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LIFE DEPENDS ON WATER

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The selection and evolution process of self-replicating species and molecules in pre-biotic conditions can be simulated with a population of letter chains in a sort of virtual primeval soup. Each chain. consisting of letters of the alphabet. duplicates itself with variable frequency. depending on its similarity with a pre-established control sentence. During this process of duplication there is a certain margin for error: some copies are slightly different from the original. If we begin with a population which is initially chosen at random. the system then evolves (just like pre-biotic species) by selecting the most "appropriate" sequences and forming chains whose meaning becomes increasingly clear. until the target sequence. or objective. is finally obtained.

Life depends on water. There are other Biological systems. with different forms and characteristics. and even different molecules. from those known on Earth. but water is something they all have in common. without exception. That is why investigations concerning life beyond our planet always start by searching for some evidence of the presence of water.

Water and time. Molecules in the primeval soup exist only in the time between their formation and their degradation (also known as hydrolysis: decomposition by chemical reaction with water). Evolution can only take place when the species is neither too unstable nor excessively stable. Unstable molecules do not have time to replicate completely before the process of hydrolysis. and overly stable molecules do not renovate sufficiently in order to allow other molecules to interact. Water plays a key role in this process: it is the fluid environment which brings molecules into contact with one another. as well as being essential for their degradation. To our knowledge. in all biochemical systems throughout the universe. water is the only suitable environment (in terms of fluidity and temperature) which allows molecules to survive long enough to undergo the process of molecular evolution.

Evolution through error. Errors in the duplication of a species (arising from the incorrect copy of a gene during the replication of a cell) are the origin of new species: as such. they form the basis of research into new sequences and molecules with new properties. The process of selecting the most suitable species among all those which appear is the keystone of evolution. Errors are therefore the driving force behind evolution. The so-called balance of selection is achieved when the most appropriate copy in a given population is selected. and then produces some erroneous copies during replication. thus forming what is known as the error trail. The most appropriate copy and its error trail together form what is known as a quasi-species. The selection of a quasi-species is absolutist: quasi-species can not co-exist because the most appropriate one is always selected (to quote Esteban Domingo).

Chaotic attraction. Five perspectives which represent chaotic dynamics followed by a hyper-cycle of four quasi-species. The different images show a projection of the orbit which is formed by representing variations in the number of copies of three of these quasi-species. The artificial coloring represents the depth of the orbit. (Original image by G.J. Mpitsos: taken from Andrade. M.A. et al. Physica D 63. 21. 1993).

Chaos and cooperation. The cooperation of quasi-species results in a superior level of organization: the catalytic hyper-cycle. in which two or more quasi-species interact catalytically. thus providing diversity. This cooperation leads to the strengthening of some species to the detriment of others. As well as the coexistence of different species. complex behavioral patterns can be achieved. whereby the population of quasi-species does not remain constant in time: instead. it increases and decreases constantly. either periodically or within a framework of dynamic chaos.

Dispersion structures. Simulation by computer of the process of decomposition in the symmetry of a system formed by a hyper-cycle of four quasi-species in a flat fluid environment with diffusion. The colors represent the total concentration of species (red being the maximum. and blue the minimum) in each area of the system. This shows the areas where there is a greater accumulation of species. compared with those areas with a minimal concentration.

Three-dimensional diagrams show more clearly the difference between those areas with a maximum presence of species and those where there are none. These patterns are stable in time and can not be destroyed once they have been formed. However. they are not static: they respond to internal dynamics. whereby the number of copies of each quasi-species changes constantly in time. following a dynamic chaotic pattern. In other words. within each "cell" there is a strong chaotic attraction. This example shows the combination of a stable spatial pattern with changing temporal dynamics. (Created by P.Chacon: taken from Chacon. P and Nuno. J.C.. Physica D 81. 398. 1995)

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Diffusion and decomposition of symmetry. Molecules or self-replicating species flow in the fluid environment, and are subjected to processes of diffusion. As in many other physical systems (including galaxies, ecosystems and chemical reactions), the dynamics of complex transformations combined with diffusion in the environment can lead to the decomposition of symmetry, which then create spatial or temporal-spatial patterns (I. Prigogine's famous dispersion structures). In other words, components of the system can spontaneously accumulate in some parts, to the detriment of others. In pre-biotic dynamics, this process explains why some self-replicating species accumulate in the form of hyper-cycles in some areas of the primeval soup, leaving other areas "empty", or without species. Two important processes then evolve: the appearance of cellular forms and co-evolution.

WATER: FROM TRANSPARENT TO RED

JOSEP MARIA MONTANER

Without water, neither human life nor the founding of towns and cities is possible. From the very beginning of the first volume of the *The Ten Books of Architecture*, Vitruvius insisted that all cities must be located in "the healthiest spots where abundant water sources are available". In addition to being built where there are extremely healthy atmospheres, a city must avail itself of water, be it from the sea, rivers, lakes and fountains or be it rainwater. These principles were heeded on laying out the ground plan and the decuman gate of each new Roman camp. The castles and fortresses were also located in areas rich in water which was guarded like a treasure in the wells located beneath the courtyards. And the monasteries were to be built on the running water bank in order to avail themselves of water for the kitchen and for the cloister lavatory and in order to be able to drain off the wastewater from the latrines. In *Semiology and Urbanism* (1973), Roland Barthes dealt with how difficult it is for those cities which do not avail themselves of water-related aspects, that is, the sea, rivers, sounds or lakes, to have their own distinguishing image. Even some of the great cultures throughout history were named for a great river: the Indians for the Indus; the Iberians for the Ebro. In other cases, it has been the trees which have lent their names to a great country which is almost a continent in itself, such as the "pao do brasil" (brazilwood).

Just as C.G. Jung wrote, the water masses are the most common representation and symbol of the subconscious. This basic, prized element possesses both the feeling of life and of the sacred as well as of the occult, the disturbing and the mysterious. All human beings feel a deep-down yearning for the large masses of water, and for those who do not enjoy them on an everyday basis, they can become a myth, a crucial desire of reaching the sea. In his patterns, the architect Christopher Alexander insisted upon the great collective and symbolic value of the water masses, upon how the views of the sea, of the lakes or of the ponds which turn into nearly sacred gazes; still waters to sit and contemplate.

In fact, water is an element present in a good part of the most highly-rated architecture. In the history of gardens, the Arab tradition, with the Alhambra of Granada, the oriental tradition of the Chinese and Japanese gardens and the European tradition of the Italian, French and English gardens have placed different meaning upon and have given different forms to water. In contemporary architecture, many emblematic examples are indeed so due to their unique relationship with the water: the still waters at the Barcelona Pavilion by Mies van der Rohe; the water which serenely flows through the works by Luís Barragán in Mexico City; or the overwhelming, untamed waters of the Atlantic Ocean in the Pools in Leça de Palmeira by Alvaro Siza Viera. Likewise, water is also the focal point of Valencia's City of the Arts and Sciences and of its Universal Oceanographic Park, designed by the architect and engineer Santiago Calatrava, precisely right on what was formerly the river bed or the Turia River and by the Mediterranean port.

All of Calatrava's work, shaped into the forms of bones, knee joints and branches, of vines, leaves and braids, has taken the universe of the organic as its point of reference, advocating fluid, crystal-clear structures full of the balance and agility which living beings have been experiencing for centuries. Forceful yet slender anatomical shapes which encounter their synthesis in the bridges reflected on the water's surface.

Water, originally transparent, is blue at sea under the sky's mantle, turning red in our bodies and, when in movement, is capable of turning into light.

In his *Spiral Jetty*, Robert Smithson sketches the rocky spiral of the red waters of the Great Salt Lake in Utah, interpreting them as similar to the blood in our bodies. Biologists, naturalists and anthropologists have found that the salt content in human blood is basically the same that of the primeval seas, thus warranting marine mammals being precursors of human beings.

And water, the life-giver, has also been the source of far-reaching importance for obtaining power in the 20th century, when in 1910-1930, the major electric power plants and the high tension wires afforded the possibility of making electricity available on a widespread basis, having transformed the earth's crust with the great metropoli.

Access to drinking water is one of the indicators of the quality of life on a planet on which the aspects defining the struggle of the classes have now changed to become the possession and management of the environment's riches. In the near future, water, a rare commodity, is going to become one of the greatest levers of power to an even greater extent, and if its distribution and treatment are not improved, one of the most highly determining factors of injustice.