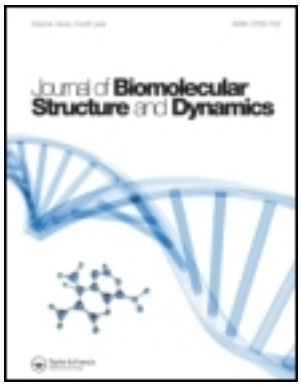

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Comment

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In his paper "Vocabulary of Definitions of Life suggests a Definition", professor Trifonov (1) analyzes the vocabulary of 123 existing definitions of life in order to provide a path for finding a possible minimal agreement among scientists. To this purpose, he compares from a linguistic point of view the definitions provided in different accounts of life and ranks the terms used therein according to their frequency. He then selects the most used words, which should also reflect the most accepted concepts about life, and groups them under generic concepts representing their common general properties (or meaning). For instance, "matter" represents the class under which "molecules", "organic matter" and "materials" fall. Finally, he reduces the conditions that the most frequently occurring "*definientia*" represent to the states of affairs or events that require them. In this fashion, for example, "energy" and "material supply" are included in the concept of "metabolism", while "self-reproduction" comprises also its essential conditions, "metabolism", "system", "energy" and "material supply". The outcome of this analysis is a definition of life as "self-reproduction with variations". This definition is claimed to be "minimalistic" for two reasons. First, it is a kind of minimum denominator of the definitions taken into consideration. Second, it is applicable to the minimal structures that can be involved in the origin of life. Moreover, the minimalistic definition is maintained to be generic, as it provides a unique common basis for all varieties of life, including extra-terrestrial life, computer models and abstract forms. However, this proposal raises two crucial questions. Is "self-reproduction with changes" a good definition? Can this definition actually provide a minimal basis of consensus?

One of the Possible Definitions of Life

The purpose of a minimalistic definition of life is to reach a minimal consensus. As Trifonov acknowledges (1), there are more than 100 definitions of life, and many of them conflict with each other. The minimalistic definition captures the list of the most recurring defining terms, based on the assumption that recurrence reflects acceptance. A problem with this proposal can arise from the assumptions underlying the grouping of the characteristics and their reduction to generic properties or more complex phenomena. A hypernym semantically includes hyponyms, but this does not correspond to the fact that who accepts a more specific concept is also willing to accept a more generic one, especially when the choice amounts to exclude a distinguishing property. Moreover, more complex states of affairs or events can include more generic concepts or precedent or essential conditions, but causal precedence does not correspond to a logical or an epistemic necessary condition. The effect of this double process of reduction is a definition of life that risks incurring the same problems of the criticized Darwinian definitions (including their chemical and biological variations) (2, 3), characterized by the same characteristics of "self-reproduction" and "variation". As Zhuravlev and Avetisov (4) put it, these characteristics are excessively discriminatory,

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as on this perspective "it is hardly possible to specify life, including early life, before the emergence of the replication machinery". Moreover, sterile beings such as mules should be excluded from the forms of life (5). Finally, the very concept of self-replication is one of the most controversial matters in the research on the origin of life, or rather "minimal life". As Luisi (6) put it:

> Even with the simplification of minimal life and way stations, it is clear that the process leading to life is a continuum process, and this makes an unequivocal definition of life very difficult. In fact, there are obviously many places in Oparin's pathway where the marker 'minimal life' could arbitrarily be placed: at the level of self-replication; at the stage where self-replication was still accompanied by chemical evolution; at the point in time when proteins and nucleic acids began to interact; when a genetic code was formed, or when the first cell was formed.

The decision of choosing the two characteristics of self-replication and variation can lead to controversies about the necessary condition of the definition, making it more specific and less general than many approaches to life origin require (7). Moreover, the definition can be also controversial from the point of view of the sufficient conditions. The definition mentions an activity (self-replication) but does not specify any quality that the agent, or rather the logical argument, needs to satisfy. As a result, life simulations can be classified as actual forms of life, as claimed by functionalists who regard life as an abstract process. However, this theoretical position, implicitly supported by the first Darwinian definitions (8), has been strongly disputed (2). The risk with this minimalistic definition is the failure to meet the essential logical requirement of a definition, its convertibility with the *definiendum* (5, 9), or rather, if we consider other scientific approaches to this logical conditions (4), its being "universal" and "minimal and specific enough".

Definitions and Methods of Definition

The collection of the properties commonly included in the existing definitions of life and their reduction to a minimal description can be hardly accepted by the different approaches to the problem of life (5). Moreover, the choice of a definition of a controversial concept counts as an implicit support to a specific theory (6), or more generally speaking, a potentially controversial viewpoint (10).

This issue becomes much more complicated if we consider that not only are definitions fundamental for finding a theoretical agreement, they are also essential for classifying entities. A genus-difference definition cannot be effective for distinguishing between living and non-living beings in space or on other planets (5, 11), while an operational definition cannot provide a theoretical ground for the origin of life (12). Ranking the properties according to their frequency can be helpful for showing their degree of acceptability. However, such a principle can be combined with other criteria not only hinging on synonymy or causal inclusion. For instance, Kompanichenko (7) started from a similar collection of definitional properties and then selected the fundamental ones based on their "discriminating power", or rather their usefulness for the purpose of distinguishing between categories. For instance, "accumulation of free energy" was chosen because it, better than other properties, allowed one to discern between active and passive systems.

This systemic account is different in method and purpose from Trifonov's one, as it is only aimed at providing a possibly shared *biological* definition of life. However, it points out two methodological dimensions that can be seriously taken into consideration in the classification of definitional properties. The first one is the selection of the kind of definition, and consequently the choice of the concept to be defined (13). The second is the grouping of the properties according to their definitional purpose. The type of definition, or better the definitional sentence, is materially related with the purpose of the definition itself. Ancient dialecticians distinguished between fifteen types of definitions (14), of which the most powerful from a logical point of view was the method of genus-difference. The so-called "essential definition" was the only one that at the same time guaranteed the convertibility between *definiens* and *definiendum* and provided a description of the fundamental semantic properties of the concept defined (9, 15). Modern scientific theories rely on similar types of definitional methods (13), plus the operational (unmentioned in the ancient treaties) and the implicit definition (16-18), which cannot be properly considered as descriptions of the *definiendum*. All such definitional methods rely on the distinction between the semantic-logical properties of the predicates: the semantic categories (such as substance, having, doing...) and the logical predicables (such as the genus-species or accidental relation between predicates). For instance, "life" is a noun abstracted from the predicate "to continue, to live" (19), therefore denoting a state of beings, or a property thereof, but not a substance, matter or entities, which can rather differentiate the biological living state (condition *of chemical systems*, as stated in some Darwinian definitions, see 6) from computer simulations. Some properties, as the ones used in operational definitions, (3) can be simply accidental, namely can characterize some forms of life, such as life on earth (11).

Conclusion

The definition of life drawn from the analysis of the properties listed in the existing definitions opens new possibilities of research. One of them consists in applying classical methods of property classification in addition to the frequency criterion. On this view, properties will be grouped according to

their logic-semantic features characterizing their definitional role. Such properties can be then selected according to their statistical acceptability or hypernymy (or rather genus-species) relations. Moreover, depending on the different purposes of the definition (and *definieda*) it is possible to formulate different potentially shared minimal definitions. The choice of alternative property classification criteria (for instance, semantic traits or observable properties) can make it possible to provide different statistically minimal kinds of definition, adequate for and aimed at distinct purposes.

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