The Nature of LIFE

by **Reik Oberrath**

The Nature of LIFE

An focus on its scientific essence and a thought work about its theoretical description

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To my wife and my son,

they make my life worth living.

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To my mother and sister,

they contributed essentially to my life in the past.

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To my friends,

the conversations with them helped me greatly thinking about life and writing this book.

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To my Ph.D. supervisor,

she taught me during my academic life to look at the big picture.

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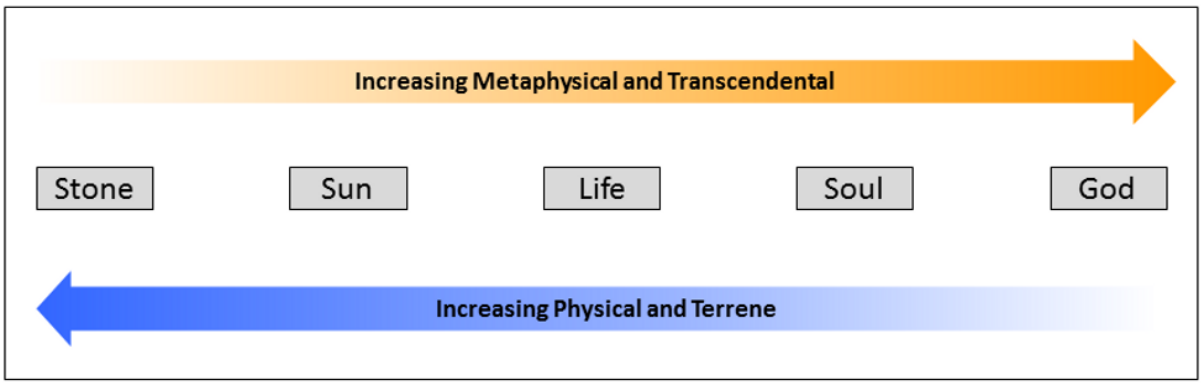
Preface

One aim of this book is to suggest an understanding of the term *Life* that may be acceptable and usable in a general way. A second aim is to summarise and recapitulate some general information about the phenomenon *Life*. You may agree to some of the statements of this book or you may not, but if it makes you thinking about the nature of life, then, writing it was worth its effort. The first five chapters are of a rather abstract nature and contain a number of different definitions as well as general descriptions of life. The last five chapters are of a more concrete nature and discuss a variety of different aspects of live. At the very beginning, however, I would like to address the following two questions.

Firstly, does it basically make sense to define the term *Life* in a general, objective way? The opinion exists that doing so is not a good idea. I think there are several reasons for this opinion.

a) We associate the term *Life* with a certain mystery and fascination, as we do for other terms as well, such as *Soul* or *God*. I think these associations have the same cause: all these terms are metaphysical and have a very personal meaning. However, different terms are metaphysical to different degrees as shown in the figure below. You may argue about the examples used there and you may find better examples for the gradients explained, but I think you will understand the basic statement: the term *Life* has two characteristics in medium degree: a metaphysical and a physical. In its physical characteristic it can be studied, analysed and described scientifically. In its metaphysical characteristic it may be better viewed by the means of humanities.



Terrene-Transcendental-Gradient with 5 arbitrary examples of different degrees.

b) Borderline cases are typical for many biological categories, mainly for phylogenetical ones. Such categories, formulated as definition or not, are cupboards in the intellectual world of human beings. There will always be cases that do not fit into existing cupboards: the borderline cases. However, they do not take sense and usefulness from building categories. In contrast, they are helpful reminders, that our categories are only an attempt to reflect reality, and that reality

itself is something else, something more complex. The existence of borderline cases must not be a reason to avoid defining terms. A meaningful communication without definitions is hardly imaginable.

c) What would be the benefit of a common understanding and definition of *Life*? Probably not much. Obviously, teaching and research of life sciences and biology does well without. However, I wonder how such a huge amount of teaching and research in very different disciplines such as e.g. botany, neurobiology, biomechanics, genetics, socio-biology, ecology, medicine… can be hold together by a thin band consisting of no more than a couple of phenomena. For a better interdisciplinary collaboration and mutual understanding between life scientists as well as comprehension for each other, it may be helpful to share solid common ground: a concept of life in which all life scientists find their intellectual root.

d) A definition for a term does only make sense, if you understand the circumstance, the concept, which is named by this term. Currently, scientists of all disciplines do not have something like a theory of life, a general concept or commonly agreed idea what life actually is. This means, that we currently use of the term *Life* without a concrete or precise perception what we mean by it. Therefore, as soon as someone reckons to see a common concept in the various phenomena of life, then I think, trying to formulate a definition is highly appreciated.

Secondly, is it fundamentally possible to define the term *Life* in a commonly valid, objective way?

30 years ago when I was studying biology, I was taught that there is no definition of the term *Life*. The best scientists can do, is to list attributes that can be associated with life[1]. On the first glance that sounded plausible to me, because life is such a complicated thing. This statement remained logically to me also on the second glance: we know only one kind of life - the one of the biosphere of Earth. In contrast, science does know many different forms of mammals. There are mammals with and without fur, teeth and legs. There are ground bound, sea living and flying mammals. There are even mammals that lay eggs. Because zoologists know so many different kinds of mammals, they can precisely tell which the key attribute is that all mammals feature: they lactate their offspring. Unfortunately, biologists do know only one kind of life and, therefore, it is impossible for them to tell which of the attributes is essential for life. Possibly, scientists will not recognize exotic life if one day they meet lifeforms in a very different form than Earth life. Thus, to describe life, we cannot do better than to simply list attributes that are typical for animated beings, can we?

On the third glance, however, there may be indeed a way to conceive the very nature of *Life*. I like to put a new view into discussion that may lead to a better understanding of *Life*. It will not, of course, clear all the questions about life, but it may provide a generally acceptable and useful understanding and definition. Before I explain my idea, I would like at first to define the term *definition*, because definitions are the spine of this book and I want to make clear, how difficult it is to formulate a good definition especially for such a complicated thing as *Life*.

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[1] http://en.wikipedia.org/wiki/The_Seven_Pillars_of_Life

(Dear reader, you may imagine that the following chapters are rather theoretical. Right! The first part of this book represents a kind of mind gymnastics. If you don't care much about definitions and abstract stuff, then, please, go ahead with chapter 6.

1. How to define the term *definition* ?

The first two of the following three definitions use a metaphor to illustrate the concept of a definition. A definition is a wall of words built to isolate a specific meaning from other meanings and from nonsense. Both definitions have the same shortcoming: they are too narrow because they only catch one of two important aspects. Definition 1.3 may be preferred because it combines the aspects of definition 1.1 and 1.2: a definition represents both a term and the idea behind this term (see also Figure 1.1).

Definition 1.1

A definition is the fencing of an *idea*[1a] made by a wall of words (clarification of a circumstance).

Defintion 1.2

A definition is the fencing of the meaning of a *term*[1b] made by a wall of words (terminology).

Defintion 1.3

A definition is a statement, that simultaneously represents both an *idea*[1a] (clarification of the circumstance) and the meaning of the *term*[1b] that stands for this idea (terminology).

1a An idea is the conception of a circumstance within the human mind.

1b A term is a name for an idea[1a], respectively for the circumstance behind this idea.

These definitions are illustrated in the following figure:

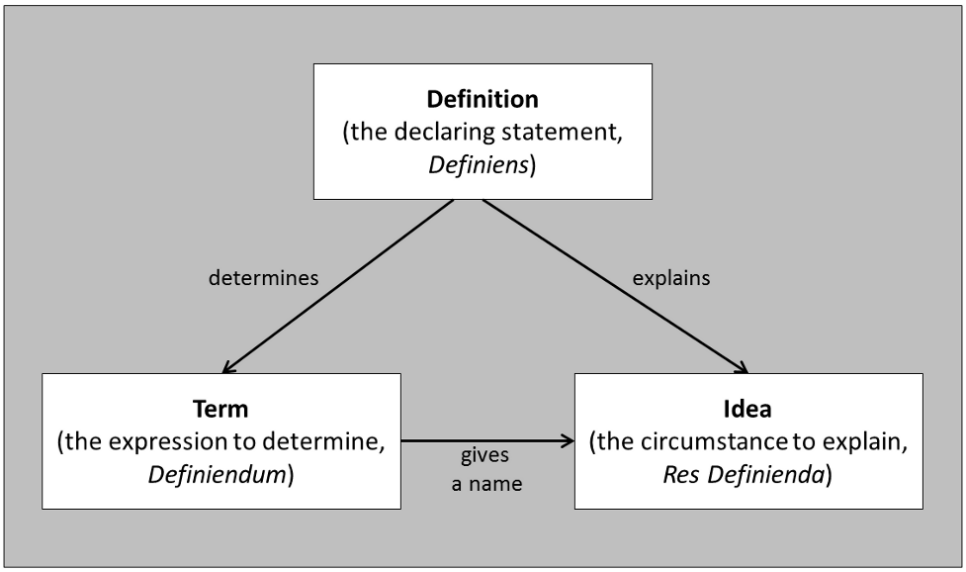

Figure 1.1: Relationship between a circumstance perceived, a term to name this circumstance and a definition to explain both.

When searching for a definition of life, a number of statements can be found on the internet, e.g.

Definition I: Life is "the period between birth and death."[2]

This definition uses terms which only have a meaning if you already know what life is. The gain of this definition may be that life is not infinite. However, no ancestor of any living unicellular organism died, because these organisms undergo cell divisions and do not decay. In addition, this definition implies that embryos do not live.

Definition II: Life is an "organismic state characterized by capacity for metabolism, growth, reaction to stimuli and reproduction."[3]

Here, the approach is applied to list attributes associated with life. However, life is not a state. To be alive is a state and life is the process that keeps alive.

Definition III: Life is "the condition that distinguishes organisms from inorganic objects and dead organisms..."[4]

In this definition life is explained by its opposite which is no help if you are searching for the very nature of life. The question remains unanswered what the essential difference between organisms and inorganic objects actually is.

Definition IV: Life is "a characteristic distinguishing objects having signalling and self-sustaining processes from those that do not."[5]

[2] http://dictionary.cambridge.org/dictionary/english-german?q=Life
[3] http://www.merriam-webster.com/dictionary/life
[4] http://dictionary.reference.com/browse/Life
[5] http://dictionary.cambridge.org/dictionary/english-german?q=Life

This definition is scientifically useful, but it calls life a characteristic of objects. This focuses on individual organisms and misses to consider the aspects such as the biosphere or evolution.

Definition V: Life is "a self-sustaining system capable of Darwinian evolution."[6]

This statement is known as the "working definition" of life used by the American space agency NASA. Although it is scientifically meaningful, it has its limitations - therefore called "working definition" by its originators. This definition calls life a system, but these animated systems (the organisms) are only the concrete implementation of life - they are alive - but life itself is a concept that is much larger. Individual organisms are not capable of evolution - they are very tiny parts of it.

These suboptimal examples illustrate how hard it is, to formulate a good definition for such a strange thing as life. The following chapters contain attempts to do better.

[6] http://www.evolutionnews.org/2013/07/gerald_joyce_de074891.html

Afterword

This book has two aims. Firstly, it suggests an understanding and definition of the term *Life* that may be generally acceptable and usable. The core statement is the one of chapter 3, respectively definition 3.1: life is the interaction between data processing and reproduction. Secondly, it summarises and recapitulates some general information about the phenomenon *Life* and draws some conclusions. One main conclusion is that life effectively is evolution with the inherent but undirected purpose to keep itself running (see chapter 10).

If you find my English far from being perfect, I will definitely not disagree. I have not written this book in my mother language in order to maximise the number of people that potentially read it. I am confident, however, that the meaning of my writing becomes clear enough to be understood. If you are an English native speaker who would like to review my formulations and wording, feel free to contact me.

Software developers usually follow a good practice when naming a release candidate: they set three single version numbers together. The first one is increased for a fundamental renewal, the second one for significant modifications such as meaningful additions and the third one for smaller changes such as corrections. I follow this best practise here, because my thoughts about this topic develop over time.

Current version: **v1.3.0**

For the current version a large number of corrections and improvements has been made in the existing chapters, but mainly, the new chapters 8 (*Artificial Life*) and 10 (*Life, Evolution and Purpose*) have been introduced. In addition, this eBook is no more optimized for the PDF format which should increase the readability of the epub and mobi format.

About the author

I started studying biology at the University of Tübingen in 1990. I did my diploma in 1996 after finishing my thesis about the colour change of flowers and its interplay with insect pollinators. From 1997 until 2000 I did my Ph.D. at the University of Aachen. I specialised in macroecology and studied the interactions of plants and their animal seed dispersers. After my Ph.D., I finished my academic life.

In 2000 I started to work as software developer. Gaining expertise in the field of software development and informatics, I applied the broad view of a macroecologist to computer systems and founded with a collaborator the knowledge base called *Clean Coding Cosmos*.

Having intensely worked on both biological and computer systems, I was able to learn the meaning of their similarities: information-processing. This experience inspired and enabled me to write this book.