



Vittorio Ingegnoli

Landscape Bionomics Biological-Integrated Landscape Ecology

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 Springer

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“The beautiful is the root of science and the goal of art, the highest possibility that humanity can ever hope to see”

Rothenberg David (2011)

Survival of the Beautiful: Art, Science and Evolution. Bloomsbury.

“quasi novitas nos magis quam magnitudo rerum debeat ad exquirendas causas excitare”

Marcus Tullius Cicero (44 BC)

De Natura Deorum

The biperspectivable systems view of landscapes, functioning simultaneously as natural and cognitive systems, and therefore as a tangible bridge between nature and mind, open the way for close cooperation among landscape researchers and scientists from all other relevant disciplines and professions

Zev Naveh (2001)

Landscape & Urban Planning 57

Foreword

The Authors of Ancient Greece and Rome never explicitly treat the concept of landscape, even if they knew the theoretical principles to measure the territorial surface and to represent the space in perspective, e.g. through the Euclidean geometry. For instance, Herodotus, one of the first famous historians (and geographer) of the Mediterranean Regions, does not present in his works a true perception of the environment. The same we can affirm for the books reporting the history of countries not yet well known, as Gallia for Julius Cesar or Germany for Tacitus. On the contrary, a good concept of environment is shown in the Bible, representing the base of the message centred on the “Promise Land”. No doubt that the contiguity between the desert and the green areas, rich of fruits and pastures, together with the religious message, leads to a clear intuition of the different life conditions offered by the environment.

A long evolution is necessary in our culture to arrive to an exhaustive conception of “landscape”. Only during the final Medieval Period a new cultural relation between man and his environment begins to emerge, as we can see in the Tuscany paintings of the late fourteenth century. A first attempt to the prospective representation may be recognised in the Scrovegni Chapel (Padua, 1305), painted by Giotto; but it is limited to the inner architectures. Anyway, as cleverly highlighted by Jessup, only after few years we can find a significant turning point, given by a letter of Francis Petrarca. The famous Poet, at that time living in Provence, writes to his master in Italy describing the rise on Mount Ventoux in 1334. Arrived on the top, he gives a look towards the valley and then far away to the Alps, hence to the sea: thus, three spatial coordinates are established from the point where the Poet was placed. This is the first written document referring a prospective vision, so Jessup identifies the beginning of a new phase of human history: the Modern Eve.

In this frame, the note painter Paolo Uccello assumes a prominent position, studying the problem of perspective both on a mathematical basis and on practical experiences: he arrives to final results in his works around 1450. The perspective vision spreads rapidly in the Tuscan paint becoming the main way to represent nature. But, in general, it is a vision of nature from afar, without a true relation with the subject of the picture. An accurate representation of nature is reached only thanks to the genius of Dürer, from the landscapes of his juvenile works to the detailed *Rasenstueck*, a true

scientific representation of a vegetation community, frequently found near the villages.

The term “landscape” is used firstly by Tiziano, in a letter to Philip II of Spain. This famous painter reproduces, on the background of his pictures, typical dolomitic landscapes which he knows very well, being born in Cadore. In Renaissance paintings the landscape is generally interpreted and represented as a perspective view of a natural or agricultural environment containing human figures, which constitutes the principal subject of the painting and the main attraction of the observer. An interesting evolution, the inversion of the goals, emerges with the landscape painters at the end of sixteenth century, not many years after Titian: the environment becomes the principal subject of the paintings, while the human figure is in a marginal position.

The cultural interpretation of the landscape in the Renaissance and near after is mainly limited to an aesthetic significance, as a component of a picture or of a story. We may frequently find this aspect in the works of the landscape painters. Usually, the nature of Central Europe is represented in these paintings, what can be understandable for the French Poussin or the Dutch painters, less for Salvator Rosa, working in Naples, or in Lorrain, working in Rome: within their pictures we can see normally the deciduous oaks, while are uncommon the Mediterranean plants, even the most typical as the holm (*Quercus ilicis*). Therefore, these representations not always result truly natural. Similarly the aesthetic sense dominates in the landscape descriptions of Canaletto, Guardi or Piranesi or, passing to literature, of Goethe or Manzoni.

The landscape assumes also a scientific significance, but only more recently: at the beginning of nineteenth century Von Humboldt realises his famous exploration of Latin America, frequently describing the landscapes, mainly characterised by the components of the tropical forest. His representation of the vegetation on the slopes of Chimborazo acquires an historical relevance as the first intuition of the vegetation belts. Von Humboldt starts from a painting vision, useful to define the landscape as an ecological unit characterised by the presence of indicator species. In his reasoning this pictorial view is analysed into its components parts, mainly the tree species which characterise the landscape as a visual element, but in other cases he may add the animals, e.g. the chamois on the Alps, the guanaco on the Andes or the kangaroo in Australia. In this way we pass from a global systemic vision of the landscape as a pictorial observation to the precise definition of its individual components, which can be considered as indicators. This method was widely developed in Europe, on the Alps by Unger and later by Kerner for the Danube area and Rikli (1942–1948) and Béguinot (1913) in the Mediterranean environment.¹

¹ Unger F. 1836—Über den Einfluss des Bodens auf die Vertheilung der Gewächse, nachgewiesen in der Vegetation des nordöstlichen Tirol's. Wien, 366 pp. Kerner A., 1863—Das Pflanzenleben der Donauländer, Innsbruck. Béguinot A., 1913—La vita delle piante superiori nella laguna di Venezia e nei territori ad essa circostanti. Studio biologico e fitogeografico, pubblicazione n. 54 dell'Ufficio idrografico del R. Magistrato alle Acque, Venezia. Rikli M., 1942–1948—Das Pflanzenkleid der Mittelmeerlande, 3 Bde., Bern.

In the cited scientific works, as in many other of the first twentieth century, plant species with an indicator value for the landscape aspects are limited only to few very indicative ones, mainly trees (except in arid areas). Anyway, in the same period, a new paradigm spreads: in natural conditions plant species tend to group themselves according to combinations that can be repeated in similar environmental conditions: these combinations are indicated with the name of community, association, Pflanzengesellschaft and their study as phytosociology. This stimulating idea is developed by Braun-Blanquet and, following him, during the first half of the twentieth century many researchers explore with a uniform method the vegetation of Central and Mediterranean Europe. This first synthesis regards the North-Western Germany (Tuexen, 1937) and indicates the importance of understanding the plant associations: through their analysis it is possible to deepen both the ecology of individual species and the definition of the characters of a territory, in a new synthetic vision. In a series of annual conferences in Germany (prior to Stolzenau and then Rinteln) scholars from all over Europe come together and discuss methods and results: I was fortunate to have participated and I keep a very vivid memory of them. An important argument is the vegetation cartography, which in that time is mainly carried out by prospecting on the ground, having its proper centre within the laboratory directed by Tuexen.

The cartographic representation of the plant communities directly leads to the identification of reiterated patterns, corresponding to different landscape types. It is merit of Tuexen to have in-depth investigated into the individual components observable in the landscape, through the census of the presence of both individual species and distinct plant communities. In this way, we achieve a connection with the results of phytosociological analysis, which in the meantime had developed in Europe. The landscape is interpreted as consisting of a plurality of plant communities, which tend to reach a degree of complexity gradually increasing up to a maximum compatible with the available physical resources: the concept of potential natural vegetation is a consequence, which at first had a wide application. The definition of landscape with the floristic-sociologic method allows us to analyse and describe in terms of quantity and quality with uniform (and comparable) criteria the set of vegetation cover of the European and Mediterranean countries and to propose a classification for different types of landscape as a result. At the basis of this interpretation is the assumption that vegetation develops in a deterministic way, but this is a first approximation without confirmation in the real world and therefore today it seems that the concept of potential natural vegetation should be subjected to a severe criticism and review.

The phytosociological approach spreads in the first half of the twentieth century in Central Europe, to become quite prevalent here. However, it can be considered questionable for the conception of the species as a fixed entity, corresponding to the Linnaean concept. Consequently, the community also appears a sort of mosaic, divisible into a collection of small stones: a simplistic approach limited to the descriptive level. A different path is traced by scholars especially in the USA, who interpret the presence of the species as a transient state subject to change and focus the interest on the changes

themselves. This represents a shift, from the simple record of the species present, to the turnover of the same due to ecological factors. In the 60s and 70s, Whittaker deepened the study of the vegetation on the basis of gradients analysis, based both on changes in physico-chemical factors than on abstract data, particularly biodiversity, for which different states (alpha-beta-etc.) were distinct and quantitative evaluation methods proposed.

Whittaker too participates at the workshops organised by Tuexen in the 60s, with very open and tolerant discussions: many of us (then young participants) remind sympathy with his work and his ideas are widely implemented mainly by Dutch researchers, but also by Italian and German one. Over the years they penetrate deeper into the Central European scientific culture leading to a gradual overcoming of a strictly deterministic concept. At the end of the 70s Whittaker deepens his experience with the study of Mediterranean-type ecosystems in Israel, in collaboration with Naveh, which even then has a wide experience of research at the regional scale. The Mediterranean vegetation here has an extraordinary diversity of species and groupings, with reports in rapid change as a result of grazing, fire and other forms of impact. A meeting lasted a few years, but that has a profound influence on Naveh, almost re-greening the biblical message mentioned at the beginning.

In his synthesis of 1984 and 1993 Naveh² presents a holistic view, based on general systems theory, on the landscape, which is interpreted as a complex system: it must be considered a whole (holon) with its own appearance (Gestalt), which is the result of the relationship between natural and anthropogenic factors. The prevailing view at the time, based on the results of the study of natural sciences and ecology, is overcome by an interpretation of human-centred, with openness to applications and must be supported by proper policy decisions: a goal toward which we should strive for, but that is seldom achieved. In this Naveh, starting from entirely different premises, approaches to the concept of cultural landscape (Settis).³

In this foreword I start from an overview of the long history of the development of the concept of landscape in Western culture, first in the artistic vision and then as a subject of scientific inquiry. I then detail the more recent developments of which I have witnessed (and in part also co-actor), in an attempt to outline the state of the art on this issue. These developments are the subject of many discussions with Vittorio, and also of a reflection together, which was published recently.⁴ But still many insights are possible, which could also develop important application aspects. So I leave it to Vittorio the difficult task to continue and deepen the discussion in this new book, and I wish the reader to derive pleasure and benefit.

Rome
January 2014

Sandro Pignatti

²Naveh Z., Lieberman A.S., 1984—Landscape Ecology. Theory and Applications. 2nd Edition 1993. Springer, New York.

³Settis S., 2010—Paesaggio Costituzione cemento. La battaglia per l'ambiente contro il degrado civile, Torino, Einaudi.

⁴Ingegnoli V. e Pignatti S., 2007—[The impact of the widened landscape ecology on vegetation science: towards the new paradigm](#). Rendiconti Lincei 18: 89–122.

Preface

A very short history of this discipline and of its name has to be premised. At the beginning of my studies on the environment, I, as a post-graduate scholarship student in Territorial Planning at the Polytechnic of Milan, presented a synthetic but crucial work at the International Congress on “Environment and Engineering”, held at the Science Museum of Milan in 1971: the paper was titled “Ecologia Territoriale e Progettazione” (Territorial Ecology and Design). The main principles of my studies contained in that work constituted the basis of a new discipline, the development of which put me in touch with different researchers as S. Langé (Polytechnic of Milan), O. Ravera (University of Milan), K. Buchwald (University of Hannover), S. Pignatti (University of Rome), R.G.H. Bunce (University of Lancaster), F. DiCasteri (UNESCO, Paris), R.T.T. Forman (University of Harvard) and Z. Naveh (University of Haifa).

At the beginning of the Eighties, DiCasteri, as the International Coordinator of Ecological Sciences, asked me to refer my studies to Landscape Ecology, recently recognised as a new important branch of Ecology at the World Congress of Veldhoven (1981). After a meeting with R. Forman in Harvard and some workshops with Sandro Pignatti and Zev Naveh in Central Italy, I decided (1990–1991) to reach a second degree in Natural Sciences to properly develop this field of studies.

After it (1994–1995) I had the possibility to deepen my researches and to participate to significant landscape studies, e.g. on vegetation in the Sila Piccola Park, CNR (Italian National Council of Research) and on landscape structure in South Africa with the University of Natal (together with M.J. Samways and J. Ott). I was also invited to write the chapter on Landscape Ecology in “Frontiers of Life”, edited by Baltimore, Dulbecco, Jacob & Levi-Montalcini.

In the early 2002, Richard Forman was asked by Springer to give a title to the new book of mine. Forman, who wrote the foreword, suggested “Landscape Ecology: a Widening Foundation”. The reason is clear: the discipline re-founded by me had taken a new direction, becoming “the biological integrated landscape ecology”.

This fact is inserted in the acquired observation that, today, we have two main Schools of Landscape Ecology: the American and the European-Mediterranean one. The first is mainly devoted to the study of the reasons of the spatial distribution of species and communities on the territory; the

second is more holistic and concerns the landscape functions and the human presence on territory too, as pointed out by Peter Weisberg (Reno University) in a recent seminar at the University of Ancona. The American School of landscape ecology is important, because it opened general ecology to scale problems and spatial structure of ecosystems. The importance of the holistic School results in allowing the landscape to be recognised as a living entity. If this concept is properly developed within a biological-integrated landscape ecology, it brings inevitably to a more complete discipline, which I proposed to name “landscape bionomics” (2010).

The recognition of the landscape as a specific level of organisation of life on Earth leads to very significant changes both in the definition and the assessment of a landscape. At a territorial scale, in a given geographical area, the “landscape” is defined as the “biological integration of a set of plant, animal and human communities and of their system of natural, semi-natural and human-cultural ecosystems in a certain spatial configuration”. The meaning of this hyper-complex system is to be a living entity, not an inconsistent set of separate issues and themes (water, air, soil, species, pollution) in which some interrelations can be found!

Inevitably, the changes in how to assess and manage the environment follow. Indeed, we recognise the structures and functions of each landscape, which is the peculiar behaviours that go beyond the traditional relationships among the components, due to systemic laws. Thus, one can speak of a “health” and a number of syndromes (or disease) of the landscape. This fact is very important, because it has been demonstrated that the pathological changes of a landscape, or part thereof, can affect human health too, even in the absence of pollution! Moreover, we must note that a discipline like this follows criteria similar to medicine thus considering an ecologist as an “ecoiatra”.

This new direction especially forces to a deep change in the applications of ecology. The landscape units (LU) need a diagnosis of their healthy state and need ecological models and indices able to evaluate these hyper-complex systems in their intrinsic integrated components. First of all, vegetation science must correspond to this vision, because mainly vegetation (composed by autotrophic species), both natural and anthropic, has the task to structure a landscape as living entity. This correspondence changed many concepts of vegetation science, as exposed by Ingegnoli and Pignatti in “The impact of widened landscape ecology on vegetation science: towards the new paradigm” (Rend. Fis. Acc. Lincei, Ingegnoli and Pignatti 2007).

This new direction enhances also the cultural and ethic implications, because men’s responsibility on Nature and Society, thus on the whole Creation, grows drastically, passing from a geographic structure to a biologic one! Even the concept of sustainability should change, because it is no more sufficient that economy has to consider “also” the ecological aspects: on the contrary, economy should be recognised as a chapter of ecology!

Pope John Paul II, making Saint Francis the Saint Patron of Ecology to underline his care for creation, said: “*not to behave like dissident predators where nature is concerned, but to assume responsibility for it, taking all care so that everything stays healthy and integrated, so as to offer a welcoming*

and friendly environment even to those who succeed us". Remember that Francis of Assisi arrived to affirm:

Be praised, my Lord, through our lady Mother Earth, who feeds us and rules us, and produces various fruits with coloured flowers and herbs.

Therefore, our Mother Earth is able not only to feed us but also to "govern us". This observation precedes and reinforces what science recently understood, recognising that a landscape is a specific level of organisation of life, able to rule even the most high creature, man, indicating him to assume responsibility for it, otherwise the "ecosystem services" can be switched in *peril* for men and the entire life. To assume responsibility we have to know how; without knowledge it is properly difficult to follow the laws of Nature managing our environment and our landscapes. Pay attention to the fact that you can intervene on the environment with the best intentions but causing damage!

This is the main focus of the book: the need to study the "landscape units" through methods following "clinical diagnosis", considering ecologists as "doctors" of ecological systems, i.e. "*ecoiatri*", and the need to implement the knowledge of the laws concerning our environment, facilitating our responsibility towards it: these are aspects contained in the title of this book, from the Greek, then Latin, "Bionomia", meaning "doctrine of the laws of life".

As this discipline is *like medicine*, the concepts of "man's impact on nature" and "strategic environmental assessment" change their significance becoming the ways to verify landscape pathologies, to suggest therapy and to check the capability of the involved subject to survive to the operations without damage. A comparison with the normal state of bionomic systems is needed:

- Man's actions on nature bring to an impact only if they are out of scale; otherwise
- We are in presence of Coevolution.

Thus even "mitigation and compensation" concepts must turn into "strategic interventions of rehabilitation and therapy", which has to be performed on a living entity!

To reach these challenging aims, we divided the book in chapters, which can be grouped into the following (conceptual) sections:

1. *Theory*, Chaps. 1, 2, 3, 4—The definition of landscape as a living entity needs an hyper-complex model and both physical and biological basis. We must follow a correct epistemology to create the new discipline of Landscape Bionomics. After a synthesis of System Theory, we have to explain landscape structure (anatomy) and functions (physiology). The landscape evolution, alteration and pathology are the remaining arguments.
2. *Analysis*, Chaps. 5, 6, 7—A more consistent pool of ecological-bionomic methods, indicators and indices are presented on vegetation, fauna, human population and communities and on the entire context. These analyses bring new important contributions especially in vegetation science and urban ecology.

3. *Evaluation and diagnosis*, Chaps. 8, 9—Non-equilibrium thermodynamics absolutely leads to an historical evaluation of the landscape, an indispensable tool for a good diagnosis. Specific criteria and methods for landscape diagnostic evaluation have been added.
4. *Therapy*, Chaps. 10, 11—Ecological therapy and environmental design (and planning) must be expressed in a wider methodology, which brings to the figure of the physician of the landscape (ecoiatra).
5. *Applications*, Chaps. 12, 13, 14—Experiences derived from European researches in which the Author applied his studies: e.g. CONECOFOR (Forest Focus, with the EU Forest State Services and Gottingen University), rural landscapes (with Leuven University), urban parks (comparison among Milan, Wien, Berlin), urban landscapes (Berlin, Milan). These experiences are applied in eight case studies: on Alpine landscapes, on plain landscapes and on the comparison between suburban-rural landscapes near Milan and Brussels.
6. *Ethics*, Chap. 15—Being the landscape a living entity, we must underline the bio-ethical principle, linked also with epistemological and economical aspects of sustainability.
7. *Main abbreviations & definitions*—A sort of brief glossary, edited by Elena Giglio: very useful.

We initiate in these last years to collaborate with the university of Leuven (Belgium) to study the suburban-rural landscapes. So, I have to underline that this book, written by Ingegnoli, add some other valid researchers in Chap. 14.

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Vittorio Ingegnoli

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1.1 Life and Its Organisation on Earth

1.1.1 The Basilar Biologic Characters of Life

“...Discoursing in my last letter on the different practice of the Italian and Dutch Painters, I observed that ‘the Italian Painter attends only to the invariable, the great, and general ideas, which are fixed and inherent in universal nature’. I was led into the subject of this letter by endeavoring to fix the original cause of this conduct of the Italian Masters. If it can be proved that by this choice they selected the most beautiful part of the creation, it will show how much their principles are founded on reason, and, at the same time, discover the origin of our ideas of beauty...”. “...This it is our business to discover and to express...” as “...the art which we profess has beauty for its object...”.

What is the significance of the previous sentences of Sir Joshua Reynolds [1], dating back to November 10, 1759, in relation to landscapes and life? What’s the thread among Italian Masters (Fig. 1.1), beauty and landscapes? Both art and science focus on the discovery of unity among variety and diversity of our experience and of Nature: as Pythagoras and his scholars have been asserting since sixth to fifth century BC. “...the beauty of a system consists of the proportion among the components parts...” or “...harmony is the unification of diversity...”. More recently, the Emerging Properties Principle asserts that “...an organic whole is more complex than the sum of its parts...” and that

“...characters of the system are the consequence of the way in which the elements organise themselves”.

The harmony of a territory with the laws of Nature breeds the beauty of a landscape, which has not only a visual value that can be perceived (semiology), but a deeper ecological and medical valence¹ too: so the capacity of “measuring”, better quantitatively esteeming, this beauty becomes a crucial point. Landscape bionomics permits it through its capacity of evaluation of the ecological state of a landscape (Fig. 1.2).

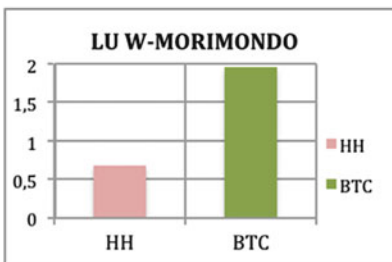
As it has been observed by many authors, from Ashby [2] to Prigogine [3], “...landscapes, as well as parts of them, are created by Nature as its most sensitive, fine and complex structures, through non reversible processes which are time oriented. “...non-equilibrium thermodynamics becomes the most important physical discipline when complex adaptive systems, such as landscapes, are involved with life processes...” [4]. Here again, harmony and beauty related to vegetation, landscapes and life on Earth come

¹ The heavy importance of having visual access to and of being within quality landscapes in developing cognitive, emotional and behavioural connections, encouraging imagination and creativity, cognitive and intellectual development and social relationships, improving job and school performance, encourages learning, inquisitiveness and alertness, alleviating mental stress and illness, restoring the mind’s ability to focus, is by now a sound and reliable scientific point.



Fig. 1.1 *The Ecstasy of St. Francis* (or *St. Francis in the Desert*), oil on panel, painted by the Italian Renaissance master Giovanni Bellini between 1475 and 1480. It is now housed in the Frick Collection in New York City

a



b

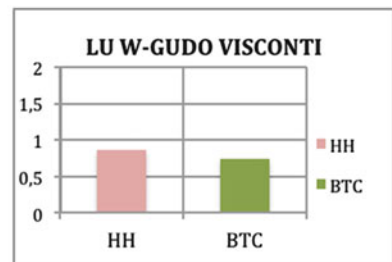


Fig. 1.2 (a) A portion of an agricultural *protective* landscape near Morimondo Abbey (Lombardy) with an acceptable beauty value, as confirmed by the good level of its Biological Territorial Capacity; (b) a portion of an agricultural *productive* landscape near Gudo Visconti (Lombardy) with a scarce beauty value due to its banalization, as confirmed by the worst level of its Biological Territorial Capacity (agricultural landscape average BTC value in Lombardy is around 1,3 Mcal/m²/year; HH = human habitat % of landscape unit (LU))



Fig. 1.3 An alpine farm in Tirol, near Nauders (Austria), about 1,500–1,600 m a.s.l. This portion of landscape, constituted by different types of ecocoenotopes, surrounded by a *Spruce forest*, confirms that life at any scale cannot exist without its environment

from non-equilibrium thermodynamic and indeterminacy.

So, are we able to define the term “Landscape” in a way comprising the whole concept? The European Landscape Convention (ELC) held in Brussels on March 1st, 2004, tried to define the concept of landscape with a compromise between the visual and the scientific meanings, in order to “promote landscape protection, management and planning, and to organise European co-operation on landscape issues”. The adopted ELC definition of landscape is the following: The landscape means an area, *as perceived by people*, whose character is the result of the action and interaction of natural and/or human factors”.

This compromise forced the ELC to ignore the advanced definitions of landscape, whereas the text of Naveh and Lieberman has been underlining, at least since 1984 [5], the necessity to study the landscape through the System Theory, and the book “Frontiers of Life”, edited by four Nobels in 1999, in the chapter on Landscape Ecology, written by Ingegnoli [6, 7], defined the landscape in a way still more innovative: “an adaptive complex system of biogeocoenosis as a specific level of biological spectrum. System of ecocoenotopes repeated over the land”.

Trying to better understand the reported definition of landscape, we have to start observing that Life is a complex self-organising system,

operating with continuous exchange of matter and energy with the outside; the system is able to perceive, to process and transfer information, to follow rules of correspondence among independent worlds (coding), to reach a target, to reproduce itself, to have an history and to participate in the process of evolution. Moreover, we observe that, in an evolutionary view, structure and function become complementary aspects of the same evolving whole.

Consequently *life cannot exist without its environment*: both are the necessary components of the system, because life depends on exchange of matter and energy and information between a concrete entity, like an organism or a community, and its environment [8, 11]. That is the reason why the concept of life is not limited to a single organism or to a group of species and therefore life organisation can be described in hierarchic levels (i.e. the so-called “biological spectrum” *sensu* E.P. Odum [12, 13]). The world around life is made also by life itself (Fig. 1.3); so the integration reaches again new levels. This is the reason why biological levels cannot be limited to cell, organism, population, communities and their life support systems: life also includes ecological systems such as ecocoenotopes [10], *landscapes*, ecoregions and the entire ecosphere (ecobiogeosphere). As all remember, the Gaia hypothesis [14] has already asserted that the Earth itself is a living entity.

SCALE	BIOTIC Viewpoint*	FUNCTIONAL Viewpoint**	SPATIAL CONFIGUR. Viewpoint***	HUMAN CULTURAL Viewpoint°	LIVING ENTITIES °°
<i>Singular</i>	Organism	Organism niche	Living space	Cultural agent	Meta-organism
<i>Stationary</i>	Population	Population niche	Habitat	Cultural site	Meta-population
<i>Local</i>	Community	Ecosystem	Micro-chore	Historic-cultural district	Ecocoenotope
<i>Territorial</i>	Set of communities	Set of ecosystems	Chore	Historic-cultural landscape	Landscape
<i>Regional</i>	Biome	Biogeographic system	Macro-chore	Historic-cultural region	Ecoregion
<i>Global</i>	Biosphere	Ecosphere	Geosphere	Noosphere	Ecobiogeosphere [§]

* biological and general-ecological criterium; ** traditional ecological criterium; ***not only a topographic criterium, but also a systemic one (Crf. Emergent Property Principle);
°cultural, intended as a synthesis of anthropic signs and elements; °° types of living entities really existing on the Earth as spatio-temporal- information proper levels; §remember the “Gaia Hypothesis”.

Fig. 1.4 Hierarchical levels of biological organisation on the Earth

The landscape as specific “system of ecosystems” has been defined by many scientists: Giacomini [15], Buchwald and Engelhart [16], Ingegneri [17, 18], Walter [19], Lorenz [20], Naveh & Liebermann [5], Forman & Godron [21], Odum [13, 22], Pignatti [23], Leser [24], Meffe and Carroll [25].

A few of these scientists, however, fully realised that the landscape is a life entity. In fact, remembering the concept of “noogenesis” [26]—available both for life and thought—and considering the definition of life as “the attitude to order the disorder”, if we recognise some intrinsic behaviours in a complex adaptive system of ecocoenotopes (i.e. landscape), we have to define this entity as a living one. Let’s go deeply.

1.1.2 The Landscape as a Peculiar Biological Level

Investigating the *environment* at different scales, it is easy to note (Fig.1.4) the present existence of four parallel hierarchies, respectively based on the biotic viewpoint, on the functional viewpoint, on the spatial (configuration) viewpoint and on the cultural (human) viewpoint, all recognising only five levels (the “white rows” in the table).

But the real environment is constituted of six levels. In fact, it is necessary to consider two hierarchic levels in the middle “biological spectrum”: (1) the ecobiota, composed of the community, the ecosystem and the microchore (i.e. the spatial contiguity characters, *sensu* Zonneveld [27]), which we will name *ecocoenotope*, and (2) the *landscape*, formed by a system of interacting ecocoenotopes (the “green row”).

No doubt that some characters of community and ecosystem are available also at landscape level and even the inverse is true: it is only reductionism which pretends to separate all the characters related to each level. For example, processes allowing the definition of life are *exportable* characters: each specific biological level expresses a process in a *proper* way, depending on its scale, structure, functions, amount of information and semiology. But we can note that each biological level presents *exportable* characters and *proper* ones [10]: Table 1.1 shows a synthesis of them.

Observe that each system which owns *proper* characters is an *entity*, and we can find *emergent* properties characterising cell, organism, population, ecocoenotope, landscape, ecoregion and ecosphere. That is why these levels are six types of concrete living entities, whose

Table 1.1 Schematic representation of the main characters of the life systems having a strong ecological interest

Biological levels and range of scales	Main proper characters (Ecological chapters)	Exportable characters
Organism $S = 10^{-2}-10^6 \text{ m}^2$ $T = 10^{-3}-10^3 \text{ years}$ $B = \text{multicellular}$ $E = \text{vital space}$	Genetic integrity, phenotypic growth, discrete bodily form, physiological autonomy, metabolism, ethology, etc. (Auto-ecology)	Basic bio-systemic: (structure, dynamics, reproduction, maintenance, etc.)
Population $S = 10^0-10^9 \text{ m}^2$ $T = 10^{-1}-10^3 \text{ years}$ $B = \text{organisms}$ $E = \text{minimal habitat}$	Genetic similarity, ecological density, age distribution, birth/death ratio, logistic growth, social behaviour, etc. (Population ecology)	Carrying capacity, habitat, etc.
Ecocoenotope $S = 10^2-10^8 \text{ m}^2$ $T = 10^0-10^4 \text{ years}$ $B = \text{species/environment}$ $E = \text{site}$	Dominant/rare species, niche, succession, trophic web, speciation, competition, foraging, etc. (Community and ecosystem ecology)	Energy flux, biodiversity, disturbances incorporation, etc.
Landscape $S = 10^6-10^{10} \text{ m}^2$ $T = 10^2-10^5 \text{ years}$ $B = \text{ecocoenotopes}$ $E = \text{land}$	Permeant populations, source-sink dynamics, ecotope role, landscape apparatuses, transformation control, etc. (Landscape ecology)	Spatial contiguity characters, context conditioning, etc.
Ecoregion $S = 10^{10}-10^{12} \text{ m}^2$ $T = 10^3-10^6 \text{ years}$ $B = \text{landscapes}$ $E = \text{region}$	Biogeographical processes, fluvial basin ecology, regional geomorphic processes, zonal climate characters, etc. (Eco-geography)	Land compensation, biome characterisation, etc.
Ecosphere $S = 10^{13}-10^{14} \text{ m}^2$ $T = 10^7-10^9 \text{ years}$ $B = \text{ecoregions}$ $E = \text{world}$	Atmospheric and oceanic bio-equilibrium, thermal balance and vegetation, organic limestone and plate tectonics, etc. (Global ecology)	Biogeochemical cycles, climatic cycles, etc.

Main dimensions: S space, T time, B biotic components, E environmental components

investigation needs these criteria to be integrated, better to be reconceived, remembering that *any ecological system* must include both a biological element and its environment, plus its cultural/information contents.

The first consequence is that we *cannot describe the behaviour of a landscape* scaling up an ecological system of communities. Therefore, the use of computer clustering landscape indicators has to be very controlled and *strictly limited*.

Similarly, even if the use of the exportable characters of a landscape, the chorological ones, is useful in different branches of ecology, because the spatial aspect may aid in studying many levels of biological organisation, note that

landscape ecology focused the attention on scale in ecology, but the landscape itself is not a concept valid at any scale!

As underlined, the landscape presents diverse intrinsic/proper characters, which cannot be found and studied in any other biological levels, e.g.

- Ecotissue structure of the landscape
- Peculiar landscape element structure
- Urban regions multiple structures
- Context role of ecotopes
- Landscape apparatuses
- Landscape efficiency of vegetation
- Permeant animal populations
- Source–sink dynamics
- Context control of transformation processes