the organization of communities, their structure and functioning.

Eu. Odum [19] believes that the term "ecology" is formed from the Greek "oikos" that means "a house" or "a dwelling". However, later this researcher expands the idea of ecology and characterizes it as a cross-disciplinary area of knowledge of the device and functioning of multilevel systems in nature and society in their interrelation [20]. Ecology is usually defined as a science about the relations of organisms or groups of organisms to the environment surrounding them or as a science about relationship between live organisms and the environment of their dwelling.

As a rule, the researchers allocate six levels of the organization of living matter forming hierarchy: molecular, cellular, organismal, populational (populational and trivial), ecosystem, biospheric) [19]. Some authors from ecological positions allocate seven levels of existence of life also taking into account the tissular level [1, 6, 25]. The existence of each level is prepared and defined by the structure of the lowest level. These levels are molecular, cellular, tissular, organismal, populational and trivial, biocenotic and biospheric. Other researchers from the positions of hierarchy of the organization of living matter conditionally subdivide it into eight levels, at the same time allocating the organ level [29].

As the concept "Ecology" its different definitions were offered. In these definitions there were terms connected with characteristic of either the nature, or life: "scientific natural history", "science about structure and function of the nature", "sociology and economy of animals", "bionomics", "science about distribution and abundance of organisms". According

to E. Pianka [22], the best definition is "ecology is a science about relationship between organisms and the environment surrounding them", at the same time the author understands the sum of all physical and biological factors having an impact on specific organismal unit as the environment (animal unit, family group, population, a species or community).

However, modern ecology is closely connected not only with various biological disciplines but also with geography, chemistry, geology. On the basis of theory of the biosphere as a planetary natural system (captured by the life of the Earth mantle) which existence is caused by the global processes of synthesis and decomposition, the global ecology is formed. The biosphere of the Earth is considered as a global ecosystem [27], as a set of all live organisms and their ecological environment within the planet" [1].

Moreover, O.I. Kalinina considers ecology not only as a science and a subject matter, but also as a world outlook [11]. From the point of view of the author modern ecology went beyond the biological framework and became the cross-disciplinary science. Ecologization of many natural, technical and human sciences arose in connection with emergence and increase of the problems of interaction of the person with the environment caused by deterioration of an ecological situation in scales of regions, countries and all the planet. As the globalizing trend in development of ecology the projection of ecological approach at the solution of the production, scientific and technical, demographic and other tasks which arose in the second half of the twentieth century because of increase of negative impact of the person on the nature is considered. Social ecology is also formed; it studies regularities of interaction of human society and the environment. Ecology becomes an important part of the World outlook. In favor of globalization of ecology N.V. Krepsha also acts. She considers modern ecology as a cross-disciplinary area of knowledge of the device and functioning of multilevel systems in the nature and society in their interrelation which specifics consist in transformation of ecology of biological science into the science which generalizes philosophical macroecology [1].

Nevertheless, if to proceed from an important role of biology in interpretation of the concept "ecology", the characterization of the structure of ecology, probably, is necessary to begin with bioecology. N.F. Reymers [23] subdivides it into two large sections: endo- and exo-ecology. At the same time, he carries to endo-ecology molecular ecology (including ecological genetics); morphological ecology (ecology of cells and tissues; physiological ecology (ecology of the individual) with sections of ecology of food, breath, etc.; ecological physiology, ecological ethology, etc.

According to the author exo-ecology includes: autoecology (of species and organisms of species); the population ecology (ecology of small groups); biocenology (ecology of biocenoses); biogeocenology (the doctrine about ecosystems of various hierarchical level of the organization); science about biosphere (theory of the biosphere); science about ecosphere (global ecology).

The original interpretation of modern ecology is given by Yu.S. Chuykov [30]. He considers ecology as a complex science which subject of studying is the biosphere of the Earth in all functions and forms of its manifestation, including social, economic, political and legal functions of the person in it.

The researchers subdivide modern ecology into six directions [31], characterizing bioecology as classical ecology (plant ecology, ecology of animals, a biocenology, etc.). At the same time the global ecology is considered as geographical ecology which object is the biosphere in general, its geographical division, distribution of ecosystems on continents and climatic zones and the features of their structure and functions connected with it. The regional ecology (as a special part of global ecology) studies specific features of this or that specific region. The applied ecology (ecological aspects of environmental management) includes: engineering (design and designing of the installations and productions directed to

environment protection against harmful anthropogenic effects, development of appropriate technologies), nature protection (management of the environment, the state and departmental control, environmental management economy, rationing, licensing, ecological insurance), reserve management and studies, construction (or environmental protection at construction, including ecology of the dwelling and ecological architecture), radiation, agricultural ecology, etc. The ecology of the person includes physiological ecology, ecotoxicology, ecoparasitology, production ecology (sanitary ecology), adaptation ecology (adaptive features of human populations to specific ecological conditions), etc. Social ecology as the direction of ecology characterizes ecological features of interaction of society with the nature though on the borders of its contact with other fields of knowledge there are systems of knowledge which cannot already be carried to actually ecology: on the border of the right and ecology there is an ecological right, on the border of ecology and ethics there is an ecological ethics, on the border of ecology and psychology there is an ecological psychology, on the border of culture and ecology there is an ecological culture.

Giving such expanded classification of the directions of ecology and proceeding from definition of a subject of studying of ecology, Yu.S. Chuykov [32] also comes to the conclusion that modern ecology is not only a science, but it is also the World outlook.

A.M. Maloletko considers that the content of science of ecology is unfairly expanded because of its anthropocentric direction [18]. The author, proceeding from the positions of ecological biocentrism, believes that in the process of development of methods of ecological researches there was a branching of this biological science representing, nowadays, the system of sciences. Except the general ecology studying regularities of connection of organisms with the habitat, the ecology of populations (ecology of microorganisms, plant ecology, ecology of birds and so forth), the physiological ecology (reveals regularities of the physiological changes which are the cornerstone of adaptation of organisms), biochemical ecology (studies molecular mechanisms of adaptive transformations in organisms in response to the change of the environment), palaeoecology (studies ecological connections of the died-out groups), evolutionary ecology (studies regularities of the structure of bodies and structures depending on dwelling conditions) are separated now.

There are also other publications which narrow the volume of the concept "ecology". In particular, I.G. Krymskaya and E.D. Ruban [14] excluded from the concept "ecology" the categories of state of the nature, which are carried to sanitation and hygiene. These authors believe that the ecology considers the developed conditions of dwelling of the person and other organisms (the biological direction), and the hygiene studies the influence of the habitat on human health (the medical direction).

According to our opinion, the ecology of the person, in particular its section "sanitary ecology" can be a link between ecology and hygiene. We believe that in the researches within this section of ecology it is possible to apply medical and biological approaches, in particular immunological. As an example it is possible to give the modern researches which characterize the impact of environmental pollution on the interaction of leukocytes of blood of the person [4]. Interaction of various types of leukocytes of the person decreases also during the pollution of the soil with heavy metals [9] that is treated as the emergence of the transformed cells in a human body [26], and the technique of their definition in combination with indication of the level of environmental pollution is recommended for the assessment of the ecological status of territories [5].

Unlike sanitation regulation of content of pollutants in the environment which purpose is the protection of the person against the adverse effect of pollutant, the ecological rationing is aimed at providing such quality of the environment at which normal development and functioning of ecological systems are possible, including the person [10].

Ecological criteria are considered as a measure of anthropogenic impact on ecosystems and landscapes at which their main functional and structural characteristics (efficiency, intensity of biotic circulation, variety of species, stability, etc.) do not go beyond natural changes.

Two primary groups of ecological indicators are allocated. Componentwise indicators are indicators of a condition of air, waters, soils and a biocenotic cover in general. The special role is played by the bioindicators reflecting the state of environment. The vitality and efficiency of a specie (community), variety of species, etc. serve as ecological indicators. Total (integrated) indicators characterize natural systems in general. This is both intensity of biotic circulation, and natural ability to self-cleaning, and energy and material balance of natural systems and other parameters of the environment, including health of the population. The degree of compliance is established by the dependence of health, "comfort" of organisms on quality of the environment [33].

Groups of medical, technological and ecological indicators are distinguished among the indicators of standards of quality of the environment, however, only the set of these criteria determines the norms of quality registering the maximum permissible norms of impact on the surrounding environment from any kind of human activity bringing physical, chemical, biological and other changes into the natural environment. Medical indicators are based on accounting of number of the harmless levels influencing a gene pool and human health during the anthropogenic impact on the surrounding environment. Technological indicators reflect the possibility of ensuring the norms determined by the existing equipment and technology. Ecological indicators are intended for ensuring the preservation of vegetable, fauna and other natural resources by means of environmental standards. The main and ultimate goal of the establishment of ecological standards consists in prevention of the environmental disasters having the destructive impact on the environment [8] and the striking impact on the person [10, 7, 3].

Characterizing modern ideas of structure of ecology, it is necessary to stop on the concepts and hypotheses forming a possible picture of emergence of predecessors of organisms (preorganisms) and ecosystems (preecosystems).

The physical and ecological concept of evolution of ecosystems and biosphere within which it is explained how there could be an increase in the power stream proceeding through the biosphere that led also to the increase of amount of the organic matter participating in biospheric circulation and to the significant change of conditions of the environment on the planet [15] is developed.

It is considered that the following stage of a biopoesis after the emergence of enough organic molecules was a process of their coacervation (combination of molecules with the formation of molecular complexes and membranes, including semipermeable membranes [21,12,24]. The membrane systems of membrane and coacervates have a capsule (a membrane) which plays the protective role for the internal environment of preorganisms. According to V.F. Levchenko preorganisms are prebiological, phase isolated, usually semipermeable structures in which some from characteristic of live organisms' processes proceed, they are also capable to create gradients of concentration for some types of substances and molecules. During the discussion of prebiological evolution of the planetary environment with preorganisms, speaking about their populations the term "primary life" is used sometimes [17]. Primary, poorly differentiated system with preorganisms is considered as a unit capable to operate the changes of the parts (embryosphere) [16].

In the process of embryosphere development its rather independent, more and more complicated components were formed: preecosystems (the circulation of substance is organized abiotic and by preorganisms), and later primitive ecosystems were formed. Live

organisms, in particular, known from paleontology, fossil of microfossil have been already included into many of their links of circulation [28, 34].

Thus, according to the physical and ecological concept of evolution of ecosystems their prebiological evolutionary change from preecosystems (abiotic circulation of substance by preorganisms) to the primitive ecosystems into which links of circulation live organisms are included which are capable to the operated self-reproduction of similar ones (autocatalytic self-reproduction), which are characteristic for the beginning of biological evolution [17].

It is possible to think that ecology as an industry of knowledge, evolves in the process of learning of ecosystems in the aspect of a scientific picture of the World from the simplest physical and ecological concept of evolution of ecosystems before globalization of ecology in the form of cross-disciplinary area of knowledge of the device and functioning of multilevel systems in the nature and society in their interrelation (macroecology) and, according to V.I. Danilov-Danilyan [2], in the twenty first century the ecology became not only the developed branch of biology, but introduced many its ideas into the related subjects to such an extent that its key concept (ecosystem) became an integral part of a conceptual framework of all modern science.

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