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THE FRACTAL LABORATORY JOURNAL: A NEW CHALLENGE IN THE POST-GENOMIC ERA

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EDITORIAL

THE FRACTAL LABORATORY JOURNAL: A NEW CHALLENGE IN THE POST-GENOMIC ERA

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The definition of shape in anatomical structures and their quantitative description are two sides of an open dilemma, which is still today not fully resolved and broadly debated by morphologists. According to the Scottish biologist and mathematician D'Arcy Wentworth Thompson (1860-1948), "it is in terms of greatness and direction that we have to report every conception of our forms. The form of an object is defined in fact when we know its greatness, absolute or relative in the different directions". Shape is one important qualitative feature of natural structures, for example in anatomical terms shape relates function, behaviour and the relationships with the surrounding environment. Although several morphologic indexes based on the Euclidean concepts of *perimeter*, *surface* and *volume* are largely applied in quantitative analyses of biological shape, they define, in only an approximate way the objects under measurement. Such lack of precision derives from the rigidity of the classical linear measures used, while in most natural objects, irregularity in shape and function is a major qualitative attribute.

Classic morphology approaches appear to have assumed that natural objects have a certain form determined by a characteristic *scale* (*i.e.* magnification). If we magnify the observational scale, no new features would be revealed. To correctly measure the properties of the object, such as length, area or volume, a reasonable approach would be to measure it at a resolution finer than the characteristic scale of the object. This simple idea is the basis of the calculus, Euclidean geometry and the theory of measurement. However, the French American mathematician Benoit Mandelbrot (1924-2011) brought to the world's attention that innumerable natural objects simply cannot be measured follow this preconceived approach. A unique spatial scale can rarely characterize natural structures in space. Mandelbrot in his seminal book entitled "The Fractal Geometry of Nature" stated that "clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line".

Although mathematical thought has not had the same impact on Biology and Medicine as on Physics, George Boole (1815-1864, an English mathematician founder of the algebraic tradition in logic) pointed out that the structure of living matter is subject to numerical relationships in all of its parts, and that all its dynamic actions are measurable and connected by defined numerical relationships. Boole saw human thought in mathematical terms and, given its nature, mathematics holds a fundamental place in human knowledge. There is not doubt that the interest in the mathematics of form go back to ancient times, as a response to specific practical needs to describe and represent the world. The use of geometry to depict and understand reality is essential to make possible reconstructing and describing the perceived order of things. As claimed by Pythagoras of Samos (570-495 BC, Greek philosopher, mathematician and founder of the religious movement called Pythagoreanism), real knowledge is necessarily mathematical. This idea was revisited in the early years of the seventeenth century, when the Italian physicist, mathematician, astronomer and philosopher Galileo Galilei (1564-1642) re-proposed the observations made by Pythagoras, with no substantial modification, affirming that the Universe is written in the language of mathematics, whose letters are geometric figures.

However, during the first half of the twentieth century, it was discovered that the geometric language of Euclid (323-295BC) is not the only geometry, but that other geometries exist that are as self-consistent as Euclid's. This led to the flourishing of new non-Euclidean geometries, where the mathematical language was shown to be capable of describing new spatial constructions in rigorous terms. While successive generations of mathematicians elaborated a number of new geometries, the beginning of the twentieth century saw the discovery of a kind of "pathological" mathematical object that seemed at first sight to be little more than curiosities devoid of practical interest. In the mid-1970s, Mandelbrot gave them new dignity by defining them as "fractal objects" and introducing with them a new language called "Fractal Geometry".

This fractal geometry moves in a different direction from the other non-Euclidean geometries. Whereas the latter are based on spaces other than Euclidean space, fractal geometry stresses the nature of geometric objects regardless of the embedding space. The novelty of fractal objects lies in their infinite morphological complexity, which contrasts with the linearity and simplicity of Euclidean forms but matches the variety and wealth of complex natural forms.

We can today highlight that: *a)* Complexity is so pervasive in the natural world that it has come to be considered a basic characteristic of a system. *b)* Natural entities, viewed at *microscopic* and *macroscopic* level of observation, show different degrees of organisational complexity. *c)* Complexity can reside not only in the structure of the system but in its behaviour, and often, complexity in structure and behaviour go together. d) A complex system admits many descriptions (ways of looking at the system). Each way of looking at a complex system requires its own description, its own mode of analysis and its own breakdown of the system into different parts, and e) The vast majority of natural systems exhibit hierarchical organisation: their component structures at different spatial scales (or their process at different time scales) are related to each other. Such ideas have found numerous applications in biomedicine, which helped to understand and resolve longstanding problems.

We believe that there is scope for the creation of a new journal where these ideas can be shared and disseminated. That belief gave rise to the creation of the "Fractal Laboratory Journal" (http://www.fractal-lab.org/journal.html), the official publication of the Virtual Fractal Lab (http://www.fractal-lab.org/). This is a free journal publishing manuscripts aimed at disseminating the Fractal Geometry in Medicine and Biology, a field of research launched in the early nineties years, promoting resources and open software and providing a forum to discuss the advances in the study of life as a complex system. The Fractal Laboratory Journal should be of interest to multidisciplinary scientists, including those interested in clinical problems, biologists, mathematicians, chemists, physicists, computer-scientists, psychologists, epistemologists and philosophers. We encourage submissions from those with an interest in the field of Fractal Geometry in Biology and Medicine. The uniqueness of the journal is the niche where fractals and biology meet. We welcome manuscripts related to fractals including original research articles, technical notes, reviews, viewpoints, editorials, book reviews and correspondence to the Editors. The Fractal Laboratory Journal offers a selective peer-review process that aims to publish only the highest quality manuscripts.

Viewing natural entities, as systems that are dynamically complex in time and space will probably reveal more about their underlying behavioural characteristics. Hopefully, The Fractal Laboratory Journal will contribute to the advancement of clinical care through sympathetic collaboration between scientists and clinicians. It is our hope that this will help mathematicians, biologists and clinicians to contribute together towards a common quantitative understanding of natural complexity.