Academy of Romanian Scientists *Volume 5, No.2, 2016, pp. 57-66*
Annals Series on Biological Sciences Online Edition ISSN 2285 – 4177

HOW ARE APPROACHED SPECIES AND POPULATION IN BIOLOGY AND ECOLOGY

Stoica GODEANU[1] , Nicolae DONIȚĂ[2]
[1]Academy of Romanian Scientists, 54 Splaiul Independentei, 050094, Bucharest, Romania
*Corresponding author, e-mail: stoica@bucura.ro
[2]Academy of Agricultural and Forestry Sciences from Romania, "Gheorghe Ionescu-Sisesti". B-dul. Marasti Nr. 61, 011464, Bucharest, Romania

Abstract

In this paper is evidenced the different manner of investigating the species in biology and in ecology. As a consequence of these approaches, there are different interpretations of the results of carried out investigations. There are reviewed the relation biology/ecology, position of biology and of ecology concerning system theory, there are also emphasized the peculiarities, the aim and the role of autecological studies and new approaches are proposed in this field.

Within the activity of investigation of living world there are different manners to consider the species and the population by biologists and ecologists. In the following paper we shall try to clarify these aspects.

Relation between Biology and Ecology

Long ago there were carried out discussions concerning the position of ecology within the large field of natural sciences. Ecology appeared as a branch of biology which evidences the way on which living organisms interact with their environment – both biotic and abiotic (Godeanu, 1998).

Biology is the science which studies the living world. In its frame there were differentiated a lot of distinct fields, as taxonomy, cell biology, genetics, biochemistry, physiology, anatomy, etology, ecology, biogeography etc.

Ecology is the science dealing with the study of mutual relationships between supraindividual systems of living matter and their life environment, both biotic and abiotic (Godeanu, 2013; Bavaru a.o., 2007). It considers first and foremost the living, which is analysed in its continuous interaction with the environment. Ecology approaches the life from three points of view, simultaneously : material, energetic and informational. Unlike biology, the results of ecological investigations are processed mainly through mathematical methods.

During the 150 years of its existence, ecology evolved, needing more and more information obtained from different fields of natural sciences (for

instance, from geography, climatology, geology, chemistry or physics), but from other domains also, as mathematics, informatics, economy, several technical or social sciences. Along the time it became more compex, ecology being, in present, in our opinion, an interdisciplinary science which, although is focused on life, it understands life in a different way in comparison with biology. The results of ecological investigations have more and more implications in mankind's life, they being useful for man by serving the development of agriculture, sylviculture, zootechny, medicine, territory arrangement, environmental protection, tourism, economy, legislation.

In present, the results of ecological studies concerns, directly, the future of our planet.

How are perceived species and population according to system theory

System theory, elaborated at the middle of past century by Bertalanffy (1968), lies at the basis of a better understanding of functioning of many fields of human activities. It allows us to settle better the boundaries between the two sciences dealing with living world – biology and ecology (N. Botnariuc, 1976).

Tackling proposed by Bertalanffy is based on the principle that material world is organized in hierarchical systems, on organization levels. Each of these is composed of subsystems which coexist and interact, the same time being subordinated to the upper level to which they belong. Every system has his own peculiarities, which, however, are not the sum of the peculiarities of its subsystems; it has specific functioning manners. The features of the whole ecosystem results from the connections of its components. Systems of each level are characterized by certain structural and functional characteristics and have specific laws (N.Botnariuc, 1976, 1984, 2005).

From the point of view of system theory, the organization levels of living world are different in biology and ecology. Ecology approaches living world from a certain biological level to the top, namely from that which depends of the abiotic environment, i.e. the first supraindividual organization level of living matter, hence the population (Fig.1).

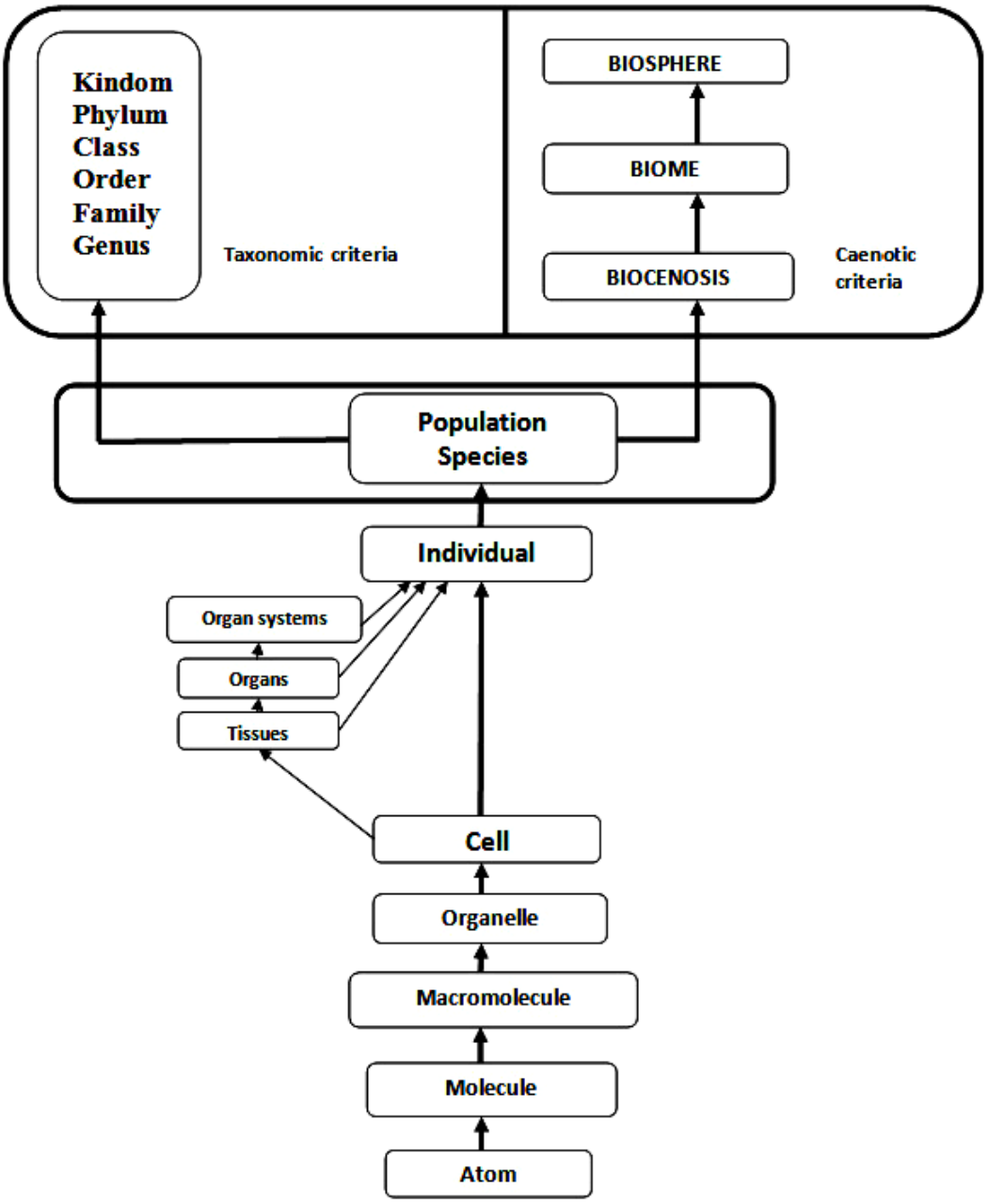

Figure 1 – Hierarchical relations in biology (Bavaru et al., 2007, modified)

Both for biologists and for ecologists species is represented by a multitude of individuals which have the same biochemical, genetic, morphologic, physiologic and behavioral peculiarities, which are living under the same environmental conditions and form populations in which they live and reproduce.

For biologists, the species is a taxonomic category composed by individuals which are identical from a lot of respects (see above the definition of the species).

For ecologists the species is represented by populations composed by individuals of the same species, characterized by a pronounced fidelity for the living in certain biocoenoses, which live under specific environmental conditions, with which they constitute a specific hierarchical unit, called ecosystem.

Bertalanffy's theory specifies clearly that the organization levels are only those that exist at planetary level. That is why in biology the first level is the individual one. In ecology, this is that of ecosystem (because an individual doesn't exist out a population, and this is, obligatory, a component of one biocoenose which, in its turn, represents the living part of an ecosystem) (Fig.2).

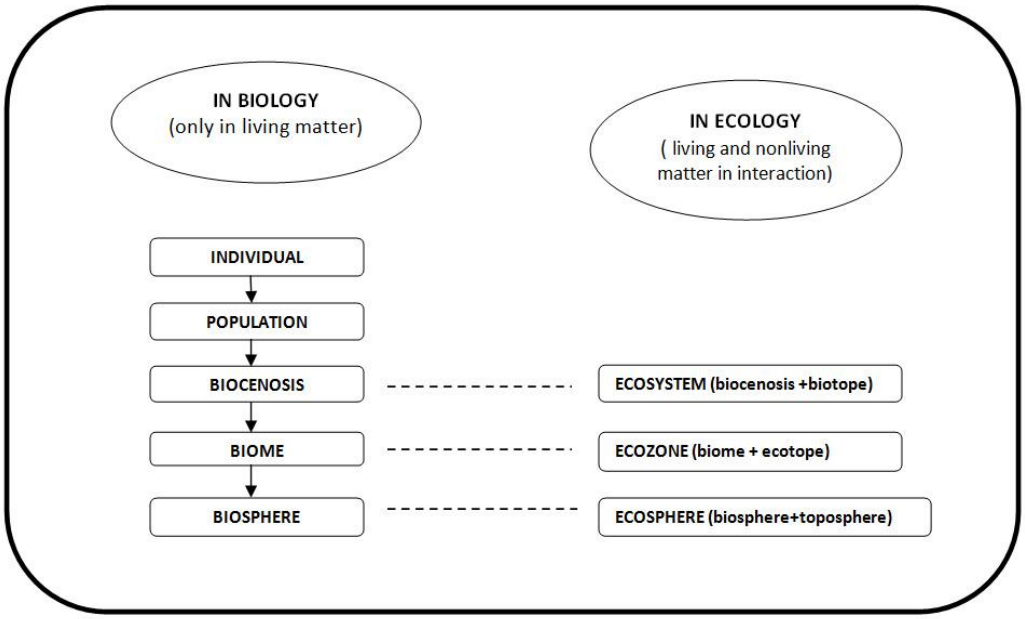

Figure 2 - Organization levels in biology and ecology, according to system theory

Both in biology and in ecology the populational level exists, but it is differently understood, and plays different role.

In a biocoenose each species is represented by a single population, which has its own ecological niche. So the ecological equilibrium of the biocoenose is balanced, that ensuring implicitly the stability of respective ecosystem.

A precise ascertaining of the characteristics of populations from each species belonging to a biocoenose affords a good development of ecological investigations.

Usually, each population has its precise, well defined role. Within the population of a species there is a permanent adaptation to the variations of specific environmental factors. This way the resulted adaptations could enter, gradually, the genetic memory of respective population. Nevertheless, when it is affected by a negative feature and it regresses (or even disappears), its ecological niche will be quickly occupied by the population of another species. This way, the ecological equilibrium of the biocoenose keeps stable, that ensuring the stability of respective ecosystem.

In order to evidence the specificity of the study of species, there are presented in Table 1 the specialists implied in biology and in ecology, and in Table 2 – what aspects of living organisms are studied in biology, and what – by ecologists.

Table 1 – Who studies the species in biology and who – in ecology

In biology			***In ecology***		
By whom	*How is done*	*Species subdivisions*	*By whom*	*How is done*	*Species subdivisions*
Biologists Biochemists Geneticians Taxonomists Morphologists Physiologists Palaeontologists Etologists	Descriptively Analytically	Race Subspecies	Biologists Physicists Chemists Geographers Climatologists Hydrologists Meteorologists Pedologists Mathematicians Statisticians Others	Using parameters and ecological indices	Population Metapopulation Subspecies

Table 2 – Aspects of the species approached by biologists and by ecologists

In biology	***In ecology***	
	From biological field	*From other fields*
Taxonomy – specific peculiarities Variability Genetics – genetic configuration Biochemistry – biochemical peculiarities Biologically active substances Morphology Colour Size/weight Physiology – metabolism Function of certain systems Motility Bioaccumulation Etology – behaviour Palaeontology – occurrence within different geological periods	<u>Structural parameters</u> - Types of biocoenoses to which they belong - Population effective Density - Specific adaptation to environmental factors - Genetic structure Frequency - Dispersal in territory <u>Functional parameters</u> - Temporal dynamics of the population effectives - Age structure - Sex ratio - Birth/death rate - Growth rhythm Ingesta/excreta - Basic metabolism - Bioaccumulation - Dynamics of biomass increase - Specific chemical compounds - Energy budget - Gross production - Net production - Dispersal in territory - Adaptations specific to the variations of environmental factors <u>Behavioral parameters</u> - Life style - Biorhythm - Intraspecific relationships (feeding, reproduction, social, defending) - Interspecific relationships (trophic, coexistence or competition, symbiosis,tolerance, defending or sheltering etc)	Geography : - areal - spreading in areal - distribution of races and subspecies - exposition - relief - variation gradients of certain environmental factors (climatic, morphologic, hydrologic) - relations with the soil (soil type, granulation, density, chemistry, organic compounds, pollutants etc - relations to other life environments (terrestrial, aquatic,subterranian) <u>Chemistry</u> : - pH - salinity - water chemistry - dissolved oxygen amount pollutants (bioaccumulable, altering the nature of the environment etc) <u>Physics :</u> - Ionization - Electromagnetic radiations - Geomagnetic net

It is important to emphasize now some aspects :

- A species occurs only through its individuals which live together in populations belonging to stable biocoenoses ;
- Several species can have a single population ; in this case, there are unipopulational species (which because of this are endangered for extinction). Other species have numerous populations, belonging either to a single type of ecosystem, or to a lot of different ecosystems. These species are multipopulational. More eurioic they are, more vitality and higher adaptation ability to environment.
- Population is an evidence how living nature, through very simple elements, but able to do complex actions, generates a lot of functions which ensure the existence, development and perpetuance of life on our planet.
- The manner of functioning, relationing and evolve the species through its populations allows to ascertain that ecological studies are yet little reflected in the mode in which the species is apprehended and defined by biologists.

Autecology of living organisms

In Table 3 there are presented several of the definitions of autecology. Looking to them, it's easy to observe how many meanings may be afforded to it. It's your choice to accept one definition or another, but only you will read this paper.

In ecology the study of populations is the object of a branch which was called autecology (exactly with this appeared ecology – but now autecology is a very important branch of ecology). During the course of history of ecology, the studies guided to apparition of synecology (the branch of ecology that put in evidence the relations between different species from an association of living organisms – the biocoenose). Then was developed the study of ecosystems (knowledge of the first organization level of ecological interrelations), study of landscapes (i.e. of the associations of ecosystems which are organized on small geographic zones having relatively unitary geographic and climatic characteristics), the study of ecozones (the ecology of certain large biogeographical zones, distinct at planetary level) and the study of global ecology (of the relations biosphere-toposphere-cosmos, i.e.at the level of the ecosphere of our planet) (Figure 3).

Ecology recognizes the fact that from the point when the mankind became the main living component which influences now decisively the destiny of our planet and which – consciously or unconsciously – affects both at local, regional and global level, the natural ecological equilibria, appeared the noosphere (Di Castri, 1981). Noosphere is, in our days, an important component of all the branches of ecology, that determining the apparition and extension of applied ecology (Godeanu 2013, Beeby1993, Newman 1984).

Table 3 – Definitions of autecology

Author	Definition
Odum E., 1971	**A** deals with the study of the individual organism on an individual species
Chapman J.L. et Reiss M.J., 1992	**A** is the study of the ecological relationships of a single species
Brewer M., 1994	**A** is the ecology of individual organism
Oxford Dictionary of Ecology 1996	**A** is the study of the interrelations at species level
Bick H., 1998	**A** is a subarea of ecology which investigates the relationships of individual species to various environmental factors; in particular it establishes under which conditions a species is viable, in which way it is adapted to a certain circumstance.
Dediu I., 2007	**A** is a branch of general ecology which deals with the study of the interrelationships (interactions) of the individual (of a given species) with its environment
Dediu I., 2010	**A** is an important section of general ecology that deals with the study of relations, interactions and interdeterminations between an organism (individual, species) and the environment, and with the spatial spreading, ecophysiological and ecological valence of the components
Godeanu S., 2013	**A** is a branch of ecology dealing with the rendering evident the influences of abiotic and biotic factors acting upon the populations of a species

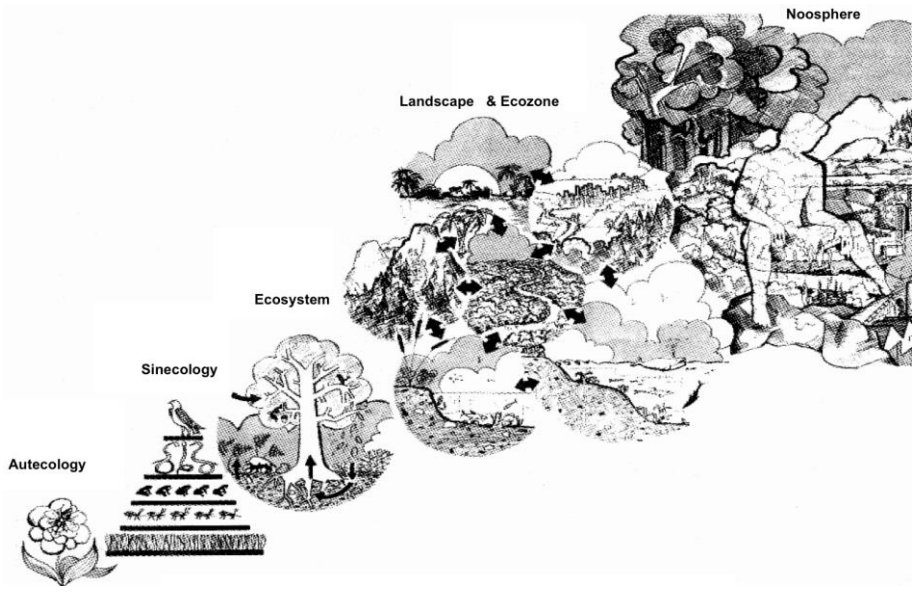

Figure 3 – Succession of apparition of different branches within ecology (Di Castri. 1981)

The aim and the role of autoecological investigations

We consider that autecological research may be done only on the basis of system theory.

Autecology may be studied only at the level of different population of a species, then is realized a synthesis which permits general assessment of the autecology of the given species.

Autecological research explains the existence of metapopulations, of races and subspecies.

Autecological research makes clear the place and the role of a certain species in any biocoenose.

Autecological research leads to the knowledge of the real ecological niche of each species.

Conclusions - Necesary Approaces in auteocological research

- Autecological research is done only at the population level (there are investigated different populations and metapopulations of one species, and only after that there data are cumulated in order to characterize autecologically a species) ;
- It is necessary that in future to increase the knowledge of « ecological niche » ;
- The role of population of each species within the biocoenose to which it belongs must be more considered ;
- It is necessary the realizing of certain global synthetic indices of biocoenoses. This implies the developing of the collaboration between ecologists, mathematicians and specialists in information processing;
- In order to offer more realistic prognoses, an important role must have the use of the simulations of processes which are running in time (and on different variants) concerning future processes affecting the ecosystems to which these populations belong.
- The use of autecological data becomes imperative in the evolutionism studies (introduction of synthetized aspects in ecological niche in evolutionist problems).

References

1. BAVARU A., GODEANU S., BUTNARU G., BOGDAN A. (2007) – Biodiversitatea și ocrotirea naturii. Ed. Academiei Române, București.
2. BEEBY A. (1993) – Applying Ecology. Chapman & Hall.
3. BERTALANFFY L. (1968) – General Systems Theory. George Braziller.
4. BICK H. (1998) – Grundzuge der Okologie. 3.Aufl., Gustav Fischer.

5. BOTNARIUC N. (1976) – Concepția și metoda sistemică în biologia generală. Ed. Academiei R.S.R., București.
6. BOTNARIUC N. (1984) – Systemic approach in ecology. *Buletinul de ecologie*, 1:20-21.
7. BOTNARIUC N. (2005) – Evoluția sistemelor biologice supraindividuale. Ed. Academiei Române, București.
8. BREWER M. (1994) – The Science of Ecology. Saunders Coll.Publ.
9. CHAPMAN J.L., REISS M.J. (1992) – Ecology – Principles and Applications. Cambridge Univ.Press.
10. DEDIU I. (2007) – Ecologia populațiilor. Phoenix. Chișinău.
11. DEDIU I. (2010) – Enciclopedie de ecologie. Știința, Chișinău.
12. DI CASTRI F. (1981) – *L'ecologie – naissance d'une science de l'homme et de la nature*. Le courrier de l'UNESCO, avril:6-11.
13. GODEANU S. (1998) - *Tehnologii ecologice si protectia mediului. 1 Ecotehnie*. Bucura Mond, Bucuresti.
14. GODEANU S. (2013) – Ecologie aplicată. Ed. Academiei Române, București.
15. NEWMAN E. (1984) – Applied Ecology. Blackwell Sci.Publ.
16. ODUM E. (1971) – Fundamentals of Ecology. 2-nd ed. W.B.Saunders Comp.
17. WHITTAKER R.M. (1975) – Communities and Ecosystems. Mac Millan.
18. x x x, (1996) – Oxford Dictionary of Ecology. Oxford Univ. Press.