The population, the species and the biocenosis are presented and analysed as systemic units which really exist, work and evolve, having reciprocal relationships with the abiotic environment at the same time, only in ecosystems. No population or species exists in isolation. From the point of view of the theory of systems, the population, as a group of organisms which can be found in a biocenosis, is a common subsystem for the two systems, i.e. the biocenosis and the species. The population also has a double function: an ecological one in the biocenosis and a genetical one within the species. All the populations and the species can be considered as ecological units because their organisms have ecological adaptations, and the populations are structural parts in the biocenosis and have ecological functions in the process of production, consumption and decomposition of organic matter in the ecosystems, which is an aspect scarcely shown so far. At the level of the populations there are also genetical functions, particularly natural selection which generates new ecological adaptations (and others) as new species.

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Population, Species, Biocenosis

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CONTENT

FOREWORD

During the last century, our knowledge about the living world has greatly increased and diversified. In biology, unsuspected technical and methodological possibilities have appeared so as to penetrate into the deepest secrets of the living matter, and the results obtained are amazing. The fine structures, the intimate mechanisms of the vital processes in the organisms are becoming better known.

Ecology has developed more slowly; only during the past 100 years research regarding supraindividual ecological units has intensified. Systemic ecology places the living matter and the non living matter on the same plane when studying these units, where cosmic energy is fixed and sets in motion local processes as well as planetary ones of great importance for the continuous existence of life in its constant transformations and evolution.

Unlike biology, which conducts research in laboratories, ecology has its field of activity in nature, where its objects operate: the organisms, the populations, the biocenoses and the habitats - united in ecosystems. Besides the inherent difficulties of undertaking research in nature, ecology does not yet possess the entire necessary logistics, especially in order to emphasize the continuous transformations occuring in these units.

Like any other science, at the beginning of its development, there are still ambiguities in defining some new concepts and in establishing the working methods. There are also many discussions about a simple, but very important notion for ecology - the population of organisms as part of the biocenosis as well as of the species *(*see also *Tomiuk, Bachmann 2009, Wikipedia).*

The authors of this paper developed and worked during this early period of development of systemic ecology. They have also reached conclusions which may lead to the elucidation of some aspects which are still unclear regarding the population and the species. These findings are based on two paradigms which have not been taken sufficiently into account so far: the systemic and typological approach of the phenomena and hence of the concepts.

In several papers published previously *(Doniţă N., Godeanu S. 2017, 2018, Godeanu S., Doniţă N. 2016)* and in the present work the authors attempt to highlight the fact that the population is a fundamental element of the existence of the biocenosis and of the species in nature, and the influence of the living and non-living environment on the population (i.e. to give a better definition of the role played by ecology in knowing the populations) as well as the importance of genetics in the evolution of the species at the level of the population.

The fact that the population has been incompletely studied and its role more often underestimated is also emphasized.

1. INTRODUCTION

1.1 Biology, Ecology, Population, Species

The systematic development of the sciences of nature began in the 18th century when, after having accumulated important collections of plants and animals, the need was felt to create an order. Thus, taxonomy was developed as the science of the classification of plants and animals into species (*Linné 1759*).

Research concerning the structure and functions of organisms belonging to different species led to the development of more sciences of nature (morphology, anatomy, physiology etc).

After several great journeys on several continents to explore the living world, biogeography was developed (*Humboldt 1805*) and the theory of the formation of species was devised (*Darwin, 1859*). This theory and the knowledge about heredity (*Mendel 1866, Morgan 1935*) led to the development of genetics. At the same time, research concerning the relations between animals and the environment began (*Haeckel 1866*), and, subsequently, the concept of biocenosis emerged (*Moebius 1877*), thus setting the foundations of ecology.

All these sciences constituted what was called ”biology”.

At the beginning of the 20th century, part of the ecological research increasingly focused on the study of the communities of organisms. So, a new ecology developed having as its subject biocenosis and its abiotic environment. Having another subject and other methods, this new ecology was called synecology, so as to distinguish it from the ecology of organisms and species, which was called autecology.

Research in synecology began with the study of forest types *(Morozov 1904, Cajander 1909)* and of plant associations *(Clements 1916, Braun-Blanquet 1921)*. The concept of ecosystem emerged *(Tansley 1935*) and the concepts and research of ecosystems as holistic units developed *(Odum 1935, Sukaciov et Dâlis 1964, 1957, Mayr 1970, Mallet, J. 2001a, 2001b)*.

Through the founding of ecological genetics (*Morley et Frankel 1959, Ford 1964*), the link between genetics and ecology was made.

In Romania, the concept about the systemic character of the organism and biocenosis was developed and the evolution of the supra-individual ecological systems was described (*Botnariuc 1967, 1976, 1985, 2005*).

The population of organisms, which had been developed as a concept at the beginning of the 20^{th} century, started to be increasingly investigated as an ecological component of biocenosis and the ecosystem, and as a genetic unit as well.

Research regarding the species also intensified, which is no longer considered as a taxonomic unit only.

There is a close interdependence between biology and ecology, because the organism as a system cannot be known in a complex manner without considering it as living in its specific abiotic and biotic environment with which it interacts in the ecosystem. And in order to understand how the biocenosis it belongs to is structured and functioning in its specific living environment, we must know the adaptations and functioning of the organisms and of the population it belongs to taken as a whole.

Biology and ecology are two systemically related sciences, because the organisms, as a lower system, is part of a population which belongs to a higher system, biocenosis. And this can only exist within an ecosystem. Through the adaptations it has in its genome, these determine the ecological niche of the population. And through the ecological and genetic processes in which it is involved in the ecosystem, its adaptations are improved, its autecology is changed, which is significant from the biological point of view.

1.2 Concepts and Definitions of the Population

The manner in which the population and the species have been understood and defined is still quite different and confusing. Discussions on this subject continue.

We shall present several such definitions to illustrate the differences existing in this matter. The definitions are taken from international and Romanian literature. They are grouped according to the criterion on which they are based.

Spatial Definitions of the Population

- A population is a group of individuals of the same species inhabiting the same area. (*Odum 1971*).

- Population, a biological system made up of a collective group of individuals of the same species, occupying a "determined" territory at a determined time (*Duvigneaud 1974*).

- "Any group of individuals of one species that occupy a given area at the same time." (*Curtis et Barnes*, quoted by *Stugren 1975*).

- A population is a group of individuals of the same species inhabiting the same area. Populations can be defined at various spatial scales. Local populations can occupy very small habitat patches like a puddle. A set of local populations connected by dispersing individuals is called a metapopulation. Populations can be considered at a scale of regions, islands, continents or seas. Even the entire species can be viewed as a population. (*Odum 1983*).

- A population – a group of individuals of one species in an area. Every population in nature is patchily distributed and the numbers of individuals vary from patch to patch (*Begon, Harper, Towsend 1996).*

- A population – a group of organisms of the same species occupying particular space at a particular time (*Krebs 2001).*

- All the organisms of a given species which interact in a specific area. A group of individuals of the same species living together in an area large enough to allow dispersion and / or migratory behavior and where numerical change is largely determined by birth and death processes (*Berryman 2002*).

- A population - those individuals of a certain species that live within a given area (*Wright 2016).*

- A group of related, but geographically different, individuals of a species, delimited in time and space (*Dexonline*).

- A population: A group of individuals belonging to the same species of animals or plants that coexist in the same geographical area. 2. The totality of the animal or plant individuals (of the same species) spread over a given territory (*https://dexonline.ro/*).

- A population consists of all organisms of a particular species living in a given area. (*Ramade 1991*)

- The population includes all the individuals of a given species from a specific area or region at a given time (*www.physicalgeography.net*).

<u>Genetic Definitions of the Population</u>

- A group of interacting organisms, whose individuals mate and who do not normally have reproductive contacts with other groups of organisms more or less similar (*Nicholson 1951,* quoted by *Fodor, 2006*).

- The population is a supra-individual infraspecific system, capable of existing indefinitely (as long as the ecological conditions allow it), independently from the reproductive point of view. It is the elementary form of existence of the species (*Botnariuc, 1999*).

- A population is a reproductive unit of a species in which intraspecific selection occurs (*Tomiuk et Bachmann 2009*).

- A group of plants, animals, or other organisms, all of the same species, that live together and reproduce (*Gotelli,* quoted by *Ceapoiu 1976).*

- The Mendelian population is a great number of individuals in which sexual reproduction occurs *(https://www.geologieportal.ch/*).

- A population is a unit in which genetic exchange can occur, unlike the individual; the population has a common genetic background (*https://www.geologieportal.ch/*)

Genetic-spatial Definitions of the Population

- A population represents a group of organisms belonging to the same species and occupying a certain territory (area). From the point of view of population genetics, this notion represents an association of individuals which share certain characteristics: they occupy a certain area, they possess the same means of reproduction, they have similar hereditary variability, and they are the result of the same natural selection. (*Crăciun, Crăciun, 1989*)

- A population - A group of conspecific individuals that is demographically, genetically, or spatially disjunct from other groups of individuals (*https://en.oxforddictionaries.com/)*

- A population is all the organisms of the same group or species, which live in a particular geographical area, and have the capability of interbreeding *(https://en.wikipedia.org/wiki/Population*)

Ecological Definitions of the Population

- The population is the group of organisms of the same species populating a biocenosis, the concrete form of existence of the species within the ecosystem (*Du Rietz*, 1930).

- The population is a concrete part of biocenosis comprising individuals of the same species with a specific function in the ecosystem (*Stugren 1965*).

- The population comprises all the individuals of a species belonging to the same biocenosis (*Ghiliarov,* quoted by *Stugren, 1982*).

- The population comprises all the individuals of a species living at a certain moment in a biocenosis. It should be regarded as a subsystem which includes the structural elements of biocenosis – the organisms (*Ivan, Doniță 1975*, *Doniţă, Purcelean, Ceianu, Beldie, 1977*).

- A population is all of the individuals of the same species within an ecological community. Ecologists are interested in the growth of a population, fluctuations in population size, the spread of the population, and any other interactions with the population or between it and other populations (*Smith, 1990*).

- Every population is a subsystem of a biocenosis comprised within an ecosystem (*Botnariuc 2005*).

Complex Definitions of the Population

- A group of individuals of a species (or other groups in which the organisms exchange genetic information) occupying a certain space, possessing many characteristics; these characteristics, although best expressed as statistical functions, characterize the group as a whole and not the particular individuals in the group (*Odum, 1971*).

- A system made up of individuals with a common origin, of the same species, carrying a specific function, making up a functional and reproductive unit attached to a particular biotope (*Botnariuc et Vădineanu 1982*).

- A population is a group of interacting organisms of the same species, and contains stages: pre-reproductive juveniles and reproductive adults. Most populations have a mix of young and old individuals, and characterizing the numbers of individuals of each or stage indicates the demographic structure of the population. In addition to demographic structure, populations vary in the number of individuals in the group, called population size, and how densely packed together those individuals are, called population density. A population's geographic range has limits, or bounds, established by the encroachment of others species, by the physical limits that the organisms can tolerate, such as temperature or aridity. A key characteristic of a population is the dynamics of whether is growing in size, shrinking, or remaining static over time (*Begon, Harper, Towsend 1986*).

- The population: the elementary, self-sufficient system, unlimited in time (due to reproduction), the elementary evolutionary unit, the field of natural selection, a link in the material, energetic and informational transfer from the biocenosis (*Botnariuc 1992*).

- A Mendelian population, defined as a group of individuals who reproduce sexually or are potentially capable of doing so, focuses on the evolutionary dimension and differs therefore fundamentally from other disciplines like general ecology or demography. Nevertheless, it is but a theoretical notion. In reality, a biological population has moving and permeable boundaries which are intimately linked with cultural and social factors (*Serrano Sanchez 1996*).

- The population is a dynamic group of individuals of the same species, genetically similar, interbreeding, but non-identical, polymorphous, living in different stages of life, occupying a certain ecological niche from a given ecosystem and possessing a self-sufficient existence (*Godeanu 2007*).

- Many animal or plant organisms, bacteria or fungi of the same species, reunited in a single group, with a common living area (habitat), with the same type of trophic, multiplication and defense relationships. As a formation - the first superorganismic system (*Dediu 2010*).

- A group of conspecific and interfecund individuals forming a reproductive unit, belonging to the same species and linked to each other through a certain degree of panmyxis, genetically isolated from other species with which they establish trophic, defense or breeding relations; the individuals of a population occupy a common territory called habitat (*Godeanu, 2013*).

- A population is a subset of individuals of one species that occupies a particular geographic area and, sexually reproducing species, interbreeds. The geographic boundaries of a population are easy to establish for the same species but more difficult for others. For example, plants or animals occupying islands have a geographic range defined by the perimeter of the island. In contrast, some species are dispersed across vast expanses, and the boundaries of local populations are more difficult to determine. A continuum exists from closed populations that are geographically isolated from, and lack exchange with other populations of the same species to open populations that show varying degrees of connectedness (*https://www.britannica.com/)*

- A population represents a group of individuals belonging to the same species and living on the same territory. This definition has two components, one genetic (the individuals belonging to the same species) and one spatial (the individuals living on the same territory), but the populations are not homogeneous either genetically or spatially, they are characterized by a series of parameters: the genetic structure describes how uniform the frequency of the genes and the genotypes is. This is the main means of quantitative estimation of the rate of adaptative transformations and the possibilities of response of the natural populations to the changes in pressures of the environment. The spatial structure (space distribution) describes the density variation in a population. Natural populations may have random, uniform or grouped spatial distribution. The age structure is defined by the number of age classes, their amplitude and the distribution of the population according to age classes *(https://ro.wikipedia.org/wiki/Wikipedia*)

x

x x

As can be seen from the above, in most definitions the population is conceived unilaterally, either as a spatial phenomenon or as a genetic phenomenon; only recently it has been considered as an ecological phenomenon as well. From most definitions, one might conclude that the population is an autonomous unit. More rarely its affiliation to biocenosis (ecosystem) is mentioned. Within the systemic hierarchy it appears either as a system or as a subsystem. Most definitions are so vague that they do not allow the identification of populations in nature, which enables us to conduct research regarding their structures and functions.

This is because we do not take into account the fact that the place of the populations is only in biocenoses, and, respectively in ecosystems of a certain type where the abiotic and biotic living environment corresponds to their ecological adaptations and genetic peculiarities. And in such biocenoses (ecosystems) in and between the populations, besides ecological processes, the genetic processes of the *evolution of species are carried on simultaneously.*

1.3. Concepts and Definitions of the Species

1.3.1. Concepts of the Species

At the basis of the sciences of life lies the species (*Zawadsky 1963, Botnariuc N., 1963,1967,1974,2003, Bertalanffy L. 1968, Lukas N. 1997*).

The notion of species was first defined by *J.Ray (1682*). Subsequent research, starting with Linné (who was the first to use the binary name of species, which he laid at the basis of modern systematics as early as 1759) and up to the present, only confirmed the reality of the existence of the species as a basic object of life sciences (*www.ibri.org/Books/ Pun_Evolution/Chapter1/1.2.htm*).

A consequence of the extraordinary diversity of the forms in which life is presented has led to the great diversity of manners in which it is defined and circumscribed (*Zawadsky 1963, Botnariuc 1967, 1976, Botnariuc, Vădineanu 1982, Mayr 1963, 1982, Simpson 1951, Rosen 1979, Templeton 1989, De Queiroz 2007 etc.*).

The definition and concept of species have evolved continuously, simultaneously with the development of biology, with the diversification of its branches, and especially as a result of the accumulation of information and the development of philosophical thinking in biology.

At present, a wide range of characteristics are recognized as criteria according to which the species must be known and described. They are given by almost all biological disciplines, from taxonomy and morphology, to genetics, biochemistry, cytophysiology, physiology, ecology, ethology, geography and up to the new molecular taxonomy. These criteria need to be analyzed, selected and correlated on a multi-criteria basis, according to the degree of knowledge and the specificity of every group of organisms.

Almost up the end of the 20th century, the morphological (in plants, animals and protists), physiological and biochemical (for some fungi and bacteria) criteria were used to determine the species. Gradually, the finer delineation of species extended based on molecular characters, especially molecular markers, specific proteins, DNA and RNA *(Ferguson 1980, Adl et al, 2012*).

There are several different concepts to characterize species. In the following we shall present the most important ones (*Godeanu, 2007*).

1. *The existentialist concept*. It was suggested by Linné, who considered that every species had three main characteristics: universality (everything living is part of a species), objectivity (all species are real, not “imagined” by someone) and fixity (any species with all its variability, is distinct from other species, both in time and as long

as it exists).

2. *The concept of morphological species*. It was the dominant concept until almost the beginning of the 21st century and still remains predominant nowadays. This concept can be characterized by the use of morphological diagnoses (now also cytogenetic and molecular markers), which serve to recognize a species. The species is a distinct discontinuity that synthesizes the characters of the individuals.

3. *The concept of biological species*. It only applies to species that reproduce sexually. The biological species is considered an objective reality, which can be described at the level of the population or through statistical parameters. Every biological species is a reproductive community with clear genetic and ecological characters. The key criterion for the biological species is reproductive isolation. The main characteristics of the biological species are:

- the species is represented by the population and the metapopulation through more or less uniform characters;
- the species are isolated reproductively;
- geographic, ecological and ethological interrelations are created between the individuals of every population;
- the species has a distinct genetic structure from that of the related species.

4. *The concept of phylogenetic/evolutionary species*. It is based on the observation that every species possesses its own evolutionary line, different from that of neighbouring species. It can be considered as being a continuous system of ancestral populations → current individuals → descendants, which are interreproducible, which belong to a more or less branching evolutionary tree and which can have both viable branches and closed evolutionary paths. Every phyletic line has its own evolutionary role, is perfectly adapted to the conditions of the biotope and ecosystem to which it belongs and has specific evolutionary tendencies.

5. *The pluralistic concept*. It emerged as a result of the simultaneous taking into consideration of a wide spectrum of situations. Usually, in this last concept three broad categories of criteria are used *(Nosil a.o. 2017)*:

a - descriptive - morphological, physiological, karyological, biochemical, genetic;

b - ethological - behavioral and sociobiological characters;

c – ecological - the type of biocenosis to which the populations of the respective species belong, the specific ecological niches, belonging to different trophic networks, their productivity in the biocenoses to which they belong, their ecological valence, etc.

1.3.2. Definitions of the Species

In Table 1.1 the most commonly accepted definitions of the species nowadays are presented.

Tab. 1.1. - *Definitions of the species, more widely accepted* (*Godeanu 2007*)

The category they belong to	*Definition*	*Author*
The species in a broad sense, as a taxon and a level of organization of the living matter	- The species represents one of the fundamental forms of existence of life, a different supraindividual level of organization of the living matter. As the field of activity of natural selection, the species has both the ability to self-reproduce and to exist for a long and indefinite time, and the ability to evolve independently. It represents the carrier and the fundamental unit of the evolutionary process. The species is inwardly contradictory: as a result of evolution it is in a relatively stable state, qualitatively determined, whole, adapted to the respective environment, stable, differentiated from the other groups (discontinuous), whereas as a nodal point and the active carrier of evolution, it is less delimited, it has a more complex character, unstable, labile and with unclear boundaries. - The species is a reproductive community, a taxon and a biological system at the same time. For this reason, the species is both a category within the taxonomic hierarchy and a level of organization of the living matter.	Zavadski, 1963 Botnariuc, 1992
The concept of biological species	- The species is a group of related natural populations that cannot cross or reproduce successfully with other such groups. - The species, biologically defined as a reproductive community, is an objective reality in itself, its delimitation being no longer arbitrary. - The species is a group of related natural populations that cannot cross or reproduce	Mayr, 1940, 1969 Bănărescu, 1973 Mayr, 1982 Paterson, 1978,1982,1985,

	successfully with other such groups and which occupies a specific niche in nature. - A species is a group of organisms that recognize one another for the purpose of crossing and fertilizing.	 Vrba, 1984
The concept of evolutionary species	- The species is a single lineage of ancestor - descendant individuals that is distinct from other origin and has its own evolutionary tendencies and history. - The species is the smallest group of organisms that is distinct from the diagnostic point of view from other such groups and where there is a parental relation from ascendant to descendant.	Simpson, 1951, 1961, Wiley, 1978 Rosen, 1979, Eldredge & Cracraft, 1980, Cracraft, Nixon & Wheeler, 1992
The concept of ecological species	A line that occupies a somewhat different adaptive area from that of other lines, in the sense that it evolves separately from other lines of the same kind.	Van Valen, 1976
The concept of species cohesion	The species is the smallest number of individuals with intrinsic cohesion mechanisms.	Templeton, 1989

Currently, the following subdivisions and supradivisions of the species are accepted (Table 1.2):

Tab. 1.2 - *Hierarchical units used in taxonomy*

Subspecific units	*Species*	*Supraspecific units*
biotype morphobiological group ecoelement ecotype subspecies semispecies	species	kingdom phylum class order family genus

From the above mentioned, one can notice that the ecological vision appears very little in the analysis of the issue of the species, only the existence of the populations being mentioned and possibly the specific environmental factors in which the respective species live.

1.3.3. Criteria Characterizing the Species

The most important features based on which a species can be characterized are the following (*Godeanu, 2007*):

1. *The number of individuals*. It must be large enough to ensure the perennity of the species and to avoid the consanguine process (in the case of cross-breeding species) for a period of at least 1000 generations, regardless of the possible (common) natural impacts. This number of individuals is called the "minimum viable population" and differs from one species to another and from one group of individuals (population) to another depending on the environmental factors that influence the viability of any species.

2. Any species must have a common *hereditary genetic background* (i.e. to have its own genome, which belongs only to the respective species).

3. *The individuals of a species must reproduce only among themselves*, producing viable descendants, capable of their own intraspecific reproduction.

4. *To be represented in the territory by at least one population*. If the species has a large area, then the species is represented by all the populations existing in the geographical area of the respective species.

5. *At the level of the various populations* from the geographic area of the respective species, *differences may appear between the general criteria characterizing the respective species*, morphae, subspecies, variability of some (morphological, ethological) characters, but especially of their ecological niches. We can speak about a polymorphism, but also about ethological variability, etc.

6. *Each species has specific ecological characteristics*, determined by the peculiarities of the biocenosis and the ecosystem where every population lives.

7. *A species occupies a certain territory*. The whole of the territory occupied by the populations of a species (including its subspecies) is specific and is related to the extent at which the species' population is a stenobiont or euriobiont. It is dynamic, fluctuating, constantly changing, either expanding or decreasing, depending on the relationships within its biotope and the fluctuations of the ecological niches of the populations of the given species.

8. Because species change continually, *they do not have a well-defined existence / life span*. It occurs in the speciation process and either it evolves giving rise to new species and subspecies, or it cannot adapt to the constantly changing conditions, it no longer evolves and it gradually disappears through the process of extinction.

Dillon (1966 quoted by *Cogălniceanu, 1999*) developed a classification of the spatial-temporal stages through which all the species can pass (Table 1.3).

Tab. 1.3 - *The four stages of development of a species according to the classification proposed by Dillon 1966 (*from *Cogălniceanu 1999)*

Name	*Stage*	*Area*	*Subspeciation*	*Abundance*
neospecies	very young	in extension	absent	very high
mesospecies	young	stable	intense	high
euspecies	mature	stable	low	moderate
telospecies	senescent	in diminution	absent	low

9. *Any species is characterized by a certain stability*. As long as a species retains the characters that differentiate it from other species, it is a good, viable species. Because the process of evolution is continuous, it can be considered that the present species as described in the taxonomic literature is only a moment of stability within the continuous process of life evolution.

10. *Any species possesses integrity*. The species behaves as a whole, as a stand-alone unit. It has its own peculiarities which make it distinct from the other species. This is why *Zawadsky (1973)* and *Botnariuc (1994)* consider that every species has a dual character: it is simultaneously a taxon (i.e. a well-defined category in the taxonomic system of the group of organisms to which it belongs), also a distinct level (the populational one) in ecology.

2. THE ORGANISM, THE POPULATION, THE SPECIES AND THE BIOCENOSIS IN THE SYSTEMIC HIERARCHY OF THE LIVING WORLD

2.1 The Hierarchy of the Living Systems

According to the theory of the systems formulated by L. von Bertalanffy in the fifth decade of the 20th century (*Bertalanffy 1968*), the system is "a set of elements in interaction". It is made up of <u>heterogeneous elements</u> (with different functions), <u>organized as a whole</u>, with its own features, other than those of the component elements, and it is capable of <u>self-regulation</u>, which in turn ensures <u>the stability</u> of the system through <u>a dynamic balance</u>.

Living systems are <u>open systems</u> which can only exist through energy and matter exchanges with their own <u>abiotic environment</u>.

Living systems are organized on several hierarchically subordinated levels. Inferior systems are included in superior systems through <u>subsystems</u>. Through the inclusion in the superior system, the operation of the subsystems depends on the operation of the superior system.

In the living world, there are several units with a systemic character, but two are related to the population. These are:

- the multicellular organism (the individual), as a system of organs and apparatuses that interact forming a whole with its own features - metabolism, reproduction, cybernetic self-regulation;

- biocenosis as a system of populations made up of individuals who interact forming a whole with its own features - the systemic ecological process, with relational self-regulation, self-recovery ability, self-reproduction, and the ability to influence the abiotic environment.

The position of the population and of the species from a systemic point of view stills needs to be clarified.

2.2 The Position of the Population in the Systemic Hierarchy

As it follows from some of the aforementioned definitions, the position of the population in the systemic hierarchy is treated differently - as a subsystem of biocenosis (*Doniţă, Purcelean, Ceianu, Beldie 1977, Botnariuc 2005*), or as a self-sufficient system (*Botnariuc 1992*).

In the systemic hierarchy scheme published by *N. Botnariuc (2005),* the position of the population does not ensue clearly because there is no explicit indication of the level of the figurative units, and the population and the species appear to be coupled as a unit between the organism and biocenosis, i.e. between two systems (Fig. 2.1). It is true that the text shows that the species is at the level of the population.

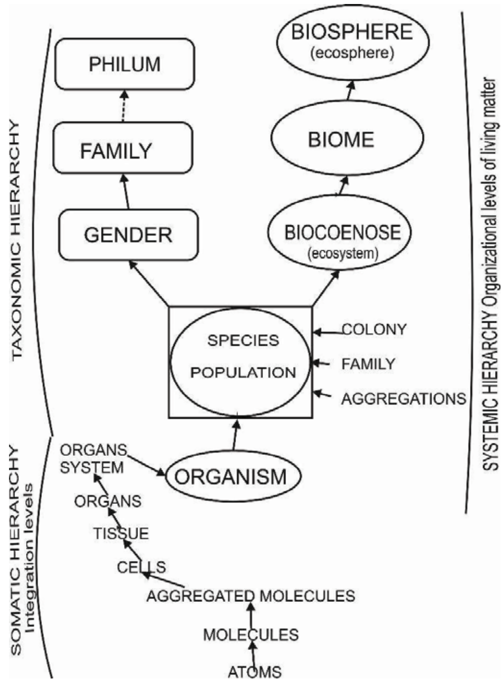

Fig. 2.1 – Hierarchical relations in the living world (*Botnariuc 2005*)

Therefore, it is necessary to establish the accurate position of the population in the systemic hierarchy in order to understand its role in biocenosis and species.

The population is made up of individuals as an inferior system and is structurally and functionally included in biocenosis as a superior supraindividual system. And, according to the systemic theory, it is obvious that the <u>*population is a subsystem*</u>*. This is confirmed by the fact that the population is not self-sufficient, it is always part of biocenosis and species. It does not have a systemic character and because it does not have other own features, its features depend on those of all the individuals and relations within the ecosystem.*

As a subsystem, the population links two important systems for the existence of life, the individual organism and the biocenosis. But what is more important, it also links the species to these systems.

The population as a subsystem does not have only two affiliations – to the biocenosis and to the species, but also two functions - ecological and genetic - of crucial importance for the existence and perpetuation of life.

These functions develop within the ecosystems where the populations, and therefore the species to which they belong, actually exist, and where there are abiotic conditions from where the energy and matter necessary to achieve these functions may be derived.

It is amazing how nature, through such a simple unit, sets in motion fundamental vital processes.

The subsystem position of the population is shown in Table 2.1. where the hierarchy of the systems is presented as well as according to the very detailed analysis of the evolution of life on our planet (*Botnariuc 2005*).

Table 2.1 - Taxonomic hierarchy and systemic hierarchy of the living world

Taxonomic hierarchy	Systemic hierarchy	
Taxonomic units	*Systems*	*Abiotic and biotic environment*
	System Biosphere (as a complex of bioms)	- Planetary abiotic covers (atmosphere, hydrosphere, pedosphere, surface geological sphere)
	↑	
	Biome as subsistem	
	↑	
Kingdom	System Biom (as complex of Landscapes)	- Biome abiotic covers - Zonal abiotic covers (atmosphere, hydrosphere, pedosphere, surface geological sphere)
Phylum	↑	
	Landscape as subsystem	
Class	↑	
Order	System Landscape (as complex of Biocenosis ans Species)	- Landscape abiotic covers
Family	↑	
Genus	Type of Biocenosis as subsystem	- Habitat (abiotic components of ecosystem)
	↑	
Taxonomic species	**Merged system of biocenosis (ecological) + species (genetical)**[1)]	
	↑	
	Population as subsystem	- Population abiotic niche

	(group of organisms component of both biocenosis and species) ↑ System Organism (individual) ↑ Suborganismal structures	- individual abiotic niche

1) The species, through its populations, is found in several biocenoses

2.3. The Position of the Species in the Systemic Hierarchy

Nevertheless, the position of the species is more complicated.

The position of the species in the systemic hierarchy is also treated differently (Table 2.2). According to *K.M. Zavadski* (1993) and *N. Botnariuc* (1992), the species would be "a different supraindividual level of organization of the living matter" and "a biological system". *N. Botnariuc* (2005) also states that "the population and the species represent the same level of organization". And the population being a subsystem, it would follow that the species is at the same level.

The species exists real in several ecosystems of a certain type, through populations made up from similar individuals. However, as it has been shown, these populations are subsystems. The species consisting of populations, i.e. subsystems, would represent a system.

It is a system completely different from the biocenosis system, because it is not unitary but dispersed in several biocenoses.

It has other features which confer it integrity. They are the genetic features of the genome of its organisms, which ensure the perpetuation of the species as a different qualitative unit, and the genetic processes occuring in the populations in biocenoses, through which the species evolves and can generate new species. And through these features and processes, the species, together with the other species with which it is associated in biocenoses, determines the specificity of the biocenoses, their existence and their perpetuation.

The species, as a genetic system, does not exist on its own in nature but is included by means of populations in biocenoses (see Figure 2.2). Because only in a biocenosis, respectively in an ecosystem, simultaneously with the ecological processes in which they participate as ecological unit, the genetic processes which are essential both for the existence of the species and the biocenosis can be performed and completed, through selection.In nature there is a close (merged) connection between *species and biocenosis.*

Biocenosis (and, implicitly, the ecosystem) is the environment without which the species cannot exist and evolve. And through his ecological functions and genetical evolution, together with other species, the existence and perpetuation of the biocenosis is ensured, as well as the formation of new biocenoses. And at the basis of this symbiosis is the population, as a common subsystem of the two systems, cumulating the two functions which are essential for the existence of life – the ecological and genetical function.

The link between biocenoses and species by means of populations is shown in Table 2.2.

Tab. 2.2 - *The link between biocenoses and the species by means of populations common to both systems [Biocenoses - systems consisting of non-similar populations, Species- systems consisting of similar populations (population types)]*

Biocoenose 1		Biocoenose 2		Biocoenose 3		Genetic - ecological systems
Population 1	+	Population 1	+	Population 1	→	Species 1
Population 2	+	Population 2	+	Population 2	→	Species 2
Population 3	+	Population 3	+	Population 3	→	Species 3
Population 4	+	Population 4	+	Population 4	→	Species 4
Population 5	+	Population 5	+	Population 5	→	Species 5
Population 6	+	Population 6	+	Population 6	→	Species 6
Population 7	+	Population 7	+	Population 7	→	Species 7

The role of the abiotic environment - the habitat in this symbiosis, must not be forgotten. The habitat, through its ecological potential, i.e. through its ability to provide energy and matter, has a selective and control role. Selectively because, according to the characteristics of the habitat, the populations making up the biocenosis are selected. And the control role, because the size of the populations, especially those producing biomass (autotrophic organisms), also depends on the quantity of resources of the habitat.

2.4 – The Population – a Basic Concept in Ecology?

The special role of the population has even led to the formulation of an opinion according to which the population is the basic concept of ecology (*Berryman 2002, Berryman, Kindlman 2008*). And this is because the population would be a <u>more real concept</u> than that of the community and higher units, which would be <u>more and more abstract, and harder to establish</u>.

Recognizing the particular role of the population at the genetic and ecological level, the real nature of the biocenosis and of the ecosystem cannot be disputed.

In the terrestrial environment, the ecosystems can be recognized and delimited with the help of plant populations which, being fixed in the substrate, are permanently noticeable, because these populations produce biomass which is used by other dependent populations making up the biocenosis. And the ecosystems can be delimited either by plants (in the litoral photic area), by bioderms on the hard substrates, by vegetal microorganisms (autotrophic bacteria, algae), by some protists (ciliates) or celenterate (corals), sponges, or by worms fixed on solid supports.

Without underestimating the importance of the population, from an ecological and genetic point of view, <u>we must firmly state that the system biocenosis - its abiotic environment, i.e. the ecosystem is the basic concept of ecology</u>. And that is because in the ecosystems three important processes for the existence life on the planet take place.

- It is the process of producing, consuming and decomposing the biomass and the necromass which is decisive for the maintenance and evolution of life.

- It is the genetic process of perpetuation, development and evolution of the species, which sets in motion this ecological process.

- It is the process of changing the habitat through the manner in which the energy flow and the circuit of matter change under the influence of biocenosis. This local change is amplified on large areas at the level of biomes, across the entire biosphere. The ecosystems, the biomes and the biosphere modify the abiotic covers on the surface of the planet - the gaseous (atmosphere), the liquid (hydrosphere), the solid (the geological surface layer) covers, which, together with the living cover, made up of biocenoses, create a more favorable environment for the existence of life.

The living systems are those that have formed the living environment of the planet. And this by:

- regulating the composition of the atmosphere regarding the amounts of carbon dioxide, oxygen and water,
- influencing the climate by redirecting the solar energy flow and the air movement,
- influencing the hydrological regime on land and through it the surface waters,
- forming and protecting the soil cover and influencing the surface rocks through pedogenesis.

2.5. The Use of Typology in Systemic Ecology

Typology is the science of classifying phenomena of any kind into types, based on their resemblance according to one or more criteria.

Typology is exteremely usefull both in science and in practice, because it groupe, in relatively few categories, large sets of similar phenomena. And this enables us in science to investigate only a few representative samples from these categories, instead of investigating all the phenomena of a certain type, which means saving enormous time and resources. In practice, the methods of transforming phenomena so that they may be used by humankind are also established on such samples. And these methods can then be applied to all the phenomena of the respective type.

The use of typology in biology and in systemic ecology. In biology, as a science, typology was used for the first time in taxonomy due to the need to group morphologically similar organisms into types - called species.

In ecology, as a science, typology was used to group phytocenoses, biocenoses, habitats, similar systems – into types of phytocenoses, called vegetal associations (*Braun-Blanquet 1926*), into types of forests and meadows (*Morozov 1904, Cajander 1909*), into types of habitats, of ecosystems (*Ellenberg 1973, Devilliers et al. 1997*).

Thus, it was possible to organize the research and experimentation of sustainable forest and meadow management methods, the research of natural ecosystems and the organization of the protection of wildlife through major programs (e.g. Natura 2000).

In order to ensure the swift development of research into systemic ecology, it is necessary, first of all, to classify into types all the natural ecosystems existing in a region or country and to determine their spread in space (and therefore their ecological area).

By classifying and determining the spread of ecosystems, without further investigations, the spread of all the populations results and, thus, of the species of plants and animals in a region. Another result is the possibility to select representative samples for detailed research regarding the populations in the ecosystems and all the ecosystemic relations and processes according to types.

2.6. Life Sciences from a Systemic and Typological Perspective

On planet earth, life is organized in three systemic forms: as individual organisms of different types (species), as biocenoses (populations of different types, made up of individual organisms) and as living covers of different types (made up of territorial complexes of biocenoses).

All these forms exist, develop and evolve in relation to abiotic environmental conditions of various types, from which they obtain the energy and the matter necessary for their existence, as open systems.

In the **Introduction** we showed how the life sciences were formed and developed, being included until the beginning of the 20th century in a general science – biology (the science of living matter, of bios).

In the 20th century, several sciences which had originally been formed and considered as branches of biology differentiated and developed strongly:

- systemic ecology, as the science of populations, biocenoses and the environment with which they interact in ecosystems,
- biogeography, as the science of territorial living units, made up of different biocenoses, in relation to the abiotic covers from the surface of the planet (atmosphere, hydrosphere and lithosphere),
- genetics, as a transgressive science, dealing with the genetic information at the level of an individual organism and with the evolutionary change of this information at the level of the population and ecosystem (reproduction, mutation, genetic drift) and at the level of the living cover (gene flow, speciation through geographical isolation, etc.).

The position of the autecology remains to be clarified, i.e. the ecology of the individual organism, which has been included in biology so far. The individual, as a system, through the population and species, is included in the supra-individual system of biocenosis - and in its environment, thus in the ecosystem. And all its relations with the abiotic environment and especially with the biotic one, are carried out within the ecosystem. This is why the individual can be investigated completely only within this framework. Autecology can only develop naturally as part of systemic ecology.

Scientific research on the various forms of systemic manifestation of the living world shall continue in four distinct sciences:

- the structures and physiological functions of the individual organisms and species in <u>biology</u>,
- the ecological structures and functions of the individuals, populations and species found in biocenoses and in their abiotic environment (i.e in ecosystems), in <u>systemic ecology</u>,
- the planetary structures and functions of the living cover, in relation to the other abiotic covers on the surface of the earth, <u>in biogeography</u>,
- the structure of individual genetic information and their changes at the levels of the population and ecosystem (through reproduction, mutations, genetic drift, natural selection) and at the level of the living cover (through gene flow, geographical isolation etc.) <u>in genetics</u>.

3. THE POPULATION IN OTHER SCIENTIFIC AND APPLIED DOMAINS

The Population in Taxonomy

Beginning with Linné and until about 50-60 years ago, the population was not taken into account because taxonomy only dealt with the individuals.

In taxonomy, the species have been described (and still are) according to the morphological characteristics of a representative specimen considered as a holotype. The conception according to which the holotype is the most important standard in characterizing a species is still maintained. However, it has gradually been proven that it is not so. Nevertheless, physiological and cytophysiological aspects are included in taxonomical investigations nowadays; likewise, biochemical and genetic analysis methods have been developed. They all enable a more accurate definition of the species.

Recently, taxonomic specialists have begun to statistically analyze some morphological features in order to obtain better results.

The specialists admit that the individuals of a species, i.e. individuals similar through many characteristics, still have a rather great variability. This can be ascertained by simply analyzing a number of specimens of the same species. Research in genetics and ecology have highlighted this variability some time ago.

More and more frequently, remarks concerning variability in point of size, color, sex or habitat, etc. are made when describing a species. More and more frequently, in the taxonomy works there are graphs showing the variations of the parameters found in the paratypes of the new species. In this way, taxonomy, still quite diffidently, tends to follow the degree of variability at the level of the local population and then to highlight the statistical differences existing between the individuals of different populations of the same species within its geographical area.

The most important steps have been taken in the studies regarding biodiversity and then in the protection of rare, endangered ones or species close to extinction (included in the Red Book of different countries or biogeographical regions).

In taxonomy work on populations has not yet been performed systematically. In fact, these are components of the species and through their study the true variability of the species could also be determined. The fact that the population has not yet been sufficiently taken into account was demonstrated by the work of *Wheeler & Valdecusas (2005)* which, referring to the current transformation of taxonomy, does not make any proposal to work on populations.

The Population in Phytocoenology

Phytocoenology developed greatly during the first half of the 20th century. It is the science which studied and still studies plant associations as separate units. Only lately it has been recognized that the phytocoenoses, which belong to these associations, are also part of biocenosis.

Curiously, since the beginning of the development of these investigations, promoted in Europe by several schools, the description of phytocoenoses in the field and their grouping into associations has been made practically on the populations, but without being aware of doing so, because the descriptions included the species and its quantitative participation in phytocoenosis. When, in fact, the population of a particular habitat was described. Even in the last treatise of the founder of the school of phytocoenology, the population is not at all mentioned, although it is commonly used in the descriptions (*Braun-Blanquet* 1964).

In phytocoenology, species, i.e. actually the populations, were characterized using quantitative indices (abundance, dominance) and by number, biomass or other indicators, i.e. actually, using population indices.

It is only in recent years that the specialists in phytocoenology have begun to work on the populations as well. As a result, numerous works on plant populations have appeared (*Falinska, 1984, 1991, Harper, 1977, 1980, White 1985, Canullo et Falinska, 2003*).

The Population in Biogeography

Biogeography is a branch of geography which deals with the description and explanation of the distribution of species, as well as with the distribution of the ecosystems at the planetary scale. Biogeography studies the aspects of the spatial distribution of biodiversity. In biogeography there are no experiments, but only findings regarding current and past situations. Therefore, biogeography is a descriptive science concerned with the development of maps and descriptions of the areas of species and higher taxonomic units, with establishing floristic and faunistic provinces and regions, landscapes, geographical areas.

The main method of work consists in identifying the locations of species or of ecosystems in a more restricted or extended territory.

The areas of all the European species and of those from the neighboring areas were determined through the working together of many botanists, zoologists and even amateurs. Afterwards, a large atlas (*Meusel 1965*) was printed. The same activities were performed for the species included in the Red Book of many countries and regions.

In biogeography no work was performed on populations, but only on the species and the units of the living cover (landscapes, provinces, regions, areas).

The Population in Ethology

Ethology deals with the study of the behavior (habits and skills) of the organisms and their reaction to their interaction with the environment.

In ethology, the individualistic vision continues to prevail. Most studies highlight the individual reactions to various biotic and abiotic stimuli from the environment, the relations at the level of the family or a restricted group (in birds, mammals, social insects), or the interactions with other species in the biocenosis. Studies on wider societies, such as the populations, have not been undertaken. Nevertheless, exactly these are of interest in the relations between the populations at the level of the biocenoses, in the populational exchanges of genetic material, in the emergence and the role of the metapopulations in evolution, in the immigrations and the emigrations, the role of the invading species, the replacement of one species by another etc.

The ethological responses of the individuals of the various populations are then generalized - in order to obtain information about the species as a whole. Extremely careful ethological studies must be carried out on as many populations as possible belonging to the respective species.

Unfortunately, so far, most ethological studies are conducted without taking into account the populational origin of the studied individuals. There are rare situations in which comparative ethological research is performed on several populations. Usually, this is not explicitly stated in the papers published.

The Population in Nature Preservation Activities

Nature preservation has evolved due to the need to use natural or semi-natural ecosystems in a sustainable manner in order to maintain natural balance on the planet. At the same time, the preservation of representative samples from these ecosystems is ensured in order to be able to study how they are made up and how they evolve without human influence. And these samples are meant to include rare, endangered, and close to extinction species, namely populations through which they can survive.

That is why, in this activity the investigation of the species according to populations shall be developed.

These investigations are performed taking into account the fact that every population lives in an ecosystem. And that the measures taken to protect these populations can only be achieved by fully protecting the ecosystems where they are present.

The Population in Forestry

Forestry is the human activity of managing the populations of living beings from the forestal ecosystems (*Doniţă et al., 1977, Kinnis 1987, Otto 1998*).

In their activity, the specialists in forestry focus on knowing and harmoniously guiding the different tree populations living in the forestal ecosystems and seek to protect them from the actions of the unfavorable biotic and abiotic factors. They supervise how the different populations coexist, they also deal with the prevention and protection against plant and animal pests, the good development of all the plants and animals populating this type of ecosystems.

The specialists in forestry have been working with the tree populations for 200 years, as well as with other plant and animal populations (game, pests) that make up the forests. A whole science has been created - dendrometry - which deals with determining the characteristics of the tree populations, and cynegetics - which deals with the populations of hunting animals. Even before the formation of ecology, dendrometry used the notions of number, dimensional structure, age structure, wood volume (i.e. biomass), growth (i.e. productivity). The so-called "dendrometric tables" have been used for a long time to determine accurately the volumes, as well as the "production tables" which contain data regarding the number, average size, volume, growth (i.e. wood mass production, etc.) according to species and age. Mention should be made that these tables refer primarily to natural forests, so that they are interesting from the ecological point of view as well (*Doniţă, Biriş 2003*).

As a result of the intensification of the activities of wood biomass exploitation in the forest ecosystems, people are currently focusing on reforestation, creating semiartificial forestal ecosystems, often monospecific ones (willow, poplar, spruce forests, etc.), which they subsequently manage in order to exploit them as fast as possible to obtain wood mass production. It is logical and normal to apply intensely aspects of populational ecology in these activities (*Warring et al. 1985, Godeanu 2013*).

The Population in Agriculture

Agriculture is the field where humans use populations of plants, animals, microorganisms to provide their food.

Agriculture emerged simultaneously with the shift from the food-gathering of plants and animals (man is an omnivorous animal) to their controlled growth and care (Figure 3.1).

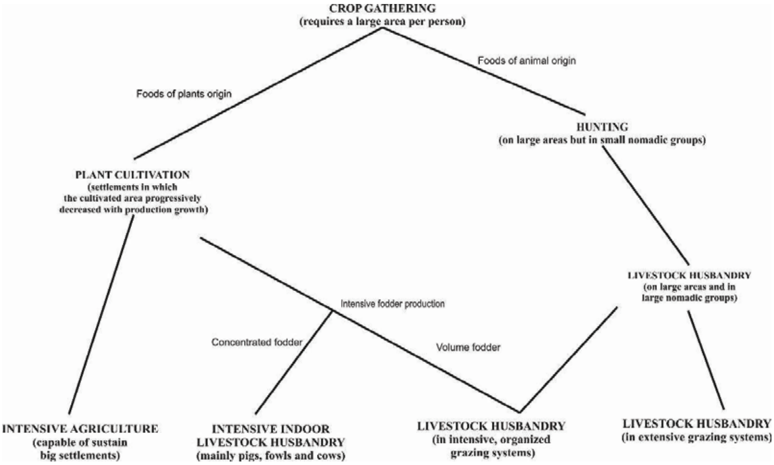

Fig. 3.1 - Genesis and evolution of agroecosystems (*Puia et al., 2001*)

People did this more and more carefully, taking into account all the aspects connected to their way of life.

In this activity people selected the plants and animals, the microorganisms useful for them, created more diversified varieties according to their needs and to the specific cultivation conditions, taking into account the local environmental factors, which they constantly changed according to their interests.

In this manner, the complete dependence of these beings on the human factor was created. That is why at present the determining factor in the life of these plants and animals is Man. In the absence of his control, the domesticated organisms will disappear, because they have been largely removed from the control of the natural factors and from the trophic chains where they were before domestication, so that they can no longer live on their own in the wilderness.

The diversity of plant species and wild animal races from which it all started is reduced. We have now reached such a great diversity that, if we analyze carefully the place of origin and the current distribution of the domestic varieties and breeds, we shall be astonished by what humanity has achieved in less than 15,000 thousand years (*Harlan 1981, Godeanu 2013*). Moreover, we can notice what huge harvests are obtained now in comparison with those from the original species.

It is important that in all the domains of plant and livestock culture the work is done on populations. This is why for the vegetal organisms and animals bred by man, the ecological terms regarding populations are used - number, age structure, biomass production and productivity. Their development and reproduction is also directed by creating favorable abiotic environments and by regulating competition. Agriculture is a form of applied ecology (*Godeanu 2013*).

Work on cultivated plants and domestic animals is performed only on populations and taking into account the influence of abiotic and biotic factors, the way people influence the organisms they grow, and at the same time act to counter the action of the unfavorable factors in the soil, water and air, the density and influence of the natural consumers of the domesticated species, and the manner in which their parasites and pathogens, etc. can be better controlled. (*Waring et al., 1985, Wezel, Soldat 2009*).

4. THE POPULATION AND SPECIES AS ECOLOGICAL UNITS

4.1. The Population as an Ecological Subsystem in the Biocenosis (Ecosystem)

The population was initially considered only as a group of conspecific individuals, wich ecologists studied for its attributes as number, density, variability and dynamics.

Subsequently, research was nuanced and expanded, and as new concepts emerged; the particular role of the population in ecological processes, then in genetic processes (ecological genetics) was recognised.

The population emerged in a new insight when the theory of systems was applied in ecology, and its attribute of subsystem of a biocenosis as well as its status within the ecosystem were established *(Botnariuc 1967, 1976, Ranta et al., 2006*)

The population (as a subsystem) is part of a biocenosis' composition and a constitutive element of the biocenotic structure, by the spatial arrangement of its organisms. For example, in an oak forest (*Quercus robur*), the population of this species is a constitutive part of the biocenosis, along with many other populations of shrubs, herbaceous plants, fungi, insects, birds, mammals. As part of the biocenosis' composition, the oak population is the dominant element, forming with other plant populations the skeleton of the biocenosis, which also contains other populations of animals, fungi, protozoans and bacteria.

In biocenoses and ecosystems, each population has a functional role in the great ecological process of biomass production and consumption as well as in the consumption and decay of necromass[1] (*Whittaker 1975, Stugren 1982, A Dictionary of Ecology 1984, Ruggiero et al 1994, Serrano Sanchez 1996*).

These processes, which combine all the vital processes within individuals and populations, all the connections – with each other and with the abiotic environment –

can be called the ecosystem process (*Odum 1971, Whittaker 1975, Ramade 1991, Colinvaux 1993, Brewer 1994, Bick 1998, Pârvu 2001*).

Depending on the ecological category they belong to, populations actively participate (through their adaptations) either to the stage of biomass production from abiotic chemical elements (carbon, oxygen, nitrogen, phosphorus etc.) using solar energy and water, either at the longer, gradual stage of biomass consumption, or at the

[1] The dead organic matter that is usually accumulated on the soil, but can also be found in the soil in the form of sediment - in sweet waters, seas and oceans.

one of necromass consumption and decay. But their share in the total amount of biomass is very different (Figure 4.1).

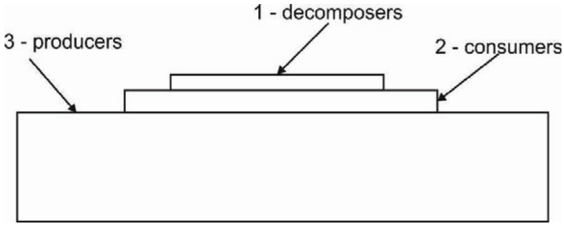

Fig. 4.1 - Biomass pyramid in a forest biocenosis: 1 – decomposers 1.5 kg, 2 - consumers 165 kg, 3 - producers 400 000 kilos (*Reiche et al., 1972*, quoted by *Doniţă et al., 1977*)

All the populations within a biocenosis participate in one way or another in this process; they are involved in relationships within trophic chains, which ensure the flow of energy and matter necessary to all individuals and populations, as well as for the wholness, self-regulation and stability of the biocenosis as a system.

Trophic chains also convey information on the state of the various components of the biocenosis, thus ensuring its self-regulation (*Connel 1970, Mayr 1970, Ebermann, Persson 1988, Frontier, Pichod-Viale 1991, Mc Arthur 1968, Neal 2004, Dediu 2007a,*).

The populations within a biocenosis also interact with abiotic agents in the habitat. On the one hand, populations use energy and matter supplies from the habitat, modifying its parameters; on the other hand, they alter it, generating a microclimate and decomposing organic matter. These interactions also cause the formation of humic acids, generating pedogenic processes which result in generating soil – as an intermediate product in the flow of water and the nutrient cycle within in the ecosystem.

The biomass and necromass are produced by each organism (i.e., at the individuals level), being thus conveyed along the trophic chains. However, it is summed up at the population level and enters the process with a certain weight which indicates the functional importance of the population within the ecosystem.

The total biomass produced by a population is *gross production*. About 55% of this is consumed by plants, to maintain their vital processes (mostly through respiration). The remaining 45% is *net production*, which enters the ecosystem cycle through one or more phytophagous populations (first-order consumers) and is then propagated along trophic chains through order II, III, IV and (rather seldom) V consumers (*Ramade 1991, Frontier, Pichod-Viale 1991, Odum 1993, Dediu 2007b)*.

The present data (*Odum 1971*) emphasize that phytophagous populations do not consume more than 10% of the net production out of producers' biomass. The rest turn into necromass and enters the cycles of decomposer populations. Only in cases of explosive propagation of phytophagous insects can most of the foliar biomass (seldom the entire one) be consumed.

Temperate forests, which have the highest amount of biomass (up to 3000 g / m^2 / year and a photosynthesis yield of 1.5%), also generate the largest amount of necromass (500-1500g / m^2 / year). In forests, most of the biomass and necromass (up to 99%) is produced by tree populations. The other populations – shrubs and herbaceous plants – produce little biomass (up to 10% of the total amount) (Figure 4.2).

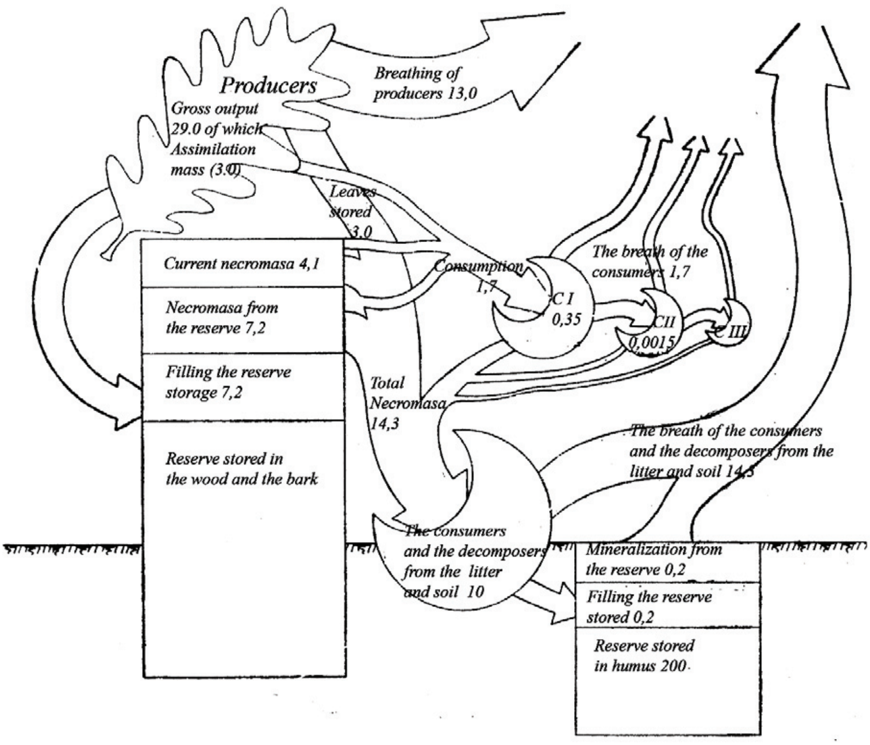

Fig. 4.2 - Organic matter flow in a forest ecosystem, in tonnes / ha / year (reserves in t/ha). The underlined figures are the biomass contained in the organisms, the unsubsidized figures represent the consumption losses (respiration) (data from *Duvigneaud et al., 1974, quoted by Doniţă et al., 1977*)

In meadow ecosystems located in temperate areas, biomass (about 600g / m^2 / year) and necromass production (about 200g / m^2 / year) is lower than in forests, as well as the yield of photosynthesis (about 0.44%). In the case of meadows, too, especially those populated by grasses, the dominant populations produce most of the biomass.

Each source of vegetal biomass (whether it is a whole body, an organ, or even part of an organ) innitiates one, sometimes even more trophic chains.

Some examples of trophic chains starting from plant biomass:

• plant → defoliant phytophagous insect → insectivorous bird → raptor bird → parasite insect → bacteria, viruses.

• plant → frugivorous phytophagous bird → predator birds or mammals → parasites → bacteria, viruses.

• plant → phytophagous micromammals (mice) → predator birds or mammals → parasites → bacteria, viruses.

• plant → phytophagous mammals (deer) → predator mammal (wolves) → parasites → bacteria, viruses.

Trophic chains do not have more than 4-5 links because each link means a 10-fold decrease in energy flow (*Botnariuc, Vădineanu 1982, Rockwood 2006*).

In the trophic chains include omnivorous, phytophagous and carnivorous populations.

As far as necromass is concerned, trophic chains are difficult to establish, because decomposition takes place in several stages and involves a great number of fungi, bacteria and microinvertebrate species, such as amoebas, rotifers, flagellates etc.

In order emphasize the multitude of species (hence, populations) involved in the decomposition of necromass, we give in the following two tables the number of individuals per superior taxa of invertebrates found in the necromass present on (Tab. 4.1) and in the soil (Table 4.2) in a mixed forest of *Quercus petraea* with other tree species (*Ionescu et al. 1971, Hondru, Mărgărit 1971*).

4.2. The Main Causes of the Existence of the Population in an Ecosystem

The main causes of a population's presence in the ecosystem are:

- the composition of the Earth' living covering;
- the ecological adaptations of species;
- an abiotic and biotic environment consistent with these adapations;
- the aptitude of organisms to multiply and to disperse.

Tab. 4.1 Invertebrates from necromass from the litter into a mixed forest ecosystem (*Quercus* + other species – according to *Ionescu et al. 1971*)

The faunistic group	Number of ind./0.25 m^2
Oligochaeta	20
Gastropoda	45
Isopoda	15
Julidae	3
Geophilidae	1
Pseudoscorpiones	2
Aranea	15
Acarina	3750
Protura	6
Diplura	2
Colembola	468
Tisanoptera	1
Heteroptera	1
Chalcididae	1
Formicidae	44
Sclaridae	3
Diptera	61
Coleoptera	10
Miriapoda	77
Lithobiidae	19

Tab. 4.2 Necromass consumer invertebrates in the soil into a mixed forest ecosystem (*Quercus* + other species – according to *Hondru et Mărgărit* 1971)

The faunistic group	Number of ind./6.25 dm^2 soil
Lumbricidae	76
Enchytreidae	30
Nematoda	21
Lithobiidae	15
Geophilidae	13
Julidae	38
Aranea	11
Acarina	4
Gastropoda	5
Diplura	3
Colembola	2
Tisanoptera	1
Homoptera	7
Coleoptera	42
Diptera	226
Formicidae	15
Isopoda	44

4.2.1. Composition of the Earth's Living Covering

Studies on the totality of living beings in areas still unaffected by humans have shown that it consists in biocenoses containing all the species. The cause is the considerable variety of the abiotic environment and of the environmental conditions and factors. Under these circumstances, life diversifies and occupies all the spaces in which it can exist (*Jørgensen, Fath 2008*).

On land, the land-forms, the rocks, the local climate, the light, heat, water amount, pressure, air movements regimes vary – often on very restricted areas.

Depending on the way these conditions and factors combine, varied – life, sites (called habitats) emerge. In this respect, habitats may be similar and dispersed in a larger territory, forming a certain type of habitats (*Doniţă, Ivan 1975*).

These similar habitats are occupied by populations whose individuals have ecological adaptations that allow them to grow, to perpetuate and to evolve using energy and matter supplies specific to the respective habitats. These populations form similar biocenoses (in terms of composition, structure and ecological functions) hence of a certain type[2], which together with their habitats form ecosystems (*Odum 1953, Ramade 1991, Frontier, Pichod Viale 1991, Colinvaux 1993, Bick 1998, Godeanu 2007b*).

A population living alone on an area is seldomly found; the phenomenon which occurs only on stripped ground (after fires or floods), on newly formed land (alluvial areas, volcanic lava etc.), or in isolated underground environments. However, even in these cases, shortly after a pioneer species occupies the new territory, organisms from other species immigrate and gradually biocenoses develop, which, together with their habitat, generate a new ecosystem.

In this respect, we mention two examples: in the steppe of southeastern Romania – a forestless area – trees and shrubs were experimentally planted. After 40 years, 1200 species of insects, 190 species of herbaceous plants, 200 species of fungi and other forest species that have immigrated in different ways, have been found in these plantations and a forest ecosystem emerged. Newly formed biocenoses also change the abiotic environment (climate, soil etc.) (*Doniţă, Godeanu, 2017*).

Another example: in Romania, a series of dams were built on many running waters (for instance, on the Bistriţa and Olt rivers). The flowing (lotic) regime of the water was replaced by a stagnant (lentic) one. In a rather short laps of time (less than 10 years), planktonic biocenoses and sediment surface biocenoses, typical for stagnant water, were found in the reservoirs. The immigrants were characteristic to this type of water body, but were not found before in the lotic systems from the reservoirs' neighborhood (*Godeanu 2013*).

It is therefore obvious that the biosphere, being entirely composed of biocenoses, all the populations and species can not exist on their own (autonomously), but only in biocenoses and their environment, i.e. in ecosystems.

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[2] There are two concepts on how the biosphere is structured: the typological conception, according to which the biocenosis is a discrete unit and can be classified into types, and the individualist conception which asserts that the biosphere is continuous, and similar biocenoses can not be distinguished so that biocenosis types can not be found. This study is based on the first conception.

4.2.2. The Ecological Adaptations of the Species

4.2.2.1. General Adaptations

Ecological adaptations are structural and functional properties of individuals of a species that have evolved through genetic processes in a biotic environment (biocenosis) and an abiotic one (habitat) of a certain type. These properties are encoded in the genome and transmitted to the descendants. They have a qualitative character and form the qualitative genotype of the species (*Ramade 1991, Chapmann, Reiss 1992, Botnariuc 2013*).

Species have very different adaptations. There are general adaptations on large or smaller groups of species, but also specific adaptations.

The very general adaptations refer to three large groups of species, according to their functions in the ecological process: a) production of biomass from abiotic elements, b) consumption of biomass, and c) consumption and decomposition of necromass.

a) The production of biomass from abiotic elements by means of solar energy is accomplished by chlorophyll plants. Plants have different adaptations – by groups of species: they are larger or smaller, they differ in terms of body shape, organs, reactions to ecological factors. The large forms of plants are trees, shrubs, grasses, mosses. Species of each category have adaptive structures responding to well-defined environmental factors, but also special structures involved in relationships with phytophagous consumers – protective organs, release of biochemical substances (either toxic or attractive ones etc.). In aquatic environments, higher plants and multicellular algae have functions and behaviors similar to plants in terrestrial environment.

b) Biomass consumption starts with animal species, fungi, phytophagous bacteria then, in successive stages, continues with species feedeeng on the first ones or between themselves. Within this group there are numerous adaptations regarding relationships with plants (way of consumption and metabolism) or with higher-ranking consumers, as well as adaptations to ecological factors (light, heat, water, minerals). In this purpose, organisms display special strategies for consumption, attack, defense, climate protection etc.

c) The consumption and decomposition of necromass also occurs in subsequent steps and is carried out by many species that consume necromass, convert it into their own biomass and then break it down to abiotic elements which will be again used by producers. All these organisms have the most varied mechanical and biochemical adaptations. An important role of necromass consumers is the synthesis of humic acids as intermediate metabolic products. In the bioclimatic microconditions created within a biocenosis, these acids prompt pedogenic processes on the surface rock, generating soil, which becomes a component of the habitat and acts as a reservoir of water and vital chemical elements that return to the habitat during the decay process. Soil provides to biocenoses the safest supply of water and minerals.

All species are part of these three major adaptive categories. They can exist only if interconnected within ecosystems, because they have different functions that can not be carried out independently (*Frontier, Pichod Viale 1991*). Plants can not grow on their own because, in the absence of decomposers, they would be suffocated by non-decomposed necromass, which would lock all vital elements. Consumers of all categories could not exist in the absence of the biomass originally produced by plants and subsequently transformed along trophic chains. Decomposers would have nothing to consume in the absence of necromass.

The presence of the three major ecological categories and the fact that all species belong to one or another of these categories demonstrates that the species can not exist isolated but only included within ecosystems.

According to its ecological adaptations, each species can exist – through its populations – in one or several types of ecosystems, in which it finds the necessary biotic and abiotic conditions. In each ecosystem of these types the species is represented by a single population.

4.2.2.2. Specific Adaptations in Primary Producers

Plants, as biomass producers, have many adaptations to the habitat they live in. (*Botnariuc, Vădineanu 1982, Falinska 2010*).

These adaptations concern in the first place the climate – the solar radiation complex (light, heat), humidity and air currents. Plants present different forms and vital processes depending on climatic zones.

For example, in equatorial areas, the most frequent plant forms are trees. Trees have tall trunks, smooth bark, leaves, flowers and fruits throughout the year, physiological adaptations to high temperatures and high humidity. In the temperate zone, trees are less high, their bark is thick, leaves, flowers and fruits occur only during the warm season and have a phase of vegetative rest during the cold ones. If, in the same areas, the climate is a dry one (the case of steppes), plants are represented mainly by grasses, with a large array of adaptations to both drought and cold.

All plants are physiologically adaptated to light; some of them develop only in full light, others are tolerant to shadow. There are short- and long-day plants.

Planktonic algae need to remain in the photic layer of the water, where they can photosynthesize, in which purpose many of them are equiped with gas or lipid grains vacuoles, which lighten the body, enabling algae to maintain themselves in the appropriate water layers and even to accede to upper ones.

Many adaptations of plants respond to the specificity of different soils – a different system of rooting, adjustments to the acidity, fertility or water regime. Some plants stand high acidity and low fertility of the soil, or are resilient to damaging salts, to stagnant water etc.

Studies concerning plant classifications according to their requirements and adaptations to temperature (T), soil acidity (R) and soil moisture (U) have been published (*Ellenberg 1979*).

Many adaptations concern defence against phytophagous organisms. Some of these adaptations are morphological: strong, non-edible protective tissues (thick, hard bark on trees, rigid, mineral impregnated tissues in herbaceous plants, spines, thorns, rigid hairs etc.).

Many morphological adaptations ensure the regeneration of injured plants (presence of sleeping buds or new buds on injured parts of the body).

Chemical adaptations are extremely diverse, concermimg both species and higher taxa levels. We mention special toxic biochemical compounds producing urticaria, repelent scent etc. (alkaloids, glycosides, phenols, terpenes, resins, etheric oils, coumarins, etc.).

Other kinds of defensive adaptations are involving the populational strategies – aggregation, for instance, which provide protection to individuals placed in the center of a group.

Many adaptations of plants involve utilization of phytophagous organisms as means of defense or in reproduction purposes. Associations between ants and plants have been reported – the insects protect their host against pests and in change use parts of it as food (*Botnariuc, Vădineanu 1982*, *Botnariuc 2003*).

Very many adaptations are ensuring the sexual or asexual reproductive process.

In the case of sexual reproduction, the number of adaptations ensuring cross-pollination is extremely high: the variety of flowers, in terms of form, color, attractant secretions, the form and weight of pollen grains, special adaptations for anemophyllic and zoocoric pollination etc. Equally large is the number of adaptations ensuring the dispersal of fruits and seeds by wind or by animals, even by means of special seed expulsion devices (as in *Cucubalus*).

In the case of asexual reproduction, we mention rhizomes, bulbs, suckers.

Some plant movements, too, have an adaptive character – for example, reduction of transpiration by changing the position of the leaves (as in *Tilia tomentosa*).

The vast variety of adaptations that plants have acquired for survival, development and reproduction, under such different conditions, is truly amazing.

4.2.2.3. Specific Adaptations in Consumers

Consumers are organisms which can not produce their own biomass starting from abiotic elements, as plants do, and they acquire the energy and matter necessary to their existence by consuming other species' biomass or necromass.

In order to obtain the nutrients they need, consumers act in different ways.

According to the type of food and the way it is obtained, there are three main categories of consumers (*Botnariuc, Vădineanu 1982, Colinvaux 1993*):

- plant consumers (phytophagous organisms) which consume part of plant organs without completely destroying the plant itself;
- zoophagous consumers, who feed on other consumers by destroying them;
- parasites – phytophagous and zoophagus consumers, placed on hosts (plants or animals) and consuming various vital products of these hosts (blood, sap, lymph, etc.), without killing the host.

Each species belonging to one or another of these groupings has its own adaptations for obtaining and using food.

Phytophagous consumers developed sense organs, mouth and stomach special structures, certain appropriate physiological processes – for example, the shape of the muzzle, the teeth, the shape and functions of the stomach etc in herbivores. Prey species (plants) have developed in return appropriate protective adaptations (morphological and / or biochemical ones, including restoration of injured organs etc.).

In zoophagous predators, senses (sight, smell, taste) are strongly developed, as well as organs that enable them to perform an important effort over short lapses of time, carnassials teeth or other kinds of dentition, special physiological processes, appropriate behaviors (strategies for tracking, attacking, alluring and killing the prey, or camouflage). For example, in stagnant waters, animals bring food towards the oral cavity by creating a water flow or by filtering water ant retaining the organisms they feed on.

Prey animals developed defense adaptations (sens organs and fast-moving abilities, or protection organs such as thorns or shells, or release toxic / repellent scents / tastes, use different types of camouflage; other adaptations concern behavior – mainly aggregation and the use of shelters.

Both predators and prey animals use camouflage, color change in case of danger, or to match the seasonal, changing colors of the evironment.

Many birds and mammals migrate in search of food on short, but also on long distances (whales, fish, birds, locusts, etc.).

In parasitic consumers adaptations involve the shape of the body, the development of various ways of fastening, different mouth types, as well as the release of secretions which improve extraction of food from the host organism. Hosts develop defense adaptations (tissue proliferations to isolate parasites, annihilation through toxin discharge, cleansing behaviors etc.).

4.2.2.4. Specific Adaptations in Decomposers

Decomposers, like consumers, can not produce biomass from abiotic elements; they acquire the energy and the necessary matter from the necromass generated by the death of other organisms, or parts of lifeless organisms.

Specific adaptations of decomposers are almost unknown because the decay process implies a large number of small, hardly identifyable species whose adaptations and role in the process is difficult to establish. In addition, decay mostly takes place in subsequent stages, each involving different decomposers with a well-established place in the process (*Odum 1971, Stugren 1982, Colinvaux 1993*).

Up to now, four major groups of species are known to have special adaptations in the four phases of biomass decay (considering the part they play in the decomposition of necromass):

- arthropods and oligochetes – in the phase of grinding the dead material;
- microscopic fungi, actinomycetes, protists, rotiferans, bacteria – in the enzymatic alteration of detritus;
- lumbricid and enchitreids – in the phase of humus formation;
- diferent bacteria – in the phase of humus decay, which frees other organic compounds and chemical elements that plants can use again.

Undoubtedly, species within each group have evolved morphological and physiological adaptations enabling them to act in a certain stage, which further studies will most certainly clarify.

The first to feed on corpses or leftovers from the kills of large predators are necrophagous large animals (vultures, hyenas, jackals), then the necrophagous insects (which bury fragments of dead meat as food for their offsprings).

The feces are buried by scavenging insects for later consumption.

It can not be established whether decay is carried out by isolated individuals of the same population or by associacions of individuals belonging to different species within spontaneously created trophic chains of decomposers.

4.2.3. The Suitable Abiotic and Biotic Environment

A populations can exist and perform its ecological and genetic functions in the ecosystem in which the environment corresponds to the adaptations of its individuals.

Populations of a species with the same type of adaptations are present only in ecosystems that have habitats and biocenoses that meet their requirements, hence in certain types of ecosystems.

In the habitats within these ecosystems, the amounts and regimes of the vital environmental factors – light, heat, water, chemical elements of the atmosphere and soil (carbon dioxide, oxygen, nitrogen, phosphorus, potassium, microelements) – must be compatible with the physiological needs of plants, allowing them to develop, reproduce, multiply and evolve normally over long periods of time.

Inhabitant biocenoses must comprise populations of other compatible species; for a normal development of interspecific connections – which do not endanger the presence of populations and contributes to their self-regulation process and stability.

The habitat is the first obstacle to the accidental penetration of individuals in one particular ecosystem. The arrival in new surroundings is a shock, considering all organisms are accustomed to particular environmental factors, which fluctuate in a particular way. There are only two alternatives left – to survive by adapting or to dye (because in most cases they do not have enough resources to migrate further on, in yet another ecosystem). If they find a population similar to the one they come from, chances of survival increase. However, newly migrated individuals must first be integrated into the current population, which have created a specific ecological niche; they hence must behave in the community as partners – in obtaining food, reproducing, sheltering, participating in specific intrapopulational interactions that may be more or less different from those they were accustomed to. This is more achievable at the level of metapopulation and practically impossible if stray individuals come from another metapopulation.

4.2.4. The Capacity of Organisms to Reproduce and Disperse

The continuity of a population in an ecosystem requires not only the presence of abiotic and biotic factors which prompt reproduction; they also must ensure its multiplication.

Multiplication is required to maintain a particular, more or less constant numerical level of the population, considering the possibility of changes in vital abiotic conditions and environmental factors (frost, drought, storms, floods etc.), which can destroy many organisms or increase competition within the population. Multiplication is also a way of reacting to pressure put by other populations in the course of interspecific relationships, which can greatly reduce the population’s number. It also has the role to compensate for normal mortality.

Moreover, multiplication enables individuals to migrate between populations of the same species, facilitating gene exchange and starting new populations in ecosystems where the species was previously lacking (*Neal 2004*).

To get an idea of multiplication, here are some data for three trees: *Quercus petrea*, *Fagus sylvatica* and *Picea abies*. In a good year of fructification, the average number of seeds per square meter is 200, 300 and 1000 in the three species, respectively. The following year, 40, 60 and 200 seedlings will be formed, of which only 12, 18 and 60 seedlings will be left at the end of the year. In spite of all the big losses, produced by various causes, there will still be enough young plants to reach maturity and to reproduce, maintaining the continuity of the respective population (*Doniţă et al., 1977*).

In various animal species, mainly insects, multiplication rates are also high, as well as mortality rate.

In general, the number of indiduals in a populations is relatively stable, as a result of self-regulation.

4.2.5. Reproduction, Adaptation, Biodiversity

The multiplication of individuals in the breeding process is a basic attribute of living matter. It is their main adaptation ment to ensure survival in the very diverse and often labile conditions of the abiotic environment, as well as of interspecific connections.

Multiplication increases the density of individuals in the habitat and the competition for resources occurs. The natural need for space expansion, for penetration into other habitats occupied / unoccupied by other species occurs. In order to survive in the new environmental conditions, species must evolve by creating adaptations that lead to the formation of new species. Thus, by multiplying, expanding into new habitats, forming new adaptations, the number and the diversity of the species also increase.

At the same time, populations moving into yet unoccupied habitats induce the emergence of new biocenoses, the diversity of which also increases as a consequence.

Through multiplication and adaptation, the diversity at all systemic levels of life organization increases.

4.3 The Ecological Niche of the Population

4.3.1. The Concept of Ecological Niche

Whenever the causes that determine the existence of the population are met and a population penetrates an ecosystem, its ecological niche to be formed.

Originally, the niche was conceived as a space occupied by a population (*Grinell, 1917*); later on, by considering the functions of the population, the concept gained a wider content (*Elton, 1927,* quoted by *Botnariuc 1984*), and has greatly expanded when niche was described as a multidimensional unit (*Hutchinson, 1957,* quoted by *Botnariuc 1984, Mc Arthur 1968*).

After *E.Odum (1971*) "the niche includes not only the physical space occupied by the organism but also the functional role of the organism in the community (for example its trophic status) and its position from the point of view of the external factors gradients - temperature, humidity, soil pH and other existing conditions". And the same author states that "Ecologists use the term habitat to designate where a species can be found and the term ecological niche to designate the ecological role of an organism in its community" (*Odum 1993*).

According to *Botnariuc (2003*) "This way of understanding the ecological niche includes the whole activity of the given population, its correlations with the ecosystem, the role and function of the population in the structure and functioning of the ecosystem".

There are other simple definitions of the niche, such as "a knot in the trophic network," and "it is strictly defined by what the species eats and who eats it" (*Mac Arthur 1957, Stugren 1982*). The same authors make an analogy between the niche and the phenotype (*Mac Arthur 1968, Stugren 1982*).

But such a concept and sometimes even the limitation of the niche to the relations and functions of the population puts on a secondary position the primordial role of the population in the very formation of the niche, the way it establishes the whole of its connections and the way it functions in the ecosystem.

Some authors already state that "the inconsistency of our thinking on the niche derives from the tendency of some ecologists to argue that the niche is independent of the organism" (*Stevens 1992, quoted by Botnariuc 2003*). Hence, the debate on the preexistence of the niche, supported by some ecologists (*Mayr 1963, Frontier et.al., 1995*).

Discussing the current opinions on the matter, N. Botnariuc points out that "the niche does not preexist, but is generated by the population through the relationships that are formed once it penetrates the ecosystem" (*Botnariuc 2003*).

4.3.2. The Content of the Ecological Niche

Considering that – as stated by the theory of systems – population is a subsystem of the biocenosis, the content of the ecological niche is put in a new perspective.

Like any systemic unit, the population must have an environment from which to obtain the energy and matter necessary to its subsistence. This environment, which originates in the ecosystem once the population is present, has an abiotic component – the whole of the abiotic agents that can selectively be used by the population in the habitat – and a biotic component – the organisms which make up the populations of other species present in the biocoenosis and with which it interacts. This state of facts is consistent with the ecological adaptations of the population.

Therefore there is a stable, permanent part of the niche as the possible life place *for the population in the ecosystem. This part preexists, but it is constituted as a niche once a population interacts with it. Relationships occur within the niche that emerged that way, but are generated by the population and are the attribute of the population and not of the niche[3]. We must therefore very definitely consider what belongs to the niche and what belongs to the population.*

And another problem: The niche does not occupy a precise site in the ecosystem, but is dispersed in micronniches of each individual of the population. The niche appears as a mosaic of individual microniches in which also take place punctual relationships with the stable elements of the niche. The effect of these connections statistically occurs at the population's level. Considering the way organisms disperse (in groups or individually), intrapopulation and interpopulation relationships can be more or less pronounced. Competition or favouring can only occur within groups and not when dispersal takes place on an individual scale.

Hence, it is obvious that each individual has a niche of its own in the ecosystem and relatios in this niche. The population's niche is mozaic, formed by individual niches, depending on way individuals are dispersed; it can be statistically described.

The abiotic part of individual and populational niches is massed in the habitat, while the biotic part consists of the entire complex of intra- and inter-specific relationships.

4.3.3. The Formation of the Ecological Niche

The ecological niche of the population is evolving as a result of the infiltration of individuals of a species, in the form of populations, into ecosystems in which they can survive. Ecosistems must be either developing ones – rich in opportunities for setting up different niches – or fully formed ones, where not all niches are occupied or where competition for niches can occur.

The penetration of individuals into new environments is usually due to their multiplication and the intrapopulational pressure that follows. Once entering a new ecosystem, they gradually becomes more and more genetic adaptations to the biotic and abiotic environment. Adaptations are fixed in the genome of individuals and species and appear in the hereditary genotype as morphological forms, biochemical compounds specific to physiological processes and individual behavior patterns.

Niche is formed as these adaptations develop, as a space in which the environment provides enough opportunities for the population to survive, develop and

[3] Drawing a parallel with a fact from real life, one can consider that a family builds a house and uses it according to its own requirements. It lives in the house, uses the utilities, has family relationships and with people around. But it is the family, not the house, who is responsible of these relationships that take place in the house.

reproduce.

Adaptations of individuals, respectively of species, only take place in ecosystems of a certain type, in which biotic and abiotic conditions are consistent with the vital needs of organisms. Moreover, in such ecosystems the populations of a species can settle or develop depending on the adaptations aquired under similar conditions. As a consequence, species are closely associated with certain types of ecosystems in which its populations can generate niches, but which other populations, formed in similar conditions, can also occupy.

4.3.4. The Variety and Variability of Ecological Niches

On land, populations' niches largely differ because the habitats and biocenoses they occupy are very diverse, depending on climate, land-forms, rock, soil and ecological factors (which are extremely variable, too) (*Chesson et al., 2008, Chesson 2011*).

Let us consider, for instance, the insect niches of a forest ecosystem: insects can be found on leaves, flowers, fruits, stems and roots of trees and shrubs, grasses, forest animals, dead wood and in debris on the forest floor (*Fodor 2006*).

In continental waters, niches formed in standing and flowing water vary according to their size of the habitat, water depth and velocity, water chemistry, thickness, nature and chemical composition of the sediments etc., as well as the general climatic characteristics of the area.

In seas and oceans, the variety of niches is very large, depending on the climate, depth and salinity of water, flow, content in solved oxygen, sediments and many other features.

Niches are not only diverse but also variable. Their variability depends primarily on the diurnal, annual and multiannual variability of climatic factors, on changes in soil and water status as well as on water movements and chemistry.

The connections between organisms within biocenoses also vary, in relation with the populations' state and dynamics, the random or permanent character of the contacts between organisms, as well as with the variability of the environment.

4.3.5. The Size and Plurality of Niches of Some Species

The size of the niches depends on the size of the organisms and the number of individuals in the population.

There are small niches, millimeter, centimeter-, decimetre- or meter-sized (for example, the ones of bark beetles on resinous trees, microscopic organisms installed on boulders in brooks, organisms inhabiting the marine psamon), average niches of hundreds and thousands of square meters (for example in tree populations, in adult, air borne dragonflies and the larvae inhabiting running waters), but also niches of tens or hundreds of hectars (in the case of lynx and bears), or thousands of square kilometers (the ones of herbivorous and predator mammals in African savannas, whales, dolphins, albatrosses) (*Whittaker 1975, Begon, Harper, Towsend 1986, Ramade 1991, Bick 1998,*).

The niche of a population is not always a unique phenomenon for a population and species as a whole. It can change according to the stages of development of organisms, sex, migration, climate, season.

In forest trees, even in the same habitat, the niches of mature trees differ from that of seedlings or of trees in other stages of life, even in the same habitat.

In raptor birds there are differences between males and females concerning niche size (in terms of hunting grounds and behavior).

Birds and migratory mammals have different niches in the breeding areas and in areas they migrate to during the cold season.

A large array of populations may have overlapping niches. For example, the niche of an oak species, the one of *Lymantria* (defoliator insect), the niche of *Lymantria*'s parazite and the niche of the latter's hyperparasite (*Fodor 2006*).

In plants, in most cases the niches are generally permanent, because individuals are not mobile.

In animals, niches are frequently both permanent and temporary. For example, birds have one kind of niche while nesting and raising their offsprings and quite different ones in the rest of the time. In some aquatic animals, niches differ in adults and larval stages, sometimes even in larvae, according to the development stages (e.g. copepods, some fish – genus *Anguilla*).

4.3.6. The Relations Between Populations and Abiotic Factors in the Ecological Niche

On land, connections established by a population with the abiotic environment are very different in plants, animals and other organisms.

Plants, being fixed to the ground and having the function of producing biomass by extracting abiotic elements from the soil, interact most closely with the abiotic environment: they use solar energy, carbon dioxide and oxygen from the air / water and nutrients from the soil. For example, plant populations in a forest ecosystem absorb about 136.3 million Kcal of solar energy per year to produce 29,000 Kg of biomass – in which part of this energy is included. The same populations take in about 4,000 m^3 of soil water, of which 3,500 m^3 goes into the atmosphere in the processes of transpiration and evaporation. They use 42,300 Kg of CO_2 and 12,800 Kg of oxygen from the air (but 29,600 Kg of oxygen returns in the atmoshere during photosynthesis). From the soil, 100 kg of nitrogen, 173 kg of calcium, and 77 kg of potassium are absorbed and used, but they are returned to the soil after the breakdown of the necromass (*Duvigneaud 1974*).

Through these relations, as well as through a series of phenomena: avoidance of solar light, retention of rain water, diminution of air movements and the production of large amounts of necromass, the plant populations dramatically change the abiotic parameters of the habitat. In this way, plants generate bioclimates, which are distinct from the general climate (i.e. a microclimate of their own) and trigger the development of soil as a new covering of the Earth among the other, abiotic ones (gaseous, liquid, solid-rock).

This relationship between plants and the abiotic environment occurs at the populations' level by selectively intake of abiotic elements according to the adaptations of each population. All the same, at the level of biocenosis, (i.e., all the populations as a whole), these connections are cumulated and act in common upon the ecosystem.

On land, animals, too, interract with the abiotic environment. They need direct solar energy, use oxygen from the air, water from springs, rivers, lakes etc., and release carbon dioxide and heat into the atmosphere. However, the amount of these elements is quite low and only slightly influences the abiotic environment in which they live.

The activity of populations responsible of the decay of necromass, as well as that of soil dwellers, is noteworthy; as a result of this activity, almost all the minerals previously absorbed and used by plants return to the soil. At this level (necromass decay), the total recycling of the matter takes place. The activity of decomposers also results in the release of a significant amount of carbon dioxide.

In the continental and marine aquatic environments, the main primary producers are green and blue algae, most of which live in the pelagic zone. From the water, they take dissolved carbon dioxide and nutrients and release oxygen (which dissolves into water); the excess of biomass is eliminated in water, where it dissolves. All primary production is performed only in the layers accessible to sunlight (the photic zone of the water mass). Some aquatic primary producers are attached to a solid substratum, or even inhabit the surface of silty sediments (sometimes as a fine biofilm), but their existence is rather precarious. In contrast to land environments, in the aquatic one consumers and decomposers play a much more important role in the cycle of matter and in the constitution of biocenoses.

A very important component of abiotic environment consists in the limiting factors, that is, the factors with values at (or below) the quantitative limit which organisms of a population need for developing and especially for a normal reproduction.

Each of the abiotic factors in the habitat and in the niche can become limiting, but only at times, otherwise the life of the organisms would not be possible. It is the case of light (as far as plant populations are cencerned), which may lack at high latitudes for a few months, heat (which in a seasonal climate may lack for a time), water (whose absence from many areas greatly reduces plant activity) or some essential salts in the soil. In terrestrial animals, limiting factors are extreme clime conditions, the amount of food etc. For these reasons, animals migrate from certain ecosystems or – during unfavorable seasons (prolonged winters, droughts, etc.). Each year, many species of birds migrate on long distances (thousands of kilometres); herds of herbivorous mammals from African savannah migrate over tens or hundreds of miles.

In the aquatic environments unfavorable factors present are: salinity, excessively high temperature, turbidity (which prevents algae from synthesizing biomass), toxic minerals and pesticides dissolved by rain-or meltwater and conveyed down the slopes into watercourses; the same phenomenon concerns excessive nutrients in over-fertilized agricultural areas etc. Aquatic animals populations are often dependent on the water-borne necromass originating in the terrestrial areas surrounding the aquatic basins and conveyed by rain water.

Individuals (hence, populations and species) have a large number of adaptations to reduce the negative effect of limiting factors (diminution of the period of activity in tundra plants, fall of leaves in temperate and tropical climates, development of drought resistent structures (as in cacti), mechanisms enabling salt elimination in halophilic plants etc. A large array of resistence forms can be mentioned in animals: (spores, cysts, resistant eggs, hibernation, etc.); in some species, immature stages live for long periods of time in water, while adults are terrestrial or aerial and have a much shorter lifespan (e. g., 1-30 days in ephemeras) (*Botnariuc, Vădineanu 1982*).

4.4 The Ecological Activity of the Population in the Biocenosis (Ecosystem)

4.4.1. The Relations within Populations (Intrapopulational Relationships)

Individuals' relationships within a population[4] are contradictory – both positive and negative. Nevertheless, on the whole, along with relationships they establish with other populations and with the abiotic environment, they ensure the maintenance of the number and activities of the population at a certain level.

The main intrapopulational relationships are:

[4] A terminological statement: it is correct to use the terms intrapopulation and interpopulation and not the terms intraspecific and interspecific, because in the ecosystem relations are occuring between populations, not species.

- Reproduction and multiplication relationships.
- Competition relationships.
- Mutual aid relationships (favouring)
- Disturbance relations

4.4.1.1. The Relations of Reproduction and Multiplication

These are the main relationships and ensure the survival of the population and its continuity over time. They also ensure the ecological and genetic functions of the population. Reproduction results in the emergence of offsprings which are similar to the ascendants, preserving the species's characters, but also contributing to species evolution by enhancing ecological adaptations, generating new adaptations and as a consequence new species.

Reproductive and multiplication connections are tremendously different in species belonging to different taxa, in respect of the organsisms' adaptations and of the mechanisms by which they take place within the population.

Reproduction is an individual process (in agamic organisms), or involving two individuals of different sexes (in alogamic organisms). However, reproduction alone – i.e., the emergence of a new individual – is not sufficient to perpetuate the population. That is the reason why, in all species, reproduction is accompanied by multiplication – the emergence of a large (often very large) number of offsprings, which represent a guarantee of the species' perpetuation.

Reproduction and multiplication occur within the population and determine an important indicator for its existence over time – birth rate.

Some of the adaptations concerning reproduction and multiplication have a very general character.

The exogenous or endogenous, sexuate or asexuate character of the process, as well as its type (r or K) are general adaptations. Moreover, each species (hence, population) has specific adaptations to conduct these relationships.

Sexuate reproduction is more complicated, because it involves special adaptations of sexual organs; moreover, it depends on environmental factors (e.g., weather conditions) and implies the search for partners, competition etc., but it ensures sexual selection and genetic diversity of the offsprings.

Asexuate reproduction promotes the accurate transmission of the genetic information and a faster multiplication, but does not produce sufficient diversification in offsprings.

In plants, which are fastened to the ground, reproductive adaptations refer to the transfer of gametes between partners and the dispersal of seeds (fruits), both in alogamic and agamic species.

In anemophyllous plants, very light pollen, produced in large quantities (pollen rains) is carried away by the wind. In zoochoric plants, pollen is conveyed by insects and birds.

In anemochoric plants, the fruits and seeds are provided with wind dispersal adaptations; in zoochoric ones – with nutrients which animals are attracted to or with various structures for alluring animals. Another adaptation consists in vegetative organs (such as bulbs or rhizomes) involved in the process, which are present in many alogamic plants.

Animals possess sexual organs of different forms and the sexual process occurs in different ways. Sexual dimorphism greatly prevails and occurs in the most diverse forms, which are well-known in birds, mammals and insects. One must also consider complex mechanisms for finding partners (sounds, like in wolves and cats, most birds, crickets or cicadas), luminous signals (in fireflies) or chemical ones (pheromones, body scent) and courtship displays (in many birds, mammals, fish, octopus etc.). During the mating season, rivalry occurs and is solved by displays meant to impress or intimidate adversaries or by fighting (as in deer, wild horses or stag beetle).

Many birds and mammals form stable pairs (storks, barn swallows, wolves, foxes) or harems (lions, deer, goats, wild horses, primates).

In some insects, reproduction is preceded by permanent or temporary swarming (ephemerans, dipterans).

4.4.1.2. The Relations of Competition

The role of competion in intraspecific relations is still subject to debate, but its existence can not be denied.

In plants, competition take place mainly because organisms are not mobile, they can not avoid each other and because they use the same reservoir of resources – the habitat within their ecosystem, from which each individual of the population selectively extracts vital abiotic elements, according to the ecological niche established by its adaptations.

In plants, competition occurs depending on the spatial distribution pattern of each species. It does not occur when the individuals of the population are distributed in isolation, only when they form groups of different sizes and it is more severe if groups are larger and more dense. This is especially the case of dominant populations that massive expanses.

In the case of clustered distribution, competition for resources triggers a quantitative differentiation of the individuals in terms of dimensions and biomass; as a result, competition and selection increase, considering that the fittest individuals produce more successors and have greater chances to ensure the continuity of the population.

The main environmental factors for plants in competition are light and water. There are any adaptations are meant to reduce this competition – some plants are able to photosynthesize at low light (herbaceous plants in forest), others can reduce perspiration or increase their ability of absorbing water etc.

Competition between generations has also been noticed in plants, especially concerning mature generations versus younger ones; this competition can consist in a different strategy of seed dispersal. Much of the the new generation disappears, mainly due to competition for resources (especially for light, but also for water and vital chemical elements). Reducing the number of new generations may also have other causes (climate impact, destruction by phytophagous animals etc.). So, at the population's level, a certain age, size and biomass structure is established.

In animals, competition is much more diversified. It concerns interconnections implying food supplies, during breeding periods, between members of the same family, between individuals of different generations, or for leadership within families/groups.

The competition for food is obvious in many predators: after a kill, the strongest and most vigorous individuals are the first to feed. After dominant males are satiated, it is the turn of females (starting with the pregnant and the nursing ones). Other adult individuals – and finally the youngsters – follow. What is left of the prey will be consumed by the weakest, the injured or the sick ones. In this way, there is always a selection in social animals, ensuring the maximum working capacity of the families (hence, a selection that ensure the continuity of the species in its evolutionary process).

The breeding competition is best observed during mating periods, when males usually fight over females (this behavior is most obvious and best known in birds and mammals, but it has also been described in cephalopods, arthropods, fish, amphibians and reptiles).

Various types of competition occur in the case of animals living in families. Typically, the leader is either the strongest and most quickwitted male or the most experienced female (recognized as such by the whole family). A family consists more often of a leader (dominant- or alfa male), one female (or more), younger individuals of both sexes and newborns. Within the family, the struggle for supremacy is endless, which causes the leader to be continuously alert. When a new dominant individual takes over the leadership, he often kills the offsprings sired by the dethroned leader, in order to have its own successors and thus perpetating its own genes. In this way, at least for a while, the family is free of internal friction and is dominated by the close relatives of the new alfa male (in this respect, wolves' behavior is an extreme one: only a dominant couple produces offsprings, who are taken care of and trained by the other females, left unfertilized). In most mammals, young females remain within the family, while young males leave or are driven away by the dominant male. They form groups of single young individuals, who live isolated from families of their own species, either seeking acceptance (through obvious displays of obedience), or challenging (when they feel more confident in themselves) older, dominant males, which they hope to replace. If they succede in doing so, they will banish their former colleagues, thus avoiding later competition.

In many monogamic species, adults provide shelters or nests for their offsprings, which will be carefully guarded by one or both parents. This activity is known in cephalopods, some crustaceans, insects, fish, reptiles, birds and many mammals.

Competition between generations occurs only starting with a certain age of the descendants. After their birth (or hatching from the eggs) and until they can fend for themselves, offsprings are protected and trained by adults. When they approach sexual maturity, they become competitors for reproduction, they are reprimanded, banished from food and especially from the breeding process.

In general, the different intraspecific relationships are the most manifest in the most basic intraspecific relationships: feeding and breeding behavior.

Some adaptive mechanisms are meant to reduce intraspecific competition in populations. Such is, for example, isolation – present in both plants and animals.

In many plant species, individuals are distributed either evenly or randomly; as a result, competition for resources is avoided.

In animals, individuals of different sexes can live appart, except for the mating season.

Isolation can also occur by parting the area inhabited by a population into family / group territories (the phenomenon of territoriality). Many species (herbivorous, omnivorous or carnivorous ones) have feeding (hunting) grounds, but also territories both for feeding and reproduction (as in many mammals and birds). Territorial boundaries are stained by marks, sounds, scent and even protected by threatening displays or fighting (Figure 4.3).

Territoriality is a phenomenon that greatly reduces competition, ensuring an optimal population size, favorable to the species/population.

4.4.1.3. The Mutual Help Relationships (Favoring)

Mutual help relationships have the role of ensuring an optimal number of the population; it implyes care for the descendants, aggregation and different forms of mutual protection of organisms.

Care for the offsprings. Care for the offspring is obvious both in reproduction and in the newly formed new generation. It implies different forms of relationships –

of remarkable variety and subtleness – in both plants and animals.

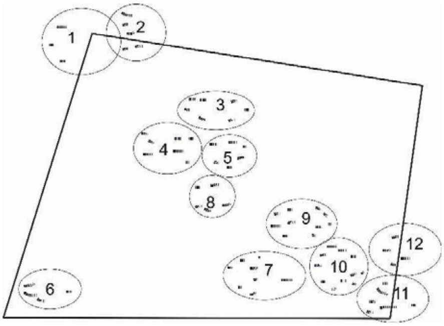

Fig. 4.3 - Territoriality at *Luscinia megarhynchos* (1-12 nesting pairs) (*Blondel 1969,* quoted by *Doniţă et al., 1977*)

In all plant species, the seeds have nutritional reserves to ensure the life of the seed, but also germination and development in the first phases of growth. Passive protection of young plants by mature ones against certain environmental factors (strong insolation – which increase perspiration, frost, wind etc.) also occurs.

In animals, strategies used for offsprings protection are much more varied and effective, regarding both the breeding process and strategies used in the starting development of the new generation.

In oviparous animals, eggs are provided with a supply of nutrients necessary to the development of embryos; the eggs are laid in groups and placed under favorable conditions, then guarded; offsprings are fed, guarded and protected from dangers, then trained by parents – all strategies occur. The forms in which these benefits are achieved differ. Defoliant insects lay eggs on appropriate plants for larvae to feed on. Parasite insects lay their eggs in eggs or in larvae of host insects. The fish spawn in sufficiently warm and well oxygenated water, on certain protective substrata. Birds build nests where they lay eggs and raise their chickens, which are nourished, sheltered against bad weather, protected from predators, trained to fly and find food.

In viviparous animals, the fetus develops in the fully protected environment of the mother's body, where it is fed. Offsprings are sheltered, fed, protected against enemies and often trained (by watching their parents) to feed, obtain food, avoid enemies, or defend themselves.

The most elaborate forms of mutual help are to be found in colonial insects – bees, ants etc., who build shelters provided with a microclimate of their own, nourish and protect fertile females, take care of the eggs, feed the larvae, protect the nest against enemies.

Aggregations (agglomerations). Aggregations are forms of concentration of the population on small areas. They occur passively or actively.

In plants, aggregations are passively generated as a result of the way descendants are disseminated. In anemochoric species, seeds are packed in sheltered places; in plants with heavy seeds or fruits, descendants are grouped in the genitors' proximity.

In animals, aggregations generally occur actively, as a result of the mobility of individuals, by instinct, according to physiological conditions, behavior, information exchange (*Botnariuc 2005*).

Aggregations may be temporary or permanent. Many reproduction aggregations result from depositing the eggs in certain places, which generate the aggregation of the next generation – e.g. migratory fish (salmon) that spawn in rivers, ephemeran insects, colonial birds (gulls, penguins).

Many agglomerations are established for breeding purposes, but some involve feeding (carnivorous mammals – wolves, lions, hyenas etc., or herbivorous ones – antelope, reindeer, deer, European bison).

Agglomerations are typical forms of a population's manifestation. They occur because they confer obvious advantages in population maintaining, but are not free of some disadvantages. In plants, aggregation provids a better pollination by wind, but also by insects, a better spreading by animals. Growth of tree roots promotes the exchange of raw and elaborate sap between specimens, as well as the exchange of mycorrhiza.

Plant agglomerations, the formation of massive expanses prompt the establishment of a more favorable microclimate, which give both mature and young plants protection against wind, insolation or excessive transpiration.

In animals, agglomerations are beneficial, providing a better protection against predators, either by warning signals or by active defense. Fatalities occur only among isolated or sick individuals. In agglomerations, nutrition is more efficient, because individuals signal to each other the presence of good food sources; besides, they are more successful in avoiding predators, which allow them longer intervals of quite feeding. In agglomerations, partners are easier to find; moreover, gregarious animals guard their offsprings (some even tend for them) collectively.

There are several ways of maintaining aggregation in animals; the most common is visual communication.

Acoustic communication (mainly in birds and mammals) plays an important part, too.

An interesting type of communication have been observed in insects; the phenomenon ensures mutual help and implies chemical means, via sexual pheromones released by individuals in search of breeding partners (marking pheromones with the role of guiding).

Of course, there are some disadvantages in agglomerations. Most important, competition for food, shelter and breeding partners increases. In plants there is an increase in the competition regards light, water and nutrients from the soil; moreover, danger of destruction by phytophagous is greater. In animals, increased competition regards nesting places, offsprings shelters, individual territories. In both plants and animals, the great disadvantage of agglomerations is the danger of fast spreading of parasites or infectious diseases.

The important thing is whether the benefits are greater than the disadvantages. The fact that individuals frequently form agglomerations proves that, nevertheless, advantages prevail.

4.4.1.4. Competition Relations

These relations appear in the case of high density or autotoxin production. Large densities can occur in trees forming dense concentrations, in defoliant insects, in nesting colonies of bird species etc. Such high densities are stressful and trigger changes in the physiological processes, disturbing development and prolificity of organisms and, consequently, the population's number.

Cramping of a population's individuals can also be caused by the negative effect of the non-degraded own necromass or the occurrence of autotoxins during decomposition. In this respect, we mention the difficulty of seeds germination and develop if seedlings when the layer of debris on soil is too thick or contains toxins, as is the case in tree species.

4.4.2. The Population Relations with Other Populations in Biocenoses (Interpopulational Relations)

Interpopulation relations (between populations of different species) drive the processes which characterize ecosystems: production, consumption and decomposition of biomass and necromass, hence the energy and matter flows that pass through the ecosystem. Every population has its place and function in this processes.

Interpopulational relationships are conducted according to the ecological adaptations of individuals and populations within the ecosystem.

The main categories of interpopulational relations are:

- trophic relations;
- competitive relations;
- symbiotic relations.

4.4.2.1. Trophic Relations

Undoubtedly, trophic relations are at the forefront of interpopulation interacting, because they set in motion the ecosystem process, as well as the energy flow and the matter cycles. They run through trophic chains, that start with the producers (green plants), pass along the entire series of consumers (animals, fungi and bacteria) and end up with decomposers (fungi, insects, bacteria) until the energy of organic substances produced by primary producers and the nutrients return to the habitat (*Botnariuc, Vădineanu 1982, Tillman 1996, Miller, Spoolman 2009, Thompson et al., 2012*).

Relations between phytophagous consumers and plants. These interconnections are achieved by phytophagous animals and do not result in the destruction of plants.

Terrestrial plants can not avoid consumption by the phytophagous animals, because they are immobile. Some water plants are in the same situation, while others are mobile.

According to current data, primary production is very high and only 10% of the resulting biomass is actually used by phytophagous consumers (*Odum 1971*). Nevertheless, this is an average estimate, because, in certain situations, phytomass consumption may be much higher (in the case of exponential propagation of phytophagous insects – invasions of locusts on grasslands, or of defoliant insects in forests).

In any case, the relationships between phytophagous animals and plants does not lead to the destruction of plants – herbivorous organisms do not act as predators but, in a way, as parasites. However, there are cases when phytophagous can be considered predators (birds and mammals consuming seeds, bulbs, roots or rhizomes).

Phytophagous populations select and consume certain plants or parts of plants, according to certain eological adaptations: the ability to distinguish plants, mouthpieces specially designed for gripping, detaching and shredding plant parts, special structures of the digestive system and processes in which symbiotic bacteria also participate, climbing organs in tree-dwelling animals, etc. (*Holt, Barfield 2013*).

In their turn, plants react by a large biomass production, the ability to restore vegetative tissues through dormant or adventitious buds, various defensive structures and/or substances.

Relations involving phytophagous animals and plants largely differ from one climatic zone to another and even within the same area, depending on the environmental factors that influence plant development, hence their relationships with phytophagous populations.

Relations between phytophagous animals and plants are continous in warm zones (equatorial area), where they are permanent throughout the year. They become periodic and are summary in areas with cold or dry seasons. In these areas, phytophagous have special adaptations (they rest during the seasons that are unfavorable to plant development, living on previously made reserves (seeds, fruits), they change foliar food with other vegetative parts (shoots, buds, roots, bulbs etc.).

Each year, certain animals (in birds and mammals) leave their winter territories and reach areas with a milder climate, in huge migrations. Occasionally, the phenomenon occurs in the same area – for example, in the case of meadows destruction by droughts.

In seas and oceans, the relationships between phytophagous animals and plants are wide-ranging. In warm water, they are permanent; in cold water they are periodic – limited to the warm seasons. As a result, large migrations of phytophagous fauna occur, depending on the development of phytoplankton and algae.

The connections between phytophagous organisms and plants may be quite intricate, in the sense that the same plant species is the source of food for several consummers, and one phytophagous species can feed on several plant species.

Plants can also develop beneficial connections with their consummers. It is the case of trophic relationships that ensure pollination in many plant species and the dispersal of their seeds. Another way plant protect themselves is the emission of entancing substances, which animals (ants) feed on, instead of destroyng the plant.

However, relationships phytophagous animals establish with herbaceous plants also depend on their relationships with predators (second degree consummers), which affect their number; consequently the pressure upon the plants decreases. An important process of self-regulation, both in plant populations and in their phytophagous consumers and predators ensues.

<u>The relations between predators and prey</u>. These relationships are established both between predators and phytophagous animals, as well as among predators of different orders.

Relationships are of a different nature than those between phytophagous organisms and plants, because the phytophagous biomass, as a prey, is much smaller than the vegetal one, which herbivorous species feed on; besides, both predators and prey are mobile. Nevertheless, in the case of the prey-predator couple, too, complex situations arise, when a single species of prey is consumed by several species of predators, or the same predator can attack several prey-species.

Predator-prey relationships are reflected in continuous variations in the number of the two or more populations involved in this process.

Generally, predators destroy a small number of prey-animals, when these are not numerous. The intensity of the attacks increases with the number of the prey-animals.

Sometimes, predator will even kill more than they can consume. The abundance of food stimulates predators' multiplication. When the numbers of prey populations decrease, so does the number of predators, but at a slower rate.

Correlated variations between the number of predators and that of the prey, with a time shift in the growth or decrease in predator's number as related to the number of prey, also occur (Figure 4.4).

Prey-predator relations can change the age- or gender structure of prey populations, as selective destruction may occur. The predators' action is also beneficial to the prey populations, because most of the less vigorous individuals are killed, including the sick ones (thus, the outbreak of epidemics is avoided). Numerous predator-prey connections also develop in populations that function in the process of necromass decay.

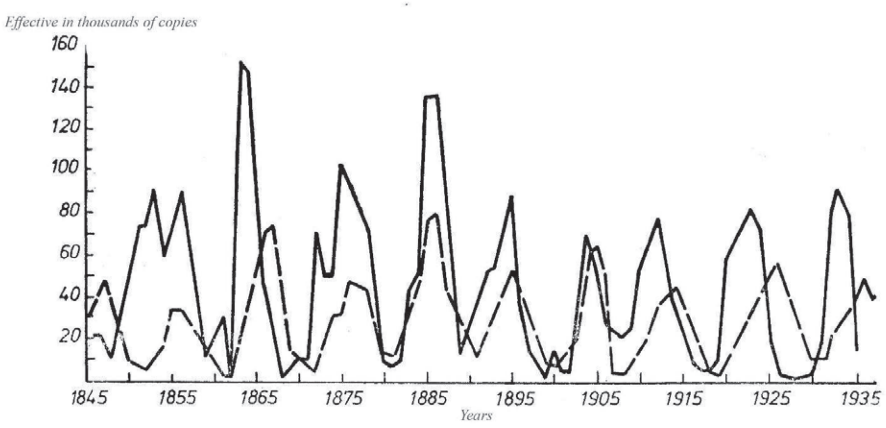

Fig. 4.4 - Correlated dynamics of rabbit and lynx populations (*MacLulich 1937,* quoted by *Odum 1971*)

Relations between the parasite and the host. Parasite-host relations have a special character because the benefiting population is found on or inside the host it feeds on, but the host organism is destroyed / consumed only in special situations – as in the case of phytophagous organisms-plant relationship.

Both plants and animals are attacked by different species of parasites on all levels of the trophic chains. They may be either ectoparazites fixed on the host, or endoparasites, inside the hosts' body.

Ectoparasites have special adaptation for fixing on the host. Anyway, both kinds consume the vital substances of the host (blood, secretions, sap, cell protoplasm) and affect the host via its excretions. Parasites have special mouth adjustments for penetrating into the skin and absorbing the substances they feed on; they also release secretions that stimulate bleeding, sap production etc.

Host species defend themselves by isolating the parasites – by means of defensive tissues (in plants) – or by various behavaviours: water- or sandbathing, as well as mutual grooming, as in social animals.

Some parasites are pathogenic (bacteria, viruses) that can cause the host's death. The host reacts by producing autoimmune substances.

Some parasites - parasitoids parasitise the host only during some stages of life (like some phytophagous insects).

Hyperparasites infest parasitic organisms at different stages of their development (egg, larvae, pupa or adult) (Figure 4.5 and Figure 4.6).

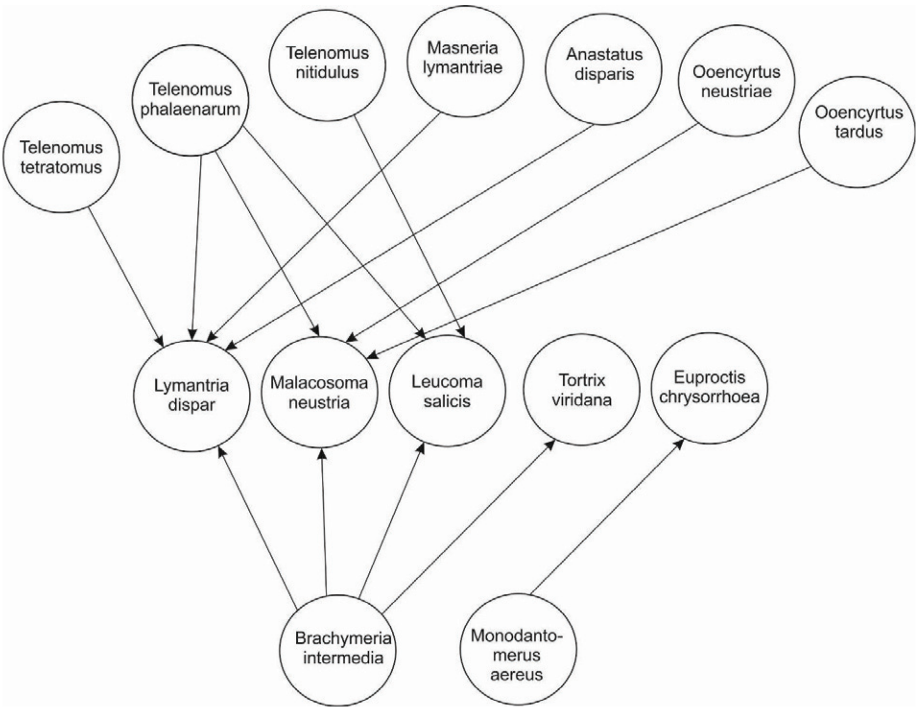

Fig. 4.5 - Parasites of eggs and crysalides of defoliators (*Lăcătuşu et al., 1978*)

In fact, all species, apart from plants, are parasitic, because they use biomass of other species. But among plants there are some parasites (e.g. the mistletoe species).

4.4.2.2. The Competition in Interpopulational Relations

The role of competition in interspecific relations is widely discussed from often contradictory positions (*Botnariuc 2005*). But role in the ecosystem is assets by a series of modern studies.

At least in plants, which are not mobile and use energy, water and nutrients from the same habitat, competition occurs both intrapopulationally and between populations of different species, in mixed phytocoenoses. In such circumstances, competition causes structural and functional changes in the organisms of the respective populations. In trees, for example, the shape of the trunk and of the crown change, and the physiological processes (assimilation, respiration, growth, fructification) are diminished. If populations have different luminosity requirements, those who need more light are partly eliminated by those that can develop in lesser light.

In animals, too, individuals of different populations compete for food. Many such cases have been mentioned for different species of insects (leaf sap consummers, leaf defoliant and mining insects, root eaters) and in different predator mammalian populations sharing the same pray.

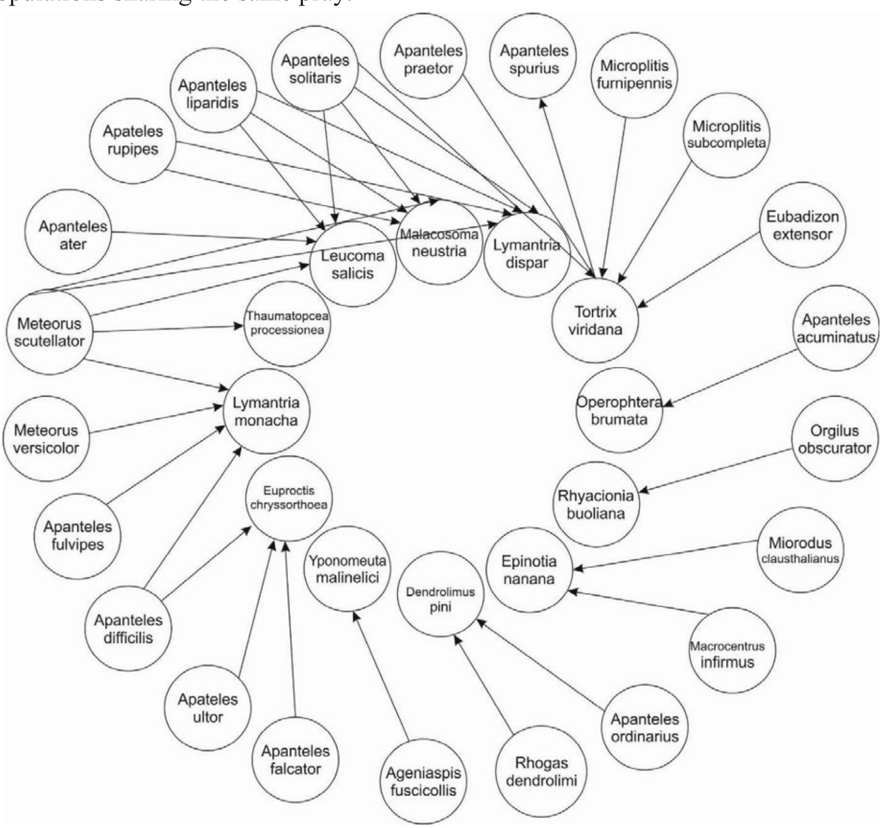

Fig. 4.6 - Parasites of larvae of defoliators (*Lăcătuşu et al., 1978*)

According to *Botnariuc (1982, 2005*), competition between populations belonging to different species is an real phenomenon that can take acute forms when new populations enter the ecosystem. However, in the ecosystem, relationships with negative effects, competition (as a relationship with negative effects) diminishes or is eliminated by self-regulation.

4.4.2.3. Symbiosis in Interpopulational Relations

Unlike competition, symbiosis between two or even more populations is widespread.

The ecosystem is an example of symbiosis, because none of the populations that form biocenosis can exist by itself, being connected in the flow of energy and matter that passes through them.

Symbiosis also occurs in other forms between organisms belonging to two or more populations. It is the case of phytophagous populations that have intestinal endosimbionts (bacteria and / or protozoans) which help digest the vegetable food (ruminant mammals and termites with some protists, or some birds).

Such is the case of the association between algae and fungi in lichens, where algae provide photosynthesis products and nitrogen, while fungi provide water and the necessary nutrients. We emphasize that the role of lichens, as the first organisms to occupy extreme habitats, is of great importance.

Association of mycorrhizal fungi or nitrogen-fixing bacteria with plant organisms is also an interesting case. Symbiosis with mycorrhizal fungi occurs in almost all plant species. Simbiosis with nitrogen fixing bacteria also occurs frequently in many plants, ensuring the supply of vital element that can not be obtained directly from the atmosphere.

Symbiosis also consists in providing food resources by cultivating fungi in the nests of coleopterans, termites and ants , or aphids – in ant-mounds.

4.4.2.4. Trophic Relations within the Necromass

The interpopulational relationships – which we mentioned above – are established on the basis of biomass consumption and take place between populations, starting with the producers – plants.

Necromass does not consist in populations, but in dead organic matter of both vegetal and animal origin.

The first level in the trophic chains within necromass is not a population, but dead matter. In this first stage of decomposition, one cannot speak about an interpopulational relationship. It is only afterwards that interpopulational connections occur; they involve the first populations that use necromass (feed on it) and the predatory and parasitic populations that consume them or consume one another; from *now on, trophic chains and interpopulational relationships are established. In the final phase, when the altered matter is consumed by the use of enzymes, there are no longer interpopulational relations.*

4.4.3. The Quantitative Development of Organisms, Populations and Species

4.4.3.1. The Factors that Determine the Quantitative Development of Organisms, Populations and Species

In each ecosystem, the habitat has a certain ecological potential, that is, a certain capacity to provide the organism, population and biocenosis with the energy and matter required for survival, perpetuation and evolution. This potential also determines a development of producers (photosynthetic organisms) from a quantitative point of view; a certain quatity of biomass to be produced. Consequently, the populations of animals, fungi, heterotrophic protists or bacteria – as consmers and decomposers develop as numbers and biomass.

The quantitative development of individuals and populations is also influenced by relationships within populations, as well as among the different species that make up biocenoses. Interpopulational connections increase or reduce the number and biomass of individuals within a population (especially as a result of trophic relationships, which then determine their distribution in space), or alter the age classes.

As a consequence of the conjugated effect of the ecological potential of the habitat and the nature of the relationships within a biocenosis, a similar living environment (in which individuals of the populations can develop quantitatively in the same way and with a certain intensity) is created in all ecosystems of the same type, and the same quantitative phenotype (both of individuals and populations) specific to the concerned type of ecosystem, is formed.

The quantitative phenotype is an adaptation of each species' genotype to the abiotic and biotic environmental conditions in which it develops. Unlike the qualitative genotype, the quantitative phenotype is not hereditary and is variable, changing according to environmental changes.

The population, as a multitude of individuals belonging to a species, develops its own quantitative characteristics – such as the number of individuals, age classes, sex ratio, birth rates, mortality etc.

4.4.3.2. The Quantitative Characteristics of the Population

Quantitative development of the population is statistically expressed by population indices. These are:

A. Status indices

- the number and density of individuals;
- the distribution of individuals in the ecosystem's space (frequency);

- the dimensional structure of individuals;

- the amount of biomass and necromass (production) in the ecosystem;

- age structure (in perennial populations);

- gender structure (in alogamic populations).

B. Indices of dynamics, i.e. of populational change

- the amount of biomass and necromass produced in a given time unit (productivity);

- the rate of appearence of new individuals in the population (birth rate);

- the rate of disappearance of individuals in the population (mortality rate);

- the rate of increase or decrease in the number of individuals in the population[5].

With the help of these indices, the researcher can describe the situation of the population at a certain point in time and can also establish its real dynamics by certain time interval control.

The number or the group is the first and most important index, because it shows the size of the population and because it is the decisive structural and dynamic element. The size of the population, that is, the number of individuals that make it up, is conclusive for its existence. Every population has a critical number under which the danger of extinction may occur.

From the structural point of view, the number determines other indices: density, frequency, dimensional structure, age structure or sex ratio. The number is also important from a dynamic point of view, because it occurs through its variation in time (which is caused by birth, mortality rate, or migration).

Density is the number of individuals of the population related to the size of the space occupied in the ecosystem. It can also be expressed by the weight of biomass per space unit.

Density is a very variable index, depending on the size of the individuals. *E. Odum (1971)* gives values between 10^{12} /sq.m (debris bacteria) and 10^{-2} /sq.m (mice), that is, a difference of 10^{14}.

The upper limit of density depends on the energy flow (productivity), the lower limit of the ecosystem on homeostasis mechanisms (*Odum, 1971*). The variation of these limits expressed by biomass is, for example 0.003-0.03 Kg / ha for a lynx and 2,0-12.0 Kg / ha for a deer (*Odum, 1971*).

Dispersion (distribution) refers to the way individuals of a population are dispersed in the ecosystem.

Dispersal may encompass the whole territory, or part of it. It is indicated by

[5] Rates result from reporting the number of organisms that occur or disappear to the total number of organisms in the population before the occurrence or disappearance of organisms.

frequency, which is obtained by relating the number of sample areas in which individuals of the population were found to the total number of investigated sample areas and is expressed as a percentage.

In this respect, individuals may be isolated or grouped – forming aggregations of different sizes.

Aggregation occurs for various reasons: local environment differences, the manner seeds are grouped when disseminated (in plants), permanent or seasonal groupings (in animals) etc.

Finally, dispersion can be regular, when isolated or grouped individuals occur in a given space in a certain order, and random (aleatory) when no such order is observed.

The dimensional structure is the distribution of the population's individuals by dimensions (length, width, volume). This structure depends on the dimensional variation of the individuals caused by genetic factors, on the microconditions in the environment, on relationships between populations resulting in the elimination of some dimensions.

The dimensional structure may take different forms. It can be renderd as a table, as graphs or as equations and can only be represented by the average value and the extreme ones.

Biomass is the living matter, expressed in terms of volume or dry weight, contained in each individual and in the whole population. It is an important index because it shows the content of energy and matter and the role of the population in their flow and circuit. It also shows the ecological potential of the abotic environment and the vital potential of the population.

Age structure is represented by the distribution of population by age or age groups. It is an index that shows the trends in populations' development. From the ecological point of view, three ages are important: pre-reproductive, reproductive and post-reproductive one (*Bodenheimer*, quoted by *Odum 1971*). The duration of these periods varies according to the life cycle of the species. In some species (e.g. insects) the first period is long, the reproductive period is short, and the post-reproductive period is of different lengths, or perhaps even absent (in ephemeras etc.).

In growing populations there are more young individuals, in the ones with a descending evolution – many older individuals.

Sex structure (only by allogenic populations). The sex ratio is typically around 1:1 in panmictic populations. But it may vary depending on adaptations (e.g. in colonial insects) or on relations between different species – by which especially individuals of a particular age are better diferentiated.

As mentioned above, quantitative development is the result of current relationships of a population's individuals with the environment of the niche, i.e. in the ecosystem.

In ecosystems with similar biocenoses and habitats, populations develop more or less similarly, the quantitative indices being about the same. These populations can be categorized into population types. According to the magnitude of ecological adaptations, species may exist in one or several types of ecosystems and in each type will form a certain type of population.

In plants, for example, faithfuly species (i.e. manifesting fidelity) or relict ones are found only in one type of ecosystems. They will have one type of population (they are unipopulational species).

Dominant species, such as *Picea*, *Quercus*, *Festuca*, etc. are found in several types of ecosystems. They will have several types of populations (they are multipopulational species).

4.4.3.3. The Quantitative Development of the Species

As stated in Chapter 2.1, the species is a genetic system in a biological system – the biocenosis. And because its constitutive subsystems, populations, have a dual (ecological and genetical) function, the function of the species in the ecosystemic process is, consistently, an ecological one, too.

The species is dispersed through populations into ecosystems of a certain type, similar as regards abiotic and biotic environment, which have the same ecological potential. In these ecosystems, the populations of the species have a more or less similar quantitative development. Such populations can be considered of the same type, and their average population indices will also characterize the species in terms of quantity.

This is important, because these indices reflect the state of the species in the type of ecosystems in which it is located, its productivity and the trends in quantitative changing.

The species with a greater amplitude of ecological adaptations, found in ecosystems of several types, have several types of ecological populations. A multipopulational species will correspondingly have several quantitative states, more productives. The phenomenon occurs in dominant species that have great ecological amplitude and are found in several types of ecosystems. One example is the dominant trees *Picea abies*, *Fagus sylvatica* which have several types of populations, in terms of quantity. Table 4.3 gives indications for the populations of *Fagus sylvatica* in two different ecosystems of different productivity.

A species with a small amplitude of ecological adaptations is found only in one type of ecosystem and will have only one quantitative state, namely the average state of its populations in the ecosystems of that type.

4.4.4. Population Dynamics

Population dynamics refers to the change in time of its indices and its physiological states. Changing in population indices occurs by changings in its number. The physiological one – by the change of its processes and phenological features.

4.4.4.1. Number Dynamics

The speed of the number changes is determined by the number of individuals that occur or disappear per time unit. And the importance of number changings for the existence of the population is obtained by relating the existent number to the number of the population before the change. With these two indicators it can be appreciated whether the population grows, stays constant or decreases – and at what speed.

Tab. 4.3 - *Population indices in two ecosystem types of Fagus sylvatica populations in Romania (Doniţă et al., 1977)*

Species and age	*Ecosystem type*	*Population indices*			
		Number of individuals	*Height (H) (m)*	*Diameter (cm)*	*Annual increase (m^3)*
Fagus sylvatica 100 years	Beech forest, very productive	411	34.0	38.0	7.9
	Beech forest, poorly productive	515	18.5	20.8	2.9

The dynamics of the number also influence other population indices: density, space distribution, frequency and biomass. Age- and size structure, as well as sex ratio also change depending on the change of the proportion between these characteristics and following the positive or negative change in the number.

Factors that affect population numbers are primarily foods resources: abiotic (in plants) or biotic ones (in animals, fungi, heterotrophic protists and bacteria). Intraspecific relationships (competition, but also number regulation by physiological and even genetical changes – in the case of high densities) interfere, as well as interspecific relationships (predation, parasitism, amensalism). Usually, these factors can act simultaneusly.

Through intra- and interspecific relationships, many of which are based on feed-back processes, the population regulates its own number, maintaining it to a certain level. In the event of abrupt changes in abiotic factors and biotic relationships, disturbances may occur – either by a sharp increase in numbers or by a sharp decrease

– thus endangering the existence of the population.

Annual dynamics of the number. In many populations, by the specificity of multiplication there results drastical changes in its number during the year.

This is the case for short-lived species, in which latent life (life as seeds, eggs, spores) prevails. We mention in this respect therophytes**,** which are growing, blooming, fruiting and drying in a few months, spending unfavorable seasons as seeds. The same is valid for animals with very short life-cycles – days (e.g. ephemerans) or months (in phytophagous insects etc.) which have the egg as latency form.

In these species, the number of populations increases sharply in spring, remains at a certain level (depending on competition or reduction by consumers) and then completely vanishes, as the perpetuation of the species is ensured by reproductive forms (Figure 4.7).

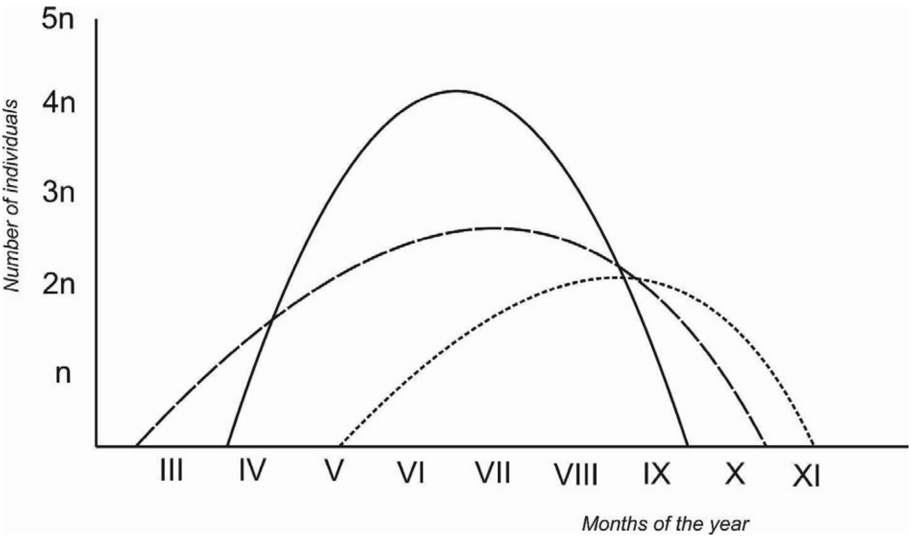

Fig. 4.7 - Curves of the annual fluctuation of one-year life cycle populations (*Doniţă et al., 1977*)

Similar annual fluctuations in the number also occur in perennial species with populations that grow once reproduction and multiplication are achieved and decrease in the following period (Figure 4.8).

Cyclical dynamics of the number is the phenomenon of multiannual change in the population. In the northern hemisphere, cycles of 3-5 or 5-10 years were recorded, during which the populatio's number increased and then decreased. It has been hypothesized that these cycles correspond to the periodical variation of solar energy

(Figure 4.9)

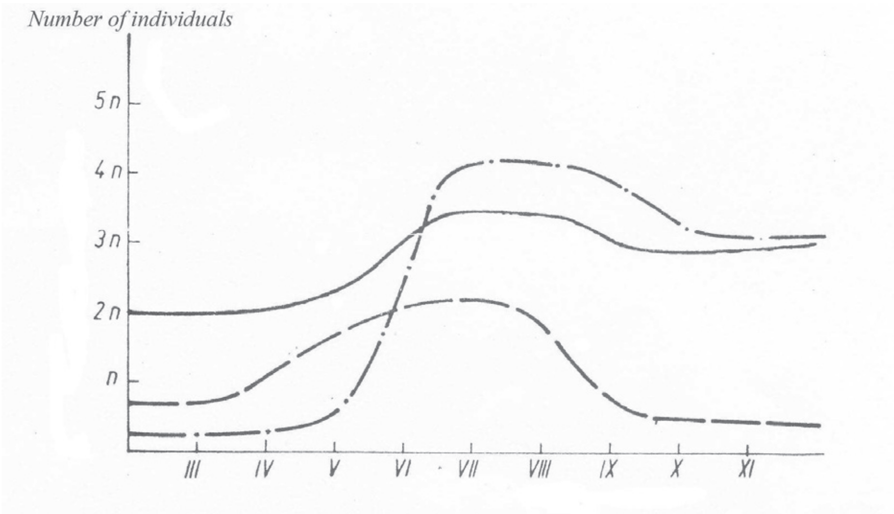

Fig. 4.8 - Curves of annual fluctuations of many years life cycle populations (*Doniţă et al., 1977*)

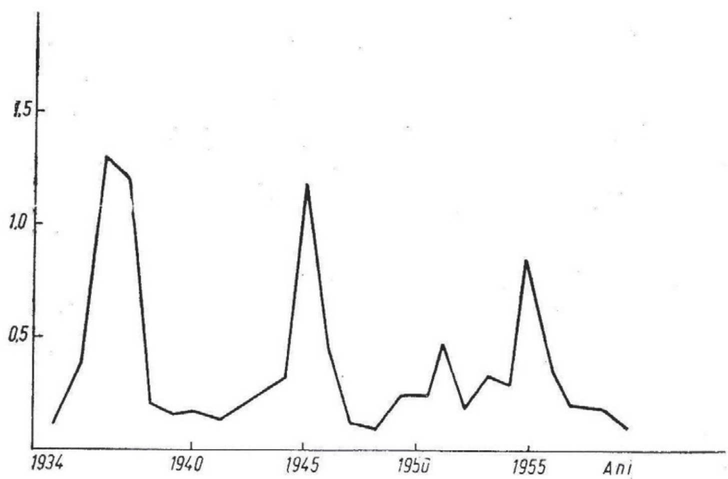

Fig. 4.9 - Multiannual fluctuations at *Thaumatopoea procesionea* (*Ohnesorge 1963,* quoted by *Doniţă et al., 1977*)

Usually, due to a result of intra- and interpopulational control, the number of a population slightly oscillates around a more or less stable average value.

In years when the number of control populations decreases, as a result of an abiotic factor (e.g. temperature) or a biotic one (a disease), the number to be controlled populations starts to rise. At first, the growth is minor, then it becomes more and more explosive. When food supplies are exhausted and the control populations are gradually multiplying, the population suddenly decreases and returns to its normal average number (Fig.4.10). Such variations are very common in defoliant insects or in the ones feeding on other organs of plants, but also in locusts and / or some phytophagous or carnivorous mammals.

Between prey and predator there may be periodic time-shifting changes of the number (Figure 4.10).

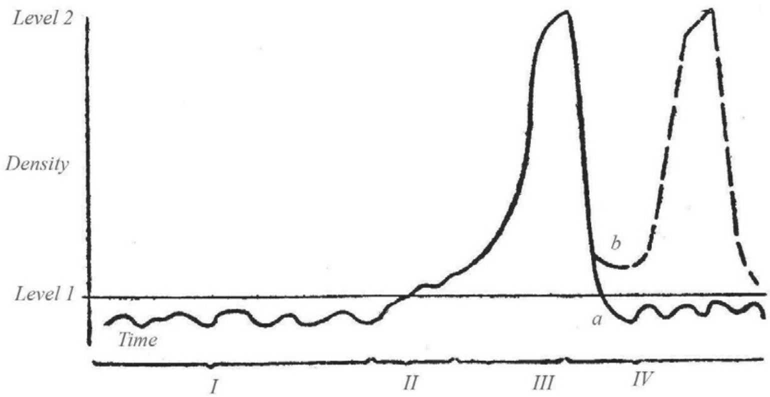

Fig. 4.10 - The population dynamics of *Cardia spina albitextura* on *Eucaliptus blakelyi* (*Clarck 1964,* quoted by *Odum 1971)*

The gradual decrease of the population, related to age, is a cyclical dynamics of another nature; the phenomenon occurs in long-lived perennials (e.g. trees): a large number of seedlings emerge from the seeds, but this number decreases gradually with age, due to intra and inter-population competition and other causes (pests or diseases). The decrease is drastic in young ages, then, in mature plants, the number stabilizes. Occurs a new wave of population regeneration... and the cycle restarts (Figure 4.11).

4.4.4.2. The Physiological Dynamics

The physiological dynamics is the change in time of the way physiological processes take place in individuals and which acquire a quantitative mass aspect at the population's level.

<u>Circadian, Physiological Dynamics</u>. Physiological Dynamics occurs circadianly (within 24 hours) in all species. The light / darkness alternation that occurs during one

day has determined organisms (and the population as a whole) to adapt circadian rhythms, which resulted in periods of activity and rest – or other manifestations.

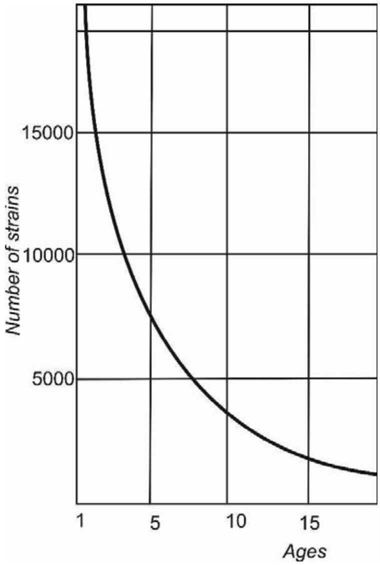

Fig. 4.11 – Natural decrease (by age) of the number of *Fagus sylvatica* seedlings (*Leibundgut 1970,* quoted by *Doniţă et al.1977)*

According to the part of the day when organisms are active or at rest, three categories of organisms have been established: diurnal, nocturnal or twilight ones (the last ones being active during sunset or dawn). Plants with chlorophyll, very many animals (many insects, birds, mammals) are active during the day – they are diurnal species; plenty of animals (mice, owls, many moths etc.) are active at night – they are nocturnal species. Some herbivorous mammals (rabbits, deers) and insects (lepidopterans, some leaf-eating insects etc.) are twighlight species.

In plants, photosynthesis starts at dawn, at a certain level of light, increases by noon and diminishes towards dusk. It may have a single maximum, but there are also species with two or several (few) maxima, depending on the water supply (Larcher 1973).

Diurnal rhythm may be monophasic when there is only one active period and one rest period. It is the case of plants and some animals (daylight butterflies, lizards). The rhythm is biphasic when there are two periods of activity and two of rest (as in the caterpillars of Lymantria dispar). Some animals have a polyphasic rhythm – they are active in several periods, resting between them (ruminant mammals, *Thaumatopoea* caterpillars etc.).

Seasonal physiological dynamics (phenological dynamics). The term „seasonal dynamics" refers to the change in appearance and physiological processes in plants and animals throughout the year (in seasonal climates). Some seasons have favourable climatic conditions for the complex activity of individuals and populations, while other climates are less or not favourable (e.g. very cold seasons, when water freezes, or very dry seasons). These are reversible changes of the qualitative phenotype of species, as phenophases in individuals and as phenoaspects at population and biocenosis levels. The landscape's appearance is truly different troughout the seasons. Each population has its phenoaspect, which combines in the biocenosis, generating the biocenotic phenoaspect.

In the temperate zone, phenological changes of individuals and populations vary. In deciduous trees and conifers with falling acicular leaves (*Larix*), the emergence of leaves take place in spring, followed by flowering, development of fruits and seeds, dispersal (which can continue until winter) then – in autumn – by the fall of the leaves. In conifers with permanent leaves (spruce, firtree), spring shoots and new leaves develop, then flowering, cone formation, maturing, and seed dissemination occur. Perennial herbaceous populations start developing stalks and leaves in spring, from regenerative organs, then develop flowers, fruits and seeds; afterwards, dissemination occurs and the aerial part dryes out. Annual plants emerge from seeds, pass through all phases, dry out; seeds remain as regenerative parts.

The developmental stages of phytophagous animals correspond to the phenological stages of plants. The stages of insect development are: eclosion, caterpillar growth in several stages, shedding, pupation, emergence of the adults, mating flight, laying of the eggs. As a rule, these stages coincide with the active development of the plants they feed on, when the heat and humidity are in sufficient amounts.

Insectivorous birds, too, nest during the warm season, and this behaviour comprises several stages: establisment of couples, nest building, egg laying, chicken feeding, shedding and seasonal migrations.

Mammals establish pairs or families for breeding, then follow a sequence of physiological states: mating, birth-giving, tending for newborns, shedding and local migrations.

In biocenoses, phenophases imply not only visual bu also acoustic phenomena, especially in bird's nesting and mammals' mating stage etc.

4.4.5. The Spatial Dispersal of Populations and Species (Population Area)

Considering a series of definitions mentioned in the introduction of this work, it is obvious that in defining the population, one criterion was its presence in a geographic area (geographical space), but with no specification as to the exact localisation of the area nor its dimensions (or other particularities).

Systemic ecological research has revealed the indissoluble link between population, species and ecosystem. This means that the area inhabited by each population is the space it occupies in an ecosystem and that the area of similar populations (type of population) found in the ecosystems of a certain type, i.e. the species, have its distribution in these ecosystems in their space (their ecological area).

The size of this area depends on the number of ecosystems, types inhabited by the species' populations and the areas they occupy.

Each species inhabits a certain distribution area. The distribution of species is not uniform in the area established by geographers. Within the species' area, the areas of its populations are insular, because populations occur only in certain ecosystem types. This is the true area of the species, called ecological area (*Doniţă et Ivan, 1977*). Populations' areas are the real spaces of the species existence. They are part of the biocenoses, which are in their turn components of ecosystems and each have a specific habitat in which they must live, adapting to the conditions this ecosystems offer.

It can be asserted that within the geographical area of the species, the areas of the populations are like islands, being most of the time isolated from each other.

The distribution in space is important for mobile populations (especially insects, fish, birds, mammals), which can move in the area of his own ecosystems type.

4.4.6. The Generation and Regeneration of the Population

The term generation is used when a new population occurs, either because a new species is born and is included in the ecosystem as a new population, or we speak of the population of an annual species (where the population is newly formed every year) or when a few individuals migrate into an ecosystem and – finding a free niche – organize and create a new population (*MacColl 2011*).

The term regeneration designates the renewal of a permanent population by the occurence of new generations, as is the case in perrenial species; the numbers of new generations are in time reduced by self-regulation under the pressure of the biocenosis and the habitat.

The generation and regeneration of a population depend on two processes:

- the multiplication of individuals belonging to a species;
- the elimination of individuals under the pressure of the environment (both the biotic and the abiotic environments, which characterize that ecosystem).

The multiplication of a population's individuals is an adaptation for the survival of the species. Because simple perpetuation, without the occurrence of a larger number of organisms, can not ensure the survival of the populations and of the species as a whole. The phenomenon can be explained by the fact that newly formed organisms are eliminated, in the first place as a result of the connections that are very rapidly established, both with individuals of their own population and with populations of other species within the biocenosis and secondly of the pressure of the habitat, which is limited in terms of surface and energetic and matter supplies.

By the self-regulation processes of both biocenotic and abiotic nature that occur in the ecosystem, population numbers stabilize in time at a certain level. But this is done gradually and, often, with very huge oscillations (*Pyron et al., 2013, Rull 2012*).

4.4.7. The population – a Continuity of the Living in Time

Individuals constituting a population and biocenosis have a limited duration and perish, due to the decrease of their natural vitality (but also to other causes).

By the occurence of collectivities, this limitation tends to disappear. The first stage of the prolongation (and even eternalness) of life is the population, in which – permanently or periodically – new generations of individuals are replacing the dead ones. The second – and more efficient – step is the biocenosis, which, as a system, has a greater stability by self-regulation not only regarding one population but all the populations it comprises.

This is confirmed by the permanence of biocenoses in time, in the same space – and of course, of its constituent populations. According to some authors, under unchanged climate conditions, the biocenoses of the equatorial forests persist as such since the tertiary. In southern Europe, the xerophilous and mesophitic forests persisted in sheltered spaces during the quaternary and migrated northwards after the glaciers retired. They remained unchanged for thousands of years – more than resinous forests, but less than deciduous ones (which followed them).

4.4.8. The Population and Species as Ecological Units

The population and the species make the subject of a vast literature. But, as it results from many definitions, the ecological character of the population and of the species is not at all revealed, or only episodically. It was only by the development of systemic ecology that the ecological role of the population (but less of the species) was emphasized.

The data presented in this chapter proves that the organism, population and species are ecological units because:

- they have ecological adaptations fixed in the genome of the organisms and genpool of the population and species which are externalized in their qualitative, hereditary genotype, which characterizes these units;

- these adaptations have developed through genetic processes in ecosystems of a certain type, in similar abiotic and biotic environments – hence in ecological units;

- according to these adaptations, organisms, populations and species are found in such ecosystems, having a structural role and ecological functions in the ecosystem processes of producing, consuming and decomposing biomass and necromass;

- in these ecosystems, organisms, populations and species also acquire quantitative characteristics that determine their quantitative, non-hereditary phenotype.

The organism, the population and the species can be ecologically characterized:

- through the qualitative, hereditary, adaptive genotype;

- through the ecological niche;

- through the ecological function in the ecosystem processes of ecosystems of a certain type;

- through the ecological relationships with the abiotic and biotic environment whithin these ecosystems;

- through the non-hereditary, quantitative phenotype that arises from these relationships.

5. THE ORGANISM, THE POPULATION AND THE SPECIES AS GENETIC UNITS

5.1. General Considerations

The individual, as a system, but also the populations it belongs to as subsystems and species, exist realy only in the biocenoses and in their abiotic environment (biotope), i.e. in ecosystems, i.e. in ecological units. And this is because only in these units the organisms find the resources necessary for their existence as open systems, and where they evolve. And at the same time individuals, populations, species are formed and develop, evolving as genetic units on this ecological support.

The genetic information specific to any species, as a genetic system distinct from that of other species, is contained in the genome of the individuals belonging to it and it changes, for various reasons, at this level.

The genetic information in the genome refers to the basic structural and functional elements of the organism, but also to the adaptive forms in which they have evolved (*Bossart, Powell 1998)*.

The genome is actualized ontogenetically in the genotype, i.e., in the qualitative traits an individual has, as an element of the species and as the way it is really found in nature. These are morphological, biochemical, physiological, behavioral traits that distinguish it from the individuals of other species. These traits are transmitted hereditarily, unmodified, from one generation to the next; some spontaneous changes may appear, yet up to a certain limit they do not radically change the species as a genetic system (*Ceapoiu 1978*).

The genotype is formed through reproduction, regardless of the environment in which it occurs and it is the qualitative genetic trait of the individual, the population, and the species. Each individual has its particularities, which do not, nevertheless, change the specific genetic traits.

Under the influence of the abiotic and biotic environment of the ecosystem in which it was formed, the genotype develops quantitatively as well; this gives rise to the individual's quantitative phenotype. This is varied, depending on the type of ecosystems in which it is formed, and it represents the individual's ecological quantitative trait[1] .

At the level of the population, based on the phenotypes of the individuals, a

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[1] Unfortunately, the ”genotype” and ”phenotype” are often used in different papers (and sometimes even in the same paper) with a different meaning, which leads to confusion

specific phenotype appears, characterized by quantitative population indices. The quantitative phenotype of the species is also formed as mean from these quantitative population indices.

The phenotype is not hereditary, even though it is identical for several generations. However, if it has adaptive characters, these can be selected and fixed in the genome (*Botnariuc 2005*).

In fact, the individual is found as a phenotype in the population and the ecosystem , i.e. through the quantitatively modified genotype. Natural selection acts upon this (*Botnariuc 2005*).

Each individual has in the same time two attributes: a genetic one - the genotype, and an ecological one - the phenotype. This results from the dual character that describes the population as a subsystem of the species and as a subsystem of the biocenosis as well.

The species is a genetic system - because its individuals have in their genome genetic information, which, trasferred into the genotype, differentiates it from other species – and because through the genetic processes in its populations the maintenance, development and evolution of the species are ensured.

But, as an open system, the species cannot exist in the absence of an environment from which it obtains its energetic and material resources. And this environment is within the biocenoses in which the species is actually found, dispersed in populations, which operate both ecologically and genetically.

From what has been known so far, species have very different lifespans. Most species are long-lived (from hundreds to millions of years) (*Botnariuc 2005*). When consulting the works on ecological genetics, concerned with outlining the factors and processes that lead to the transformation of the species or to the appearance of new species, can be misled by the material into thinking that species are in constant change. But this is not true. The transformations of species are not permanent, but occur intermittently throughout their long existence.

It is certainly interesting how these transformations occur, so as to understand why there is such a large number of species.

5.2. The Evolutionary Genetic Processes in the Population

There are two major fields of knowledge in genetics: the study of the genomic composition as a reservoir of genetic information and the study of genomic modification processes. This second field touches upon the existence and functions of individuals, populations and species in ecological units, as active genetic and ecological elements (*Enescu 1985, Li et al. 1991, Leberg 2005, Lowe et al., 2004,* *2014)*.

The processes of genome modification occur at the population level, because they all involve the participation of more/several individuals, and the natural selection through which the new characters are fixed in the genome can only occur in large groups of individuals, i.e. populations and ecosystems, most often following a lengthy process of selection (*Stern 1974, Wright 1977a, 1977b, Wiens 2004*).

The evolutionary genetic processes are:

- recombination, which occurs in the allogamous species during the reproduction process,

- hybridization, segregation, clonal variation in the autogamous species,

- mutation, which occurs radically in both the allogamous and autogamous species,

- genetic drift,

- gene flow in metapopulations, - natural selection.

5.2.1. The Reproduction Process in the Genetic Evolution

The reproduction process has, without any doubt, a leading role in evolution, because it acts permanently and on a large scale. It represents the way in wich the individual's and species' genetical attributes are transmitted along generations. At the same time, evolutionary changes occur within this very process.

The allogamous reproduction creates the most possibilities for evolution by recombining the genetic material of individuals of the two sexes that interact. By recombination, especially when different biotypes exist, a new combination of genes is produced from which natural selection can pick up new genetic characters.

The allogamous reproduction process can only occur in populations, because in most cases, more than two organisms participate in this process. For example, in zoophylous and anemophylous plants pollen originates from many individuals. In animals also reproduction often involves more individuals.

In autogamous species, characterized by the direct transmission of characters, there is no recombination, yet there are other mechanisms of polymorphic variation: - by hybridization between sexual and optionally agamospermous forms, - between the optionally agamospermous, by segregation in parthenogenetic female gametes, - by mutations (*Ceapoiu 1988, Butnaru 2004, 2007*), or – by clonal variation (*Botnariuc 2005*).

As a rule, ecological genetics pays the most attention to allogamic reproduction.

5.2.2. Mutations in the Genetic Evolution

The mutation is a radical, discontinuous and permanent change in the genome and consequently in the genotype as well. It is an internal process of the individual, externalized through the formation of new genotypic characters, which may be favorable (or unfavorable) to the existence of the species.

Mutations result from changes in the position of nucleotides or their constituent bases, and their causes may be internal (mutant genes) or external (radiation, thermal shocks, pollutants) (*Ceapoiu 1988, Butnaru 2004, 2007*).

Mutations occur spontaneously, they increase the heterozygosis of the population and create a varied material for selection. Their possible number in a generation is infinitesimal: of the order of 1/100 000 to 1/1 000 000 (Popescu 2013), but even so they may be favorable or unfavorable to the species.

Mutations are assigned the greatest role in evolution, and their infrequent appearance explains why species are so long-lived (hundred up to milions of years).

In recent years, mutations in bacteria and viruses have become quite common due to new trigger factors created by humans in the process of fighting them with the aid of chemical substances.

Selection within the population and the ecosystem, through relationships with the abiotic environment and between the different organisms of other species, is the one that chooses useful mutations, in respect of the ecological improvement of the species or capable of triggering the development of new species.

5.2.3. The Drift in the Genetic Evolution

The genetic drift is, like the mutation, an internal process of the organism.

It consists in altering the frequency of alleles in the transition from one generation to the next. This variation may be subject to selection. It is an effect of the tendency of alleles to randomly vary their frequency . This variation either disappears over time or reaches frequencies of 100%, increasing the individual's homozygosis. In this respect the drift is the opposite of mutation (*Popescu 2013*).

The genetic drift is more common in small populations than in large populations.

The migration of organisms may alter the frequency of alleles by reducing it. (*Popescu 2013*).

5.2.4. The Gene Flow in the Genetic Evolution

The flow of gene into metapopulations occurs through the migration of individuals from one population to another in the same region, and sometimes in different regions as well (in the case of migratory species) (*Bossart et al., 1998*).

If different biotopes are involved, new recombinations (in the case of allogamic species) or hybridizations, segregations (in the case of autogamic species) will appear by cross-breeding. This increases polymorphism and provides a wider field for selection.

5.2.5. The Natural Selection in the Genetic Evolution

Natural selection is the process by which the other genetic processes in the population are finalized, leading to the formation of new adaptations or even individuals of a new species (*Wright 1977, 1978, Enescu 1985, Mayer 1986, Butlin, Tregenza 1997, Diekmann, Doebeli 1999, Futuyma, Mallet 2001, Ridley 2004, Rieseberg, Willis 2007, Ritchie 2007, Vuileumier et al., 2010, Scordato, Safran 2014, Nosil et al. 2017*).

Natural selection is applied to the phenotype, takes place in the population and the ecosystem, and is the result of the relations individuals forge with the abiotic and biotic environment in which they live (Botnariuc 2005). Thus it has a pronounced ecological character.

There is yet no common perspective on how selection occurs. In a modern interpretation, selection would result from the differentiated reproduction of organisms that have the best adaptations to the environment and which have greater prolificity. This would not entail competition or the struggle for survival (*Mayr 1982*). Since it was unclear what happened to the other individuals in the population, there were opinions that a differentiated mortality and fecundity, determined by various causes, occurs (*Grant 1985, Popescu 2013*).

Selection is a contradictorious process. Natural selection, i.e. the screening of variations created by genetic polymorphism, has a negative character, eliminating the variations that have not acquired adaptive traits corresponding to abiotic and biotic conditions in ecosystems of the type in which the evolutionary processes occur. However, it also has a positive character because, through this elimination, it ensures a better development of the variations that have new adaptive characters corresponding to these conditions.

Unlike the random nature of the genetic processes that create the so-called genetic polymorphism, the selection has an oriented character because it acts under the pressure of the factors from a certain environment, the one in which only variations with new adaptations corresponding to this environment can develop and evolve.

Therefore, biological aspects and ecological aspects are also involved in selection.

Selection is a strong force of change in the population through its positive effects, of developing its adaptations and of self-regulation by the elimination of badly-adapted individuals (Figure 5.1).

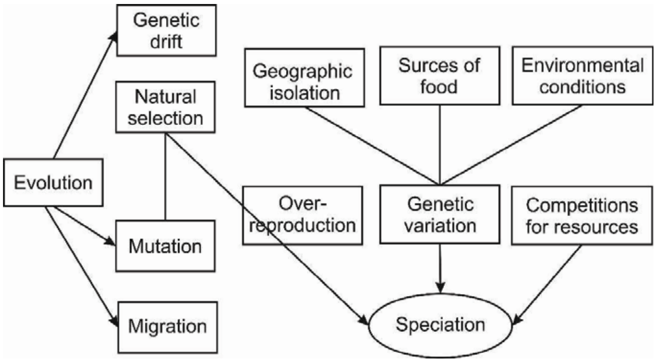

Fig. 5.1 - The manner in which populations adapt through random mutations (*Waldovski and Rhorick 2009, quoted by Popescu 2013*)

5.3 The Role of Genetic Information and Genetic Processes in the Formation, Perpetuation and Evolution of the Living Systems as Ecological Units

Living systems, as open systems, cannot exist outside a suitable environment, from which they can obtain the energy and matter necessary for their own metabolism. They are, from this point of view, ecological systems.

In order to be able to exist and spread out in different environments, a diversification of organisms – and correspondingly of populations and species – occured. The perpetuation of these diversifications over many generations was achieved by encoding the information about their adaptives organic structures and functions in the individual genome. Changes over time in the individuals' transformations were accomplished through genetic processes at genomic level and through selection in populations and ecosystems.

Thus, as an ecological necessity, information structures and genetic functions have developed, factors which can ensure the perpetuation and evolution of the ecological structures and functions of the individuals, the population and the species. The genetic information and genetic processes have thus become implicit and necessary components for the existence and the evolution of species and of biocenoses (ecosystems) as ecological units.

The ecology and the genetics of organisms, of populations and species must develop in connection one to another in order to understand / realize the maintenance and evolution of life, as the planet's living cover, with extremely important planetary functions.

CONCLUSIONS

Concerning the organism:

- The organism is the individual system of a species which, according to its ecological adaptations, lives and functions in a biocenosis (ecosystem) as an element of the population, engaged in ecological processes that provide it with the necessary energy and matter for its development and perpetuation.

- The organism has the general and adaptive information of the species encoded in its genome, externalized in the hereditary qualitative genotype, through the morphological, biochemical, physiological, behavioral characteristics. This genotype, in its ecological relations with the abiotic and biotic environment, acquires quantitative traits, forming the quantitative, non-hereditary phenotype of the organism.

- In the population where the individual organism lives, this information and the genotype can be modified by genetic processes, leading to the evolution of the species and the formation of new species.

- The organism, as a complex individual system, has thus both an ecological and a genetic side.

Concerning the population :

- The population is a multitude of individuals of a species which, according to their ecological adaptations, can be really found in a biocenosis (ecosystem). In the systemic hierarchy of the living world, the population is a subsystem connecting an individual system - the organism and two supra-individual systems – the species and the biocenosis.

- The population, as a subsystem, is simultaneously a structural part of the biocenosis and of the species, with ecological functions in the biocenosis and genetic functions within the species.

- The population has the sum of the qualitative traits of the genotype of the constituent organisms. However, through the quantitative development of this genotype, the population acquires its own quantitative characteristics – size (number), distribution in the ecosystem, dimensions, age and sex structures, biomass production and productivity, birth and mortality rate.

- The population, as a subsystem of the biocenosis, is a structural part of it, has an ecological niche in the ecosystem and functions as a producer, consumer or decomposer in the ecosystem processes of transferring energy and matter along trophic chains. This is the ecological side of the population.

- The population, as a subsystem of the species, is a structural part of it, and in it there are evolutionary genetic processes in which its organisms are involved (recombination, hybridization, segregation, clonal variation, mutation, genetic drift). These lead to the improvement of the species and the formation of new species. This is the genetic side of the population.

- The population is not an independent unit, as it would result from some definitions, but it is always included in an ecosystem. It has a practically unlimited existence through reproduction and multiplication. Its area is the surface of the ecosystem in which it is located.

- The population could be defined as follows: ***The population is a multitude of organisms of a species which, according to its ecological adaptations, exists really in a biocenosis (ecosystem) of a certain type as a subsystem with ecological functions, which is simultaneously a subsystem of the species, with genetic functions. The population is therefore both an ecological and a genetic unit.***

Concerning the species :

- The species is a particular system, which is not found as a whole, but as a dispersed unit, through its populations, in biocenoses of a certain type of ecositstems, with life conditions corresponding to the ecological adaptations of its organisms. Its area is the sum of the areas of these ecosystems in which it is dispersed.

- In the biocenoses in which the species is present, the species participates, through its populations, in the organization and the ecological functions of these units. The species has therefore the quality of an ecological unit.

- As a genetic system, the species is the sum of the genomes of its organisms and evolves through genetic processes that occur in populations and ecosystems.

- The species becomes manifest qualitatively through the hereditary genotype, of its organisms and quantitatively through its phenotype.

- The species is, like the population, both an ecological and a genetic unit.

Concerning the population and the species :

- Through their ecological functions, populations and species drive the great ecological process of production, consumption and decomposition of the biomass and necromass, which is a prerequisite for life. In this way, populations and species modify the flow of energy and the circuits of the matter on the surface of the planet, on which life on our planet depends.

- Through their genetic functions, populations, as subsystems of the species, ensure its continuity - by reproduction and multiplication, and by evolution they also ensure the diversification of species and biocenoses.

- These functions take place in ecosystems where populations and species really exist and function.

Concerning the biocenosis and ecosystem :

- The ecosystem, as an ecological unit made up of a biocenosis and its abiotic environment, is a huge reservoir of genetic information contained in the genomes of organisms and also the location where genetic processes in populations and species are developed and completed through genetic and ecological relations. The biocenosis and the ecosystem evolve to the extent that through these processes existing species are improved and new species are created. Thus, like individuals, populations and species, biocenosis, have both an ecological and a genetic character.

- It seems that the genetic information and processes that modify them have evolved to ensure the perpetuation and diversification of life in ecological systems (biocenoses), where individuals, populations and species acquire the necessary energy and matter for the existence of life through relations with the abiotic environment.

- The overall conclusion is that the living wild world is organized into biocenoses in which individuals, populations and species function ecologically and evolve genetically.

- By classifying ecosystems into types and establishing their distribution in a region, the inventory and the areas of all populations and species will be determined without further investigation; moreover, a selection of representative samples for through ecological and genetic research on the types of ecosystems of interest can be done.

Literature

Adl, S. M.; Simpson, A. G. B.; Lane, C. E.; Lukeš, J.; Bass, D.; Bowser, S. S.; Brown, M. W.; Burki, F.; Dunthorn, M.; Hampl, V.; Heiss, A.; Hoppenrath, M.; Lara, E.; Le Gall, L.; Lynn, D. H.; McManus, H.; Mitchell, E. A. D.; Mozley-Stanridge, S. E.; Parfrey, L. W.; Pawlowski, J.; Rueckert, S.; Shadwick, L.; Schoch, C. L.; Smirnov, A.; Spiegel, F. W. (2012). *The Revised Classification of Eukaryotes*. Journal of Eukaryotic Microbiology. **59** (5): 429-514.

Aldhebiani AY. (1997) - *Species concept and speciation*. Saudi Journ. Biol. Sci.; On line.

Begon M., Harper J.L., Towsend C.R. (1986) - *Ecology. Individuals, Populations and Communities.* Blackwell Sci.Publ.

Berryman A.A., (2002) – *Populations: a Central Concept for Ecology?* Oikos, **97** (3): 439-442.

Berryman A.A., Kindlman P. (2008) – *Population Systems. A General Introduction.* Springer. Science.

Bertalanffy L. (1968) – *General Systems Theory*. George Braziller.

Bick H. (1998) – *Grundzuge der Okologie*. 3.Aufl., Gustav Fischer Verlag, Stuttgart, Jena, Lübeck.

Bossart J.L., Powell D.P. (1998) – *Genetic Estimates of Population Structure and Gene Flow Limitations, lessons and Harmdirections.* Trends in Ecology and Evolutions, **13**: 201-206.

Botnariuc N. (1967) – *Principii de biologie generală.* Ed. Academiei RSR, Bucureşti.

Botnariuc N. (1976) – *Concepţia şi metoda sistemică în biologia generală.* Ed. Academiei RSR, Bucureşti.

Botnariuc N. **(**1984) – *Cu privire la abordarea sistemică în ecologie*. Buletinul de Ecologie, **1**: 15-21.

Botnariuc N. (1992) – *Evoluționismul în impact?* Ed. Academiei R.S.R., București, 286 p.

Botnariuc N. (2005) – *Evoluția sistemelor biologice supraindividuale*. Ed. Academiei Române, București.

Botnariuc N., Vădineanu A. (1982) – *Ecologie*. Ed. didactică şi pedagogică, Bucureşti.

Braun-Blanquet J.(1921) – *Prinzipien einer Systematik der Pflanzenges-selschaften auf floristischer Grundlage.* Jahrb.d.St.Gall Nautrwiss.b Gesselscheaft, **57**.

Braun-Blanquet J. (1964) - *Pflanzensoziologie. Grundzüge der Vegetations-*

kunde. Springer, Wien, New York.

Brewer M. (1994) – *The Science of Ecology*. Saunders Coll.Publ.

Butnaru G. (2004) – *Genetica.* Ed. Eurobit. Timişoara.

Butnaru G. (2007) – *Diversitatea genetică:* 76-108. În: A.Bavaru, S.Godeanu, G.Butnaru, A.Bogdan – *Biodiversitatea și ocrotirea naturii*. Ed. Academiei Romîne, Bucureşti, 580 p.

Cajander A.K. (1909) – *Űber Waldtypen*. Acta Forest.Fenn.,**1,** 1.

Cannulo, R., Falinska K. (2003) – *Ecologia vegetale – la struttura gerarchica delle vegetation*. Ed. Liguore, Napoli.

Ceapoiu, N. (1976) – *Genetica și evoluția populațiilor biologice*. Ed. Academiei R.S.R., Bucureşti.

Ceapoiu, N. (1980) – *Evoluția speciilor*. Ed. Academiei, Bucureşti.

Ceapoiu, N. (1988) – *Evoluția biologică. Microevoluția și macroevoluția*. Ed. Academiei R.S.R., Bucureşti.

Chapman J.L., Reiss M.J. (1992) – *Ecology – Principles and Applications*. Cambridge Univ.Press.

Chesson P. (2011)- *3. Ecological Niches and Diversity Maintenance*:43-60. In I.Ia.Pavlinov - *Research in Biodiversity - Models and Applications*. In Tech.

Chesson P., Ewens W.J., Tuljapurkar S., (eds.) (2008) – *Theoretical Population Biology*. **74**, 3.

Clements F.E. 1916 – *Plant succession*. Carn.Inst.Washington.

Cogălniceanu D., 1999 – *Managementul capitalului natural*. Ars Docendi, Bucureşti.

Colinvaux P., 1993 – *Ecology 2*. John Wiley & Sons Inc., New York, Chichester, Bisbane, Toronto, Singapore.

Dediu I. (2007) – *Ecologia populațiilor*. Phoenix. Chișinău.

Dediu I. (2007) - *Tratat de ecologie teoretică*. Acad. Naț. de Ecologie, Ed. Phoenix, Chișinău.

Dediu I. (2010) – *Enciclopedie de ecologie*. Știința, Chișinău.

De Queiroz K. (2007) – *Species Concepts and Species Delimitation*. Systematic Biology, **56** (6): 879-886.

Devillers P., Devillers-Terschuren J. (1997) – *A Classification of Palearctic Habitats. Nature and Environment.* Strassb. Council of Europe.

Doniță N., Biriș A. (2003) – *Creation of Ecological Basis for Sustainable Forest Management in Romania.* ICAS Annals, Ser. I, **46**:81-90.

Doniță N., Godeanu S. (2017) – *Population and the concept of species.* Journ.Biol. Nature, **8**, 3:106-110.

Doniță N., Godeanu S. (2018) - *30. Population – Structural and Functional Basic Element of Biocenosis and Species. The Role of Population in the Knowledge of Species Autecology*, 507-517. In C.W.Finkl, C.Makowski (eds.). *Diversity in Coastal Marine Sciences*. Coastal Research Library 23.

Doniță N, Ivan D. (1977) - *Areal geografic și areal ecologic*. An. Univ. Buc., Biologie.**26**: 53-56.

Doniță N., Purcelean S., Ceianu I., Beldie Al. (1977) – *Ecologie forestieră*. Ceres, București, 372 p.

Du Rietz G.E. (1930) - *Vegetationsforschung auf soziationsanalitischer Grundlage*. Handb. der biolog. Arbeitsmeth.; **11**:5.

Duvigneaud P. (1974) – *La synthese écologique*. Dunod, Paris.

Ebenman B. Persson L. (Eds.) (1988) - *Size-Structured Populations Ecology and Evolution***.** Springer-Verlag. Berlin Heidelberg New York London Paris Tokyo.

Ellenberg G.E. (1970) – *Zeigerwert der Gefässpflanzen Mitteleuropas.* Scripts Geob. 9

Enescu V. (1985) – *Genetica ecologică*. Ed. Ceres, București, 236 p.

Falinska K. (1984) – *Problemi di demographia nelle piante*. Inf.Bot.Ital., **16** (1): 19-37.

Falinska K. (1991) – *Plant demography in vegetation succession*. Kluwer Acad.Publ., Dordrecht, Boston, London.

Falinska K. (2002) – *Przewodnik do badan biologii populacji roslin (A guide to studies on plant populations biology).* PWN Warszawa.

Falinska K. (2010) - *Concept of the population structure of communities: plant demography and phytosociologie*. Braun-Blanquetia: **46**: 241-249.

Ferguson A. (1980) – *Biochemical Systematics and Evolution.* Blackie et Sons, Glasgow.

Fodor K. (2006) – *Ecologia ecosistemelor forestiere*. Univ. Oradea.

Ford E.B. (1964) - *Ecological genetics*. Chapmann Hall., London.

Frontier S., Pichod-Viale D. (1991) – *Ecosystèms: structure, functionement, evolution.* Masson, Paris,Milan,Barcelona, Bonn.

Godeanu S. (2007a) – *Cap. 3.3. Diversitatea sistematică și taxonomică*. p.108-147. În A. Bavaru, S. Godeanu, G. Butnaru, A. Bogdan (2007) – *Biodiversitatea și ocrotirea naturii*. Ed. Academiei Române, București.

Godeanu S. (2007b) – *Cap. 3.4. Diversitatea ecologică.* p.182-228. În A. Bavaru, S. Godeanu, G. Butnaru, A. Bogdan (2007) – *Biodiversitatea și ocrotirea naturii*. Ed. Academiei Române, București.

Godeanu S. (2013) – *Ecologie aplicată [Applied Ecology].* Ed.Academiei

Române, Bucureşti, 790 p.

Godeanu S., Doniță N. (2016) – *How are Approached Species ans Population in Biology and Ecology*. Acad.Rom. Sci.Annals, Ser.Biol.Sci., **5** (2): 57-66.

Harlan J.R. (1971) – *Agricultural Origins: Centers and Non Centers.* Science, **174**: 468-474.

Harper J.L. (1977) – *Population biology of plants*. Acad.Press., London.

Harper J.L. (1980) – *Plant demograhy and ecological theory*. Oikos **35**, 244-254.

Holt R.D & Barfield M. (2013) – *Direct plant–predator interactions as determinants of food chain dynamics.* Journ Theor. Biol. **339 :**47–57.

Hondru N., Mărgărit G. (1971) – *Cercetări ecologice asupra nevertebratelor din solul pădurii Babadag* (321-350). In I. Popescu-Zeletin (red.) ”*Cercetări ecologice în podișul Babadag*” Ed. Academiei RSR, București.

Ionescu M., Zamfirescu A., Niculescu-Burlacu F. (1971) – *Cercetări ecologice asupra faunei de nevertebrate din frunzarul de pădure* (301-319). In I. Popescu-Zeletin (red.) ”*Cercetări ecologice în podișul Babadag*” Ed. Academiei RSR, București.

Ivan D., Doniță N. (1975) – *Metode practice pentru studiul și cartarea vegetației*. Univ. București, București.

Kinnis J.P. (1987) – *Forest Ecology*. McMilan Publ.Comp.New York.

Lăcătușu M., Tudor C., Teodorescu I., Ceianu I. (1978) – *Complexul de himenoptere parazite ale dăunătorilor forestieri*: 184-188. In R.Codreanu (ed.)-*Probleme de ecologie terestra*. Ed. Academiei R.S.România.

Lowe A., Harris S., Ashton P. (2004) – *Ecological Genetics.* Blackwell Publ.Comp., Oxford.

Lowe W.H. & McPeek M.A.(2014) - *Is dispersal neutral?* Trends in Ecology & Evolution. **29** (8): 444- 460.

Lukas N. (1997) – *Die Gesellschaft der Gesellschaft*, 2 Bd. Suhrkomp, Frankfurt/M.

Mallet J. (2001) - *The speciation revolution*. J . Evol.Biol. **14**:887-888.

Mallet, J. (2001a) - *Species concepts.* 427-440. In Levine, S. et al. (eds.) *Encyclopedia of Biodiversity*. Volume 5. Academic Press.

Mallet, J. (2001b) - *Species, subspecies, semispecies*: 523-526. In Levine, S. et al. (eds.) *Encyclopedia of Biodiversity.* **5** Academic Press.

Mc Arthur R. (1968) – *The theorie of the niche.* 159-176. In: *Population Biology and Evolution.* Lewontin Syrac Univ.Press., Syracuse.

Mc Arthur R, Connel J. (1970) - *Biologia populațiilor*. Ed. Științ. Enciclop., București.

Mayr E. (1957) - *Species concept and definitions*: 1-22. In: *The species problem*. The Amer. Ass. Adv.Sci. Publ.;**50**. Washington DC.

Mayr E. (1963) – *Animal species and evolution*. Belknap Press of Harvard Univ.Press. Cambridge, Mass.

Mayr E. (1970) –*Population, species and evolution*. Belknap Press of Harward Univ. Press, Cambridge, Mass.

Mayr E. (1982) – *The growth of Biological Thought: Diversity, Evolution, and Inheritance*. Harward Univ.Press, Cambridge.

Meusel H., Jäger E., Weinert E. (1965) – *Vergleichende Chorologie der zentraleuropäischen Flora.* Jena.

Miller G.T., Spoolman S.E. (2009) – *Essentials of Ecology*. 5-th ed. Brooks/Cole, Cengage Learning.

Morozov G.F. (1904) – *Soderjanie i Zadaci Obschestvo Lesovodstva*. Izv.Imper.Lesnovo Inst., **11.**

Neal D. (2004) - *Introduction to Population Biology*. Cambridge Univ.Press.

Nosil P., Feder J.L., Flaxman S.M. & Gompert Z. (2017) - *Tipping points in the dynamics of speciation.* Nature Ecology & Evolution **1** :1-8.

Odum E.P. (1953) – *Ecology.* Modern Biology Series. Holt, Rinehart, Winston, N.Y.

Odum E.P. (1971) – *Fundamentals of Ecology*. W.B.Saunders Comp., Philadelphia, London, Toronto.

Odum, H. T. (1983) - *Systems Ecology: an Introduction*. John Wiley & Sons.

Odum E.P. (1985) – *Trends Expected in Stress Ecosystems.* BioScience **35**: 419-422.

Odum E.P. (1993) – *Ecology Our Endangered Life-Suport Systems*. Sinauer Assoc., Inc.

Otto H.S. (1998) – *Écologie forestière.* Inst.Develop.Forestier, Lyon.

Popescu A. (2013) – *Genetică*. Ed. Univ. Pitești.

Ramade F. (1991) – *Élements d'écologie. Écologie fondamentale.* McGraw Hill.

Ranta E.S., Lundberg P., Kaitaka V. (2006) - *Ecology of Populations*. Cambridge Univ.Press.

Ruggiero L.F., Hayward G.D., Squires J.R. (1994) – *Viability Analysis in Biological Evaluations: Concepts of Population Viability Analysis, Biological Population, and Ecological Scale.* Conservation Biology, **8** (2):364-372.

Serrano Sanchez C. (1996) - *The concept of population*. International Journal of Anthropology, **11**, (2–4): 15–18.

Simpson G.G. (1951) - *The species concept*. Evolution **5**:285-296.

Smith L. R., (1990) – *Ecology and field Biology*, Fourth Edition, Harper and Row, Publ., N.Y.

Stern K, Roche L. (1974) - *Ecological genetics*. Fischer, Stuttgart.

Sucaciov V., Dâlis N. (1964) – *Osnovâ Lesnoi Biogheocenologhii*.Nauk., Moskwa.

Stugren B. (1975) – *Ecologie generală.* Ed.Didactică și Pedagogică, București.

Stugren B. (1982) – *Bazele ecologiei generale*. Ed. Ştiinţifică și Enciclopedică, Bucureşti.

Thompson R.M., Brose U., Jennifer A. Dunne J.A., Hall Jr. R.O., Hladyz S., Kitching R.L., Martinez N.D., Heidi Rantala H., Romanuk T.N., Daniel B. Stouffer D.B., and Jason M. Tylianakis J.M. (2012) - *Food webs: reconciling the structure and function of biodiversity.* Trends in Ecology and Evolution, **27** (12): 689-697.

Tilman D. (1996) – *Biodiversity: Population Versus Ecosystem Stability*. Ecology, **77** (7): 350-363.

Tomiuk J., Bachmann L. (2009) – *Populations, Species*, *Communities*. Encyclopedia of Life Support Systems. vol. 1.

Van Valen L. (1976) - *Ecological species, multispecies and oaks*. Taxon. **25**:233-239.

Vuilleumier S., J. Goudet J., N. Perrin N. (2010) - *Evolution in heterogeneous populations: From migration models to fixation probabilities.* Theoretical Population Biology **78**: 250–258.

Warring R.H., Schlessinger W.H. (1985) – *Forest Ecosystems. Concepts and Management.* Academic Press Inc., Orlando, San Diego, New York.

Wezel T., Soldat W.M. (2009) – *Quantitatve and Qualitative Historical Analysis of the Scientific Discipline of Agroecology.* Internat.Journ.Agricult.Sustainability, **7** (1):53-218.

White J. (Ed.) (1985) – *The population structure of vegetation*. Junk Publ., Doordrecht, Boston, London.

Whittaker R.M. (1975) – *Communities and Ecosystems*. Mac Millan.

Wiens J.J. (2004) - *What Is Speciation and How Should We Study It*. Am. Nat. **163** (6): 10 p.

Willey E.O. (1981) - *Remarks on Willi's species concept*. Syst. Zool. **30**:86-87.

Wright S. (1977) – *Evolution and the genetics of populations*. Chicago Univ.Press, Chicago, London.

Wright S. (1977) – *Evolution of the genetics of populations. 3. Experimental results and evolutionary deductions*. Chicago Univ.Press, Chicago.

Wright S. (1978) – *Evolution of the genetics of populations. 4. Variability within and among natural populations*. Chicago Univ.Press, Chicago.

Zavadski K.M. (1963) – *Teoria speciei*. Ed. Științ., București.

XXX – *A Dictionary of Ecology*. Oxford Univ. Press.

XXX – *Dexoline*. https://dexonline.

XXX – *Encyclopedia Britanica Illustrates Science Library*. Chicago a.o.

XXX – *Wikipedia.*https:/en.wikipedia.org/wiki/population.

XXX – *Oxford Dictionary of Ecology*. Oxford Univ. Press.

XXX – *Physical Geography*. https://www.researchgate.net.

XXX – *http:/mygeologypage.ucdavis.edu/cowen/.../populations.htm*

XXX – *Online Dictionary.* https://www.dictionary.com.

XXX - *scienceblogs.com/.../2006/10/.../a-list-of-26-species-concepts...*

XXX - *www.ibri.org/Books/Pun_Evolution/Chapter1/1.2.htm*

GLOSSARY

Abiotic - without life, non-living (see *abiotic factor*).

Abiotic environment - all non-living elements that make up the habitat.

Abiotic factor - natural or artificial lifeless-factor. The natural physical factors are the solar radiation, the energy field and the planetary attraction, the air, the water, the rocks, the magma. The natural chemical factors are the chemical elements that make up the air, the water, the rocks. Artificial factors are all man-made artifacts.

Adaptation - the appropriate response of individuals, populations or biocenoses to the action of the environmental factors (abiotic, biotic) or of some modified factors.

Allele - one or more forms of a dominant or recessive gene that coexist in a locus and cause different phenotypes.

Allochthonous species - a new species coming into an ecosystem, attracted by its food availability.

Allogamy – mode of reproduction in which fertilization occurs by combining gametes formed on sexualy different individuals.

Apomixis - an asexual mode of reproduction that shows the traits of sexual reproduction, but which is not the result of fertilization.

Aquatic environment - the environment of organisms living in water.

Area - the territory in which an individual, a population or a species lives. There are four distinct types of areas with ecological implications: continuous, discontinuous, geographic and ecologic.

Autecology - the branch of ecology that deals with highlighting the influence of the abiotic or biotic factors upon individuals of a population.

Autochthonous species - a species naturally present in the ecosystem.

Autogamy - mode of reproduction through natural self-fecundation. It is considered that in autogamic populations allogamy does not exceed 4%.

Autotroph - an organism that is capable of producing complex chemicals to meet its food needs, starting from simple, inorganic chemicals, having either the solar light or some chemical reactions as energy sources.

Biodiversity - the totality of forms through which life is diversified in an individual, a population, a biocenosis, or the biosphere.

Biocenosis - 1. the living component of an ecosystem. 2. a stable group of living populations belonging to different, functionally complementary species, which occupy a particular habitat and which together constitute an ecosystem.

Biodiversity – 1. all the forms through which life is diversified at all levels. 2.

the variety of species or other taxa grouped into populations, that live in a particular ecological system. Biodiversity exists in all organization and integration levels of the living systems. 3. the plurality of species, biocenoses, living covers existing on our planet.

Biogeography – a branch of geography dealing with the description and explanation of the species distribution as well as the distribution of ecosystems at the planetary scale.

Biological system - an open, informational system, possessing the capacity for self-preservation, self-reproduction, self-regulation and self-development; it has an antientropic and completed behavior that gives it stability in relationships with other systems. The biological systems have the highest degree of heterogeneity, have an appreciable information content and show great stability, self-control and self-organization.

Biomass - the amount of living matter in a organism, population, biocenosis, living cover, measurable as wet weight, dry weight, biovolume, carbon or nitrogen content, or content of ATP, ADP, AMP.

Biosphere - the planet's living cover.

Biota - 1. all organisms that make up a biocenosis. 2. all the living organisms living on this planet and that make up the biosphere.

Biotic – with life, living.

Biotic environment – all the organisms that live in an ecological system.

Biotic factor – the organism, the population, the biocenosis, the planet's living cover.

Biotope - the physical environment (the occupied space, the hydrological, the geological, the pedological and the climatic factors) and the chemical environment (the chemical composition of the air, the water, the soil and of the necromass) changed and in which a biocenosis carries out its activity.

Biotope-biocenosis relation – the interdependence relations between a community of organisms belonging to different species and its biotope occupied within an ecosystem.

Carnivorous - an organism that feeds on other living organisms.

Circadian rhythm - the succession of living or non-living processes every 24 hours, at individual, population, ecosystem, or at planetary level.

Competition - a form of negative interaction within a population or between populations situated on the same trophic level that use the same environmental resources.

Consumer - an organism that can not produce its own food and must obtain it through the consumption of another living organism, or from a dead or decomposing one (thus from the necromass).

Cooperation - the interaction between the members of the same species or two different species that help each other in order to survive and that have mutual benefits.

Cross - mating two genetically differentiated parental forms.

Density - the number of individuals in a gived volume, space or territory.

Degrader - organism that decompose a dead organic matter, a necromass.

Detritivorous (detritus feeding animal) - individual who consumes dead organic matter in decomposition. Detritus eater.

Detritus - crushed dead organic matter, consisting of residues of vegetable or of animal origin in different degrees of decomposition.

Development - 1. the process of successive transformations through which the fertilized cell passes to form a differentiated organism. 2. the successive changes in an individual's ontogeny to form its own structure.

Dispersion - the passive or active spread of the descendants of a population.

Distribution - the manner in which a population is spread on a particular territory.

Dominance - the determinant role of the population of a one species (as abundance or as a way of coordinating the energy and substance flows) at the level of a biocenosis. Dominance is not determined by the population effective, but by the role that this population plays in the development of the ecological processes.

Dynamics of biocenosis - change according to the time factor of the number of individuals, of the biomass or the specific component of a biocenosis.

Dynamic balance - the state in which a biological system (individual, population, biocenosis) is maintained approximately within the same limits, although it exhibits constant fluctuations in time and space.

Ecological area – the area which is occupied by individuals, populations or species in ecosystems in which they are real.

Ecological balance - an ecological system in which the living is interconnected with the non-living for long periods of time and is maintained based on the permanent fluctuations of all its structural and functional parameters.

Ecological conditions - the set of abiotic and biotic factors within and outside a complex ecological system that determines the development of an individual, a population, or a biocenosis.

Ecological diversity - the variety of forms and means by which an ecological system organizes its structure and functioning according to the action of various environmental factors.

Ecological genetics - 1. part of genetics that studies the adaptation process of the wild populations to their living environment. 2. a branch of genetics that studies the action of the ecological factors in relation to the polymorphism of the living creatures. It also deals with the influence of the ecological factors on the quantitative expression of the phenotype in the process of adaptation and speciation.

Ecological information - message transmitted in an ecosystem by a living or non-living component.

Ecological niche - a hypervolume that includes all the factors on which the existence of a population in an ecosystem depend. It depends on the nutritional resources, the existing biotic and abiotic factors and represents the functional role of the respective population in the energetic and material relations.

Ecological process – change of an ecological system, either in the sense of its complexity, or in the sense of the simplification of the interactions between its components.

Ecological production - the amount of organic substance existing in a biological system at a given time.

Ecological productivity - the amount of organic substance produced in a unit of time and space by a population, a species, or a biocenosis.

Ecological succession – the modification of the structure and functioning of an ecological system under natural conditions or under the influence of different human impacts (progressively or regressively).

Ecological system - a set of living and non-living elements, organized and interconnected into a whole characterized by a certain structure and function, that organizes matter, energy and information in a spatial unit for an unlimited duration of time, during which a process of evolutionary succession (positive or regressive) takes place.

Ecological tolerance - the capacity of some organisms to develop or to live together in certain environmental conditions, which are different qualitatively and quantitatively speaking. From this point of view, there are distinct eurioic and stenoic species, which indicate different degrees of tolerance to the action of different types of environmental factors.

Ecology - interdisciplinary science that studies the systems of organizing the living matter in their interrelations with the environment, highlighting the structure and the functionality of the nature in its whole complexity.

Ecology of the population - the field of ecology that studies the populations of different species in their relations with the biotic and abiotic environment.

Ecosphere - the functional unit of all the living components (the biosphere) and their abiotic substratum (the troposhere, i.e. the atmosphere + the hydrosphere + the lithosphere + the pedosphere). It is mistakenly confused with the biosphere (see the definition of the *biosphere*).

Ecosystem - the smallest, space-time, independent formation that locally integrates the living and the abiotic environment into a coherent whole. The ecosystem is the basic unit of the ecosphere.

Ecosystemic process - the process of capturing and transferring the energy and matter through biomass and necromass into the biocenosis and, respectively, into the ecosystem (see the ecological process).

Effective - the number of individuals of a population at a given time.

Emigration – the act of definitive abandonment of some individuals from a population, of their living place, in search of new food resources and for reproduction. Emigration is the result of the interactions between the genetic and the ecological factors.

Energy flow – the energy transfer and its way of use in the ecological systems.

Energy resources - all the forms of energy that contribute to the functioning of the ecological systems.

Energy structure of the ecosystem - 1. the structure of the ecosystem according to the speed of the energy fixation and of the way it is then distributed and used. 2. the manner of energy distribution in its abiotic and biotic components.

Energy transfer - achieving the energy flow along the trophic chains and the trophic networks in an ecological system.

Environment - the system of living and non-living components from any ecological system.

Environmental conditions – all the abiotic factors in which an individual (population, biocenosis) lives. For a gene, the environmental conditions are the neighboring genes upstream or downstream of it and of the nuclear matrix. For a chromosome, the environmental conditions are also the other neighboring chromosomes and the cellular matrix of the same tissue.

Environmental factor - any environmental component that acts directly or indirectly, favorably or unfavorably, upon the living organisms or upon the ecological systems.

Environmental resource - all forms of substance, energy or information from nature that provide the formation and the independent functioning of any living systems.

Eurioic - an organism with large ecological valences, which supports large oscillations of the environmental factors, so an organism characterized by a broad ecological valence.

Factor - any component in the natural environment that acts directly or indirectly, positively or negatively, upon an individual, population, biocenosis or live coating. It can be of physico-mechanical, chemical or biological origin. Often various factors act synergistically, in interaction with each other.

Fecundity - the ability of individuals in a population to produce a number of offsprings, that are able to ensure, despite the action of various environmental factors, the perennity, the permanence and the constancy of a population.

Feed-back – a control system for an activity where the final product controls, as effector, its own action. The interaction of the material circuits and of the energy flows under the informational control generates self-organized feed-back systems without the need for distinct control structures, because the biological and ecological systems are not passive entities; they behave actively by selecting or creating optimal operating conditions by properly self-adjusting the internal state parameters and implicitly neutralizing the consequences of variability of the environmental factors. The ecological response through a feed-back circuit is efficient, fast, short-lived and of low intensity. It is a normal process of regulating a system's responses to each environmental factor in order to maintain its unity and functional integrity.

Fidelity - the degree of attachment of a individual or a population to a particular biocenosis.

Flow of genes - leakage or migration of genes.

Flow of substances - the succession of processes by which material components pass through the various living and non-living components along trophic chains.

Fluctuation - change in the numerical component of a population or a biocenosis in response to the changes of the environmental factors; fluctuation is one of the unpredictable causes of the population dynamics of any species.

Food regime - type of nutrition (carnivorous, omnivorous, vegetarian).

Forest - type of ecosystem characterized by at least 3 vegetation layers, of which the arborescent layer is the predominant one and gives the name of the ecosystem.

Genetic code – the genetic information from the DNA or RNA triplets.

Genetic differentiation - Genetic variability among populations. Establishing the measure of genetic variability in a population and among different populations.

Genetic diversity - 1. the amount of genetic variation existant in a population or species appreciated as compared to the assumed heterozygosity. 2. measure establishing the genetic variation in a population or species based on the probable heterozygosity average.

Genetic drift - random change (directed or not directed) into the frequency of the alleles of a gene within populations.

Genetic information - all the information stored in the genetic background of an individual, or in the gene pool of an supra-individual system.

Genetic information resources – the information stored by the organisms in their genetic patrimony.

Genetic marker - a sequence of DNA or protein that can be found and whose attributes are characterized and can be used to highlight the genetic variation.

Genetic variability - variability that can be considered as being made up of three components: genetic diversity, genetic differentiation and genetic distance.

Genofund - all the genetic information in a population, species or biocenosis.

Genome - all the genetic information contained in a biological individual.

Genotype – the transposition of the genetic information from an individual's genome into its basic structural, functional and adaptive attributes.

Habitat - the set of abiotic environmental conditions in which a population, biocenosis or species lives.

Habitat niche - the place where the population of a species lives.

Herbivorous - organism (animal, protist, fungus or bacterium) consumer of vegetal material.

Heterogeneity - qualitative variability of the components or constituents of a system.

Heterotrophic - organism that can not produce its own food and needs to satisfy its nutritional needs through the consumption of living or dead matter produced by other living creatures.

Hierarchy - a system of classification of the living creatures or things, where each element of the system is subordinated to another element.

Hybrid - the result of the crossing between two different organisms from a genetic point of view, which have well defined, constant characters and have consanguineous lines.

Immigration - the entering of some individuals into a pre-existing population and that occupy a well-established position from the biocenosis of a particular ecosystem. The success of an immigration depends on the capacity of adaptation of the immigrants to the living conditions of the population where they are trying to enter.

Individual – organism / specimen that has its own existence and is part of a population of a species.

Information - message about the status of a system. The structure and dynamics of the information flow regulate the transport and the energy flow of the ecological systems.

Information flow - how the information gathered in the living and non-living systems ensures the smooth running of the environmental processes.

Integrality - the character of the whole of an ecological system with its own attributes.

Integrity of the systems - the living and non-living components of an ecosystem, which are permanently interacting, behave as a whole, maintaining its own existence and its own features, in the conditions of permanent fluctuations of the environmental factors.

Interaction - reciprocal relations between two living or non-living components of ecosystems (biotope-biocenosis, population-biocenosis, host-parasite, prey-predator).

Interpopulational - a process that occurs between individuals of populations from different species.

Interpopulational relationships - relations established between individuals of populations from different species within a biocenosis.

Intrapopulational - a process that occurs between individuals of the same population.

Intrapopulational relations - relations established between individuals of the same population.

Invasive species - a plant, animal or microorganism, either native or allochthonous, that is introduced into a foreign living environment and, if it survives and forms a stable population, can influence or affect the ecological balances of the entire biocoenosis.

Isolation - action by which a material (living or non-living) factor, a geographical, physiological or ethological obstacle prevents the integration of all the individuals of a population into a unitary community.

K-type strategy - the mode of reproduction that characterizes species that populate stable, mature ecosystems, most often found in the climax status. They are larger in size, live longer, have lower rates of fecundity, birth and mortality, are less eurioic and more stenoic and are susceptible to sudden changes of the environmental factors. The organisms that make up such ecosystems have a higher energy efficiency, and have a pronounced anti-entropic character.

Level of organization - special, distinct, discontinuous quality system category with universal character, characterized by specific structural and functional features, which has specific laws and is characterized by universality.

Longevity – life span of the individuals of the population, species and biocenosis.

Metapopulation - a group of populations of the same species that occupies a certain type of ecosystem or a complex of ecosystems separated by geographic or physiological barriers from other similar groups. Evolution and speciation usually occur at the level of the metapopulations.

Microelement – chemical compound commonly found in infinitesimal quantities, which plays an important role in the metabolism of plants or animals.

Migration - rhythmic or arhythmic displacement of some animals from one geographic area to another under the influence of a complex of abiotic environmental factors.

Mineral resources - inorganic resources that provide organisms with the material needed to build their own structures.

Mineralization - the decomposition of some organic substances into the mineral constituents from which they were originally synthesized by the primary producers.

Mortality - the process of disappearance through death of the individuals from a population over a given period of time, due to natural causes or due to changes of the environmental factors.

Natural environment - a portion of Earth's crust in which all processes are carried out within natural parameters unmanaged by humans.

Natural resources - any component of the environment (soil, subsoil, water, flora, fauna) that contributes to the good functioning of an ecological system.

Necromass - organic substances from dead organisms, or parts of them, which are undergoing biodegradation.

Necrophagous - an animal that consumes non-living organic substances or dead organisms.

Niche – place and way of life of an individual or population in an ecosystem, and species in ecosystems of the type in which it exists.

Oligotrophic – an environment poor in the mineral substances necessary for autotrophic organisms, or in the organic substances necessary for the heterotrophic organisms.

Omnivorous - organism that feeds both on plant products and animal products.

Organism - living being. Organisms may be aquatic, terrestrial, amphibian or underground, diurnal or nocturnal, fixed or mobile etc.

Parasite - an organism that lives in or on another organisms, that consumes parts of it but does not kill it.

Parasitism - a trophic relation in which a species (at least at a stage in its development) lives on or in another living being and feeds on it but does not kill it.

Phenology – the change in the life and aspect of the organisms conditioned from the temporal change by both environmental and internal factors (genetic, metabolic, endocrine).

Phenotype - the sum of the quantitative qualities of an individual, population, species resulting from the interaction of the genotype with its living environment.

Photic zone - the uppermost layer of the water mass from a sufficiently luminous aquatic pool to allow photosynthesis to be carried out by all types of potential primary producers.

Photosynthesis – the synthesis of plant-based organic substances starting from carbon dioxide and water by using light energy.

Phytocenosis – a stable community of plant populations belonging to different plant species; primary producer into the ecosystem.

Phytophagous - a plant-based consumer (of primary producers); organism that can not produce its own organic substances from mineral compounds and solar energy.

Phytocoenology – 1. branch of ecology dealing with the study of vegetal associations (types of phytocoenoses) in terms of qualitative structure (of populations from different species) and quantitative aspect (of the quantitative indices of these populations). 2. scientific field studying the vegetal community made up of a determined number of autotrophic plant populations adapted to cohabitation in a relatively uniform biotope within an ecosystem.

Population dynamics - the fluctuations in time of the qualitative or quantitative parameters of a population, especially their number and biomass. The population dynamics is the variation in time of the size of a population, expressed by the average rate and the specific growth rate.

Population growth - increasing the number of individuals when the birth rate exceeds the mortality rate, or when immigration exceeds emigration in a population.

Predator - an organism that feeds on other living organisms that it kills.

Prey - an organism captured and consumed by a predator.

Primary production - all the organic substances made by the primary phototrophic or chemotrophic producers.

Producer - organism that creates its own organic substance from abiotic substances.

"r" type strategy - the modality of reproduction of the species that constitute a biocenosis found in a biotope characterized by very variable values of all the environmental factors. This strategy is characteristic of young ecosystems. Species that use the "r" strategy are of a smaller size, have a high fecundity, have high density fluctuations, are characterized by high birth and mortality rates, have a shorter lifespan, but their effectives are restored very quickly. They are all eurioic species. This type of strategy is high in energy consumption.

Reducer - organism that splits the organic substances to its simpler components; it can possibly go down to the chemical elements or mineral compounds from which they have been created.

Redundancy - the realization by different means, including through excess of repetition, of the accuracy of the information received by an ecological system, in order to ensure its operation in optimal conditions, even if disturbing factors appear.

Regeneration - 1. the formation of new generations within a population, a biocenosis. 2. restoring the effectives or the interactions within a population or a biocenosis.

Relationship - interaction - positive, negative or neutral - between two or more phenomena or living beings, or between living or non-living components of the environment.

Rhythm – manner of periodically developing processes in the nature.

Seasonal rhythm – the seasonal manifestations of the organisms from the temperate climates.

Selection - 1. the ability of organisms to take or to use from the environment substances or sources of energy that are useful to them or which contribute to their own survival. 2. genetic process of maintaining in a population the individuals that are better suited to the ecosystemic environment and eliminating the other individuals.

Self-fertilization - the process of joining gametes produced by the same organism. It is a natural process in the autogamic forms, but accidental in allogamic forms. In plants it consists of fertilizing an egg with the pollen grain produced by the same plant. Self-fertilization causes consanguination and production of consanguineous organisms.

Synecology - a branch of ecology that has as object of study the relations between the supraindividual populations that constitute a biocenosis, as well as their relations with the abiotic environment in which they live.

Soil - the terrestrial rock surface layer resulted from the activities of the overground living organisms in a certain climate; it is composed of a mixture of minerals, living organic substances (organisms, especially the roots of the plants and their bacterial rhizosphere) and dead organic matter undergoing decomposition (especially humus).

Stability - the tendency of the ecological systems to return to the original balance, or to stay close to this equilibrium point, after having undergone some disturbance.

Station (or habitat) - a limited natural territory, practically homogeneous. A station is characterized by a geographical situation, terrain conditions, lithological substrate and specific soil, as well as by schemes of the ecological factors (climatic, edaphic, hydric).

Steady state - a dynamic balance that ensures the stability of the ecological systems by permanent compensatory changes of its biotic and abiotic components.

Stenoic - organism with reduced or narrow ecological valence.

Stratification - way of organizing the vegetation in an ecosystem with different levels of primary producers.

Structure – the distribution of substances, energy and information, individuals or populations in the space of the ecosystems; it reflects the types of relations between the component elements. In any ecosystem, several types of structures are distinguished.

Structure of the biocenosis – spatial distribution of the components of a biocenosis.

Structure of the ecosystem - the way in which the components of an ecosystem are placed in space. The structure of the ecosystem is determined by the biotope structure and that of the biocenosis and represents a descriptive analysis of the ecosystem.

Substances flow - the succession of processes through which the material components pass through the various living and non-living components along the trophic chains.

Succession - irreversible transformation of the composition, structure and functions of a biological system.

Survival - all the activities of a population, in order to ensure its continuity.

Symbiosis - permanent association between two organisms of different species, from which they both benefit.

System - assembly of elements in interaction.

System hierarchy - a set of subordonated systems.

System theory - a theory that starts from the idea that the objective reality is made up of organizational units - systems, i.e. assemblages of elements in interaction. In the living world, the systems have the most obvious and complex organization.

Terrestrial environment - the life environment of organisms living on the surface of the earth's crust, on the ground, on a dry surface, with or without a minimum of water (maximum in the wetland terrestrial areas).

Territoriality - the occupation, organization and maintenance of a certain territory, with its resources by an individual or a population, in order to protect its own living space.

Territory - an area – with variable size – within an ecosystem, where an individual or a population lives and carries out its activity.

Trophic chain – the nutritional relations between certain populations of producers, consumers and decomposers in a biocenosis through which matter and energy circulate in an ecosystem. The trophic chains start with a primary producer, continue with its consumers (which can succeed one after the other by forming trophic links of different levels) and in each can intervene after their death, decomposers of different types, which, in turn, arranged in other trophic links, in the end accomplish the return back to the abiotic environment of the elements taken by the primary producers from it.

Trophic level – group of different taxonomic organisms, but having the same position in a trophic chain, using the same type of food sources; represents a single step in the way matter and energy are distributed into an ecosystem.

Trophic network - a complex system of interconnection of the existing trophic chains within an ecosystem through the populations of some key species.

Trophic regim - type of nutrition (carnivorous, omnivorous, vegetarian).

Trophic structure - grouping of different types of populations within a biocenosis according to their trophic regimen.

Turnover – 1. the way the energy and matter circulate within a biocoenosis and eosystem. 2. the time required to renew all the substances in an individual, population, or biocenosis (ecosystems).

Type of nutrition - way of feeding.

Typology - way of classifying any kind of things, beings or objects, based on their likeness by one or more criteria.

Ubiquist - organism or individual living under various environmental conditions.

Underground environment – life environment of organisms living in slots, cracks or caves of the earth's crust.

Variable - value indicating the extent to which the surveyed individuals show the feature or character studied by the researcher.

Variation - modification of an abiotic factor, of an individual, population or biocoenosis over a certain period of time.

Wet zone - area with different species of organisms that are adapted to live in wet soil, or on water saturated or water covered soil.

Wholness - the character of a whole, with attributes of its own, that an ecological system possesses.

Wholness of systems - the living and non-living components of an ecosystem, which are permanently interacting, behave as a whole, maintaining its own existence and its own features, in the conditions of permanent fluctuations of environmental factors.

Zoocenosis - all animal populations within a biocenosis.