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Life-Functional Theories of Life

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Introductory Comments

On a beautiful fall day in 1990, my wife, my daughter, and I went for a walk on a very pretty hill near our home. As we were coming down the hill, I noticed a garter snake by the side of the path. I pointed this out to my wife and daughter. The snake was quite motionless. My daughter asked, 'is it alive?' I nudged the snake with the toe of my shoe. It did not move. I suspect that it was dead.

Imagine a scene at NASA headquarters. Suppose some TV images are being received from the Viking Lander which has landed on Mars. Suppose that a blurry object is seen in certain of the pictures. The object looks something like a colony of lichen or fungus growing on some rocks. On the other hand, it might just be some dust, or perhaps a discoloration on the surface of the rocks. The NASA engineers are fascinated. One asks, ‘Do you think it might be alive?’ Another answers, ‘No, that’s not alive. It’s just a patch of mineral discoloration on the surface of those rocks. There are similar rocks on earth.’

Imagine a trip to Disneyland. A small child is amazed by a roaring, tooth-gnashing, lifelike robot dinosaur. He fears that it might be real. He asks his parents whether the dinosaur is alive. They assure him that it is only a machine. It is not alive.

Imagine a high school biology class. A cold, limp frog lies on the lab table. The students gather around. The instructor attaches two wires to the frog. The other ends of the wires are attached to small battery. When a switch is closed, the frog twitches. The students are startled and some jump back. One student asks whether the frog is alive. The instructor explains that the frog is not alive, but electrical stimulation of the nerves in the big leg muscles still make the muscles contract. That’s why the frog moved.

In all these cases, and in countless others relevantly like them, someone uses the word ‘alive’. When they ask these questions, or make these assertions, the speakers presumably take themselves to understand what they have said. Others — the ones who hear their questions or statements — presumably also take themselves to understand what has been asked or said. They think they understand what the word ‘alive’ means.

Of course, if we look at the matter from a certain perspective, the presumption is true enough. We all know how to use the word ‘alive’, and we all have some vague grasp of some of the ways in which living things.
commonly differ from nonliving ones. However, if we look at the matter from another perspective, I think we have to conclude that we don’t know what ‘alive’ means. More exactly, my point is that none of us can give a clear and precise account of what the word ‘alive’ means. Strictly, then, I think we do not know precisely what we mean when we ask whether something is alive, or when we say that something is alive. I think none of us has grasped the concept of life explicitly.

Many philosophers and biologists have attempted to explain what ‘alive’ means. I will not attempt in this paper to discuss all the views that have been proposed. There are too many of them. Instead, I will focus on a few members of one influential family of such accounts. These accounts have this in common: in each case, it is alleged that we can explain what we mean when we say that something is alive by mentioning something about some so-called “life functions.” Thus, I will be discussing some life-functional explanations of life.

A Distinction

In order to make my topic clearer, I should distinguish it from another topic with which it may easily be confused. There is, on the one hand, an empirical, scientific question about the common properties distinctive of actual living organisms here on earth. To find the answer to this question, one would have to identify all the main kinds of living things on earth, and one would have to examine them closely to discover whether there is in fact some feature they all share. One would then have to consider whether these features are distinctive of living things. In other words, one would have to determine that only living things have the common features.

Suppose some microbiologist discovered that all and only actual living things on earth have certain microbiological features X, Y, and Z. She could then say that all and only living things here on earth have features X, Y, and Z. That might answer this biological question. But note that such a claim would at best be contingent. No matter what X, Y, and Z might be, even the microbiologist would admit that it is still possible that there might be living things elsewhere that lack X, Y, and Z. The microbiologist surely would also admit that if life on earth had evolved in some other way, living things here might have lacked X, Y, and Z. So the answer to this first question is at best empirical, contingent, and restricted to “life as we know it”.

I mean to be discussing a much more fundamental question. My question is not a question in biology, to be answered by careful study of actual living things here on earth. My question is a question about the concept of life itself. It is a philosophical question, rather than a biological one. A satisfactory answer to my question would not be contingent or empirical. It would be a necessary truth, telling us something about the
concept of life itself. Those raised in the analytic tradition might hope that the answer to this question would appear in the form of a philosophical analysis of the concept of life, or a definition of ‘x is alive at t’. Of course, it is not essential that the answer should take precisely this form. It is the content of the answer, not the form, that matters.

Suppose we decide in the end ‘alive’ means ‘has features A, B, and C’. If this account of the meaning of ‘alive’ is correct, then not only on earth, but everywhere in the universe, things that are alive must have features A, B, and C. Furthermore, if the account is correct, then there is no conceivable way in which evolution could have progressed in which living things would have lacked A, B, and C. This is not shocking. For, if the account of meaning is correct, then, when we say that these things would have been alive, all we mean is that they would have had features A, B, and C. Obviously, then, there couldn’t be a living thing without the specified features.

So my question will not be answered by some contingent, empirical statement about living things as we know them. It will be answered by a necessary, conceptual statement about living things, of whatever possible sort.

**Why Ask This Question?**

There are several independent reasons for taking this question seriously. One of these concerns the status of biology as a unitary science. Traditionally, biology has been defined as the science of life. The main thing that ties all branches of biology together is that they are all various ways of studying living things. If it should turn out that living things have nothing in common, then biology would lose its claim to be a single science.

A second reason to enquire into the nature of life itself is prompted by recent interest in exobiology. When NASA designed a space probe to search for life on other planets, they did not design the probe merely to react to “life as we know it”. The probe had to be designed in such a way as to recognize life even in forms quite different from those with which we are familiar here on earth. NASA engineers obviously recognized that life itself is not restricted to the earthly forms. Living things might appear in all sorts of forms — some might even be so bizarre that no one at NASA could anticipate their details.

I can imagine some NASA engineers puzzled about their project. “We want to design a probe that will react to life in whatever form it might take. We can’t anticipate the details of all possible forms. So what are we looking for? What do we mean when we say we are looking for life?” Thus, an interest in exobiology might provoke an interest in our philosophical question.

A third possible reason to be interested in life is a moral reason. Some
think that there is a moral reason to respect life; that living things have a special sort of value. Surely it would be mere planetary chauvinism to accord this value only to life as we know it on earth. If life itself is valuable, then life of all sorts — even sorts we cannot imagine — is valuable. So if we think that life itself is valuable, we may want to enquire into the nature of life. If we don’t know what life itself is, then this moral doctrine is to a certain extent empty. We say that living things are valuable, but we don’t know precisely which things we are thereby praising.

My own view is that the enquiry into the nature of life needs no justification. Philosophers enquire into the nature of knowledge, causation, beauty, obligation, justice, etc. Since the concept of life is at least as interesting and important as these other concepts, it is appropriate that philosophers seek to understand it, too. The search need not be premised on some pragmatic payoff. Of course, if there is a further, pragmatic justification for our enquiry, then so much the better. My point is that the enquiry needs no such justification. Like all serious philosophy, it is intrinsically worthwhile.

In any case, let us turn to some proposed answers to our question about the nature of life.

**Life Functionalism**

If you turn to the first chapter of a typical high school or college biology textbook, you will almost certainly find a discussion of our question. And in virtually every case, the question will be answered by appeal to a list of “life functions”. So, for example, in Chapter One of my younger daughter’s 10th grade biology textbook, we find a list mentioning these life functions:

1. Nutrition - converting materials from the environment into forms the organism can use.
2. Transport - moving usable materials from one part of the organism to another.
3. Respiration - releasing chemical energy from nutrients.
4. Synthesis and assimilation - combining simple substances so as to make more complex ones.
5. Growth - increasing in size.
7. Regulation - maintaining a stable internal environment.
9. Metabolism - seems to be a combination of 1, 3, 4.

In the first chapter of my older daughter’s college level textbook, we find a significantly different list. In answer to the question, “What characteristics do all living things have in common?”, the authors of that book say:
... all are chemically complex and highly organized. All use energy (metabolize), organize themselves (develop), and reproduce. All change (evolve) over generations. So far as we know, no nonliving thing possesses all these attributes. In addition, and perhaps most important, only the living organism has a set of instructions, or "program" resident in its genes, that directs its metabolism, organization, and reproduction, and is the raw material upon which evolution acts.

In Ernst Mayr's *The Growth of Biological Thought*, there is a section entitled "Special Characteristics of Living Organisms." Mayr asserts that 'the process of living can be defined.' He proceeds to mention a number of characteristics that, according to him, 'are not or not in the same manner found in inanimate objects.' His list includes the following items:

1. Complexity and organization.
2. Chemical uniqueness - the chemical characteristics of living things are different from those of nonliving things.
3. Quality - living things have properties, and stand in relations that 'can be expressed, in most cases, only qualitatively, not quantitatively.'
4. Uniqueness and variability - no two living things are exactly alike; each one changes through time.
5. Possession of genetic program - 'All organisms possess a historically evolved genetic program, coded in the DNA of the nucleus of the zygote (or in RNA in some viruses).
6. Historical nature - species are organized by common descent, rather than by similarity.
7. Natural selection - has no exact equivalent among processes of change in the inanimate world.
8. Indeterminacy - living things often display emergent characteristics, that could not have been predicted on the basis of their previous states.

I find a certain feature of these three lists astonishing. In order to make this feature more obvious, I have constructed a chart that presents a condensed formulation of the information contained in the lists. In the chart, 'S&S' indicates Schraer and Stoltze, 'K&G' indicates Keeton and Gould. An 'x' indicates that the author mentioned at the top of the column claims that the life function at the left of the row is partially definitive of life.
<table>
<thead>
<tr>
<th>Function</th>
<th>S&amp;S</th>
<th>K&amp;G</th>
<th>Mayr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiration</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synthesis</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excretion</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproduction</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Metabolism</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complexity</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Development</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evolution</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programmed</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chem. Unique</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Quality”</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Uniqueness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hist. Nature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indeterminacy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Even this very brief glimpse of just three respectable texts in biology should make one fact clear. Modern life-functionalists are in wild disagreement about which properties are the life functions. Schraer and Stoltze agree with Keeton and Gould on **two** items; they disagree on **eleven**. The list provided by Mayr contains **eight** items. Not **one** of these appears in the Schraer and Stoltze list. Only **three** appear in the Keeton and Gould list.

Another puzzling feature of these lists is this: each of the authors cited suggests in some passages that each of the relevant life functions is necessary for life, and that they are jointly sufficient. However, each of the authors also remarks that there are borderline cases, and that there are exceptions. So, it is not clear that any of these authors was in fact attempting to answer our question. Indeed, in light of the remarks about exceptions and borderline cases, it is not entirely clear what question they were trying to answer.

Perhaps it would be a good idea, then, to begin at the beginning. Let us start by considering one of the oldest and most distinguished versions of the life functional approach. This is the version presented by a man who was both the first great biologist and one of the first great philosophers — Aristotle.
Aristotle's Life Functionalism

Although different texts suggest different lists, Aristotle seems to have recognized the following main life functions:

1. Nutrition: the capacity to get food, absorb it into oneself, and thereby to grow. Surprisingly, Aristotle maintains that nutrition is inseparable from reproduction; that these are both functions of the same "soul" — the nutritive soul. "Nutrition and reproduction are due to one and the same psychic power." Reproduction is the capacity to produce offspring. Aristotle maintains that the capacity to engage in nutrition is the most basic and widely distributed life function. His view seems to be that every living thing, plant or animal, has this capacity; no nonliving thing has it. Thus, apparently according to Aristotle, a thing is alive if and only if it can engage in nutrition and reproduction.

2. Sensation: An organism has sense if it is capable of receiving into itself the sensible forms of things without...." This capacity operates in two different modes. Certain senses (touch and taste) operate on objects that are in contact with the organism. Aristotle seems to have believed that all animals have the capacity to engage in this "immediate sensation". Plants, however, do not have it. The second mode of sensation involves the perception of objects that are not in direct contact with the organism. Sight, smell, and hearing are the instances of this mediate form of sensation. Aristotle claims that these senses are not found in every sort of animal, but only in animals that can move. He apparently felt that there would be no point in giving sight, for example, to a fixed animal such as a barnacle. After all, even if the barnacle could see a tasty bit of food a few inches away, it would not be able to do anything about it. Having sight would not improve the well-being of a barnacle. Hence, nature did not give barnacles eyes.

3. Motion: An organism has "the locomotive soul" provided that it is capable of moving itself from place to place. Aristotle apparently held that the locomotive soul is always found in conjunction with the sensitive soul. Stripped of its soulful terminology, the claim amounts to this: a creature can move itself about if and only if it can see, hear, or smell.

4. Thought: some organisms are able to think. This includes people, and perhaps some other rational beings. (Aristotle says that this sort of "rational soul" is 'capable of existence in isolation from all other psychic powers.' Perhaps he is thinking of gods. There seems to be a slight tension between this remark and his later remark that 'the nutritive soul then must be possessed by everything that is alive..." Perhaps he means to say this: among mortal beings, the nutritive soul is universal. If we include immortal beings, we find instances of things with rational souls but without nutritive souls.) Aristotle maintains that 'of the psychic powers above enumerated, some kinds of living things, as we said, possess all, some less than all, others one
only. If we simplify slightly, and emphasize certain texts rather than others, we can present the outlines of Aristotle's view in a chart:

<table>
<thead>
<tr>
<th></th>
<th>Plants</th>
<th>Fixed Animals</th>
<th>Beasts</th>
<th>People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Reproduction</td>
<td>Yes*</td>
<td>Yes*</td>
<td>Yes*</td>
<td>Yes*</td>
</tr>
<tr>
<td>Near Sensation</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Far Sensation</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Motion</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Thought</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

A few comments may be in order. First, it is important to recognize that Aristotle views nutrition and reproduction as functions of the same "soul" — the nutritive. Furthermore, he explicitly acknowledges that there are many cases in which individual plants and animals are incapable of engaging in reproduction. Thus, I have asterisked the 'yes' in each occurrence concerning reproduction.

While the chart is surely suggestive, it does not yet constitute an answer to our fundamental question: 'What is Life?' One natural answer, based on these Aristotelian ideas, would be this:

**LF1:** $x$ is alive at $t = \text{df. } x$ is able to perform at least one of the life functions at $t$.

It seems to me, however, that there are very serious problems for LF1. One of these problems concerns motion. If we understand motion in a straightforward manner, we will have to say that any mechanical device that is capable of setting itself into motion displays this sort of life function. As a result, LF1 seems to imply that natural objects such as tornadoes and volcanoes, as well as artifacts such as alarm clocks, robots of various sorts, automatic lawn sprinkling devices, etc. are all alive.

Reproduction raises some interesting puzzles, too. Consider a dead tomato plant hanging forlornly in the frozen garden of some careless gardener who forgot to clean up after the fall frosts. That plant surely is not alive. Yet, there are seeds in the shriveled tomatoes. When spring comes, those seeds may germinate, giving rise to a whole flock of baby tomato plants. My question is this: is the tomato plant capable of performing the life function called 'reproduction'? If so, then LF1 implies that it is still alive. If not, then how can this be squared with the fact that it still has the capacity to produce a flock of seedlings in the spring?

Aristotle himself seems to have been particularly impressed by the apparent universality of the nutritive soul. In a widely quoted passage, he says:
This [the power of self-nutrition] is the originative power the possession of which leads us to speak of things as living at all...

And in another just a few paragraphs later we find:

... first of all we must treat of nutrition and reproduction, for the nutritive soul is found along with all the others and is the most primitive and widely distributed power of soul, being indeed that one in virtue of which all are said to have life. The acts in which it manifests itself are reproduction and the use of food...

On one interpretation, Aristotle might be taken to be maintaining this view about life itself:

LF2: \( x \) is alive at \( t \) =df. \( x \) is able to engage in nutrition and reproduction at \( t \).

Obviously, however, this won’t do. As Aristotle himself pointed out, very many living things cannot engage in reproduction. He cites three sorts of cases in which living things lack the capacity to reproduce. Some cannot reproduce because they are too young. (I suppose we could add that some cannot reproduce because they are too old.) He goes on to mention organisms that are “mutilated”. Finally, he mentions organisms whose mode of reproduction is spontaneous. Aristotle seems to have thought that some creatures are produced by spontaneous generation, and don’t have to bother with reproduction. Be this as it may, the first two points are surely conclusive. Lots of things cannot engage in reproduction even though they are alive. Thus, LF2 is clearly wrong.

We could modify LF2 merely by deleting the second conjunct. This would yield:

LF3: \( x \) is alive at \( t \) =df. \( x \) is able to engage in nutrition at \( t \).

Aristotle devotes several pages to his discussion of nutrition. He presents a fascinating discussion of the analysis of the concept of “food”, and he talks about the nature of growth. In the end, however, stripped of complexities, his view seems to be this: a creature can engage in nutrition at a time if and only if it is able at that time to acquire some food, absorb that food and make it part of itself, and as a result, grow and have the energy needed to do what needs to be done.

By way of criticism of LF3, I here quote at length a moving passage from *The Nature of Living Things* by C. Brooke Worth and Robert K. Enders.
Worth and Enders have been describing an experiment with a cecropia moth. Shortly after the moth emerged from its pupal shell, Worth and Enders tied a string around its waist and placed it outdoors where a male could find it. According to their account, a male did find the moth:

Copulation lasts through the day. In the evening we untether the female and put her in a shoe box for an hour or so. By this time she has laid fifty eggs. So we let her go. For the next few nights she will lay the rest of her eggs, some two or three hundred, on various trees. What then? Already her gorgeous wings are a bit tattered. Her abdomen has shrunk and she is beginning to tremble. But naturally! She has been so busy that food has been forgotten. Now she is faced with tragedy greater than one would suspect. For her entire race has forgotten about food. The caterpillar’s digestive tract, taken to bed in the pupa’s interior, was completely demolished during moth formation, but no substitute was provided. So here flits the cecropia, completely absolved of her responsibilities to posterity, but unable to taste the rewards of accomplishment. No mouth, no stomach — only a small additional reserve of stored energy. The moth flies about bright lights for a few evenings more but then falls ragged and quivering to the ground, where ants slowly extinguish the rest of its waning life.12

The case of the cecropia moth demonstrates, I think, that a creature can be alive at a time even though it is not then able to engage in nutrition. Other examples come to mind. While undergoing abdominal surgery, a person’s digestive system might be temporarily detached and “shut down”. Furthermore, the patient himself might be unconscious and paralyzed. Though the patient is clearly alive, he cannot acquire any food (because he’s paralyzed and unconscious) and he cannot absorb any food (because his intestines are detached). As it stands, LF3 is unsatisfactory.

It should be obvious that we cannot modify LF3 in anything like this way:

LF3: x is alive at t =df. either (i) x is able to engage in nutrition at t, or else (ii) x was able to engage in nutrition at some time earlier than t.

The problem with LF3’ is that nearly every dead organism satisfies the second disjunct of the definiens. Corpses are nonliving things that formerly were able to engage in nutrition.
It seems clear, then, that Aristotle’s version of the life-functional approach suffers from some pretty serious problems. Perhaps two thousand years of biological research has provided the basis for a more plausible formulation. Let us therefore consider some typical modern examples of the life-functional approach to the analysis of the concept of life.

Some Modern Life-Functional Analyses of Life

In Philosophy: An Introduction to the Art of Wondering, James Christian says:

At present, it appears that “life” can be defined with two qualities: self-replication and mutability. Any organism possessing these two qualities can be considered alive. In these two characteristics is contained the essential processes of evolution: continuity and adaptation. ... But mutability — the ability to effect changes from one generation to another and adapt to a fluid environment — is essential. Without the ability to change and adapt no species could long survive. Environmental conditions are forever changing; species must be able to change along with their environments. So far as we know, only living organisms have these two qualities, and an organism must possess both qualities to be considered alive.23

Since Christian is a philosopher, and not a biologist, it might seem that his views are not worthy of consideration here. Thus, it is interesting to compare Christian’s view with a view presented in a college-level biology textbook written by my good friend, Richard Goldsby. Goldsby is a respected biologist. Goldsby mentions the exobiologists at NASA and their reflections on the nature of life. Goldsby reports:

These scientists have tried to reduce the functional definition of life to the most simple, general, and abstract criteria. Their conclusion is that only two characteristics distinguish living entities from inanimate nature: the ability to reproduce themselves, and the means of producing and perpetuating genetic variations among the offspring.24

Goldsby goes on to claim that this very abstract definition of life has certain corollaries. In order to reproduce, an organism has to stay alive at least for a little while. This requires metabolism (the ability to “absorb, transform, and use material from the environment”) and adaptation (the
ability to make useful, genuinely “homeostatic” responses to changes in the environment. Christian also mentions these other life functions along with a few others, but it isn’t clear that he views them as “corollaries” of the core definition.

Thus it appears that NASA (at least according to Goldsby) and Christian would agree that life itself can be defined as follows:

\[ \text{LF4: } x \text{ is alive at } t = \text{df. } x \text{ is able to reproduce at } t \& x \text{ is able to produce and perpetuate genetic variation among offspring at } t. \]

The influence of Charles Darwin is obvious in this account of life. As both Christian and Goldsby point out, this analysis of the concept of life very naturally leads to the conclusion that living things will be able to evolve as their environment changes (so long as the environment changes at a suitable rate, and the mutations occur at a suitable rate). In virtue of this emphasis, this sort of analysis is sometimes called “the genetic analysis of life”. It is nowadays quite popular with philosophers and biologists.

Nevertheless it is clear that, as it stands, LF4 won’t work. As we have already noted, lots of living things are unable to reproduce. In some cases, infertility is only temporary, but in other cases it is permanent and life-long. Among ants and bees, for example, many living individuals are permanently sterile. The same holds true for certain hybrids, such as mules. Obviously, if a thing can’t produce offspring at all, then it surely cannot produce offspring manifesting genetic variations from itself. Thus, each conjunct of the the proposed analysis of life is clearly too narrow, and the analysis itself fails.

Two-tiered Views

One natural modification of LF4 suggests itself. We must distinguish between the concrete, individual organism (“this particular mosquito - the one that just bit my ear”) and the species (in this case, I suspect, *Culex pipiens*). Living individuals may be unable to reproduce. But, as a number of authors going back to Aristotle have remarked, a viable species must have some standard method (or methods) of reproduction. Typical adult, unmutilated instances of the species generally reproduce in the method standard for the species.

In the case of variation, the focus on the species rather than the individual is even more obvious. It makes virtually no sense to say that an individual mosquito undergoes genetic variation from generation to generation. The individual has the same genetic makeup throughout its existence, and is a member of exactly one generation, no matter how long it lives. However, it does make sense to say that a species undergoes genetic variation from generation to generation. Roughly, what this means is that
individuals of one generation are genetically different from individuals of
other generations.

In order to simplify our discussion, let us introduce some convenient
abbreviations. We can say that a species is *reproductive* just in case there is
a method of reproduction such that typical members of that species
reproduce by that method. Thus, the ameba is reproductive because
typical members undergo fission; the tomato is reproductive because
typical members produce viable seeds; the lion is reproductive because
males inseminate females who then carry their cubs to term; etc. Going
beyond this, we can say that a species is *variably reproductive* just in case it
is reproductive, and furthermore individuals of one generation are capable
of producing offspring that manifest small genetic differences from their
parents. We need not attempt to define what is meant by ‘small’ genetic
differences.

Making use of these abbreviations, and taking note of the distinction
between species and individuals, we could replace LF4 with:

\[ \text{LF5: } x \text{ is alive at } t = \text{df. } x \text{ is a member of some variably reproductive species at } t. \]

The advantage of LF5 over LF4 is clear. Immature, “mutilated”, and post-
reproductive individuals are not counterexamples to LF5. Such individuals
are counted as living, not because they can reproduce, but because they
are members of reproductive species. Furthermore, sterile ants and bees
also count as alive on LF5, since they are members of variably reproductive
species. Their own sterility is here irrelevant. Unfortunately, a moment’s
reflection will reveal that LF5 casts the net of life much too widely. It
correctly counts the senile as alive; it incorrectly counts the deceased as
alive. A dead chicken is still a chicken; it is still a member of a variably
reproductive species. LF5 therefore tells us that each such chicken is still
alive.

Someone might insist, as a sort of desperate defensive maneuver, that a
dead chicken is really not a chicken. Such a person might claim that the
corpse of a member of a species is not itself a member of that species. This
seems to me to be wrong. If we reflect for a moment on the activities of
taxonomists, its wrongheadedness will become even clearer. The typical
entomological taxonomist, for example, does virtually all of her work with
dead specimens. She sorts individuals into species — but the individuals
are rarely living. She points to her cases of dead butterflies and says, ‘This
is the Monarch; that is the Viceroy. Notice the difference in the pattern.’
If the current proposal were correct, the taxonomist would be wrong.
Strictly speaking, there would be no Monarchs or Viceroy’s in her case.
Only a dedicated philosopher could say such a thing with a straight face.

This sort of approach gives rise to further profound difficulties. Perhaps
the most intractable of these is this: LF5 makes use of the notoriously
obscure concept of "species". In order to make LF5 fully satisfactory as a philosophical analysis of the concept of life, we would have to give some account of the concept of species, and that would be a most difficult task. However, if we insist on altering our concept of species in such a way that, as a matter of conceptual necessity, each species contains only living members, then the task becomes vastly more difficult. Furthermore, as should be pretty obvious, the task presupposes a solution to our present problem. In order to define 'species', we would have first to define 'alive'.

**Conclusion**

In spite of its magnificent pedigree and its popularity, it seems to me that the life functional approach to the analysis of life is unsuccessful. I see no satisfactory way to define life by appeal to some set of life functions. This leaves open some very baffling questions: precisely what is it that makes biology into one unified science? precisely what is it that life-seeking space probes are looking for on other planets? (for those who think that life is sacred) precisely what is it that you think is sacred?

The rest of us — who are neither exobiologists nor committed to the sacredness of life — still confront this question: precisely what do you mean when you say that something is alive? Can you give a clear account of precisely what my daughter meant when she asked whether the garter snake was alive? My hunch is that none of us can do it.

**Notes**


5. Ibid.


13 ibid.


17 This chart is derived from one presented by Thomas S. Hall in his Ideas of Life and Matter, (Chicago: University of Chicago Press, 1969), Volume 1, 109.

18 Aristotle, De Anima, 415a27.


