Chapter 1

General ecology (module 1)

Topic #1

History of the development of ecology

Motivation

Ecology as a science is aimed at understanding the functioning of ecosystems, the relationship of species of living beings with their environment, the conditions for the development and balance of such systems. Its object is natural ecosystems, as well as ecosystems transformed in the process of production and economic activity, studied by biological methods. It studies the relationship of living organisms, their natural and artificial groups with their environment and among themselves.

There is a figurative expression that we live in the era of three "E": economy, energy, ecology. At the same time, ecology as a science and a way of thinking attracts more and more close attention of mankind.

The term "ecology" was introduced by the German naturalist E. Haeckel in 1866. Literally translated from Greek, it means the science of the house (*oikos* - house, dwelling; logos - teaching).

For this reason, ecology is sometimes associated only with the study of the environment (house) or environment. The latter is fundamentally correct with the significant amendment that the environment cannot be considered in isolation from organisms, just like organisms outside their habitat. These are components of a single whole. It was organisms that shaped the modern environment. They also play a primary role in neutralizing those impacts on the environment that have occurred and are occurring for various reasons.

Each science has its own starting point and milestones of development. The study of the history of ecological studies makes it possible to understand how researchers managed to identify certain very important patterns in the structure of populations, communities, ecosystems, as well as to analyze the causes of failures and circumstances hindering the development of ecological thought.

The purpose: is to introduce the main stages and prerequisites for the formation of environmental science.

Topic related questions
practical lesson:

1. Ecology as a science. Purpose, objects and tasks of ecological research.
2. Methods of ecological research. Relationship with other sciences.
3. The main stages in the development of ecology. Principles of construction of periodization of development of ecology.

Independent work of students in the classroom

1. Speech with abstract messages on the topic of the lesson (individual task).

2. Participation in a regulated discussion (the topic is indicated in the task for the practical lesson):

Topics of regulated discussion

2. 1. Variety of the term "ecology". Differences between scientific and everyday approaches to the concept of "ecology". What is the difference between the original and modern definitions of ecology as a science?

2. 2. Comment on E. Haeckel's statement: "Ecology is the knowledge of the economy of nature ...".

2.3. What are the functional differences and tasks of theoretical and applied ecology?

2. 4. What is the "greening of knowledge" and what causes it? Ecologization of pharmaceutical knowledge.

3. Work with training test tasks (test tasks No. 1 and No. 2):

Test task №1

Choose the correct answer from the options provided (choice of one answer).

1) The term "ecology" was introduced into scientific use in 1866:

a) J. Liebig;

b) V. V. Dokuchaev;

c) E. Haeckel;

d) N. A. Severtsev.

2) General ecology is a science that studies:

a) general scientific methods of cognition of reality;

b) specific groups of living organisms and their relationship with the environment;

c) the totality of organisms together with the environment;

d) reactions of environmental components to anthropogenic impacts.

3) Synecology studies:

a) the relationships of individual organisms with the environment;

b) relationships of individual species with the environment;

c) structure and functioning of populations;

d) structure and functioning of natural communities and ecosystems.

4) The science of interaction with the environment of the biosphere is called:

a) social ecology;

b) global ecology;

c) urban ecology;

d) general ecology.

5) Ecology as a science solves the following problems:

a) conservation of reference areas of the biosphere; b) creation of a scientific basis for rational nature management;

c) ecological indication of the properties and components of the environment;

d) justification of the transition from farming to fishing;

e) regulation of the human population on Earth.

6) Mathematical models that take into account random parameters available in real systems are:

a) deterministic models;

b) stochastic models;

c) optimization models;

d) game models.

7) The mathematical model of Volterra-Lotka is dedicated to the simplest ecological system:

a) the landlord;

b) symbiont host;

c) predator-prey;

d) predator-predator.

8) The Law of Limiting Factors was formulated in 1909:

a) J. Liebig;

b) W. Shelford;

c) G. Odum;

d) F. Blechman.

Multiple choice questions

9) The areas of engineering ecology include:

a) agroecology;

b) bioresource ecology;

c) ecological ergonomics;

d) transport ecology;

e) industrial ecology.

10) The methods of environmental research include:

a) laying out and description of trial plots and accounting sites;

b) marking of animals;

c) experiments in natural conditions;

d) mathematical modeling;

e) modified methods of physiology.

Multiple Choice

11) Choose the correct judgments (from 0 to 4).

a) The mathematical model of the Gaia biosphere was developed under the leadership of D. Meadows (1972);

b) The first model for predicting the consumption of resources was the model of T. Malthus (1798);

c) The model of M. Mesarovic and E. Pestel describes the world system as a set of regional systems;

d) Mathematical models help confirm the data obtained during the experiment.

12) Choose the correct judgments (from 0 to 4).

a) According to the one percent rule, a change in the energy of a natural system within 1% does not bring it out of equilibrium;

b) The best chance for self-preservation has a system that least contributes to the flow of energy and information from outside;

c) Some factors can enhance or soften the force of other environmental factors;

d) The endurance of an organism is determined by the strongest link in the chain of its ecological needs.

Sequencing

13) Restore the correct sequence of steps for building mathematical models:

a) development of a mathematical theory describing the processes under study;

b) the study of real phenomena that need to be modeled;

c) calculation based on the model and comparison of results with reality.

14) Restore the correct sequence of stages of system analysis for solving practical environmental problems:

a) modeling;

b) evaluation of possible strategies;

c) implementation of the results;

d) choice of problem;

e) choice of ways to solve problems;

f) setting the problem and limiting the degree of its complexity;

g) establishing a hierarchy of goals and objectives.

Test task number 2

Ecology is an integral science. After reading Rosenberg's "Calendar of Environmental Events," highlight turning points in the development of environmental knowledge. Fill out the table, noting the accompanying breakthroughs for ecology in related sciences.

Table 1

Stage / The science	I	II	III	IV	V
Botany					
Zoology					
Genetics / Evolutionary doctrine					
Chemistry/Physics					

Reference material

Ecology is a science that studies the organization and functioning of supraorganismal systems at various levels: populations, biocenoses (communities), ecosystems and the biosphere. Ecology is also defined as the science of the relationship of organisms with each other and with the environment. Main sections of modern ecology:

- general (theoretical) ecology,

- bioecology,
- geoecology,
- human ecology and social ecology,
- applied ecology.

Environmental objectives:

1. study of bilateral relations between biological objects of different levels of organization and the environment;
2. study of mechanisms of adaptation to the environment;
3. study of the mechanisms of ecosystem stability;
4. study of mechanisms for maintaining biodiversity;
5. research of production processes;
6. modeling of environmental systems and processes;
7. studying the laws of interaction between human society and nature, forecasting and optimizing this interaction, etc.

Classification of methods used in environmental studies

Among the methods used in ecology, according to the peculiarities of their application, one can single out both *general scientific* and *private* , only ecological methods. According to another classification, ecology methods can be divided into: laboratory and field methods. The latter, in turn, are divided into the following methods: route, stationary, descriptive and experimental. Field research in ecology is the most significant, since it is they that make it possible to study environmental phenomena directly in the natural environment. They allow you to establish the relationship of organisms with the environment, identify environmental environmental factors and determine the adaptation of living things to the environment.

General scientific research methods. Among the general scientific methods there are: observation and description; comparative method; historical method; experimental method; modeling method; statistical method, etc.

Private Methods of Ecological Research . Among ecological methods in science, the following are more often used: monitoring, microscopic, isoenzyme analysis, X-ray diffraction analysis, biomorphological analysis, group analysis, morphophysiological indicators, introduction, indication of environmental pollution, remote study of ecosystems, atomic absorption spectrophotometry.

Periodization of the development of ecology

Ecology as a biological discipline arose in the middle of the 19th century, and became an independent science only in the first half of the 20th century. However, the emergence of ecology was preceded by a long prehistory. The accumulation of environmental information began with the appearance of man on Earth and is closely related to the initial knowledge of plants, animals and environmental conditions.

The entire history of the development of ecology can be conditionally divided into *five* stages:

1 . The stage of accumulation of ecological information about the interaction of plants and animals with the environment within the framework of botany and zoology. This stage lasted from ancient times until the end of the 18th century.

2. The stage of formation of ecological directions within the framework of biological and zoological geography. It lasted from the end of the 18th century. until the middle of the 19th century.

3. The stage of formation of plant ecology and animal ecology as sciences about the adaptation of organisms to the environment. This stage lasted from the middle of the 19th century. until the 20s of the XX century.

4. The stage of formation of ecology as a general biological science, which is the theoretical basis for nature conservation, lasted from the 20s to the 60s of the XX century.

5. The stage of development of global ecology with the allocation of human ecology within its framework. Started in the 60s of the XX century. and continues at the present time (Maglysh S.S., 2001).

Of great interest is the periodization of the history of ecology by G.S. Rosenberg (2005). It is “tied” to dates significant for ecology and reflects the change of paradigms in it:

The first period - from ancient times to 1866 (the concept of "ecology" is defined and justified as an independent scientific discipline). This is the preparatory period, the period of "naive ecology", when its elements appear in the works of botanists, zoologists and other natural scientists. A characteristic feature of this period is the absence of a conceptual apparatus of its own for ecology.

The second period is from 1866 to 1935 (the definition of the concept of "ecosystem" is given). This is the period of the formation of factorial ecology, the discovery of the patterns of the relationship of animals or plants to various abiotic factors.

The third period is from 1935 to the beginning of the 70s. This is the period of synecological research, when the study of the relationship of populations in ecosystems came to the fore. The basis of the research of this period was seven provisions:

- establishment of ecology as a fundamental theoretical discipline;
- the idea that nature is predominantly in balance;
- synecological approach;
- primacy of competitive relations;
- low “weight” of evolutionary factors in the development of ecosystems;
- idea of discreteness of ecosystems.

The fourth period is from the early 1970s to the mid-1980s. At this time, the seven "theses" of the third period were opposed by the corresponding "antitheses":

- difficulties in identifying any general laws of community development;
- constant disturbances of equilibrium states;
- renewed interest in population (demecological) research;
- rejection of competition as the main factor in community formation;
- study of ecosystems in their development (including evolutionary factors);

•the prevalence of the concept of continuum over the concept of discrete ecosystems;

•the increased role of random factors in explaining the structure and dynamics of ecosystems. *The fifth period* is the last 20 years, when there has been a tendency to combine the ideas of the deterministic-population second period, the deterministic-synecological third and stochastic-population fourth periods, which made it possible to speak about the beginning of the formation of a truly systematic approach to the study of ecological objects. G.S. Rozenberg in 2005 proposed the "Calendar of Ecological Events", which briefly highlights the most important events for the formation of ecology, and notes the contribution of domestic and foreign scientists to the development of science (Table 2).

Table 2

Calendar of events in the field of ecology

(according to G. O. Rozenberg, with changes and additions)

Time: centuries, years	**Author**	**A country**	**Summary of the environmental study**
1	**2**	**3**	**4**
6th-4th centuries BC e.		ancient india	The epic poems «Ma habharata and «Ramayana »describe the lifestyle and habitats of about 50 species of animals .»
490–430 AD BC e. (years life)	Empedocles of Acragas	Ancient Greece	Considered the relationship of plants with the environment

384–322 BC e. (years life)	Aristotle	Ancient Greece	In the treatise «History of Animals, »he proposed a classification of animals, which had an ecological coloring.
370–285 AD BC e. (years life)	Theophrastus (Theophrastus) of Eresia	Ancient Greece	In the book «Studies on Plants », he described about 500 plant species and their groupings; laid the foundations of geobotany
23–79 (years life)	Pliny the Elder	Ancient Rome	In 37 books, «Natural History »summarized data on zoology , botany, forestry , described the practice of using animals in various sectors of the economy
1202	Leonardo of Pisa (Fibonacci)	Italy	Formulated the first problem of the mathematical theory of populations (taking into account the age structure)
1670	Boyle R.	England	Carried out the first ecological experiment: the effect of low atmospheric pressure on various animals
1686	Ray J.	England	He formulated the problem of determining the biological criteria for identifying a species (later «the concept of a species »was developed by the works of C. Linnaeus, J. B. Lamarck, C. Darwin, etc.)

1700	Tournefort J. P. de	France	He was one of the first to describe the vertical zonality of vegetation in the mountains and compare it with the horizontal zonality of vegetation in the plains (based on the data of the expedition to Mount Ararat)
1715	Leeuwenhoek A. van	Holland	For the first time he studied «food chains »and some mechanisms of population regulation
1749	Linnaeus K.	Sweden	«Saving nature »- proposed a typology of plant habitats. «The social structure of nature »(1760) - laid the foundations of taxonomy
1749–1788	Buffon J. L. L. de	France	«Natural history »in 36 vols. – developed the idea of species variability under the influence of the environment and the unity of flora and fauna .
1763	Lomonosov M.V.	Russia	He made a number of assumptions about the influence of the environment on the body
1775	Kaverznev A. A.	Russia	«On the rebirth of animals »- made a conclusion about the variability of organisms under the influence of environmental factors
1786	Zuev V.F.	Russia	«Inscriptions of natural history »- the first school textbook of an ecological profile
1794	Darwin E.	England	He published the work «Zoonomy, or the Laws of Organic Life », in which he developed peculiar ideas about the evolution of organisms. In the poems «The Botanical Garden »(1789) and «the Temple of Nature »(1803), he popularized his - natural science views in poetic form.
1798	Malthus T. R.	England	In the work «Experiment on the law of population, »he proposed an equation for

			geometric (exponential) growth; first mathematical model of population growth
1809	Lamarck J. B. P.	France	In the two-volume «Philosophy of Zoology, »he gave an idea of the essence of interaction in the «organism-environment system.»
1824	Edwards W.	France	«The influence of physical agents on life »- the first summary of environmental physiology
1831–1836	Darwin C.R.	England	Circumnavigation on the «Beagle »; all observations are summarized in «the Research Diary »(1839), one of the first comprehensive environmental studies
1840	Morran Sh.	Belgium	Fixed the term «phenology »for the doctrine of seasonal phenomena in nature
1840	Liebig Yu.	Germany	Formulated the law of the minimum (limiting factors)
1854	Geoffroy Saint-Hilaire I.	France	In the book «Natural History of the Organic World, »he laid the foundations of ethology, which studies the «relationships of organisms within families and groups, in an accumulation, in a community ». A number of researchers consider I. Geoffroy Saint-Hilaire, and not Haeckel, «the »godfather of »modern ecology, considering the proposed term «ethology as a synonym «for ecology»
1854	Baer K. M. von	Russia	Laid the foundations of the modern theory of fish population dynamics
1855	Severtsov N. A.	Russia	«Periodic phenomena in the life of animals, birds and reptiles of the Voronezh province »- a comprehensive ecological study

1855	Decandol A.	France–Switzerland	«Botanical geography », in 2 volumes - studied the patterns of plant settlement depending on the environment and geological history, created the foundations of the doctrine of the origin of cultivated plants
1858	Roulier C.F.	Russia	Substantiated the method of ecological study of animals, substantiated the impact of the environment on the development of the organic world
1859	Darwin C.R.	England	In the work «The Origin of Species by Natural - Selection, or the Preservation of Favored Breeds in the Struggle for Life »– in addition to widely known evolutionary ideas, the work presents a large amount of material on the ecological patterns of the life of plant and animal communities. The work became fundamental for E. Haeckel in creating the science «of ecology»
1860	Middendorf A.F.	Russia	«Journey to the north and east of Siberia », in 2 vols., based on travels to the Kola Peninsula (1840), Taimyr and Yakutia (1842–1845) – biogeographic patterns of Siberia are described
1860	Pasteur L.	France	Laid the foundations of the ecological direction in microbiology (in 1922, S. N. Vinogradsky formalized this new scientific direction)
1861	Secheno v I. M.	Russia	In public lectures, «The so-called plant acts in animal life », where he expressed the principle of unity: «An organism without an external environment that supports its existence is impossible; therefore , the scientific definition of

			an organism should also include the environment that affects it»
1866	Haeckel E.	Germany	«General morphology of organisms », in 2 vols. – proposed the concept «of ecology »: «... biology is mixed with ecology, with the science of economy, of lifestyle, of the external life relationships of organisms with each other, etc. »(vol. I, p. 8)
1868	Reclus E.	France	Proposed the concept «of biosphere»
1868	Wallace A.R.	England	«The Malay Archipelago - the homeland of the orangutan and the bird of paradise »- proposed the concept of «a biological niche », substantiated the methods of biogeographic analysis
1870	Spencer g.	England	«The Study of Sociology ». Together with the works of T. G. Huckley (1863) and J. P. Marsh (1864), he laid the foundations of human ecology
1875	Suss E.	Austria	«The Face of the Earth »- established the concept «of the biosphere in science »(independent of E. Reclus)
1877	Mobius K. A.	Germany	«Oysters and oyster farming »- proposed the concept «of biocenosis ». In domestic science, biocenotic studies were started by S. A. Zernov in 1913, complex studies by V. N. Beklemishev in 1923.
1883	Dokucha ev V.V.	Russia	«Russian black soil »- laid the foundations for the doctrine of soils (pedology) and landscapes («Our steppes before and now », 1892)

1887	Forbes S.	USA	He proposed the concept «of »microcosm . For the first time he considered the lake as a microcosm, gave the beginnings of the doctrine of the ecosystem
1895	Warming J.E.	Denmark	«Ecological geography of plants »(Russian translation, 1901) - first used the term «ecology »in relation to plants, following F. Unger developed the foundations of ecological botany. Introduced the concept «of life forms»
1896	Beketov A.N.	Russia	«Plant geography »- the first original textbook
1896	Hudson W.	England	He proposed the concept of «a wave of life »to describe the dynamics of the number of animals (rediscovered in 1905 by S.S. Chetverikov).
1896	Schroeter K., Kihner O.	Germany, Swiss-ria	They proposed to distinguish between aut- and synecology (fixed in 1910 by the decision of the III International Botanical Congress)
1899	Dokuchaev V.V.	Russia	«To the doctrine of natural zones. Horizontal and vertical soil zones»
1901	Coles T.	USA	Created the doctrine of successional series, and simultaneously with G. Whitford (USA) proposed the concept of «menopause»
1902	Jacquard P.	France	Developed a quantitative method for comparing floras, laying the foundations for the quantitative and statistical direction in the study of ecosystems
1903	Johansen V.L.	Denmark	Borrowed from demography and introduced the concept «of population into ecology»

1903	Raunkier K.	Denmark	He created the doctrine of the life forms of plants (based on the concept introduced by E. Warming).
1909	Kolkwitz R., marson m.	Germany	Developed the basics of bioindication of pollution of water bodies.
December 29 , 1909 - January 6, 1910		Russia	XII Congress of Naturalists and Physicians of Russia (Moscow) – keynote speeches by G. F. Morozov, V. N. Sukachev, L. G. Ramensky, B. A. Keller and others.
1910	Gleeson G.	USA	He formulated an individualistic hypothesis, which consists in recognizing the uniqueness of the ecology of each species
1910	Ramensky L. G.	Russia	Formulated the principle of continuity. At present, the principle of L. G. Ramensky and the hypothesis of G. Gleason are united by the concept of continuum. Later, these same principles were independently described by G. Negri (Italy, 1914) and F. Lenoble (France, 1926)
1910		Belgium	III International Botanical Congress (Brussels). Report by Sh. Flao and K. Schroeter on fixing the basic geobotanical terminology, defining the concept «of association ». The concepts of »autecology and «synecology are »separated«
1910		Russia	The Permanent Biogeographical Commission was founded at the Russian Geographical Society (P. P. Semenov-Tyan-Shansky)

1911	Petersen K., Ekman S.	Denmark, Sweden	For the first time, quantitative studies of benthos were carried out using bottom grabs (K. Petersen also proposed the very concept of «benthos »)
1911	Shelford W.	USA	Formulated the law of maximum (tolerance)
1912	Keller B. A.	Russia	He proposed the concepts «of ecological group of species », «ecological series»
1912	Morozov G. F.	Russia	«The doctrine of the forest »is a classic work in forest geobotany. According to V. N. Sukachev, «Morozov , like no one else, filled the concepts of "plant community" and "phytosociology" with rich content and showed the practical significance of the latter.»
1913	Brown-Blanquet J.	Switzerland-ria, France	He laid the foundation for the development of a method for classifying vegetation (we can also talk about the classification of ecosystems marked by plant communities) based on ecological and floristic criteria. This method is currently the most widely used in the world.
1915	Alekhin V.V.	Russia	Formulated the rule of anticipation (independently rediscovered by G. Walther in 1951 and known in modern ecology as the Walther–Alekhine rule). A similar principle of stations for insects was proposed by G. Ya. Bei-Bienko in 1959.
1915	Vysotsky G. N.	Russia	Introduced the concept of «ecotope»
1917	Grinell J.	USA	Proposed the concept «of spatial ecological niche»

1918	Gams H.	Switzerl and – Austria	He divided biology into idiobiology (the study of organisms) and biocenology (the study of communities of organisms), introduced the concept of «phytocenology », «synusia »(the term was used in his lectures in 1917 by the Swiss geobotanist E. Rübel; Lippmaa T. M. made a great contribution to the study of synusia) , independently proposed the concept of «phytocenosis »(proposed in 1915 by I.K. Pachosky)
1921	Park R., Burgess E.	USA	They proposed the concept of «human ecology»
1925	Lotka A.	USA	«Fundamentals of biophysics »- together with V. Volterra (1926) laid the foundations of mathematical ecology
1926	Vernadsk y V.I.	USSR	«Biosphere », in 2 vols. – developed ideas about the planetary geochemical role of living matter
1926	Volterra W.	Italy	Together with A. Lotka (1925) he laid the foundations of mathematical ecology. Developed mathematical models for the growth of individual populations and populations related by relations of competition and predation (Lotka-Volterra models)
1927	Leroy E.	France	Suggested to understand under «the noosphere» «the spiritual layer of life »(Teilhard de Char den, 1930 adhered to a similar path of ki)
1927	Friedrich K.	Germany	He put forward a hypothesis according to which the regulation of population size is a consequence

			of the totality of the influence of all factors (abiotic and biotic) at the level of biocenosis
1927	Elton Ch.	England	«Animal ecology »- designed a new scientific direction - «population ecology », proposed the law «of the pyramid of numbers », the concept of «a trophic ecological niche»
1928	Beklemishev V. N.	USSR	In the works «Organism and community (on the formulation of the problem of individuality in biocenology) »and «Basic concepts of biocenology as applied to the animal components of terrestrial communities »(1931), he proposed the concept of Geomerida - consideration of all living matter of the biosphere as some kind of systemic unity
1933	Kashkarov D.N.	USSR	«Environment and community (basics of synecology) »; «Fundamentals of Animal Ecology »(1938) – the first Russian textbooks on ecology
1933	Leopold O.	USA	Proposed the concept of «edge effect»
1933	Nicholson A.	Austria	He put forward a hypothesis of density-dependent regulation of the population size (self-regulating process)
1934	Gause G.F.	USSR	«Struggle for coexistence »- outlined the principles of competitive exclusion; described the first experimental study of species relationships
1935	Tansley A.	England	Introduced the concept of «an ecosystem»

1938	Williams W.R.	USSR	«Soil science »- proposed a hypothesis of independence of fundamental environmental factors : «... plants for their life require both the joint presence or the same influx of all the conditions or factors of their life without exception»
1938 February		USSR	I All-Union Environmental Meeting (Leningrad)
1939	Troll K.	Germany	He defined a new scientific direction - «landscape ecology »(based on the works of K. D. Glinka and L. S. Berg; USSR, 1927–1929)
1940		USSR	I All-Union Environmental Conference (Kyiv); II–IV were held there in 1950, 1954 and 1962; All-Union Environmental Conference (Moscow, 1973)
1940	Vernadsky V.I.	USSR	Proposed a fundamental principle (in fact, an axiom) about the biogenetic migration of elements
1941	Severtsev S. A.	USSR	Connected ecology with evolutionary ideas and defined «ecology »as the science of the mechanisms of the struggle for existence
1942	Lindeman R.	USA	Article «Trophy-dynamic direction in environmental research »- described the law «of the energy pyramid »(10% rule) and methods for calculating the energy balance of an ecosystem
1942	Sukachev V. N.	USSR	Proposed the concept «of »biogeocenosis
1944	Vernadsky V.I.	USSR	Article «A few words about the noosphere »: «The biosphere of the 20th century is turning into a

			noosphere, created primarily by the growth of science, scientific understanding and the social labor of man based on it»
1951	Beklemishev V. N.	USSR	He proposed the concept «of consortium »(in 1952, this concept was independently proposed by L. G. Ramensky). V. V. Masing made a great contribution to the development of ideas about consortia
1951	Margalef R.	Spain	For the first time, he proposed to use informational entropy measures to assess the ecological diversity and stability of ecosystems; further developed ideas about communities as self-organizing (cybernetic) systems
1952	Burkholder P.	USA	He proposed a classification of biotic interactions according to quantitative effects («+ »- positive, «0 »- neutral, «- »- negative)
1954	Grigoriev A. A.	USSR	Developed (together with M. I. Budyko) the concept of periodic geographic zoning
1957	Hutchinson J.	USA	Generalized the concept of «a niche »by J. Grinell and C. Elton and proposed the concept of a «multidimensional or hyperspatial ecological - niche »; also proposed the concept of «a - realization ecological niche ». Simultaneously with R. McArthur, he developed a formal system of mathematical relations for describing ecological diversity
1961	Hutchinson J.	USA	He described «the paradox of plankton »and was one of the first opponents of the idea of

			competition as the main force that forms the community
1963	Sochava V. B.	USSR	He proposed the concept «of geosystem»
1965	Rodin L. E.	USSR	«The dynamics of organic matter and the biological cycle of ash elements and nitrogen in the main types of vegetation on the globe »- one of the first monographs on the cycle of substances in ecosystems
1966	MacArthur R.	USA	«Population Biology »(together with J. Connell) and «The Theory of Island Biogeography »(together with E. Wilson, 1967) - in these books and earlier works, he approved a deterministic point of view on ecological processes, the primacy of stability and competition in the formation of communities, which contributed to the formation mathematical (analytical) ecology; proposed the concept of «a minimum viable population »(1967)
1968		France	MAB («Man and the Biosphere ») is a scientific program adopted in Paris at the UNESCO Intergovernmental Conference on the rational use and protection of biosphere resources
1968		Italy	The Club of Rome »was founded «- an international scientific (non- governmental) organization created to develop strategies for solving many global (including environmental) problems. Gave impetus to the construction of simulation models global processes in the biosphere

1971	Commoner B.	USA	The work Closing Circle was published «, in »which four laws of ecology are formulated
1971	Odum Yu.	USA	«Fundamentals of Ecology »(Russian translation, 1975), «Ecology »in 2 vols. (1983; Russian translation, 1986)
1972	Meadows D. et al.	USA	Report to the Club of Rome «Limits to Growth»
1973	Lovelock, J. Margulis L.	USA	They put forward «the hypothesis of Gaia »- considering the Earth as a single cybernetic system with biological mechanisms of regulation
1974		Holland	I International Congress of Ecologists (The Hague). The International Society of Ecologists (INT- EKOL) was founded
1977	Budyko M.I.	USSR	«Global ecology »- the foundations of a new scientific direction have been laid
1988			«The Center for Our Common Future »is a philanthropic organization to promote the involvement of the public and organizations around the world in efforts towards sustainable development
1992		Russia	The Law on Environmental Protection was adopted
1992		Brazil, Rio de Janeiro	UN Conference on Environment and Development; The document «Agenda for the 21st Century was adopted », etc.

1992	Meadows D. et al.	USA	Report to the Club of Rome “Beyond Growth”
1996		Russia	Presidential Decree on Russia's transition to the concept of sustainable development
1997		USA, New York	UN Conference on Environment and Development "Rio+5"
1997		Greece, Thessaloniki	International Conference “Education for Sustainable Development”
1999		Denmark, Aarhus	International Convention on Environmental Information and Citizen Involvement in Environmental Decision-Making
2000			The 52nd session of the UN General Assembly proclaimed 2000 the International Year for the Culture of Peace
2001		Italy, Genoa	G8 summit
2002		South Africa, Johan - Nesburg	UN Conference on Environment and Development «Rio+10»
2003		Russia Moscow	International Conference on Climate Change