IV JORNADAS "PEIRCE EN ARGENTINA"

AUGUST 26-27, 2010

Variescence – Cosmic progress and contemporary science

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> I may however spend a few minutes in explaining a bit more clearly what I *mean* by saying that if the universe were governed by immutable law there could be no progress. In place of the word progress I will put a word invented to express what I mean, to wit, *variescence*, I mean such a change as to produce an uncompensated increment in the elements of a situation. (Semiotics and significs, p. 143)

1. Introduction

In the above citation, taken from a letter to Lady Welby, Charles S. Peirce introduces one of his usual neologisms, *variescence*, to name his concept of **cosmic progress**. What can be the meaning of such expression? In what follows an answer to this question is offered by pointing to a close connection between some peculiar ideas of Peirce, generally forgotten or neglected until now, and discoveries of current physics, biology and cosmology.

The notion of progress, as an optimistic expectation of a continual improvement and perfection in the conditions of human life, is rooted in the ideals of the Enlightenment. Its acceptance reached its climax in the nineteenth century, especially in positivistic philosophical doctrines and in the ideological expressions of revolutionary movements that fought political oppression and social and political injustice. The enormous catastrophes issued by the twentieth century, with its world wars and atrocious genocides, helped to undermine the trust in the inevitability of progress. Toward the end of the century the collapse of the Soviet Union and some deplorable consequences of the global expansion of the free market, together with increasing indications of impending environmental catastrophe, have reinforced a pessimistic stance concerning the reality of progress, in spite of undeniable advances in science and technology. At present this lack of faith in the reality of progress is oppressively reflected in various cultural trends and reaches its most acute intellectual expression in some currents of the so-called post-modern philosophy.

Peirce shared with his contemporaries an optimistic stance towards progress but, far from conceiving this notion in terms of the immediate prospects of foreseeable advances for humanity, he endeavored to place it within a historical

and conceptual narrative of extraordinary scope and generality ─ the history of the entire universe, from its creation to its most remote future.

In this communication I will sketch my interpretation of Peirce's conception of progress as variescence. In the following section I will explain, in a somewhat superficial manner to avoid technicalities, the surprising and detailed corroboration of some of his speculations by recent scientific developments. Finally I will review some possible research avenues that might serve to entrench and expand these ideas both in philosophy and in the sciences.

2.Variescence and habit

The definition of variescence as a change "able to produce an uncompensated increment in the elements of a situation" is somewhat cryptic and its elucidation is further complicated by the fact that this neologism does not seem to reappear in those of Peirce's writings that have been published up to now. Nevertheless it is the possible to retrieve the sense and intension of this expression by referring to other passages where he expounds his ideas about the evolution of universe.

Peirce's evolutionism is one of the most radical and comprehensive in the history of philosophy. According to him nothing is totally intelligible without reference to the evolutionary antecedents of its origin, **including the idea of evolution itself**. All of reality, of which the actually existent is only a part, is characterized by its **evolving evolvability**. In plainer terms, in this conception the capacity for evolving itself evolves, frequently towards a new and more complex evolvability.

Some biologists have recently rediscovered the idea that evolvability evolves[i] but in Peirce's thought its scope is not restricted to the sphere of living beings and their associations. On the contrary, evolvability thus understood is what makes possible and characterizes the creation and subsequent evolution of the physical universe in its totality starting from its very first instants.

In order to grasp the implications of this idea of evolvability it is necessary to introduce one of Peirce's key conceptions, expressed by the special and highly generalized meaning he attaches to the term "**habit**." It represents a particular instance of the category of **thirdness**, that is, of a mediating relation between spontaneity (firstness) and coerciveness (secondness). Habit is a tendency of things or processes to reproduce the same behaviors each time the same circumstances are themselves reproduced. For Peirce a habit is basically "a tendency to repeat any action which has been performed before" (Peirce MS 875 of 1883/1884, reprinted in Peirce 1992, EP 1:223).

Magnetism, for instance, manifests the habit of magnets of attracting iron filings each time the situation of having them in close proximity is repeated. If such

circumstances do not obtain magnetism stays as a latency, a tendency to be actualized only in the presence of well defined triggering situations.

There are cosmic habits. For Peirce those are what we call the **laws of physics**. In “The Architecture of Theories” of 1891 he states:

> Now the only possible way of accounting for the laws of nature and for uniformity in general is to suppose them results of evolution. (Peirce 1992, EP 1.288).

The coerciveness factor is very high in laws of very general character. The principle of energy conservation, for instance, constrains the phenomena in such a way that, from the numberless ways in which the development of a process may conceivably take place, the immense majority cannot obtain. There are allowed to happen only those very special ones where a certain quantity (which we call *energy*) remains constant. Peirce thinks that the coerciveness of the laws is never absolute, as it would be the case in a strictly deterministic world, there being always a margin of spontaneity that, even if generally quite narrow, allows exceedingly small random deviations from rigid determination.

The laws we know have issued from the evolution of previous, less restrictive, laws. The laws known to us have their origin in a habit that made possible the earlier laws: **the habit of acquiring habits**. This higher-order habit is a tendency to adopt tendencies, a sort of meta-tendency that compels the evolution of evolvability.[ii]

Peirce’s speculative cosmology is, just as the scientific cosmology of the present, a historic cosmology. At the beginning of time there was a total void of determination and, concomitantly, a plenum of real possibility (a chaos, as indicated by the story in the biblical Genesis). Symmetrically, in the most remote future there is a plenum of determination and a void of possibility.

As Peirce explains:

> I may mention that my chief avocation in the last ten years has been to develop my cosmology. This theory is that the evolution of the world is hyperbolic, that is, proceeds from one state of things in the infinite past, to a different state of things in the infinite future. The state of things in the infinite past is chaos, tohu bohu, the nothingness of which consists in the total absence of regularity. The state of things in the infinite future is death, the nothingness of which consists in the complete triumph of law and absence of all spontaneity. Between these, we have on our side a state of things in which there is some absolute spontaneity counter to all law, and some degree of conformity to law, which is constantly on the increase owing to the growth of habit. The tendency to form habits or tendency to generalize is something which grows by its own action, by the

habit of taking habits itself growing. (Peirce 1958, CP 8.317, 1891).

3. Habits and symmetry breaking

Even later philosophers who took his logic and semiotics quite seriously almost always neglected these Peircean speculations, as passing eccentricities. It is thus quite surprising that these notions have reemerged on their own and have become embedded into current fundamental physical and cosmological theories through the work of researchers who, for the most part, never heard about Peirce's ideas.

I believe Peirce was not able to transform his philosophical cosmology into a positive and experimentally corroborable scientific theory because he died before gaining knowledge of two crucial discoveries of the twentieth century, one theoretical and the other empirical. The first is probably the deepest theoretical realization of contemporary physics, and an essential element of relativity theory, quantum physics and condensed matter physics. I refer to the relation between the laws of physics and the general **principles of symmetry and invariance**. The second is an astronomical discovery made more than a decade after Peirce's death. This is the continuous **expansion of the universe**, a fact that has become the cornerstone of current cosmology and scientific cosmogony.

The concept of symmetry is at the basis of the so-called Standard Model of elementary particles (quarks, electrons, photons, etc.), the entities responsible for the existence of materials objects and their energetic interactions. As we shall presently see, the physics of elementary particles, in contrast to previous physical theories, is developed as a **history,** the story of the emergence of new particles and forces and of new laws that constrain their manifestations as a consequence of **symmetry breakings**.

The metric expansion of the universe means that at intergalactic distances the distance separating two objects with respect to a common reference frame grows spontaneously. This is the experimental ground of the so-called standard model of present-day cosmology, known as **inflationary cosmology**. The term "inflationary" refers to an exponentially fast metric expansion, which is postulated for the earliest instants of the universe's history. Since the last decade of the twentieth century there is growing evidence that the current universal expansion is also accelerated, albeit as a much lesser rate.

Because of this ongoing expansion the universe cannot reach the final state of thermal equilibrium towards which all spontaneous physical processes tend in closed systems, according to the second law of thermodynamics. As it expands the universe "cools" (energy concentration decreases). According to the

Standard Model of particle physics the four fundamental forces operating at the energy scales (temperatures) in which we are located (gravity, electromagnetic interaction and the strong and weak nuclear forces) were at the beginning an undifferentiated single force at an enormously high level of energy concentration.

As the cosmic expansion went on reducing levels of energy concentration the original symmetry was successively broken, yielding the less general symmetries that govern the universal forces at present, except for gravity. By means of these symmetries and the mechanism of their breaking the Standard Model of particle physics was able to explain in detail the organization, origin and properties of subatomic particles and to predict with great accuracy the existence and properties of new particles, such as the Y and Z bosons.[iii]

Symmetry breaking can be illustrated with phenomena of everyday life, such as the freezing of water — its sudden and spontaneous transition from the liquid to the solid state as the temperature decreases below a critical value. In the liquid state the molecules can move at random in any direction. When water freezes a crystal is formed, arranged according to a particular system of directional axes, and the locations of the molecules become restricted. The symmetry represented by the indifference to the direction of motion is broken. In Peircean terms we can say that the molecules have acquired a habit: statistically they have globally lost degrees of freedom and will tend to become aligned in a well-defined direction.

4. Variescence and emergence

"Emergence" is a subject of great interest in the philosophy or science at present. Hundreds of articles and numerous books are concerned with it.[iv] Emergence is really an abbreviation for "emergence of novelty" — the rise of new properties, new relations or new kinds of processes or causes.
Current discussions tend to focus on the emergence of properties or phenomena within wholes that have no counterpart in the parts that make them up. The capacity of ordinary water to make things wet, for instance, has no counterpart in the molecules of H_2O. Often the wholes under consideration are complex systems and the emergent properties are frequently attributed to **self-organization**, a peculiar characteristic of many of such systems, such as tornados, swarms and living beings in general. Already in the 1970's and 80's Prigogine and his collaborators had popularized an important kind of emergence as "order out of chaos," in books such as *Order out of Chaos: Man's new dialogue with nature* (See Prigogine and Stengers 1984). In this case the self-organizing complex systems are studied as far-from-equilibrium dissipative thermodynamic systems.

I believe that under the term *variescence* Peirce intended to express his conception of a possible variant among the several interpretations of what is

currently known as emergence. This conception is based on his ideas of evolvability and habit. Variescence is — says Peirce — such a change as to produce an uncompensated increment in the elements of a situation. What does it mean to be "an uncompensated increment in the elements of a situation"? I think the key to unlock this meaning is to inquire into what kind of compensation is meant.

In view of its construction the word "variescence" intends to characterize progress as enrichment in **variety**. The existence of authentic progress demands not only the rise of elements of novelty but also that their production should not happen at the expense of previous novelties. The new elements must not be compensated by the disappearance of others but, on the contrary, they must add themselves to the continuous enrichment in variety that constitutes the progress of the universe.

That novelty is not compensated becomes obvious when we consider the deployment of progress that is most familiar to us — that of the procession of novelties unfolded by biological evolution. The rise of multicellular organisms, for instance, in no way impeded the continued evolution of bacteria and other unicellular microorganisms.[v] On the contrary, they kept evolving in interaction, and frequently in cooperation, with plants, fungi and animals. They are ubiquitous; they represent almost half of the biomass of the planet and often establish mutually beneficial relations with multicellular organisms. We, for instance, transport in our bodies some ten bacterial cells for each one that hereditarily belongs to us.

6. Some conclusions

If my interpretation is correct the term "variescence" points to an original perspective on the emergence of novelty in all spheres of reality. It has the attractive feature of being supported by an entire network of logical, scientific and metaphysical conceptions that find support in each other and in their common roots in the three Peircean categories.

Reflecting on this conception of progress as a continuous upwelling of spontaneous variety one immediately envisions possible avenues for further research. Among them it is worth mentioning the relations between the Peircean notion of habit and current work to base physical causation on the enactment of powers, tendencies or capacities.[vi] Another promising vein to explore is the role of symmetry breaking in the emergence of evolvability as a physical phenomenon. In theoretical biology and biosemiotics current discussions on the major evolutionary transitions and the growing role attributed to biosemiotic transactions in their progressive unfolding afford opportunities for introducing the ideas of habit and evolvability as instruments for explanation and synthesis.

It seems scarcely probable that the term *variescence* is to become part of the

technical vocabulary in research on emergence and irreducibility in the philosophy of science. As is the case with other Peircean ideas that have been rediscovered in philosophy and science, what is at stake for those of us who take Peirce's thought seriously is to preserve not the terms he coined, but his ideas. What is important is to establish their currency, to confront them with present knowledge and problems and to restore them into the flow of living thought, into the changing paths that the future may have in store for them.

NOTES

[i] See e.g. Massimo Piglucci's article "Is evolvability evolvable?" (Pigliucci, 2008). According to this author the idea of an evolving evolvability "… may constitute one of several pillars on which an extended evolutionary synthesis will take shape during the next few years, although much work remains to be done on how evolvability comes about."

[ii] The notion of habit has also a central role in the definition of the symbol in Peirce's most mature conception. As Nöth explains in exemplary fashion (see Nöth 2010) his evolutionary conception of the concept as a "growing habit" allows Peirce to overcome the entrenched dualism between the semiotics of humans and the semiotics of nature.

[iii] A current and accessible treatment Standard Model of particles will be found in Oerter 2006.

[iv] The bibliography on this subject is quite vast. The following works review the most discussed positions and provide ample references to other publications: Bedau and Humphreys 2007, Bitbol 2007, Clayton and Davies 2006, Damiano 2010.

[v] On the vastness and complexity of the bacterial world see, for instance, Whitman *et al*. 1998 and Dykhuizen 1998.

[vi] In my contribution to the Tenth International Conference on Biosemiotics I have attempted to introduce an interpretation of physical causation based on a reinterpretation of Peirce's conception of habit. See Fernández 2010.

BIBLIOGRAPHY

Barrena, Sara F. (2010). Los hábitos y el crecimiento: una perspectiva Peirceana,. *Razón y Palabra,* (21) 2010. Available at http://www.razonypalabra.org.mx/anteriores/n21/21-_sbarrena.html

Bedau, Mark A. and Humphreys, Paul (Eds.). (2007). *Emergence: Contemporary Readings in Philosophy and Science*. London: MIT Press.

Bitbol Michel (2007) Ontology, matter and emergence, *Phenomenology and the Cognitive Science* 6: 293–307. Previous version available at http://philsci-archive.pitt.edu/archive/00003363/01/Emergence1.pdf

Christiansen. Peder V. (1997). Peirce and modern cosmology: attractors and broken symmetry, *Transactions of the Charles S. Peirce Society*, **33** (4) 941-957.

Clayton, Philip and Davies. Paul (eds.) (2006). *The Re-Emergence of Emergence*, Oxford: Oxford University Press.

Damiano, Luisa (2010). Co-emergences in life and science: a double proposal for biological emergentism, *Synthese* (in print).

Dykhuizen, Daniel E*. (1998*). Santa Rosalia revisited: Why are there so many species of bacteria? Antonie van Leeuwenhoek, *73 (1) 25-33.*

Fernández, Eliseo (2008). Signs and Instruments: The Convergence of Aristotelian and Kantian Intuitions in Biosemiotics. *Biosemiotics*, 1 (3) 347-359.

Fernández, Eliseo (2010). Living is surviving: causation, reproduction and semiosis. Presented at the Tenth Annual Conference on Biosemiotics, Gatherings *in Biosemiotics*, Braga, June 22-27, 2010. Available at http://www.lindahall.org/services/reference/papers/fernandez/survive.pdf

Hardwick, Charles S. (Ed.) (1977) *Semiotic and significs: the correspondence between Charles S. Peirce and Victoria Lady Welby.* Indiana University Press: Bloomington and Indianapolis.

Nöth, Winfried (2010). The criterion of habit in Peirce's definitions of the symbol. *Transactions of the Charles S. Peirce Society*, 46 (1) 82-93.

Oerter, Robert (2006). *The theory of almost everything: The Standard Model, the unsung triumph of modern physics*. New York: Pi Press.

Peirce, Charles S. (1958*). Collected papers of Charles Sanders Peirce*, vols. 1–6 (1931-1935), Charles Hartshorne & Paul Weiss (eds.); vols. 7–8 (1958) Arthur Burks (ed.). Cambridge: Harvard University Press.

_____ (1992,1998). *The essential Peirce: Selected philosophical writings*. Volumes 1 and 2. Peirce Edition Project (Ed.). Bloomington & Indianapolis: Indiana University

Pigliucci, Massimo (2008). Is evolvability evolvable? *Nature Reviews Genetics,* **9**: 75-82.

Prigogine, Ilya and Stengers, Isabelle (1984). *Order out of Chaos: Man's new dialogue with nature*. Flamingo.

Whitman, William B., Coleman, David C. and Wiebe, William J. (1998). Prokaryotes: The unseen majority. *Proceedings of the National Academy of Sciences USA, **95***: *6578-6583.*