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THE BIOLOGICAL PRINCIPLE OF NATURAL SCIENCES AND THE LOGOS OF LIFE OF NATURAL PHILOSOPHY: A COMPARISON AND THE PERSPECTIVES OF UNIFYING THE SCIENCE AND PHILOSOPHY OF LIFE

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Abstract: Acknowledging that Nature is one unified whole, we expect that physics and biology are intimately related. Keeping in mind that physics became an exact science with which we are already familiar with, while, apparently, we do not have at present a similar knowledge about biology, we consider how can we make useful the clarity of physics to shed light to biology. The next question will be what are the most basic categories of physics and biology. If we do not want to cut laws of Nature into different parts, we obtain a constraint, and the remaining part of physics will be the input data to the equations of physics. In these terms, our question will be: if we keep biological laws intact, as indivisible units, what remains in case of biology? This approach, just because it is more fundamental, has significant consequences for philosophy, and obviously offers a new conceptual framework considering the relation between the ontopoietic principle of Anna-Teresa Tymieniecka and the

biological principle. The quintessence of science, namely, the first essentially complete scientific world picture is presented in a detailed form.

Introduction

The aim of science is to understand, explain and predict the world of observable phenomena occuring in Nature; in its widest sense, to understand Man, Life and Nature in their full extension, depth and meaning, including the interrelations between Man, Life and the Universe.

In order to obtain well-founded, reliable knowledge, science requires a tool which gives a compact and transparent picture about the essence of our present knowledge, indicates which questions are interesting to consider and how to obtain well-founded knowledge. Such a tool is called as the „scientific world picture".[1] By the term „scientific world picture" we mean the *summarizing essence of all our scientific knowledge about the Universe in a compact, transparent, easy-to-use manner*, in a form which is able to yield ways of explanation and obtaining scientific knowledge. The scientific world picture is not only a map of the realm of Nature, enlisting what can be found there, but also a tool: a) by which we can orientate ourselves about the present state of our knowledge, b) which is able to tell us what are the important questions and c) which indicates how they might be answered. Certainly, among the ingredients of the scientific world picture must be: a) logic, b) the theory and methodology of explanation, and c) philosophy, answering such questions as „what is essence?" and „what is well-founded, reliable knowledge?" and „what is the scientific world picture"? Indeed, the scientific world picture must be in an important, explanatory sense „ultimate", because it cannot be based on something more simple or basic, since if it would, this latter one should serve as a better one. From our definition it is clear that such an inevitable tool of scientific research can be obtained only in an iterative process[2]. The scientific world picture can be regarded as the quintessence of science: the most perfect, simple, and elegant picture; the pure and concentrated essence of science.

The construction of a scientific world picture requires not only a deep understanding of Nature (in the widest sense), but also of science, and, especially, of scientific explanation. Nature is extraordinarily rich not only in the variety of phenomena, but also in its depth and meaning. Ultimately, Nature is one, it is in itself inseparable, we have to accept it as it is. Therefore, at its deepest level, which we call „core", Nature must be easily understandable, and so, the construction of a scientific world picture is possible, which is in itself an achievement. The recognition of the core of Nature makes it possible that through the scientific world picture we are able to see the picture of the core. The extraordinarily rich and deep nature of the Universe indicates that exploring its reality requires an extraordinary amount of attention, thoroughness, persistence, and devotion. We have always to keep in mind that the last word is not for us, picture builders, but for Nature, as it is.[3]

Of course, such a usage of the term „ scientific world picture" requires that it has to represent an essentially complete, self-consistent and unified system of theoretically conceivable and empirically testable, scientific framework of the Universe[4]. From here on, by the term „fundamental" we mean the ultimate explanatory level in the system of explanations; by the term „general" we mean the widest possible scope of a given field of knowledge at a given level. The fact that Nature at its phenomenal level shows a breath-taking width and variety, while at its core a similarly breath-taking simplicity and conceptual compactness, indicates that Nature has an „inverted cone" explanatory structure, namely, all the innumerable and diverse phenomena can be explained by a minimum number of deep concepts.
If we will be able to find the quintessence of science, the essentially complete scientific world picture, then we may become able to envisage Nature in a unified and scientific manner, and so it will become possible to draw the outlines of a new, Universal Natural Science. Now we can introduce the term Universal Natural Philosophy contemplating the fundamental level of that new science.

We arrived to the stage where we have to consider what do we mean on the terms „essential" (and, later on, „complete"). The question „what is essential?" is a key question of the scientific world picture, because it is absolutely basic to build a summarizing picture about the world. The difficulty is

that on its surface, Nature shows an unlimited variety. As we indicated above, simultaneously, at its core, Nature is one, undivided. It seems that it is the core what we must regard as the essence. In order to obtain a more concrete understanding of „essential", let us consider now how physics, the quintessential exact science makes this core of Nature explicit.

In physics, the „surface" of the realm of physics corresponds to observable phenomena, and „core" corresponds to physical laws. Starting with physical laws, the remaining part of Nature in physics is: data input that must be determined in advance; the input data give all necessary information about the physical system in its initial state. Input data can be obtained from observations of physical phenomena. Considering that phenomena occur occasionally, accidentally, while the physical laws are always the same; and, even more importantly, that one physical law can explain and predict an innumerable large number of phenomena, we can realize that the explanatory power (defined as the ratio of the number of explanandum to that of the explanant) of physical laws is practically infinite. The knowledge of one physical law is more valuable than the knowledge of an innumerable large number of occasional phenomena that are explained by the law. On that basis, we define 'essential' from the angle of explanation, by the following meaning:

A definition of essential: One can regard as 'essential' a thing if and only if it has a (practically) infinite explanatory power in a scientific theory.

The key importance of the concept „essential" is illustrated by the fact that it directs our attention to those laws of physics which have the highest explanatory power.

As a first consequence of our result, we are led to a new question: which physical law has the highest explanatory power? Generally it is not acknowledged that all the fundamental physical laws can be derived from one single principle, the least action principle (e.g. Heron of Alexandria; Fermat; Maupertuis; Euler; Hamilton; Feynman, 1942, 1994; Taylor, 2010). The least action principle is the principle that determines the trajectory of a physical object between a given initial and final state. The least action principle turns out to be universally applicable in physics. All physical theories established

since Newton can be derived from it. The action formulation is also elegantly concise. „The reader should understand that the entire physical world is described by one single action" (Zee, 1986, 109). Therefore, we can introduce a specific meaning to the term 'first principle'.

Definition of first principle: A fundamental law can be regarded as a "first principle" if and only if all of the fundamental laws of the given branch of science can be derived from it.

Due to our definition of 'essential', we were able to recognize that in all physics, the most essential physical law is the first principle of physics. This recognition can make physics extremely transparent for scientists and philosophers, and makes it ideally suited as a pillar of the scientific world picture. Moreover, the insight given by physics, namely, that the world can be divided into three levels of reality, a) the level of phenomena, b) laws and c) first principles, is ideally suited to the purpose to construct an essentially complete scientific world picture, because the number of first principles must be small. If all physics can be derived from the physical principle (a shorter expression for the first principle of physics), then all what remains in order to obtain the essentially complete scientific world picture is to find the first principles of fundamental natural sciences. Regarding that physics considers the realm of 'inanimate' world, we consider that the second fundamental natural science is biology[6].

At present, it seems that nobody knows the equivalent in biology of Newton's laws. In order to obtain a scientific world picture, we have to generalize our present picture about biology, and use the term 'biology' in a new sense, including not only the presently popular form of it, but the Bauerian 'theoretical biology', which gives the most general laws of living organisms. This use of the term 'biology' will give it a status that is similar to that of physics. Theoretical physics worked out its fundamental laws and first principle, which is the least action principle (Taylor, 2003; Moore, 2004). The Bauerian theoretical biology already worked out its first principle, which is known as the Bauer-principle (Bauer, 1967) which is shown to be equivalent to the greatest action principle (Grandpierre, 2007). The universal law of biology, the Bauer principle tells that: "A system is living if and only if it invests work from the budget of its free energy initiated by itself against the equilibrium which should

occur according to the physical and physico-chemical laws given the initial conditions of the system" (Bauer, 1967, 51). We can re-formulate it in other words: living systems manifest continuously maximal mobilization of their free energy against inertness. The Bauerian theoretical biology concentrates on the fundamental law of biology and, because of that, it underlies all specific sub-branches of biology that are intensively investigated today.

The next question arises: Are there any other fundamental natural sciences, besides physics and biology? As I indicated in the Introduction, the deepest questions of existence are threefold, questioning the Universe, life, and self-consciousness. From that it follows that the third fundamental natural science should the study of self-consciousness[7]. If we regard that psychology is the science of human psyche, and that the most characteristic property of human psyche is self-consciousness, we are led to the idea that the science of self-consciousness will be psychology. Of course, this interpretation present psychology as a science from a new angle, indicating a new direction for the future development of psychology, in which it can find its first principle also in a mathematical form. If the above three are the three fundamental questions, than these three must be the three fundamental sciences. This is an important point, because we wanted to outline the basis of an exact and essentially complete scientific world picture. If the ultimate first principles are those of physics, biology and psychology, then these first principles can be regarded as 'ontological principles' - as such they have a special significance for philosophy which is the study of the most general aspects of reality.

This new scientific world picture, as a side-effect, unites the four different views of metaphysics[8]. Now we can conceive the idea of a new, universal natural philosophy studying the most fundamental aspects of the universal natural science.

An important objection against recognizing the fundamental significance of the physical principle

Actually, the principle of least action currently attracts little attention among philosophers (Stöltzner, 2003), despite the fact that it underlies everything in the realm of physics. I think this is because the role

that the principle of least action has been played in physics and philosophy is still highly controversial. On the one hand, the principle reflects a so-called “apparent” economy or teleology, which most physicists presume to be alien to their branch of science. Yet, as I indicated, we must be aware of the fact that the last word belongs always to Nature. Actually, teleology is defined in the Encyclopedia Britannica as “explanation by reference to some purpose or end”. Definitely, the least action principle is based on a relation between some initial and final state; therefore, reference to some end — i.e. to a subsequent physical state — is already explicit. Therefore, when we explain with the least action principle all physical phenomena, the explanation always refers to a final state, and so it is inevitably teleological, because that is what teleology is. It is another point that physical teleology is different from biological or human teleology, which admits purposeful behavior, too. In biological and human teleology there is an evidence of motivation that is obscured in physical teleology and replaced by an apparent mechanical teleology. Central to this controversy is the attempt to avoid any questions around the concept that Nature might use means to an end.

We illustrate the resistance against acknowledging the significance of the action principle by a quotation from James Woodward (2009): „For example, the mere fact that we can describe both the behavior of a system of gravitating masses and the operation of an electric circuit by means of Lagrange's equations does not mean that we have achieved a common explanation of the behavior of both or that we have “unified” gravitation and electricity in any physically interesting sense.” In contrast, we note that the physical principle is a relation between fundamental physical quantities. Physical laws express relations between observable physical quantities, while mathematical laws express a relation between mathematical quantities. Physical laws therefore can be tested by empirical observations, which is not the case for mathematical laws. If the observationally confirmed relation has a lawful character, it has an importance in a physically interesting sense. If the observationally confirmed physical relation expresses a law serving as the basis from which all the fundamental physical laws can be derived, it has a primary significance for physics as well as for the philosophy of science.

One of the two basic requirements of a law of physics is that it has to be mathematically formulated. The other is that it refers to entities existing in Nature. Physical reality is based on two pillars: one is observational testability, and the other is its spatio-temporally detailed character that can be described by mathematically formulated physical laws.

As Carl Hempel (1966, 71-72) formulated: „Newton's theory includes specific assumptions, expressed in the law of gravitation and the laws of motion, which determine a) what gravitational forces each of a set of physical bodies of given masses and positions will exert upon the others, and b) what changes in their velocities and, consequently, in their locations will be brought about by these forces. It is this characteristic that gives the theory its power to explain previously observed uniformities and also to yield predictions and retrodictions." These two pillars appear in the practice of the physicists in the form of input data (a necessary minimum set of physical parameters of the initial state) for the equations of physics, and, on the other hand, in the form of the equations of physics. Moreover, Hempel adds: „A good theory will deepen as well as broaden that understanding. First, such a theory offers a systematically unified account of diverse phenomena." (ibid., p. 75). On that firm basis, we can draw the conjecture that the unification offered by the least action principle, since it is not only observationally testable, but is also fitting all observations, and is mathematically formulated in spatio-temporal details, therefore, in contrast to Woodward's opinion, has a primary importance for natural science and for the philosophy of natural science as well.

Yet the point raised by Woodward remains: we have to find the physical importance of the mathematical unification expressed by the Lagrange equations. First we point out that the unification by the Euler-Lagrange equations does not extend merely to gravitation and electricity, but also to mechanics, thermodynamics, and quantum physics, actually, to all the fundamental equations of physics. Second, the Euler-Lagrange equations represent only an intermediary step between the integral form of the least action principle and its applications. The real power of the action principle relies in its integral form. The Euler-Lagrange equations in general contain the Lagrange function; its application in

gravitation, electricity or any branches of physics requires the specification of the interactions present in the given type of physical process that the physicist considers. Woodward is right in pointing out that the specific form of the Lagrange function has an important physical meaning, but lacks scientific basis when, implicitly, claiming that there is no physics beyond the special forms of physical interactions. The Euler-Lagrange equations in their general, unspecified form still express that all the fundamental laws of physics are equations of change that can be described by second order differential equations. We point out that, for instance, the integral form of the action principle represents an additional, physically important meaning, expressing the very economical aspect of the least action principle. Indeed, this integral aspect explains the „sum over all possible paths", which is so important at Feynman's path integral interpretation of the action principle (Feynman, 1942, 1965). Actually, the „summing up" of quantum probability amplitudes is the result of the integral operation, represented by the integral form of the action principle. All types of interactions are based on that concrete physical "mechanism" indicated by Feynman: all quanta, independently from the type of interaction, acts through summing up all possible paths. This summing up seems to be mechanical, yet we point out that it requires explanation. It is a strange ability from a quantum, regarded as being absolutely inanimate, to behave mathematically, sum up anything, and solve mathematical equations in order to reach one point from another. How do they "perceive", how do they behave "as if" they "know" that they have to sum up anything, and how are they able to do that according to the least action principle? By our opinion, these fundamental problems transcend beyond the superficial, mechanical framework of present-day physics. Anyhow, this concrete physical "mechanism", quantum exploration through the spontaneous emission of virtual particles to all possible paths, and their summing up, attaches a concrete physical meaning to the least action principle and to the unification it suggests, even implies.

The essentially complete picture of the structure of the Universe

Regarding Nature from these deepest aspects of physics the universal natural philosophy considers that physical reality consists from three basic ingredients: a) concrete 'things', represented by the input data, and, b) at a deeper level of reality, from physical laws, represented by the fundamental equations of physics, and, c) at the fundamental level of physical reality, from the least action principle. Therefore, the first significant achievement of the universal natural philosophy is that it succeeded to obtain the first essentially complete scientific world picture, which is the following.

The Universe has a primary fundamental hierarchy: a three-leveled structure of the Universe, apparently, not recognized until now. The three levels of reality are: a) phenomena, b) laws of Nature, and c) first principles of Nature. The secondary fundamental structure of the Universe is its division into a) physics, b) biology and c) psychology, which are all interrelated. This secondary fundamental structure is categorized by the character of the observable behavior, or, equivalently, by the first principles, or by the ultimate constitutive elements: a) atom, b) feeling, c) thought, or a) matter, b) life, and c) self-consciousness. Since there are no more first principles, the picture is essentially complete. One last question is: is it possible to go beyond the first principles, and find a still deeper principle, the very first principle of the Universe? We think the correct answer is yes. The physical principle can be regarded as the special case of the biological principle in case when the freedom of selection of the endpoint shrinks to zero. Moreover, regarding that the relation between consciousness in general and self-consciousness is the relation between the general and the special case, self-consciousness is the special case of consciousness, and, therefore, the psychological principle is another special case of the biological principle. This means that the three principle is united in one, in the biological principle: we have a Trinity, in which the middle of the horizontally conceived triad is also the vertical element, the ultimately unifying principle, the principle of the One, which is, strangely, again the biological principle. Therefore, the picture is indeed essentially complete, no essential element is left out from it. We found two Triads: phenomena, laws, and first principles, versus physics, biology and psychology.

From this overall picture about the architecture of the Universe the present scientific world picture accepts only the physical realm. The main reason for it is that at present physics is the only exact natural science. We think that the first big question of the 21st century is how to make biology into a science similarly exact to physics. Our answer is outlined below.

Biology, the science of the 21st century, in a new light

"In the twenty-first century more and more biological data are accumulated. In the absence of a general theoretical biology, there is an increasing frustration between millions of biologists" (Brent and Bruck, 2006, 416). Recently, following the groundbreaking work of Ervin Bauer (1967), who was the first to discover the biological principle and to work out the scientific basis of exact theoretical biology, we developed theoretical biology from the approach requiring it to be as close to theoretical physics as possible. We recognized that the minimal extension of physics into biology is possible by generalizing the least action principle, allowing the selection of the endpoint of its integral in accordance with the greatest action principle (Grandpierre, 2007).[9] The difference between biological and physical behavior can be illustrated with the example of a fallen bird from the Pisa tower. If the bird is dead, its trajectory will be similar to that of all physical objects: a straight line vertically to the ground; the dead bird follows the law of free fall. Yet if the bird is living, its trajectory will be characteristically different. In the simplest case, when there are no any disturbing circumstances like a hawk around, the bird will follow a trajectory that allows it to regain its height above the ground within a suitably short time with the minimum effort.

This approach will ensure that the generalized physical principle becomes suitable to grasp the teleology so eminent in biology[10]. Indeed, teleology is the most characteristic aspect of biological functions and biological behavior. While in physics falling bodies as well as light travels on the shortest routes between their initial and end states, living organisms select the endpoint of their activities according to the greatest action principle. Action is a basic quantity having a dimension (energy)$*$(time),

integrated for the given process between the final and initial states. Illustrating the greatest action principle we note that all living organisms tend to live as long as possible (maximizing the second term in the product (energy)$*$(time), and, in the meantime, to increase their vitality of quality of life (which, in a physical language, can be measured in terms of their free energy, therefore, maximizing the first term of the product (energy)$*$(time), and so, maximizing the product yielding the action in the period of their lifetime[11]. This example illustrates that living organisms, since behaving on the basis of the greatest action principle, cannot be governed by the least action principle. Indeed, since the greatest action principle of biology is an extension of the least action principle, it cannot be reduced into the physical principle; biology must be an autonomous science. Biological entities make use of the least action principle as a means to biological ends. Therefore, it is the primary task of science and philosophy to realize the importance of the Bauerian theoretical biology, and work out theoretical biology according to its actual weight in the new, essentially complete scientific world picture.

About the relation between biology and physics

Now if biology is not reducible to physics, then how can we conceive the fact that physical laws apply to all living organisms? How is it possible that the gross behavior of living organisms occurs accordingly to a different, biological principle, if physical laws apply to them? The paradox can be avoided if we allow that the initial conditions, which are the input data in physics, in case of biology have a further "degree of freedom": they can vary in time in a suitable manner to result in biological behavior when as input data are attached to the physical laws.

The situation is the following. Biological behavior can be described, equivalently, in two different languages. One is in the language of biology. It tells that biological behavior is governed by the biological principle. The other is in the language of physics. It tells that the observed biological behavior is the result of physical laws, admitting that the input data of the physical laws is variable in such way that it results in the observed biological behavior. The only question that remains in this second case:

what causes the input data to vary in a way that is unpredictable on the basis of physical laws? We are led to the fundamental problem of control theory: to govern a cybernetic system's input in a suitable way to produce a given or prescribed output. Control theory considers problems like how to construct a rocket in order to make it able to follow an airplane governed by a human. In order to achieve that feat, control theory works with an additional free variable with values that correspond to the decisions of the agent. Certainly, if we allow that the input data are continuously injected into the equations of physics in a suitable manner to result in the prescribed biological behavior (for example, when you are thirsty and go for drink, you navigate yourself using many feedback processes), biology arises as the control theory of physics.

We found that we are living in a living Universe, which we distinguish from the physical universe with the capital letter. Yet, at the same time, it seems that life, as we know it, is rare or unique. Yet life should not be protein-based, since plasma life forms are also possible (Grandpierre, 2008a). Indeed, if we look after life forms with the help of the exact criteria of life given by Bauer (above), then it is possible to see that even apparently inanimate matter can carry hidden, transient life forms on extremely long or short time scales. Indeed, absolutely sterile inanimateness seems to be a mere abstraction from the actual reality present in Nature. The Universe can be full with an extreme variety of cosmic life forms (Grandpierre, 2008a). If so, life can be literally more widespread than exactly inanimate matter.

In this way, surprisingly, one can recognize that the three first principles we found plays a similar role to the ancient Chaldean first principles of (material) existence, life (or power) and Act (Majercik, 2001); the primordial first principle Ilu (the One or the Good), unites three first principles, his three first manifestations: Anu (time, the universe, or matter), Hea (reason and life) and Bel (the creator, the governor of the organized universe; Lenormant, 1999, 114). Moreover, the first principles of matter, life and self-consciousness were also recognized in ancient China (e.g., the jing, the material principle, chi, the life principle, and shen, the principle of spirit; see e.g. Beinfield and Korngold, 1991). In ancient

Hindu philosophy, a similar trinity is known under the term “three gunas” (the sattva, the quality of spirit; the rajas, the quality of life, and tamas, the quality of matter; Bhagavad Gita, Chap. 7, verses 12-14).

Biological principle, logic and logos of life

My point is that the universal natural philosophy promises clearer understanding of the nature of logic, logos, and the “logos of life”, proposed by Tymieniecka. Logic is frequently equated with Aristotelian logic: the laws of logic are applied to the premise in order to obtain the logical conclusion. We point out that this approach shows a remarkable similarity to the approach of physics, in which the equations of physics are applied to input data. Machines work in a similar manner. We insert a coin, and the result comes out at the output; push a button, and the Mars bar appears. Machines are working mechanically, step-by step, linearly in an immutable order. On that basis, we can classify Aristotelian logic as mechanical. Now if biology is the control theory of physics, generalizing the input data, and injecting further input into the equations of physics during the process, than the following interesting idea surfaces: is it possible to generalize mechanical logic in the same sense which makes biology the control theory of physics? We think that the answer is: yes, and the generalized form of mechanical logic is nothing else but the logos of the ancient Greeks.

In order to proceed, we have to prepare the stage, at first we have to consider the following questions: What is the difference between mathematical and physical laws? “What is it that breathes fire into the equations and makes a universe for them to describe?” (Hawking, 1988, 174) We consider here that the essential difference between mathematical and physical laws is that mathematical laws represent lawful relations between abstract, mathematical properties, while physical laws represent lawful relations between observable, physical properties. The relation between the equations of physics and the physical laws is that the former exist in our mind, while the latter in Nature. In other words, the difference between physical equations and laws is that of map and territory.

All empirical sciences are built on the concept of "fact". Facts, in contrast of non-facts, are manifestations of some existent entities. Therefore, it is necessary to discern correctly "facts" from things that are not facts. There are some universal criteria for that, like the criteria of consistency. When we consider whether a thing is a fact or not, we know a priori that a fact cannot contradict to the existence of other facts. Another criterion is systematic and universal confirmation or validation by observations as well as by theoretical knowledge. In order to illustrate the importance of theoretical knowledge in evaluating what counts as 'fact' and what not, we note that e.g. the life principle is not yet accepted in science. The reason to reject it is not its immaterial nature, since all laws of Nature are immaterial. Yet, as Hempel (1966, 72) pointed out, the assumptions made by a scientific theory about underlying processes must be definite enough to permit the derivation of specific implications concerning the phenomena that the theory is to explain. The doctrine about the life principle (Hempel, apparently, does not know Bauer's work; he refers to the ancient idea of „entelechy") fails on this account. It does not indicate under what circumstances the life principle will go into action and, specifically, in what way it will direct biological processes. This inadequacy of the life principle doctrine does not stem from the circumstance that the life principle is conceived as nonmaterial agency which cannot be seen or felt. This becomes clear when we contrast it with the explanation of the regularities of planetary and lunar motions by means of the Newtonian theory. Both accounts invoke nonmaterial agencies: one of them vital „forces", the other, gravitational ones. But Newton's theory includes specific assumptions, expressed in the law of gravitation and the laws of motion, which determine (a) what gravitational forces each of a set of physical bodies of given masses and positions will exert upon the others, and (b) what changes in their velocities and, consequently, in their locations will be brought about by these forces. It is this characteristic that gives the theory its power to explain previously observed uniformities and also to yield predictions and retrodictions. Thus, the theory was used by Halley to predict that a comet he had observed in 1682 would return in 1759, and to identify it

retrodictively (Hempel, 1966, 72). On that basis, we can deduce that gravity has a factual existence, its existence is a fact.

I point out that if theoretical biology can be formulated also in a mathematical form, and if it will be confirmed by all available empirical evidences, and capable of predicting yet unexplained phenomena, then, if applying the same kind of considerations as accepted in the case of theoretical physics, theoretical biology has to become an established science. This means that although we all experience the evidently observable facts that the behavior of living organisms is fundamentally different from that of physical objects, at present science does not accept the life principle just because it seems for most scientists and philosophers, including Hempel, that we do not know it in such an exact and empirically testable mathematical form as we know the laws of physics. I point out that the role of our – frequently incomplete - theoretical knowledge is many times decisive in our judgments about what we count as "fact" and what not. It is clear that Hempel did not know the work of Ervin Bauer, because for the Bauer-principle of life all the criteria he presented fulfils. It is clear that such a life principle should be accepted in science since it is not only known in a mathematical and testable form, but is consistent with all observations. In that case, the existence of the life principle must be regarded as a fact.

Logic is the basis and partner of laws of Nature

From this point onward I want to regard logic in a wider sense, including not just only human logic. I mean that human logic is only an aspect of "natural logic" that belongs to the core of Nature. Natural logic acts on natural processes. Similarly to our human logic, which determines the right inferences, natural logic determines what will occur in Nature. Now because we defined Nature as the self-consistent system of relations with observable phenomena, therefore natural logic must contain the rules by which the future events can be realized and built up into the self-consistent body of Nature. Among others, natural logic has two basic functions: it generates the possibilities and it selects from these

possibilities the ones that are consistent with the whole body of Nature and the given situation in a way that its realization can be regarded as optimal on the basis of the first principles. Therefore, natural logic is in the following intimate relation with physical laws: it generates the possibilities of the world process, and selects from them the ones that can be realized by the physical laws, and so the function of physical laws is to realize them, i.e. attach the suitable physical properties to these possibilities selected by natural logic. The consequence of that is that physical laws cannot function separately from natural logic. Natural logic is the basis and a partner of physical laws. That part of natural logic, which generates the physical possibilities, will be termed as physical logic.

It becomes clear that it is natural logic that prepares the ground for establishing the relations (like physical laws) between such specific entities as the physical properties. Or, to put it differently, natural logic belongs to the physical laws. Regarding that human logic is suitable to reveal the conditions of truth, and put severe constraints on what can be realized and what not, assuming a parallelism between human and natural logic we can conceive natural logic as a basis and partner of the laws of Nature working out the conditions of realization of natural processes. We can conceive "physical logic" as working out the preconditions of realization of physical processes. In other words, "physical logic" (i.e. the logical aspect of the inseparable logic-physical law organic unit) can be regarded as the very basis of physical reality.

Mechanical logic and biological logic

In general, one can distinguish three versions of logic that correspond to the three fundamental natural sciences: the physical, the biological and the psychological. Since biological logic acts in Nature, it can act within our organisms, as we are members of the biological species Homo Sapiens, a part of Nature; therefore, biological logic can be present within us and shape our internal mental processes, so it can work in the process of our thinking. In this way, it can modify, if it is necessary, continuously the input conditions of mechanical logic, in co-operation with the biological principle. Moreover, the co-operation

of natural logic and the laws of Nature that is responsible for the generation of Homo Sapiens, including self-consciousness, that is, psychological logic and the psychological principle, is responsible for the generation of human logic as a phenomenon of Nature, as a phenomenon of self-consciousness. Therefore, physical, biological and psychological logic acting in Nature can be regarded as the physical-biological-psychological basis of our human logic. Our result is that human logic is driven not only by the autonomous part of self-consciousness, but also by a natural "force": by natural logic and the laws of Nature.

We note that the riddle of creativity presents a paradox at the level of mechanical logic, since mechanical logic is programmable into a software of a computer, it represents only the surface of our knowledge. Actually, since self-consciousness is ultimately a natural phenomenon, there is a parallelism between natural and human logic. Therefore, in many cases it is not necessary to distinguish them when speaking about "logic", at least in cases when what we say can refer to both context, the natural and the human as well. From now onwards, when we do not indicate about which logic are we speaking, the sentence can refer to both cases, either to the natural or to the human logic, or both.

Since mechanical logic works mechanically, it does not have a room for creativity. Although mechanical logic, like software programs, represents algorithmic complexity (Grandpierre, 2008a), and so it is suitable to solve physical problems, it is not deep enough in order to account about creativity. We can realize that creativity must correspond to a deeper level of reality. Since the principle of creativity must be also consistent with the laws of logic, therefore this "creativity principle" represents the logic of reality in a fuller sense than the physical laws and mechanical logic. Therefore, it is useful to distinguish this more general creativity principle of logic from the usual term denoted by "logic" (which refers usually to mechanical logic).

We think that the most suitable term for this deeper creative logical principle is "logos". Since we can regard that such creative principles like logos exist at a deeper level of reality than laws, we can regard that logos is the creative source of logic. Now since logos can be regarded as universally valid, it

can be conceived as the basis and partner of the laws of Nature; therefore, we propose to consider it as the common basis and partner of the physical, biological and psychological laws.

Actually, the self-renewing logic that can recharge its input in the process is not mechanical; it can be conceived that self-renewing logic stands in a similar relation to mechanical logic as biology with physics. The creativity principle is what governs the renewal of logic within the continuously changing inner and outer conditions. The deepest level of logic can be conceived as being the creative logic.

We can consider that logos, in a narrow sense, can be identified with creative logic, or, in a wider sense, we can select the option to regard logos as logic in its dynamic, vital, organic fullness, the organic unit of creative, self-renewing and mechanical logic. We will refer to the former with the term 'creative logos', and to the latter simply as 'logos'. Therefore, we propose to regard logos as extending from the creative, principal level of reality, through the level of laws of Nature, until the phenomenal level. At the level of laws logos has three versions: physical (or mechanical, formal), biological and psychological (or self-conscious) logos. At the phenomenal level logos is not creative and is not problem-solving, but simply perceptive, self-consistently and consistently with all the deeper levels of logos (we can refer to this kind of phenomenal logos with the term perceptive logos).

Animating principle

The origin of the animating principle goes back to prehistoric animism, frequently regarded as the first religion or wisdom of mankind (Kirk, Raven és Schofield, 1998, 154). Heraclitus (ca. 535-475 B.C.) considered that "the Logos is a component of all existing thing, yet has a single collective being: it is a component of order or structure or arrangement, not the whole of an object's structure or shape but that part of it which connects it with everything else. Since there is one common rule or law which underlies the behavior (ginestai) of all things, then men are subject to this law and, if they want to live effectively, must follow it (Kirk, 1975, 58). This ancient idea fits well to our proposal about the existence of natural logic. It became a familiar saying, frequently attributed to Einstein: „The most incomprehensible thing

about the world is that it is comprehensible." The solution of this problem is not complicated: the world is comprehensible because we are a part of Nature, and so the universal laws of Nature are present also in our organism.

Recently, Anna-Teresa Tymieniecka (2010/11) developed a remarkable system of idea about the „ontopoietic principle", which is also called as the „logos of life" (Tymieniecka, 2009). The first naming seems to indicate an ontological principle characterized by its creativity (poiesis). The latter term indicates the twofold character of the „logos of life", being reasonful and playing the role of the life principle. She claims that the root of the logos is in its creative imaginative metamorphosis (Tymieniecka, 2010/11, p. 12). This fits our view to regard logos as including its deepest level ingredient, the creative principle, yet including something more as well, namely, in our picture it includes physical, biological, psychological, mechanical and perceptual logic. She considers that the living agent's experience advances along the steps of the logos following its constructive devices from one step to the next, timing their deployment according to its constructive completion, that these processes reach the point of tying the knot in a synthesizing objectifying act of the logos. (ibid., 18). Another remarkable and detailed agreement between our results corresponds to the question what is the relation of human logic, natural logic and the ontological principles. Tymieniecka points out that „The cognitive/conscious constitution of objectivity is convertible with the natural functional root of existential generation. In fact, these movements are inseparable, even if in abstraction they are distinct." (ibid., 19-20) We find here again a surprisingly detailed agreement with our picture. Tymieniecka speaks about the natural functional root of existential generation, which in our terms is natural logic, or natural logos. She found that the cognitive/conscious constitution of objectivity is convertible with this natural entity. This is interpreted in our framework as the psychological (self-conscious) aspect of the natural logic acting in Nature is convertible with the joint working of the natural logic, co-operating with the first principles of Nature, with the ontological principles of physics, biology and psychology. This

means that Tymieniecka found that the logos and laws of Nature are acting in co-operation. As we found, logos is the basis and partner of the laws of Nature.

Tymieniecka (2010/11, 23-24) writes: „the logos of life in its intrinsic metamorphosis during the evolutionary course of the individualizing genesis of beingness unfolds numerous modalities that reach realms beyond those geared to survival and which culminate in the full-fledged unfolding of the human creative virtualities." This translates in our picture into the indication that the first principle of biology acts on the same manner as the least action principle of physics, by virtual particles that are suitable to map instantaneously the whole of the Universe (because they exist not in the usual 3+1 dimensional space-time, but in the infinite dimensional Hilbert space, see Grandpierre, 2007), securing a kind of instantaneous „primary perception" (Grandpierre, 1997). Tymieniecka adds that „Having reached beyond the existential/evolutionary parameters of vitally significant (survival-oriented) horizons to the spheres of communal/societal life, the creative logos now throws up spiritual and, lastly, sacral horizons of experience that actually surpass the now narrow confines of the existential horizon." All these findings of Tymieniecka nicely fits with our indications telling that the biological principle is the „greatest action principle" (in terms of physical properties), or, more suitably, the „greatest happiness principle" (Grandpierre, 2010/11), in terms of biological properties. From our formulation of the greatest happiness principle (Grandpierre, 2007, 2010/11) it is clear that the greatest happiness principle has an integral character, summing up happiness for our lifetime, therefore it has two basic ingredients, one is lifetime, the other is life's quality or happiness. This latter factor is the one that point out beyond survival, towards communal/societal life, throwing up spiritual and sacral horizons.

In summarizing our comparison of the biological principle and Tymieniecka's logos of life, we found that both have a twofold nature, conceived as consisting from two basic constituents, a) logos, having a metaphysical status, preparing the conditions for the activity of the first principles of Nature, being the basis for the actions of laws of Nature, and b) the first principle of life or the "natural law" aspect of the "logos of life", having an ontological status and belonging to the natural sciences. Both our

results and of Tymieniecka's indicate that these two factors, logos and the ontological principle, are in actual reality inseparable, they are partners of each other, co-operate in their activity. In other words, we can say that the biological principle has a basic logical or logoic character, or that the "logos of life" can be identified with the biological principle.

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Notes

1) I prefer to use the term scientific „world picture" instead of „world view" because I want to arrive to a picture that we can agree on, even when using different views. I regard worldview as the world picture plus the factors arising from our personal angle.

2) In a process that repeats itself in a loop-like manner until it distils to the most concentrated and clear form.

3) The picture is always less detailed than Nature itself.

4) At some point, astronomy must come into the picture. Since the basis of the world picture is the Universe, it must give a scientific picture about the world in its entirety, therefore you cannot omit astronomy.

5) The fundamental laws in physics, namely, that of classical mechanics, electromagnetism, thermodynamics, theory of gravitation, and quantum physics, including quantum field theories and

string theory. In classical mechanics, the Euler-Lagrange equations, in electromagnetism, the Maxwell equations, the second law of thermodynamics, the Schrödinger-equation of quantum mechanics etc.

6) At present, biology, the science of life, is widely conceived in a restricted manner. 7) The question of self-consciousness can only be dealt with after the question of biology, which we are discussing in this paper, is solved.

8) According to Encyclopedia Britannica, these four views present metaphysics as: (1) an inquiry into what exists, or what really exists; (2) the science of reality, as opposed to appearance; (3) the study of the world as a whole; (4) a theory of first principles.

9) The integral refers to a sum total between the initial and final states. In the following example the sum total is of the quantity of „action", which arises if you add up all the energy invested in each of the time intervals of the flight, multiplied with the length of each corresponding individual time interval.

10) Biological teleology is a teleology of consciousness, so it can be different from human teleology which can be a self-conscious teleology, too. We do not have to underestimate consciousness, which in many cases can be much more efficient than the self-consciously controlled and narrowed self-consciousness.

11) The first thing we as humans would automatically opt for is to prolong our lives; but we do also take the quality of that life into consideration. Quantity (length) is then also a function of quality (happiness, energy, vitality).

References

Bauer, E. 1935/1967, *Theoretical Biology* (1935: in Russian; 1967: in Hungarian) Akadémiai Kiadó, Budapest, 51.

Beinfield, H. and Korngold, E. 1991, *Between Heaven and Earth: A Guide to Chinese Medicine,* Ballantine Books, 1991.

Brent, R. and Bruck, J. 2006, Can computers help to explain biology? Nature 440, 416-417.

Feynman, R. P. 1942, The Principle of Least Action in Quantum Mechanics, Ph. D. Thesis. Princeton University. Source: Dissertation Abstracts International, Volume: 12-03, page: 0320.

Feynman, R. P. and Hibbs, A. R. 1965, *Quantum Mechanics and Path Integrals.* McGraw-Hill, New York.

Feynman, R. P.: 1994, *The Character of Physical Law*. (Random House, Inc., New York, Chapter 4, pp. 97-100)

Grandpierre, A. 1997, The Physics of Collective Consciousness, World Futures, **48:** 23-56.

Grandpierre A. 2007, Biological Extension of the Action Principle: Endpoint Determination beyond the Quantum Level and the Ultimate Physical Roots of Consciousness, *Neuroquantology*, Vol. 5 (4), 346-362, http://arxiv.org/abs/0802.0601

Grandpierre, A. 2008a, Cosmic Life Forms. In: From Fossils to Astrobiology. Records of Life on Earth and the search for Extraterrestrial Biosignatures, Seckbach, J. Walsh, M. (Eds.) 369-385. http://www.springerlink.com/content/qh5r5664348n0032/

Grandpierre, A. 2008b, Fundamental complexity measures of life. In: Seckbach, J. & R. Gordon, *Divine Action and Natural Selection: Questions of Science and Faith in Biological Evolution*, Singapore: World Scientific, 566 - 615; http://www.worldscibooks.com/lifesci/6998.html, http://www.konkoly.hu/staff/grandpierre/Complex.htm.

Grandpierre, A. 2010/11, On the first principle of biology and the foundation of the universal science. In: Astronomy and Civilization in the New Enlightement, Budapest, August 10-13, 2009, Tymieniecka, A.-T. and Grandpierre, A. Analecta Husserliana, Vol. 107, Springer (in print).

Hawking, S. 1988, A Brief History of Time. Bantam, New York, 174.

Hempel, C. G. 1966, Philosophy of Natural Science. Prentice-Hall Inc., Englewood Cliffs, N. J., 70-72.

Kirk, G. S. and Raven, J. E. 1971, The presocratic philosophers. Cambridge University Press. London.

Kirk, G. S. 1975, Heraclitus: The Cosmic Fragments, 1971, Syndies of Cambridge University Press. London.

Lenormant, F. 1877/1999, Chaldean Magic. Its Origin and Development. Samuel Weiser, Inc. York Beach, USA, 114.

Majercik, R. 2001, Chaldean Triads in Neoplatonic Exegesis: Some Reconsiderations. The Classical Quarterly, New Series, Vol. 51, 265-296.

Moore, T. A. 2004, Getting the most action out of least action: A proposal. *American Journal of Physics,* 72, 522–527

Stöltzner, M. 2003, The Principle of Least Action as the Logical Empiricist's Shibboleth, *Studies in History and Philosophy of Modern Physics*, 34, 285-318.

Taylor, E. F. 2003, *A call to action*. Guest Editorial. American Journal of Physics, 71: 423-425.

Taylor, E. F. 2010, *Principle of Least Action*, http://www.eftaylor.com/leastaction.html

Tymieniecka, A.-T. 2009, The Fullness of Logos in the Key of Life, Anal. Huss. 100.

Tymieniecka, A.-T. 2010/11, The New Enlightement: Cosmo-Transcendental Positioning of the Living Being in the Universe. In: Astronomy and Civilization in the New Enlightement, Budapest, August 10-13, 2009, Tymieniecka, A.-T. and Grandpierre, A. Analecta Husserliana, Vol. 107, Springer (in print).

Woodward, J. 2009, Scientific Explanation, in: Stanford Encyclopedia of Philosophy, http://plato.stanford.edu/entries/scientific-explanation/

Zee, A. 1986, *Fearful Symmetry. The Search for Beauty in Modern Physics*. Macmillan Publ. Co., New York, 107-109, 143.

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