Journal of Biomolecular Structure & Dynamics, ISSN 0739-1102
Volume 29, Issue Number 4, February 2012

Comment

Definition by Means of Indefiniteness

Yuri N. Zhuravlev

Institute of Biology and Soil Science,
Russian Academy of Sciences,
Far Eastern Branch, 159 100-letiya Ave,
690022, Vladivostok, Russia

http://www.jbsdonline.com

Humans recognize themselves as a part of humanity, of the biological world and of life simultaneously. They identify themselves differently in each case. However, in the absence of an accurate definition of life, the process of the identification of humanity remains incomplete. The incompleteness of this process justifies the numerous attempts to define life. Nevertheless, none of these previous attempts has been indisputably successful. This previous lack of success implies that life possesses some elusive feature(s) escaping the (current) definition. In a recent paper (1), Edward N. Trifonov tries to find these features of life with a "word count" approach. This work is akin to publications that analyze sets of published definitions (see reference in ref. 1), but it differs from them in its level of generalization. The definition obtained after such generalizations, is, I am afraid, only loosely connected with the essence of life. Four comments below will illustrate the reasons for my mistrust.

1. Concerning the approach. Any statistical analysis is fruitful if and only if the sample is representative. In this case, there are two uncertainties: whether the definitions for analysis were selected correctly and whether the selected definitions actually include the principal features of life. Both aspects are of importance because statistics cannot help to discover characteristics absent from the sample. As I noticed above, the life possesses some elusive feature(s) escaping the (current) definition so life cannot be defined exhaustively at present time.

   Statistical analysis (even if the second aspect of the problem, *i.e*., the content of the definitions, is incomplete) can be useful for studying the history of scientific reflections about life. However, the latter is not the purpose of the work reviewed here. The goal of the work is to give a "possible shorter definition" of life "containing components that are both necessary and sufficient". To achieve that goal, all the words from the 123 definitions of life published at different times were considered, and the frequency of these words was calculated (Table 1). The relative frequency of use of the words was not considered in the subsequent analysis. Instead, the words were combined in 10 groups according to their common meaning, and the 6^{th} group was given further consideration. The author was clearly under the impression that the 6^{th} group was chosen on the basis of word count. However, this group was clearly chosen on the basis of an evaluation of the inclusive capacity (although no measure of capacity was presented in the text) of certain arbitrarily selected words. All of the subsequent analyses in the paper are unrelated to word counts.

2. Concerning the subject under consideration. In discussions of the definition of life, many authors use (explicitly or otherwise) the terms "life" and

Corresponding author:
Yuri N. Zhuravlev
E-mail: zhuravlev@ibss.dvo.ru

"organism" as synonyms (2). This shortcoming can be discovered in many of the 123 papers reviewed. Strictly speaking, this shortcoming makes the exploitation of the method of principal components unacceptable in this case. This shortcoming explains (in part) the reason that "the definitions are more than often in conflict with one another" (because different subjects were treated). In the paper reviewed, the author avoids this topic entirely. However, to disregard the distinction between life and organism is a shortcoming of great significance. To interpret life as an organism means to overvalue the genetic constituents of the system and to underestimate all other features.

I hypothesize that a biological object cannot be exhaustively defined solely in terms of its genetic constituents. It is necessary to combine the internal and external definitions of a biological object (3). The internal definition is primarily genetic and considers the biological object as a triad: $O_{int} = (P, F, Ph)$, where p denotes program, f – functions and ph – observables [see details in (3)]. The successions, recursions and compositions of mappings (on the basis of these three components) make the object. The external definition reflects the position and role of the biological object in its surroundings (in unity of living and non-living). Here, the object can be interpreted as a certain operator converting the surroundings: $O_{ext} = \Phi{:}S_1 \rightarrow S_2$. This definition is more ecological. Separately, no definition can be sufficient to define a biological object. However, both definitions, even if taken together, are insufficient to define life as a system because the multitude of biological objects is only a list of elements related to life, whereas the production of the system from its elements introduces novel properties that cannot be inferred directly from the characteristics of the elements. Thus, the definition of life as a system must include characteristics absent from the definitions of biological objects. The potential infinity of life (in contrast to the finite nature of objects) is an example of such novel characteristics. Again, this topic was not addressed by the paper and that remains unclear what is characterized through "exact replication".

3. A comment regarding the attempt to improve Darwin. The short Darwinian formula "descent with modifications", which Darwin used to ground the theory of origin of species (not the origin of life), was transformed by the author into "self-reproduction with variations". Even if one pays no attention to the legitimacy of such a transformation, a question remains: are the pairwise substitutions "reproduction/descent" and "variation/modification" (as a substitution of one versatile term for another such term, where the content of the two terms overlaps in part) fruitful in any sense? Here, the author uses the term "self-reproduction", which he explains as "exact replication of the ideal RNA duplex …", thus obtaining the definition that life is *exact replication with variation (non-exact).* Generally speaking, the neologism "self-reproduction" lies beyond intuition and even beyond second law of thermodynamics, but its content (used in the paper) was not specified by the author. As result, clear Darwinian formula was converted in the vague vulnerable allegation in which nothing of Darwinian formula was conserved.

4. The title of the paper, "Vocabulary of Definitions of Life Suggests a Definition", gives the impression that the approach used was valid (almost without the author's participation) to produce the conclusion that "all is life that copies itself and changes". I believe that the author intervened in at least three principal instances: first, through the supposition (undoubtedly incorrect) that the definitions considered include all necessary and sufficient properties of life; second, through the substitution of the word-count method for a method of inclusive capacity evaluation; and third, through the transformation of the Darwinian formula [operating with natural selection and organic beings (4)] into the definition of life [operating (here) with undefined subjects] and through subsequent "generalization". This tangled and dashed line, by which the author connected the word count results with the meaningful laboratory experiments by Spigelman, can be characterized as an operation of arbitrary treatment but not that of compression whereas the latter operation is usually used in information theory to convert a string in the shorter string (5). As consequence of this arbitrary treatment, the image of the soap bubble divided into two smallest bubbles is easily located in the scope of the final definition of life (as it is given in the paper reviewed), but this waning image is inappropriate to recover the plethoric image of the biological object or of that of life as a system.

References

1. E. N. Trifonov. *J Biomol Struct Dyn 29*, 259-266 (2011).
2. Yu. N. Zhuravlev and V. A. Avetisov. *Biogeosciences 3*, 281-291 (2006).
3. Yu. N. Zhuravlev and V. A. Avetisov. In: *Genetic Transformation*, M. Alvarez (Ed.), InTech, 29-52 (2011).
4. C. Darwin. Origin of species, John Murray, London (1859).
5. P. M. B. Vitanyi and M. Li. *IEEE Trans on Inf Theory 46*, 446-464 (2000).