

THE ECOSYSTEM DYNAMICS OF THE GARDEN

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ABSTRACT

Gardens have always been seen as places stimulating well-being and pleasure. This feature emerges from the dynamics of these peculiar ecosystems. In the present paper these dynamics are analyzed in the framework of recent approaches to self-organization. The role of the different components of a garden is examined.

Keywords: coherence, ecosystems, gardens, living systems, water.

1 INTRODUCTION

From the most ancient times the garden has been considered a privileged place for achieving emotional and physical well-being and pleasure. This result emerges by a skilful combination of ingredients, whose main components are water, rocks, plants and architectural design. This combination induces in the humans staying in the garden a strong enhancement of many inner capabilities, including the most hidden or less utilized ones. We could say that humans visit gardens in order to discover hidden parts of themselves, to feel well and to be in harmony with nature.

An intriguing connection has been discovered in ancient times between gardens and healing places. For instance the famous Asclepeion, the sanctuary of Asklepios at Epidaurus, in Greece, was built around a network of pathways that exhibit in a sequence symbols, shapes, places able to induce healing and transformation processes.

The aim of the present article is to analyze these properties of gardens in the frame of some concepts introduced by the holistic approaches of modern science, such as thermodynamics of irreversible processes (TIP) and quantum field theory (QFT). These approaches are discussed in other articles of the present issue of the journal [1-4].

2 SOME FEATURES OF THE DYNAMICS OF LIFE

The main achievement of the holistic approaches to biology is that life emerges from a process of self-organization. This conclusion is the result of a long chain of achievements that starts from the vitalistic tradition whose main exponent at beginning of last century has been Driesch [5, 6]. Further steps have been accomplished by Gurwitsch [7] with the discovery of mitogenetic radiation, Piccardi [8, 9] with the recognition of the fundamental role of water and ambient electromagnetic (e.m.) background in the dynamics of life. Tentative synthesis have been formulated along the last century by Bauer [10], Szent-Gyorgyi [11, 12], Prigogine [13] and Froehlich [14, 15].

The following formulation emerges at the end of this chain: living matter comes out from a process of self-organization, absent in non-living matter, centred around water.

Let us summarize the properties of liquid water as emerging from the QFT approach [16]. Liquid water is a mixture of two interspersed phases, one coherent, where all microscopic units oscillate in unison between two configurations of the molecule electron cloud, the other, noncoherent, made up of noncorrelated molecules behaving as a dense gas. In bulk water there is a continuous crossover of molecules between the two phases. However, near a hydrophilic surface the coherence domains get stabilized by the interaction between molecules and wall, so that the coherent fraction is allowed to develop a long-lasting dynamics. The coherent phase of liquid water has the peculiar property that the oscillation of the electron clouds occurs between a ground state where all electrons are tightly

bound and an excited state just below the ionization threshold. Consequently, the coherent phase of water produces, during its coherent oscillation, a reservoir of almost free electrons kept in tune by an e. m. field, which is kept trapped within water by the peculiar quantum dynamics, as shown in [4, 16–18]. Moreover every incoming amount of energy, provided that is smaller than the energy gap (namely the difference of energy between coherent and non coherent states), produces excited states of this reservoir of quasi-free electrons that appear as vortices, which are in turn sources of e.m. fields. It has been shown [17] that the interplay among the excitations of several coherence domains could produce more extended domains emerging from the phase locking of many coherence domains (supercoherence) and this last phenomenon is just at the origin of self-organization [18] through the induced phenomenon of a dramatic decrease of entropy (negentropy).

The coherent and supercoherent structures are stabilized near interfaces. This property agrees with the findings of Pollack [3] who has been able to show that a thick layer of ‘anomalous’ water (EZ water) is present on hydrophilic surfaces up to a depth of half a millimetre. The properties of this peculiar water agree with the expected properties of coherent water, in particular EZ water is able to release a large amount of electrons, being therefore a chemical reducer. Coherent water becomes therefore the main catalyst of most biochemical reactions.

In conclusion turbulent water, where vortices produce supercoherence, through the induced excitations of coherence domains, is an essential element to promote life as well as the veils of water running on rocks. These veils should be assumed to be totally coherent water able to affect deeply the living organisms present nearby. Both turbulent and interfacial water are mediators within a complex organization. They, when inserted in a non-living environment, would not be able by themselves to produce life. Their pro-biotic role arises when they become able to transform high entropy (low grade) energy into low entropy (high grade) energy within a coherent dynamics. This is the rationale of the peculiar combination of ingredients at work in the garden; water is the main agent together with rocks that stabilize its coherent fraction, plants that excite coherent water with their peculiar coherent emissions and, last but not least, boundaries that protect the dynamics from too much external noise and induce a particular ordering of the dynamics through the symmetry-breaking [19]. The chemical composition of the rocks also plays a fundamental role since as, shown in Voeikov [2], the compounds of carbon, in particular bicarbonates, act as fundamental catalysts in the biochemical reactions in aqueous solutions. The system described here fits the definition of confined ontic open system (COOS) described in [1]. In conclusion this system appears to develop, being dynamically triggered by the e.m. fields at selected frequencies (whose ensemble is the content of information of the ecosystem). The relevance of this e.m. background in living organisms has been recently stressed by Montagnier et al. [20]. We will try in the following to describe the interplay of all the aforementioned elements in the garden.

3 THE GARDEN AS AN ECOSYSTEM

Let us address the garden according to the Italian tradition. In this context the garden could be regarded as an example of COOS [1] since it emerges neatly from a surrounding featureless environment, is protected from the atmospheric and is designed in such a way so as to optimize its aqueous resource, its fertility and its ratio of sunlight–shadow. The garden is an ‘Ontic System’ since it emerges always from an historical background, the history of the component plants, the history of the dialogue between water and rock occurring from millennia in the place; this history is the tale of the dialogue between humans and nature that occurred in the garden, that tells the origin of the world and unveils the secrets of life through signs and symbols. No wonder therefore that among the fundamental sources of inspiration for designers of gardens when they wish to get an insight of meanings, paths and plays there is the Ovidian text ‘The Metamorphoses’ [21]. The fabrics of these texts have

been got through the language of the change so that the traditional garden is based on a 'fear of rest' ('horror quietis' in Latin) analogous to what happens in nature according to the QFT. Therefore the metamorphic vision of Latin and Renaissance cultural traditions acquires a new meaning and value in the framework of QFT. Moreover the garden is an 'Open System' since it is involved in a large number of interchanges: the soil is permeable, it is open toward the sky that funnels into it the influxes of the Sun, of the Moon, of the planets and also of the rain. Furthermore the side openings are the gates that bring humans in.

Following this line of thinking we can say that the oasis, which is a good example of the aforementioned model, is one of the primeval gardens in human history, being the matrix of the Bible garden and also a source for the development of the COOS model.

We can simplify the complex description of an actual garden by introducing two extreme fundamental types: the 'horizontal garden' and the 'mountain garden'.

3.1 The horizontal garden

Let us examine the horizontal garden. In this case we have a fountain just in the middle, from where four branches arise. Early, the book of Genesis tells us that a river got out of Eden to irrigate the garden and later became split in four. Ancients Persians believed that a cross divided the world in four and a spring laid in the middle. The splitting of a river in four can be found in Buddhist iconography also. The same structure can be found in the Islamic gardens where a fountain or a lake is laid in the middle, as well as in the Roman and Middle Age gardens.

What has been the line of thinking of so many humans that have tackled during the centuries the problem of designing the many versions of gardens available?

In all these gardens water emerges as an ordering element at the centre of a simple geometrical figure (a square) that provides a message of unity. Water splits itself to divide the surrounding primeval unity in four producing the emergence of a geometrical order from a previous symmetric configuration. In a totally symmetric configuration we have many equivalent possibilities, all directions are equally appealing. The creation of order means that different possibilities can be distinguished and this demands a breakdown of the original symmetry.

The emergence of a square (or a cross) in a landscape rotationally symmetric means that different directions can be recognized and then the landscape has acquired an organization. The fountain, and hence water, is shown in this representation as the element that produces geometrical order in the real world from a symmetric starting point. We now try to transfer the very ancient intuition of the role of water, based on symbols, in the framework of the understanding recently acquired about the properties of coherent water. According to what has been said in the last section, we can say that a spraying fountain produces a turbulent state of water that in turn generates the vortices able to produce e.m. fields. Since coherent structures are kept together by a long range field such as the e.m. field, we could generate also a coherent ensemble of separated droplets as actually occurs in clouds, which are correlated ensembles of droplets [4]. The interplay among the excitations of different coherence domains of water induces a long-range supercoherence among them that transforms the ensemble of droplets of water into dissipative structures [18].

Consequently the entropy decreases and the possibility of self-organization, involving nonaqueous elements too, arises. Actually in the network of biochemical reactions water is the organizing element as shown by the well-known fact that an unordered dry protein gets ordered and assumes a regular helicoidal shape (protein folding) when hydrated. On the contrary a biologically active protein gets disordered, and then is denatured, when dehydrated. It is possible to observe the same dynamics in the plants where, when in their resting state, the seed is what looks like a mineral

because of its lack of movement and absence of water. It is just water that creates the difference between the ‘mineral’ seed and the living vegetable, since water activates information presents in the seed. It is interesting to quote Goethe [22] who proposed the metamorphosis as the main element of the plant dynamics in the same way that the Ovidian *Metamorphoses* has been the guiding model for many designers of gardens; we discover a resonant dialogue between the dynamics of gardens and the dynamics of vegetables and plants.

Let us distinguish three steps in the history of the seed:

1. when dehydrated, the seed is a mineral;
2. water activates and organizes information present in the seed;
3. the creative elements (soil, light and heat) give a shape to the information present in the seed and activate the process of growth.

By combining the first two steps, we get a process where the seed rots and gets transformed by water into a vegetable, since actually rotting is a vital process in plants. When we add also the third step, the seed gets completely activated and becomes a living plant. Hydration induces life in the seed like in proteins. Water is the ‘Principium Vitae’; in nature symmetry is like still-water, a featureless matter where all directions, and hence none, can be selected. The living process creates features within this manifold of equally likely configurations well represented by the manifold of possibilities of the mineral seed. It is just water that breaks this symmetry by showing to the dead featureless seed a specific direction along which organization develops. This description fits with the meaning that water is given in the book of Genesis and in many other texts that address cosmogony in different traditions. Water organizes living matter by selecting specific features in the huge reservoir of possibilities. By doing so, entropy is decreased.

Let us come back to the horizontal garden. Almost all the fountains laid in the middle produce a vertical spray (Fig. 1).

This is a symbol showing that water can rise to the sky forming clouds and come back to the earth as rain. The capability of droplets of liquid water to have a vertical dynamics defies the gravitational field and is a feature that comes from coherence. It is out of the scope of the present paper to analyze this property in physical terms. Here it is enough to say that in particular conditions coherent pieces of matter can levitate and this property is exploited by modern technology as, for example, in the magnetic levitation trains.

Horizontal gardens always have a fountain in the middle. The location of the fountain was determined *a priori* as the place where the influence of water was felt more strongly. We can connect this influence with the phenomenon described by Tedeschi [23], tied to the e. m. emissions present in water. This influence could also be understood as what ancients called the *genius loci*. In this place a fountain is built; this fountain is able to spray around water coming from underground that gives rise to the ‘garden as a living system’.

The special properties of water in this place are presumably the consequence of the combined effect of the turbulence in the underground vein of water and of its interaction with the hydrophilic surfaces of the spongy rocks.

It has been proposed [24] that the emotions felt by a living organism are the subjective perceptions of the e.m. activity originating in the coherent water in the body.

The presence of electromagnetically active water in a place should consequently produce in the nearby living organisms an intense emotional activity. This could occur in particular in the presence of whirling and spraying water, vortices and *jeux d'eau*. As a matter of fact, it is well known that



Figure 1: The vertical spraying water jet of the Fountain of Draghi in Villa D'Este at Tivoli close to Rome. Courtesy of Soprintendenza per i Beni Architettonici e Paesaggistici per le Province di Roma, Rieti e Viterbo.

people willing to meditate prefer to do so near waterfalls; this is usual in the ancient Chinese practice of *Qi Gong* [25].

The whirling fountain concentrates the complex dynamics occurring underground into water jets that in turn organize life overground. The particular shape and geometry of the fountain determines the specific directions around which the system-garden grows.

3.2 The mountain garden

Let us now address the 'mountain garden' where water gets out from high and comes down along a slope. The flow of water is shaped by the features of the ground and its coherence is governed by the branchings, mergings, jumps and tortuous pathways that occur during the descent. The garden, therefore, becomes the result of such adventures of water and the mediator is just the coherent dynamics. The main axis of organization becomes the vertical axis (sky-earth) along which water is flowing. Pathways able to produce vortices acquire a paramount relevance.

The vertical axis can be travelled in two directions:

1. from sky to earth by waterfalls, ladders and falling water chains (Fig. 2);
2. from earth to sky, by *jeux d'eau* and sprays.



Figure 2: The water chain in Villa Lante at Bagnaia near Viterbo close to Rome. Courtesy of Soprintendenza per i Beni Architettonici e Paesaggistici per le Province di Roma, Rieti e Viterbo.

Quite often water flows in the gardens in the form of thin veils of water moving on spongy rocks. This architectural solution had been introduced in ancient times. According to the results described in [3] a thin veil of water on a hydrophilic surface acquires peculiar pro-biotic properties (EZ water). This could explain the feeling of well-being felt in the presence of this feature. In particular water in these conditions behaves as a viscoplastic material as shown in the beautiful experiment of the ‘floating water bridge’ reported by Fuchs et al. [26]. The role of the jumps of water could be understood by considering that a jump is a discontinuity between two different coherent regimes. An ensemble of water jumps would then produce the hydro-diversity that is a dynamical precondition of biodiversity [23]. As a matter of fact the stationary coherence of a system doesn’t allow the system to evolve, would give rise to a dead system. Water jumps allow just the continuous transition among different configurations, which is a necessary condition for life.

The role of water chains can be understood also since vortices produced by the frequent changes of the flow direction create the conditions for the onset of the coherence among the coherence domains (supercoherence) [4], especially when water flows on a spongy water surface, thus becoming an EZ water. Sponginess of the rock increases very much the active interface water-rock, enhancing the activation of water. A consequence of this activation is the appearance of a large population of moss-cover and other green organisms on the interface water-rock in the ladders and water chains. In a different context the same dynamics of reference [23] is here at work. Thus the dynamics is further enhanced in the case that this flow of water occurs within a tunnel of plants that confines the field created by water, acting as a convergent lens.

The component bushes of the tunnel define a cavity where their own e.m. fields couple with the e.m. field of water giving rise to new e.m. modes able to start, according to the dynamics outlined in [4], new biochemical possibilities and then the appearance of new forms of life, increasing the possibility of biodiversity. There is a mutual enhancement of the fields of the different components producing a highly organized system able to include in its coherent dynamics the newcomers passing by. We can understand in this way the increase of health of the visitors of the garden. In a manner similar to the dynamics proposed by Tedeschi [23] the combination of water, hydrophilic surfaces, light and vegetables gives rise to an expanding process of self-organization able to include surrounding non-living matter within the biosphere. It is possible to observe striking examples of these dynamics by

visiting the garden of Alhambra in Granada, Spain, Villa d'Este near Tivoli close to Rome and villa Lante in Bagnaia near Viterbo close to Rome.

A further element of the mountain garden is the cave (Fig. 3). Caves are also included in horizontal gardens artificially, by building artificial caves made up of rocks extracted from natural caves. All these rocks are spongy, so that they trigger an intense water activity. However the cave exhibits such a large quantity of rocks that a 'mass action' of rocks is triggered. Rocks and the enclosed water become a unique coherence domain that gives rise to a sort of 'living organism', just the cave. The cave acts as an e.m. cavity able to govern the activity of all the living organisms present in it. These organisms become members of a coherent dynamics and perform in unison. This feature has been used [27] to try to decipher the rock art manifestations seen in prehistorical times that seem to emerge from collective human activity that occurred in the cave. The cave has also been used in ancient times as a healing place as shown in the example of *Asclepeion*. The healing properties of the cave could be understood in the framework of the dynamics of creation of coherence at the interfaces water-rock. This could be the reason why, in very ancient times, humans started to build artificial caves in their gardens.

I conclude this section by pointing out the important role of light. Usually waterfalls in the mountain gardens end their runs into lakes (see Fig. 4) that mirror light around. The same mirroring is



Figure 3: A detail of a cave. Fountain of Diluvio in Villa Lante at Bagnaia. Courtesy of Soprintendenza per i Beni Architettonici e Paesaggistici per le Province di Roma, Rieti e Viterbo.



Figure 4: The system of lakes in the garden of Villa Garzoni at Pistoia in Tuscany. Courtesy of Fondazione Carlo Collodi.

produced by the water veils running on the ground. Light has been brought in caves as has been observed in the garden built by A. Pope in Twickenham [28].

In the 'philosopher gardens' of the 500' and 600' centuries, ways to increase the light with the aid of water were worked out; in particular creating a vibrating light that is mirrored by moving water. In the garden of Boboli in Florence, *Grotta Grande* (namely 'Big Cave') gets light from a little hole that is at the top centre of the vault through a particular device that creates a coupled dynamics of water, living systems and light: the device is nothing else but a transparent glass bowl containing some red fishes. The light coming from the sky traverses the bowl and is continuously deviated by the movements of the fishes!

In the Pratolino garden, north of Florence, a vault was built, made up of a long sequence of sprays of water that created a passage into which the visitors could enter without becoming wet! During the daytime, these arcs of water created a special experience of light and water. Unfortunately this artifact was completely destroyed but a lot of descriptions of it remain for memory. In this artifact an interplay between water and light was at work. A walking path through a similar tunnel of water is present also in the garden of Villa D'Este in Tivoli (Fig. 5). The water of the tunnel is taken from the waterfalls of the Fontana dell'Ovato.



Figure 5: The waterfall forming the water tunnel in Villa D'Este at Tivoli close to Rome. Courtesy of Soprintendenza per i Beni Architettonici e Paesaggistici per le Province di Roma, Rieti e Viterbo.

Water played the simultaneous role of organizer of coherence and of a filter of light, whereas light gives rise to the onset of supercoherence through the induced oscillation of the coherence domains and eventually leads to photosynthesis.

4 CONCLUSIONS

In every cultural tradition the garden is a representation of the origin of world unveiling the secrets of life through the use of symbols and signs.

The main actress of this opera is water, which represents the life in her regeneration since the source is, in the traditional thought, inexhaustible. In the traditional thought metamorphosis is produced by water or fire. The garden uses water to start metamorphosis.

Today the interplay of TIP and QFT [18] gives a new meaning to the theory of metamorphosis of the ancients.

We may draw the following conclusions:

1. The garden is an artificial structure, where the dynamics of water plays a pivotal role. In the garden the dynamics of water is enhanced compared to the dynamics of water in usual environments.
2. From some contemporary studies of physics, chemistry and biology we know that life is connected to an active and collective dynamics of water.
3. The collective dynamics of water in the garden is stimulated by the interaction with living organisms (plants, animals and humans) and porous rocks such as limestone (concretions, travertine, stalactites), volcanic rock (tufa), pebbles of river, mosaic tesserae, translucent and reflecting material.
4. In the garden the dynamics of water is stimulated by gushes and tortuous performances of water that produce vortices. A vortex is the origin of dissipative structures (Prigogine) and, from the biological view, is a structure very vital since water in the vortex dynamics produces e.m. fields

that, in turn, govern biological reactions.

5. Turbulent water flowing on rocky surfaces produces an environment very vital and stimulating for the living organisms.
6. The different styles of gardens in the human story were designed to stimulate this vitality.

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