

# Review of: "Provisional Definition of the Living State: Delineation of an Empirical Criterion that Defines a System as Alive"

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Potential competing interests: No potential competing interests to declare.

The author appears to think he is the first person to discuss the definition of life. There is no mention of Erwin Schrödinger, or Julien Jean Offray de La Mettrie, or Stéphane Leduc, or D'Arcy Thompson, or Robert Rosen, or Manfred Eigen and Peter Schuster, or Stuart Kauffman, or Humberto Maturana and Francisco Varela, or Tibor Gánti, or Purificación López-García, or Daniel Koshland, or Maureen O'Malley, or Carol Cleland, or Kepa Ruiz-Mirazo, not to mention a whole host of lesser figures. If the author reads all (or at least many) of the publications cited by Cornish-Bowden and Cárdenas (2020) in *BioSystems*: DOI 10.1016/j.biosystems.2019.104063, and, having done so, thinks he has something new to say, then OK, as long as it is presented in the context of previous work.

The author also seems unaware of previous studies of the thermodynamic aspects of the living state, but this has been considered by many people, most recently, perhaps, by Hans Westerhoff. Again, this previous work needs to be mentioned as well as anything the author wants to say.

There are just three (!!) references in the paper, one of them an advertisement for the author's previous work, one of them more or less relevant, and one from a popular book (that may be a misquotation).

Ref. 1 (in a junk journal for crackpots) contains such gems as "the recursive information encoding feedback processes of the quantum spacetime micro-wormhole network, which we refer to as spacememory, enables memory and learning in physical systems across all scales, resulting in universal evolutionary tendencies towards higher levels of ordering and complexity — foundational to evolution, sentience, and awareness." It does not appear to have anything useful to say about the definition of life.

Ref. 2 is perhaps the most relevant, but it has its problems. Its author wants to define artificial life to encompass modification of a living organism to one that does something different ("The goal of this work was to use genetic manipulation in plants so that they would produce more  $\alpha$ -tocopherol, or vitamin E. The problem at hand was that plant oils, the main dietary source of tocopherols, typically contain  $\alpha$ -tocopherol as a minor component with high levels of its biosynthetic precursor,  $\gamma$ -tocopherol. A genomics-based approach was used to find and clone the final enzyme in  $\alpha$ -tocopherol synthesis,  $\gamma$ -tocopherol methyltransferase  $\gamma$ -TMT), and manipulate an overexpression of  $\gamma$ -tocopherol methyltransferase in *Arabidopsis* seeds to shift the oil composition in favor of  $\alpha$ -tocopherol"). But by that criterion a

chihuahua, a wolf modified by many generations of selection, is an example of artificial life.

Ref. 3. The reference is seriously incomplete: on what page did Richard Dawkins say this? Did he really write it, or is the author paraphrasing something someone said to him? It deals with a small point, and the author seems to be taking as literal truth what Dawkins may well have intended as an exaggeration to make people think. In any case, where did the author get the idea that Dawkins's view is part of "the current consensus paradigm"? Has he never read anything by Denis Noble, for example? Or by any of Dawkins's other critics?

#### Points of detail

1. Abstract, "Within this study it is found that the requirements for abiotic matter to transition to a living system are only dependent upon a far-from-equilibrium thermodynamic low entropy state ...". Without the "only" this would be a statement of something everyone has known for decades. Adding the "only" makes it nonsense.
2. "there are no clear criteria for identifying when they are present": Only because the author hasn't read the relevant literature.
3. Fig. 1. Despite the legend the figure has no arrow leading to the conclusion that a system is alive.
4. "it would be regarded as conscious — and hence alive." Throughout the paper the author seems to be confusing life with consciousness (here the word "hence" is evidence of that). I don't think one can be conscious without being alive, but one can certainly be alive without being conscious. Bacteria are certainly alive, but you need to be an adherent of a fringe religious sect to think they are conscious. What about a much more complex organism like an ant? Is it alive? Just about everyone would say yes. Is it conscious? I very much doubt it.