

## **Comment**

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### **The Complexity of Life: Can Life be Simply Defined?**

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In the interesting article by Trifonov (1), the definitions of Life were analyzed from a variety of sources and 10 groups of terms were compiled. Based on these terms, the author attempts to provide a succinct definition of what “Life” is; that is, “Life is self-reproduction with variations”. While the terms underpinning the definition clearly provide a reasonable characterization of Life, there appears to be a lack of certain key elements of what “Life” embodies.

One of the main issues with the definition as based on the vocabulary used is that there is no mention that Life, as it had evolved (2-6) on earth, came about without a purpose. One of the definitions the author had quoted was from Kompanichenko who stated that the category of terms that encapsulates the definitions of Life is one that includes, among other characteristics, “the display of self-perfecting logic”. First of all, there is a slight problem with the term “self-perfecting”, as it tends to give the impression that there is a teleological attempt by “Life” to drive towards a particular aim such as survival or an increase in complexity. Secondly, words under the category of “Ability” more often than not promote the perception that living things are consciously able to respond physiologically to external environment and to evolve accordingly, rather than there being a selective pressure exerted by the external environment, thereby sieving out organisms not suited for survival in that particular circumstance.

As argued by Richard Dawkins (7), “Life” evolved without an aim or a purpose. As such no pre-determined conditions existed that favoured a particular life form over another or any life forms for that matter. Conversely, organisms are not capable of evolving specifically to adapt to various conditions on Earth. The process of evolution, as expressed by François Jacob (8), is one of “tinkering”, during which the selective process “works on what already exists, either transforming a system to give it a new function or combining several systems to produce a more complex one”. That vestigial organs or lack of a perfect design in organisms (9) can be found today supports this notion. While the author (1) was relying on terms previously used to derive a concise definition of Life based on the frequencies of their usage, I would suggest that there could be a description to reflect Life as an entity or property that is amenable to (natural) selection without a purpose (direction).

In addition, words such as organization and information under the groups “system” and “complexity” do not completely embody the idea of “emergent properties” that relate to developmental biology at the individual organism during embryogenesis, as well as for the entire collection of living organisms. As put forth by Oyama (10), there appears, at least during the development of a multicellular organism, to be more than the information encoded by genes. Indeed, the interaction among cells is critical during development to ensure the proper unfolding of the resulting

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organism. Such an important essence of “Life”, where invariant properties such as information encoded in the genes and how cells interact with its environment determine how multicellular organisms develop, might need to be included in the definition of “Life”.

Likewise, the terms under the section on “evolution” appear to fall short of representing the full complexity of how organisms can evolve as part of being a living thing. Currently, there is a trend towards examining the “evolvability” of organisms as an extension of the ideas behind the Modern Synthesis of evolutionary biology (11). This is based on the authors’ count of 364 papers in which this word had been used (11). Simplistically, “evolvability” can be loosely referred to as the propensity of a genotype to generate variability and as such, determine the success of a species during natural selection. While the notion of “evolvability” has not been formally defined and empirically validated, based on the authors’ argument, I suggest that the concept might eventually be a more useful one to explain mechanistically how different species of organisms could have arisen. This term does not seem to be encapsulated in the short definition of “Life” that is provided (1) and it is not clear if it could be in the future. Furthermore, the definition should encompass the notion that while the various properties of “Life” as compiled (1) are carried within each living organism, it is the collective existence all living things as a result of organisms interacting with the environment that we are able to witness the phenomenon of “Life”.

The definition of Life is important as it is needed for philosophical and practical reasons (12). Given the complex nature of “Life”, it might require a more elaborate definition (13) to cater to specific applications (14) than simply being distilled from the vocabulary of previous definitions of “Life” to be of practical use.

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