HUMANITY IN THE WORLD OF LIFE

by Hwe Ik Zhang

Abstract. The position and role of humanity in the world of life is examined in the light of the ontological structure of life itself. This problem is approached by considering the possible units of life representing various modes of life phenomena. I argue that the only meaningful unit of life without interposing some special external conditions is "global life" framed in a star-planet system. Any other possible unit of life exhibited by various kinds of individuals is conditional in the sense that it would leave out an essential part as "co-life." The relationship between human being and the global life should be understood in this general scheme of individual and global life. It is emphasized, however, that human being occupies a unique position in global life in the sense that humanity can promote either a cancerous situation or a healthy higher-order enhancement of the global life.

Keywords: cofunctionator; co-life; global life; humanity and nature; unit of life.

One of the problems of utmost importance in this age is to establish the proper position and role of human being in the world of life. Modern humanity has acquired the power to destroy the world of life irrestorably, but we lack the insight required to sustain ourselves in it and to help the living world maintain itself for a prolonged time. To do this we need first to comprehend the dimensions and structure of life and to discern the object of real significance from the less significant ones. One way to approach this problem is to consider the possible units of life representing the various modes of existence exhibiting at least some characteristics of life.

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There are many candidates to be considered as possible units of life, including genes, cells, organisms, and species. But as I shall show later, none of these are genuine units of life but can only be understood as conditional ones. On the other hand, the whole interconnected system of living beings framed in a star-planet system can be regarded as the proper unit of life. This whole connected living system, which I call the *global life*, can therefore be regarded as the most significant object and all other entities can only be regarded as objects of contingent significance.

To arrive at this conclusion, I base my argument not on the metaphysical conceptions of holistic philosophy but on physical principles and empirical observations concerning physical and living systems. It is therefore the most natural starting point for our argument to examine the basic characteristics of living beings in as scientific a manner as possible.

Characteristics of Life

One of the classics dealing with the basic characteristics of life is the celebrated little book by E. Schrödinger titled *What is Life?* ([1944] 1967). In this well-conceived inspirational work Schrödinger contributes valuable insights into the physical aspects of the nature of life (Yoxen 1979). Notably, he introduces two concepts which might not be original but which subsequently have been regarded as expressing the essence of life: the concepts of *code-script* and *negative entropy*. He notes that "It is these chromosomes . . . that contain in some kind of code-script the entire pattern of the individual's future developments and of its functioning in the mature state. . . . In calling the structure of the chromosome fibres a code-script we mean that the all-penetrating lay immediately open, could tell from their structure whether the egg would develop, under suitable conditions, into a black cock or into a speckled hen, into a fly or a makize plant, a rhododendron, a beetle, a mouse or a woman" (Schrödinger [1944] 1967, 22-23). In another famous passage he emphasizes the importance of negative entropy: "Thus a living organism continually increases its entropy—or, as you may say, produces positive entropy—and thus tends to approach the dangerous state of maximum entropy, which is death. It can only keep aloof from it, i.e., alive, by continually drawing from its environment negative entropy—which is something very positive as we shall immediately see. What an organism feeds upon is negative entropy" (Schrödinger [1944] 1967, 76).

I do not attempt, in this paper, to arrive at a concrete definition of life. Rather, drawing upon the above-cited characteristics of life phenomena, I would argue that something to be called life should

properly have the functioning code-script within the system and should be in a situation to be supplied with the necessary negative entropy.

The code-script contained in chromosomes is now understood as the DNA molecules with definite sequences to nucleotide bases. In the passage cited above, Schrödinger stresses the role of information stored in the chromosomes (DNA molecules) as the sole determiner of the fate of the individual, with only the minor qualifying phrase "under suitable conditions." But this qualification should be emphasized and carefully examined. By the "suitable conditions" we mean in fact very specific conditions without which the information loses all its significance.

The DNA molecules located outside the cell body, for instance, can no longer function as a code-script. Even within the cell, they cannot function as a proper code-script unless the physical states of the material composition of the cell are within a certain extremely restricted range. In other words, to make the DNA molecules work as proper information, the system surrounding the molecules should be in a very special composition and in a very special "functioning state." The role of this particular surrounding system in this particular functioning state should properly be recognized and conceptualized. For the convenience of further discussion, I will designate this particular system the *cofunctionator* to the main *body of function*, the DNA molecules in this case.

We can summarize the situation thus: if information is to be processed, two complementary factors are needed, the main body of information and the corresponding cofunctionator. This situation is very clearly demonstrated in the case of written information in ordinary books. In this case the body of information is the physical print of words on paper and the cofunctionator is the human beings capable of comprehending it. It is obvious that the words are meaningless unless there exists the human intelligence comprehending them. In the case of DNA information, the body of information is the DNA molecules with particular codon arrangements, and the cofunctionator is the surrounding material within the cell and the environment outside the cell. Together, they are the law-code and executive power, but separated they lose all their meaning as an information system.

This situation can be generalized further to any localized system which performs its proper function only in association with the surrounding complementary system. So the president of a nation, the main body of function for the presidency, can perform his or her function only in association with the people of the nation, the cofunctionator. Abstractions such as DNA information, contents of a book, and the president of a nation, in dissociation from their very

specific cofunctionators, might lead to serious misconceptions about their ontological status in the world in which they are presumed to be located. The relational concepts introduced here—the body of function and the corresponding cofunctionator—are intended to represent the underlying ontological structure properly.

Possible Units of Life

We now turn to the possibility of defining the unit of life by the "body of information" considered above. For the case of DNA information, the body of information might be the gene (a segment of DNA molecule with a definite codon arrangement) or the genome (set of genes in a nucleus). But as soon as we try to unitize the life by these entities, we find ourselves in the awkward situation of depriving the entities of living character. The unitization implies at least a conceptual isolation of the unitized entity and this isolation of the genes or genomes would deprive them of their function: working in association with their cofunctionators. This situation is contrasted with the unitization of an ordinary material, say, water. We can arbitrarily define the unit quantity of water, for instance, one liter or one cubic centimeter. This unit quantity of water maintains its character as water independently of the situation surrounding it. We can therefore differentiate two kinds of units—"normal" and "conditional." The conditional unit is conditional in the sense that it leaves out an essential part, a condition for its own functioning. The liter of water as one "unit" is "normal," but one gene as a "unit" of life is conditional since this leaves out the cofunctionator which is essential to its own functioning as a living being.

Are the more inclusive entities like cells and organisms better qualified as the possible units of life? Certainly cells and organisms are much more inclusive and independent entities compared with genes and genomes. A cell body, for instance, includes not only the DNA molecules forming the genes or genomes but also much of their cofunctionators within a system. A multicellular organism consists of cells that include all these contents and more, such as blood, interorganic space, and so on. In some sense, cells and organisms behave almost like independent living units.

Still, however, they are not sufficiently qualified as normal units of life, because they would soon lose their character as living beings once isolated from their proper environments. This point will immediately be clear once we consider another basic characteristic of life, discussed by Schrödinger in the second passage cited above. Since every organism (and in this respect every cell as well) continually increases its own entropy it can only keep alive by continually drawing on negative entropy (or "free energy" in the more widely used terminology) from

its environment. This situation should be compared with the case of crystals. A piece of crystal can remain a crystal without drawing any negative entropy from its environment and may easily qualify as a normal unit of crystal in the sense defined above. But an organism or a cell, which is in a metastable state with a very low entropy, cannot maintain this state unless continually supplied with free energy from the surroundings. This is not simply a matter of fact for the cells and organisms but a matter of principle for a system maintaining a living state. This does not mean, however, that it is sufficient for the system to be located in the route of free energy flow; rather, a very specific external condition should be maintained for the system to benefit from an actual supply of free energy. The concept of cofunctionator applies here. Cells and organisms maintain the living state only in association with their respective cofunctionators, the very suitable external conditions supplying the necessary free energy. Therefore, cells and organisms as units of life, useful practically and appealing commonsensically, can at best serve only as conditional units and should be understood accordingly.

The Global and Individual Character of Life

To search for a proper unit of life, we can proceed further and consider more comprehensive entities than the organisms. The obvious candidates are species, monophyletic taxa, and the like on the genealogical line and such entities as populations and ecosystems on the ecological line. But it is easy to demonstrate that the arguments applied to cells and organisms can also be extended to these entities. Whatever the precise definitions of these entities, it is certain that all of them are larger systems containing the organisms as their subsystems. And since each of the organisms can only stay alive by continually drawing free energy from its surroundings, the larger system containing the living organisms as its subsystems inevitably needs a supply of free energy from outside unless it includes the ultimate source of free energy in itself. As is well-known, the source of free energy for life on earth is the sun, and life flourishes in the path of this free energy flow.

Therefore, the only proper unit of life without any accompanying external supply of essentials—the free energy—is the star-planet system, if it is inhabited by life phenomena. We have at least one such life-realm in the universe, which is the life in our sun-earth system. On the other hand, we have every reason to believe that this is not the only life in the universe. There are billions and billions of stars in the universe, each of which in principle can have life. Each life-realm on each star is truly independent in the sense that it can sustain its living state without any external supply of resources.

It is therefore legitimate to assign the notion of a "normal" unit of life to the whole of the connected living beings framed in a star-planet system, which might properly be called the "global life." This unitization of life in fact reflects the ontological structure of life, which is truly global in character.

The global character of life, however, does not deny the possibility of defining individuals such as cells, organisms, and species as meaningful entities. It simply denies granting such entities the status of normal unit of life, emphasizing their dependence on the corresponding cofunctionators. According to the usual definition an individual is "any spatiotemporally localized entity which develops continually through time, exhibits internal cohesiveness at any one time and is reasonably discrete in space and time" (Hull 1981). The historical character of individuals is recognized by D. Hull (1981) and N. Eldredge (1985), Hull maintaining that "individuals are historical entities, individuated in terms of their insertion into history." In view of the global ontology of life, this point becomes even clearer. Individuals are regarded as the historical products of the spaciotemporal development of global life, representing the spaciotemporal modes of life itself. In this view, evolution can be seen as a way global life develops into spaciotemporally discrete but connected structures of individuals. The conceptual division of life into these historically developed individuals is therefore quite natural and practical in discerning various features of the living world.

As noted above, however, it is improper, strictly speaking, to grant an "individual" the status of "life" independently of the remaining constituents of the whole. We may attach the status of "individual life" to such an entity with the understanding that it is meaningful as a life only in association with the whole context of its life. This remaining complementary part might be termed the *co-life* of the "individual life" thus rendered. Co-life defined this way performs the role of cofunctionator, allowing the individual to function as a living system. But in contrast to the concept of cofunctionator the concept of co-life is more than function. To the extent that the individual is granted the status of life, the co-life is also granted the status of life in the complementary sense.

The concept of co-life largely overlaps in content with that of environment. However, there are some differences in emphasis and connotation. *Environment* usually means the external background common to many individuals, while the co-life is a relational concept meaning the specific remainder of global life for a given individual. Another difference is that environment usually implies the "nonliving" section of a living system while co-life strongly connotes the

complementary character of the parts composing a whole undivided living system.

Characteristics of Individuals

Individuals formed in the developmental process of global life can be regarded as "auto-catalytic entities with code-script." The code-script in these individuals is some specific but normally insignificant physical detail, usually engraved in a certain part of the physical body, which becomes significant in performing a very specific function once the proper co-functionator is given. The function this code-script performs is twofold. First, it enhances the replicating performance of the individual in producing new individuals of its own kind, including the specific detail of its code-script; and second, it helps to maintain the individual in a "functioning"—that is, a living—state. As we have seen, these functions can only be performed in the context of some very specific external conditions which I have called the co-life of the individual.

The biotic individuals characterized above can exist in many different modes and levels. Auto-catalytic individuals with a code-script that are located in variable environments should perform their functions with variable degrees of efficiency, and therefore the replications made are inevitably differential. This possibility of differential replication is essential for the evolution of individuals themselves. Once such a possibility is allowed, evolutionary pressure will drive the individuals toward steadier and tighter association with their immediate co-functionators, since such association will greatly increase their survival value. The resulting composite system, the original individual and its immediate co-functionator, becomes a new entity which also has all the characteristics of an individual. A genome forming a cell around it might be a typical example of such a case.

This process of composing new individuals can be repeated again and again, resulting in many levels of more and more inclusive kinds of individuals. The composite individuals formed by this process inevitably vary widely in many respects: in shape, extension, cohesiveness, lifetime, and so on. It might be convenient, however, to classify them into two broad categories: replicators and subsistors.

Individuals classified as replicators are primarily units of replication. A unit of replication can be identified by comparing its structure with that of its immediate progenitor. If the structure including the code-script is sufficiently similar to or identical with that of the progenitor, we can classify it as a replicator. The gene in the cell is the best example of this kind.

On the other hand, individuals classified as subsistors are mainly units of subsistence. The most conspicuous characteristic of this kind of individual is that it makes a rather abrupt transition from a living state to a non-living state. The birth and growth of an individual of this kind is usually gradual, and the extension of its existence is sometimes difficult to recognize, but the process of demise is generally abrupt and sharp. Observationally, therefore, subsistors can be regarded as the units of demise. Cells and organisms exhibit more of this characteristic than do replicators.

The distinction between replicators and subsistors really represents only a matter of degree. The individual classified as a replicator must also maintain its subsistence as an individual, and the individual classified as a subsistor usually has some mechanism to help produce individuals similar to itself. A gene, for instance, replicates itself and also maintains itself, depending heavily on its co-functionator; so do cells and organisms with their respective cofunctionators.

It should be noted that the existence of such individuality might be a necessary condition for global life to flourish in variety and richness. Recognizing that an individual can be both a unit of replication and a unit of demise is very important for understanding how global life can flourish through these individuals. The individuals, as units of replication, can be produced at ease and with some redundancy and, being the unit of demise, can be diminished naturally and without much damage to the overall global life. The subsistence of each individual depends vitally on its co-life and hence on the global life, but the global life itself depends only marginally on any particular individual. This asymmetrical pattern of mutual dependence between global life and individual may provide the secret for the flourishing of global life by means of individualization. If we imagine a successful living world without the individuals composing it, the only conceivable structure is a giant organized system without any discernible units. Such a structure—if it happened to be formed—would be extremely insecure, because any slight malfunction of a minor part could damage it irreparably.

Human Being and Global Life

Since a human being is an organism and a biotic individual of the kind considered above, the relationship between a human being and global life can only be regarded as a special case of the more general relationship between an individual and global life. A human being cannot be a genuine unit of life but is just one of the ephemeral individuals forming the mode of existence for global life in the evolutionary process. It is granted the status of life only in association with the co-life, which is the specific remainder of global life for that particular individual.

On the other hand, the human being, either as a particular organism or collectively as a particular species, is a very special individual in the sense that it has the power to extinguish global life technically and also the capacity to comprehend it intellectually. Therefore, the relationship between human being and global life deserves special attention.

In one sense, this relationship is not a static one completely fixed by external conditions but a rapidly developing one with a great degree of flexibility on the part of the human being. Two aspects of this relationship are vitally important for the fate of global life and of humanity as well. These aspects can best be illustrated by similes derived from a lower-level world, namely, the relationships between certain subhuman individuals and the human body. One of these is the relationship between cancer cells and the host body, and the other is the relationship between neural cells and the human body.

Human beings, like cancer cells, have a tendency to colonize the living world, that is, the body of global life, and transform it for the sake of their own prosperity and generativity. On the other hand, human beings, like neural cells, can also function as agents for all kinds of information processing that may help secure the subsistence and flourishing of global life. These two aspects of humanity in relation to global life are contradictory in the sense that they lead to opposite destinies for global life. As is well known, the colonization of cancer cells on the host body is fatal not only to the host but eventually to the cancer cells themselves. Neural cells, on the other hand, are generally helpful for the survival of the host body and perform quite sophisticated activities for the higher order development of a host organism such as a human being.

The crucial factor deciding the fate of global life—a cancerous situation or a healthy higher-order progression—is therefore the human role in the world of life. I do not believe that any sane human being would deliberately take the cancerous role once he or she fully comprehended the whole picture of humanity's relation with global life. But the capacity to comprehend it might be either severely limited or not yet fully utilized.

I conclude, therefore, that the most important and urgent matter facing humanity is to comprehend our position and role in global life and to examine whether we have taken the right path. One criterion for making that assessment is the perspective we will take toward our co-life. If we interpret it only as our "environment" in the conventional sense, we very likely will have chosen to continue spreading ourselves like a cancer.

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