

Bacteria Guided Reflections on Water Order and Water Memory

Eshel Ben-Jacob

Abstract

Although much effort has gone into trying to understand the ways in which water is involved in life-sustaining processes, current science does not provide clear and convincing answers to what it is about water that makes it a particularly 'fit' substance to form the 'matrix of life'. This state of affairs, which severely limits our ability to understand life, is rooted in the simplistic and misleading assumption of water's role in the chemistry of life as a passive, structureless solvent that is close to thermodynamic equilibrium (under the normal conditions that permit life).

I will present my view of water as an active solvent of complex organization with long-range order (microns) and long-time memory (minutes to hours), actively interacting with biomolecules and engaging in inter- and intra-cellular processes in complex, subtle, and essential ways. This view emerged following over twenty years of theoretical and experimental investigations of self-organization in nonliving systems (snowflake formation and electrochemical deposition) [1], and close to ten years of studying self-organization during bacteria colony development [2,3].

Guided by bacteria response to treated water, I will further reflect on the possibility that water can store biological relevant information, presumably in its complex structural organization (long range water). For that I will present the results of a novel approach of using bacteria, the most fundamental organisms that have the most "intimate relations" with Nature, to sense the effect of rf (radio frequency) treatment and nano particle doping of water. Using the bacteria as biosensors, I could infer that water treatments by rf radiation and nano particle doping induce long-range order, which I will reason occurs through the formation (self-organization) of a network of gas nano-bubbles with non arbitrary complex organization in which information might be stored. This paradigm will be further supported by experimental results of electrochemical deposition in treated water, and the effects of the water treatments on Z-potential. Put together, the physical, chemical and biological results provide important support to the notion of waterformatics – the possibility to induce endured long range order in water [4]. Consequently I will reflect on the possibility that phenomena like "water order", "water memory" and "water information" are real and not artifacts or mysticism as they are still perceived by the scientific community at large. And if so, the existence of water order and memory calls for rethinking of water and the development of a new theoretical framework for the understanding of water.

[1] "The Formation of Shapes in Nonequilibrium Growth". Ben-Jacob, E., Garik. P., *Nature* **343**, pp. 523 (1990).

[2] "Generic Modeling for Cooperative Growth Patterns of Bacterial Colonies". Ben-Jacob, E., Sochet, O., Tenenbaum, A., Cohen, I., Czirok, A., Vicsek, T., *Nature* Vol. **368**, pp. 46-49 (1994).

[3] "Bacteria harnessing complexity." Ben-Jacob, E., Aharonov, Y., Shapira, Y., *Biofilms* Vol. **1**, pp. 239–263 (2005).

[4] "The Effect of rf-irradiation on electrochemical deposition and its stabilization by nano particle doping." Katsir, Y., Miller, L., Aharonov, Y., Ben Jacob, E., *Journal of the Electrochemical Society*, Vol.,**154**(4), pp. D249-D259 (2007).