The Exosomatic Mode of Human Evolution, and a Clarification of Nicholas Georgescu-Roegen’s Thoughts on Entropy, the Economic Process, Dialectics and Evolution

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This paper is concerned with the following four points. First, a critical appraisal of Elias L. Khalil’s four types of metaphor is made. Second, the alleged “identificational slip” of Georgescu-Roegen is shown to be due to Khalil’s misunderstanding of Georgescu-Roegen’s work. Third, since the concept of evolution is so tangled, an at-temp is made at clarifying this notion in Georyescu-Roegen’s framework along with several issues of the entropy law and dialectical concepts. Fourth, after touching on the recent development of evolutionary theory in biology, the neutral theory of molecular evolution in particular, it is claimed that neo-Darwinian selection is not firmly established even in the field of biology. Thus we should reorient our research to taking much more due account of our peculiar mode of evolution, i.e., the exosomatic evolution, instead of making hurried resort to biological analogies.

In the latest issue of this journal Elias L. Khalil [Khalil, 1992] presented a welcome discussion of eight possible links between economics and biology. Since Khalil’s paper covers a wide range of issues between the two disciplines, I concentrate only on the four points mentioned in the abstract above.

1. A Critical Appraisal of Khalil’s Four Types of Metaphor

Khalil begins his analysis with an introduction of the four types of metaphor. Although metaphor “is the fundamental language of poetry” [The New Encyclopaedia Britannica, NEB for short], it can be effectively used with due care “on all levels and in all kinds of language” [NEB]. There are, however, several problematic issues concerning Khalil’s classification, besides the lack of effective use of the four types in the subsequent part of his paper.

First of all, there is no reasonable basis to resort to biological terms (homologous and heterologous) in order to classify metaphor. Khalil presents a strange example of heterologous metaphor: “the driving of an automobile to work and the driving of the automobile for the pleasure of it” [Khalil, 1992, p. 30]. Analogy “is a functional similarity of structure based not upon common evolutionary origins but upon mere similarity of use” [NEB]. Analogy should be applied to among different ‘species’. In Khalil’s example above the same automobile is used for two different aims or purposes, that is, to work and for pleasure. Hence this example has nothing to do with heterologous metaphor.

Khalil introduces another misleading instance for homologous metaphor: “the driving of an automobile to work and then driving a truck to deliver goods” [Khalil, 1992, p. 30]. In biology homology is “similarity of the structure, physiology, or development of different species of organisms based upon their descent from a common evolutionary ancestor” [NEB]. What corresponds to a common evolutionary ancestor in the example is not clear at all.

These two examples give us important caveat against abuse of metaphors: “[m]any critics regard the making of metaphors a system of thought bypassing logic” [NEB].

Khalil also introduces “the unificational metaphor which expresses sameness” [Khalil, 1992, p. 30]. He, however, does not define what sameness means in his classification. Then he refers to Newton’s law of gravitation to explain that “celestial motion and terrestrial acceleration” are governed “by the same law of gravity”. I cannot understand why Khalil introduces a physical law here. The introduction of physical laws along with biological concepts (homologous and heterologous) does
vitiate consistency of his subsequent argument. In his amusing book, Richard P. Feynman, a Nobel prize winner, succinctly states the essence of physical laws:

there’s a generality aspect that you feel when you think about how things that appear so different and behave so differently are all run “behind the scenes” by the same organization, the same physical laws [Feynman, 1985, p. 237].

The physical laws do not have anything to do with the two biological concepts. Consequently Khalil’s classification itself is untenable.

2. The Alleged “Identificational Slip” of Geogescu-Roegen

Before getting into the main theme of this section, let me indicate a common mistake shared by many scholars as to a theoretical possibility of converting all thermal energy from a single source completely into work. Contrary to their claim, it is possible to convert heat from a single source completely into mechanical work [Fermi, 1956, p. 30f; Geogescu-Roegen, 1987, p. 154; Planck, 1945, p. 82]. The first phase of a Carnot cycle (if the gas contained is an ideal gas of the second kind, precisely speaking) does this. Therefore Khalil’s claim “any attempt of generating [mechanical] energy from a chaotic source, necessitates the waste of some of the inputs into a sink” [Khalil, 1992, p. 37] — is wrong.

Khalil’s main claims concerning the alleged “identificational slip” of Geogescu-Roegen can be summarized as follows.

1. Geogescu-Roegen identifies useful resources with negative entropy [Khalil, 1992, P. 35]

2. “While the heat death and the economic process exhibit a superficial similarity”, Geogescu-Roegen “conceived them not only heterologously and homologously related, but also considered the two non-reversible phenomena as the manifestation of the same law, viz., the entropy law” [Khalil, 1992, p. 30].

Geogescu-Roegen states about the first claim: “low entropy is a necessary condition for a thing to be useful” [Geogescu-Roegen, 1971, p. 278]. He also gave the example of poisonous mushrooms in order to indicate that there are some non-useful resources with low entropy [Geogescu-Roegen, 1971, p. 18]. These citations of mine clearly show that the first claim of Khalil is baseless.

To show that the second claim is also groundless, it is useful to quote a sentence from Geogescu-Roegen’s book: “the Entropy Law applies only to an isolated system as a whole” [Geogescu-Roegen, 1971, p. 192]. Thus a Heat Death is inevitable if the system is isolated. On the other hand Geogescu-Roegen represented the economic process as an open system, not as an isolated one [for example see, Geogescu-Roegen, 1986b, p. 263, TABLE 8.1]. He consequently recognizes the impossibility of blind application of the entropy law to the economic process. He never considered the economic process as “the manifestation of the entropy law”. To wit:

While I thus insisted (as I said in the Preamble) that the economic process is entropic in all its material fibers, I hastened to add that it cannot be reduced to the degradation of low entropy [Geogescu-Roegen, 1986a, p. 8].

In another place he stated again: Economic phenomena certainly are not independent of the chemico-physical laws that govern our external and internal environment, but they are not determined by these laws [Geogescu-Roegen, 1986b, p. 272].

My analysis thus far proved that Geogescu Roegen never considered the heat death and the economic process “as the manifestation of the same law, viz., the entropy law.”

“Inputs of low entropy resources into the economic process and outputs of high entropy waste from it are two unavoidable flows of our economic activities” [Mayumi, 1992, p. 102]. Contrary to Khalil’s claim, the title of Geogescu-Roegen’s book is quite appropriate: “[t]hing things are scarce in a sense that does not apply to [Richardian] land, because, first the amount of low entropy within our environment [in the solar system] (at least) decreases continuously and irrevocably, and second, a given amount of low entropy can be used by us only once [under a given environment condition]” [Geogescu-Roegen, 1971, p. 278].

In spite of the late Kenneth E. Boulding’s sincere hope, the most unfortunate thing with this book is that there is only a very limited number of scholars who perused and appreciated the messages from this magnum opus. Mark Blaug’s sober verdict still holds true for this book:

It is only fair to add that Geogescu-Roegen’s later books have not been well received, or, rather, have been respectfully received and quickly put away. For various complex reasons, not to mention the difficult style in which they are written and the intimidating references which they contain to theoretical
developments in physics and biology, these works have received virtually no critical discussion from economists” [Blaug, 1985, pp. 71-72].

But we have to realize that “only an analysis of the intimate relationship between the Entropy Law and the economic process can bring to the surface those decisively qualitative aspects of this process for which the mechanical analogue of modern economics has no room” [Georgescu-Roegen, 1971, p. 3].

3. The Entropy Law, Dialectical Concepts and Evolution

Without giving any reasonable argument, Khalil claimed that “[c]ontrary to his [Georgescu-Roegen’s] argument, however, the entropy law should not be the entry point to the study of dialectical entities and evolutionary processes” [Khalil, 1992, p. 41].

It might be helpful to introduce a concise explanation of Georgescu-Roegen’s thoughts on the entropy law, dialectical concepts and evolution to the readers of this journal.

The Entropy Law determines “neither when (by clock-time) the entropy of a closed system will reach a certain level nor exactly what will happen.” The Law leaves “some substantial freedom to the actual process”, which can be termed as “the entropic indeterminateness”. The entropic indeterminateness along with “the novelty by combination” inevitably introduces us to the phenomena of life, where we have to deal with so many “dialectical concepts” such as “forms and qualities”. In this domain “arithmomorphic concepts” are often useless. We cannot dispense with “such basic yet dialectical concepts as species, want, industry” and so on, in the world of life phenomena. Qualitative change “eludes arithmomorphic schematization” and has been “a central theme of the life science” including biology and economics. Hence there is an important link between the entropic indeterminateness (not the entropy law per se) and dialectical concepts.

Georgescu-Roegen defines in his sense an evolutionary law: it “is a proposition that describes an ordinal attribute $E$ of a given system and also states that if $E_i < E_j$, ($E_j$ follows $E_i$ in the ordinal pattern of $E$) then the observation of $E_j$ is later in Time than $E_i$ and conversely”.

In this framework the attribute $E$ plays a role as an evolutionary index of the system considered just like the entropy in the framework of Classical Thermodynamics. Consequently the Entropy Law of Classical Thermodynamics is strictly an evolutionary law in Georgescu-Roegen’s own sense defined above: “evolution is the process that links birth to death”. Hence there is nothing wrong with Georgescu-Roegen’s argument here.

However Georgescu-Roegen noticed insuperable difficulty in dealing with evolutionary changes. Evolutionary changes cannot be seen except in an isolated system. But unfortunately, since any evolutionary process cannot be seen in a nonevolutionary environment, we are forced to treat the whole universe. According to Georgescu-Roegen, the evolution of the simplest microorganism raises far more formidable issues than that of the whole universe. In this setting Georgescu-Roegen envisioned the following picture of the universe based on the hypothesis of matter creation and annihilation: it “is a universe consisting of a congregations of individual worlds, each with an astronomically long but finite life, being born and dying at a constant average rate. The universe is then an everlasting steady state.”

Even in this universe there is evolution in Georgescu-Roegen’s own sense. To wit:

Certainly, this picture no longer compels us to believe in absolute novelty. For in a steady state nothing fundamentally new can happen: essentially the same story is told over and over again by each transient world. In such a universe there is nevertheless evolution, but in a different sense than the term has for the biologist. The tenet in biology is that only an aggregate of similar but not identical individuals, i.e. a species, can evolve; an individual never evolves, it only comes into existence, lives, and dies. In the sense proposed here evolution is reflected in the life of any individual part of the universe, be it a galaxy, a species, or a minuscule worm. It is the process that links a birth to a death in each of the countless cases of generation and annihilation that occur continuously in nature” [Georgescu-Roegen, 1971, p. 206].

4. Biology, Society and the Exosomatic Mode of Human Evolution

First let me briefly review recent progress of the neutral theory of molecular evolution. This theory was presented by Kimura Motoo, a Japanese geneticist, and has gained empirical support as a theory of molecular evolution. Kimura stated: the great majority of evolutionary changes at the molecular level, as revealed by comparative studies of protein and DNA
sequences, are caused not by Darwinian selection but by random drift of selectively neutral or nearly neutral mutants. The theory does not deny the role of natural selection in determining the course of adaptive evolution, but it assumes that only a minute fraction of DNA changes in evolution are adaptive in nature, while the great majority of phenotypically silent molecular substitutions exert no significant influence on survival and reproduction and drift randomly through the species [Kimura 1983, p. xi].

The picture of evolution envisioned by Kimura is very similar to that of Stephen J. Gould and Niles Eldredge’s punctuated equilibrium [Gould and Eldredge, 1977]: “the evolutionary record is one of long periods of essentially no change interspersed with rare periods of sudden change” [Kimura’ 1983, p. 327]

In contrast with the exosomatic mode of human evolution, a long period of stasis in biological evolution might be “rule rather than the exception.” However, for fairness to Darwin we should note that Darwin himself acknowledged that natural selection (he had in mind) is “not the exclusive means of modification” [Darwin, 1859, p. 239]. Darwin also admitted in a letter to Lyell that “[i]f I had to commence de novo, I would have used ‘natural preservation,’” [Goldsmith, 1988, p. 72], noticing the long period of stasis in the biological evolution. According to W. Irvine, Darwin combined Victorian conservativeness with the economic conceptions of laissez-faire liberalism [Gould and Eldredge, 1977, p. 145].

The important point is that since we have not obtained a satisfactory explanation of biological evolution yet, we as economists should refrain ourselves from blind resort to biological analogies to tackle our own problems.

We should also note that “man transgressed the biological evolution by entering into a far faster evolutionary rhythm [exosomatic evolution] — the evolution in which organs are manufactured, instead of being inherited somatically” [Georgescu-Roegen, 1986b, p. 249]. Our exosomatic rhythm of evolution has been accelerated ever since the industrial revolution [Mayumi, 1991]. Our exosomatic mode of evolution works its way not only through technological knowledge but also through the cultural tradition. Georgescu-Roegen aptly remarked:

The institutions of the market, money, credit and enterprises of all sorts emerged in response to the progressive evolution of the exosomatic nature of Homo sapiens sapiens. Mankind’s mode of existence is dominated neither by biology nor by economics” [Georgescu-Roegen, 1986b, p. 249].

Edith T. Penrose seems to share a similar view with Georgescu-Roegen albeit from a different angle:

But in seeking the fundamental explanations of economic and social phenomena in human affairs the economists, and the social scientists in general, would be well advised to attack problems directly and in their own terms rather than indirectly by imposing sweeping biological models upon them [Penrose, 1952, p. 819].

Thus it is high time for economists to reconsider our ‘bent for reducing everything to biological analogies.

* I would like to thank Prof. Khalil for letting me know this symposium on Economics and Biology. I also appreciate Prof. Mok’s kind invitation to this symposium. Any remaining errors are, of course, mine.

Notes

1. Khalil seems to confuse homologous metaphor with heterologous metaphor: in one place he stated that the “four types of metaphor are the superficial, homologous, heterologous (analogous), and unification.” In another place we see the phrase, “the biological distinction between heterologous and homologous (or analogous)” [Khalil, 1992, p. 30].

2. Khalil made the same mistake in other writing [Khalil, 1990 p. 168, 1993].

3. The same claim can be seen from the following [Khalil, 1990, p. 173-174, 1993].

4. All references in this section are Georgescu-Roegen’s 1971 book unless otherwise specified.

5. “Most of the properties of water, for example, are not deducible by the some universal principles from the elemental properties of its components, oxygen and hydrogen.”

6. Georgescu-Roegen refers to any concept that has the property of discrete distinction as “arithnomorphic” because any particular real number has this property. On the other hand he refers to “the concepts that may violate the Principle of Contraiction as dialectical.” Dialectical concepts are not “discretely distinct” but nevertheless “distinct.” “A [dialectical] penumbra separates a dialectical concept from its opposite.”

7. “What makes “want” a dialectical concept is that the means of want satisfaction can change with time and place”, for instance.
8. In Georgescu-Roegen's picture of the universe the entropy of the whole universe is kept constant by the hypothesis of matter creation and annihilation. "But the existing entropy never decreases in any part of the universe", for example, in our solar system. It is very important to note that in the universe there is evolution in Georgescu-Roegen's own sense independently of whether the universe is in a steady state, or an expanding whole, etc. For recent theoretical (or rather hypothetical) development of the picture of the universe see [Hawking, 1988].

9. Kimura believes that Darwinian (positive) selection mainly acts through phenotypes which are the end results of the action of many genes. He explains that unlike Darwinian (positive) type of selection the most common type of natural selection at the phenotypic level is 'stabilizing' selection, which eliminates phenotypically extreme individuals and preserves those that are near the population mean.

10. In a sense Gould and Eldredge rediscovered a vision of successful monsters mentioned by Richard Goldschmidt [Goldschmidt 1933, p. 547]. Gould and Eldredge regard their theory as the basis for a theory of macroevolution. They believed in consistency with basic Darwinism. The punctuated equilibrium "represents no departure from Darwinian mechanisms, but only the previously unrecognized mode of operation for natural selection at hierarchical levels higher than the local population" [Gould and Eldredge, 1977, p. 139].

11. Darwin stated: "the expression often used by Mr. Herbert Spencer of the Survival of the Fittest is more accurate [Darwin, 1952, p. 32].

12. Gould and Eldredge share the same view: "gradualism was part of the cultural context not of nature" [Gould and Eldredge, 1977, p. 145]. Marx and Keynes held the same view [Jones, 1986].

References


